Mullard Outlook

AUSTRALIAN EDITION

MAY-JUNE, 1965
VOL. 8, No. 3

MULLARD-AUSTRALIA PTY. LTD.

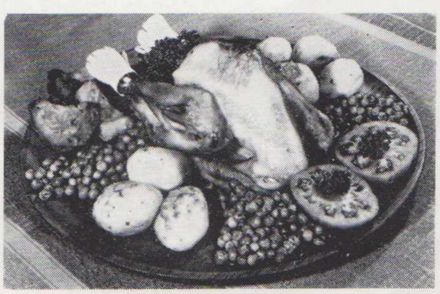
VOL. 8 — No. 3 MAY-JUNE, 1965

Editorial Office:
35-43 Clarence Street, Sydney.
Telephone: 29 2006

Editor:
JOERN BORK

Outlook Reference Number
Mitchell Library, Sydney, N.S.W.
Q 621.3805
1

TABLE OF CONTENTS



A conventional dish prepared in a microwave oven, the subject of an article in this issue.

MULLARD-AUSTRALIA PTY. LTD.
35-43 CLARENCE STREET, SYDNEY
Phone: 29 2006
123-129 VICTORIA PDE., COLLINGWOOD, N.5
VICTORIA
Phone: 41 6644
Associated with
MULLARD LTD., LONDON

"TO MAKE A RAGOÛT FIRST CATCH YOUR HARE . . ."

"Le Cuisinier Francais" La Varenne

So it wasn't Mrs. Beeton after all and La Varenne died in 1794; the culinary honours we leave to the French who have complicated our menus and long since won most gustatory battles with epicurean dishes for the most inspired gastronomes.

The accolade conferred and an understanding toward the traditions of serious food preparation, pleasant eating and stimulating conversation —the busy housewife, the quick service restaurateur, the airline chef and the automatic food vending promoters, all have a new tool complementary to the needs of our day, for ultra-high speed, "inside-out" cooking is here at last—and to stay, perhaps with La Varenne's and Mrs. Beeton's ethereal blessing, but soon destined for a chapter or two in contemporary culinary literature.

For the uninformed, this Outlook issue delves into microwave cooking and the elegant magnetrons aided with a little infra-red that will cater for both the gourmet and the snack connoisseur with his bangers or a crusty pie.

The magnetrons and oven electronics from the old firm, for the precincts of our Applications Laboratory are now strong with the succulent aromas of sophisticated microwave cooking and tooth-picks evident, our engineers in post-prandial contemplation.

M.A.B.

PRINTED IN AUSTRALIA BY STAR PRINTERY PTY LTD.

VIEWPOINT WITH MULLARD

MULLARD EXHIBITS AT CANBERRA

Acclaimed to be the most successful on record, the tenth biennial I.R.E.E. Convention and Exhibition was held in the national capital on March 22-26th, 1965, and was attended by over 500 delegates and visitors.

The Convention was officially opened by Sir Frederick White, O.B.E., Chairman, C.S.I.R.O. who in his opening address called for more interest by Industry in research institutions and closer working contact between research workers and industrial engineers in order to aid production and development in Australia and to contribute practical industrial experience to the training of the engineer and scientist of tomorrow.

Guest lecturer, The Hon. A. Fairhall, M.P., Minister of Supply, also stressed the need for local electronics research, development and production. There was a natural inclination to perpetuate the wool-and-wheat economy, but this was not the way to build a strong industrial nation, he said. Australia was in danger of being "dealt out" of modern electronics as a by-product of the revolution introduced by solid-state devices, integrated circuits, thin-film techniques and micro-electronics.

Mullard Exhibits

The Mullard exhibits were linked by the theme "creative elements in electronics" and included both static and dynamic displays. The static displays consisted of thin-film and integrated circuits, semiconductor devices, special and transmitting valves including a 6Gc/s travelling wave tube, 11 inch and 25 inch Panorama television tubes, Geiger counter tubes, Ferroxcube, building elements and components.

The working exhibits demonstrated new developments from the Mullard Research Laboratories in the U.K. and the Mullard Applications Laboratory in Sydney. An item of particular interest to the visitors was the BAY66 VHF/UHF silicon varactor diode operating as a frequency multiplier and delivering an output of 3W at 1000 Mc/s, in conjunction with a solid-state transmitter. This transmitter consists of a power generation unit using silicon power transistors giving up to 10W at 83·5Mc/s, followed by three stages of frequency multiplication to 1000Mc/s using the BAY66 in each stage.

Silicon planar transistors and diodes were shown in an analogue-to-digital converter and a solid-state decimal counter used silicon mesa low-voltage transistors to provide direct drive to a numerical indicator tube. The new field-effect metal oxide silicon transistor (development type number 95BFY), having a typical input resistance in excess of $10^{10}\Omega$ was shown in a timer circuit, while the time interval was displayed on decade counter tubes employing high voltage silicon transistors in the drive circuitry.

The Mullard Stand at the I.R.E.E. Exhibition in Canberra.

Visitors to the Mullard Stand at the Exhibition were (from left to right); The Hon. A. Fairhall, M.P., Minister of Supply, Mr. D. Eltringham, Director of Telecommunications and Electronics, Department of Supply, Mr. R. Tremlett, then President of the I.R.E.E., Mr. M. A. Brown, General Manager of Mullard-Australia Pty. Ltd.

Norbit solid-state static switching was featured in a fire-alarm system, triggered by either heat or smoke detectors and there was also a fail-safe alarm using Laddic to provide the active switching.

Mullard Educational Service

The Mullard Educational Service was prominently featured and four experiments were demonstrated using working models. These were—"Critical Potential in Gases";* "Hall Effect in Semiconductors";* "Curie Point in Ferrites"* and the "Charge/Mass Ratio of an Electron".*

A comprehensive selection of leaflets, data sheets and application notes describing the full range of Mullard products was distributed to visitors to the Stand which was one of the busiest at the Convention, as engineers, physicists and technicians sought further details of the latest developments.■

* See pages 34 to 40 of Outlook, Volume 8, Number 2. Ed.

MICROWAVE COOKING
USING CONTINUOUS-WAVE MAGNETRONS

The heating and cooking of food is undergoing a revolutionary development. Until recently, only conduction, convection and radiation (roasting, boiling, frying, steaming, grilling) were used, however these methods are by no means ideal. The main drawbacks are to be attributed to the fact that the outside of the food is heated first and this heat has to spread to the centre by conduction. As solid food is generally a bad conductor of heat, this is a slow process and it takes considerable time to heat the food through and through. This also results in the reduction of nutritional value (loss of vitamins and minerals).

The introduction of the continuous-wave magnetron allows food to be heated according to a new technique—microwave heating—in which these drawbacks are avoided. With microwave heating the food is uniformly heated in a microwave range within a very short time, and almost all of the nutritional value is maintained. Microwave ranges have a wide field of application wherever quick serving of food is essential and where the quality should meet high standards, such as in homes, hotels, restaurants, cafeterias, in hospitals and institutions, in barracks, on ships and in aircraft. The ranges are used either for cooking food or for heating food that has been cooked beforehand and kept in store in a refrigerator or in a deep-freeze cabinet.

Heat Transfer

Heating of food is a procedure that has been applied ever since mankind became acquainted with fire. Though there are many possible ways of achieving this purpose, all methods used hitherto were based on the principle of the transfer of heat from the surface to the interior of the food, be it liquid or solid. With liquids, their own circulation, whether or not assisted by stirring, provides for a quick internal heat transfer, so that the heating speed can easily be accelerated by increasing the power of the heat source. With solid foodstuffs, however, the heat transfer to the interior takes place exclusively by means of conduction, and the speed at which the heat penetrates from the heat source into the food is thereby determined by its thermal conductivity and the available temperature difference. Of these two factors only the latter can be varied; and since all solid foodstuffs are poor heat conductors, high temperature differences are required to avoid a lengthy process. In practice, a limit is imposed on the outside temperature of the food because an excessive temperature would result in the food being burnt. The time required for heating a piece of meat, for instance, by conventional methods depends on the highest permissible outside temperature and on the thickness of the meat, so that the process cannot be speeded up.

