SNO-STR-91-042

Division of the Acrylic Vessel

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1 Introduction

At UBC we are working on another variant on the theme of splitting the acrylic into brine and fresh regions. This time we propose a flexible diaphragm, probably teflon, which will be inserted during the operational phase and made to fit around the equator.

Construction:

It will consist of a single circle of teflon with an inflatable boom around the edge, a few cm wide.

The connection between the boom and the acrylic vessel will be either:

- A groove on the underside of an equatorial ring in the acrylic vessel. The piping may be routed through the equatorial ring.
- A butt joint against the inside of the vessel. The plumbing will go through a collapsible teflon chimney connected to a hole in the centre of the diaphragm.

The collapsible chimney may in any case be necessary to allow calibration sources access to the lower half of the vessel.

There is a possibility of fixing the diaphragm in the vessel permanently.

Deployment:

The divider will be lowered into vessel without emptying. When it is beneath the equator, the boom will be inflated to stretch the sheet and allow the divider to rise until the boom fits in the groove in the equatorial ring. For the butt joint, the boom will expand against the wall of the vessel.

Diffusion of NaCl:

We have measured the diffusion of NaCl through 1 mil teflon sheet to be $20 \pm 20 mg/m^2/day$. With an area of $113m^2$, this gives a total of $2 \pm 2g/day$. If the circulation time of the water is 25days, this means losses of the order 50g, compared to the total amount of 1.25 tons.

If the contact between the boom and its housing allows an exit path for NaCl via a gap of 1mm around a 10cm arc of boom, the diffusion rate will be $0.1g/day$. This is much smaller than the losses through the surface.

2 Impact on Acrylic Vessel

The ring option will require a small (20cm) ledge around the equator with a groove in the bottom to accept the divider boom. Plumbing will pass through this ledge or in flexible tubes attached to the teflon sheet.

The butt joint case has no impact on the structure of the vessel, except for string attachments.

The vessel will carry the brine in its lower half and the fresh water in the top. The small difference in densities will cause stress patterns which will need to be calculated, but are not seen as a problem and the stresses will probably be less than filling the vessel with brine (Stachiw, Doe, priv. comm.).

3 Pros/Cons

This divider has several advantages over a spherical bladder:

- Simpler construction.
- Simpler deployment.
- No need to balance densities in the two halves.
- Data subtraction from volumes of the same shape.
- Possibly less impact on vessel design.

And some disadvantages:

- No possibility of recovery from disastrous acrylic radioactivity.
- Increased acrylic radioactivity (Equatorial ring option only).
- Loss of spherical symmetry.

4 Costs

We have no estimate of the cost of the divider. The total bill is likely to be dominated by the possible need to double up the water system. These costs have been guesstimated by David Sinclair to be \$ 200K (over and above the plain salt option) for a plant to handle the fresh side. If we put boron in the top half, these costs could rise to \$ 500K.

5 Modelling the Divided Vessel

We have built a model inside our 24" diameter acrylic vessel to test the concept. Lack of scaling is a problem but at least the model helps to imagine problems and solutions in 3-D. A swimming pool size test will probably be necessary to assess handling difficulties.

We are doing a Fratiesque analysis (see SNO-STR-91-19) of the likely signals in this scheme to determine how much we gain (if any) over the plain salt option. At the time of going to press, we had reproduced all of Frati's results for the White Book option. Now we will split the vessel in an *ad hoc* way and repeat the analysis. Particular attention will be paid to the possible reduction in the high sensitivity to calibration errors. A cleaner separation of the neutral current signal is expected to provide some measure of self-calibration.

6 Figures

1 Equatorial Ring Option Deployment 1.

2 Equatorial Ring Option Deployment 2.

3 Equatorial Ring Option Deployment 3.

4 Equatorial Ring Option. Detail of ring and diaphragm boom.

5 Equatorial Ring Option. Detail of boom welding. See figure 4 for location of points A, B and C.

6 Equatorial Ring Option. Glove box with control line capstans.

7 Butt Joint Option Deployment. Note: bottom control lines may not be necessary.

8 Butt Joint Option. Details of collapsible chimney and supply tube for lower hemisphere. See figure 7 for location of point D.

