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SSC Cold Bore Tube High Pressure Test

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Summary

This note describes a fixture, provides basic calculations, shows piping and results of a high pressure test of SSC cold bore tube.

Introduction

An interest was expressed to determine a maximum pressure which might be externally applied to the present SSC cold bore tube.

It was decided to flange a piece of a bore tube, place it into a closed chamber and apply external pressure incrementally to the bore tube through that chamber until the bore tube collapses.

Fixture

Figure 1 shows a fixture consisting of an external chamber created by tube 1 with two welded flanges 2 and 3, and bore tube 7 welded inside to the flange 2 via flange 4. External and internal chambers connected to the outside world through pipes 5 and 6.

Basic Calculations

Collapsing pressure for externally pressurized cylinder is defined by the following formula:

$$W_c = KE\left(\frac{t}{D}\right)^3; \qquad \ell b/IN^2$$

where

W_c – collapsing pressure, $\ell b/IN^2$

E – modulus of elasticity, $\ell b/IN^2$

t – wall thickness; in

D – outer diameter, in

$$K \cong \frac{2}{1 - \mu^2}$$ where μ–Poisson's ratio.

If $t = .035$

$D = 1.360$

$E = 30 \times 10^6$
$\mu = .32$
} stainless steel 2169,

then

$$W_c = \frac{2}{(1 - .32^2)} \times 30 \times 10^6 \times \left(\frac{.035}{1.360}\right)^3$$

$$= 1{,}136.36 \text{ } \ell b/IN^2$$

If internal chamber is going to collapse around 1,200 $\ell b/IN^2$ let us assume that we have to supply up to 1500 $\ell b/IN^2$ pressure into an external chamber.

Minimum pipe wall thickness for the pressurizing cylinder (internal pressure) shall be determined by formula:

$$t_m = \frac{PD}{2(SE + P_y)} + A$$

where

t_m – minimum pipe wall thickness, in

P – maximum internal pressure, $\ell b/IN^2$

D – pipe O.D., in

SE – maximum allowable stress in material due to internal pressure and joint efficiency, $\ell b/IN^2$

y – coefficient;

A – allowance for threading, mechanical strength and corrosion, in

If P = 1,500

D = 4.5 (for 4" IPS pipe)

SE = 17,500 (stainless teel 247)

y = .4

A = 0.40 (no corrosion, no threading),

then

$$t_m = \frac{1{,}500 \times 4.5}{2(17{,}500 + 1{,}500 \times .4)} + .040 = .226$$

Assume 4" IPS pipe, schedule 40

4.5 O.D. × 4.026 I.D. × .237 W

Head flange thickness is determined by formula:

$$t = d\sqrt{\frac{CP}{SE}}$$

where

t – min. thickness of flat head flange, in.

d – I.D. of the pipe, in

P – pressure, $\ell b/IN^2$

SE – see above

C – coefficient;

If d = 4.026

P = 1,500

C = .5

SE = 17,500,

then

$$t = 4.026 \sqrt{\frac{.5 \times 1,500}{17,500}} = .833$$

Assume 1" flange thickness.

Basic dimensions of a fixture shown on Fig. 1 were taken in accordance with basic calculations:

Outer tube: 4.5 O.D. × 4.026 I.D. × 237 W

Flange thickness: 1"

Piping

Figure 2 shows piping for the high pressure test. Fixture was put into the dewar filled with liquid nitrogen. Inner chamber was connected to a low pressure helium line, outer chamber – to a high pressure helium line.

