RADIOTRONICS

AMALGAMATED WIRELESS VALVE CO. PTY. LTD.

BOX No. 2516BB, G.P.O., SYDNEY

TECHNICAL BULLETIN No. 104 **15th May, 1940**

In this issue:—

RADIOTRON 1.4 VOLT 5 VALVE RECEIVER
Circuit No. RB52

In the previous issue of Radiotronics a receiver was described which employed type 1N5-GT valves in R.F. and I.F. stages. Although excellent on weak signals, the performance on strong signals is not so good owing to the sharp cut-off grid characteristics of these valves.

In this issue is described an improved receiver using Radiotron Australian-made 1P5-GT valves in R.F. and I.F. stages. A simple A.V.C. system has been incorporated, and overloading does not result in any serious distortion until the input to the aerial terminal exceeds 0.4 volt. The arrangement is relatively free from cross modulation under normal receiving conditions.

Since the converter valve (1A7-GT) has a sharp cut-off characteristic it was decided not to apply A.V.C. to this stage, although a small fractional part of the controlling voltage could be applied with, perhaps, some slight benefit. It was considered, however, that the possible improvement was not sufficient to justify the resulting complication. Full A.V.C. is applied to both R.F. and I.F. grids.

Features.

The main features of the receiver are evident from an examination of the Circuit Diagram (RB52). The circuit is quite conventional in most respects, but one or two special features are of interest. The **diode-load filter** arrangement is similar to that in Circuit No. RB51, in that the second filter condenser is connected to the grid of the 1H5-GT, and thus combines improved filtering at low settings of the volume control with a slight tone-control effect.

The **oscillator circuit** employs "padder feedback" to assist in obtaining uniform grid current over the band. It was found desirable, in order to obtain the best results from this device, to reduce the number of primary turns on the oscillator coil to four turns (see Coil Details). With a "bogie" valve* and exact voltages as shown on the circuit diagram, using the special coils specified below, the oscillator grid current varied from 36μA. at the extreme low frequency end of the band, to 49μA. at 1000 Kc/s. and then down to 32μA. at the extreme high frequency end of the band. The average is thus higher than the optimum (35μA.), but this is of advantage when the batteries are partially run down.

With a "bogie" 1A7-GT valve and an A Battery delivering 1.1 volts **the oscillator still continues to oscillate** when the B Battery voltage is decreased to 45 volts, with a battery internal resistance of 1,000 ohms.

The lowest A battery voltage at which the receiver continues to operate is largely affected by the condition of the valve; a valve which has had a long service life is likely to fall out of oscillation at a higher filament voltage than 1.1 volts.

* A bogie valve is one having the exact rated characteristics.

Back-bias is employed in order to eliminate the necessity for a C Battery and to give a decrease in bias as the B Battery runs down. Under working conditions the **total B Battery drain** is only about 9.5 milliamperes with a **maximum** output of 168 milliwatts at 10% total distortion. The bias resistor could, of course, be adjusted to give either increased or decreased bias as desired. An arrangement which is also suggested for consideration is to employ an "**economy switch**" giving the choice of two values of bias at will. There is one difficulty with this arrangement in that a load resistance which is optimum for one bias voltage will not be optimum for the other. A table showing the performance of type 1Q5-GT with selected values of over-bias was given in Radiotronics 102, pp. 1-2, with a further reference in Radiotronics 103, p. 21.

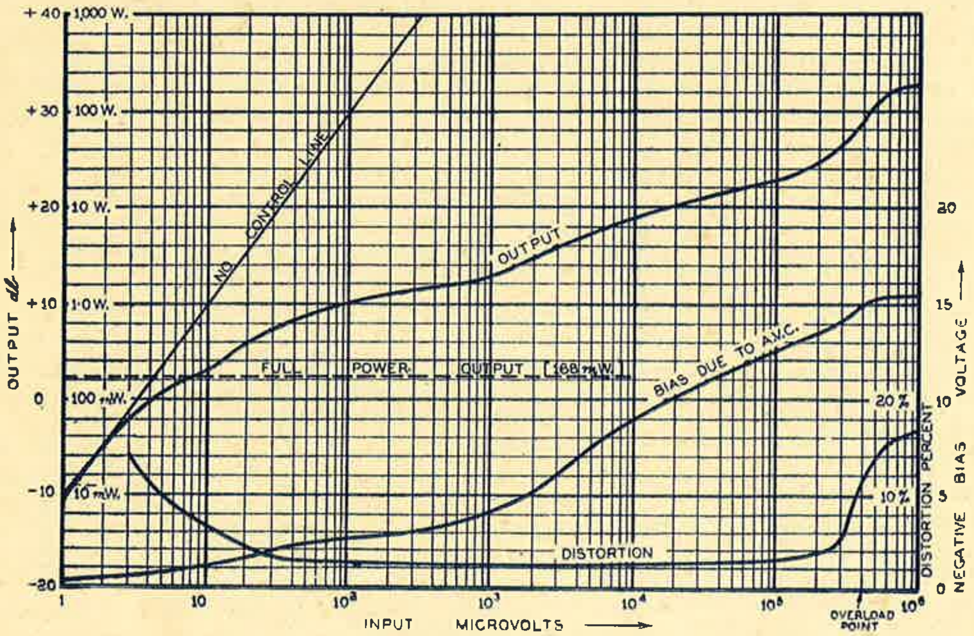
A three-position **tone control** is shown in the circuit diagram. The capacitances were selected by aural test, but may need to be adjusted to suit different cabinets and speakers.

Performance.

