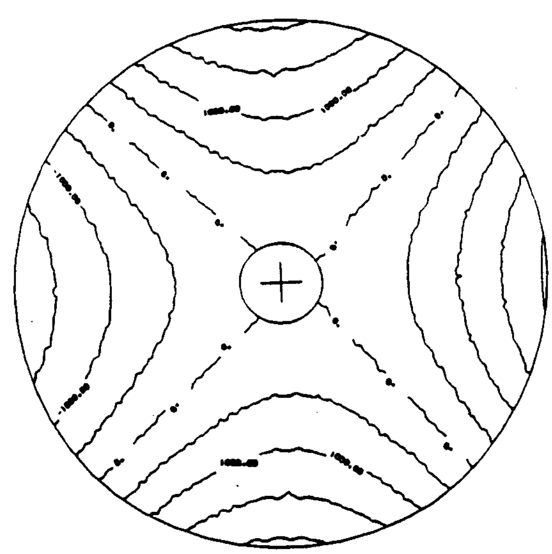
BCV
progetti s.r.l.

COLUMBUS PROJECT

MIRROR BLANK 8. mt diam F1.2

WIND ON A THIN MENISCUS MIRROR BLANK



Report N. 114 Rev. 0
Milano, 1989, May 15th

1. INTRODUCTION

In the following we analyse, for a meniscus mirror, the effects of a wind pressure varying linearly from 0. at one side of the mirror, to 50. Pa to the opposite mirror side.
The wind load is reported in figure 1-a.
The pressure load is balanced (to the translation and rotation) by the uniform pressures P_1 and P_2 on figure 9-b.
The reaction values are:

$P_1 = 2.3275 Pa$

$P_2 = 36.336 Pa$

Since the plane Y=0. is a symmetry plane, we have analysed one mirror half having the following characteristics:

- External diameter = 8000. mm
- Internal hole diameter = 1200. mm
- Thickness = 200. mm

The material is silica, and it has the following mechanical characteristics:

- Young modulus = 74500. $\frac{N}{mm^2}$
- Poisson modulus = 0.17

In our Rep. N. 113 we have compared the global stiffness of such a mirror with the honeycomb Columbus mirror as regards astigmatic deformations.
So the results obtained for a thin meniscus can be related to the honeycomb mirror using the stiffness ratio obtained in our Rep. 113.

In figure 2 is reported a view of the finite element mesh used.

The applied load is the sum of the pressures reported in figures 1-a and 1-b. In figure 3 are reported the isocontours of the applied load.
On each finite element the pressure is constant and it corresponds to the value computed in the element C.G.
In order to avoid rigid movements we put the costraints on figure 4. Being the loads self-balanced the constraints must be unloaded. In fact we obtain the following constraint reactions:

- CONSTRAINT 1 F = 0.75 N
- CONSTRAINT 2 F = -.57 N
- CONSTRAINT 3 F = 0.14 N

1.1. RESULTS

The optical performances of the meniscus, obtained by the finite element analysis, are reported in next tables:

RMS - PEAK TO VALLEY	
RMS as to the bestfit paraboloid *Axial Displacement Peak to Valley*	$0.934\ 10^{-3}$ mm $0.4\ 10^{-2}$ mm

The bestfit paraboloid has the following movements:

- Axial movement = $0.18\ \ 10^{-5}$ mm
- Tilt around Y = -0.08 arcsec
- Focal variation = $0.11\ \ 10^{-3}$ mm

In figure 5 are plotted the isocontours (step=500. nm) of the axial component of the displacement perpendicular to the optical surface referred to the bestfit paraboloid.

The first 45 coefficient values of the upper plate strain expansion in Zernike polynomial serie are reported in the following table:

ZERNIKE POLYNOMIAL COEFFICIENTS		
$c_{00} = 0.000$	$c_{11} = 0.000$	$d_{11} = 0.000$
$c_{20} = 0.000$	$c_{22} = -2.25\ 10^{-3}$	$d_{22} = 0.000$
$c_{31} = -8.65\ 10^{-5}$	$d_{31} = 0.000$	$c_{33} = 0.000$
$d_{33} = 0.000$	$c_{40} = 0.000$	$c_{42} = 1.51\ 10^{-4}$
$d_{42} = 0.000$	$c_{44} = 7.03\ 10^{-5}$	$d_{44} = 0.000$
$c_{51} = 0.000$	$d_{51} = 0.000$	$c_{53} = 0.000$

