KEB Jay.
Notebook A

DRAFT

Note of Conversation with Mr. D. W. Fry. 16th March, 1954.

This conversation was intended primarily to provide material for the Times Review article but Fry went over the whole history of accelerators in some detail.

Cyclotron.

Pickavance went to Berkeley around 1945 to collect information. In the meantime a team at Malvern had begun to consider the construction of the machine. When Pickavance returned the whole group began work on the essentials of the design; they had originally intended to build a large machine but Chadwick insisted that a hundred and ten inch was the maximum; as it turned out this was the worst possible size. Having considered the essentials of the design some parts were contracted out; C. A. Parsons built the magnet and G.E.C. developed a big valve for the R.F. unit. Nearly all the rest of the equipment including the R.F. equipment was made at Harwell. The generators to supply exciting current to the magnet were all bought second hand from Birmingham Tramways.

The cyclotron took about three years to build. Details are given in an A.E.R.E. report.

Some reference ought to be made to the Liverpool cyclotron for which a contract was placed with Metro Vickers. Moore at Liverpool handled the design and Harwell did work on the R.F. unit, making a model (Snowden). M-V's work on the Liverpool cyclotron represents a very large contribution by this firm in the Atomic Energy Field.

Van der Graaf.Machine.

It was decided to build this accelerator late in 1945 and Fortescue went to M.I.T. to bring back information. A team was formed at Malvern under Fortescue and a machine was built, and much of the design work was done at the T.R.F. Engineering unit. The A.E.R.E. team built the control equipment and some other ancillary equipment. The machine was assembled at E.U., then removed to Harwell, first to one of the Link trainer huts and finally to Hangar 8.

The information brought back by Fortescue was also made available to English Electric who were designing a machine for the Cavendish. The firm built the machine which is now operated by Shire. English Electric also used the top stack of their machine to make a 2 MeV machine for the Chemistry Division.

English Electric wanted to do basic research on accelerating tubes but Harwell did not consider that their ideas were good enough to warrant the expenditure of a great deal of money. There were considerable differences of opinion between the two places.

Synchrotron.

Goward demonstrated the principle of the synchrotron in 1946 and it was decided to build a 30 MeV machine for experimental purposes and to provide design data for the big Glasgow machine. The magnet for this 30 MeV machine was sub-contracted to English Electric who considered that these machines had commercial possibilities and asked to do two machines for the M.R.C.; M.R.C. wanted these machines quickly for clinical research. English Electric hoped to get these machines finished more quickly than Harwell but did not succeed. They ultimately built them and they have been installed at the Royal Cancer Hospital and at Addenbrook's Hospital, Cambridge. Neither has been completely successful particularly in so far as they have failed to give required output. Fry remarked at this point that he thought that this early work with synchrotrons showed that they had no advantage for energies certainly up to 30 MeV compared with the Betatron.

About this time Clarendon, after conversations with A.E.R.E., asked English Electric to make a 140 MeV machine. This is now working though the maximum energy is believed to be only 125 MeV.

In all these machines the design and development of donuts was done by the G.E.C. This included the design of electron guns which presented one of the main problems; they operate at 100 KeV, have to be made very small and to close limits, and are liable to much vibration owing to the operation of a Tungsten filament in a strong alternating magnetic field. Another trouble with donuts arose from the flaking of the internal conducting coating. All the donuts so far mentioned were not sealed off but were continuously pumped.

In 1946 work also began on the Glasgow 300 MeV synchrotron. The design was a co-operative effort between Glasgow, Harwell and Metro-Vickers; the latter were the main contractors. M-V designed, built and tested the magnet and also the high tension rectifier for charging the condenser back; they sub-contracted to B.T.H. the design of the circuits for switching the condenser to the magnet windings; this switching required special ignitrons which were particularly large and the design was developed and paid for by C.V.D. The

The condensers were sub-contracted to B.I.C.C. but the design was bad and a year was lost owing to these faults. A.E.R.E. Malvern did the R.F. side, building the equipment and the control gear for the timing of the sequence of operations.

