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Rutherford Laboratory Report

A Design Proposal for a Concrete Insulated Magnet for the European 300 GeV Accelerator

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Science Research Council

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Rutherford High Energy Laboratory
Chilton Didcot Berkshire
1969

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A DESIGN PROPOSAL FOR A CONCRETE INSULATED MAGNET FOR THE EUROPEAN 300 GeV ACCELERATOR

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ABSTRACT

A bending magnet suitable for a separated function machine has been designed, using concrete insulation for the coils and concrete restraints for the laminated yoke, resulting in an integral prestressed concrete structure. The magnet has the advantage of being unaffected by high energy radiation.

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Introduction

The magnet has the same operating parameters as the one described with epoxy resin insulated coils (NIMROD/ND6/69-23)[1] and has the same external connections. The basic arguments for the increased stiffness of a tubular geometry also apply. The method of construction is different in that the whole magnet is located in a steel tube with compressively stressed concrete holding both the laminations and flight tube in position and also insulating the coils.[2]

The magnet is thus virtually hermetically sealed to prevent possible ingress of moisture.

The general assembly of the magnet is depicted in Fig.1.

Construction

1. Outer Casing

A 1 metre diameter mild steel tube having a wall thickness of 1½ cm, has registers and end clamp supports welded inside. Lifting points, main support feet, and conductor entry ports are welded externally. The structure is stress relieved. It is then machined to the required tolerances,[1] and the ends of the tube are prepared for welding on temporary end covers required at the concrete filling stage (Fig.2).

2. Yoke and Coils

The laminations are stacked in two halves of a suitable jig. A pressure of about 2 tonnes is applied at each end of the laminations to reduce voids, and produce a small compressive strain in the stack. The preformed conductors are then placed in position with suitable ceramic spacers to locate them accurately in the magnet throat (Fig.3). The two halves of the yoke are then brought together with a layer of glass fabric between the mating faces of the yoke and a collapsible gauge bar inserted to give the exact gap required (Fig.4).

3. Assembly

The whole of this assembly is now placed in the prepared tube. Two strips of thin rubber line the lower lamination registers and two flat steel tubes with rubber facings line the upper registers (Fig.5).

A hydraulic pressure of 500 kg/cm^2 is applied to the tubes and this causes the laminations to line up accurately on the gauge bar. The pressure is then reduced to 30 kg/cm^2 and a pressure of about 70 tonnes is applied axially to the end plates of the laminations; these are now clamped in position and the gauge bar removed. The individual laminations can no longer move with respect to their neighbours due to the clamping pressure, but a small pressure is maintained on the registers to keep the yoke in the required position.

The flight tube is now inserted into the pole gap and welded to flanges at each end. These flanges serve the dual purpose of vacuum flanges for the flight tube and reinforcement anchors for the concrete round the coil ends. The coil connectors are brazed to the tail ends and brought outside the steel tube through temporary seals (Fig.6).

Covers are placed over the ends of the flight tube with a small water pipe connection. Two domed ends are now welded to the previously prepared ends of the outer tube. One end has a connection for pumping concrete into the magnet, and a small connection for supplying water to the flight tube to balance the concrete pressure. The other end has a suitably reinforced porous disc bolted in for de-watering the concrete (Fig.7). Suitable restrictors have to be placed in the larger passages through the magnet to enable an even flow of concrete to be maintained. Concrete is now pumped through the magnet at a low pressure; when the vessel is full the concrete supply is isolated and a water pressure of 55 kg/cm^2 applied to the concrete and internally to the flight tube to maintain a balance of load. This pressure is maintained during the curing period. After curing, the domed ends are cut off and surplus concrete removed from the surfaces which had previously been covered with release agent, thus exposing the flight tube.

The whole magnet is now baked for three days at 150°C until its resistance to earth rises to the prescribed value. Exposed concrete surfaces are now sealed to prevent any long term deterioration due to ingress of water.

Electrical and water connections are now completed. Following magnetic survey, adjustments can be made to the support feet if necessary to enable the magnet to be placed in a pre-determined position.

