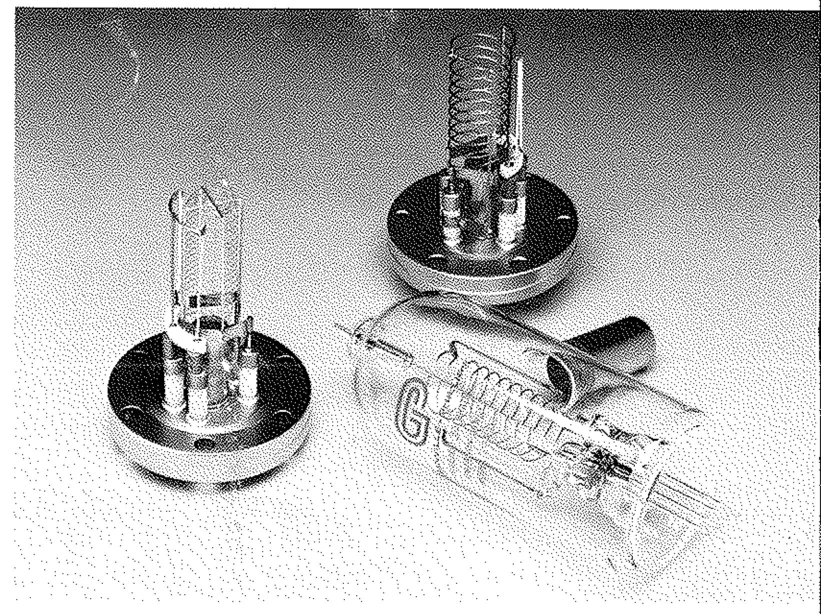
274
BAYARD-ALPERT TYPE
IONIZATION GAUGE TUBES



Installation and Operating Instructions

GRANVILLE-PHILLIPS

YOU SHOULD READ THIS INSTRUCTION MANUAL BEFORE INSTALLING, USING, OR SERVICING THIS EQUIPMENT

This manual is for use only with Series 274 Ionization Gauge Tubes with the following part numbers.

			274032
274002	274012	274020	274036
274003	274013	274021	274037
274005	274015	274022	274041
274006	274016	274023	274042
274007	274017	274028	274043
274008	274018	274031	274051

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 ON THIS MANUAL.

ELECTRICAL SHOCK

WARNING: Ionization gauges are safe for use only if all exposed conductors on the gauge and on the controller and on the vacuum system are grounded.

During electron bombardment degas, as much as 700 volts may be applied to some electrode pins. Do not touch any gauge tube electrodes while the tube is connected to the controller.

All connections to the gauge tube pins should be covered by insulation. All gauge tube pins should be covered by connectors or by pin covers. In normal operation, 180 volts is on the grid connections.

Implosion and Explosion

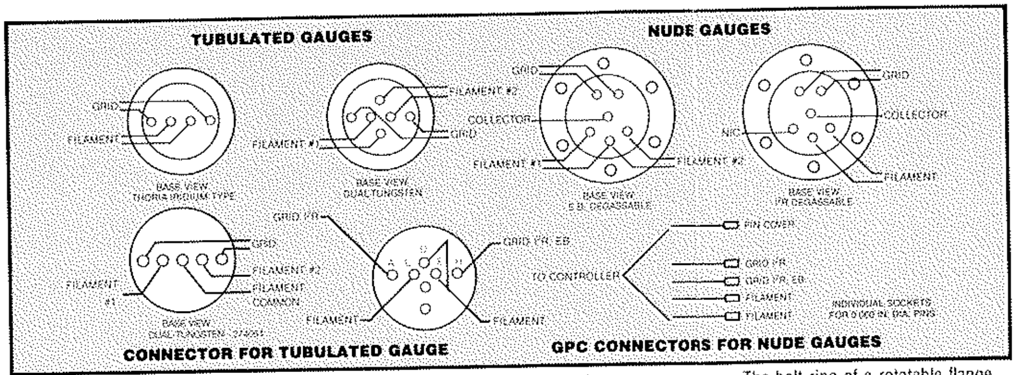
Glass ionization gauges, if roughly handled, may implode under vacuum causing flying glass which may injure personnel. Be sure that cabling to the gauge tube has proper strain relief so that cable tension cannot break the glass. If pressurized above atmospheric pressure, glass tubes may explode, causing dangerous flying glass. A substantial shield should be placed around vacuum glassware to prevent injury to personnel.

