1.2: Calibration of Pressure Probes in Free Jets: Observed Discrepancies

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1. INTRODUCTION

One pressure probe was calibrated at three aerodynamic laboratories (Brown Boveri and Co. (B.B.C.), Sulzer, Escher-Wyss (E.W.)). The obtained results of calibrations differed in an unexpected magnitude. So far no explanation has been found to this problem.

It is the purpose of this contribution to lay open only the results and hopefully stimulate some discussion.

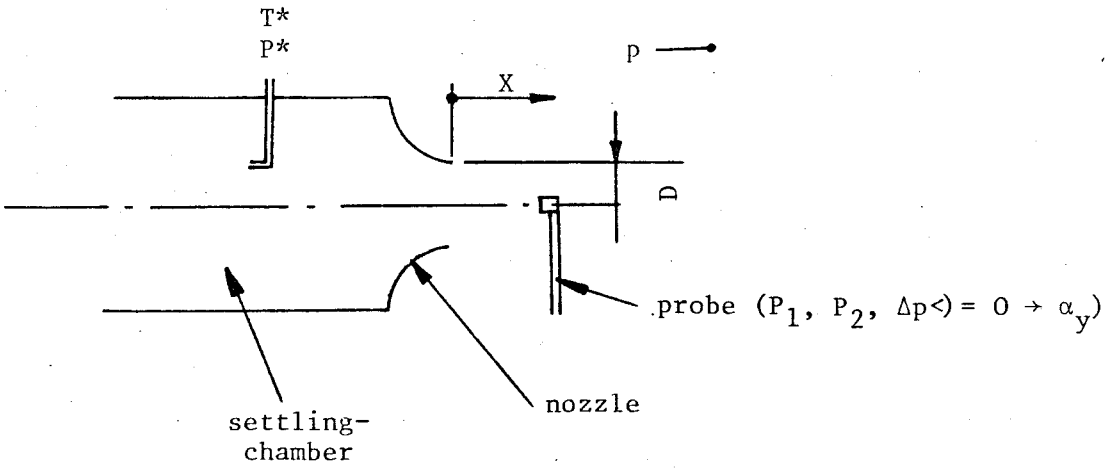
2. CALIBRATION RIGS

2.1 Test Rig at B.B.C. (Fig. 1.2.1) — Nozzle-contour according to Wille
D = 150 mm

2.2 Test Rig at Sulzer (Fig. 1.2.2) — D = 90 mm

2.3 Test Rig at E.W. (Fig. 1.2.3) — Nozzle-contour according to Popow
D = 100 mm 68 mm

3. BASIC TEST SET-UP



4. PROBE GEOMETRY

4.1 Wedge Probe (Fig. 1.2.4)

This shows a two-dimensional, directional Probe, four hole, wedge shaped measuring section, which measures total and static pressure and yaw angle (separate).

4.2 Prism Probe (Fig. 1.2.5) (Type United Sensor)

This shows a three-dimensional, directional Probe, five hole, prism shaped measuring section which measures total and static pressure, yaw and pitch angle.

5. RESULTS

Fig. 1.2.6 shows the calibration coefficient for the static pressure in function of the Mach number.

Definition of B: $B = \frac{p^* - p_2}{p^* - p}$

Fig. 1.2.7 shows the calibration coefficient B in function of X/D.

6. DISCUSSION

The calibration coefficient B at constant Mach number is increasing when the nozzle diameter increases.

The curves tend to converge at Mach number = 1 !

