

Laboratori Nazionali di Frascati

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G. Corazza: CONSTRUCTIVE DATA FOR THE PLANNING, DEVELOPMENT AND CONSTRUCTION OF THE DOUGHNUT OF THE ITALIAN ELECTROSYNCHROTRON.

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G. Corazza: CONSTRUCTIVE DATA FOR THE PLANNING, DEVELOPMENT AND CONSTRUCTION OF THE DOUGHNUT OF THE ITALIAN ELECTRO-SYNCHROTRON.

1) - Description of Doughnut

Complete data for the planning, development and building of the doughnut of the Italian Electrosynchrotron are given in the attached drawings. Omitted are only the straight sections, planning of which is not yet finished.

Length of the doughnut on the equilibrium orbit of the electrons : 27.440 mm.

Drawing D059V shows one section of the doughnut and its position in the gap of the magnet. Overall size of the doughnut : 212 mmq. Wall thickness: 10 mm.

Each quadrant is composed by 15 pieces of 377 mm. medium length, corresponding to a 6° arch. To facilitate assembling and eliminate as far as possible vacuum seals, the pieces corresponding to the above mentioned size are welded together five by five, as shown in top-drawing I₈, a complete quadrant requiring thus three sectors of 1,885 mm. medium length each.

Vacuum seals placed between the various sectors of the doughnut are secured by a 3,5 mm. thick gasket of type 'OR' neopren. This gasket is located in a 4,5 mm. large and 2,4 mm. deep groove, obtained on every sector head by means of a pantograph (see drawing D072C and D073C). Connection is effected by means of two tie rods, located in the two ears welded on every head to be subsequently connected with the anterior and posterior pieces of the doughnut. Location of ears is shown

in top-drawing I₈.

Each quadrant consists of 10 pieces (see drawing D072C) and of 5 pieces (see drawing D058V). Frontal of the pieces shown in drawing D058V is penetrated by two openings, one of 130 x 45 mm. in size and the other of 25 x 45 mm.

As shown in the drawing, the larger window is closed by a glass pan; its purpose is to help explore the inside of the doughnut and to watch the little fluorescent flag aimed at searching the beam. This little flag is being inserted into the doughnut through the smaller window.

The little flag is manipulated from outside by means of a strap seal (see particular 11 of drawing D058V) and may be set whether normally to the electron's path, so as to intercept their position, or very close to the frontal, so that the available space inside the doughnut may be felt completely free. This movement is being obtained in a mechanical way by means of an endless screw set solidary to the shaft of the vacuum seal strap, and of a cogged-crown located on the axis of rotation of the little flag.

Location of the little beam searching flag along the quadrant is shown in drawing I₈.

Glass windows and seal straps are connected to the doughnut's frontal by means of stud bolts, welded directly to the frontal (see particular 6 of drawing D058V), the seals being secured by 3,5 mm. thick, type 'OR' gaskets.

The doughnut pieces are build in two parts, and subsequently fixed and stucked together.

Amagnetic inoxidable steel strips, of 0,05 mm thickness and 15,7 mm width, are used for the inner metallization of the U-shaped pieces. A space of 0,3 mm is left between each of the steel strips.

A continuous strip of this same steel is used for the metallization of the frontal; it covers the whole inner part of the frontal and is bent for about 5 mm. over the shelf. Subsequently, by means of a milling cutter, the steel part close to the curved frontal wall is cut at spaces of 15 mm.

The continuous steel strips resulting on the shelves after frontal and U-shaped parts have been fixed together are thought to secure electric contact between all the metallization strips; metallization itself is grounded from outside by means of the contacts as shown in particular 6 of drawings D072C and D073C, concerning the pieces with and without windows, respectively.

2) - Building process and mechanical features

The above described doughnut is being entirely built of araldit and quartz.

To obtain the frontal and the U-shaped pieces, type B araldit, and quartz of 6000-meshes per square centimeter mixed in proportion of 225 grams of quartz for every 100 grams of araldit, are being poured in special iron-cast molds. Polymerisation of the araldit follows at 120°C during 14 continuous baking hours.

Details of the metallization process of the U-shaped pieces are given hereafter :

- I) - Strips are shaped into the desired width by means of a grinder. Precision is of about $\pm 0,01$ mm.
- II) - Strips are subsequently assembled on an implement, identic in size and form to the male used for casting the U-shaped pieces. Spacers of 0,3 mm. are fixed on this implement, to serve as guides to the steel strips and help getting them fixed at the chosen distance.