ZERNIKE POLYNOMIAL COEFFICIENTS		
$d_{53} = 0.000$	$c_{55} = 0.000$	$d_{55} = 0.000$
$c_{60} = 0.000$	$c_{62} = -1.02\ 10^{-4}$	$d_{62} = 0.000$
$c_{64} = 0.000$	$d_{64} = 0.000$	$c_{66} = 0.000$
$d_{66} = 0.000$	$c_{71} = 0.000$	$d_{71} = 0.000$
$c_{73} = 0.000$	$d_{73} = 0.000$	$c_{75} = 0.000$
$d_{75} = 0.000$	$c_{77} = 0.000$	$d_{77} = 0.000$
$c_{80} = 0.000$	$c_{82} = -1.24\ 10^{-4}$	$d_{82} = 0.000$
$c_{84} = 0.000$	$d_{84} = 0.000$	$c_{86} = 0.000$
$d_{86} = 0.000$	$c_{88} = 0.000$	$d_{88} = 0.000$

The results related to the structure function are reported in the following table:

STRUCTURE FUNCTION			
DISTANCE cell side	COUPLE NUMBER	AVERAGE VALUE (mm)	STANDARD DEVIATION (mm)
1 side	4470	$-0.135\ 10^{-5}$	$0.595\ 10^{-4}$
2 sides	4374	$-0.275\ 10^{-5}$	$0.119\ 10^{-3}$
4 sides	4306	$-0.53\ 10^{-5}$	$0.239\ 10^{-3}$
8 sides	4444	$-0.10\ 10^{-4}$	$0.474\ 10^{-3}$
16 sides	3612	$-0.109\ 10^{-4}$	$0.91\ 10^{-3}$
32 sides	2382	$0.89\ 10^{-5}$	$0.153\ 10^{-2}$

In figure 6 is reported the Structure Function "distance - standard deviation".

In figure 7 are plotted the areas around the focus related to an assigned percentage of the total energy; such areas have been plotted for the percentages from 10.% to 100.% step 10.%. From this figure we obtain that the 90. % of the total energy is included in a "cone" having 0.95 arcsec angle.

