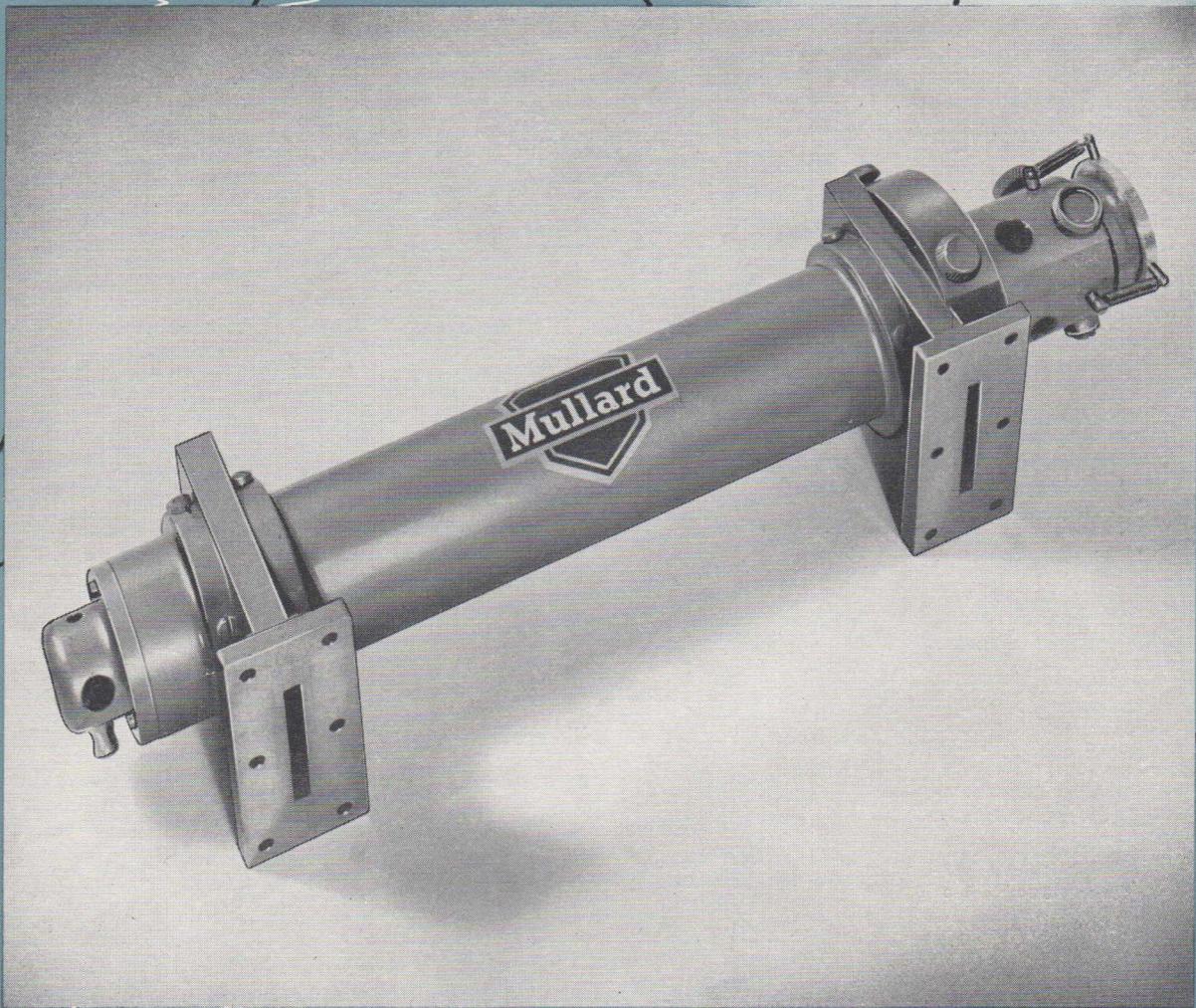


# Mullard

## Outlook

Australian Edition



VOL. 2 No. 2, MARCH-APRIL  
1959



MULLARD - AUSTRALIA PTY. LTD.



VOL. 2—No. 2

MARCH-APRIL, 1959

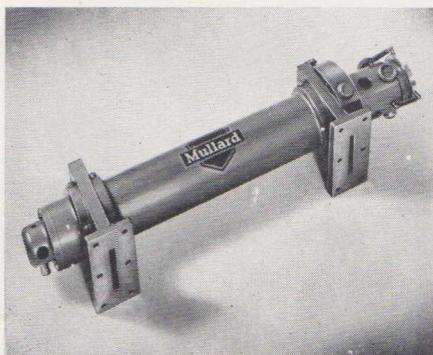
Editorial Office:  
35-43 Clarence Street, Sydney.  
Telephone—BX 2006.

Editorial Staff:  
B.P.A. BERESFORD, A.M.I.R.E. (Aust.)  
JOERN BORK

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LA4-250 TRAVELLING WAVE AMPLIFIER

This new amplifier, for the 3.6-4.2 kMc/s communications band, has a gain of 25 dB and will deliver, under saturation, 200 mW of power. The amplifier may be used as the driver for the 2 Watt tube (LB4-2), and is suitable as a frequency changer or modulator. Focusing is obtained by the use of periodic permanent magnets.

**MULLARD-AUSTRALIA PTY. LTD.**

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**STEREOPHONIC SOUND**

**RETAILERS** — The radiogram market is far from saturated, stereo has started the whole cycle of sales once again and you are now being offered more and more well designed stereophonic radiograms backed with good publicity and sales promotion. The ultimate in sound reproduction is no longer the sole domain of the enthusiast — it is for your customers. Arrange demonstrations — sensible demonstrations — don't overdo the gimmick discs, develop your sales story with the absolute minimum of technical content — say it in basic English and claim your share of the stereo sales.

**ENGINEERS AND ENTHUSIASTS** — The technique of stereophonic sound storage and high quality reproduction at moderate cost has prompted a reappraisal of valve and semiconductor audio frequency circuit application.

We emphasize once more high quality and low cost, the theme that established the popular Mullard 3-3, 5-10 and 5-20 single channel amplifiers. Few enthusiasts have escaped the fascination and simplicity of the 5-10 in particular, and all three have been the engineering basis of a vast quantity of professional amplifiers and radio-gramophones manufactured in many countries in all continents.

The impressions of position and spaciousness offered by this new technique are outstanding with valve and semiconductor amplifiers of quality, and this issue of the OUTLOOK describes the Mullard 2 Stereo 2 dual channel amplifier for stereophonic reproduction.

