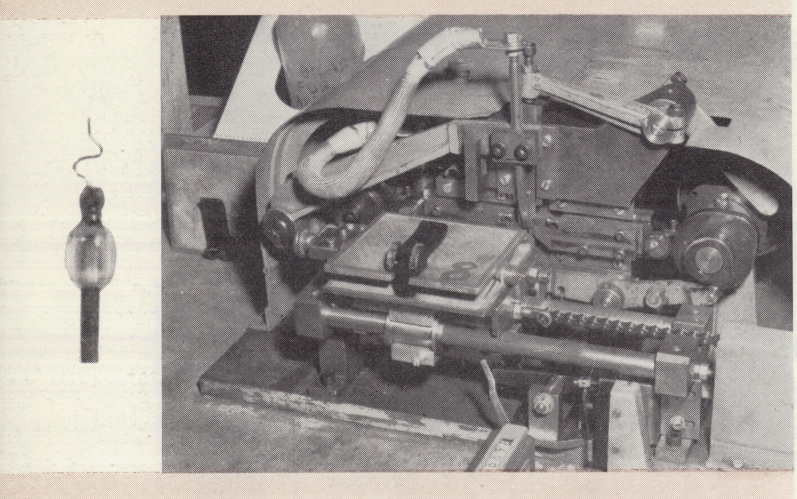

Fig. 3. Whisker forming and welding machine used during manufacture of anode assemblies. On left is a completed anode assembly.

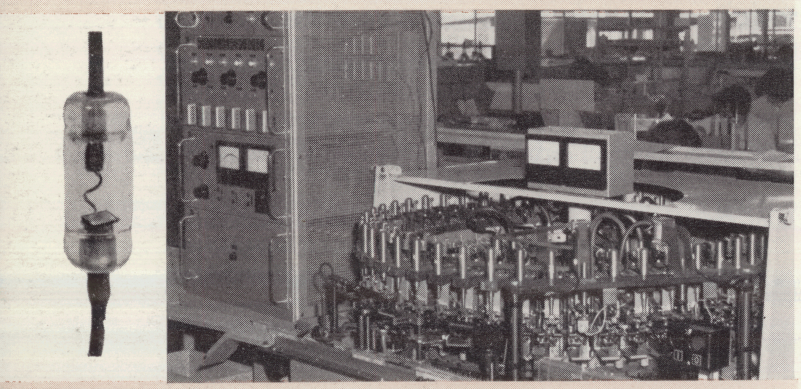

Fig. 4. A 48-head testing and sealing machine which assembles the half-diode and anode assemblies. On left is a finally sealed diode.

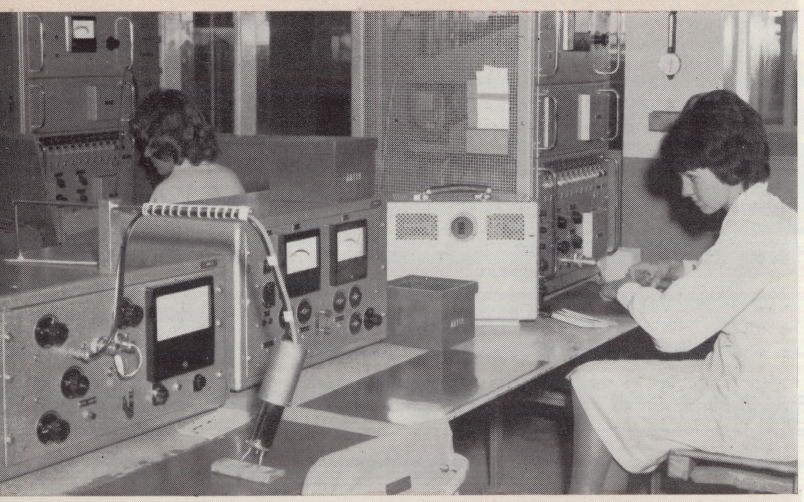

Fig. 5. Semi-automatic final test on diodes.

