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A PROPOSAL FOR 20 x 1 or 10 x 2 BUNCH EJECTION

FROM THE CPS TO THE 300 GEV MACHINE

BASED ON A NEW FAST CHARGING SYSTEM

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The described system shall be capable to drive one set of four kicker magnet modules 20 times with a time interval of 50 μs between pulses. Therefore the 20 x 1 bunch ejection could be done in 1 ms. The ejection is foreseen at an energy of 10 GeV with a deflecting force of 1.5 mrad (when using 4 modules in a short straight section, each 20 cm long, 15 Ω impedance, such as proposed by D. Fiander for fast ejection 16).

The essential novelty of the system described here (see fig. 1) is the fast recharging system, using a second H.V. thyratron 2 to determine the beginning of the recharging cycle.

The recharge energy for all 20 pulses is stored before in the slow line, so that no high power mains connection will be needed.

The recharge thyratron 2 may be fired and will start the recharging cycle after deionization of the main switch tube 1 which produces the kick.

The reproducibility of the amplitude of the twenty kicks is given by the performance of the slow storage line as long as the total time taken by firing the twenty pulses does not exceed twice the propagation time of this line.

Unvoluntary firing of Th 2 (when firing Th 1) is prevented by "despiking" the anode voltage of Th 2 by means of the L_1 C_2 R_2 network. A time constant of several hundred nanoseconds, comfortable for hold-off of the tube is admissible within the 10 µs recharge time.

Kicker recharging cycle

1. Slow charge (1 sec) of PFN 2 to 75 kV (PFN 1 discharged).
2. Fire tube 2 (Th 2) and charge of C_1 to 80 kV (L_1-C_1-Z_o : strongly damped resonant circuit with ≈ 6 °/o overswing).

   Charge time : 10 µsec.
3. Deionization of Th 2 : 20 µsec.
4. Fire tube Th 1 : kick ≈ 40 nsec flat top
5. Deionization of Th 1 : 20 µsec.
6. ⟶ 1. ready for next cycle.

The discharge pulses propagate down in the slow line and are reflected at the open end (left-hand side on fig. 1). The 20th pulse must be passed before arrival of the 1st discharge reflection on the right hand-side of the slow line. After a 20 pulse-cycle the slow line is only partly discharged.

Technical remarks

1. Resonant circuit L_1 C_1 Z_o :

   $Q \approx 0.7$; 6 °/o overswing ($\hat{=}$ 5 kV) strongly, but under-critically damped. The overswing voltage (5 kV) covers the difference between the slow line (ms-line) voltage (75 kV) and the PFN (cables) - voltage (80 kV).

If L_1 C_1 Z_0 is overcritically damped, the tube 2 will not turn off.

If L_1 C_1 Z_0 is not enough damped (overswing > 15 °/o) the tube 2 will fire in the inverse sense (tube damage).

2. <u>Circuit R C_2 (- L_1)</u>

   Limitation of the voltage rise time on tube 2 to > 100 nsec. (if faster, the tube cannot be protected against self-firing).

   L_1 may eventually be realized with a saturating ferrite core.

3. For fast deionization of both thyratrons (1 + 2) double pulsing of grid 1 + 2 shall be applied.

4. The tube 2 with fast rising anode voltage needs a $-\frac{du}{dt}$ proportional current feedback to grid 2 to prevent against self-firing.(Similar system developed for 800 MeV PS injection).

5. <u>Possible recharging cycles</u>

   5.1 <u>20 x 1 bunch</u> in $\geqq$ 1 ms = 20 · 50 μsec
   (PFN : 14 μF for 4 modules)

   5.2 <u>10 x 2 bunch</u> in $\geqq$ 0.5 ms = 10 · 50 μsec
   (PFN : 28 μF for 4 modules)

   The PS effort is about the same for both cases.

6. The H.V. Supply for the slow line is proposed to be realized with a voltage doubling stray-transformer one phase rectifier (~10 kVA).

Cost estimate for a fast cycling 80 kV-20 pulse power supply

	full size kFr.	model kFr.
Slow line (1.5 μF/80 kV) high reliability	50	
low reliability		12
Thyratron C x 1171	13	13
Metal mounting	20	20
Double pulse trigger system	10	10
Control circuits	10	10
Voltage doubling rectifier (10 kVA)	30	borrowed in CERN
	133	75

Cost estimate for a 1.5 mrad 10 GeV ejection system

1.	Main switch 80 kV/10700 A/15 Ω , 4 x parallel	
	4 x C x 1171	52 kFr.
	Metalwork	20 "
	Trigger system (double pulse trigger)	20 "
		92 kFr.
2.	Terminating resistors	
	Constantan bands, air-cooled	10 kFr.
3.	PFN : 80 kV semi-conductor screened cables or SF6 pressurized cables 100 m/15 Ω / 80 kV total	10 kFr.
4.	Connection cables 80 kV	10 kFr.
5.	20 pulse fast cycling power supply	130 kFr.
6.	Measuring system	15 kFr.
7.	Timing system	25 kFr.
		40 kFr.
	Interlocks and protections	10 kFr.
	T o t a l	382 kFr.

