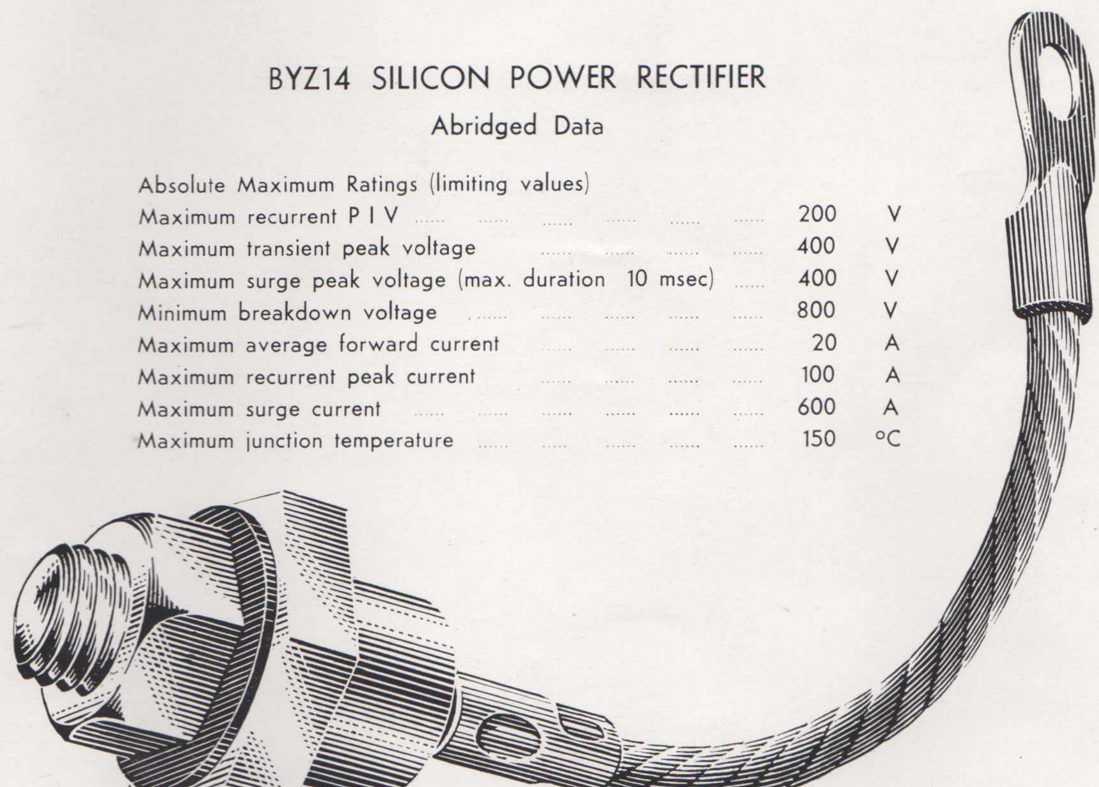
Mullard Outlook

Australian Edition

BYZ14 SILICON POWER RECTIFIER

Abridged Data

Absolute Maximum Ratings (limiting values)		
Maximum recurrent P I V	200	V
Maximum transient peak voltage	400	V
Maximum surge peak voltage (max. duration 10 msec)	400	V
Minimum breakdown voltage	800	V
Maximum average forward current	20	A
Maximum recurrent peak current	100	A
Maximum surge current	600	A
Maximum junction temperature	150	°C



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JOERN BORK

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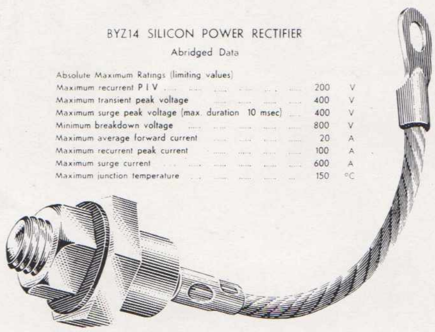


The Mullard BYZ14 is a new 20 A, 200 V silicon power rectifier, rugged and reliable for industrial conditions. In addition it has built-in safety margins which are more than adequate as may be seen from the Abridged Data. The BYZ14 is now readily available.

CUSTOMS AND HABITS

"That monster, custom, who all sense doth eat,
Of habits devil . . ."

HAMLET: ACT 3: SCENE 4

Let us not dwell upon pancakes on Shrove Tuesday or haggis on 'Burns nicht' nor debate whether it is supreme optimism or habit that causes some folk to consistently peep beneath the bed before retiring—but consider where our particular science might be if it were not bound by some custom or habit.

Schoolboy enthusiasts today are most likely to use a transistor before a valve and to the non-technical the fascinating marvel of television is perhaps now over-shadowed and swamped by the programme content—sophistication in another sense.

With Mullard valves and electron tubes the custom or habit is high performance with long life and reliability, be it valves for television receiving or transmitting equipment, navigation and telecommunications equipment or electro-medical equipment, for it is an even chance that the X-ray tubes in your nearest hospital are also Mullard.

VIEWPOINT WITH MULLARD

INSTITUTION OF RADIO ENGINEERS AUSTRALIA RADIO AND ELECTRONIC ENGINEERING CONVENTION CHEVRON HILTON HOTEL, MARCH, 1961

Outstandingly successful — largest ever gathering

Without question, those who attended the Convention and Exhibition of the Institution of Radio Engineers, held in Sydney in March last, were well rewarded, for there was little indeed that could not be described as 'stimulating and impressive.' Some idea of its magnitude can be gathered from the fact that nearly 100 papers on a wide variety of engineering topics were presented, including three by Mullard Senior Applications Engineer, Mr. J. R. Goldthorp. These were entitled "The Influence of Alloy Diffused Transistors on Domestic Television Receiver Design"; "Transistors and the Domestic Broadcast Receiver"; and "A Power Valve Test Fixture Synthesising Low Frequency Class C Operating Conditions." An estimated 7,000 people attended the Exhibition.

The theme of the Mullard display was 'Applications Service' and the centre panel highlighted the applications engineering and technical services that are available for assistance in equipment engineering development. Augmenting this technical service are, of course, the well-known Mullard technical publications, and a selection of these formed part of the backdrop to the centre motif. Featured on the Mullard Stand were a number of new developments in valves, electron tubes, semiconductors, microwave devices and specialised products which have not been seen previously in this country. Perhaps the most interesting of these was the latest S-Band solid state Maser developed by the Mullard Research Laboratories in the U.K. The Maser (microwave amplification by stimulated emission of radiation) is basically a very low-noise microwave amplifier —the heart of radio telescopes and long-range radar systems for radio astronomy and satellite tracking.

Other microwave devices shown included a travelling wave tube complete with focussing assembly, ferrite isolators for X-band and S-band, magnetrons, klystrons and disc seal triodes. Of particular interest was the first of the Mullard ceramic disc seal triodes for 4,000Mc/s operation.

In the field of semiconductors, a number of interesting developments included a high-frequency transistor capable of delivering 3W at 8Mc/s, and a new alloy-diffused transistor with a noise figure of 6dB at 200Mc/s suitable for front-end service in VHF communications equipment. Also shown were fast switching transistors for computer and logic circuits, a germanium PNPN transistor suitable for use as a switched speech path in telephony systems, and an avalanche transistor intended for use in sampling oscilloscopes and as a general purpose high-speed pulse generator.