The results obtained on this receiver on test are given in tabular form below. The **sensitivity** is below 3μV. for 50 mW. absolute over the whole broadcast band. The **noise level** for 50 mW. absolute output with the volume control at maximum varies from 7 mW. at 1500 Kc/s. to 12 mW. at 600 Kc/s. The noise at the aerial terminal expressed in Ensi is from 0.38 μV. at 1500 Kc/s. to 0.43 μV. at 600 Kc/s. The **maximum power output** is 168 mW. at 10% total harmonic distortion. The **B Battery drain** is 11.0 mA. with no signal, falling to 9.3 mA. on an unmodulated 100,000 μV. signal, rising to 9.55 mA. at full output on the same signal strength.

The A.V.C. characteristic has been drawn according to Scroggie's method.* It will be seen that the 50 milliwatt output level is reached at slightly above 2μV. input, and the full power output at 80μV. The average slope of the A.V.C. characteristic from 20 to 200,000 μV. is 4.4 db. for 10:1 ratio of input voltages. Overloading occurs at an input of 400,000 μV. The apparent harmonic distortion shown at low input levels is largely noise combined with diode distortion.

The overload point occurs at a grid bias of –15 volts, and is probably due to the limited grid base of the controlled valves. It might be possible to increase by a small amount the signal voltage at which the receiver overloads by applying only a fractional part of the A.V.C. Voltage to the controlled valves, but this would result in a poorer A.V.C. characteristic and would appear to be unnecessary under almost all listening conditions. It is interesting to note that the receiver still operates satisfactorily with an input of 2 volts to the aerial terminal, although the distortion is high. With an input exceeding 0.4 volt, there is a tendency towards feedback when the internal resistance of the B Battery rises with age. This may be eliminated by connecting a 4 μF. condenser across the B terminals, but in most cases its use is quite unnecessary. Without this increased capacitance, no feedback is evident with input voltages up to 0.4 volt, even with a B Battery in very bad condition.



* See the Radiotron Designer's Handbook, Third Edition, pp. 177-178 also pp. 236-237.

SENSITIVITY AND NOISE LEVEL

For 50 mW. Absolute Output.

Position	Frequency Kc/s.	Sensitivity μV.	Stage Gain	Noise Level mW.	Ensi μV.
1P5-GT Control Grid	455	7,000	—	—	—
1A7-GT Signal Grid.	455	90	—	—	—
	600	100	—	—	—
	1,000	100	—	—	—
	1,500	100	—	—	—
1P5-GT (R.F.) Control Grid	600	10	10	4	—
	1,000	11.5	8.7	3.2	—
	1,500	15	6.6	2	—
Aerial ..	600	2.7	3.7	12	0.43
	1,000	2.4	4.8	10	0.41
	1,500	2.9	5.1	7	0.38

NOISE LEVEL AT 5μV. AND 10μV. INPUT TO AERIAL

50 mW. ABSOLUTE OUTPUT

Frequency Kc/s.	Input to Aerial 5μV.	10μV.
600	4.0 mW.	2.2 mW.
1000	3.5 mW.	1.8 mW.
1500	3.0 mW.	1.5 mW.

BAND WIDTH

Frequency (Kc/s.)	Band width (Kc/s.) Ratio 10	100	1,000	10,000
600 ..	—	—	25	—
1000 ..	10	17.5	27.5	42.5
1500 ..	—	—	30	—

DISTORTION

At 25,000 μV. input to aerial at 1000 Kc/s., 30% modulated at 400 c/s., with 12,500 ohm resistive load in place of loudspeaker:

Output (mW.)	Harmonic Distortion (total)
50	2.7%
100	3.5%
168	10.0%

Maximum "undistorted" power output 168 mW. at 10% total distortion.

BATTERY DRAIN

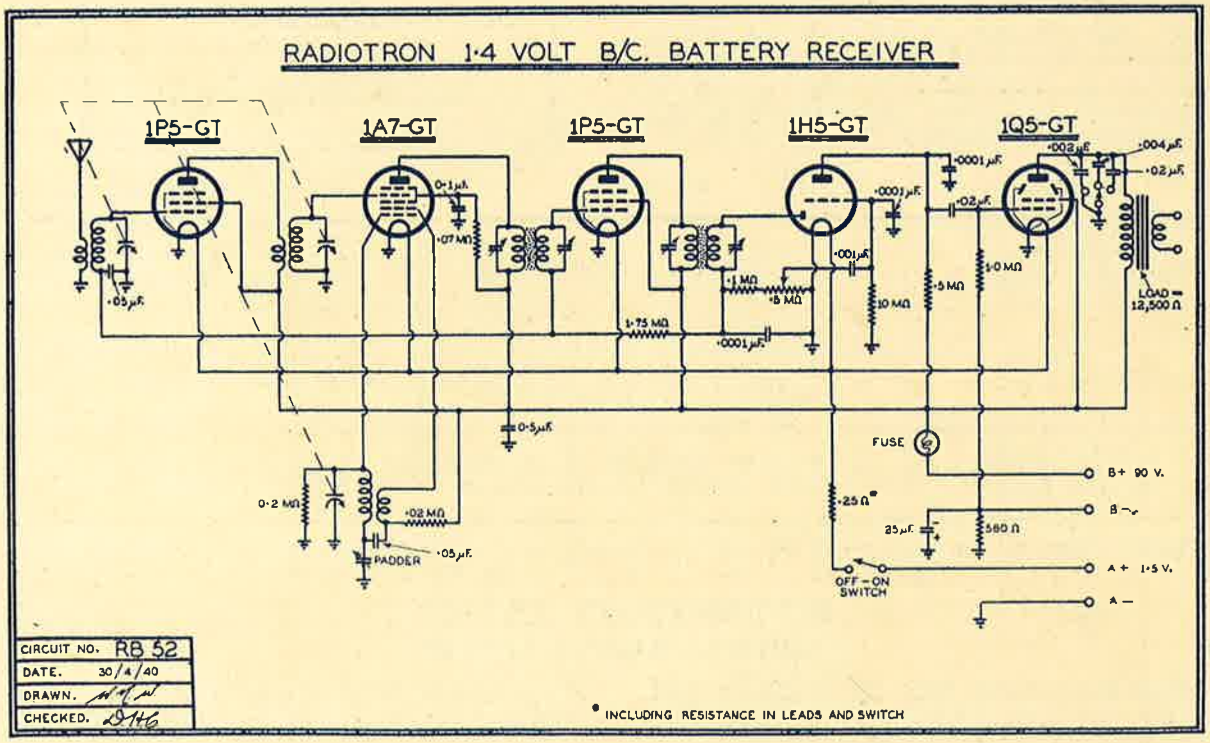
	Current Drain	1Q5-GT Bias Voltage
A Battery	0.3 A.	
B Battery—no signal	11.0 mA.	6.4 V.
0.1V signal no modulation	9.3 mA.	5.4 V.
0.1V signal full output	9.55 mA.	5.55 V.

