DEVELOPMENT PROGRAM FOR THE MAGNET OF THE EUROPEAN 3.7 METER BUBBLE CHAMBER (BEBC)

CERN Study Group for the Large European Bubble Chamber

Presented by

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I. INTRODUCTION

In order to define major parameters and to gain some operational experience with superconducting magnets, a magnet development program has been established. This program should lead to the final design of the BEBC magnet.

Figures 1 and 2 give some general view of the entire project.

The magnet has been designed to produce a magnetic field of 3.5 T in the center of the chamber. Consisting of two coils separated by a gap and surrounded by an iron stray field shield, it has at the present time the following characteristics:

Total number of ampere turns	2.05×10^7
Rated current (copper stabilization)	8 kA
(aluminum stabilization)	10 kA
Axial peak field on the conductor	5.1 T
Radial peak field on the conductor	3.8 T
Stored magnetic energy	750 MJ

II. MODEL MAGNET

The first experimental device which has been put into operation was a 1:20 model of the BEBC magnet which has been used to determine the stray field around the chamber and the various forces acting on the coils for different shield geometries.

With an iron shield of about 1800 tons, composed of two pole pieces of 500 mm thickness and a cylinder of 12 m diameter and 340 mm thickness, the stray field will be reduced by a factor of 6 above and below the pole pieces and by a factor of 1.25 around the shielding cylinder. The stray field distribution is presented in Fig. 3.

The lateral force caused by the presence of an iron neutrino filter will amount to about 18 tons and the attraction between the coils and the pole plates will amount to about 800 tons.

III. SHORT SAMPLE TEST FACILITY

To test the conductors proposed by different manufacturers for the winding of the BEBC magnet, a test facility named BRARACOURCIX was developed. The general lay-out is shown in Fig. 4. This facility consists of a split coil magnet housed in a ring-shaped cryostat, and a short sample stretching device suitably arranged in a central separate Dewar. The stretching device is shown in Fig. 5. It is made of a stainless-steel bellows which can be pressurized by helium. The maximum force developed by the pneumatic-hydraulic system is 9000 kg, with a maximum stroke of 1.5 mm.

The magnet has the following general characteristics:

Inner diameter of the first layer	400 mm
Free bore of central Dewar	363 mm
Total height of the assembled coils	699 mm
Total ampere turns	4.14×10^6
Rated current	1000 A
Total inductance	4.1 H
Central field	6 T
Stored energy	2.05 MJ
Current density of the top coil (Al-stabilized conductor)	4900 A/cm^2
Current density of the bottom coil (Cu-stabilized conductor)	4420-5180 A/cm^2

On short samples of the coil conductors the following results have been obtained at 6.6 T:

<u>Copper-stabilized conductor</u> (cross section 10 x 1.5 mm^2)

Resistivity	3.3×10^{-8} Ω·cm at 4.2°K
Recovery current	1200 A

<u>Aluminum-stabilized conductor</u> (cross section 5 x 3 mm^2)

Resistivity	1.12×10^{-8} Ω·cm at 4.2°K
Recovery current	1350 A

The resistances of all joints on either type of conductor are better than 3×10^{-8} Ω.

The measuring arrangement is represented in Fig. 6. It also shows the 2000 A, 5 V power supply and the dumping resistors.

Some typical recordings of the differential voltage signals are given in Fig. 7. These signals have been measured with outside dumping resistors of 2 x 0.250 Ω.

When exposed to the magnetic field and stretched by the above-mentioned system, the short samples are fed by a power source delivering a maximum current of 16 000 A at 4 V.

Figure 8 illustrates the lay-out of the above-described test system.

Figure 9 shows short samples from different suppliers in their final test form.

IV. GEOMETRY OF BEBC MAGNET

For the time being the coil parameters are envisaged as follows:

Number of coils	2
Number of pancakes per coil	14
Number of turns per pancake	
a) with copper stabilization	91
b) with aluminum stabilization	72
Inner diameter of the first turn	4720 mm
Over-all current density with copper stabilization	1030 A/cm^2

The configuration of the pancake winding inspired by the development at Brookhaven for the 7-ft Bubble Chamber is shown in Fig. 10.

Models of the chosen arrangement are at present prepared in order to check the thermal behavior of the system. Results will be reported later.

