

Operation and Installation Manual



**Variable Leak Valve
Model 1000**

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1. Introduction

The Variable Leak Valve can be added to any vacuum system to establish an adjustable leak. It offers unprecedented control sensitivity and stability with leak rates as small as 1×10^{-10} torr-liters per second. Leak rate adjustment is controlled with finger knobs. The entire valve, including the drive mechanism, is bakeable to 450°C in either the open or closed position. Both components of the seal mechanism (sapphire assembly and gasket assembly) are easily replaceable.

2. **Specifications**

Minimum Leak Rate

1×10^{-8} torr-liters/sec. in normal operation.

1×10^{-10} torr-liters/sec. with condensable vapors eliminated from leak gas.

Rate of Change of Leak

The valve provides an increasing rate of change as the size of the leak increases giving precise control in proportion to the size of the leak.

Vacuum Range

From atmosphere to below 10^{-11} torr.

Temperature Range

Up to 450°C in either the open or closed position.

Inlet Gas Pressure

500 psig maximum.

Gasket Life

For unbaked systems, approximately 300 closures.

For baked systems, 20 to 30 closures @ 450° C.;

100 closures @ 250°C

Gasket assemblies are replaceable.

Materials

Clean, bakeable materials: 300 series stainless steel; sapphire; kovar, inconel, and copper alloy

3. Operation

A precisely designed sapphire against copper alloy valve seal provides extremely sensitive leak-rate control. The seal consists of a movable piston with an optically flat sapphire face that meets a "captured" metal gasket. The sapphire surface presses against the gasket to form a seal completely free from friction or galling.

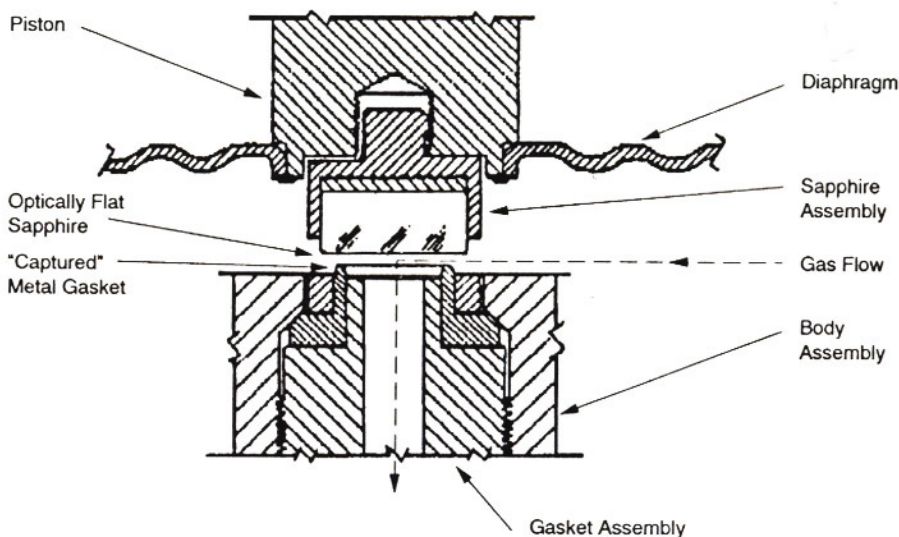


Fig. 1

3.1 Initial Operation

The valve is received in a closed, leak tight position. The adjusting knobs are tightened against the handle.

- **To open a leak**, turn the knobs a minimum of two full turns counter-clockwise. During normal operation, the knobs are locked with respect to each other and to the fine drive screw.
- When the collar butts against the handle, the stop position is reached. See Figure 2 on the following page.

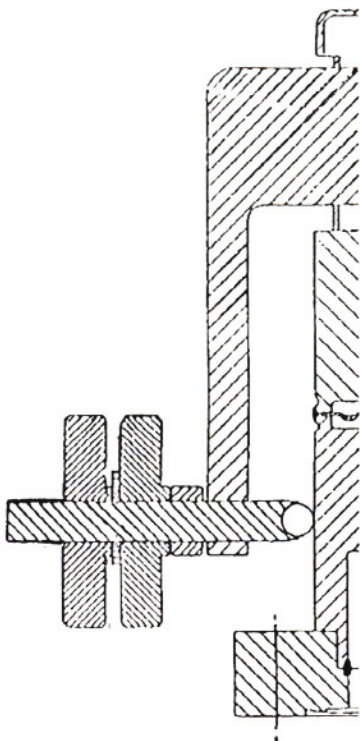


Fig. 2

■ **To adjust the leak rate:**

Turn the knobs counterclockwise at least two turns until the meter (leak detector, vacuum gauge, etc.) reads the desired value. You may wish to establish a chart or graph of number of turns versus meter reading.