7. NOMENCLATURE

7.1 Geometric Parameters

D = Throat diameter of nozzle

X = Distance nozzle - outlet - probe

7.2 Thermodynamic Parameters

p^* = Total pressure in the settling chamber

T^* = Total temperature in the settling chamber

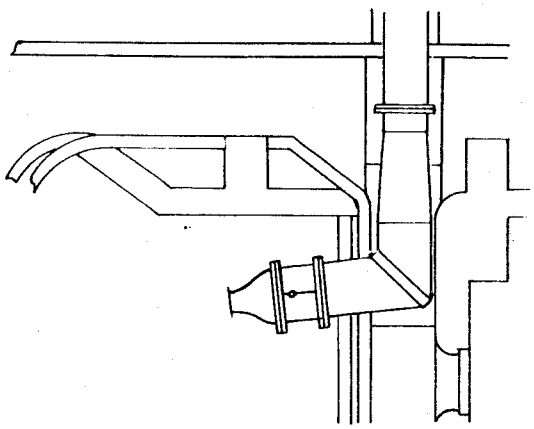
p = Ambient static pressure

p_1 = Total pressure at the probe

p_2 = Static pressure at the probe

$\Delta p\sphericalangle$ = 0 → yaw angle α_y

Fig. 1.2.1.-1.2.7. attached.



NOZZLE–CONTOUR ACCORDING TO WILLE
D = 150 mm

FIG. 1.2.1. TEST RIG AT B.B.C.

