Rutherford Laboratory

Technical Leaflet

E7

THE OXFORD ELECTROSTATIC GENERATOR PROJECT

The particle accelerator for the new nuclear physics research centre (Fig.1 photograph of model) at Oxford University comprises two Van de Graaff electrostatic generators: a large, specially designed, vertical machine which injects negative ions at energies up to 8 MeV into a commercial horizontal tandem machine, purchased from the High Voltage Engineering Corporation of Burlington, U.S.A., which further accelerates the ions to a total of 20 MeV. The design is such, however, that the two units can be used as separate accelerators, when this feature is required the vertical magnet is turned to deflect the beam into a separate target room and the horizontal tandem machine has its own ion source. A cross section and plan of the project are shown in Figs. 2 and 3.

The N.I.R.N.S. Electrostatic Generator Group, supported by engineers from the Engineering Division, is responsible for the design and construction of the vertical machine and for commissioning the system as a whole.

The vertical generator consists of a steel cylindrical shell, 13 ft. internal diameter by approximately 42 ft. 8 in. high. It is constructed mainly of $1\frac{1}{2}$ in. thick plate and weighs 67 tons (Fig. 4). There are a number of observation portholes and service ports in the wall of the vessel. A 24 in. diameter manhole at the lower end, and a 9 ft. diameter hole at the top, are provided for gaining admittance by maintenance staff and introducing the inner components into the vessel respectively.

The terminal, carrying the high voltage charge of up to 8 million volts, is in the form of a highly polished stainless steel cylinder 5 ft. diameter by 7 ft. high, capped by a hemispherical dome. The ion source is housed in the terminal and the whole is supported at a height of 24 ft. from the bottom of the vessel on three columns. The general construction of the columns is from glass blocks 5 in. diameter by $1\frac{1}{4}$ in. thick alternating and concentric with stainless iron plates $7\frac{1}{2}$ in. diameter by $\frac{1}{4}$ in. thick. These are cemented together with Polyvinyl acetate. Each of the three columns comprises, a bottom section of 12 in. diameter steel tube 4 ft. high, an intermediate section 12 ft. high of three single columns braced at 2 ft. intervals for greater rigidity, and an upper section which is a single column 8 ft. high.

A steel ring rests on the top of the intermediate section to hold the three triple columns together and support a larger polished stainless steel electrode 8 ft. diameter by 21 ft. high, referred to as an intershield, which surrounds the upper section of the assembly. The total weight of the whole stack is approximately 8 tons. This is supported by a steel baseplate, which is itself supported external to, and independent of, the vessel. During operation the vessel is filled with hydrogen to a pressure of 250 p.s.i.

The inspection, maintenance and cleaning of the stack, require an adjustable platform. Two lifts are provided, one inside the stack, and the other in the annular space between stack and vessel. Both lifts are independently propelled by hydraulic telescopic rams at the base of the vessel, the inner lift having one ram, and the annular lift, three rams. The oil pumps are situated outside the vessel.

The vertical magnet (Fig. 5) weighs 40 tons and the problem of rotating it has been solved by floating the turnable on a film of oil, lateral movement being prevented by rollers at a few points around the circumference. (Fig. 6) is a photograph showing the magnet being lowered into the basement.

The horizontal magnet (Fig. 7) may be traversed, on rails, the length of the tandem vault, to deflect the beam to any experiment in either target room. The accurate alignment of the magnet is achieved by locating it on three short pillars for height, and two spigots for horizontal orientation. Since the magnet weighs 8 tons, the frictional forces in the final horizontal adjustment could be considerable; therefore, while the magnet is lowered on to the spigots it 'floats' on an air cushion.

A particular feature of this machine is that it needs to operate negative with high reliability and stability. Experience of machines of this kind is very limited and a test machine, operating in the range 4 - 5 MV was constructed and stabilisation of a negative electron beam to within 80 electron volts was achieved during the trials.