Molecular Friction

With the microwave method these disadvantages no longer exist, because the heat is generated by molecular friction when the food is exposed to an alternating electric field. The heat is consequently developed more or less homogeneously in the interior of the food, without temperature differences being required. The heating process can therefore be speeded up considerably.

The process of heating without the use of fire, although fairly recent, is not new. In industry it has been successfully applied for many years, to heat wood, plastics, and other non-conductive materials. The amount of heat developed depends on the intensity and the frequency of the alternating field and on the electrical properties of the material. To make practical use of the possibility of speeding up the heating of food by this dielectric heating method, the frequency of the alternating field should be in the microwave region. Until recently the available power at microwave frequencies was insufficient, and it is only the development of the continuous-wave magnetron that has opened up the possibility of its application in the preparation of food.

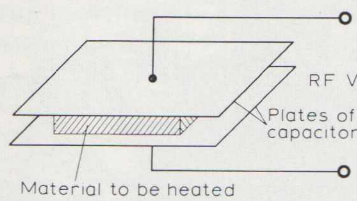


Fig. 1

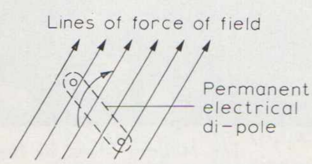


Fig. 2

CW Magnetrons

A continuous-wave magnetron is an electron tube that is in itself a complete generator, generating a continuous output power at an ultra-high frequency. Four types are at present available for the heating of food, namely, an air-cooled 1 kW magnetron, an air-cooled and a water-cooled version of a 2 kW magnetron, and a 5 kW magnetron operating at a fixed frequency in the band of 2.45 Gc/s $\pm$ 25 Mc/s. The frequency of 2.45 Gc/s is a good compromise between the heat generated in the food and the penetration depth of the microwave field.

Oven Configurations

With the microwave heating method, the food is heated in a microwave range. Two types of microwave ranges can be distinguished, namely cavity types and conveyor-belt types. With the first type the food is heated in an oven space (the cavity); with the second type the food is placed on a conveyor-belt and passes one or more radiators which are fed from a magnetron. As a rule a cavity type of microwave range has the same dimensions as conventional gas and electric ranges. It contains the generator, in the form of a magnetron, the coupling between the magnetron and oven, the power supply with protection devices, the switching and programming devices (timers and so on), and finally means to carry off heat dissipated in the magnetron. An additional infra-red radiator may also be built in the oven space for grilling, although it should be recognised that with the use of this radiator the main advantage of microwave heating—the saving of time—is partly lost, since grilling takes up much more time than that required for microwave heating. The conveyor-belt type of range has been designed for the large-scale heating of complete, ready-to-serve, quick-frozen meals.

Heating Times

As to the useful output power for which microwave ranges should be designed, the following must be kept in mind. The thermal equivalent of 1 kW hour is 860 kcal and of 1 kW minute is 14.4 kcal. With an energy of 1 kW the temperature of 1 kg of water can thus be raised 14.4°C per minute. For example, to heat 1 kg of ice from -18°C to the required temperature of $+80$°C, 178 kcal are required (18 + 80 kcal accounting for the temperature increase and 80 kcal for the heat of fusion of ice); from refrigerator temperature ($+5$°C) to $+80$°C 75 kcal are needed. If a meal has a water equivalent of 0.5 kg the heating time in a 1 kW cavity type of microwave range would be 6.2 minutes from an initial temperature of -18°C, and 2.6 minutes if this temperature is $+5$°C. While this is ideal for home use, even shorter heating times would be welcome, for hotels, restaurants, etc., and for this reason a magnetron has been developed which is able to deliver twice this power (2 kW), so that the heating times mentioned above are halved. For smaller portions, or if the required increase in temperature is less, the heating times are of course even shorter. With the use of a 2 kW magnetron the power taken from the line is approximately 4 kW, which roughly amounts to the power needed for a present-day electric range. A particular application for the 5 kW magnetron is in microwave ranges of the conveyor-belt type.

Dielectric Heating

Microwave heating originates from the dielectric heating process which is widely used in various branches of industry. Dielectric heating can be used for heating any material which has a low electrical conductivity, such as plastics or wood. These materials are used as a dielectric between the plates (electrodes) of a capacitor to which a voltage is applied that varies at a high frequency (see Fig. 1). With this method the amount of energy that can be transferred to the material is limited by the maximum voltage that can be applied between the electrodes without a risk of flash-over; the higher the moisture content of the material, the lower this voltage will be. The only way to increase the heating energy at the highest permissible voltage is to increase the frequency. This explains why, for heating foodstuffs which have a high water content, higher frequencies (2.45 Gc/s) are required than those used at present for industrial dielectric heating (up to about 100 Mc/s). The development of CW mag-

→ Page 45

← Page 44

netrons has opened new possibilities. A magnetron offers the advantage that it is in itself a complete generator operating at a fixed frequency, which greatly simplifies the construction of microwave heating installations.

With dielectric heating between the plates of a capacitor the material can only be uniformly heated with uniform-voltage distribution over the surface of these plates, and this can be achieved only if their dimensions are small compared with the wavelength, so that for microwave heating this method is unsuitable. The food is therefore either placed in a cavity (the oven space) to which the energy generated by the magnetron is fed or it is heated by the energy radiated from a reflector.

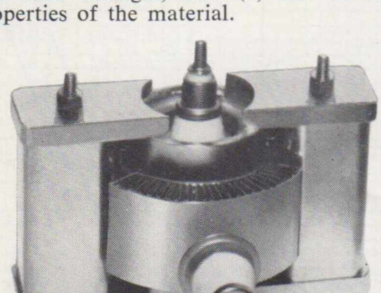
Principle of Microwave Heating

Microwave heating is based on the fact that when poorly conducting materials are subjected to an alternating field of high frequency (RF field), heat is developed in these materials. In RF transmitting and receiving apparatus measures are always taken to reduce this effect, since in these applications all heat developed means loss of energy. With the microwave heating technique, however, the effect is used intentionally, the microwave energy produced by the magnetron being transformed into heat in the material.

The physical process of heating by means of microwave energy can be explained as follows. The material to be heated consists of atoms and molecules. Under the influence of an electric field the atoms and molecules of the material may be considered as small induced dipoles. The orientation of these dipoles is reversed in sympathy with the alternations of the field. The intermolecular friction thus experienced is manifested in heat. Moreover, even when no RF field is applied, those molecules of the material which have an asymmetrical structure may be considered as permanent dipoles. Under the influence of an electric field the latter dipoles tend to turn parallel to the lines of force of the field (Fig. 2). Since in an alternating field the orientation of these dipoles also changes with the polarity of the field, the resulting intermolecular friction contributes to the heat development.

Power

It follows from these comments that the heating process depends on (1) the number of alternations per second, or the frequency of the field, (2) the intensity of the field (the field strength) and (3) the electrical properties of the material.



DX206 Magnetron for Domestic Applications

For the sake of simplicity it will be assumed that the food is placed between the plates of a capacitor to which an RF voltage is applied. The following relation then holds:

$$P = f\varepsilon_r'' E^2 55.61 \times 10^{-14} \qquad (1)$$

in which

P = the heating power in watts, developed per cm^3 of material

f = the frequency (in c/s) of the applied voltage

ε_r'' = the dielectric absorption factor, depending on the electrical properties of the material

E = the magnitude of the field strength expressed in V/cm.

The increase in temperature, resulting from the developed heating power P follows from

$$\Delta T = \frac{f\varepsilon_r'' E^2}{c\rho} 8 \times 10^{-12} \qquad (2)$$

in which

ΔT = increase in temperature (°C/min)

c = specific heat of the material (calories per gramme and per degree centigrade)

ρ = density of the material (g/cm^3).

