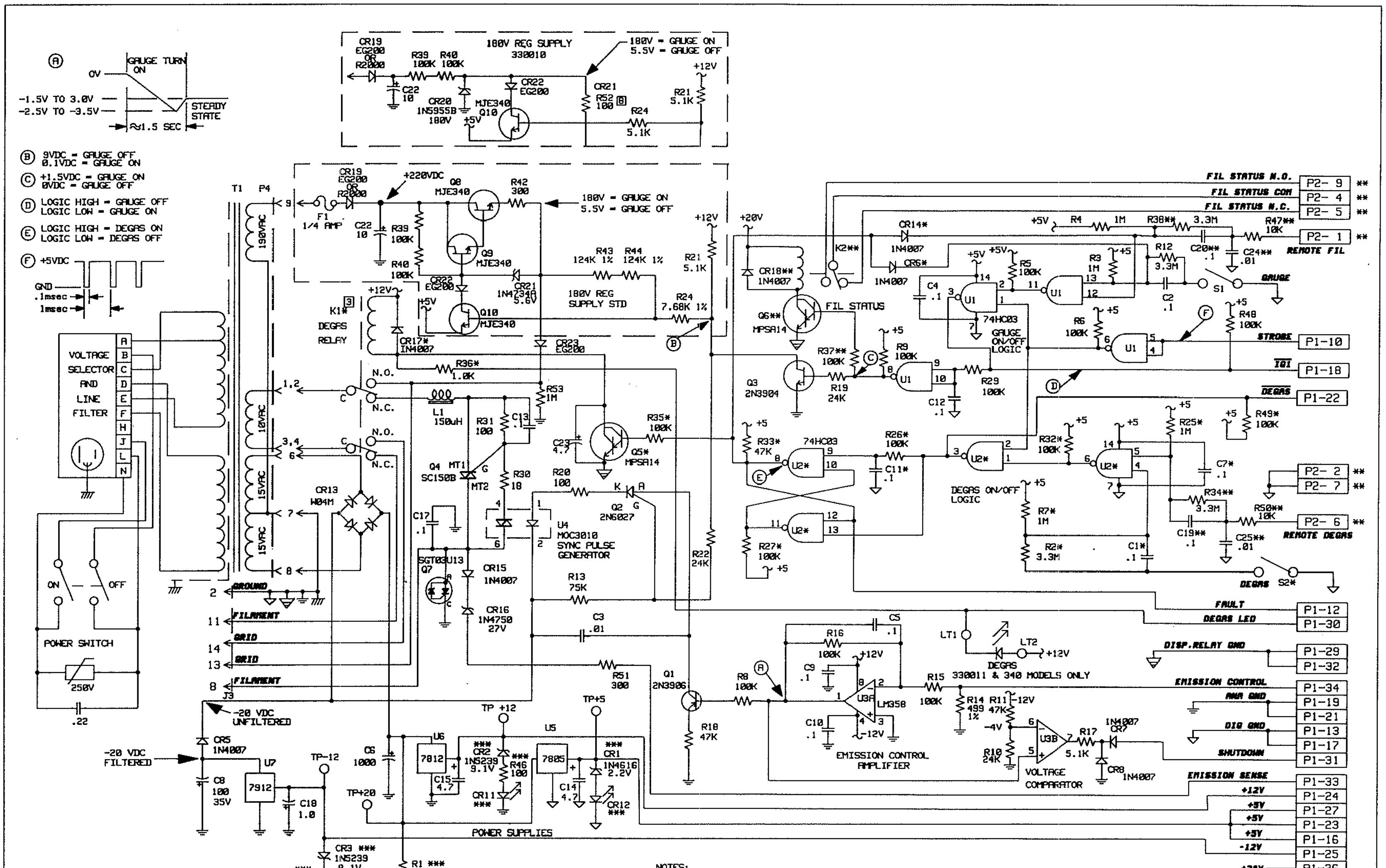
SERIES 340

VACUUM GAUGE

CONTROLLER

INSTRUCTION MANUAL

GRANVILLE-PHILLIPS



NOTES:

1. ALL CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE NOTED.
2. ALL RESISTOR VALUES ARE 5%, 1/4 WATT IN OHMS UNLESS OTHERWISE NOTED.
3. JUMPER K1 N.C. TO COMMON IF DEGAS OPTION IS NOT INSTALLED, 2X.
4. * DENOTES COMPONENTS INSTALLED FOR DEGAS OPTION.
5. ** DENOTES COMPONENTS INSTALLED FOR REMOTE I/O OPTION.
6. *** DENOTES COMPONENTS NOT USED IN 330010
7. LAST REFERENCE DESIGNATORS USED: CR21, C25, R52, Q10, U7
[B] INSTALL R52 IN PLACE OF CR21 FOR 330010.

FILED IN THE CAD AS EDIT /330/SC/9601100S; SHO -E50 -E51

GRANVILLE- PHILLIPS			BOULDER COLORADO
SCALE:	DATE	UNLESS SPECIFIED TOLERANCE / FINISH	PART DESCRIPTION
DWN BY DKN	10/9/87	DIMENSIONS	SCHEMATIC 330 POWER MODULE
CHK'D BY NRE	10/19/87		SERIES 330 / ADDRESS
APP NRE	10/20/87	ANGLES	NEXT ASSY. / PART NUMBER 009601 100 S
APP MDB	4/27/88		SIZE C/B

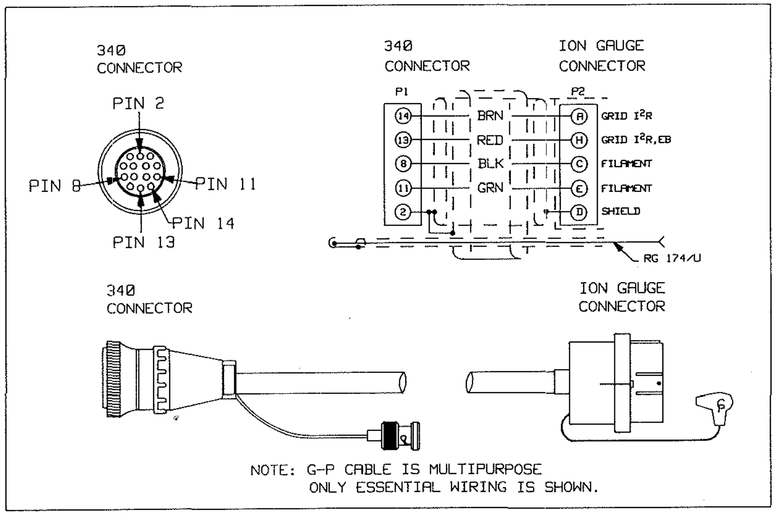


Fig. 4.10 Cable for Varian 564 Ion Gauge

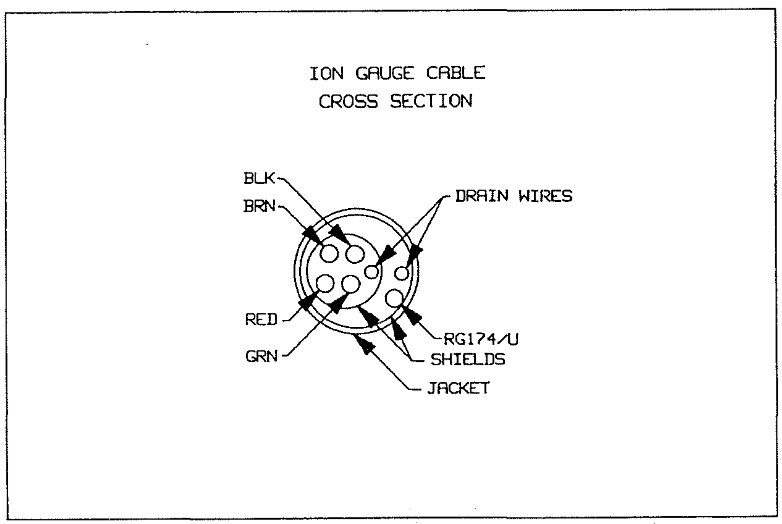


Fig. 4.11 Ion Gauge Cable Cross-Section

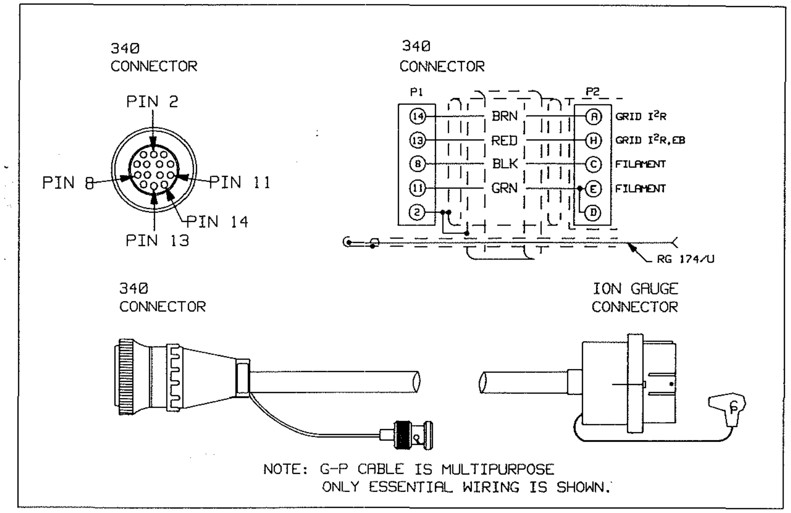


Fig. 4.8 Cable for Standard Glass Ion Gauge

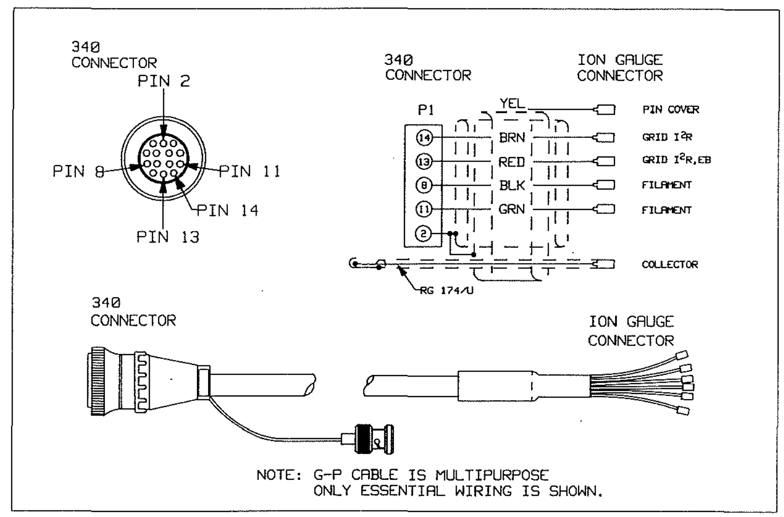
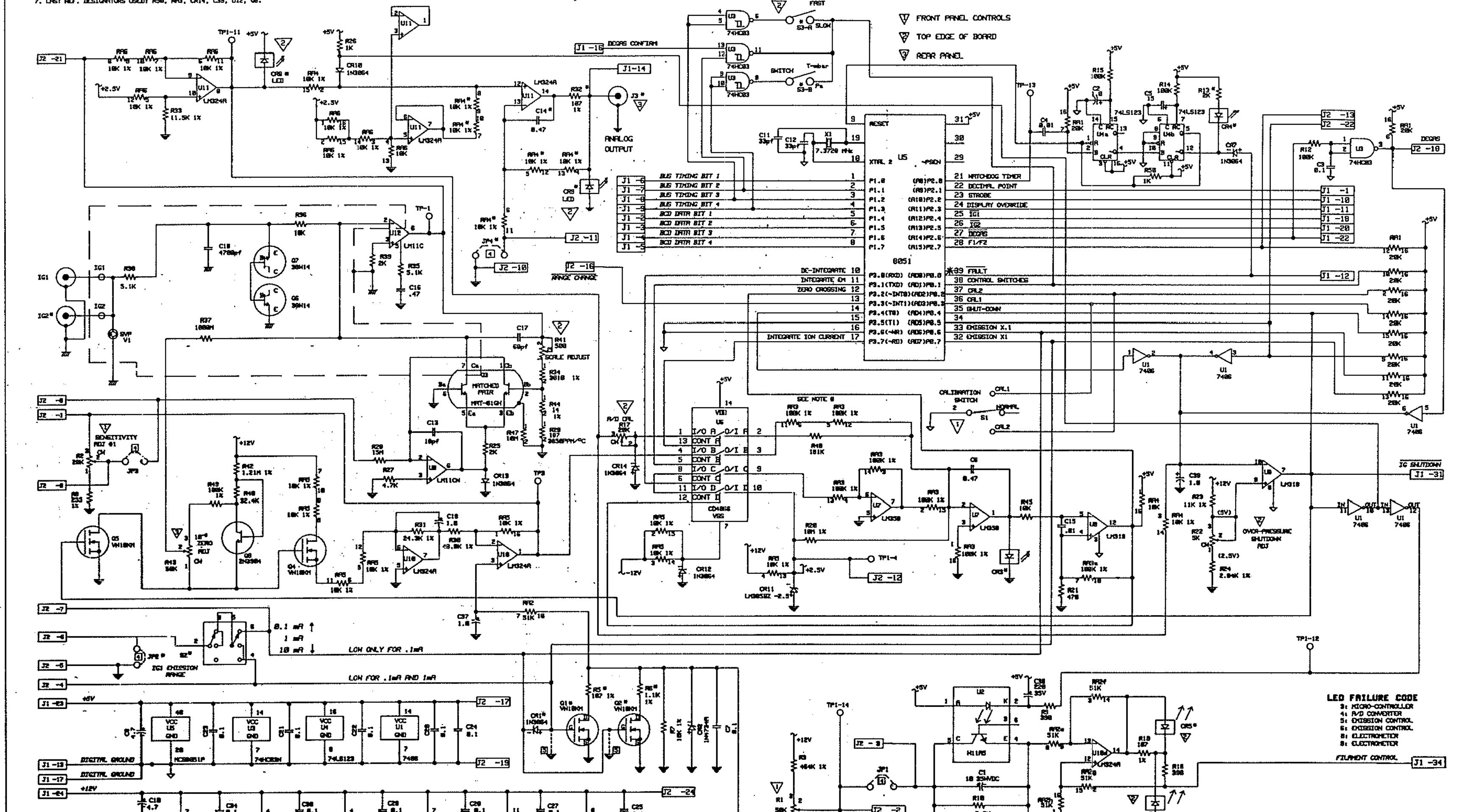


Fig. 4.9 Cable for Nude Ion Gauge

NOTES:
1. FILAMENT POWER SUPPLY SHOULD HAVE + LEAD TO EMISSION SENSE TO PREVENT DAMAGE WHEN LEAD IS SHORTED TO GROUND.
2. ALL CAPS IN MICROFARADS UNLESS OTHERWISE NOTED.
3. ALL RESISTORS ARE 1/4 WATT 5% IN OHMS UNLESS OTHERWISE NOTED.
4. JUMPER FOR STD ELECTROMETER.
5. GROUND FOR MODELS WITHOUT EMISSION RANGE SWITCH.
6. * NOT USED ON ALL MODELS.
7. LAST REF. DESIGNATORS USED: R50, RA9, CR14, C39, U12, Q8.
8. FOR 307111



LED FAILURE CODE
3: MICRO-CONTROLLER
4: A/D CONVERTER
5: EMISSION CONTROL
6: EMISSION CONTROL
7: ELECTROMETER
8: ELECTROMETER

FILED IN THE CAD UNDER EDIT /307/SC/9046102S;

GRANVILLE-PHILLIPS BOULDER COLORADO

SCALE:	DATE	UNLESS SPECIFIED TOLERANCE	FINISH
DWN BY DKN	10/2/86		
CHK'D BY JHH	10/13/87		
APP MDB	10/13/87		
APP MDB	10/13/87		

PART DESCRIPTION: SCH, VGC 307 ELECTROMETER STD

SERIES 307 | ADDRESS | NEXT ASSY.

PART NUMBER: 009046 102 S D/B

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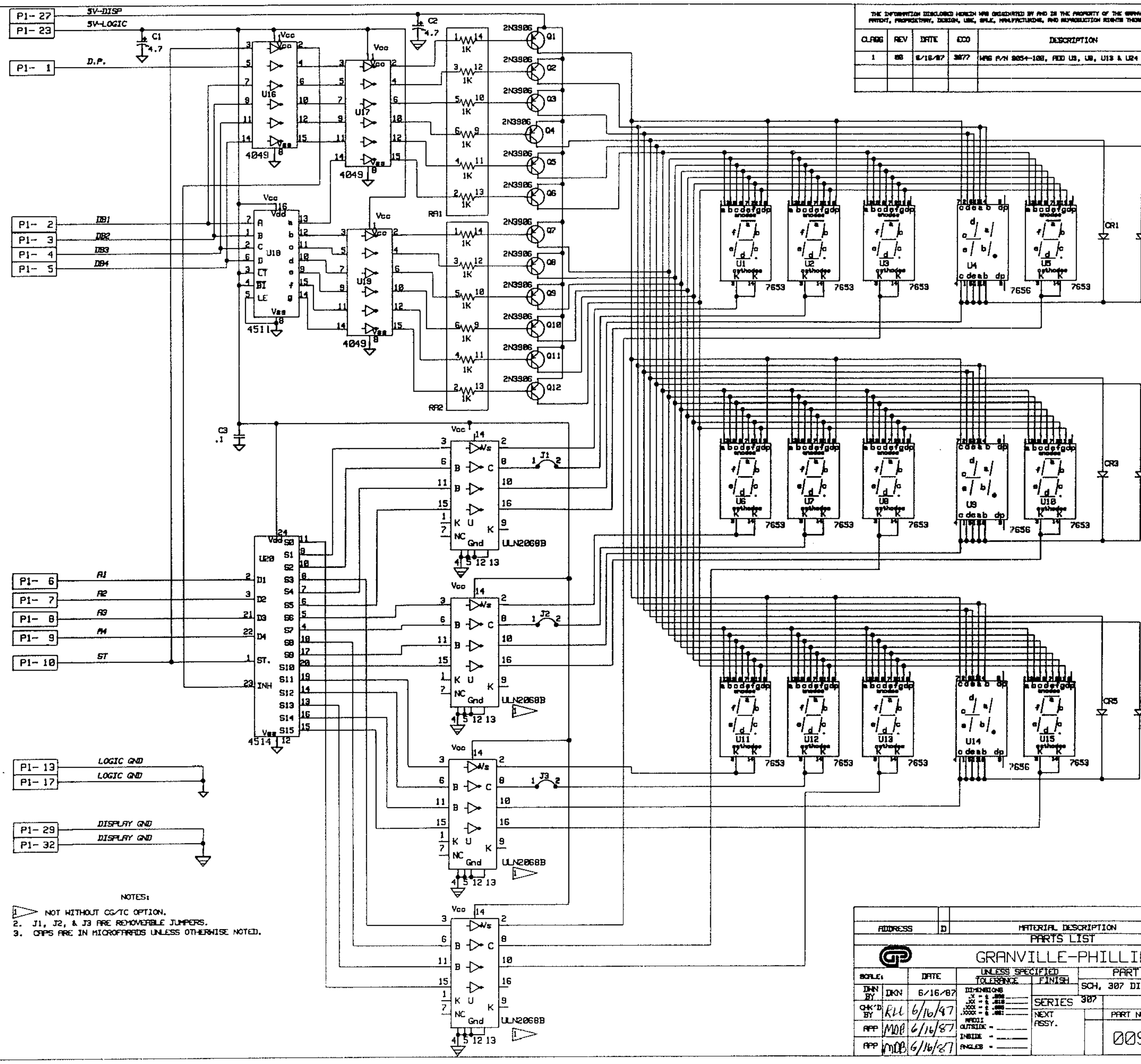
CLASS	REV	DATE	ECO	DESCRIPTION	BY	CHK'D	PROJ MGR	ENG MGR
1	00	6/16/87	3877	WAS P/N 9054-100, ADD U3, U8, U13 & U24	DKN	RLL	MDB	MDB



NOTES:

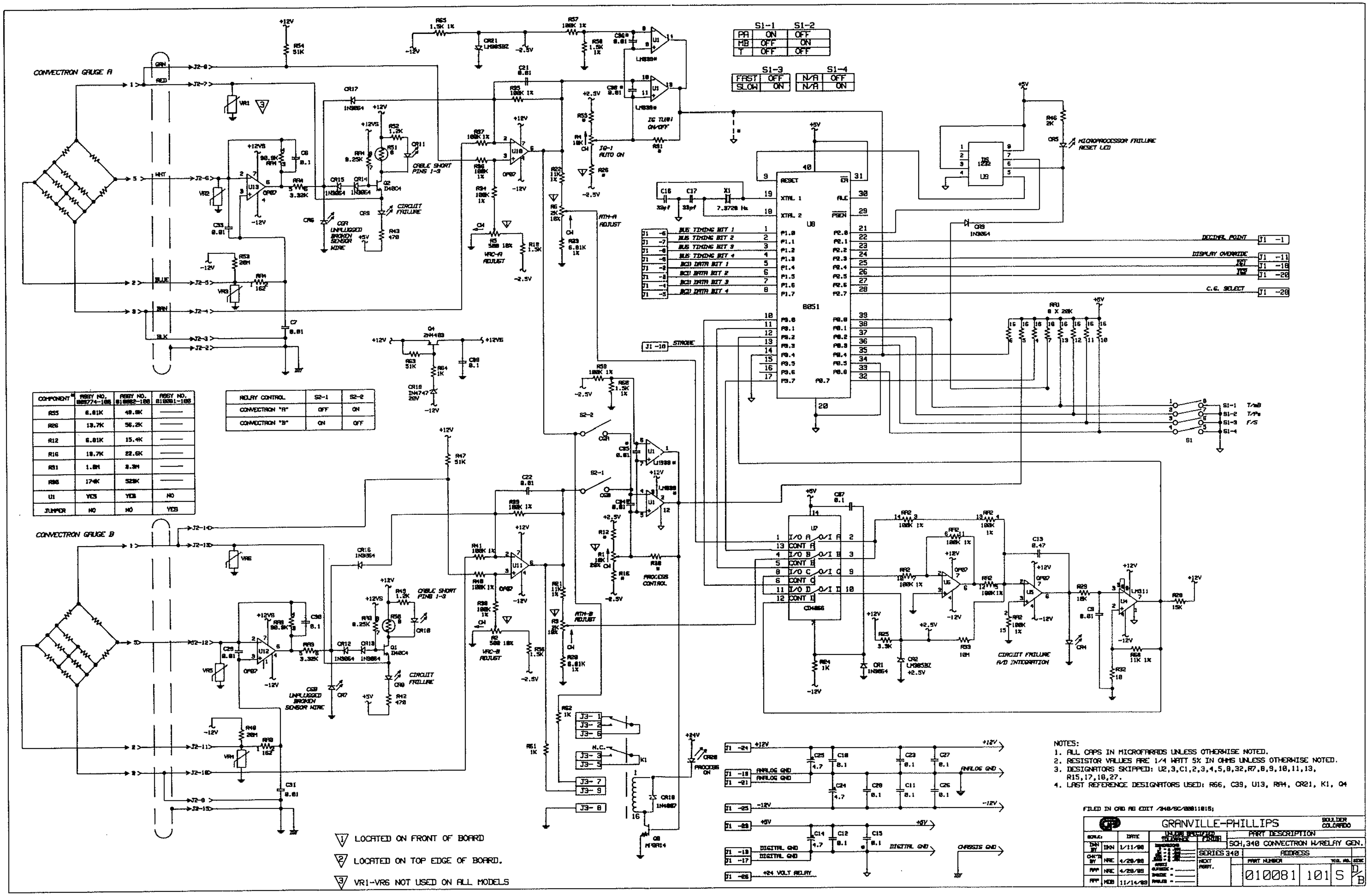
1. NOT WITHOUT CG/TC OPTION.
2. J1, J2, & J3 ARE REMOVEABLE JUMPERS.
3. CAPS ARE IN MICROFARADS UNLESS OTHERWISE NOTED.

