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ACCELERATOR PROGRESS IN ENGLAND

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ACCELERATOR PROGRESS IN ENGLAND

R.S. Rettie

(edited by G.A. Miller)

These notes do not pretend to be an exhaustive survey and are obviously coloured by the author's work at the Clarendon Laboratory, Oxford. They are simply written from recollections of various conversations and meetings over the past eighteen months.

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I. LINEAR TYPES

A. There are a number of H.V. Rectifier Accelerators in England, including the Cambridge million-volt set, and a Phillips (Holland) 0.1 m.e.v. set now being installed at the Clarendon Laboratory, Oxford, after ten years' delay due to the war. This type of machine is normally used with positive ions. The one at Clarendon will first be used on the D-D reaction. Van de Graaff Accelerators are installed at Cambridge and at A.E.R.E. Harwell.

Various r-f cavity resonators have been built, including one by Dr. L.W. Brown at B.T.H., Rugby. It is designed to operate on a wavelength of about 70 centimeters, and is believed to have given over one million volts. If details are desired they should be obtained by a liaison visit, since no external reports have been issued and the project has been dropped.

B. In the accelerator field, now usually called linear, work is being done at A.E.R.E., Malvern, under Fry. Work is concentrated on the travelling wave type in a loaded round E_0 guide, because this group has shown that the efficiency of this type is greater than that of the series of resonant cavities.

The latest report is that they have reached 4 m.e.v. in a length of 2 meters at 2 megawatts r-f (10 centimeters) giving 3 roentgen/minute at 1 meter. They use external magnetic coils to give focussing.

Fry has three of these accelerators in mind:

(1) To extend the 4 m.e.v. to 10 m.e.v. for medical purposes.
(2) To extend the 4 m.e.v. to 20 m.e.v., perhaps by using non-isotropic dielectrics to give loading with low losses.
(3) Then, in the distant future, they may try to reach 1000 m.e.v. using an accelerator (or series of same) 100 meters long and at a wavelength of 25-50 centimeters.

C. Other work in this field:

(1) Standard Telecommunications have a 1 m.e.v. accelerator.
(2) G.E.C. is building a 1 m.e.v. accelerator.
(3) Bristol University is working on a proton accelerator - single cavity at a wavelength of 50 centimeters to give .5 m.e.v.

II. MAGNETIC ACCELERATORS

A. Cyclotrons.

Cambridge and Liverpool have 60" machines; Harwell has a 110" machine; Liverpool is building a 140" machine, and there is believed to be another at Birmingham started before the war and now completed.

B. Betatrons.

(1) An early Kerst 4 m.e.v. machine was used at Woolwich Arsenal. (It has since been converted to a 16-20 m.e.v. synchrotron by T.R.E.)

(2) Metropolitan Vickers have built a 20 m.e.v. machine from Kerst-G.E. drawings. It is now working at very low output and is being used for nuclear research work.

(3) A 16.3 m.e.v. Betatron of relatively advanced design has been made by B.T.H. Co. It was designed by Dr. K.J.R. Wilkinson, and is being installed at the Clarendon Laboratory, Oxford. It is only one-fourth the weight of a Kerst 20 m.e.v. machine, and requires only 80 KVA to excite it, as compared with 1750 KVA for the Kerst machine.

This is achieved by having a very narrow relative aperture (doughnut area/orbit radius). In addition it is fully flux-forced, making possible a closed central leg for the accelerating flux. The important thing about this machine is that it is possible to use a narrower relative aperture than formerly, which allows a higher maximum energy for a given expenditure on iron and condensers.

(4) General Notes on Betatrons.

There is no known work in progress on flux biasing.

The importance of understanding the mechanism of injection applies to both Betatrons and Synchrotrons. If this is cleared up it may be possible to get greater beam currents in these machines.

Another possibility of increasing output is to allow gas (He) to enter the chamber (say at 10^{-3} mm Hg) and by "over-betatroning", cause collision-liberated electrons to be accelerated. "Over-betatroning" is the provision of extra accelerating flux to overcome collision losses (about 1 volt per turn).

It is hoped to get a beam of electrons out and to use them in studying inelastic collisions at high energies.

C. Synchrotrons.

(1) Fry's group, AERE-TRE, includes Edward who made the first synchrotron work in 1945 (see B(1) above).

Work in hand includes a series of 30 m.e.v. synchrotrons. There is one at TRE now, one is believed to have been shipped to Glasgow, and a third, to be smaller and lighter, is under development for the Medical Research Council.

In addition, English Electric is constructing two synchrotrons under Fry's direction; one is 140 m.e.v. to be delivered to the Clarendon Laboratory in a year or so, and the other is a 300 m.e.v. to be installed at Glasgow under Prof. P.I. Dee, in about one year. Eventually higher energies still will be looked for if funds are available.

Finally they are building a 2 or 3 m.e.v. synchrotron for electrons in order to investigate F.M. synchrotron action in the non-relativistic region. Injection is at 10 kv, and 1/2-second is required to reach peak field.

(2) Oliphant's group at Birmingham is building a 1000 m.e.v. proton synchrotron. Because of the low and changing velocities of protons of 10 to 100 m.e.v., it is necessary to frequency-modulate the r-f accelerating voltage:--in this case over a range of 40:1 with many kilowatts output. This formidable task has been accomplished. The magnet is being assembled--orbit diameter about 10 feet. Exciting energy will be stored in a d-c generator with a heavy flywheel which will be short-circuited through the synchrotron at a recurrence rate of six cycles per minute.

It should be noted that this machine has a narrower relative aperture than the BTH-Oxford betatron, but its greater absolute size makes the problem of building an injector mechanism relatively less difficult.

III. HIGH-CURRENT GENERATORS

In addition to work on high-energy particles, much interest is shown in the problem of the generation of currents of the order of a million amperes in a gas discharge. Such generators would be useful in thermo-nuclear reaction work.

The problem is one of confining the current as well as generating it. Confining magnetics fields of the order of 10^6 gauss are considered necessary.

Sir George Thomson, Imperial College, London, has a German "Wirblerohr" working at over 10^4 amperes. A great many people are working on various phases of this problem. Much of the work is secret, but certain material is open.