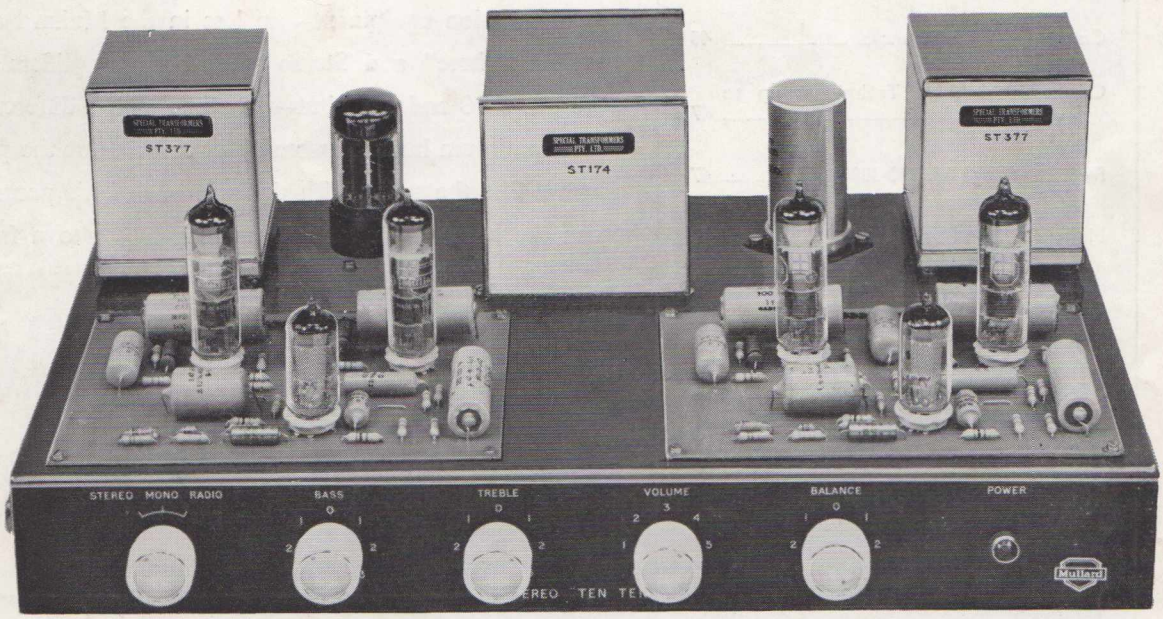
Mullard Outlook

AUSTRALIAN EDITION



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VOL. 5 — No. 4 JULY-AUGUST, 1962

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JOERN BORK

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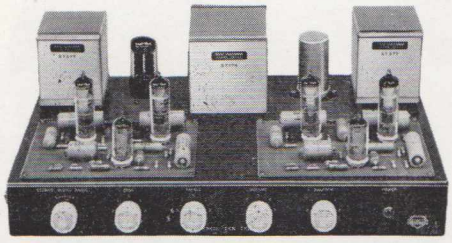

MULLARD STEREO "TEN-TEN"

High quality reproduction is achieved in this Amplifier with a complement of two 6GW8/ECL86 valves and one low-noise AF pentode type EF86 in each channel, with a 5AR4/GZ34 rectifier common to both channels. The power output is 10W per channel.

MULLARD-AUSTRALIA PTY. LTD.

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Associated with
MULLARD LTD., LONDON

Goonhilly . . . .

The name conjures a mixture of Spike Milligan and a shillelagh and as our Parent Journal, Mullard Outlook U.K., puts it—"a radio station near Lizard Point!"

Telstar has captured the imagination of all, indeed the name Telstar will live; and just as lively is the "heart" that responds to the feeble signals from it—the Maser—the key unit of the Goonhilly Station, designed by scientists of the Mullard Research Laboratories.

Do-it-yourself . . . .

Much high grade effort is expended in developing better sound reproduction equipment—no less in the Mullard camp where the Stereo "Three-Three" and Stereo "Ten-Ten" amplifiers are worthy successors to the 5-10 and 5-20 but—this time with a difference—on printed boards for minimum human assembly errors and for the professional, who somewhat like the tailor with the seat out of his pants, can return to favour on the home front and show his prowess to a family perhaps doubting that he still has the touch.

M.A.B.

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VIEWPOINT WITH MULLARD

Mullard Maser Provides Vital Link in World Satellite Communications

Millions of television viewers in the United States of America and Europe recently saw the first pictures from outer space. The pictures were relayed across the Atlantic via "Telstar" the world's first communication satellite. A travelling wave Maser amplifier, operating at 4170 Mc/s built by scientists at the Mullard Research Laboratories and installed at the G.P.O. Satellite Communication Ground Station at Goonhilly Downs, Cornwall, England, was used in the first stage of the receiver to amplify signals received via "Telstar".

The maser for the G.P.O. satellite station in its test rig at the Mullard Research Laboratories. Mr. F. W. Smith (right) is controlling the transfer of liquid helium into the Dewar flask housing.

The electronic instruments of the first experimental satellite, "Telstar", contain altogether 15,000 components, of which 1064 are transistors and 1464 are diodes. "Telstar" is meant to have an active life of approximately two years, although the ultimate aim is to achieve a useful life-span of five to ten years.

To meet the specified delivery date this Maser—a unique British achievement—was designed, constructed and tested in only six months. The realisation of this project has been made possible only by the extensive experience and facilities of the Mullard Research Laboratories in microwave research and quantum electronics at temperatures approaching absolute zero.

Because of its ability to amplify without introducing appreciable noise, the Maser enables the power of the satellite transmitter —and consequently the payload requirements of the launching rocket—to be reduced so that this form of communication becomes practicable.

Dr. J. C. Walling and Mr. F. W. Smith, leaders of the team responsible for the project, have confirmed that the Maser's performance is in some respects considerably better than the G.P.O. specification. Dr. Walling said, "Our laboratory tests have shown that the figures of 20dB power gain over a bandwidth of 25 Mc/s, stipulated by the Post Office, have been exceeded."

The signal applied to the Maser input is in the order of 10^{-12}W. Conventional, thermionic devices, if used to try to amplify a signal of this small magnitude, would produce an unacceptably high noise level. However, the Maser behaves as a virtually noiseless amplifier, since it operates at a very low temperature (in the present case, about 2°K, i.e. —271°C) and, moreover, does not depend for its operation on an electron beam. To maintain it at the required temperature, the device is immersed in liquid helium.

A magnetic field is essential for the operation of all practical Masers*. Early models have used large electro-magnets but the replacement of these by small superconducting magnets in the helium bath is extremely attractive. Development of a suitable superconducting magnet is proceeding at Mullard Research Laboratories and very promising initial results have been obtained. Owing to the short time available to develop the device, the first version of the Goonhilly Maser is equipped with an external permanent magnet.

The Maser is housed in a cabin mounted directly behind the 85 feet aerial dish; as the dish moves through an elevation angle of 90°, the Maser has been designed to operate satisfactorily when tilted through 45° either side of the vertical.

