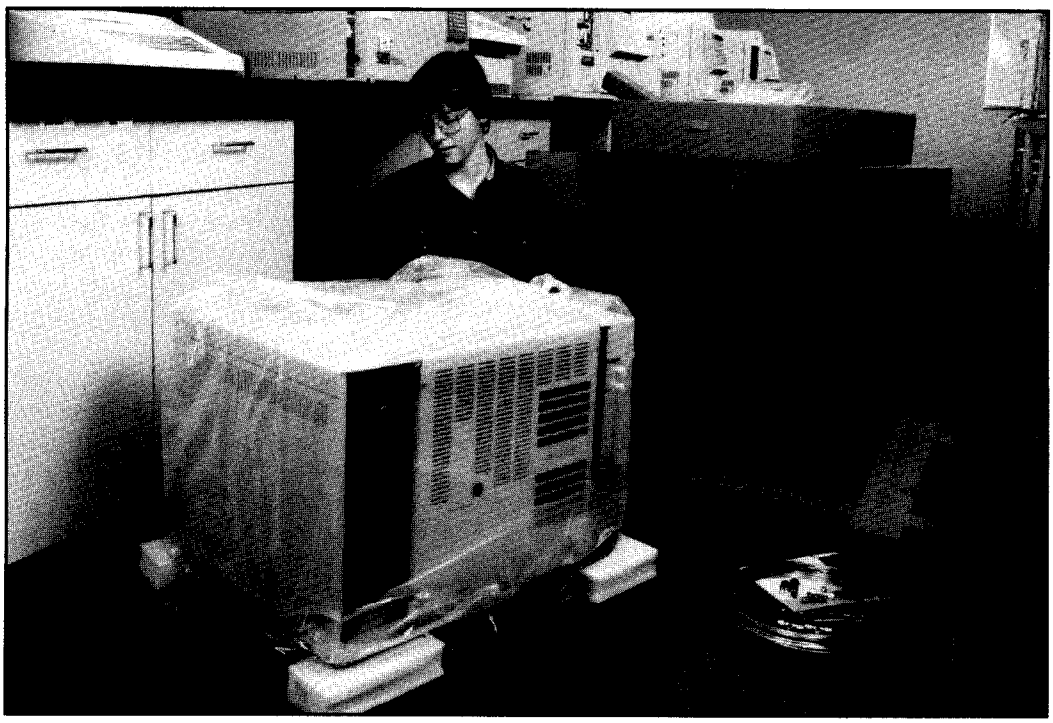
A Guide to GC Set-up



This guide covers:

- Pre-installation instructions
- Tools required to plumb a GC
- Choosing the Proper GC gases
- Plumbing Gases to the GC
- GC gas purification
- Leak checking
- Instrument logbook
- Accessories

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Gas chromatographs are shipped with an instrument manual that includes information on the pneumatics, electronics, computer hardware, and software installed in the new instrument. Unfortunately, practical instruction on how to set up the gas chromatograph is one area that many manuals do not adequately cover. This guide presents the basic steps in setting up a new GC and useful information on efficient and proper installation.

Index

Pre-Installation Instructions

The first, and perhaps most important, rule of setting up a new GC is to never throw anything away. All items are grouped and labeled by the manufacturer. Keeping all parts and manuals together will significantly reduce the chance of misplacing critical documentation or spare parts. It is a good idea to save the original box and packing materials in case the GC must be returned to the manufacturer. The GC oven fan is often bolted in place during transportation. The shipping bolt must be removed from the back of the GC before turning on.

Next, determine where to install the GC. Allocate sufficient bench space to permit installation of recorders, chromatography data systems, autosamplers, and other GC equipment. Two inches of space at the sides of the GC permits free air circulation. Allow two feet of access space at the rear of the GC for ease of service or future plumbing changes. Make the installation site accessible to easily change traps and connect gas lines.

Do not place the GC near a heating or air conditioning vent. Variations in room temperature can affect the heated zones of the GC. Chromatographically this problem is seen as retention time or baseline instability as the heating or AC units cycle on and off. A constant room temperature and a site free of hot or cold spots ensures optimum GC performance.

If the lab is not equipped with existing gas lines, set-up the GC in a location near the gas source. This will minimize the amount of tubing required to plumb new instruments. Continuous lengths of tubing between the cylinder and GC manifold should be used to eliminate the possibility of fitting leaks. If several GCs are being plumbed on the same carrier gas line, connecting tees should be easily accessible for leak checking and troubleshooting. (Do not hide tees or connectors in a ceiling or wall. This makes it difficult to periodically leak check!)

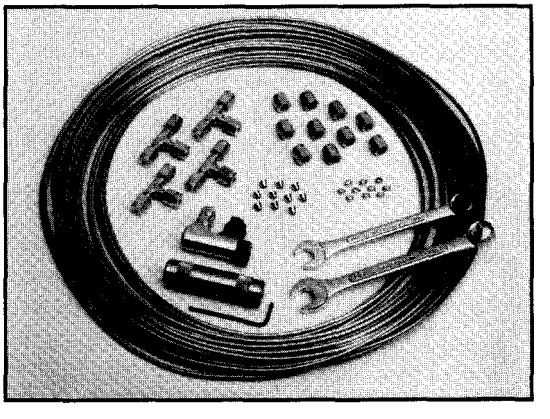
Determine the power requirements of the GC. If the power requirement is less than 15 amps, the instrument may be plugged into a 15 or 20 amp branch circuit. If the unit draws 15 amps or more, the GC power cord will have a 20 amp plug and must be plugged into a 20 amp circuit (a 20 amp plug looks similar to a standard three-prong plug, except that one prong is turned at a right angle towards the other one). If the plug on the GC doesn't fit the outlets in your lab, consult a qualified electrician before proceeding!

Generally, only one GC should be plugged into a single 15 or 20 amp branch circuit. Plugging multiple GCs into the same electrical circuit may cause the circuit breaker to trip on occasions when two instruments are heating at the same time.

If possible, integrators or data systems should be plugged into the same outlet or circuit as the GC from which it is acquiring data. This will help to prevent ground loop currents from developing between the two instruments, which can contribute to baseline noise. To further reduce electrical noise, use high quality, shielded signal cables and keep the cables as short as possible.

Tools Required to Plumb the GC

Once the instrument site is prepared, you are ready to consider what gases are needed for the GC. Items necessary to install a new GC include the following:
(See ***pages 13-25 for catalog numbers.)***
Wrenches (1/8, 1/4, 7/16, 9/16, and 1/2-inch) • Phillips & flat head screwdrivers • Solvent rinsed & heat treated stainless steel tubing • Hoke plug valves • SS diaphragm regulators • MINICYL regulators • Ferrules • Tubing cutter • Tubing bender • Reamer • Files • Replacement fittings • Adjustable wrench • Teflon tape • Electronic leak detector • Brass tees • Swagelok nuts & ferrules • Pigtail fittings • Traps • Reducers • Septa • Deactivated sleeves • O-rings • Capillary column



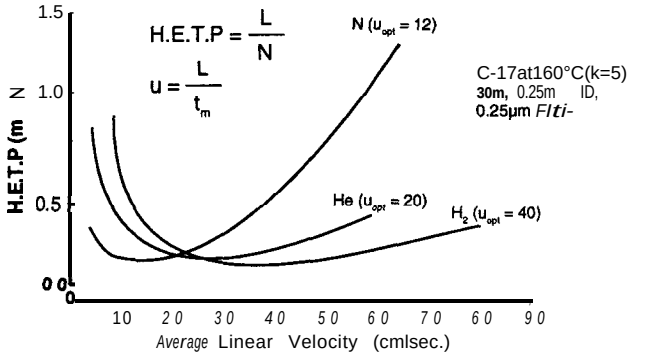
Choosing the Proper GC Gases

Using the correct carrier and detector gases are an important factor in installing a new GC. The five gases commonly used as carrier gas and detector fuels in capillary gas chromatography are helium, hydrogen, nitrogen, argon-methane, and air. The types of gases necessary are partly determined by the detection system used. Factors to consider for each individual gas are discussed below.

Carrier gas choice

Carrier gases that exhibit a broad minimum on a van Deemter profile are essential in obtaining optimum performance. Volumetric flow through a capillary column is affected by temperature. When temperature programmingfrom ambient to 300"C, the flow rate can decrease by 40 percent. A carrier gas that retains high efficiency over a wide range of flow rates and temperatures is essential in obtaining good resolution throughout a temperature programmed run. Figure 1 shows the van Deemter profile for hydrogen, helium, and nitrogen carrier gases.

Figure 1 · van Deemter Profile of Hydrogen, Helium, and Nitrogen



Hydrogen is the fastest carrier gas (Uopt,), with an optimum linear velocity of 40cm/sec, and exhibits the flattest van Deemter profile. Helium is the next best choice; with an optimum linear velocity of uopt = 20cm/sec. Nitrogen's performance is inferior with capillary columns because of its slow linear velocity, Uopt = 12cm/sec. Argon-methane has a slower optimum linear velocity than nitrogen and is not recommended for use as a carrier gas with capillary columns. Air is not recommended as a carrier gas because it can cause stationary phase oxidation.

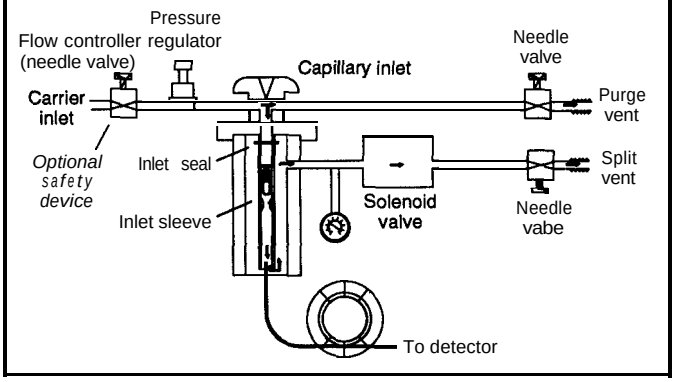
With hydrogen and helium as carrier gases, the minimum H.E.T.P. values can be maintained over a broader range of linear velocities than with nitrogen, and high linear velocities can be used without sacrificing efficiency. Nitrogen is beneficial only when analyzing highly volatile gases under narrow temperature ranges where increasing stationary phase interaction is desirable. Otherwise, the use of N2 results in longer analysis times and a loss of resolution for compounds analyzed on a wide temperature range.

Exert Caution when Using Hydrogen as a Carrier Gas

Hydrogen is explosive when concentrations exceed 4% in air. Proper safety precautions should be utilized to prevent an explosion within the column oven. Most gas chromatographs are designed with spring loaded doors, perforated or corrugated metal column ovens, and back pressure/flow controlled pneumatics to minimize the hazards when using hydrogen carrier gas. Additional precautions include:

- Frequently checking for leaks using an electronic leak detector (Restek's Leak Detective'", cat.# 21607, 110 volts/ cat.# 21609,220 volts).
- Using electronic sensors that shut down the carrier gas flow in the event of pressure loss.
- Minimizing the amount of carrier gas that could be expelled in the column oven if a leak were to occur by installing a flow controller (needle valve) prior to the carrier inlet bulkhead fitting to throttle the flow of gas (for head pressure controlled systems only) as shown in Figure 2.

Figure 2 - Use a **flow *controller or needle valve to throttle the* flow *of H, carrier gas should a leak occur.***



Fully open the flow controller (needle valve) and obtain the proper column head pressure, split vent flow, and septum purge flow rates. Decrease the needle valve flow rate until the head pressure gauge begins to drop (throttle point). Next, increase the flow controller (needle valve) setting so that the right amount of flow is available to the system. Should a leak occur, the flow controller will throttle the flow, preventing a large amount of hydrogen from entering the oven.

Make-up and Detector Fuel Gases

Choosing the correct make-up and detector gases will depend ***on*** both the detector and application. Most GC detectors operate best with a total gas flow of approximately 30ml/min. to ensure high sensitivity and excellent peak symmetry. Refer to your GC manual for optimum flow rates on different instruments. Carrier gas flows for capillary columns range from 0.5 to lOml/min. which are well below the range where most detectors exhibit optimal performance. To minimize detector dead volume, make-up gas is often added at the exit end of the column to increase the total flow entering the detector. Make-up gas helps to efficiently sweep detector dead volume thereby enhancing detector sensitivity. Make-up

gas can be added directly to the hydrogen flame gas for flame ionization detectors (FID), nitrogen phosphorous detectors (NPD), and flame photometric detectors (FPD) or added to the column effluent by an adaptor fitting. However, GCs such as Perkin-Elmer and Fisons do not require make-up gas.

Combustion type detectors (FID, NPD, FPD) use three gases: make-up, hydrogen (fuel gas), and air (combustion/oxidizing gas). For non-combustion detectors, such as the thermal conductivity detector (TCD), electron capture (ECD), and photo ionization detector (PID), only carrier and make-up gases are required. In the case of the electrolytic conductivity detector (ELCD), the make-up gas is hydrogen, as a reaction gas in the halogen and nitrogen mode or air in the sulfur mode. Table I shows recommended gases for various detectors.

