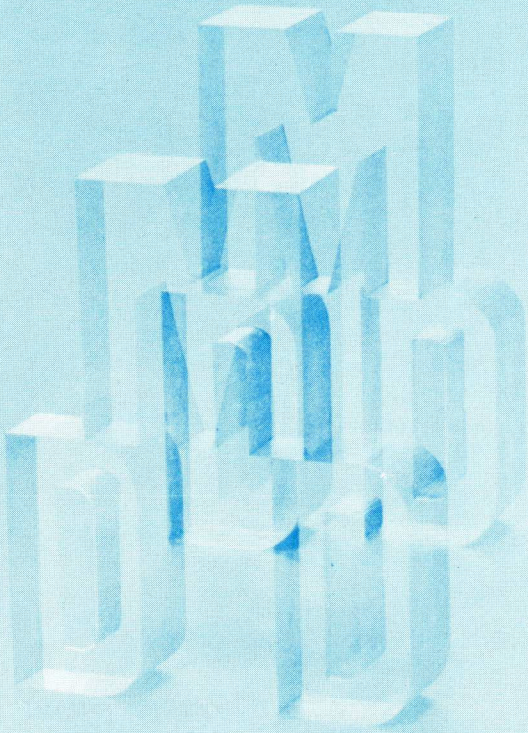


MICROWAVE DEVICE DIVISION / SYLVANIA ELECTRIC PRODUCTS, INC.





*MICROWAVE DEVICE DIVISION / SYLVANIA ELECTRIC PRODUCTS, INC.*



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# Introduction

The Microwave Device Division of Sylvania Electric Products Inc. is active in the area of applied research, product development, and manufacture of microwave devices. Included are all devices used to generate, amplify, and control microwave power: klystrons; magnetrons; traveling-wave tubes; ferrite isolators, rotators, and circulators; and diode devices such as parametric amplifiers, switches and frequency converters.

The Microwave Device Division is an organization of approximately 800 people whose accumulated skill and experience cover all phases of the development and production of high quality, reliable products at a reasonable price.

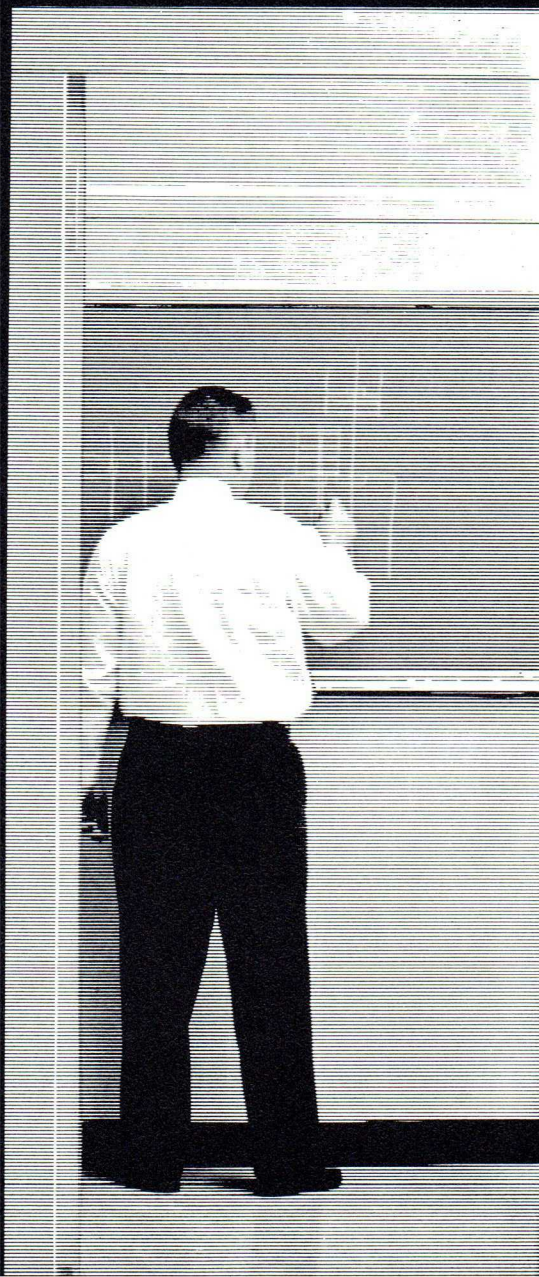
In addition to the Microwave Device Division technical staff, the organization is backed up by the total resources of the General Telephone and Electronics Corporation. This provides a tremendous source of broad technical competence to call upon when problems arise that are beyond the scope of MDD.

The division has two locations. The Williamsport, Pennsylvania, facility is devoted to the development and manufacture of magnetrons, planar disc seal tubes, waveguide windows, and TR's. In Mountain View, California, applied research in all product lines is carried on as well as product development and manufacture of traveling wave tubes, backward wave oscillators, klystrons and solid state devices.

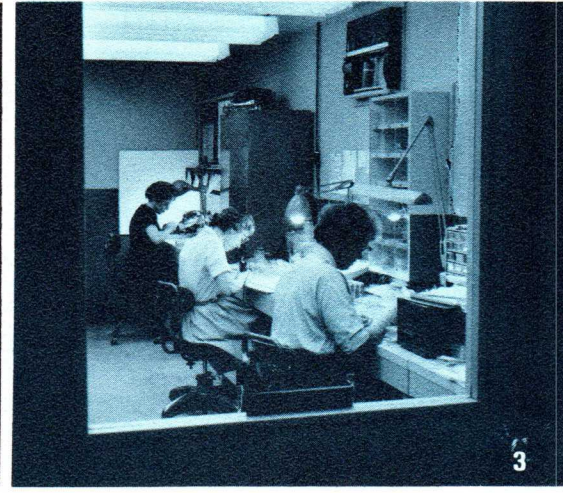
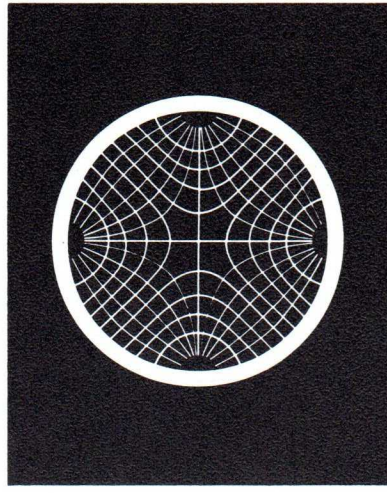
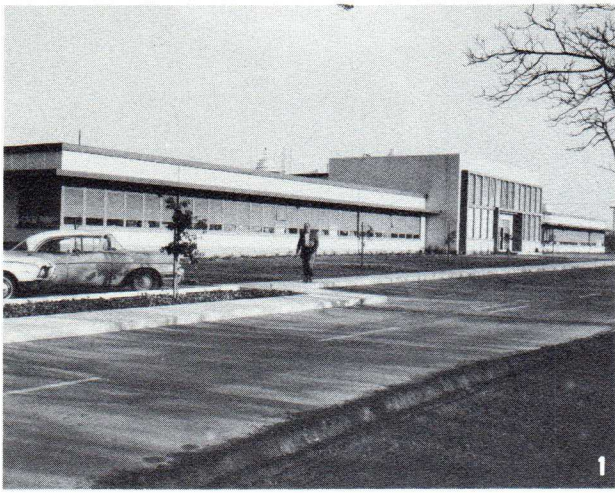


# Facilities









**Microwave Components  
Laboratory, Mountain  
View, California**

**1/** The Microwave Components Laboratory contains all the facilities necessary to accomplish a complete development program from computer design of a tube to fabrication and testing at the pilot line level.

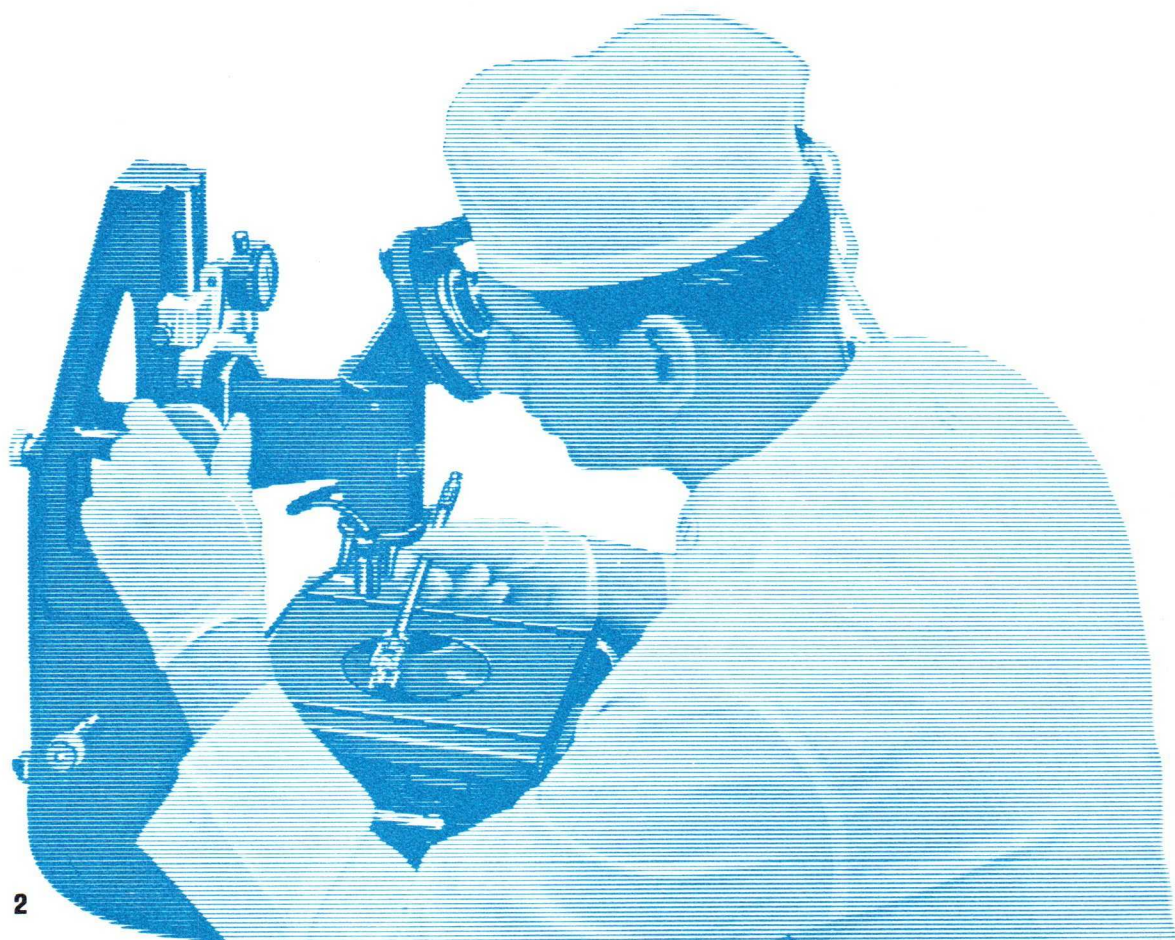
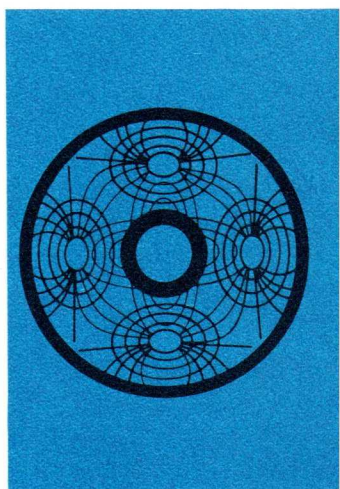
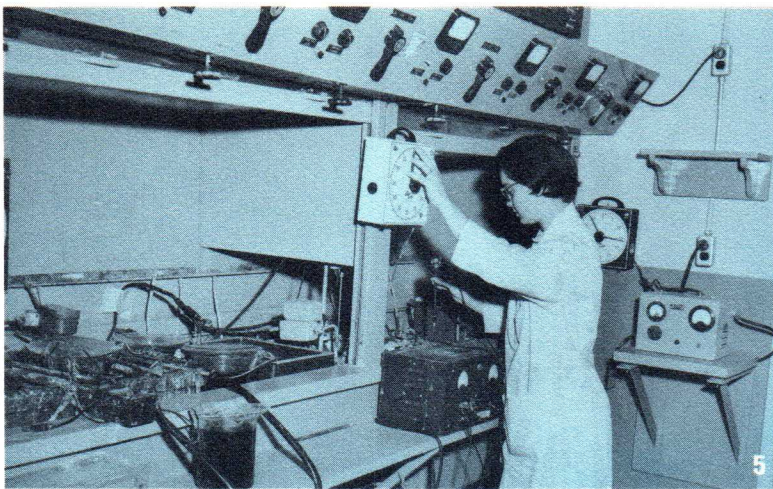
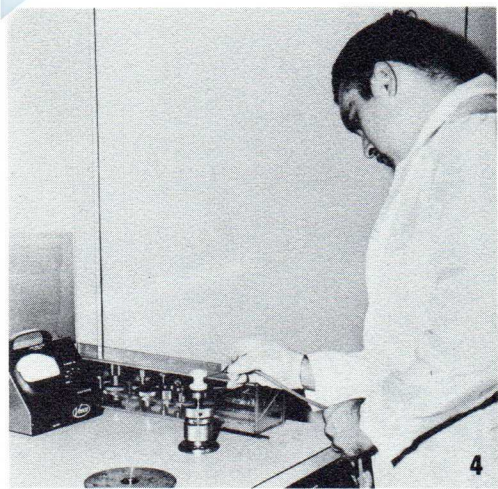
**2/** One of several ultra-clean assembly rooms where dust counts are at most one millionth of that found in the normal atmosphere. These are specially designed temperature and humidity controlled areas with absolute air filters for dust control. Special lint free clothing is always worn in these areas.