9 Butt Joint Option. Glove box with break-out vessel for bottom control lines.

FIG. 1

RING OPTION

DEPLOYMENT 1

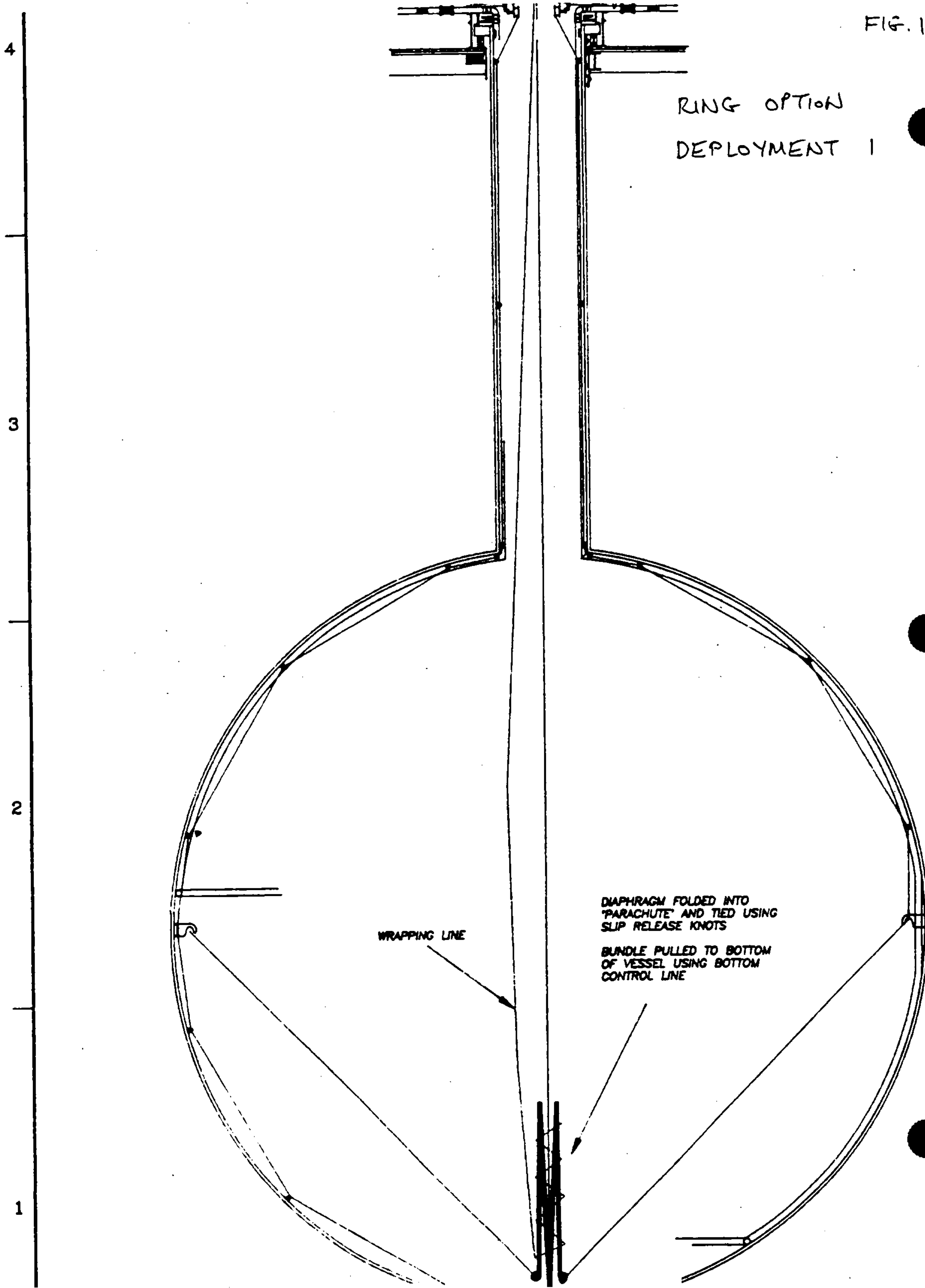