OSCILLATOR GRID CURRENT

(0.2 megohm grid resistor)

Frequency (Kc/s.)	Grid Current (μA.)
550	36
1000	49
1600	32

[For coil details, see page 28.]



The oscillator circuit as shown is only for use with the specified coils. If a conventional oscillator coil is used, the .05μF. condenser from the primary coil should be returned to earth instead of to the top of the padder.

COIL DETAILS

Suitable for Radiotron Converter Types 1A7-G, 1A7-GT.

Band Coverage—Broadcast Band: 1600-550 Kc/s.

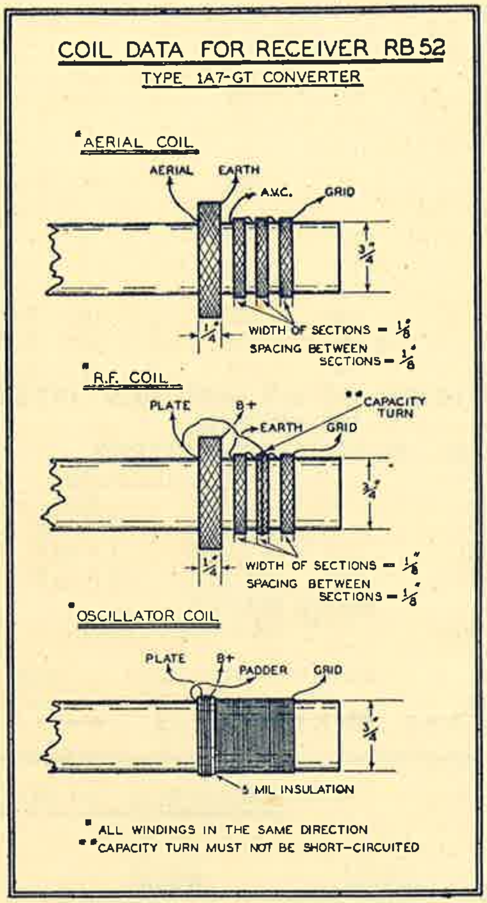
Tuning Condenser: 12-440 $\mu\mu$F. Other types of condensers may be used provided that suitable adjustment is made to the inductance of the coils.

Maximum effective stray capacitances: 45 $\mu\mu$F. including valve input, trimmer, wiring and coil capacitances.

Padder Capacitance: 440 $\mu\mu$F.

Shield Can: Internal Diameter 2⅛".

Note that these coil data apply only to particular conditions, and adjustment will normally be required in differing layouts. The effective inductance of the coils is affected by the lengths of leads, the shield can, and proximity to other components in the case of unshielded coils. The band coverage is affected by the total stray capacitances as well as by the minimum capacitance of the gang condenser. Any minor adjustments in the coils should be made in the same proportion to both primary and secondary. In the accompanying illustration the primary and secondary of each coil is wound in the same direction. The single capacity turn wound over the second section of the secondary of the R.F. coil is joined to the inner end of the high impedance primary winding which is connected to the plate of the R.F. Amplifier.



COIL	PRIMARY	SECONDARY
AERIAL 550-1600 Kc/s.	375 turns 40 S.W.G. S.S.E.	120 turns 5/44 B.&S. Litz, in three equal sections.
R.F. 550-1600 Kc/s.	950 turns 40 S.W.G. S.S.E. with one turn over second section of secondary.	120 turns 5/44 B.&S. Litz, in three equal sections.
OSCILLATOR 550-1600 Kc/s.	4 turns 34 B.&S. E. wound over bottom of secondary*.	105 turns 31 B.&S. E.

* The first turn of the primary is wound immediately over the first turn of the secondary.

RADIOTRON 1A7-GT
GRID CURRENT LIMITS

Tests have shown that the oscillator grid current of Radiotron 1A7-GT should preferably be between 25 and 50 microamperes, the greatest gain occuring at 35 microamperes. Under no conditions should the oscillator grid current drop below 20 microamperes since the cathode current rises steeply below this point. The maximum permissible cathode current is 3 mA.

The recommended oscillator grid resistor has a resistance of 200,000 ohms, and all values of oscillator grid current are in relation to this resistance value only.

OPERATION OF 1.4 VOLT VALVES FROM 2 VOLT ACCUMULATOR

It is quite practicable to operate the Radiotron 1.4 volt series of valves from a 2 volt accumulator if the correct value of dropping resistor is used. For example, one or more individual valves in a receiver may be of the 1.4 volt type provided that dropping resistors of the correct values are used. If three or more 1.4 volt valves are used in one receiver it is practicable to use a common dropping resistor for them. If the whole receiver uses 1.4 volt valves operating from a 2 volt accumulator it is practicable to use a common dropping resistor for the whole receiver. Thus it may be seen that any number of individual valves in a 2 volt receiver may be 1.4 volt valves operated from a 2 volt accumulator. The correct values of resistors to be used are given in the table below.