The new fast charging system could either be adapted

i) to the full aperture kicker 16, or

ii) could be connected to a new kicker magnet in another short straight section.

When using a new straight section (ii) the additional costs for 4 modules + 1 vacuum tank are about 80 kFr. This has to be balanced against possible problems in the first case (i).

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20 × 1 bunch fast cycling Kicker Circuit

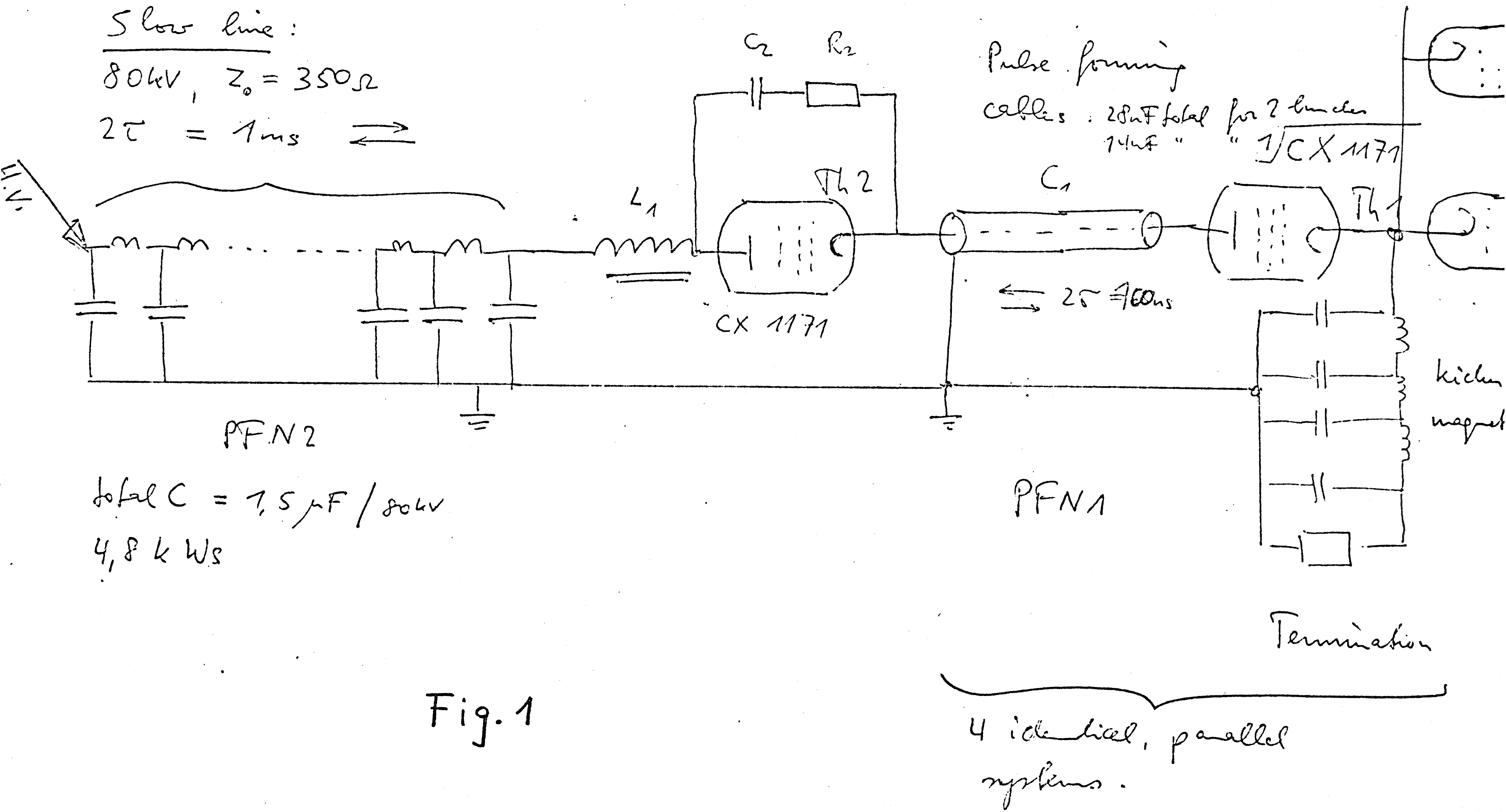

Fig. 1