FIG. 2

RING OPTION

DEPLOYMENT 2

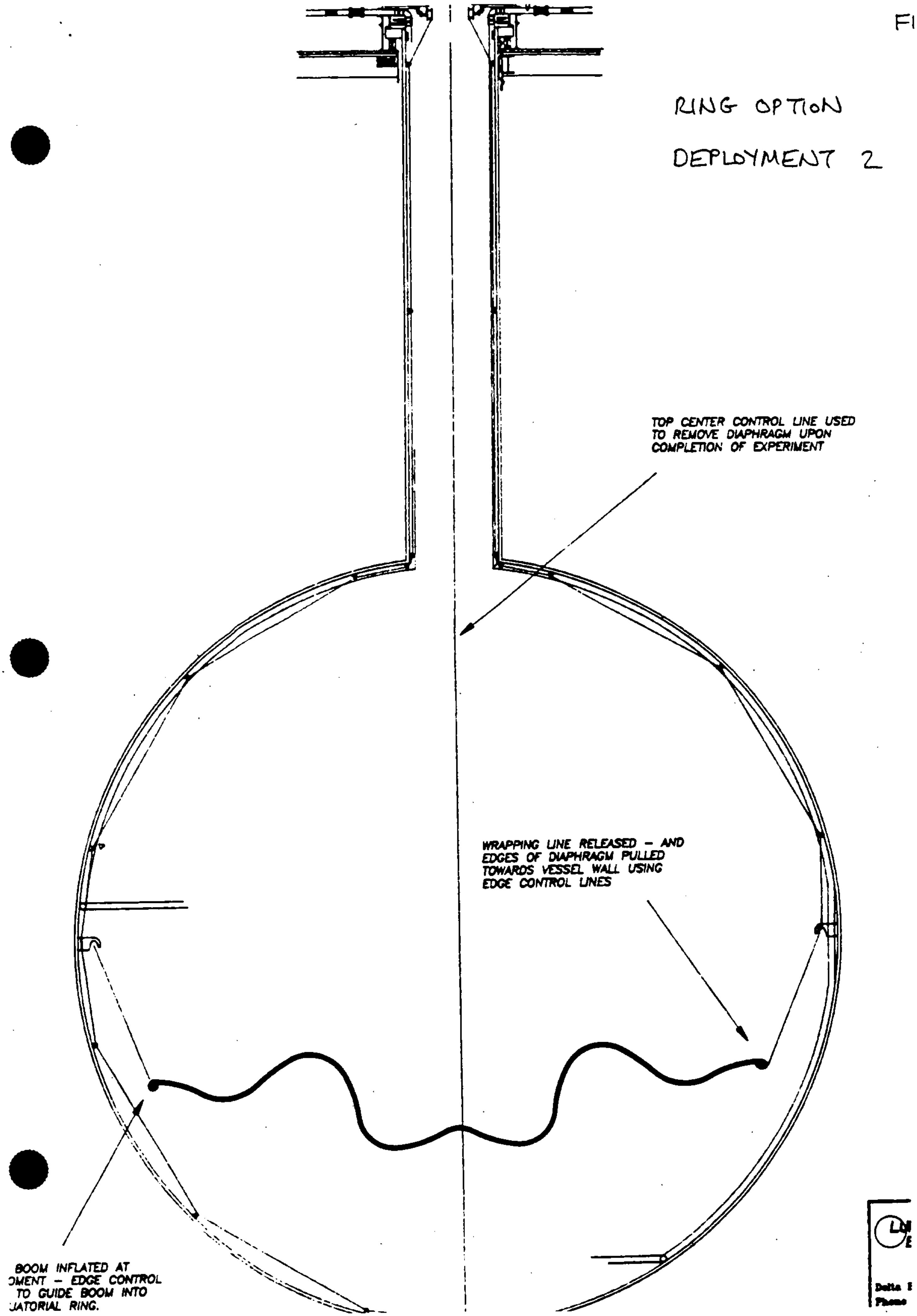

FIG. 3

RING OPTION

DEPLOYMENT 3