With all modesty we trust that stereo amplifiers constructed to Mullard circuit data will provide as much pleasure and enjoyment as their widely accepted single channel predecessors.

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# VIEWPOINT WITH MULLARD

## MULLARD VALVE AND ELECTRON TUBE SALES AND SERVICE CENTRE

Now 297-299 Trafalgar Street, Petersham, N.S.W. Sales, LM 9213—Service, LM 9284

The premises at Petersham, formerly known as 221 Trafalgar Street, have been acquired for the express purpose of offering our many customers a more efficient valve and electron tube sales and maintenance service.

### SERVICE CENTRE



The primary function of this department is to check valves, tubes and semiconductors returned as faulty and to replace those that actually are faulty, provided of course that they are still within the guarantee period.

A secondary function is the testing of television picture tubes and issuing of reports for service organisations wishing to claim on insurance policies taken out by television receiver purchasers.

The test equipment is most comprehensive and enables accurate measurements to be carried out on returned valves and tubes. For this reason all valves returned should be labelled with the suspected fault and should also be free from external damage such as bent pins, etc. Broken valves are not normally replaceable under guarantee.

Television picture tubes returned for examination should be accompanied by the prescribed form (in duplicate for insurance claims) which will gladly be supplied on request.

Picture tubes received for checking are first physically examined then electrically tested for electrode shorts,

gas current, emission and so on followed by further tests under actual operating conditions. From time to time picture tubes returned are 100% serviceable and, in such cases, of course, the claim for replacement under guarantee is rejected. It is important that all tubes being returned are adequately packed so that face plates, etc., are not damaged during transit; indeed, tubes being returned should always be treated as though they were brand new and fully serviceable.



## MULLARD AT THE I.R.E. CONVENTION

MELBOURNE, 25th to 30th MAY, 1959

Stand 17-19, WILSON HALL

During the Convention, Mullard will display a wide range of valves, electron tubes, semiconductor devices, ferrite components and equipment for industrial, communications and research applications. Ultrasonic drilling and cleaning equipment, stereo amplifiers, television line selector and devices showing applications of silicon power diodes, transistors and photoconductive cells will be demonstrated.

### VIEWPOINT MEETING

Enfield Boulevard Hotel

14 Coronation Pde., Enfield, N.S.W.  
Wednesday, 6th May, 1959, at 8 p.m.

## MULLARD FILM STRIP LIBRARY

The Film Strips listed below are complete with Lecture Notes and may be borrowed subject to the usual requirements. A small projector is available for limited periods.

### CONDITIONS OF LOAN

- (1) Mullard will arrange to forward the film-strips to you so that they will be available for screening at the required time.
- (2) After screening, the films are to be replaced in their original containers, and details of any damage noticed whilst screening should be indicated.
- (3) The borrower should forward the Film Strips to this office at his own expense, so that they will be received by the due date. Where Film Strips are on loan in country districts or interstate, it is requested that the fastest transport service available be employed.

### FILM STRIP TITLES

- E1 An Introduction to Electronics.
- E2 Electronic Devices I (Electronic Tubes).
- E3 Electronic Devices II (Semiconductors).
- E4A Basic Valve Circuits.
- E4B Basic Valve Circuits.
- E6 Principles of the C.R.T.
- E7 Valve Characteristics.
- E15 The Manufacture of Thermionic Valves.
- E17 The Manufacture of C.R.T.'s.
- E21 Magnets and Magnetic Materials.
- E22 Secondary Cells.
- E23 D.C. Machines.
- E24 Armature Windings.
- E25 Armature Reaction.
- E26 Commutation.
- E27 D.C. Motors.
- E28 The Thermionic Valve.
- E29 The Cathode Ray Oscilloscope.
- E30 Filament Lamps.
- E31 Discharge Lamps.
- E32 Photometry.
- E33 Indicating Instruments.
- E34 Energy Meters.
- E35 A.C. and the Alternator.
- E36 Vectors.
- E37 Transformers.
- E38 Rectification.
- E39 Power Distribution.
- E40 Underground Power Cables.
- E50 The History of Radio.
- U39 Electronics—The Radio Valve, Parts
- U40 Electronics—The Radio Valve, Part 3
- U41 Electronics—The Radio Valve, Part 4
- U42 Electronics—The Radio Valve, Part 5
- U43 Electronics—The Radio Valve, Part 6
- 7 Television—Part 1.
- 8 Television—Part 2.
- 14 The Story of Television.