Overpressure

Do not use quick connects or other friction type connections where positive pressure will exist within the gauge tube, such as in backfilling operations.

Temperature

During degas, the envelope of the gauge tube becomes heated much more than in normal operation. Be sure that



materials that are heat sensitive are not in contact with the gauge tube. Be sure that the gauge tube is not located where personnel performing necessary system operations might come in contact with the gauge tube.

INSTALLATION INSTRUCTIONS

Receiving Inspection

Domestic Shipments

Inspect all material received for shipping damage.

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

International Shipments

Inspect all material received for shipping damage. Confirm that your shipment includes all material and options ordered. If items are missing or damaged the carrier making delivery to the customs broker must be notified within 15 days of delivery.

Example

If an airfreight forwarder handles the shipment and their agent delivers the shipment to customs, 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, **not** the freight forwarder.

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

Vacuum Connections

1. Location on system: The gauge tube should be located as close as possible to the section of the vacuum system where pressure measurement is important. Valves or other constrictions between the gauge tube and the area where pressure measurement is required may cause erroneous readings.
2. Gauge port: Pressure measurement in the high vacuum range does not require special attention to port size. However, as the pressure of interest approaches the ultra-high vacuum range, a small conductance between the gauge tube and the system volume of interest can cause a significant difference in the two pressures. One inch tubulation is minimal, and at extreme vacuum the nude tube geometry is best whereby the gauge tube actually protrudes into the chamber volume.
3. Mounting orientation: All orientations are acceptable.
4. Connections: When using O-ring quick connects on glass tubulations, care must be used when sliding the glass tubulation into the quick connect. Gently tighten the compression ring so that the glass tubulation is not chipped or cracked. Non-rotatable flanges are ordinarily installed on glass gauge tubes. The bolt ring of a rotatable flange can inadvertently be dropped on the tube and break the glass tubulation.

Electrical Connections

Fig. 1 shows the pin connection code for the various Series 274 gauge tubes.

Do not use gauge cables with exposed conductors such as alligator clips. All gauge tube pins should be covered by connectors or by pin covers. Gauge cables should be firmly clamped to the vacuum station to provide strain relief. This ensures there will be negligible strain transmitted to the gauge tube pins if there is relative motion between the vacuum station and the ionization gauge controller.

If the resistance heated degassable nude gauge is being used with an electron bombardment degas controller, be sure that the unused grid pin is not exposed. Cover it with a suitable insulator, if necessary.

OPERATION

1. **Operating Voltage Potentials**
The recommended potentials are: Collector, 0V; Grid, +180V; Filament, +30V. The dependence of ion current on variations of these parameters is shown in the Specifications Section.

2. **Filament Emission**
As a general rule, low emission current is used in the high pressure end of the range of the gauge tube. This helps to avoid the ion current turn-around phenomenon and glow discharge. High emission current is used at ultrahigh vacuum to obtain ion currents that are large enough for convenient measurement. Typical values are 100μA at 10^{-3} Torr and 10 mA at 10^{-9} Torr. The trade-offs on emission current are that high emission current gives better readout stability and sensitivity but more gauge tube pumping if the gauge tube is clean and more gauge tube outgassing if the gauge tube is contaminated. Likewise, low emission currents minimize gauge tube outgassing (important for a contaminated gauge tube) and minimize gauge tube pumping (important for a clean gauge tube at low pressures). However, low emission currents yield low ion currents which are sensitive to electronic noise and which may be too low for a given electrometer to measure.

3. **Gauge Tube Degas**
The contamination level and thus the outgassing rate of a gauge tube may be greatly reduced by heating the electrodes. The hot electrodes heat the envelope thereby cleaning the tube further. The two types of cleaning (degassing) used are resistive heating (I^2R) of the grid, and electron bombardment (E.B.) of the grid. E.B. degassing is preferable only at ultra high vacuum and is more expensive. I^2R heating requires longer degassing periods. Gauge tube degas is only useful at pressures below 10^{-5} Torr and only a few minutes degas is required at pressures above 10^{-5} Torr since at these higher pressures, the recontamination of surfaces occurs readily. If a system is going ultimately to the UHV range, it is useful to degas in the 10^{-6} Torr range and then again as the system pressure approaches the expected ultimate. The tubulated gauge and the I^2R degassable nude tube may be degassed by either I^2R or E.B. degas. The E.B. degassable nude tube may be **only** E.B. degassed.