The negative ions are produced in the terminal of the vertical machine where they are repelled by the negative charge, on the terminal, down an evacuated tube, which finally protudes from the lower end of the machine, and then to the large vertical electromagnet which deflects the ions through 90°, so that they continue on their way along the horizontal tube to the tandem machine. The terminal of the generator is electrically charged positively to 6 MeV and attracts the negative ions. As they pass through the terminal, the ions travel through a long narrow tube containing sufficient gas to strip the electrons and convert negative ions into positive, so that again repulsion occurs and another boost is given to the ion which proceeds along the tube to a horizontal electromagnet, which deflects it through 90° into the target room where it enters the experimental apparatus. The tendency of the beam ions is to diverge from the centre of the tube, and this is prevented by electrical or magnetic lenses placed at intervals along the tube.

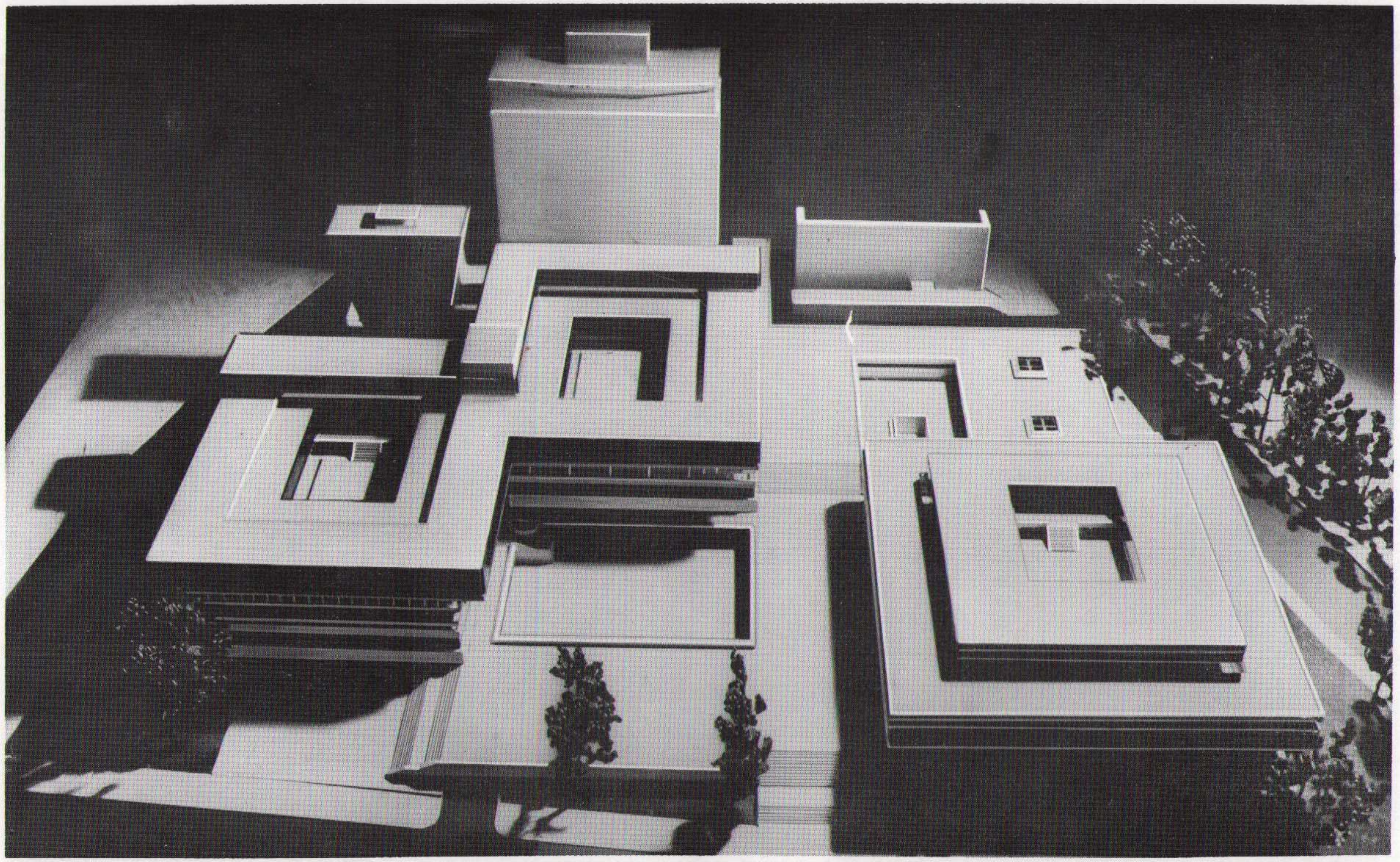

FIGURE 1. OXFORD ELECTROSTATIC GENERATOR PROJECT: PHOTOGRAPH OF MODEL OF BUILDING

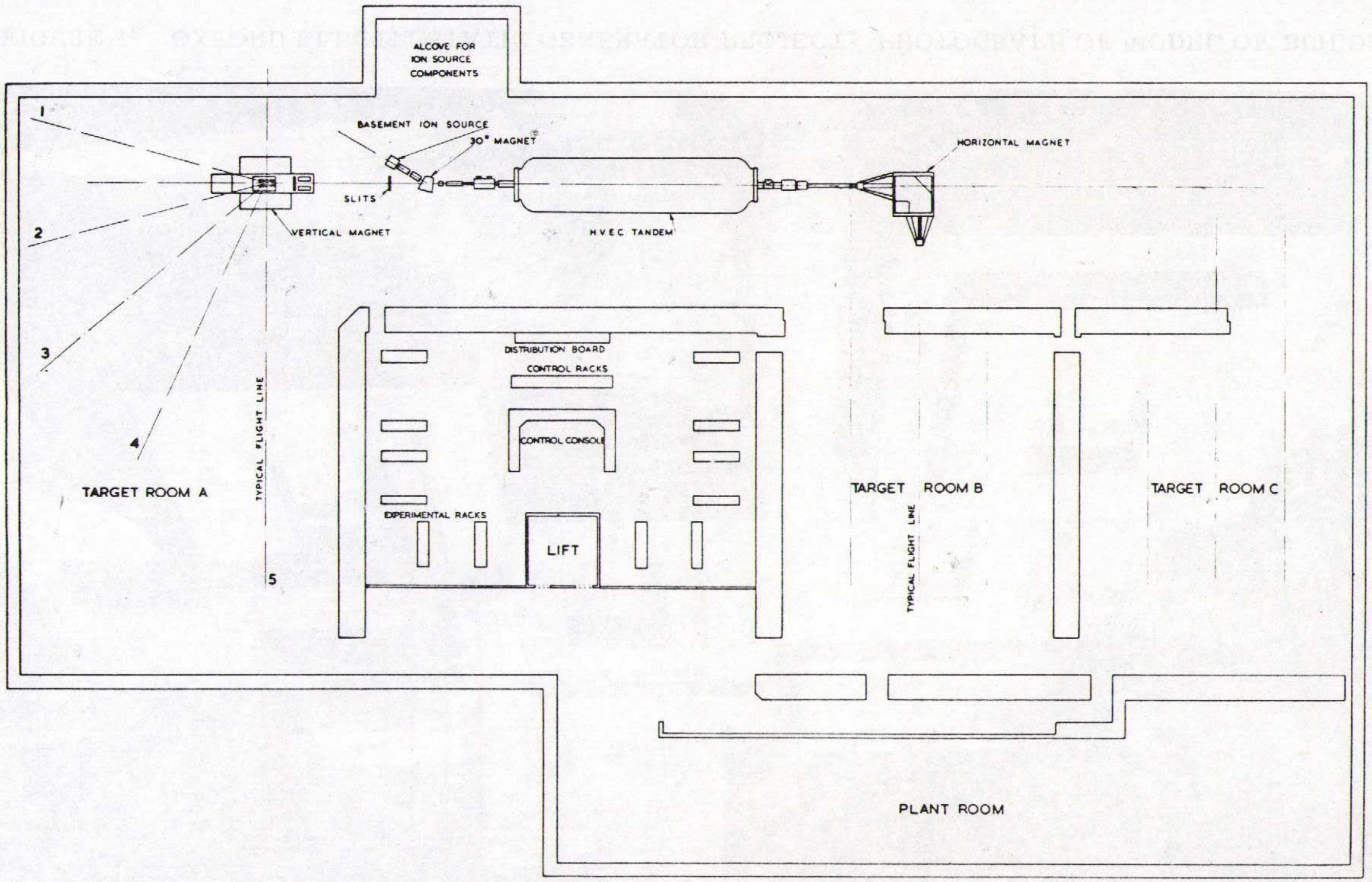

FIGURE 2. OXFORD ELECTROSTATIC GENERATOR PROJECT: PLAN OF BASEMENT

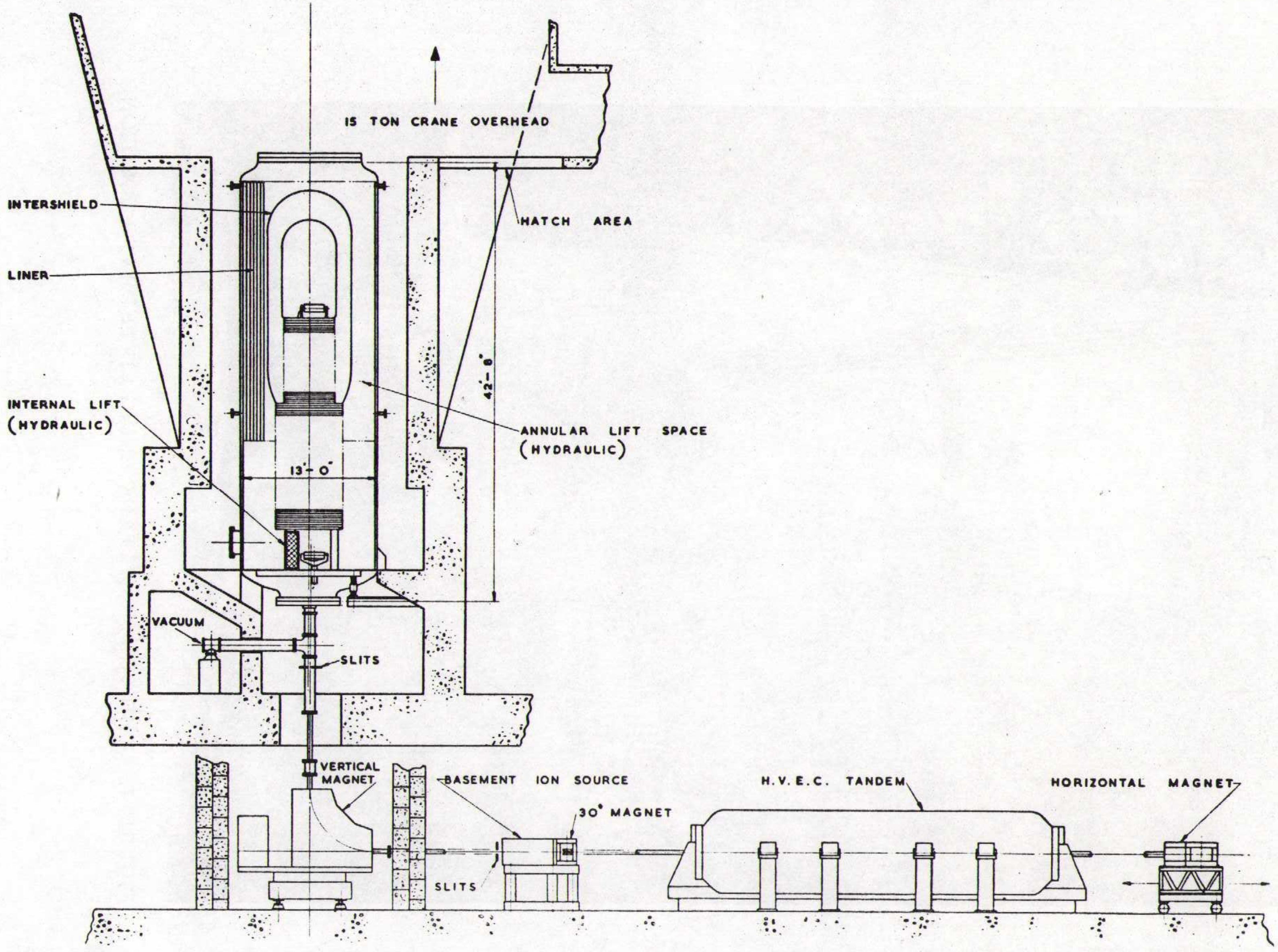

FIGURE 3. OXFORD ELECTROSTATIC GENERATOR PROJECT: SECTION THROUGH TOWER.