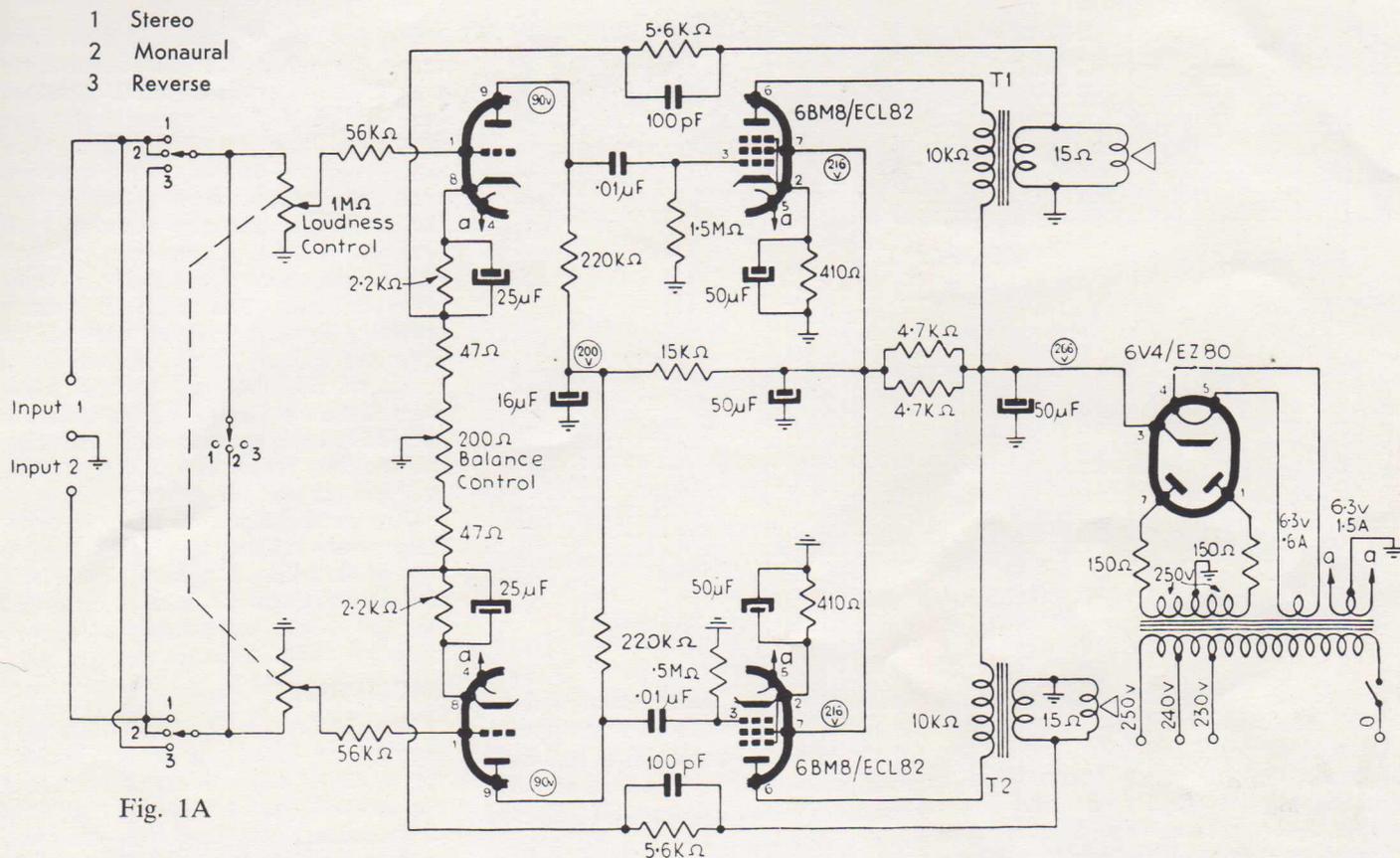


Fig. 1A

gated. Detailed examination shows, however, that a more compact and efficient amplifier is obtained with a design featuring two 6BM8/ECL82 valves.

### THE 2 STEREO 2 AMPLIFIER

This design is presented in two forms — (a) with volume control and separate bass boost and treble cut controls, and (b) with loudness control. The circuit has been designed by Mullard engineers for those constructors who wish to assemble a low cost quality stereo amplifier. It is suited to most types of stereo crystal pickups and has a rated output of 2W per channel at less than 2% total harmonic distortion.

### CIRCUIT DESCRIPTION

The amplifier, which is operated from the A.C. mains, uses three Mullard valves, a 6BM8/ECL82 as triode voltage amplifier and pentode output stage in each channel and a 6V4/EZ80 as the rectifier. Figures 1 and 1A show the schematic with alternative control arrangements whilst the comparatively high sensitivity of 200mV for 2W output in each channel coupled with an input impedance of

1 megohm accommodates most stereo crystal pickups and allows if required input equalising networks.

In this design the triode section of the 6BM8/ECL82 is used as a voltage amplifier to feed the output pentode section. As the overall gain of this configuration is such that the amount of negative feedback which can be employed is limited to about 9dB if an input sensitivity of 200mV is to be maintained, careful selection of the operating conditions of the pentode

section is necessary to ensure low distortion. Additional to this is the problem of ensuring a low hum and noise level without bulky and costly filtering components in the high tension supply and these two requirements are met by the adoption of a set of operating conditions for the pentode section of the 6BM8/ECL82 where the screen grid voltage is lower than the anode voltage. With 9.5dB of feedback a nominal amplifier delivers 2W to the loud speaker at

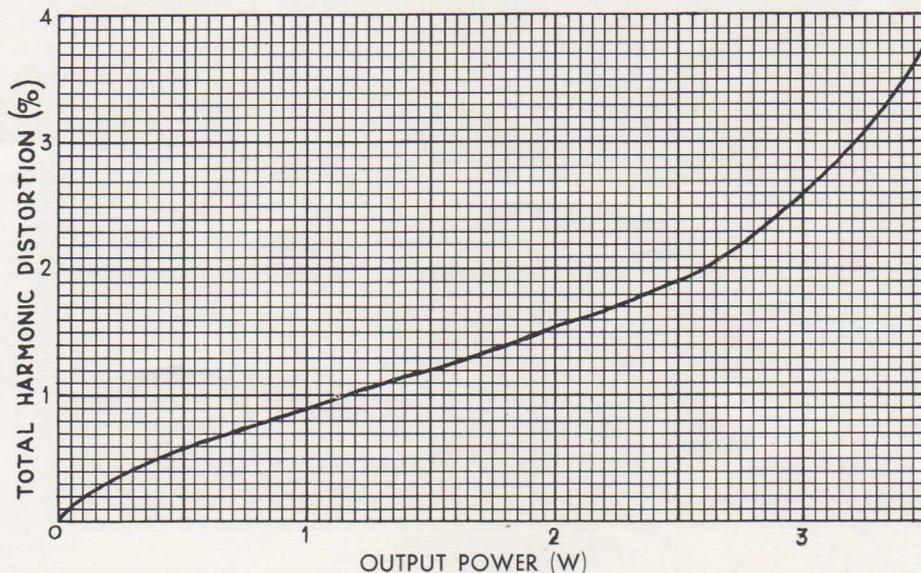


Fig. 2

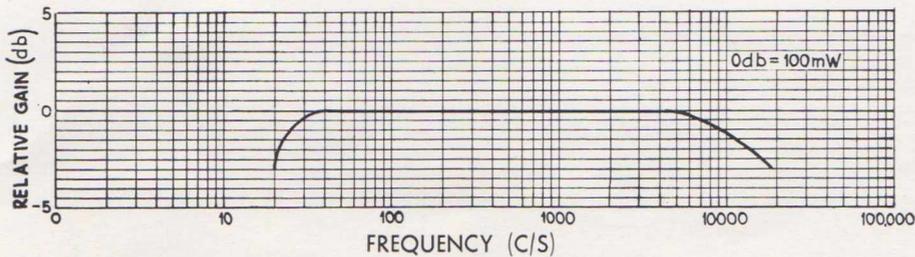


Fig. 3

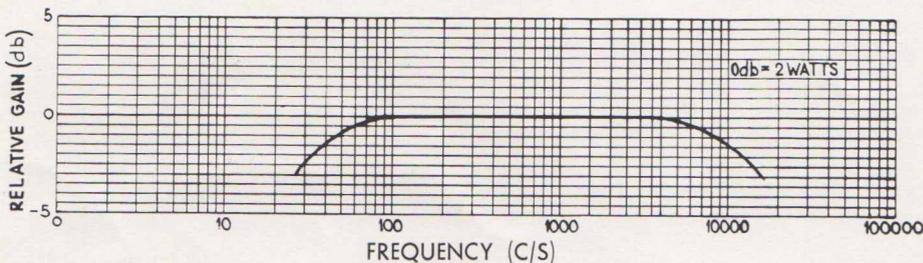


Fig. 3A

1.5% total harmonic distortion and 3.2W before the onset of clipping as shown in figure 2. Figures 3 and 3A illustrate the frequency response of each channel at the 100mW and 2W output levels respectively. The range of the tone controls is illustrated in figure 4.