The steel strips are kept close to the implement by means of pulling vises (one for each strip). After the steel has been fixed on the implement, this latter is coated with a glass wool fabric, well stretched so as to adhere perfectly to the steel. The glass wool fabric is then impregnated with type XV araldit and the whole is subsequently polymerized at 120°C during 14 continuous baking hours. After baking, the steel sticks perfectly to the glass wool fabric.

- III) - The male of the mold which serves to pour the U-shaped pieces is coated with the previously obtained piece; quartz and araldit are then poured in the above fixed percentage, after outgassing under vacuum for a few minutes.

Purpose of the outgassing is to avoid the forming of gas pockets in the poured pieces.

Because of the impossibility to make araldit and quartz stick directly to the steel during smelting operations, metallization of the U-shaped pieces must necessarily follow the above described process.

Realisation of the frontal proceeds as follows:

- I) - The frontal piece is poured in a special mold with type B araldit and quartz, per cent in weight 100:225; polymerization follows at 120° during a continuous 14 hours baking.
- II) - On the piece thus obtained, a continuous steel strip by means of type 121 S araldit, so as to cover completely the inner frontal piece.
- Sticking is obtained by keeping the steel close to frontal by means of a shaped vise.
- After baking it at 40°C for about one hour, the piece is removed from the grip of the vise, and polymerized at room temperature for about 24 hours (temperature should not be lower than 25°C).

III) - By means of a 0,3 mm. milling cutter, the steel is cut in the already described way, that is only on the curved frontal wall.

After the two pieces - u and frontal - are obtained, they are stucked together with type 121 S araldit.

Sticking is obtained in a press which enables lining of the frontal, square to the U-walls. Araldit is then polymerized first at 40°C for about one hour, and subsequently for 24 hours at room temperature (not lower than 25°C).

After fixing and sticking together the two pieces, type B araldit is poured into the V-shaped groove between the frontal and the Ushaped pieces, and subsequently polimerized at 40°C during one baking hour. This last pour secures a good vacuum seal to the fixed joint, type D araldit being very fluid.

As illustrated in Chapter 1), the 1,885 mm. sectors are obtained by sticking together five pieces (see sheme of drawing I₈) with type D araldit, to be subsequently polymerized at 40°C.

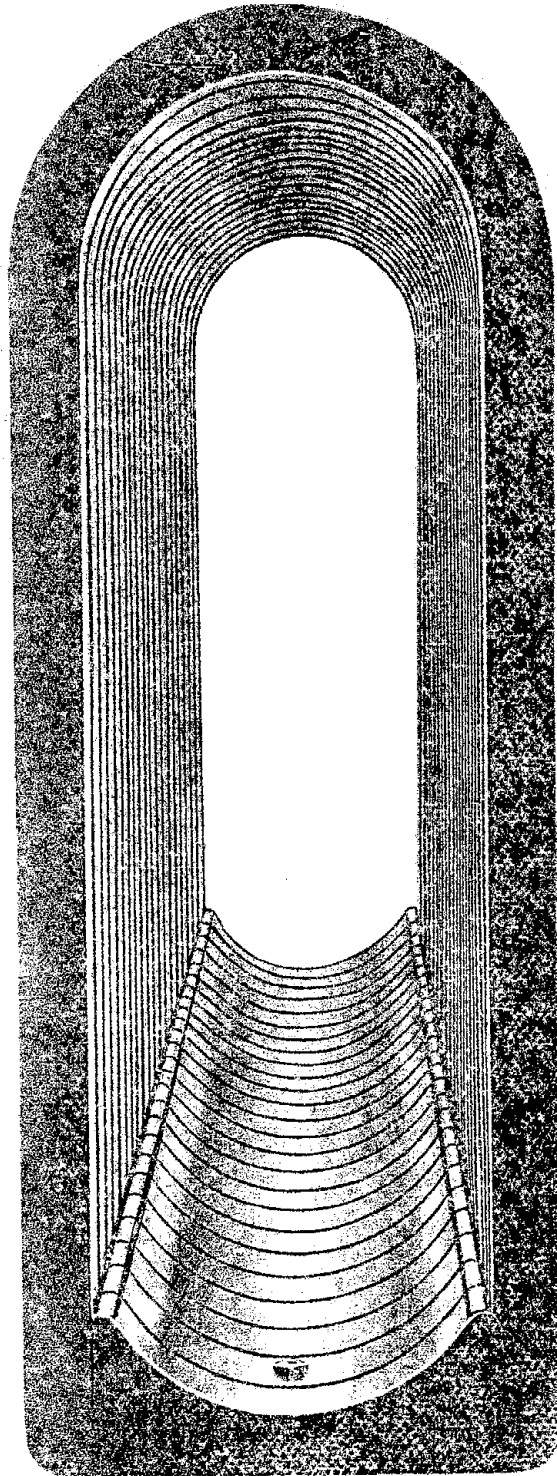
Before being assembled in sectors, the thus obtained single pieces are tested at 2 ± 2,5 atm. in an hydraulic compressor.

