Rutherford Laboratory

Technical Leaflet

E1

DESIGN AND MANUFACTURE

A display in the centre of R9 Workshop shows how the various groups and sections integrate toproduce equipment for use with NIMROD or for the experimental programme.

Many requirements start life with little information other than a very broad statement of what they should and should not do. (Fig.1) The designer is invariably limited in his answer by space, time and money.

A period of intensive scheming and drawing board work with much further discussion (Fig.2) leads to layout drawings which can be used to detail the various parts for manufacture. (Fig.3) If it is a "one off" job such as the Polarised Proton Target this workshop usually produces it complete. The shop is designed and equipped to provide a wide range of unusual and high precision equipment for jobs needing the close attention of the physicist or design engineer and required in the shortest possible time. (Fig.4) It includes a wide range of machine tools, lathes, milling and grinding machines, horizontal borers and drilling machines equipped with a very extensive range of accessories and fitments to enable the maximum precision and versatility to be achieved. The shop is able to evolve new techniques to produce parts (sometimes in exotic materials) unobtainable from industry. For example for the Polarised Proton Target tubes in copper, 3 inches long closed at one end square in section and only 0.001 inches thick; or a large pantograph (Fig.5) capable of drawing a 36 inch dia. circle within 0.001 inches. In a similar manner techniques were evolved to enable spark chambers to be made at all, e.g. the stretching of 0.001 inch aluminium foil drum tight over areas up to 39 inch and 24 inch (Fig.6) or machining unannealed "perspex" 26 inch dia. to within 0.002 inches.

Such techniques, when established, are freely passed to private industry to further the total manufacturing potential available to the Laboratory. Other jobs such as the Target Mechanism, which involve a fair amount of repetition are often passed direct to private industry for manufacture.

Costing is of great importance, it can influence design and manufacture drastically (Fig.7) and enables a proper perspective of the job to be maintained as work proceeds.

'Outside manufacture' as work by private industry is known, must also be carefully supervised.. (Fig.8) It must produce parts, or complete pieces of equipment, which do no more than is asked of them, at the right price and in the time required, headings often in conflict with each other. An inevitable part of "one off" and indeed of experimental work in general, are modifications - sometimes redesign would be a better word. These modifications must be fed in with the least possible effect on parts already made or on delivery times. Adequate trials and tests must be satisfactorily completed before installation in NIMROD or in the Experimental Halls, and these trials call for much intensive work by design, electrical, electronic and mechanical sections all working in complete accord.

Typical examples of such design and manufacture are the Polarised Proton Target and Target Mechanisms.

First a few words about the Target Mechanisms. When the protons in NIMROD have been accelerated to the desired energy level a 'target' (a block of beryllium for example) is put into its path. This produces many different kinds of particles as the protons crash into the atoms of beryllium. The beam line is then "tuned" to the particular kind of particle required for that experiment.

The target mechanism (Fig.9) has to enter into and be attached to the outside of the main vacuum vessel, to hold the target. It must "flip up" the target in less than $\frac{1}{2}$ second, must be capable of radial adjustment depending on the energy level of the protons and must be capable of having the target changed without letting up the vacuum also remotely because it is radioactive. It must be fully automatically controlled from the main Control Room.

A number of such mechanisms are now in NIMROD and a full scale demonstration of the versatility of the Mechanisms can be seen in Building R.8.

Quite a different design and manufacture problem is the Polarised Proton Target shown in the pictorial diagram. (Fig.10) It is housed in the field of a normal bending magnet but later a special magnet will be used, this magnet has to be fed from a "standard" power supply unit. (Fig.11) The 500 amp current stabiliser was also specially designed and developed for use with the Target. The physics of the Target are involved but some of the problems may be envisaged from the following notes. One of the factors which determines how elementary particles interact when they collide is the "spin" of the particles. Spin is normally randomly orientated so that only the average effect is observed. If therefore it is possible to make either the bombarding or the target particles all have the same spin or polarize them then information otherwise impossible to sort out will become intelligable.