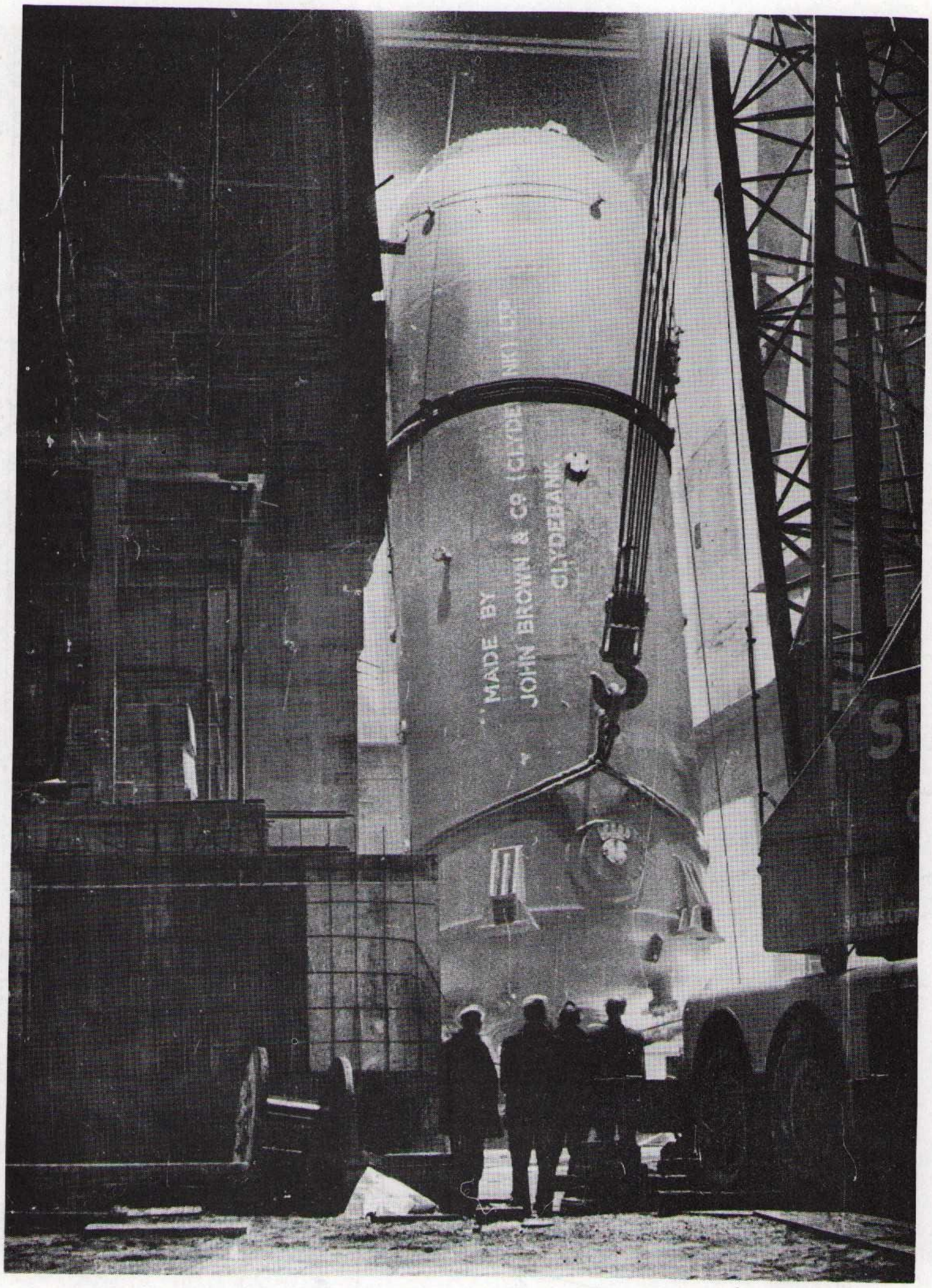

FIGURE 4. THE VERTICAL TANK BEING LIFTED