**The operating principle of an S-Band Solid State Cavity Maser has been described in Outlook, Vol. 4, No. 2.—Ed.*

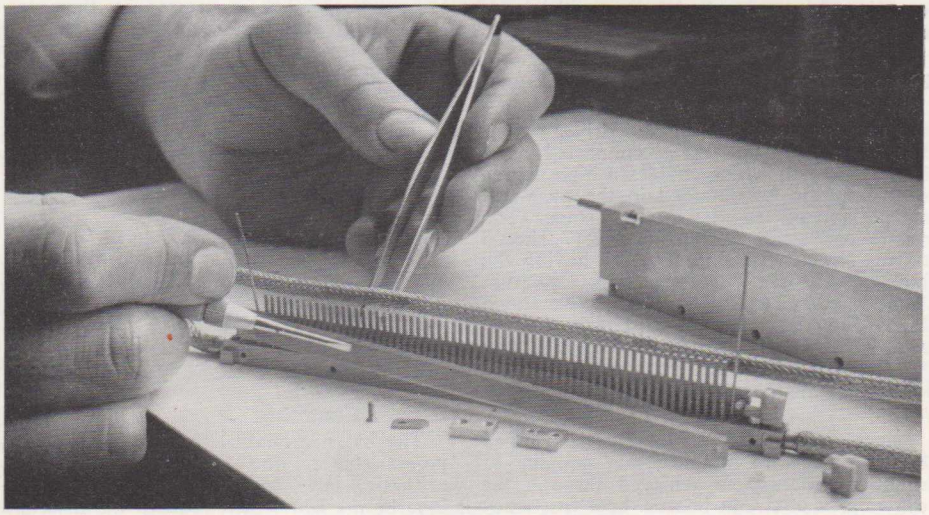
MULLARD-AUSTRALIA PERSONALITIES

Mr. W. J. Weller

From his training with the South Australian Railways and his years in the motion picture industry and in broadcast and television stations, it is only logical that John's present interest remains in this field, in offering with his engineering sales appointment a fund of practical user experience. You are, therefore, likely to see his happy countenance anywhere in Australia.

A hobbyist with a sporting background, he says he misses Australian Rules football in N.S.W., but makes up for it with tennis, motor sports and many hours in his workshop.

John is married and has two daughters.



The comb structure of the travelling wave maser amplifier for the G.P.O. satellite station is seen in this picture.

MULLARD STEREO "TEN-TEN"

WITH PRINTED CIRCUIT BOARDS

High quality reproduction is achieved in this amplifier with a complement of two 6GW8/ECL86 valves and one low-noise AF pentode type EF86 in each channel, with a 5AR4/GZ34 rectifier common to both channels. The power output is 10W per channel and the performance is comparable to that of the Mullard High Quality 10W Amplifier[1] (the well-known Mullard "Five-Ten").

A high degree of stability and freedom from stray capacitive coupling results from the use of printed circuit boards. Home constructors are recommended to utilise this method of assembly since the high voltage gain of the 6GW8 requires good wiring and component placement. Passive tone control circuits provide more than adequate tone control characteristics (+12 to —12 dB at 30 c/s and +10 to —16 dB at 15 kc/s) and the sensitivity of the amplifier is sufficient for use with crystal or ceramic pick-up heads. Where a magnetic pick-up head is used, a stereophonic pre-amplifier is necessary.

Circuit Description

The design of the circuit shown in Fig. 1 is similar in principle to that of the well-known Mullard "Five-Ten" High Quality Amplifier. Since both channels are identical, only one channel and the common power supply are shown. The complete amplifier uses two EF86 low-noise AF pentodes, four 6GW8 triode pentodes and one 5AR4 rectifier valve.

Input Selector Switch

The input stages of both channels are connected to the 3-way input selector switch SA which provides facilities for stereophonic reproduction from a crystal or ceramic pick-up head and dual-channel monophonic reproduction from a monophonic pick-up head or a wide range tuner.

Input Stage

The input stage utilises an EF86 which provides high voltage amplification, the stage gain being approximately 120 times. A high stability, cracked carbon resistor is used as anode-load and gives an appreciable improvement in the measured level of background noise when compared with an ordinary carbon resistor. Capacitive coupling is employed between this stage and the phase-splitter.

Phase Splitter

The triode sections of the 6GW8 valves are used as phase-splitter and driver amplifier. The phase-splitter is connected as a long-tailed pair which enables a high degree of balance to be obtained in the push-pull signal applied to the output stage. The anode-load resistors R15 and R17 should be matched to within 5%, R17 having the higher value for best operation. Optimum balance is achieved when the effective anode loads differ by 3%. The grid resistors R20 and R21 of the output stage should also be close tolerance components as they are in shunt with the anode-loads of the driver stage.

Since HF balance is largely determined by wiring layout, the necessary equality of shunt-capacitances is achieved through the use of printed circuit boards. Low frequency balance is controlled by the time-constant, formed by C9 and R13 in the grid circuits of the triode sections and the time-constant shown in Fig. 1 will give adequate balance down to very low frequencies.

The high amplification factor of the triode section of the 6GW8 (100) provides an effective gain of the order of 25 times which overcomes the disadvantages of the cathode-coupled phase-splitter in that the effective voltage gain is about one-half that attainable with one section used as a voltage amplifier.

Output Stage

The push-pull output stage uses the pentode sections of the two 6GW8 valves, operating under Class AB conditions with distributed loading (20% primary turn taps). With an anode-to-anode load of 9kΩ and an anode-to-cathode voltage of 300V, the distortion level with feedback is less than 0.2% (a typical value being 0.15%) for an output of 10W.

The output transformer should be of the construction normally used in high-quality amplifiers. In particular, it should be free from any pronounced resonance up to about 50 kc/s. The turns ratio should be such that the anode-to-anode load is 9kΩ. The transformers used in the prototype have the following specifications:—

Total primary inductance	100 H
Primary resistance per half	265 Ω
Leakage inductance (whole primary with secondary short-circuited)	21 mH
Secondary resistance at 15Ω terminals	0.9 Ω

Negative Feedback

Overall negative feedback of approximately 20 dB is applied from the secondary winding of the output transformer to the cathode circuit of the input stage. Low frequency stability is ensured by the inter-stage coupling time-constants which are considerably greater than the transformer time-constant. A 'phase advance' network in the feedback path gives adequate high-frequency stability. The amplifier design is such that more than 17 dB of the negative feedback is effective over a frequency range of 30 c/s to 30 kc/s.

Tone-Control Circuits

Passive tone-control circuits providing bass-boost and cut and treble-boost and cut are provided. The input impedance of the tone control circuit is approximately 500kΩ.

Balance Control

The balance control consists of a tandem potentiometer, one track obeying a logarithmic law and the other an anti-logarithmic law which reduces the insertion loss to a maximum of 1 dB.

Power Supply

The power supply requirements for both channels of the amplifier are:—

Heaters		6.3V at 3.2A
High Tension—		
320V	No signal	138 mA
315V	10W sine wave per channel	160 mA

Accessory Sockets

Separate accessory sockets are provided on the rear of the chassis to enable power to be supplied to a radio tuner and stereo pre-amplifier. The accessory socket circuits shown in Fig. 1 include component values for a stereo pre-amplifier, having an HT current consumption of approximately 6mA at 230V; and for a radio tuner having an HT current consumption of approximately 18mA at 125V. The sockets are wired in such a way as to prevent interchangeability of connecting leads. The power supply has adequate reserve to accommodate the additional heater and HT-drain of typical units.

Performance

Sensitivity

The sensitivity of the amplifier is 2.6mV without feedback, 26mV with feedback and including tone controls, for an output power of 10W, is 250mV.

Frequency Response

The frequency response of the basic amplifier (without tone controls) is shown in Fig. 2. At an output level of 50mW, the response is flat to within 3 dB from 3 c/s to 60 kc/s. As also shown in Fig. 2, the 3 dB points for the power response (for 10W output) are positioned at 25 c/s and 45 kc/s respectively.

Harmonic Distortion

In Fig. 3, the total harmonic distortion, measured with an input signal at 1 kc/s, is plotted against output power. The total harmonic distortion at an output power of 10W is less than 0.1%, a typical value being 0.05%.

Output Impedance

The output impedance of the amplifier measured at the 15Ω terminals is 1.4Ω for an output of 1W at 1 kc/s. This results in a damping factor of 10.7.

Tone Control Characteristics

The response characteristics of the tone-control circuits are shown in Fig. 4. The ranges of control with respect to the response level at 1 kc/s are approximately:—

Bass:	+12 dB to —12 dB at 30 c/s
Treble:	+10 dB to —16 dB at 15 kc/s

Hum and Noise

The level of hum and noise in the prototype amplifier, measured with a short-circuited input, is typically 70 dB below 10W.

[1] Mullard "Circuits for Audio Amplifiers" is obtainable from Mullard-Australia Pty. Ltd., branches, distributors and wholesalers in all States, priced at 12/6d. plus 1/5d. postage.

