resource systems, inc.

INSTRUCTION MANUAL
HYDROGEN PURIFIER
MODEL RSD-2-VCR
(ABRIDGED)

Except, possibly, for pure outlet termination, this manual is correct for all RSD-Series Purifiers of current manufacture of 1 or 2 SCFH capacity.

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WARNING

HYDROGEN IS A FLAMMABLE GAS. A MIXTURE OF HYDROGEN WITH OXYGEN OR AIR IN A CONFINED AREA WILL EXPLODE IF IGNITED BY A SPARK, FLAME OR OTHER SOURCE OF IGNITION. HYDROGEN FLAME IS VIRTUALLY INVISIBLE.

TAKE EVERY PRECAUTION AGAINST HYDROGEN LEAKS. ESCAPING HYDROGEN CANNOT BE DETECTED BY SIGHT, SMELL OR TASTE. BECAUSE OF ITS LIGHTNESS, IT HAS A TENDENCY TO ACCUMULATE IN THE UPPER PORTIONS OF CONFINED AREAS.

KEEP HYDROGEN AWAY FROM SOURCES OF IGNITION. DO NOT PERMIT ANY ACCUMULATION OF GAS.

PRINCIPLE OF OPERATION

Resource Systems' line of integrated packaged purifiers takes advantage of the fact that hydrogen, and only hydrogen, can be made to pass through a palladium barrier. RSI uses palladium-silver alloy tubing which has been optimized for this use.

The rate of hydrogen diffusion through palladium alloy tubing:

1. Varies exponentially with temperature, increasing at a decreasing rate as the temperature increases, and

2. Varies directly with the difference between the square roots of the pressures of hydrogen on both sides of the palladium-silver alloy tubing.

The purifier operates at a constant temperature so that, in service, the pure hydrogen flow rate is controlled by varying the feed gas inlet pressure. The feed gas inlet pressure must not exceed 250 PSIG.

RSI purifiers operate with the high feed pressure on the inside of the palladium-alloy tubing. This keeps the normal operating pressure from collapsing the tubing and causes intimate contact between the feed gas and the tubing along its entire length. This prevents stagnant areas where impurities can accumulate and allows high efficiency recovery of hydrogen from the feed gas.

The temperature of the purifier is held at 800°F by a non-indicating temperature controller. In order to prevent impurities from building up inside the palladium alloy tubing where they would decrease and eventually stop the flow of pure hydrogen, they are bled out of the purifier with a small amount of undiffused hydrogen. This flow is controlled by the bleed gas valve and is burned or safely vented.

SHORT-TERM SHUT-DOWN.

If the purifier is to be shut down for short periods of time or overnight, the heater is allowed to remain on. Short-term shut-down consists of closing off the flow of feed hydrogen and closing the external pure hydrogen valve.The feed gas pressure will bleed down to approximately 1 atmosphere and approximately 1 atmosphere of product gas will be trapped in the pure gas chamber.

NOTE: The short term shut-down procedure creates the possibility of cooling the purifier in hydrogen in the case of a power failure. This risk may not be acceptable in areas where power failures are frequent or of long duration.

LONG-TERM SHUT-DOWN

1. Shut off the feed gas supply.

2. Remove all hydrogen from the pure hydrogen lines by purging and/or evacuating. Be sure evacuated hydrogen is safely vented.

3. Purge the feed gas lines with nitrogen allowing the nitrogen to flow through the purifier and bleed gas lines. It must also be realized that purging the impure hydrogen lines with nitrogen can also be used to create a vacuum in the pure hydrogen lines since hydrogen will back-diffuse from the pure hydrogen side into the nitrogen stream flowing through the impure gas lines.

CAUTION: Since the nitrogen purge can cause a vacuum in the pure gas lines, care must be taken to keep from pulling unwanted impurities, such as doping agents, into the pure gas side of the hydrogen purifier.

