PS/ML/Spec 85-20
30.09.1985

SPECIFICATION OF SOLENOIDS Ø 50/220 AND Ø 60/240

DRAWINGS 029-005LM3 and 034-002LM2

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
CERN
1211 GENEVA 23, SWITZERLAND

1. INTRODUCTION

This paper specifies two types of solenoid magnets. Both are quite similar and are used for the same purpose. The main difference between them is the size which is given in the title where the first number indicates the diameter of the central bore and the second one the overall length of the magnet. Any other significant difference will be mentioned in this specification.

2. The solenoid magnets are used for focusing the proton beam in front of the CERN RFQ particle accelerators at energies lower than 100 keV.

3. With its laminated iron body and specially shaped coil cast with epoxy resin into one solid block, the magnet can well resist electrical pulses. The form of the iron and the coil was calculated to obtain a magnetic field shape suitable to focus proton beams.

4. The current source which will power the magnets can give 1250 A of 3,5 ms half period and 0,3 ms flat top. Peak voltage is 1250 V max., the repetition rate 2 Hz.

5. The heat losses in the magnet are 32W (40W) in nominal operation, 75W (90W) at full power. The values in brackets refer to the larger magnets. No forced cooling is provided; cooling by free convection in the air is sufficient. The highest temperature in the magnet coil is 70°C approximately when operating at full power.

6. The iron body is made of two halves. Each half has 150 stacks. The stack itself is composed of four U-shaped stamped laminations of various sizes which are glued at only few points in a jig. A contact glue of cyanocrylate type is used for this operation. The stacks are now pressed into an aluminium mould which is placed into a tank under vacuum for epoxy resin casting. The type of resin is the same as in point 9.

   The final operation here is the machining of the three grooves, two for the copper wire, one for the epoxy resin inlet for the final casting.

7. the magnet coil is composed of eight cakes of different inner diameters connected in series. Each cake is produced of a flat enamelled copper wire wound on a mandrel which will give to the cake the precise shape indicated in the drawing.

   There is no additional insulating material between the coil windings. The finished cake must be a solid body which is achieved by point glueing during the winding and wrapping operation. A glass-cloth band 15 mm large and 0,1 mm thick with simple overlap on the inner diameter is used for the wrapping.

Each cake should be tested at 500 V, by observing the waveform of a pulsed circuit into which the cake is incorporated. A correct waveform will indicate the absence of shorted turns.

Special connection-plates screwed and softsoldered in the cake wire are used for the coil assembly. The connection must be mechanically rigid. Note that two connections on the outer diameter should be made with all cakes fully connected on the inner diameter and mounted on the central piece, called "tourillon de remplissage" in the drawings.

The material proposed for the central piece is dolomite-charged resin becuase of the easy machining, but any other organic material compatible with the resin compound in point 9 can be used.

8. The magnet assembly begins with placing the coil in the lower half of the steel body where it should be centered, radially as well as longitudinally, using glass-cloth epoxy shims. A centering cylinder (not shown on the drawings) is now inserted and covered with the upper half of steel body. After this operation the aluminium block can be slid over the body, centered logitudinally and tightened. The gap in the aluminium block, particularly around the copper wire, should be filled with epoxy resin plates (shims). To prevent leakage during the resin casting, the mould is sealed with an adhesive sealing compound in all places where a leakage may occur.

   At this stage the coil to iron isolation should be tested at 2 kV.

9. The final casting of the solenoid is made in vacuum with an epoxy resin compound of Araldite F + HY 960 hardener + DY 040 flexibilizer in standard proportions. Note that the assembly as it is prepared makes the mould for the casting, but it is advisable to insert two slightly conical plugs into the central bore. The plugs which should be prepared for easy retraction after the curing for 30 hours at 80°C are replacing the centering cylinder mentioned above.

10. The final machining concernes two sides of the aluminium block as indicated in the drawings. This sides are used as reference for alignment of the solenoids in the proton beam line. In case that some epoxy resin is obstructing the central bore, the resin should be machined out, but great care must be taken that the steel laminations at the bore diameter are not touched during this operation.

11. The acceptance tests will be for the coil to steel insulation at 1 kV dc for a period of one minute where the leakage rate should be $< 0.5\ \mu A$. This will be followed by a pulse test for six hours with the source defined in point 4 but with 450 Amps. After this test no signs of mechanical or electrical deterioration should appear.

12. <u>The packing and the transport to CERN</u> will be the responsability of the manufacturer. In case that CERN supplies some magnet components to the manufacturer the responsability for this transport will be of course on CERN.

13. The manufacturer must guarantee the magnets for faulty workmanship and damage in transport. If the magnet field test done in CERN reveal defects due to manufacturers faulty work, such as eccentric coils or missing windings, CERN shall be entitled to the urgent repair or replacement of the faulty magnet free of charge.

E. Boltezar/PS