POWER SUPPLIES OF THE SYNCHROTRONS FOR NUMATRON PROJECT

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Abstract

Power supplies of two synchrotrons, 1st-Synchrotron and 2nd-Synchrotron, for the NUMATRON project are designed. The two power supplies consist of motor-generator-flywheel set, thyristor equipments and DC filters.

The average power and the peak power are 1.1 MW and 36 MW for 1st-Synchrotron, and 3.7 MW and 20 MW for 2nd-Synchrotron, respectively. The repetition rate of the both synchrotrons is 1 Hz.

1. Introduction

Now, we are planning to construct the accelerator complex in the NUMATRON project, which consists of 10 MeV/u Linac, 250 MeV/u 1st-Synchrotron and 1300 MeV/u 2nd Synchrotron.[1)]

The two synchrotrons are designed with separated-function, strong focusing lattice. Their specifications are shown in Table 1.

The power supplies are required the following special features;

1) the maximum energy of 2nd Synchrotron is adjustable between 250 MeV/u and 1300 MeV/u continuously,
2) it is possible to vary the maximum energy of 2nd Synchrotron pulse to pulse.

At present, the detailed design of the magnets and the investigation of the power supplies are in progress.

In this report, the power supplies are discussed.

2. Operation Modes

The typical patterns of the operation modes of the 1st-Synchrotron and 2nd-Synchrotron are shown in Fig. 1, and the maximum power requirements are shown in Table 2.

As above mentioned, the actual operation mode consists of the patterns of the various maximum energies in some cases, as well as the case consists of only the same pattern. In addition, the excitation current should be varied corresponding to the kinds of accelerated ions, even if the operation energy is the same.

Then, the following procedures are done by utilizing a computer,

1) the patterns are generated precisely, which are prescribed by the kinds of ions and the energy requirements,
2) the patterns are programed in the order of the schedule of parallel experiments.

3. Constitution of Power Supplies

The block diagram of the power supplies are shown in Fig. 2.

The power rates of the rotating machines are about 6.5 MW, 20 MVA and 25 MVA for the motor, for the generators of 1st and 2nd synchrotrons, respectively.

The motor-generator-flywheel set is favorable to adjust the excitation level of the synchrotron magnets throughout the wide range, because the generator output voltage, which is supplied to the thyristor equipments is able to be adjusted by the excitor field and it leads the firing angles of the thyristors to be little.

The thyristor equipments are constructed as 24-phase convertor and followed by passive and active filters. Then the current ripple is reduced to the order of 10^{-4}.

References

1) T. Katayama et al., "NUMATRON and TARN" INS-NUMA-17, 1980.

Table 1

	1st-Synchrotron	2nd-Synchrotron
Injection Energy	10 MeV (U^{+46})	250 MeV (U^{+92})
Maximum Energy	250 MeV (")	1300 MeV (")
Lattice Structure	FODO	FODO
Average Radius	29.40 m	33.61 m
No. of Bending Magnet	48	48
No. of Q-Magnet QF	32	32
QD	24	24

Table 2

	1st-Synchrotron		2nd-Synchrotron	
	B-Mag.	Q-Mag.	B-Mag.	Q-Mag.
Injection	787 A	436 A	1567 A	724 A
Acceleration	6.3 kV	1.5 kV	3.3 kV	1.1 kV
Flat Top	4500 A	2500 A	4500 A	2500 A
Deceleration	-5.7 kV	-1.0 kV	-2.3 kV	-0.5 kV

Fig. 1

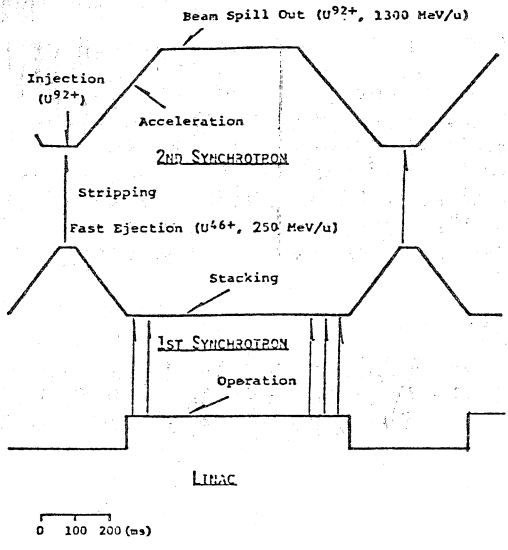

Fig. 2