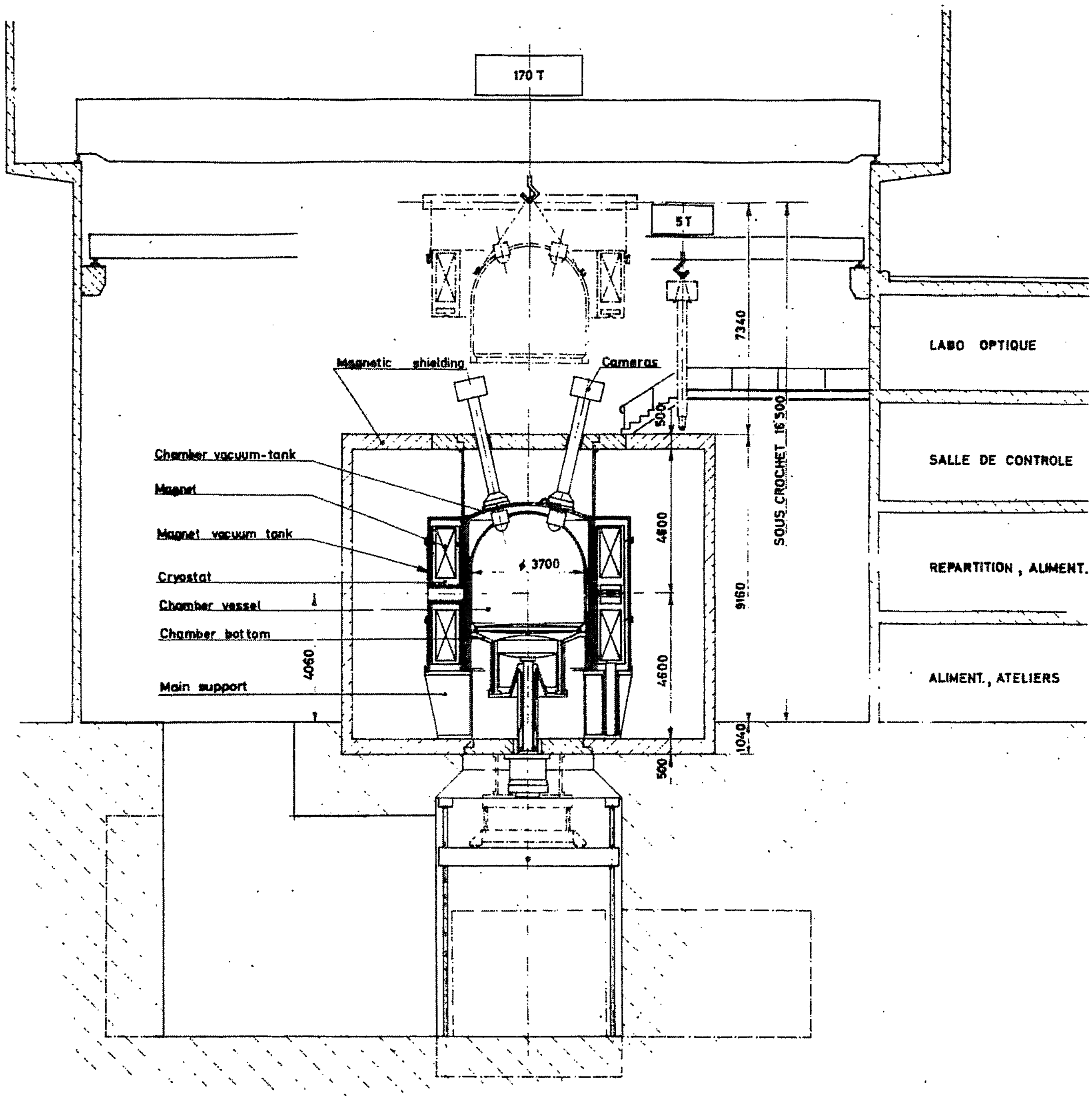


Fig. 1. General assembly of the Bubble Chamber.