For faster adjustment in future operations the knobs may be adjusted to provide: 1) a new stop position and 2) a stop position at a desired leak rate.

3.2 Operating at Low Leak Rates

When the valve operates with leak rates of 1.0×10^{-8} torr-liters/sec. or smaller, condensable vapors and contaminants (water, solvents, etc.) and in time can reduce the leak rate. The valve must be baked to 200°C – 250°C in the open position for at least 30 minutes to drive off these adsorbed vapors. See "Bakeout Procedure", Section 3.4.

For best overall performance it is recommended to use a dry, filtered gas for all operations.

For operation at leak rates of 1.0×10^{-9} and lower, in addition to baking described above, the inlet gas *must* be free of condensable vapors. If a particulate drying material is used a filter *must* be used.

3.3 Changes in Leak Rate with Variations in Room Temperature

Changes in room temperature will cause changes in leak rate. As the temperature rises, leak rate increases. A leak setting should be made in the range of interest and mild heat applied to the valve to the expected temperature. If the leak rate change is not acceptable to the experiment, some means of control at elevated temperature should be provided.

3.4 Bakeout Procedure

Bakeout in the open position:

- No special steps are required to bake in the open position (up to 450°C).
- If a leak has been set at room temperature it will increase due to thermal expansion as the valve temperature increases. Monitoring of system pressure and readjustment of the leak will be necessary if a constant leak is desired during bakeout.

Bakeout in the closed position:

- The valve knobs must be overdriven three turns past closure (normal setting is two turns) to compensate for differential expansion of materials during bakeout.
- To prepare for the bakeout, follow the procedure in the following section, "Establish a New Stop Position", with the following exception: in Step 5 substitute "three turns" for the "two turns" specified.

Operation after bakeout:

- Bakeout in the closed position to 250°C and above will increase the size of the leak for a given setting of the knobs. Three full turns may not be required to open a leak after bakeout. Both bake and degree of temperature rise will determine the amount of change.

- If the stop position is to be readjusted, follow the procedure described in Section 3.5.
- Lubricate the threads of the fine screw. Use a small amount of Fel-Pro C-100 anti-sieze lubricant. See Section 5.4, "Lubrication".

3.5 Establish a New Stop Position

Each time a seal is made, the valve's captured metal gasket is compressed and the springback is not 100%. And so the gasket is gradually compressed in a series of seals. High temperature bakeout will accelerate the compression of the gasket. If no change is made to the position of the knobs on the fine screw, the point of closure will gradually come closer to the point at which the knobs and collar butt against the handle. Eventually the stop will be engaged before a leak tight closure is made. When this happens a new stop position must be established. To determine this point proceed as follows:

- The valve must be attached to a leak detector or a vacuum system equipped with gauging adequate to determine when no leak exists.
- With the knobs butted against the handle, unlock the knobs from each other by holding the inner knob and turning the outer knob counterclockwise about four turns.
- Turn the inner knob counterclockwise until it is locked tight against the outer knob.
- Turn the two locked knobs clockwise until the valve closes as indicated on the leak detector or system gauge.
- Turn the knobs clockwise two additional turns past the leak tight closure point.
- Loosen the knobs from each other without allowing the fine screw to turn. Turn the inner knob clockwise until the collar butts against the handle. Then turn outer knob clockwise until it locks against the inner knob. The knobs are now in position to return to and stop at a point two turns past leak tight closure.
- After the stop has been adjusted several times, the handle must be reset as described in Section 5.1.