Table I - Carrier and detectorfuel gases used with various GC detectors:

Detector	TCD	ECD	FID	NPD	PPD	ELCD	PID
Carrier Gases	He H2 N2	He N2	He H2 N2	He H2 N2	He H2 N2	He H2	He H2 N2
Combustion/Reaction Gases			H2 Air	H2 Air	H2 Air	H2	
Make-up Gases	N2 He	N2 ArCH4	N2 He	N2 He	N2 He		N2 He

Recommended Gas Purities

Gas purity is very important. The expense of using high purity gases in combination with carrier gas purifiers will be offset by longer column lifetime and less GC maintenance. Carrier gas should contain less than lppm of oxygen, moisture, or other trace contaminants to prevent column degradation, increase column lifetime, and decrease stationary phase bleed. Carrier gas impurities can also contribute to detector noise. Figure 3 illustrates 0, contamination on a sensitive ECD and shows how an impure carrier gas can affect detector performance. Contaminants such as trace hydrocarbons can be detected by an FID during a temperature programmed run, causing ghost peaks to appear. Make-up and fuel gases should be contaminant-free to reduce baseline fluctuations and excessive detector noise.

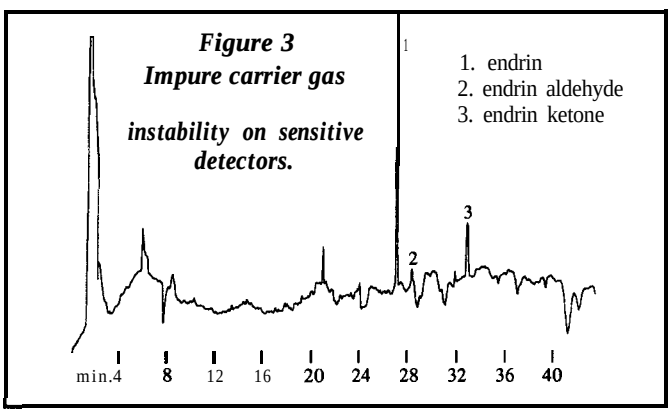


Figure 3
Impure carrier gas

instability on sensitive detectors.

Plumbing Gases to the GC

Once the proper carrier and detector gases are selected, they must be connected to the instrument. The gas flow path travels through regulators, pigtails, tubing, valves, and traps (Figure 4). Each component in the flow path will be discussed in sequence with helpful hints on their proper use.

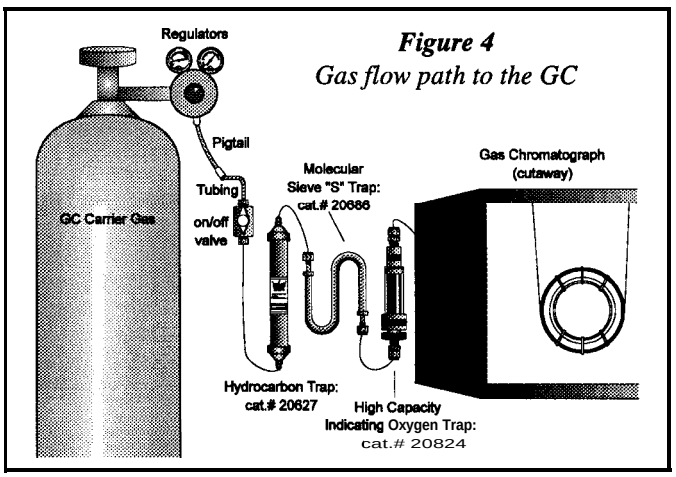
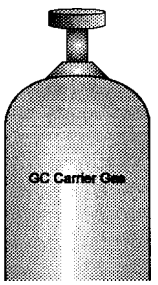
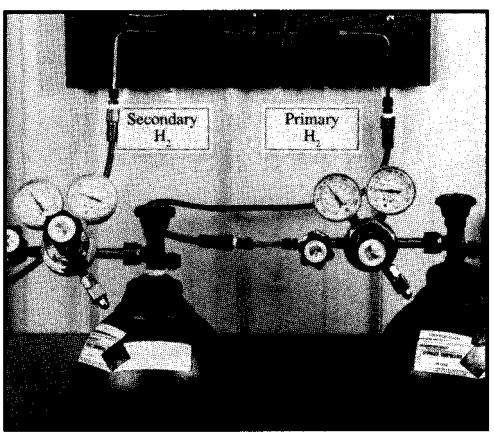


Figure 4
Gas flow path to the GC

Gas Sources



Gases are most often supplied to the instrument by gas cylinders. Begin installation at the cylinder and work towards the GC. Cylinders are under very high pressure and dropping one could result in an extremely dangerous situation. All cylinders (full or empty) should be securely chained to a wall or bench for safety. Any spare cylinders should also be chained to a wall in their storage location with the valve cap intact. It is advisable to have back-up cylinders on all gas lines to avoid any interruption of flow. This is particularly important for carrier gas. Should you lose carrier flow while the column is being heated, irreversible column damage may occur. Two-stage pressure regulators are used with gas cylinders to reduce the pressure of a gas supplied from a high pressure source to a desired working pressure. For safety reasons, when removing a regulator from a cylinder, always position yourself so that the regulator is pointing away from you.



It is common for a newly installed gas cylinder to shut down unpredictably (within the first 24 hours) if the main valve is not completely opened when it is installed. As the cylinder pressure decreases, the force against the valve seat decreases, allowing it to close. Always make sure cylinder valves are completely open when installing new tanks and completely closed before removing the regulator.

As a general rule, change a cylinder when the pressure regulator indicates that there is 200-300psi remaining in the cylinder. As the cylinder pressure drops, the concentration of impurities such as moisture and hydrocarbons increase. Therefore, column damage or premature purifier consumption will occur if you attempt to "save money" by using all the gas left in a cylinder. In addition, if the cylinder pressure drops below the supply pressure required by the GC, retention times and detector sensitivities can slowly change and affect the validity of your data.

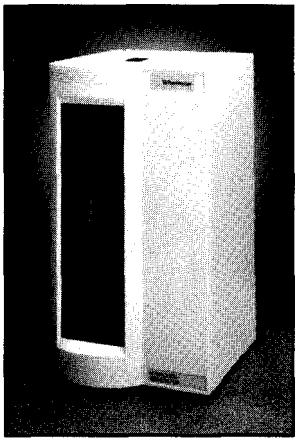
Hints for Proper Handling of Gas Cylinders

Observe safe laboratory practice in the tranportation, storage, and usage of gas cylinders under high pressure:

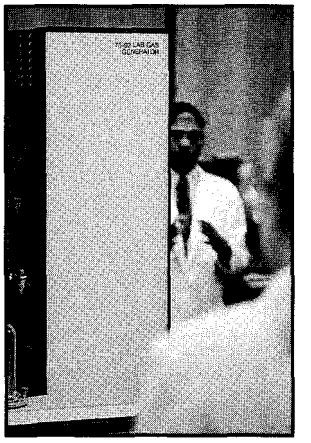
* Never move a cylinder with a regulator installed. Make sure safety caps are in place over the gas valve when transporting the cylinder.
* Always chain or strap cylinders to stationary objects in the laboratory and while in storage
* Always use cylinder condition labels to show whether tank is FULL, IN USE, or EMPTY.
* Always leave at least 200psi residual gas in a depleted cylinder, Store the empty tank in the storage area with the tank valve closed, Mark and date the empty cylinder.
* Do not expose? cylinders to temperatures above 125°F.

Gas Generators

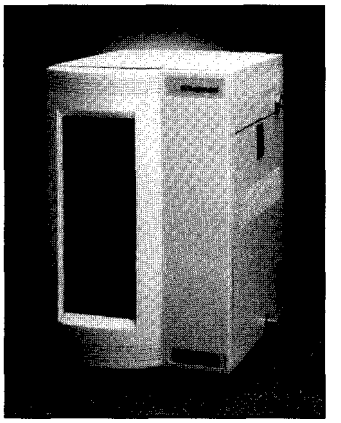
As an alternative to gas cylinders, many labs use gas generators. Generators reduce the costs and safety hazards involved with high pressure gas cylinders. Hydrogen generators supply hydrogen from the electrolysis of water. These units are convenient, safe to use, and produce very pure hydrogen. Air compressors can be used for air supply. However, most compressed air contains hydrocarbons from oil based lubricants. Compressed air that contains hydrocarbons or sulfur gases is not recommended for operating an FID, FPD, TSD, or ELCD. It is advisable to use filters and purifiers to remove hydrocarbon contamination from the compressed air source.



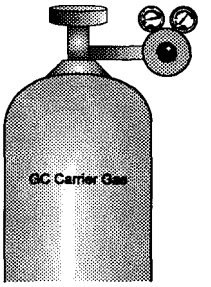
Hydrogen Generator: **(see** page 23 for cat.%)



Nitrogen Generator: (see page 24 for cat.#)



Zero Air Generator: (see page 24 for cat.#s)



Regulators

The purpose of a pressure regulator is to maintain constant gas pressure to the GC. Regulators may be classified as two types: cylinder regulators and line regulators. Cylinder regulators attach directly to the cylinder valve. The cylinder regulator reduces the gas pressure from the cylinder pressure (usually 2500psi for a new cylinder) down to a more usable pressure (around 100psi for gas chromatography). Cylinder regulators have two pressure gauges: an inlet, or high pressure gauge which reads the cylinder pressure; and a delivery, or outlet pressure gauge. This final delivery pressure is user adjustable by turning the large knob on the front of the regulator.

Cylinder regulators may be either single-stage or two-stage regulators. Two-stage regulators actually employ two regulators back-to-back in one housing. The first stage reduces the cylinder pressure to 200-600psi, while the second stage performs the final pressure reduction. Two- stage regulators are less prone to "creep" (a slow increase in delivery pressure as the tank empties) but have a lower flow capacity than single-stage regulators. Although more expensive, two-stage regulators should be used when a very constant delivery pressure is required, such as when controlling gas flows for a gas chromatograph.

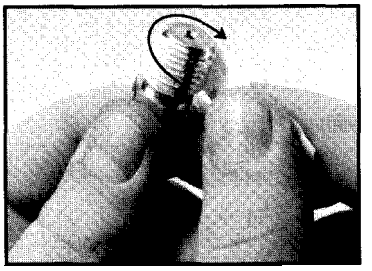
Line regulators have a lower allowable inlet pressure (typically 300psi) and must never be attached directly to a gas cylinder. Line regulators are used to further reduce the pressure of a gas from the supply line to that required at the point of use. Line regulators are always single-stage regulators, and may be equipped with a single pressure gauge to indicate outlet pressure. (See page 25 for regulators.)

Oxygen, moisture, and elastomeric contaminants can migrate through rubber or elastomeric diaphragms and enter the carrier gas. Therefore, all regulators should incorporate metal (Teflon@ coated stainless steel) diaphragms to assure that contaminants will not enter the gas line. Consult Table II to determine the proper type and size of cylinder valves as described by the Compressed Gas Association (CGA) numbers for each regulator.

Table II - High Purity Two-Stage Regulators
Proper type and size of cylinder valves:

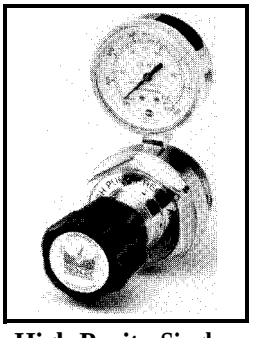
CGA 580	N_2, He & Ar	cat.# 20606
CGA 350	H_2	cat.# 20607
CGA 590	Air	cat.# 20608

When installing any regulator, be sure to use high quality Teflon@ tape on all machine thread connections, DO NOT use Teflon tape on Swagelok-type compression fittings.

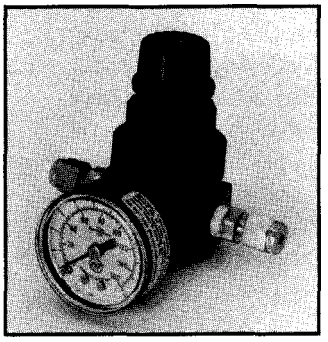


Wind Teflon tape clockwise to ensure a good seal.