New silicon rectifiers included the BYZ10 which has a current rating of 6.0A at 600 PIV and the BYZ14 which has an average forward current of 20A and a max. PIV of 200V. The range of silicon zener diodes has been extended with the addition of four new series, including a range of subminiature diodes for computer logic circuits and a medium current series having a dissipation of 1.5W.

Continued on Page 23

General Manager, Mr. M. A. Brown, visits the Mullard Stand and is seen with (from left to right) Mr. L. A. Wade, Commercial Manager, Mr. W. R. Penberthy, Sales Engineer, and Mr. J. Bork, Editor of Outlook.

'TWIN THREE-THREE' STEREOPHONIC AMPLIFIER CIRCUIT

The circuit described in this article has been developed from the Mullard 'Three-Three' amplifier circuit to meet the demand for a simple stereophonic amplifier of good quality. The stereophonic unit comprises two three-three amplifiers (minus one power supply) mounted on one chassis. (One 6CA4/EZ81 power-supply stage suffices for both channels.) Four controls, ganged between channels, are included in the amplifier—treble and bass tone controls and volume and balance controls.*

The sensitivity of each channel is 110mV, which is ample for use with existing stereophonic crystal pick-up heads. Although the circuit has been adapted from a monophonic version for stereophonic purposes, facilities for monaural reproduction are still retained.

PERFORMANCE

Distortion

The relationship between the total harmonic distortion and the output power for each channel is shown in Fig. 1. At the rated output of 3W the distortion is 1%. It will be seen that for a typical amplifier, with output powers above about 3.5W, the distortion increases rapidly. This indicates the point beyond which overloading occurs.

Frequency Response

With the treble and bass controls in Fig. 3 in their minimum effective positions, the frequency response of each channel is essentially flat from 35c/s to 30kc/s (Fig. 2). With maximum application of the respective controls, a treble cut of 20dB is available at 10kc/s, and a bass-boost of 15dB is available at 70c/s. The bass-boost is obtained by reducing the main feedback at low frequencies by means of RV11 and C7 (Fig. 3).

Sensitivity

The sensitivity of each channel for the rated output of 3W is 110mV.

Hum and Noise

The level of hum and noise in each channel is 67dB below 3W.

Cross-talk Interference

Cross-talk interference between channels is 52, 38 and 23dB below the rated output at 100c/s, 1kc/s and 10kc/s respectively. (Cross-talk interference is measured in one channel when the input of that channel is open-circuited and the signal applied to the other channel is sufficient to give the rated output from that channel.)

Output Impedance

The output impedance of each channel for a loudspeaker load of 15Ω is less than 1.5Ω. This gives an adequate damping factor of more than 10 (that is, > 15/1.5).

CIRCUIT DESCRIPTION

Only one channel of the amplifier is shown in Fig. 3. The circuitry appearing between the dotted lines is for the left-hand channel: it should be duplicated for the right-hand channel. The circuitry drawn outside the dotted lines (the power supply, for example) is common to both channels.

Input Selector Switch

The input stages of both channels are connected to the 3-way selector switch SA. The switch positions indicated in Fig. 3 provide the following facilities:

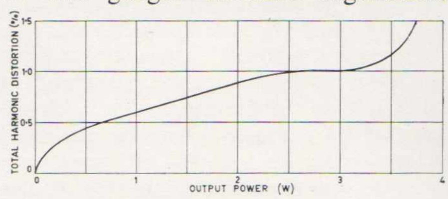
(a) Stereophonic reproduction from stereophonic crystal pick-up heads.

(b) Dual-channel monaural reproduction from a monophonic pick-up head. In this position, the left-hand pick-up input terminal is 'live', and both channels are connected in parallel at the input. The input terminal for the right-hand channel of a stereophonic pick-up head is earthed at position b of SA2. If position b of SA3 is earthed instead of being connected to position b of SA1, single-channel reproduction is possible.

(c) Dual-channel monaural reproduction from an FM tuner unit. The input socket in Fig. 3 is connected for monophonic applications. If position c of SA3 is connected to the right-hand input terminal instead of the left-hand terminal, the circuit will be suitable for reproducing stereophonic transmissions. If position c of SA3 is earthed instead of being connected to the input socket, the system gives single channel monaural reproduction from an FM tuner unit.

Controls

Volume, balance and treble controls are incorporated in the grid circuit of the input valve. The bass control is included in the feedback loop. The volume and bass controls both consist of two ganged matched logarithmic



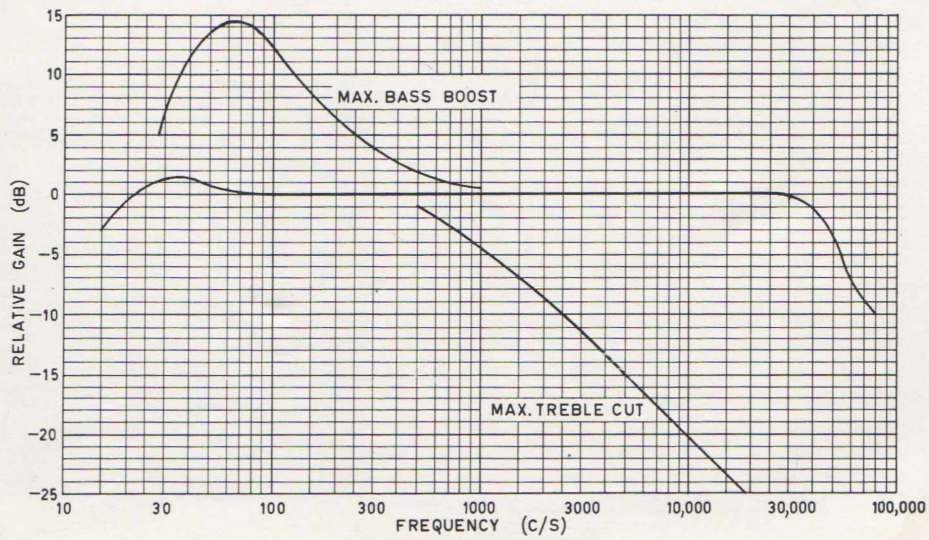


Fig. 2—Frequency response of each channel showing relative gain without application of tone controls, and also showing relative gain with maximum application of tone controls

**'Circuits for Audio Amplifiers' pp. 55 to 58. Published by Mullard Ltd., 1959 Price 12/6, plus 1/5 postage.*

potentiometers and the treble control consists of two ganged matched linear potentiometers. These enable simultaneous adjustments to be made to both channels.

However, differences between the signal level in each channel can occur because of (i) the difference in the outputs from the halves of the pick-up head, (ii) the unequal sensitivities of the loudspeakers and (iii) the very small difference in gain of the two channels. Consequently some form of balance control is necessary. The balance control used in Fig. 3 consists of two ganged, matched potentiometers, one of which obeys a logarithmic law and the other an antilogarithmic law. The antilogarithmic potentiometer is connected normally and the logarithmic potentiometer is connected in reverse. If linear potentiometers connected in this way are used for the balance control, there is a 50% loss in gain, whereas only a 10% loss is incurred with the logarithmic-type potentiometers. The normal position for balance with either type of potentiometer is 50% rotation.

Amplifying Stages

Because of the higher level of distortion with single-ended output stages, appreciable negative feedback around the output stage is necessary to produce an output of acceptable quality. From considerations of stability, this feedback should be taken around the minimum number of stages. The basic sensitivity of each channel without feedback is about 11mV, which, when the desirable level of feedback of about 20dB is used, gives an overall sensitivity of about 110mV.