If 1.4 volt valves are used in a 2 volt receiver it is necessary to limit the plate voltage to 90 volts so as not to exceed the maximum ratings. Under some circumstances it is possible to obtain satisfactory operation from 2 volt valves operating with a 90 volt B battery. For further information on this subject reference should be made to a separate article elsewhere in this issue. Radiotron type 1Q5-GT has characteristics which enable it to give a power output of up to 270 mW. with a plate supply of only 90 volts. This is considerably higher than may be obtained from either of the power pentodes 1L5-G or 1F5-G, and is higher than is obtainable with type 1G5-G, at the same supply voltage. Thus, there is an advantage in using Radiotron 1Q5-G in a 2 volt receiver operating with a 90 volt B battery. A further reason for using the 1.4 volt series in a 2 volt receiver may be in order to obtain greater economy in A battery current.

Every receiver designer may therefore choose the valves most suitable to his particular requirements, and combine them in a single receiver even though this may mean a mixture of 2 volt and 1.4 volt types.

In some localities it may be preferred to operate a 1.4 volt receiver from a 2 volt accumulator in place of a dry cell A battery. Under such conditions the dropping resistor should be as given in the table below.

DROPPING RESISTORS

FOR USE WITH 1.4 VOLT VALVES OPERATED FROM A 2 VOLT ACCUMULATOR

These resistors have been calculated so as to give a voltage of 1.4 volts across the valve filaments when the accumulator supply voltage is 2.1 volts. Although the resistance should include the resistance of the leads, in most cases the latter may be neglected.

A common dropping resistor should not be used for two 1.4 volt valves in parallel since the failure of one filament may result in failure of the other, owing to excessive filament voltage. With three or more 1.4 volt valves in parallel a common dropping resistor is quite practicable since the rise of voltage occurring with the failure of one filament will not be excessive.

Total Current through Dropping Resistor (mA.)	Resistance of Dropping Resistor (ohms.)
50	14.0
100	7.0
150	4.7
200	3.5
250	2.8
300	2.3
350	2.0
400	1.75

DROPPING RESISTORS FOR USE WITH 1.4 VOLT VALVES OPERATED FROM A 6 VOLT ACCUMULATOR

When 1.4 volt valves with the filaments connected in series are operated from a 6 volt accumulator it is important that the correct value of dropping resistor be employed. In the general case the value of dropping resistor may be calculated so as to give a voltage of 1.4 volts across each valve filament when the accumulator supply voltage is 6.3 volts. The following typical cases will cover most requirements:—

CASE 1:

Four valves with filaments in series.

Current	Resistance
50 mA.	14 ohms.
100 mA.	7 ohms.
150 mA.	4.7 ohms.

CASE 2:

Three valves with filaments in series.

Current	Resistance
50 mA.	42 ohms.
100 mA.	21 ohms.
150 mA.	14 ohms.

CASE 3:

Two valves with filaments in series.

Current	Resistance
50 mA.	70 ohms.
100 mA.	35 ohms.
150 mA.	23.3 ohms.

When two or more entirely separate "strings" of filaments are used, it is preferable to use separate dropping resistors for each "string". When one or more valves are common to two or more "strings", a warning should be placed on the receiver that no valve should be removed from its socket while the A Battery is switched on, since otherwise damage may be done to the valves. Failure of one filament with this arrangement may result in one or more additional valves being damaged. It is therefore not a desirable arrangement.

The Effect of Plate Current

When several filaments are connected in series, the plate and screen currents (i.e., the "cathode current") of the most positive valve must pass through the filaments on its negative side. The filament on the extreme negative end of the "string" must therefore carry the whole cathode currents of all the remaining valves in the string.

With the 1.4 volt series of valves the ratio of cathode current to filament current is particularly high, and this effect is more marked than with valves of the 2 volt 0.12 ampere series. **In order to avoid incorrect filament voltages under series-filament conditions it is necessary to connect a shunt resistor across all filaments except the one at the positive end of the string.** The correct value of resistance may be found experimentally, or may be calculated. Further information on this matter will be given in these columns at a later date.

90 VOLT OPERATION OF 2 VOLT VALVES

All of the 2 volt series of battery valves may be operated at 90 volts provided that attention is paid to the design of the receiver. Types 1M5-G or 1D5-G as R.F. or I.F. amplifiers may be operated with 90 volts supply without appreciable falling-off in performance. The screen voltage should normally be maintained at the same value as for 135 volt B battery operation. Type 1K7-G as a duo-diode resistance-coupled pentode may be used on 90 volts without any circuit change from that used for 135 volt operation.

The principal objections to the use of a 90 volt supply are due to difficulties arising in the converter and power output stages. Radiotron 1C7-G may be made to operate without any difficulty on the broadcast band with a 90 volt supply, and with careful attention to coil design may even be made to operate on the 16-50 metre short-wave band.

Radiotrons 1L5-G and 1F5-G are not particularly suited to operation with a 90 volt supply since the power output obtainable from them under such conditions is very small. Radiotron 1G5-G, however, is capable of giving an output of 250 mW. with 90 volts on plate and screen and -6 volts bias. The plate and screen currents under these conditions are 8.5 and 2.5 respectively at no signal; the load resistance should be 8,500 ohms.

Alternatively Radiotron 1Q5-GT (1.4 volt beam tetrode) may be used in the output stage with a 90 volt supply provided that a suitable dropping resistor is used in series with its filament. Reference should be made to the article elsewhere in this issue regarding the correct value of resistor to use.