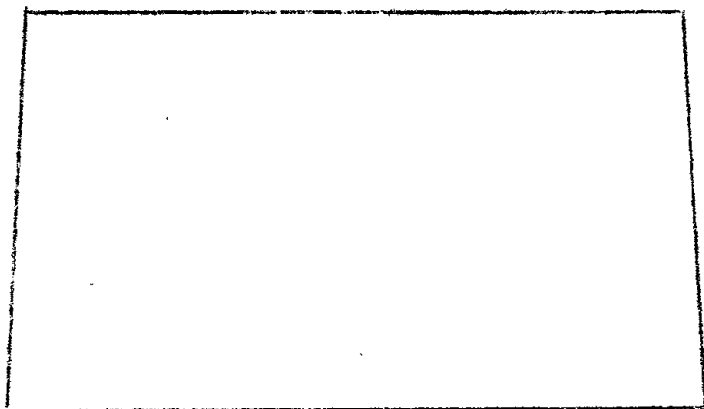
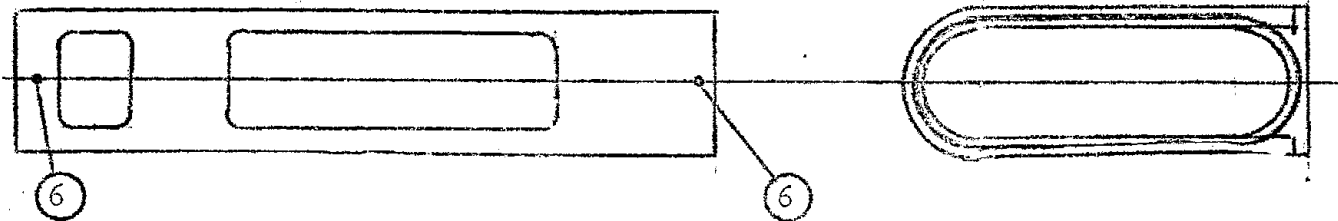
Closed frontal pieces breack at over 3 atm., while pieces with openings on the frontal breack at over 2,8 atm.

Percentage of quartz and its particular measurement of granularity were selected so as to increase the araldit's elasticity modulus, the purpose being to reduce flexion of the pieces to a reasonable value when are under vacuum. With such a percentage, the elasticity modulus is of 1.200 ± 1.400 Kg. per mm² vs. 300 ± 400 Kg. per mm² of pure araldit and the total flexion of a

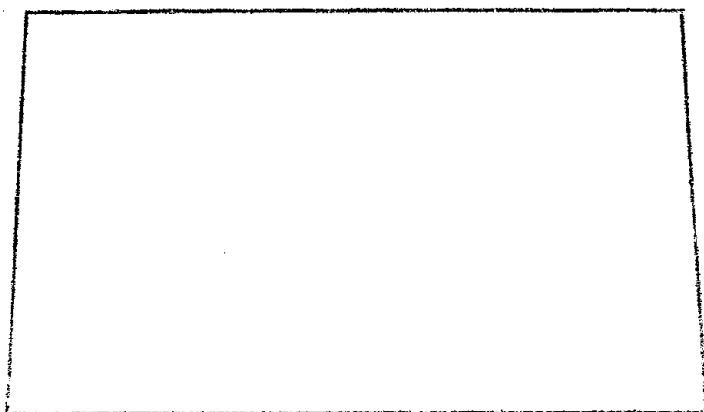
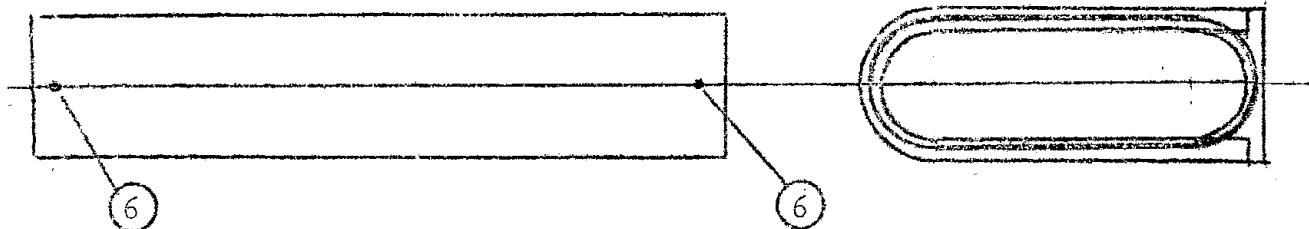
doughnut piece measured on the plane walls is of less than 14/10 mm.-