WIND PRESSURE

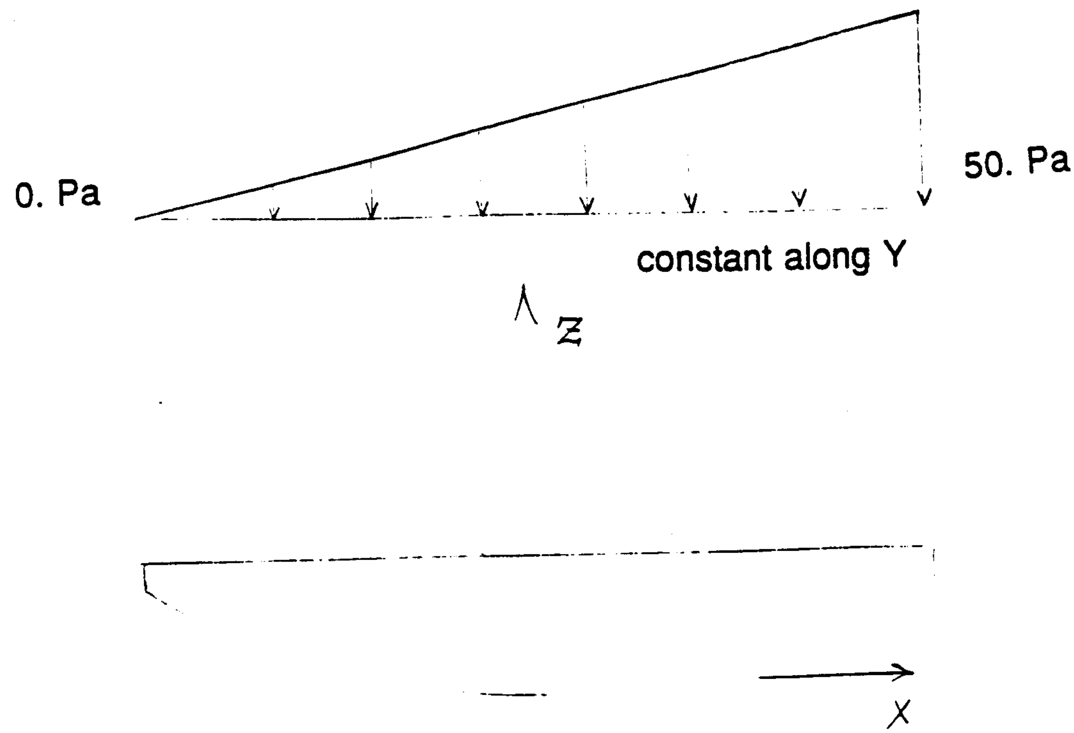


FIGURE 1-a