Test

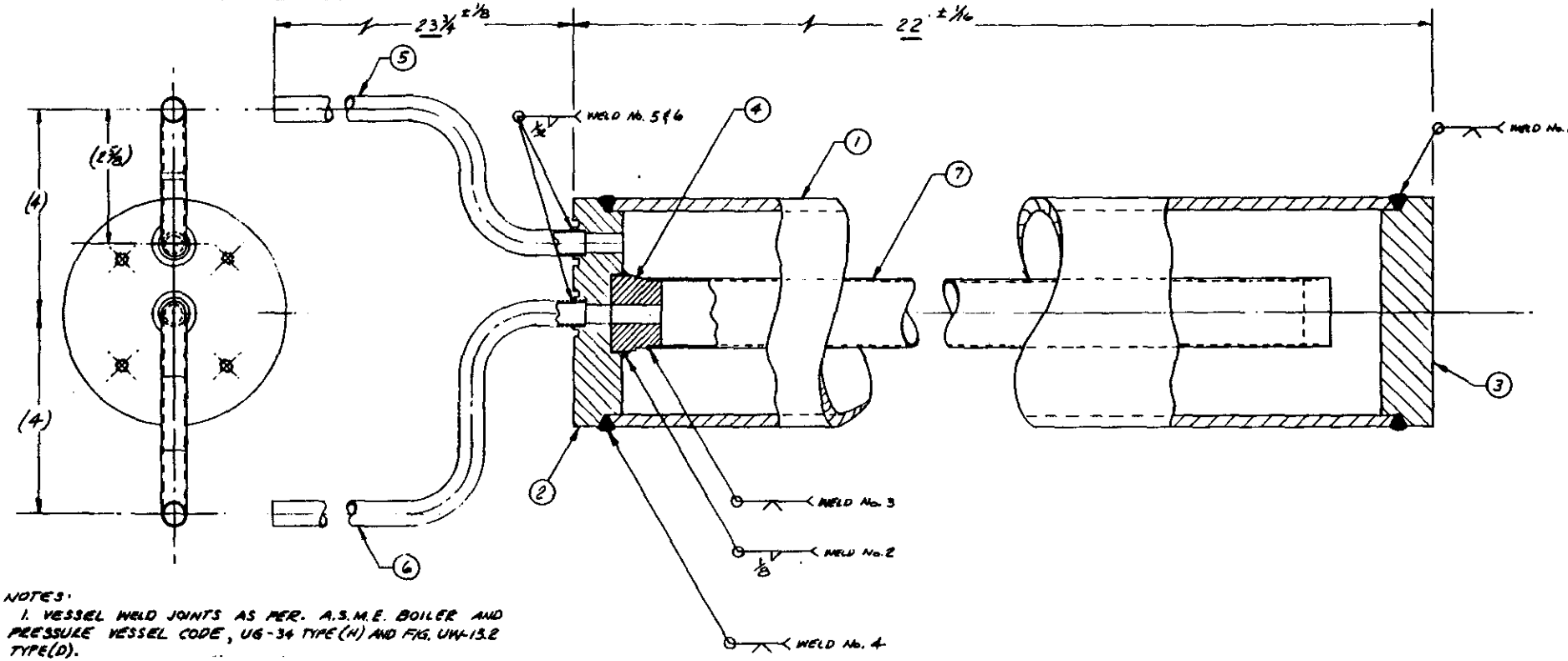
Low pressure inner chamber was charged with 25 psi. High pressure in outer chamber was incrementally increased from 0 psi to 1200 psi (each increment was 100 psi) when inner tube collapsed – liquid helium shot off the low pressure relief valve.

Conclusion

Present SSC cold bore tube can handle an external pressure up to 1,000 $\ell b/IN^2$

				REV.
1	1	OUTER SHELL	25.683.03-3	-
2	1	UPPER END PLATE	25.683.04-3	-
3	1	LOWER END PLATE	25.683.05-3	-
4	1	TUBE ADAPTER	25.683.08-2	-
5	1	HELIUM SUPPLY TUBE	25.683.10-2	-
6	1	HELIUM RETURN TUBE	25.683.11-2	-
7	1	INNER TUBE WELDMENT SUB ASS'Y	25.683.12-2	-

25.683.14 -4



NOTES:
1. VESSEL WELD JOINTS AS PER. A.S.M.E. BOILER AND PRESSURE VESSEL CODE, UG-34 TYPE(H) AND FIG. UW-13.2 TYPE(D).
2. HYDROSTATIC TEST WELDMENT TO 1875 P.S.I. FOR ONE HALF HOUR, CONNECT TUBES ITEM No. 5 & ITEM No. 6 TO ENSURE PRESSURE TO INNER AND OUTER VESSELS WILL BE EQUAL DURING TEST CYCLE.
3. TUBE FITTINGS MAY BE ADDED TO ENDS OF TUBES AS REQ'D. FOR HYDROSTATIC TEST AND THAN REMOVED AFTER TESTING.
4. AFTER TESTING ALL MOISTURE SHOULD BE REMOVED BY HEATING AND VACUUM PUMPOUT OF INNER AND OUTER VESSELS.