4. After purging is complete, close the nitrogen purge valves.

5. Move the electrical power switch to the "Off" position. Pull out the electric plug.

CAUTION: The above start-up and shut-down procedures prevent heating or cooling the palladium-silver alloy tubing in the presence of hydrogen. This is extremely important. Heating or cooling the unit in hydrogen can cause premature failure of the palladium alloy tubing. In the event of a power failure or any other reason for loss of temperature, the long-term shut-down procedure must be executed immediately.

CAUTION: After a long-term shut-down procedure has been completed and the purifier is cold, it is necessary to relieve the vacuum in the pure hydrogen lines by admitting clean air into these lines. This prevents contamination, which may be present in the vacuum pump and vacuum lines, from being drawn into the purifier at the next start-up.

MAINTENANCE

1. Periodic checks of the system integrity are recommended. The preferred method is by helium mass spectrometer leak checker. The system is checked at operating temperature with the helium mass spectrometer pumping directly on the pure gas outlet of the purifier and helium at moderate pressure, e.g. 5 PSIG, filling the impure side of the system.

DERATING

The pure gas flow rate from an RSD purifier is proportional to the square root pressure difference between the feed and product hydrogen. The unit is rated at 250 PSIG (264.7 PSIA, 18.0 atm) feed pressure and one atmosphere (14.7 PSIA) product hydrogen pressure. The flow rating is included in the Model Number, e.g., an RSD-100 will deliver 100 SCFH (47.2 SLPM) at 1 atm from a 250 PSIG (18 atm) feed.

The derated flow at pressures other than 250 PSIG and 1 atm. can be calculated from the following equations:

$$F_{SCFH} = K(PSIA_{feed}^{1/2} - PSIA_{pure}^{1/2})/12.44$$

$$F_{SLPM} = K(atm_{feed}^{1/2} - atm_{pure}^{1/2})/6.872$$

where F_{SCFH} = calculated flow rate, SCFH. F_{SLPM} = calculated flow rate, SLPM.

K = rated flow, e.g., 100 SCFH for an RSD-100

$PSIA_{feed}$ = absolute hydrogen feed pressure, e.g., 150 PSIG is 164.7 PSIA

atm_{feed} = absolute hydrogen feed pressure, e.g., 164.7 PSIA is 11.2 atm.

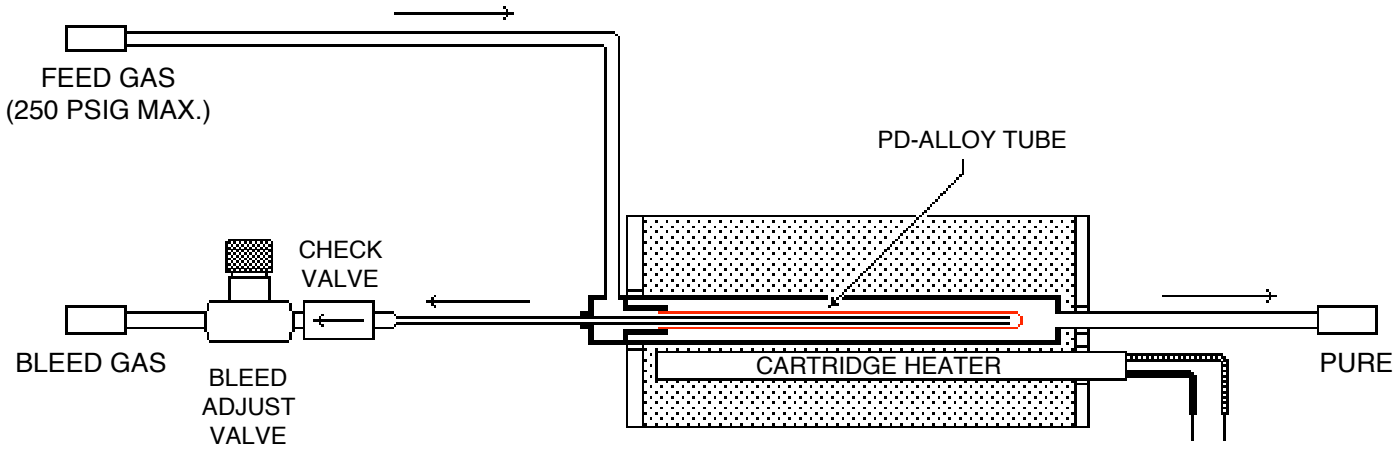
$PSIA_{pure}$ = absolute product hydrogen pressure, e.g., 5 PSIG is 19.7 PSIA.