These formulae show that for rapidly heating a certain material, high values of f and particularly of E are favourable, since the field strength is squared. However, in practice a limit is set to the magnitude of the field strengh by the occurrence of flash-overs.

Choice of the Frequency

Equation (1) reveals that as far as heating is concerned, the most favourable condition will be that at which the product of the frequency f and the dielectric absorption factor ε_r'' is a maximum. For most meals the water content is so high that this factor may to a fair approximation be considered equal to that of water. As shown by Fig. 3,

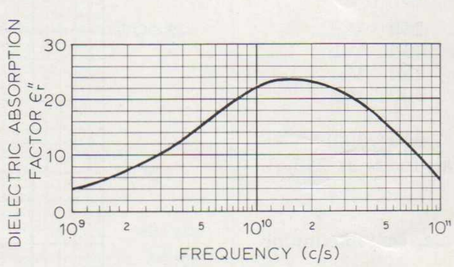


Fig. 3

the value of ε_r'' of water is by no means constant, but passes through a maximum at approximately 20 Gc/s (λ = 15 mm), so that in this respect it would be advantageous to choose a frequency in this region. There is, however, another important factor to be considered, on account of which it is necessary to choose a considerably lower frequency.

When lossy material, like foodstuffs, is placed in an RF field, this field will not penetrate uniformly into the material, but its intensity decreases with the depth of penetration. As a result the heating will decrease from the surface towards the interior. The penetration depth ρ is defined as the depth at which the energy of the RF field has fallen to 37% (that is the reciprocal of the base of the natural logarithm) of its value at the surface of the material (assuming one-sided radiation of the field), and is given by the expression:

$$\rho = \lambda_o \sqrt{\varepsilon_r'}/2\pi\, \varepsilon_r'' \text{ cm} \qquad (3)$$

in which ε_r' denotes the real component of the permittivity of the material, and λ_o the wavelength (in cm) of the RF signal in vacuum.

This expression reveals that in order to obtain uniform heating, a low-frequency is favourable. This requirement thus conflicts with the frequency requirements for maximum heating power. Since, in practice, the radiation field surrounds the material and penetrates it from all sides, there is no need to choose as low a frequency as that suggested by the above expression; furthermore, the heat conduction will contribute towards an even heat distribution.

Experiments have revealed that a frequency between 2 Gc/s and 3 Gc/s is a good compromise between maximum heating and uniformity. In this frequency region, microwave power of some kilowatts can conveniently be generated by means of recently introduced continuous-wave magnetrons.

MULLARD MAGNETRONS FOR MICROWAVE COOKING

Type No.	*Application*	*Power*	*Cooling*
DX206	Domestic	1 kW	Convection or forced air
DX260	Industrial	1 kW	Convection or forced air
JP2-2.5A	Domestic or Industrial	2 kW	Forced air
JP2-2.5W	Industrial	2 kW	Water
JP2-5W	Industrial	5 kW	Water

For more detailed information on microwave devices and their associated components, see Volume 3A of the Mullard Technical Handbook.

JP2-2.5A Magnetron for Domestic or Industrial Applications

The fixing of a particular operating frequency in the 2 Gc/s to 3 Gc/s region is dictated by the frequency allocation. Like telecommunication transmitters, RF generators radiate RF energy (stray radiation). Such radiation, even if it is very small, may be an annoying source of interference in telecommunications. Well-defined frequency bands have therefore been allocated for industrial, scientific, and medical purposes. The frequency band of 2.45 Gc/s ± 25 Mc/s has been chosen as the most suitable available for magnetrons for microwave heating. ■

Mullard

MULLARD A65-11W PANORAMA

The A65-11W is a new, 25 inch, long life Panorama television picture tube featuring integral protection against mechanical tube failures so that no separate safety glass is required. The tube has a metal-backed screen, electrostatic focussing, 110° magnetic deflection and is provided with four metal mounting lugs.

PRELIMINARY DATA A65-11W

HEATER

Indirect by AC or DC; suitable for series or parallel supply.

Heater voltage	V_f	6·3	V
Heater current	I_f	0·3	A

Note—If the tube is used in a series heater chain, the surge heater voltage should not exceed $9{\cdot}5V_{r.m.s.}$ when the supply is switched on. If necessary, a current limiting device must be used to ensure that this value is not exceeded.

OPERATING CONDITIONS

Final accelerator voltage	$V_{a,g3,g5}$	18	18	kV
Grid No. 2 voltage	V_{g2}	400	500	V
Grid No. 4 voltage	V_{g4}	0 to 400	0 to 400	V(1)
Negative Grid No. 1 voltage for visual extinction of focussed raster	V_{g1}	40 to 77	50 to 93	V
Cathode voltage for visual extinction of focussed raster	V_k	36 to 66	45 to 80	V

LIMITING VALUES
(design centre limits)

Final accelerator voltage (at $I_{a,g3,g5} = 0\mu A$)	$V_{a,g3,g5}$	18	kV_{max}
Final accelerator voltage	$V_{a,g3,g5}$	11	kV_{min}(2)
Grid No. 4 voltage			
positive value	V_{g4}	1000	V_{max}
negative value	$-V_{g4}$	500	V_{max}
peak positive value	$V_{g4}p$	2500	V_{max}(3)
Grid No. 2 voltages	V_{g2-g1}	850	V_{max}
	V_{g2-k}	700	V_{max}(4)
		350	V_{min}
Cathode voltage			
positive value	V_k	150	V_{max}
negative value	$-V_k$	0	V_{max}
peak negative value	$-V_{kp}$	400	V_{max}(3)
peak positive value	V_{kp}	2	V_{max}
Cathode-to-heater voltage			
cathode positive	V_{kf}(k pos)	250	V_{max}
cathode negative	V_{kf}(k neg)	135	V_{max}
peak value, cathode negative	V_{kfp}(k neg)	180	V_{max}
peak value, cathode positive	V_{kfp}(k pos)	300	V_{max}
during warm-up period not exceeding 15 secs.	V_{kf}(k pos)	410	V_{max}

(1) Voltage range necessary for optimum overall focus at 250μA beam current.

(2) Absolute limit.

(3) Maximum pulse duration = 22% of a cycle, but maximum 1·5msec.

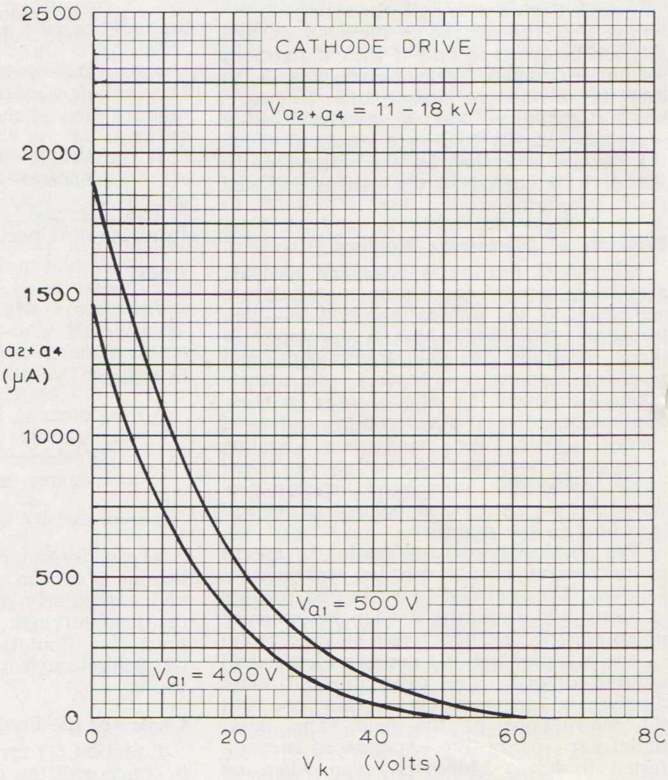
(4) $V_{k-g1} = 0$.