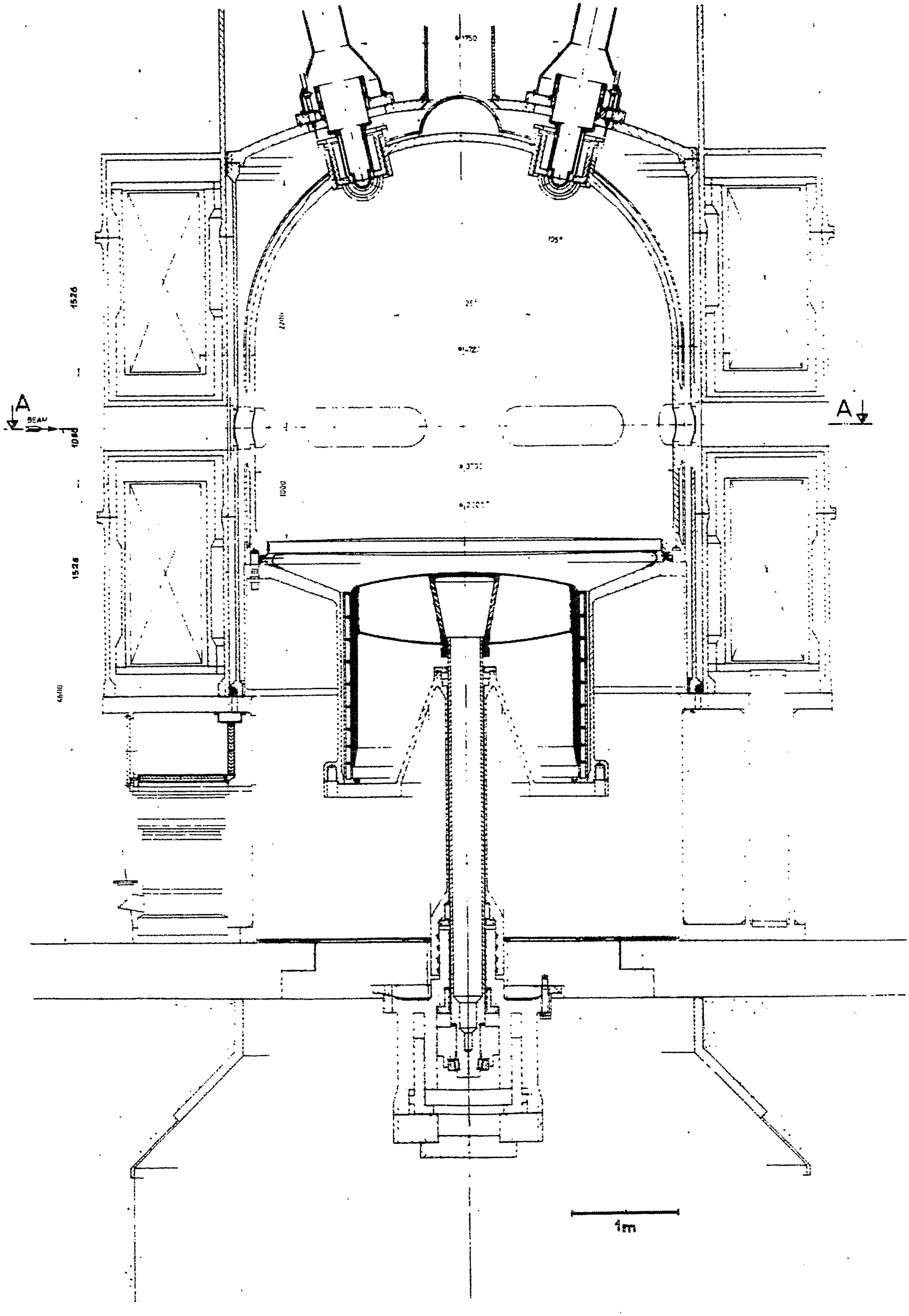


Fig. 2. Lay-out of the magnet coils.

STRAY FIELD (in Gauss)