atm_{pure} = absolute product hydrogen pressure, e.g., 19.7 PSIA is 1.34 atm.

Example: An RSD-100 is to operate from a 150 PSIG (164.7 PSIA, 11.2 atm) feed and deliver product at 5 PSIG (19.7 PSIA, 1.34 atm) Calculate throughput.

F_{SCFH} = $100(164.7^{1/2} - 19.7^{1/2})/12.44$
= $100(12.834 - 4.438)/12.44$
= $100(8.395)/12.44$ = **67.5 SCFH**

F_{SLPM} = $100(11.2^{1/2} - 1.34^{1/2})/6.872$
= $100(3.347 - 1.158)/6.872$
= $100(2.189)/6.872$ = **31.9 SLPM**



resource systems, inc. 7 MERRY LANE • EAST HANOVER, NJ 07936	**USED ON:** RSD-1, -2	**DRAWN BY**
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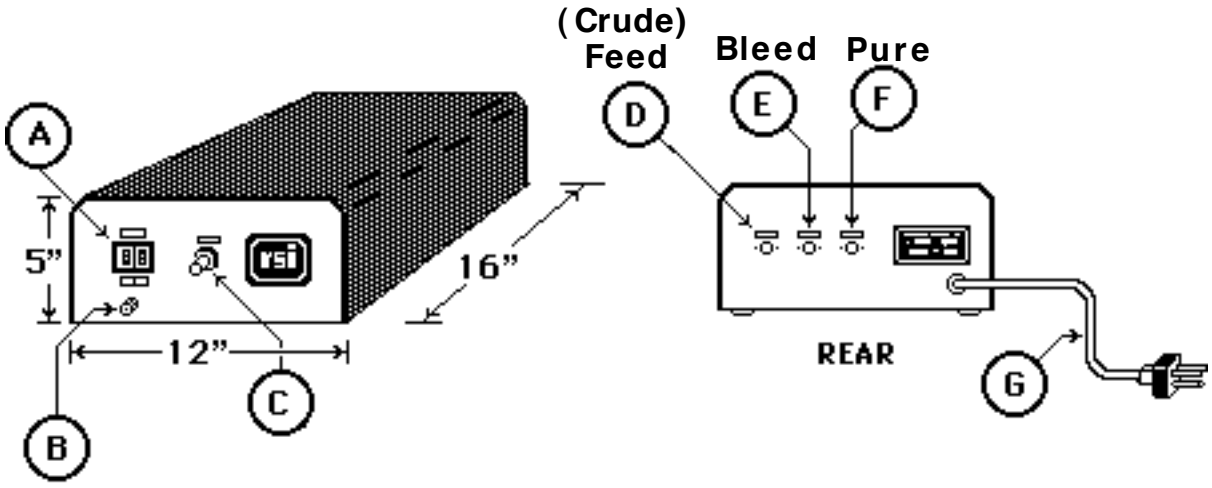

ITEM	DESCRIPTION
A	Power Switch
B	Circuit Breaker
C	Bleed Valve
D	Feed Inlet, 1/4"
E	Bleed Outlet, 1/4"
F	Pure Outlet, 1/4"
G	Power Cord