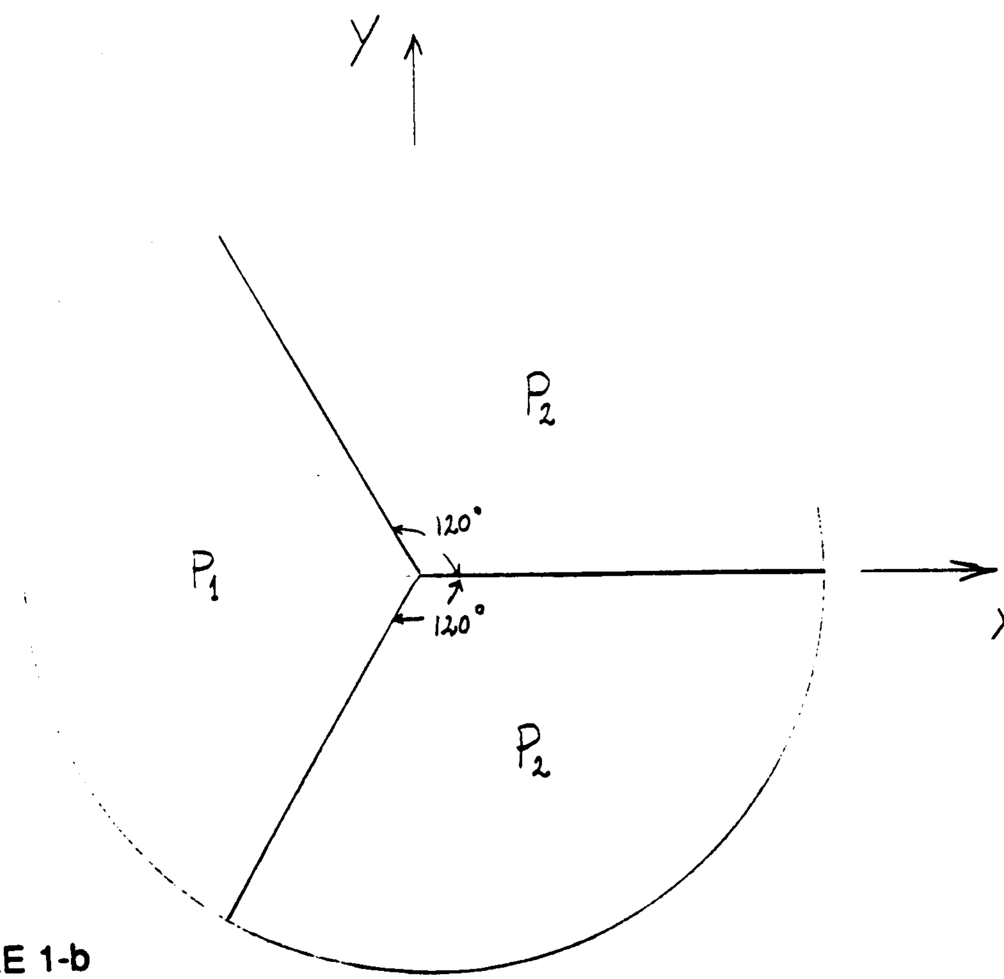
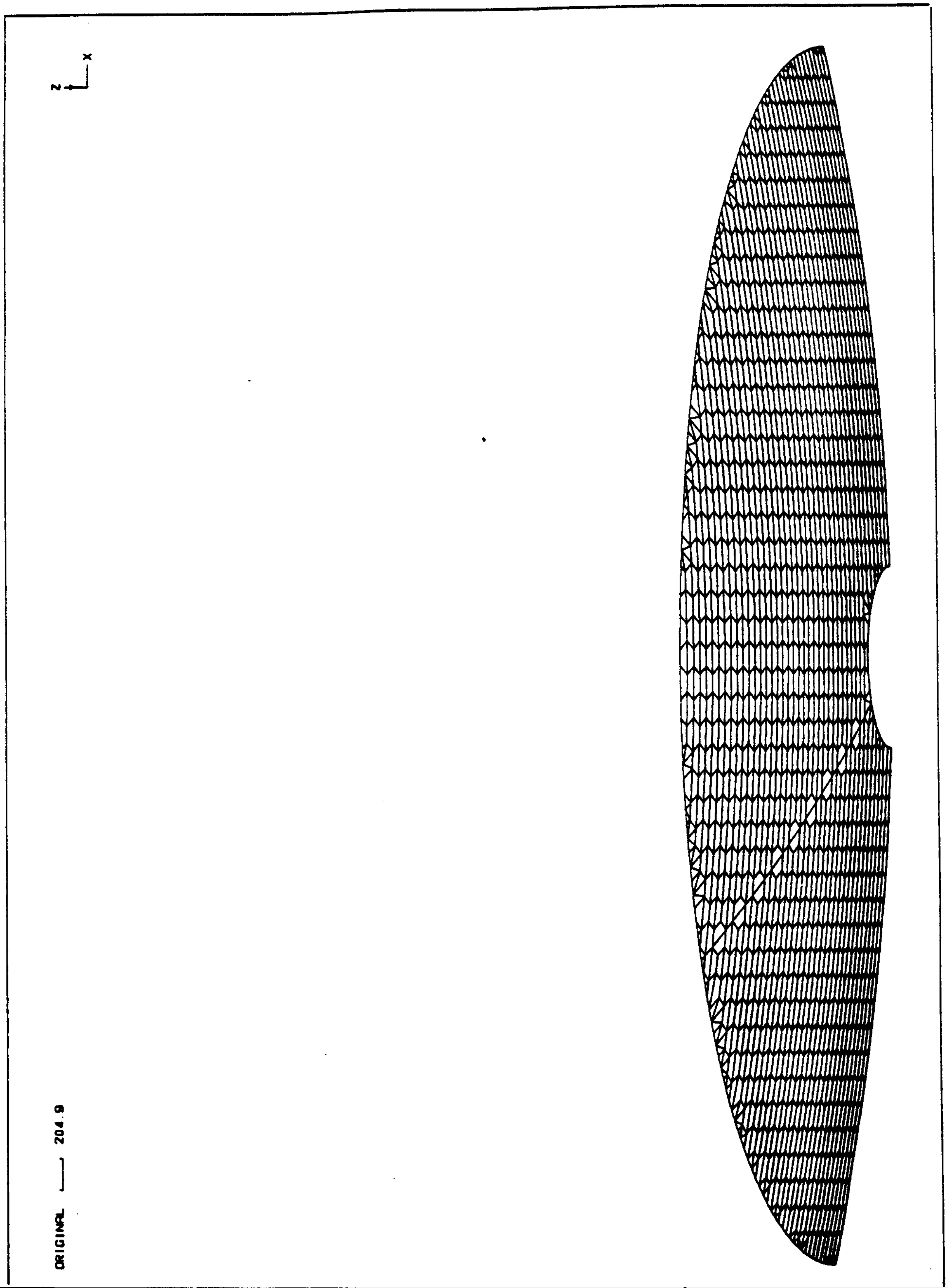