FIG. 1

					25.683	1
10/15/86	NOTED	FULL			BROOKHAVEN NATIONAL LABORATORY ASSOCIATED UNIVERSITIES, INC. UPTON, N.Y. 11973	
H.R. McNEILL	#1				MAGNET FIXTURES BORE TUBE TEST VESSEL VESSEL WELDMENT ASS'Y	
					25.683.14	-4

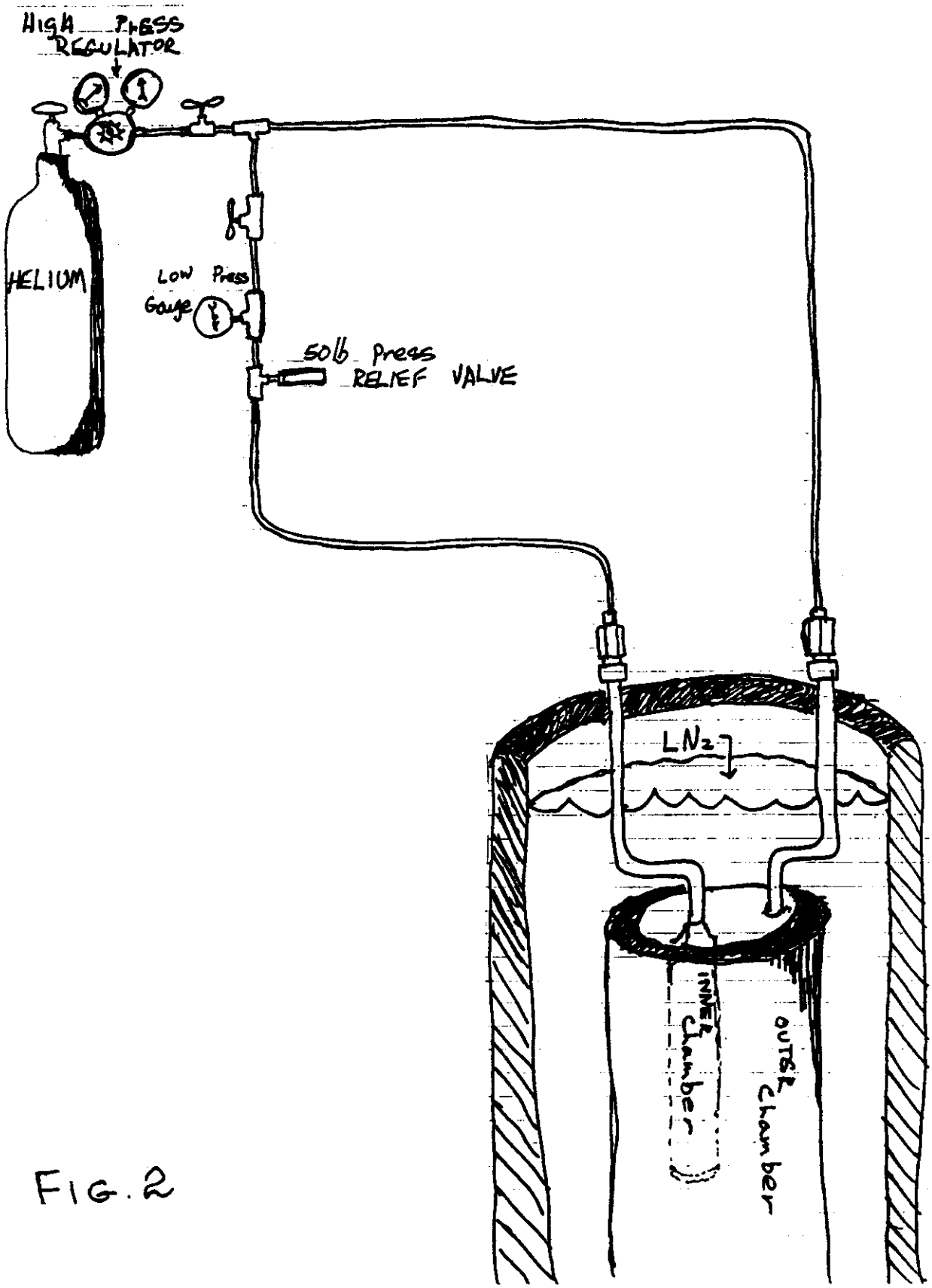

HIGH PRESS REGULATOR
HELIUM
LOW Press Gauge
50lb Press RELIEF VALVE
LN_2
INNER Chamber
OUTER Chamber

FIG. 2

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