PS/Int. EA 60-2
18th March 1960

# PROGRESS IN FAST EJECTION.

## SUMMARY.

The principle of fast ejection as well as a reduced model setup are outlined. An oscillogramme is shown of an 800 A, 100 mμs long, square current pulse with a rise and decay time of shorter than 15 mμs together with the magnetic kick *) produced thereby in a ferrite core delay line magnet. The rise and decay time of the kick are 45 mμs, its top is flat during 60 mμs and the field density is 650 gauss.

## OUTLINE OF THE SYSTEM.

The C.P.S fast ejection system will comprise a scaled up version of the delay line magnet as proposed by O'Neill [1]). This will be part of a system [2]) that will include a fast kicker magnet and a slower, pulsed, bending magnet together with their power supplies controls and mechanisms to bring the magnets into position at the end of the acceleration cycle.

The kicker will give the beam an angular deflection such that 1/4 of a betatron wavelength furtheron the beam enters the aperture of a bending magnet which bends it out of the machine. The rise-time of the magnetic field will be small with respect to the revolution time of the protons in the C.P.S. It will be attempted to synchronise this rise-time between the proton bunches (spaced at approximately 80 mμs) to reduce background radiation and particle loss. The ejection of a single bunch, e.g. for bubble chamber experiments, lies then within the possibilities by choice of the length of the excitation current pulse. The major part of the beam would then be left undisturbed for further use.

Fig. 1 gives a simplified scheme of the delay line arrangement. When the gap G is fired a square current pulse propagates to the right through the delay line magnet into a dissipation resistor. The rise-time of the magnetic kick is the sum of the rise-time of the current pulse and the delay time of the magnet.

*) "Magnetic kick" is used here for the integral of the magnetic field along the magnet.

## DESCRIPTION OF A REDUCED MODEL.

A reduced model of 10.4 Ω was built and operated around 16 kV. The assembly is shown in fig. 2. 5 parallel coaxial cables of 52 Ω, giving a current pulse duration of 100 mμs, form the storage line. The upper cylinder (fig. 3) contains a sparkgap and a mutual inductance giving a signal proportional to the time derivative of the current. 5 other cables lead then to the kicker magnet (fig. 4) in the oiltank with glass window and from the latter to the dissipation resistor (fig. 5) in the lower tank.

## EARLY RESULTS.

The current pulse, as produced by discharging the 5 cables by a sparkgap into the 10.4 Ω system, was displayed on a 517 Tektronix scope by integrating the signal coming from the mutual inductance. The trace is shown in fig. 6, where 1 division horizontally represents 20 mμs. The slight droop can be accounted for by the 50 Ω cable terminating resistor shunting the RC integrating network. The departure from a flat top is actually smaller than 5 o/o of the height of the pulse. Taking into account the rise time of the scope (∼10 mμs) the estimated rise and decay time of the current pulse is smaller than 15 mμs. Its duration is 100 mμs and its intensity 800 A.

The magnetic kick produced by above current pulse in the delay line magnet was measured with a long single turn probe going through the entire length of the kicker aperture. This probe gives a signal proportional to the time derivative of the kick. Again, the signal was displayed on a 517 scope after integration (fig. 7). As the delay time of the kicker magnet is 30 mμs the rise and decay time of the kick is around 45 mμs. The top is flat for around 60 mμs. The flux density is 650 Gauss.

## FURTHER DEVELOPMENT.

In a new model of a kicker magnet the influence of the grade of ferrite will be studied as well as the problems arising from the use of voltages up to 100 kV that are necessary to produce the high currents required (6000 A).

Simultaneously the time jitter and long term variation between an incoming synchronisation pulse and the rise of the magnetic field will be studied.

It is intended to build a prototype unit, i.e. one of the four kicker magnet units with its storage lines for single bunch and full turn ejection, a spark gap adjustable for voltage and a dissipation resistor early this Summer. Extensive tests will be performed thereon.

The second half of 1960 will be taken by manufacture and testing of the remaining three units, the bending magnet with its power supply, the moving mechanics, controls and vacuum vessels.

It is hoped to install the complete system in the beginning of 1961.