IMPORTANT

The valve handle must remain within $\pm 5^\circ$ of being parallel with the valve body in the leak tight position. See Section 5.1

3.6 To Set Stop Position at Any Leak Rate:

- Open the valve to a desired leak rate as determined by a leak detector or system gauge.
- Loosen the knobs from each other without allowing the fine screw to turn.
- Turn the inner knob clockwise until the collar stops against the handle. Turn outer knob clockwise until it locks against the inner knob.
- The valve can now be opened to larger leak rate and, when returned to the stop position, will provide a leak of the pre-set leak rate.

IMPORTANT

The valve cannot be closed leak tight with the stop set in this manner. To close the valve, follow the procedure outlined in Section 3.5, "Establish a New Stop Position".

4. Installation

Flange Connection:

The Conflat® flange on the leak valve mates with any 2¾ inch O.D. Conflat® flange.

- Place a new clean copper gasket between the two flanges.
- Lubricate and install screws and nuts. Use Fel-Pro C-100 high temperature lubricant on threads and the face of the nuts. Or use silver plated screws and nuts.
- Tighten each nut to 5 – 8 ft. lbs. torque. This will partially close the gap between the flange faces. Repeat the sequential tightening until flange faces meet. Do not exceed 12 ft. lbs. torque.
- The side port flange is a mini Conflat® 1.33 O.D. and mates with any other mini Conflat®.
- Lubricate screws and tighten until flange faces mate in the same manner as the 2¾ flanges. Do not exceed 48 in. lbs. torque.

5. Maintenance

5.1 Adjustment of Handle Position:

As described in "Operation", continual reduction in gasket height necessitates resetting of the stop position and eventual readjustment of the handle position. When the angle between the handle and body at the point of closure has changed from its original parallel to an angle of $\pm 5^\circ$, the valve handle should be readjusted. This position will maintain the proper relationship between handle travel and the size of leak.

- Set handle. Adjust knobs and fine screw to be approximately parallel with the side of valve body.
- Remove cover from top of valve.
- Close valve using coarse adjusting screw with the valve installed on a leak detector.
- With $\frac{3}{16}$ " allen wrench, tighten coarse adjusting screw to approximately 4 ft. lbs. of torque.
- Leak check. If not leak tight, tighten coarse adjusting screw until leak tight.

CAUTION

Do not exceed 8 ft. lbs. torque or the sapphire may be fractured.

- Readjust knobs to two turns past leak tight.
- Replace the cover.
- Two turns counterclockwise on the knobs should initiate a leak.

5.2 If Valve Will Not Close Leak Tight

If the valve is not leak tight after the knobs have been turned to the stop position, one of several problems may be the cause:

- The gasket has been compressed and all stops must be reset.
- The seal surfaces are contaminated and need cleaning.
- The gasket is scratched, nicked or compressed beyond further use and must be replaced.
- The sapphire is fractured and must be replaced.

The following procedures should be followed in the order listed:

Reset the Stops:

Follow the steps outlined in Section 5.1, "Adjustment of Handle Position". If the valve is still not leak tight, proceed to the steps below.

Disassemble, clean and inspect the sealing components:

Particles, oxide on the gasket or other contaminants may prevent the valve from closing leak tight. Disconnect the valve from other components and disassemble, inspect and clean the valve, sapphire and gasket in the following steps.

1. Disassemble:

- Turn the knobs counterclockwise four turns.
- Remove the cover and, with a $\frac{3}{16}$ " allen wrench, loosen the roughing screw two turns.
- Use a clean $\frac{1}{4}$ " allen wrench to remove the gasket assembly. The thread is normal right hand thread. 20 – 25 ft. lbs. of torque will be required to loosen it.

2. Inspect and Clean Valve Body:

- Check the valve body for any loose particles or other contaminants.
- Remove any contaminants by flushing acetone† (CP grade recommended) through the inlet flange while holding the valve upright.

WARNING

When using acetone or other solvents, follow the manufacturer's precautions and recommendations for use. Use proper eye and skin protection and provide adequate ventilation. Refer to the Material Safety Data Sheet.

- Blow out the valve with a clean, dry gas through the inlet flange.

IMPORTANT

Do not use shop air to blow out the valve. The usual high content of particles, water vapor and oil will contaminate the valve. Recleaning and possible gasket replacement may be required.

Repeat these two steps if necessary.