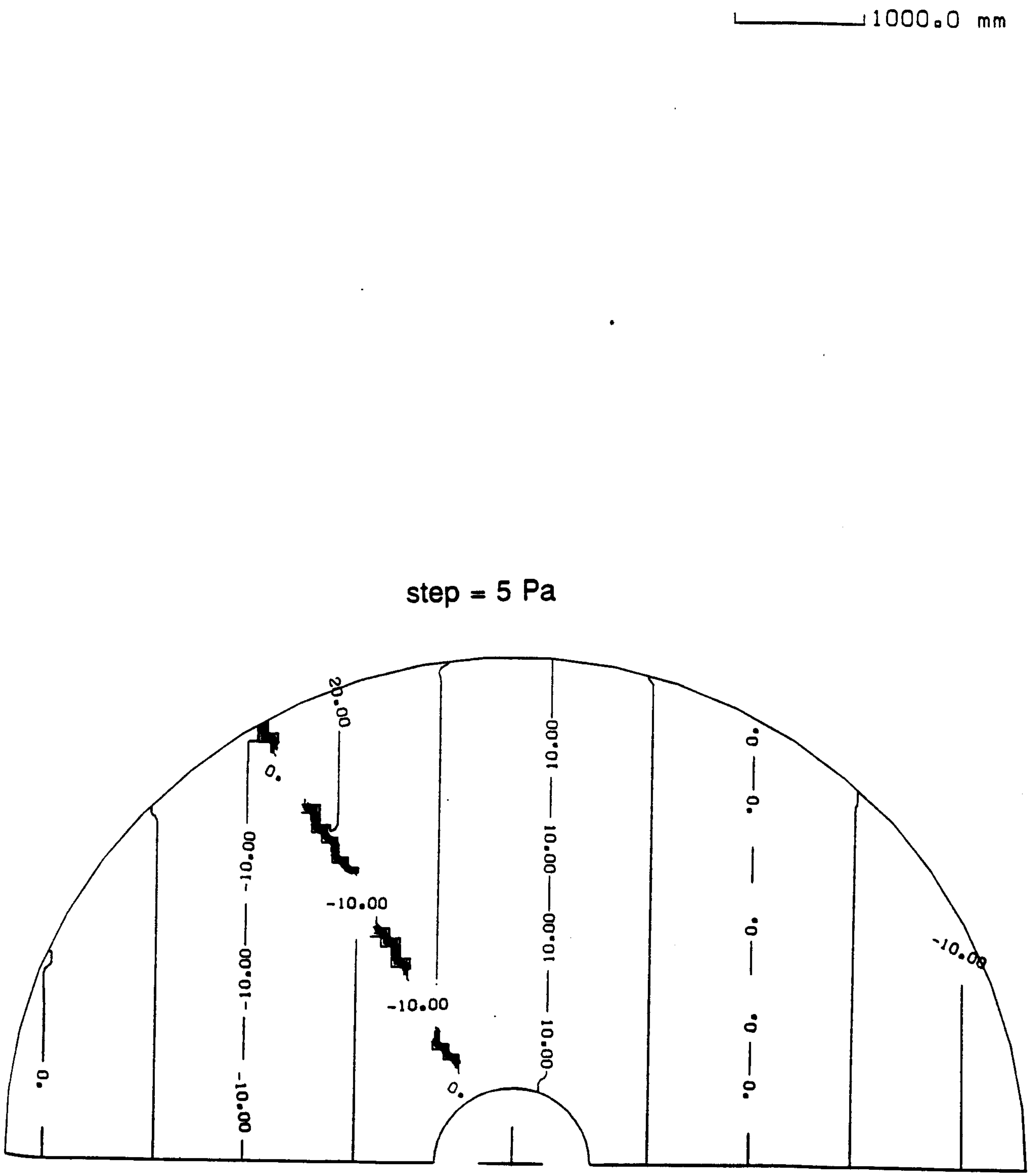
FIGURE 1-b

REACTIONS

FIGURE 2



PRESSURE DISTRIBUTION