A.E.R.E. also accepted responsibility for getting the donut made and, as well as asking G.E.C. to develop a glass one, get Steatite and Porcelain Ltd., to develop a porcelain donut. In the end it turned out that the strength of glass for this application was marginal and the steatite one was used. Fry remarked at this point that English Electric had asked to develop a sealed off ceramic donut for small synchrotrons though, as far as he knew, they had yet to supply one to the M.R.C.

The Glasgow machine is now working, it is believed, at 150 MeV.

Linear Accelerators.

A.E.R.E. Malvern made first a ½ MeV and then a 3.2 MeV machine, establishing the principles and designing the wave-guides. The larger machine was then re-engineered by Mullards for installation at Harwell. This engineering included everything except the wave-guide and involved a good deal of work on electronic gates.

There followed ~~an outgoing~~ a continuing programme on development of linear accelerators following two ~~machines~~ lines, first machines for medical use and second machines for fast neutron sources.

The interest in medical machines came from M.R.C. who placed a contract with M-V to develop, in consultation with the radiotherapeutic unit at Hammersmith Hospital and with A.E.R.E., and to build a 10 MeV machine. This contract was placed towards the end of 1948 and the machine operated for the first time, December, 1950. M-V's work in this field was excellent; they not only did engineering design but they also did a great deal of research to establish the nature and cause of discrepancies between theory and practice in the performance of the machine. When the machine worked the energy was a bit low but the intensity was well up and all the operating facilities worked.

M-V then went on to make three 4 MeV machines for the Ministry of Health; Phillips also undertook two machines of the same type for this programme. Each firm has now supplied one machine and both give 4 MeV at about 200 R/Min/1 M. Both firms were their own design authorities on this contract, though Fry co-ordinated in the early stages. M-V are now quite able to design a good

linear accelerator off their own bat.

For neutron source machines a development contract for 15 MeV machine was placed with Phillips; A.E.R.E. provided the wave guide data but Phillips did all the engineering design including a major job of the 100 gate electronic circuits. This has been a very satisfactory machine. Rotblat from Barts has now asked Phillips for a 15 MeV machine for clinical use following the lines of our machine.

New demands are now being made on M-V for a new project (the 10 - 600 MeV section of the proton accelerator). English Electric are doing valves.

General Comments on Accelerator Programme.

I remarked to Fry that we seem to have used only four firms. He said that the reason for this wasthe very wide variety of work in accelerator development and manufacture - vacuum technique, micro wave technique, heavy engineering in cyclotrons and rectifiers, heavy ~~difference~~ switching valves, and complicated electronics.

There is a continuing programme in electron accelerator development and to meet this we need new and more powerful R.F. sources. These include a high ~~min~~ mean and ~~big~~ peak power klystrons which are being developed by M-V.

Electron Accelerators are made for possible application for the irradiation of pharmaceuticals and plastics. Fry remarked that it is true that fission products offer a long term source of radiation but that at present they are expensive and machines could be used immediately for irradiating comparatively small quantities and if more power from R.F. sources becomes available then machines should be really useful in industry. For example for the production of Charlesby type plastics; and for the de-infestation of wheat. M-V have demonstrated a 4 MeV machine for sterilising pharmaceuticals.

Electro magnetic separators.

It was decided to build this machine because it was felt that we ought to have experience of electro magnetic separation of uranium isotopes and because they were versatile for producing special isotopes for research purposes. Allen brought back information from Berkeley and the designs were based on this information The small machine, which was mainly built at Harwell, was intended to gain experience. The parts of the large machine were built by three contractors; M-V did the magnet, vacuum chamber, pumps, ion source ovens and collectors;

B.T.H. did the control system; G.E.C. did the rectifier system, ~~designed~~ using four valves and provided 200 kilowatts at ± 45 KeV.

Mass Spectrometers.

M-V were given a Tubealloys to develop mass spectrometers; data of the Nier type machine was provided from American sources. Since then M-V have developed a fairly wide range of machines and have done some important work. We now have a contract with them for high resolution solid source machines. It ought to be emphasised that these spectrometers are widely used in the factories as well as at Harwell where there are nine. A small firm was brought in to make a 'poor man's' mass spectrometer but these machines have not found as much use as was expected.