There may be some home constructors who feel that 2 watts per channel at one and one half per cent. distortion is inadequate for realistic reproduction but with a high efficiency speaker system such as the one described over leaf the 2 stereo 2 has been used in rooms of 1200 cu. ft. to reproduce the dynamic range of an orchestra and effects such as trains, aircraft flying

overhead, motor racing, etc., without the need being felt for a more powerful amplifier. In larger rooms and halls more power will be required and discriminating enthusiasts will demand lower distortion but for a serious introduction to stereo the low cost 2 stereo 2 amplifier represents a forthright approach.

### ACOUSTICS

Although it is generally conceded by most authorities that listeners are unable to appreciate the direction of sound waves below 300 c/s and therefore this band of frequencies cannot

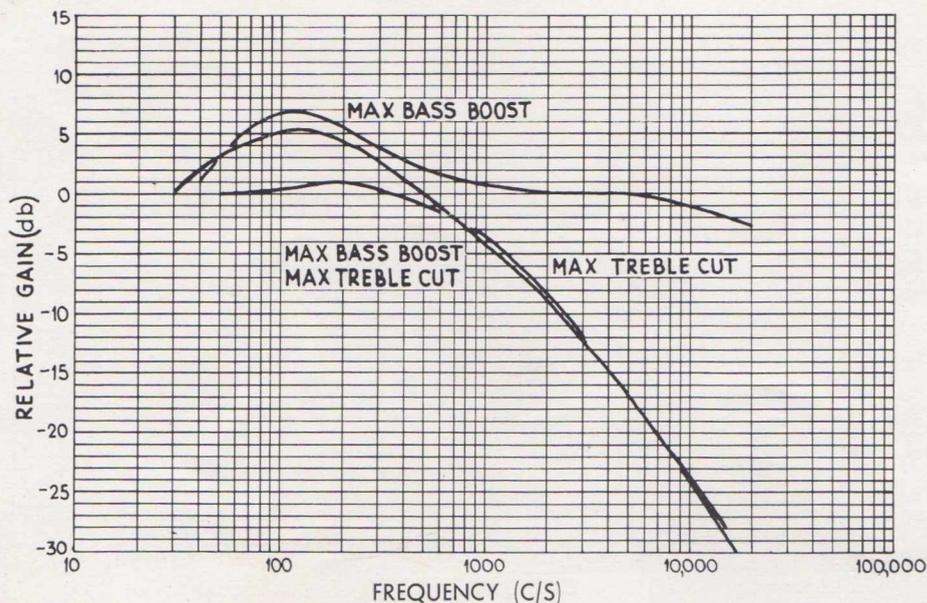


Fig. 4

assist the stereo effect, it has been noted by other acoustic researchers that double bass and drum passages can be defined in space when reproduced stereophonically. The view that frequencies below 300 c/s do not contribute to the illusion has led to the technique that the bass of both channels is fed to a common "woofer" or low frequency speaker system with separate mid and high frequency speakers for each channel located for optimum stereo effect. Indeed, as a result of this premise we find some manufacturers suggesting a separate amplifier and speaker unit covering the audible range above 300 c/s as an "add on unit for stereo."

The performance of these two arrangements seldom approaches that of two identical loud speaker units and this latter approach is recommended for the home constructor and professional alike.