Construction of 10W Amplifier Chassis

The chassis outlines and dimensions are shown in Fig. 5. The chassis includes tone, volume and balance controls and thus forms a self-contained amplifier. When used with a separate pre-amplifier, these controls may be omitted and the grid of the EF86 connected directly to the input socket. A 2.2 MΩ grid leak (HS ½W) resistor should be connected from the grid to the earth bus-bar thus allowing the amplifier to be used in conjunction with a stereophonic pre-amplifier and a magnetic pick-up head. The chassis is made from separate pieces of 16 B.G. metal sheet and the dimensions of these pieces are as follows:—

(a) Main Chassis $21\frac{1}{4}'' \times 14\frac{1}{2}''$;
(b) Screen $22\frac{1}{4}'' \times 2\frac{1}{2}''$;
(c) Cover Plate $18'' \times 11''$.

Each piece should be marked as shown in Fig. 6 and the holes should be cut as indicated. The metal pieces should be bent up at 90° at the dotted lines.

Printed Circuit Board

A printed or etched circuit (correctly termed 'printed wiring board') is a board 1/16th" thick made of an insulating phenolic material with a pattern of lines and dots of copper foil bonded to one side of the board.

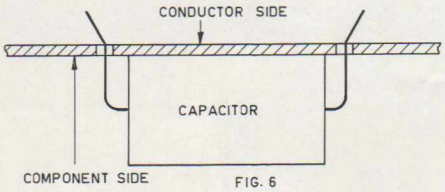


FIG. 6

Fig. 6 shows a side-view of a printed circuit with a capacitor inserted for soldering. The component pigtails are pushed through the board, bent over to hold the component in place, cut to length and soldered.

In another side view of the board, shown in Fig. 7, one of the flat faces of the soldering-iron tip is held against the copper foil at the same time touching the component wire, whilst the flux-cored solder is fed against the wire so that it melts when the wire becomes sufficiently hot. It will then flow down over the wire onto the copper conductor of the printed circuit board. The iron must be held in place until the solder forms a globule completely covering the copper area around the pigtail. Most of the heat transmitted to the copper of the printed circuit board is thus carried by the solder.

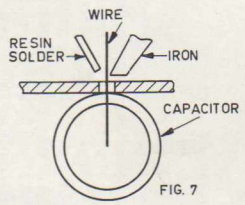


FIG. 7

To ensure proper connection of soldered points on the printed circuit board, the point where the wire emerges from the solder should be inspected (see Fig. 8). If the wire has not been sufficiently heated the solder will appear as in Fig. 8B. The connection should then be re-heated until the results shown in Fig. 8A are obtained.

There are only two further points requiring special attention in printed circuit soldering. Firstly, care must be taken not to use so much solder that it over-flows the connection point, thus forming a short-circuit to adjacent conductors. Secondly, as a great deal of excessive heat will destroy the adhesive, bonding the copper to the insulating material, causing the foil to "lift", it is essential not to continue heating any part of the copper longer than necessary. In this respect, flux-cored solder, containing 60% tin and 40% lead is ideal for printed circuit board wiring because of its low melting temperature.

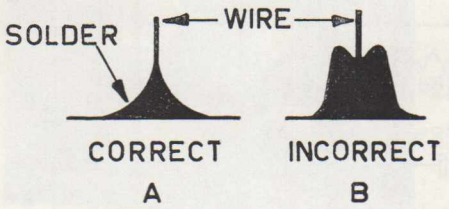


FIG. 8

DC Conditions in Each Channel of 10W Amplifier

Point of Measurement	Voltage (V)	Range of DC Avometer*
C17		
(common to both channels)	320	1000
C14	270	1000
C5	180	250
6GW8		
Pentode anode	315	1000
Pentode screen grid	317	1000
Pentode cathode	10	25
Triode anode	250	1000
Triode cathode	60	1000
Triode grid	55	1000
EF86		
Anode	110	1000
Screen grid	80	1000
Cathode	1.75	10

*Resistance of Avometer:
1000V-range, resistance = 20 MΩ
25V-range, resistance = 500 kΩ

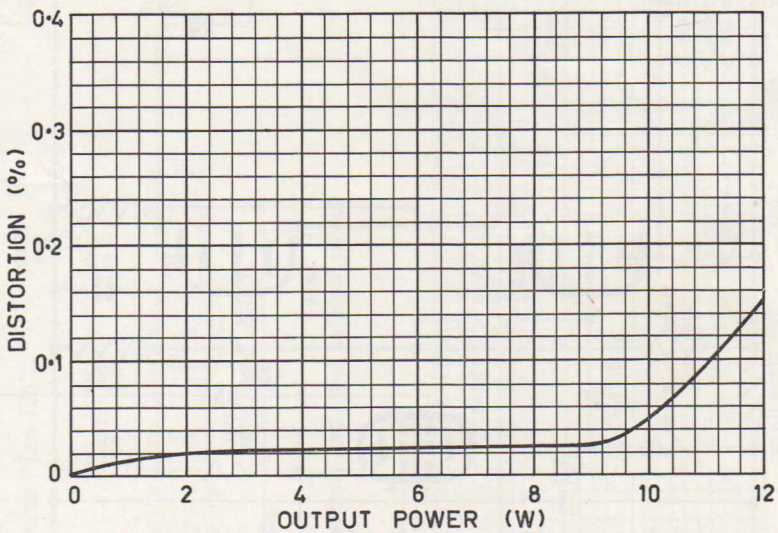


Fig. 3. Total harmonic distortion plotted against output power for Stereo "Ten-Ten".

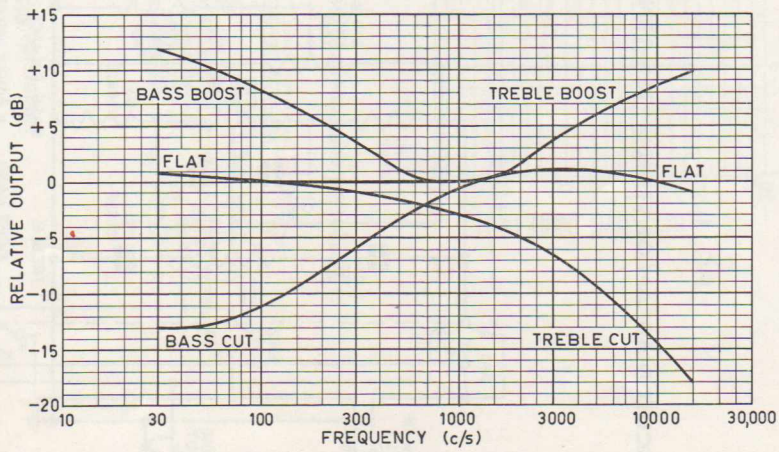
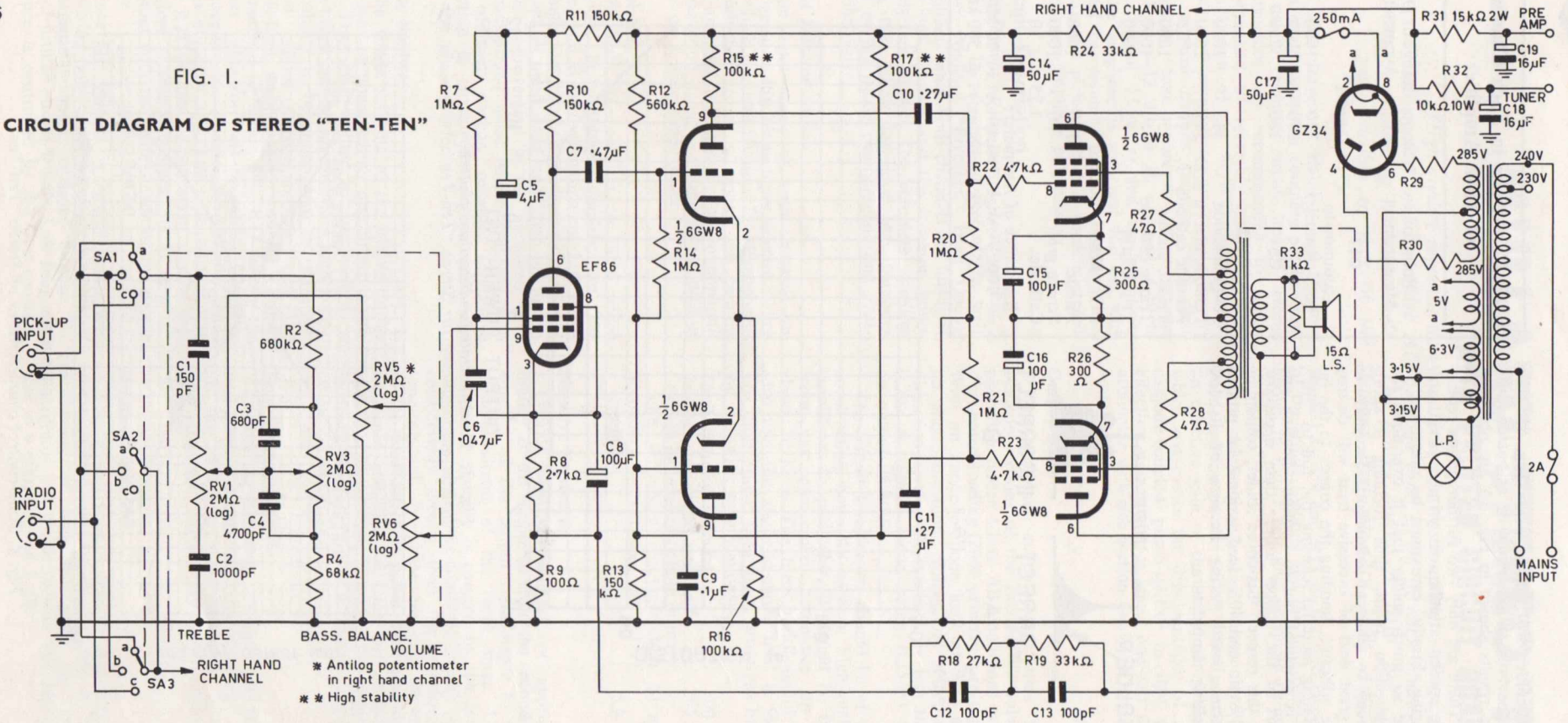


