Ing. Manfredi, 0039-0583-701-471

D > 20 d, bending

3.1 BACKGROUND

Demonstration of the feasibility of the cable forming the active coil is the most critical task within this project.

Requirements related with this prototype were not affected by changes during the work, this fact being reasonably due to the long time needed by this activity performed in LMI under ANSALDO Ricerche subcontract.

The ACC cable is in principle a Pyrotenax conductor caractherized by out-of-standard dimensions and, consequently, very large drawing tools.

Pyrotenax cable currently manufactured and marketed are made with a conductive copper core insulated with Magnesium Oxyde powders sinterized during drawing when the external cupro-nickel jacket squash the powder on the inner conductor in way to provide MgO itself with high density, thermal and electric strenght.

On the market, such standard cables do not exceed 30 mm overall diameter. In the present case 80 mm are required; a further matter of concern is due to the material (AISI 304 L) to be employed in the jacket which may cause some problem during drawing, being is deformability different from the one of the copper.

Demonstration of the feasibility of bending the cable on a very small radius is the last, and most difficult activity to be performed, considering also that the cable should be bent like a solid rod.

3.2 FIRST PROTOTYPE DRAWING

Construction of the first straight prototype was completed in the first half of 1990 with positive results as a whole.

Starting from an initial cable assembly as in Fig. 3.2.1 having the dimension indicated in Fig. 3.2.2, after about 40 drawing and 20 annealing manufacturing steps, a prototype with the following dimensions (in mm) was obtained (Fig. 3.2.3).

Final lenght	2500
Outer steel jacket diameter	80
Inner copper diameter	24
Outer copper diameter	72
Average Insulating thickness	2.3

A dielectric strenght of 2 kV/mm, almost in accordance with the NET requirements, was measured; this result indirectly ensures that in the MgO, as it occures in standard Pyrotenax cables manufacturing, the values of the asymptotic density (2 kg/l) and of the thermal conductivity (2.2 W/mk) were obtained. This confirms the soundness of the choiced criterion in selecting the drawing starting dimensions.

As far as the main goals that were reached, some problems were detected and taken into account for the future prototypes manufacturing improvements.

Some leak in the jacket was observed (Fig. 3.2.4) near to the cable ends (Fig. 3.2.5) as a consequence of the not perfect choice of the lubricant.

The possibility to complete a next drawing in a less number of steps has been considered to avoid thermal damaging during annealing to the copper as it is possible to see in Fig. 3.2.6.

Finally (Fig. 3.2.7-8) more care will be taken in order to reduce the irregularity of the copper inner diameter.

In Fig. 3.2.9 the geometric measurement of intermediate cable sections are shown.

3.3 FIRST PROTOTYPE BENDING TESTS

Parts of the prototype described in the above paragraphs were employed to test the possibility of bending the cable on a 80 mm (1 time the diameter) radius this being required in view to place in the NET machine the upper coil U-modules which underneath the blancket parts.

After a non-completely negative attempt which considered the use of a very simple press (Fig. 3.3.1), able to bend just locally the cable on the required radius, serious problem were encountered.

In fact (see Figg.3.3.2-3) a 50% decreasing of the dielectric strenght was measured, this being acceptable also from the standard point of view which foresees such a reduction for Pyrotenax cable after squashing.

Unfortunately the second step of such bending procedure, which was aimed at realizing a 90 degree angle and performed separately with another press, led to a full loss in insulation and to a further increasing of the compressive deformation of the jacket at the inner radius.

Further attempts for improving the bending procedure, consisting in a pre-heating of the cable and in the addition of another containment coaxially with the part of the cable to be bent, failed.

As a consequence of this result it was decided to increase up to 3 mm the insulation thickness and to redesign the bending tool in order to put in tension the cable during bending and to limit the raise of compressive instability at the inner radius.

3.4 TEST OF THE THERMAL RESISTANCE

The measurement of the dielectric strenght should be enough in order to be sure about the good thermal conductivity of the MgO. Anyhow, the thermal resistance of the cable section has been experimentally tested, mainly to be sure that no additional contact resistances between the interfaces Copper/Magnesium and Magnesium/Steel jacket take place.

In Fig. 3.4.1 a preliminary layout of the testing for thermal-flux measuring is shown.

