A STABILIZER FOR DEE VOLTAGE AND RESONATOR FREQUENCY IN INR CYCLOTRON

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Abstract

The INR cyclotron which was converted from a classical one has been put into operation for two years. For improving the stability of extracted beam current, a new stabilizer for dee voltage and resonator frequency has been successfully developed in this machine. The design feature of this system operated in frequency range from 10 MHz to 20 MHz are reported. Some comparative results with and without the feedback system are also given.

Dee Voltage Regulation System

According to the conversion project of this machine[1,2] the accelerating system with two-180° dees was replaced by a single 180°-dee system. A new capacitive pick up probe is used for the regulator to obtain the feedback signal This signal is firstly detected, then compared with a precise reference voltage , and gained by an IC operational amplifier . Finally it is fed to the second cascade of RF generator. For all of these connections between probe and device, the coaxial cables are used in order to avoid the heavy interference of RF electromagnet field. The main block diagram of this system is shown in Fig.1

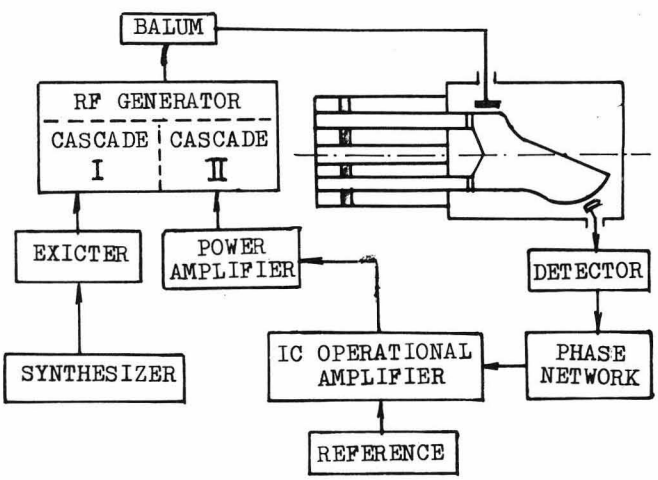

Fig.1. Main block diagram of the dee voltage regulation system

A network for phase correction is inserted to prevent the oscillation caused by self-exciting action, it also improves the shape of the pulses when the machine is running with a variety of marco duty factor. Fig.2 is the pulse shape in different conditions. The pulse width is 1 ms.

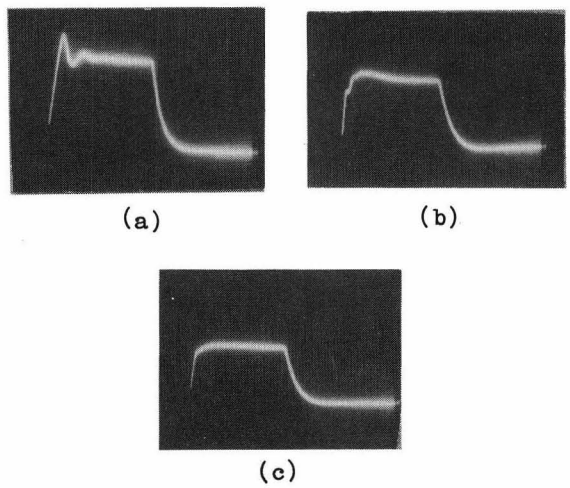

Fig.2. The pulse shape in different conditions.

a) short of compensation
b) over compensation
c) suitable compensation

Resonator Frequency Regulation System

Because of the final power amplifier is grid-ground circuit in our RF generator, the phase error signals are obtained from both the cathode and plate in this cascade. The phase difference between two electrodes varies with the tuned condition of the resonator sensitively. For filtering the harmonics occured in Class-C amplifier, there is a bandpass filter in the input of each circuit. A special limiter keeps the input amplitude of the phase detector constantly over more than 28 db of RF voltage variation. In this system a sample-holding circuit is applied which satisfies the need of controller in pulse operation. Fig.3. shows the main block diagram of this system.

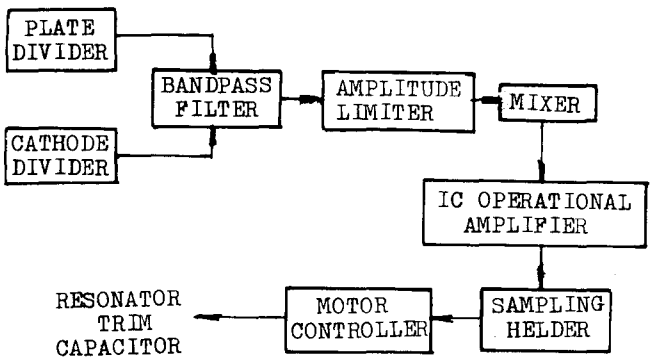

Fig.3. Main block diagram of the resonator frequency regulation system

Tests and results

Due to the influence of the electrical power and other factors, the dee voltage variation can get up to 10% sometimes, but after using this system , this value drops down to $5 \cdot 10^{-3}$ instantly in the same condition. The long term stability is also found good enough from the readings of the digital voltage meter.

In order to keep the resonator tunning at the working frequency , the operators had to adjust the trim capacitor, such precedure is not necessary anymore.

Tests have shown that the frequency stability of the resonator is better than $2 \cdot 10^{-4}$ and the phase shift is less than 0.6°(RF degree).

After upgrading the RF generator, more effective feedback system will be tested.

Reference

1. J.Zhang and X.L.Liu, IEEE Trans.Nucl. Sci. NS-32,No.5 (1985) 2821.
2. Chang Hongjun et al., 9th Intl Conf on cyclotron and their applications September 7-10th, 1981.