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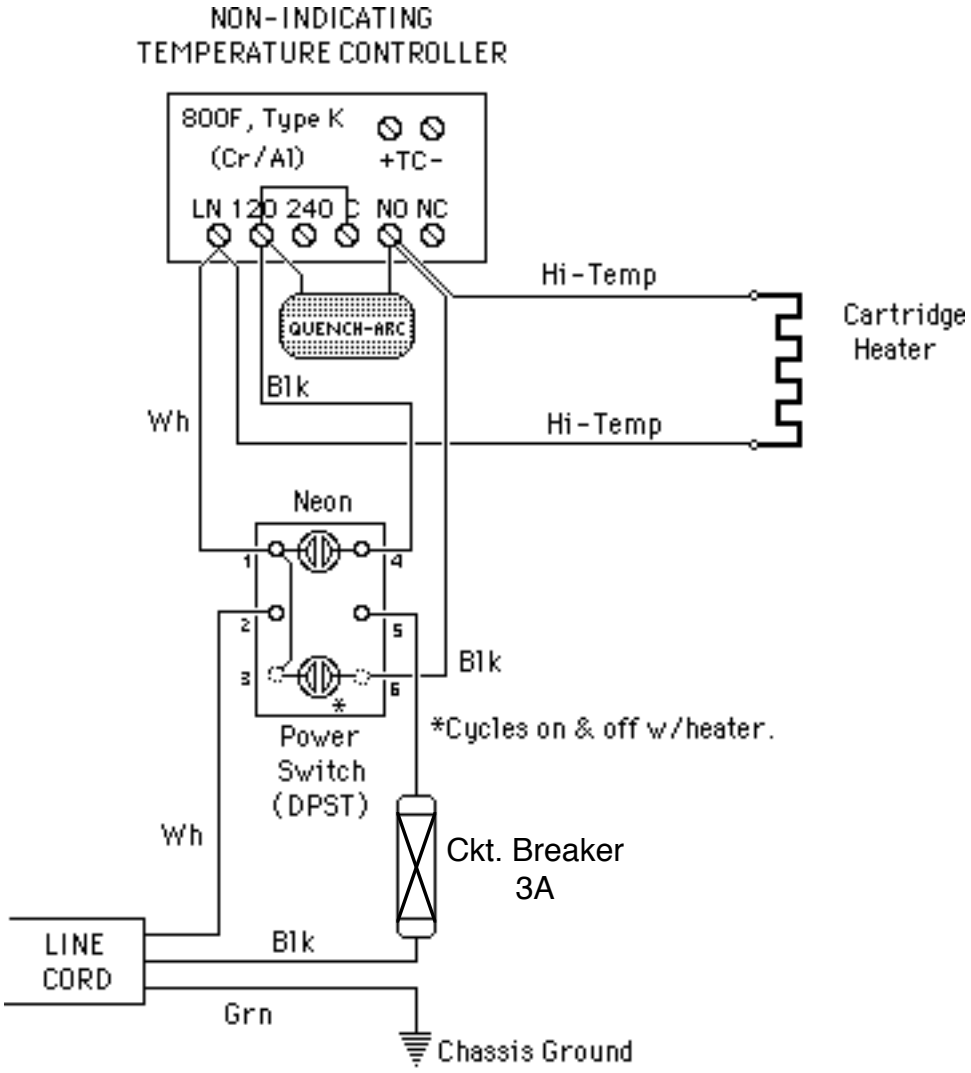
USED ON: RSD-1, RSD-2

TITLE: OUTLINE DRAWING

DRAWN BY

APPROVED BY L.k.k. 6/10/98

DWG. NO. A-3504C



ITEM	DESCRIPTION
D	3A CKT. BREAKER
C	QUENCH-ARC ADDED

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USED ON:
RSD-1, -2 (120 VAC)

TITLE:
WIRINGDIAGRAM

DRAWN BY

APPROVED BY
L.k.k. 1/28/87

DWG. NO.
A-3433D