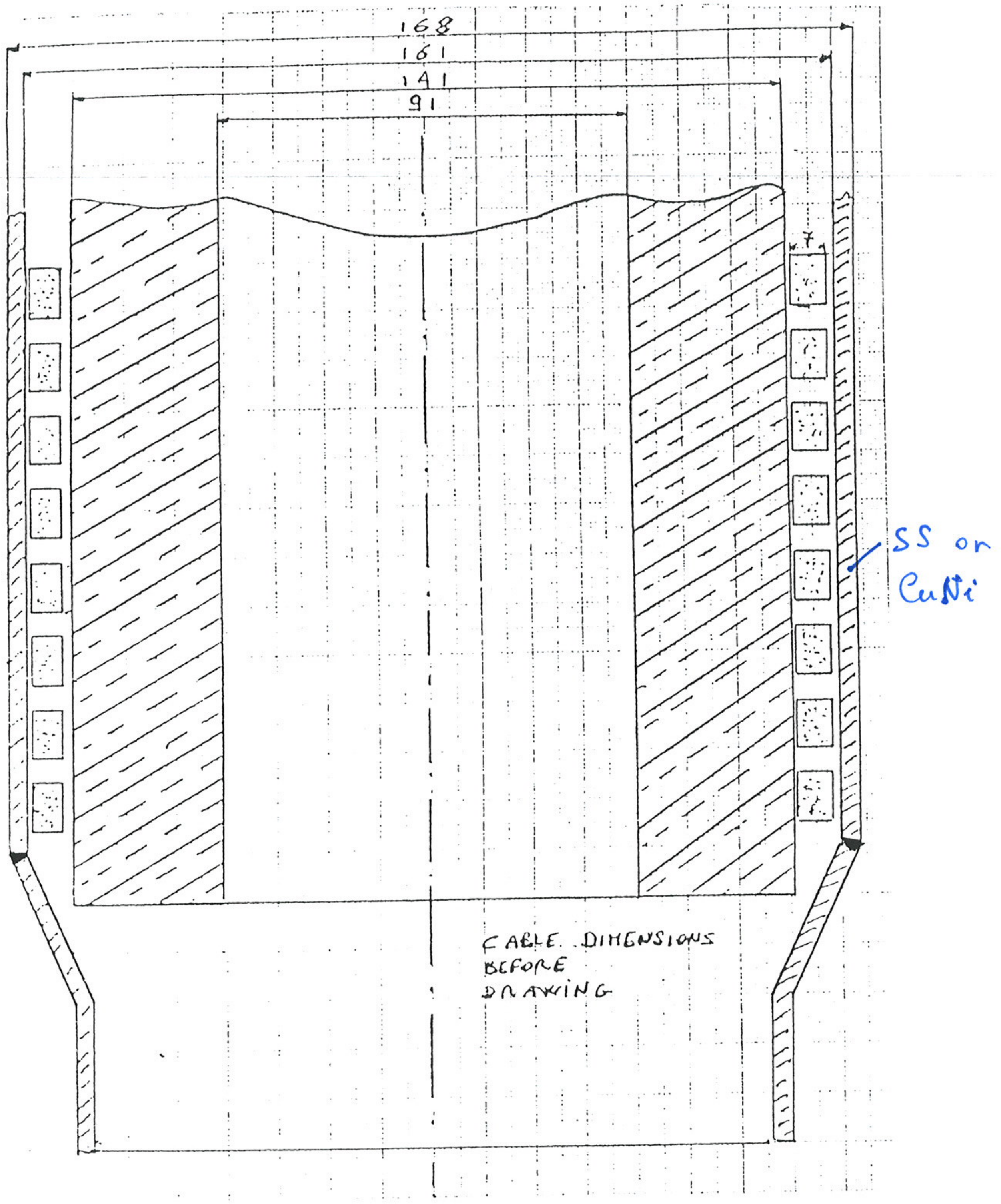

Fig. 3.2.2

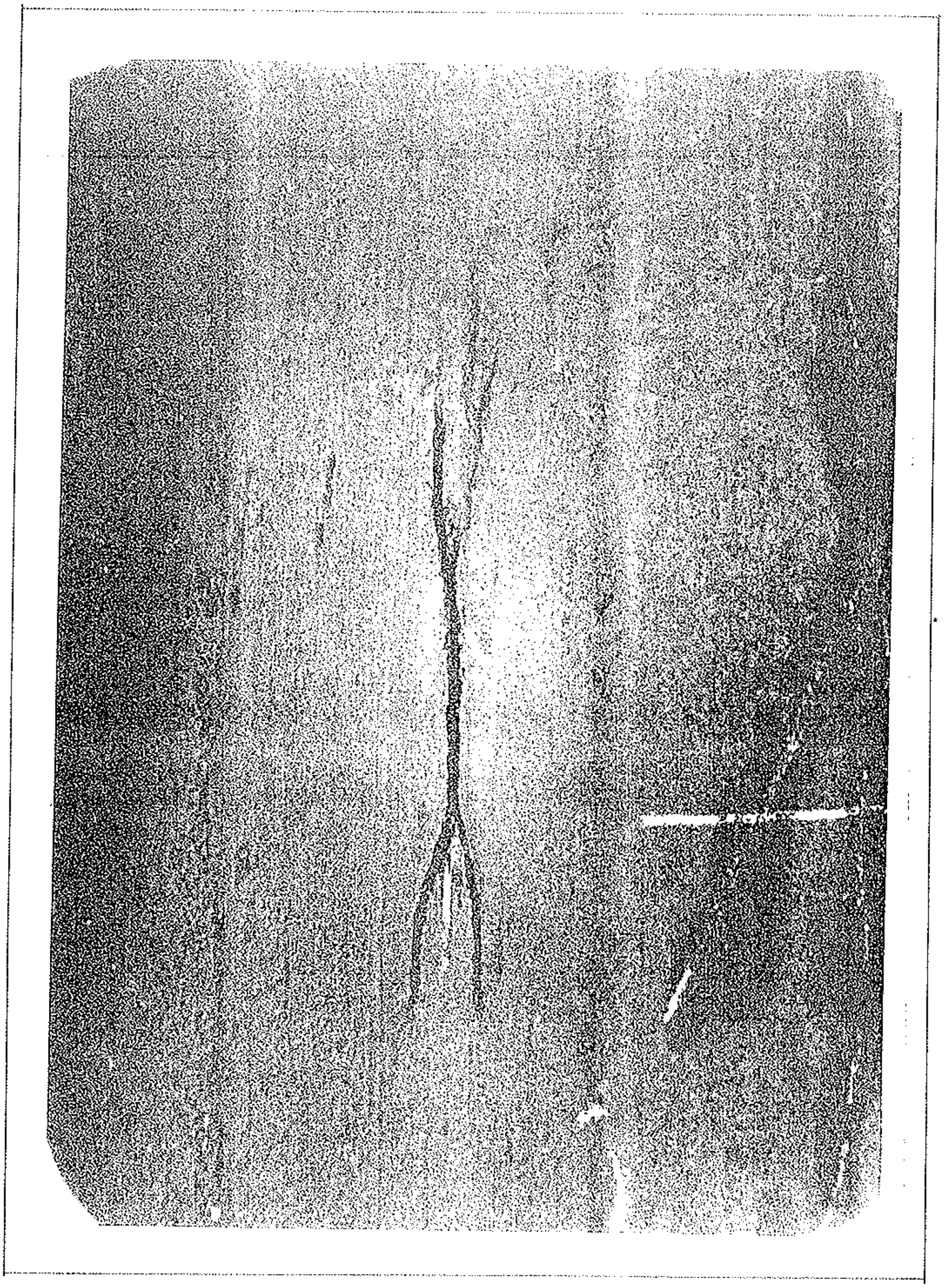

Fig. 12.1