Fig. 4. Tone-control characteristics of Stereo "Ten-Ten".

FIG. 1.

CIRCUIT DIAGRAM OF STEREO "TEN-TEN"



Capacitors

Resistors and capacitors in the left-hand channel are numbered 1, 2, 3, etc. Corresponding components in the right-hand channel are numbered 101, 102, 103, etc.

Circuit ref.		*Value*	*Tolerance* (±%)	*Description*	*Rating*
C1	C101	150 pF	5	polystyrene	125 V
C2	C102	1000 pF	5	,,	125 V
C3	C103	680 pF	5	,,	125 V
C4	C104	4700 pF	5	,,	125 V
C5	C105	4 μF		electrolytic	450 VW
C6	C106	0.047 μF	10	polyester	400 V
C7	C107	0.47 μF	10	polyester	400 V
C8	C108	100 μF		electrolytic	4 VW
C9	C109	0.1 μF	10	polyester	400 V
C10	C110	0.27 μF	10	polyester	400 V
C11	C111	0.27 μF	10	polyester	400 V
C12	C112	100 pF	5	polystyrene	125 V
C13	C113	100 pF	5	polystyrene (adjust value for best square wave response)	
C14	C114	50 + 50 μF		dual electrolytic	350 VW
C15	C115	100 μF		electrolytic	25 VW
C16	C116	100 μF		,,	25 VW
C17		50 μF		,,	350 VW
C18		16 μF		,,	450 VW
C19		16 μF		,,	450 VW

Resistors

Circuit ref.		*Value*	*Tolerance* (±%)	*Rating* (W)
RV1		2 MΩ	ganged logarithmic potentiometer	
RV101		2 MΩ		
R2	R102	680 kΩ	5	½
RV3		2 MΩ	ganged logarithmic potentiometer	
RV103		2 MΩ		
R4	R104	68 kΩ	5	½
RV5		2 MΩ	ganged logarithmic antilogarithmic potentiometer	
RV105		2 MΩ		
RV6		2 MΩ	ganged logarithmic potentiometer	
RV106		2 MΩ		
R7	R107	1 MΩ	5	½
R8	R108	2.7 kΩ	5	½
R9	R109	100 Ω	5	½
*R10	R110	150 kΩ	5	½
R11	R111	150 kΩ	10	½
R12	R112	560 kΩ	5	½
R13	R113	150 kΩ	5	½
R14	R114	1 MΩ	10	½
*R15	R115	100 kΩ	5	½
R16	R116	100 kΩ	5	½
*R17	R117	100 kΩ	5	½
R18	R118	27 kΩ	5	½
R19	R11[illegible]	33 kΩ	5	½
R20	R[illegible]	1 MΩ	5	½
R21	R1[illegible]	1 MΩ	5	½
R22	R122	4.7 kΩ	20	½
R23	R123	4.7 kΩ	20	½
R24	R124	33 kΩ	10	½
R25	R125	300 Ω	5	1
R26	R126	300 Ω	5	1
R27	R127	47 Ω	20	½
R28	R128	47 Ω	20	½
R29		22 Ω	10	1
R30		22 Ω	10	1
R31		15 kΩ	10	2
†R32		10 kΩ	10	10
R33	R133	1 kΩ	10	½

* High stability
† Wire wound.

Printed Circuit Board—Part No. 606

R.C.S. Radio Pty. Ltd., 651 Forest Road, Bexley, N.S.W.

Chassis

Heating Systems Pty. Ltd., 97 Marriott Street, Redfern, N.S.W.

Traffolyte Panel

A. E. Russell (Engravers) Pty. Ltd., 218 Sussex Street, Sydney, N.S.W.

Miscellaneous

Switch SA1-2-3: 3-pole, 3-way wafer type
Tagstrip: 13 lugs (2)
5 lugs (2)
4 lugs (1)
Fuseholder Belling Lee min[illegible] (2)
Fuses: 2A (1), 250mA (1)
Lampholder and Bezel (1)
Indicator Lamp 6.3V, 0.3A (1)
Input socket 2-pin (Acme) (2)
Output socket 4-pin (2)
Output socket 5-pin (2)
Knobs (5)
Miscellaneous hardware, screws, grommets, etc., as required.

Mullard Valves

EF86 (two); 6GW8 (four); 5AR4.

Valveholders

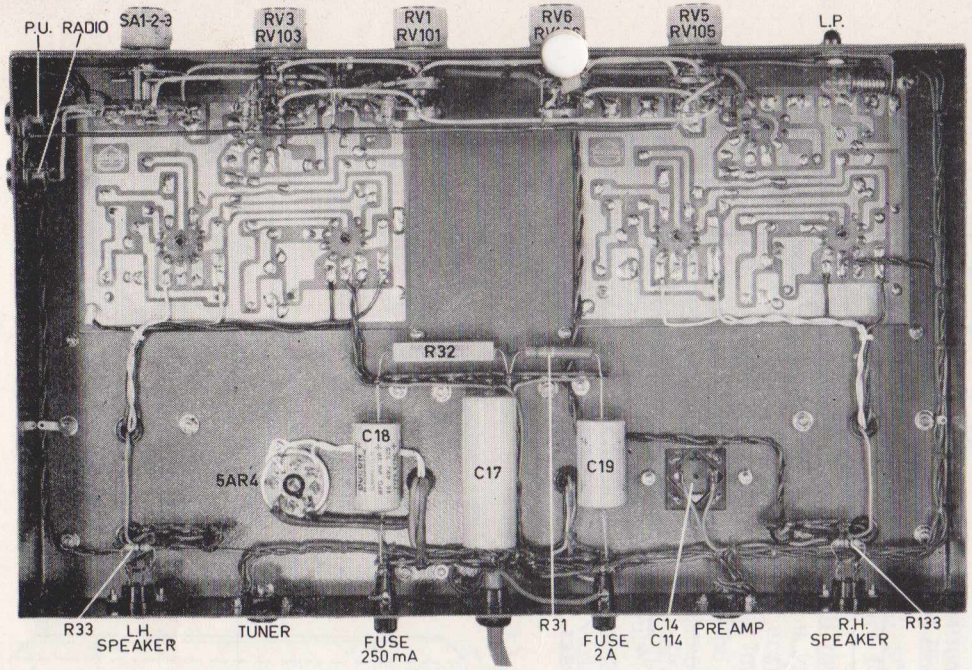
B9A (printed circuit type) preferably with screening skirt, nylon phenolic filled—(six).

