Wave Guide Acceleration of Particles

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LINEAR accelerators have been successfully operated to obtain energetic particles, and Hg ions have been accelerated to energies of 1.26 Mev.[1] A major disadvantage in this type of accelerator is the fact that successive electrodes become increasingly longer. This difficulty may be overcome to some extent by using a very high frequency in the accelerator, but a limit is reached when the impressed wave-length becomes comparable to the dimensions of the circuit elements.

The disadvantages mentioned may be overcome by constructing an accelerator from wave guide. The guide could be bent into any suitable geometrical shape, but a relatively simple spiral configuration is shown in Fig. 1. The important point is that the *transverse* field in the guide may be used for the acceleration of particles, and, by proper shaping of the guide, the total ion path may be made quite small. The evacuated system would include the guide and a column of moderate diameter built between the successive spirals of the guide. This type of acceleration should be applicable to either positive ions or to electrons. The problem is relatively simple with electrons, since these particles may be accelerated by very high frequency fields of moderate amplitude; lower frequencies or an initial injection velocity must be used with heavier ions.

Figure 2 shows the maximum potential difference at one megawatt input power which exists between the walls of a wave guide as a function of the width of the guide. This potential difference is inversely proportional to the square-root of the wave-length; values for three different wave-lengths in copper guide at room temperature are shown in Fig. 2. The potential difference becomes arbitrarily large as the width of the guide is diminished to the cut-off point $a_0(=\lambda/2)$, but attenuation also increases rapidly. The value of the attenuation α (if we assume no loss by reflections along the guide) at the various wave-lengths for guides whose width is 1.10 times the cut-off width is given in Table I.

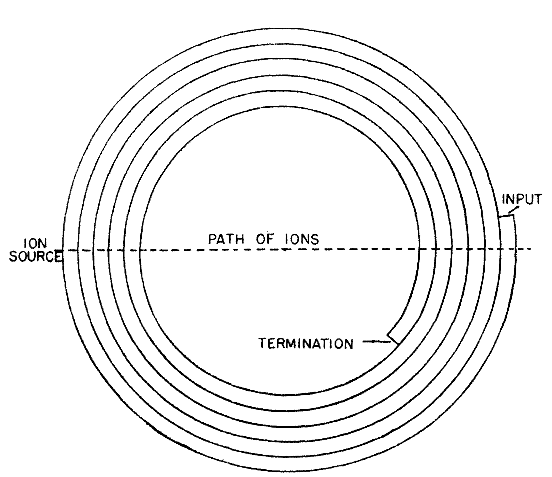

FIG. 1. Schematic diagram of a possible type of wave guide accelerator. If the guide oscillates as a whole, the total length may be as short as will sustain the full input load.

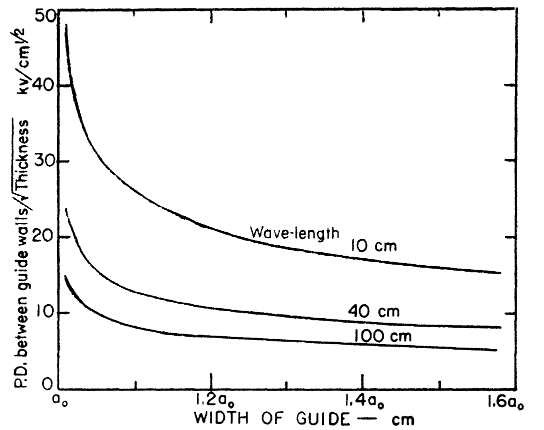

FIG. 2. Potential difference between walls of guide as a function of guide width. The curves were calculated without regard to reflections in the guide. TE_{01} mode; a_0 = critical width of guide; Power $=10^6$ watts.

A guide of several meters length could be terminated with a reflector (short circuit), and the whole configuration made to oscillate as a cavity. In such a case, potential differences of perhaps several hundred thousand volts could be realized between the two walls of the guide. Results with single cavity oscillators have already been reported.[2]

TABLE I. Attenuation in wave guide.

λ (cm)	Width of guide (cm)	Thickness of guide (cm)	α (db/meter)
10	5.5	1	0.1075
		2	0.0663
40	22	1	0.0425
		4	0.013
100	55	1	0.0241
		10	0.0030

Proper phasing must be obtained by proper spacing of holes in the guide and by correct separation of the successive turns of the guide. Several units could be operated in tandem to obtain highly energetic particles.

[1] D. H. Sloan and E. O. Lawrence, Phys. Rev. **38**, 2021 (1931).
[2] J. Halpern, E. Everhart, R. A. Rapuano, and J. C. Slater, Phys. Rev. **69**, 688 (A) (1946).

Atmospheric Helium Three and Radiocarbon from Cosmic Radiation

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A. INTRODUCTION

NUCLEAR physical data indicate that cosmic-ray neutrons produce C^{14} and H^3 from atmospheric nitrogen, the radiocarbon being the principal product. The purpose of this letter is to call attention on this basis