3. Inspect and Clean Gasket Assembly:

- Inspect the copper alloy gasket to assure that it is clean, smooth, free of oxide and protrudes above the surface of the gasket collar by at least .002 inch. An eye loupe or microscope will facilitate inspection of the surface.
- If the top surface of the gasket is scored, scratched or nicked, the gasket assembly must be replaced.
- If the copper portion of the assembly does not protrude at least .002 inch above the collar, the gasket assembly must be replaced.
- Oily films or other residue should be removed using acetone†.
- Oxide or other slight surface imperfections can generally be removed by polishing with a very fine rouge paper. When polishing, rotate the gasket assembly about its center axis to avoid leaving scratches that cross the sealing surface. Clean the gasket with acetone† after any polishing to remove abrasive residue.
- Clean the sapphire removal tool with acetone†, insert it through the hole that held the gasket assembly, and engage the fingers of the tool with the slots on the periphery of the sapphire assembly.

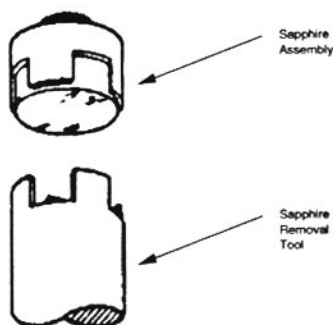


Fig. 3

- Hold the valve and tool in the upright position and turn the tool counterclockwise to remove the sapphire assembly. Four full turns will disengage the threads.
- Maintain the upright position of valve and tool, and lower the tool and sapphire assembly from the valve.

4. Inspect and Clean Sapphire:

- Check the sapphire to assure that it has no cracks or chips. Any fractures will require replacement of the sapphire assembly.
- Check the cleanliness of the polished face by viewing light reflected from its surface. Flush the face with acetone† and wipe off any film or grease. Assure that no particles remain on the sapphire assembly when ready for re-assembly.
- Protect the gasket from contamination while awaiting re-assembly.

5. Re-install Sapphire Assembly:

■ Hold the sapphire removal tool upright and mount the sapphire assembly to the tool engaging the four slots. Be certain that the tool is clean.

■ With the valve in the upright position, insert the tool and sapphire into the valve. Turn the tool clockwise to engage the threads. Only light finger pressure is required to tighten the assembly into the valve properly.

CAUTION

Heavy tightening can cause the tool to raise a burr in the slots of the sapphire assembly. These burrs can prevent subsequent removal of the sapphire assembly from the valve.

6. Re-install Gasket Assembly:

■ To avoid contamination, hold the valve in the upright position. Install the gasket assembly and tighten finger tight.

■ Tighten the gasket assembly to 22 – 24 ft. lbs. of torque. Assure that the allen wrench is clean before using.

7. Leak Check and Adjust Closure:

Reset the handle position, roughing screw and knobs, and leak check the valve as described in the section "Adjustment of Handle Position".

5.3 Loss of Sensitivity at High Leak Rates

Repeated bakeouts at 450°C will result in partial annealing and a loss of tension in the spring washers that provide the force to open the valve. This will be evidenced by decreasing sensitivity of control at high leak rates. This is not a common situation, but may occur after months of use under high temperature conditions. Replacement of the spring washers and adjustment are required.

Disassemble drive mechanism:

- Open the valve four counterclockwise turns of the knobs.
- Withdraw the two screws on the upper part of the valve body and remove the cover.
- Remove the coarse adjusting screw.
- Remove the two pivot pins using a screw for pulling. Lift out the handle.

Replace spring washers:

- With a 3/4 inch hex-socket wrench remove the nut above the spring washers.

- Remove and replace the spring washers.
- Replace the $\frac{3}{4}$ inch hex nut.

Adjust tension:

- With a $\frac{3}{4}$ inch hex-socket wrench tighten the nut above the spring washers just enough so that there is no clearance between the washers and the nut. Then tighten $\frac{1}{8}$ of a turn, 2 hex flats on the nut.

