P Selman

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POWER SUPPLIES FOR BEAM-TRANSPORT MAGNETS AT BROOKHAVEN.

The AGS group is currently taking delivery of their first batch of solid-state rectifier sets for powering bending magnets and quadrupoles. They are quite pleased with the way in which these units have turned out; the following is the result of a brief discussion with Cottingham on 15 June 1960.

They have on order and partly delivered 30 units: -

16 of 175 kW (75 V x 2330 A) at ~ £ 12,200 each

8 of 300 kW (125 V x 2400 A) at ~ £ 18,000 each

6 of 600 kW (125 V x 4800 A) at ~ £ 30,000 each

They are all three-phase full-wave sets, fundamental ripple frequency 360 Hz, regulated and stabilised by magnetic amplifiers. The two smaller units contain 36 diodes, the largest contains 72, with a P.I.V. rating of 600 V. The working P.I.V. for 125 V output is about 170 V and it is normal to use a safety factor of 2½ to 3, so the next smaller P.I.V. rating of 500 V was considered to be marginal.

They assume that all loads will have a time-constant of at least 0.2 second, and the stabilisation servo is designed to be reliably stable under these conditions. To keep the ripple within reasonable limits they have an off-load tap-changing switch at 10 o/o intervals, so they never need to regulate downwards more than 10 o/o with the magnetic amplifier. Using a magnet made of 1 inch plates, padded out to a time constant of 0.2 s, they find

Ripple current at full volts	0.085 o/o peak-to-peak
Ripple current at 90 o/o volts	0.11 o/o peak-to-peak

The ripple in the field was about a factor 5 smaller. If the load has a time constant much greater than 0.2 s, or if more ripple is tolerable, it is possible to regulate downwards over a greater range with the magnetic amplifier.

No special precautions were taken to keep the phase-balance accurate in order to minimise lower frequency ripple. The first 75 V unit delivered had

60 Hz ripple: -

at 80 V output , 4 V peak-to-peak

at 50 V output , 8 V peak-to-peak

This is probably tolerable for most purposes, but all other units delivered so far were at least twice as good. They may have a few (e.g. bubble-chamber) applications in which low frequency ripple needs to be very low, then they can put six independently adjusted shunts on the control windings and balance it out to any desired accuracy. This has been tried on the unit mentioned.

Their bending magnets are solid iron, but their quadrupoles are laminated (0.030 inch) so they will probably not get the useful factor of 5 between I-ripple and B-ripple in this case. However, quads are usually less critical, and from some rough experiments with shorted turns they believe that copper bars in suitably placed holes in the pole tip may enable them to make quadrupoles with a factor even better than 5, if this should turn out to be desirable for precision-optics beams.

The stabiliser design was based on an aim of 0.1 o/o change, or less, for a 10 o/o load change; they measure 0.03 o/o. They can operate in three possible ways:-

Field regulation (Hall)

Current regulation (from a 100 mV shunt)

Voltage regulation.

The voltage regulation may be used on one of the units if two are operated in series. They specify a 2500 V insulation test on the whole output side.

To conserve floor space the units are designed so that they can be stacked two-high.

H.G. Hereward.

Distribution: (open)

P.S. Parameter Committee
Spare copies with K. Tekelenburg.

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