Acknowledgements

Thanks are due to Mr. P. Bowles, Mr. D.A. Gray, Dr. L.C.W. Hobbis and Mr. G.E.Simmonds for their advice and encouragement, and to Mr. H. Aram for the experimental work carried out in support.

References

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   A Magnet Design for the European 300 GeV Accelerator. NIMROD/NDG/69-23.

2. A.T. Gresham, R. Sheldon, G.B.Stapleton.
   The Construction of Magnets for Particle Accelerator Physics using Cementatious Aggregates RHEL/R 185.

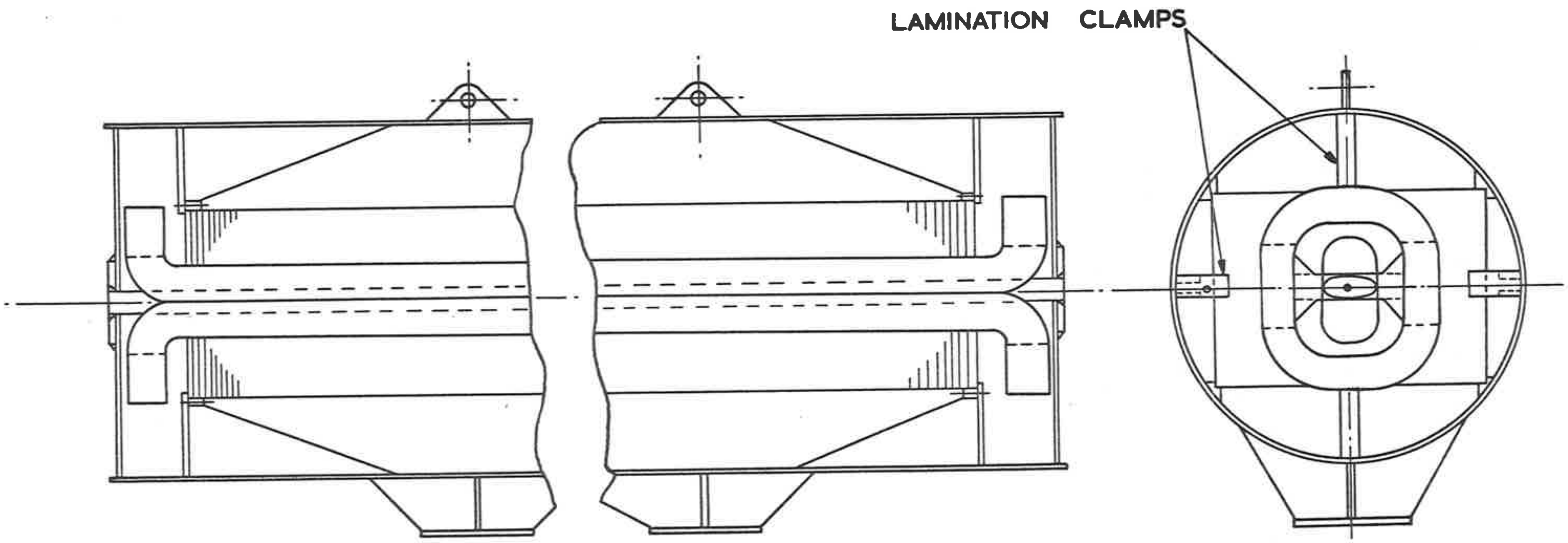

FIG. 1 GENERAL ARRANGEMENT

