RADIOTRONICS

Registered at the General Post Office, Sydney, for transmission by post as a periodical. Single Copy, One Shilling

VOL. 21 JANUARY 1956 NO. 1

1/-

AMALGAMATED WIRELESS VALVE COMPANY PTY. LTD.

EDITORIAL

Effective with this issue of Radiotronics, the journal has undergone a change in editorship, Mr. D. Cunliffe-Jones being succeeded by Mr. A. J. Gabb. Such a time is appropriate to review the past achievements, and to forecast the proposed form and policy of Radiotronics.

During 1955, the great majority of articles were of Audio circuitry; in particular the Ultra Linear Amplifier was examined in some considerable detail. Application Notes were published on the 5762 and 6BK8/Z729. The journal continued to keep subscribers abreast of RCA new releases. The popularity of Radiotronics increased in no small measure by the inclusion of a variety of articles of practical value.

Mr. D. CUNLIFFE-JONES

• • • •

It is our aim to carry on the tradition of service by providing the articles most welcomed by our readers. These will include further original articles on Audio and Television circuitry from our Applications and Radiotronics Laboratories. We anticipate publishing technical bulletins and pamphlets throughout the year on Receiving and Power Valves, Cathode Ray Tubes and other data required by designer and hobbyist alike. A reprint of Phototube data from Radiotronics, January 1952, has been completed and is now available to Radiotronics subscribers. This year, we may expect many new valves for TV circuits will be introduced in Australia. Further Application Data on these valves will be published as it becomes available.

• • • •

1956 will be a very interesting year for the radio industry. With the impending advent of commercial television in Australia there will be a complete re-orientation of the thinking and policy of many manufacturers and retailers as all climb on this new bandwaggon. TV will, in the near future, become a major contribution to world peace. We may expect some day to see international TV links which will help to create new understanding between the people of the world. Further, the use of TV will be introduced to industrial applications as part of the general trend for electronics to control both industrial and domestic life.

The success of television, as of all undertakings, depends on the service arrangements and the practical desire to assist the public to obtain the best possible TV programmes.

• • • •

Technical queries concerning valves and their applications are welcomed either by mail or phone to our Technical Sales Service, Amalgamated Wireless Valve Company Pty. Ltd., 47 York Street, Sydney.

• • • •

In conclusion, may we give all readers the seasonal greetings for a prosperous Year.

Arthur J. Gabb.

See introductory article in June '53 issue, P.79.

LOW DISTORTION DIODE DETECTOR CIRCUITS

*By E. Watkinson**

Although amplifier design has progressed to a stage at which harmonic distortion figures of 0.1% are readily attainable, typical detector circuits are still of a type which give distortion readings at least ten times greater than this under commonly-encountered conditions.

One of the first difficulties in designing low-distortion detector circuits is to obtain a source of modulated signals in which the modulation distortion is of the same order as that quoted for amplifiers above.

Until such equipment is available for this work, detection-distortion figures for the low-distortion detector circuits given below cannot be quoted, but as a matter of interest a description of the circuits and their method of operation is presented for those who may care to experiment with them.

Conventional Circuits.

Fig. 1 shows a conventional a-m detector followed by an a-f amplifier, and Fig. 2 presents the set of curves by which the operation of the detector circuit can be most readily analysed.

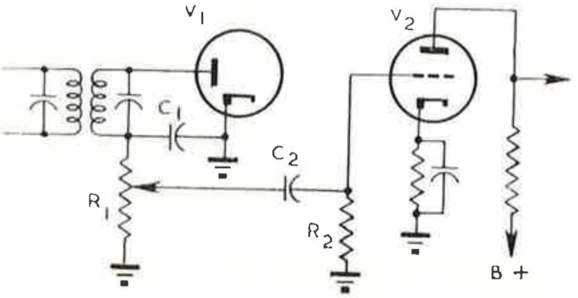


Fig. 1. Conventional a-m detector followed by a-f amplifier.