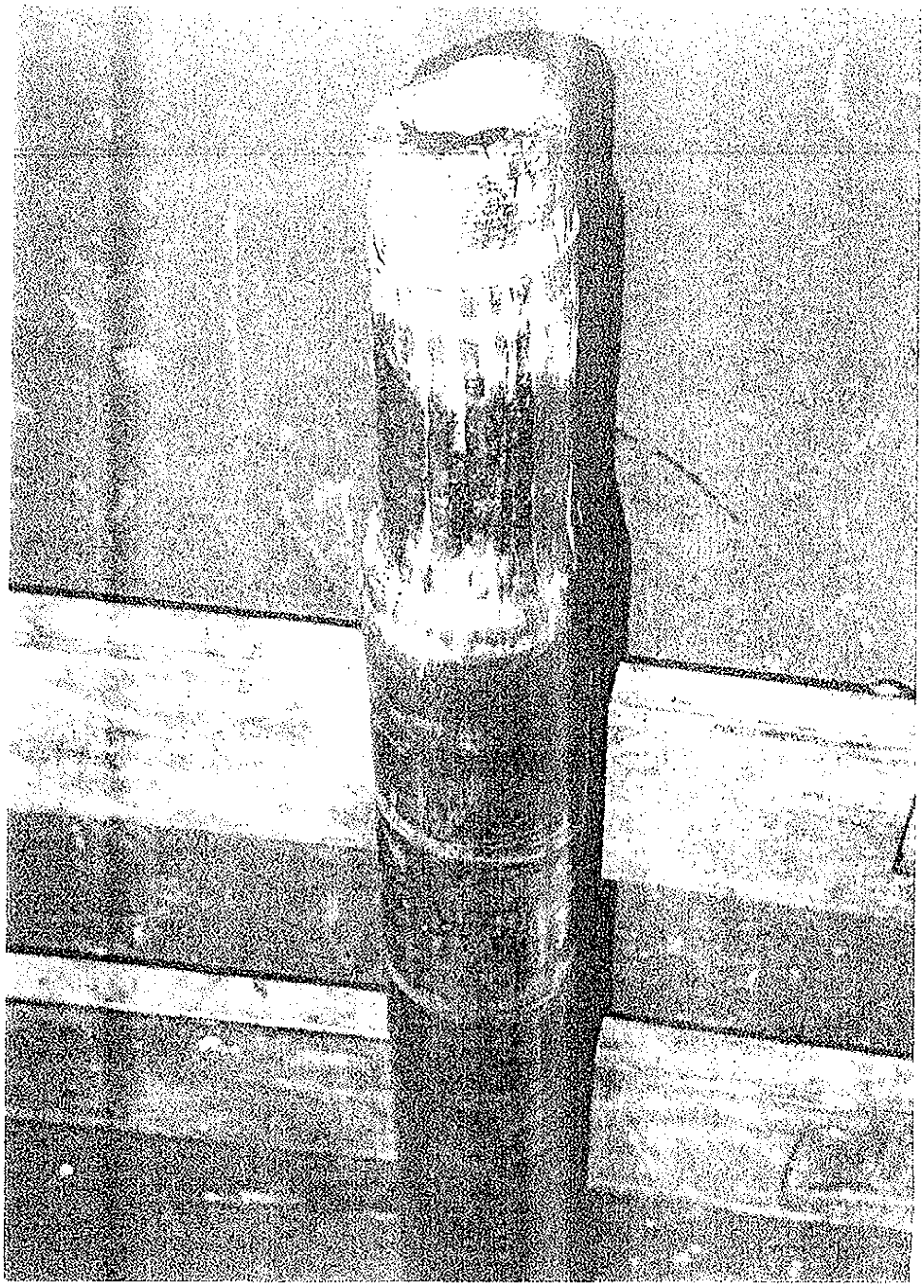

Fig. 3.2.5

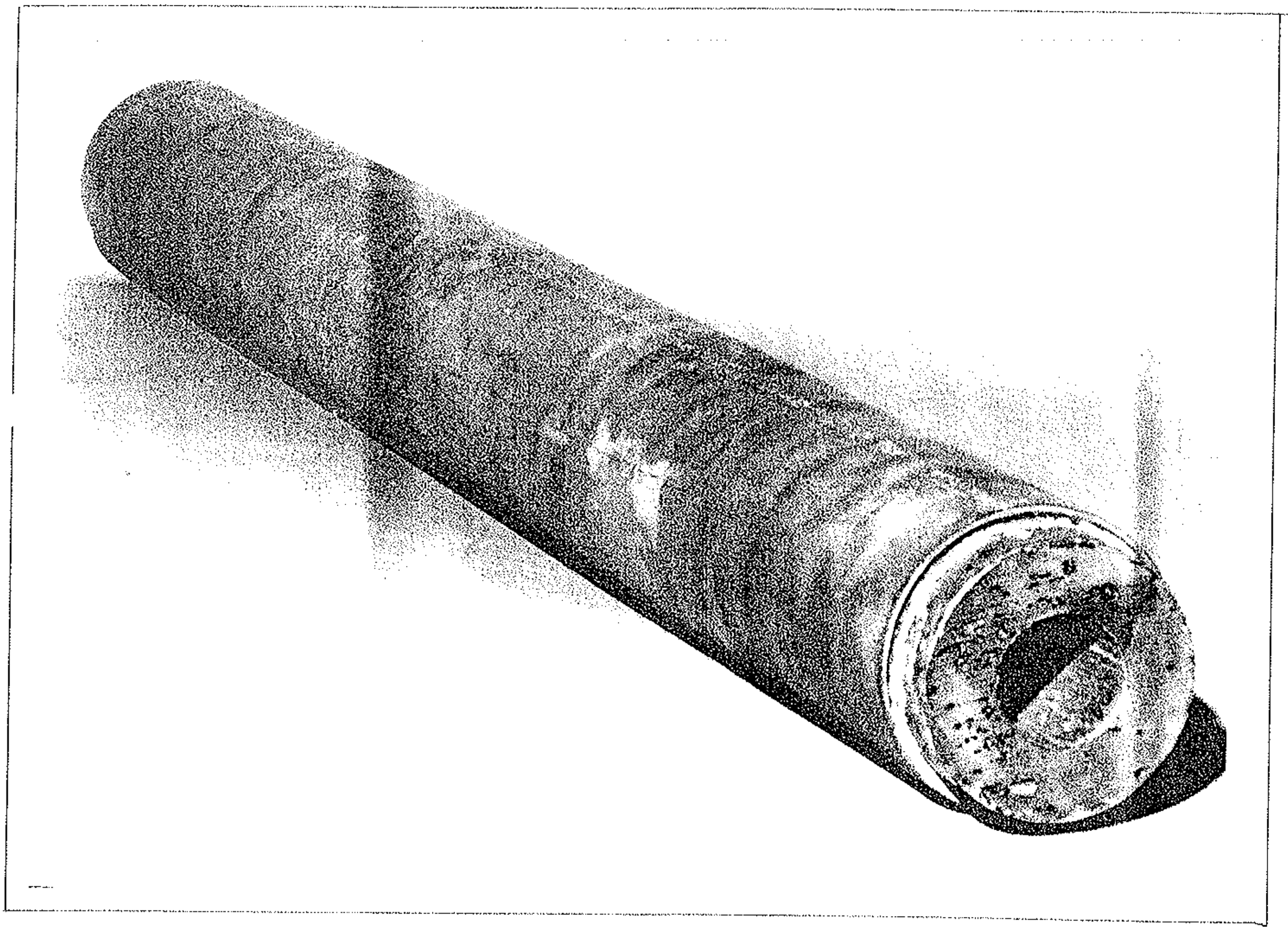

Fig. 3.2.6

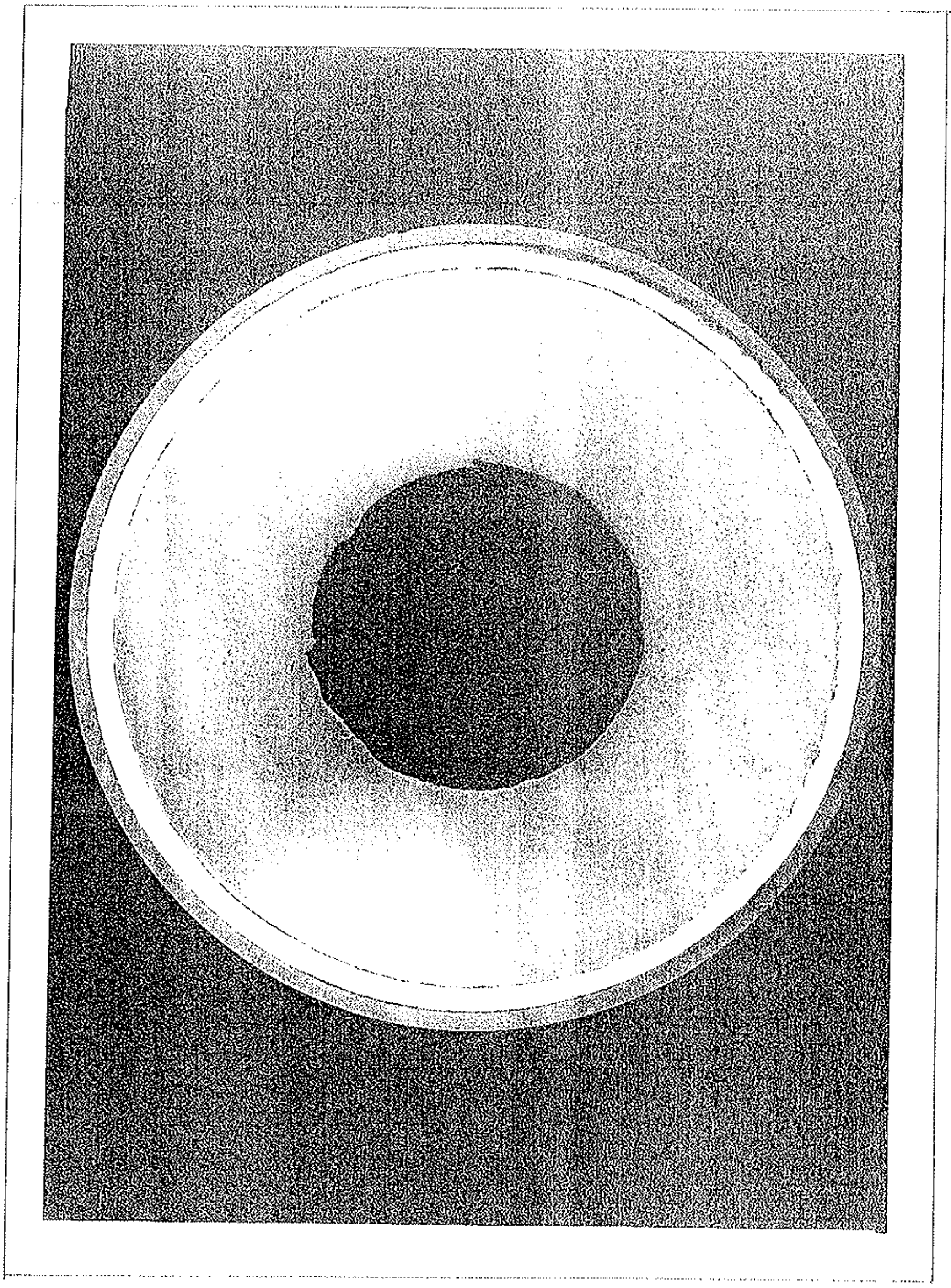