**3/** An air conditioned, humidity controlled area is maintained for metallizing ceramic pieces to be used in high reliability metal/ceramic tubes.

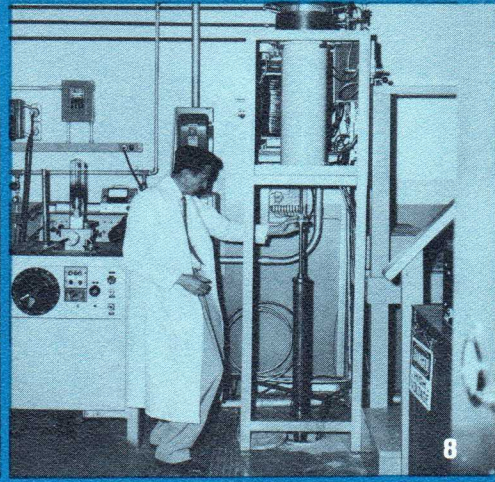
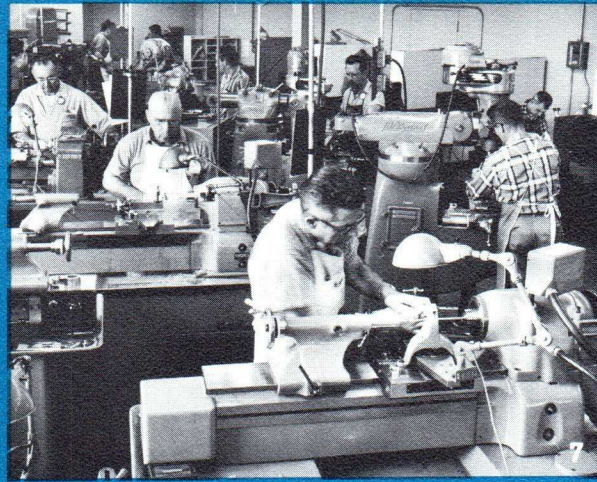
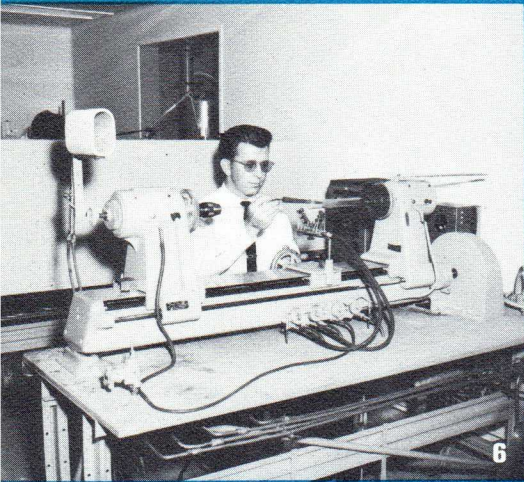
**4/** Ultra-sensitive helium leak detectors are used to check brazed ceramic assemblies for vacuum tightness.

**5/** Complete facilities for the development of cleaning and plating procedures for new materials are available. The evolved procedures are strictly enforced by a staff of competent chemists and metallurgists in both engineering and manufacturing areas.

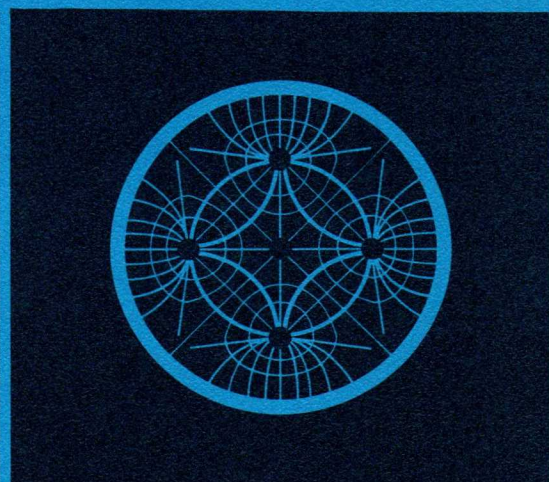
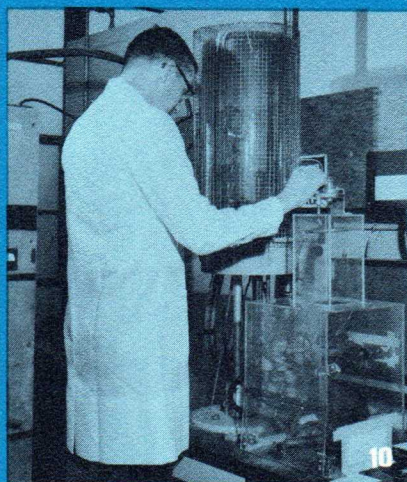
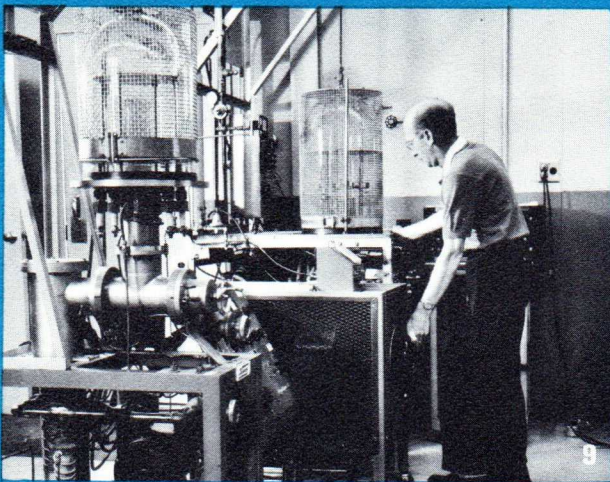












**6/** For the engineering of glass tubes, a well-equipped glass shop is available.

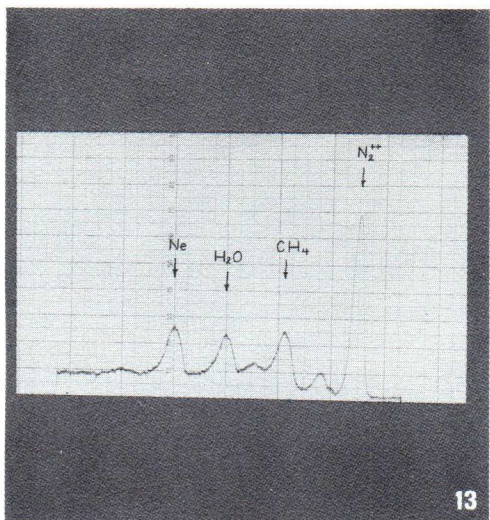
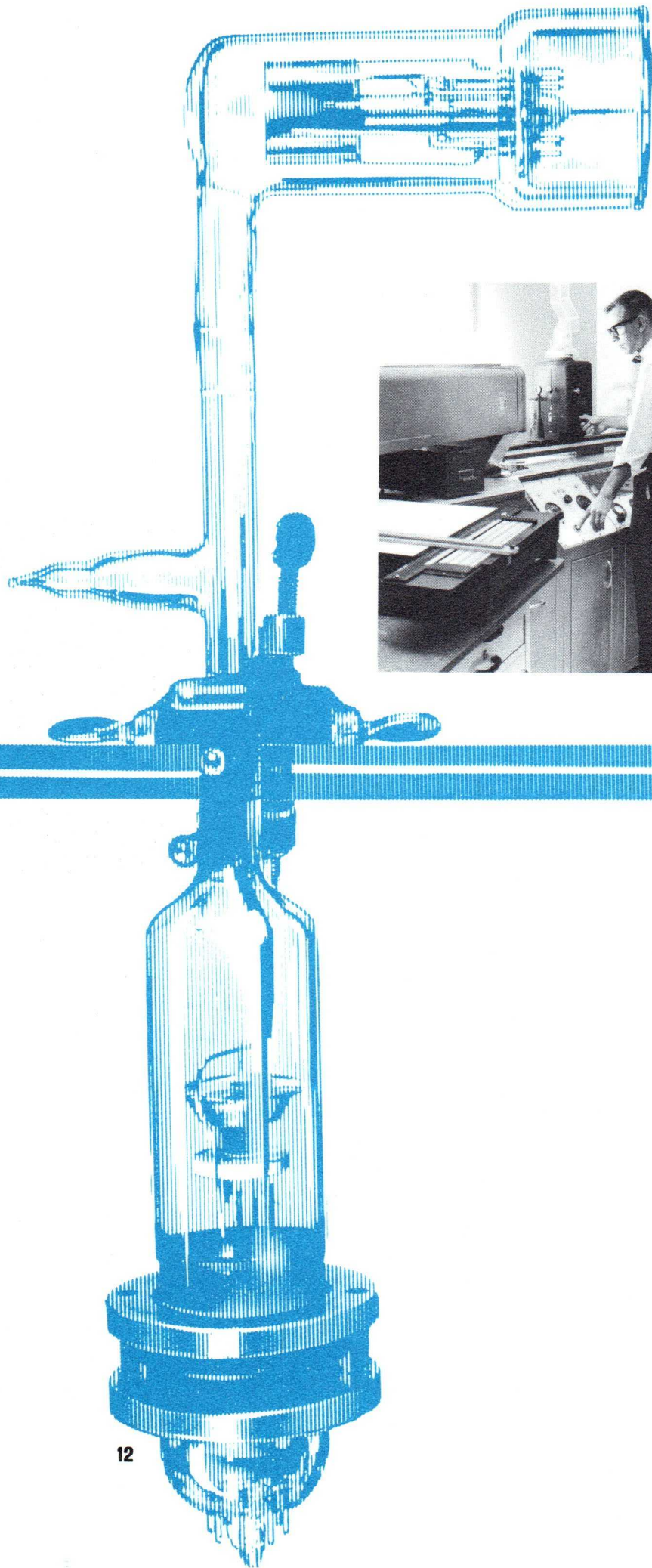
**7/** The staff of the Model Shop is made up primarily of highly experienced tool and die makers.