ADDRESS	D	MATERIAL DESCRIPTION	SEQ	QUANTITY	UM

PARTS LIST

GRANVILLE-PHILLIPS BOULDER COLORADO

SCALE:		DATE	UNLESS SPECIFIED TOLERANCE	FINISH	PART DESCRIPTION
DWN BY	DKN	6/16/87	DIMENSIONS .X = ± .000 .XX = ± .010 .XXX = ± .005 .XXXX = ± .001		SCH, 307 DISPLAY BOARD
CHK'D BY	RLL	6/16/87	RADII OUTSIDE =	SERIES 307	ADDRESS
APP	MDB	6/16/87	INSIDE =	NEXT ASSY.	PART NUMBER 009518 100
APP	MDB	6/16/87	ANGLES =		SIZE C



COMPONENT*	ASSY NO. 005774-100	ASSY NO. 010082-100	ASSY NO. 010081-100
R55	6.81K	40.9K	———
R26	10.7K	56.2K	———
R12	6.81K	15.4K	———
R16	10.7K	22.6K	———
R51	1.0M	3.3M	———
R98	174K	523K	———
U1	YES	YES	NO
JUMPER	NO	NO	YES

RELAY CONTROL	S2-1	S2-2
CONVECTRON "A"	OFF	ON
CONVECTRON "B"	ON	OFF

1 LOCATED ON FRONT OF BOARD

2 LOCATED ON TOP EDGE OF BOARD.

3 VR1-VR6 NOT USED ON ALL MODELS

NOTES:

1. ALL CAPS IN MICROFARADS UNLESS OTHERWISE NOTED.
2. RESISTOR VALUES ARE 1/4 WATT 5% IN OHMS UNLESS OTHERWISE NOTED.
3. DESIGNATORS SKIPPED: U2,3,C1,2,3,4,5,8,32,R7,8,9,10,11,13, R15,17,18,27.
4. LAST REFERENCE DESIGNATORS USED: R66, C39, U13, RA4, CR21, K1, Q4

FILED IN CAD AS EDIT /340/SC/00011010;

GRANVILLE-PHILLIPS BOULDER COLORADO

PART DESCRIPTION: SCH,340 CONVECTRON W/RELAY GEN.

SERIES 340

DWN BY DKN 1/11/90 · CHK'D BY NAE 4/20/90 · APP NAE 4/20/95 · APP MDB 11/14/90

PART NUMBER 010081 101 S D/B

Service Guidelines and FCC Verification

When returning equipment to Granville-Phillips, please use the original packing material whenever possible. Otherwise, contact your shipper or Granville-Phillips for safe packaging guidelines. Circuit boards and modules separated from the controller chassis must be handled using proper anti-static protection methods and must be packaged in anti-static packaging. Granville-Phillips will supply return packaging materials at no charge upon request.

FCC Verification

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with this instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio or television technician for help.

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VACUUM GAUGE CONTROLLER

INSTRUCTION MANUAL

READ AND UNDERSTAND THE CONTENTS OF THIS MANUAL BEFORE ATTEMPTING TO INSTALL OR USE YOUR SERIES 340 VACUUM GAUGE CONTROLLER.

This manual is for use only with the following catalog numbers:

340001	340018
340003	340019
340004	340021
340011	

For assistance in using or servicing this instrument contact:

GRANVILLE-PHILLIPS CUSTOMER SERVICE DEPARTMENT
5675 ARAPAHOE AVENUE
BOULDER, COLORADO 80303 U.S.A.
TELEPHONE (303) 443-7660
FAX (303) 443-2546

SEE WARNINGS ON PAGES 0.3, 0.4, 0.5, 1.2, 1.4, 3.7

Manual Catalog No. 340005 101

Revised November 1995

340

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SEE WARNINGS ON PAGES 0.3, 0.4, 0.5, 1.2, 1.4, 3.7

Manual Catalog No. 340005 101

Revised December 1996

RECEIVING INSPECTION

On receipt of your equipment, inspect all material for damage. Confirm that the shipment includes all items ordered. If items are missing or damaged, submit a claim as stated below for a domestic or international shipment, whichever is applicable.

If materials are missing or damaged, the carrier that made the delivery must be notified within 15 days of delivery, or in accordance with Interstate Commerce regulations for the filing of a claim. Any damaged material including all containers and packaging should be held for carrier inspection. Contact our Customer Service Department, 5675 Arapahoe Ave., Boulder, Colorado 80303, telephone (303) 443-7660, if your shipment is not correct for reasons other than shipping damage.

INTERNATIONAL SHIPMENT

Inspect all materials received for shipping damage and confirm that the shipment includes all items ordered. If items are missing or damaged, the airfreight forwarder or airline making delivery to the customs broker must be notified within 15 days of delivery. The following illustrates to whom the claim is to be directed.

- If an airfreight forwarder handles the shipment and their agent delivers the shipment to customers, the claim must be filed with the airfreight forwarder.

- If an airfreight forwarder delivers the shipment to a specific airline and the airline delivers the shipment to customs, the claim must be filed with the airline.

Any damaged material including all containers and packaging should be held for carrier inspection. If your shipment is not correct for reasons other than shipping damage, contact our Customer Service Department, 5675 Arapahoe Avenue, Boulder, Colorado 80303, U.S.A., fax (303) 443-2546 or telephone (303) 443-7660.

LIMITED WARRANTY

This Granville-Phillips Company product is warranted against defects in materials and workmanship for 1 year from the date of shipment provided the installation, operating and preventive maintenance procedures specified in this instruction manual have been followed. Granville-Phillips Company will, at its option, repair, replace or refund the selling price of the product if GPC determines, in good faith, that it is defective in materials or workmanship during the warranty period, provided the item is returned to Granville-Phillips Company together with a written statement of the problem.

Defects resulting from or repairs necessitated by misuse or alteration of the product or any cause other than defective materials or workmanship are not covered by this warranty. GPC EXPRESSLY DISCLAIMS ANY OTHER WARRANTY, WHETHER EXPRESSED OR

IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. UNDER NO CIRCUMSTANCES SHALL GRANVILLE-PHILLIPS COMPANY BE LIABLE FOR CONSEQUENTIAL OR OTHER DAMAGES RESULTING FROM A BREACH OF THIS LIMITED WARRANTY OR OTHERWISE.

SEE WARNINGS ON NEXT 3 PAGES

WARNING

READ THIS INSTRUCTION MANUAL BEFORE INSTALLING, USING, OR SERVICING THIS EQUIPMENT. IF YOU HAVE ANY DOUBTS ABOUT HOW TO USE THIS EQUIPMENT SAFELY, CONTACT THE GRANVILLE-PHILLIPS CUSTOMER SERVICE DEPARTMENT AT THE ADDRESS LISTED ON THIS MANUAL.

DANGER, HIGH VOLTAGE

180 V is present in the controller, on the cable, and at the ion gauge tube when the tube is turned on.

EXPLOSIVE GASES

Do not use Series 340 instruments to measure the pressure of explosive or combustible gases or gas mixtures. Ionization gauge cathodes operate at high temperatures. The sensor wire of the series 275 transducers normally operates at only 125 °C, but it is possible that momentary transients or controller malfunction can raise the sensor temperature above the ignition temperature of combustible mixtures. Thermocouple gauge transducers also operate at elevated temperatures, and the same safety considerations apply.

IMPLOSION AND EXPLOSION

Glass ionization gauges, if roughly handled, may implode under vacuum causing flying glass which may injure personnel. If pressurized above atmospheric pressure, glass tubes may explode. A substantial shield should be placed around vacuum glassware to prevent injury to personnel.

Danger of injury to personnel and damage to equipment exists on all vacuum systems that incorporate gas sources or involve processes capable of pressurizing the system above the limits it can safely withstand.

For example, danger of explosion in a vacuum system exists during backfilling from pressurized gas cylinders because many vacuum devices such as ionization gauge tubes, glass windows, glass bell jars, etc., are not designed to be pressurized.

Install suitable devices that will limit the pressure from external gas sources to the level that the vacuum system can safely withstand. In addition, install suitable pressure relief valves or rupture discs that will release pressure at a level considerably below that pressure which the system can safely withstand.

Suppliers of pressure relief valves and pressure relief discs are listed in Thomas Register under "Valves, Relief", and "Discs, Rupture".

Confirm that these safety devices are properly installed before installing the 340 Vacuum Gauge Controller (VGC). In addition, check that (1) the proper gas cylinders are installed, (2) gas cylinder valve positions are correct on manual systems, and (3) the automation is correct on automated systems.

WARNING

Operation of the 340 VGC with line voltage other than that selected by the power supply internal jumpers can cause damage to the instrument and injury to personnel.

WARNING

Do not attach cables to glass gauge pins while the gauge is under vacuum. Accidental bending of the pins may cause the glass to break and implode. Cables once installed should be secured to the system to provide strain relief for the gauge tube pins.

WARNING

Safe operation of ion producing equipment, including the 340 VGC, requires grounding of both its power supply and the vacuum chamber. **LETHAL VOLTAGES** may be established under some operating conditions unless correct grounding is provided.

Research at Granville-Phillips has established that ion producing equipment, such as ionization gauges, mass spectrometers, sputtering systems, etc., from many manufacturers may, under some conditions, provide sufficient conduction via a plasma to couple a high voltage electrode to the vacuum chamber. If conductive parts of the chamber are not grounded, they may attain a potential near that of the high voltage electrode during this coupling.

Potentially fatal electrical shock could then occur because of the high voltage between these chamber parts and ground.

During routine pressure measurement using ionization gauge controllers from <u>any</u> manufacturer, about 160 V may become present on ungrounded chambers at pressures near 10^{-3} Torr. All isolated or insulated conductive parts of the chamber must be grounded to prevent these voltages from occurring.

Grounding, though simple, is very important! Please be certain that the ground circuits are correctly utilized, both on your ion gauge power supplies and on your vacuum chambers, regardless of their manufacturer, for this phenomenon is not peculiar to Granville-Phillips equipment. Refer to Safety Instructions and Section 1.2, Installation, for additional information. If you have questions, or wish additional labels or literature, please contact one of our technical personnel.

SAFETY WARNING

CONCERNING INSTALLATION OF VACUUM COMPONENTS

All conductors in, on, or around a vacuum system that are exposed to potential high voltage electrical discharges must either be shielded so as to prevent human contact, or be connected to earth ground for safe operation.

When high voltage is present in any vacuum system, a life threatening electrical shock hazard may exist unless all exposed conductors are maintained at earth ground. The power cord of this product should be connected only to a properly grounded outlet. However, grounding this product does not guarantee that other components of the vacuum system are maintained at earth ground.

This hazard is not peculiar to this product.

Be aware that an electrical discharge through a gas may couple dangerous high voltage directly to an ungrounded conductor almost as effectively as would a copper wire connection. A person may be seriously injured or even killed by merely touching an exposed ungrounded conductor at high potential.

This hazard is not peculiar to this product.

Under certain conditions, dangerous high voltage can be coupled directly to an ungrounded conductor through a gas almost as effectively as through a copper wire connection. This hazard, which is not peculiar to this product, is a consequence of the ability of an electric current to flow through a gas under certain circumstances. A person may be seriously injured, or even killed by merely touching an exposed ungrounded conductor at high potential.

WHEN HIGH VOLTAGE IS PRESENT, ALL EXPOSED CONDUCTORS OF A VACUUM SYSTEM MUST BE MAINTAINED AT EARTH GROUND.

- All vacuum components, such as gauges, valves, etc., or parts thereof, that are electrically insulated from the main vacuum system must be reliably connected to an earth ground, or shielded to positively prevent human contact.

- All components utilizing vacuum connections, such as quick connects, taped threads, plastic, glass, rubber tubing, etc., must be reliably grounded.

  For example, a metal gauge envelope that is not reliably grounded through its vacuum connector may be grounded by using a metal hose clamp on the gauge, connected by a 12 awg copper wire to the grounded vacuum chamber.

- High voltage can couple through a gas to the internal electrodes of a gauge. Do not touch the exposed pins on any gauge installed on a vacuum system where high voltage is present.

This hazard is not peculiar to this product. It is a characteristic of all vacuum systems having equipment installed that is capable of producing high voltage within the vacuum environment. Check all of your vacuum systems periodically for proper grounding of all exposed conductors.

TABLE OF CONTENTS

CHAPTER 1 - THE 340 VGC

1.1 INTRODUCTION

General Description

The 340 Vacuum Gauge Controller (VGC) measures pressures from less than 1 x 10^{-9} Torr (1.3 x 10^{-9} mbar or 1.3 x 10^{-7} Pa) to atmosphere by use of a single ionization gauge and two *CONVECTRON* gauges. Pressure readout is via a front panel display and analog outputs. Resistance heating degas is standard. An interlock is provided to only allow degas when the gauge tube has been on and displayed pressure is below 5 x 10^{-5} Torr. Pressure reading during degas is not possible.

The 340 VGC is a modular instrument with infrequently used controls housed behind a hinged front panel, thus reducing front panel clutter and allowing the VGC to reside in a half-rack space.

Available Options

Remote Input/Output

The VGC can be ordered with a factory installed remote I/O option which provides an IG status relay, remote gauge on/off input and remote degas on/off input functions.

Process Relay

The VGC can be ordered with factory installed process relay option which provides automatic ion gauge turn-on from *CONVECTRON* channel "A" and a *CONVECTRON* process relay output user selectable to operate from channel "A" or "B".

IG Cables

The VGC is capable of operating an ion gauge located up to 50 feet away from the controller by using standard cables. Degas power delivered to the gauge decreases with cable length. Cables are available for use with glass B-A gauges, nude B-A gauges, and the Varian 564 gauge.

Mounting Options

The VGC can be ordered with a variety of mounting options to fit your needs. This includes half rack (standard), bench, full rack, or two units in a full rack.

1.2 INSTALLATION

Line Voltage Selection

Verify that the line voltage selector card displays the line voltage value of the available local ac line voltage. If the card does not display the correct line voltage value as shown in Fig. 1.1, perform the following procedure (refer to Fig. 1.2).

Line Voltage (Vac)	Selector Card Setting	Fuse F2 Type
90-115	100	1.25A SB
105-130	120	1.25A SB
200-230	220	.60A SB
230-260	240	.60A SB

Fig. 1.1 Line Voltage Selector Setting

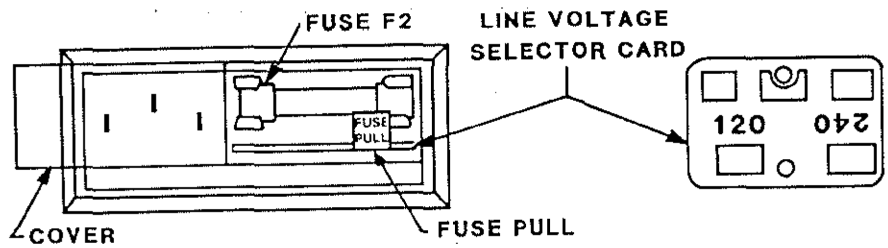


Fig 1.2 Line Voltage Selector Feature

1) ON the rear panel (lower right), slide the cover over fuse F2 to the left.

2) Remove fuse F2 by pulling the fuse extractor tab, FUSE PULL, outward and to the left. Leave the extractor tab in the-full-left position.

3) Use a pointed tool or small wire hook to extract the line selector card from its holder. Pull card straight out.

4) Reinsert the card such that the correct line voltage (refer to Fig. 1.1) is readable from the rear of the VGC.

WARNING

Operation of the VGC with the line voltage selector card improperly set can cause damage to the VGC and injury to personnel.

5) Verify that fuse F2 is the correct value as shown in Fig. 1.1. Position fuse extractor tab, FUSE PULL, to the right-hand position and install fuse F2 in fuse holder.

6) Slide the cover to the right over fuse F2.

<u>Mounting Configurations</u>

Fig. 1.3 illustrates the various configurations available for mounting the 340 VGC.

Note that the 340 controller should be mounted in a location with free air flow and ambient temperature less than 40 °C.

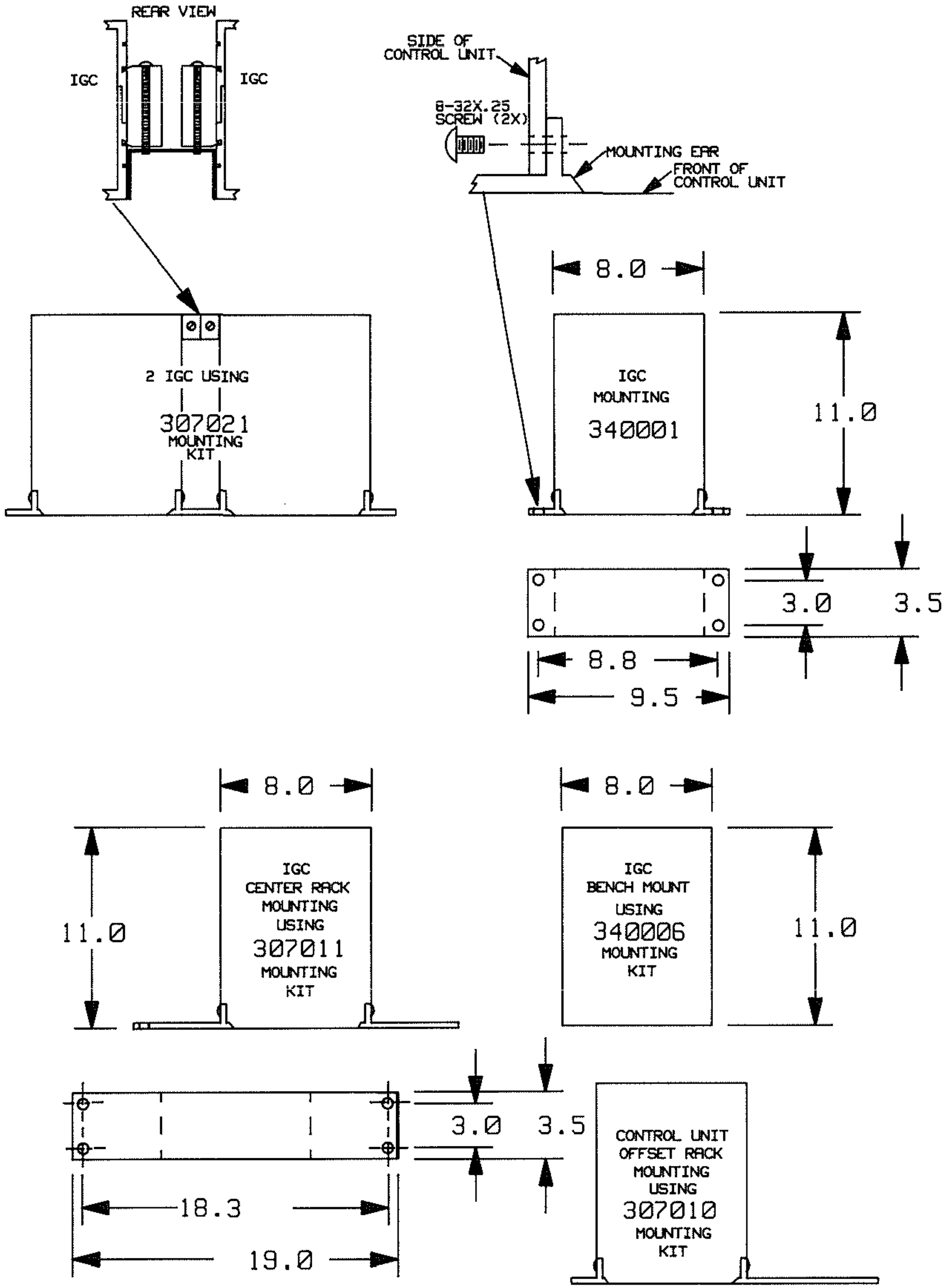


Fig 1.3 340 Mounting Configurations

Ionization Gauge Types and Installation

WARNING

Do not attach cables to glass gauge pins while the gauge is under vacuum. Accidental bending of the pins may cause the glass to break and implode. Cables, once installed, should be secured to the system to provide strain relief for the gauge tube pin.

