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STATUS OF THE NEW FAST KICKER DESIGN

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Collider Accelerator Department

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AGS DIVISION TECHNICAL NOTE

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In the last eight months considerable evolution has occured on the proposed Fast Kicker design as previously discussed in E.B. Forsyth's Technical Note #23 of July 25, 1966 and the writer's Technical Note #48 of March 28, 1968. Since this evolution has been the result of both changes in requirements and actual initial testing on the one-quarter prototype, it seems appropriate to issue a new note at this time.

The Fast Kicker previously described contained the ability to electrically select the number of AGS beam bunches ejected for each Fast Kicker pulse within the limits to one to four bunches. This feature has been reviewed in detail with the following conclusions:

1. Ejection kicks of three and four bunch width are not required.
2. An ejection kick two bunches in width may never be required, and in any case, mechanical changeover is acceptable.

Therefore, the requirement for electrically adjusting the pulse length has been suspended for the foreseeable future. However, the system will be designed to allow for the addition of mechanical switching into the double bunch pattern. Manual switching into a full twelve bunch extraction mode will also be included. The feature of multiple Fast Kicker pulses for each

AGS cycle is being retained and, in fact, broadened to encompass the possibility of pulsing the Fast Kicker up to twelve times in each AGS cycle. Thus it will be possible, as far as the Fast Kicker is concerned, to extract one proton bunch up to twelve times each AGS cycle.

The elimination of the electrically variable pulse length feature of the Fast Kicker left the "tailbiter" circuit, which was proposed as a solution to both that need and as a device for shortening the pulse fall time, somewhat in limbo. It was agreed to not build the "tailbiter" into the original system but to allow for its provision in case the fall time required it. This provisional discarding the "tailbiter" then led to consideration of a Blumlein circuit which had been previously ignored, largely due to the great complexity of operating such a circuit with a "tailbiter" configuration.

The virtue of the Blumlein circuit is its ability to put full pulse forming network (PFN) charging voltage onto the load, instead of the half voltage of the conventional PFN circuit. Since PFN charging voltage which is the thyratron hold-off voltage has been a limiting parameter, and the Blumlein circuit yields the equivalent of doubling this, the benefit can be reaped in several ways. But due to the limitation in available cable impedances and the small safety factor the previous circuit allowed in rise and fall times, it seems most advantageous to take the benefit largely in rise and fall time by increasing the load impedance from 7 to 14 ohms. This reduction in rise and fall time could be somewhat traded-off by increasing the magnet length, which was reduced in the former design to favor rise time. This could, in turn, allow a slight increase in aperture height, which is now desired, and a slight decrease in tube current. Details of these trade-offs will be determined after tube characteristics are more clearly defined by prototype operation.

Until life tests are run, the tube current remains an indeterminate limit. One requirement of the Blumlein circuit is double the tube current. This requirement is being met by an effort to use two tubes, one on each of the two PFN cables, but tests will be run on the prototype using only one tube to evaluate that condition. Even in the case of two tubes, however, the complexity is not severe since all power supplies and triggers for the two tubes can be common.

Some operational experience using the Blumlein circuit, as shown in the accompanying sketch, has been accumulated on the prototype set-up. The prototype is designed to closely simulate one of the four circuits ultimately required. Operation, so far, has been in air to simplify modifications, and has, therefore, been limited to 30 kV due to corona. Oscilloscope photos (see last page) of the current in the simulated magnet, a 1.2 microhenry choke, show excellent results for rise and fall times when peaking capacitors are used to help shape the pulse being transmitted down the transmission line separating the tube and PFN from the magnet and load. This prototype circuit has now been modified to use two switchtubes. Preparations are now being made to attempt full voltage operation.

It should be noted that the preliminary operation took place with the magnet separated from the load resistor by 60 ft of transmission line. This infers the possibility of leaving the load resistors in the FEB building and the possibility of removing the oil container which they required from the ring.