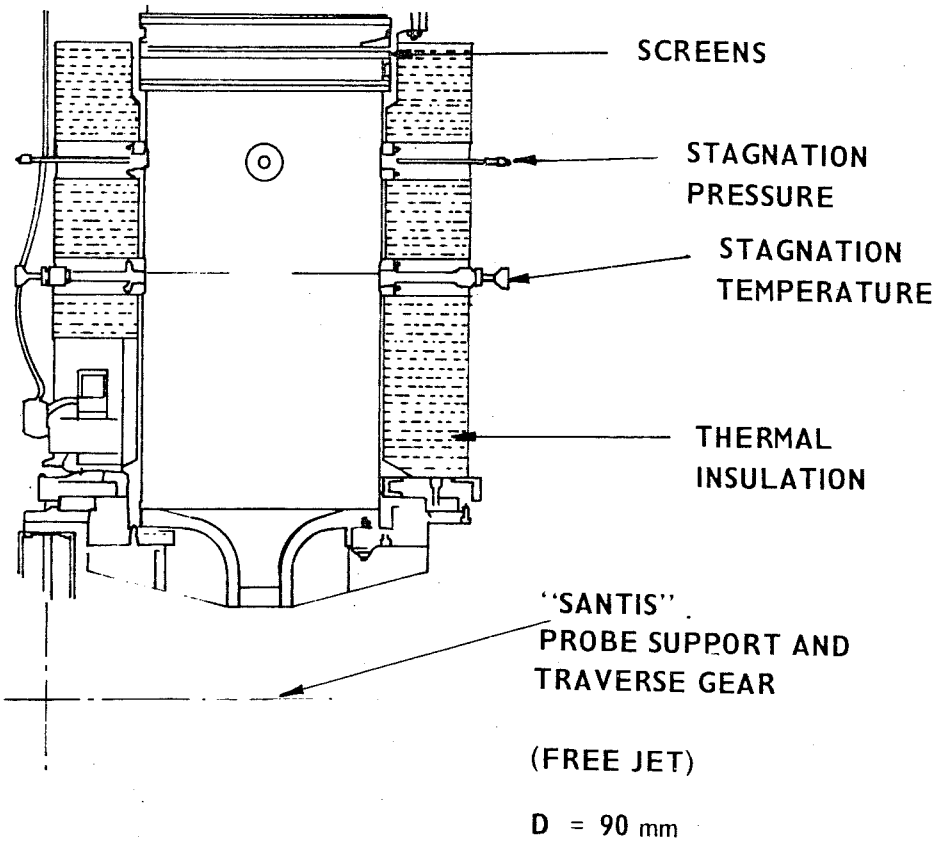
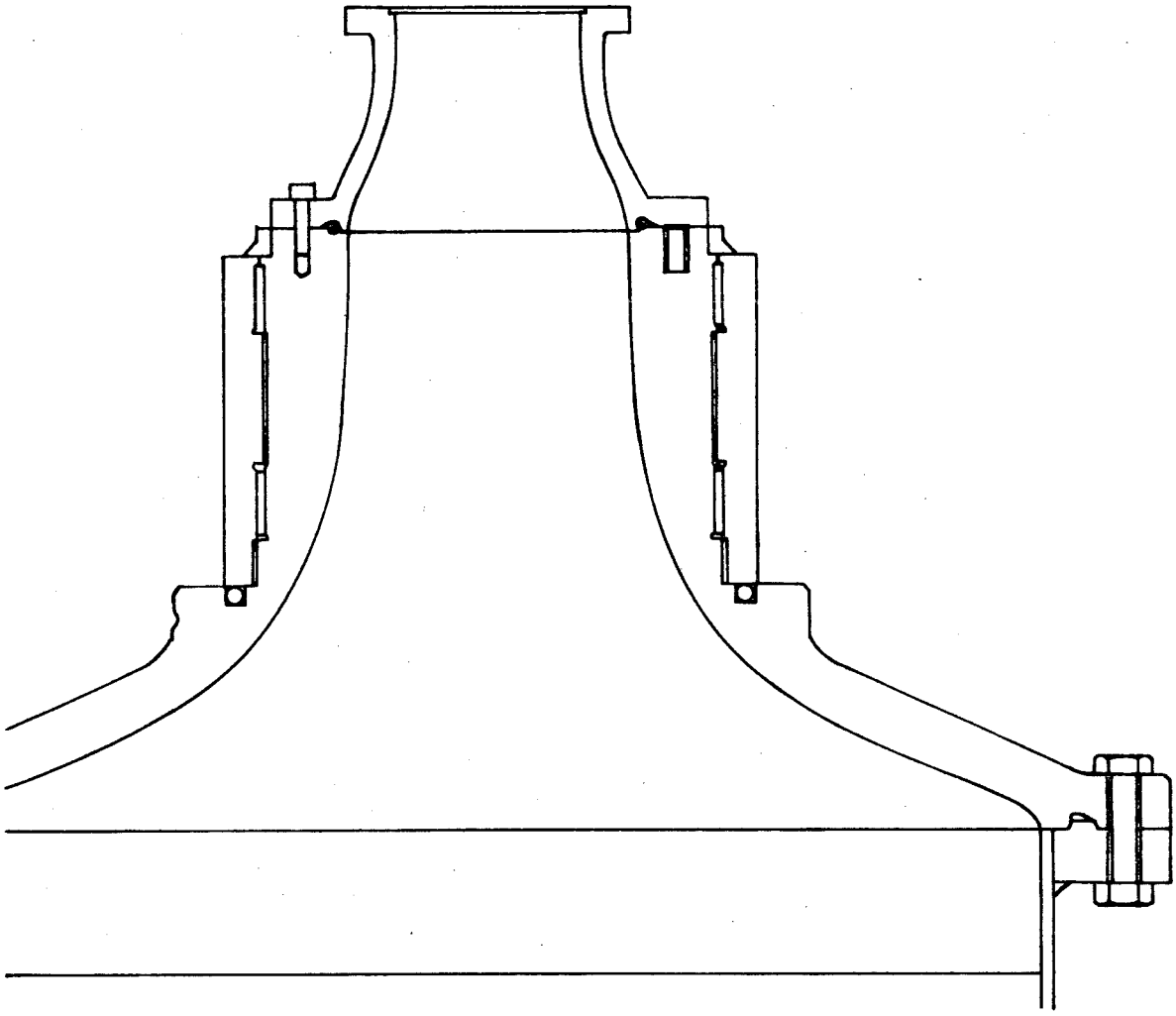


FIG. 1.2.2. TEST RIG AT SULZER



NOZZLE–CONTOUR ACCORDING TO POPOW

D = 100 mm, 68 mm

FIG. 1.2.3. TEST RIG AT E.W.