In the Polarised Proton Target use is made of the fact that the spinning proton acts as a very weak magnet and applying a very strong magnetic field tends to line them up in one direction. To enable this to be done the protons thermal vibrations have to be reduced to a low level by very low temperature (1.25°K or -272 °C) and the protons used are in close combination with ions in a rare earth crystal, a combination that enables them to be magnetised 700 times more strongly. Feeding in very short wavelength radio waves of precise frequency "flips" the protons (coupled with the rare earth ions) so that they point in the same direction along the magnetic field. At least 60% of the protons are polarised by this method.

The Target is now installed in the Experimental Hall, the photograph shows (Fig.12) trials in Lab.R25.

FIGURE 1. PRELIMINARY DESIGN DISCUSSIONS

FIGURE 2. DESIGN DISCUSSION

FIGURE 3. DRAWING OFFICE

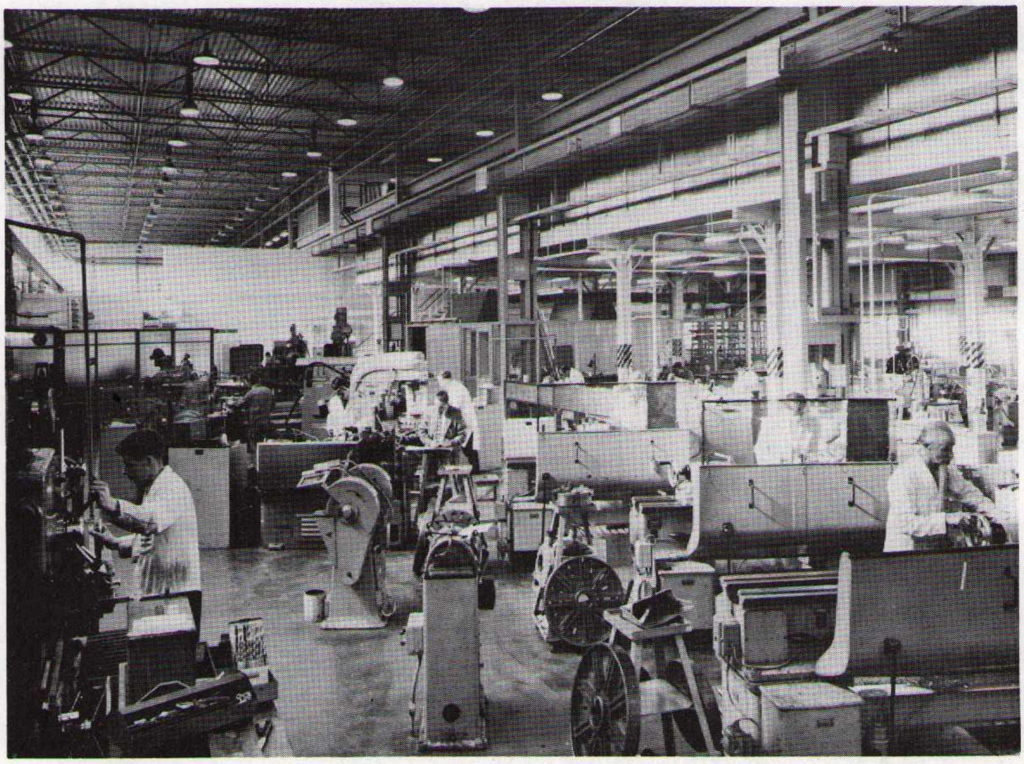


FIGURE 4. CENTRAL ENGINEERING GROUP WORKSHOP

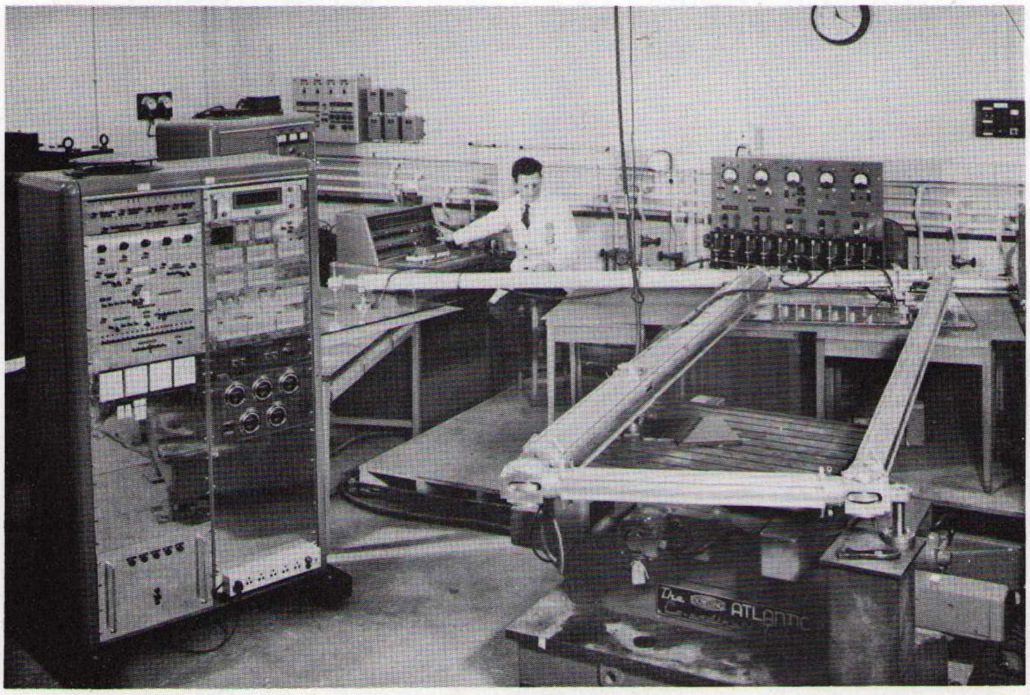


FIGURE 5. PANTOGRAPH

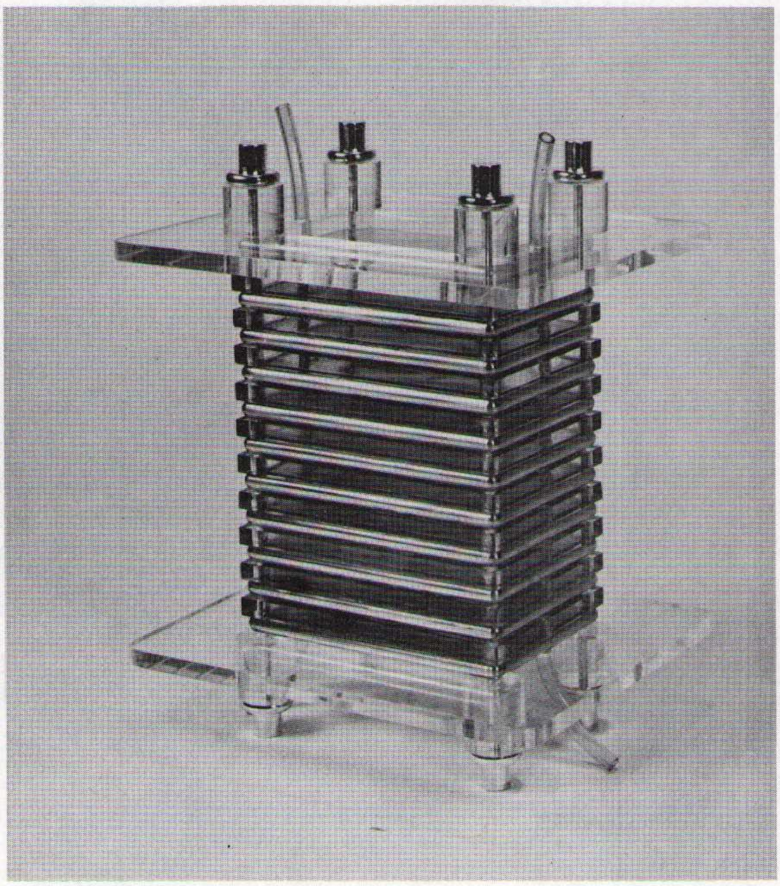


FIGURE 6. SPARK CHAMBER

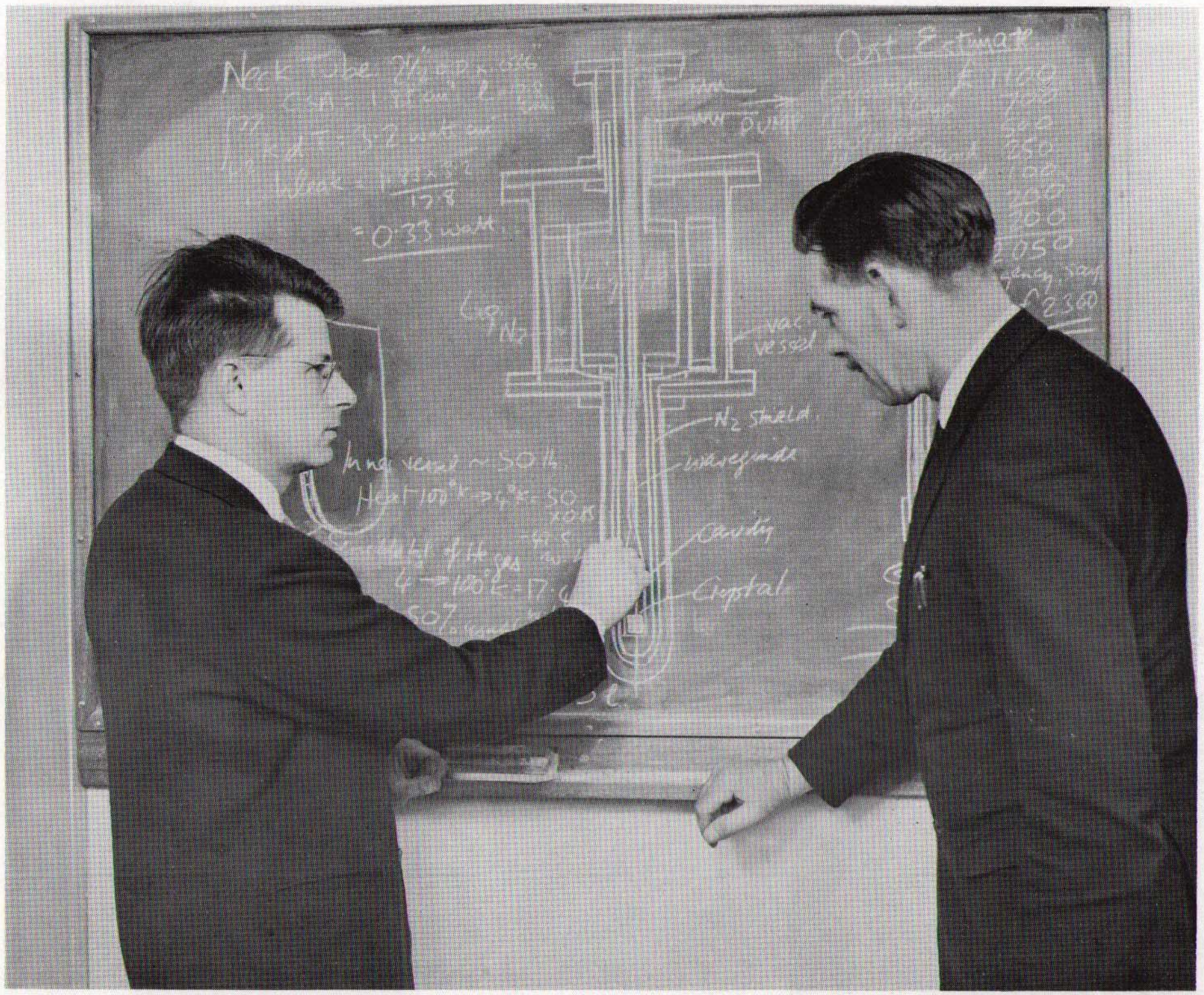
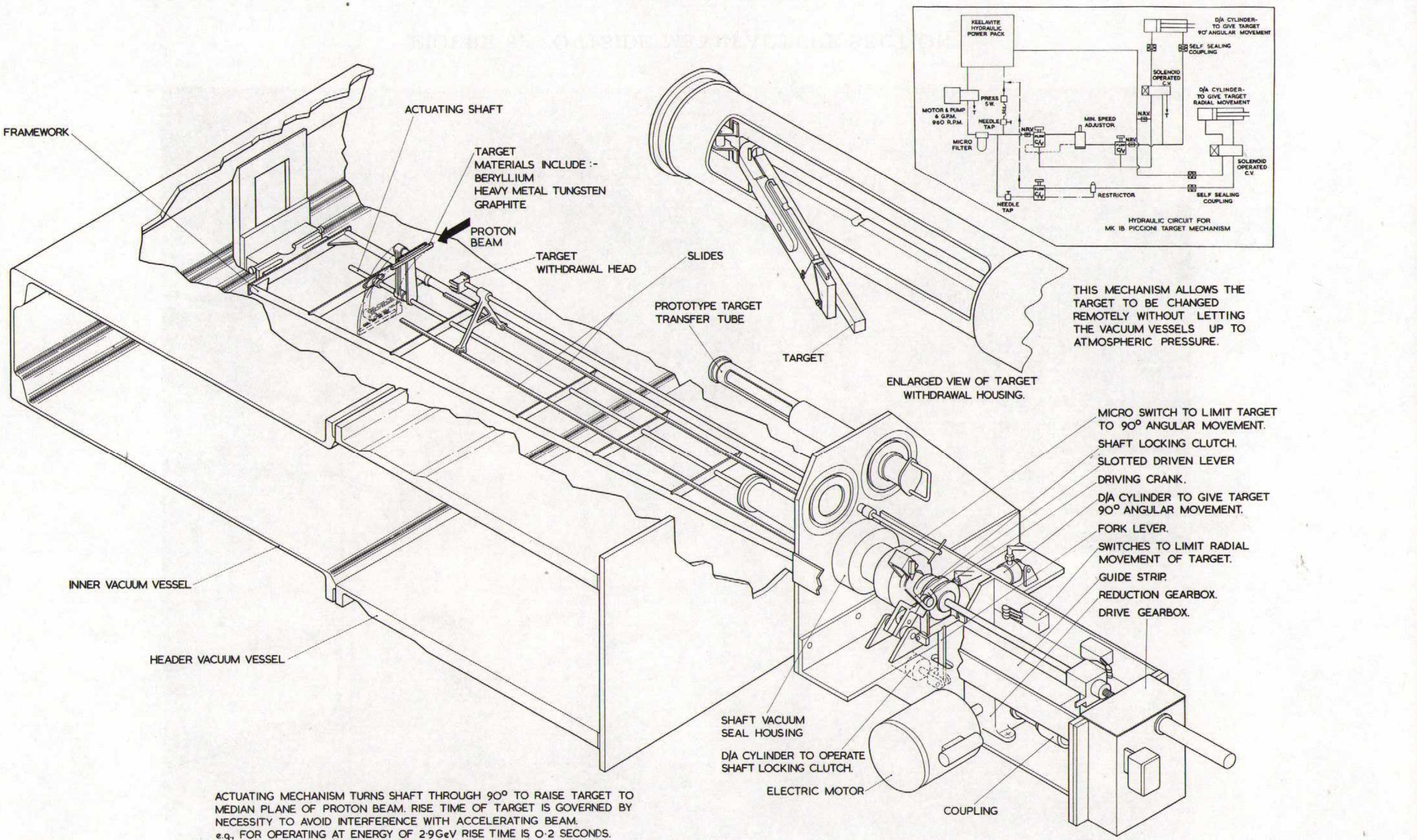