The 340 VGC is designed to operate a Bayard-Alpert type or equivalent ionization gauge. Coated Iridium cathode type gauges are recommended since at higher pressures they provide longer operating life and greater burnout resistance. When installing your ion gauge, note that if placed near the pump, the pressure in the gauge may be considerably lower than in the rest of the system. If placed near a gas inlet or source of contamination, the pressure in the gauge may be higher.

If an unshielded gauge is placed near an electron beam evaporation source or used in a sputtering system, spurious electrons or ions may disturb the measurement. Screens or other shielding should be placed between the gauge and the system if spurious charged particles or severe electromagnetic interference is present. Consideration should also be given to electrostatic shielding of glass tubulated gauges when measuring pressures near their x-ray limits.

Granville-Phillips offers 3 cable types for ion gauges. One has a standard connector for the Series 274 tubulated gauge tubes. One has individual pin sockets for use with non-standard pin configurations as well as with Granville-Phillips "nude" tubes. This nude gauge cable is also available with a molded connector that can mate with nude gauges that have a pin shield feature. The third is for use with the Varian 564 broad range tube. Note that to use the second cathode of a dual cathode gauge, the cable connector at the gauge is removed and rotated 180°, then reinstalled.

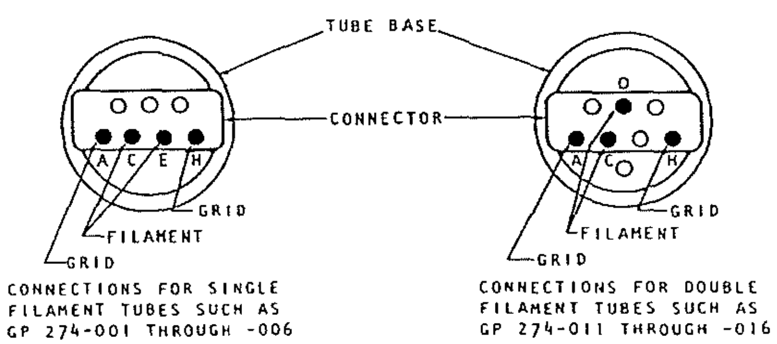


Fig. 1.4 Standard Base Tube Configuration

Fig 1.4 shows typical tube base configurations used with the standard connector cable.

<u>System Ground Test Procedure</u> (Refer to the Safety Instructions on page 0.3 for further information).

Procedure: Physically examine the grounding of both the 340 VGC and the vacuum chamber. Is there an intentional heavy duty ground connection to all exposed conductors on the vacuum chamber? There should be. Note that a horizontal "O" ring or "L" ring gasket, without metal clamps, can leave the chamber above it electrically isolated. Power can be delivered to mechanical and diffusion pumps without any ground connections to the system frame or chamber. Water line grounds can be lost by a plastic or rubber tube interconnection. What was once a carefully grounded vacuum system can, by innocent failure to reconnect all ground connections, become a very dangerous device. <u>Use the following procedure to test each of your vacuum systems which incorporate an ionization gauge.</u>

This procedure uses a conventional volt-ohm meter (VOM) and resistor (10 ohm, 10 watt.)

1) With the gauge controller turned off, test for both dc and ac voltages between the metal parts of the vacuum chamber and the power supply chassis.

2) If no voltages exist, measure resistance. The resistance should not exceed 2 ohms. Two ohms, or less, implies commonality of these grounds that should prevent the plasma from creating a dangerous voltage between them. This test does not prove that either connection is earth ground, only that they are the same. If more than 2 ohms is indicated, check with your electrician.

3) If ac or dc voltages exist and are less than 10 volts, shunt the meter with a 10 ohm, 10 watt resistor. Repeat the voltage measurement. With the shunt in place across the meter, if the voltage remains at 83% or more of the unshunted value, commonality of the grounds is implied. Repeat the measurements several times to be sure that the voltage ratio is not changing with time. If,

$$\frac{\text{Voltage (shunted)}}{\text{Voltage (unshunted)}} = .83 \text{ or more,}$$

   this should prevent the plasma from creating a dangerous voltage between these grounds. If more than 10 volts exists between grounds, check with your electrician.

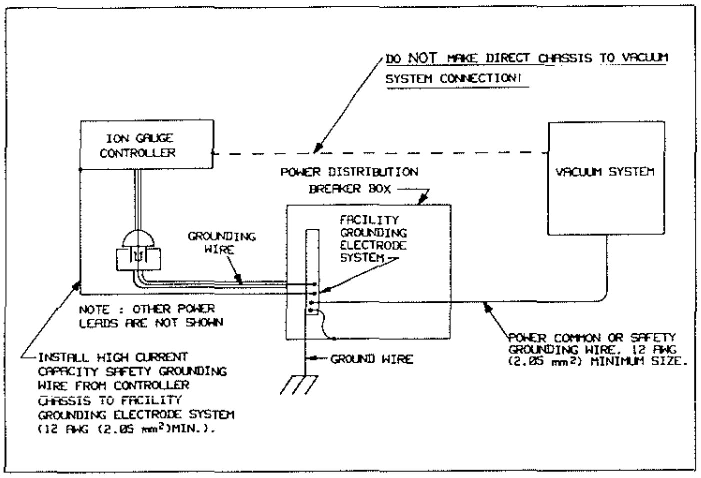


Fig. 1.5 Correct System Grounding

4) If the voltage change in Step 3 is greater than 17%, due to the placement of the shunt, it complicates the measurement. The commonality of the grounds may be satisfactory and the coupling poor, or the commonality could be poor! Your electrician should be asked to check the electrical continuity between these two ground systems. The placement of a second ground wire, (dashed line in Fig. 1.5), between the vacuum chamber and the VGC chassis is not a safe answer for large currents could flow through it. Professional help is recommended.

Grounding the System

1. Connect a heavy duty ground wire #12 AWG or larger from the ground lug on the back (the Control Unit) to your facility grounding electrode system. This will provide an earth ground for the Control Unit in the event the power cable is not in place. Do not connect the ground lug to the vacuum system or other component. Connect it directly to the facility grounding system such as a grounded outlet box or a grounded copper water supply pipe. Do not rely on small metal water lines to ground a component. Later on someone may replace the metal tubing with plastic tubing thus unwittingly causing a potentially dangerous situation.

> Be aware that an electrical discharge through a gas may couple dangerous high voltage directly to an ungrounded conductor almost as effectively as would a copper wire connection. A person may be seriously injured or even killed by merely touching an exposed ungrounded conductor at high potential.
>
> This hazard is not peculiar to this product.

2. Provide a connection to ground for other instruments with electrodes in the vacuum system possibly exposed to high voltage electrical discharges.

3. Provide a connection to ground for each ungrounded metal component in, on or around the vacuum system, including the gauge envelopes, which personnel may touch and which can potentially be exposed to high voltage electrical discharges within the vacuum system. For example, a metal bell jar resting on an organic O-ring must be connected to ground if an ionization gauge is to be used or if other high voltage sources are present in the vacuum system.

> ⚠ Complying with the usual warning to connect the power cable only to a properly grounded outlet is necessary but not sufficient for safe operation of a vacuum system with this or any similar high voltage producing product. Grounding this product does not and cannot guarantee that other components of the vacuum system are all maintained at earth ground.

> ⚠ All conductors in, on, or around the vacuum system exposed to potential high voltage electrical discharges must either be shielded at all times to protect personnel or must be connected to earth ground at all times.

1.3 OPERATION

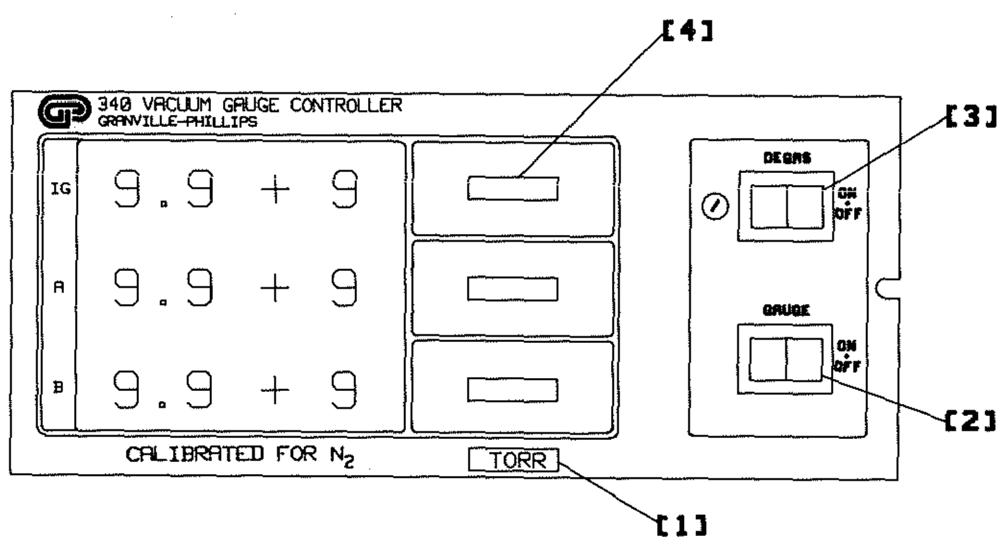


Fig. 1.6 340 VGC Control Unit Front Panel

Summary of Controls and Indicators

A description of the controls and indicators found on a basic 340 VGC is given in this section. For detailed instructions pertaining to particular functions, please consult the chapter for that function.

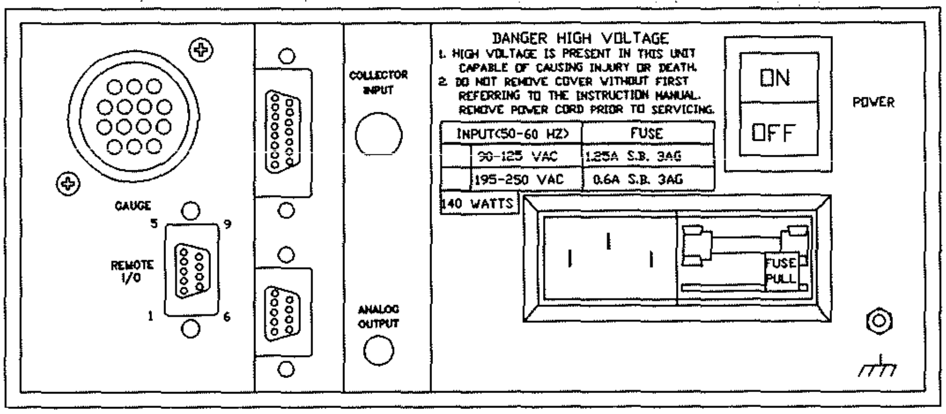


Fig. 1.7 340 VGC Control Unit Rear Panel

Units of Measure [1]

The unit of measure displayed is selectable via switches on the Electrometer Module, and *CONVECTRON* Module. These units will be indicated on the front panel label when shipped from the factory. See the electrometer and *CONVECTRON* chapters for instructions on changing units. The pressure units label [1] can be changed by the user if the system of units is changed. Slide the label out from the top.

Power On/Off

To turn on the VGC, depress the top half of the power switch located on the rear panel. "Power On" indication is by the turning on of the two *CONVECTRON* displays after an initial two second delay.

Ion Gauge On/Off [2]

The ion gauge may be turned on or off by the front panel momentary rocker switch or by remote control (if remote input/output is installed).

To turn on the ion gauge from the front panel, press the momentary rocker switch [2]. To turn it off, press again. The gauge on indicator is the display itself. The display will turn on immediately and display 9.9+9. After an approximate 2 second delay the actual pressure will be displayed. **Note:** The maximum voltage appearing on the gauge tube contacts will be 5.5 Vdc when the ion gauge is off.

Degas On/Off [3]

The I^2R degas may be turned on or off by the front panel momentary rocker switch, [3], or the remote control input (if remote input/output option is installed). To turn degas on, press the degas momentary rocker switch. To turn it off, press again or press the gauge momentary rocker switch to turn off degas and turn on the gauge.

Degas "ON" indication is by the degas LED adjacent to the rocker switch on the front panel. Degas cannot be activated unless the gauge has been turned on and indicated system pressure is below 5×10^{-5} Torr. This prevents degas turn-on at pressures where emission can not be established or where degas is of no practical use. Ion gauge pressure measurement is not possible during degas. Note that during degas the display will turn off.

Channel Identification Windows [4]

A channel identification label is included in the accessory kit to enable you to customize your 340 VGC for your application.

Remote Input/Output Option

Two TTL compatible inputs are provided through the rear panel allowing control of the ion gauge and degas. The function of the front panel keys is reproduced by either a contact closure or an asserted low (0V) logic state on these inputs. This low state must be held continuously for at least 25 milliseconds. After this, the input must be allowed to pull high for at least 105 milliseconds before another low will be accepted. These inputs have passive pull-ups.

A single-pole, double-throw relay is provided to indicate ion gauge status (normally open contact is open when the ion gauge is off).

Pin No.	**Function**
1	Gauge On/Off Remote*
2	Ground
3	Not used
4	Gauge Status Common
5	Gauge Status N.C.
6	Degas On/Off Remote*
7	Ground
8	Not used
9	Gauge Status N.O.

* Active low inputs

Fig. 1.8 Remote Input/Output Connector

1.4 THEORY OF OPERATION

Ion Gauge Theory

The functional parts of a typical ionization gauge are the cathode, grid (anode) and ion collector, which are shown schematically in Fig. 1.9. These electrodes are maintained by the gauge controller at +30, +180, and 0 volts, relative to ground, respectively.

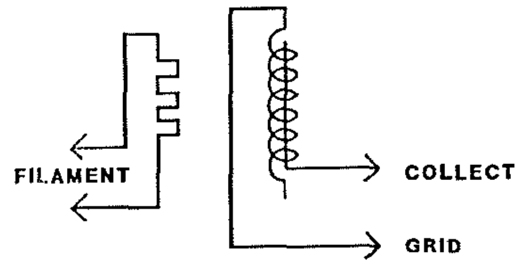


Fig. 1.9 Ion Gauge Schematic

The cathode is heated to such a temperature that electrons are emitted, and accelerated toward the grid by the potential difference between the grid and cathode. Most of the electrons eventually collide with the grid, but many first traverse the region inside the grid one or more times.

When an energetic electron collides with a gas molecule an electron may be dislodged from the molecule leaving it with a positive charge. Most ions are then accelerated to the collector. The rate at which electron collisions with molecules occur is proportional to the density of gas molecules, and hence the ion current is proportional to the gas density (or pressure, at constant temperature).

The amount of ion current for a given emission current and pressure depends on the ion gauge design. This gives rise to the definition of ion gauge "sensitivity", frequently denoted by "K":

K = ion current/(emission current x pressure)

Bayard-Alpert type gauges typically have sensitivities of 10/Torr when used with nitrogen or atmosphere. Sensitivities for other gases are given in Section 2.3

The ion gauge controller varies the heating current to the cathode to maintain a constant electron emission, and measures the ion current to the collector. The pressure is then calculated from this data.

Ion gauge degas is accomplished by resistance heating (I^2R). During I^2R degas a large current is passed through the grid structure raising its temperature and driving off contaminants. Note that some ion gauge tube designs do not allow I^2R degas.

CONVECTRON Gauge Theory

The *CONVECTRON* transducer is represented in Fig. 1.10 as R1, R2, R3, and R4. These four resistances form the legs of a bridge circuit, with R1 designating the sensor wire of the transducer. R2 is a resistive network in the tube which compensates for changes in the ambient temperature. At bridge null, R1=R2XR3/R4. If there are no changes in ambient temperature, the value of R1 is a constant and the bridge is balanced.

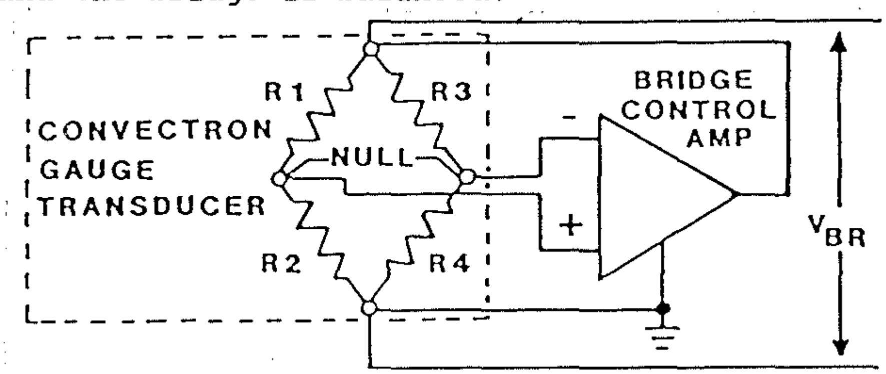


Fig 1.10 Simplified Schematic *CONVECTRON* Gauge Module

As the vacuum system pressure is decreased, there are fewer molecules in the system to conduct the heat away from the sensor wire causing the temperature and resistance of R1 to increase. The increased resistance of R1 causes the bridge to unbalance and a voltage is developed across the null terminals. The bridge control circuit senses the null voltage and decreases the voltage across the bridge until the null voltage is again zero. When the bridge voltage is decreased, the power dissipated in the sensor wire is decreased causing the resistance of R1 to decrease to its previous value. The opposite events happen for a pressure increase. The bridge voltage is a non-linear function of pressure.

All materials have been chosen for ultra high vacuum service, corrosion resistance and bakeability to 150 °C. The gauge tube envelope is type 304 and 305 stainless steel. All metallic joints in the envelope are TIG welded. No solder is used within the envelope. The following materials are exposed to the vacuum: Type 304 and 305 stainless steel, Carpenter Alloy 52, Kovar®, Kapton®, gold plated tungsten, borosilicate glass and Dow-Corning 9015 glass. The blue trim cover is molded of Ultem® polyetherimide resin suitable for service above 150 °C.

<u>Microcontrollers and Bus Structure</u>

The Electrometer Module in the 340 has a dedicated microcontroller with internal ROM, RAM, timing and interrupt management functions. This architecture provides high-performance at low cost with greater reliability and noise immunity than more complicated microprocessor systems using external buses and memory hardware.

The microcontroller is equipped with a watchdog timer, which automatically generates a reset if the processor fails to fulfill timing "checkpoints" within its code. Inter-processor communication is accomplished via the display bus. These lines carry BCD-format pressure data which is used to generate the 340 display.

1.5. SPECIFICATIONS

Physical	
Width	241 mm (9.5 in.) with half rack mounting ears
Height	89 mm (3.5 in.)
Depth	356 mm (14 in.) includes 76 mm (3 in.) for connectors and cables
Weight	5.0 kg (11.0 lb.)
Electrical	
Voltage	90-130 Vac or 200-260 Vac
Frequency	50 to 60 Hz
Power	100 watts max.
Fuse Ratings	Line fuse 1.25 A (90-130 Vac) .60 A (200-260 Vac), 250 Vac
Environment Temperature	0 °C to 40 °C

Ion Gauge Pressure Range

Emission Range		
.01 mA to .1 mA	.1 mA to 1 mA	1 mA to 10 mA
1×10^{-7} to 1×10^{-1} Torr	1×10^{-8} to 1×10^{-2} Torr	1×10^{-9} to 1×10^{-3} Torr

Internal overpressure limiter is factory adjusted to trip at 1-decade below the upper limits specified above. See Section 2.4 for readjustment instructions.

Electronic Accuracy	Typical +/- 3% of reading at ambient temperature of 25 +/- 5 °C.
Display Units	Torr unless otherwise requested. Adjustment and internal selector switch provides readout in mbar or pascal.
Display Resolution	Scientific notation, 2 significant digits.
Display Update Time	0.5 sec. typical as shipped. Internal switch selectable to 3 sec./reading averaged.
Ion Gauge	
Sensitivity	3/Torr to 50/Torr (factory setting

	is 10/Torr).
Emission Current	10 uA to 10 mA in 3 decade ranges (factory setting is 1 mA).
Collector Potential	0V.
Grid Potential	+180 Vdc.
Cathode Potential	+30 Vdc.
Degas	I^2R: 8 Vac @ 10 A maximum.
Analog Output	0-10 V; Logarithmic; 1 V/decade.
Remote I/O	
Gauge and Degas On/Off Inputs	Less than 0.4 V @ 10 uA for 25 msec (min). Must go to greater than 3.5 V for 105 msec (min) before next low state.
Cathode Status Relay Contact Rating	4 A, 250 Vac resistive load or 30 Vdc.
CONVECTRON Specifications	
Gauge Type	G-P Series 275.
Pressure Range	1 x 10^{-4} Torr to 990 Torr, N_2 equivalent.
Display Resolution	2 significant digits, except for 1 significant digit in 10^{-4} Torr decade.
Gas Type	N_2, Air (for direct reading).
Display Update Time	0.5 sec typical. Switch selectable to 3 sec/reading, averaged.
Analog Output	Nonlinear 0-5.3 Vdc +/-5% corresponding to 0-1000 Torr.
Ion Gauge Turn-on Range	OFF to 50 mTorr.
Process Relay Rating	Resistive load. Max switched power 30 W or 60 VA. Max switched current 2 amps. Max switched voltage 30 Vdc or 300 Vac. UL rating 1 A @ 30 Vdc; 0.5A @ 125 Vac.
Process Relay Turn-on Range	OFF to 200 mTorr.