It is hoped to make available, in the near future, valve data sheets giving 90 volt operation of 2 volt types.

RADIOTRON DESIGNER'S HANDBOOK

CLOTH BOUND EDITION

The Radiotron Designer's Handbook, in addition to its well known form with a paper cover, is now also available with good binding and cloth covered. This cover is of board with black Rexine cloth covering and gold lettering. Not only is this new volume capable of withstanding continued usage, but it is capable of being opened flat out on the desk—a distinct advantage when referring to tables or nomograms.

The Radiotron Designer's Handbook (Third Edition) is available from all booksellers or from Amalgamated Wireless Valve Co. Pty. Ltd., 47 York Street, Sydney, at 3/- (Postage 4d.), for the paper cover. With a black Rexine cloth cover it is available only from Amalgamated Wireless Valve Co. Pty. Ltd, at 7/6 (Postage 6d.).

AUSTRALIAN-MADE RADIOTRON TRANSMITTING VALVES

Ten Types

A complete range of Radiotron Transmitting Valves is now being manufactured in Australia. This range extends from the smallest (a 10 watt pentode) to the largest which is able to provide a carrier output of 635 watts capable of being modulated 100%. By the use of these valves it is possible to construct any transmitter up to a carrier power of 3 kilowatts. The range includes triodes, a beam power tetrode, pentodes and mercury vapour rectifiers.

In the following table the valves are rated in terms of plate dissipation in continuous commercial service. The power output will naturally be very much greater than the plate dissipation, but the exact value depends largely upon the operating conditions. Instructional leaflets on these types are available on request.

AUSTRALIAN-MADE RADIOTRONS

6P6	10 watt pentode for suppressor-grid modulation (replacement purposes only).
802	10 watt shielded pentode with indirectly-heated cathode for A.F. Class A, R.F. Class B Telephony, Suppressor-modulated Class C Telephony, Grid-modulated Class C Telephony, Plate-modulated Class C Telephony (Pentode Connection), Plate-modulated Class C Telephony (Tetrode Connection), Class C Telegraphy (Pentode Connection) and Class C Telegraphy (Tetrode Connection).
804	40 watt shielded pentode for R.F. Class B Telephony, Suppressor-modulated Class C Telephony, Grid-modulated Class C Telephony, Plate-modulated Class C Telephony (Pentode Connection), Plate-modulated Class C Telephony (Tetrode Connection), Class C Telegraphy (Pentode Connection), and Class C Telegraphy (Tetrode Connection).
805	125 watt high-mu triode with the plate connection at the top of the bulb and a maximum plate voltage of 1500 volts; for A.F. Class B, R.F. Class B Telephony, Plate-modulated Class C Telephony and Class C Telegraphy.
807	25 watt beam power tetrode with indirectly-heated cathode for A.F. Class A1, Class AB1, Class AB2, R.F. Class B Telephony, Plate-modulated Class C Telephony and Class C Telegraphy. It may also be used as a triode.
809	25 watt high-mu triode for A.F. Class B, R.F. Class B Telephony and Class C Telegraphy. The plate is taken to a top cap, and the maximum plate voltage (CCS) is 750 volts.
833	300 watt high-mu triode of ultra-modern design for A.F. Class B, R.F. Class B Telephony, Plate-modulated Class C Telephony and Class C Telegraphy. Under Plate-modulated Class C Telephony conditions each valve is capable of giving a carrier output of 635 watts. Under Class C Telegraphy conditions each valve is capable of a carrier output of 1000 watts.
866	Mercury-vapour rectifier, peak current 1.0 ampere, peak inverse voltage 7,500 volts.
866A	Mercury-vapour rectifier of the shielded type, peak current 1.0 ampere, peak inverse voltage 10,000 volts.
872	Mercury-vapour rectifier, peak current 5.0 amperes, peak inverse voltage 7,500 volts. Six type 872 rectifiers in a full-wave three-phase system are capable of delivering a D.C. output of 3.75 amperes at 7,000 volts.

REVISED RATINGS

The revised ratings of certain popular types of valves were given in Radiotronics 103. Further revised ratings are given below.

It should be clearly understood that these are "Design Maxima" and not absolute maxima, and incorporate provision against normal line voltage fluctuations.

Where the maximum screen supply voltage is specified (e.g., 300 volts) this indicates that the screen voltage should not rise above 300 volts when the screen current is reduced to zero. Thus a dropping resistor may be used to drop the voltage from a 300 volt source to the "maximum screen voltage" (e.g., 100 volts). The "maximum screen voltage" (e.g., 100 volts) is to be interpreted as being the maximum voltage which may be applied to the screen under the maximum current conditions.

For example type 6U7-G is rated at "Screen Supply Voltage—300 max. Volts" and "Screen Voltage—100 max. Volts". It is thus permissible to operate the screen of this valve type with a dropping resistor from a 300 volt source, of such a resistance that with maximum screen current flowing the voltage drop in the resistor is 200 volts and the screen voltage is 100 volts. When a more negative bias is applied to the control grid the screen voltage will obviously rise above 100 volts, but provision has been made for this rise of voltage in specifying the maximum supply voltage.