B. Kuiper
G. Plass

REFERENCES

1) G.K.O'Neill, V. Korenmann, Int. Report
(GKO'N-10, VK3)
Princeton University Accelerator Project

2) B. Kuiper, G. Plass, "On the fast extraction of particles from a 25 GeV proton synchrotron,CERN 59-30

/fv

Distribution: (open)
Parameter Committee
Magnet Group

All parts have characteristic impedance of 10.4 Ω

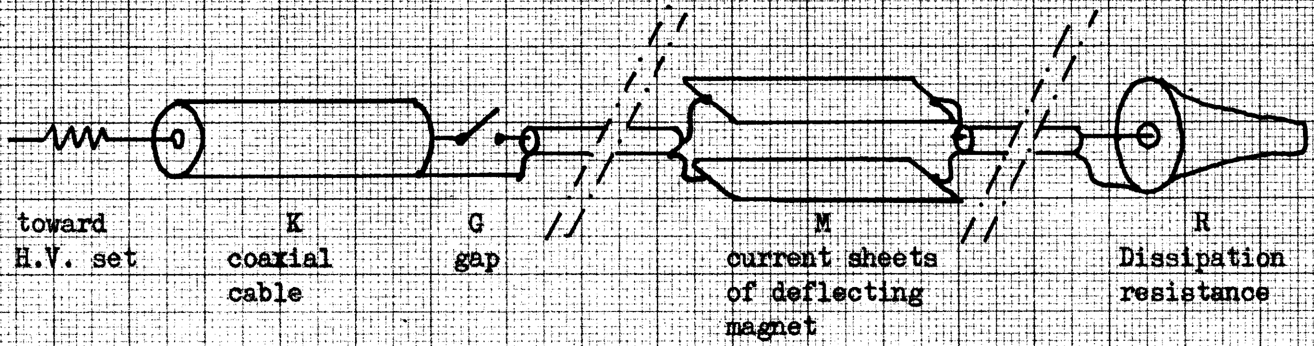


Fig. 1 Simplified scheme of fast ejection circuit.