Quality Control

In addition to the production testing, samples are taken at various stages throughout production to control the sealing quality and the means of the electrical parameters (Figs. 6, 7 and 8).

Stringent mechanical, climatic and electrical tests are also carried out to ensure that the outgoing products have the best possible quality.

TESTING AND QUALITY CONTROL

Incoming Material Control

Testing of miniature diodes starts, naturally, with tests done on the original materials. This is normally called incoming material control.

All glass components are checked for thermal expansion and homogeneity while wire is checked for purity, uniformity and surface finishing. Crystals are checked for resistivity and orientation. Auxiliary materials, such as chemicals, are tested according to the importance they will play in the process.

Process Control in the Factory

During production of the diode, checks are made at various stages to ensure that the rejection rate will be kept to a minimum and that the manufacturing quality will be as uniform as possible.

The anode assembly is checked for welding quality, shape and whisker cross-sectional shape on point of whisker, and alignment of whisker point with anode shank. This last point is very important since the assembly is done on an automatic machine.

The cathode assembly has various samples sectioned to keep control on the thickness of the solder used to fix the germanium wafer on to the cathode holder (see front cover). This is most important in the determination of Kappa and hence the thermal stability of the diode at elevated temperatures. The sealing quality is also tested by polarised light to ensure that glass cracks will not occur later in the life of the diode, thus leading to premature failure.

After assembly in the 48-head sealing machine, the assembled diode has a second seal on the anode wire checked visually, and general alignment is also checked at this time.

After the diode has been lacquered and the leads tinned it is subjected to a 100% visual inspection and a statistical paint adhesion test.

All the tests done on process control are carefully analysed and relevant ones are charted on process control graphs with action limits being applied where necessary.

Electrical Testing

The diode, after lacquering and tinning as mentioned above, is subjected to a 100% factory test on selected parameters. These parameters include reverse leak-

age current at various reverse voltages up to the peak rating, and forward voltage drop at various values of forward current up to a maximum forward current rating. In addition, the breakdown voltage is tested and, depending on the type of diode being made, any other relevant parameters are measured. For example, all OA90 diodes are tested at 30 Mc/s in a typical video detector circuit in accordance with the published data sheets. As another example, the OA95 is tested for leakage currents at elevated ambient temperatures since this type has specifically a low reverse leakage current.

The diode, after branding and a further general inspection, is stored until required for delivery. Upon delivery each box has a statistical test applied to it. Various AQL's are used depending on whether the diode shows as non-operative or merely deviating from the normal requirements. Batches failing on any test are fully tested 100% and all results are carefully recorded. All records are analysed by the Quality Laboratory and a very careful check is kept on the overall outgoing quality.

Quality Control

In addition to the normal tests performed in the factory, the Quality Control Laboratory removes samples at regular intervals from the production line. These are tested for many parameters additional to those being checked in the factory. All diodes, for instance, are tested at elevated temperatures for leakage current and performance generally in the conditions which they will be expected to receive in the field. Also extensive life testing (Fig. 8) is done at elevated temperatures and maximum ratings.
In addition to all the electrical testing, the mechanical and climatical performance of the diode is checked. The diodes are subjected, amongst others, to the following types of test:—

Bending and pulling test
Vibrations test
Temperature cycling tests
High temperature storage tests
Shock loading tests
Humidity tests
Lead solderability tests
Paint and brand adhesion tests.

In general, the American and British military standards are followed very closely and a standard is aimed at which is at least as good as that required by the above-mentioned specifications.

The results of all these tests are correlated every three months into a total spread graph for each parameter over that period. These results are then combined with those of other manufacturing centres so that comparisons can be made of the relative qualities between centres making the same type. This serves as a very useful guide as to the ultimate qualities that may be aimed at for a particular product, and by inter-centre co-operation the overall benefit to all centres is quite considerable.