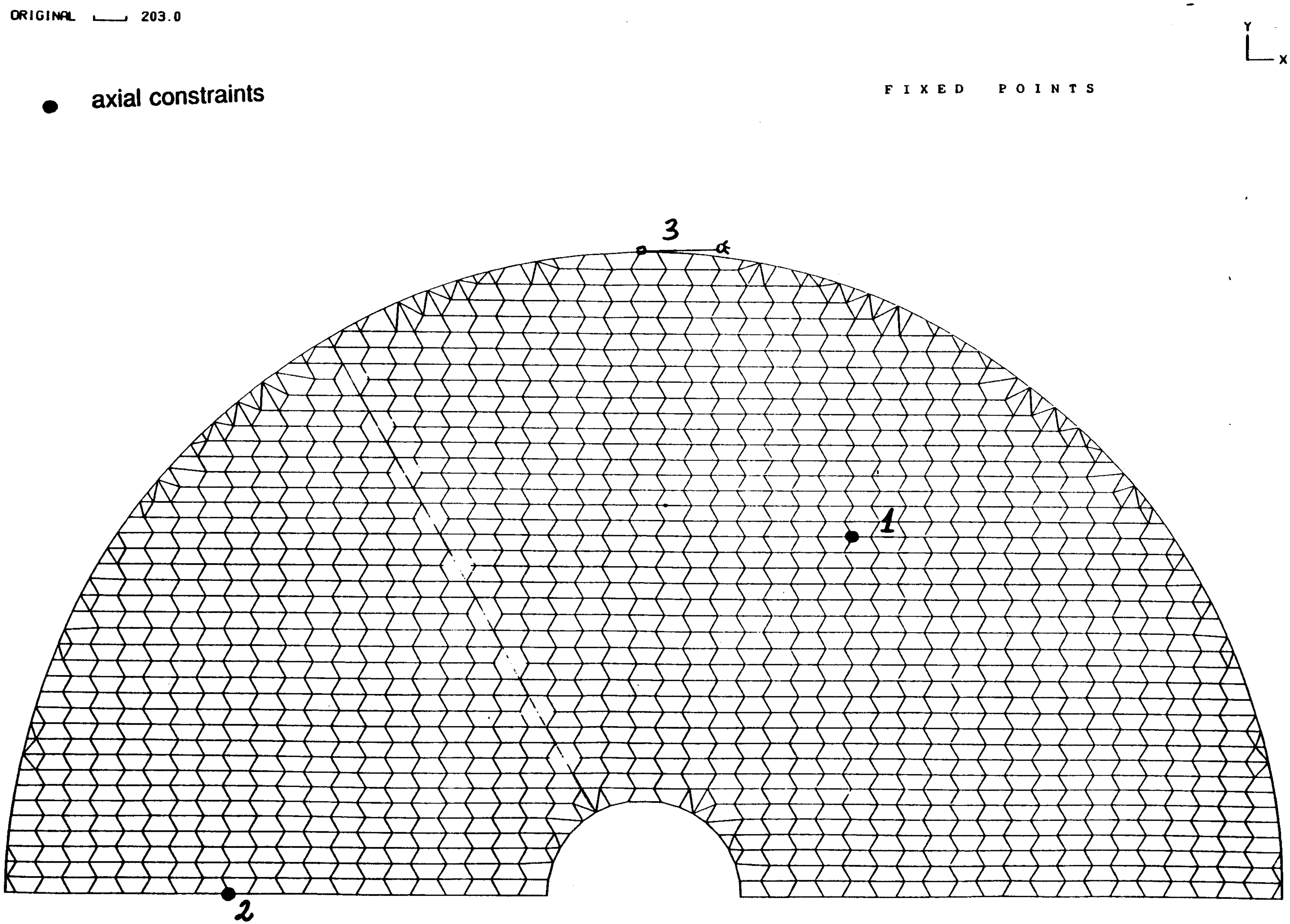


FIGURE 4

WIND ON MENISCUS

isocontour step = 500. nm

