R. F. PROBLEMS ASSOCIATED WITH INCREASING THE MAXIMUM ENERGY OF THE HARWELL CYCLOTRON ABOVE 170 MeV.

The following data refer to the existing design -

Centre Field 16,000 gauss

Field at n = 0.2 15,500 "

Max. Energy 170 MeV.

Starting Frequency 24.5 Mc/s.

Frequency at n = 0.2 20.1 Mc/s.

% Frequency Modulation requifed 18% assuming the field can be shimmed to be only 3% down at n = 0.2 and that the diameter for n = 0.2 will be 100 inches.

As the Frequency Modulation law given by the rotary condenser is approximately sinusoidal it has been assumed that only the part between $\theta = 30^{\circ}$ and 150° can be used for the accelerating period. The peak to peak modulation depth is therefore 18/.866 = 20.8% and the total frequency sweep 19.65 - 24.85 Mc/s.

The modifications to the Cyclotron can be listed under the headings -

Case 1. Increase in power to Magnet Coils.

Case 2. Increase in pole diameter.

Case 3. Increase in pole diameter and power to coils.

Case 1.

a) The present power to the magnet is 250 KW for a centre field of 16,000 gauss. The existing generator can be run up to 400 KW. to give a centre field of 17,000 gauss. The following data would then be applicable.

Field at n = 0.2 16,500 gauss

Starting Frequency 26 Mc/s.

Max. Energy 190 Mev.

% Frequency Mod^{n} 19.3 %

Frequency at n = 0.2 21 Mc/s.

Peak to Peak Modulation 22.3%

b) A new generator capable of supplying 850 KW would give a centre field of 18,400 gauss and the energy obtained would be 220 MeV.

The starting frequency is now 28.1 Mc/s. and the Peak to Peak Modulation 24.9%, the total frequency sweep being 28.57 - 21.61 Mc/s.

/Increasing

Increasing the power to the coils and hence the centre field of the magnet does not materially affect the diameter where n = 0.2. The Dee itself therefore need not be changed. However, the maximum frequency has to be increased from 24.85 Mc/s to 28.57 Mc/s and the percentage modulated increased from 20.8% to 24.9%.

An increase in starting frequency involves a change in length of the F.M. condenser line and this cannot be done very readily but it is possible that some improvisation such as the reduction of the line impedance by increasing the diameter of the inner might be more easier. Increased % F.M. can best be obtained by increasing the physical size of the condenser though some small increase in % modulation might be achieved by minor modifications to the existing design.

The remaining parts of the oscillating circuit are the coupling lines and the oscillator valve C.A.T. 17. It is known that the C.A.T. 17 functions satisfactorily as a neutralised amplifier at 22.5 Mc/s but no information is obtainable at higher frequencies. It seems reasonable to assume that the valve will continue to work at reduced efficiency up to 27.5 Mc/s. The coupling lines in the present design have been kept as short as possible. Experiments on the tenth scale model have shown that the shorter the coupling lines the easier it is to attain satisfactory operation over the frequency band. An increase in frequency may therefore make it more difficult to obtain satisfactory operation over a wide frequency band.

To accommodate the modification of Case 1, it will therefore be necessary to make changes to the condenser line and the condenser, the second of these involving the most work. In addition extra difficulty in obtaining satisfactory operation is expected. The delay caused by this may amount to about 3 months.

Case.2.

For this modification an increase in field is obtained by the increased diameter of the main part of the pole (the pole tip diameter cannot conveniently be increased). Similar arguments to Case 1 therefore apply.

Case 3.

Here the field is increased both by using more power and increasing the pole diameter. A centre field of 19,500 gauss is expected and the energy

/obtainable

obtainable 245 MeV.

The starting frequency is now 29.7 Mc/s and the peak to peak modulation 26.8%, the total frequency change being made from 30.23 - 22.29 Mc/s.

To change the R.F. circuit to meet this requirement would involve a major redesign. The F.M. condenser would have to be increased in size considerably and the condenser line shortened. It is possible that the amount of shortening of the condenser line will not be feasible and that a new line of lower impedance will have to be used.

However, it is felt that as the modification to the magnet will take several months an entirely new Dee circuit should be designed and manufactured.

Assuming Zircon insulators are available and that experience has been gained on the present design the changeover to the new Dee system could probably be achieved in the 6 - 8 months taken to modify the magnet.

M. Snowden.

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