**8/** Brazing of tube parts is done in many ways. This is a vertical furnace where the work is raised into the hot zone by an elevator arrangement.

**9/** Vacuum type bell jars are used to do special work where the surrounding atmosphere must be reduced to a minimum to prevent chemical reaction and unreliable brazes.

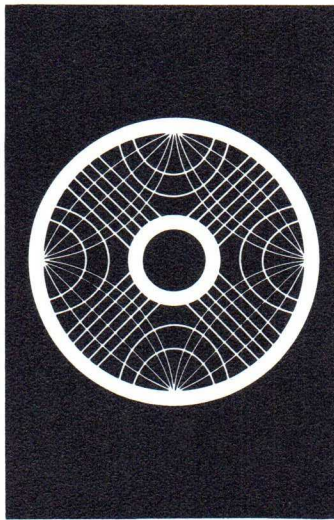
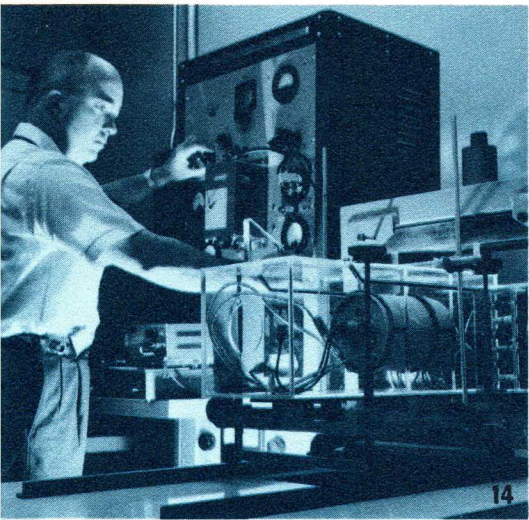
**10/** Hydrogen bell jars are versatile and efficient devices for both experiment and production where the heat source is a hot filament.





12





**11/** Spectrographic techniques serve both for quality control and research. The spectrometer is primarily used in the determination of trace elements in tube materials. It is a precise and valuable tool for assuring that detrimental elements, even in trace quantities, are kept within strict limits during production.

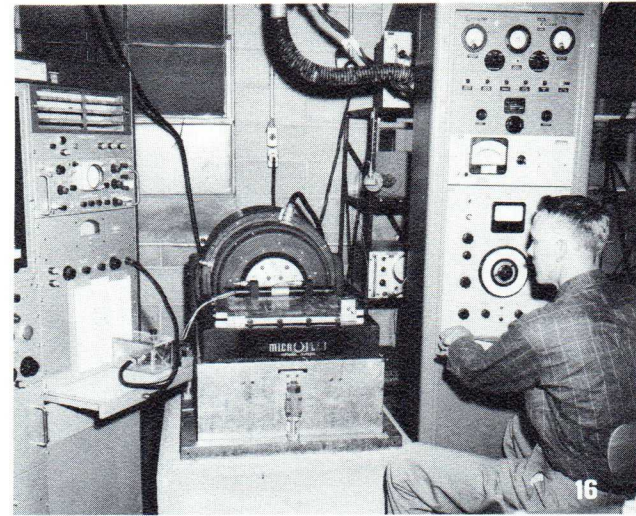
**12/** Since no vacuum is ever perfect, life expectancies of microwave tubes are effected by the kind and amount of very minute quantities of residual gases present. Measurement of these gases was once a difficult and tedious procedure. The use of the omegatron has provided an accurate, rapid method of

analysis by a simple scanning procedure. In this test, the omegatron is attached to a special heater-cathode assembly.

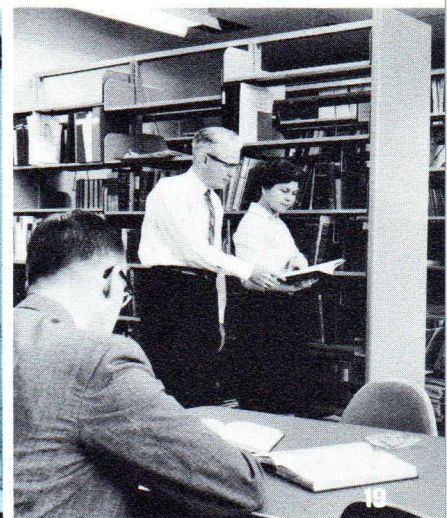
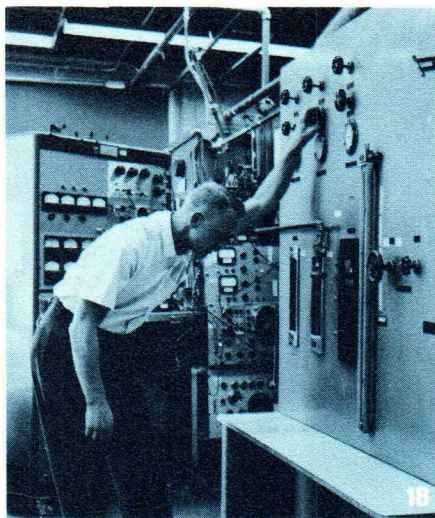
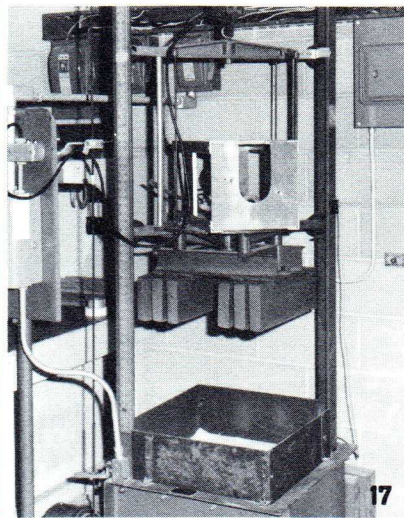
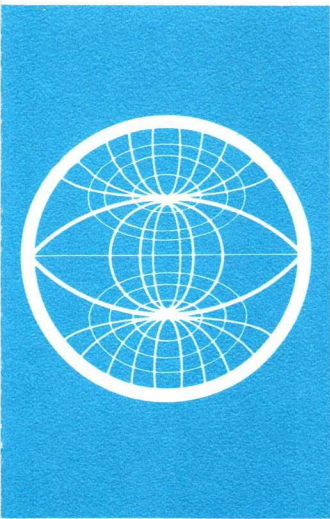
**13/** Recordings are made of the omegatron scan. The ordinate represents mass number, and the abscissa, relative number of molecules of each kind of gas per cubic centimeters.

**14/** To aid in the evaluation of life capabilities of a high power traveling wave tube an omegatron is attached and measurements are made of the quantity and mass number of desorbed residual gases.









**15/** An altitude chamber, complete with temperature control of moving air, permits determination of heat transfer characteristics under various altitude conditions.

**16/** Simultaneously with the altitude environment, vibration characteristics of devices can be measured either at a fixed vibration frequency or with a random noise type generator attached so that more realistic conditions can be simulated.

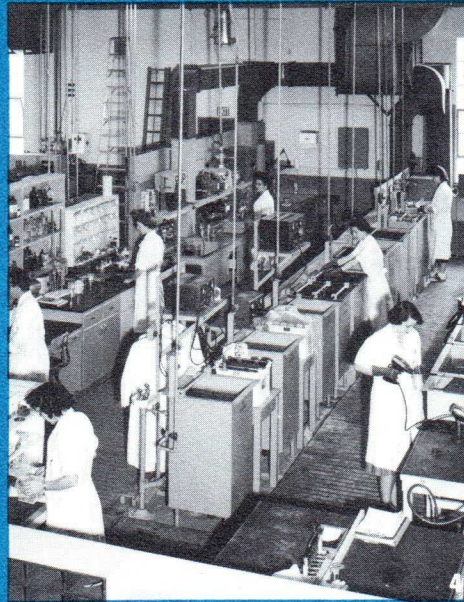
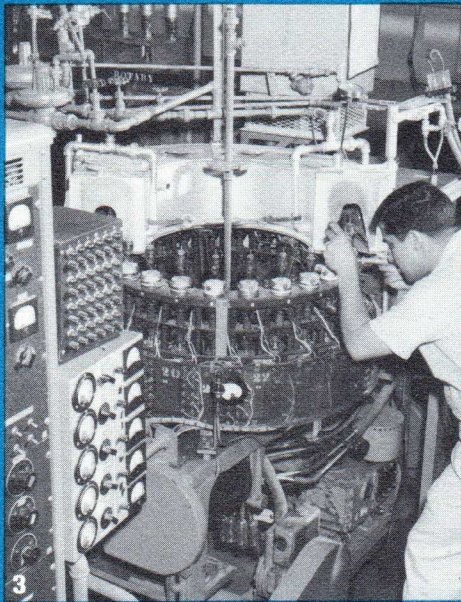
**17/** Standard shock tests are made routinely on the ASTM-approved testing machine.

**18/** Wide variations of temperature and humidity can be set up in the chamber to evaluate resistance of materials to climatic conditions.

**19/** A well-stocked library, with professional library supervision, is maintained to provide immediate access to current literature. In addition, the library services of two nearby major universities are available.



# Mountain View Plant



**1/** Klystrons, traveling-wave tubes, backward wave oscillators, and solid state devices are manufactured at the Mountain View Plant. The plant is a self-contained facility with all the equipment necessary to carry out an efficient manufacturing operation available under the supervision of the manufacturing group. Due to the proximity of the Components Laboratory and the Manufacturing Plant, close collaboration between design and production is maintained. In this way the transfer of a product from engineering to manufacturing is expedited. In the early phases of production, design engineers work directly with manufacturing personnel.

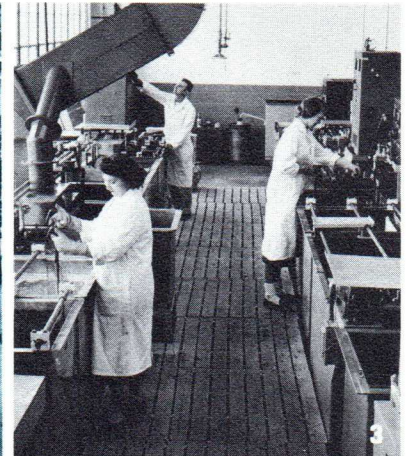
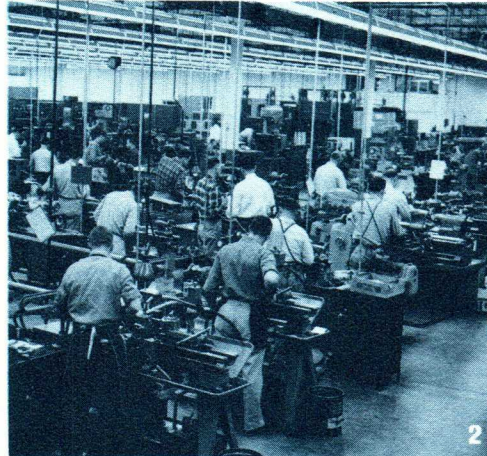
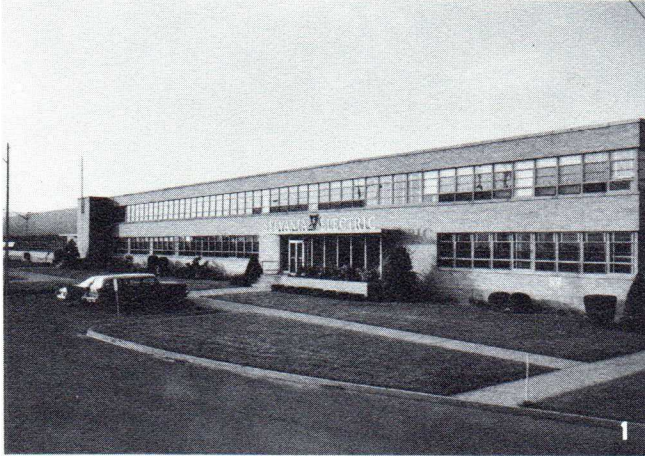
**2/** Tube assembly is performed by operators trained in the special mechanical skills peculiar to microwave devices and in areas where cleanliness is paramount.