NOTES

CHAPTER 2 - THE ION GAUGE ELECTROMETER MODULE

2.1 INTRODUCTION

The Ion Gauge (IG) Electrometer Module provides ion gauge pressure readout from less than 1 x 10^{-9} Torr (1.3 x 10^{-9} mbar or 1.3 x 10^{-7} Pa) to 1 x 10^{-1} Torr, air equivalent, depending on the gauge and emission current used.

Adjustments are provided for gauge sensitivity and emission current. Adjustment and an internal switch allow change to mbar or Pascal pressure units, and a user selectable "slow update" feature triggers measurement averaging, resulting in a display update frequency of about once every three seconds. The overpressure shutdown threshold is internally adjustable.

Internal failure indicator LED's aid diagnosis of problems by indicating certain out-of-bounds electronic conditions.

2.2 INSTALLATION

Units of Measure

Your unit will have been shipped from the factory preset to display the unit of measure, torr, millibar or Pa, that you requested. If you wish to change units, proceed as follows:

1) Shut off power to the control unit.

2) Remove the top cover. Locate the IG Electrometer Module.

3) Locate [5], display units control switch.

4) Set switch to desired position, off = torr/mbar units, on = Pa units. The unit's control switch on the *CONVECTRON* Gauge Module must also be set for the same units.

5) Slip the label card out of the top of the front panel and apply appropriate pressure units label.

Selection between torr and mbar units is done by adjusting the IG tube sensitivity to the appropriate units. For example, a typical Bayard-Alpert tube has a sensitivity of 10/Torr or 7.5/mbar. Thus, for this tube, adjusting the sensitivity for a display reading of 1.0+1 will result in display of pressure in torr. Adjusting to 7.5+0 will result in display in mbar.

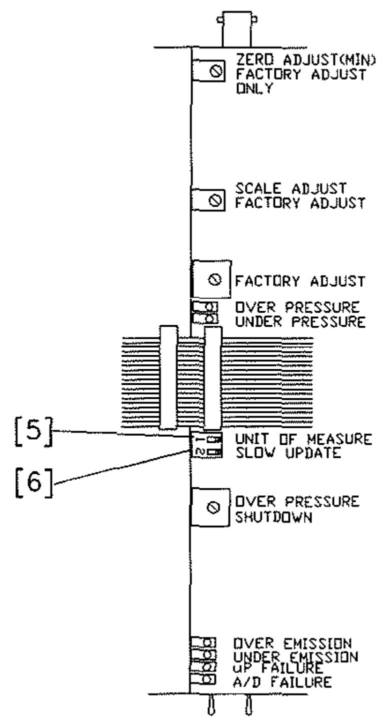


Fig. 2.1 Ion Gauge Electrometer Module Top View

Display Update Rate Switch

Locate [6] slow update switch. Setting this switch "ON" will enable pressure averaging. The display will update about every 3 seconds rather than the normal 0.5 sec typical period.

2.3 OPERATION

Displaying Sensitivity and Emission with the Calibration Switch [7]

This switch is used for displaying pressure, gauge sensitivity or emission current. It is activated by setting either to the left or right. The function depends on the state of the ion gauge tube:

If the tube is off, setting the switch displays the tube sensitivity in the display. This will be in scientific notation.

If the tube is on, the switch displays emission current in amperes. Note the display will blink at a two second rate in this mode to warn the user that pressure is not being displayed.

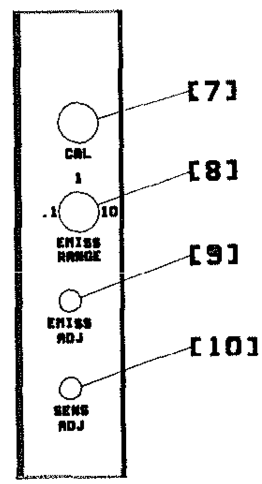


Fig. 2.2 Electrometer Module Front Panel

WARNING

Do not leave the calibration switch set after you are done viewing sensitivity or emission; otherwise, the display reading may be mistaken for an actual pressure reading.

Emission Range Switch [7]

This switch selects between three emission ranges; 0.1 milliampere, 1.0 milliampere, or 10.0 milliampere. Adjustment within each range is achieved with the emission adjustment pot (see below).

In general higher emissions are used at lower pressures. If, for example, you are using a broad range IG tube and wish to measure to its upper pressure limit, the 0.1 mA range is recommended. If you are measuring very low pressures or have a low sensitivity IG tube, the 10.0 mA range is better. In general, lower emissions will increase tube life.

Note that changing the emission range by one decade will also change the overpressure shutdown point by one decade. See Section 2.4 "Electrometer Calibration" for details of the overpressure shutdown adjustment. Adjustment of emission within a range (see below) will not affect the overpressure shutdown point.

Emission Adjustment [9]

This potentiometer provides control of the emission within the decade value selected by the emission range switch. The calibration switch must be set with the IG tube turned on to view emission during adjustment. The span of adjustment is from approximately 10% to 120% of the range value.

Please note that on some earlier generation IG controllers, the emission current adjustment was used to correct for varying tube sensitivities. This is not appropriate on the 340 controller, as an independent sensitivity adjustment is provided (see below).

Theoretically, varying the emission current will not affect the pressure reading since the electrometer is actually calculating:

$$P = \frac{I+}{S(I-)} \quad \text{OR} \quad \text{Pressure} = \frac{\text{Collector Current}}{\text{Sensitivity (Emission current)}}$$

In actuality, there will be slight differences dependent on gauge cleanliness and gauge pumping.

Sensitivity Adjustment [10]

This adjustment is used to match tubes of different sensitivities. The calibration switch [6] must be set left or right with the IG off to view sensitivity during the adjustment.

The VGC is set for a tube sensitivity of 10/Torr which is typical for Bayard-Alpert type tubes such as the Granville-Phillips 274. The approximate range of the adjustment is 3 to 50/Torr.

Relative Gas Sensitivities

Sensitivity depends on the gas being measured as well as the type of IG tube. Fig. 2.3 lists the relative gauge sensitivities for common gases. These values are from NASA Technical Note TND 5285, "Ionization Gauge Sensitivities as Reported in the Literature", by Robert L. Summers, Lewis Research Center, National Aeronautics and Space Administration. Refer to this technical note for further definition of these average values and for the gauge sensitivities of other gases.

To adjust the 340 VGC to be direct reading for gases other than air or N_2, calculate the sensitivity K_x for gas type x as follows:

$$K_x = (R_x)\ (KN_2),$$

where KN_2 is the gauge sensitivity for N_2 and R_2 is found from Fig. 2.3.

GAS	Rx	GAS	Rx
He	0.18	H_2O	1.12
Ne	0.30	NO	1.16
D_2	0.35	Ar	1.29
H_2	0.46	CO_2	1.42
N_2	1.00	Kr	1.94
Air	1.00	SF6	2.5
O_2	1.01	Xe	2.87

Fig. 2.3 Relative Gas Sensitivities

Analog Output [11]

This voltage is proportional to the logarithm of the pressure, scaled to 1 volt per decade with 0 volts at 1×10^{-12} Torr at 10 mA emission current. Emission range setting affects the scaling of the analog output, see Fig. 2.5. When the IG is turned off, the output will switch to slightly over +10 Vdc.

A standard 1/8" miniature phone jack connector is supplied.

For 10 mA emission, PRESSURE = $10^{(\text{volts}-12)}$.
For 1 mA emission, PRESSURE = $10^{(\text{volts}-11)}$.
For .1 mA emission, PRESSURE = $10^{(\text{volts}-10)}$.

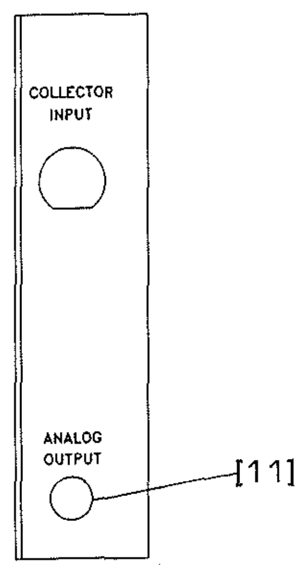


Fig. 2.4 Electrometer Module Back Panel

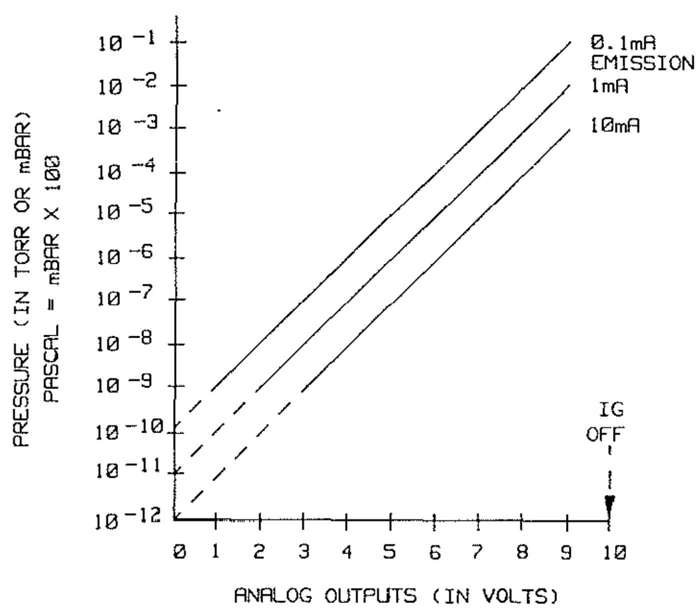


Fig. 2.5 Analog Outputs (in volts)

2.4 ELECTROMETER CALIBRATION

Refer to Section 2.3 for instructions on calibrating ion gauge sensitivity and emission current.

Electrometer Minimum Adjustment (Rear Panel) [12] - This potentiometer calibrates the electrometer for very low inputs. Factory set, do not adjust. Refer to the trouble-shooting Section 3.4 for further information.

Electrometer Scale Adjustment [13] - This is a factory calibration point and should not normally be changed by the user.

Overpressure Shutdown Adjustment [14] - This control is factory set so that the ion gauge will shut down when the pressure rises above the following levels:

Emission Current (milliamperes)	**Overpressure Point (Torr)**
0.1 range	1×10^{-2}
1.0 range	1×10^{-3}
10.0 range	1×10^{-4}

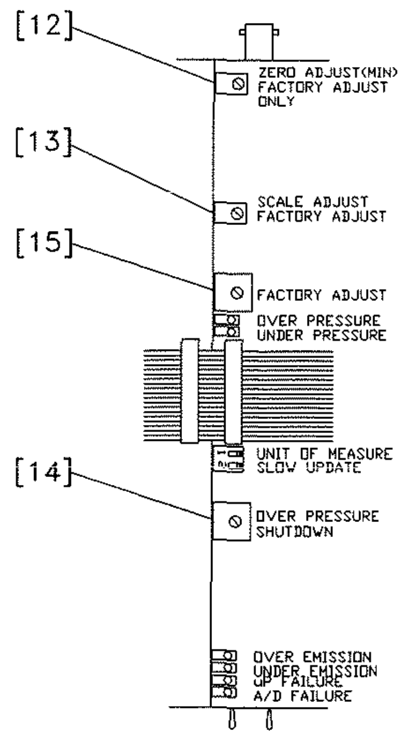


Fig 2.6 Ion Gauge Electrometer Module

The overpressure shutoff point does not depend on the adjustment of the emission level within a range.

To adjust the overpressure shutoff point to a different level:

1) Maintain system pressure at the desired shutoff point.

2) Rotate the overpressure adjustment potentiometer fully counter-clockwise.

3) Turn on the ion gauge.

4) Rotate the adjustment pot clockwise slowly until the IG turns off.

AD Calibration [15] - Factory set, do not adjust.

NOTES

CHAPTER 3 - THE *CONVECTRON* GAUGE MODULE

SAFETY INSTRUCTIONS

SAFETY PAYS. THINK BEFORE YOU ACT. UNDERSTAND WHAT YOU ARE GOING TO DO BEFORE YOU DO IT. READ THIS INSTRUCTION MANUAL BEFORE INSTALLING, USING, OR SERVICING THIS EQUIPMENT. IF YOU HAVE ANY DOUBTS ABOUT HOW TO USE THIS EQUIPMENT SAFELY, CONTACT THE GRANVILLE-PHILLIPS PRODUCT MANAGER FOR THIS EQUIPMENT AT THE ADDRESS LISTED IN THIS MANUAL.

<u>Explosive Gases</u>
Do not use the gauge tube when there is danger of explosion from ignition of combustible gas mixtures. The sensing element normally operates at only 125 °C but it is possible that momentary transients or controller malfunction can raise the sensor above the ignition temperature of combustible mixtures, which might then explode, causing damage to equipment and injury to personnel.

<u>Limitation on Use of Compression Mounts</u>
Do not use a compression mount (quick connect) for attaching the gauge tube to the system in applications resulting in positive pressures in the gauge tube. Positive pressures might blow the tube out of a compression fitting and damage equipment and injure personnel. The *CONVECTRON* gauge should not be used above 1000 Torr (1333 mbar or 1.33×10^5 Pa).

<u>Tube Mounting Position</u>
If the gauge tube will be used to measure pressures greater than 1 Torr or 1 mbar, the tube must be mounted with its axis horizontal. Although the gauge tube will read correctly below 1 Torr when mounted in any position, erroneous readings will result at pressures above 1 Torr if the tube axis is not horizontal. Erroneous readings can result in over or underpressure conditions which may damage equipment and injure personnel.

<u>Overpressure</u>
CONVECTRON gauges should not be used above 1000 Torr true pressure. **Do not use above 1000 Torr true pressure.** Series 340 instruments are furnished calibrated for N_2. They also measure the pressure of air correctly within the accuracy of the instrument. Do not attempt to use a *CONVECTRON* gauge calibrated for N_2 to measure or control the pressure of other gases such as argon or CO_2, unless accurate conversion data for N_2 to the other gas is properly used. If accurate conversion data is not used or improperly used, a potential overpressure explosion hazard can be created under certain conditions.

For example, at 760 Torr of argon gas pressure, the indicated pressure on a *CONVECTRON* gauge calibrated for N_2 is 24 Torr. At an indicated pressure of 50 Torr, the true pressure of argon is considerably above atmospheric pressure. Thus, if the indicated pressure is not accurately converted to true pressure, it is possible to overpressure your system. Overpressure may cause glassware, such as ionization gauges, to shatter dangerously, and if high enough may cause metal parts to rupture, thus damaging the system and possibly injuring personnel. See Section 3.3 for proper use of conversion data.

A pressure relief valve should be installed in the system should the possibility of exceeding 1000 Torr exist.

<u>High Indicated Pressure</u>
For some gases, be aware the indicated pressure will be higher than the true pressure. For example, at a true pressure of 9 Torr for helium, the indicated pressure on a *CONVECTRON* gauge calibrated for N_2 is 760 Torr. The safe way to operate the gauge is to properly use accurate conversion data. See Section 3.3 for proper use of conversion data.

<u>Chemicals</u>
Cleaning solvents, such as trichloroethylene, perchloroethylene, toluene and acetone, produce fumes that are toxic and/or flammable. Use only in areas well ventilated to the outdoors and away from electronic equipment, open flames, or other potential ignition sources.

<u>Sensor Failure</u>
If the gauge tube becomes disconnected from the controller or if the sensor wire in the gauge tube fails, the controller will indicate 9.9E+9. If the tube is unplugged for a powered controller, there may be an instantaneous (0 to 0.2 seconds) drop in the pressure indication and the process control relay could activate for this brief time, depending on the order in which the tube pins break contact.

<u>Tube Contamination</u>
The calibration of the gauge will be seriously affected by any gas which will attack the gold plated sensor, and could result in overpressurizing the system. Two primary gases in this category are mercury vapor and fluorine.

3.1 INTRODUCTION

The *CONVECTRON* Gauge (CG) Module provides pressure measurement from 1.0×10^{-3} Torr (1.3×10^{-3} mbar or 1.3×10^{-1} Pa) to 1000 Torr, and one meaningful digit pressure indication down to 1×10^{-4} Torr, air equivalent. Two transducers are displayed simultaneously in the second and third display lines and are denoted here by "CGA" and "CGB", respectively.

Analog output is also provided. The *CONVECTRON* can also be used to automatically turn on or off the ion gauge and the process relay.

3.2 INSTALLATION

<u>Units of Measure</u>

Your instrument will have been shipped from the factor pre-set to display the units of measure, torr, millibar, or pascal, that you requested. If you wish to change units, proceed as follows:

1) Shut off power to the control unit.

2) Remove the top cover. Locate the *CONVECTRON* Module.

3) Locate [16] the millibar and [17] pascal units switches.

4) Leave both switches open for torr units. Close the appropriate switch for either millibar or pascal units.

5) Modify the units of measure of the electrometer to be consistent with the *CONVECTRON*.

6) Slip the label card out of the top of the front panel and apply the appropriate pressure units label.

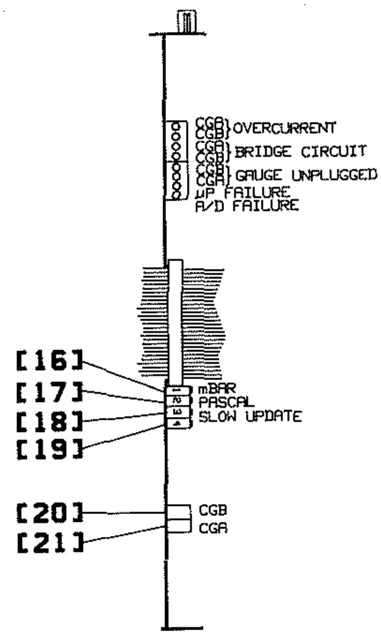


Fig. 3.1 *CONVECTRON* Module Top View

<u>Display Update Rate Switch</u> [18]

When "ON", this switch enables pressure averaging. The display will be updated approximately every 3 seconds. When "OFF", the update period is approximately 0.5 sec.

Not used. [19]

<u>CG"B" Select Switch</u> [20]

When "ON", selects CG"B" as the controlling gauge for the process relay.

<u>CG"A" Select Switch</u> [21]

When "ON", selects CG"A" as the controlling gauge for the process relay.

<u>Accessory Connector</u>

Process relay and analog output connections are available from the 9 pin "D" connector located below the dual *CONVECTRON* gauge cable on the rear of the module. This includes two sets of relay contacts from a double-pole, double-throw relay and two analog outputs.

Pin No.	Function
1	Pole 1 normally closed contact
2	Pole 1 normally open contact
3	Pole 2 normally open contact
4	Not used
5	Pole 2 common
6	Pole 1 common
7	*CONVECTRON* gauge "A" analog output
8	Ground
9	*CONVECTRON* gauge "B" analog output

NOTE: The normally closed contact of pole 2 is not available on the connector.

CONVECTRON Gauge Tube Installation

Important Precautions for Gauge Tube Installation

The following precautions in the use and installation of the *CONVECTRON* gauge tube must be observed.

IMPORTANT

1. Observe the precautions at the front of this chapter regarding tube mounting position and high pressure operation.

2. It is recommended that the gauge tube be installed with the port oriented vertically downward to ensure that no system condensates or other liquids collect in the gauge tube. It is not necessary, however, from a performance standpoint.

3. Keep the tube clean. **Do not** remove the mounting port cover until you are ready to install the tube.

4. **Do not** mount the gauge tube in a manner such that deposition of process vapors upon the internal surfaces of the tube may occur through line-of-sight access to the interior of the gauge tube.

5. **Do not** install the tube where high amplitudes of vibration are present. Excessive vibration will cause forced convection at high pressure giving erroneous readings.

6. **Do not** bake the tube to temperatures above 150 °C.

7. **Do not** install the gauge tubes where they will be exposed to corrosive gases such as mercury vapor, chlorine, or fluorine, which will attack the gold plated sensor.

8. For greatest accuracy and repeatability, the gauge tube should be located in a stable room temperature environment.

> ⚠ When high voltage is present, all exposed conductors of a vacuum must be maintained at earth ground.

9. Under certain conditions, dangerous high voltage can be coupled directly to an ungrounded conductor through a gas almost as effectively as through a copper wire connection. This hazard, which is not peculiar to this product, is a consequence of the ability of an electric current to flow through a gas under certain circumstances. A person may be seriously injured, or even killed by merely touching an exposed ungrounded conductor at high potential.

   When high voltages are used within the vacuum system and the *CONVECTRON* gauge envelope is not reliably grounded through its vacuum connection, either a separate ground wire must be added, or the envelope must be shielded to positively prevent human contact. The gauge envelope may be grounded by using a metal hose clamp on the gauge connected by a #12 awg copper wire to the grounded vacuum chamber.

   High voltage can couple through a gas to the internal electrodes of a gauge. Do not touch the exposed pins on any gauge installed on a vacuum system where high voltage is present.

<u>Gauge Tube Orientation</u>

It is important to consider the orientation of the gauge tube if accurate readings above 1 Torr are desired.

<u>Below 1 Torr:</u> The gauge tube will operate and accurately read pressures below 1 Torr when mounted in any orientation. <u>Above 1 Torr:</u> The gauge tube will accurately read pressures above 1 Torr only when mounted with its axis horizontal, preferably with the port pointing vertically downward, as shows in Fig. 2. It is valuable to point the port downward to facilitate the removal of condensation and other contaminants.

Furthermore, the gauge is factory calibrated with the port pointing vertically downward. Installation of the gauge with the port in other orientations may affect the accuracy of the indicated pressure.