Fig. 3.2.7

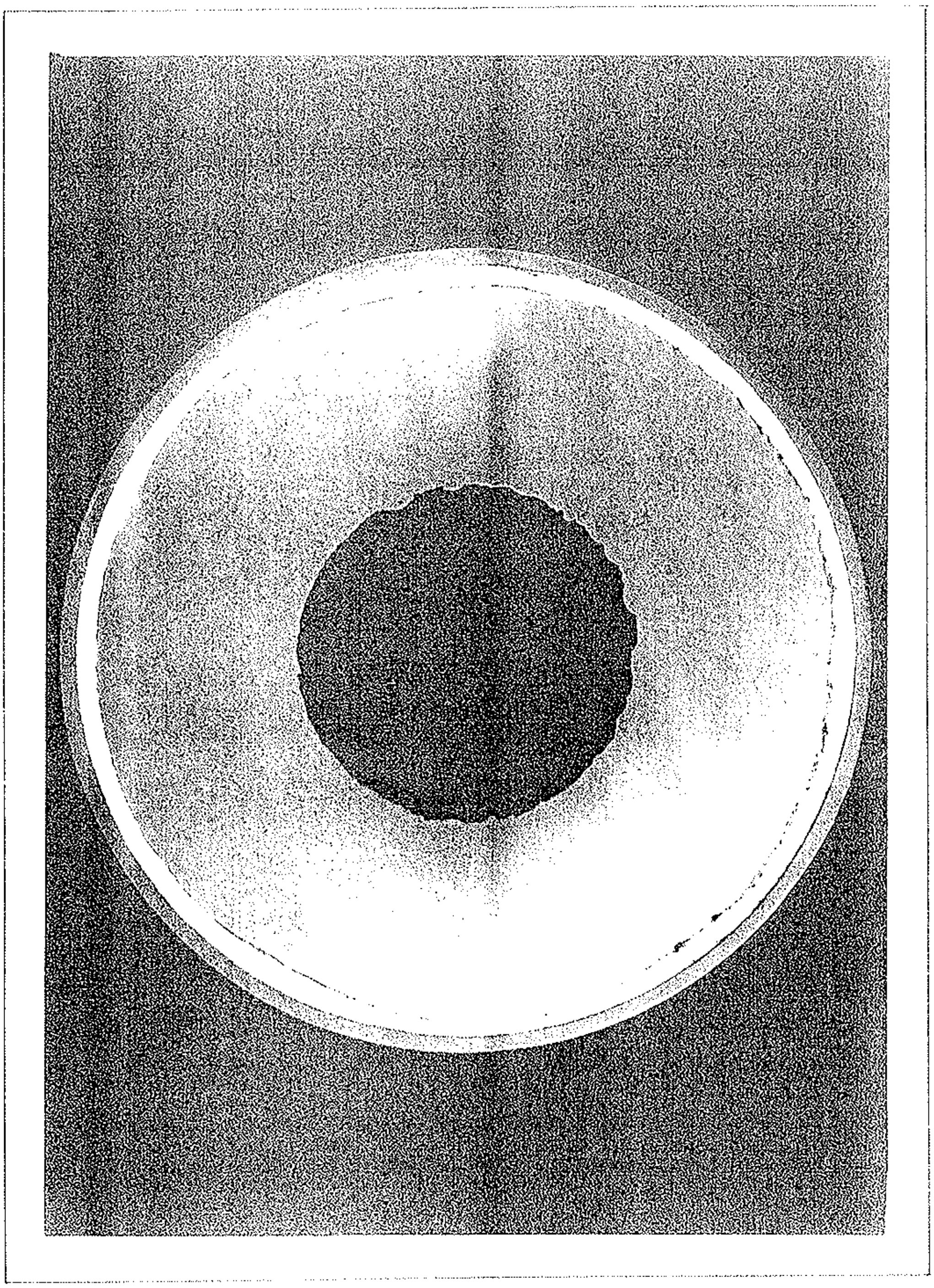

Fig. 3.2.8

SALA METROLOGICA

DIAMETRO "A"

mm SPESSORE ACCIAIO	mm SPESSORE MGO
1,68	1,99
1,52	2,26
1,59	2,29
1,68	2,12
6,47	8,66
MEDIA 1,62	MEDIA 2,17
DIFF. 0,16	DIFF. 0,30