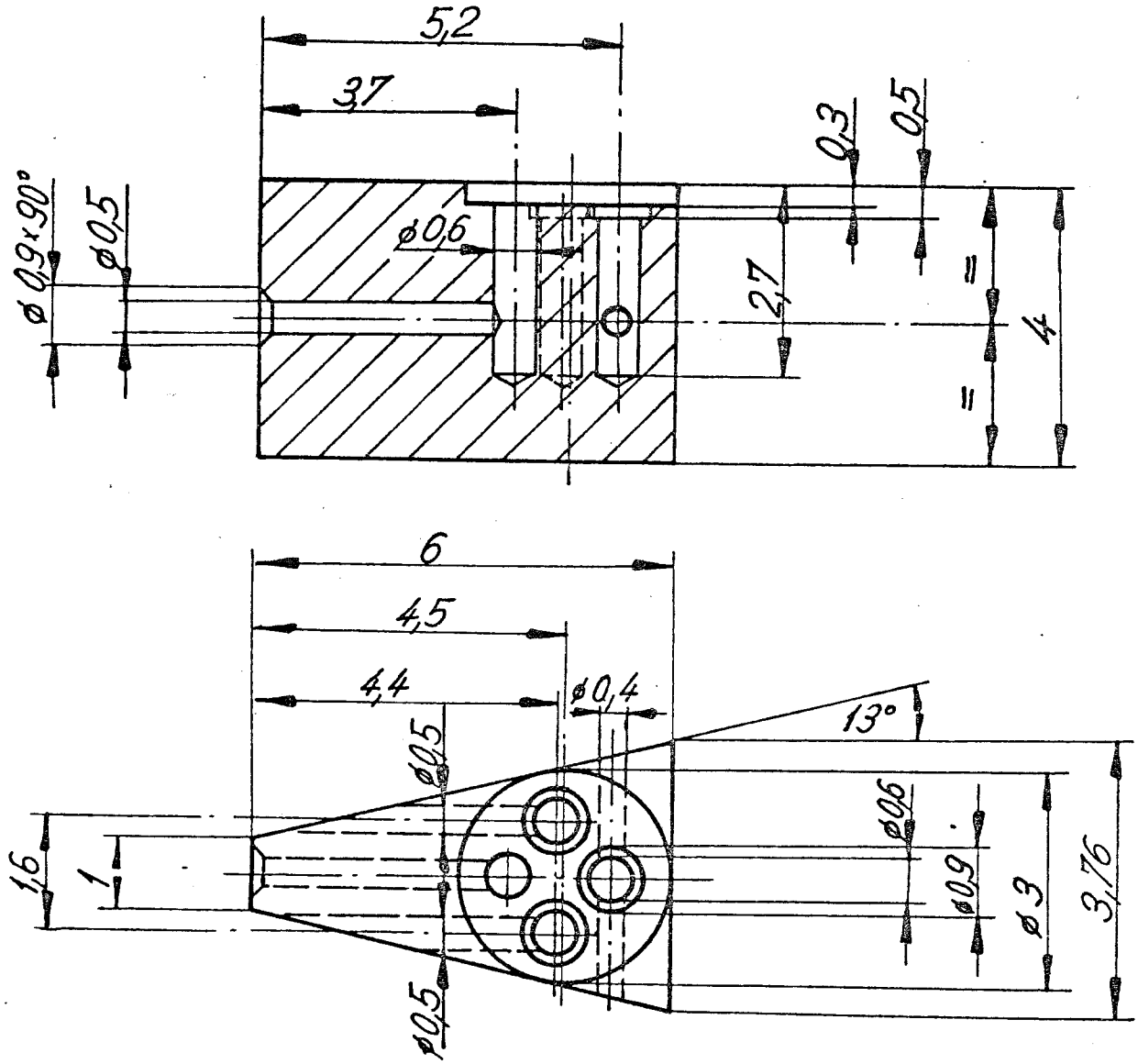

5,2
3,7
0,3
0,5
ø 0,9x90°
ø0,5
ø0,6
2,7
4
6
4,5
4,4
ø0,4
13°
ø0,5
1,6
1
ø0,6
ø0,9
ø 3
3,76
ø0,5

FIG. 1.2.4.