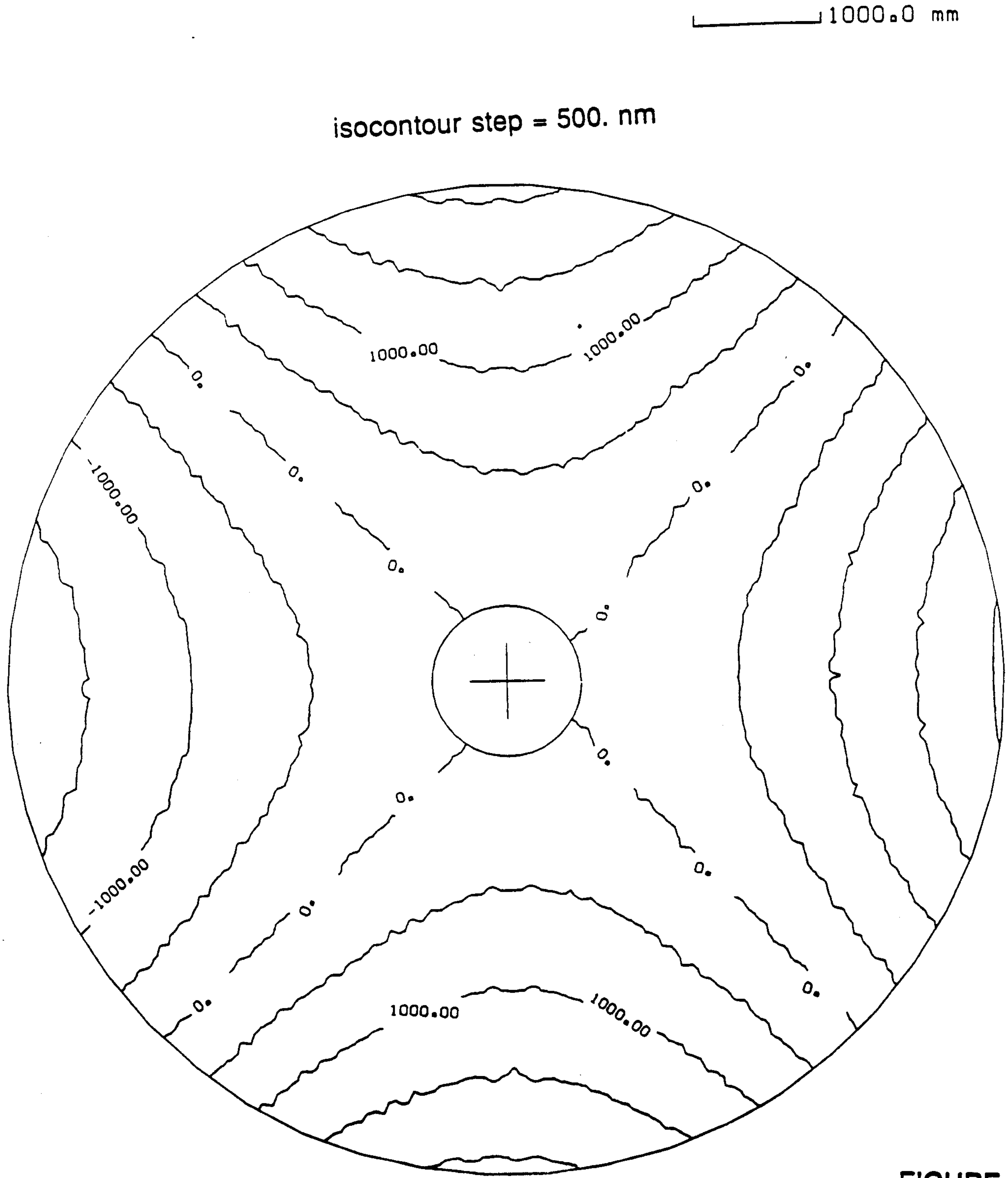
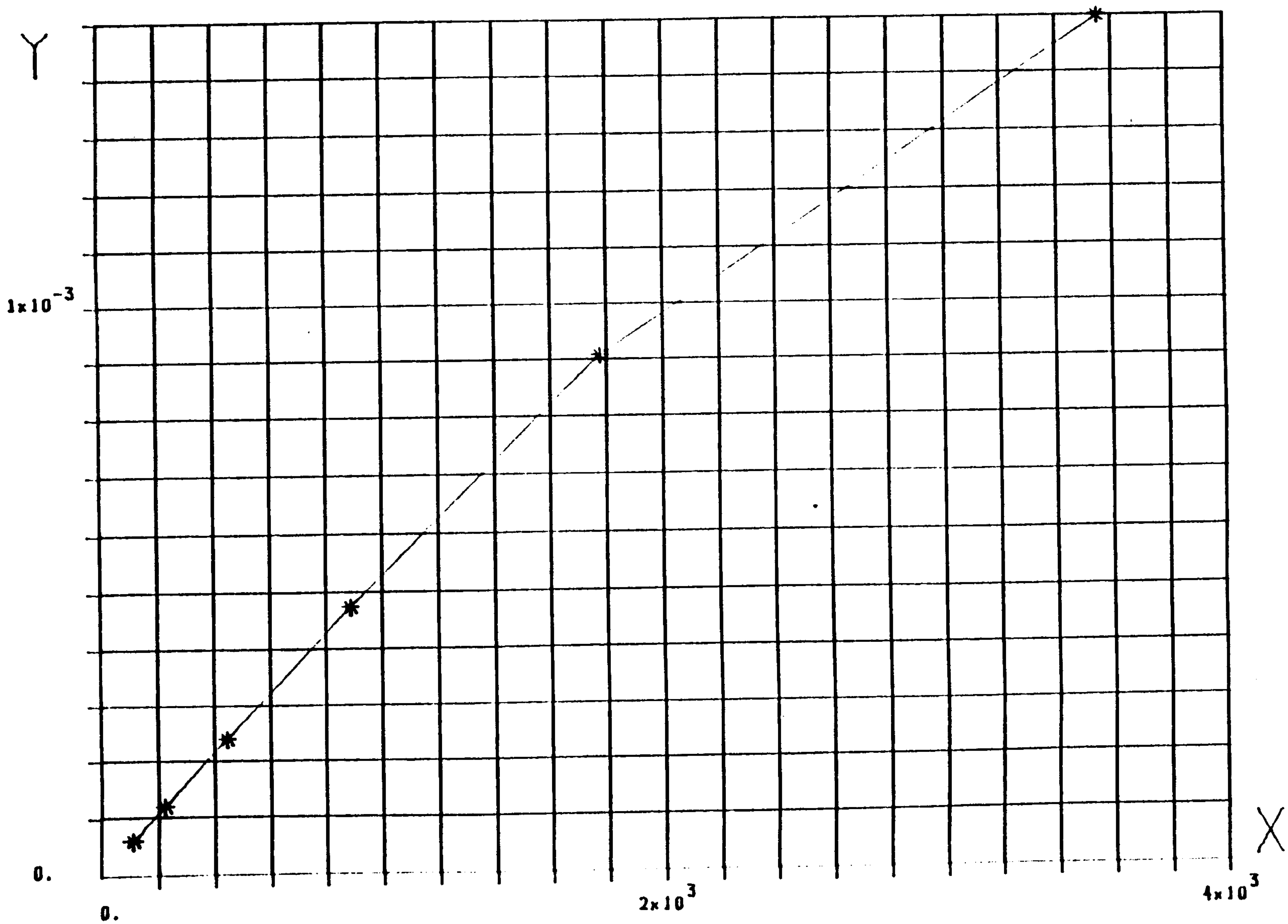