Output Transformers

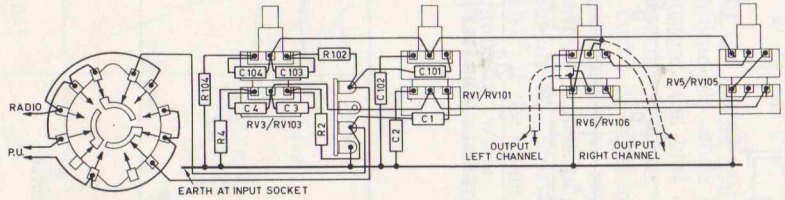
Primary impedance, 9kΩ tapped at 20% turns
Primary inductance ≥ 90H
Leakage inductance (primary to secondary) ≤ 21 mH
Primary resistance per half ≤ 265Ω
Resonant frequency ≥ 50 kc/s
Special Transformers Type No. ST377
Ferguson Type No. OP447/15
Electronic Transformers Type No. A348.

Mains Transformers

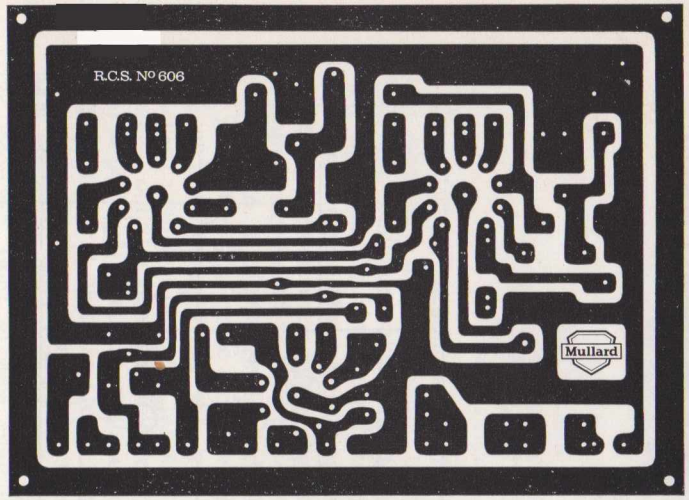
Primary: 0-230-240V
Secondary: HT 275V-0-275V-165mA;
LT 3.15-0-3.15V-3A, 6.3V-3A,
O-5V-2A
Special Transformers Type No. ST174
Ferguson Type No. PF174
Electronic Transformers Type No. P521
R29 and R30 to be inserted in each leg of the transformers rated at 285-0-285V secondary.

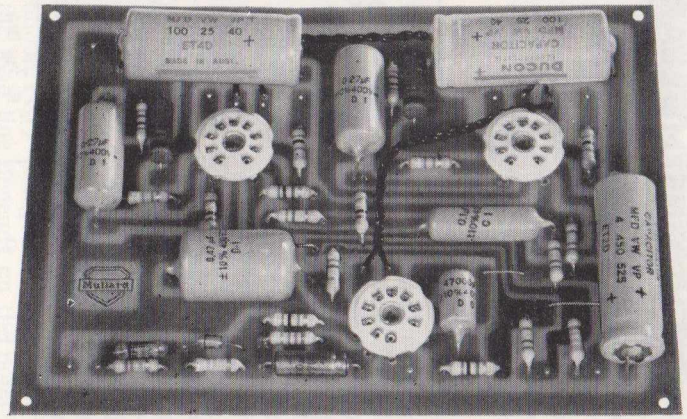


Underside view of Stereo "Ten-Ten"



Suggested component layout for controls and input selector switch





(top) underside view (bottom) showing components

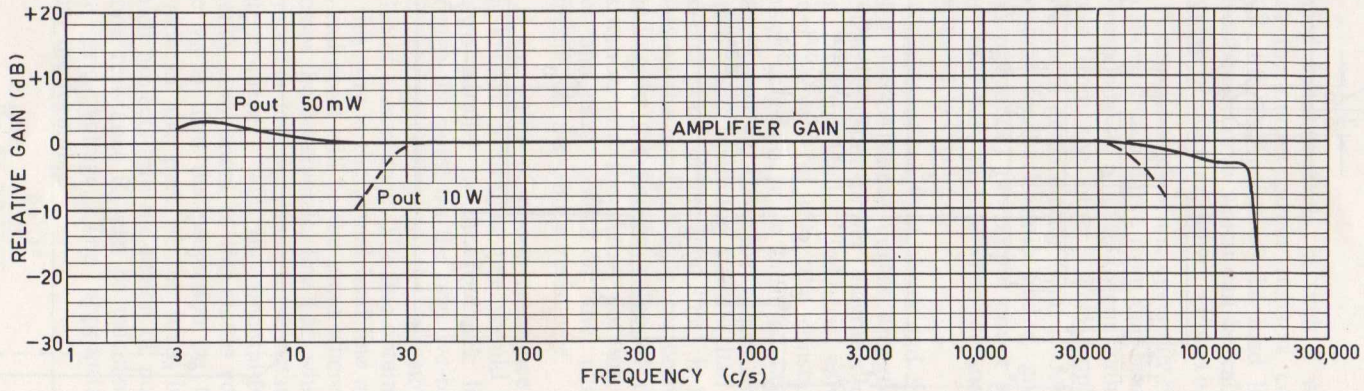
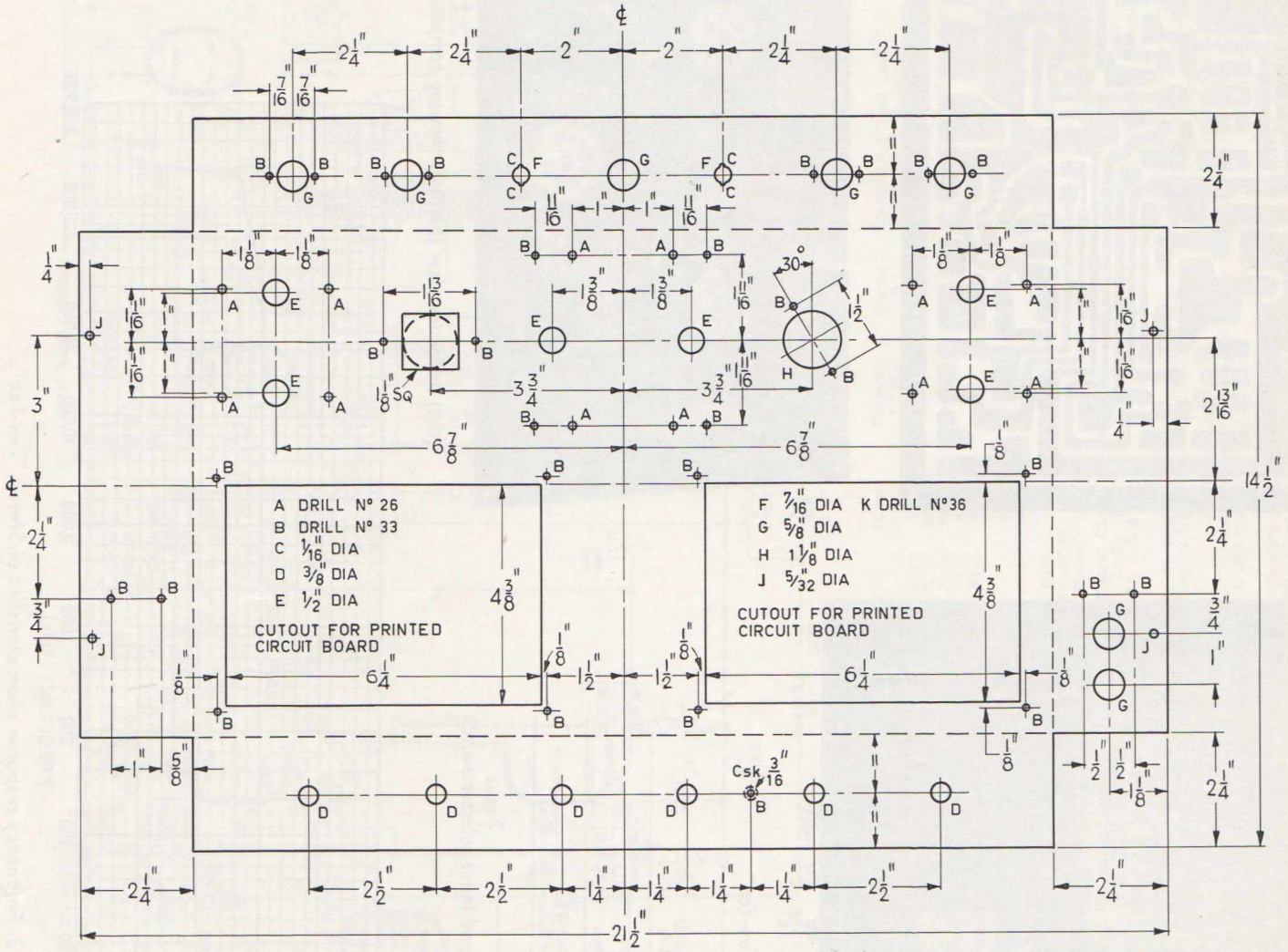
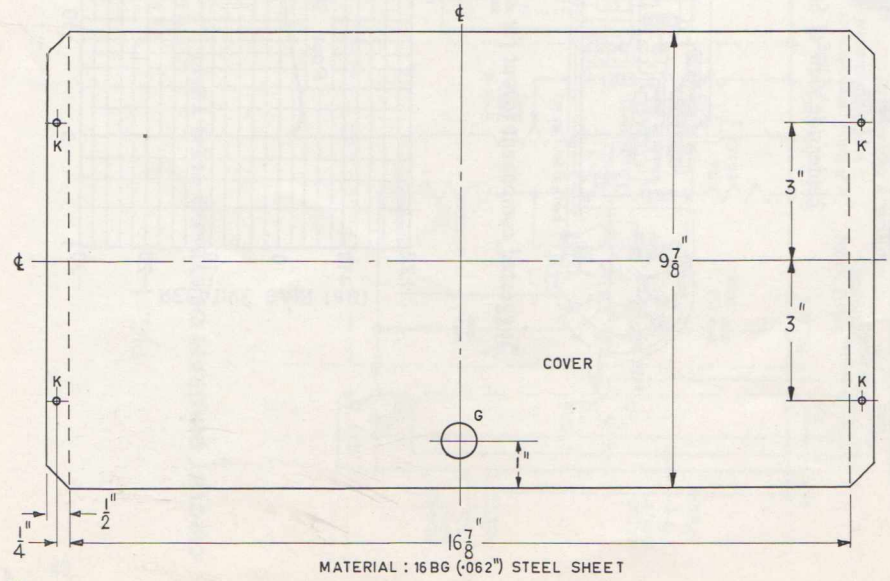