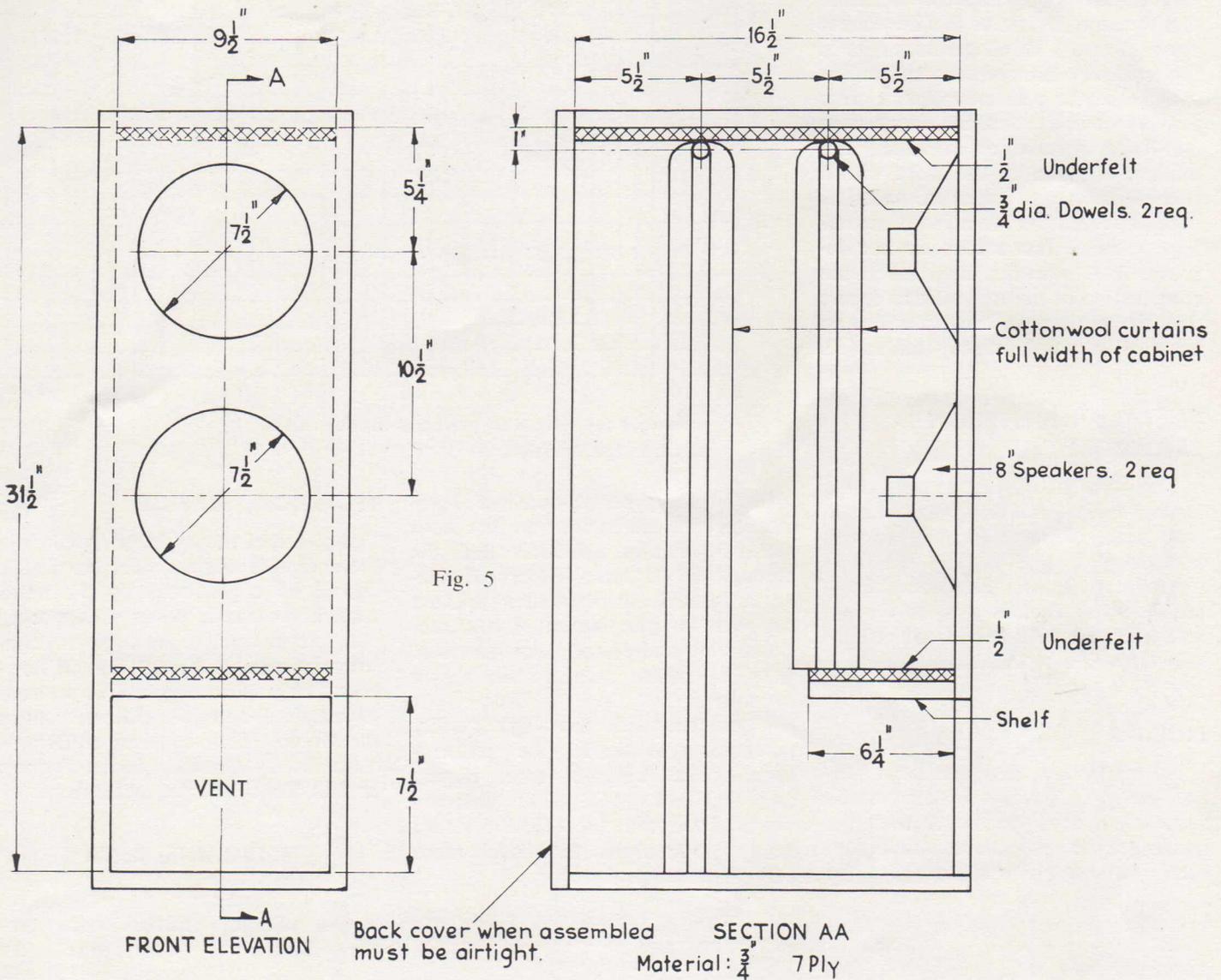
### ENCLOSURES

The duplication of any suitable loud speaker enclosure will be satisfactory for a stereo reproducing system, but two normal sized enclosures may tend to crowd the smaller living room and lead to protests from the distaff side. For this reason constructional details are included of a small vented enclosure housing two 8" speakers capable of providing full well-damped bass to 35 c/s. As two of these enclosures (one for each stereo channel) occupies less space than many conventional monaural enclosures and the double 8" speaker vented enclosure can be readily adapted for side mounting by ensuring that the cotton wool curtains hang in the vertical plane.

Small Swedish style legs enable the unit to be used as a contemporary coffee table, thus simplifying the problem of introducing stereo to the home.

### ENCLOSURE CONSTRUCTION

Figure 5 details the front and sectional elevation of the enclosure. It will be noted that to ensure rigidity and freedom from panel resonances ¾" 7-ply has been specified for the construction. Carpet underfelt ½" thick is affixed to the upper side of the shelf forming the tunnel and the interior of the top panel and together with the two double thickness cotton wool curtains results in a close approximation to critical damping with quality 8" loud speakers. Suggested units for this enclosure are the Philips 9710M, the Magnavox 8WR and the Rola 8MX although any wide range 8" speaker with a free air cone resonance of approximately 45 c/s should be suitable. Slight modification to the thickness of



### LIST OF MATERIALS

(For two enclosures)

- 1 only sheet 6' x 3' 7 ply
- 1 only sheet 7' x 3' 7 ply
- 2 only 12" wide 16 oz. rolls cotton wool
- 4' of  $\frac{3}{4}$ " dowel stick
- 5' under carpet felt  $\frac{1}{2}$ " thick, 12" wide
- Beading for front of enclosure
- 2' of speaker silk 36" wide.

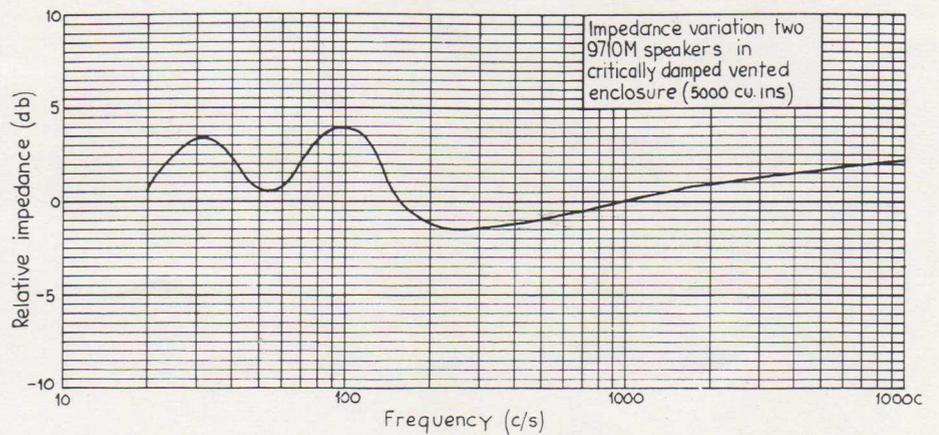


Fig. 6

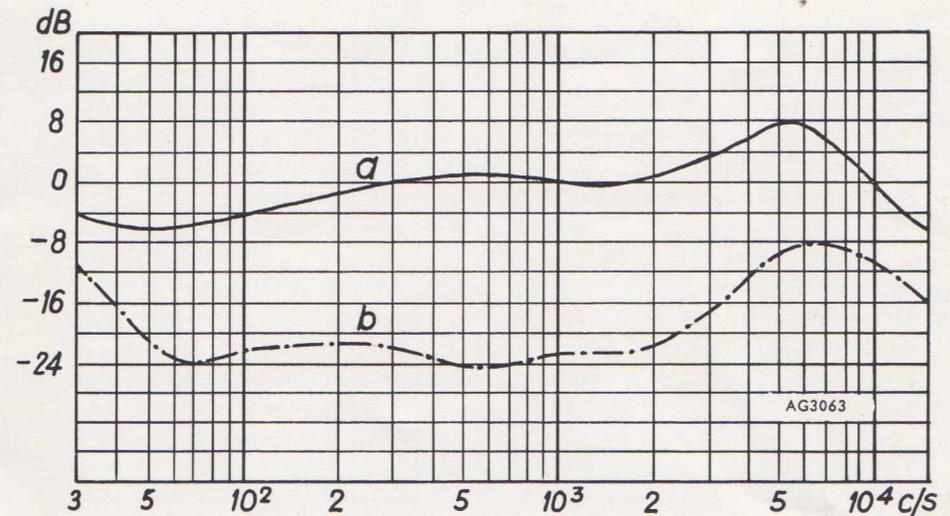
the cotton wool curtains may be necessary to critically damp the enclosure and figure 6 illustrates the impedance curve of two 9710M speaker units in this critically damped enclosure. The cabinet may be polished to match other furnishings and a suitable open weave non-fluffy material or expanded aluminium attached to the front with a suitable trim. If expanded metal is used, care must be taken in the mounting to ensure that rattles do not develop. It is likewise important in the construction of the enclosure to ensure that the removable back provides an air tight seal when finally assembled.