POPULAR TYPES (DESIGN MAXIMA)

5U4-G	As Full Wave Rectifier.	
	Peak Inverse Voltage	1550 max. Volts
	Peak Plate Current per Plate	675 max. mA.
6B8-G	TRIODE CONNECTION	
	Plate Voltage (new rating)	250 max. Volts
	Grid Voltage (new rating)	0 min. Volts
	Plate and Screen Total Dissipation (new rating)	2.4 max. Watts
6G8-G	PENTODE CONNECTION	
	Plate Voltage increased to	300 max. Volts
	Screen Voltage unchanged at	125 max. Volts
	Screen Supply Voltage (new rating)	300 max. Volts
	Control-Grid Voltage (new rating)	0 min. Volts
	Plate Dissipation (new rating)	2.4 max. Watts
	Screen Dissipation (new rating)	0.3 max. Watt
	TRIODE CONNECTION	
	Plate Voltage (new rating)	250 max. Volts
	Grid Voltage (new rating)	0 min. Volts
	Plate and Screen Total Dissipation (new rating)	2.4 max. Watts
6J8-G	Heptode Plate Voltage increased to	300 max. Volts
	Heptode Screen Supply Voltage (new rating)	300 max. Volts
	Other ratings to follow later.	
6L6-G	TETRODE CONNECTION	
	Plate Voltage decreased to	360 max. Volts
	Screen Voltage decreased to	270 max. Volts
	Plate Dissipation (new rating)	19 max. Watts
	Screen Dissipation (new rating)	2.5 max. Watts
	TRIODE CONNECTION	
	Plate Voltage (new rating)	250 max. Volts
	Plate and Screen Total Dissipation (new rating)	10 max. Watts
6N7-G	Plate Voltage unchanged at	300 max. Volts
	Peak Plate Current per Plate unchanged at	125 max. mA.
	Average Plate Dissipation per Plate changed to	5.5 max. Watts
6U5/6G5	Plate Supply Voltage unchanged at	250 max. Volts
	Target Voltage unchanged at	250 max. Volts 100 min. Volts

6V6-G

TRIODE CONNECTION

Plate Voltage (new rating)	300 max. Volts
Plate and Screen Total Dissipation (new rating)	12.5 max. Watts

6X5-G, 6X5-GT

AS FULL-WAVE RECTIFIER

Peak Inverse Voltage	1250 max. Volts
Peak Plate Current per Plate	210 max. mA.
D.C. Heater-Cathode Potential	450 max. Volts

25L6-G, 25L6-GT

Plate Voltage	117 max. Volts
Screen Voltage	117 max. Volts
Plate Dissipation	4 max. Watts
Screen Dissipation	1.25 max. Watts

25Z6-G, 25Z6-GT

Peak Inverse Voltage	700 max. Volts
Peak Plate Current per Plate	450 max. mA.
D.C. Heater-Cathode Potential	350 max. Volts

RADIOTRON 6V6-G AS TRIODE

Radiotron 6V6G may be operated as a triode with screen tied to plate, and one application of this arrangement has already been described.* Tentative ratings and typical operating conditions are given below, and it will be seen that a single valve is capable of giving an output of 1.0 watt with 250 volts on the plate, and 1.65 watts with 300 volts. As a push-pull amplifier, an output of 3.3 watts in Class A1 and 4.75 watts in Class AB1 may be obtained with 300 volts on the plates. It should be noted that the Class AB1 conditions tabulated are for fixed bias operation only.

* Radiotronics 100, pages 48-49, "A new 2A3 amplifier" and page 50, "6V6-G triode operation."

TENTATIVE DATA

OPERATION WITH PLATE TIED TO SCREEN

STATIC AND DYNAMIC CHARACTERISTICS

Heater Voltage	6.3	volts
Plate Voltage	250	volts
Screen Voltage	*	
Grid Voltage	−15	volts
Amplification Factor	9.6	
Plate Resistance	2400	ohms
Transconductance	4000	μmhos
Plate Current	37.5	mA.

*Screen tied to plate.

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Plate Voltage	300 max. volts
Plate and Screen Dissipation (total)	12.5 max. watts

SINGLE-VALVE AMPLIFIER — CLASS A1

Typical Operation

Heater Voltage	6.3	6.3	volts
Plate Voltage	250	300	volts
Grid Voltage	−15	−20	volts
Cathode Bias Resistor	400	513	ohms
Peak A-F Grid Voltage	15	20	volts
Zero Signal Plate Current	37.5	39	mA.
Load Resistance	3500	4800	ohms
Power Output⊕	1.0	1.65	watts

⊕For 5% second harmonic distortion.

PUSH PULL AMPLIFIER

Values are for 2 valves

Operation	Class A1	Class AB1	
Heater Voltage	6.3	6.3	volts
Plate Voltage	300	300	volts
Grid Voltage	−20	−25	volts
Cathode Bias Resistor	256	**	ohms
Peak A-F Grid-to-Grid Voltage	40	50	volts
Zero Signal Plate Current	78	42	mA.
Load Resistance (plate to plate)	9600	6000	ohms
Power Output	3.3	4.75	watts

**Fixed bias only.

DETUNING BY A.V.C.

When a control voltage from an A.V.C. network is applied to the control grid of a tuned amplifier stage, the input capacitance varies when the signal strength varies. In the case of a highly selective I.F. amplifier, or an R.F. amplifier with a very small tuning capacitance, the variation may be sufficient to result in evident detuning.

The cause of the input capacitance variation is not a simple one, but rather a combination of causes. For example, as the gain of the stage varies with change of bias, the "Miller Effect" reflected capacitance also changes. Even if the stage is completely neutralized, however, so that the "Miller Effect" capacitance is zero, the remaining causes may still be sufficient to result in appreciable detuning.

In a "space-charge limited" valve, such as is the case for all normal amplifying valves used under the standard operating conditions, the hot input capacitance is greater than the input capacitance of the same valve when cold.

(Continued on page 36.)