INTO POSITION

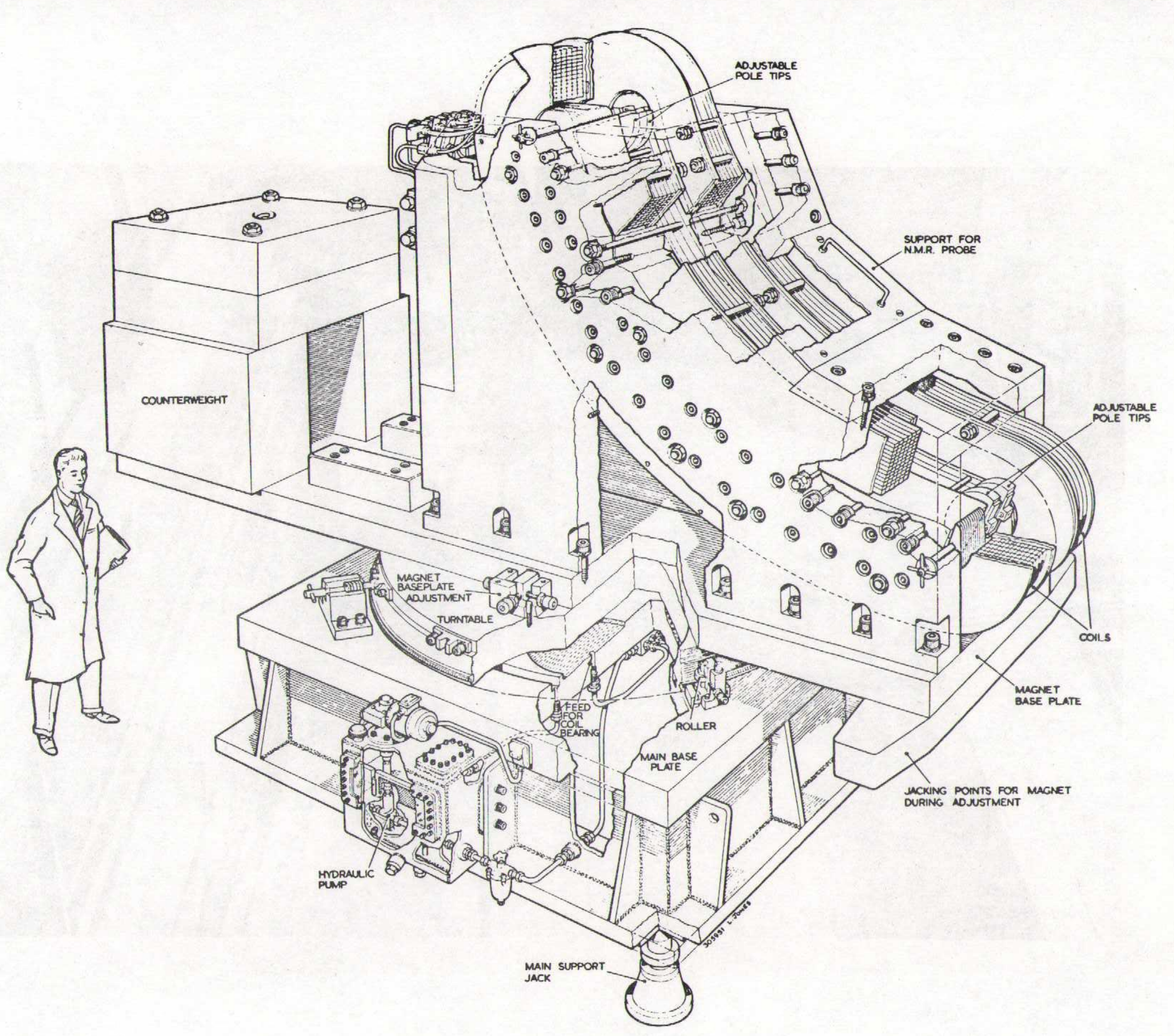

FIGURE 5. VERTICAL MAGNET