Schematic illustrative drawings are attached to this Report. For constructive plan drawings ask the 'Laboratori Nazionali del Sincrotrone Frascati'.

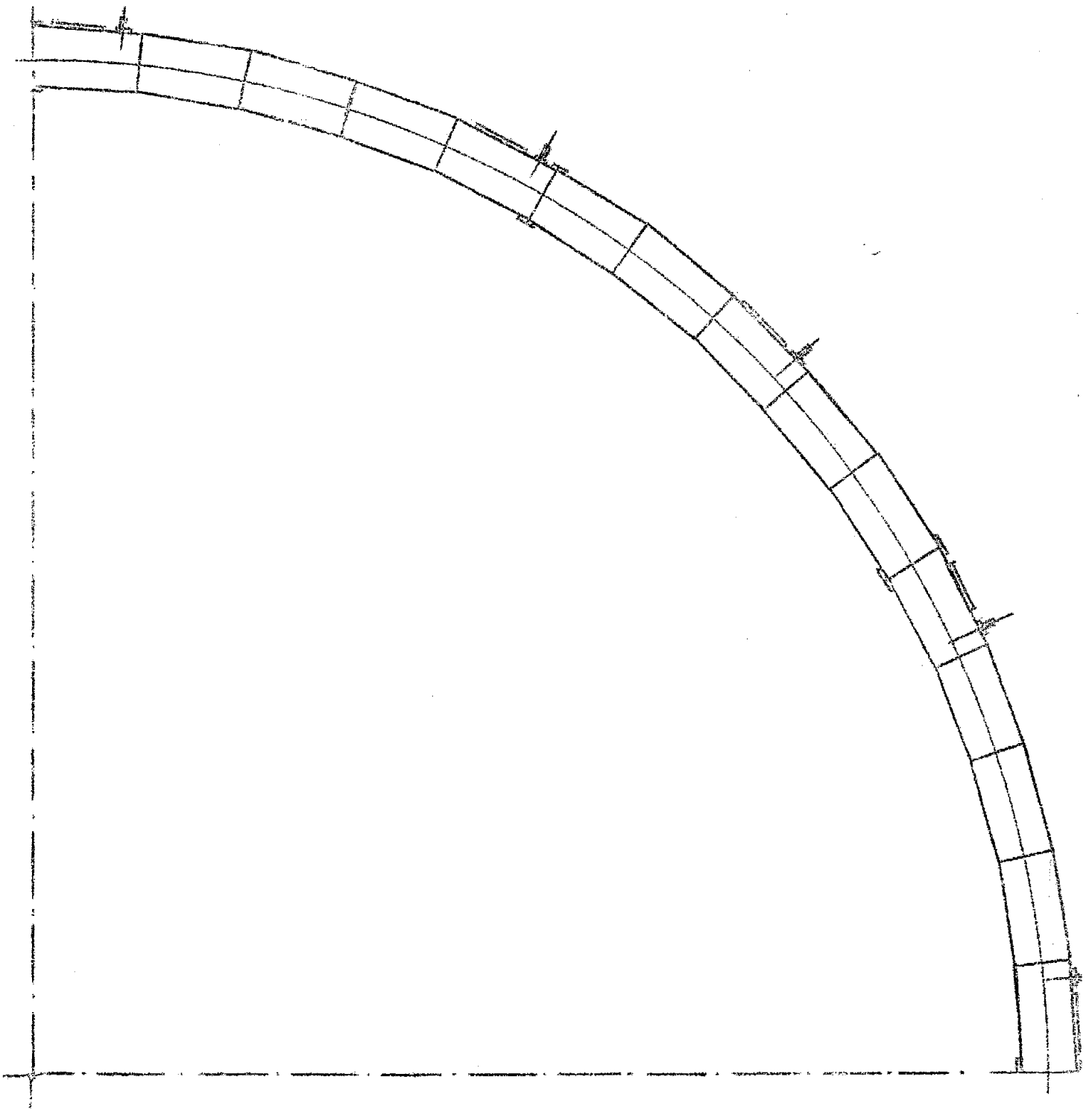




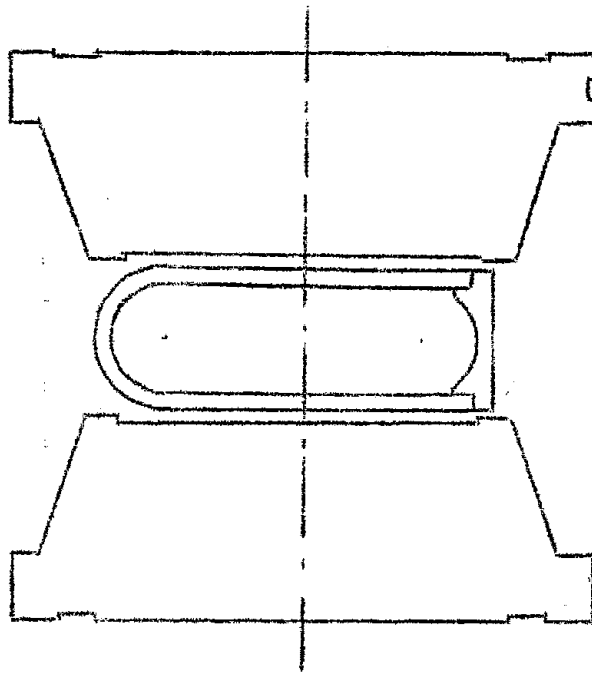
Drawing n° DO-73/C -
DONUT SECTOR WITH WINDOW
(Scale 1:4)