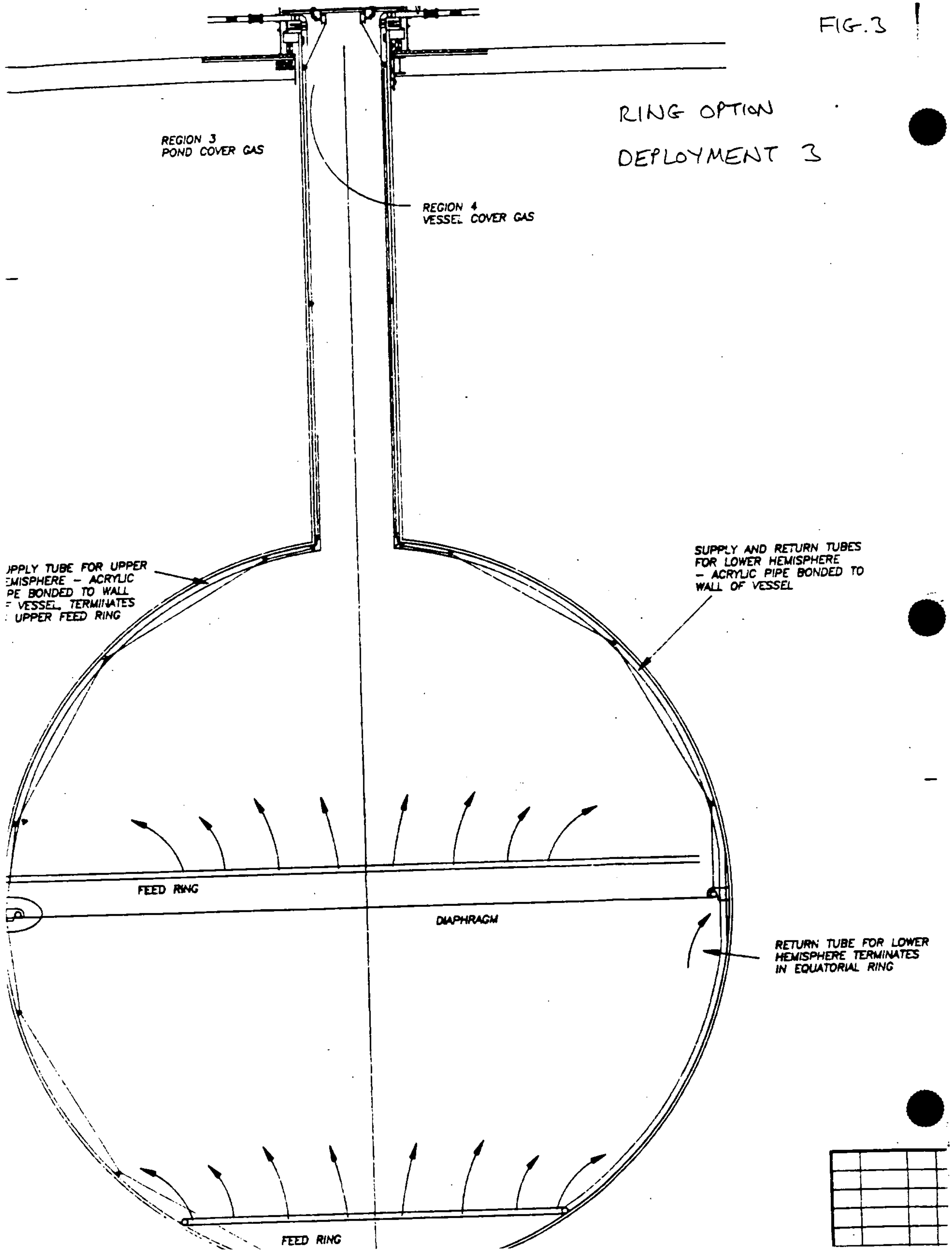

FIG.4

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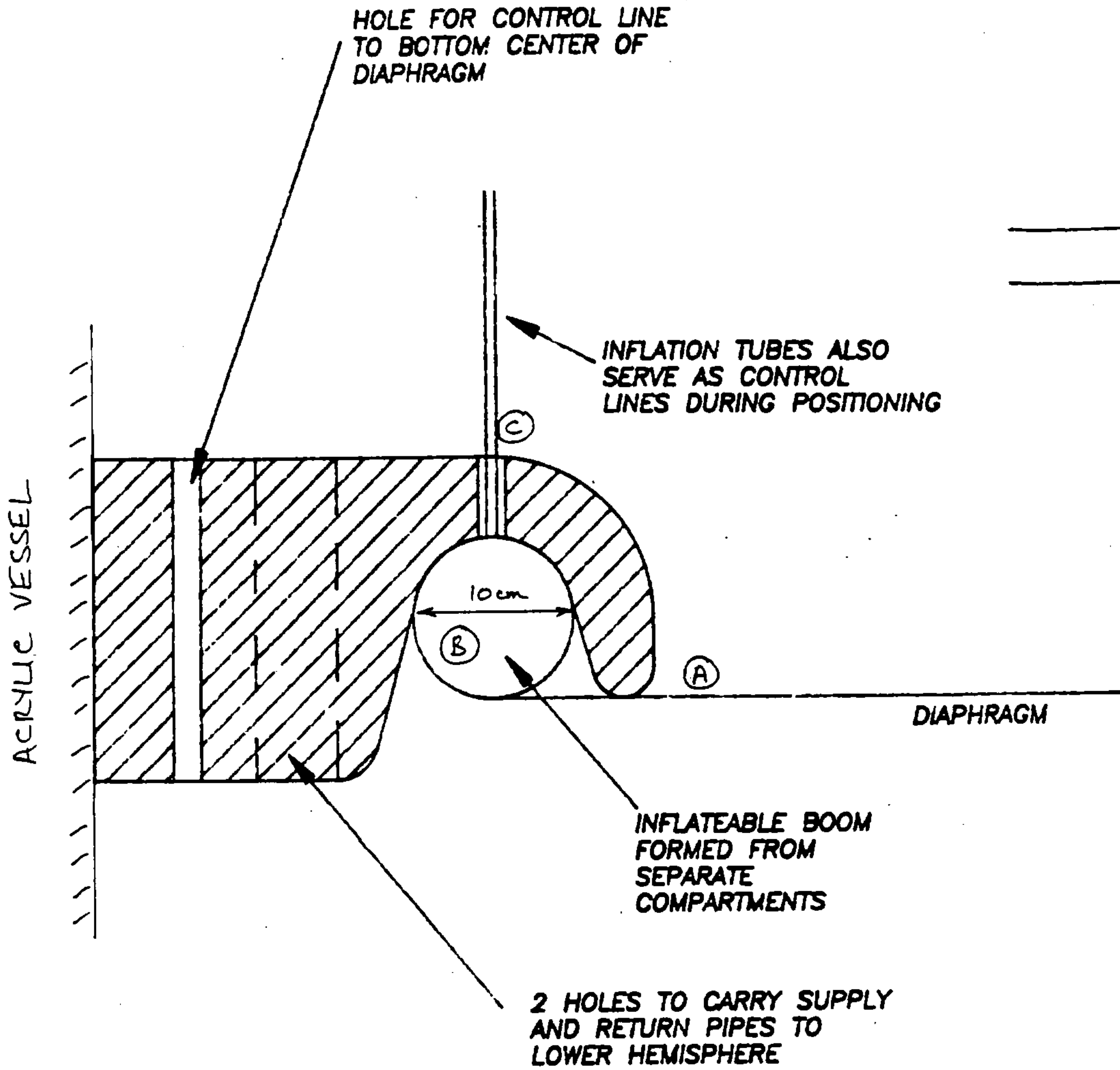