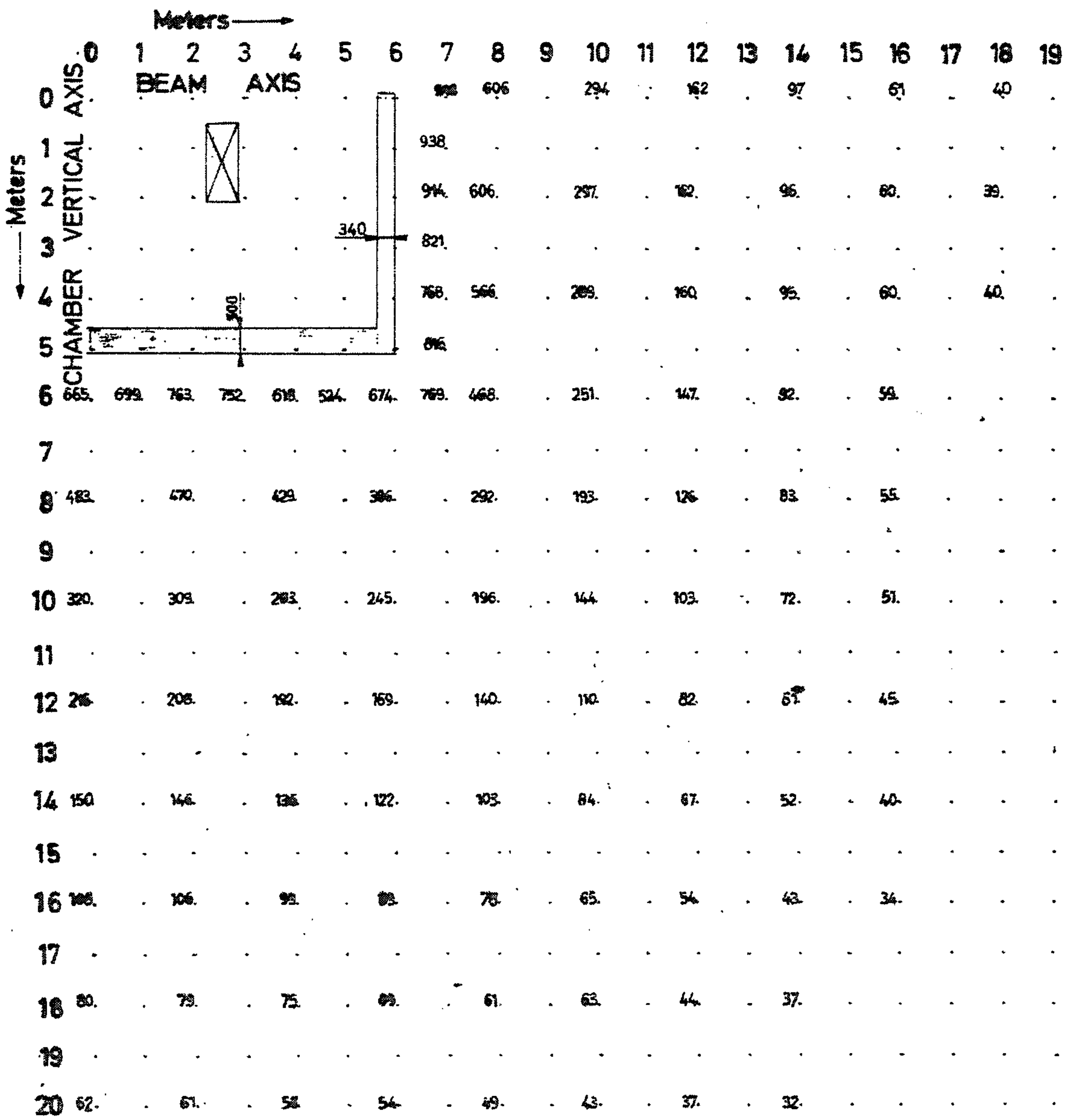