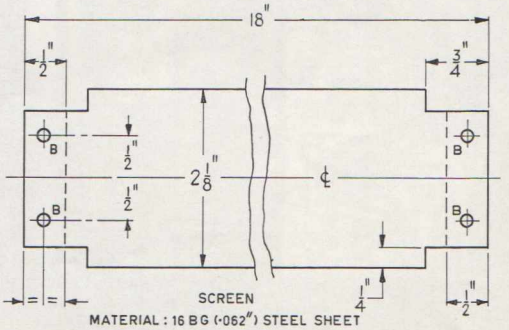
Fig. 2. Frequency response characteristics of Stereo "Ten-Ten".

CHASSIS OUTLINES AND DIMENSIONS MULLARD STEREO "TEN-TEN"

(NOT TO SCALE)







CONSTANT-POWER VALVES

FOR INDUSTRIAL APPLICATIONS

The modern tendency to present power valve data in the form of constant current curves has simplified power output stage design. For industrial heating applications, design may be even further simplified by the use of "constant power" curves.

For many RF heating applications, it is necessary that the power taken from the oscillator valve should not vary appreciably during the processing of the work piece. However, the nature of the work piece often entails changes of impedance during the heating cycle which, with a conventional triode in the generator, will cause variations in the output power from the valve, because optimum output power is obtained only for one specific value of load impedance. Thus, if constancy of output power is necessary for a particular application, compensation must be provided by, for example, changing the feedback ratio or the coupling between the tank circuit and load once or several times during the heating cycle.

The series of Mullard industrial valves (types TY5-500, TY6-800, TY8-15A, TY8-15W, TY12-20A, TY12-20W) has been designed in such a way that the output power is, to a large extent, independent of the load resistance. For variations in the load resistance between about 0.5 to 1.5 times the matched value, the output power will remain between about 0.85 and 1.15 times the average value. Thus, with these types of valves, the compensating provisions indicated above will often be unnecessary.

The "constant power" properties of these valves can be illustrated with reference to Fig. 1. (The curves of this figure both relate to the air-cooled and water-cooled types TY8-15A and TY8-15W. To prevent confusion, constant-current curves are not included.) In Fig. 1a, a load line for an oscillator triode is drawn for a specific value of anode resistance. The slope (tan α) of this load line is determined by the feedback ratio K, which is defined as the ratio v_{g1}/v_{a1} of the corresponding values of the fundamental-frequency components of the grid (v_{g1}) and anode (v_{a1}) voltages. The position of the load line depends on the point on the negative-bias axis corresponding to the value of the bias voltage. The load line extends into the region of positive grid voltage and the value of bias can be taken as the product of the average grid current and the bias resistance R_g.

If the value of the anode resistance R_a is varied continuously while K and R_g are kept constant, the end of the load line will describe a curve, which can be called a curve of constant bias resistance. If this process is repeated for different constant values of R_g, a family of constant-R_g curves is obtained (Fig. 1b). If the value of R_a is varied continuously while R_g is varied simultaneously in such a way that the output power remains constant, the end point of the load line describes a curve which can be called a curve of constant power (Fig. 1b).

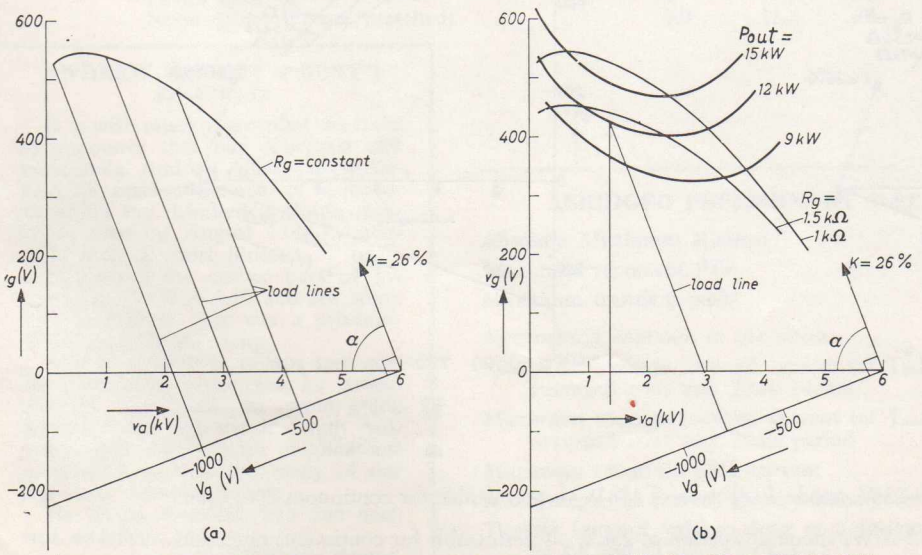


FIG. 1. ILLUSTRATION OF CONSTANT-POWER PROPERTIES

A comparison* of the curves in Fig. 1b shows that a curve from one family corresponds to a large extent with a curve from the other. This implies that, for a given circuit (that is, for a constant feedback ratio and a given bias resistance) the output power will vary only very slightly when the anode resistance is changed.