The curves of Fig. 2 are obtained by applying to the diode plate an a.c. voltage of the value indicated on each curve, in series with a d.c. voltage, and noting the variation in direct current as the d.c. voltage is carried. For example, with an a.c. voltage of 8 volts r.m.s. and a d.c. voltage of —10 volts applied to the diode plate, a current of 40 microamps flows in the diode circuit.

Diode Non-Linearity.

The 0.25, 0.5 and 1 megohm load lines drawn from the original in Fig. 2 show the path of operation of the detector circuit of Fig. 1 with the indicated values of diode loads as the carrier level is changed. By taking as an example a 5 volt r.m.s. 100% modulated signal applied to a detector circuit with a 0.5 megohm diode load the first cause of distortion with typical diode detection circuits will become obvious.

Fig. 2 shows that a steady 5 volt carrier will develop 6.5 volts d.c. across the 0.5 megohm diode load, and since 100% modulation of the carrier results in its varying between 0 and 10 volts the diode-load voltage at the peaks of the modulation can be read from Fig. 2 as —1.0 and —12.9 volts. Thus the a-f output voltage of the diode detector is 5.5. volts in one direction and 6.4 volts in the other, representing a distortion of the order of 3 or 4 per cent.

It will be noted that the inherent cause of the distortion is the voltage, about one volt, that appears across the diode load even when no signal is applied to the circuit. Signals smaller than this standing voltage do not produce a d.c. output proportional to their magnitude.

As all the non-linearity of the path of operation occurs at the low-carrier-voltage end, this type of distortion can be minimized by increasing the carrier amplitude, the checks from Fig. 2 with carrier levels of ten or even fifteen volts will show that distortion as low as 1% is very difficult to obtain with a 100% modulated signal.

However, these considerations explain the common statement that the carrier level at the diode detector should be at least ten volts for reasonably distortion-free detection.

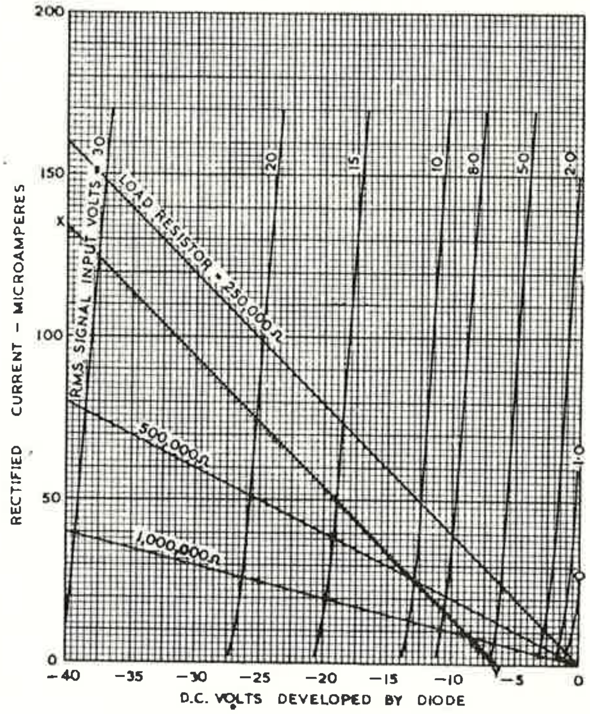


Fig. 2. Typical diode characteristics.

---

* Amalgamated Wireless Valve Co.

Reflex Detector.

Measurements carried out on a reflex detector circuit (A.R.T.S. & P. Bulletin 30, July, 1936) give values of 2½ to 3 per cent. distortion with a 4 volt 100% modulated carrier so that no appreciable improvement can be anticipated from this type of circuit.

Reduction of Modulation in Receiver.

In all normal types of radio receivers, the degree of modulation applied to the detector is always less than the modulation of the incoming carrier, as explained in the 4th edition of the Radiotron Designer's Handbook Section 27.1 (C) (d), page 1078. Moreover, side-band cutting reduces the modulation depth of high frequencies still further.