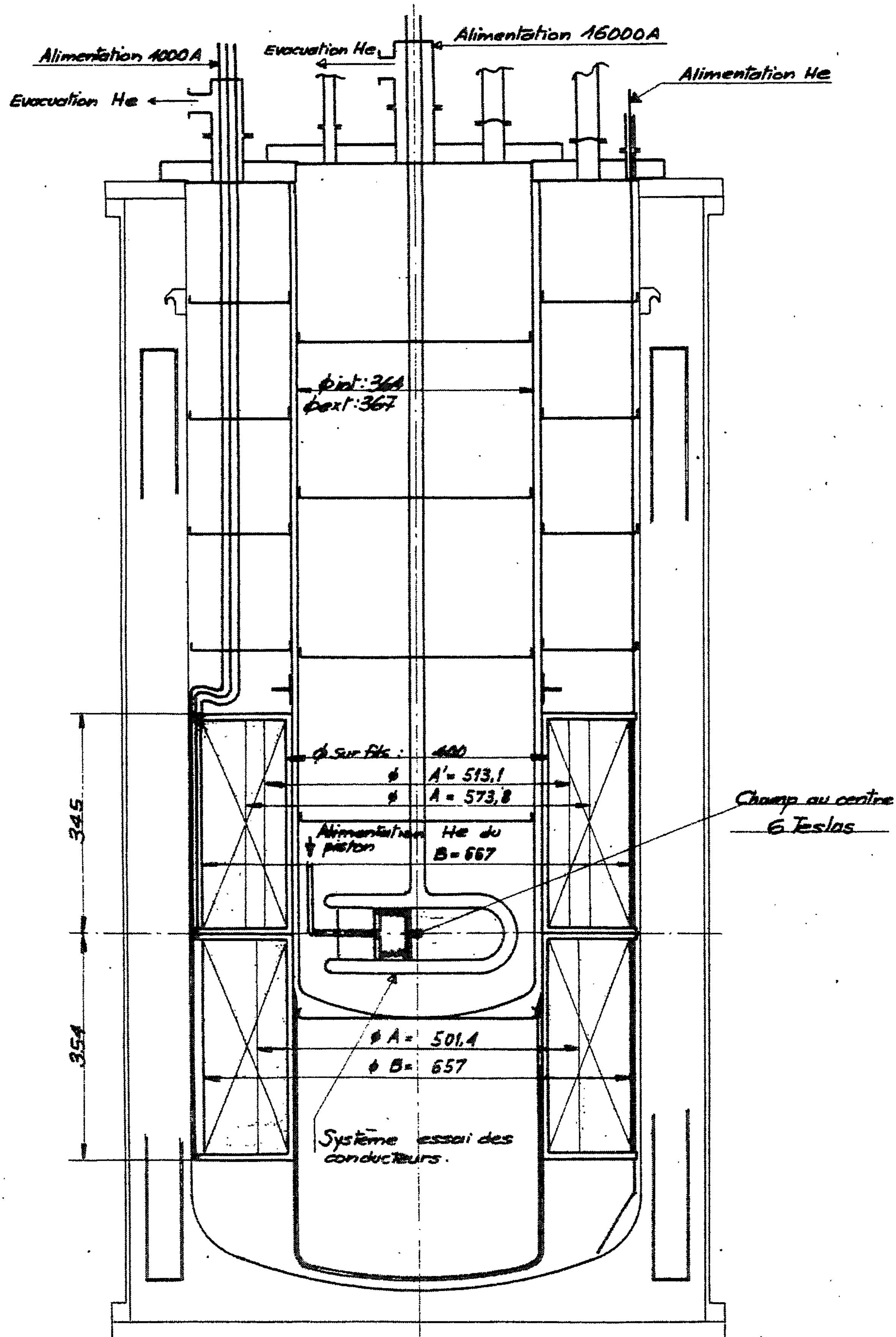