### FACTORY CONSTRUCTED ENCLOSURE

For those who prefer to purchase a factory constructed enclosure, samples have been submitted for our approval by Albert Wright of 793-795 New Canterbury Road, Hurlstone Park, N.S.W. The enclosure is also available in kit set form from Cabinet Kits, 160 High Street, St. Kilda, Vic.

### PICKUPS

No matter how excellent the amplifier the final quality of any music system can never be better than the quality of the programme source. Recently crystal pickups have become



a. Frequency response (velocity loaded 100K)  
b. Cartridge crosstalk

available which permit excellent reproduction from stereo records. The Acos GP71-3, Philips AG3063 and the Ronette BF40 have been used successfully with this amplifier without the need for equalisation. A constructional view and performance curves of a typical stereo cartridge are shown on this page.

Consistent with the high quality moderate cost theme, the performance of the AG2002 record player, and AG1014 (AG1003T) changer-player, fitted with the AG3063 stereo head, is comparable with much more expensive units.

### TECHNICAL SERVICE

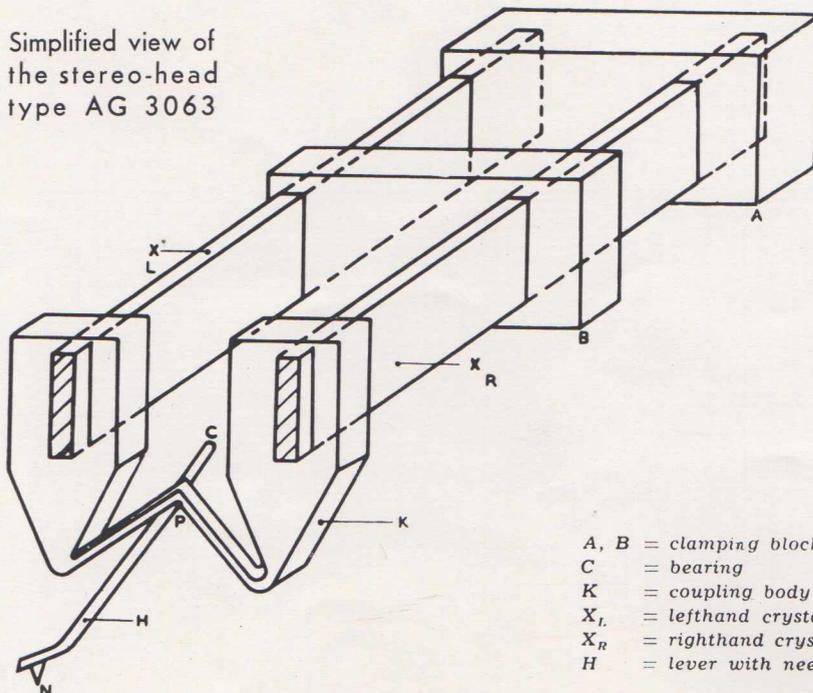
Because of the engineering effort in the design of this amplifier no trouble should be experienced by the home constructor music lover if approved output transformers are used and construction details followed. Should, however, the performance not be to your expectations do not hesitate to contact the Mullard Technical Service Department, 35-43 Clarence Street, Sydney; or 592 Bourke Street, Melbourne.

### TECHNICAL DATA

#### AG 3063

Output voltage per system	120mV/cm perpendicular to groove wall at 400 c/s
Load resistance	≥ 0.5 MΩ
Load resistance (velocity loading)	= 100 kΩ
Channel separation	-20 dB at 1000 c/s
Compliance	lateral 3 × 10 <sup>-6</sup> cm/dyne vertical 2 × 10 <sup>-6</sup> cm/dyne
Capacity	1500 pF
Recommended vertical needle force	4 - 6 grams
Needle tip radius	AG 3060 diamond tip 18 μ AG 3063 sapphire tip 18 μ

Simplified view of the stereo-head type AG 3063



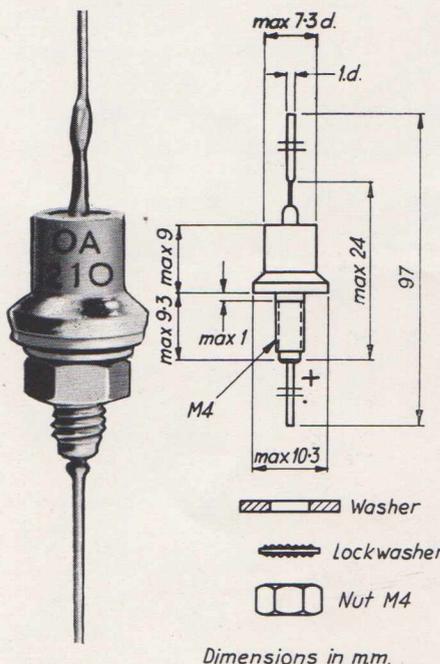
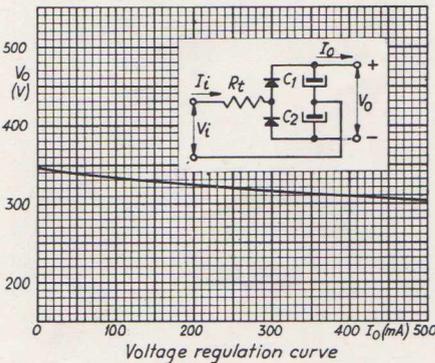
- A, B = clamping blocks
- C = bearing
- K = coupling body
- X<sub>L</sub> = lefthand crystal element
- X<sub>R</sub> = righthand crystal element
- H = lever with needle tip N.





## SILICON DIODE OA210

Whilst silicon power rectifiers have been used in industrial equipment now for some years, it is mainly the increased high tension power requirements of 110° television receivers which have stimulated the development of these devices to the stage where they have become an economical alternative to the thermionic valve rectifier. The saving in heater power, whilst significant, is only one contributor to the economic use of these devices—a more important factor in general being the greater utilisation of both the rectifiers and the copper in the secondary of the power transformer by adoption of a full wave voltage doubling technique. Performance of the OA210 under these conditions from a 127V secondary winding is shown on the accompanying graph and practical experience indicates that in television receiver power supplies up to 400mA of high tension current can be drawn without the need for a heat sink.



## NEW VOLTAGE REFERENCE DEVICES

### 83A1: 83-VOLT REFERENCE TUBE

While the Mullard 85A2 is being used extensively as a reference tube in all types of electronic equipment, a requirement has arisen for a tube having even better all-round performance, particularly for use in high quality power supplies, laboratory test gear, and the like.

To cover this requirement, Mullard have devoted considerable effort to the development of a new miniature tube, the 83A1, which gives a considerable improvement in tolerances, stability, jumps, linearity of temperature coefficient, and performance at high temperature.

