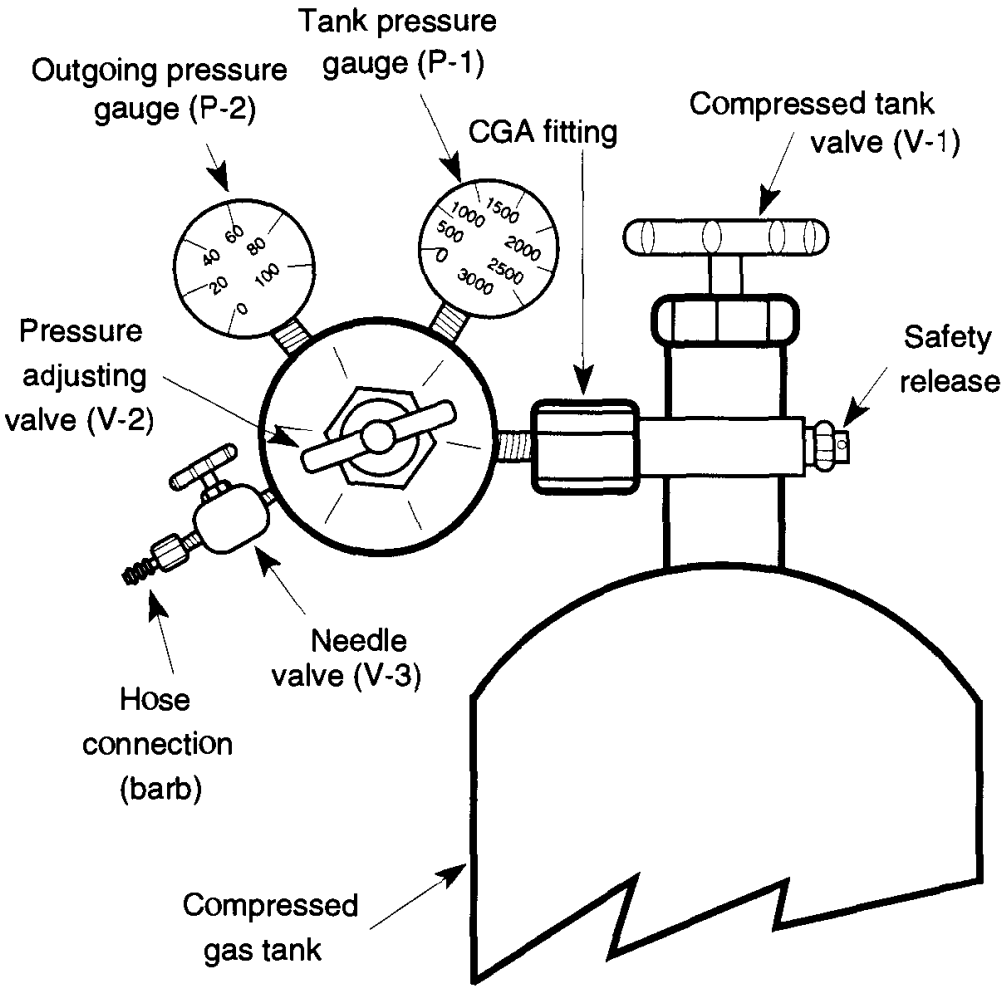


Fig. 5.4 Parts of the regulator.

are sufficient. Never open the main valve of an acetylene tank more than one and one-half revolutions, and always open it slowly.

The Tank Pressure Gauge (P-1). This gauge displays the pressure inside the tank. It represents the pressure coming into the regulator. This gauge is not necessarily on all systems, especially those that have a constant pressure, such as a house air pressure system (see Fig. 5.2) or those with a liquefied gas such as propane.* This gauge is used to measure the pressure remaining in the compressed gas tank. Thus, if you notice you are low on gas, you can make arrangements for tank replacement before an experiment has begun (and thereby avoid problems or an emergency situation). It is a good idea to observe the amount of gas you use per experiment or per day to better estimate your needs. This practice can prevent the downtime of waiting for a fresh tank caused by poor planning.