DIAMETRO "B"

mm SPESSORE ACCIAIO	mm SPESSORE MGO
1,63	2,29
1,61	1,83
1,62	1,94
1,66	2,24
6,52	8,10
MEDIA 1,63	MEDIA 2,02
DIFF. 0,05	DIFF. 0,46

DIAMETRO "C"

mm SPESSORE ACCIAIO	mm Spessore Mgo
1,87	2,59
1,89	2,40
1,90	2,44
1,84	2,37
MEDIA 1,87	MEDIA 2,45
DIFF. 0,06	DIFF. 0,22

DIAMETRO "D"

mm SPESSORE ACCIAIO	mm Spessore Mgo
1,78	2,70
1,78	2,60
1,84	2,53
1,78	2,57
MEDIA 1,80	MEDIA 2,60
DIFF. 0,06	0,17

DIAMETRO "F"

mm SPESSORE ACCIAIO	mm Spessore Mgo
1,58	2,89
1,44	2,50
1,56	3,03
1,60	2,66
MEDIA 1,54	MEDIA 2,77
DIFF. 0,16	DIFF. 0,53

DIAMETRO "E"

mm SPESSORE ACCIAIO	mm Spessore Mgo
1,74	2,33
1,73	2,37
1,66	2,32
1,66	2,44
1,70	2,36