4. **Gauge Tube Bakeout**
It is also useful to externally bake the gauge tube if the entire system is expected to pump down to an ultraclean state. Gauge tubes must not be baked over 450°C as glass softening occurs just above that temperature.

5. **X-ray Limit**
The X-ray limit refers to the lowest pressure indication which may be obtained in a Bayard-Alpert gauge. Beyond the limit the collector current is mainly due to X-ray induced photo-emission. The photo-electron current has a value equivalent to a pressure indication of approximately 3×10^{-10} Torr in glass gauge tubes, approximately 4×10^{-10} Torr in I^2R degassable nude gauge, and approximately 2×10^{-11} Torr in E.B. degassable nude gauge tubes.

6. **Gauge Tube Accuracy**
Due to geometric variations in electrode structures, a given gauge tube is typically accurate to within ±20% when reading the gas type for which it is specified.

TECHNICAL INFORMATION

1. **Pressure Indication**
Ionization gauge controllers actually measure the positive ion current in amperes from the gauge tube but the readout is in pressure units. Even more specifically, these pressure units are direct reading only for the gas for which it is specified, usually nitrogen (also air): this is called a readout of nitrogen equivalent pressure. Other gases may give much different readings from nitrogen.

2. **Gauge Tube Sensitivity**
To be able to present conversion tables from gas type to gas type, the gauge tube sensitivity, K, is defined:

$$K = \frac{i_+}{i_- P}$$

where i_+ is the positive ion current to the collector, i_- is the electron emission current from filament to grid, and P is the pressure.
The glass envelope gauge tube and the I^2R degassable nude gauge tube have K = 10/Torr for nitrogen (or air), and the E.B. degassable nude gauge tube has K = 25/Torr for nitrogen (or air).

Gauge tube sensitivities for various gases are tabulated in reference material in two general ways. One, directly in $Torr^{-1}$ and listed, for example, as K_{gasx}/K_{N_2}; thus $r_{N_2} = 1.0$.

3. **Gas Type Conversions**
In general there are two ways to read the pressure of a gas other than the gas for which a gauge tube is specified. Method A, perform a mathematical conversion on the direct pressure readout (usually nitrogen equivalent pressure). Method B, use an emission current other than the value for which the ion gauge controller is set up.
Method A: To correct for an ionization gauge controller which is set up

for some other sensitivity ($K_{N_2,cont}$) than the gauge tube ($K_{N_2,tube}$), the following correction to the pressure readout will yield the nitrogen equivalent pressure:

$$P_{N_2} = P_{ind} \left[\frac{K_{N_2,cont}}{K_{N_2,tube}}\right]$$

To convert the readout to some other gas, the equation must also include $K_{gasX,\,tube}$ thusly,

$$P_{gasX} = P_{ind} \left[\frac{K_{N_2,\,tube}}{K_{gasX,\,tube}}\right] \left[\frac{K_{N_2,\,cont}}{K_{N_2,\,tube}}\right]$$

this then can be written either

$$P_{gasX} = P_{ind} \left[\frac{K_{N_2,\,cont}}{K_{gasX,\,tube}}\right] \quad \text{or}$$

$$P_{gasX} = \left[\frac{P_{ind}}{r_x}\right] \cdot \left[\frac{K_{N_2,\,cont}}{K_{N_2,\,tube}}\right]$$

Example: For the nude tube of $K_{N_2} = 25/\text{Torr}$ using a controller of $K_{N_2,\,cont} = 10/\text{Torr}$ and for gas_x of argon for which $r_x = 1.2$.

$$P_{Ar} = \frac{P_{ind}}{1.2} \cdot \frac{10}{25} = \frac{P_{ind}}{3}$$

Method B: The usual ionization gauge controller is designed for some calibrated set-point of emission $= i_e$. The new emission that will correct both for controller sensitivity and for gas type is

$$i_e' = i_e \left[\frac{K_{N_2,\,cont}}{K_{gasX,\,tube}}\right]$$

or

$$i_e' = \left[\frac{i_e}{r_x}\right] \left[\frac{K_{N_2,\,cont}}{K_{N_2,\,tube}}\right]$$

