PREFERRED
RELIABILITY
PRACTICES

DESIGN OF AN IMPROVED GAS TRANSFER VALVE FOR LEAK TIGHT TESTING

Practice:

A needle-point penetration gas transfer valve has been developed at JSC that is leak tight and gives very reliable results in transferring low or high pressure gases from sample containers to laboratory measuring devices such as chromatographs.

Benefit:

The reliability benefits of this new valve are that it can be used to transfer gas without risking the loss of the sample or the sample's purity. This improved reliability is in comparision to normal refrigeration gas transfer valves which are not leak tight and are not suitable for gas transfer where limited and unique gas samples are available and absolute gas measurements are required.

Programs That Certified Usage:

Space Shuttle Program

Center to Contact for More Information:

Johnson Space Center (JSC)

Implementation Method:

The purpose of this gas transfer valve was to provide a leak tight method of delivering gases from an Orbiter Aft Fuselage Gas Sampling System (OAFGSS) bottle assembly to a laboratory chromatograph. A commercial gas transfer system was modified to accomplish this task. A tube piercing valve was redesigned to replace the dynamic shaft seal with a compressible hermetically-sealed metal bellows. The redesigned valve and the component parts are illustrated in Figure 1.

The redesigned valve incorporates existing technologies into a compact and most importantly leak-tight device. The metal bellows assembly was obtained from an off-the-shelf valve which was readily available. The body of the valve had to be fabricated; however, the basic idea was obtained from commercial valves. A high vacuum fitting was used as the outlet fitting of the valve due to its excellent ability to provide a leak-tight connection.

The redesigned valve also has an adjustable stem travel which allows the stem tip penetration to be set to the desired level without excessive deformation of the tube which could lead to valve leakage.