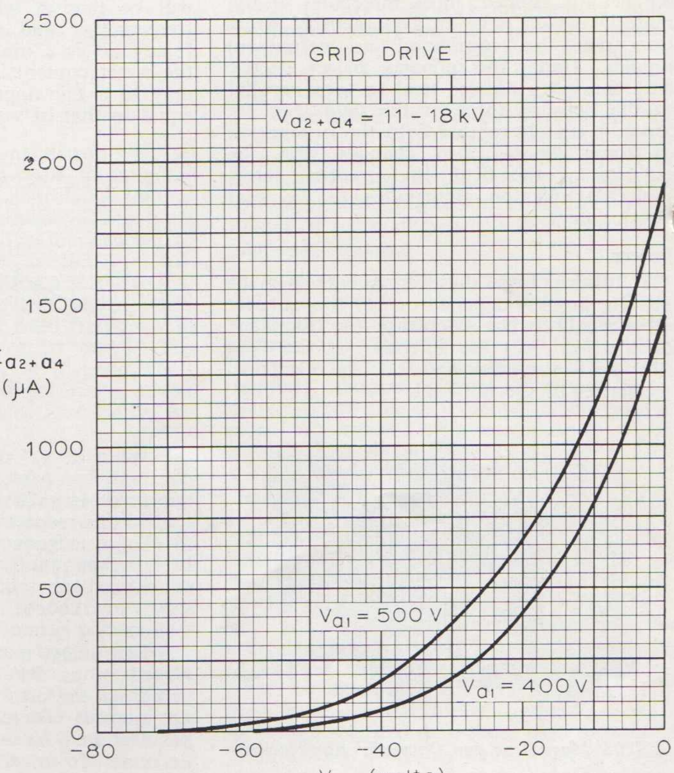
CAPACITANCES

Grid No. 1 to all other electrodes	C_{g1}	6	pF
Cathode to all other electrodes	C_k	4	pF
External conductive coating to final accelerating electrode	$C_{m-a,g3,g5}$	> 1700 < 2500	pF pF
Metal band to final accelerating electrode	$C_{m'-a,g3,g5}$	450	pF

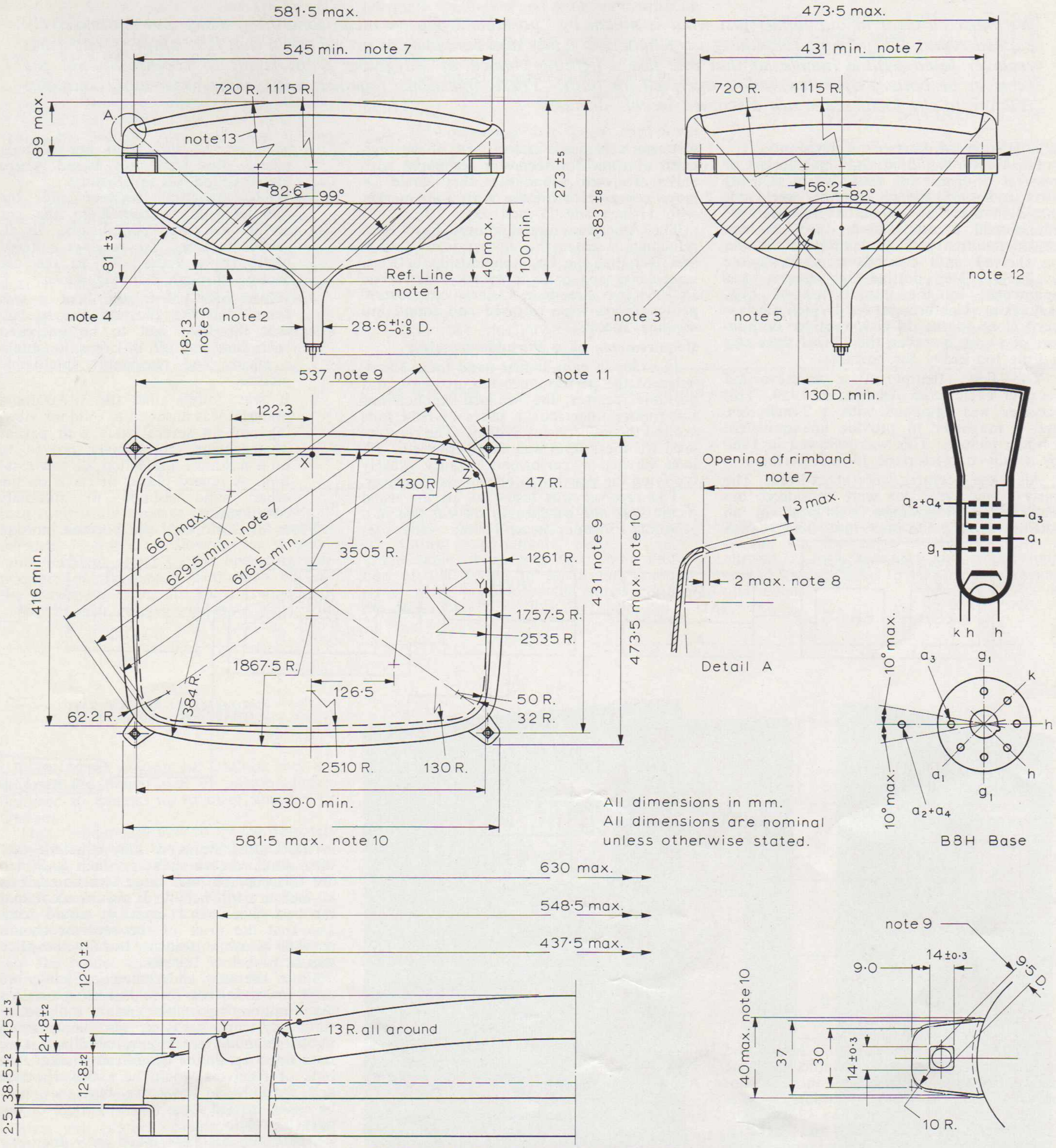
SCREEN

Metal backed	
Luminescence	White
Light transmission	43%
Useful diagonal	616·5mm min
Useful width	530 mm min
Useful height	416 mm min
Mounting position	any
Nett Weight	18 kg





LONG LIFE PICTURE TUBE



NOTES TO OUTLINE DRAWINGS

1. Reference line is determined by the plane of the upper edge of the flange of the reference line gauge (Jedec 126), when the gauge is resting on the cone.
2. End of guaranteed zone.
3. The configuration of outer conductive coating is optional, but contains the contact area as shown on drawing.
   The external conductive coating must be earthed.
4. Recessed cavity contact.
5. This area must be kept clean.
6. The maximum neck and cone contour given by reference line gauge.
7. Opening of metal rimband. The eccentricity of this opening with respect to the centre of the screen is 1.5 mm max. (See detail).
8. Meniscus of resin filler on screen.
9. The mounting screws in the cabinet must be situated inside a circle of 9.5 mm diameter drawn around the true geometric position i.e. corners of a rectangle of 537 mm x 431 mm.
10. Minimum space to be reserved for mounting lugs.
11. The metal rimband must be earthed.
    Electrical contact between the band and the mounting lugs is guaranteed.
12. The deviation of any lug with respect to the plane through the other three lugs is maximum 2 mm.
13. Applies also to diagonal.

Mullard

PORTABLE TELEVISION

We must be clear in our minds just what is meant by "portable". Do we mean something easily and unobtrusively carried about the person; something very light, very tiny and personal, or do we mean that it is simply a television receiver fitted with a handle so that one has a fighting chance of staggering from room to room? Should the receiver be battery operated, mains operated, or both? These questions together with some interesting thoughts relative to the local scene are discussed in this article.