Summary of Revised Specifications

Nominal deflecting force, maximum:	200 kG-cm
Nominal flux density:	1312 Gauss
Operating volts for nominal deflecting force:	105 kV
Rise time (to 1% of peak amplitude)	190 ns maximum
Base line to base line pulse width:	420 ns maximum
Flat top length:	30 ns minimum or 2.7 microsec. (manually switched)
Maximum number of fast kicker pulses for AGS cycle:	Single bunch extraction - 12 Full extraction - 1
Minimum time between pulses:	Single bunch extraction - 100 msec Full extraction - 500 msec
Magnet aperture:	7.00 cm high x 15.25 cm wide
Magnet length, total of four:	152.5 cm
Polarity:	Reversible in 8 hours
Field stability:	1%
Pulse flat top ripple, max:	1%
Number of magnet sections:	4
Number of switchtubes:	8
Deflecting force control, partial extraction:	Each pulse individually programmable

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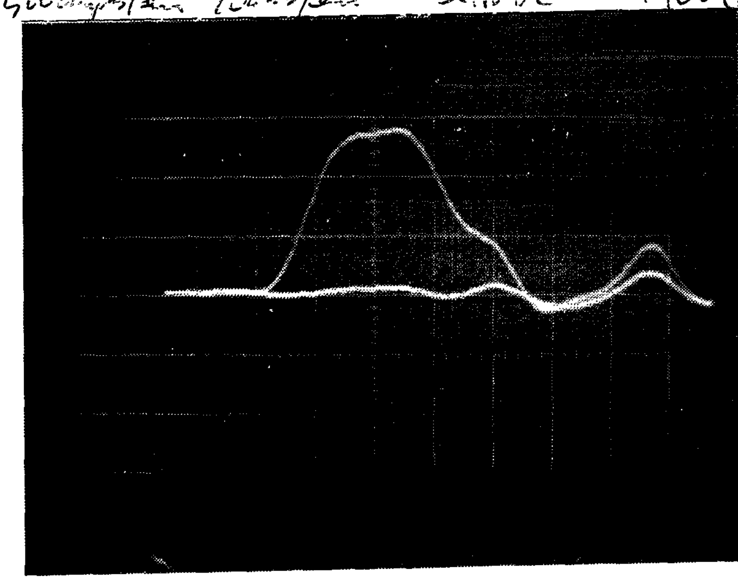
500 amps/cm 100 ns/cm 20 kV DC 12/5/60 (1)