**3/** Where mass production techniques are needed, devices such as the rotary exhaust machine used in other Sylvania areas have been adapted to microwave tubes.

**4/** Cleaning and plating of parts for use in a vacuum requires special knowledge and exacting controls. Specially selected production equipment is installed for this purpose.



# Williamsport Plant



**1/** Engineering and manufacturing facilities for the product development and production of magnetrons, planar disc seal tubes, TR's, and waveguide windows are located at Williamsport, Pennsylvania. The facilities include the laboratory equipment and space necessary to design, construct and test any variant or new version of the assigned products of the plant. Included also are separate pilot production facilities for the reduction of new designs to practice prior to placing these types in production.

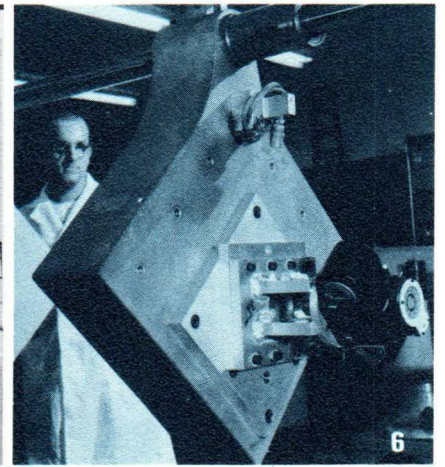
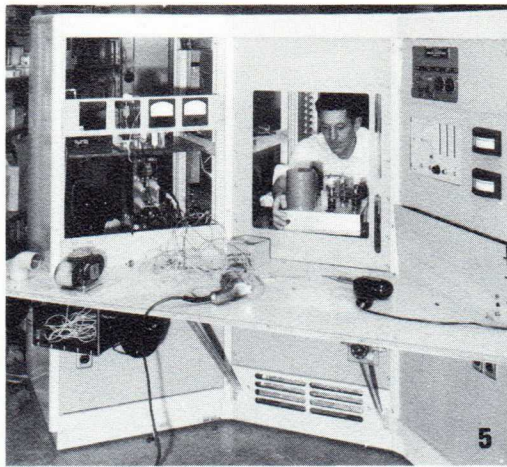
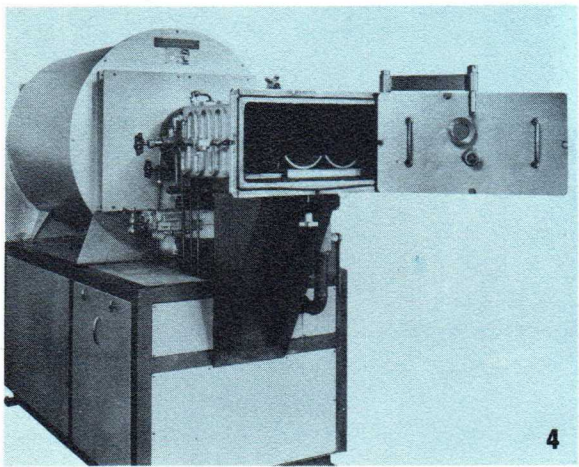
In support of the Williamsport Operation work on advanced crossed-field devices is being carried out at the Mountain View Components Laboratory. This work includes development of high CW power backward wave magnetrons in ku band and high CW power forward wave amplifiers.

Each product class in this plant is managed and supervised independently of the others and encompasses all phases of operations concerning that product line, from design to volume manufacture. In general, facilities are separate for each, so that quick reaction time is maintained and transfer time loss between engineering development and production avoided.

**2/** The plant produces about 50% of the tube parts it uses, and a modern machine shop equipped with precision machine tools is provided.

**3/** Equipment is available to carry out electroplating operations to the rigid specifications required to maintain high quality standards of reliable microwave tubes. Facilities exist to plate copper, nickel, silver, rhodium, iron, gold and other less common metals.





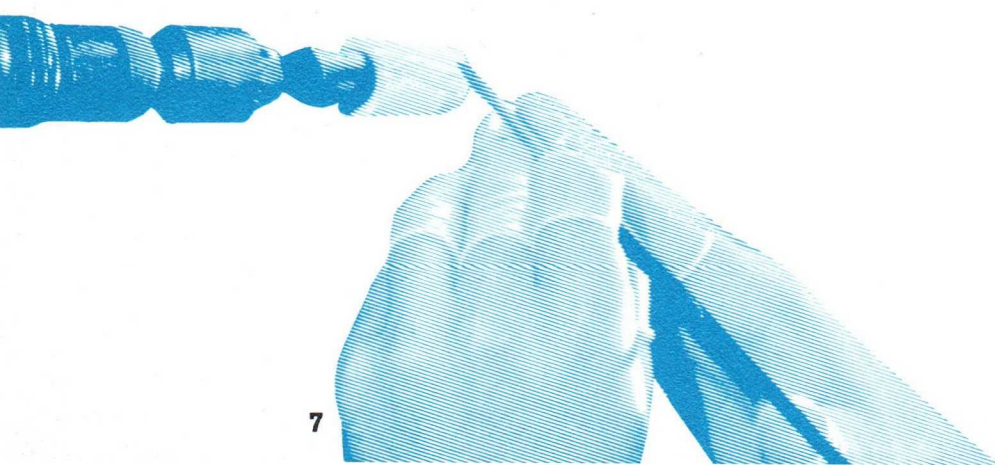
**4/** Considerable vacuum firing is used to reduce residual gas content of construction materials prior to tube assembly instead of the more conventional hydrogen firing procedures. For higher production rates, large vacuum furnaces are required.

**5/** The expanding need for specialized test equipment to measure electrical characteristics of magnetrons is being met in our own equipment construction shop. A versatile magnetron test kit is shown under construction.

**6/** Quality control environmental test equipment for meeting all MIL specifications is a prime requirement for a modern microwave tube facility. This Sylvania facility has been approved for the conduct of in-plant qualification tests.

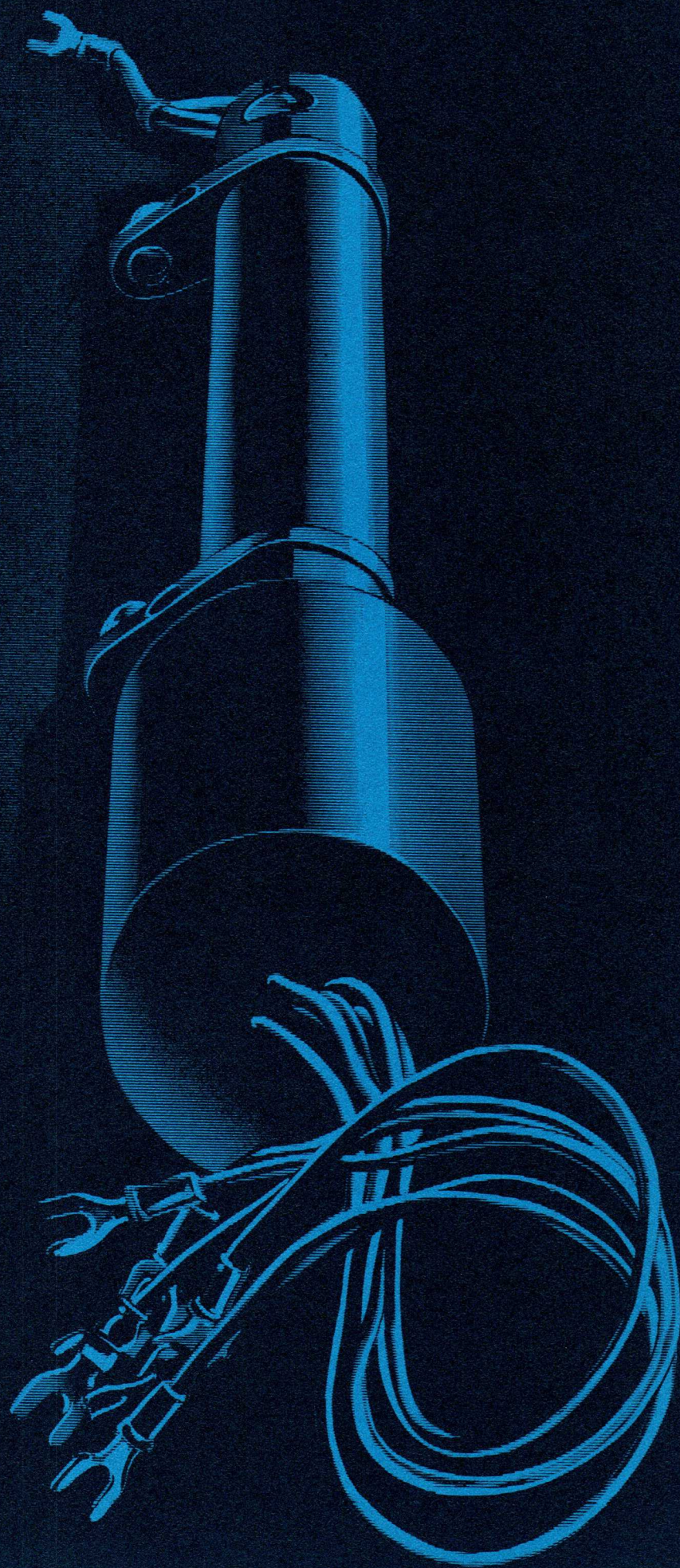
In addition to customary vibration test mounts, there is available a shock test machine of unusual design in which the shock and time of application can be quite closely controlled.

**7/** Operations such as this ceramic preparation for metal sealing are routinely done in an atmosphere-controlled clean room.