If actual emission current is not read out in current units, then these equations may be expressed as fractions of full scale as

$$\frac{i_e'}{i_e} = \frac{K_{N_2,\,cont}}{K_{gasX,\,tube}}$$

and

$$\frac{i_e'}{i_e} = \left[\frac{1}{r_x}\right] \left[\frac{K_{N_2,\,cont}}{K_{N_2,\,tube}}\right]$$

Note that Method B is useful only for decreases in emission current or small increases.

4. Gas Sensitivity Tables

The following table lists **relative** gauge sensitivities for various gases. The values listed are averages of several gauges and several references from the literature. These values are from Table II, Ionization Gauge Sensitivities As Reported in the Literature, from NASA Technical Note TND 5285, by Robert L. Summers, Lewis Research Center, National Aeronautics and Space Administration. Please see this reference for further definition of these average values and for calculations of the gauge sensitivities of other gases.

To convert ionization gauge readout from nitrogen equivalent pressure, divide the readout by the values listed for r_x.

Gas	Average Values $r_x = \frac{K_{gasX}}{K_{N_2}}$
He	0.18
Ne	0.30
D_2	0.35
H_2	0.46
N_2	1.00
Air	1.00
O_2	1.01
CO	1.05
H_2O	1.12
NO	1.16
Ar	1.29
CO_2	1.42
Kr	1.94
SF_6	2.50
Xe	2.87
Hg	3.64

Ordering Information

See GPC brochures No. 270, No. 271, No. 280, No. 303, No. 307, No. 330, No. 332, No 340, and No. 350 available free on request for Gauge Controllers.

Tubulated Ionization Gauge Tubes

	Catalog Numbers					
	Thoria Coated Iridium Filament			Dual Tungsten Filaments		
CONNECTION	¾ in.	1 in.	15 mm	¾ in.	1 in.	15 mm
Pyrex	274002	274005	274036	274012	274015	274037
Kovar	274003	274006	----	274013	274016	----
1⅓ in. Conflat flange	274020	----	----	274021	----	----
2¾ in. Conflat flange	274007	274008	----	274017	274018	----
NW25KF flange	274032	----	----	----	----	----
Pyrex 5 pin inline	----	----	----	----	----	274051

NUDE IONIZATION GAUGE TUBES

On 2¾ in. Conflat flange	Catalog Numbers
Dual tungsten filaments, EB degas only	274022
Dual thoria coated iridium filament, EB degas only	274023
Single thoria coated iridium filaments, I^2R or EB degas	274028
274022 style with pin guard/connector locking ring	274041
274023 style with pin guard/connector locking ring	274042
274028 style with pin guard/connector locking ring	274043

ACCESSORIES

Replacement dual tungsten filaments, for 274022 only	274024
Replacement dual coated iridium filament, for 274023 only	274025
Replacement thoria coated iridium filament, for 274028 only	274029
Vacuum simulator, tubulated ion gauge pumped down and pinched off at 1×10^{-5} or lower	274031

Information regarding order placement, technical assistance, or the location of the sales office nearest you is available through our corporate office.

Limited Warranty

This Granville-Phillips Company product is warranted against defects in materials and workmanship for one 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 FORM A BREACH OF THIS LIMITED WARRANTY OR OTHERWISE.

WARNING!—Safe operation of vacuum equipment requires grounding of all exposed conductors of the gauges <u>and</u> the controller <u>and</u> the vacuum system. **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 electrical conduction via a plasma to couple a high voltage electrode potential to the vacuum chamber. If exposed conductive parts of the gauge, controller, and 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 exposed conductors and ground.

During routine pressure measurement using ionization gauge controllers from *any* manufacturer, about 160V may become present on ungrounded conductors at pressures near 10^{-3} Torr. All isolated or insulated conductive parts of the controller, the gauge, and the vacuum system 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 on your ion gauge power supplies, gauges, and vacuum chambers, regardless of their manufacturer, for this phenomenon is not peculiar to Granville-Phillips equipment. If you have questions, please contact one of our technical personnel.

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