Fig. 3. Stray field around the rion shield.



TEST FACILITY

Fig. 4. Lay-out of the BRARACOURCIX test facility.

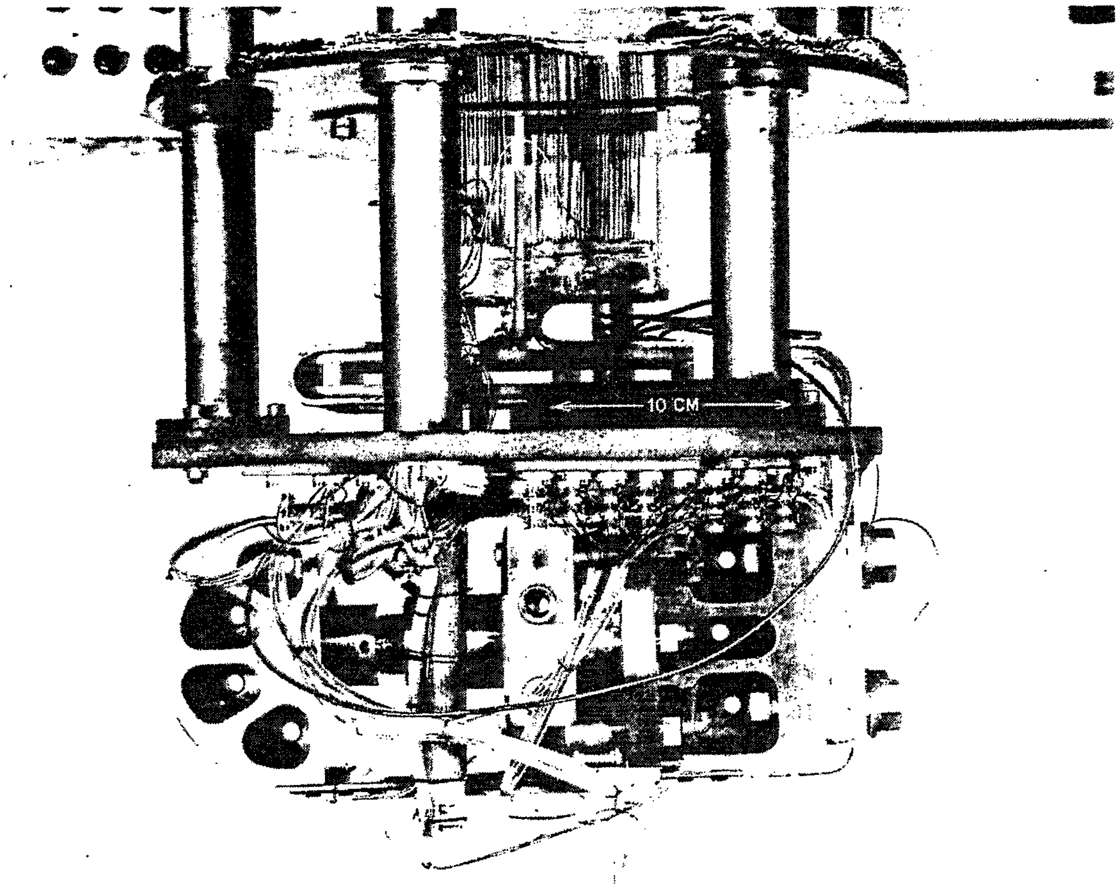


Fig. 5. Stretching device.