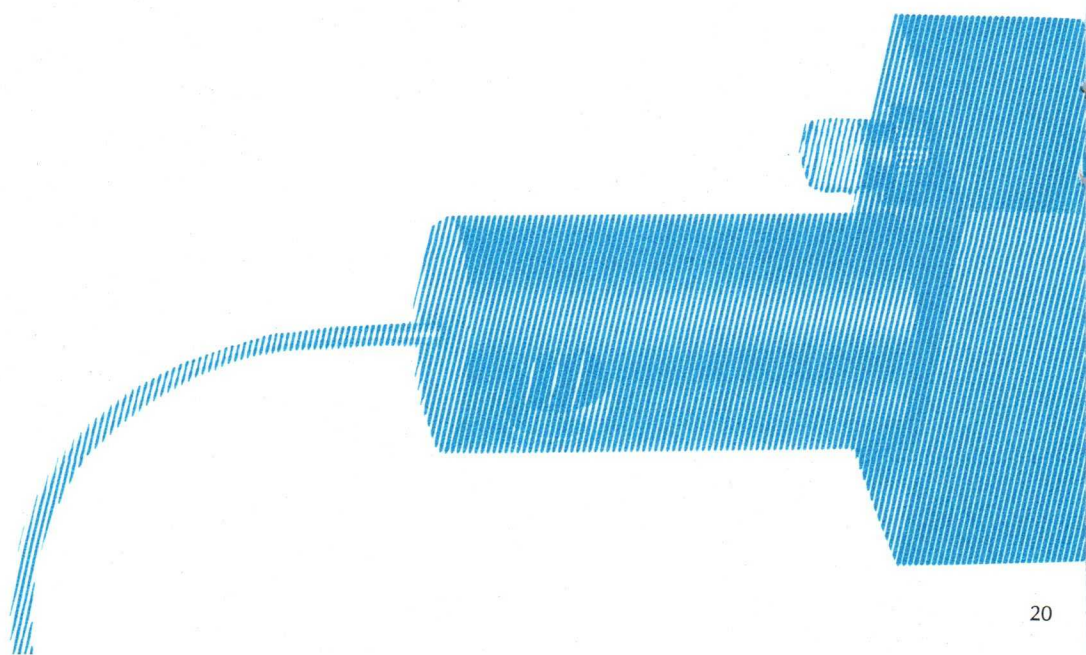
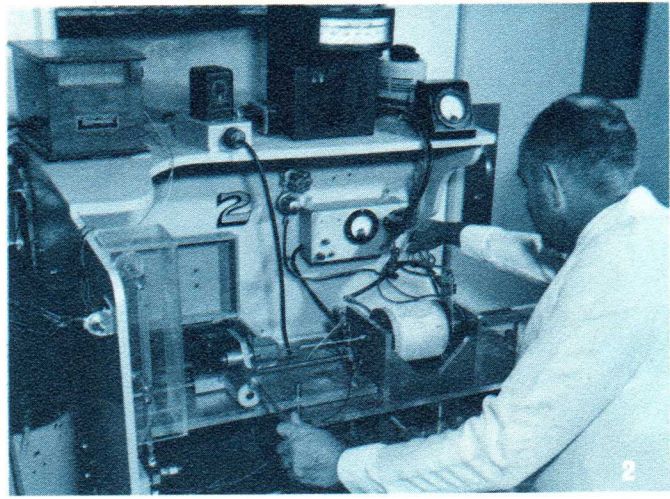
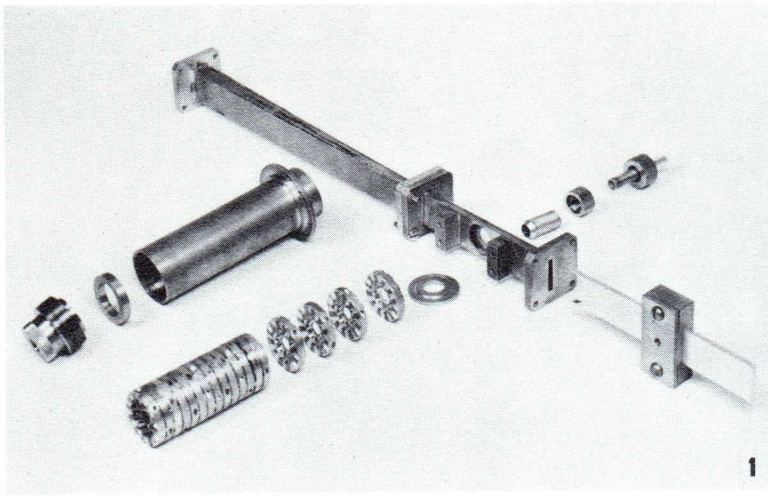




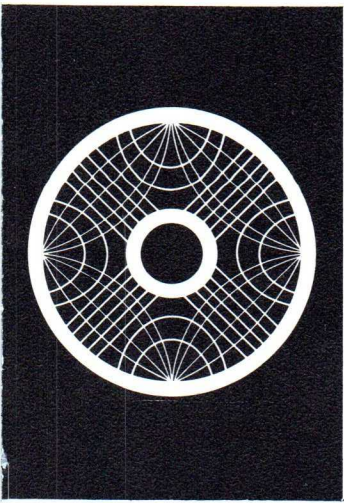
# Traveling- Wave Tubes











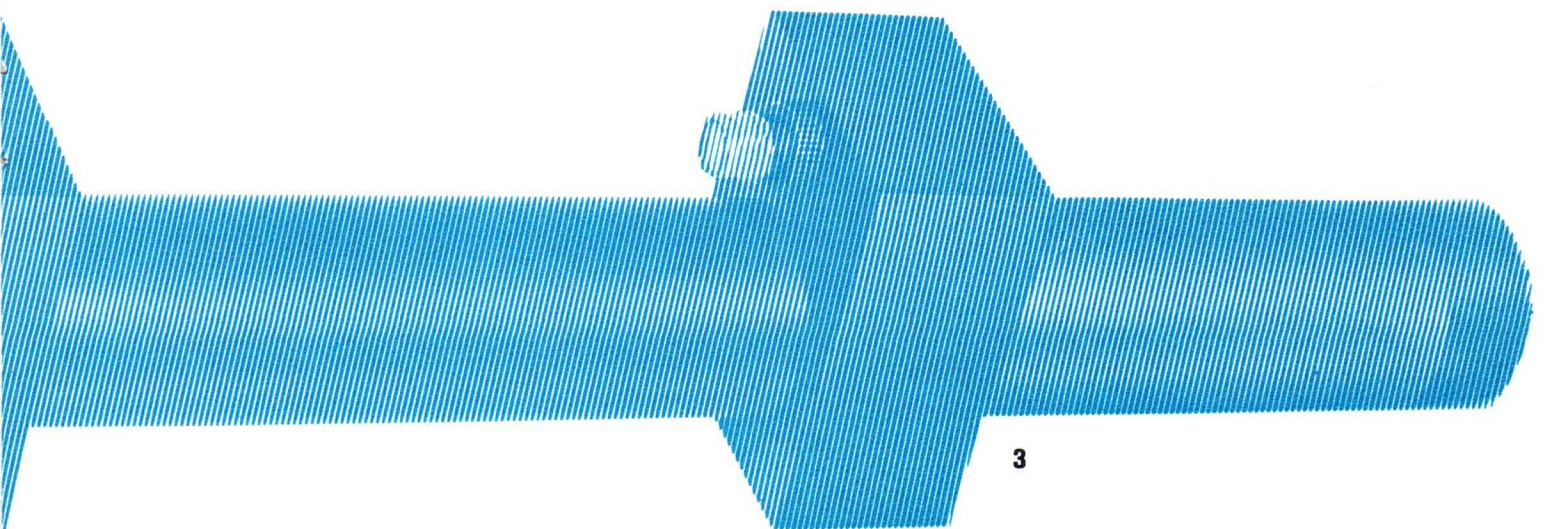
Sylvania's activities in traveling-wave tubes started in 1947 at the Research Laboratories on Long Island, New York. Later the facility was shifted to Mountain View to make it possible to develop and manufacture tubes for the Defense System of the B-58 Hustler Supersonic Bomber. A tremendous increase in personnel and facilities was required, and by 1957 MDD was delivering tubes for the B-58's with its first fully qualified, operational system.

Today, MDD has a large competent staff of engineers and technicians capable of undertaking any task in the field of traveling-wave tubes.

**1/** This new X-band TWT, seen in exploded form, has a 2 megawatt peak power capability over a 20% band. Its slow wave structure is made up of intricate, mutually interweaving assemblies.

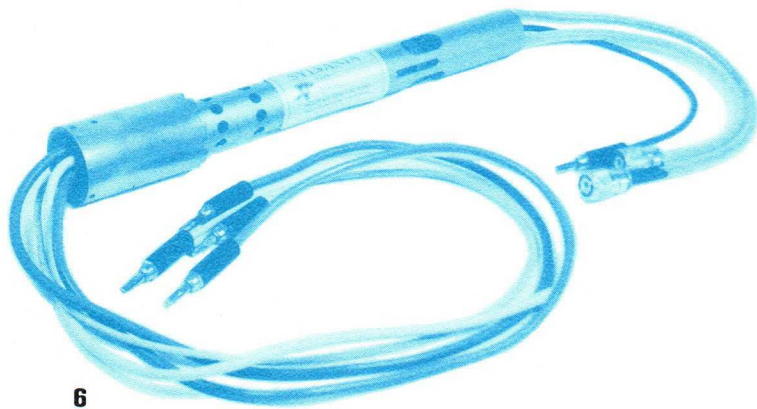
**2/** To precisely make attenuators in TWT's, a unit has been developed for the automatic deposition of pyrolytic carbon on alumina substrates in accord with a prescribed specification. The thickness, length, and uniformity of the coating must be controlled to precise limits.

**3/** This tube is illustrative of Sylvania's complete line of PPM focused low level and medium power tubes covering the frequency range of 1,000 to 12,000 megacycles. It is an adaptation of Sylvania's permanent magnet focused TWT to meet special system mounting requirements.

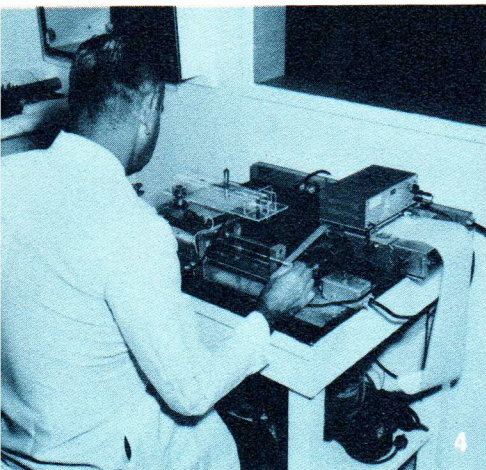


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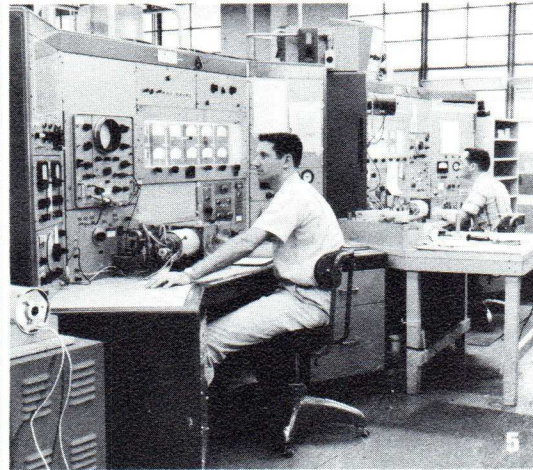




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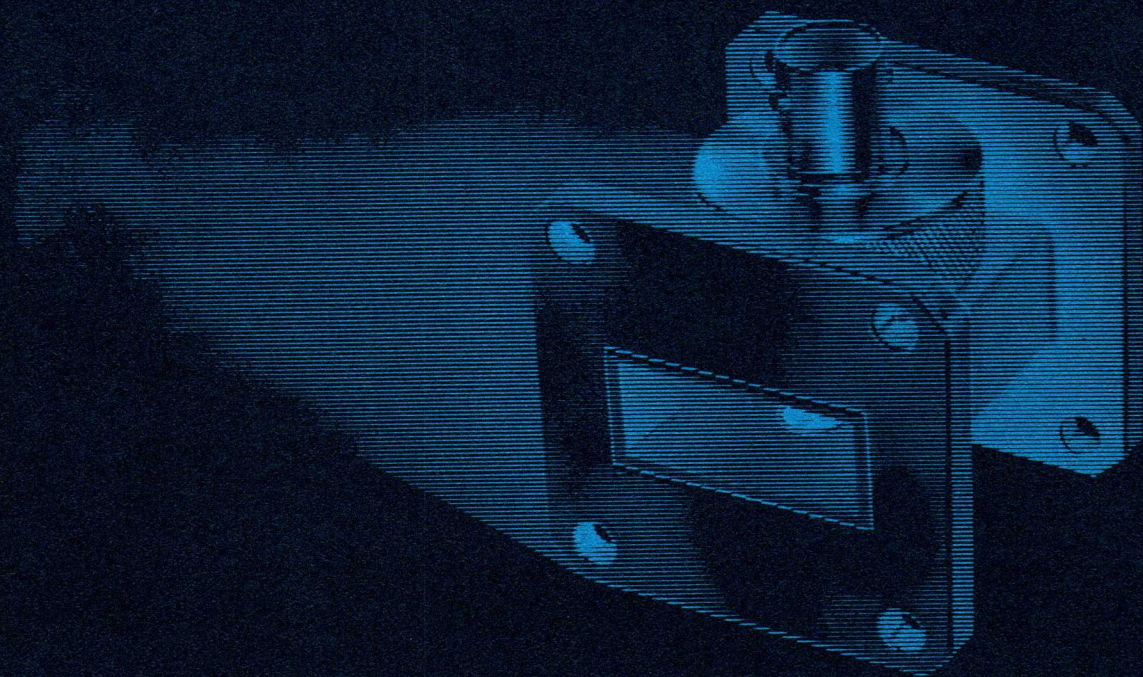
4/ Each attenuator is closely checked by a special instrument that measures the conductivity of the coated element.