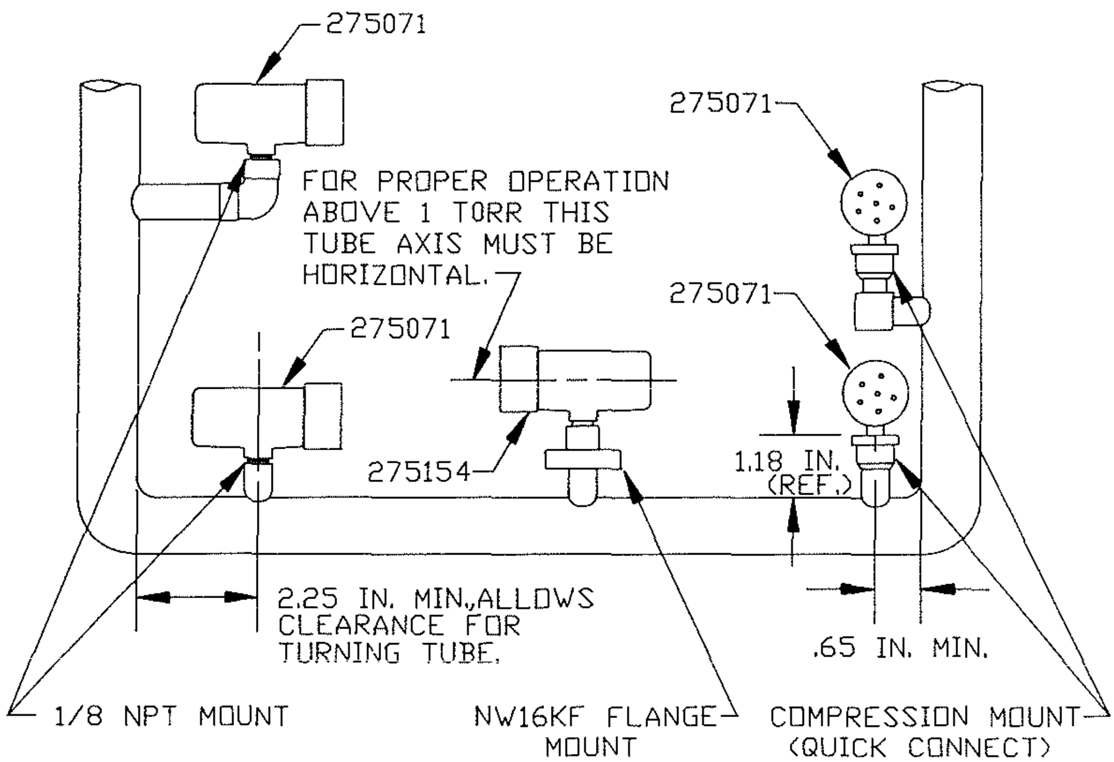


Fig. 3.2 *CONVECTRON* Gauge Mounting

1. Compression Mount (Quick Connect)

   Do not use for positive pressure applications.

   The gauge tube port is designed to fit a standard 1/2 in. compression (quick connect) mount such as the Cajon® Ultra-Torr® fittings.

   Remove the caplug from the gauge tube port, insert the gauge tube port into the compression fitting and finger tighten the press ring. If a seal is not achieved it may be due to extreme cleanliness of the O-ring. A light film of vacuum grease such as Apiezon[1] will insure sealing and is normally preferable to the use of pliers or pipe wrench to further tighten the press ring. You may point the electrical pins of the gauge tube anywhere you wish in a 360 degree horizontal circle for optimum routing of the gauge tube cable.

2. 1/8 NPT Mount

   The threads on the gauge tube port will fit a standard 1/8 NPT female fitting. Wrap the threads of the gauge tube port with Teflon tape and screw these threads into the system fitting hand tight. Do not use any wrench or tool. The gauge tube body functions adequately as its own wrench. Tighten only

[1]Trademark of James G. Biddle Co.

sufficiently to achieve a seal. After this, one half turn additional tightening is all that can be gained without overstressing the tube port.

3. NW10, 16, 25 and 40KF Flange Mount

The KF mounting system requires an O-ring and centering ring to be placed between the mating flanges. The flanges are then held together with the aluminum flange clamp by tightening the wing nut. Maximum pressure for this style mounting system is 1000 Torr absolute.

3.3 OPERATION

Reading Pressure

WARNING

IF USED WITHOUT PROPER CALIBRATION OR WITHOUT REFERENCE TO PROPER CALIBRATION TABLES, *CONVECTRON* gauges can supply misleading pressure indications. This may result in dangerous overpressure conditions within the system. As supplied from the factory, the controller is designed to read pressure for nitrogen. For use with any other gases, consult the gas type correction charts found later in this manual.

The *CONVECTRON* pressures are read in displays A and B of the 340 control unit. These pressures are displayed to 2 digits, except in the 10^{-4} Torr range, where only 1 meaningful digit is displayed.

Special Considerations for Use Below 10^{-3} Torr

During a fast pumpdown from atmosphere, thermal effects will prevent the *CONVECTRON* from tracking pressure rapidly below 10^{-3} Torr. After about 15 minutes, readings in the 10^{-4} range will be valid and response will be rapid. Calibration at vacuum may be performed at this time, or sooner if readings in the 10^{-4} range are not needed.

The 10^{-4} range is accurate to about 0.1 milliTorr provided the instrument has been carefully zeroed at vacuum. See Section 3.4 for vacuum and atmosphere calibration procedures. For accurate use in the 10^{-4} Torr range, zeroing should be repeated frequently.

Pressure readings in the 10^{-4} Torr range may differ from those found from ion gauges, since ion gauges usually lose sensitivity near their upper pressure limits.

Use With Gases Other than N_2 and Air

Before using the *CONVECTRON* gauge to measure the pressure of other gases, make certain the ATM adjustment is correctly set for air. See Section 3.4.

It is important to understand that the indicated pressure on a *CONVECTRON* gauge depends on the type of gas in the tube, and on the orientation of the tube axis as well as on the gas pressure in the tube. *CONVECTRON* gauges are supplied calibrated for N_2 within the accuracy of the instrument. With certain safety precautions, the *CONVECTRON* gauge may be used to measure pressure of other gases.

CONVECTRON gauge tubes are thermal conductivity gauges of the Pirani type. These gauges transduce gas pressure by measuring the heat loss from a heated sensor wire maintained at constant temperature. For gases other than N_2 and air the heat loss is different at any given true pressure and then the indicated reading will be different.

Indicated vs. True Pressure Curves

Figures 3.3, 3.4, 3.5, 3.6, 3.7, and 3.8 show the true pressure vs. indicated pressure on Series 340 instruments for eleven commonly used gases. The following list will help to locate the proper graph for a specific application:

Fig.	Range and Units	Gases
3.3	1 to 100 mTorr	All
3.4	0.1 to 1000 Torr	Ar, CO_2, CH_4, Freon 12, He
3.5	0.1 to 1000 Torr	D_2, Freon 22, Kr, Ne, O_2
3.6	10^{-3} to 10^{-1} mbar	All
3.7	0.1 to 1000 mbar	Ar, CO_2, CH_4, Freon 12, He
3.8	0.1 to 1000 mbar	D_2, Freon 22, Kr, Ne, O_2

Note that 1 mbar = 100 Pa, so the mbar charts may be used for pascal units by multiplying the values on the axes by 100.

A useful interpretation of these curves is, for example, that at a true pressure of 2×10^{-2} Torr of CH_4, the heat loss from the sensor is the same as at a pressure of 3×10^{-2} Torr of N_2 (see Fig. 3.3). The curves at higher pressure vary widely from gas to gas because the thermal losses at higher pressures are greatly different for different gases.

The *CONVECTRON* gauge tube utilizes convection cooling to provide resolution superior to any other thermal conductivity gauge near atmospheric pressure of N_2 and air. Because convection effects are geometry dependent, the true pressure vs indicated pressure curves for the *CONVECTRON* gauge tube are likely to be much different from curves for heat loss tubes made by others. Therefore, it is not safe to attempt to use calibration curves supplied by other manufacturers for the gauges with the *CONVECTRON* nor is it safe to use curves for the *CONVECTRON* gauge with gauges supplied by other manufacturers.

If you must measure the pressure of gases other than N_2 or air, use Figures 3.3 through 3.8 to determine the maximum safe indicated pressure for the other gas as explained below.

EXAMPLE 1 Maximum safe indicated pressure.

Assume a certain system will withstand an internal pressure of 2000 Torr or 38.7 psia. For safety you wish to limit the maximum internal pressure o 760 Torr during backfilling. Assume you wish to measure the pressure of argon. On Fig. 4 locate 760 Torr on the left hand scale, travel to the right to the intersection with the argon (Ar) curve and then down to an indicated pressure of 24 Torr (N_2 equivalent). Thus in this hypothetical situation the maximum safe indicated pressure for argon is 24 Torr.

For safety, it is prudent to place a warning label on the instrument face which, under the assumed conditions, would read "DO NOT EXCEED 24 TORR FOR ARGON."

EXAMPLE 2 Indicated to true pressure conversion.

Assume you wish to determine the true pressure of argon in a system when the *CONVECTRON* is indicating 10 Torr. On Fig. 3.4, read up from 10 Torr (N_2 equivalent) indicated pressure to the argon curve and then horizontally to the left to a true pressure of 250 Torr. Thus 250 Torr argon pressure produces an indication of 10 Torr, (N_2 equivalent).

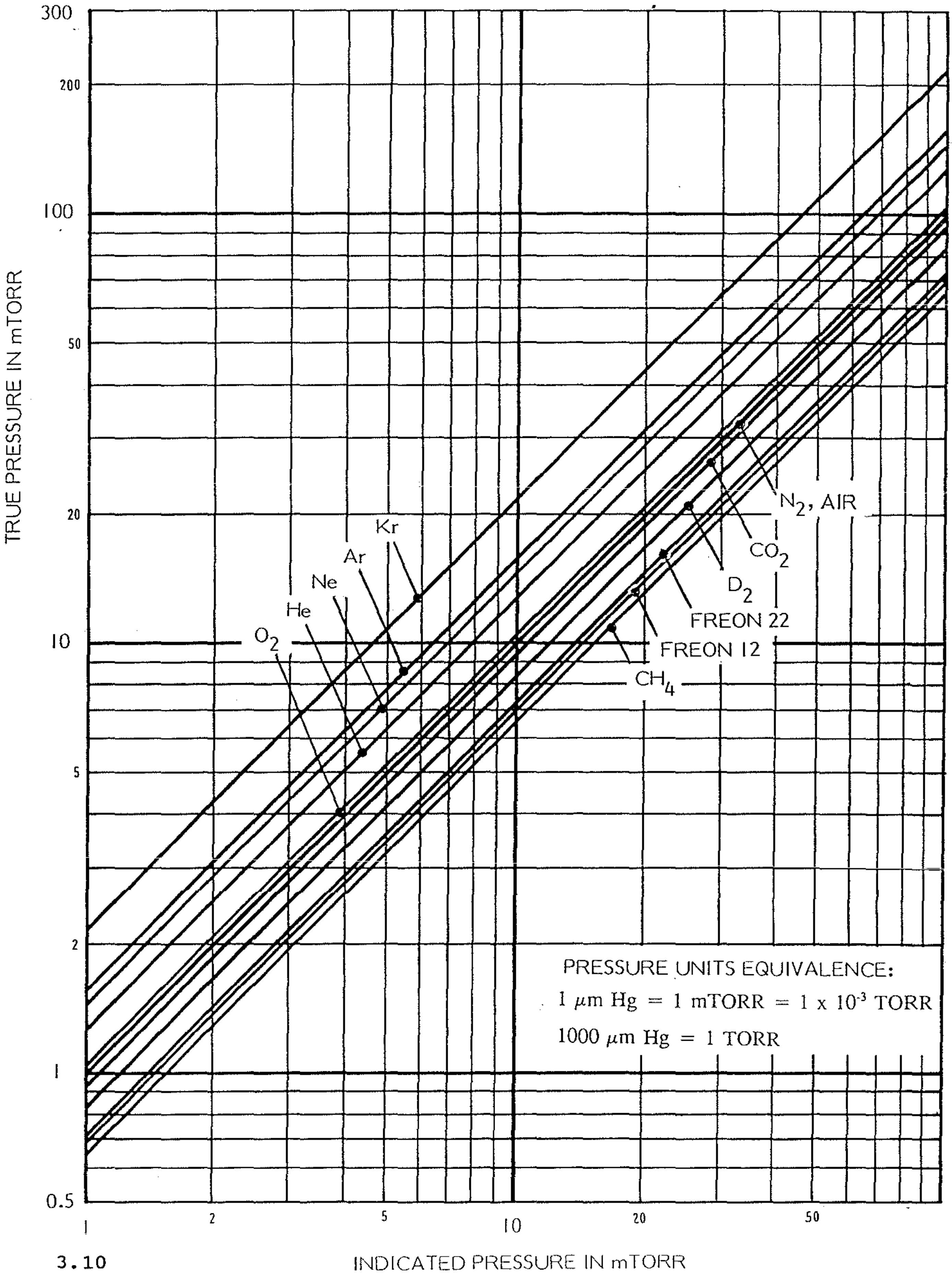
EXAMPLE 3 True to indicated pressure conversion.

Assume you wish to set a process control setpoint at a true pressure of 20 Torr of CO_2. On Fig. 3.4, locate 20 Torr on the true pressure scale, travel horizontally to the right to the CO_2 curve and then down to an indicated pressure of 6 Torr (N_2 equivalent). Thus the correct process control setting for 20 Torr of CO_2 is 6 Torr (N_2 equivalent).

EXAMPLE 4 True to indicated pressure conversion.

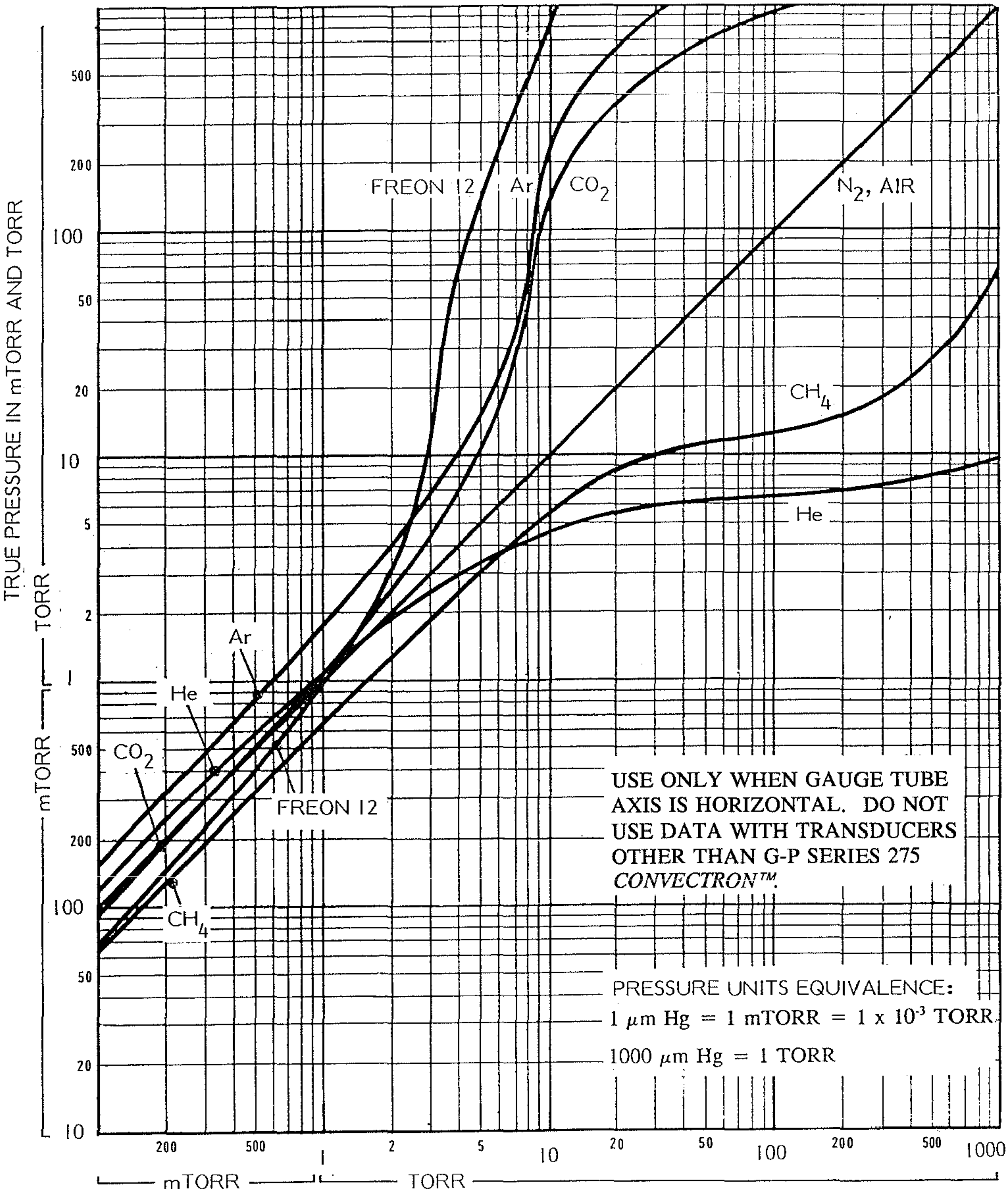
Assume you wish to obtain a helium pressure of 100 Torr in the system. On Fig. 3.4, locate 100 Torr on the left hand scale, travel horizontally to the right to attempt to intersect the He curve. Because the interaction is off scale it is apparent that this true pressure measurement requirement for helium exceeds the capability of the instrument.

For gases other than those listed, the user must provide accurate conversion data for safe operation. The *CONVECTRON* gauge is not intended for use above 1000 Torr true pressure.



TRUE PRESSURE IN mTORR
300
200
100
50
20
10
5
2
1
0.5
1
2
5
10
20
50
Kr
Ar
Ne
He
O_2
N_2, AIR
CO_2
D_2
FREON 22
FREON 12
CH_4
PRESSURE UNITS EQUIVALENCE:
1 μm Hg = 1 mTORR = 1 x 10^{-3} TORR
1000 μm Hg = 1 TORR
INDICATED PRESSURE IN mTORR
(N_2 EQUIVALENT)

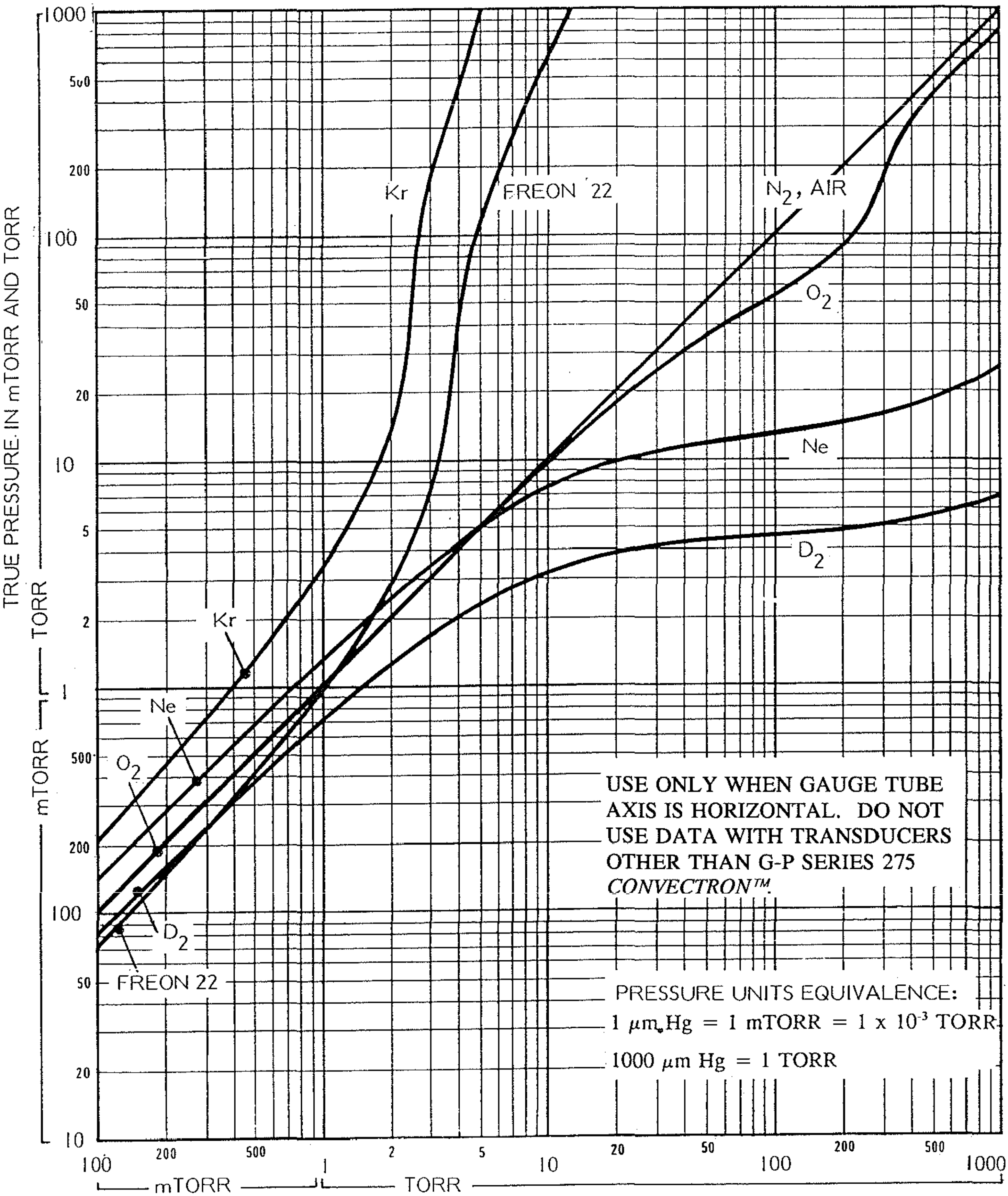
Fig. 3.3



INDICATED PRESSURE IN mTORR AND TORR

(N_2 EQUIVALENT)