Reassemble:

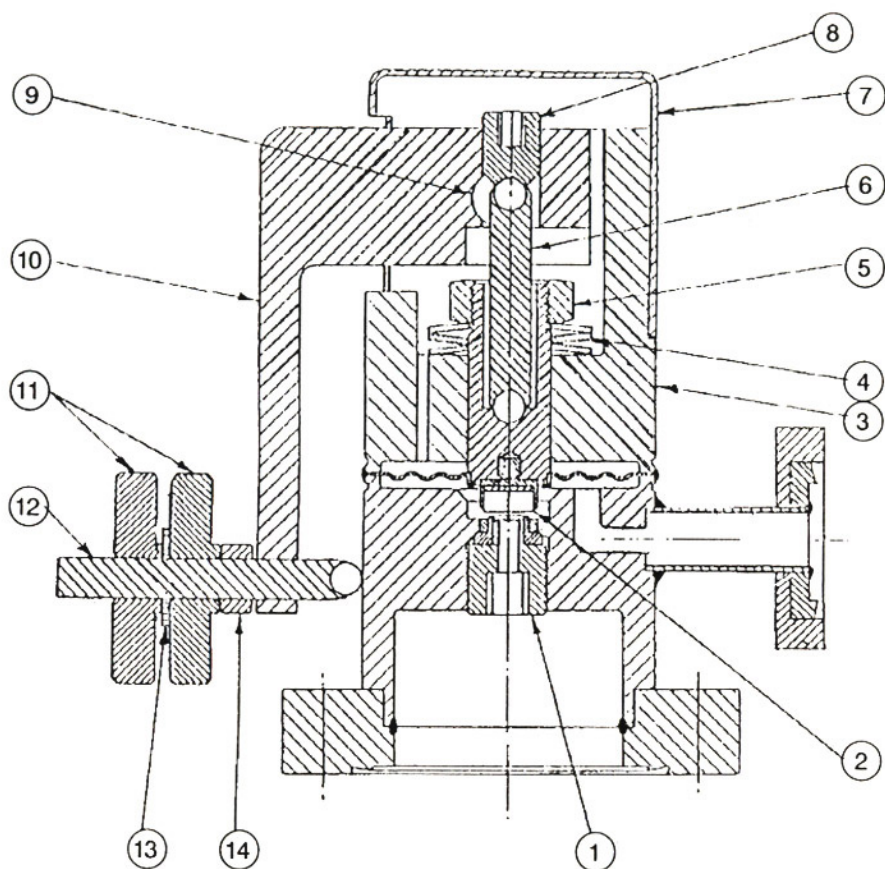
- Replace the handle, pivot pins and coarse adjusting screw.
- Repeat the closure adjustment to reposition the handle and knobs.
- Replace cover.

5.4 Lubrication Instructions

Fel-Pro C-100 is recommended for lubrication. After each bakeout cycle, lubricate the threads of the fine-drive screw. After every three bakeouts at temperatures over 300°C, disassemble the drive mechanism, clean and lubricate it. Use a stainless steel brush to remove flaky or caked-on lubricant before re-lubrication.

- Open the valve four counterclockwise turns on the knobs.
- Withdraw the two screws on the upper part of the valve body and remove the cover.
- Remove the coarse adjusting screw. Lubricate its threads and the spherical socket.
- Insert the screws that held the cover into the two pivot pins and, using the screws as handles, pull out the pins, remove handle.
- Remove the push rod assembly and lubricate both ends. Replace it.
- Lubricate the pivot pin hole in the handle. Do *not* lubricate the pivot pin holes in the body.
- Reassemble the handle and pivot pins.
- Reassemble the roughing screw.
- Follow the procedure specified in Section 5.1, "Adjustment of Handle Position", to close the valve and adjust the drive mechanism for proper operation.
- Replace top cover and the two screws.

† WARNING: When using acetone or other solvents, follow the manufacturer's precautions and recommendations for use. Use proper eye and skin protection and provide adequate ventilation. Refer to the Material Safety Data Sheet.



Item	Qty	P/N	Description
1	1	102507	Gasket Assembly
2	1	102502	Sapphire Assembly
3	1	102505	Body Assembly
4	3	101504	Belleville Washer
5	1	101512	Nut
6	1	101521	Pushrod Assembly
7	1	101519	Cover
8	1	101515	Coarse Adj. Screw
9	2	101513	Pivot Pin
10	1	101520	Handle
11	2	101518	Knob
12	1	102510	Fine Screw Assembly
13	1	101511	Belleville Washer
14	1	101514	Fine Screw Spacer
15	2	Pan Head Screw, 8-32x1/4	

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