Accelerator Department
BROOKHAVEN NATIONAL LABORATORY
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AGS DIVISION TECHNICAL NOTE

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M. Fruitman and E.B. Forsyth
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DESIGN OF THE NEW FAST KICKER

Until now the new fast kicker design has been referred to as the 80 kV kicker due largely to the E.B. Forsyth Technical Note #23 of July 25, 1966 which set the maximum limit at 80 kV. This was done at the time because the highest voltage rated tube available was the CX1168 at 80 kV and because the required deflecting force was anticipated to be 132 kilogauss-cm.

The design described here deals with an anticipated deflecting force of 200 kilogauss-cm minimum and thus requires the CX1171 thyratron which has been tentatively rated at 120 kV. Furthermore, the former consideration of two pulses per AGS cycle has given way to three pulses per post conversion AGS cycle. This is a three-fold increase to three pulses per second for partial extractions. The previous specification of "any number of bunches" has been limited, due to practical considerations, to any number up to four per kicker pulse. The previously proposed "tailbiter" circuit will still be used to accomplish this variable bunch feature. Full extraction will still be possible through manual switching of the PFN and tailbiter. A layout is now planned such that the magnets, feedthroughs, load resistors and a polarity switching device are in the AGS tunnel. All other components will be located in

a "cool" area outside.

The New Design

The new design starts from the following premises:

1) The minimum required deflecting force is 200 kilogauss-cm for the post conversion beam.

2) The maximum tolerable risetime is 200 nanoseconds due to the time between bunches.

3) The maximum usable magnet length in a 10 ft straight section is 80 inches or approximately 200 cm.

4) The maximum usable voltage at this time is 120 kV which is the maximum forward voltage rating on the CX1171.

5) The maximum usable current at this time is 8000 amperes which is optimistically based on the present operation of the CX1168 at 6500 amperes.

Three further conditions are added, based on the experience with the present operating fast kicker:

1) The present magnet cross section of 2-5/8 inches (6.65 cm) high by 6 inches (15.25 cm) wide is satisfactory and using these dimensions in all computations, neglecting conductor and insulation thickness, has proven satisfactory within our accuracy of design.

2) The stray inductance in the circuit including the tube, load resistors and connections can be expected to approach 875 nanohenries.

3) The effective magnet length for purposes of computation is assumed to be 1.5 times the height longer than the actual magnet length. Thus, each magnet used is effectively 10 cm longer, based on our magnet height.

Two safety factors were used in all calculations:

1) 175 nanoseconds was used to assure a risetime of less than 200 nanoseconds.

2) A worst case design goal of 250 kilogauss-cm was chosen to yield an expected nominal deflection force of 200 kilogauss-cm.

The specifications and limitations noted above leave only a few variables, all interrelated by the accepted design formulas. Computations were made for each of the cases where the total magnet was composed of one through five equal magnet sections and the results were tabulated. Of these possibilities only the case with four magnets fell within the limits of current, voltage and length previously specified. This case, with each magnet driven by a separate switch tube, yields an optimum of 7.58 ohms load impedance with a magnet length of 128 cm and a current of 7900 amperes at 120 kV.

Additional calculations were made for a similar circuit, but using 7 ohms which would be available based on the nominal impedance of 14 ohms for 100 P2/2 cable. Within the 8000 ampere maximum current this forces a compromise of either the 250 kilogauss-cm deflecting force or the 175 nanosecond risetime. The following summary of proposed characteristics is the result of that compromise and is the design goal for the prototype system which will consist of one quarter of the final system.

Summary of Proposed Specifications

Nominal Deflecting Force, Maximum:	200 kilogauss-cm
Rise and Fall Time (5% points):	190 nanosec.
Flat Top Length:	Infinitely variable, 0-660 nanosec. or 2.7 microsec. (manually switched).
Maximum Number of Fast Kicker Pulses Per AGS Cycle:	Partial extraction - 3 Full extraction - 1
Minimum Time Between Pulses:	Partial extraction - 100 millisec. Full extraction - 500 millisec.
Magnet aperture:	6.65 cm high x 15.25 cm wide
Magnet length, total:	126 cms
Polarity:	reversible in 8 hours
Field stability and ripple, max.:	1%
No. of magnet sections:	4
No. of switch tubes:	4
No. of tailbiter tubes:	4
Operating volts at nominal deflecting force:	100 kV
Deflecting force control, partial extraction:	first, second and third pulse per AGS cycle independently adjustable.