5/ Complex test consoles have been built for production testing of the many electrical parameters usually specified for TWT's.

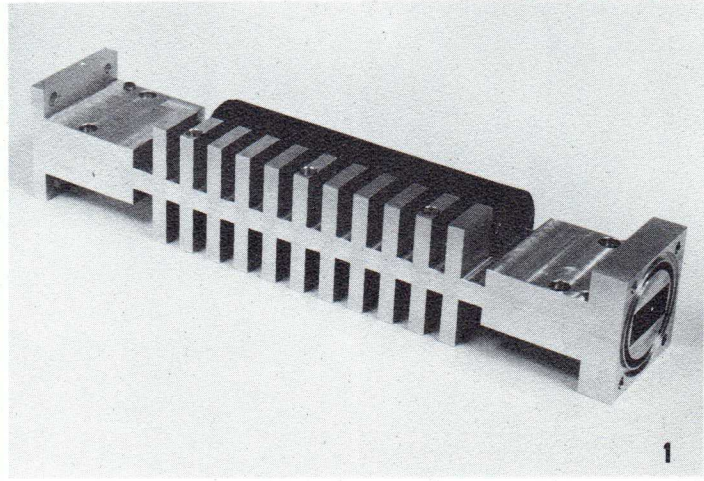
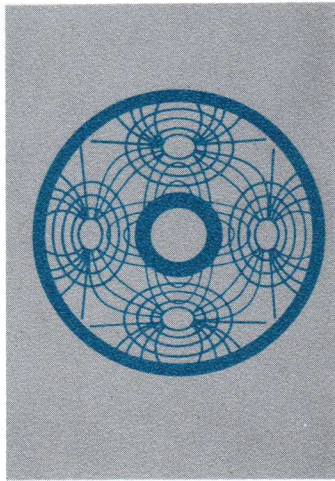
6/ Wide band pulse tubes with power outputs in excess of 1 kilowatt are in production.



**Solid  
State  
Devices**



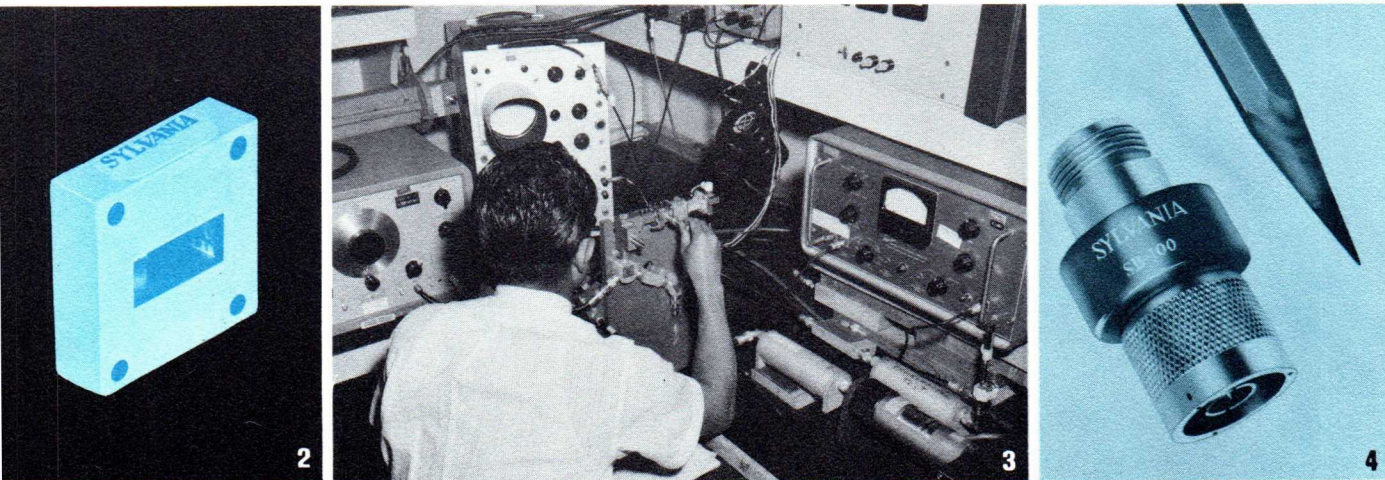






Devices using solid state materials have played a vital role in microwave systems. MDD has been active in the field of microwave ferrite devices for many years. Presently a broad line of standard ferrite type devices such as isolators, rotators, and circulators are available. This quick-reaction facility makes it possible to design, develop, and manufacture devices for special applications.

The semiconductor diode has been used at microwave frequencies for many years. More recently oscillators, amplifiers, frequency multipliers using semiconducting materials were developed. For some time MDD has had a growing activity in this field.



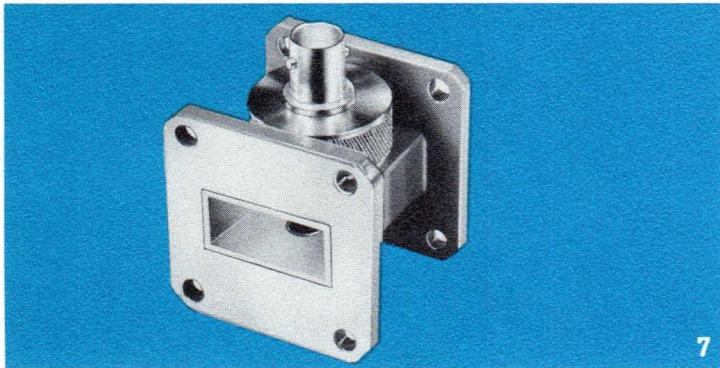
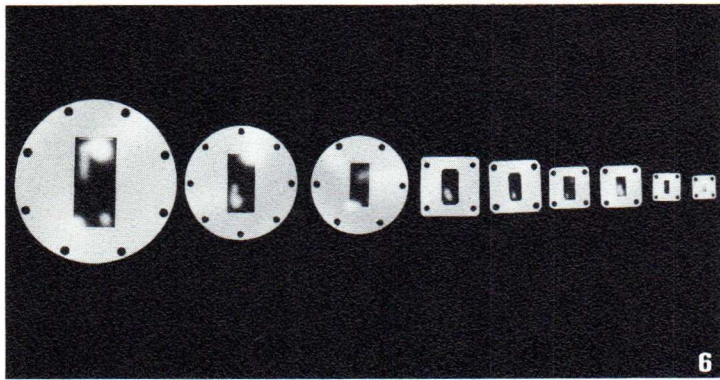
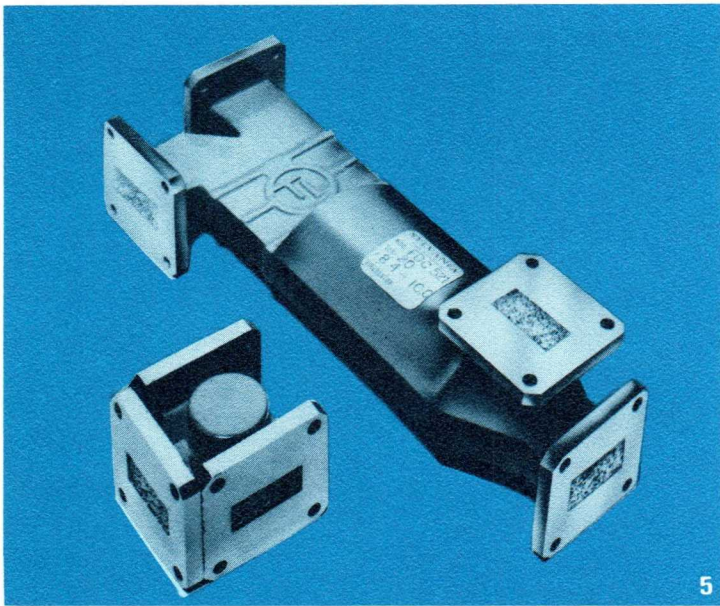
**1/** Development of ferrite devices to accommodate new systems requirements are under way. An example is a high power broadband isolator capable of handling 2 Kw of average power and 20 Kw of peak power over a frequency band of 7.5 to 10.5 Gc. This unit is effective at temperatures up to 250°C and will handle in excess of 100 watts of reflected power with only convection cooling.

**2/** For special application where space and weight are at a premium, narrow band X-band isolators have been developed. The entire unit, including magnets, is of the same dimension as an X-band waveguide flange and only ½" long. Its weight is approximately 3 ounces.

**3/** Where very low noise is a factor, MDD's staff and equipment for designing tunable parametric amplifiers are available.

**4/** Sylvania's coaxial d.c. blocks solve the problems of d.c. voltage isolation in transmission lines. These are available in practically any type of coaxial connector.