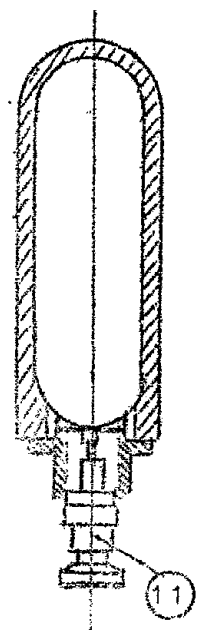
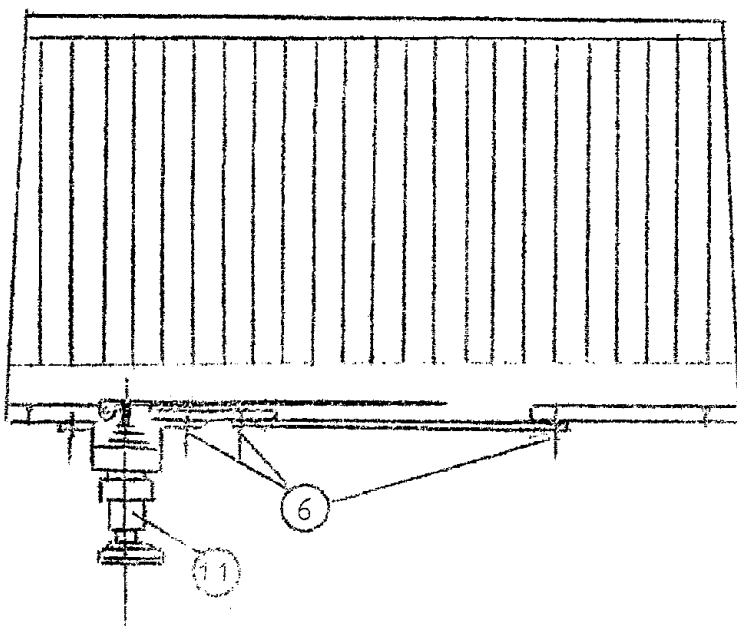
Drawing n° DO-72/C -
DONUT SECTOR
(Scale 1:4)



Drawing n° I-8 - DONUT QUADRANT (Scale 1:20)



Drawing n° DO-59/V - DONUT AND CORRECTING
COILS D.C. (Scale 1:4)



Drawing n° DO-58/V - DONUT WITH WINDOW AND
FLAG (Scale 1:4)