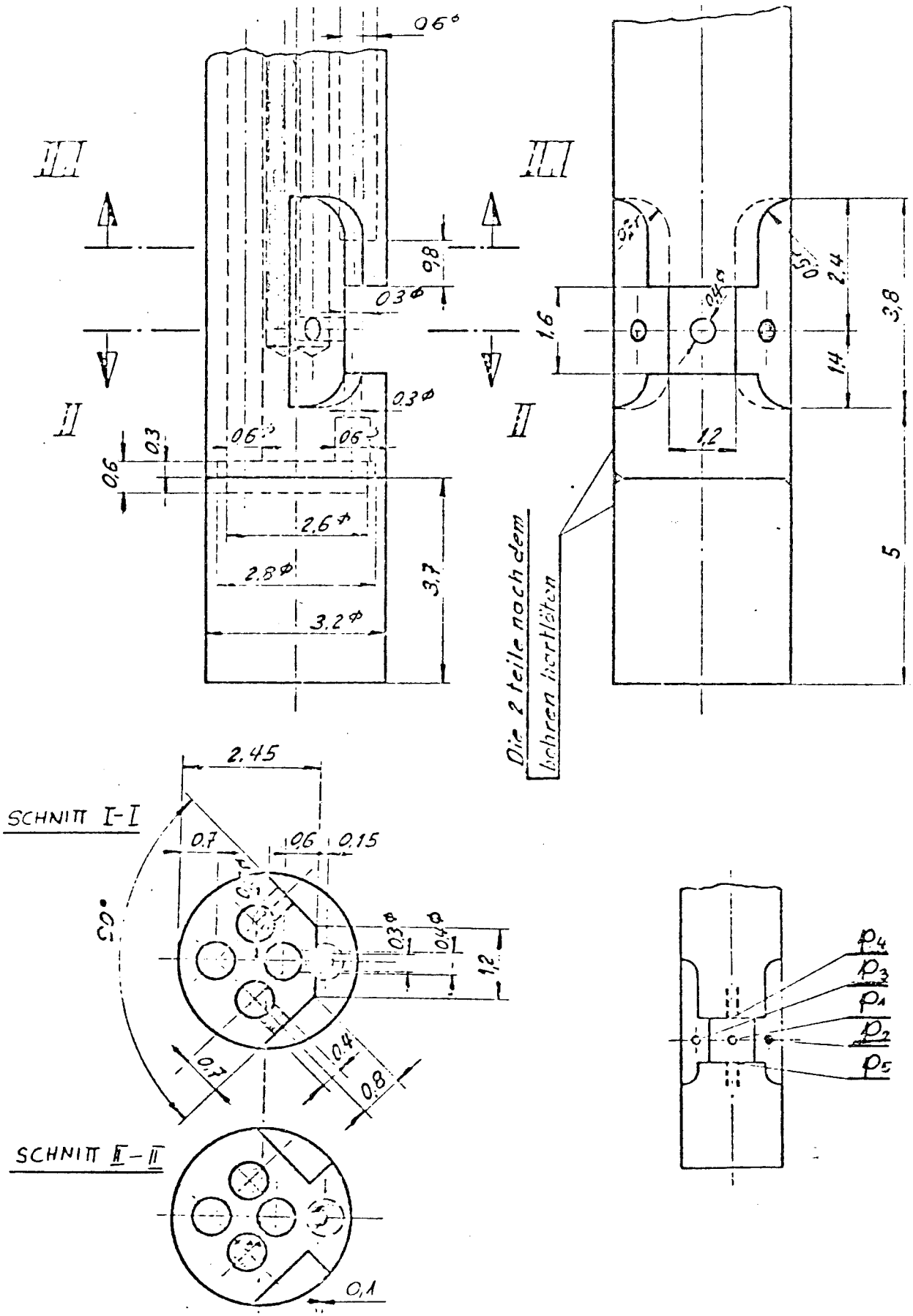

SCHNITT I-I
SCHNITT II-II
Die 2 teile nach dem bohren härten
2.45
0.7
0.6
0.15
2.6
2.8
3.2
3.7
9.8
1.6
2.4
3.8
1.4
1.2
5
0.1
P4
P3
P1
P2
P5

FIG. 1.2.5.