The Pressure Adjusting Valve (V-2). This valve adjusts the pressure that leaves the regulator. It rotates CCW to decrease pressure and CW to increase pressure, which is exactly the opposite from a water faucet and can potentially create a dan-

*Gauges on liquefied gas tanks, such as propane, cannot indicate the remaining gas or the amount of gas used over a period of time. These tank pressure gauges only indicate the pressure of the gas (above the liquid) within the tank known as the head pressure. Volume of remaining gas must be determined by comparing the weight of the tank against its tar pressure (ee Sec. 5.1.1)

gerous situation. Before opening the tank valve (V-1) on a system that has more than one user, it is best to assume that the outgoing pressure is wrong. If someone had inadvertently rotated this valve CW with the intention of closing the flow, it would have actually opened the valve to full pressure. This could easily destroy hoses, connections, glassware, or anything else on the line. To prevent this from occurring, rotate the pressure adjusting valve CCW until it turns free.* Open the tank valve, then rotate the pressure-adjusting valve CW to the desired working pressure. *Note*: The pressure from the regulator cannot be decreased unless gases are being released from the system. Therefore make sure that the needle valve (V-3) and any other gas flow valves are open to the atmosphere at least a small amount when attempting to decrease the regulator pressure

The Outgoing Pressure Gauge (P-2). This gauge displays the pressure that is set by the pressure adjusting valve (V-2). If you are trying to decrease the pressure and do not see any change, be sure the system beyond the regulator is open to the atmosphere (see previous subsection).

The Needle (Flow Control) Valve (V-3). This valve controls the volume of gas leaving the regulator. It rotates CCW to open and CW to close. If the regulator is connected to a glass system and/or rubber tubing, this valve should be closed when first opening up the pressure adjusting valve (V-2) to prevent damage to the system from too great a pressure. The needle valve (V-3) should be fully open if the system has a second needle valve further down the system, such as the valve of a glassblowing torch. The needle valve is not on all regulators, but can easily be added or removed.

The Hose Connection. This connection is called a barb by the welding and gas industry and is seldom on the regulator when purchased. Like the needle valve it can be easily added or removed. Alternatively, copper or high-pressure tubing can be attached directly to the regulator (with the proper fitting), which provides a more secure connection than that which can be obtained by forcing plastic or rubber tubing over a hose connection. If you need to order a hose connection, be sure to order a left-handed threaded nut if it's to go onto a tank for combustible gas (see Sec. 5.2).

There are two types of regulators: single- and two-stage (sometimes called double-stage). Both work on the same principle of (a) gas pressure pushing on one side of a diaphragm and (b) the pressure adjusting valve pressing a spring against the other side of the valve. The greater the spring pressure against the diaphragm, the greater the gas pressure available to leave the regulator. However, in a single-stage regulator, as the pressure within the tank goes down, you must back off the spring pressure (using the pressure adjusting valve) to maintain the same outgoing pressure. Otherwise the outgoing pressure slowly increases as the tank pressure decreases. The two-stage regulator avoids this problem by having two single-stage regulators linked end-to-end. The first maintains an outgoing pressure between

*If you turn it too far, it will unscrew from the regulator. This is not a disaster; simply rescrew it back in several turns CW.

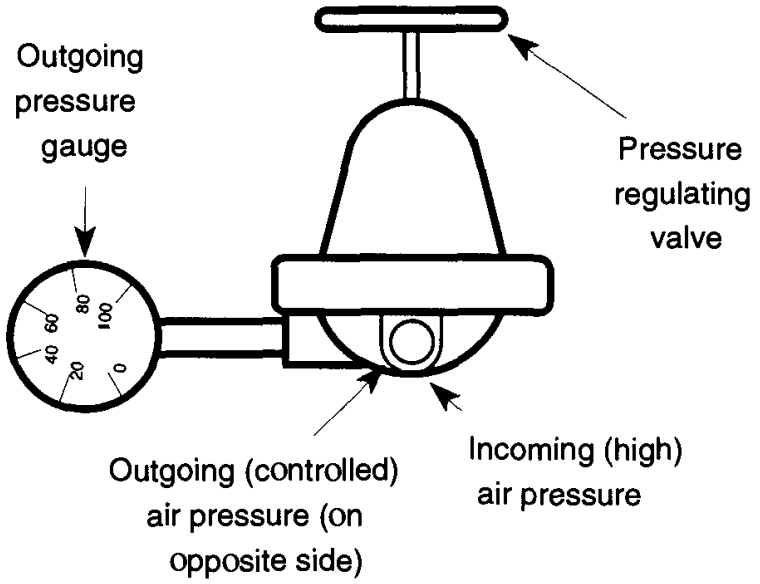


Fig. 5.2 Typical regulator used with a constant gas source such as house compressed air.