The EF86 in the voltage-amplifying stage is used under conditions approaching those of starvation operation. With a high value of anode load resistance (R5 is 1MΩ) and reduced

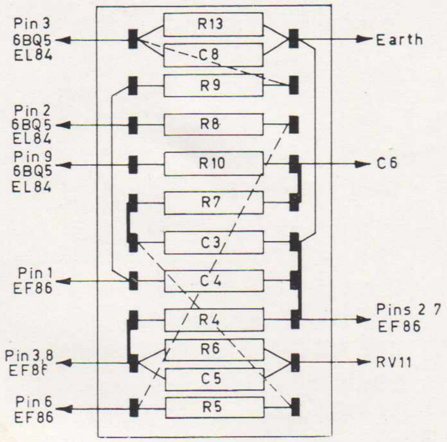


Fig. 4—Tagboard for left-hand channel (Tagboard for right-hand channel is replica of this)

Resistors

Circuit ref.	*Value*		*Tolerance (±%)*	*Rating (W)*
[1]RV1, RV101	1	MΩ	log. pot.	
[2]RV2, RV102	500	kΩ	lin. pot.	
R3, R103	10	MΩ	20	½
[3]R4, R104				
for 15Ω speakers	82	Ω	5	½
for 7.5Ω speakers	100	Ω	5	½
for 3.75Ω speakers	150	Ω	5	½
R5, R105	1	MΩ	10	½
R6, R106	6.8	kΩ	5	½
R7, R107	390	kΩ	10	½
R8, R108	1	kΩ	20	½
R9, R109	22	kΩ	10	½
R10, R110	150	Ω	20	½
[1]RV11, RV111	50	kΩ	log. pot.	
R12, R112	3.9	kΩ	10	½
R13, R113	560	Ω	5	3
R14, R114	1	kΩ	20	½
R15, R16	values depend on mains transformer, 150Ω in prototype		20	2
[1]R17	1	MΩ	log. pot.	
[1]R117	1	MΩ	antilog. pot.	

[1]Ganged, matched, 10% law
[2]Ganged, matched
[3]High stability, cracked carbon

Capacitors

Circuit ref.	*Value*		*Description*	*Rating (V)*
C1, C101	0.02	μF	paper	400
C2, C102	390	pF±20%	silvered mica	
C3, C103	0.25	μF	paper	350
C4, C104	25	μF	electrolytic	50
C5, C105	390	pF±10%	silvered mica	
[4]C6, C106	50	μF	electrolytic	350
C7, C107	0.1	μF	paper	400
C8, C108	25	μF	electrolytic	50
[4]C9	50	μF	electrolytic	350

[4]C6, C106, C9 should be (50–50–50)μF

Output Transformers

Primary Impedance: 5kΩ at 50mA
Secondary Impedances: 15, 7.5, 3.75Ω
3W rating

Mains Transformer

Primary: 10–0–200–220–240V
Secondaries: H.T. 300–0–300V, 100mA
L.T. 3.15–0–3.15V, 2.2A (for 2 x EF86, 2 x 6BQ5/EL84)
0–6.3V, 1A (for 6CA4/EZ81)

Valves

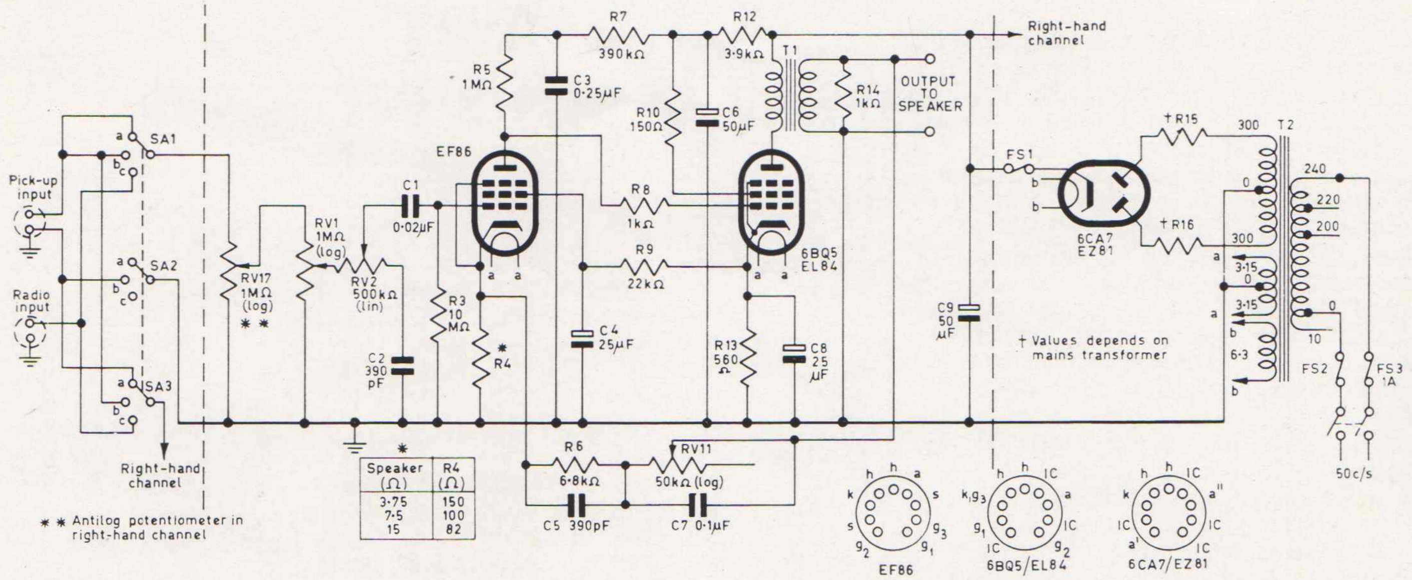
Mullard EF86 (two), 6BQ5/EL84 (two), 6CA4/EZ81.

Valveholders

B9A (noval) (three)
B9A (noval) (two), nylon-loaded with screening skirt.

Miscellaneous

Mains input plug
Mains switch
Mains voltage selector
Fuseholder
Lampholder (optional)
Indicator lamp (optional) 6.3V, 0.15A, L.E.S.
Auxiliary mains socket (if required)
Input socket, 2-pin (two)
Output socket, 2-pin (two)
Selector switch, 3-pole, 3-way
Tagboard, 10-way (two)
Pointer knob (five)



Speaker (Ω)	R4 (Ω)
3·75	150
7·5	100
15	82

Fig. 3—Circuit diagram of 'Twin Three-Three' stereophonic amplifier (left-hand channel only is shown: circuitry between the vertical broken lines should be repeated in right-hand channel)

values of anode and screen-grid voltage, the gain of the stage is raised two or three times above that obtained under normal operating conditions. This increase is attributable mainly to the fact that, because the voltage at the anode of the EF86 is very low, direct coupling can be used between this anode and the control grid of the 6BQ5/EL84 in the output stage. Thus the shunt loading on the anode circuit of the EF86 is least when at low and medium frequencies.

The use of direct coupling between the stages necessitates a higher cathode voltage in the output stage than is required with RC coupling. The value of R13 is thus greater than is usual for the cathode resistance. The screen-grid voltage for the EF86 is taken from the cathode of the 6BQ5/EL84. In this way, negative DC feedback (which is essential in a directly coupled circuit to stabilise the operating conditions of both stages) is applied to the voltage amplifier.