The 83A1 should be operated at the preferred current of 4.5mA, where the tube-to-tube spread in maintaining voltage is 1.5V and the maximum jump level is 1mV.

Information on long life performance is being accumulated and will be quoted as it becomes available. However, tubes maintained at an envelope temperature above 100°C have shown a maximum voltage change of 0.6V during the first 2000 hours of life. Previous experience indicates that stability at room temperature will therefore be extremely good.

The temperature coefficient of the tube is relatively linear, decreasing gradually from approximately  $-2.4V/°C$  at 50°C to  $-1.9V/°C$  at 90°C.

For reference tube applications which do not involve error signal amplification, a low incremental resistance, even at the expense of higher jumps, is required. The possibility of recommending a lower preferred current for this duty is now being investigated.

The 83A1, whose design is an extension of the pure metal cathode and sputtered envelope technique, should offer extremely long life and high reliability. Its mechanical strength is good.

It should be emphasised that this tube is not a direct plug-in replacement for the 85A2, though in many equipments the pin wiring and operating voltages may allow interchangeability.

Brief data on the 83A1 is given below. The tube is now available in sample quantities.

#### Tentative Information

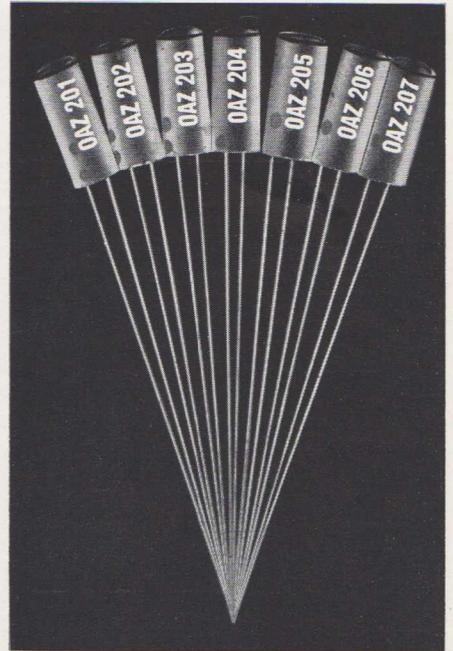
Min. voltage necessary for ignition (light or dark)	125	V
Operating current range	3 to 6	mA
Preferred operating current	4.5	mA
Maintaining voltage at 4.5mA	82.6 to 84.1	V
Max. jump within current range	1	mV

	1st Dot	2nd Dot	Nominal*	Voltage Range	V
OAZ200	Yellow	Violet	4.7	4.4 to 5.0	V
OAZ201	Green	Brown	5.1	4.8 to 5.4	V
OAZ202	Green	Blue	5.6	5.3 to 6.0	V
OAZ203	Blue	Red	6.2	5.8 to 6.6	V
OAZ204	Blue	Grey	6.8	6.4 to 7.2	V
OAZ205	Violet	Green	7.5	7.1 to 7.9	V
OAZ206	Grey	Red	8.2	7.7 to 8.7	V
OAZ207	White	Brown	9.1	8.6 to 9.6	V

\* Zener voltage at 1 mA and at 25°C.

Max. incremental resistance at 4.5mA	350	$\Omega$				
Temp. coefficient at 50°C	$-2.4$	$V/°C$				
Base	B7G					
1	2	3	4	5	6	7
a	k	IC	IC	IC	IC	IC

### LOW-VOLTAGE ZENER REFERENCE DIODES



In addition to the cold cathode reference tube, operating in the region of 80 volts, reference/stabiliser devices can be made which have output voltages of about 4 to 8 volts. These devices are silicon zener reference diodes.

When a specially produced low-voltage silicon diode is operated in its reverse direction with a defined current, so that it is on the verge of reverse breakdown, a constant voltage across the diode is produced. These specially made diodes have a sharply defined reverse breakdown effect, and they exhibit a very high impedance up to this point. If the current is further increased, the internal impedance rapidly falls to a few ohms.

Zener reference diodes may be used in similar ways to cold cathode tubes, either as voltage references associated with a power regulator, or as direct stabilisers.

Mullard zener reference diodes are marked with two coloured dots which indicate the nominal zener voltage, in accordance with the standard resistor colour code. The first dot is the one nearest to the leads.

