INTER-CAVITY PHASE CONTROL SYSTEM FOR THE KEK BOOSTER SYNCHROTRON

Kikuo Kudo, Eizi Ezura and Motoh Kondoh

National Laboratory for High Energy Physics

Abstract

The principle and the performance of the system which control the phase difference between two cavities for the KEK booster is reported. A plan for the new phase control system is briefly described.

1. Introduction

At present the proton beam in the KEK booster is accelerated by the single RF station. In order to increase the maximum RF voltage, the new RF station has been constructed and is now being tuned. The new cavity is placed 45 degrees apart from the existing one. Therefore it is desirable for efficient acceleration that the phase difference between two cavities is kept at 45 degrees throughout the acceleration period, in which the frequency changes from 1.6 MHz to 6 MHz.

2. Phase Control System

Fig.1 shows the arrangement of the two RF cavities along the booster ring. Since the harmonic number of the machine is unity, the electrical phase is the same as the geometrical one. Fig.2 shows the block diagram of the RF system, including the phase control loop. The phase controller contains the quadrature hybrid, the PIN diode attenuators and the power coupler as shown in Fig.3. The low-level RF signal from the VCO is divided, in the phase controller, into two signals in equal amplitude with a phase difference of 45 degrees. Information on the deviation from the reference phase (45 degrees) is obtained by a phase comparison between two cavity voltages. The correction signal from the phase detector followed by the balanced-output amplifier is fed into the phase controller to bias the PIN diode attenuators. The bias currents supplied to the diodes control the attenuations of the quadrature phased RF signals, which are summed with the power coupler to vary the phase of No.2 cavity.

3. Results of Measurement

Fig.4 shows the phase difference between two cavities measured in dynamical operation (20 Hz); Fig.4-(a) was taken when the loop was open and Fig. 4-(b) when loop was closed. The phase control system does not have sufficient performance yet, because of (1) unbalanced phase shifts in two amplifier systems, (2) narrow phase dynamic range, and (3) low loop gain. Improvements in these points are being done as machine downtime permits.

4. Plan for New Phase Control System

We are planning the new phase control system in which the phase difference can be controlled over the range of 0 ∿ 180 degrees. Fig.5 shows the block diagram of the new phase control system.

Acknowledgement

The authors wish to thank Dr. J.E. Griffin of Fermilab for his suggestion on the phase control system which covers a wide phase range.

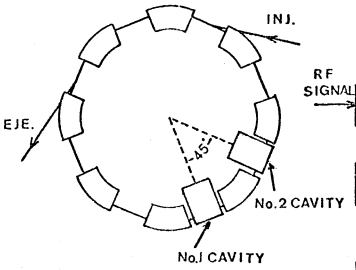


Fig.1 Arrangement of the two RF cavities.

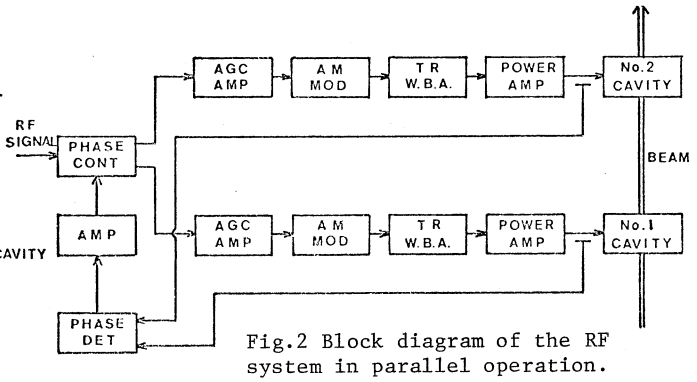


Fig.2 Block diagram of the RF system in parallel operation.

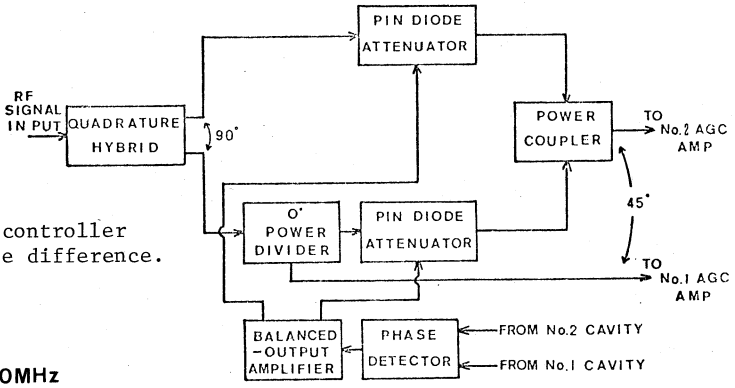
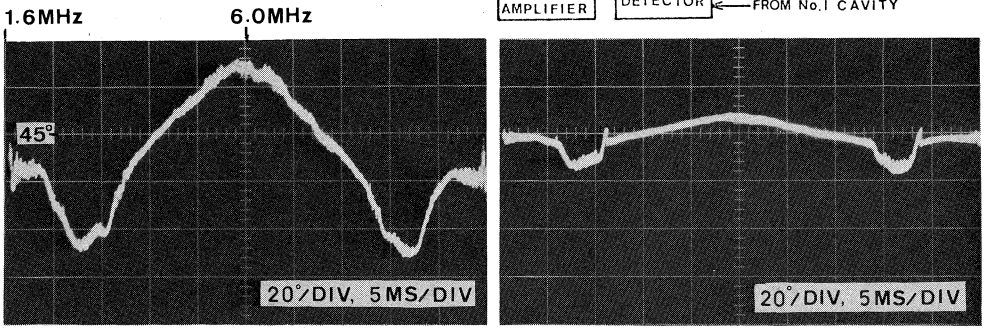


Fig.3 Phase controller for 45° phase difference.



(a) open loop (b) closed loop

Fig.4 Phase difference between two cavities measured in dynamical operation.

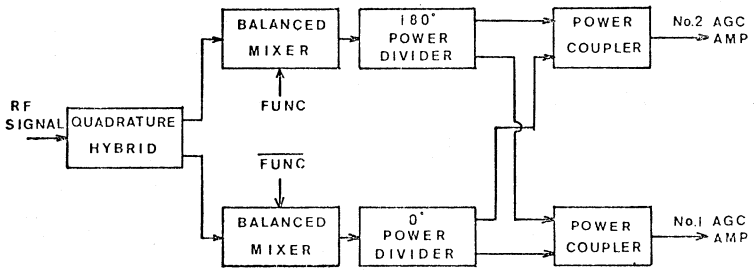


Fig.5 New phase control system.