High Purity Two-Stage Regulator (CGA 580): cat.# **20606**

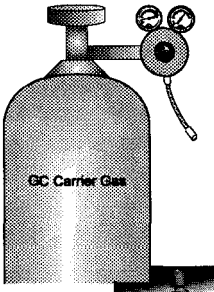


High Purity Single-Stage Regulator: cat.# **20609**

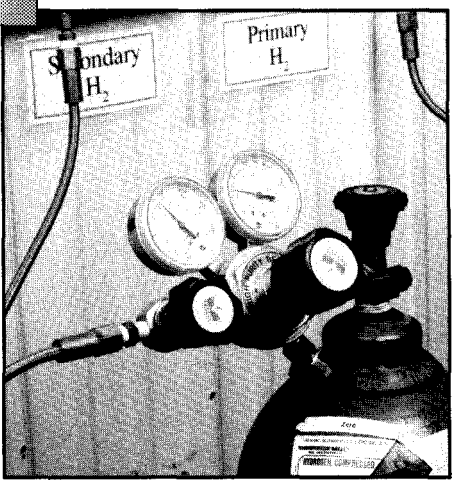


MINICYL General Purpose 1/8" Regulator: cat.# 20610

Flexible Pigtails



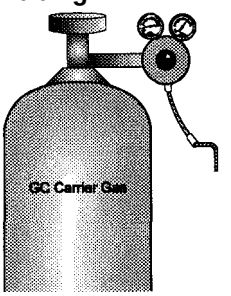
Pigtails (cat.# 20615) are commonly installed between the two-stage regulator and the gas lines. They allow the necessary flexibility in removing regulators from the cylinder. Pigtails are constructed of braided stainless steel with an inert Teflon core.*



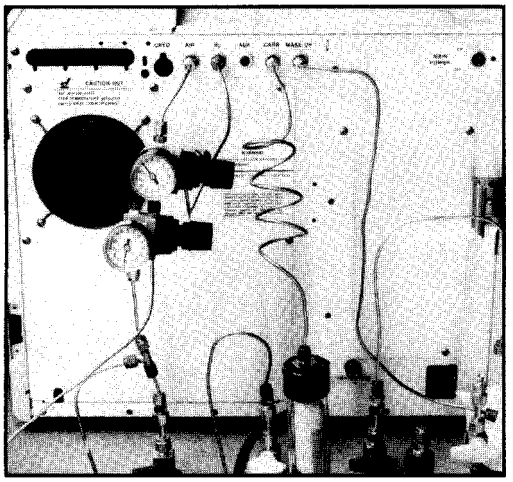
Flexible ***pigtails make it easier to change gas cylinders.***

**** Some 02 and moisture will diffuse through the Teflon core stainless steel braided pigtails. Always use oxygen and moisture traps downstream of flexible pigtails.***

Tubing



The next step in plumbing GC gases to the instrument is choosing the appropriate tubing size. Most GCs are plumbed with 1/8" bulkhead fittings, therefore 1/8" tubing is commonly used. The location of the gas cylinders also determines if a larger diameter tubing is required between the tanks and the GC. If only one GC is being plumbed from tanks located in the same room, 1/8" tubing is sufficient. However, if the tanks are located outside the room or if several GCs are being plumbed from the same source, 1/4" tubing is recommended to reduce pressure drop in the line and supply adequate gas for several instruments. When using 1/4" tubing, plumb the GC with a 1/4" line from the tanks to back of the GC. Then use a 1/4 to 1/8" female reducer (cat.# 21825) to allow attachment to the first purifier. Connect both purifiers to the carrier gas line with 1/8" tubing loosely coiled. When measuring the 1/8" tubing, provide extra length to coil the tubing into shock loops. Shock loops will prevent instrument vibrations from being transferred to the supply lines and loosening fittings or breaking gas purification traps. Additionally, shock loops allow an instrument to be moved on the lab bench. Complete the installation by plumbing 1/8" tubing from the outlet of the last purifier to the GC bulkhead fitting.



Shock loops to prevent purijer breakage can be made by bending 1/8" tubing into a coil shape.

It is essential to use clean chromatographic grade tubing prior to installing a GC. Tubing can contain residual hydrocarbon contamination from the drawing process. These contaminants can migrate into the gas stream causing elevated background noise and increase instrument down time. Tubing can be solvent rinsed with methanol or other various solvents that do not provide a response on the detector being used. (Caution: do not use methylene chloride when using ECDs.) Restek offers a full line of pre-cleaned, heat treated tubing to plumb GCs without the need for solvent rinsing (see page 16). GC manufacturers recommend copper or stainless steel tubing for plumbing gas lines between the gas source and the instrument. Plastic tubing material such as Teflon, polyvinyl chloride, or Tygon should not be used when plumbing GCs since these materials will allow air and water to diffuse into the gas lines. In addition, plastic tubing can give off organic impurities which can cause ghost peaks and baseline instability.

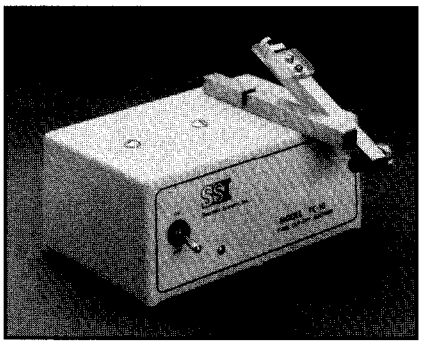
Tubing Cutting and Bending

The first step toward leak free plumbing is correctly cutting and bending the tubing. Either a hand-held or a motorized tubing cutter can be used to cut tubing. With a hand-held device, the tubing is scored by guiding a cutting wheel along the outside surface of the tubing. By increasing the pressure, the cutting wheel is forced into the tubing, thereby making a cut. With a motorized cutter, the cutting wheel is driven by a high speed motor and the tubing is hand-fed onto the spinning wheel. The mechanical cutter*, though more expensive, will easily pay for itself when plumbing several instruments since it is faster and makes a clean, open cut.

** Catalog number 20186 is recommended for 1/16" and 1/8" tubing only.*

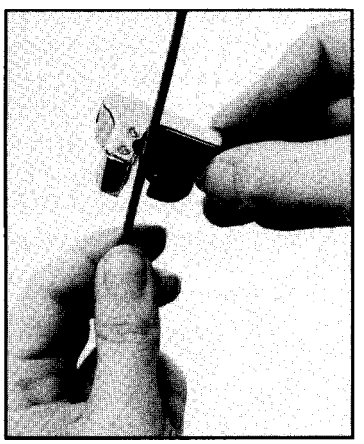
To place an order, call customer service or your local distributor

When using a tubing cutter, a burr or ridge will form on the tubing end. This burr must be removed to allow unobstructed gas flow and to obtain a leak-free connection with the compression fittings. Use a file or exterior deburring tool to remove the burr on the outside of the tubing and an interior deburring tool for the inside. Restek also offers a special tool that deburrs the inside and outside of tubing simultaneously (cat.# 20134 for 1/4" and 1/8" tubing, or cat.# 20188 for 1/16" tubing). Always hold the tubing open end down when deburring to prevent fragments from falling into the tubing.



SSI Tubing Cutting Machine:
cat.# 20186

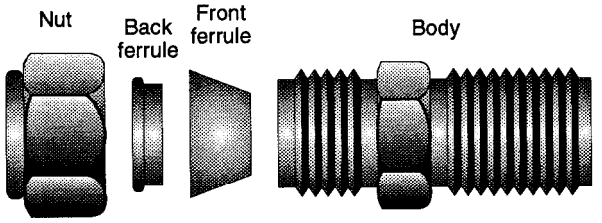
Small tubing cutters allow cuts to be made in tight places (cat.# 20184)



Tubing Benders

Tubing often requires bending during installation. Copper and thin walled 1/8"" stainless steel tubing can easily be bent by hand. However, heavy walled 1/8 and 1/4" stainless steel tubing will require a tubing bender. A tubing bender incorporates the use of lever arms that reduce the force required to bend the tubing. Bends should be made with a uniform radius and should not kink or deform the tubing in a manner that obstructs flow. Try the bending procedure on some spare tubing first to help avoid costly mistakes on expensive tubing.

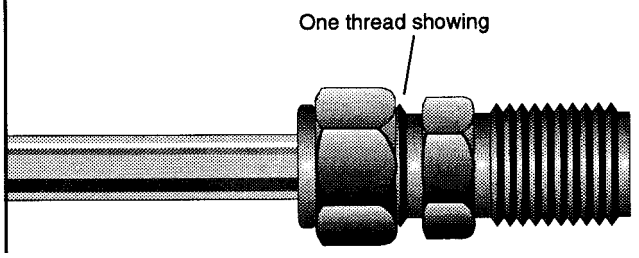
Figure 6
Compression *fitting* ***with two-piece ferrule design***



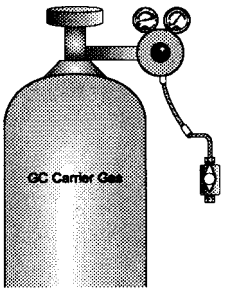
Fittings

Compression fittings provide gas-tight, leak-free connections without the use of Teflon tape or adhesives. A Swagelok-type compression fitting consists of a nut, a back ferrule, a front ferrule, and the fitting (union, elbow, tee, etc.) as shown in Figure 6. Slide the nut and ferrules onto clean, deburred tubing and insert the tubing into the fitting as far as possible. Hand tighten the nut, then use a wrench to tighten further. For t/s" tubing, tighten the nut 3/4-turn past finger-tight. For '14" tubing, tighten the nut liLturns past finger-tight. When tightened, the back ferrule forces itself into the front ferrule causing it to compress and grip the tubing forming a leak-free seal. Be careful not to over-tighten the nut, or the tubing and ferrules can become deformed and not seal. A properly tightened compression fitting usually shows one thread from the back of the nut (Figure 7). Overtightened fittings show no thread and are prone to leakage.

Figure 7 - A properly tightened compression *fitting*



Valves

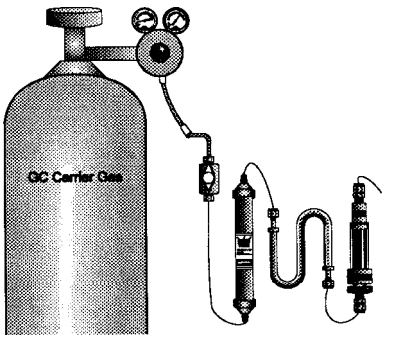


To expedite troubleshooting, the entire GC network should incorporate valving. 1/8"' brass plug valves (cat# 21889) are recommended to isolate the system to check for leaks or to allow the GC to be taken off-line for repairs. Plug valves use a rotating cylinder to control gas flow in one direction only. Ball valves use a ball encased in Teflon packing and allow flow in either direction. One drawback of ball valves is the potential for Teflon to flow form and cause the valve to leak when used under fluctuating temperature conditions.

Valves should be placed before gas purification traps to allow simple trap replacement without shutting down other GCs on the same line. For easy identification and troubleshooting, label or color code each valve throughout the system to help identify each gas type. After the system is pressurized, leak check valves in all possible positions using a thermal conductivity leak detector (cat.# 21607).

Caution: Two different gas types should never be connected together by a tee or a valve to allow easy change-over of carrier gases. Mixing will inevitably occur making trouble-shooting very difficult.

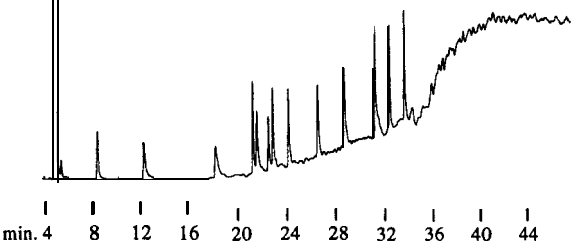
GC Gas Purification



Clean carrier gas is the key to longer column lifetime and less detector noise. Oxygen and moisture can enter downstream of the carrier gas cylinder through fitting leaks or connectors that utilize rubber o-rings. Also, contamination of the tubing with solvents or lubricating oils can increase background noise and cause ghost peaks with GC systems. Therefore, traps should always be used (even with ultra high purity gases) to prevent impurities from entering the GC system. Individual traps are designed to remove moisture, oxygen, hydrocarbons and other contaminants from the gas supply. Traps are available with either 1/4 or 1/8" compression fittings and are typically constructed with metal or glass bodies. Plastic bodied traps should never be used since oxygen and moisture permeation will occur. Several common carrier, make-up, and detector gas purifiers are discussed in the following section.

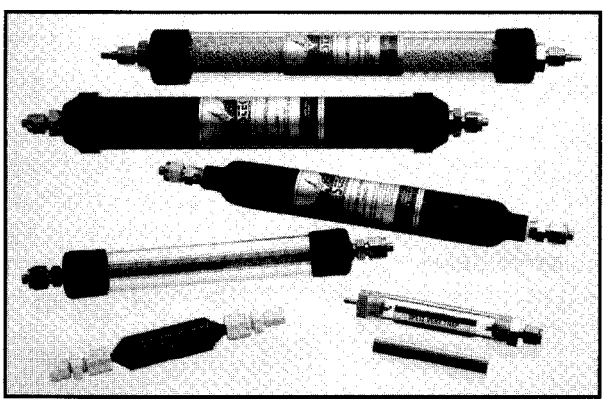
The most common contaminants in carrier gas are oxygen, water, and hydrocarbons. Both oxygen and moisture degrade the stationary phase and shorten column lifetime. Hydrocarbons cause ghost peaks or increase detector noise. Oxygen contamination in carrier gas can produce excessive column bleed at high temperatures (Figure 8). Although some

Figure 8 - 02 damage results in high bleed and peak tailing.



stationary phases are more resistant to oxidation (methyl and phenyl/methyl polysiloxanes), all stationary phases will eventually degrade when exposed to oxygen in the carrier gas at high temperatures.

Oxygen can be removed using getters, or materials that adsorb or chemically react with oxygen. Some getters must be heated to effectively remove oxygen, while others can be used at room temperature. Getters also differ in their capacity and mechanism to remove oxygen. Heated getters may release hydrogen or other impurities into the carrier gas stream, whereas most room temperature getters simply bind or react with oxygen. Some room temperature getters are extremely reactive when broken, therefore care must be taken not to break the trap or expose the trap material. Getters can also remove trace moisture but this diminishes their capacity to remove oxygen. Removing moisture with molecular sieve traps is more effective and will extend the lifetime for most getters. Molecular sieve traps exhibit excellent capacity for removing trace levels of moisture from carrier gas. Indicating molecular sieve traps are available, however, the indicating media is only sensitive to high levels of water and are not usually recommended. The l/8" "S" type molecular sieve traps (cat& 20686) are usually the best choice for chromatographers. They are packed, activated at oven temperatures of 300°C sealed, and are ready to-use. Because of their small size, they can be reconditioned in a GC oven when contaminated.