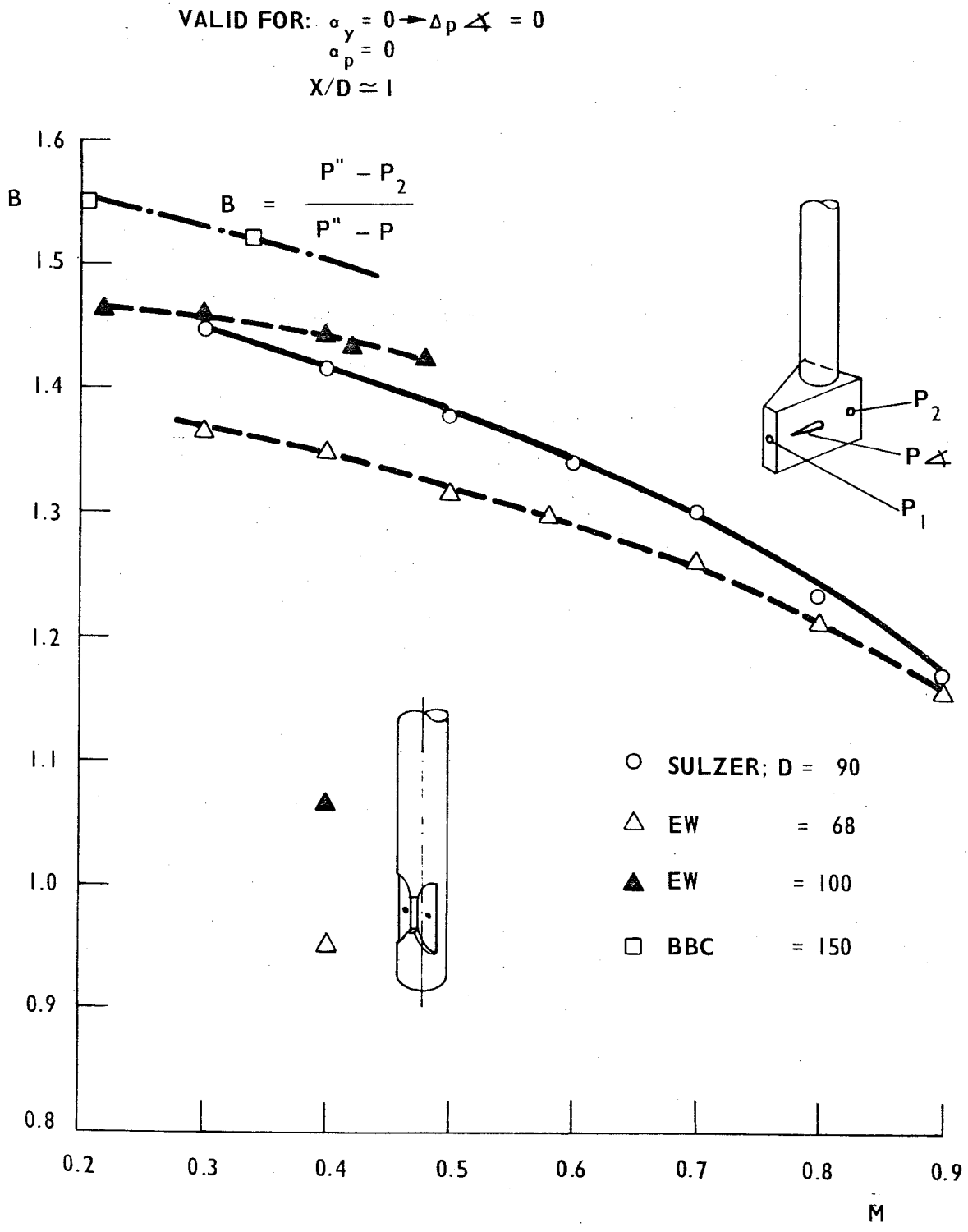


FIG. 1.2.6. CALIBRATION CURVES 'B' IN FUNCTION OF MACH NUMBER