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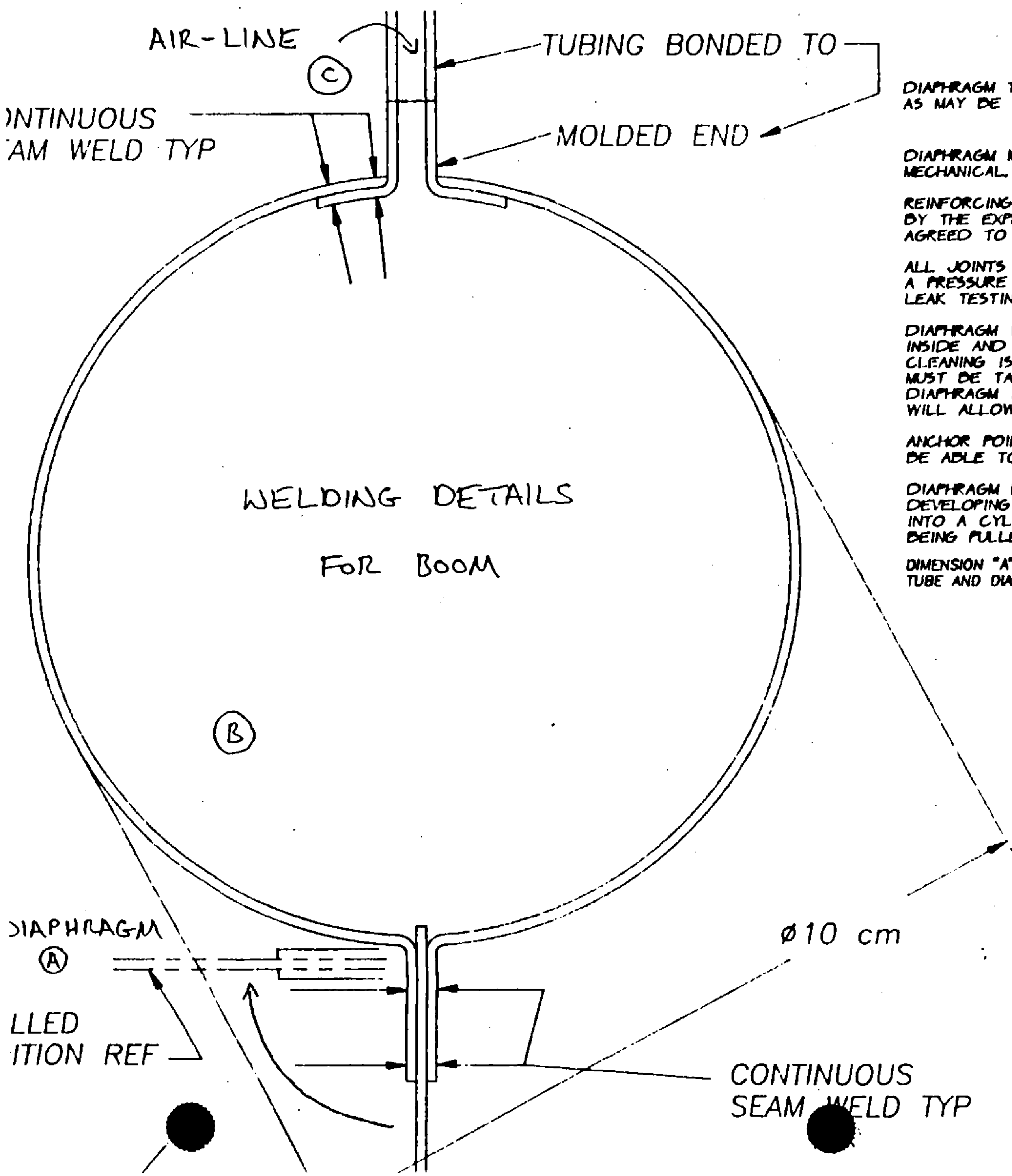


NOTES

DIAPHRAGM TO BE MADE FROM .02" THICK TEFLON FILM OR OTHER SUCH MATER AS MAY BE AGREED UPON BY EXPERIMENTERS.

DIAPHRAGM MATERIAL TO MEET EXPERIMENTER'S SPECIFICATIONS FOR MECHANICAL, CHEMICAL, AND OPTICAL PROPERTIES.

REINFORCING PATCHES SHALL BE APPLIED ONLY IN LOCATIONS AGREED TO BY THE EXPERIMENTERS, AND SUCH PATCHES SHALL BE MADE FROM MATERIALS AGREED TO BY THEM.

ALL JOINTS AND MATERIALS TO BE TOTALY LEAK-TIGHT TO WATER APPLIED AT A PRESSURE OF _______ " W.G.
LEAK TESTING TO BE CARRIED OUT BY MEANS OF PROCEEDURES AGREED UPON

DIAPHRAGM IS, AS FAR AS IS POSSIBLE, TO BE DELIVERED IN A CLEAN CONDIT INSIDE AND OUT, FREE FROM DUST AND PARTICLES.
CLEANING IS TO BE CARRIED OUT ONLY WITH MATERIALS AGREED UPON. GREAT MUST BE TAKEN TO PREVENT THE INTRODUCTION OF CERTAIN CONTAMINENTS.
DIAPHRAGM IS TO BE DELIVERED IN SUITABLE PROTECTIVE, NON-RIGID COVERIN WILL ALLOW IT TO BE CARRIED THROUGH A MINE-SHAFT BEFORE BEING UNWRA