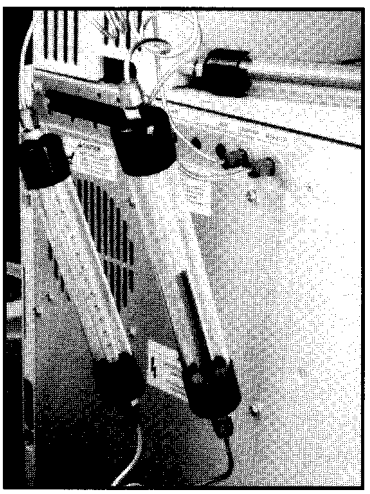
A wide assortment of traps are available for carrier, makeup, and detector ***fuel gases.***

Hydrocarbon impurities in the carrier gas lines will result in detector instability, ghost peaks, and in extreme cases will result in column contamination. High levels of hydrocarbon impurities are not usually present in commercially available carrier gas sources, therefore most chromatographers do not find hydrocarbon traps necessary.

Hydrocarbon and solvent contamination is frequently removed using activated coconut charcoal. Since indicating hydrocarbon traps are not available for carrier gas lines, the analyst must note the date of installation and change the trap after approximately six months of use. Indicating traps, which are available from compressed air lines (1/8'":cat.# 20637), should be used when oil lubricated air compressors are used as the FID air source.

What are the differences between indicating and non-indicating traps?

Some traps can indicate oxygen, moisture, or hydrocarbon removal by changing color. Indicating traps are made with glass housings to allow visual inspection of the color change. Although glass housings are fragile, they prevent oxygen from diffusing into the carrier gas and allow visual indication of the purifier activity level. Plastic materials are permeable to oxygen and are not recommended for any trap installed on a carrier gas line. Non-indicating traps are generally contained in a metal housing for strength and ruggedness. It is important that indicating oxygen traps are made with either glass or metal housings.



Indicating traps change colors as they .are depleted, telling you when it is time to change them.

Indicating traps have an advantage over non-indicating traps since you can visually determine when to install a new trap. With non-indicating traps, it is impossible to accurately determine when the trap needs to be replaced. Non-indicating, high capacity traps should be installed prior to an indicating trap. When the indicating trap shows a color change, the non-indicating trap has been depleted and should be changed.

In what order should the traps be installed?

The order in which the traps are placed inthe carrier gas flow path and their proximity to the GC is very important. Figure 9 on page 10 shows the recommended order for installing carrier gas traps. The hydrocarbon trap should be placed first in line from the carrier gas tank. This is to prevent trace hydrocarbons from contaminating the molecular sieve trap. The molecular sieve trap should be placed after the hydrocarbon trap to remove water. The oxygen trap should be placed closest to the GC bulkhead fitting. In general, traps should be installed on each GC as close to the bulkhead fitting as possible. Traps installed near the gas cylinder will not remove oxygen that may enter the carrier gas from leaky fittings downstream.

Traps should be installed vertically to avoid channeling. Channeling results from the packing material settling which, when a trap is positioned horizontally, may allow carrier gas to pass through without sufficient interaction with the packing.

Figure 9 *- Trap recommendations, order, and installation tips.*

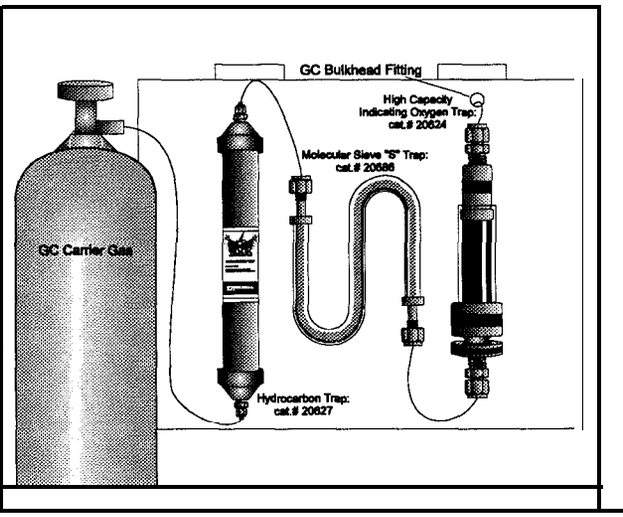
Hints for Using Traps:

- Install close to GC bulkhead fitting.
- Install vertically.
- If using a high capacity, non-indicating 02 trap, use a low capacity indicating trap after it.

Trap Recommendations:

Carrier gas: oxygen, moisture, and hydrocarbon (optional)
Make-up gas: none required*
Air (FID, etc.): hydrocarbon (when trace oils are suspected)
H2 (FID, etc.): none required
ELCD reaction gas: hydrocarbon

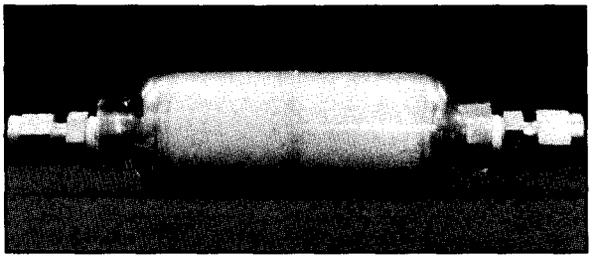
** Use oxygen and moisture traps on ECD make-up gas.*



Should purifiers be used for other gases?

In addition to carrier gas, traps can also be used for other gases such as make-up and detector gases. Make-up gas for Flame Ionization Detectors (PID) does not require purification unless the PID is operated at high sensitivities. However, oxygen and moisture traps are highly recommended for make-up gas when operating sensitive detectors such as Electron Capture Detectors (ECD). The hydrogen reaction gas used for sensitive Electrolytic Conductivity Detectors (ELCD) also requires a hydrocarbon trap to remove trace impurities. These impurities can cause baseline instability and decrease the lifetime of the nickel reaction tube.

Many analysts use "house" compressed air from oil based compressors which can emit hydrocarbon vapors. Trace oil vapors can increase the background noise and contaminate PID detectors. A new compressed air trap (cat.# 20637) is available which reduces oil vapors to levels less than Sppm. This trap changes color as oil vapors are detected to indicate when the trap is depleted. Because of its plastic body, the indicating compressed air trap is not recommended for carrier gas lines.

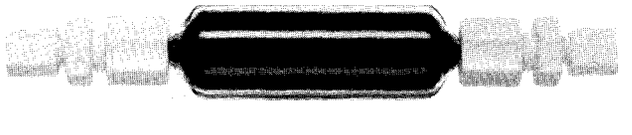


Compressed air traps change colors to indicate oil contamination.

After running the gas supply lines to the lab bench, it is time to plumb the gas supply lines to the GC. Special care should be taken to connect the correct gas type to the appropriate fitting on the GC. The gas inlets for the GC will be located in different places depending on the make and model of your instrument. Refer to your installation manual for the location of the gas inlets.

Hints for ECDs: Always uses high purity moistme traps like our 1/8" "S" trap (cat.# 20686) and 1/8" high purity oxygen trap (cat.# 20624) on ECD carrier and make-up gas lines.

Traps are Necessary for Split Vents to Prevent Breathing Air Contamination



Potentially hazardous or carcinogenic chemicals can enter the lab atmosphere through the split vent in a capillary GC. As much as 99% of the sample injected vents to the air where chemists working nearby breathe these pollutants. This problem is further magnified when multiple GCs are used in the same lab. Split vent traps, packed with charcoal, reduce the uncontrolled release of hazardous materials into the lab.

The best trapping material is activated coconut charcoal due

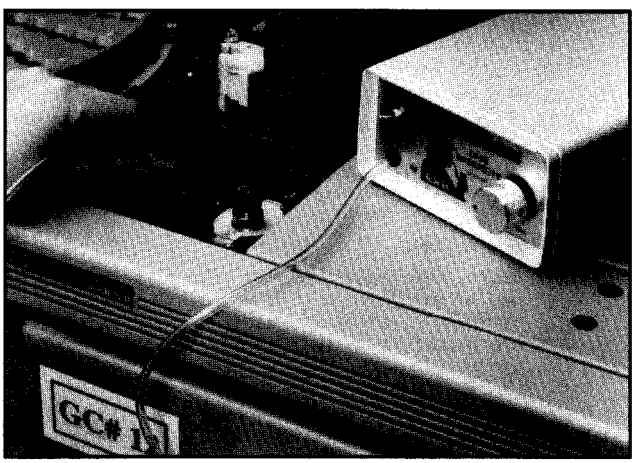
to its tenacious trapping ability. Narrow 1/4" trap bodies cause increased back pressure on the inlet system and severely increase retention times. In addition, the excessive back pressure on the split vent outlet can cause the back pressure regulator to perform erratically when the solvent expansion pulse occurs. Therefore, a large trap body design maximizes the quantity of charcoal that comes in contact with the sample vapor stream without causing unreasonable back pressure. Trap bodies made from solvent resistant plastics either crack or leak with continuous solvent exposure. A glass trap body provides the best resistance and longevity from repeated solvent injections.

The trap capacity determines the number of injections that can be performed before solvent breakthrough occurs. High capacity traps provide protection for thirteen hundred injections or fifty days if one analysis is performed per hour.

Leak Checking

Many GC problems can be avoided by leak checking the system during the plumbing process. Loss of GC gases, reduced trap lifetime, damage to capillary columns, and increased detector maintenance will result if a leak is present. Leak checking the instrument before column installation and conditioning prevents column degradation indicated by high bleed and short lifetime. Irreversible damage can occur if a column is exposed to oxygen at high temperatures. Additionally, some detectors (for example, an ECD) are very sensitive to oxygen and can easily be damaged by oxygen exposure. Leak checking should be performed from the tanks to the GC, including all the fittings inside the GC. The GC fan should be turned off during leak checking. Next, check the external fittings along the carrier gas line for leaks. Leak detectors such as the Restek Leak Detective (110 volts: cat.# 21607, 220 volts: cat.# 21609), Gow-Mac Leak Detector (cat.# 20130), or Compact Leak Detector (cat.# 21605), detect minute traces of helium or hydrogen without contaminating the system. Never use liquid leak detectors that contain soap or surfactants. Liquids can be drawn inside the fitting at the site of a leak by the Venturi effect and contaminate the system.

If a thermal conductivity leak detector is not available, a pressure decay test can also be used to find major gas leaks. To perform a pressure decay test, first cap off all possible gas outlets including the injection port and the detector fittings. Next, shut off the gas supply at the cylinder. In a leak free system, the line pressure observed at the two-stage regulator will hold constant for 15 minutes or longer. A rapid loss of pressure indicates that leaks are present. If this is the case, isolate smaller sections of the plumbing by capping off the line closer to the cylinder and recheck the pressure drop after closing off the gas supply. Repeat this process untilthe leak is found, then retest the entire system to ensure pressure is maintained.



Proper leak checks increase column lifetime/reduce detector noise.

Instrument Logbook

Another step in setting up a GC is creating an instrument logbook. Detailed documentation is crucial to the operation of any testing lab, therefore, record all of the steps involved in installing the new GC in your laboratory. Additionally, develop a GC maintenance schedule and document all maintenance performed (Figure 10 on page 12). A routine GC maintenance schedule will minimize system troubleshooting, increase sample throughput, and improve analytical accuracy. A good GC maintenance program focuses on the inlet, capillary column, detector(s), oven calibration, traps and purifiers, and leak checking. GC documentation should also include analytical information (number of analytical sequences run, type and number of samples analyzed, appearante of sample) and any troubleshooting or repair work performed on the instrument. Documentation and routine maintenance will make future troubleshooting efforts less time consuming.

	Figure 10 *Routine GC Maintenance Documentation*	GCl	*GC2*	*GC3*	*GC4*	*GC5*	*GC6*	*GC7*	*GC8*	*GC9*	*GC10*
GC and Column Documentation	**Column Information** Column installed Column catalog # Column serial # Date of installation Analysts initials GC# Ferrules used with column Carrier gas used Linear velocity Dead time Date column removed from GC Analysts initials Columns sealed with										
	Analytical Information # of standards run Type of standards run # of samples run Type of samples run Solvent sample standards were diluted with Sample concentration Injection size Septa used Inlet sleeve Packing materials? Injector temperature Injection mode Split vent flow Septum purge Splitless hold time										
Routine GC Maintenance	Injector Replace septa Replace sleeve Replace column ferrule Replace injector fitting Replace inlet seal Replace o-ring Clean needle guide Clean needle disk Clean inlet seal Clean injection port Clean septum nut Leak check										
	Detector Replace detector sleeve Replace detector fitting Replace detector ferrules Clean detector Clean detector port Clean collector Leak check										
	Instrument Replace GC traps Replace chemical filters Leak check ah fittings Check gas flow rates Check make-up gas flows										
	Misc. Sweep oven Special problems										

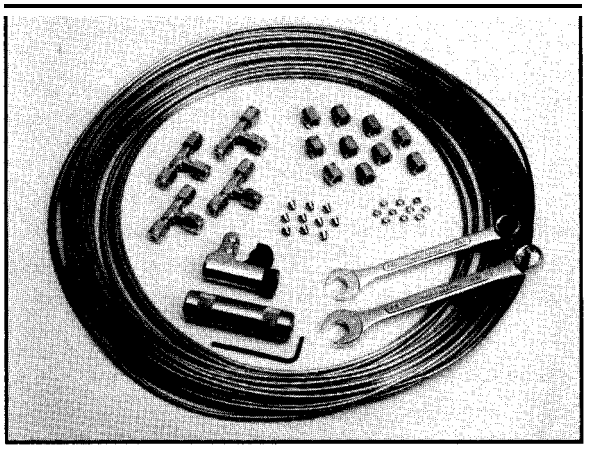
Products Used for GC Setup

GC Installation Kit

This kit contains the necessary tubing and fittings to add an additional GC to your lab bench. Also included in the kit are four l/g" tees, so GC gases like hydrogen, helium, nitrogen, and air can be routed to the new inlet or detector from the existing gas lines. Additional parts, such as purifiers or regulators, may be ordered separately to customize the GC installation to your labs specifications.