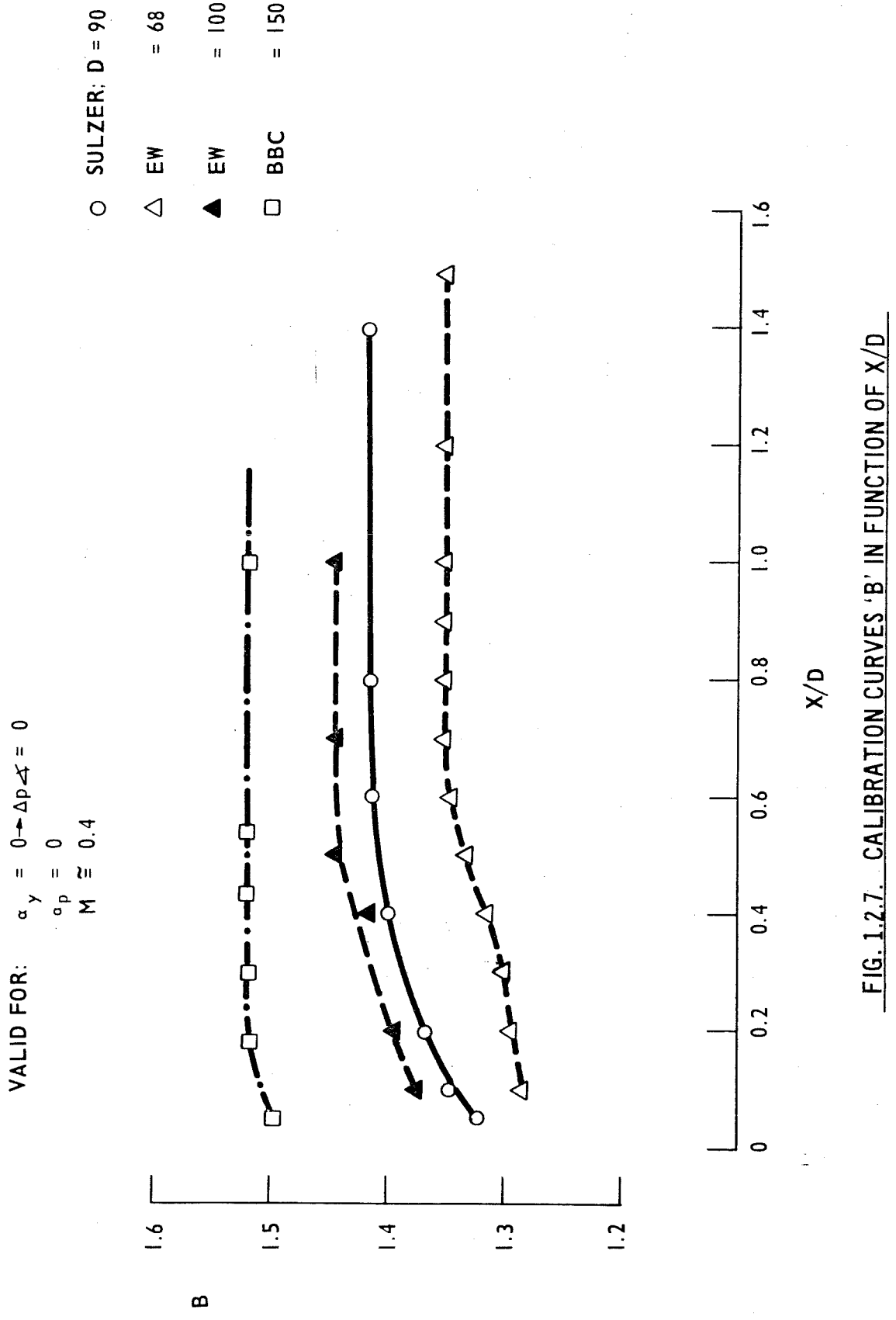


FIG. 1.2.7. CALIBRATION CURVES 'B' IN FUNCTION OF X/D