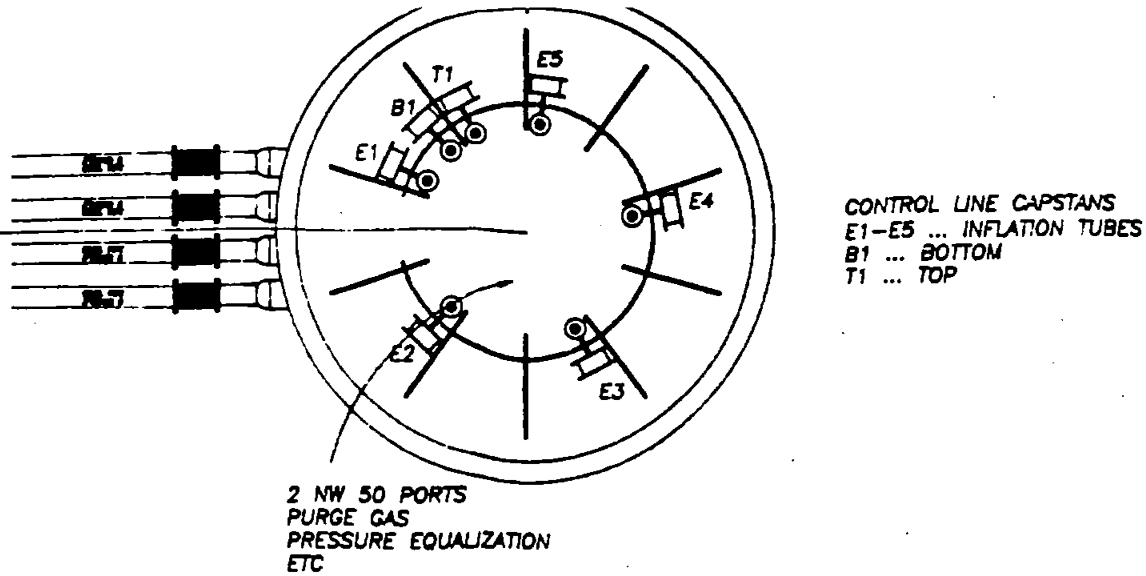
ANCHOR POINTS FOR CONTROL LINES TO BE WELL BONDED TO DIAPHRAGM, ANC BE ABLE TO WITHSTAND A PULL OF _____ LBS WITHOUT TEARING OR LEAKING

DIAPHRAGM MUST BE ABLE TO WITHSTAND ANTICIPATED ROUGH TREATMENT WITH DEVELOPING LEAKS. SUCH ROUGH TREATMENT IS ENVISAGED TO INCLUDE BEING INTO A CYLINDER SMALL ENOUGH TO BE INSERTED INTO A 0.5M DIA HOLE, AS BEING PULLED BACK THROUGH THAT HOLE BY CONTROL LINE TI

DIMENSION "A" TO APPLY WITH ANULAR TUBE INFLATED TO A PRESSURE OF PSI AND TUBE AND DIAPHRAGM ORIENTED IN FITTED POSITION AS SHOWN.