Kit includes: one tubing cutter, one 1/8" x 1/4" reamer, one 7/16"" wrench, one 1/2" wrench, four 1/8" brass tees, ten 1/8" brass nuts, ten brass front and back ferrules, and 50' of pre-cleaned 1/8" copper tubing.

GC Installation Kit: cat.# 21325

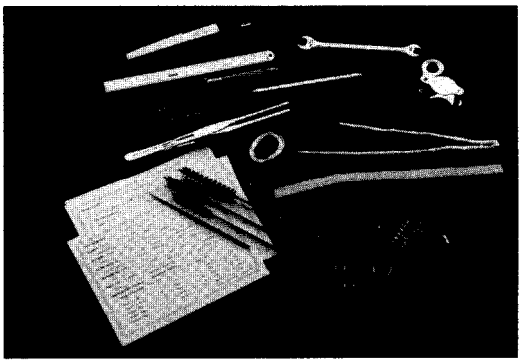


MLE Tool Kit

This kit contains all the tools necessary for installing and maintaining your capillary columns.

The MLE Tool Kit Includes:

- Rubber-tipped Slide-Lok tweezers
- 15cm compact steel ruler
- Sapphire scribe
- Pocket magnifier
- Pin vise with three drills (0.41,0.5 ,0.8mm)
- Four-inch tapered needle file
- Six stainless steel jet reamers (0.25-0.65mm)
- Five self-adhesive capillary column labels
- Septum puller
- Three nylon brushes (l/8", 3/16", 1/4")
- Pipe cleaner (one-foot)
- ' 1/4-3/16" wrench
- One-meter of high temperature string (400C)
- Three stainless steel brushes (3/16", 1/4', 3/8")
- Stainless steel toothbrush
- Glass wool puller/inserter
- Capillary column installation guide
- Chromatography Essentials Wall Chart

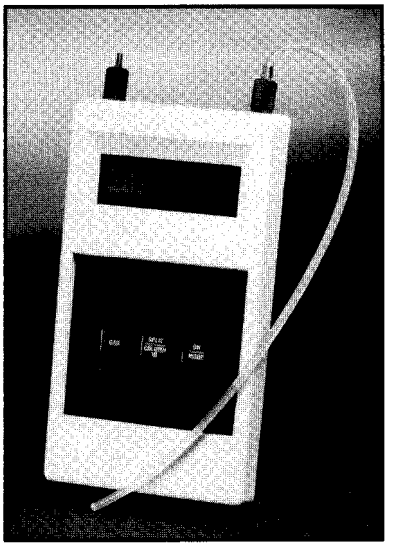


MLE Tool Kit: cat.# 20118

Electronic Flow Calibrator

- NIST traceable calibration
- Displays flow, linear velocity, or split ratio
- Measures 0.1 to 500ml/min.
- Works with hydrogen, helium, nitrogen, air, or argon/ methane
- Battery operated for easy portability

The Electronic Flow Calibrator can be used to measure any of the common gases used with GCs. Each flow meter is calibrated using NIST traceable standards. Flows from 0.1 to 500cc/min. can be accurately measured and easily switched between gases. The Electronic Flow Calibrator measures mass flow that is independent of changes in ambient temperature and pressure which can affect soap film or acoustic sensor meters.



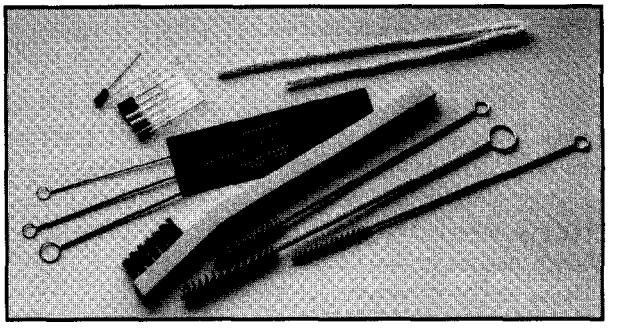
Electronic Flow Calibrator: cat.# **21606**

FID/Injector Cleaning Kit

Kit includes everything needed to keep your FID and injection ports clean.

- Nylon tube brushes (1/8", 3/16", 1/4") pipe cleaners
- Stainless steel tube brushes (1/8", 3/16", 1/4"
- Stainless steel surface brush
- Stainless steel jet reamers
- Emery cloth

FID Injector Cleaning Kit: cat.# 20120

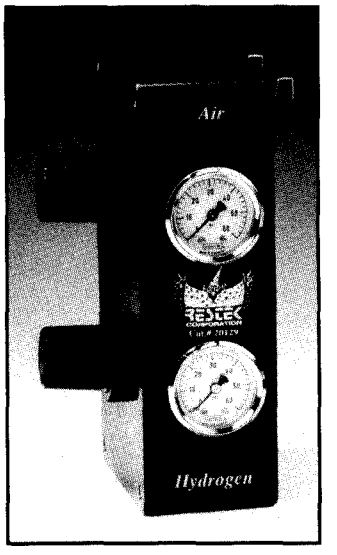


FID Gauge Pack

- Conveniently mounts ***on the*** side of the HP 5890 GC.
- Standard i/i" inlet and outlet fittings.
- Up to 250psi inlet pressures, 0-60psi outlet pressures.
- Front mounted gauges for easy visibility.
- Side mounted regulator knobs for easy control.

HP 5890 GCs do not include the pressure regulators necessary to adjust the air and hydrogen flows to the Flame Ionization Detector (FID). Since most labs operate their gas supply lines at a higher pressure than necessary for the proper operation of the FID, chromatographers must supply their own regulators to adjust flows for optimum detector performance.

Restek's FID Gauge Pack simplifies GC installation by incorporating pressure regulators and gauges for both air and hydrogen in a single enclosure. The unit conveniently mounts on the side of the GC, and l/s" bulkhead fittings allow convenient hook-up to instrument and supply lines.



Control HP 5890 FID Gases with Restek's Gauge Pack.

FID Gauge Pack: cat.# 20129

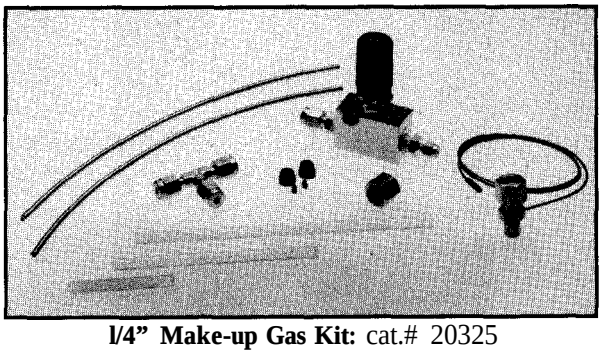
Make-up Gas Kits

Universal 1/4" & 1/8" Make-up Gas Kits*

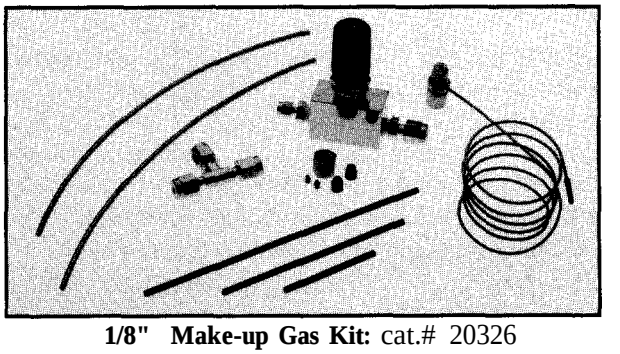
**** The ECD/FID Dual Purpose Make-up Gas Fitting is recommended for use with HP GCs.***

Each Kit Includes:

- Custom stainless steel make-up gas fittings.
- A high performance variable flow restrictor.
- Standard 1/8" tee and 2 x 9" sections of 1/8" stainless steel tubing for connection to the GC bulkhead fitting.
- Three different sleeve lengths; 2" (51mm), 4" (102mm), and 6" (153mm). The 1/4" kit contains 1/4" OD by lmm ID deactivated glass sleeves with one end slotted and one end chamfered. The 1/8" kit contains 1/8" 2mm ID fused silica lined Silcosteel sleeves.
- All nuts and ferrules necessary for connecting the sleeve to the detector and the column to the make-up gas fitting.
- Complete step-by-step instructions.



l/4" Make-up Gas Kit: cat.# 20325

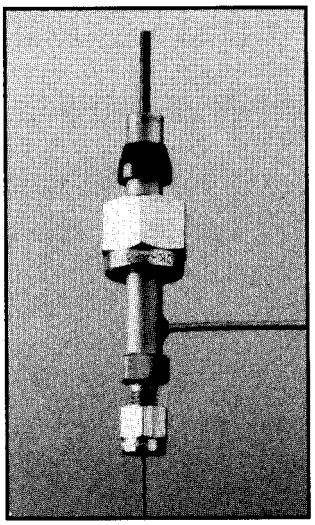


1/8" Make-up Gas Kit: cat.# 20326

ECD/FID Dual Purpose Make-up Gas Kit for HP 5890 GCs

This ECD make-up gas fitting uses a straight section of inert SilcosteeP tubing as the capillary column guide to replace the fused silica column guide found in the original equipment design. To use the fitting with an FID, remove the Silcosteel guide. A replacement fitting with a special end connector is also available for GCs that are factory equipped with make-up gas.

The replacement fitting includes a 1/4" nut and graphite ferrule and a 1/16" nut with a 0.4mm ID graphite capillary ferrule. The complete kit (for GCs not factory equipped with make-up gas) includes a make-up gas fitting, 1/4" nut and ferrule, 1/16" nut and a 0.4mm ID graphite capillary ferrule, and a high quality fine metering valve.



Make-up gas kit:
cat.# 21300
Replacement fitting:
cat.# 21301
Silcosteel guide:
cat.# 21302

Ferrules

Restek offers graphite and VespelYgraphite (60%/40%) ferrules to use with capillary columns. The graphite ferrules are made from highly-compressed ribbon that will not crack or split under torque. The Vespel/graphite ferrules are designed to seal easily with minimal torque, are reusable, and are preferred for vacuum and high pressure uses. Both ferrule types are stable to 400°C.

Capillary Ferrules for 1/16" Swagelok-type fittings

Ferrule ID	Fits column ID	Graphite 10-pack cat.#	Vespel/graphitc 10-pack cat.#
0.3mm	0.20mm	20233	—-—
0.4mm	0.2.5mm	20200	20211
0.5mm	0.32mm	20201	20212
0.6mm	0.28mm	____	20232
0.8mm	0.53mm	20202	20213

Ferrule ID	Fits column ID	Graphite 50-pack cat.#	Vespellgraphitc 50-pack cat.#
0.4mm	0.25mm	20221	20229
0.5mm	0.32mm	20228	20231
0.8mm	0.53mm	20224	20230

Compact Ferrules for HP GCs (for capillary injection ports)

Ferrule ID	Fits column ID	Graphite 10-pack cat.#	Graphite 50.pack cat.#
.4/.5mm	0.25-0.32mm	20250	20251
0.8mm	0.53mm	20252	20253

Standard Ferrules (for 1/16", %", and '14" fittings)

Fitting Size	Ferrule ID		VespeWgraphit S-pack cat.#
1/4"	3/16"		20258

Fitting Size	Ferrule m	Graphite 10-pack cat+	Vespel/graphite 10-pack cat.#
'116"	'116"	20207	20218
'18"	'Is"	20208	20219
'18"	red. t0 '/IS"	20209	20220
'Id*	'14"	20210	20221
'14"	rd. to W	20225	20222
W'	red. t0 '/IS"	20226	20223

Two-hole Ferrules (for 1/16" Swagelok-type fittings)

Ferrule ID	Fits column ID	Graphite 5-pack cat.#	Vespel/graphitc 5-pack cat.#
0.4mm	0.25mm	20235	20241
0.5mm	0.32mm	20235	20242

Two-hole Ferrules (for 1/8" Swagelok-type fittings)

Ferrule ID	Fits column ID	Graphite 5-pack cat.#	Vespel®/graphitc 5-pack cat.#
0.8mm	0.53mm	20245	20246

Reducing Ferrules

Fitting Size	Fits column ID	Graphite 5-pack cat.#	Vespel/graphitc 5-pack cat.#
1/8"	0.25mm	20205	20254
1/8"	0.32mm	20205	20255
1/8"	0.53mm	20206	20215
1/4"	0.25mm	20203	20256
1/4"	0.32mm	20203	20257
1/4"	0.53mm	20204	20217

Blank Ferrules (fo 1 '16" capillary fittings)

Fitting Size	Ferrule ID	Vespel//graphite 10-pack cat.#
1/16'"	no hole	20240

Buy ferrules in bulk 50-packs and SAVE!

Instrument Grade Stainless Steel Tubing

Heat-Treated Stainless Steel Tubing

- Solvent cleaned and heat-treated to remove volatile impurities.
- Ideal for sensitive GC detectors such as ECDs, MSDs, NPDs, and ELCDs that require pure carrier gas.
- Perfect for concentrating inlet systems such as purge and trap or thermal desorption units.
- Available in continuous lengths to minimize potential leaky connectors.
- Economically priced..

