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THE NEXT FAST KICKER

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AGS DIVISION TECHNICAL NOTE

No. 23

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The present fast kicker at L-10 has been installed since 1963, meanwhile new components have arrived on the market which will enable a new kicker to be built with several operational improvements. The improvements proposed are:

1. Larger magnet aperture
2. More deflecting force
3. Capability for ejecting any number of bunches
4. Two pulses per AGS cycle

In order to keep development time reasonable (probably about 18 months anyway) the same basic design of the present kicker will be kept, ie., thyratron switches and picture frame magnets.

Some of the improvements conflict with each other, suggested design compromises and quantitive performance figures are given below.

General Design

In order to provide any number of bunches the circuit shown in Fig. 1 is proposed. A wavefront can be propagated in the pulse forming network from either end by closing S_1 or S_2. The field flat top time depends on the phasing of S_1 and S_2 triggers, as shown in Fig. 2. If the wavefront generated by S_2

closing has a very fast rise time, then the field rise and fall times in the magnet are essentially the same. Fig. 2 shows the relationship between S_1 and S_2 triggering and the field flat top.

Deuterium thyratrons will be used as the switches (English Electric CX 1168), all the high voltage components will be mounted in oil. A possible mechanical layout is shown in Fig. 3.

Performance

The system will be designed to run at 80 kV maximum, with the design specification met at 72 kV. Some development work is required to discover the safe maximum current for the CX 1168 under low duty cycle conditions.

Suppose the current is 7,500 amps, then the magnet current is 3750 amps. For a magnet aperture 7 cms high this yields about 650 gauss. The PFN impedance is $\frac{3.6 \times 10^4}{7.5 \times 10^3} = 4.8$ ohm. This is a very practical value, similar to the present fast kicker (4 ohm when first made and 3.4 ohm when modified to 2½ in. vertical aperture).

The rise-time requirement now sets the value of magnet inductance, given the value of the characteristic impedance of the network. This gets rather involved as a guess must be made at the stray inductance contributed by the switch tube[1]. For an AGS 10-ft. straight section the practical limit on magnet length is 20-ins. each for a set of four. From rise-time considerations the maximum magnet inductance should be about 1.4 microhenries. This now fixes the horizontal aperture, which turns out to be 16 cms (6.3 ins.) This aperture is reduced in practice by the conductors and insulators. An approach worth considering is to build magnets with field only in the center, two models are shown in Fig. 4. The problem is to have no gradient over the middle two inches or so. These designs reduce the effective magnetic width of the magnet and so lower the inductance. A magnet built in this style will be essential if the maximum current permitted in the switch tube turns out to be higher than

7,500 amps.

Knowing the flux and magnet shape the operational characteristics can be summarized:

Magnet aperture: 2 3/4-ins. high x 6-ins. wide.

Deflecting force: 5.2×10^4 gauss ins.

Rise and fall times: 180 nS (to 5% points).

Flat top width: 0 to 2.8 μs (infinitely variable).

Conclusion:

A fast kicker with a wider aperture and 50% more kick than the present design appears to be feasible using deuterium thyratrons. The performance may be improved even further by development work on the tube characteristics and the magnets. The mechanical and electrical problems raised by the approach specified in this note are difficult but not insurmountable.

References

1. Accelerator Department Internal Report EBF-2. "Comparison of Lumped and Distributed Inflector Magnets." by E.B. Forsyth.

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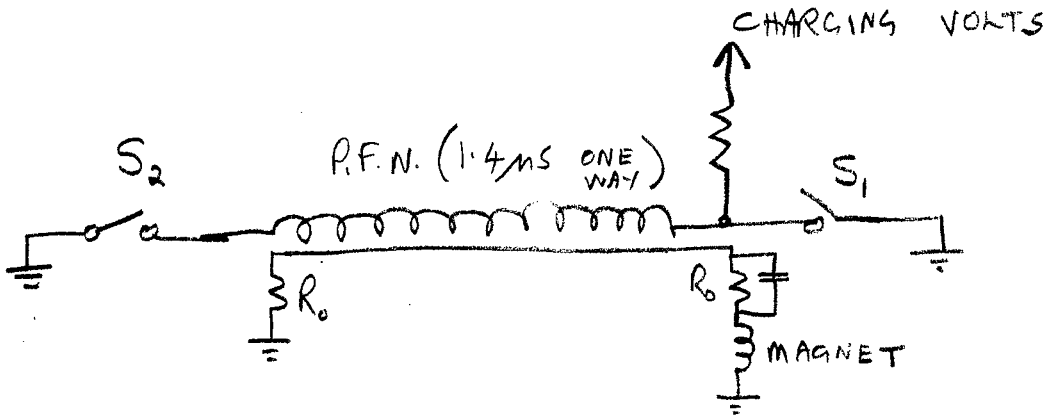