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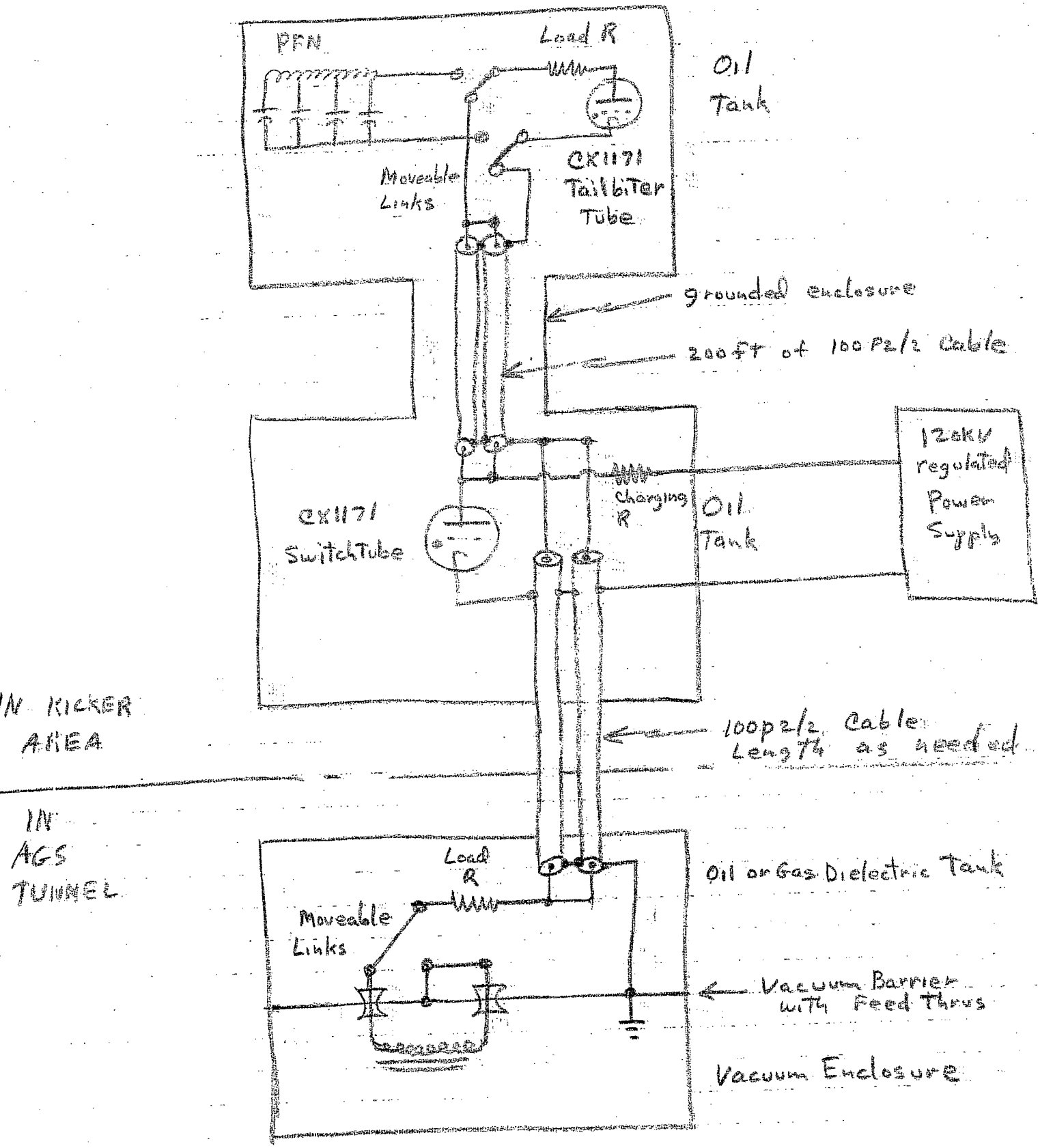
One quarter of full Fast Kicker System