Heat-treated to eliminate contaminants

Most stainless steel tubing contains hydrocarbon impurities that migrate into the carrier gas stream and cause background noise or ghost peaks. Solvent cleaned tubing can still contain contaminants that were either insoluble in the cleaning solvent, or left over as a residue from the cleaning process. Restek's chemists have found that gradient solvent rinsing, used in combination with a high temperature treatment under a flow of clean carrier gas, is the best way to guarantee ultra high purity carrier gas lines. Background contamination is eliminated and new instruments can be plumbed with confidence.

Available in longer lengths

Tight manufacturing tolerances ensure close inside and outside dimensions. The 304 stainless steel tubing is annealed for added flexibility. Continuous lengths up to 500 feet are available to eliminate the need for connectors.*

Plumb your instrument with the best. Try Restek's heat-treated, solvent cleaned, instrument grade tubing.

Top quality heat-treated stainless steel tubing priced conservatively

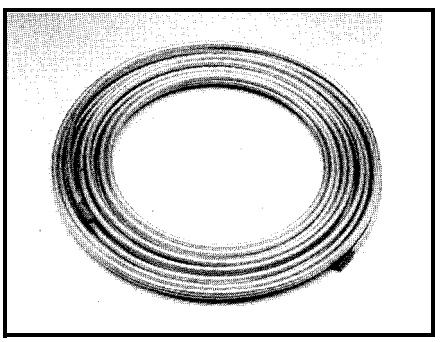
Stainless Steel Tubing Dimensions	25 ft. cat.#	26-100 ft. cat.#	>100 ft. cat.#
0.01" ID, 1/16"OD	21500	21501	21502
0.02" ID, 1/16"OD	21503	21504	21505
0.03" ID, 1/16"OD	21506	21507	21508
0.04" ID, 1/16"OD	21509	21510	21511
0.085" ID 1/8" OD	21512	.21513	21514
0.21" ID, 1/4"**OD**	21515	21516	21517

* Please inquire before ordering to determine the availability of continuous lengths up to 500 feet. The availability of long lengths is subject to inventory constraints.

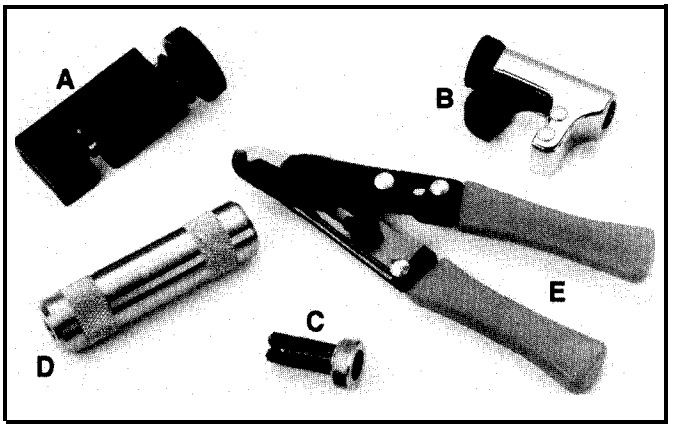
Pre-Cleaned Copper Tubing

cat&	OD	wall	ID	length
21590	1/8"	0.030"	0.065"	50 ft.
21592	1/4"	0.030"	0.190"	50 ft.

- Adheres to ASTM B-280.
- Specially cleaned to be chromatographically free of background contamination.
- Use for plumbing GC systems.



Tubing Cutters



A) Restek 1/16" Tubing Cutter

- Produces square, even cuts for 1/16" tubing.
- Eliminates distortion of the tubing.
- Replaceable cutting wheel.

Restek 1/16" Tubing Cutter: cat.# 20192
Replacement Wheels: cat.# 20185,3-pack

B) Imp'" Tubing Cutter

- Excellent for cutting 1/8" or 1/4" metal tubing
- Compact size is ideal for tight spaces.
- Replaceable cutting wheel.

Imp* Tubing Cutter: cat.# 20184
Replacement Wheels: cat.# 20185,3-pack

C) Tubing Cutter Dressing Tool

Designed to work separately or with the SSI tube cutting machine, these dressing tools do a magnificent job at opening the column bore and removing burrs from the column exterior. Several twists and the bore is fully open.

1/16" **Dressing Tool:** cat.# 20188
1/16" **Replacement Insert:** cat.# **20189**
1/8" **Dressing Tool: cat.# 20190**
1/8" **Replacement Insert: cat.# 20191**

D) Restek Tubing Reamer

This combination 1/4" and 1/8" tubing reamer incorporates a non-slip safety design and is excellent for deburring stainless steel tubing.

Tubing Reamer: cat.# **20134**

E) Cutting Pliers

- Ideal for cutting 1/16" tubing.
- Cuts quickly, reducing distortion of the bore.
- Clean cuts eliminate need for deburring.

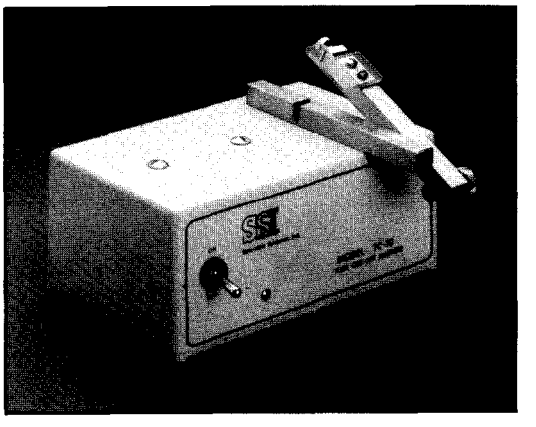
Cutting Pliers: cat.# **20193**

SSI Tube Cutting Machine

- Works for 1/8" and 1/16" tubing.
- Electrically operated bench-top model.

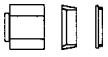
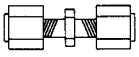
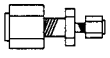
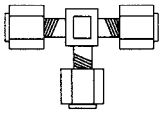
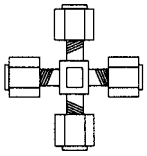
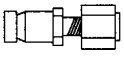
This high speed tube cutting machine squarely cuts either 1/8" or 1/16" tubing (with inner diameters as low as 0.010"). The tubing is held in a specially designed clamp at the end of a safety swing arm. As the arm is lowered, the tubing is guided through a narrow slot where it is cut by a dry abrasive cutting wheel. A dressing tool on the swing arm is provided to deburr and ream the inside and outside of the tubing.

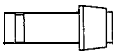
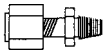
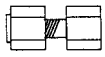
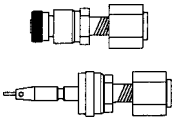
SSI Tube Cutting Machine: cat.# 20186
Replacement Wheels: cat.# **20187, 3-pack**



Tube & Pipe Fittings

Restek offers an extensive line of brass and stainless steel tube and pipe fittings to help you install and maintain your gas chromatography equipment. Parker's (A-Lok) two-piece ferrule design, along with NPT fittings, are ideal for installing new equipment, modifying existing instrumentation, or replacing worn connections. Quick couplings are also available to connect and disconnect gas lines quickly and easily. If you frequently relocate instrumentation, switch carrier gases, or change make-up gases for different detection systems, these quick couplings are a worthwhile addition to your system.

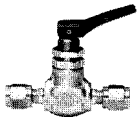
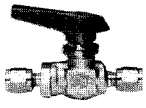
Fitting Type	Size (inches)	Brass cat.#	Brass quant.	Stainless Steel cat.#	Stainless Steel quant.	Replaces Parker #	Replaces Swagelok #
 **Nut**	1/16 1/8 1/4	21800 21801 21802	**20** **40** **40**	21900 21901 21902	5 10 10	lNU1 2NU2 4NU4	102-l 202-1 402-1
 **Front Ferrule**	1/16 1/8 1/4	21803 21804 21805	**20** **40** **40**	21903 21904 21905	10 20 20	1FFl 2FF2 4FF4	103-l 203-l 403-l
Back Ferrule	1/16 1/8 1/4	21806 21807 21808	**20** **40** **40**	21906 21907 21908	10 20 20	1BF1 2BF2 4BF4	101-l 204-1 404-1
 **Nut & Ferrule Set**	1/16 1/8 1/4	21809 21810 21811	10 20 20	21909 21910 21911	2 5 5	— — —	— — —
 **Plug**	1/16 1/8 1/4	21815 21816 21817	5 10 10	21915 21916 21917	2 4 4	1BLP1 2BLP2 4BLP4	100-P 200-P 400-P
 **Union**	1/16-1/16 1/8-1/8 1/4-1/4	21818 21819 21820	3 5 5	21918 21919 21920	1 2 2	1SC1 2SC2 4SC4	100-6 200-6 400-6
 **Reducing Union**	1/8-1/16 1/4-1/16 1/4-1/8	21823 21824 21825	5 5 5	21923 21924 21925	1 2 2	2RUl 4RUl 4RU2	200-6-1 400-6-1 400-6-2
 **Tee**	1/16 1/8 1/4	21826 21827 21828	**2** **2** **2**	21926 21927 21928	1 1 1	1 ET 1 2ET2 4ET4	100-3 200-3 400-3
 **Cross**	1/8 1/4	21829 21830	**2** **2**	21929 21930	1 1	2ECR2 4ECR4	200-4 400-4
 **Tube to Compression Reducer**	1/8-1/16 1/4-1/16 1/8-1/4 1/4-1/8	21831 21832 21833 21834	**5** **5** **5** **5**	21931 21932 21933 21934	2 2 2 2	2TURl 4TUR1 2TUR4 4TUR2	100-R-2 100-R-4 400-R-2 200-R-4

Fitting Type	Size	Brass cat.#	Brass quant.	Stainless Steel cat.#	Stainless Steel quant.	Replaces Parker #	Replaces Swagelok #
 Port Connector	1/8	21835	5	21935	2	2PC2	201-PC
	1/4	21836	10	21936	2	4PC4	401-PC
	1/8-1/4	21837	5	21937	2	2PC4	401-PC-2
 Male NPT Connector	1/8-1/8 NPT	21841	10	21941	2	2 MSC 2N	200-1-2
	1/4-1/4 NPT	21842	10	21942	2	4 MSC 4N	400-1-4
	1/16-1/8 NPT	21843	5	21943	2	1 MSC 2N	100-1-2
	1/8-1/4 NPT	21844	10	21944	2	2 MSC 4N	200-1-4
	1/4-1/8 NPT	21845	10	21945	2	4 MSC 2N	400-1-2
 Female NPT Connector	1/8-1/8 NPT	21846	5	21946	2	2 FSC 2N	200-7-2
	1/4-1/4 NPT	21847	5	21947	2	4 FSC 4N	400-7-4
	1/4-1/8 NPT	21848	5	21948	2	4 FSC 2N	400-7-2
 Quick Couplings	1/8 male*	21857	1	21957	1	2A-Q4VN	QC4D-200
	1/8 male	21858	1	21958	1	2A-Q4P	QC4S-200
	1/8 female*	21859	1	21959	1	2A-Q4CN	QC4B-200
	1/4 male*	21860	1	21960	1	4A-Q4VN	QC4D-400
	1/4 male	21861	1	21961	1	4A-Q4P	QC4S-400
	1/4 female*	21862	1	21962	1	4A-Q4CN	QC4B-400

** Includes self-sealing shut off valve.*

Shut-off Valves

Hoke Toggle, Ball, and Plug Valves

Valve type	Brass 1/8"	Brass 1/4"	Stainless Steel 1/8	Stainless Steel 1/4"
 Toggle	21885	21886	21985	21986
 Ball	21887	21888	21987	21988
 Plug	21889	21890	21989	21990

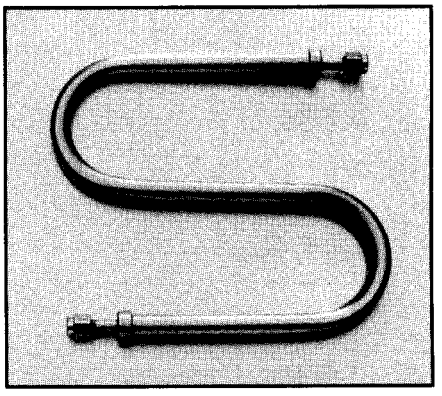
Restek offers Hoke toggle, ball, and plug valves. These high quality, precision machined valves are available in 1/8" and 1/4" sizes in both brass and stainless steel. The toggle valves are ideal for applications when instant on/off control is necessary. Hoke toggle valves are rated to 200psig at 21°C and have a maximum operating temperature of 149°C. The forged body ball valves are ideal for high pressure applications. Hoke ball valves have a floating ball to assist in sealing and reduce operating torque and dual seats provide leak-tight bidirectional sealing. They are rated to 6000p at 21C and have a maximum operating temperature of 249°C. The plug valves are ideal for applications where throttling or on/off operations are required. Hoke plug valves have dual retaining rings to prevent accidental plug removal. They are rated to 3000psig at 21°C and have a maximum operating temperature of 205°C.

Purifiers/Traps

Rechargeable Molecular Sieve "S" Trap

- Increases column and 02 trap lifetime.
- Reduces baseline noise for sensitive detectors such as ECDs and mass spectrometers.