Negative AC feedback is applied from the secondary winding of the output transformer to the cathode of the EF86. This feedback loop incorporates the bass-boost control, the amount of feedback being changed continuously at low frequencies as the resistance of the control potentiometer RV11 is varied.

Power Supply

The power supply for both channels uses the 6CA4/EZ81 in combination with a mains transformer meeting the specification contained herein. The anode of the 6BQ5/EL84 in each channel is supplied from the common capacitor C9, and the screen-grid is supplied through the filter R12, C6 situated in each channel.

CONSTRUCTION AND ASSEMBLY

The chassis for the amplifier is made from two separate pieces of 16 s.w.g. aluminium sheet. The dimensions (in inches) of these pieces are:

(*a*) Cover plate $14\frac{7}{8}$ x $7\frac{7}{8}$

(*b*) Main chassis 18 x 11

Each piece should be marked as shown in the drawings of Fig. 6, and the holes should be cut as indicated.

Most of the smaller components should be mounted on two tagboards. The wiring of the tagboard for the left-hand channel is shown in Fig. 4. The tagboard for the right-hand channel is a replica of this. The larger components such as switches, valve-holders and transformers should be mounted in the chassis in the positions indicated in the layout diagram of Fig. 5. The recommended wiring between these components is also indicated in Fig. 5.

DC CONDITIONS

The DC voltages at points in the equipment should be tested with reference to Table 1. The results shown in this table were obtained using an Avometer No. 8.

KEY TO HOLES IN CHASSIS

Hole	Dimension	Use	Hole	Dimension	Use
A	$\frac{11}{16}$ in. dia.	Output socket	M	$\frac{3}{4}$ in. dia.	B9A valveholder
B	$\frac{3}{4}$ in. dia.	Auxiliary mains socket (if required)	N	$\frac{3}{4}$ in. dia.	B9A valveholder
C	$\frac{11}{16}$ in. dia.	Output socket	O	$\frac{3}{8}$ in. dia.	Selector switch, 3-way
D	$\frac{5}{8}$ in. dia.	HT fuseholder	P	$\frac{3}{8}$ in. dia.	1MΩ log./antilog. potentiometers
E	$1\frac{1}{8}$ in. dia.	Voltage selector, fused	Q	$\frac{3}{8}$ in. dia.	2 x 1MΩ log. potentiometers
F	$\frac{3}{4}$ in. dia.	Mains input plug	R	$\frac{3}{8}$ in. dia.	2 x 500kΩ lin. potentiometers
G	$1\frac{1}{4}$ in. dia.	Electrolytic capacitor	S	$\frac{3}{8}$ in. dia.	2 x 50kΩ log. potentiometers
H	$\frac{11}{16}$ in. dia.	Input socket	T	$\frac{3}{8}$ in. dia.	Lampholder
I	$\frac{11}{16}$ in. dia.	Input Socket	U	$\frac{15}{32}$ in. dia.	Mains switch
J	$\frac{3}{4}$ in. dia.	B9A skirted nylon-loaded valveholder	X	Drill No. 49	Self-tapping screw
K	$\frac{3}{4}$ in. dia.	B9A valveholder	Y	Drill No. 34	6 B.A. clearance
L	$\frac{3}{4}$ in. dia.	B9A skirted nylon-loaded valveholder	Z	Drill No. 27	4 B.A. clearance

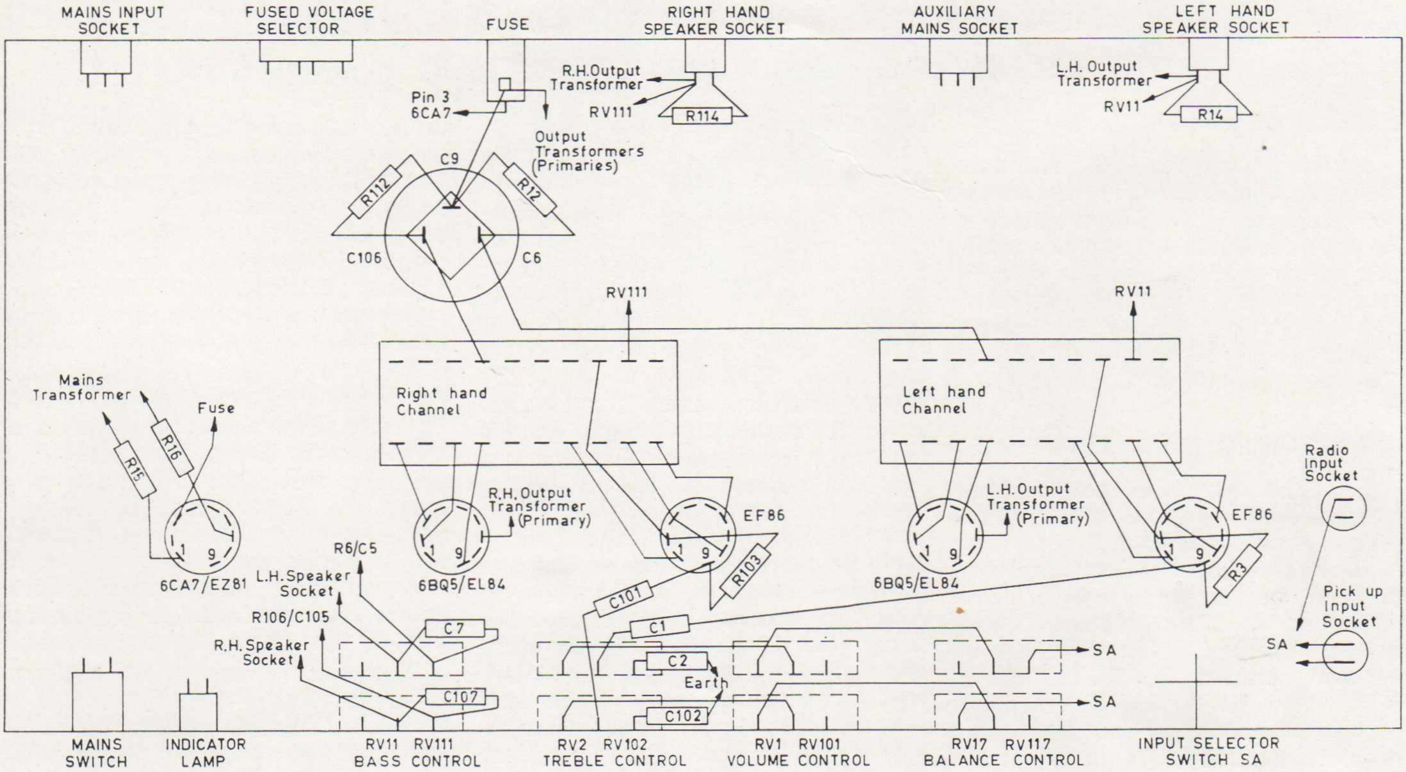
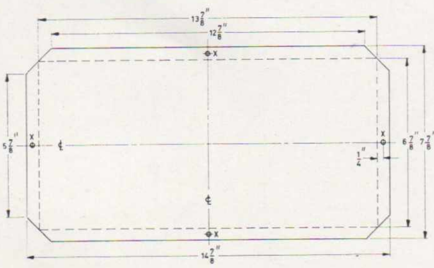


Fig. 5—General layout diagram

TABLE 1
DC Conditions

Point of Measurement	Voltages (V)	DC Range of Avometer* (V)
C9	310	1000
C6, C106	285	1000
C3, C103	215	1000
6BQ5/EL84		
Anode	300	1000
Screen grid	285	1000
Cathode	32	100
EF86		
Screen grid	24	100
Anode	31	100