350 and 500 psig, which is the incoming pressure of the second. Because the pressure between the first and the second stage remains very consistent, the outgoing pressure is held equally consistent throughout the life of the tank. In addition, single-stage regulators typically cannot deliver large quantities of gas at high pressure. Any attempts to push a single-stage regulator beyond its capabilities typically result in a loud wailing sound from the regulator.

5.2.2 House Air Pressure System

It is common for labs to have a high air pressure system built into benches, fume hoods, and other parts of the building. Sometimes the air pressure is too powerful for equipment to be attached. A simple regulator (see Fig. 5.2) can be attached directly on such a system using pipe fittings.

5.2.3 How to Install a Regulator on a Compressed Gas Tank

A few minutes of preparation will save you hours of cleanup time, replacement of equipment, and/or serious injury. Therefore, be sure to follow this general procedure:

1. Examine the edge of the regulator CGA fitting to determine whether the thread is right- or left-handed (see Fig. 5.2). Use an open end wrench, or large crescent wrench, to remove the regulator from the emptied tank. If the nut is notchless, it is a right-handed thread. If that is true and you are staring at the regulator and tank so that they are in the same orientation as in Fig. 5.4, the wrench should be placed so that the end is facing out from the page. To release the regulator, move the end of the wrench upward. An upward whack with the palm of the

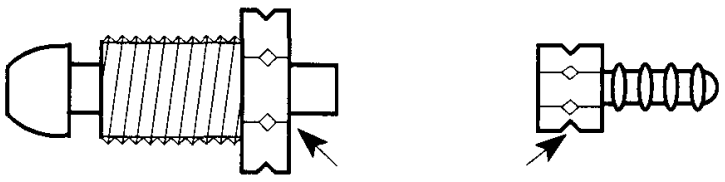
hand may be necessary to start the movement. Once loose, it should be possible to support the regulator with one hand and finish removing the nut with the other.

2. Strap the new, full tank securely into its proper position. Even though the old tank is empty, it should also be secured with the same level of safety. Full or empty, these tanks are heavy; and if they are accidentally knocked over, they can still do a lot of damage.

3. Examine the CGA threads of the tank and of the regulator to be sure that they are free of dirt, dust, and grease. [If there is any grease on the threads of the tank, return the tank to the supplier. If there is any grease on the threads of the regulator, return it to an authorized repair dealer.]

4. Stand to the side of the tank and quickly crack open and close the main tank valve. This action will force out any dust, dirt, or other particulate matter from the valve seating before you attach the regulator. This matter, if not removed, can get into the regulator and either shorten the regulator's life span or get into the area where you are trying to deliver "clean" gas. Do not stand in front of the valve port and be sure that the valve port is not aimed at anyone or anything. The force of air can easily blow papers or glassware a considerable distance.

5. Attach the regulator to the new tank tightly with a wrench as mentioned in step 1, except tightening would be done by moving the end of the wrench toward the operator. Be sure to follow the direction of the threads. The fitting should be snug. Remember that the part of the CGA fitting that actually makes the seal is the end of the fitting. The threads are only securing the fit, and any leakage will not occur at the threads. Therefore, overtightening of the threads will not assist in any leak prevention. Use of plumber's Teflon tape will not hurt anything, but it will also not help ensure against leakage.



Left-handed nuts and fittings have a notch cut into the corners to help identify the direction of the thread.

Fig. 5.2 Samples of left-handed nuts and fittings.

5.2.4 How to Use Regulators Safely

Always open the main tank valve slowly. Intense pressure against the regulator's diaphragm can cause premature wear and aging. In addition, after the main tank valve has been turned off, the regulator should not remain under pressure for extended periods of time (i.e., several hours or beyond). The procedure of closing the tank valve (V-1; see Fig. 5.4) and then bleeding the system to release any remaining gases will help extend the life of the regulator. This bleeding procedure is more critical with two-stage regulators which may trap a small quantity of gas within the first of their two stages. This gas can then burst out unpredictably and potentially dangerously.

Another practice for extending the life of a regulator is to unscrew (CCW) the pressure adjusting valve (V-2; see Fig. 5.4) before opening the tank valve (V-1; see Fig. 5.4) and before setting the regulator to the desired pressure. In addition, open the tank valve slowly to limit the amount of shock on the diaphragm. Continued shock on the diaphragm causes premature aging.

When opening the main tank valve to allow gas into the regulator, you should stand to the side (not in front or behind) of the gauges, preferably with the main tank valve between you and the regulator. If an old worn diaphragm bursts during the sudden pressure increase, glass and metal shards could spray out. This damage cannot happen if the pressure adjusting valve is unscrewed before you open the main valve because there is no pressure against the diaphragm.