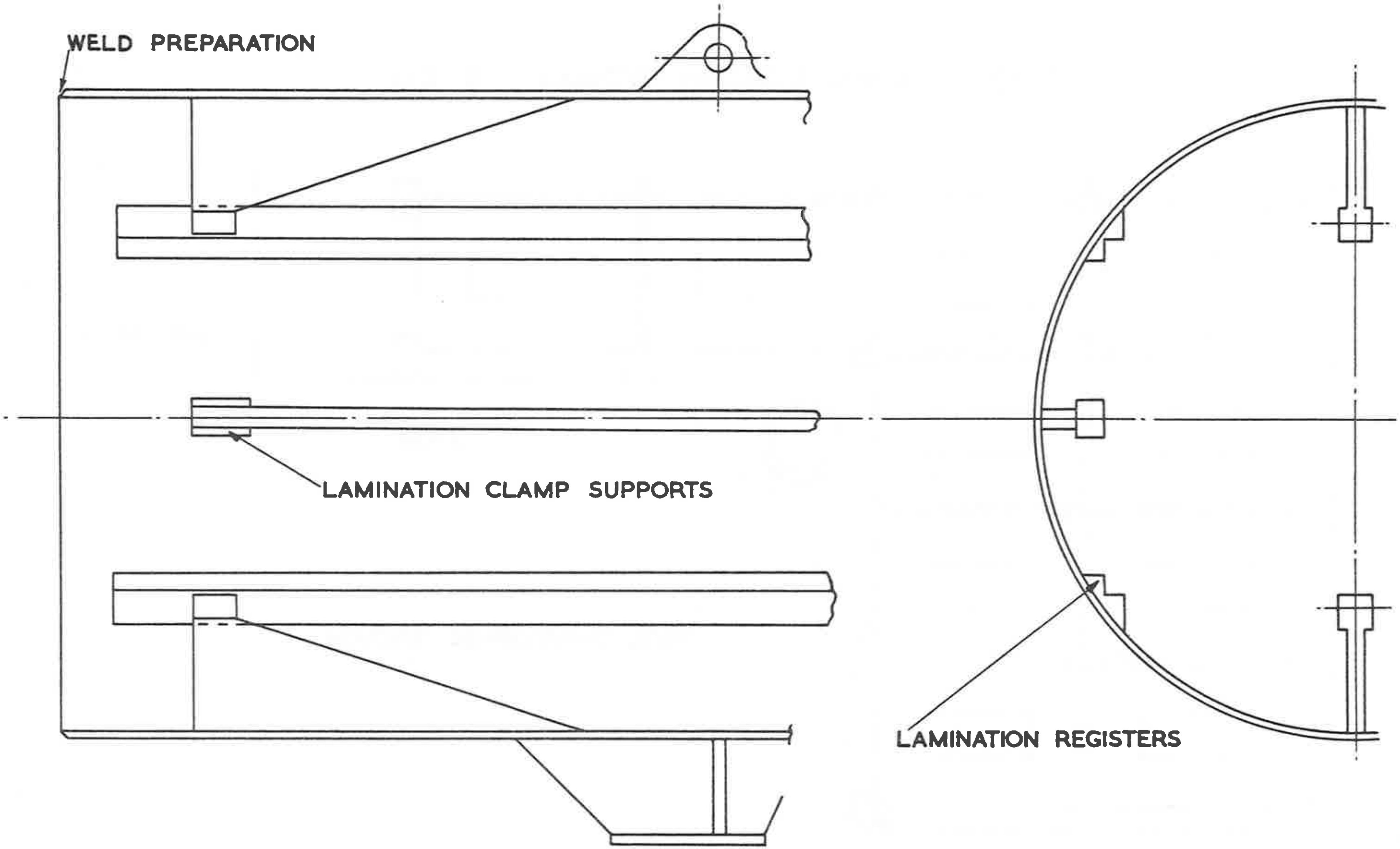

FIG. 2 STEEL STRUCTURE

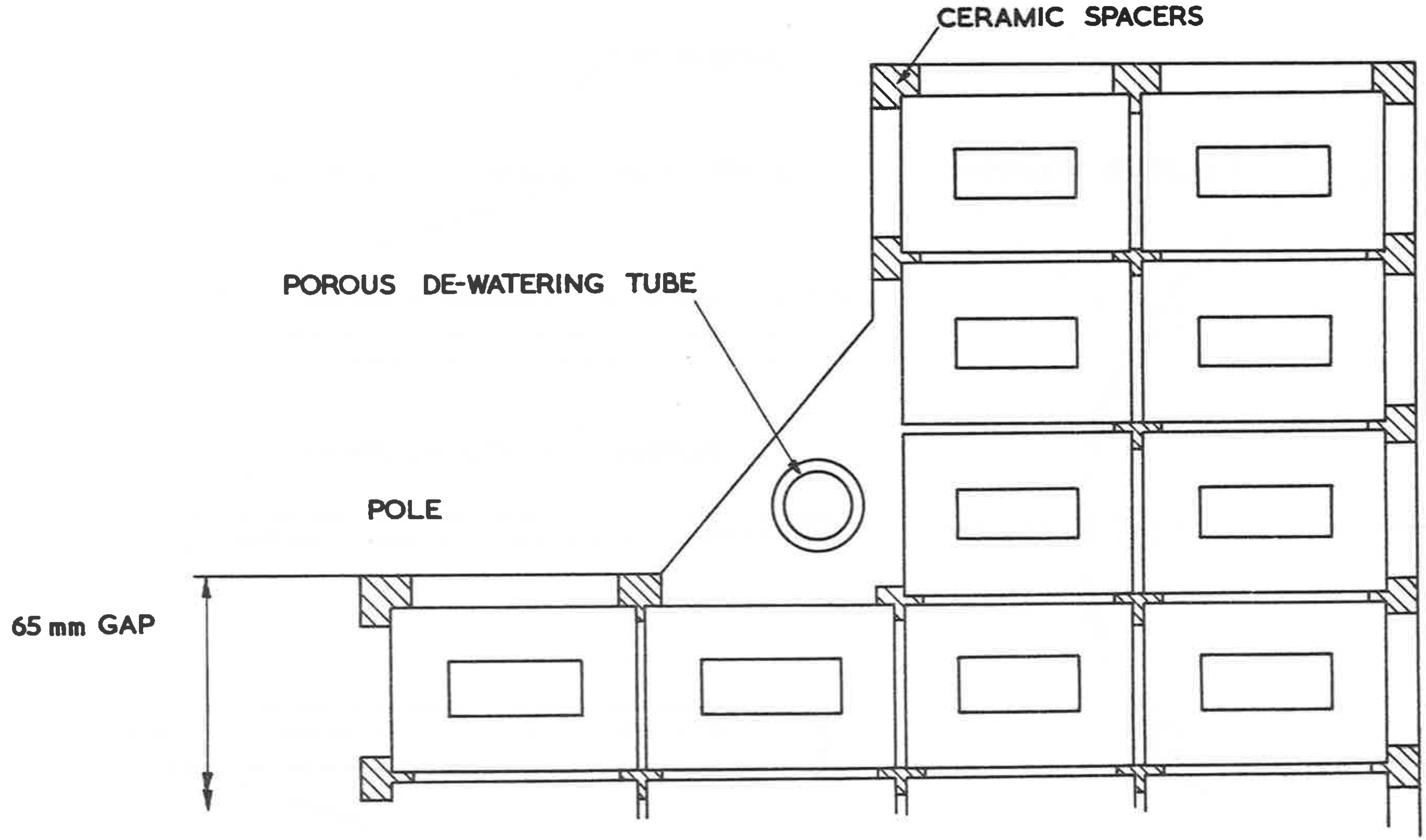

FIG. 3 TYPICAL SECTION THROUGH COIL

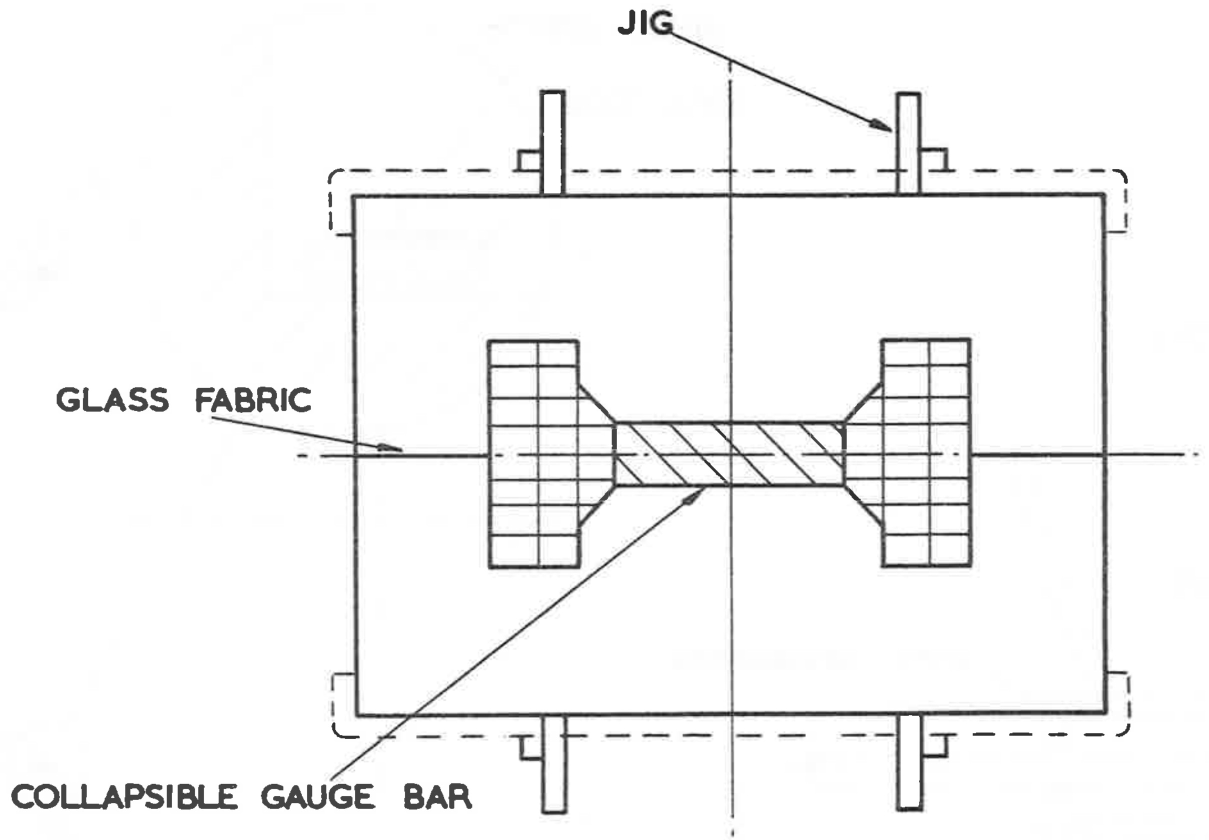