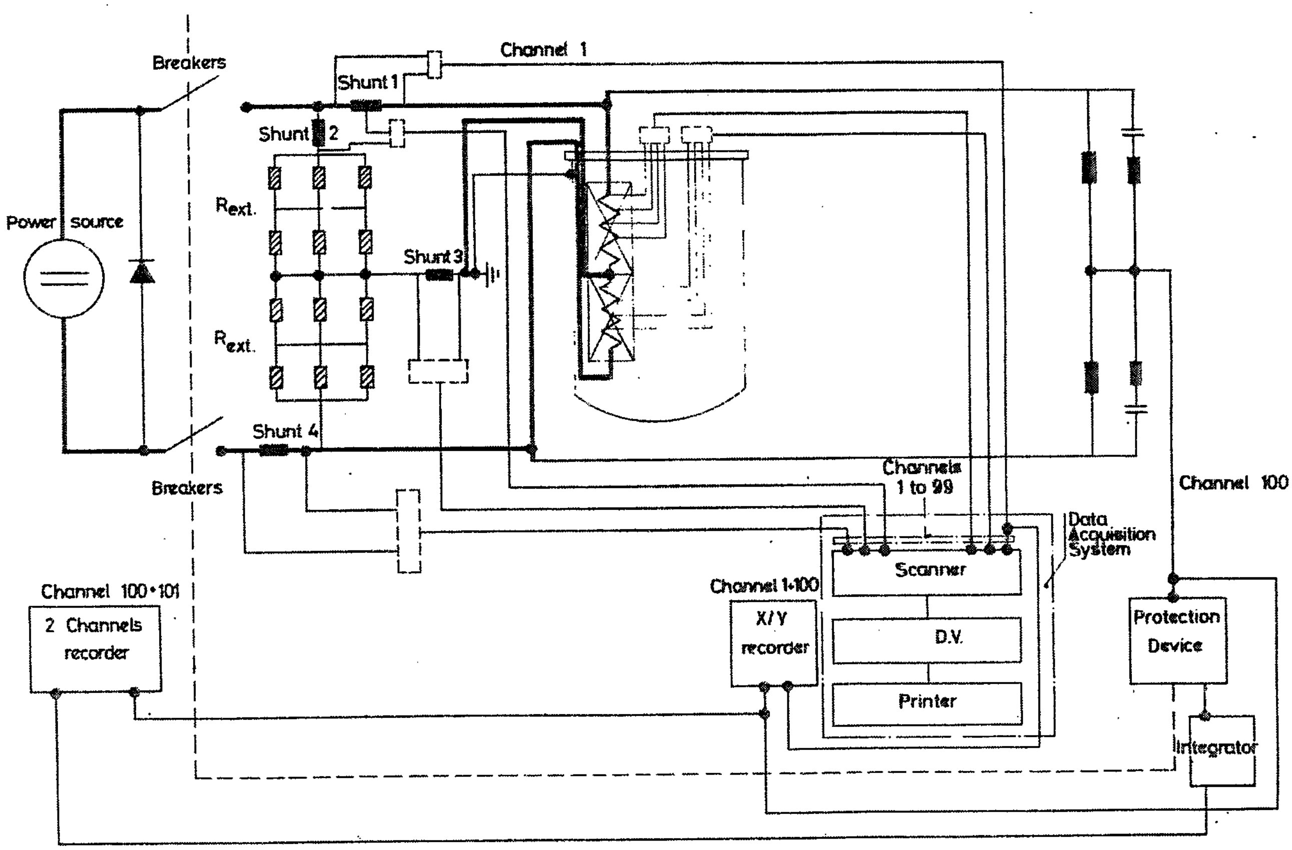


Fig. 6. BRARACOURCIX measuring system.

CURRENT INCREASE WITH 2 V - CHANNELS 1 AND 100

TEST OF "BRARACOURCIX"

Fig. 7. Recording of voltage signals during energizing of BRARACOURCIX.

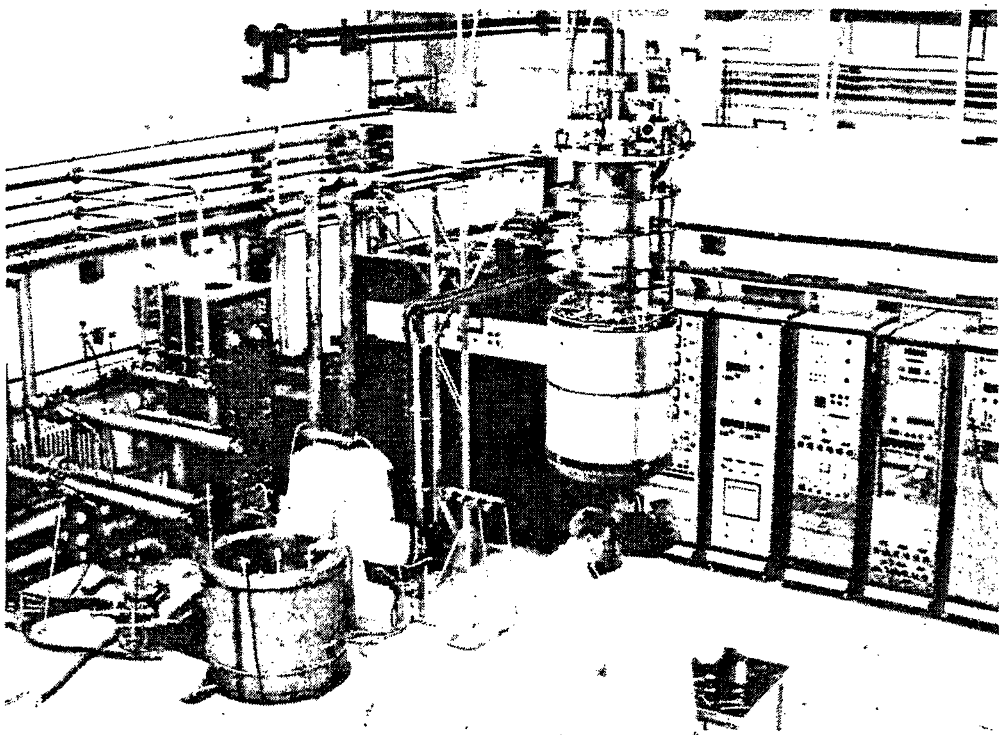


Fig. 8. General view of the BRARACOURCIX test facility.