*Resistance of Avometer
1000V-range, resistance = 20MΩ
100V-range, resistance = 2MΩ



Cover Plate

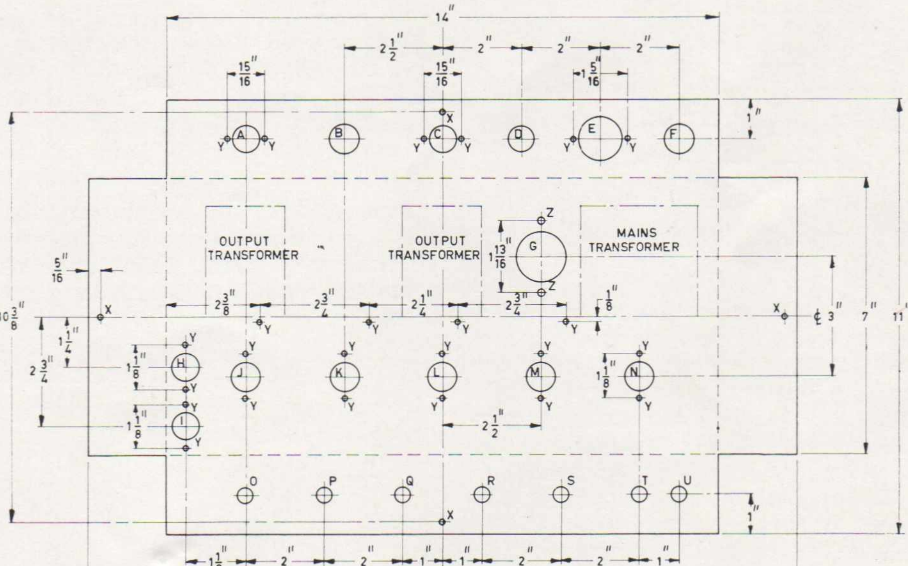


Fig. 6—Chassis details (the pieces should be bent down along all dotted lines)

S-BAND SOLID STATE CAVITY MASER

DISPLAYED FOR THE FIRST TIME IN AUSTRALIA AT THE RECENT I.R.E. RADIO AND ENGINEERING CONVENTION

1. INTRODUCTION

At the present time the solid state "Microwave Amplification by Stimulated Emission of Radiation" device is the most sensitive pre-amplifier available in the microwave region because of its extremely small noise contribution (approximate noise temperature 2° Kelvin). The Maser is one form of "quantum mechanical" amplifier.

2. PRINCIPLE OF OPERATION

In a solid state Maser the amplifying material is a crystal of a weakly paramagnetic substance acted upon by incident magnetic and radio frequency fields so that it is *emissive* at a "gyromagnetic" or "spin resonance" frequency. To simplify the description of the operating mechanics of a Maser it is desirable to review the technology of "paramagnetic" or "nuclear magnetic" resonance.

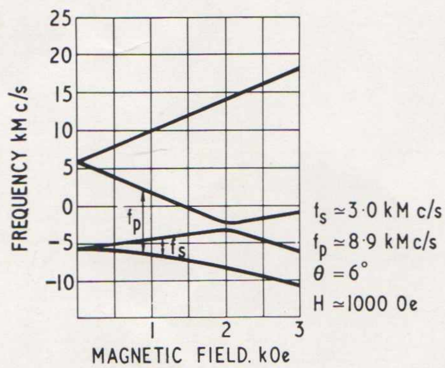


Fig. 1

The fundamental method employed in this technique is to place a sample of the substance under investigation in a crossed uniform magnetic and radio frequency field. If the uniform magnetic field is held constant and the frequency of the RF field varied, it will be observed that at certain discreet frequencies absorption of RF energy by the substance occurs. This is due to the paramagnetic ions oscillating at their gyromagnetic frequency and this electronic technique of spectroscopy is a modern tool for the analytical chemist. In most compounds paramagnetic ions or radicles exist at discreet energy levels and, consequently, different substances exhibit different spectra showing various absorption coefficients at discreet gyromagnetic frequencies and hence the spectra may be related to known chemical compounds or admixtures.

It will be appreciated that absorption of RF energy takes place because energy is required to excite paramagnetic ions at their spin resonant frequencies.

The Mullard S-Band Cavity Maser employs a "Pink Ruby" (Al_2O_3:Cr) crystal which has three distinct energy levels for paramagnetic ions. In this paramagnetic crystal the magnetic ions are constrained in discreet energy levels, the separation between levels being dependent upon the steady magnetic field applied to the crystal and its orientation with the crystal axis. A typical energy level diagram for Ruby $(Cr_{0.001}\,Al_{0.999})_2O_3$ is shown in Figure 1, whilst the relative populations in the case of thermal equilibrium are governed by the Boltzmann distribution (refer Figure 2). Transitions between the various levels, possibly leading to a change in population distribution, occur either spontaneously due to thermal agitation or due to stimulation by an applied RF magnetic field of the appropriate frequency.

In the first case thermal agitation may or may not be due to incident radiation, whilst in the second the probabilities of stimulation from the lower of the pair of levels to the upper, and vice versa, are equal.

It is for this latter reason that, when RF power is applied to the system in thermal equilibrium, there is a net absorption of energy and paramagnetic resonance is detected. In a Maser, however, an inversion in population between levels 1 and 2 (Figure 2b) is brought about by the application of a RF magnetic field at the "pump" frequency f_p energy being taken in by the crystal at a rate faster than it can leak away into the lattice and so the population of level 1 increases at the expense of level 3 until they become equal and the transition is said to be saturated.

The rate at which energy leaks from the energy level system to the lattice is inversely proportionate to temperature and hence is one of the reasons for operating solid state Masers at relatively low temperatures. In this way the input power at the pump frequency for saturation may be reduced to a few milliwatts and thermal effects within the crystal, due to the absorption of this pump power, minimised.

The effect of incident RF power at signal frequency upon the crystal is now to produce an emission of radiation; the emitted power output being $P_{em} = (n'_1 - n_2)\,h.f_s.K.\,(H_{fs})^2 \ldots (1)$ where K is a constant for a particular configuration and $H_{(fs)}$ is the RF field strength at the signal frequency.

3. THE CAVITY MASER

In some way the magnetic fields at the pump and signal frequencies must be concentrated in the Maser crystal. This can be done at the signal frequency by the use of either a resonant cavity or a travelling wave structure.

The demonstration uses a resonant cavity. This is shown, together with the Maser crystal — synthetic Ruby (Al_2O_3:Cr) — in Figure 3.

Pump power is also propagated in this structure which is not resonant at the pump frequency.