MINOR POINTS IN RECEIVER DESIGN

(1) LOW LEVEL REPRODUCTION

Most radio receivers are usually tested, both in the showroom and in the client's home, at a high audio level. For this reason many receivers are sold on a side-by-side comparison with other receivers which may be operated at, or even beyond, the point of overload. While there may be some reason for this method of testing it is felt that it is not a sufficiently complete test of the receiver, even when operated on local stations, since the set is also required to operate at a low level.

Experience has shown that some receivers have marked harmonic distortion or lack of tonal balance at very low levels and an otherwise satisfactory receiver may be marred by such a defect. Since the latter may in most cases readily be remedied once it is known to exist, the following comments may be of interest.

Any rectification occurring at points up to and including the final I.F. amplifier valve produces distortion, particularly at low audio volume. Distortion which occurs while receiving strong signals may be due to overloading of the I.F. amplifier, and may be particularly in evidence if one stage of the I.F. amplifier is reflexed. When two "straight" I.F. stages are used, the second stage should be operated at fixed bias so as to reduce this distortion to a negligible value. When only a single I.F. stage is used, the screen of the I.F. amplifier valve may be supplied through a dropping resistor or from a high resistance potentiometer so as to minimise the effect. Alternatively a fractional part of the total A.V.C. voltage may be applied to this valve. Either of these methods will reduce the amount of "modulation rise" which is evident as harmonic distortion in the output of the receiver.

Rectification may occur with a reflexed I.F. amplifier to such an extent that, as the audio volume control is turned down, a point is reached at which the audio output is a minimum and then as the control is turned to zero the volume rises again. Distortion is greatest at the minimum volume point since at this point the rectification in the I.F. amplifier is to some extent balanced against the rectification of the diode, and as a result, the higher harmonics are accentuated out of proportion with the fundamental. This effect is present to some extent in any receiver but, as the distortion is usually very much less than in a reflex amplifier, it is less noticeable. The effect may be detected by a listener having a critical ear and attention should be paid to it in the design of the receiver.

Any capacitive coupling from either primary or secondary circuits of the final I.F. transformer to the grid circuit of the first audio frequency amplifier may cause distortion. Owing to this capacitive coupling, any rectification in the I.F. amplifier may be passed directly to the audio amplifier in such a way as to cause interference with the normal signal rectification. The existence of this effect can be noted by turning the volume control to zero and by disconnecting the lead from the moving arm of the volume control. This completely eliminates the possibility of any signal being passed from the volume control to the grid of the audio amplifier. Any signal which is audible in the loudspeaker or which can be detected with an output meter will be due to this capacitive coupling effect. It may be cured by an improvement in the layout or by screening. This screening should preferably take some form other than a screened grid lead since this latter tends to bypass the higher audio frequencies. A screened lead may, however, be used in receivers where a slight degree of high audio frequency attenuation is permissible.

Any tendency towards **instability** in the receiver tends to result in a peculiar form of distortion at low levels. The cure is obvious.

Tonal balance is largely a function of the loudspeaker, the power valve, the coupling between the power valve and the loudspeaker, and any tone control or tone compensation which is used in the receiver. An arrangement which gives a satisfactory tonal balance at high levels may be badly unbalanced at low levels. Without going into detail concerning the principles involved, it is sufficient to point out that some form of tone compensation may be necessary in certain receivers. If accentuation of high frequencies is required at low levels, this may be obtained by a slight degree of capacitive bypassing from the grid of the first audio frequency amplifier to earth. As the volume control is set at a lower position, so the bypassing becomes less severe and the high frequencies are thereby accentuated more at low settings of the volume control than at high settings. If a tapped volume control is used, there are many arrangements for obtaining any desired form of tone compensation. For further information on this subject see the third edition of the Radiotron Designer's Handbook, Chapter 9, pages 58-73.

The detection efficiency of a diode falls off rather badly at low input voltages. This loss of detection efficiency is necessarily accompanied by audio frequency harmonic distortion. Distortion may therefore be expected to occur when listening to weak stations, but this should not be any more pronounced at low audio levels than at high audio levels. This effect is made more apparent by the use of an audio frequency amplifier having high gain. For this reason alone, therefore, it is desirable that the audio frequency gain be limited to approximately 60 times in the voltage amplifier stage when followed by an ordinary output pentode or beam power valve such as types 6F6-G or 6V6-G. There are other reasons which also make it advisable to limit the audio frequency gain to this value since trouble may be experienced through noise from the volume control or hum. Some method of negative feed back, which is varied as the setting of the volume control is varied, has distinct advantages in this regard, but the gain even at maximum volume control settings should not exceed the limit given above, while the gain at minimum settings would naturally be less. Thus both noise from the volume control and hum will be reduced when listening to stronger signals as is usually the case with local reception.

There is a relationship between desirable gain ahead of the second detector and desirable gain following the second detector. High gain ahead of the second detector ensures that the majority of stations will give a reasonably high voltage at the diode detector so that diode distortion will not be unduly high. Under these conditions a reasonably high audio frequency gain may be used.

VALVE DATA SHEETS

Valve Data Sheets

Six Radiotron Loose Leaf Valve Data Sheets are being released concurrently with this issue. These are:—

Type 5U4-G	1 sheet (data)
Types 6A7, 6A8, 6A8-G	1 sheet (data)
Type 6B8-G	2 sheets (data and curves)
Types 6J7, 6J7-G ..	1 sheet (data)
Type 6V6-G	1 sheet (curves)

The sheet of curves for Radiotron 6V6-G covers pentode operation with 100 volts on the screen, and triode operation with plate and screen tied together.