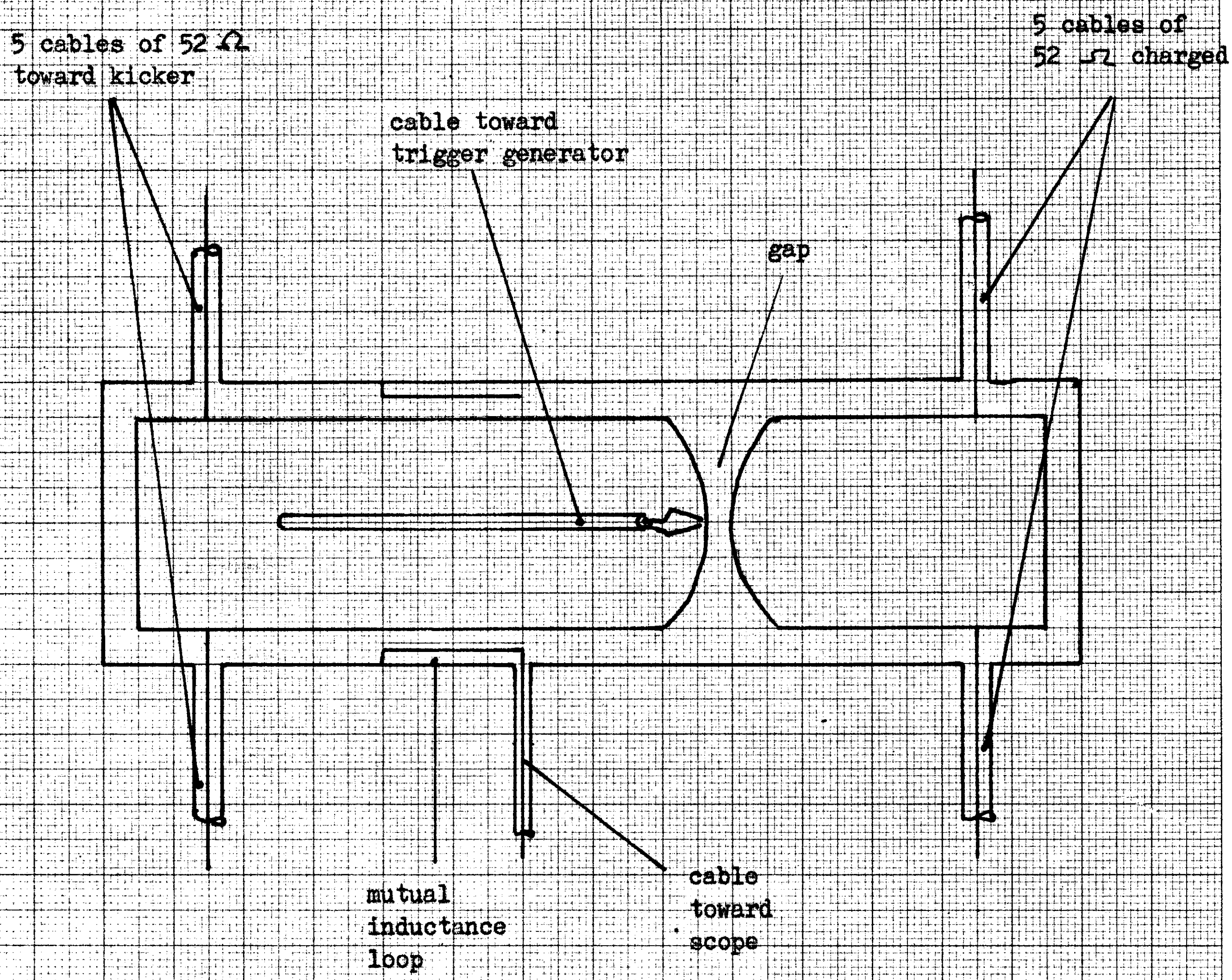


Fig. 3 Sketch of sparkgap assembly.