Fig. 3.2.9

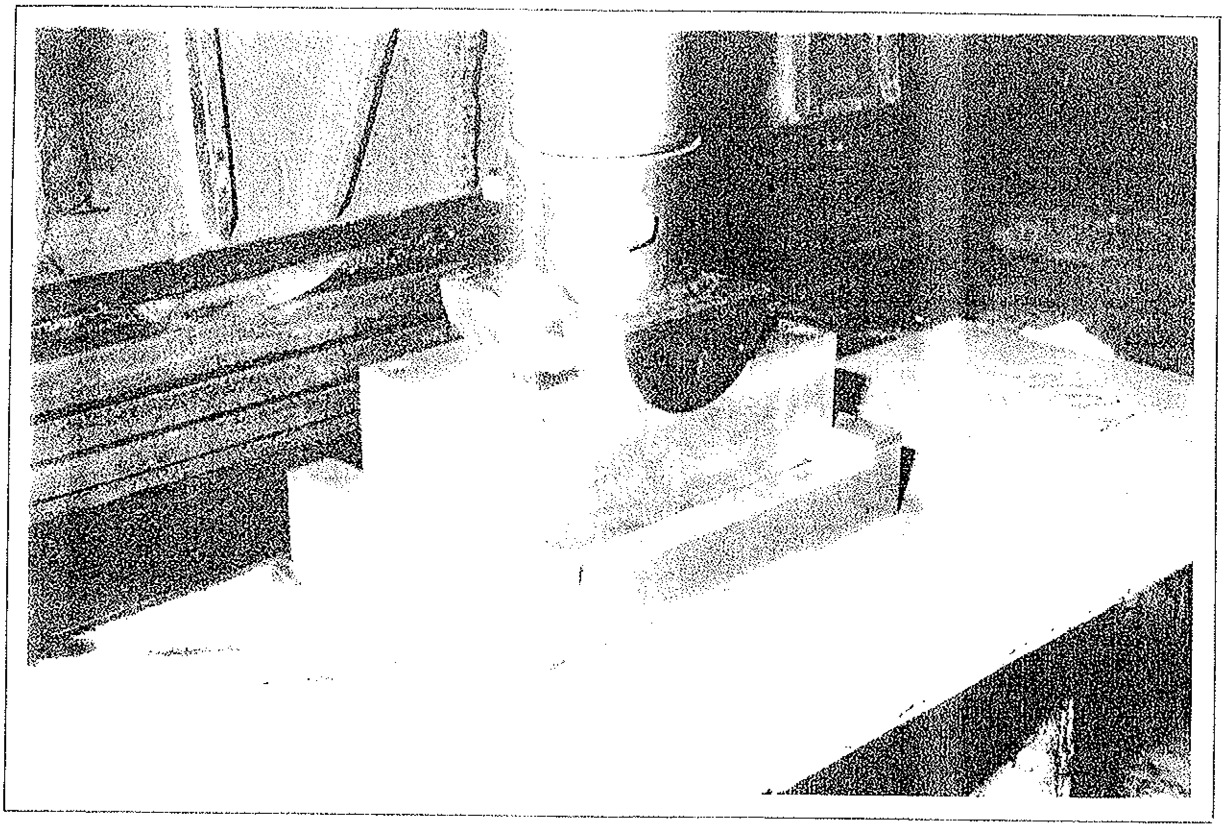

Fig. 3.3.1

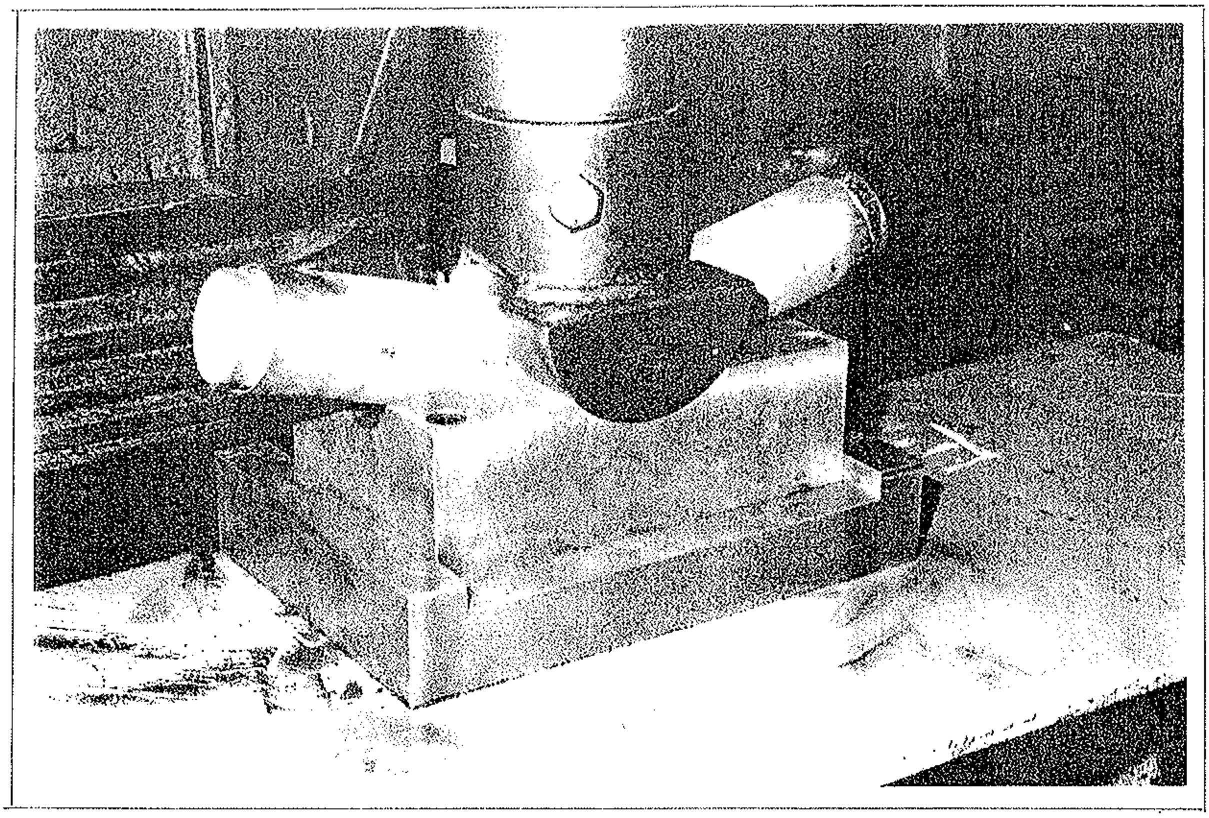

Fig. 3.3.2

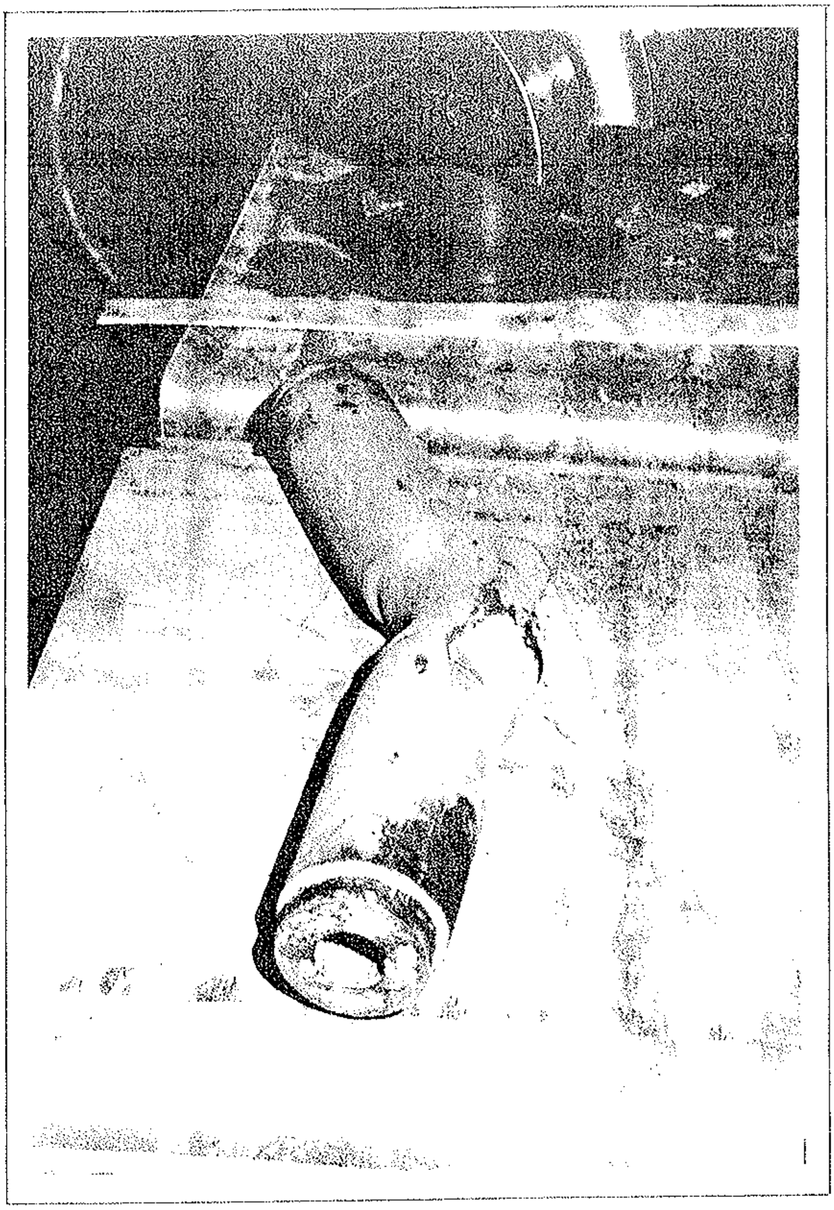

Fig. 3.3.3

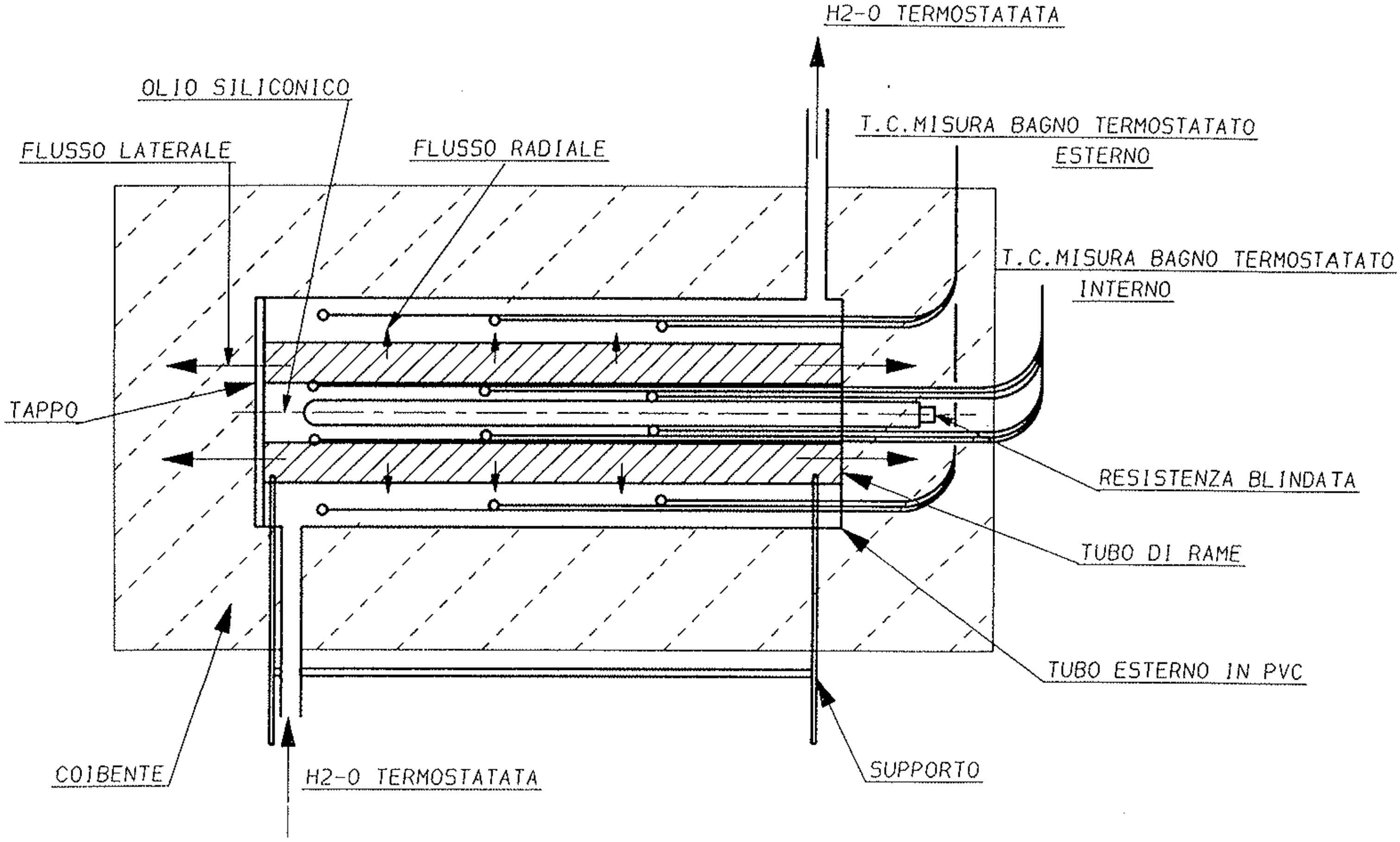
H2-O TERMOSTATATA
OLIO SILICONICO
T.C.MISURA BAGNO TERMOSTATATO
ESTERNO
FLUSSO LATERALE
FLUSSO RADIALE
T.C.MISURA BAGNO TERMOSTATATO
INTERNO
TAPPO
RESISTENZA BLINDATA
TUBO DI RAME
TUBO ESTERNO IN PVC
COIBENTE
H2-O TERMOSTATATA
SUPPORTO

Fig. 3.4.1