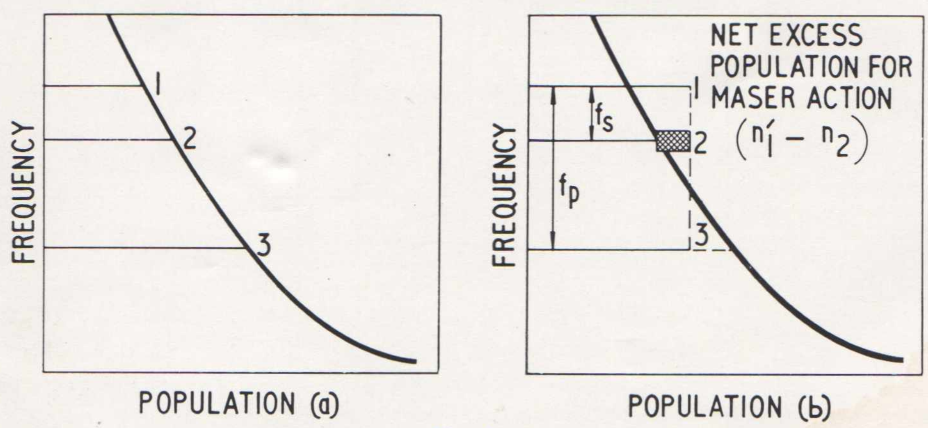


Fig. 2

4. NOISE PERFORMANCE

At present microwave Masers are operated at low temperatures, in fact to obtain the lowest noise output and optimum amplification, temperatures as low as 1.5°K are used (as in the demonstration).

Primarily, the low noise performance is obtained because amplification does not involve interaction with a beam of moving charged particles as it does in the case of a conventional amplifier.

In fact, the main noise contributions are thermal, made up as follows:

(1) Emission of thermal energy due to a lossy transmission line between the aerial and the Maser.

(2) Emission of thermal energy by the walls of the Maser structure, in this case the cavity.

(3) Emission of thermal energy by the Maser crystal magnetic spin system.

Power emitted under heading (1) can be reduced by careful design of the input line to that corresponding to 10 to 20°K; that emitted under (2) and (3) is quite small — 3 to 10°K for liquid helium temperature operations.

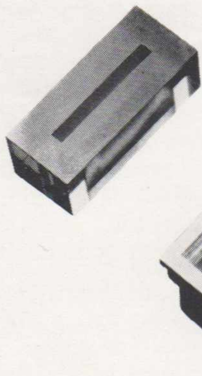


Fig. 3

5. APPLICATIONS AND PERFORMANCE

The S-band Maser in the packaged form shown in Figure 4 is intended for use close to the focus of a radio telescope or radar aerial. The total weight is about 80 lbs, including liquid nitrogen and liquid helium, which are used as refrigerants.

The gain-bandwidth product is about 20 Mc/s, the mechanical tuning range is 3000 ± 50 Mc/s.

6. REFERENCE

(1) Singer, J. R.: Masers, John Wiley (1959).
Troup, G.: Masers, Melhuen Monograph (1959).

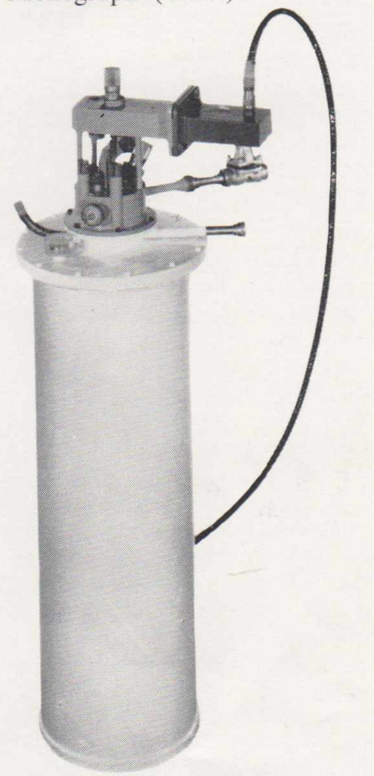
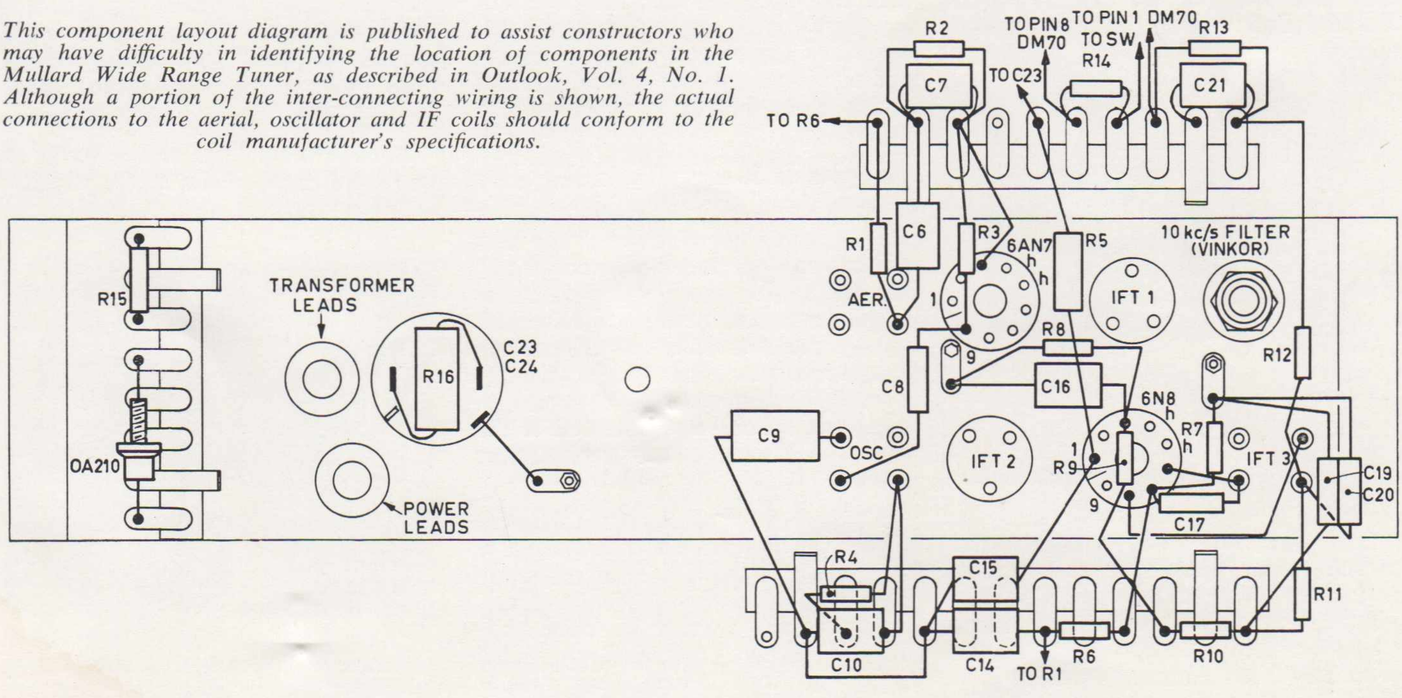


Fig. 4

MULLARD WIDE RANGE TUNER

Additional Information

This component layout diagram is published to assist constructors who may have difficulty in identifying the location of components in the Mullard Wide Range Tuner, as described in Outlook, Vol. 4, No. 1. Although a portion of the inter-connecting wiring is shown, the actual connections to the aerial, oscillator and IF coils should conform to the coil manufacturer's specifications.