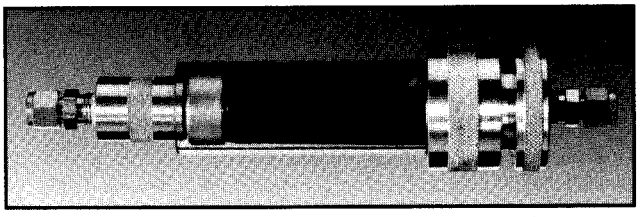
While glass indicating moisture traps offer convenience, they are fragile and add to waste disposal problems since they are discarded when spent. Restek's rechargeable molecular sieve moisture trap offers the best alternative. The "S" design allows the trap to be regenerated in the GC oven. The metal body and single end fitting design eliminate the possibility of leakage or breakage and the built-in 40 micron frit prevents particulate contamination from damaging regulators or needle valves. Each trap is individually activated to insure maximum reactivity for removing moisture.



1/4" female Swagelok-type fitting: cat.# **20685**
1/8" female Swagelok-type fitting: cat.# **20686**

High Capacity Indicating Oxygen Trap

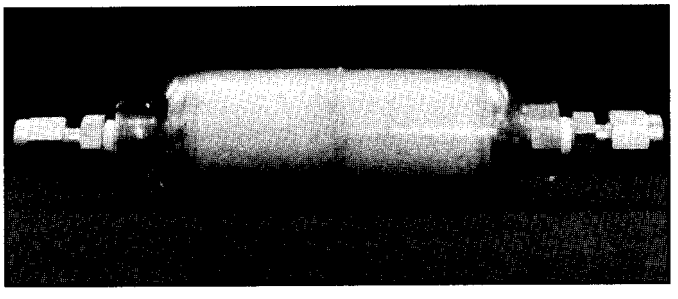
- Indicator changes color as O_2 & H_2O are trapped.
- Heavy duty body design virtually eliminates breakage.
- High capacity (>300s.c.f.) design lasts longer than three smaller traps.
- Economic replacement cartridges change easily.
- Usable with multiple GC systems.
- Removes impurities at flow rates up to 230s.c.f.
- Removes O_2, H_2O, and trace contaminants.
- Usable with all carrier gases.
- Ambient operating temperature, 100psig operating pressure.
- Built-in microparticulate frit.
- Discharge Gas Purity:
  02 < 0. lppm where inlet does not exceed 15ppm.
  H2O < 0.5ppm where inlet does no t exceed 10 ppm.



Includes cartridge housing and one cartridge.

1/4" tube compression fitting: cat.# 20623
1/8" tube compression fitting: cat.# 20624
Refill cartridge (fits 1/4 or 1/8" cat.# 20625

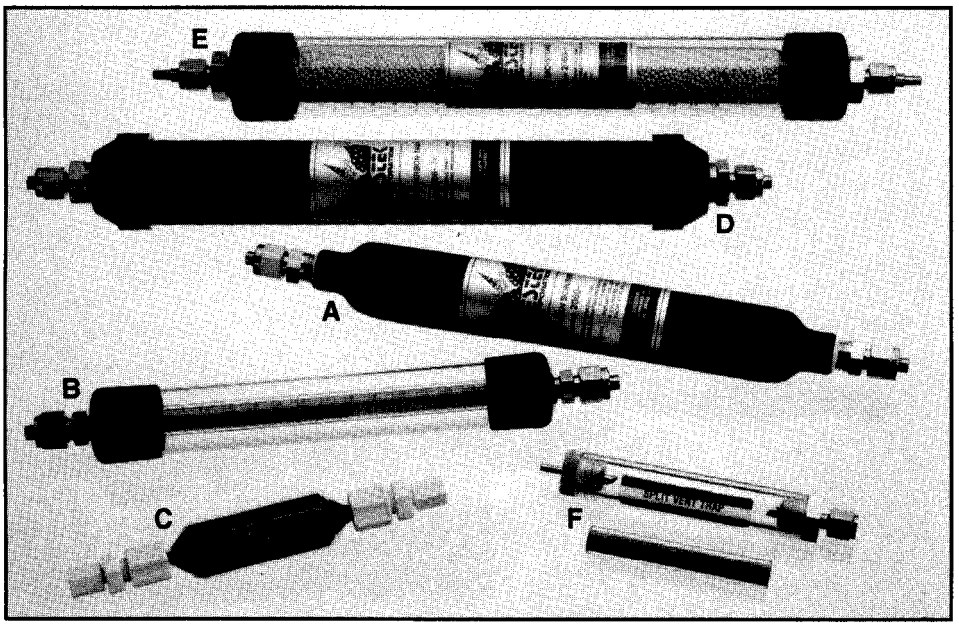
Indicating Hydrocarbon Trap for Compressed Air



Many laboratories now run Flame Ionization Detectors (FID) from oil lubricated air compressors or from house air lines. Although most of these systems have extensive filtration devices to remove oil vapors or mist from the air stream, there is no way to determine if these filters are doing their job or when to change them. The only indication that the filters are not working is when oil contamination reaches the detector and creates massive baseline disturbances, ghost peaks, and clogged jets. By then, it is too late and only laborious solvent rinsing of the gas lines and detector fittings will restore the stability of the FID.

The Restek Wizards have come up with a novel solution to this problem. Our Indicating Hydrocarbon Trap changes color as it absorbs oil vapors. This trap gives advanced warning should the filters on the compressed air lines ever fail. In addition to changing color, the trap reduces oil vapor concentration down to five parts per million to prevent gross contamination of the instrument lines. Available with l/s" or 1/4"' tube compression fittings, these traps are a must for any lab using oil lubricated air compressors as a gas source for their FIDs.

1/4" Indicating Hydrocarbon Trap: cat.# **20636**
l/8" Indicating Hydrocarbon Trap: cat.# **20637**



A) High Capacity Oxygen Trap

- Most effective oxygen trap available.
- Long life, typically lasts for over five 200cf cylinders.
- Traps carrier gas contaminating moisture.

1/4" **female Swagelok Type fitting:** cat.# **20690**
1/8" **female Swagelok Type fitting:** cat.# **20601**

B) Indicating Oxygen Trap

- Reduces both 02 & H2O to less than 15ppb.
- Indicator changes color as 02 & H2O are trapped.
- Quickly identifies contaminated gas cylinders or carrier gas leaks before column damage occurs.
- Heavy-walled glass body prevents 02 & H2O diffusion.
- Integral protective plastic shield for maximum safety.
- 4Opm frit prevents microparticulate damage to needle valves and flow controllers.
- Pre-purged with helium for fast stabilization time.
- Vespel sealing rings used.
- 100psig maximum operating pressure.

1/4" female Swagelok-type fitting: cat.# 20603
1/8"**female Swagelok-type fitting:** cat.# 20602

Return unbroken traps to us and give them a new life!
Regenerated Trap 1/4" fitting: cat.# 20617
Regenerated Trap 1/8"fitting: cat.# 20616

C) High Capacity Split Vent Trap

The use of split vent traps packed with activated coconut charcoal reduces the release of hazardous materials in our breathing space. This large bodied trap allows 1,500 injections to be performed before solvent breakthrough occurs. Replace the trap once a month or after 1,500 injections. Includes connecting lines and mounting kit.
cat# 20698
caL# 20699, 5pack

D) Hydrocarbon Trap

- Removes trace carrier gas impurities for sensitive detectors such as ECDs, PIDs, & MS.
- 20urn frit prevents particulate contamination.
- Contains fine mesh coconut shell activated charcoal.
- Stops carrier gas interferences with purge& trap systems.
- Refillable and rechargeable.

1/4" **tube compression fitting:** cat.# *20628*
1/8" **tube compression fitting:** cat.# *20627*
Carbon refill (two recharges): cat.# 20626

E) Indicating Moisture Trap

- Reduces both 02& H2O to less than 15ppb.
- Reduces noise for high sensitivity detectors.
- Indicator changes color as H2O is trapped.
- Heavy-walled glass body prevents 02 & H2O infusion.
- Integral protective plastic shield for maximum safety.
- 40um frit prevents microparticulate damage to needle valves and flow controllers.
- Pre-purged with helium for fast stabilization time.

1/4" **female Swagelok-type fitting:** cat.# 20604
1/8" **female Swagelok'-type fitting:** cat.# 20605

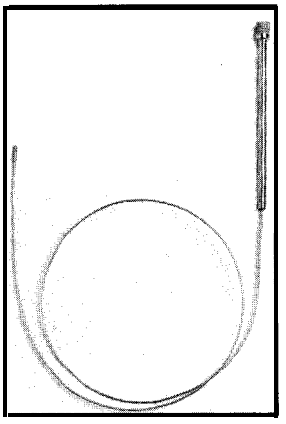
F) Split Vent Trap Kit

Stop polluting the environment. Install a trap to the split/splitless vent port outlet. The easy to install trap incorporates a male and female 1/8" fitting to accommodate most GCs. Special impregnated high capacity carbon filter traps most chemicals. Each kit includes three replacement traps. Replace after 300 injections.
Split Vent Trap Kit: cat.# 20640
Replacement cartridges: cat.# 20641, 3-pack

Replacement Chemical Trap for HP 5890 GCs

GC carrier gas line contamination is a difficult problem to diagnose and correct. Carrier gas line contamination can occur from carrier gas impurities or by sample backflash. Contamination can appear as ghost peaks or a rising baseline not attributed to the inlet, column, or detector. **HP 5890 GCs** incorporate a small chemical filter in the carrier gas line to reduce the possibility of contamination. However, the trap capacity is low and must be periodically changed or contamination will occur. It is recommended the traps be replaced annually under normal operating conditions or more frequently under heavy usage.

Restek's chemical trap is easy to install and attaches to the same fittings as the original equipment. It incorporates built-in frits and adsorbents to remove both moisture and hydrocarbons. Additionally, Restek's trap can be regenerated to remove trapped contaminants and restored to its original performance.



Replacement Chemical Trap for HP 5890 GCs: cat.# 21610

Leak Detectors

Restek's Leak Detective

- Detects minute leaks not possible with liquid leak detectors*.
- Compact, lightweight, hand-held design.
- Lowest cost thermal conductivity leak detector available.
- Contamination-free leak detection.
- Battery or line operated.
- Detects helium or hydrogen leaks at >20ul/min. or >200ppm.

Restek's new Leak Detective is the affordable solution for GC leak detection. Leaks can increase detector noise, cause baseline instability, waste carrier gas, and shorten column lifetimes. The Leak Detective detects minute gas leaks which may go undetected by liquid leak detectors.

The compact design of the Leak Detective ensures comfortable hand-held operation. Trace leaks of both helium and hydrogen**can be detected. Sensitivity is similar to other models on the market with detectability of helium or hydrogen and leak rates of 20ul/min. or an absolute concentration less than 200ppm. Leaks are indicated by an audible alarm, as well as an LED readout. Two 9-volt batteries (included) provide 10-12 hours of continuous operation, or the unit can be used with an AC adaptor (included).

Restek's Leak Detective (110 volts): cat.# 21607
(220 **volts):** cat.# 21609

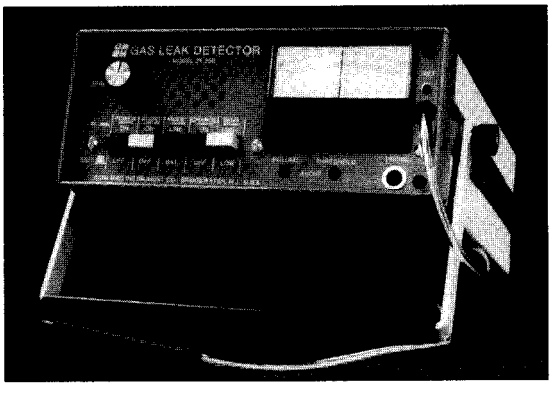
** ***Not designed for use in explosive atmospheres.***

Gow-Mac Leak Detector

- Identifies minute leaks that are undetectable by liquid leak detectors*.
- Contamination and residue-free leak detection.
- Prolongs column life.

The Gow-Mac leak detector is a must for all capillary chromatographers. It is a portable unit that operates on line voltage or on an internal, rechargeable lead/acid gel battery.

Gow-Mac Leak Detector: cat.# 20130



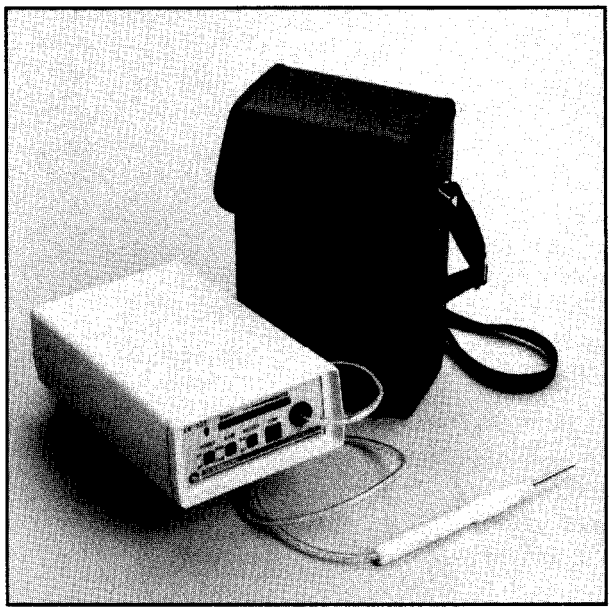
* ***Never use liquid leak detectors on a capillary system because liquids are actually drawn into the column.***

Compact Leak Detector

. Portable
- Quick response
- High sensitivity
- Simple operation
- Contamination-free leak detection

Leaks in a gas chromatographic system can cause problems ranging from increased detector noise, baseline instability, and short column lifetime, to wasting expensive carrier gases. Electronic leak detectors allow analysts to detect minute gas leaks undetected by liquid leak detectors. This leak detector's compact size is designed for easy transport and hand-held usage. Simple push button operation allows one-touch zero adjustment, while the low dead volume sampling line provides quick sample response. Trace leaks of both helium and hydrogen* can be detected using the high sensitivity range. Four AA alkaline batteries (not included) provide up to 12 hours of continuous operation.