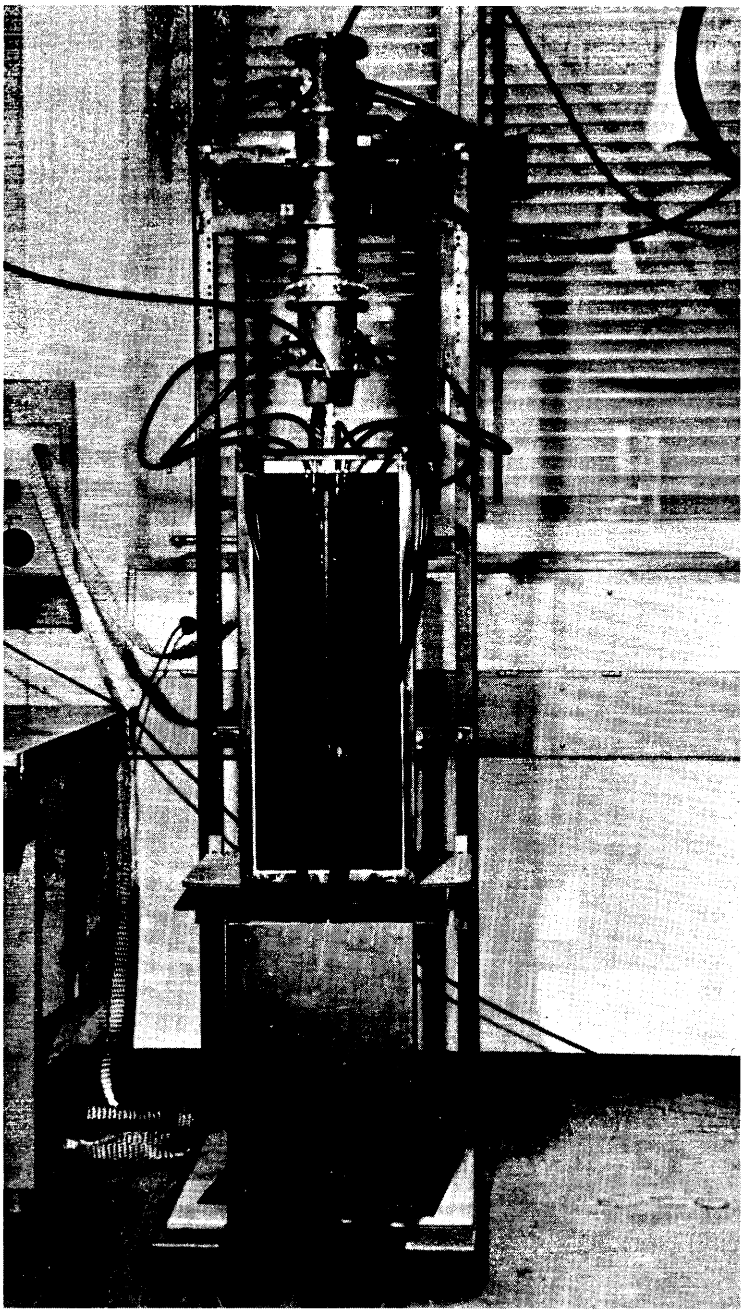

Fig. 2 Model of delay line ejector assembly. Upper cylinder contains spark-gap and mutual inductance. Oil tank with glass window contains delay line magnet. Lower tank contains dissipation resistor.