Families of constant power and constant bias-resistance curves are given in the "constant-power diagrams" of Fig. 2 for the Mullard industrial valves listed above. In using the constant-power diagrams, care must be taken that K and R_g have the values indicated. The operating point (that is, the end point of the load line) is the point on the constant-R_g curve corresponding to the chosen value of this resistance, and the actual position of the operating point on the curve depends on the anode resistance.

If the value of anode resistance is not known, a straight line should be drawn parallel to the feedback line through the point on the negative-bias axis corresponding to the measured value of bias voltage. The line obtained in this way is the actual load line and its end point will be the point where it crosses the constant-R_g line (or, which is more or less the same, the constant-output curve). The fundamental-frequency component of the anode voltage v_{a1} is then the projection on the v_a-axis of the part of the load line which projects into the region of posi- anode resistance R_a can be calculated tive grid voltage. The appropriate from the formula:

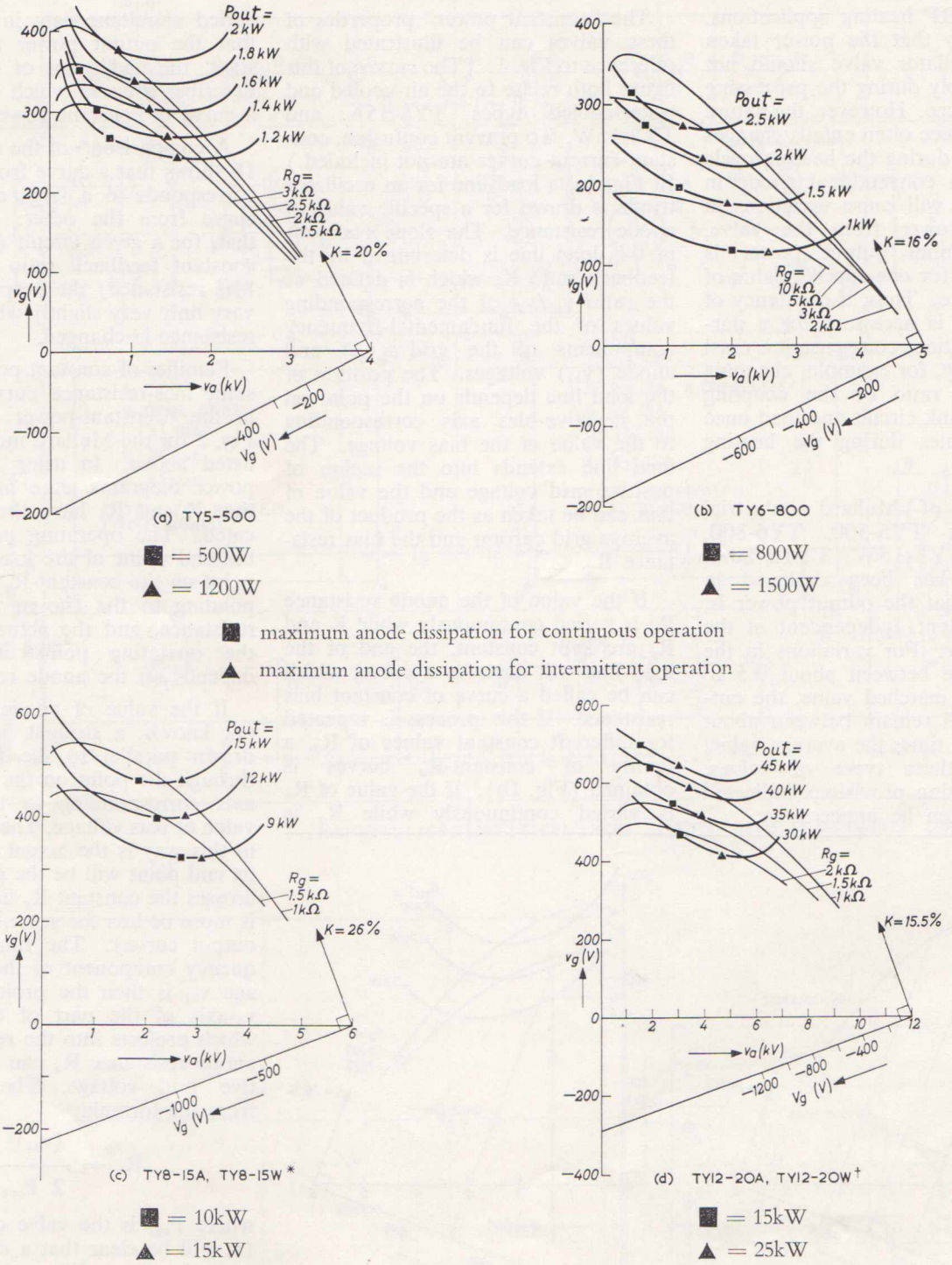
$$R_a = \frac{(v_{a1})^2}{2\ P_{out}},$$

where P_{out} is the valve output power. (It will be clear that a different value of R_g implies a different value of R_a.)

The anode dissipation p_a for a given load line can be estimated by comparing the position of the end point of

the load line with the points indicating anode-dissipation limits in the constant-power diagrams. To prevent excessive dissipation, the load line should not lie to the right of the point indicating the appropriate limiting value. The total anode input power P_{in} can be found by adding the estimated anode dissipation to the anode output power P_{out}. The direct anode current I_a is obtained by dividing the anode input power P_{in} by the direct anode voltage V_a. The direct grid current I_g is obtained from the ratio of the values of bias voltage V_g and bias resistor R_g.

If this procedure is adopted for different values of negative grid bias, values of all the important quantities can be obtained as functions of the anode resistance.



* for water-cooled version, TY8-15W, anode dissipation of 15kW, is permissible for continuous operation

† for water-cooled version, TY12-20W, anode dissipation of 25kW, is permissible for continuous operation

FIG. 2. CONSTANT-POWER DIAGRAMS

CONVENTIONAL VALVE TECHNIQUES UP TO 1000 Mc/s

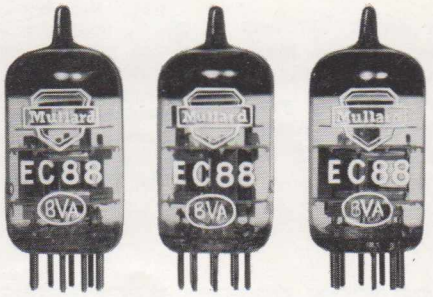
Until recently only disc seal valves were considered suitable for operation at ultra-high frequencies. Now, by special application of conventional valve techniques, a grounded-grid triode has been produced which is able to provide comparable performance at greatly reduced cost.

Performance Requirements

The main performance requirements of a valve of this class are adequate power gain with a good margin of stability and a low noise factor. These are achieved in the EC88 by a design which provides a high mutual conductance, low capacitances, low electron transmit times and low grid lead inductance.

Wide Application

The EC88 has proven performance in 300 to 1000 Mc/s front-end applications, where only two stages provide adequate RF selectivity without the need for complicated filter networks and full automatic gain control without excessive variation of aerial matching.



EC88 grounded-grid triode for operation up to 1000 Mc/s.

Although primarily intended for use at frequencies up to 1000 Mc/s, stable operation with some reduction in performance is possible up to 1400 Mc/s where a gain of 8dB has been obtained in practical circuits.