FIGURE 7. DESIGNER DISCUSSES COSTS WITH ESTIMATOR

FIGURE 8. OUTSIDE MANUFACTURE SECTION



ER 016045

FIGURE 9 MK. 1B PICCIONI TARGET MECHANISM

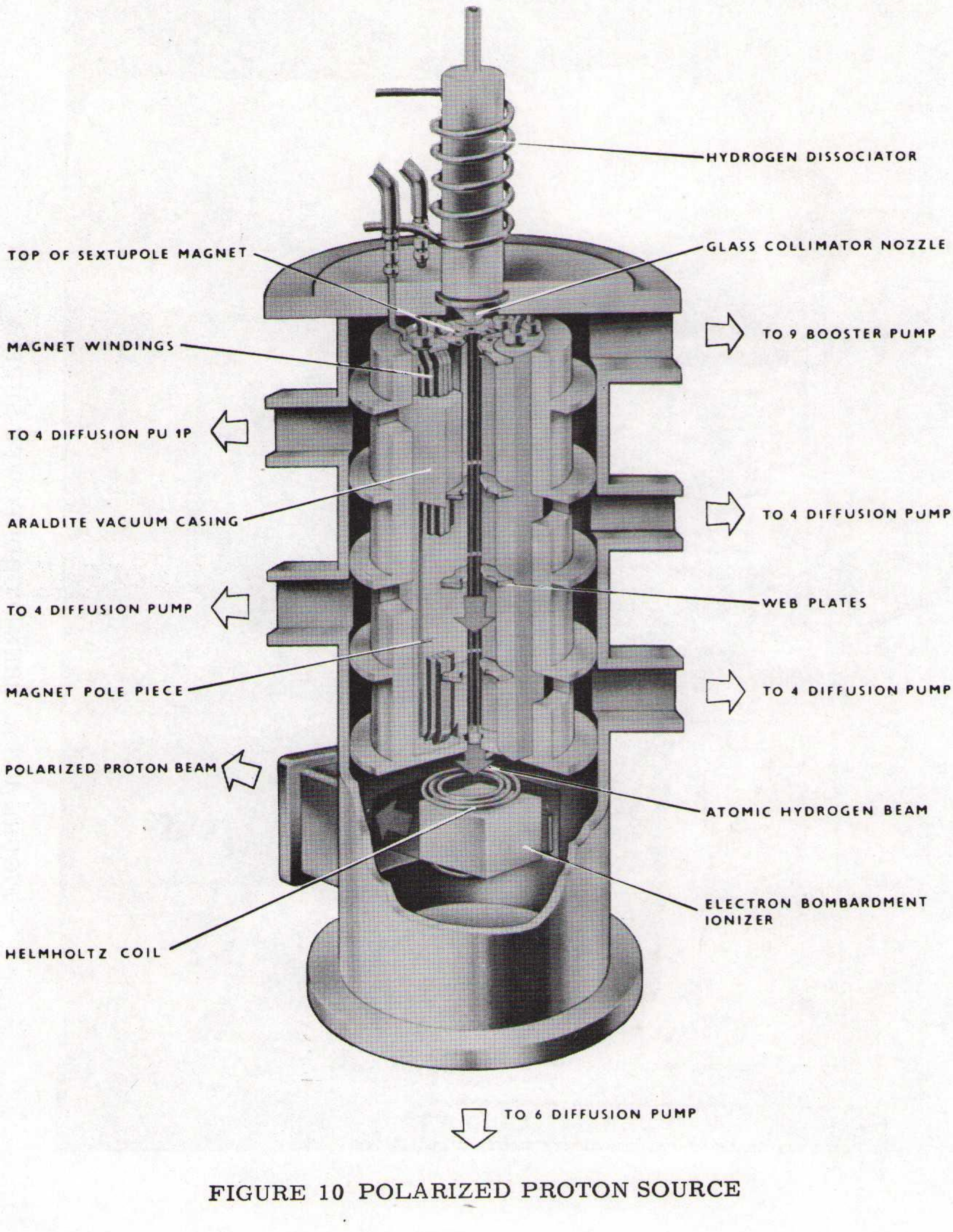


FIGURE 10 POLARIZED PROTON SOURCE

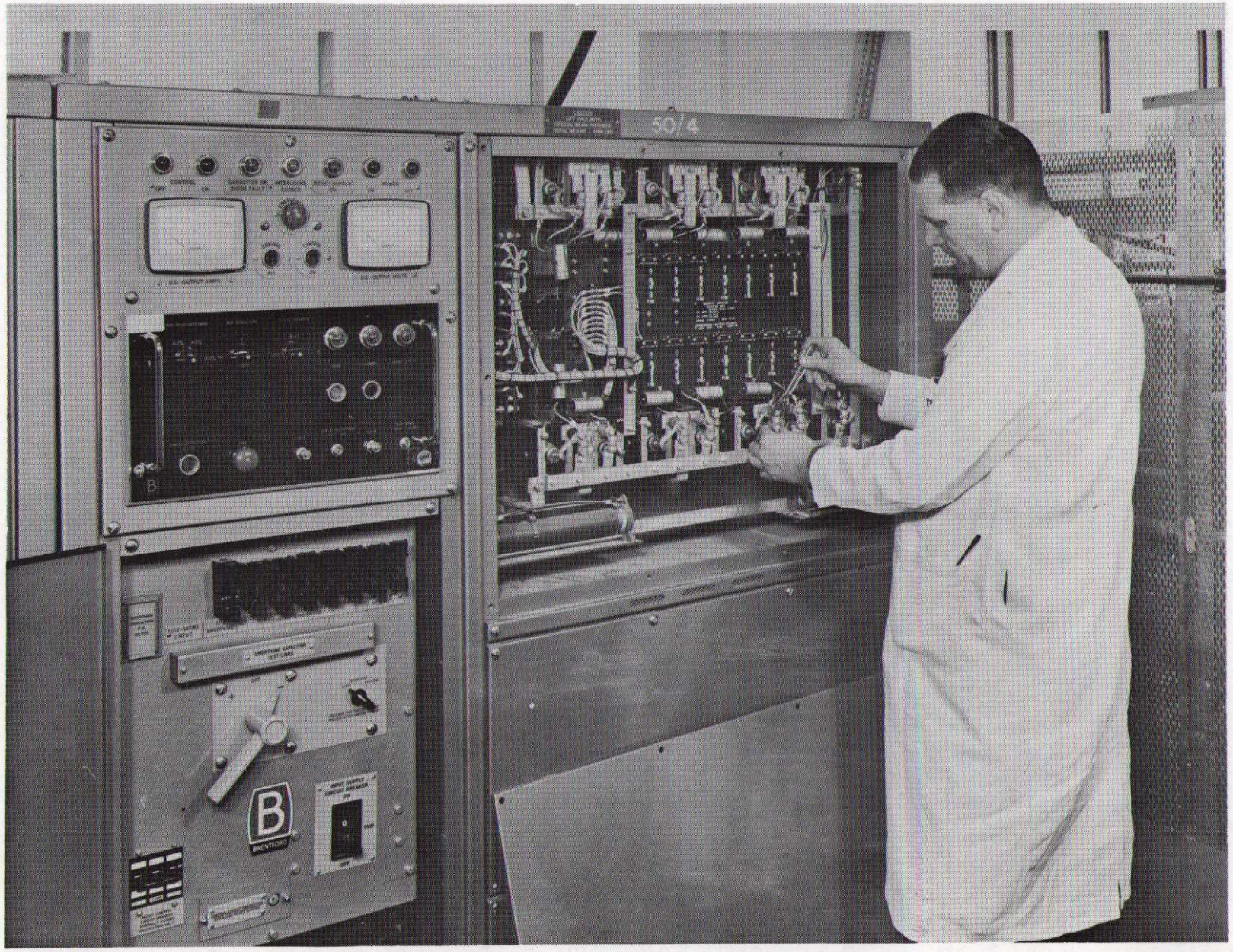