Never use oil in or around a regulator. Oxygen regulators (CGA fitting 540) pose special dangers because oxygen decreases the ignition temperature of flammable materials. Oil around compressed oxygen can explode. Do not use plumbing "pipe dope" on a CGA fitting. If a CGA fitting needs "pipe dope," there is something wrong with the fitting and it should not be used.

Do not use a regulator that has been dropped or shows any signs of physical abuse. If in doubt, have the regulator checked at the manufacturer's service center.

When storing a regulator, place it in a plastic bag to prevent dirt and dust from settling on, and in, the regulator. Dust and dirt can damage the diaphragm, or wedge within the sections, preventing complete closing of the diaphragm parts. Regulator cleaning and repair should be done by a service agency and should not be done by inexperienced personnel.

5.2.5 How to Test for Leaks in a Compressed Gas System

The first leak to check is within the regulator: To see if there is gas leakage past the diaphragm, rotate the pressure adjusting valve CCW until it is fully open, then slowly open the main tank valve. If any gas leaves the regulator, the regulator is defective or broken and needs repair or replacement.

To see if you have a leak within the line of your pressure system, close all normal outlets. Then, after opening the main tank valve and rotating the pressure adjusting valve (V-2; see Fig. 5.4) to the desired pressure, turn the main tank valve

off. If you see a dropping off of pressure on the tank pressure gauge, you have a leak somewhere in your system.

To limit the region needing examination, rotate the pressure adjusting valve CCW one or two revolutions. If the reading on the tank pressure gauge drops, there is a leak in the compressed tank valve, the CGA fitting, or the tank pressure gauge. However, if the outgoing pressure gauge drops, there is a leaky outlet fitting, needle valve (if any), outgoing pressure gauge, hose, tubing leaving the regulator, or any other part of the system beyond the regulator. Finally, if the tank pressure gauge drops and the outgoing pressure gauge rises, there is a leak in the regulator itself. (It is normal to see this last pressure rise when you are bleeding the pressure from a single-stage regulator just as the pressure in the regulator is almost extinguished.)

If you know you have a leak but are not sure of the location, do not use a flame to aid your search.* If the gas is flammable, the dangers are obvious, but otherwise there is concern of burning parts and equipment. The best and safest technique is to spray, squirt, or drip a soapy water solution on the suspected area. Use either a diluted liquid dish soap† or a commercial solution such as Snoop®.‡ The evidence of bubbles is a sure sign of a leak. However, be sure you witness bubble formation as opposed to bubbles just sitting there, which are likely to have formed during the application of the bubble solution.

5.2.6 How to Purchase a Regulator

Most regulators can provide uniform and accurate high-pressure output. Where regulators vary is in their output potential. A large gas demand requires a regulator with a large output potential. By selecting a regulator that only satisfies the minimum flow rate for your expected needs, you may be unable to achieve unexpected high-flow demands.

A wailing noise coming from your regulator is a symptom of using a large quantity of gas at a rate faster than the diaphragm within the regulator is capable of supplying. Unless you are able to use a smaller quantity of gas, the best solution is to purchase a larger regulator with a higher flow capacity (typically a two-stage regulator) and/or a better quality regulator.

If you absolutely need constant outgoing pressure, regardless of varying tank pressure or the varying rate of outgoing gases, select a two-stage regulator; otherwise, a single-stage regulator is sufficient. Although the changes are subtle, single-stage regulators have less stable outgoing pressures as tank pressure drops or as you increase the rate of outgoing gases.

If you are using a corrosive gas, it is imperative to use a stainless steel regulator. Otherwise, a brass regulator is sufficient.

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*Some people use the flickering of a flame as an indication of a leak.

†Liquid dish soap can corrode stainless steel, so rinse it off when completed.

‡SNOOP®, Product of the Nupro® Company, Willoughby, OH 44094.

When you order a regulator, expect to receive only the regulator. Unless you specify that you also want a needle valve and/or a barb (hose connection), you probably will not get one! Be sure to ask the salesperson what you will be receiving with the regulator. This information becomes more important if you are ordering a regulator for a tank that has a left-handed CGA fitting such as a propane tank, because all the fittings for this regulator will also left-handed. If you wish to add a hose connection onto the regulator after it has arrived at your lab, you might end up digging through drawers filled with right-handed fittings and no luck in finding a left-handed hose connection. If this happens, you may have to go back to your mail-order supplier or to a local welding supply house.