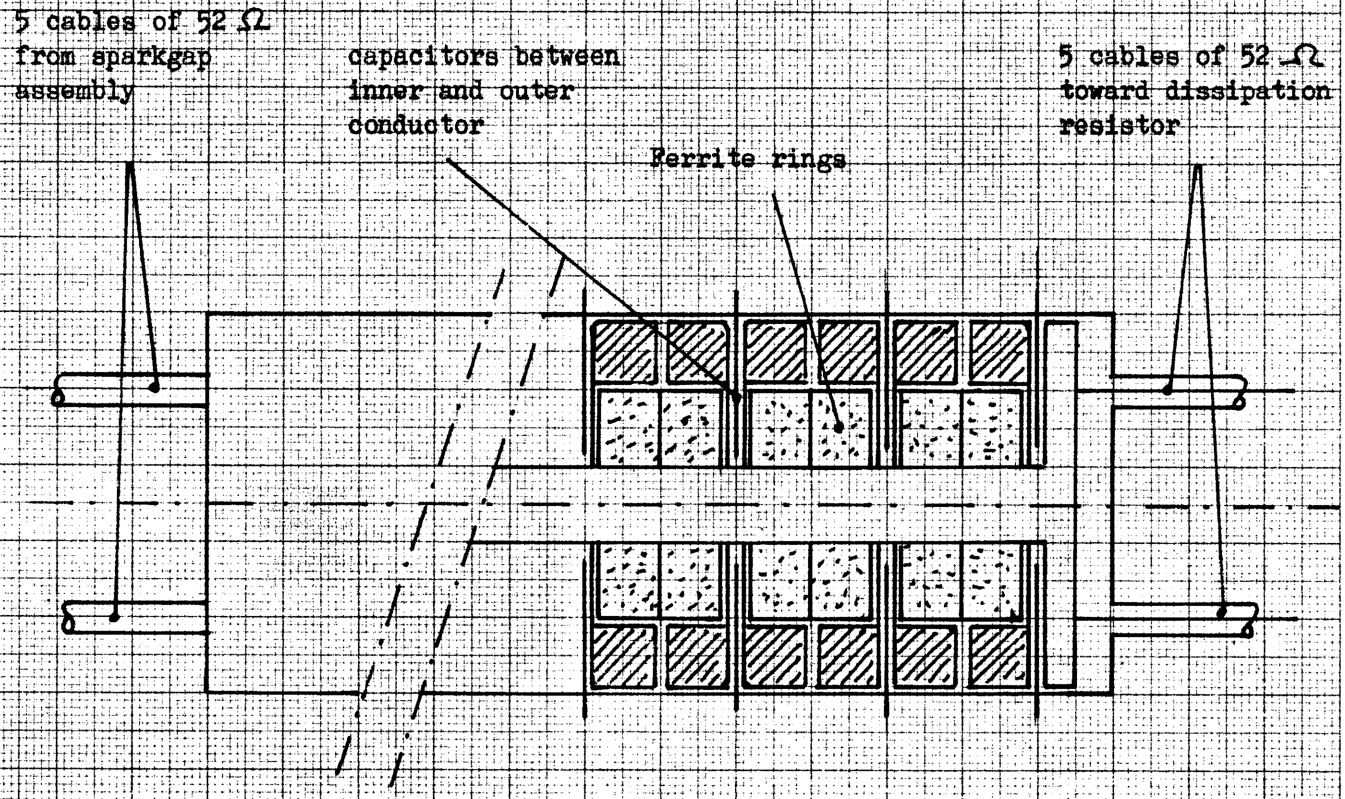


Fig. 4 Sketch of delay line kicker magnet

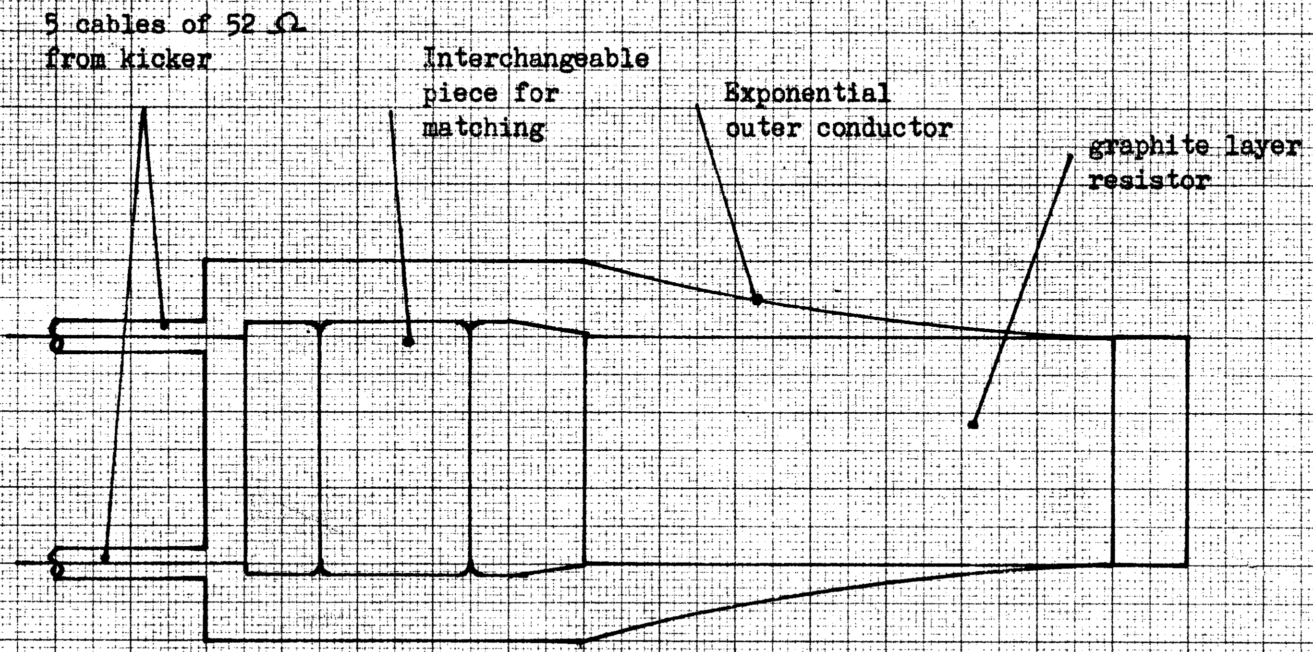


Fig. 5 Sketch of dissipation resistor.

PS/1355

Fig. 6 Current pulse of 800 Amps. Integrated signal from a mutual inductance. Timebase 20 ns/cm.

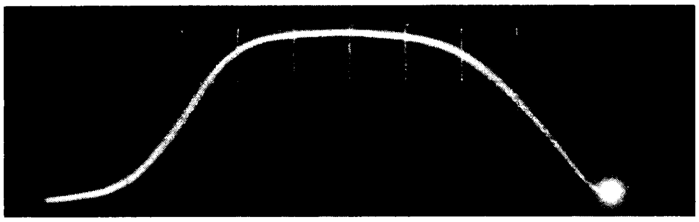

Fig. 7 Field pulse of 650 Gauss. Integrated signal from a field measuring loop. Timebase 20 ns/cm.