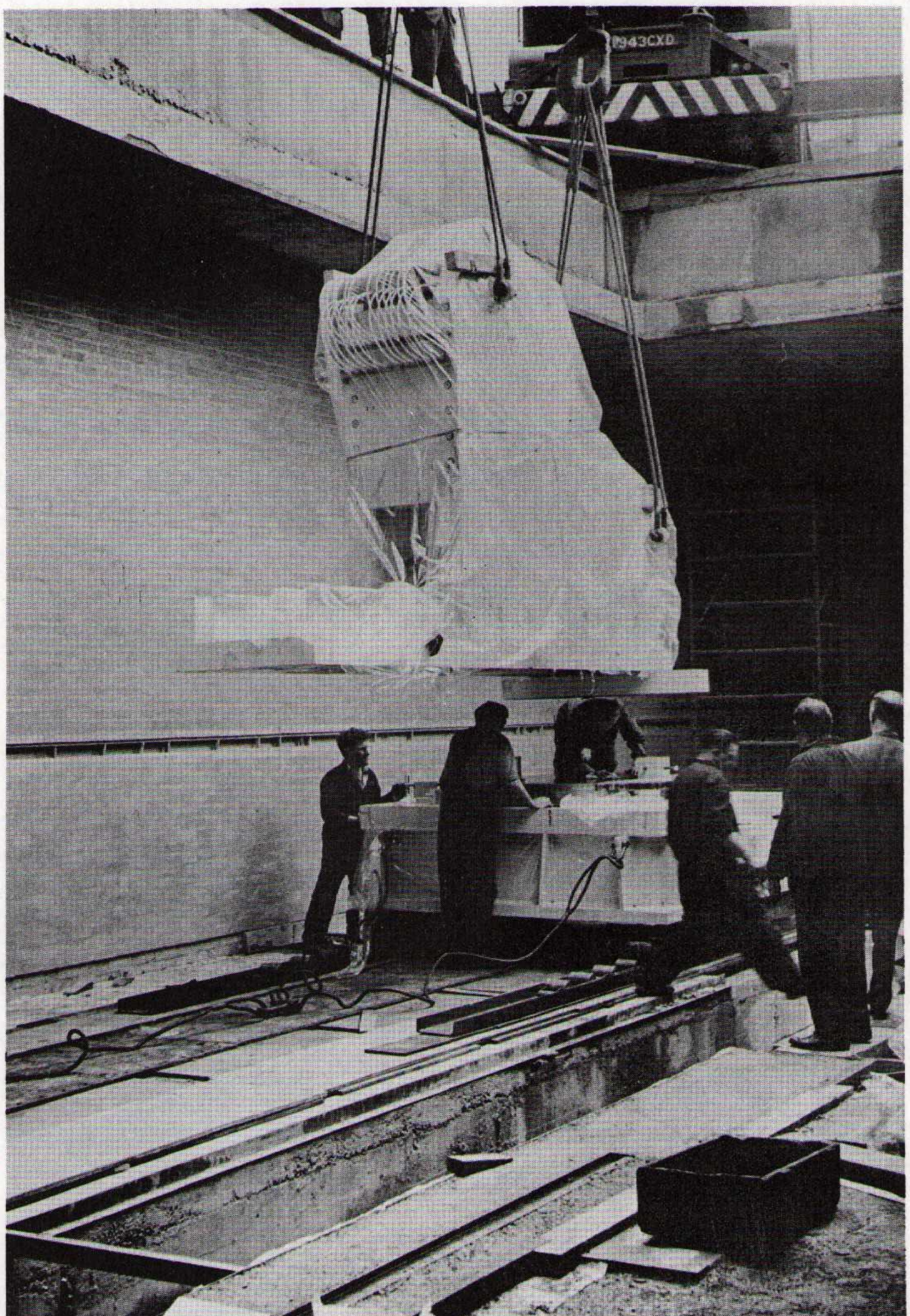

FIGURE 6. VERTICAL MAGNET BEING LOWERED