ABRIDGED PRELIMINARY DATA

Heater

V_h	6.3	V
I_h	165	mA

Characteristics

V_a	160	V
I_a	12.5	mA
V_g	−1.25	V
g_m	13.5	mA/V
r_a	4.8	kΩ
μ	65	
R_{eq}	240	Ω

Operation Conditions as Amplifier ($\frac{\lambda}{4}$ *trough line*)

f	600	1000	M/cs
V_b	200	200	V
R_a	3.3	3.3	kΩ
R_k	100	100	Ω
I_a	12.5	12.5	mA
g_m	13.5	13.5	mA/V
B	12	12	Mc/s
Power gain	18	17.5	dB
Noise factor (power matched)	9.0	12.5	dB

ANDREW ALBERT ("BERT") SINFIELD

It is with much regret that we have to announce that our colleague and team mate, Andrew Albert (Bert) Sinfield, 48, resident member of Mullard-Australia Pty. Limited in South Australia, died on August 13th in Adelaide after a short illness.

Bert spent the earlier part of his career in the R.A.A.F. and for some time during the war was a prisoner-of-war in Changi camp.

Always willing to oblige and with the electronics experience he gained through the years, he won many friends in the Industry in South Australia. Bert was a keen amateur experimenter, as also are many of our engineers and technicians.

He leaves a widow, son and married daughter.

Maurice Brown.

RECTIFIER RANGE 6A 200-800V

The Mullard range of silicon rectifiers has been expanded to include four types of double-diffused diode rectifiers for use in the medium current range. These are the BYZ13, BYZ12, BYZ11 and BYZ10, which cover the range of peak inverse ratings from 200V to 800V respectively and are capable of delivering maximum recurrent peak currents of 20A.

Recommended Applications

These rectifiers are recommended for high voltage medium current applications and are particularly suitable for intermediate power applications, featuring high PIV ratings and low forward voltage.

The forward voltage drop at 5A is 1.4V and the maximum junction temperature is 150°C with maximum recurrent PIV of 200V (BYZ13), 400V (BYZ12), 600V (BYZ11) and 800V (BYZ10). These four types are encapsulated in a stud-mounting hermetically sealed, all metal envelope with overall body dimensions of 31mm long and 7.3mm diameter.

Large Scale Production

They are in large scale production to ensure immediate availability at an economical price.

Reversed Polarity versions of these devices are not yet available but are expected in the near future; details of their availability will be released as soon as possible.

Brief data on these Mullard Intermediate Power Rectifiers are given below.

One of the double-diffused rectifiers in the new Mullard Silicon Power Rectifier range.

ABRIDGED PRELIMINARY DATA FOR THE BYZ10 TO BYZ13

Absolute Maximum Ratings	BYZ10	BYZ11	BYZ12	BYZ13
Maximum recurrent PIV	800	600	400	200V
Maximum transient peak	1200	900	600	300V
Information common to the series:				
Maximum average forward current (at T_{case} = 25°C) averaged over any 20ms period				6.0A
Maximum average forward current (at T_{case} = 125°C) averaged over any 20ms period				1.5A
Maximum recurrent peak current				20A
Maximum surge current for any 200μs period (at T_{amb} = 25°C)				75A
Typical forward voltage drop at a forward current of 5A and (T_{case} = 25°C)				1.4V
Maximum reverse current at maximum PIV and (T_{case} = 125°C)				600μA

MULLARD SILICON POWER DIODES UPRATED

TYPES BYZ14, BYZ15*, BYY15 AND BYY16*

New Ratings

The new ratings for Mullard Silicon Power Rectifiers listed above bring you mains rectification at even lower cost. The current ratings have been doubled from 20A to 40A average and from 100A to 200A recurrent peak. These rectifiers are recommended for use in all industrial applications where high current is required at a low forward voltage drop across the diode junction.

Heat Sinks

Since the maximum junction temperature remains at 150°C, users are reminded that greater emphasis must be placed on heat sink design if these rectifiers are to be operated near the maximum average current rating and at high ambient temperatures. Where such conditions of operation are likely to exist, consideration may be given to forced air cooling in order to minimise heat sink area. Some practical aspects of heat sink design will be discussed in the forthcoming issue of Outlook.

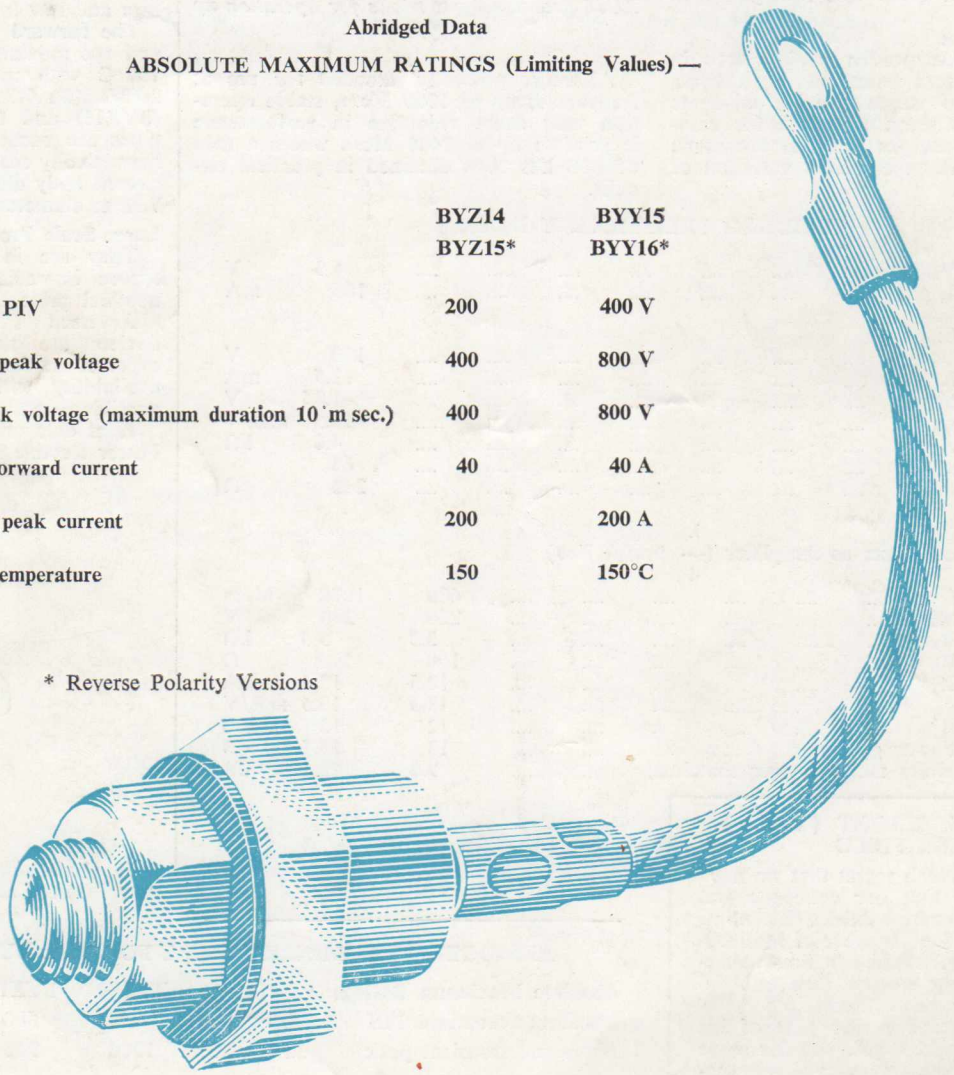
SILICON POWER RECTIFIERS

Abridged Data

ABSOLUTE MAXIMUM RATINGS (Limiting Values) —

	BYZ14 BYZ15*	BYY15 BYY16*
Maximum recurrent PIV	200	400 V
Maximum transient peak voltage	400	800 V
Maximum surge peak voltage (maximum duration 10 m sec.)	400	800 V
Maximum average forward current	40	40 A
Maximum recurrent peak current	200	200 A
Maximum junction temperature	150	150°C

* Reverse Polarity Versions



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1. Notify Mullard-Australia Pty. Ltd. immediately.
2. If possible, let us know in advance. Thirty days' notice will enable our mailing system to operate more efficiently.
3. Notify us in writing and include the address label from one of the recent issues showing your old address and code line.

THANK YOU.

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