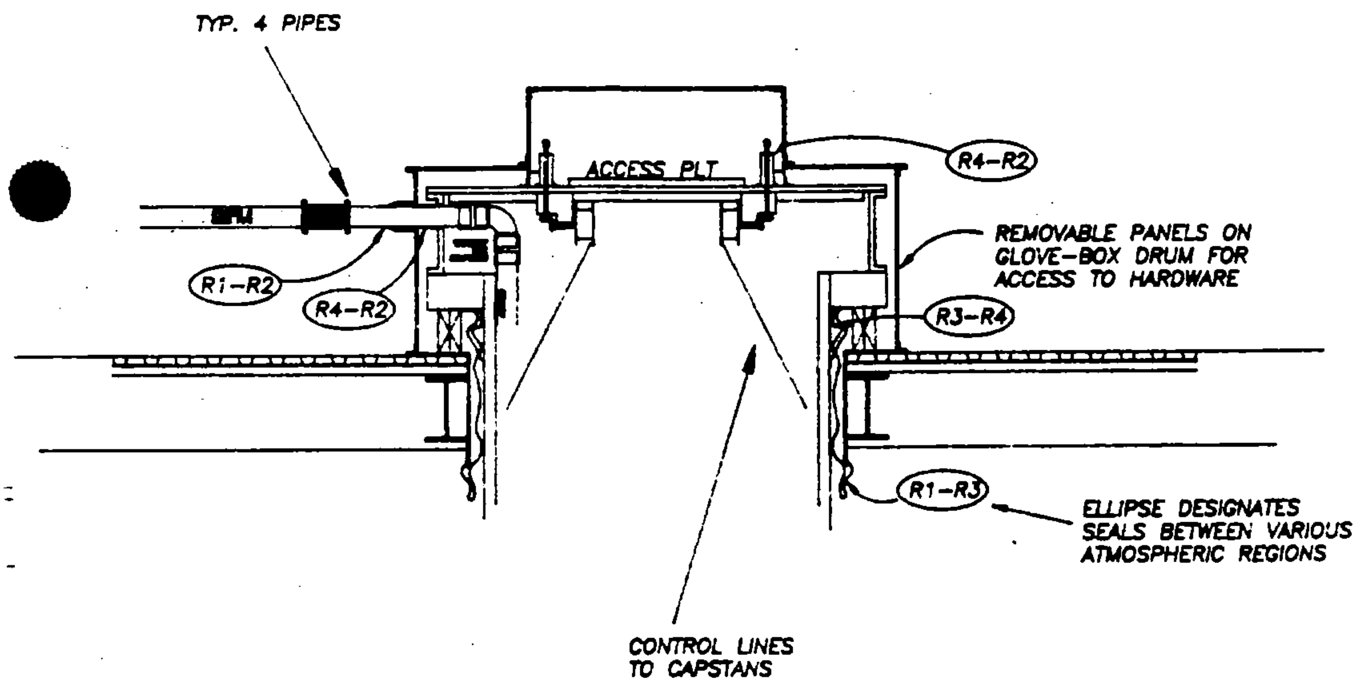
FIG. 5

FIG. 6



DETAIL OF VESSEL HEAD

SCALE 1:24



LUNA-TEK ENTERPRISE

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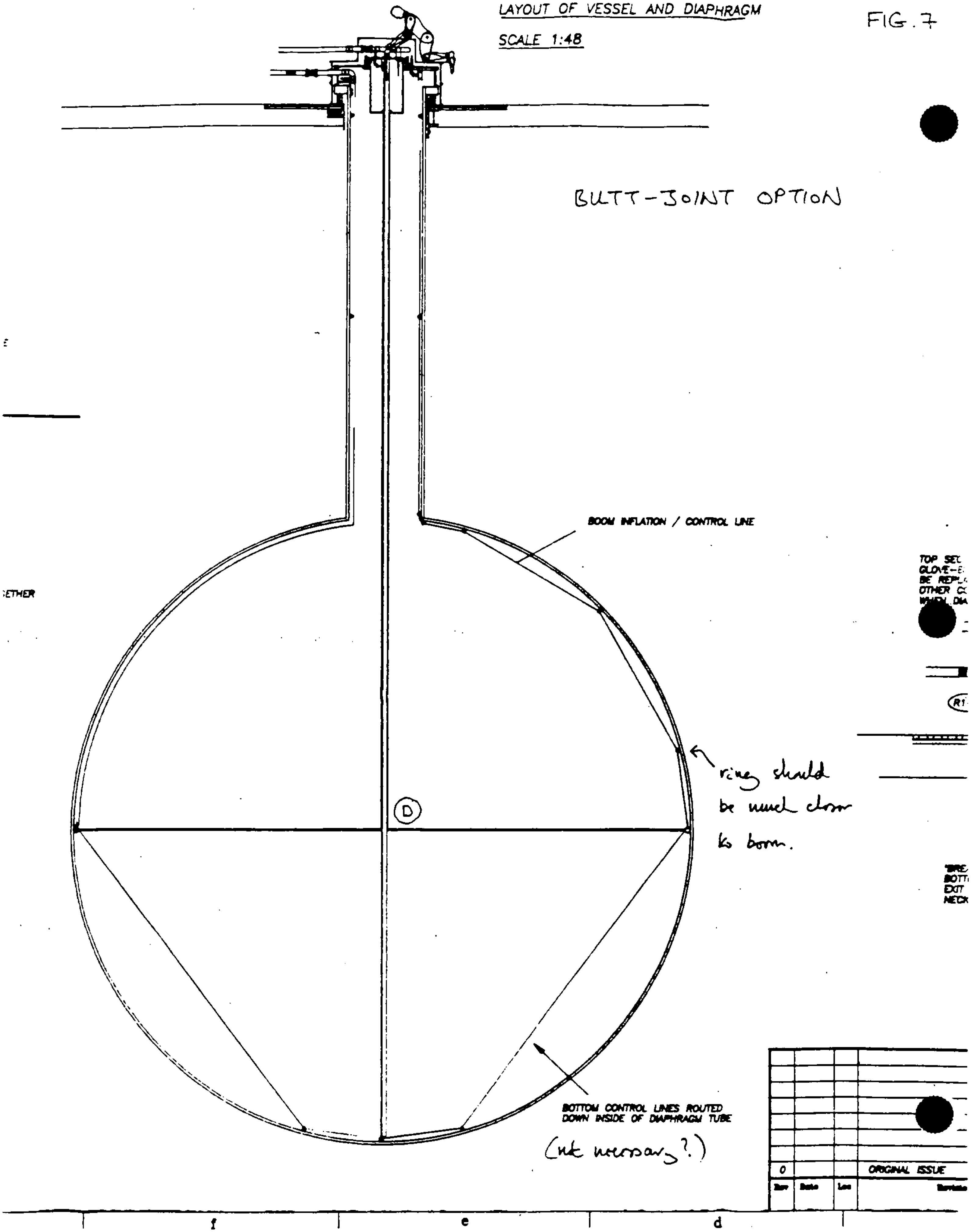
SOLAR NEUTRINO OBSERVATOR