The History of Portable Television

Portability has fired the imagination of receiver designers for many years. During 1954 and 1955 10-inch receivers were produced in the U.S. without a great deal of commercial success and by 1957 it was considered that perhaps "portables" should be shelved until suitable transistors were available. The decline in interest was aggravated by the introduction of 110° deflection which brought the 17-inch receiver very close to the 14-inch receiver both in size and cost, however, the 17-inch tube was a little too heavy for portables.

The first attempt at a transistorized receiver came from America in 1959. This receiver was equipped with a 2-inch tube and a magnifier to provide an equivalent 14-inch picture. This was followed in 1960 by a fully transistorized 19-inch portable.

All these ventures were short-lived. The early 10-inch receivers were considered too small and performance was poor in an attempt to keep the price low. The 14-inch and 17-inch receivers were too heavy and in any case there was insufficient price differential to 19-inch. The 2-inch did not prove to be a satisfactory solution and was regarded as a gimmick and the 19-inch portable proved far too heavy and costly.

At this point portable-production stagnated in America but the Japanese entered the all-transistor portable market with a fantastic range of picture tube sizes from 4½-inch to 12-inch. The greater part of these receivers are exported to America but the market has never emerged from the novelty stage. It is interesting to note that the Japanese over the past two years have gradually increased the tube size as they apparently found that the very small screens were not acceptable and in view of the high price of transistor receivers compared with valve receivers, found that they could be more competitive on the American market with 11-inch and 12-inch sets.

The American manufacturers have been reluctant to enter the all-transistor market and feel that the best relationship between screen size and price is found with valves. In 1963 two American 11-inch valve equipped receivers were released and found immediate success.

Requirements of a Portable Receiver

In order to gain at first hand some knowledge of the performance requirements of a portable receiver, the Mullard Applications Laboratory undertook a series of field tests around the environs of Sydney. The receiver used for these tests was an all-transistor 19-inch having a performance fairly closely typifying the Australian present day receiver.

The receiver was tested at all the usual picnic sites and beaches, in the car and in a boat on Pittwater near Sydney. The sites were spread over a distance of some 200 miles, the furthest test points from the transmitters being at Gosford and the National Park. The results of these tests may be summarized as follows:

1. Despite an E.H.T. of 16.5 kV, the ambient light was so high that the raster was not visible unless well shaded by trees.
2. Almost all the picnic sites or places where one would care to rest awhile are in valleys, or shielded by hills. All homes in these areas were well equipped with high multi-element antennas, whereas the portable was required to work at ground level with a rod antenna. The picture was usually snowy and almost invariably suffered from ghosting. On high ground the performance was good but suitable picnic sites were not found where the reception was satisfactory.
3. Whilst travelling between sites the receiver was connected to the car aerial and tested periodically. In all suburban areas, the receiver suffered badly from flutter due to the car passing through standing waves.
4. Whilst operated in the boat it was found that the ghosting was so bad that the boat had to be anchored both fore and aft in order to obtain a steady and reasonably intelligible picture.
5. It was found that the programme material was unsuited to outdoor viewing and on several tests with parties of teenagers the receiver proved to be a nuisance and killed all conversation. A record player or radio on the other hand seemed to stimulate conversation.

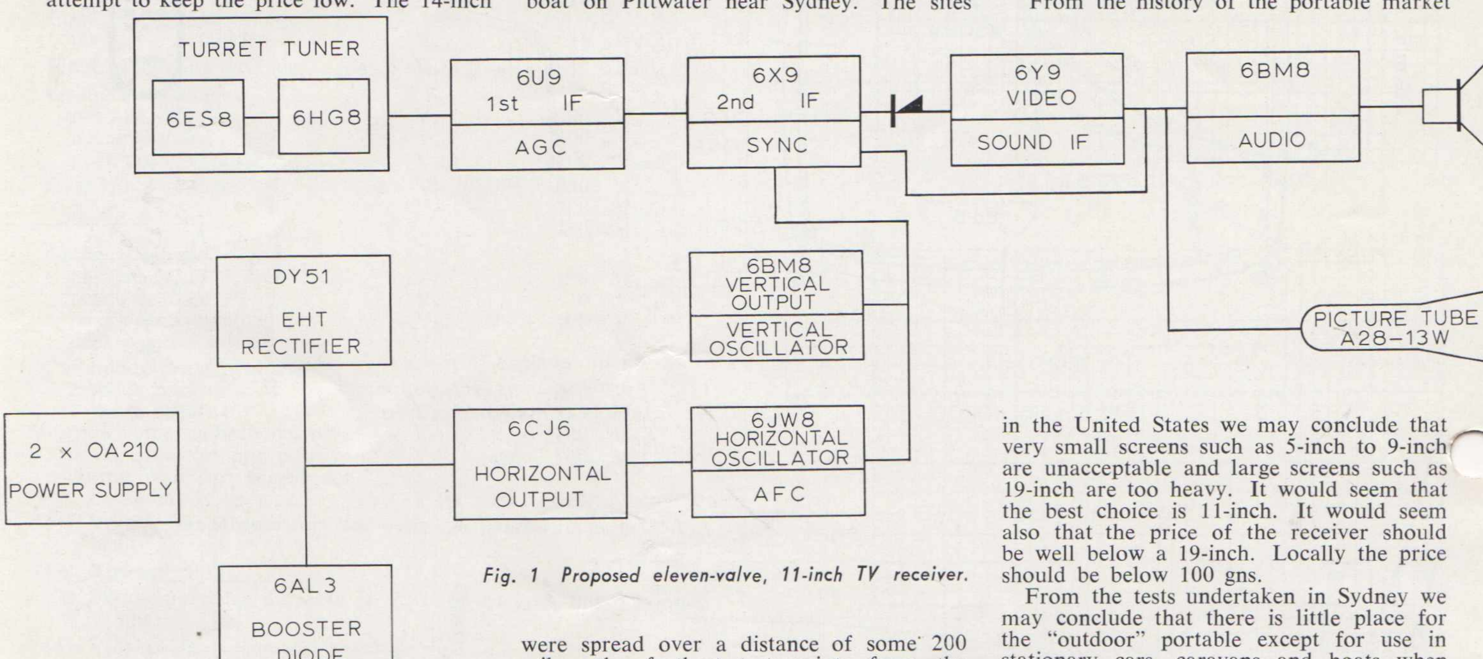


Fig. 1 Proposed eleven-valve, 11-inch TV receiver.

From the history of the portable market in the United States we may conclude that very small screens such as 5-inch to 9-inch are unacceptable and large screens such as 19-inch are too heavy. It would seem that the best choice is 11-inch. It would seem also that the price of the receiver should be well below a 19-inch. Locally the price should be below 100 gns.

From the tests undertaken in Sydney we may conclude that there is little place for the "outdoor" portable except for use in stationary cars, caravans and boats when the surrounding terrain is suitable; and if we note once again the American market, the bulk of receivers would be mains operated and portable in the sense that they may be easily carried from room to room or out onto the patio.

Also from the tests taken in Sydney, we can see that there is no possibility of deteriorating the performance in order to reduce production cost except possibly the removal of noise gating circuits.

If we consider the market for a receiver to perform in caravans and outdoors it would need to be designed for 12V operation but in view of the purchase price it would need to also operate from the mains.

→ Page 49

← Page 48

A receiver of this type should be all-transistor but at this stage of the art an 11-inch transistor receiver would retail at about the price of a 23-inch receiver or possibly more. As it would be essentially a second receiver, it is difficult to imagine a large market at this price. Further, if the receiver is required to operate outdoors as a portable it would also need to be fitted with a re-chargeable battery, and automatic battery charging equipment, thus adding further to the cost and weight.

If on the other hand it is felt that there is a market for a small receiver, mains operated which can be moved from room to room or out onto the patio, the receiver could be valve operated and with the new decal range of valves, it is possible to produce a receiver, having adequate performance, at a retail price of approximately 100 gns.

