Rutherford Laboratory

Technical Leaflet

A26

NIMROD MAGNET POWER SUPPLY

The Nimrod Magnet power supply consists of two motor alternator flywheel sets which power the magnet via phase splitting transformers and ninety-six single anode water cooled steel tank mercury arc rectifiers. The alternators are 60 MVA, 12.8 KV machines, the flywheels each weigh 30 tons and the slipring induction motors are each 5100 H.P. A twenty-four phase circuit arrangement has been adopted.

The motor-alternator-flywheel set weighs about 400 tons and this is mounted on a reinforced and post stressed concrete foundation block weighing about 1,200 tons. This foundation block is supported on 80 spring units and twelve viscous damper units. When the power plant is pulsing this special foundation block ensures that virtually no vibration is transmitted to nearby plant and buildings.

The motor-alternator-flywheel set has equipment which measures bearing vibration and shaft eccentricity, and the shaft system is also continuously monitored for excessive torsional stress.

Since the drive motor rotors, alternator rotors and flywheel half shafts have a central borehole a special ultrasonic flaw detection equipment is used to inspect these forgings from the bore.

Each alternator feeds four rectifier transformers each having a primary rating of 11.93 MVA. Each transformer has two secondary windings connected double star with interphase transformer. The primary windings of the four transformers are connected star, delta, extended delta plus fifteen degrees and extended delta minus fifteen degrees, arranged as a twenty-four phase system.

Each transformer feeds twelve single anode steel tank convertors of the water cooled continuously evacuated excitron type.

The power supply is, in effect, in two identical parts. This gives a valuable measure of standby protection since if any serious defect develops on one half of the power supply, the other half can still be used to pulse the magnet, although this will be only at half of the normal repetition rate.

The magnet current pulse is such that it demands three distinct modes of operation of the convertor plant.

(1) A period of approximately 0.7 secs during which time all convertors are operating as free firing rectifiers and current is increasing in the magnet. The actual time of current rise is variable depending on the value of magnet field required.

(2) A short period which is adjustable in one millisecond increments during which time the magnet current is held approximately constant. This condition is obtained by arranging that only half of the convertors operate as rectifiers whilst the remainder function as invertors. The degree of inversion is such that there is just sufficient forward voltage to overcome the resistive drop in the magnet and its connections.

(3) A period of time similar in magnitude to the current rise time (1) during which the magnet current decays to zero. During this time all convertors function as invertors to transfer the energy stored in the magnet back to the power supply system. It is desirable to operate with the maximum degree of inversion possible, and this involves continuously altering the phasing of the convertor grid impulses as a function of load current in order to maintain the minimum safety angle.

The magnet power plant is controlled from a separate control room which also houses the two most important pieces of control equipment, namely the Master Timer Unit and the Automatic Voltage Regulator. The latter maintains the required alternator output voltage as selected at the control desk. The Master Timer Unit can be regarded as the brain of the power plant and it is this unit which controls the precise shape, magnitude and repetition rate of the synchrotron magnet current pulses.

The signals from the timer are fed to the mercury arc converter grid control sets. Each of the sixteen groups of 6 convertors has its own transistorised grid control unit.

The master timer is also a transistorised printed circuit unit built up of seven separate timers coupled together. In addition to the various timers to control the different stages in the pulse programme the master timer also contains circuits to prevent incorrect programme settings, and to interrupt the programme in the event of a fault in the installation.