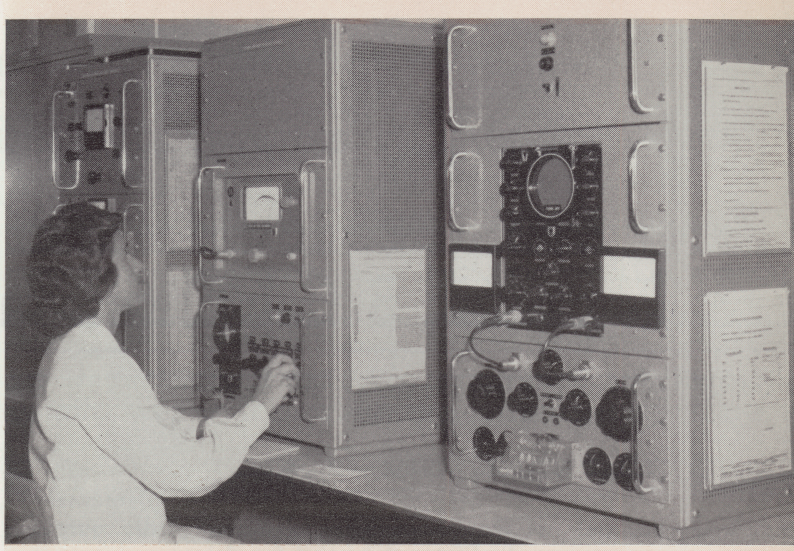

Fig. 6. Laboratory sample testing—a dynamic check being made on pairing of 2-AA119 under operating conditions.

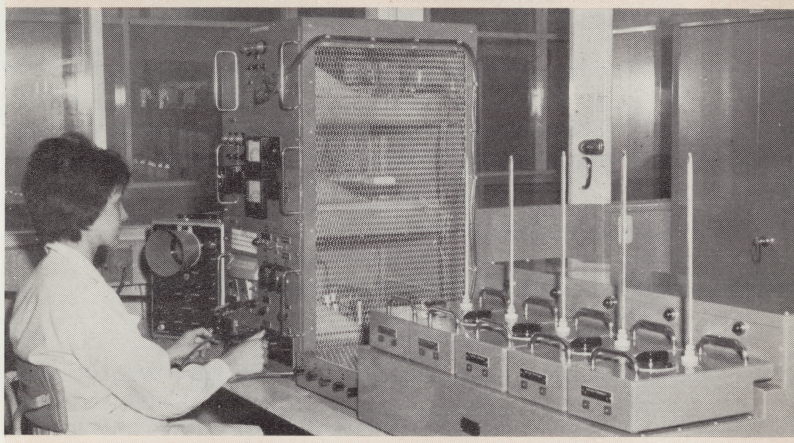

Fig. 7. Laboratory measurement of thermal resistance, an important factor in determining reliability.

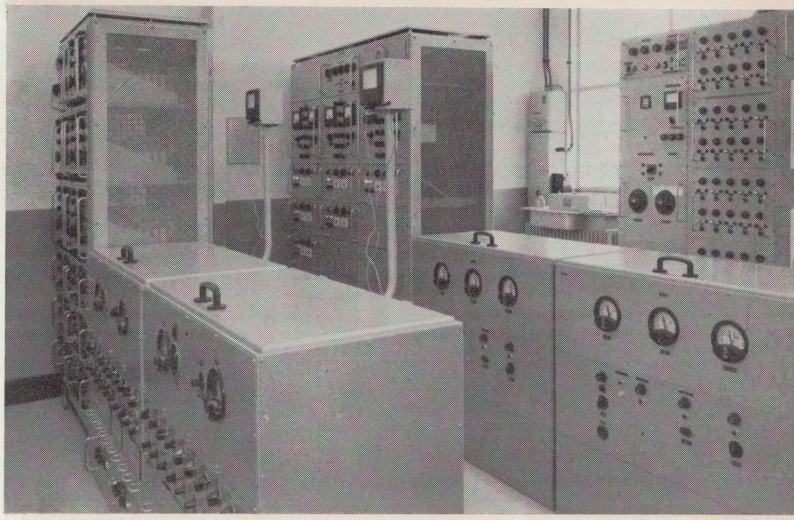

Fig. 8. Part of life test installation—the heart of any reliability programme introduced to approve release of new types.