Typically, a TV receiver dissipates approximately 135 W, producing in a 23-inch cabinet, an average temperature rise of approximately 25°C and 35°C in regions adjacent to valves. Allowing for a maximum ambient of 45°C, the operating temperature of the circuit can reach 80°C—the maximum rating for most components.

An 11-inch receiver cabinet, built with similar proportions would be only 0.125 the volume of a 23-inch cabinet so that considerable care is necessary in providing adequate ventilation and reducing dissipation to a minimum.

In consideration of this problem, Mullard have developed the A28-13W 11-inch tube. This tube makes possible a considerable reduction of input power by means of the following:

1. 90° deflection has been chosen in order to achieve the lowest possible scanning power. As the tube is fitted with a short gun, the overall length is very little greater than a conventional 110° tube.
2. The neck diameter has been reduced from 28 mm to 20 mm resulting in a further reduction in scanning power. This reduction in neck size coupled with the 90° deflection angle considerably reduces the overall size of the yoke thus increasing the available chassis space.
3. Grid drive has been reduced to 45 V thus reducing the video amplifier power requirement.

Picture Tube Type	*23″ 110° 28 mm neck*	*11″ 110° 28 mm neck*	*11″ 90° 20 mm neck*
E H T	*18kV*	*11kV*	*11kV*
Horizontal Driver Input Power	34 W	25 W	9.5 W

The table above will give some indication of the saving in horizontal scanning power made possible by the introduction of the A28-13W.

If we now consider the block diagram proposed in Fig. 1, the following power savings can be made:

Horizontal output stage:	24.5 W
Vertical output stage:	4.8 W
Video amplifier	2.4 W
Elimination of noise gate:	4.4 W
Audio amplifier:	2.4 W
TOTAL SAVING	38.5 W

From this it can be seen that it is possible to reduce the power input from 135 W in the case of a 23-inch receiver to 97.5 W for the 11-inch receiver. With this reduction in input power and by taking reasonable precautions with ventilation it should be possible to remain within the temperature ratings of all components.

In conclusion then, it can be said that a mains operated 11-inch valve receiver, to retail at approximately 100 gns. is feasible with an eleven decal valve chassis and the new A28-13W 11-inch 90° picture tube. An 11-inch battery operated receiver is best left to transistor circuitry but at this stage of the art, the price would be close to current 23-inch receivers and would only extend its usefulness to viewing in caravans and boats. ■

H. S. WATSON

OUTLOOK BINDERS

In a recent edition of Outlook we announced the preparation of plastic binders designed to contain up to three volumes of Outlook.

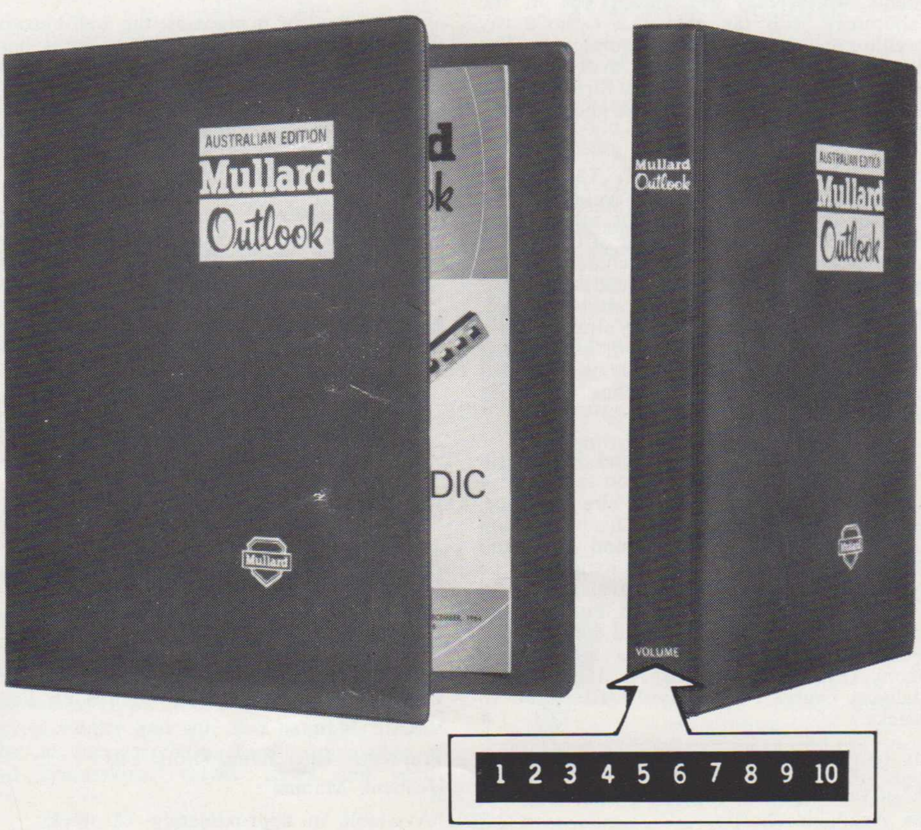
These binders are now ready for despatch. Those readers who have expressed interest in these binders have already been contacted and additional binders may be obtained from the Sydney Office priced at £1/5/- plus postage (parcel postage rates are shown below).

The method of securing copies of Outlook into the binder is unique to Australia and individual copies may be removed and re-inserted with ease. A self-adhesive, interchangeable strip from which appropriate portions may be detached for titling purposes, will be supplied with each order, thus making the binder suitable for past and future issues.

When ordering by mail, please print your name and address and the number of binders you require, clearly and in block letters, in order to avoid misdirection in the mail. ■

POSTAL RATES

	per binder
N.S.W. (Metropolitan area)	2/–
N.S.W. (Country area)	2/6
Q'land, Victoria, Tasmania	3/–
W.A., S.A., N.T., T.P.N.G.	4/–



MULLARD EDUCATIONAL SERVICE

Several publications will shortly become available through the Mullard Educational Service and may be obtained by educational establishments on payment of a nominal charge to cover handling and postage. A number of these is listed below. When quantity supplies are to hand and landed charges determined, a price list will be issued via the Educational Service mailing list.

"A Simple Explanation of Semiconductor Devices"

This booklet provides a non-mathematical treatment of semiconductors and some of the devices in which they are employed. In dealing with this subject emphasis has been given to explanation of the physical aspects of electron and hole conduction, mainly for the benefit of the less advanced student.*

"How it Works" Leaflets

Each set of leaflets describes in brief non-technical language some basic concepts of how radio works, how television works, how radio valves work, how cathode ray tubes work, how FM works, how transistors work.**

"Simple Transistor Measurements"

The approach used in this publication is practical rather than theoretical and concentrates on a number of experiments for the examination of the properties and behavior of alloy junction transistors.•

"Simple Oscilloscope Measurements"