TRIODE OPERATION OF PENTODES AND TETRODES

All types of pentodes and tetrodes may be operated as triodes by connecting together the plate and screen. The suppressor, if brought out to a separate base pin, may be connected to the plate or to the cathode, the difference in characteristics between the two arrangements being quite small. The maximum ratings as given for pentode or tetrode operation should not be exceeded, unless special ratings are given for triode operation. For example, a valve rated at 125 volts maximum on the screen and 300 maximum on the plate may only be operated at 125 volts maximum (when plate and screen are tied together) unless special triode ratings are given.

The maximum ratings usually include plate dissipation, screen dissipation, plate voltage, screen voltage and minimum grid bias. No one of these may be exceeded with the line voltage at its nominal value, irrespective of other factors. For example the plate voltage may not be increased because the plate dissipation is low—each rating is to be considered entirely alone. The minimum bias is, in most cases, "0 minimum". This indicates that the bias may be zero or any negative value, provided that none of the other ratings is exceeded. The working bias will normally be adjusted for optimum performance without exceeding any of the maximum ratings.

It is possible to obtain a very rough approximation to the **triode amplification factor** from the published characteristics of a sharp cut-off pentode or tetrode. This is equal to the screen voltage in volts divided by the grid bias voltage in volts for plate current cut-off. Since the curvature near the point of cut-off affects the accuracy of the calculation, it is preferable to take a value of grid bias voltage corresponding to a small plate current near the cut-off point.

For example, with type 6J7-G having 100 volts applied to the screen, the negative grid bias corresponding to plate current cut-off is slightly over 5 volts. Taking the value of 5 volts for the purposes of calculation, the triode amplification factor will be 100/5 or 20.

Triode operating data have been published for types 1K4, 1K5-G, 1K6, 1K7-G, 6B8-G, 6C6, 6F6-G, 6J7-G, 6L6-G, 6V6-G, 42, 57, 77, 807 and 1603. Requests for data on other types will be welcomed by the Unified-Sales Engineering Service.

RADIOTRON NEWS

Radiotron 2X2 is the new designation of the existing type 2X2/879. No change has been made in characteristics, and the new type number has been adopted on account of its brevity.

Radiotron 3A8-GT is a 1.4-2.8 volt diode-triode-R.F. pentode having characteristics similar to the combined characteristics of types 1H5-GT and 1N5-GT. This type is not at present available.

Radiotron 6AB7 is the new designation of the existing type 6AB7/1853. No change has been made in the characteristics.

Radiotron 6AC7 is the new designation of the existing type 6AC7/1852. No change has been made in the characteristics.

Radiotron 6AD7-G is a 6.3 volt triode-power pentode. The triode has an amplification factor of 6.0 and a mutual conductance of 325 micromhos and is intended for phase inversion service. With a load resistance of 0.2 megohm, 250 volts supply and a grid bias of 22 to 25 volts the gain is approximately 3. The pentode section has characteristics closely resembling those of type 6F6-G, and the total heater current is 085A. This type is not at present available.

Radiotron 6AE6-G is a single grid, twin-plate triode for supplying the control voltages to the two ray-control electrodes of a twin Magic Eye Tuning Indicator. This type is not at present available.

Radiotron 6X5-GT is a Bantam valve having electrical characteristics identical to those of type 6X5-G. An announcement regarding the availability of this type will be made in this column in a future issue.

Radiotron 7B5-LT is a power pentode on an 8 pin octalox base, having characteristics closely resembling those of type 6K6-GT. This type is not at present available.

Radiotron 7B6-LM is a metal duplex-diode high-mu triode having characteristics electrically identical with type 6B6-G. It is fitted with an 8 pin octalox base. This type is not at present available.

Radiotron 7B8-LM is a metal pentagrid converter having characteristics electrically similar to those of type 6A8-G. It is fitted with an 8 pin octalox base. This type is not at present available.

Radiotron 7C5-LT is a beam power amplifier having characteristics almost identical with those of type 6V6-GT. It is fitted with an 8 pin octalox base. This type is not at present available.

Radiotron 70L7-GT is a combined beam power tetrode and half wave rectifier rated at 110 volts maximum on the amplifier section and 125 volts R.M.S. maximum on the rectifier section. This type is not at present available.

Radiotron 117Z6-GT is a full-wave rectifier voltage doubler with a centre-tapped 117 volt heater. This type is not at present available.

Radiotron 520B, a 5KW. water cooled triode, has now been withdrawn.

Radiotron 801A is a slightly modified type 801, having the same electrical characteristics and dimensions. This type is not at present available.

Radiotron 829 is a push-pull R.F. beam power amplifier intended primarily for ultra-high-frequency transmission. It is generally similar to type 832 but has higher ratings. This type is not at present available.

Radiotron 889 is a 5KW. water-cooled triode which may be operated at maximum ratings at frequencies as high as 50 Mc/s. and at reduced plate voltage and input up to 150 Mc/s. Two grid terminals are arranged on the base to permit low impedance connections.

Radiotron 1652, a 5KW. water-cooled triode, has now been withdrawn.

* * *

Published information on new types does not necessarily imply that stocks are available.

(Continued from page 33.)

As the bias is increased from the normal bias voltage towards the point of cut-off, the input capacitance decreases and approaches the cold capacitance. There is thus a change in input capacitance due to the charge induced on the grid by electrons from the cathode.

In a "temperature limited" valve (e.g., types 6A8-G, 6K8-G or 6SA7 as converters) the hot input capacitance is less than the cold input capacitance. In both "space-charge limited" and "temperature limited" valves there is also an effect on the input capacitance due to the inductance of the cathode lead, but this effect is usually very small.

Further information on this subject is given in the third edition of the Radiotron Designer's Handbook, pages 96 and 98, and methods for reducing the effect are mentioned briefly on pages 159-160.

Published by The Wireless Press for Amalgamated Wireless Valve Co. Pty. Ltd.
Printed by The Cloister Press, 45-49 George St., Redfern