FIG 1. GENERAL ARRANGEMENT

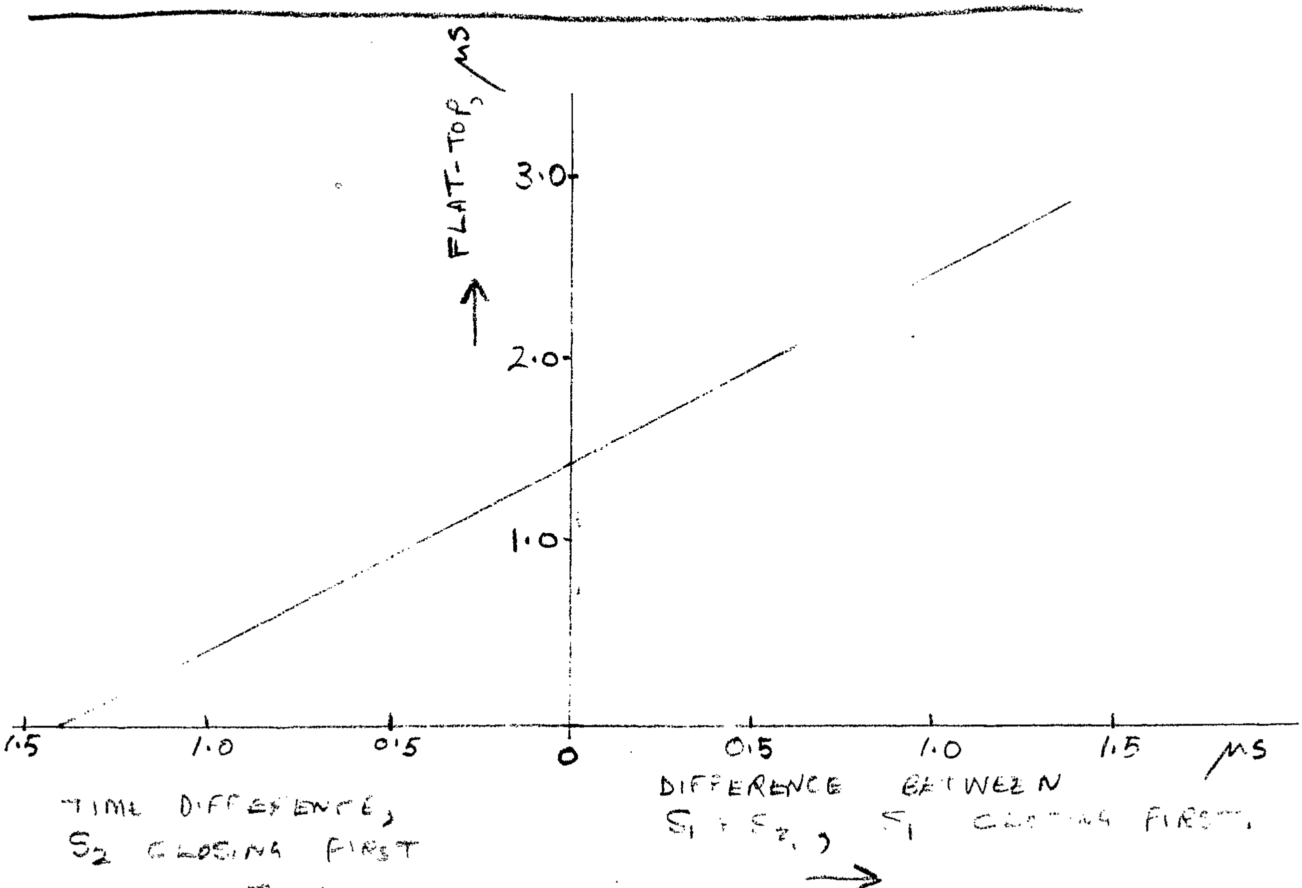

FIG 2. FIELD FLAT-TOP VS S_1 TO S_2 PHASING

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