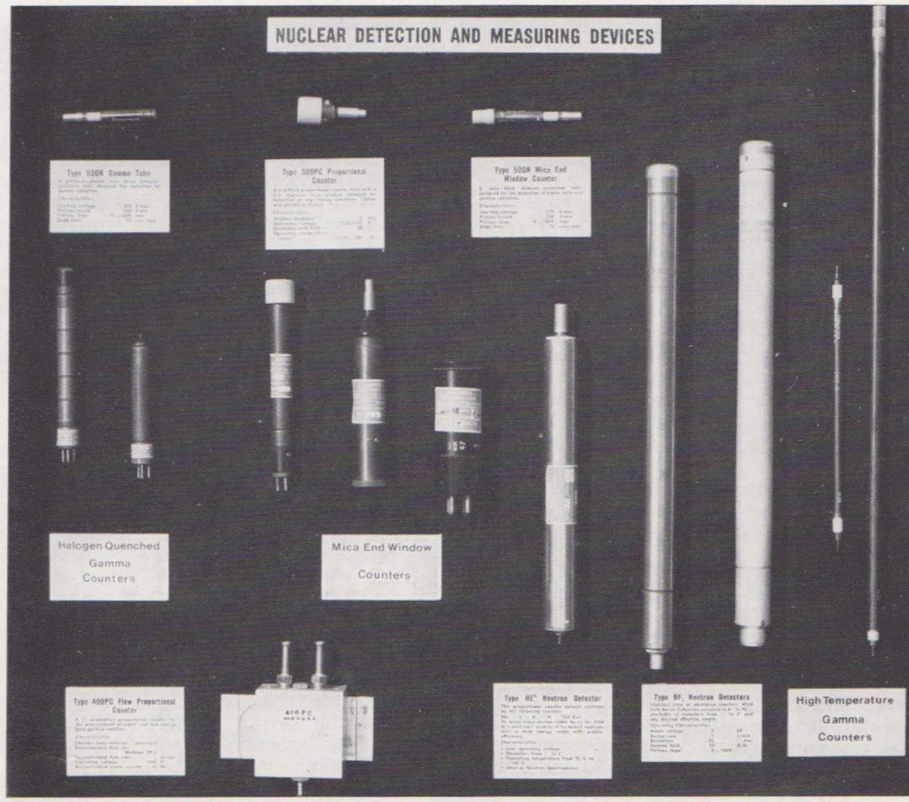
Another of the simple measurements series, contains suggestions for a number of experiments which may be carried out in the laboratory with the aid of a cathode ray oscilloscope and auxiliary equipment. The experiments vary in technical level and those chosen are the ones felt to be of direct interest to students at secondary schools and technical colleges.•

"Simple Valve Measurements". This booklet contains suggestions and instructions for a number of experiments for the examination of the properties and behaviour of thermionic valves. These experiments include measurements from which the characteristic curves of various types of valves can be plotted. It is assumed that the student already has a working knowledge of the principles of the thermionic valve and hence a detailed discussion of basic theory has not been provided.•

"Mullard Educational Film and Film Strip Catalogue" may be obtained on receipt of a stamped, addressed, foolscap size envelope, endorsed "Film Catalogue". This publication lists the range of 16mm sound films and 35mm film strips available on loan from the Mullard Educational film library. Films and film strips may be purchased outright and price lists will be forwarded on request. Please note that these items are ordered from U.K. on receipt of firm order and delivery cannot be promised earlier than 16 weeks. ■

* Available now—5/3d + 8d postage.
** Available now—no charge.
• Available shortly.

NUCLEAR DETECTION DEVICES



A section of the Mullard stand at the 1965 I.R.E.E. exhibition, featuring a selection of Nuclear Detection Devices.

In the field of nucleonics, the well-known range of Mullard Geiger-Müller Tubes has always played an important role and in keeping with the aim to offer a wide selection of devices incorporating latest developments to physicists and engineers, Mullard announces the introduction of a new range of nuclear detection devices.

The additional types available will augment the existing range and extend into allied fields. As well as a number of specialised Geiger-Müller Tubes, several Neutron Detectors and a Neutron Generator Tube are now offered.

A wide range of sensitivities is covered and one fission counter is capable of measuring six decades of neutron flux, thus offering significant advantages over techniques now usually employed for this purpose.

The Neutron Generator Tube provides a compact, rugged, inexpensive source of fast or thermal neutrons, one of the features of the Tube being that it is completely sealed and requires no external pumping.

A selection from this new range is shown above. ■

MULLARD PUBLICATIONS

	Price	*Postage*
Reference Manual of Transistor Circuits	15/0	1/5
*Circuits for Audio Amplifiers	12/6	1/5
Transistor Radios—Circuitry and Servicing	5/3	8d.
Valve, Tube and Semiconductor Guide	15/0	1/5
Stereo Sound Systems	6/3	8d.
Simple Explanation of Semiconductor Devices	5/3	8d.
Transistor Radio Servicing Course (6 Lectures)	10/0	1/2
Vinkor Manual	5/3	free
Transistor Interchangeability List	2/6	free
Heatsink Manual	2/6	free

*Available in approximately 12 weeks.

8236 POWER PENTODE FOR SSB TRANSCEIVERS

The demand for a higher-power output replacement for the 6DQ5 is catered for by the 8236. For initial equipment, however, the Mullard preferred range of SSB valves is recommended. Readers are referred to the Table in Outlook Vol. 5, No. 5 Page 52, which shows the Mullard range of SSB valves and to which the YL1150 is the latest addition.

Comprehensive technical information on SSB transmitting valves may be found in Volume 3 of the Mullard Technical Handbook.

The 8236 is a high perveance, high dissipation, beam power valve which is rated and tested for use as an RF power amplifier. It may also be used as a series regulator and as a general purpose power valve. In most cases the 8236 will function as a high dissipation, direct plug-in replacement for the 6DQ5. In RF service up to 30Mc/s the 8236 will handle 200W input and deliver 141W to the load. Because of its high perveance design, these conditions can be obtained at the relatively low anode voltage of 900V. Its carbon anode and hard glass envelope permit continuous operation at 50W anode dissipation.

The 8236 is available from stock and tentative data are given below:—

TENTATIVE DATA 8236 POWER PENTODE

(Linear RF power amplifier in Class 'AB1' SSB Service with suppressed carrier)

Maximum Ratings: absolute maximum system for frequencies up to 30Mc/s

Anode voltage	1400	V	DC
Grid No. 2 voltage	250	V	DC
Grid No. 1 voltage	−150	V	DC
Anode current	300	mA	DC*
Anode dissipation	60	W	
Grid No. 2 dissipation	3·2	W	
Bulb temperature	250	°C	
Maximum Grid No. 1 circuit resistance	30	kΩ	

Typical operation with two-tone modulation

Frequency	30	Mc/s	
Anode voltage	1000	V	DC
Grid No. 2 voltage[1]	160	V	DC
Grid No. 1 voltage[2]	−66	V	DC
Zero signal anode current	25	mA	DC
Zero signal Grid No. 2 current	1·0	mA	DC
Effective RF load resistance	2·8	kΩ	
Maximum signal peak RF grid voltage[3]	66	V	
Anode current	170	mA	DC*
Average anode current	116	mA	DC
Grid No. 2 current	5·0	mA	DC*
Average Grid No. 2 current	2·5	mA	DC
Average Grid No. 1 current[4]	0·01	mA	DC
Power Output	115	W*	
Average Power output	57·5	W	
3rd Order Intermodulation Products[5]	−25	dB	
5th Order Intermodulation Products[5]	−33	dB	

* at peak of envelope.
1 preferably obtained from a well-regulated source.
2 preferably obtained from a separate, well-regulated source.
3 the peak signal voltage should be equal to the DC grid voltage.
4 this value is the approximate grid No. 1 current due to initial electron velocity effects when the grid is driven to zero volts at maximum signal.
5 referenced to either of the two tones and without the use of feedback to improve linearity.

NOTE: A number of commercial transceivers currently in use, employ the 6HF5 power pentode in the transmitter-output stage. This valve is now available from stock for replacement purposes.

NEW MULLARD REPRESENTATIVE IN QUEENSLAND

Mr. E. V. Avenell

We have pleasure in introducing our new Resident Representative in Queensland, Mr. E. V. (Ted) Avenell.

He has a sound background, covering a wide field of telecommunications, industrial electronics and television service. A member of the Brisbane Division of the I.R.E.E., he is well known to members of the radio industry in Queensland.

Mr. Avenell will be responsible for the Mullard Valve and Tube Service Centre and will also be glad to assist you with technical queries relating to the application of industrial and professional valves, tubes and semi-conductors. ■

VHF TETRODE YL1150

ABRIDGED ADVANCE DATA

Radiation and convection cooled beam power tetrode intended for use as a linear VHF amplifier for SSB, Class 'C' VHF amplifier or AF class 'AB' amplifier or modulator.