DESIGN OF AN IMPROVED GAS TRANSFER VALVE FOR LEAK TIGHT TESTING

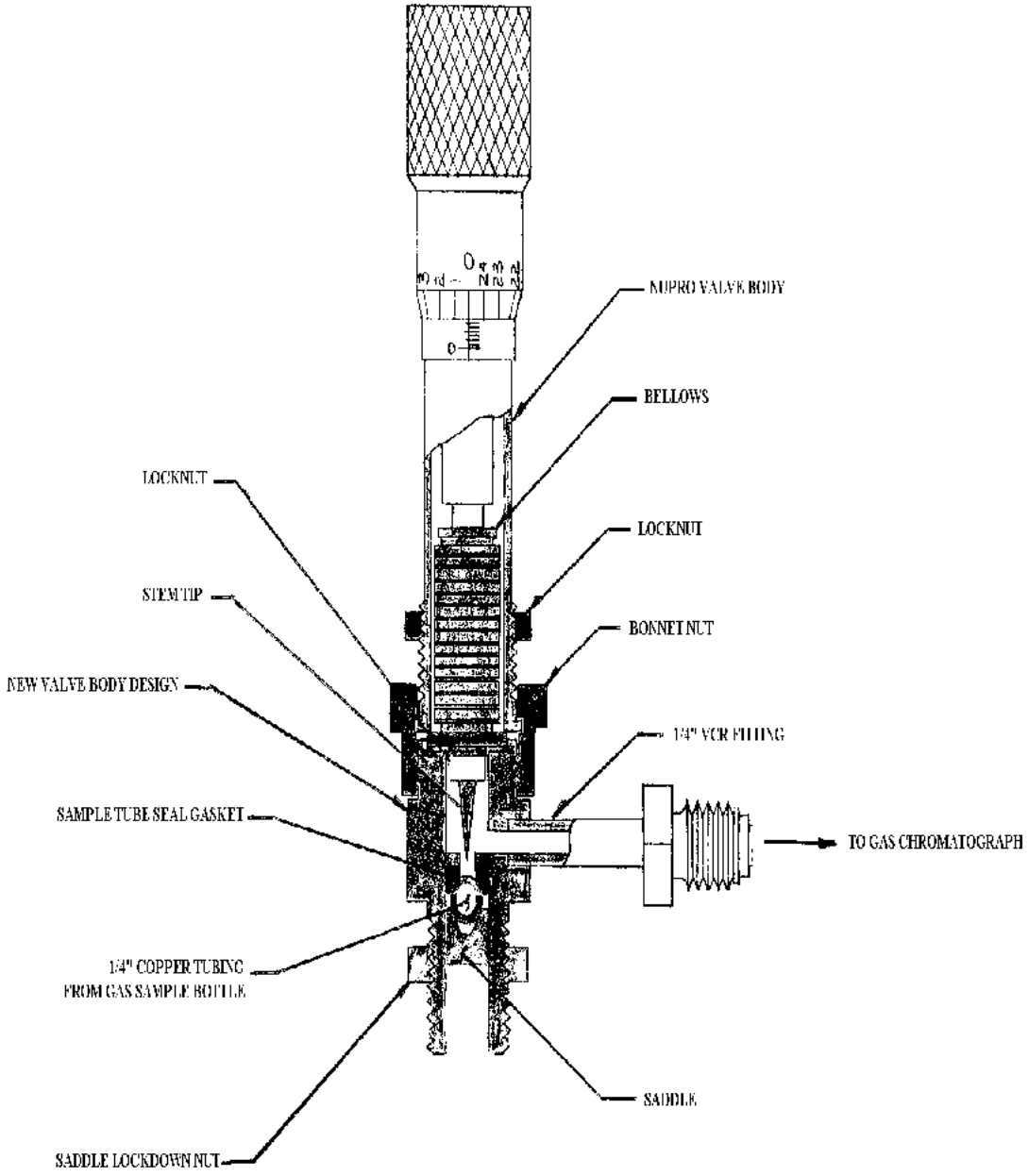

Figure 1. Valve Assembly and Gas Transfer Set-up

DESIGN OF AN IMPROVED GAS TRANSFER VALVE FOR LEAK TIGHT TESTING

Helium leak checks were made on the valve after its development to determine leak rates and are shown in Table 1. The leak detector was configured to detect helium leaks as low as $1x10^{-8}$ standard cubic centimeters per second (sccs) during valve functioning. The values shown in Table 1 indicate that the valve is leak tight.

Technical Rationale:

It was desired by the Space Shuttle Program to determine if and at what levels explosive exhaust gasses were being collected in the Orbiter Aft Fuselage during ascent of the Orbiter. For this purpose, several gas transfer assemblies were developed and flown on the Orbiter. Each of the assemblies were programmed to sample exhaust gasses at several locations and altitudes along the Orbiter ascent trajectory. After a mission, these assemblies were downloaded and taken to a laboratory for gas analysis.

Commercial tube piercing gas transfer systems were first used to penetrate the assemblies' access tube for chromatography testing. This technique was not suitable in some cases because of valve leakage and not reliable in others because of sample contamination, i.e., smaller samples were sometimes completely lost while other samples became contaminated with atmospheric constituents that rendered the test results meaningless. For this reason, a new gas transfer valve was developed for use that was leak tight and preserved the sample and its integrity during testing.

Impact of Nonpractice:

The use of the redesigned tube-piercing valve in place of the commercial valve provided one with no leakage and more robust and reliable operational characteristics. Re-use of the commercial valve would give less than satisfactory results in OAFGSS testing.

Related Practices:

None.

References:

None.

DESIGN OF AN IMPROVED GAS TRANSFER VALVE FOR LEAK TIGHT TESTING

Table 1. Leak Tests on the Gas Sampling Valve

Cycle #	Baseline Leak Rate (sccs)	Functional Leak Rate (sccs)
1	3.0 x 10-9	<1.0 x 10-8
2	4.4 x 10-9	<1.0 x 10-8
3	4.0 x 10-9	<1.0 x 10-8
4	4.4 x 10-9	<1.0 x 10-8
5	4.2 x 10-9	<1.0 x 10-8
6	3.8 x 10-9	<1.0 x 10-8
7	4.0 x 10-9	<1.0 x 10-8
8	4.4 x 10-9	<1.0 x 10-8
9	4.6 x 10-9	<1.0 x 10-8
10	5.0 x 10-9	<1.0 x 10-8
11	5.2 x 10-9	<1.0 x 10-8
12	5.4 x 10-9	<1.0 x 10-8
13	6.0 x 10-9	<1.0 x 10-8
14	5.2 x 10-9	<1.0 x 10-8
15	0.8 x 10-10	<1.0 x 10-8
16	6.0 x 10-10	<1.0 x 10-8
17	1.2 x 10-9	<1.0 x 10-8
18	1.4 x 10-9	<1.0 x 10-8
19	1.2 x 10-9	<1.0 x 10-8
20	2.6 x 10-9	<1.0 x 10-8
21	3.0 x 10-9	<1.0 x 10-8
22	3.4 x 10-9	<1.0 x 10-8
23	2.2 x 10-9	<1.0 x 10-8
24	4.0 x 10-9	<1.0 x 10-8
25	4.0 x 10-9	<1.0 x 10-8
26	5.0 x 10-9	<1.0 x 10-8
27	3.4 x 10-9	<1.0 x 10-8
28	5.4 x 10-9	<1.0 x 10-8
29	6.0 x 10-9	<1.0 x 10-8
30	5.0 x 10-9	<1.0 x 10-8