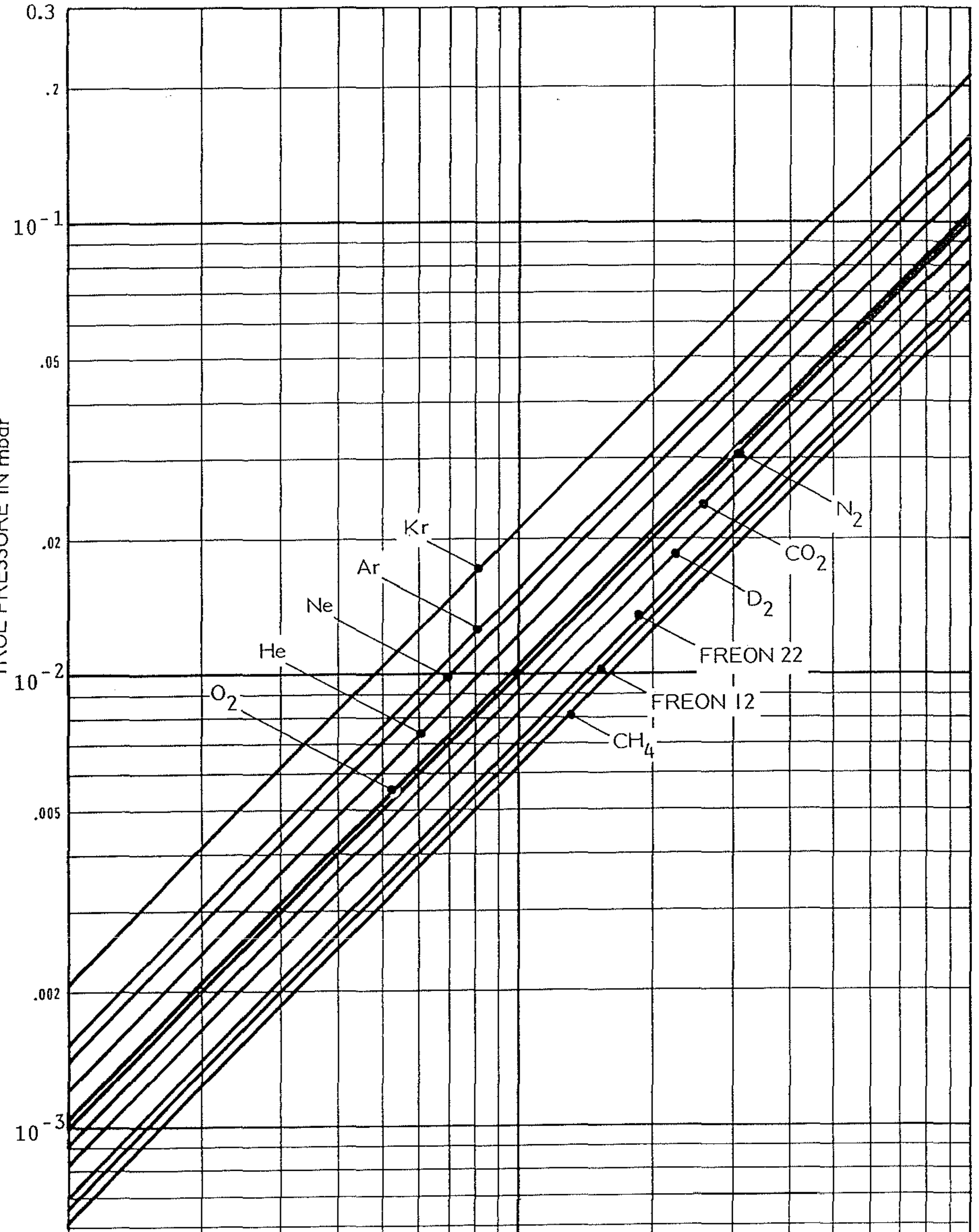
Fig. 3.4



INDICATED PRESSURE IN mTORR AND TORR

(N_2 EQUIVALENT)

Fig. 3.5



INDICATED PRESSURE IN mbar
(N_2 EQUIVALENT)

Fig. 3.6

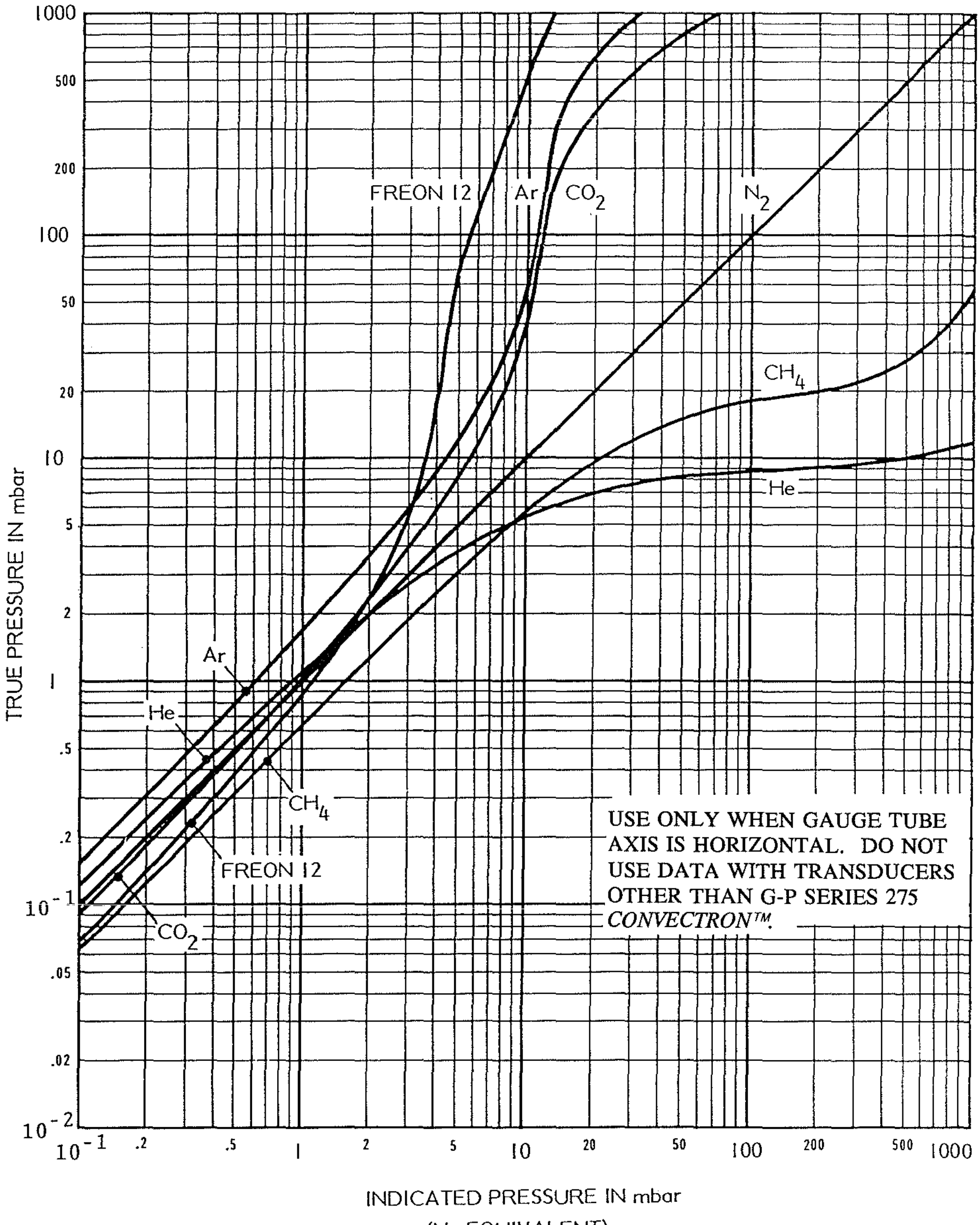
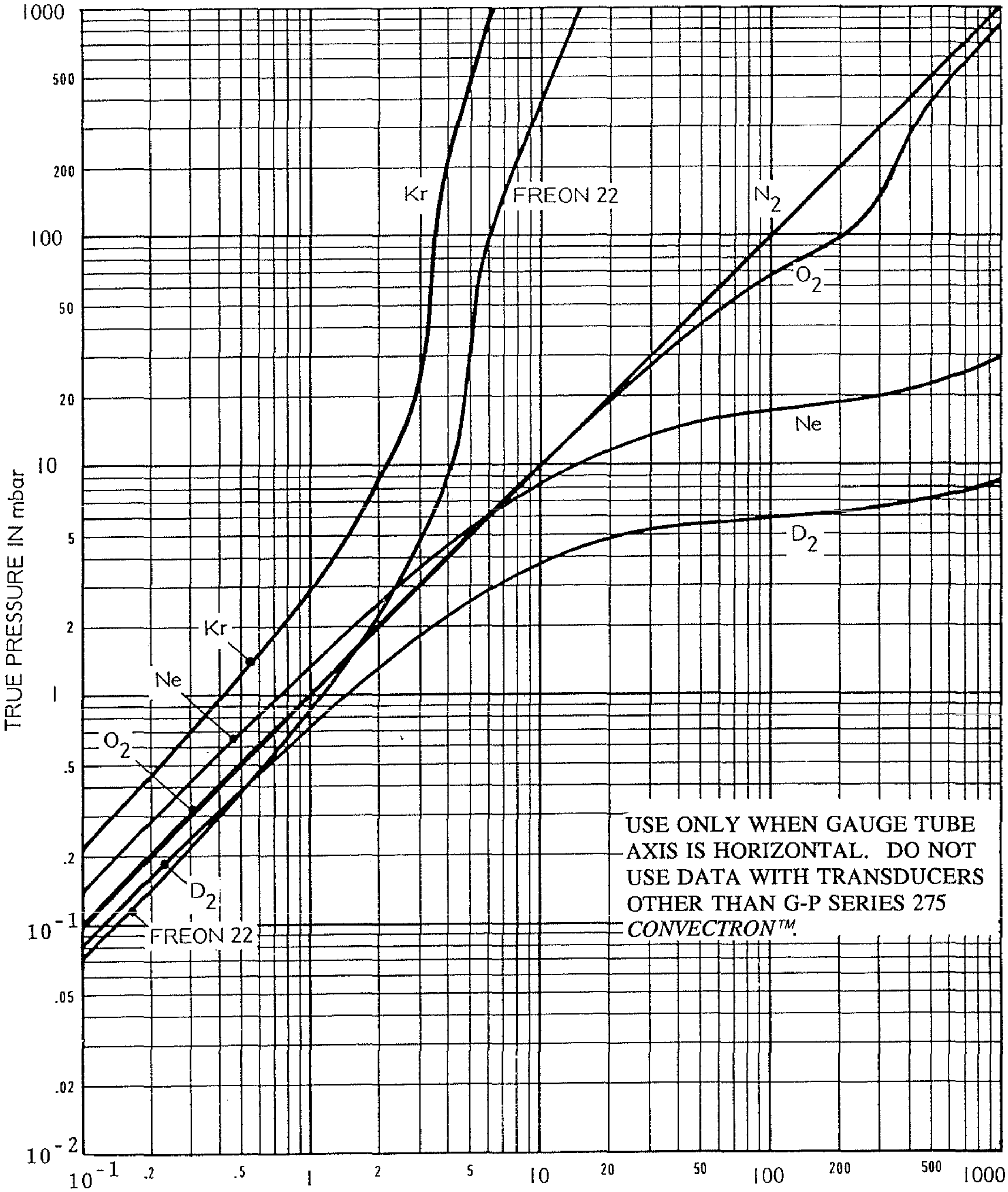

1000
500
200
100
50
20
10
5
2
1
.5
.2
10^{-1}
.05
.02
10^{-2}
10^{-1}
.2
.5
1
2
5
10
20
50
100
200
500
1000
TRUE PRESSURE IN mbar
FREON 12
Ar
CO_2
N_2
CH_4
He
USE ONLY WHEN GAUGE TUBE AXIS IS HORIZONTAL. DO NOT USE DATA WITH TRANSDUCERS OTHER THAN G-P SERIES 275 *CONVECTRON™*.
INDICATED PRESSURE IN mbar
(N_2 EQUIVALENT)

Fig. 3.7



INDICATED PRESSURE IN mbar

(N_2 EQUIVALENT)

Fig. 3.8

Analog Output

On the rear panel accessory connector analog outputs for both gauges are provided. These are nonlinear dc voltages with an accuracy of ±10% used primarily for driving a strip chart recorder.

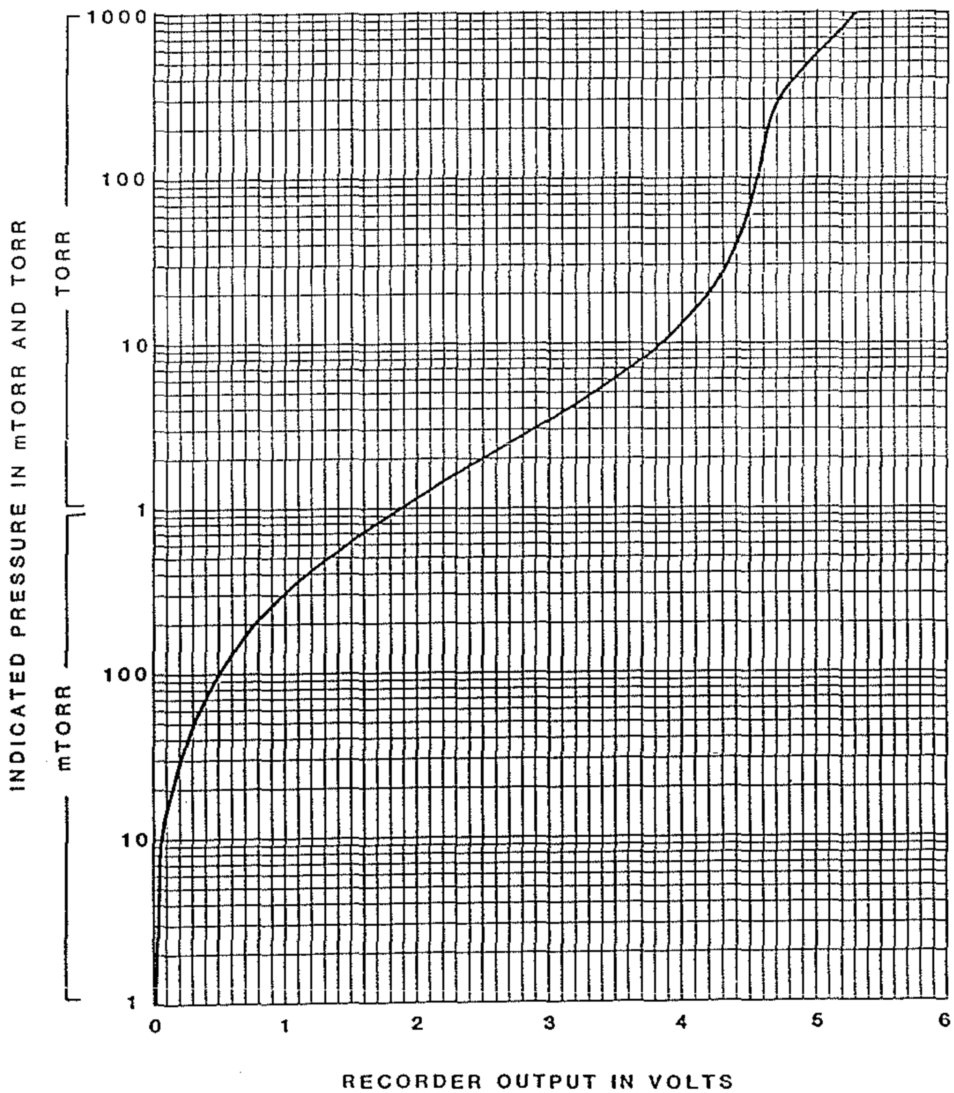


Fig. 3.9 *CONVECTRON* Gauge Pressure Analog Output

Filament Auto Turn-On [24]

CGA may be used to automatically turn on the ion gauge. Auto turn-on occurs when the CG pressure drops below the setpoint defined by the auto turn-on adjustment potentiometer. The IG will also automatically be turned off when the pressure rises above this point.

The automatic off/on function will execute only once per setpoint crossing. For example, the IG may be turned off manually when below the setpoint, and the auto-on function will not turn it back on again until CG pressure has risen above the setpoint and once again dropped below.

The auto turn-on potentiometer [24] is marked with rough pressure calibration markings. To set the pressure at which the IG will turn on with falling CG pressure, and off with rising pressure, simply adjust the pot to the desired pressure.

More precise control may be achieved by fixing the system pressure at the desired auto turn-on pressure, and adjusting the potentiometer slowly until the gauge turns on.

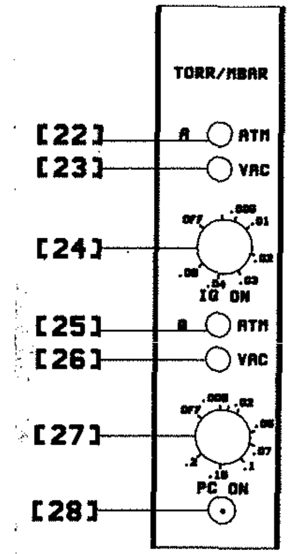


Fig. 3.10 *CONVECTRON* Module Front Panel

To disable the auto turn on function, adjust the CG auto turn-on pot counterclockwise OFF.

Process Relay Turn-on [27]

Depending on the switch position of the two internal selector switches either CGA or CGB may be used to control the process relay. Process relay turn on occurs when the selected CG pressure drops below the setpoint defined by the process relay adjust potentiometer [27]. The process relay will also automatically be turned off when the pressure rises slightly above the setpoint. To disable the process relay, adjust the process relay turn-on pot completely counterclockwise OFF.

Process Relay On Indicator [28]

The process relay on indicator LED will be on anytime the process relay is energized.

3.4 CALIBRATION

Each gauge tube is individually calibrated for N_2 and air prior to leaving the factory. The *CONVECTRON* gauge tube itself has a temperature compensated design. Each controller is also individually calibrated to provide accurate readout of N_2 and air pressure with any calibrated tube. Therefore, initial calibration should not be necessary. See Section 3.3 for use with gases other than N_2 or air.

Calibration should be performed if accurate readings in the 10^{-4} Torr range are desired, if the tube becomes contaminated, does not read correctly, or to readjust for use with long cables. The gauge and controller can be calibrated as a system by performing the following steps:

Zero Adjustment [23] and [26]

1. Evacuate the system to a pressure less than 1×10^{-4} Torr.

2. With the gauge tube operating, adjust the VAC pot until 0.0 0 shows in the display. Note that if the adjustment is turned too far below zero, a minus sign will appear before the exponent (0.0 -0). Thus, proper zero calibration is achieved when only 0.0 0 appears.

Atmosphere Adjustment [22] and [25]

1. Allow the system pressure to rise to atmospheric pressure of N_2 or air.

2. Adjust the ATM pot until the pressure displayed agrees with the absolute pressure as read on an accurate barometer. Use absolute pressure, not corrected to sea level.

NOTE: 1 atmosphere normal at sea level = $7.6 \times 10^{+2}$ Torr = $1.0 \times 10^{+3}$ mbar = $1.0 \times 10^{+5}$ Pa.

CHAPTER 4 - MAINTENANCE

General Information

Although this instrument was designed using as many commonly available components as possible, thus allowing easy service, it is still recommended that only qualified technical personnel attempt repairs.

Should difficulties be encountered in the use of your controller, the following list of symptoms and remedies, along with the schematics, can prove useful in quickly getting back into operation. Since the majority of parts are readily available at local electronics supply stores, it may, in some cases, prove most expedient for you to repair minor troubles should they occur.

If the prescribed remedies do not correct the troubles, or if additional assistance or special parts ar required, contact the Technical Service Department., Granville-Phillips Company, 5675 Arapahoe Avenue, Boulder, Colorado, 80303. Telephone: (303)-443-7660. Repairs properly made with equivalent electronic parts and rosin core solder, which do not damage other portions of the unit, do not represent a violation of the warranty.

Check the following list for the observed symptoms. This listing of symptoms and remedies is not complete, but should be sufficient to solve most problems. <u>All possible causes of failure should be thoroughly explored before attempting any component replacement</u>.

Guidelines

Since the 340 VGC contains static-sensitive electronic parts, the following precautions must be followed when troubleshooting:

1. Use a grounded, conductive work surface.
2. Use static dissipative envelopes to store or ship MOS devices or printed circuit boards.
3. **Do not** operate the 340 VGC with MOS devices removed from the unit.
4. **Do not** handle MOS devices more than absolutely necessary, and only when wearing a ground strap.
5. **Do not** use an ohmmeter for troubleshooting. Rely on voltage measurements.
6. Use grounded-type soldering irons only.

SEE WARNING NEXT PAGE

DANGER, HIGH VOLTAGE

HIGH VOLTAGES ARE PRESENT WITHIN THE POWER SUPPLY, CAPABLE OF CAUSING INJURY OR DEATH USE EXTREME CARE WHILE TROUBLESHOOTING WHEN POWER IS APPLIED.

