A FOUR GAP SYNCHROTRON RF CAVITY*

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Summary

A proposed four gap synchrotron cavity is described here. The drift tube (140° long) is rigidly supported by a reentrant conducting structure near each end. Each support structure provides two accelerating gaps. The potential across each gap is approximately the same as the potential between the drift tube and the vacuum tank wall in the central region. The reentrant feature has the effect of a two-turn center tapped transformer, which is achieved in the cavity by passing one current surface through another by means of spokes and holes.

The Cavity

Rapid cycling synchrotrons are producing a need for rf systems with higher energy gain per unit length. Because of the nonlinear relationship between gap size and breakdown voltage, mutiple gap cavities may be capable of higher energy gain per unit length. The topology of a proposed four gap synchrotron cavity is illustrated in Fig. 1. This insulator-free structure has good mechanical rigidity and all metal coolant paths. To evaluate voltage distribution, power consumption, Q, etc., approximate solutions to the wave equation have been pieced together from solutions for coaxial and radial transmission lines. The results of such a calculation for a four gap cavity with the support points located 25% of the way in from each end are listed in Table I.

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Table I. Cavity Characteristics

Drift Tube Diameter	0.10 m
Tank Diameter	0.61 m
Tank Length	2.40 m
Gaps	0.08 m
Resonant Frequencies	
Fundamental Mode	48.3 MHz
Antisymmetric Mode	53.9 MHz
Fundamental Mode Q	4,800
Voltage Distribution	
Outer Gaps	139 kV
Inner Gaps	128 kV
Spoke-to-Hole	100 kV
Drift Tube to Tank (Max.)	118 kV
Energy Gain (140° Transit)	503 keV
Stored Energy	2.75 Joules
Dissipation (Copper)	175 kW

Conclusions

The cavity design presented here has not been optimized. Comparisons with other synchrotron cavities at equal energy gain per unit length and similar frequency show that this cavity has a comparable amount of stored energy per unit length and somewhat (≈40%) higher power requirements. It is believed that the power can be reduced by optimizing the configuration. The four gap design appears to be conservative in terms of voltage breakdown, and thus may provide a means of achieving higher values of energy gain per unit length.

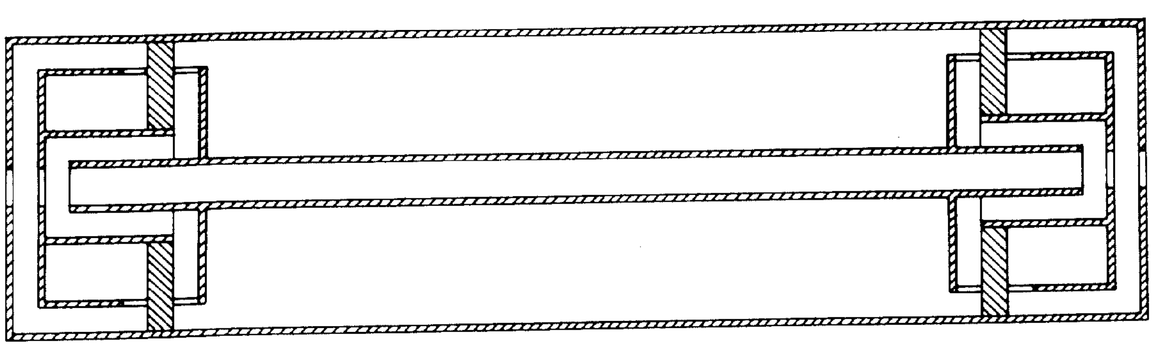

Fig. 1. The four gap drift tube cavity. The cavity is axially symmetric, except for the spokes which support the central structure and the holes through which they pass.