However, these effects, although minimizing detection distortion to a degree, do not change its order of magnitude, as would be required in order to make the distortion of the detector circuit comparable with that from modern amplifiers.

Diode-Load Shunting.

A second cause of distortion with diode detectors is the shunting of the diode load by either capacitively-coupled resistors (as C_2, R_2 in Fig. 1) or by pure capacitance (as the diode-load bypass C_1 in Fig. 1).

To take a rather extreme case, consider the effect of shunting a 0.5 megohm diode load with a 1 megohm a-f grid leak and a 1 megohm a.v.c. resistor. The three parallel resistors give an a-f load of 0.25 megohm and to examine the operation of such a circuit an a-f load line at a slope of 0.25 megohm is drawn on Fig. 2 at a carrier level of 10 volts.

The path of operation of the detector circuit lies along this new load line and a reduction of carrier level from 10 volts to 5 volts reduces the diode current almost to zero and gives an a-f output voltage of 6.4 volts. However, since the diode current cannot become negative, any further reduction in carrier voltage does not produce a corresponding increase in a-f output voltage. Consequently if the 10 volt carrier is modulated to less than approximately 5 volts, i.e., modulated more than 50%, a flat top appears on the a-f output waveform.

This effect has been summarized by Terman (Radio Engineer's Handbook, 1st edition, p. 555) by stating that the greatest modulation depth, m_{max}, that can be demodulated with low distortion is

$$m_{max} = \frac{Z_m}{R_{DC}}$$

where Z_m = the impedance of the diode load to this modulation frequency,

and R_{DC} = the resistance of the diode load.

The ratio $\frac{Z}{R_{DC}}$ is commonly referred to as the a.c./d.c. ratio of a detector circuit.

Thus for low-distortion detection of a 100% modulated signal with a conventional detector circuit no a.c. shunting of the diode-load resistor is permissible by means of either bypass capacitors or capacitor-coupled resistors (e.g. grid leak of following stage or a.v.c. resistors). A by-pass capacitor is nevertheless essential for conventional diode detection.

Improved Circuits.

Circuits have been devised which by means of feed-back or in other ways make the a.c./d.c. ratio $\frac{Z_m}{R_{DC}}$ as close to unity as possible, e.g., Australian patent 125,163 and Radiotronics, June 53, page 79.

However, the objects of the circuits of Fig. 3 and Fig. 5 are firstly to provide an effective a.c./d.c. ratio greater than unity, and thus to make possible the detection of a 100% modulated a-m signal with a minimum of distortion, and secondly to reduce the curvature of the small-signal characteristic of the diode detector, with a consequent further reduction of distortion.

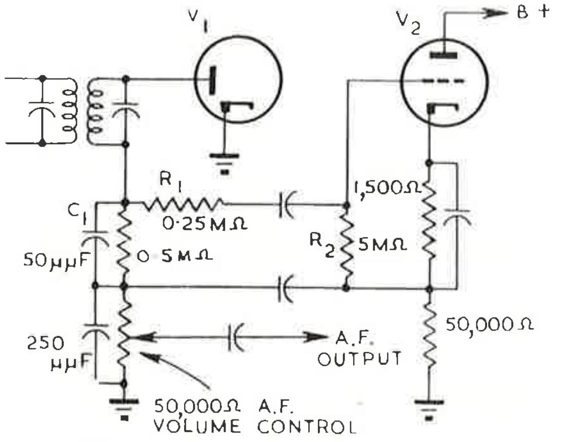


Fig. 3. Circuit to provide effective ac./d.c. ratio greater than unity.

Circuit to Reduce Effect on Shunting Impedance.