4.1 POWER INPUT PROBLEMS

SYMPTOM	POSSIBLE CAUSE	CURE
1. *CONVECTRON* gauge displays will not light (all functions inoperative.	1. Power cord not plugged in.	Plug in power cord.
	2. No power to receptacle.	Restore power to receptacle.
	3. Controller input power fuse blown.	Replace fuse with correct type and value as indicated on rear panel.
	4. Defective power transformer T1, power switch, or line filter. Check secondary voltages of T1 at connector of transformer P4 where it plugs into the power supply module. PIN(S) — AC VOLTAGE (RMS) ±10% 1-2 to 3-4 — 10 6-7 — 15 8-7 — 15 9-7 — 190	Troubleshoot and repair.
2. Controller input power fuse blows as soon as the power switch is turned on.	1. Incorect power source. Check power source vs. controller requirements.	Connect controller to proper source of power or reset selector card to voltage in use as explained in Section 1.2.
	2. Incorrect fuse rating.	Use correct fuse as indicated

SYMPTOM	POSSIBLE CAUSE	CURE
		on rear panel.
	3. Defective line filter, transformer, power switch or transient suppressor. Unplug transformer secondary from the power supply module (P4). If fuse does not blow go to possible cause 4.	Troubleshoot and repair.
	4. Defective component on power supply module (see below).	Locate defective component and replace.

4.2 POWER SUPPLY PROBLEMS

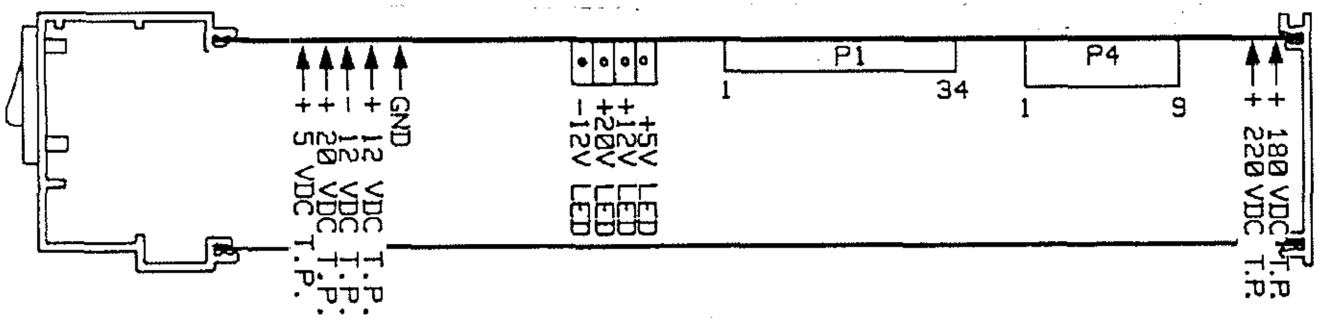


Fig. 4.1 Power Supply Module Top View

Whenever a problem persists after elimination of possible external causes by removing all cables except the power cable, and thus appears to be in the controller, the power supplies should be checked first. Use a standard DVM to check the labeled points for the following outputs with respect to ground. Test points are located across the top edge of the power supply module as shown in Fig. 4.1. Note that it is permissible to remove the 34 pin bus cable during this procedure to eliminate the Electrometer, *CONVECTRON*, or Display Module as a source of the problem.

SYMPTOM	POSSIBLE CAUSE	CURE

Test Point	Reading (Vdc)
+5	+4.75 to +5.25
+20	+18 to +23
+12	+11.4 to +12.6
-12	-11.4 to -12.6
+180	+170 to +190
+220	+190 to +250

If measured voltages do not agree with these readings, it will be necessary to correct this problem before proceeding further. In a great majorit8y of the cases, correcting the power supply problem will correct the original problem as well.

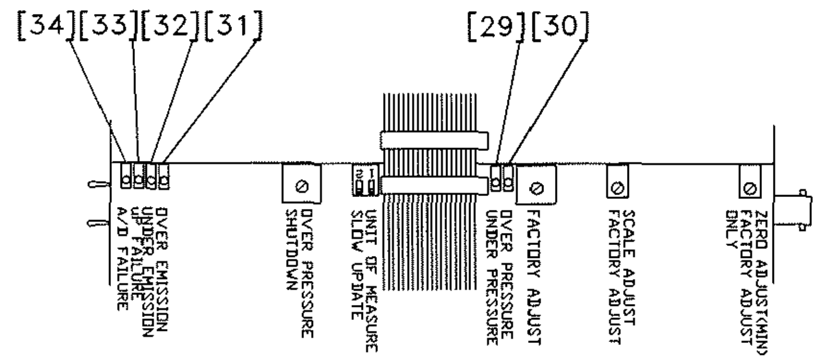


Fig. 4.2 Ion Gauge Electrometer Module Top View

4.3 FILAMENT TURN ON AND EMISSION PROBLEMS

1. Gauge tube filament will not light when gauge switch is toggled. (Display reads 9.9+9 and then after approximately one second turns off).	1. Gauge tube not connected to gauge cable.	Connect gauge tube.
	2. Gauge cable not connected to controller.	Connect gauge cable.
	3. Open filament in ion gauge tube.	Replace ion gauge tube or switch to second filament if available.

SYMPTOM	POSSIBLE CAUSE	CURE
	4. Open in gauge cable filament wire.	Repair or replace gauge cable.
	5. Defective component in the emission control loop which consists of triac, Q4, synchronous pulse generator, Q2, amplifier, U10C or U10D of Fig. 3.4. Using an oscilloscope, verify that the waveform on U3A, pin 1, is as shown when the filament light is on. Trouble lights [31] or [32] possibly on.	Troubleshoot and repair.
	6. Momentarily short out the main terminals 1 and 2 or the triac and observe that the gauge tube filament turns on. If it does not, the problem is with the gauge tube, cable, L1, K1 or transformer secondary 1,2-3,4. Use caution in not shorting the triac for too great a time period or possible tube damage may occur by over-powering the filament.	Troubleshoot and repair.
	7. Using an oscilloscope, check for firing pulses on the triac Q4 gate to main terminal 1 (across R31) during the period when the display reads 9.9+9. If pulses are present the triac is defective. If pulses are not present and the waveshape at U3A, pin 1, is ramping negative, check	Troubleshoot and repair.

SYMPTOM	POSSIBLE CAUSE	CURE
	Q1, Q2 and associated components.	
2. Gauge tube filament will not light when gauge switch is toggled. Display does not show 9.9+9 momentarily.	1. Power supply voltage problem.	Refer to power supply problems.
	2. Defective U1, S1, or associated circuit component (refer to Fig. 3.3 or 3.4). Check test-points C, D, & F of Fig. 3.3.	
3. Gauge tube filament lights when the filament switch is toggled on and then turns off after approximately 1 sec.	1. Pressure in tube too high to permit emission.	Decrease system pressure.
	2. Normal operation. Pressure in tube greater than the over-pressure shutdown level from the electrometer circuit.	Decrease system pressure or decrease the emission by selecting a lower emission.
	3. Low line voltage.	Connect to power line of proper voltage.
	4. Open in gauge cable grid wire.	Repair or replace gauge cable.
	5. Grid bias supply shorted by either tube or cable.	Troubleshoot and repair.
	6. Degraded filament emissive coating not furnishing required emission.	Replace gauge tube.
	7. Glass tube envelope electrostatically charged.	Remove static charge. Apply anti-static coating, or use other static removal procedures.
	8. Loss of feedback signal to pin 1 of IC10 shown on Fig. 3.4.	Troubleshoot and repair.

SYMPTOM	POSSIBLE CAUSE	CURE
4. Gauge tube filament turns on as soon as ac power is turned on. Display is not on. Filament glows very brightly indicating high	1. Shorted triac Q4 of Fig. 3.3. Apply a short from gate to anode (across C23). This will turn off a good triac.	Replace triac.
	2. Defective synchronous pulse generator.	Troubleshoot and repair.
	3. U3A output is shorted to negative power supply.	Replace U3.
5. Gauge tube filament turns on as soon as power is applied. (Emission normal with display on.)	1. Defective component in gauge on/off logic circuit. Check test points B and C of Fig. 3.3 for proper operation.	Troubleshoot and repair.
	2. Gauge switch S1 shorted.	Replace switch.
	3. External filament remote control applying a ground to P2-1.	Correct external remote control circuit. It must be as momentary type of input.

4.4 DEGAS PROBLEMS

1. Degas switch does not turn on front panel degas indicator. Tube grid does not heat up.	1. Normal operation. Gauge has not been turned on or gauge is on and pressure is higher than $5x10^{-5}$ Torr.	Turn on gauge or lower system pressure to less than $5x10^{-5}$ Torr.
	2. Defective U2, S2, Q5, K1 or associated circuit component. Refer to Fig. 3.3.	Troubleshoot and repair.
2. The gauge filament and front panel display turn off during degas.	1. Normal operation. The gauge filament and degas circuit both use the same transformer winding.	
3. The gauge grid does not	1. Open grid circuit in gauge	Troubleshoot and repair.

SYMPTOM	POSSIBLE CAUSE	CURE
heat up during degas. The front panel degas indicator is on.	tube, gauge cable, or defective relay contact in K1.	

4.5 ELECTROMETER PROBLEMS

The 340 electrometer design is based on a log type amplifier (Q9, U12, Q3 and associated components). Conversion is then accomplished by a dual slope A-D converter (consisting of the microprocessor U5, analog switch U6, amplifier U7, comparator U8 and associated components).

SYMPTOM	POSSIBLE CAUSE	CURE
1. Pressure reads less than system is capable of producing. Otherwise, gauge operates normally.	1. Collector cable not connected to gauge tube and/or controller.	Connect cable.
	2. Collector cable open or shorted. Check continuity of collector cable.	Repair or replace cable.
2. Pressure reading higher than expected from system. Display possibly erratic.	1. Possible contamination of gauge tube. Disconnect collector cable and observe that the display reads less than 1×10^{-9} Torr. Note that current leakage from the +180V grid bias will result in a higher pressure reading.	Clean or replace gauge tube.
	2. Material from process entering gauge tube and depositing on insulators.	Provide line of sight baffling to gauge tube.
3. Pressure reading in low ranges does not agree with other IGC's.	1. Minimum adjust pot not set properly.	Note that because the electrometer design is based on a log amplifier, it is not possible to zero the reading. Instead, proceed as follows:

SYMPTOM	POSSIBLE CAUSE	CURE
		a. With the gauge off, set the tube sensitivity for a display reading of 1.0+1 (10/Torr).
		b. With the gauge on, set the emission for a display reading of 1.0-2 (10 mA).
		c. Feed into the collector input of the electrometer a calibrated current of 2.0x10^{-10} amps.
		d. Adjust the minimum adjust pot for a reading of 2.0-9.
		e. Readjust the sensitivity and emission current control to suit your gauge and application.
4. Display pressure reading blank or erratic. Emission control loop operation normal.	1. Check failure indicator lights [29], [30], [33], or [21] for possible problem area:	
	a. Underrange [29] light on. Possible defective Q9, U10, U11 or associated component.	Troubleshoot and repair.
	b. Overrange [30] light on. Possible defective Q9, U10, U11 or associated component.	Troubleshoot and repair.

SYMPTOM	POSSIBLE CAUSE	CURE
	c. Microprocess [33] failure light on. Posssible defective U5 or U4.	Troubleshoot and repair.
	d. A/D [34] failure light on. Possible defective U6, U7 or associated component.	Troubleshoot and repair.

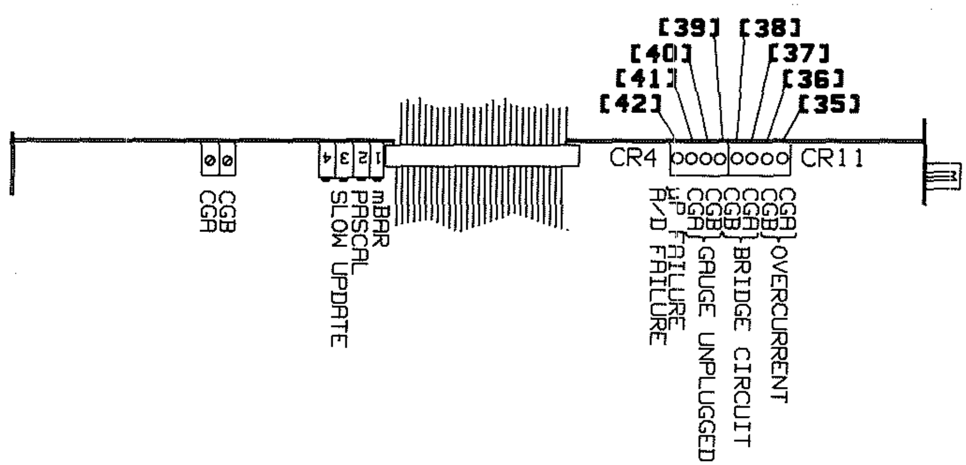


Fig. 4.3 *CONVECTRON* Gauge Module Top View

4.6 CONVECTRON PROBLEMS

1. Display reads 9.9+9 for channel A or B. Trouble light 35,36,39 or 40 on.	1. Gauge tube not connected to gauge cable.	Connect cable to gauge tube.
	2. Gauge cable not connected to controller.	Connecto cable to controller.
	3. Defective gauge cable.	Repair or replace.
	4. Defective gauge tube.	Replace gauge tube.

SYMPTOM	POSSIBLE CAUSE	CURE

Do not perform electrical continuity tests with instruments applying in excess of 1 volt when the tube is at vacuum, or 5 volts when at atmospheric pressure.

The 275 transducer should show the following resistances (pin numbers are embossed on the transducer cap):

Pins 1 to 2	20 to 25 ohms
Pins 2 to 3	50 to 60 ohns
Pins 1 to 5	175 to 190 ohms
Any pin to envelope	open circuit

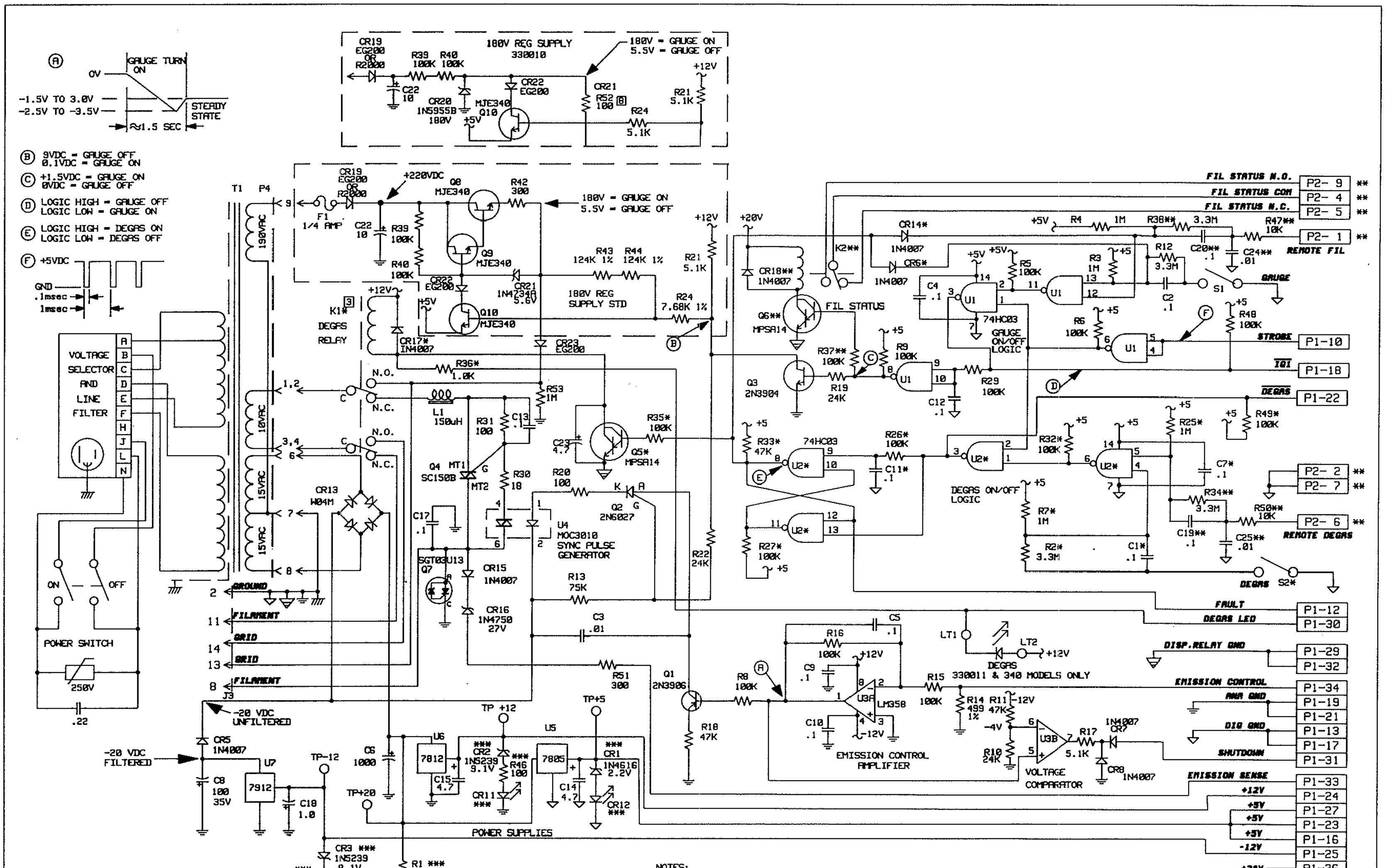
If the resistance from pin 1 to 2 is about 800 ohms, the sensor wire is broken.

SYMPTOM	POSSIBLE CAUSE	CURE
2. Operation appears normal but pressure reading is not accurate.	1. Gas in system is not N_2 or air.	Convert reading using graphs of Section 3.
	2. Gauge tube orientation not horizontal to ground.	Re-orient gauge tube.
	3. Sensor is damaged due to reactive gas such as mercury vapor or fluorine which attack the gold plating on the sensor.	Provide active filter to eliminate reactive gas seen by gauge tube. Relocate gauge tube elsewhere in system. Valve off gauge tube during period when reactive gas is introduced.
	4. Gauge tube is exposed to mechanical vibration.	Relocate gauge tube.
	5. Gauge tube is contaminated with pump oil or other foreign material.	Clean the gauge tube. The *CONVECTRON* gauge may be baked to 150 °C. See Section 3.5 for a list of materials exposed to vacuum. When the fine sensor wire is so contaminated with oil or

SYMPTOM	POSSIBLE CAUSE	CURE
		other films that its emissivity of its diameter is appreciably altered, a change of calibration will result. Cleaning with trichloroethylene, perchloroethylene, toluene, or Acetone is possible but it must be done very carefully so as not to damage the sensor. <u>**CAUTION**</u>: The fumes from any of these solvents can be dangerous to your health if inhaled and they should be sued in well ventilated areas exhausted to the outdoors. Acetone and toluene are highly flammable and should be used away from open flame or electrical equipment. Hold the tube with the main body horizontal and the port projecting upward at an angle of 45° and slowly fill it with solvent using a standard wash bottle with the spout inserted in the port to where it touches the screen. Let the solvent stand in the tube for at least ten minutes. Do not shake he tube if the tube is only

SYMPTOM	POSSIBLE CAUSE	CURE
		partially filled as liquid forces on the sensor can become large enough to affect the transducer calibration. If the tube is completely filled, shaking is not helpful. To drain the tube, position it horizontally with the port facing downward. By slightly warming the tube, a positive pressure will build up internally forcing the solvent out past the screen. Then allow tube to dry overnight with port vertically downward and uncapped. Be certain no solvent odor remains before reinstalling tube on system.
3. *CONVECTRON* display erratic or completely dark. Ion gauge operation normal.	1. Microprocessor failure. Remove cover and check for trouble light 41 or 42 on.	Troubleshoot and repair.

NOTES



NOTES:

1. ALL CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE NOTED.
2. ALL RESISTOR VALUES ARE 5%, 1/4 WATT IN OHMS UNLESS OTHERWISE NOTED.
3. JUMPER K1 N.C. TO COMMON IF DEGAS OPTION IS NOT INSTALLED, 2X.
4. * DENOTES COMPONENTS INSTALLED FOR DEGAS OPTION.
5. ** DENOTES COMPONENTS INSTALLED FOR REMOTE I/O OPTION.
6. *** DENOTES COMPONENTS NOT USED IN 330010
7. LAST REFERENCE DESIGNATORS USED: CR21, C25, R52, Q10, U7
[B] INSTALL R52 IN PLACE OF CR21 FOR 330010.