INTO POSITION

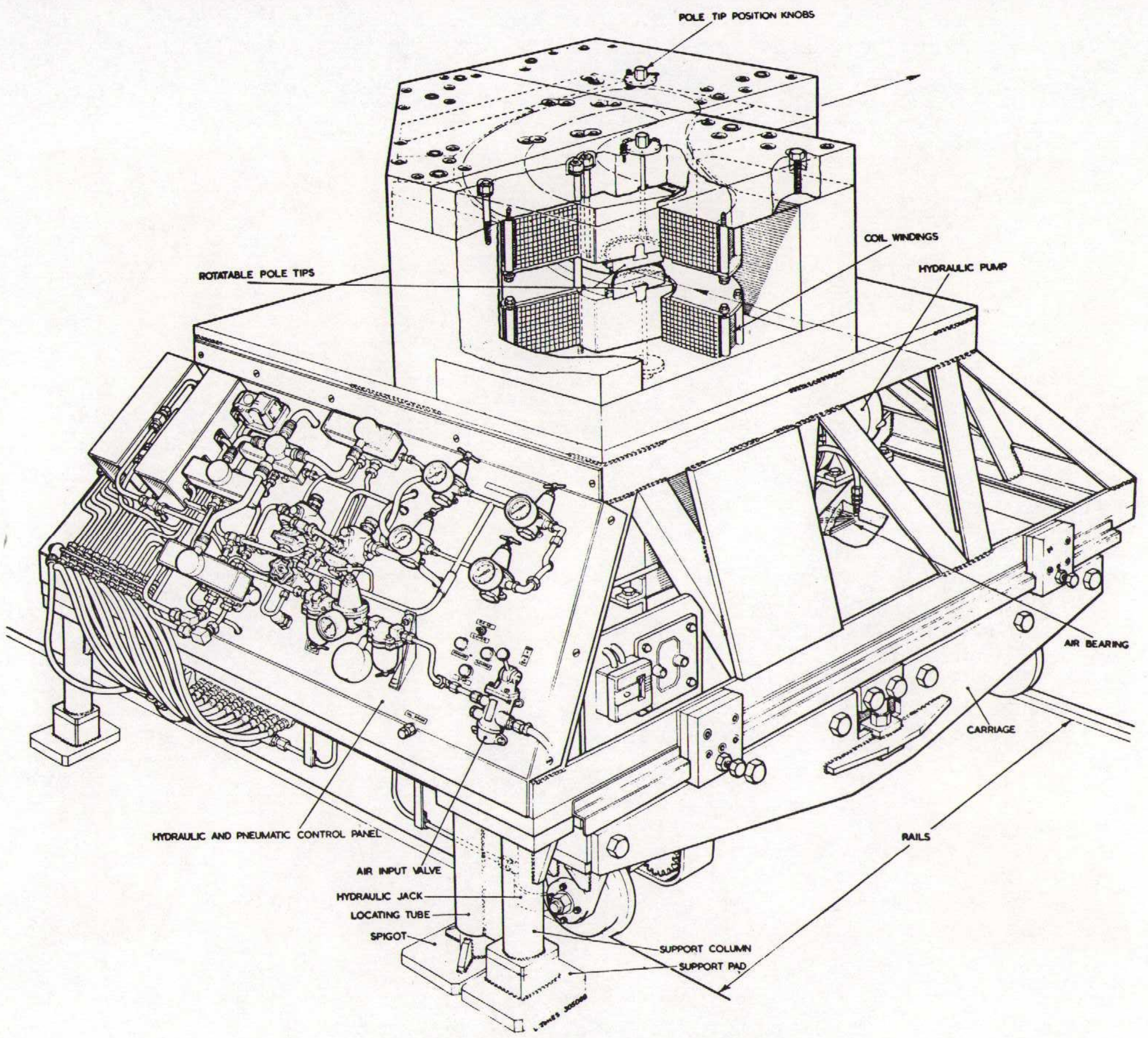

FIGURE 7 HORIZONTAL MAGNET