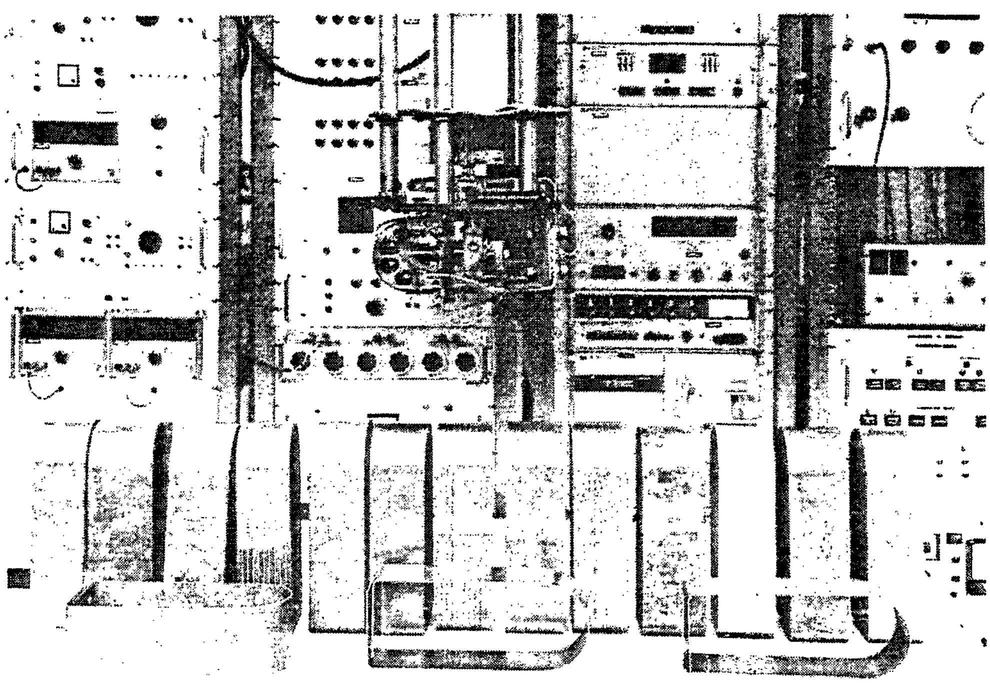


Fig. 9. Short samples of potential conductors for the BEBC magnet.

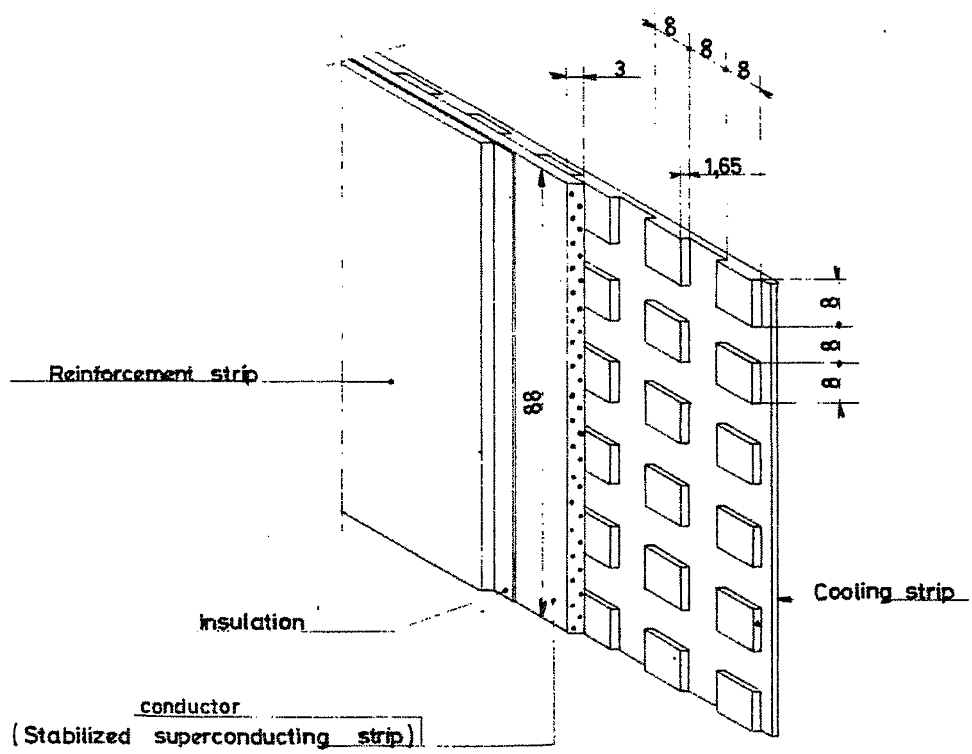


Fig. 10. Configuration of the pancake winding for the BEBC magnet.