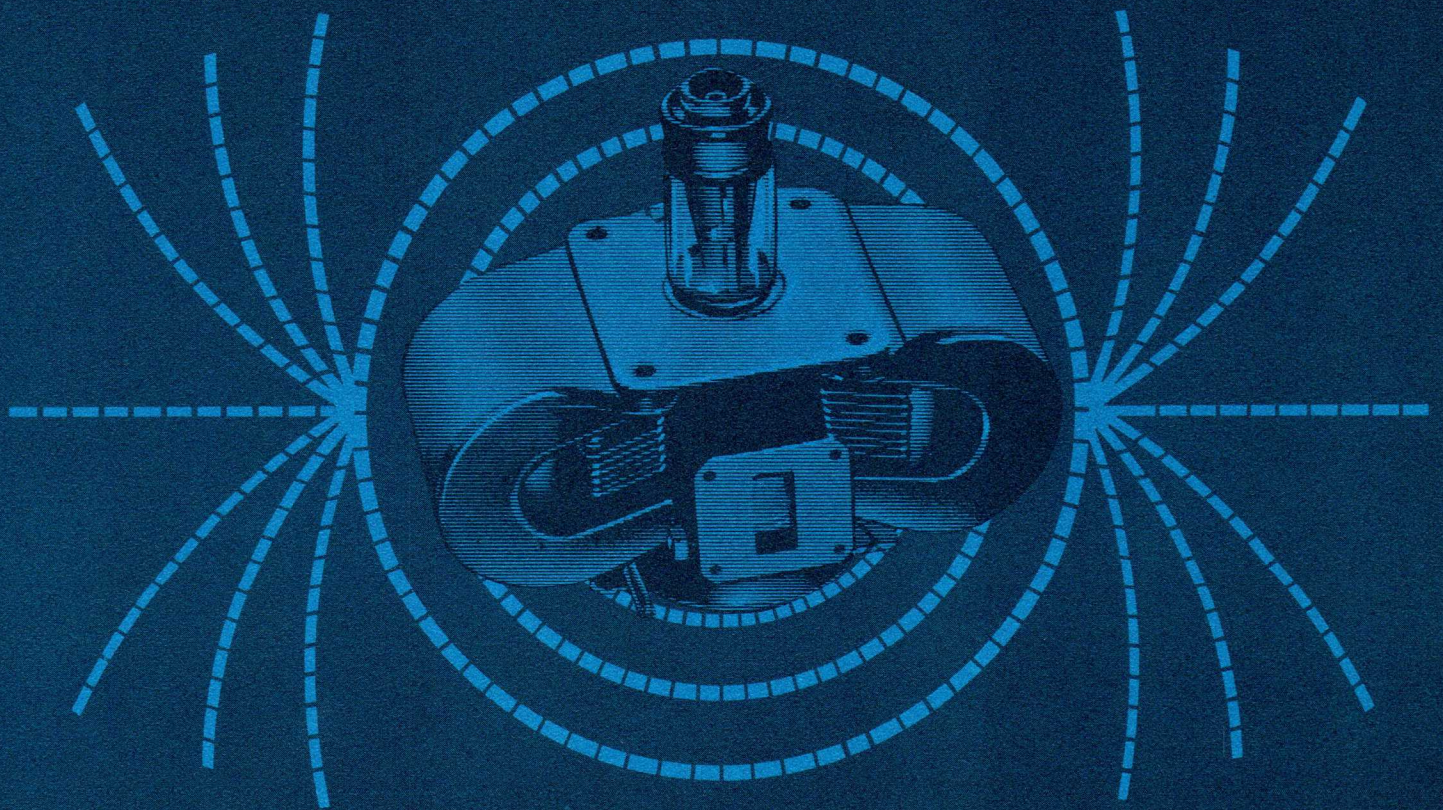
**5/** When special applications demand unusual features, Sylvania's broad experience results in imaginative design. This hybrid coupler, 4-port circulator has the same frequency range and electrical characteristics as the resonant, 3-port circulator. However, the mechanical configuration can be adapted to specific system requirements.

**6/** For problems of pressurizing or evacuating transmission lines or other microwave components, high quality wave-guide windows (S through K bands) have been developed and are available.

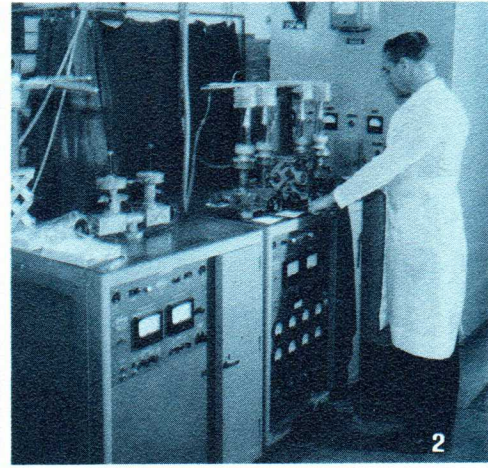
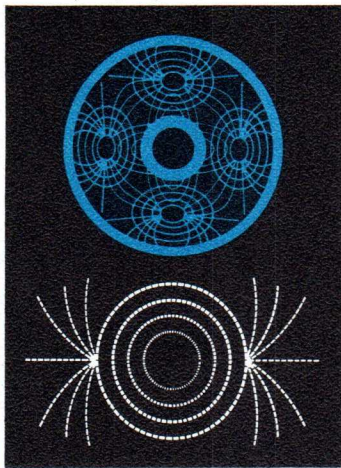
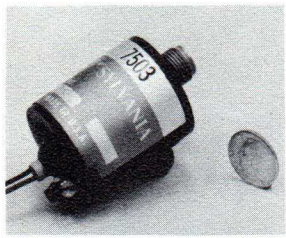
**7/** Extremely fast acting microwave switches using computer diodes have been developed. These switches are particularly applicable to airborne systems where size and weight limitations are important.



# Magnetrons







The magnetron product line of the Microwave Device Division consists of pulsed types in the low to medium power category, tunable and fixed frequency in X-band and higher frequencies.

In X-band, Sylvania offers magnetrons ranging in peak power from a 100 watts for beacon application (type 7503) to 200 KW for use in airborne radar fire control equipment (type 7692A).

The X-band tunable group also includes the 20 KW peak power M-4264 and the 80 KW peak power 6543.

A number of variants of the basic 200 KW peak power X-band tunable magnetron are available, dependent upon pulse conditions required, extent of band coverage and method of tuning in the system. Sylvania's engineers are presently active in the development of an hydraulically tunable version for airborne applications with a tuning rate of 100,000 Mc/sec. across the band of 8500 to 9600 MC.

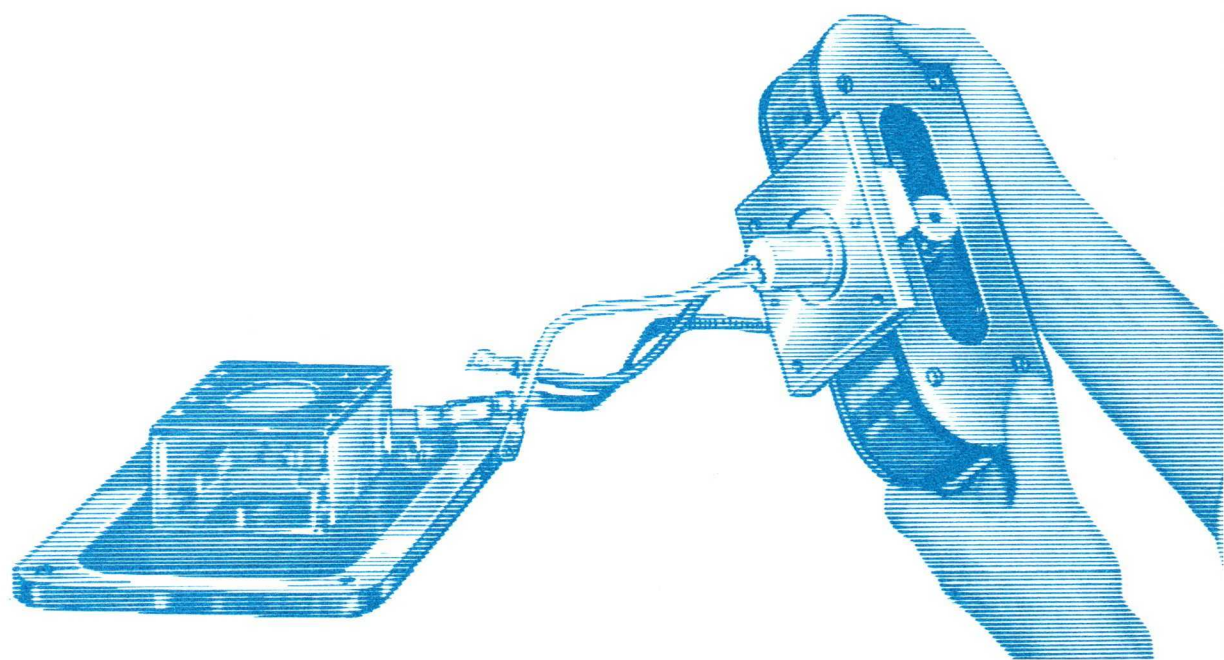
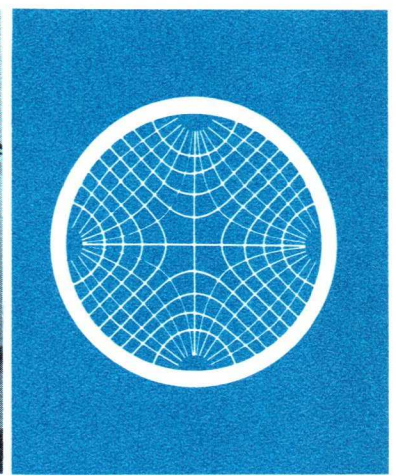
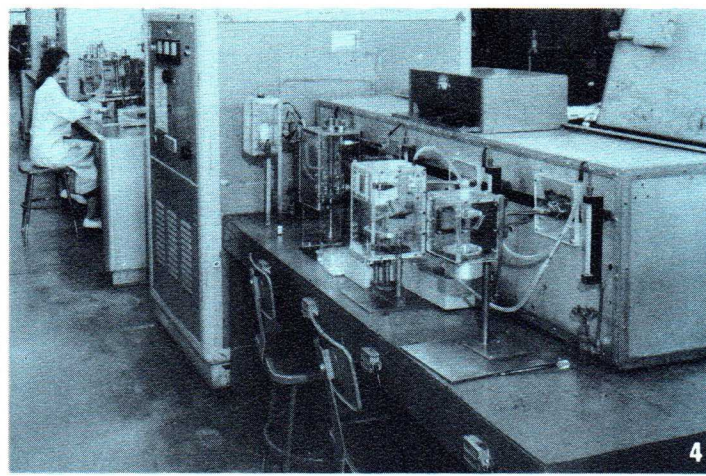
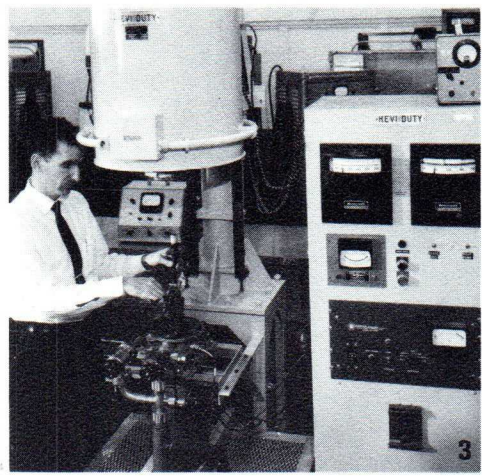
**1/** The heart of a magnetron is its cathode. For optimum life, good "snap-on" characteristics and high reliability, much depends upon the cathode. An essential step in magnetron design is the determination of cathode temperatures by means of an optical pyrometer at various stages of processing. This is done with special prototype assemblies and provides proven control specifications.

**2/** These production units are used to carry out pre-processing and brazing under vacuum.

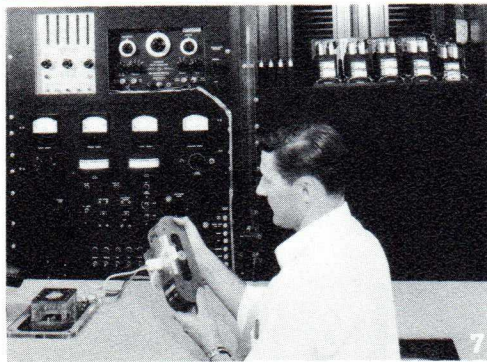
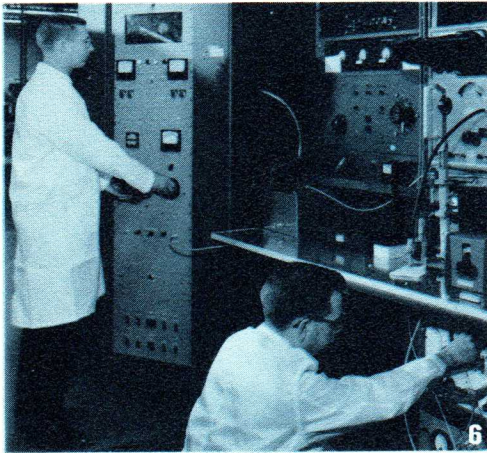
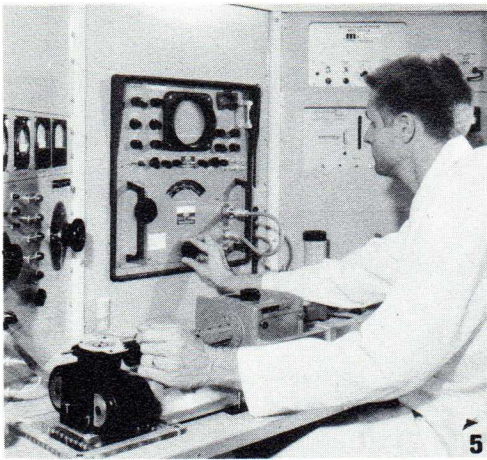
**3/** Magnetrons are pumped in double walled vacuum ovens to prevent the outside of the tube from oxidizing, eliminating the need for acid removal of the oxide. Such acid cleaning releases highly mobile hydrogen ions which can migrate through the walls of the tube and impair the vacuum.