FILED IN THE CAD AS EDIT /330/SC/9601100S; SHO -E50 -E51

GRANVILLE- PHILLIPS BOULDER COLORADO

SCALE:	DATE	UNLESS SPECIFIED TOLERANCE / FINISH	PART DESCRIPTION
DWN BY DKN	10/9/87		SCHEMATIC 330 POWER MODULE
CHK'D BY NRE	10/19/87	SERIES 330	ADDRESS
APP NRE	10/20/87	NEXT ASSY.	PART NUMBER 009601 100 S C/B
APP MDB	4/27/88		

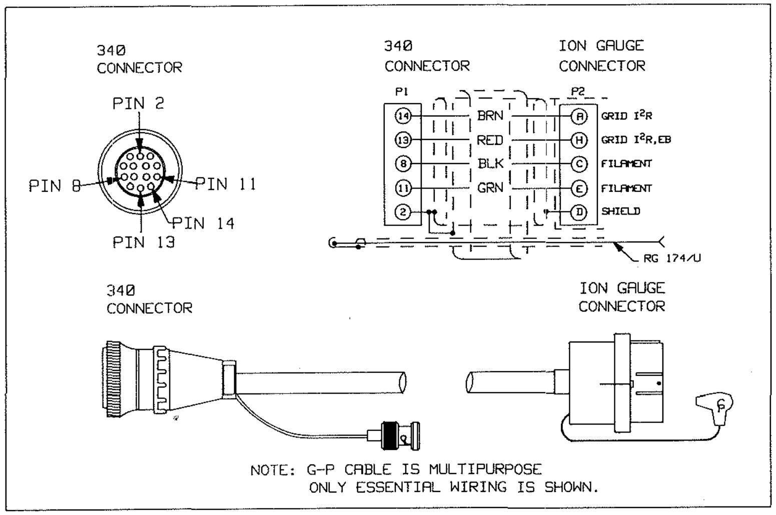


Fig. 4.10 Cable for Varian 564 Ion Gauge

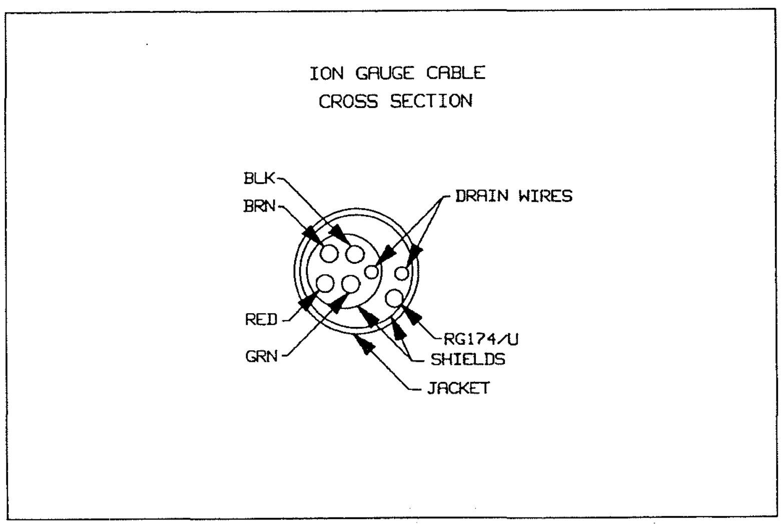


Fig. 4.11 Ion Gauge Cable Cross-Section

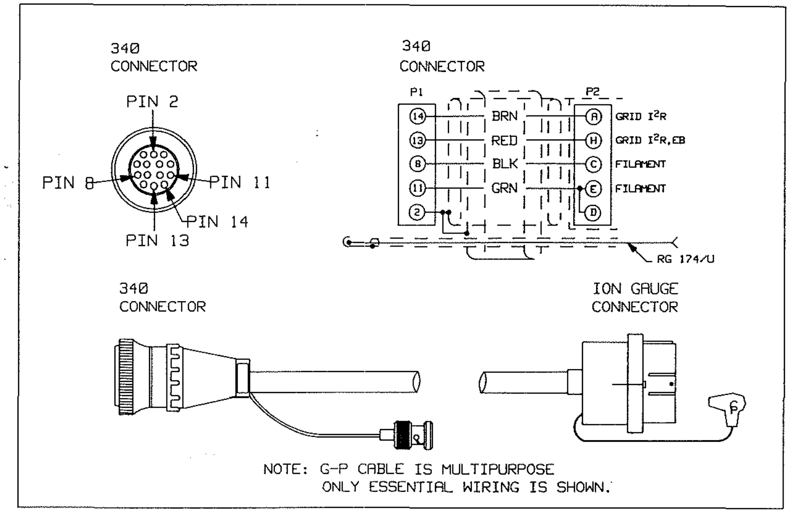


Fig. 4.8 Cable for Standard Glass Ion Gauge

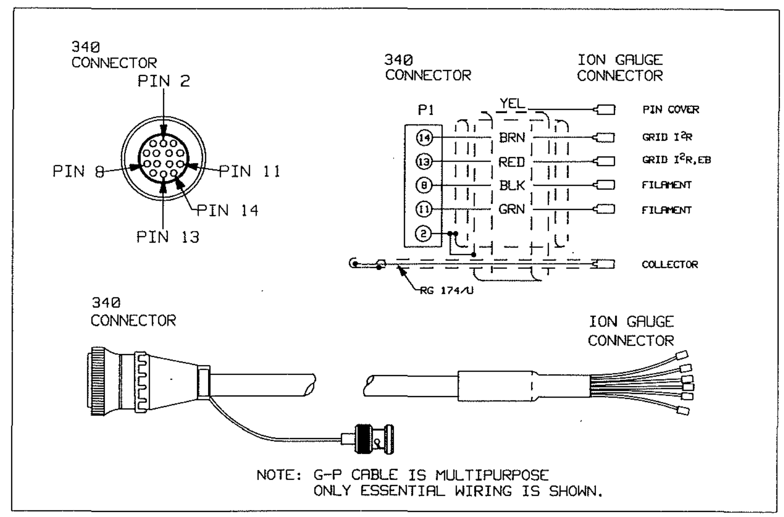
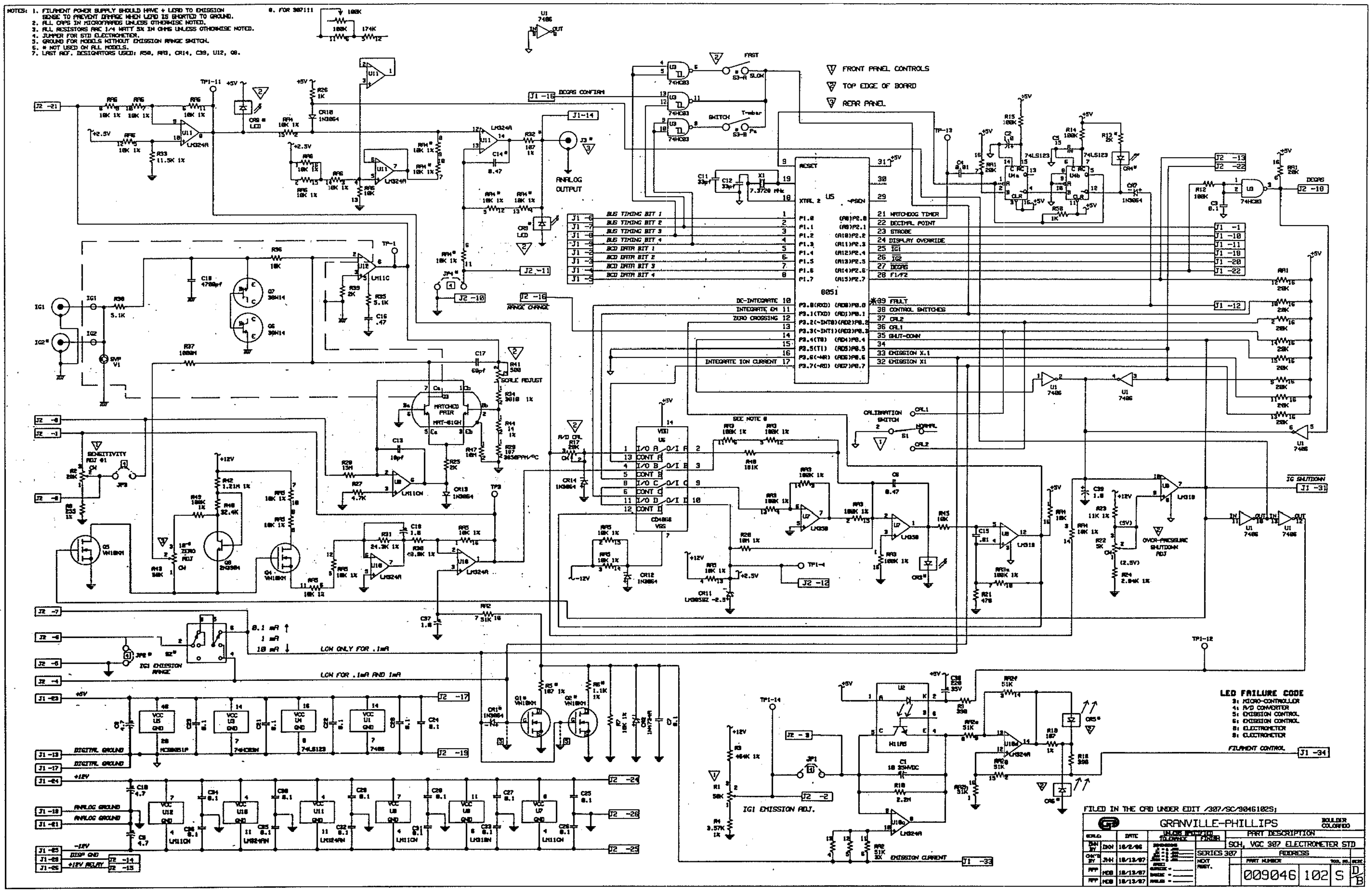
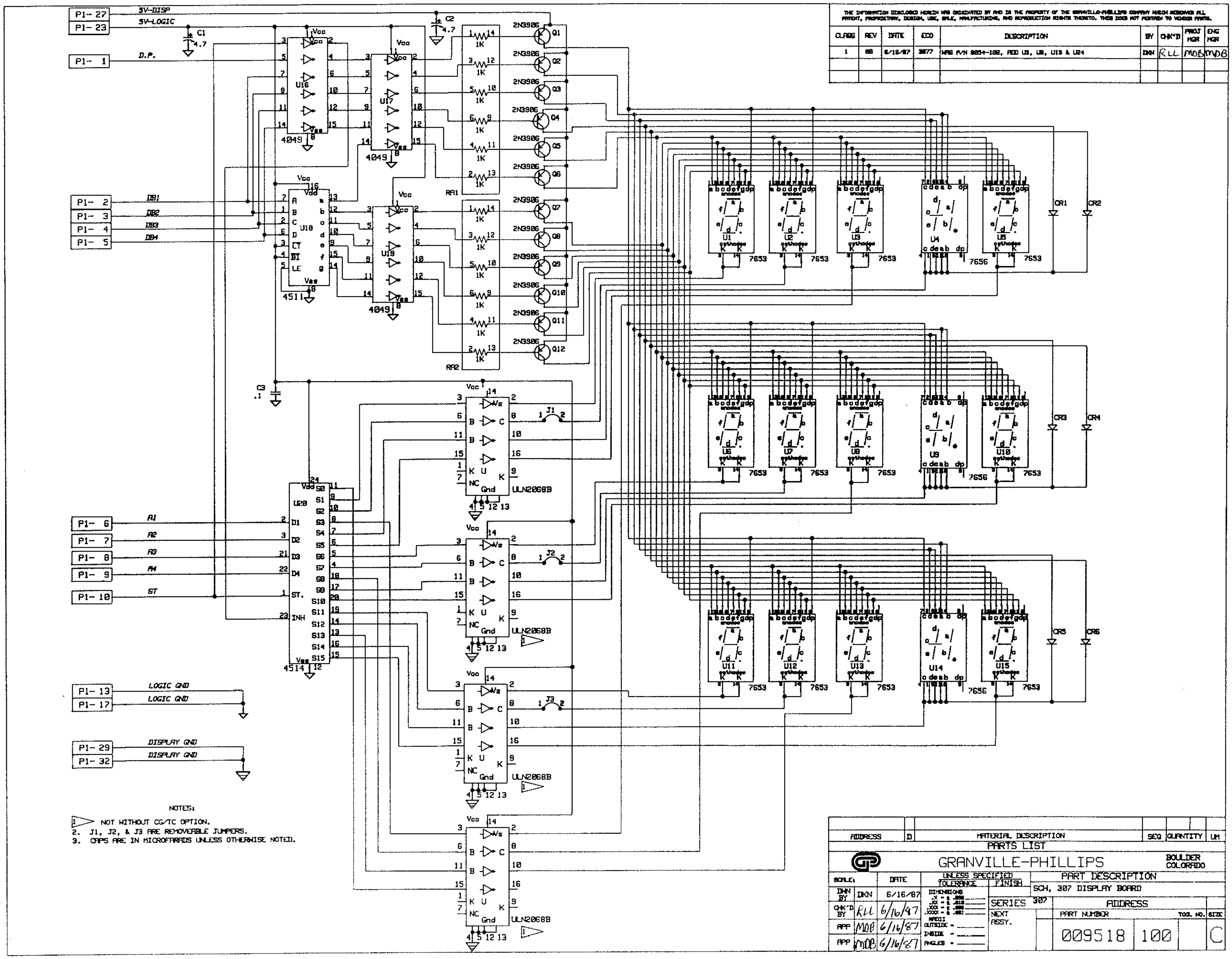


Fig. 4.9 Cable for Nude Ion Gauge


NOTES: 1. FILAMENT POWER SUPPLY SHOULD HAVE + LEAD TO EMISSION SENSE TO PREVENT DAMAGE WHEN LEAD IS SHORTED TO GROUND.
2. ALL CAPS IN MICROFARADS UNLESS OTHERWISE NOTED.
3. ALL RESISTORS ARE 1/4 WATT 5% IN OHMS UNLESS OTHERWISE NOTED.
4. JUMPER FOR STD ELECTROMETER.
5. GROUND FOR MODELS WITHOUT EMISSION RANGE SWITCH.
6. * NOT USED ON ALL MODELS.
7. LAST REF. DESIGNATORS USED: R50, RA9, CR14, C39, U12, Q8.
8. FOR 307111
FRONT PANEL CONTROLS
TOP EDGE OF BOARD
REAR PANEL
ANALOG OUTPUT
BUS TIMING BIT 1
BUS TIMING BIT 2
BUS TIMING BIT 3
BUS TIMING BIT 4
BCD DATA BIT 1
BCD DATA BIT 2
BCD DATA BIT 3
BCD DATA BIT 4
WATCHDOG TIMER
DECIMAL POINT
STROBE
DISPLAY OVERRIDE
DEGAS
DEGAS CONFIRM
FAULT
CONTROL SWITCHES
CAL2
CAL1
SHUT-DOWN
EMISSION X.1
EMISSION X1
DC-INTEGRATE
INTEGRATE EM
ZERO CROSSING
INTEGRATE ION CURRENT
RANGE CHANGE
MATCHED PAIR
SCALE ADJUST
SENSITIVITY ADJ
ZERO ADJ
A/D CAL
CALIBRATION SWITCH
NORMAL
IG SHUTDOWN
OVER-PRESSURE SHUTDOWN ADJ
IG1 EMISSION RANGE
LOW ONLY FOR .1mA
LOW FOR .1mA AND 1mA
DIGITAL GROUND
ANALOG GROUND
DISP GND
+12V RELAY
IG1 EMISSION ADJ.
EMISSION CURRENT
FILAMENT CONTROL
LED FAILURE CODE
3: MICRO-CONTROLLER
4: A/D CONVERTER
5: EMISSION CONTROL
6: EMISSION CONTROL
ELECTROMETER
ELECTROMETER
FILED IN THE CAD UNDER EDIT /307/SC/9046102S;
GRANVILLE-PHILLIPS
BOULDER COLORADO
PART DESCRIPTION
SCH, VGC 307 ELECTROMETER STD
SERIES 307
DATE
DWN BY DKN 10/2/86
CHK'D BY JHH 10/13/87
APP MOB 10/13/87
APP MOB 10/13/87
NEXT ASSY.
PART NUMBER
009046 102 S D/B



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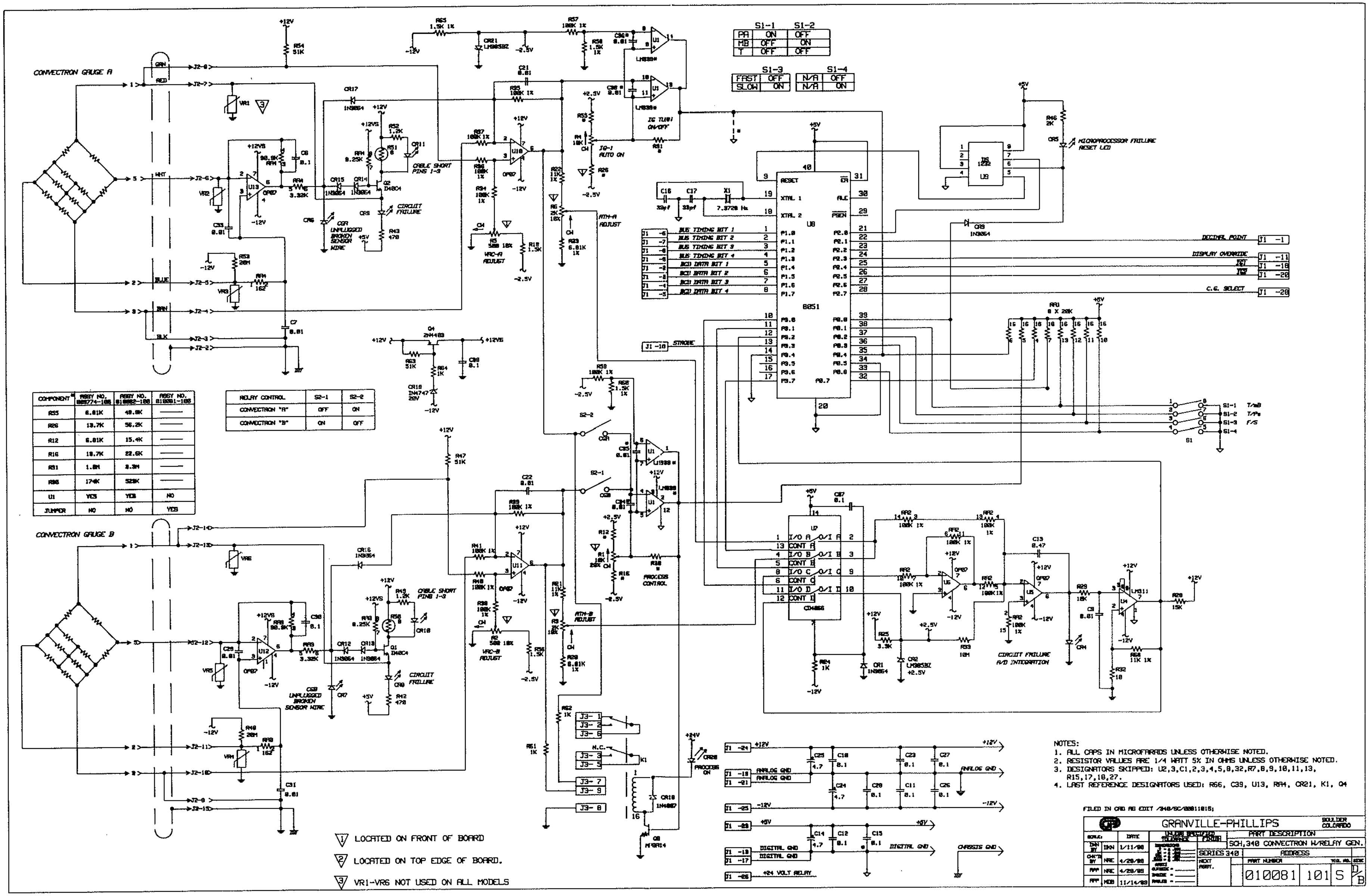
CLASS | REV | DATE | ECO | DESCRIPTION | BY | CHK'D | PROJ MGR | ENG MGR
1 | 00 | 6/16/87 | 3877 | WAS P/N 9054-100, ADD U3, U8, U13 & U24 | DKN | RLL | MDB | MDB
P1- 27 5V-DISP
P1- 23 5V-LOGIC
P1- 1 D.P.
P1- 2 DB1
P1- 3 DB2
P1- 4 DB3
P1- 5 DB4
P1- 6 A1
P1- 7 A2
P1- 8 A3
P1- 9 A4
P1- 10 ST
P1- 13 LOGIC GND
P1- 17 LOGIC GND
P1- 29 DISPLAY GND
P1- 32 DISPLAY GND
NOTES:
1. NOT WITHOUT CG/TC OPTION.
2. J1, J2, & J3 ARE REMOVEABLE JUMPERS.
3. CAPS ARE IN MICROFARADS UNLESS OTHERWISE NOTED.
ADDRESS | D | MATERIAL DESCRIPTION | SEQ | QUANTITY | UM
PARTS LIST
GRANVILLE-PHILLIPS
BOULDER COLORADO
SCALE:
DATE
UNLESS SPECIFIED
TOLERANCE
FINISH
PART DESCRIPTION
SCH, 307 DISPLAY BOARD
DWN BY DKN 6/16/87
CHK'D BY RLL 6/16/87
APP MDB 6/16/87
APP MDB 6/16/87
DIMENSIONS
RADII
OUTSIDE =
INSIDE =
ANGLES =
SERIES 307
NEXT ASSY.
ADDRESS
PART NUMBER
TOOL NO.
SIZE
009518 100
C



S1-1		S1-2
PA	ON	OFF
MB	OFF	ON
T	OFF	OFF

	S1-3		S1-4
FAST	OFF	N/A	OFF
SLOW	ON	N/A	ON

COMPONENT*	ASSY NO. 009774-100	ASSY NO. 010082-100	ASSY NO. 010081-100
R55	6.81K	49.9K	———
R26	10.7K	56.2K	———
R12	6.81K	15.4K	———
R16	10.7K	22.6K	———
R51	1.8M	3.3M	———
R56	174K	523K	———
U1	YES	YES	NO
JUMPER	NO	NO	YES

RELAY CONTROL	S2-1	S2-2
CONVECTRON "A"	OFF	ON
CONVECTRON "B"	ON	OFF

1 LOCATED ON FRONT OF BOARD

2 LOCATED ON TOP EDGE OF BOARD.

3 VR1-VR6 NOT USED ON ALL MODELS

NOTES:
1. ALL CAPS IN MICROFARADS UNLESS OTHERWISE NOTED.
2. RESISTOR VALUES ARE 1/4 WATT 5% IN OHMS UNLESS OTHERWISE NOTED.
3. DESIGNATORS SKIPPED: U2,3,C1,2,3,4,5,8,32,R7,8,9,10,11,13, R15,17,18,27.
4. LAST REFERENCE DESIGNATORS USED: R66, C39, U13, RA4, CR21, K1, Q4

FILED IN CAD AS EDIT /340/SC/00811015;

GRANVILLE-PHILLIPS BOULDER COLORADO

PART DESCRIPTION: SCH,340 CONVECTRON W/RELAY GEN.

SERIES 340

		DATE
DWN BY	DKN	1/11/90
CHK'D BY	NRE	4/20/90
APP	NRE	4/20/90
APP	MDB	11/14/90

PART NUMBER: 010081 101 S D/B