HEATER

Indirectly heated, oxide coated cathode

	Parallel	Series	
V_h	6.3	12.6	V
I_h	2.6	1.3	A

TYPICAL CHARACTERISTICS

Class 'B' Linear Amplifier for SSB

f	30	60	Mc/s
P_{out}	*120	*109	W
f max.	60		Mc/s
V_a max.	750		V
p_a max.	75		W

*P.E.P.$_{out}$

CAPACITANCES

c_{out}	10.7	pF
c_{in}	22	pF
c_{a-g1}	0.2	pF

CHARACTERISTICS (measured at V_a = 600V, V_{g2} = 250V and I_a = 100mA)

g_m	35	mA/V
μ_{g1-g2}	4.7	

MOUNTING POSITION

Vertical or horizontal with plane of anodes vertical. ■

NEW SERIES OF MULLARD AVALANCHE DIODES

A series of silicon rectifier diodes with controlled avalanche characteristics have recently been introduced by Mullard. Carrying the type number BYX25, the series consists of:—

(a) BYX25-600 and BYX25-800 with maximum crest working reverse voltage ratings of 600V and 800V respectively;

(b) BYX25-600R and BYX25-800R which are reverse polarity versions.

The maximum mean forward current rating of these diodes is 12A at an ambient temperature of 125°C with a maximum forward surge current rating of 240A.

The controlled avalanche characteristic enables the rectifier to absorb considerable reverse transient energy without damage; and the transient ratings of the BYX25 series are listed below:—

18kW for a duration of 10 μsec at 25°C junction temperature

3kW for a duration of 10 μsec at 175°C junction temperature

Rectifiers of this type can be used in series without PIV sharing capacitors and resistors. Encapsulation is in the standard DO-4 envelope. ■

Mullard

THERMOCOUPLES FROM −320°F TO +4000°F

In view of the special and varied applications for thermocouples, it is possible that one or other of the existing devices may be suitable and only representative samples for guidance purposes are held in Australia, however, thermocouples, together with high temperature mounting accessories, are offered to specified customer requirements.

The last decade has produced a spectacular growth in the use of metal-sheathed, ceramic insulated thermocouple wire, cable and assemblies.

One of the leading companies producing thermocouples in the U.S.A. is Continental Sensing Inc., of Illinois, U.S.A. who, after several years of intensive research and test evaluation, has produced a large range of thermocouples, capable of operation at temperatures from −320°F to +4000°F. Mullard are pleased to offer these devices, which are available under the name of Con-O-Pak.

Con-O-Pak thermocouple wire and cable consists of high purity metallic oxide insulation and premium grade conductors which are processed under high pressure into a surgically clean outer metal sheath. The material produced by this process has the accuracy, repeatability, ductility, insulation resistance and dielectric strength necessary for 100% reliability.

These devices can be bent around a diameter equal to their own without damage to or change in values. They can be inert arc, electric arc or oxygen-acetylene brazed without destroying their properties. All Continental Sensing wire is manufactured to meet or exceed the requirements of any known military or industrial specifications; however, only Class 'A' tests are performed unless otherwise specified.

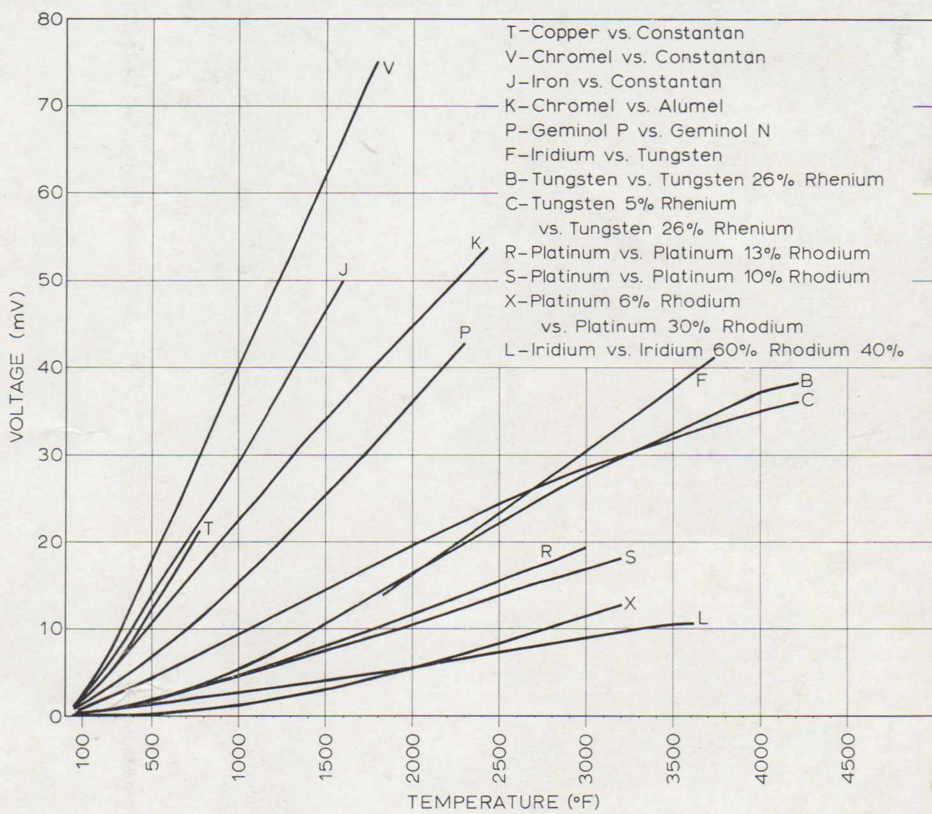
Other Combinations

Continental Sensing Inc., also specialises in thermocouples, wire and cable for unusual applications and aluminium, copper, nickel, hastalloy, Inconel X, titanium and Zircalloy II are popular and readily available sheath materials, together with materials for use up to 4000°F.

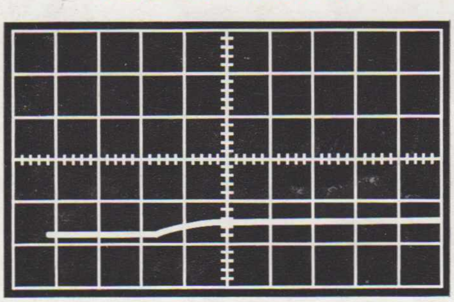
For information on your special requirements, please contact the Mullard Technical Service Departments.

Con-O-Pak thermocouple wire contains duplex conductors of solid parallel construction. Con-O-Twist, which is Continental's newest material, is constructed exactly as Con-O-Pak except that the solid ceramic insulated duplex conductors helically rotate around each other at approximately 15 turns per foot. This revolutionary construction reduces to a minimum the extraneous noise levels and parasitic EMF which affect the accuracy of thermocouple wire and cable. ■

TEMPERATURE — MILLIVOLT GRAPH



SPEED OF RESPONSE



Each major division in the graph equals 100 milliseconds and shows a typical response time for a 98% step change from ice water to boiling water for a 1/16" diameter tantalum sheath, BeO insulated, tungsten/tungsten 26% rhenium thermocouple having a grounded junction.

WIRE MATERIAL SELECTION CHART

Sheath O.D.	*B&S Wire Gauge*	*Nominal Dia. in Thous. of Inch*	*Wire Material* — *Positive (+)*	*Wire Material* — *Negative (−)*
			Iron	Constantan
·375	14	·064	Chromel	Alumel
·312	16	·051	Chromel	Constantan
·250	18	·040	Copper	Constantan
·187	20	·032	Geminol P	Geminol N
·125	24	·020	Pt 10% Rh	Platinum
·090	28	·0126	Pt 13% Rh	Platinum
·062	30	·010	Pt 30% Rh	Pt 6% Rh
·040	36	·005	Ir 60% Rh 40%	Iridium
·025	38	·004	Tungsten	Iridium
·020	40	·003	Tungsten	Tungsten 26% Re
·011	44	·002	Tungsten 5% Re	Tungsten 26% Re