Q-BAND FERRITE ISOLATOR

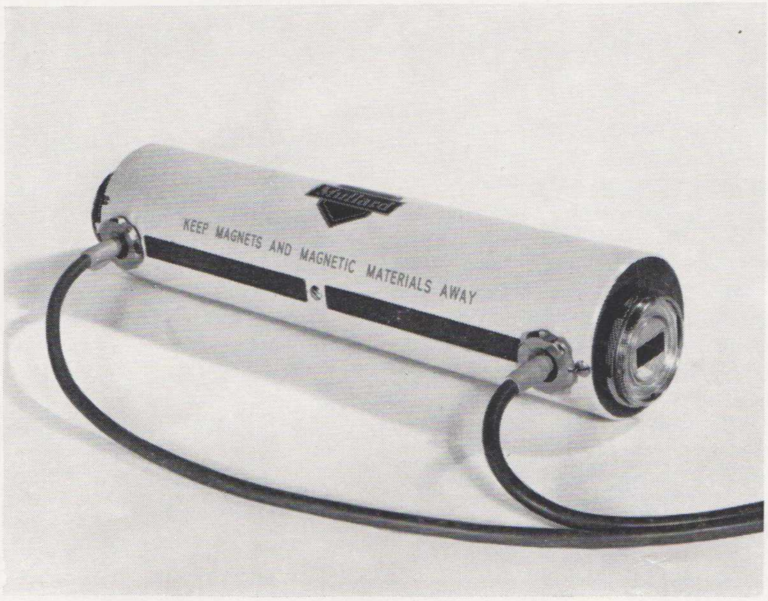
The high power isolator L.384 has been developed to meet the need for a device to protect a magnetron transmitter against load mismatch with minimum insertion loss.

The field patterns in a rectangular waveguide excited in the TE_{01} mode are such that for propagation in one direction, the magnetic field at a point approximately one-quarter of the way across the waveguide is a vector rotating in a clockwise direction. The rotation is anticlockwise for the reverse direction of propagation. Since the gyromagnetic absorption of a ferrite in a transverse steady magnetic field occurs for only one sense of circular polarisation of the microwave field a non-reciprocal attenuation condition can be established.

Gyromagnetic resonance at 35 Gc/s in the Ferroxcube material employed requires a very high applied magnetic field; thus to keep down the size and weight of the magnet required to produce the resonant field a reduced height waveguide is employed to minimise the air gap in the magnetic circuit.

Matching of the ferrite loaded waveguide section to standard British waveguide 22 at each end is by means of integral matching transformers. The power handling capacity of the isolator is obtained by sealing the waveguides with resonant glass windows and pressurising the unit with sulphur hexafluoride.

The isolator is fitted with a simple adjustable magnetic shunt for applications requiring maximum isolation at any wavelength within the range of the isolator.



TECHNICAL SUMMARY

Electrical

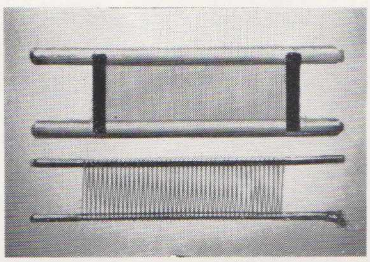
Frequency range:	34 to 35.5 Gc/s
Isolation:	15 dB to 20 dB
Insertion Loss:	0.6 dB to 0.8 dB
Peak power capacity:	100 kW
Mean power capacity:	40 W
Input v.s.w.r.:	1.03 to 1.18

Mechanical

Waveguide size:	22
Length between terminals:	50 mm
Weight:	560 grams

TWO NEW MULLARD FILMS

The Manufacture of Frame Grid Valves (Full colour 16 mm. sound film)



A typical frame grid (A) for receiving valves consists of 2 stout rods which are held rigidly apart by stiff cross-pieces.

(B) A conventional receiving valve grid.

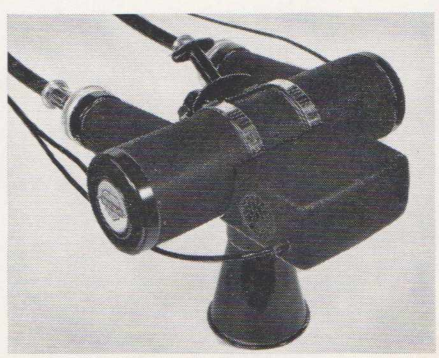
This film, which has been prepared in full colour, shows the construction and manufacture of these new high gain valves. The frame grid valve utilizes a control grid wound with Tungsten wire only 3 ten-thousandths of an inch thick and the film shows the processes necessary for the manufacture of this incredibly fine wire. Quality control methods used in the assembly and testing of the finished product are also illustrated.

Principles of X-rays (Black and white 16 mm. sound film)

Yet another contribution to the now well-known "Advanced Science Series," this film, which has a running time of just under twenty minutes, commences with a reconstruction of Roentgen's laboratory, where, in 1885, was discovered X-radiation. The film goes on to give an animated explanation of the nature of X-rays in terms of nuclear physics.

The generation of X-rays is the next subject dealt with and descriptions of both historical and modern tubes are given, together with a detailed explanation as to the manner in which they function. Before commencing the final section on applications, some care is taken to explain the difference between "soft" and "hard" X-rays. The applications described and illustrated include medical diagnoses, industrial inspection and X-ray crystallography.

Both of these films are available on loan upon application to the Mullard Film Library.



A Mullard rotating anode X-ray tube widely used for medical diagnostic purposes.

TRANSISTOR RADIOS

This article is the second of the series on transistor portable receivers and cordless radios. In this issue particular attention is given to problems associated with battery replacements.

DESIGN CRITERIA

For a specific receiver, the minimum battery voltage considered by the circuit designer is largely dependent upon the circuit configuration adopted in the audio output stage. (The various circuits will be described in future issues.) For the conventional transformer, coupled push-pull stage and the single-ended or transformerless output stage, the design criteria is that all stages of the receiver shall continue to operate normally when the supply potential has fallen to the minimum designed value — some two-thirds of its nominal value.

To a first approximation the load on the battery constituted by the receiver may be considered as a fixed resistance. Consequently, when the supply potential falls to two-thirds of its nominal value the current consumption of the receiver will also fall to two-thirds of the nominal figure. The power consumption at this "end of life" point is therefore $(2/3rd)^2$, i.e., 44% of its original value. Since the AF output stage has the largest power consumption of any section of the receiver, it becomes clear that the circuit designer contends that the end user will replace the battery before the AF output power of the receiver has fallen to half its rated value and the increase in distortion with class B operation that this drop in supply potential entails.

Normally, the listener will request battery replacement before the arbitrary "end of life" point is reached because of inadequate volume, excessive distortion or both. Under extreme conditions, the local oscillator may cease to function over the entire tuning range, and obscure faults may appear to be present.

The fall in battery potential results in a smaller increase in distortion with the 'split load' type of output stage (to be described in a future issue).

END OF LIFE

The variation of terminal voltage with life, of the type of cell normally used in radio receivers, exhibits, after the initial "jump," a gentle decline for most of the working life, falling rapidly at the end of life. It is wise, therefore, to discard and replace any battery delivering as low as three-quarters of its nominal value on load, as in a comparatively short time it will have reached the end of life point manifesting in the receiver the effects previously discussed.

In contrast, the mercury cell maintains closely its rated terminal voltage throughout life; however, the higher cost factor does not normally permit its use in transistorised receivers.

MEASUREMENT UNDER LOAD

Battery voltage measurements must always be carried out under load conditions, i.e., with the receiver tuned in to a local station and with the volume turned up to a reasonably high level for the type of receiver concerned. Of course, where battery replacement fails to ensure satisfactory operation, normal fault-finding technique (to be described in later issues) must be applied.

POLARITY OF SUPPLY

Where energisers are used the connections are made with flying leads having non-reversible contacts. With single cell supplies, the spring contacts are usually arranged so that contact will not be made unless the cell is correctly inserted.

Although reversing the polarity of the power supply may not destroy transistors of the alloy junction type, it could well result in a deterioration of performance.