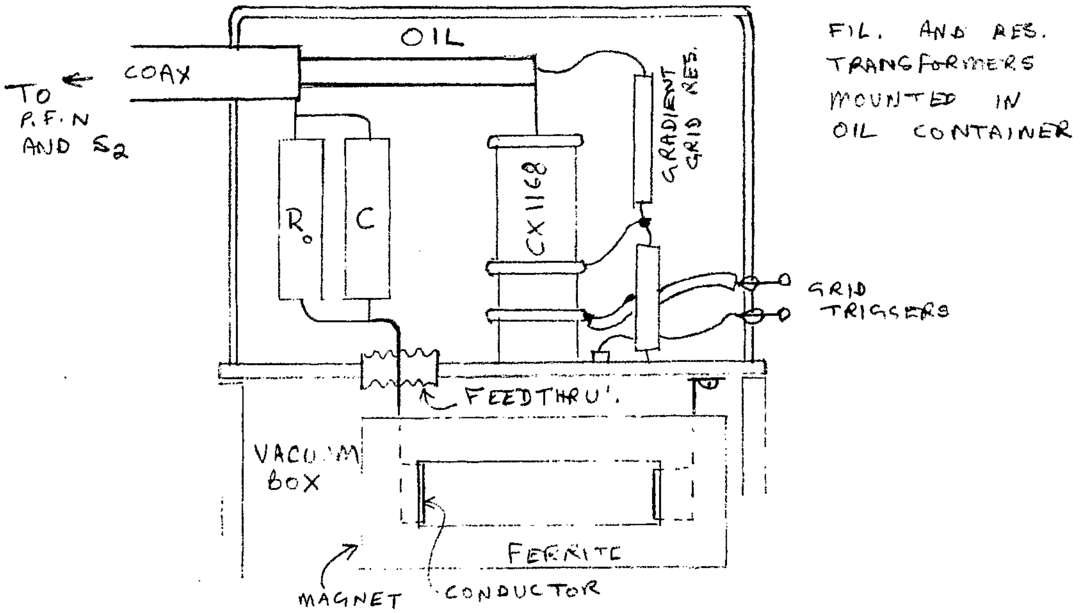

FIG 3. MECHANICAL ARRANGEMENT.

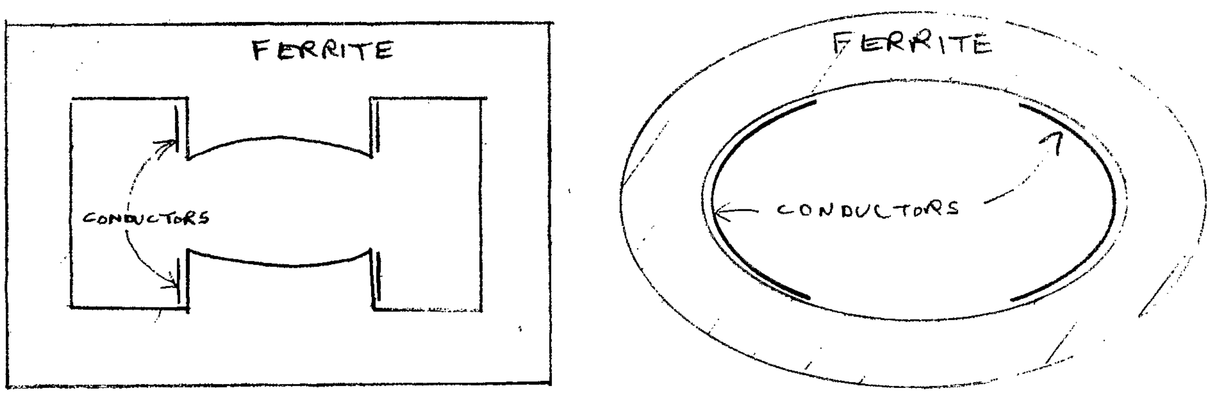

FIG 4 LOW INDUCTANCE KICKER MAGNETS