**4/** Production brazing boxes, in which magnetron subassemblies are brazed, employ R. F. inductors heating in a reducing atmosphere.









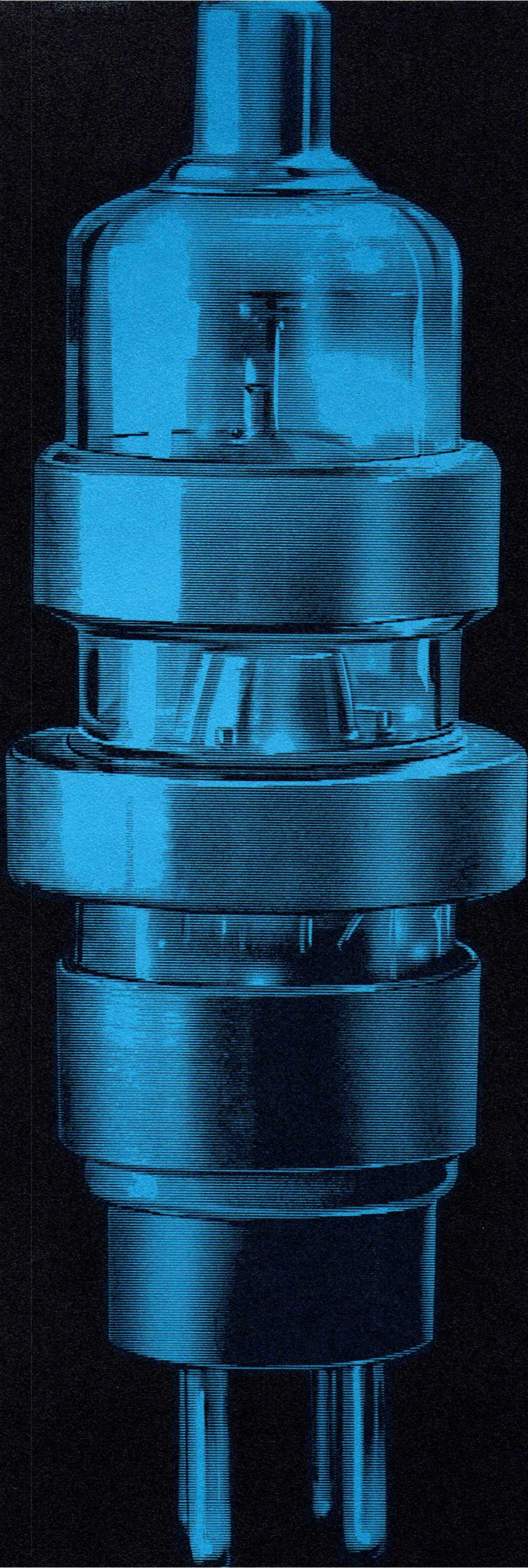
**5/** An X-band 200 KW tunable magnetron under testing supervision of one of our highly skilled applications technicians.

**6/** Increasingly stringent system requirements on frequency deviation within a particular pulse and from pulse to pulse emphasizes the importance of this highly specialized test equipment. Extremely stable frequency sources and precisely shaped pulses are essential for the measurements.

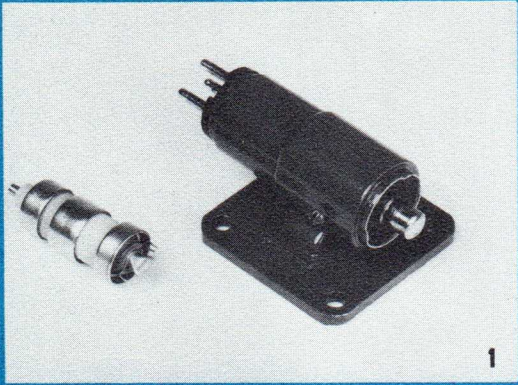
**7/** Sylvania features a full line of Ka band (8 mm) magnetrons covering the range of peak power output from 20 KW to 100 KW. Shown here is a universal Ka band test kit used by the development engineers.



# Klystrons









The klystron product line of the Microwave Device Division is devoted to reflex oscillators up to power levels of several watts. These are intended for use primarily as local oscillators, transmitters for radio relays, and test equipment. Sylvania's long experience started in early 1949 with the development of the disc seal external cavity reflex klystron, the 6BL6, 6BM6 etc. series. Recent developments extended the range of this series to 15,000 megacycles. The external cavity concept provides great flexibility for the user and for rapid development of 'special application' types.

Sylvania is presently active in the development of new forms of reflex klystrons for use primarily in communication relay system. Methods for improving phase linearity, amplitude fidelity, tuning capabilities, frequency stability and life are being examined.

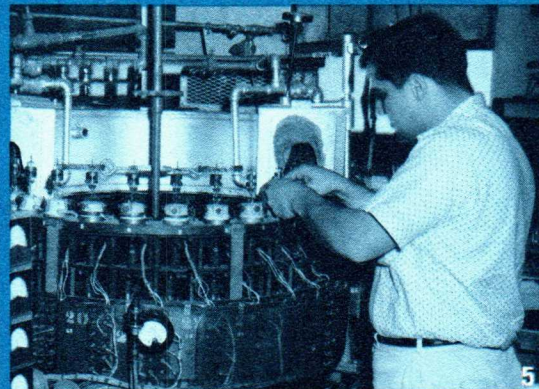
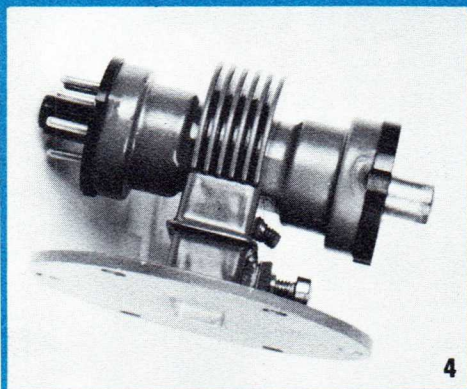
**1/** The extension of the disc seal concept is illustrated by the 11 Gc model which employs a metal ceramic-envelope. By slight modification of the non-vacuum portions of this assembly, a wide range of frequencies can be covered.

**2/** The versatility and adaptability of this concept is demonstrated when the same electron tube is used in a variety of special applications such as weather radar, police speed radar and common carrier communications. These types are tunable from 10.7 to 11.7 Gc.

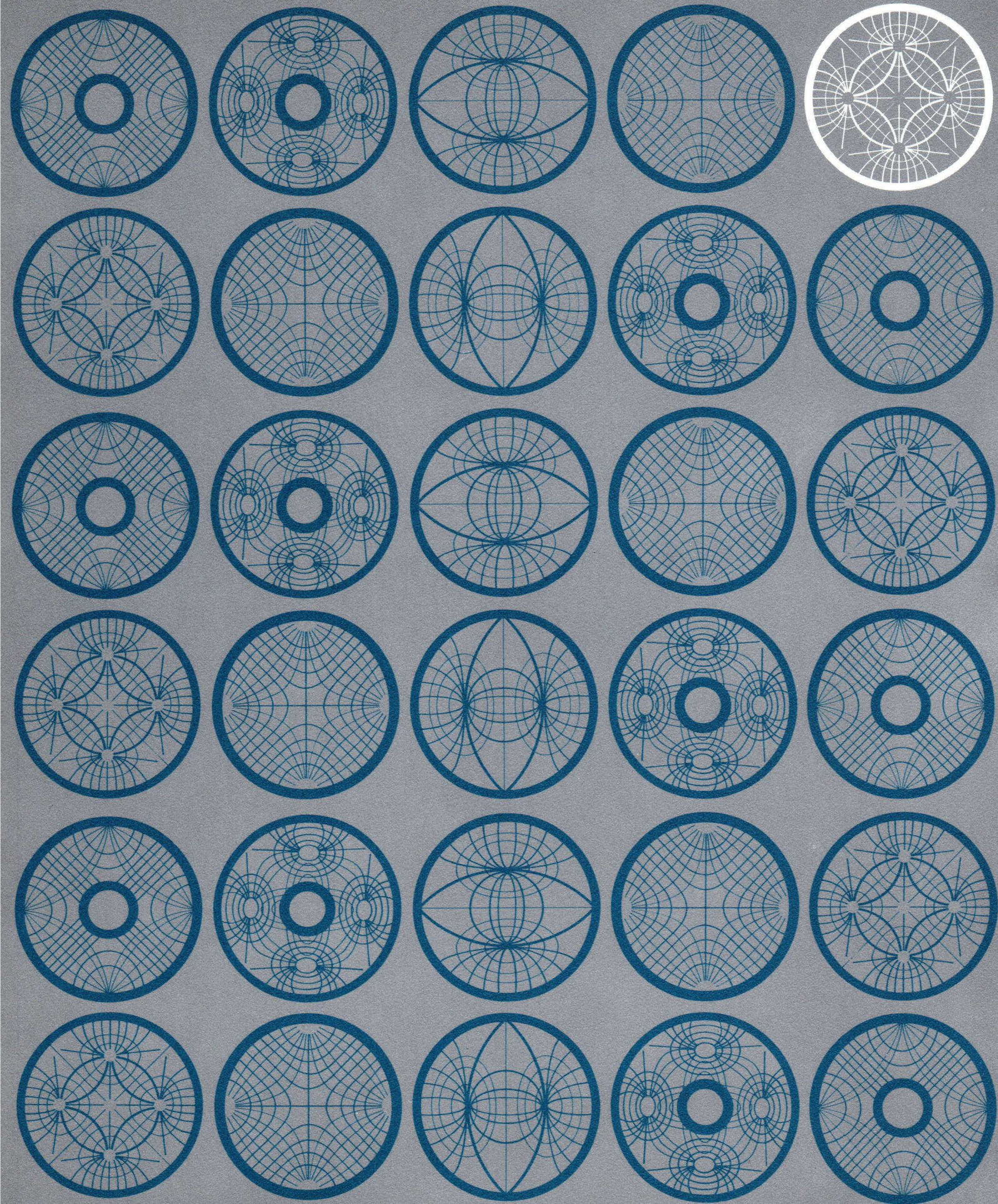
**3/** The time-consuming and costly process of testing disc seal klystrons has been reduced to a minimum by the development of special test consoles.

**4/** Communication link klystrons are represented by the SK-220 which is one of many long life-high reliability tubes for common carrier use in the 7000 Mc region.

**5/** In order to produce quality items at minimal prices, Sylvania has utilized rotary exhaust machines for processing disc seal klystrons.









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