FIG. 4 ASSEMBLY OF LAMINATIONS FOR INSERTION INTO TUBE

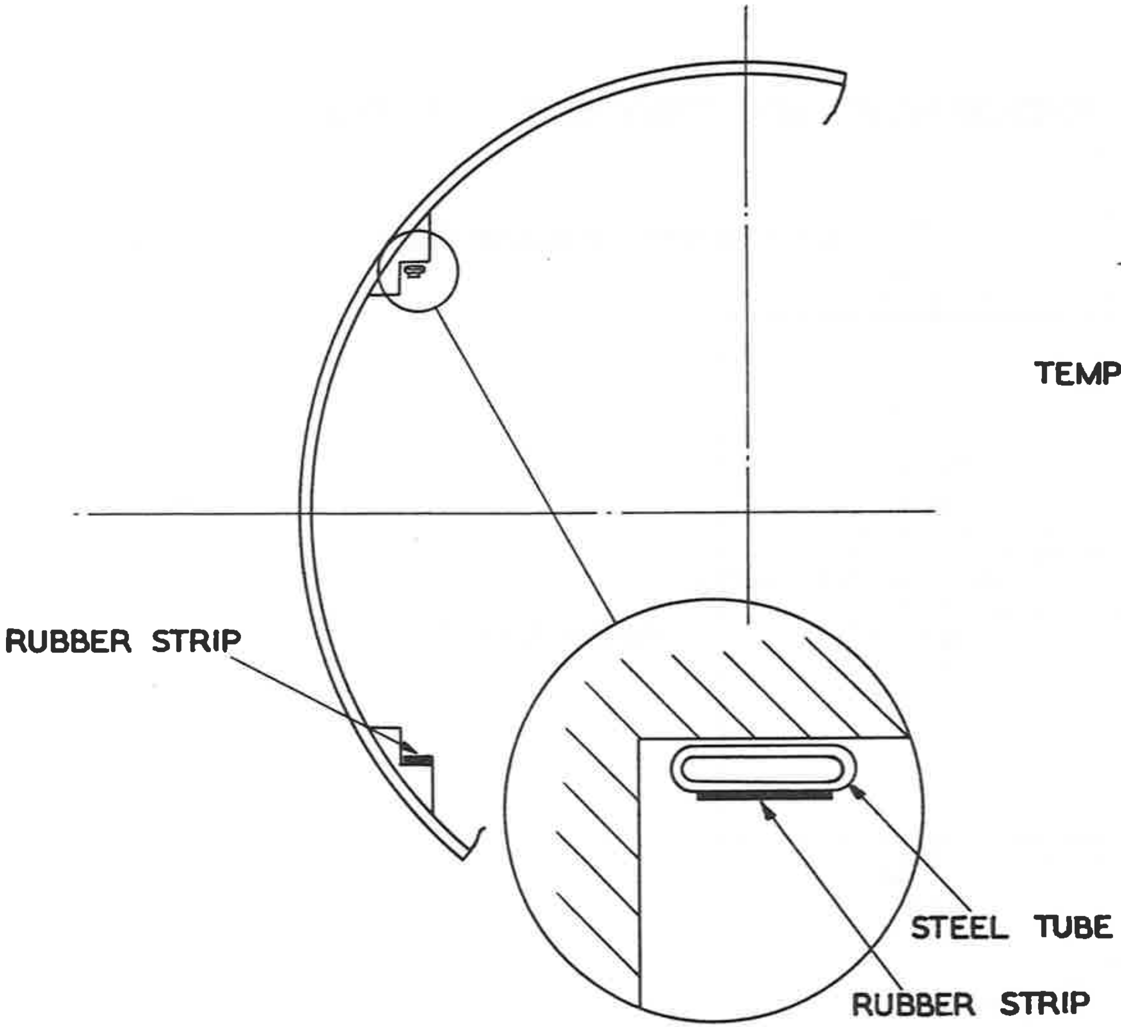
RUBBER STRIP
STEEL TUBE
RUBBER STRIP

FIG. 5

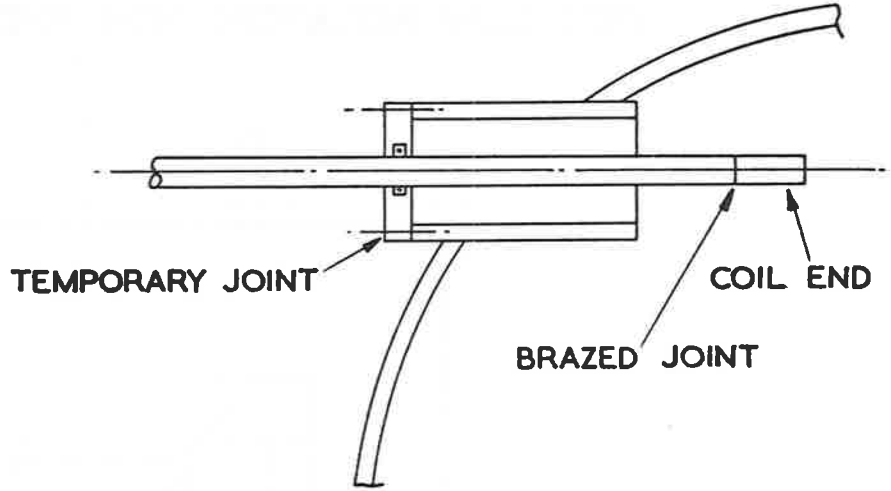
TEMPORARY JOINT
COIL END