* ***Not designed for use in explosive atmospheres.***



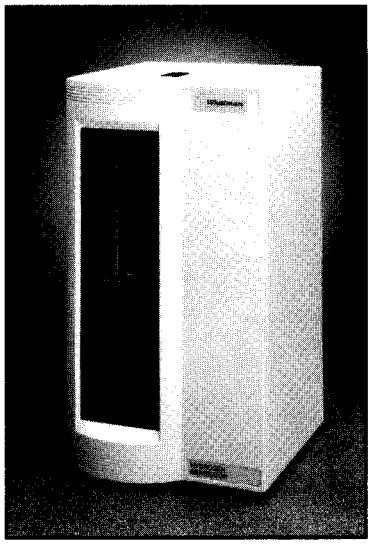
Compact Leak Detector: cat.# 21605

Generators

Whatman Hydrogen Generators

Whatman hydrogen generators produce ultra-pure hydrogen for use as a GC carrier gas or a fuel gas for FIDs, NPDs, FPDs, or a reaction gas for ELCDs. Hydrogen is produced by electrolytic dissociation of water and purified using a palladium membrane.

- Produces ultra-pure hydrogen (99.99999+%).
- Available in two sizes, 150cc/min. or 300cc/min.
- Pressure output from 0 to 60psig.
- Requires deionized water and electricity only.
- Low maintenance, no dessicant cartridges required.
- Meets OSHA requirements.
- Less than 50ml of hydrogen stored at any time.
- Safety features include automatic shutdown for over-pressure, electrolyte leak, and low water supply.
- Compact size takes up little bench space.
- Leasing available for low monthly payments.



Hydrogen Generator (150cc/min.):
cat.# 20687

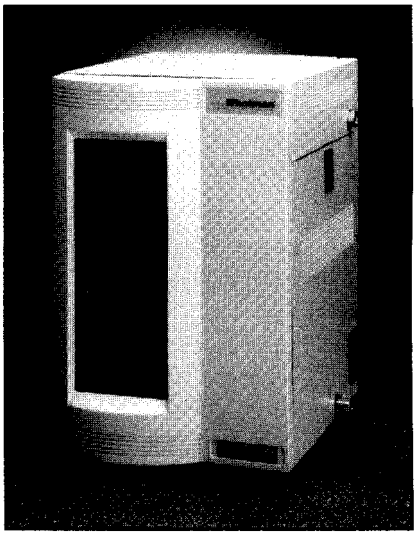
Hydrogen Generator (300cc/min.):
cat.# 20688

Whatman Zero Air Generators

Whatman air generators turn your in-house compressed air supply into ultra-pure air for use with FIDs. Four sizes are available to supply from two to fifty FIDs.

- Produces ultra-pure air (less than 0.lppm total hydrocarbons).
- Available in four sizes (650cc/min. to 18000cc/min.).
- Pressure output up to 125psig.
- Typical payback is less than one year.
- Three year supply of filter elements supplied with each unit.
- Compact size takes up little bench space.
- Installs easily and operates quietly.
- Leasing available for low monthly payments.

l000cc/min.	3500cc/min.	7000cc/min.	18000cc/min.
cat.# 20684	cat.# 20680	cat.# 20681	cat.# 20682



Zero Air Generator

Whatman Nitrogen Generators

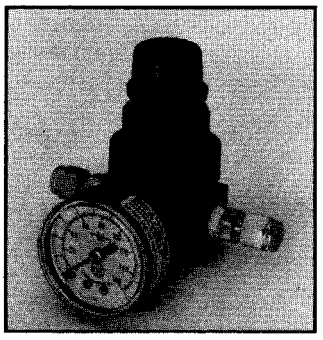
Whatman nitrogen generators produce ultra-pure nitrogen for use as a GC carrier gas or make-up gas for FIDs, NPDs, ECDs, or FPDs. The generator can also be used for evaporating solvents, switching valves, purging valves, and purging chambers. The nitrogen is produced by a three stage process which first eliminates hydrocarbons from the compressed air supply, then removes 02 to less than 25ppm and removes water vapor and CO2. The final step removes trace levels of oxygen, water vapor, carbon monoxide, carbon dioxide, and hydrocarbons to less than lppm.

- Produces ultra-pure nitrogen (99.9995%).
- 550cc/min. capacity.
- Only requires a compressed air source and a l00, 60 Hz electrical supply.
- Contains a downstream scrubber for maximum purity.
- Provides a supply of gas to maintain consistent analytical results.
- Safe, reliable, low maintenance.
- Compact size takes up little bench space.
- Frees valuable floor space by eliminating costly, inconvenient gas cylinders.
- Leasing available for low monthly payments.

Nitrogen Generator (550ml/min.): cat.# 20696

Regulators

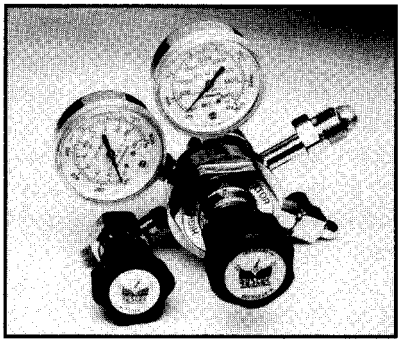
MINICYL General Purpose Regulator



This compact general purpose regulator has hundreds of laboratory applications including air-drying glassware, sparging or evaporating solutions, and controlling pneumatic valves. It is constructed of light-weight aluminum with an elastomer diaphragm. Each regulator comes with a 0-60psig gauge and eith2 1/8" o r 1 /4'female tube fittings.

1/8" **female fitting:** cat.# 20610
1/4" female fitting: cat.# 20611

High Purity Two-Stage Regulator



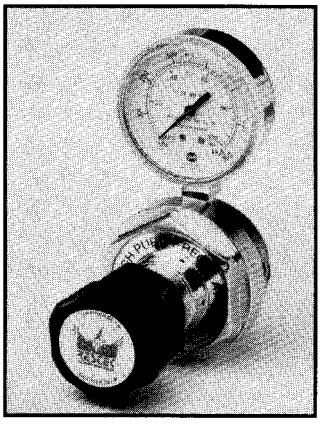
These two-stage regulators are ideal for use with high purity gases. They are constructed of chrome-plated forged brass with stainless steel diaphragms on both stages. A diffusion-resistant diaphragm valve is installed at the outlet of the regulator for easy on/off control. These regulators are designed to deliver constant pressure regardless of fluctuations in tank pressure. The maximum inlet pressure is 3000 psig and the outlet pressure range is 5-125psig. The outlet port accepts 1/4" male NPT fittings. Available for flammable gases, inert gases, and air.

CGA 580 (N2, **He, & Ar):** cat.# 20606
CGA 350 **(H2 and P,):** cat.# 20607
CGA 590 (Air): cat.# 20608

1/4" NPT Chrome Plated Nuts & Nipples with Internal Frit

CGA 580 (N2, He, & Ar): cat.# 20878
CGA 350 (H2 and P,): cat.# 20879
CGA 590 (Air): cat.# 20880

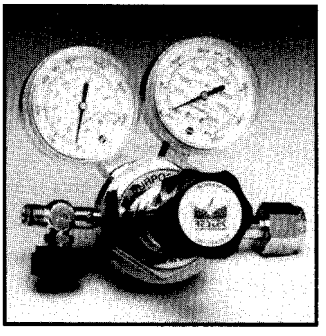
High Purity Single-Stage Regulator



This single-stage regulator is ideal for low-pressure lines supplying gases to gas chromatographs. It is constructed of chrome-plated forged brass with a stainless steel diaphragm. The maximum inlet pressure is 350psig and the outlet pressure range is 4-80psig. The inlet and outlet ports accept 1/4" male NPT fittings.

cat# 20609

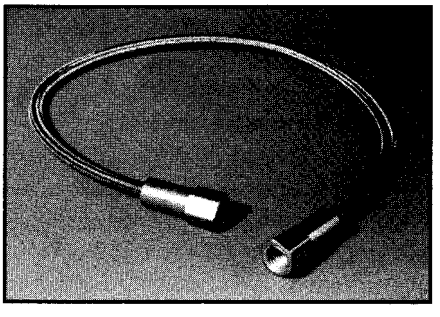
General Purpose Two-Stage Air Regulator



General purpose regulators are perfect for supplying air to FIDs, NPDs, mechanical actuators, and other applications where diffusion through a polymeric diaphragm is not a concern. These two-stage regulators are constructed of chrome-plated brass with nylon reinforced diaphragms. Maximum inlet pressure is 3000psig and outlet pressure range is 2-125psig. Outlet connection is a 1/4" male NPT fitting. Available for industrial air (CGA 590) and breathing air (CGA 346).

CGA 346: cat.# 21675
CGA 590: cat.# 21674

Flexible Pigtails



These flexible pigtails are 24 inches long and are constructed of braided stainless steel with a Teflon core. The Teflon core provides an inert gas pathway. They are rated for pressures up to 300psig. Each end is equipped with 1/4" NPT male fittings.

Flexible Pigtail: cat.# 20615

Educational Materials

Restek's Capillary Chromatography Seminar

Our seminar is geared towards the practical aspects of capillary chromatography. Information used on a day-to-day basis is presented. The following is a description of Restek's general capillary chromatography seminar:

New Multimedia Presentation Format!

Capillary Background and Terminology

This section discusses the essential basics of capillary chromatography. What are the differences between a packed and capillary column? What types of capillary columns are available to an analyst? How do they work? Concepts of chromatographic retention, separation efficiency, and selectivity will be presented on a practical, rather than theoretical level. Chromatographic equations and symbols will be defined and applied in a user-friendly format.

Inlet Systems and Injection Techniques

This section focuses on how carrier gas flow is controlled in a GC and discusses all of the common capillary injection techniques including split, splitless, flash direct and on-column, cool on-column, temperature programmable, and purge & trap. Advantages and disadvantages of each injection technique will be fully discussed with helpful hints on ways to optimize injector reproducibility.

Detection Systems

This section discusses background terminology pertaining to detectors such as sensitivity, selectivity, and dynamic range. The most commonly used capillary detectors including PID, TCD, MSD, ECD, PID, ELCD, NPD, and FPD are fully discussed with detailed detector specifications and operating hints. Animation is utilized to demonstrate the sample flow path and mechanism of detection.

Column Selection

This section utilizes many application chromatograms to show chromatographers the practical effects of changing column parameters. The effect of how column ID, film thickness, and length affect both resolution and total speed of analysis are demonstrated chromatographically to show chromatographers how to utilize and optimize each of these parameters. Stationary phase selectivity is demonstrated from a structural and functional composition. The use of dual column confirmational analysis is also discussed highlighting different ways to perform the analysis depending upon the instrument used.

Installation, Stand-by Operation, and Maintenance

This section discusses capillary carrier gas choice and how it affects sample analysis times and resolution. It covers pre-analysis instrument preparation, including regulator, trap, and purifier use, and sleeve deactivation procedures, plus additional inlet and detector considerations. A trouble-free installation sequence and proper column conditioning is presented to prevent inadvertent column damage. Stand-by operational hints are also discussed to maximize the column lifetime. The column and system maintenance section discusses how to minimize system problems and instrument down time by performing routine system maintenance. Prevention of column contamination is shown through the use of packed inlets or guard columns. Ways to rejuvenate a contaminated column will also be discussed. System integrity can be monitored through test mixtures, selective indicators, and GC optimization. Sources and solutions for common problems will be shown and discussed.

Application Specific Seminars from the Restek Wizards:

- **GC** Method Development
- Environmental
- Clinical/Forensics
- Petroleum

Have questions about the course content? Would you like an estimate for your location? Call (800) 356-1688 and our marketing department will be happy to answer your questions.

Capillary Column Installation Video

Restek's Ideal Training Tool for New Chromatographers!

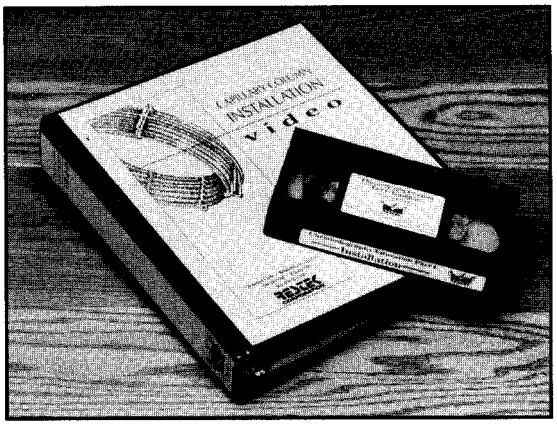
The technical wizards at Restek produced an instructional video that takes the mystery and frustration out of capillary column installation.

This essential resource covers critical points in the proper installation of a capillary column such as:

- Choice of carrier gas
- Instrument preparation
- Trouble-free installation
- Leak checking
- Setting carrier and detector gas flows
- Column conditioning

The installation sequence allows you to install your capillary column correctly, minimize downtime, and get your GC up and running quickly. The video follows ASTM Method E1510-93 for installing fused silica open tubular capillary columns in gas chromatographs to insure that your lab conforms with industry standards.

We guarantee this video will be the most useful instructional tool you'll ever use or we'll refund your money!



VHS: cat.# 20490; PAL: cat.# 2049 1

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