LAYOUT OF VESSEL AND DIAPHRAGM

SCALE 1:48

FIG. 7



ENLARGED DETAIL AT CENTER OF DIAPHRAGM

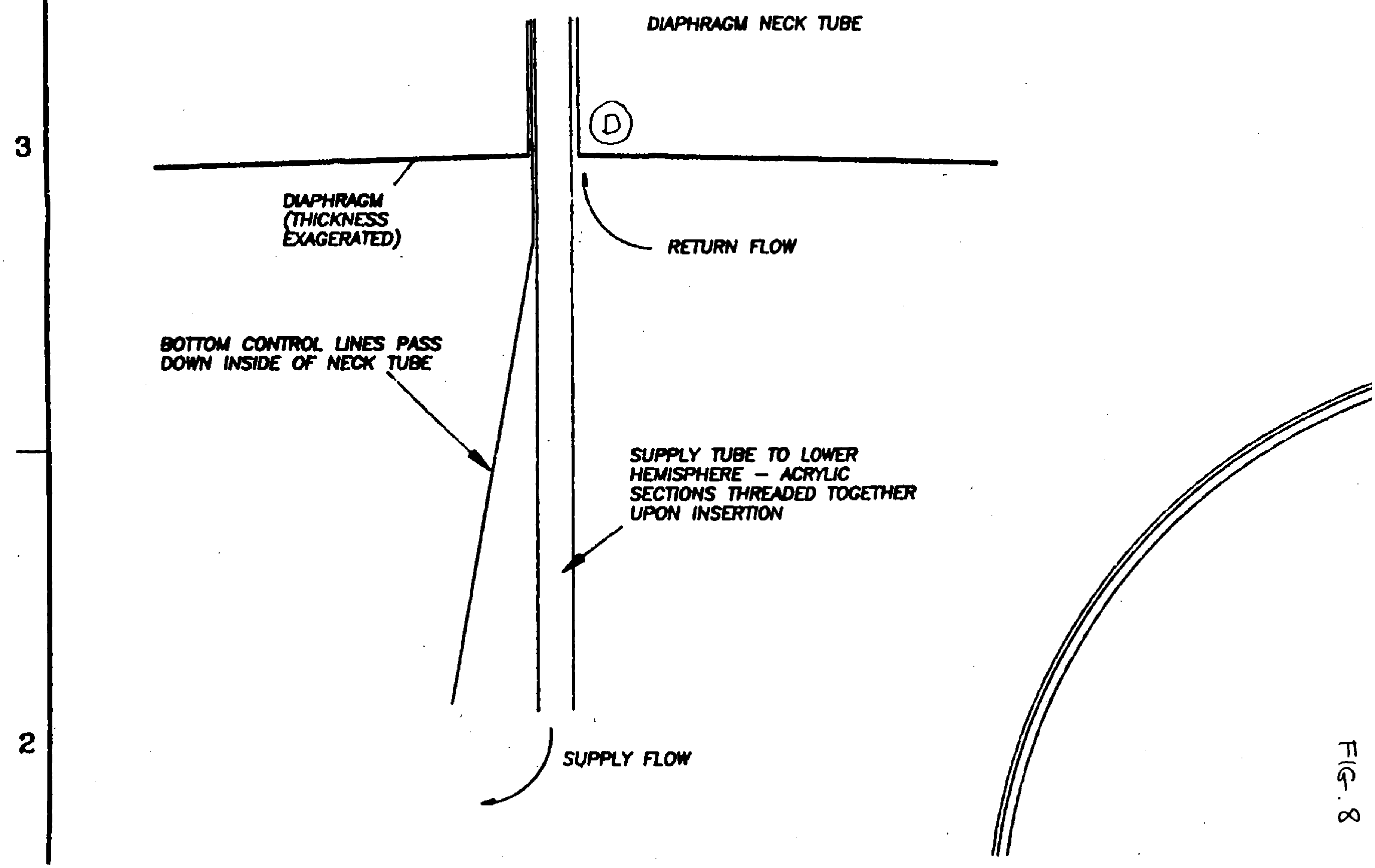
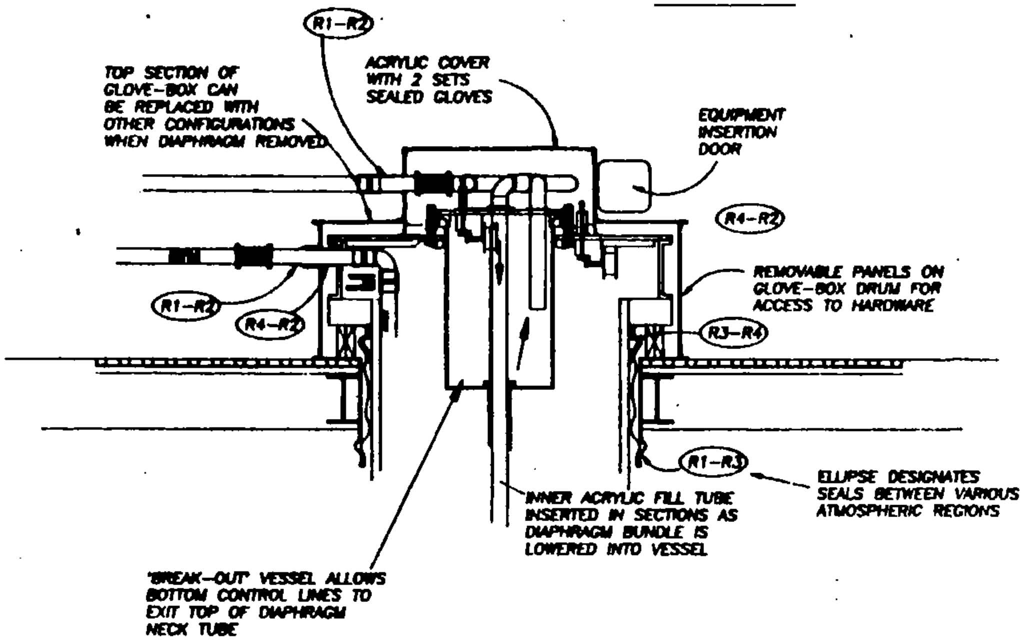


FIG. 8

DETAIL OF VESSEL HEAD

SCALE 1:24



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SOLAR NEUTRINO OBSERVATORY

DIAPHRAGM WITHOUT EQUATORIAL RING

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c b a

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FIG. 9