FIGURE 5



X = DISTANCE (mm)

Y = WIND ON MENISCUS - STRUCTURE FUNCTION (mm)

FIGURE 6

ENERGY PERCENTAGE

0.1E-01 mm

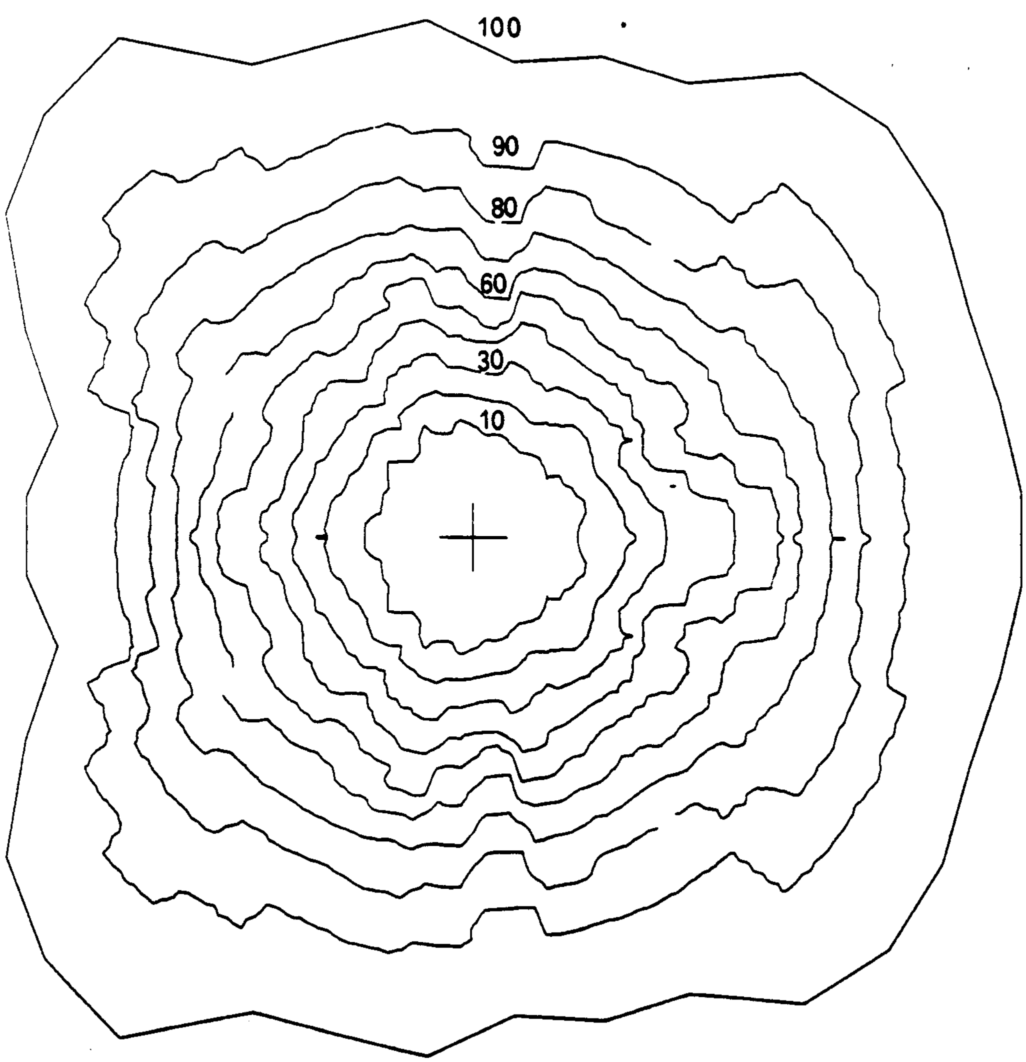


FIGURE 7