BRAZED JOINT

FIG. 6

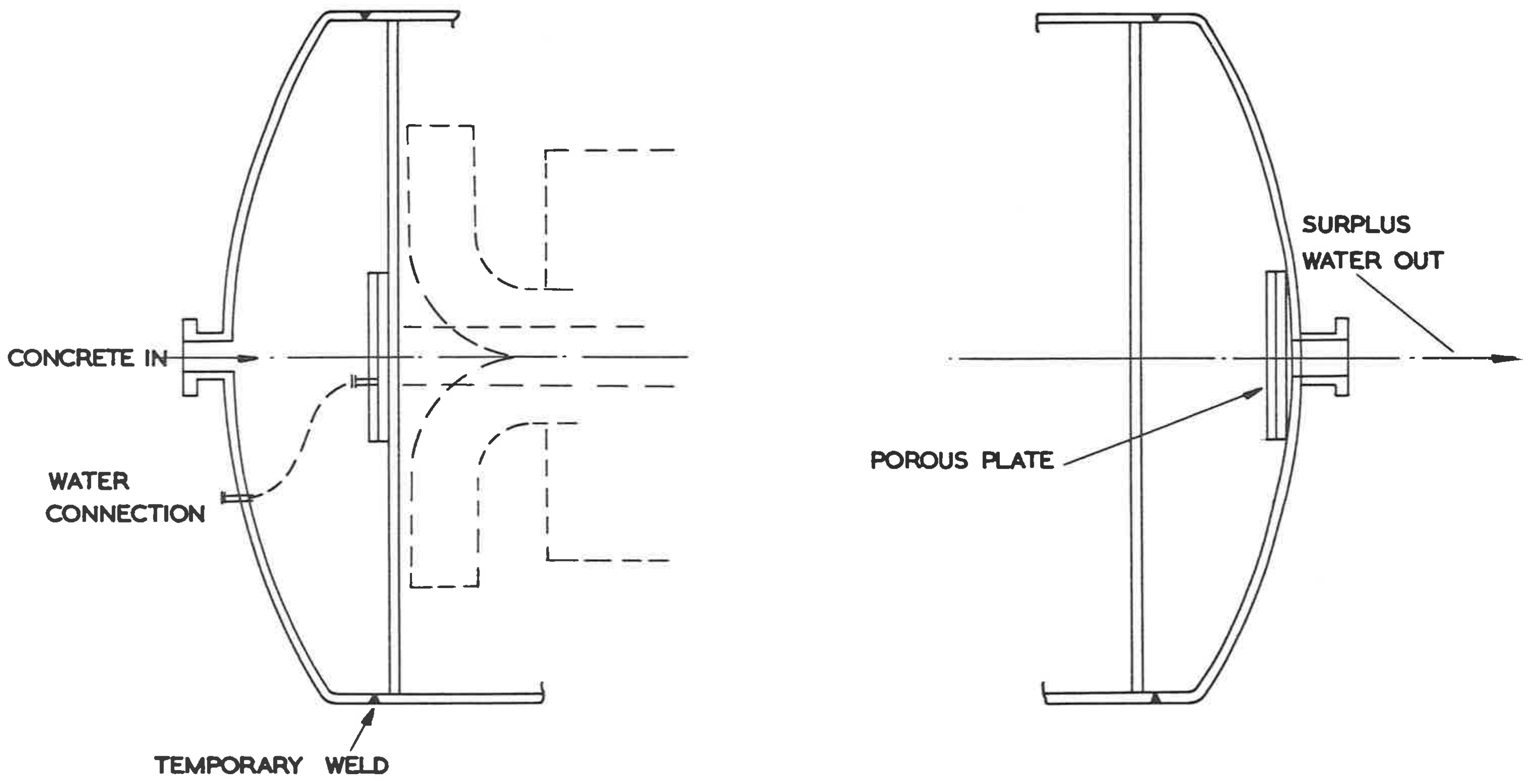
CONCRETE IN
WATER
CONNECTION
TEMPORARY WELD
SURPLUS
WATER OUT
POROUS PLATE

FIG. 7

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