FIGURE 11. A 'BRENTFORD' POWER SUPPLY UNIT

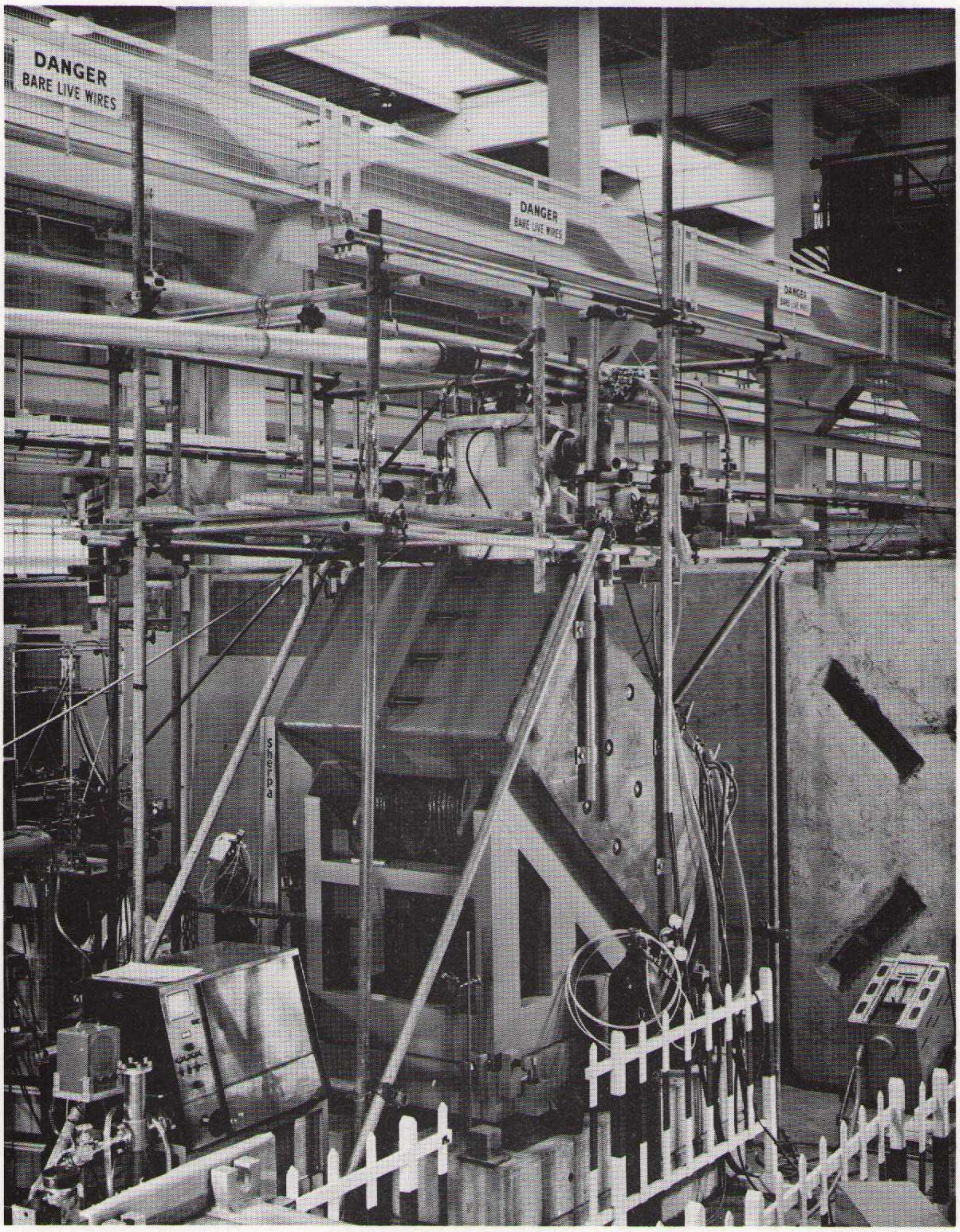


FIGURE 12. TRIALS ON POLARISED PROTON TARGET