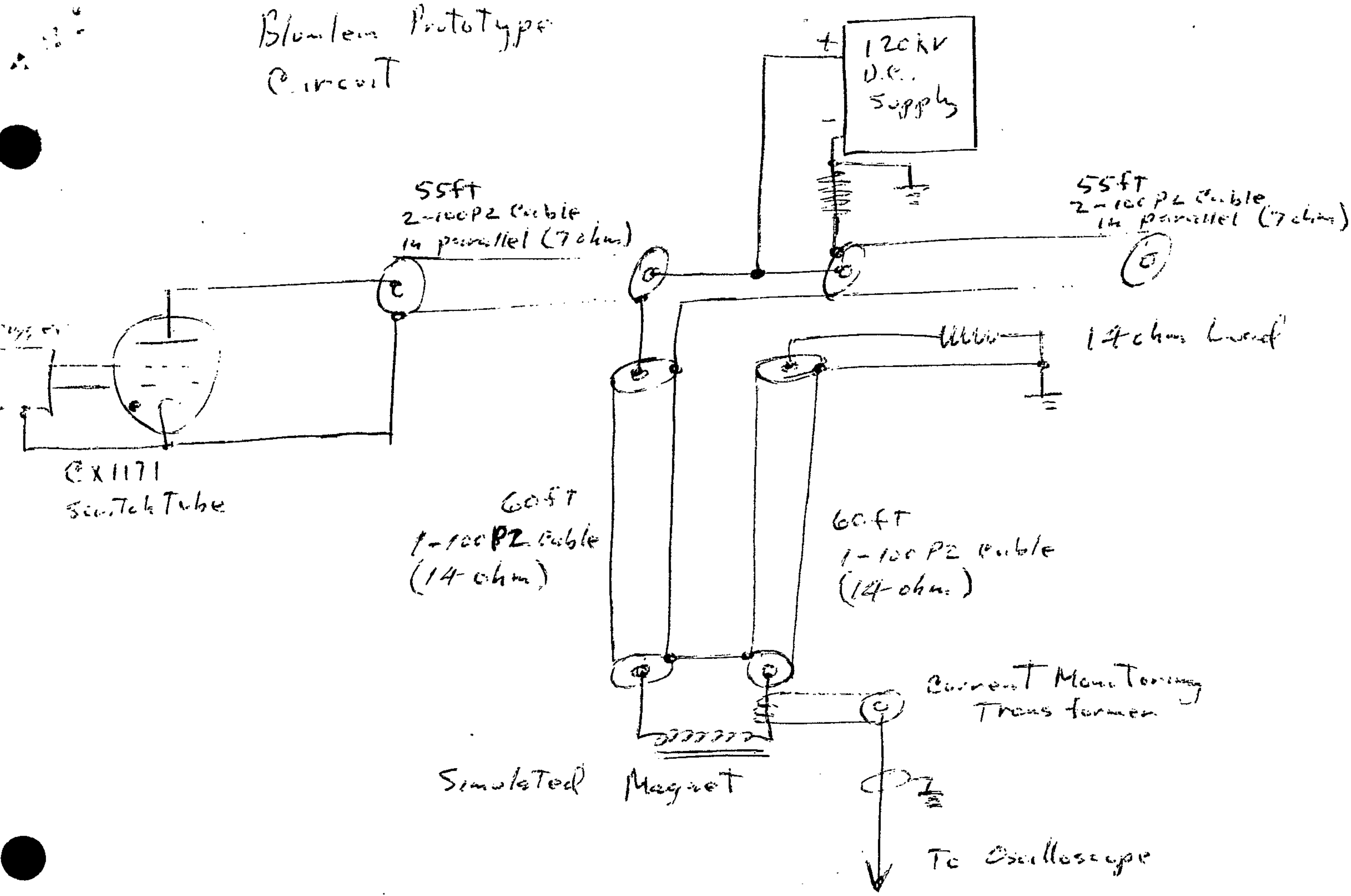
500 amps/cm 100 ns/cm

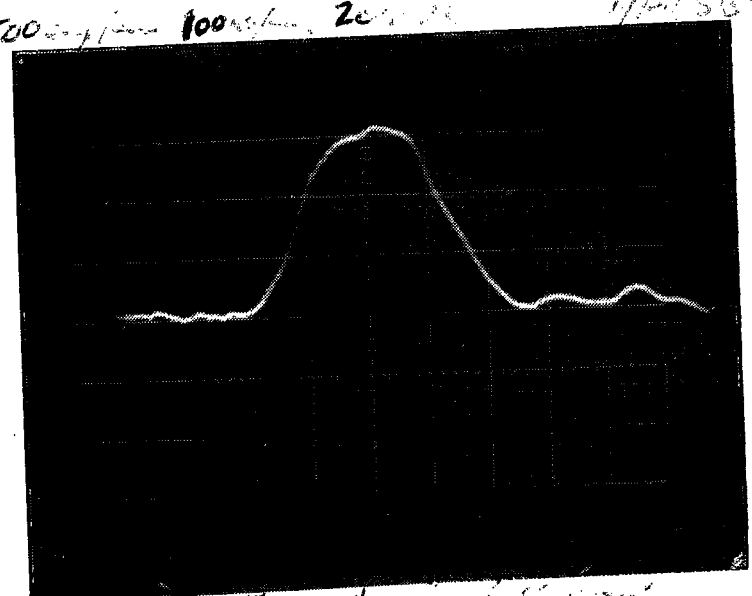
20 kV

Magnet coil current monitored by Pearson transformer with cable shield waveform also shown.

Blumlein circuit, two tubes, 14 ohm load, gated dc supply, magnet coil in center of 120 ft of transmission line.

Blumlein Prototype Circuit





500 ... 100 ... 2 ...