E88CC STRUCTURAL ALTERATIONS

The E88CC special quality high slope double triode was originally introduced mainly for two applications: RF cascode circuits, and pulse applications in computers and similar circuits. Its characteristics have made it an attractive choice for many other applications including low level video amplifiers. In these circuits the main limitation to the signal level which could be handled by the valve was its microphony performance since these amplifiers are more sensitive to microphony than RF or pulse amplifiers.

Minor constructional modifications to the valve to improve its microphony performance have been successfully developed and these changes are now being incorporated into production. All valves delivered will have the new construction, and a significant improvement in microphony performance in sensitive circuits may be expected.

VIEWPOINT WITH MULLARD

Continued from Page 15

The comprehensive range of Mullard Ferroxcube included square hysterisis loop cores, completely assembled matrix planes and stacks for use as magnetic stores in computers, together with rods, tubes, rings, E, I and U cores and *Vinkor* adjustable pot cores. Shown for the first time was the new 'red range' of *Vinkors* which extends the max. frequency to 3Mc/s. Devices for ultra-high vacuum techniques included ionisation gauges suitable for measurements down to 10^{-10}mm of mercury for use as ion pumps at 5×10^{-11}mm and a Penning pump, based on the Penning gauge principle in which electrons are made to oscillate between two plain cold cathodes equidistant from a central cylindrical anode. Pumping speeds of 5 litres per second are achieved with this pump.

Considerable interest was shown in two new halogen-quenched high efficiency Geiger-Müller counter tubes especially designed for thyroid and urine radiation uptake measurements in the field of medical electronics.

Two new tubes from the range of electron optical devices were shown. Firstly, an information storage tube has been developed, capable of storing high resolution half-tone information. The second, a bi-stable storage tube with a 4″ screen, is thought to be the first 'infinite persistence' tube nearing production in the U.K.

Of particular interest to mobile equipment manufacturers were two new quick-heating double tetrodes with cathode heating times of less than one second.

A barium titanate transducer, driven by a 1Mc/s 500W ultrasonic generator, was used to produce a fountain in a tank of water, thus demonstrating the beaming effects obtained with high frequency ultrasonics. On display for the first time was a fully transistorised analogue-to-digital converter which samples an input analogue in the range of 0-10V and gives a binary output of 10 bits, available in parallel or serially. From the rapidly expanding range of communications equipment now available from Mullard, a 1kW wideband matching transformer was shown. This transformer is designed for HF transmitter applications to provide a wide band low-loss transformation between a 600 Ω balance source and a 75 Ω unbalanced load or vice versa.

During the Exhibition, the screening of technical films from the Mullard film library created considerable interest.

SIMPLE OSCILLOSCOPE MEASUREMENTS

This is the second article of "Simple Oscilloscope Measurements" which is the second of the "Simple Measurements" series being published in "Outlook" and contains suggestions for a number of experiments which can be carried out in the laboratory with the aid of a cathode ray oscilloscope and auxiliary equipment.

Four controls are associated with the time-base generator; these are an X shift control which can deflect the spot horizontally across the screen of the tube, an X amplitude control which, in the simple oscilloscope mentioned in the first article in this series (Vol. 4, No. 1), is simply a potentiometer which attenuates the signal to the X deflection plates, a frequency control which varies the frequency of the saw-tooth waveform and, finally, a simple switch which selects either the time-base waveform or an external signal for application to the X input terminals.

The synchronisation amplifier is a conventional amplifier circuit situated between the time-base generator and the vertical amplifier. Its function is to ensure that the time-base sweep and the input signal to the Y deflection plates commence at the same instant of time. Varying the synchronisation control thus results in a trace being 'locked' (i.e., held still) on the screen.

It has been stated before that all these units derive their power from the same source and, therefore, little need be written concerning the power supply unit except to state that it provides a high tension supply for the valves, an extra high tension supply for the final anode of the cathode ray tube and sufficient low tension current to operate the heaters of the valves and tube. The only components of the power unit normally found on the control panel of the oscilloscope are the fuses and "mains on/off" switch.

SIGNAL GENERATOR

One particularly useful item of auxiliary apparatus is the signal generator and many of the experiments detailed in subsequent sections involve the use of such an instrument.

A signal generator produces an alternating current over the audio frequency range and may also be capable of producing square, pulsed and saw-tooth waveforms.

The pulsed wave which is, in effect, a half-wave rectified square wave, is of use in experiments where the action of a simple switch connected to a source of direct current is to be simulated. For instance, in the experiment investigating the charge and discharge curve of a capacitor, it is necessary to apply a voltage which rises quickly from zero to a positive maximum and then decays immediately. This may be simulated by a signal generator producing a pulsed square wave.

NEW PHOTOCELL FOR INFRA-RED APPLICATIONS

Mullard have developed a new photoconductive cell, the ORP13, which has a higher detectivity than any other photocell with infra-red applications yet commercially available in the world. It is intended for applications involving infra-red spectroscopy and research into the properties of materials.

The cell, which has a sensitive area of approximately 3 sq. mm. of indium antimonide, is attached to its own Dewar flask and is cooled by liquid nitrogen to a temperature of 77°K. (—196°C.). This cooling system enables superior noise figures to be obtained and its efficiency is such that the cell can be used for 45 minutes without refilling the flask.

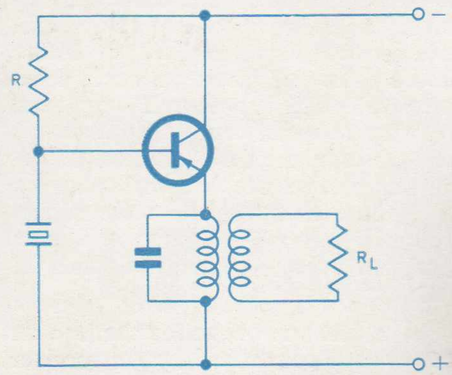
The spectral range of the ORP13 is from visible light to about 5.4μm, the peak occuring at between 4.5 and 5μm. Its sensitivity to monochromatic radiation is 15mV/μW of incident radiation.

The Noise Equivalent Power (N.E.P.) per unit bandwidth (1c/s) which is a measure of the smallest radiation power conveniently detectable by the cell, is better than 1.3 x 10^{-11}. This figure gives an area-normalized detectivity (D*) of better than 1.3 x 10^{10}cm W^{-1}.

D, unlike N.E.P., is independent of sensitive area since it is the square root of the sensitive area divided by N.E.P. It is a figure of merit for photocells used for detecting low level radiation and represents a basis for the comparison of photocells of different sensitive areas and different materials. The figure obtained for the ORP13 is 1.3 x 10^{10} cm W^{-1} which is higher than any other cell yet commercially available covering the range up to 5μm.*

AMATEUR EXPERIMENTERS COLUMN

NEGATIVE RESISTANCE CRYSTAL OSCILLATOR



The negative resistance fundamental frequency crystal oscillator operates by means of the effective negative input resistance of an emitter follower type transistor amplifying stage when the load circuit is largely capacitive.

In practice, a coupled resonant circuit in the emitter is proportioned to reflect an emitter load consistent with the desired swing of collector-emitter voltage, collector current and, hence, desired output power level.

When tuned to the high frequency side of the crystal frequency the resultant reflected negative input resistance makes possible self-oscillation at the crystal frequency. The forward biasing resistor R ensures that the forward current gain β of the transistor is adequate to initiate oscillation when the supply voltage is connected.

CIRCULATION

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