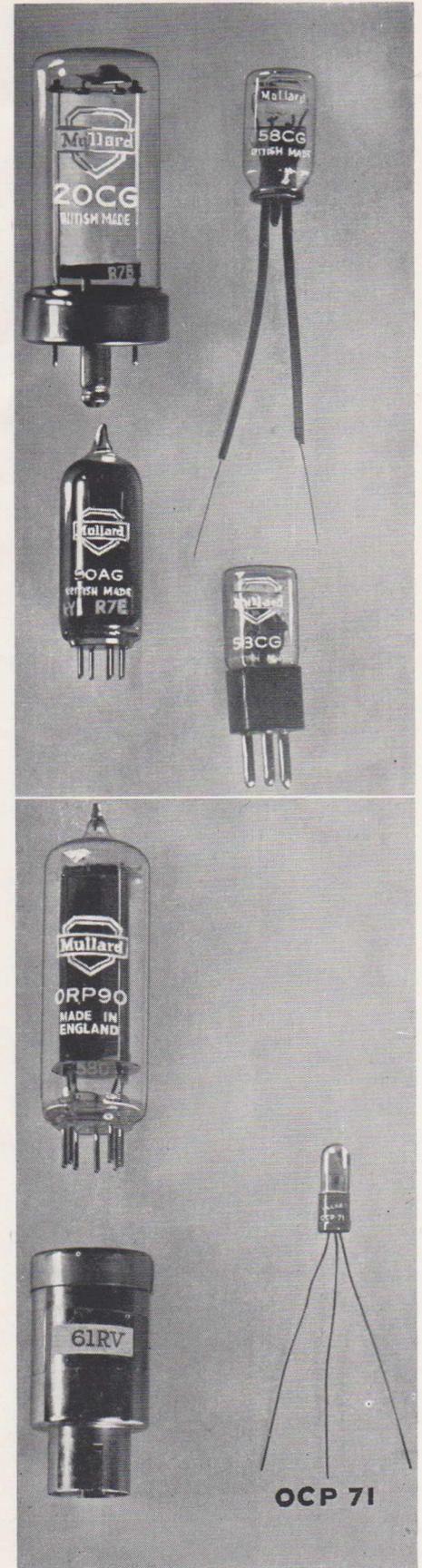
# PHOTO - SENSITIVE DEVICES

	Description	Base	Sensitivity <sup>(a)</sup> μA/Lm
20CG	Gas-filled Photocell with Caesium/Oxidised Silver Cathode	B8G	25
20CV	Vacuum Photocell with Caesium/Oxidised Silver Cathode	B8G	(V <sub>a</sub> = 100V)
53CG	Gas-filled Photocell with Caesium/Oxidised Silver Cathode, for end-on incidence of illumination	B3A	100 (V <sub>a</sub> = 85V)
53CV	Vacuum Photocell with Caesium/Oxidised Silver Cathode, for end-on incidence of illumination	B3A	20 (V <sub>a</sub> = 50V)
58CG	Gas-filled Photocell with Caesium/Oxidised Silver Cathode, for end-on incidence of illumination	Flying Leads	100 (V <sub>a</sub> = 85V)
58CV	Vacuum Photocell with Caesium/Oxidised Silver Cathode, for end-on incidence of illumination.	Flying Leads	20 (V <sub>a</sub> = 50V)
90AG	Gas-filled Photocell with Caesium/Antimony Cathode	B7G	130 (V <sub>a</sub> = 85V)
90AV	Vacuum Photocell with Caesium/Antimony Cathode	B7G	45
90CG	Gas-filled Photocell with Caesium/Oxidised Silver Cathode	B7G	125
90CV	Vacuum Photocell with Caesium/Oxidised Silver Cathode	B7G	20 (V <sub>a</sub> = 50V)
61RV	Uncooled Lead Selenide Cell having a sensitive area of 0.06 sq. cm.	B2B	60
61SV	Uncooled Lead Sulphide Cell having a sensitive area of 0.36 sq. cm.	B2B	150
63TV	Cooled Lead Telluride Cell having a sensitive area of 0.1 sq. cm.	Flying Leads	250
ORP10	Uncooled indium antimonide photo-conductive cell for high speed infra-red spectroscopy	Flying Leads	Min. detectable power: Less than 4 milli-microwatts at 6 microns wave-length and and band-width of 1/cs.
ORP11	Uncooled cadmium sulphide cell with high sensitivity in the yellow, red and near infra-red regions	B3A	1.2 mA./ft. candles (at 5ft. candles and 20V)
ORP90	Uncooled cadmium sulphide cell with high sensitivity in the red/infra-red region. Sensitive area 1.8 sq. cm.	B7G	2 mA./ft. candles (at 5ft. candles and 20V)
OCP71	General purpose phototransistor of the p-n-p type	Flying Leads	1.5 to 4.0 <sup>(b)</sup>

(a) Sensitivity measured at max. anode supply voltage with the whole cathode area illuminated by a lamp of colour temperature 2700°K and with a series resistor 1 Megohm.

NOTE: Caesium/Antimony Cathode is particularly sensitive to daylight and bluish light. Caesium/Oxidised Silver Cathode is particularly sensitive to incandescent light and near infra-red radiation.

(b) V<sub>c</sub> = -2V, uniform illumination = 75ft. candles with a lamp of colour temperature of 2700°K.





# DH 13-97 OSCILLOSCOPE TUBE



The most interesting feature of this five-inch tube is its use of graded post-deflection acceleration. Two successive bands (a4 & a5) are used giving a high ratio between the voltage on the final gun anode and the final acceleration voltage.

The large voltage difference enables a high writing speed to be obtained while preserving a high deflection sensitivity. This system of two-stage post-deflection acceleration is equivalent in operation to the widely-known spiral band system. The deflector plates are brought out to side connections on the neck of the tube, to reduce the deflector plate capacitance to a minimum.

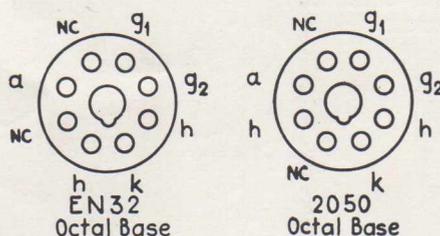
### Abridged Data

$V_h$	6.3	V
$I_h$	550	mA
$V_{a1}$	1500	V max
$V_{a2}$	750	V
$V_{a3}$	2000	V max
$V_{a4}$	5.5	kV
$V_{a5}$	6-12	kV
$V_g$	-200 to -1	V
$V_{h-k(pk) max}$	250	V
$S_x$	33.5	V/cm
$S_y$	12.5	V/cm

# EN32 THYRATRON

Due to a shortage of the 2050 thyatron, equipment designers have been forced to consider more readily available alternative types. The EN32 may be interchanged with the 2050 in most applications, by bridging socket pins 1 and 2.

A 300 mA tetrode thyatron with an inert gas filling, the EN32 is suitable for use in relay circuits, regulated power supplies, servo-motor controls and general industrial applications. The small control-grid current allows a high value grid resistor to be used, so that the valve can be controlled from a high impedance signal source such as a photocell.



A comparison of the EN32 and 2050 characteristics is given below:—

### ELECTRICAL

	EN32	2050
Heater voltage	6.3	6.3 V
Heater current	0.95	0.60 A
Control ratio		
$g_2$ to k and $R_{g1} = 0\Omega$	275	800
$g_1$ to k and $R_{g2} = 0\Omega$	370	250
Anode voltage drop	10	8 V

### LIMITING VALUES

	EN32	2050
Max. peak anode voltage		
Inverse	1.3	1.3kV
Forward	650	650 V
Max. Cathode Current		
Peak	2.0	1.0 A
Average	300	100 mA
Surge	10	10 A
Max. negative control grid voltage		
Before conduction	250	250 V
During conduction	10	10 V
Max. average control-grid current	20	10 mA
Max. average positive shield-grid current	20	10 mA
Max. negative shield grid voltage		
Before conduction	100	100 V
During conduction	10	10 V
Peak Heater—Cathode Voltage		
Heater positive	25	25 V
Heater negative	100	100 V
Min. heating time	15	10 secs.
Ambient temp. range	-75 to +90	-75 to +90°C

# AMATEUR EXPERIMENTERS COLUMN

## 6-VOLT PREAMPLIFIER

The preamplifier illustrated is suitable for a low impedance source, such as a microphone, feeding into a valve amplifier.

The quiescent current is 400 $\mu$ A for a nominal transistor and the collector to emitter voltage is therefore about 3V at room temperature. At an input voltage of 16mV r.m.s., the output voltage is 1.0V r.m.s., and the voltage gain 62.