Fig. 3 shows one form of the circuit in which, as an introduction, only the former type of distortion is reduced. The valve V1 is a conventional diode and the series-connected 0.5 and 0.05 megohm resistors form the diode load. The grid of cathode-biased valve V2 is connected through the isolating capacitor and the 0.25 megohm r-f filter resistor R_1 to the top of the diode load, and the a-f (cathode) load of V2 is the 50,000 ohm resistor, capacitance coupled to the 50,000 ohm a-f volume control. The series-connected 50 μμF and 250 μμF capacitors across the diode load from the diode load r-f bypass.

Now assume that a voltage gain of 25 times is obtained across the 50,000 ohm cathode resistor from the triode, V2, with respect to any signal applied between its grid and cathode. If a 100% modulated signal is applied to the diode such that a d.c. voltage of 26 volts and a peak a.c. voltage of approximately 26 volts is developed across the whole diode load, then neglecting the voltage-divider action of R_1 and R_2 the a.c. voltage will be divided by V2 in the ratio of 1 volt from grid to cathode (i.e., across the 0.5 megohm section of the diode load) and 25 volts from cathode to ground (i.e., across the 50,000 ohm section of the diode load). This ratio of a.c. voltages will apply regardless of the actual a.c. voltage across the diode load.

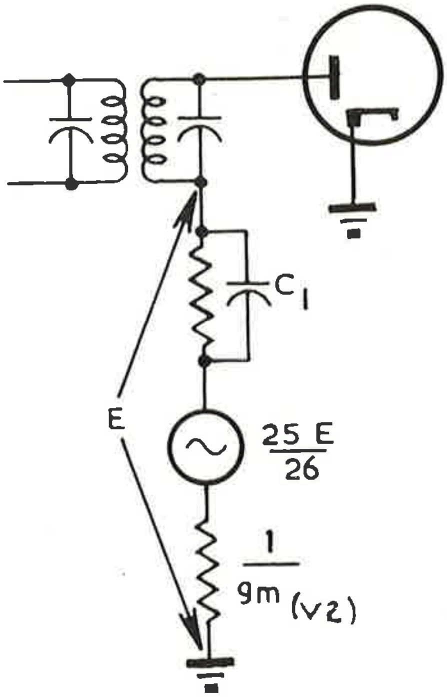


Fig. 4. Circuit of Fig. 2 with V_2 replaced by equivalent generator.

Thus the operation of the detector can be represented as in Fig. 4, in which the function of V2 is taken over by an equivalent generator of impedance equal to the cathode-to-ground impedance of V2 and of a voltage equal to twenty-five twenty-sixths of the value of, and in phase with, the a-f voltage across the diode load.

Moreover, due to the configuration of the circuit, any distortion introduced into the voltage developed across the cathode load resistor is applied out-of-phase to the grid of V2, which, from the point of view of distortion, is operating as a cathode follower.

Considering again the condition in which 26 volts peak a.c. appears across the diode load, since only 1 volt appears across the 0.5 megohm resistor the peak current in the resistor is $\frac{1}{0.5}$ microamps, i.e., 2 microamps.

However, when a current of 2 microamps flows in a circuit with an applied voltage of 26 volts the impedance of the circuit is 13 megohms.

Similarly, the current flowing in the bypass capacitor C_1 is reduced 26 times so that the effective diode load impedance to a.c. is represented by a 13 megohm resistor in parallel with a $2\mu\mu F$ (approx.) capacitor.

These impedance calculations apply regardless of the a-f voltage across the diode load so that even at almost 4 megohms, i.e., eight times greater than the highest frequency normally considered audible, a.c./d.c. ratio is greater than unity and referring back to Fig. 2 it will be seen that the a.c. load line should be at least as linear as the d.c. load line.

Factors in addition to the diode load r-f bypass which in normal circuits reduce the a.c./d.c. ratio of the diode load are the impedances, which are usually connected across the diode load (or a section of the diode load), due to the a-f amplifier and the a.v.c. network. In the circuit of Fig. 3 the a-f output is taken across the output of V2 and thus does not affect the calculations already carried out.

Furthermore, the impedance at the cathode of V2 is approximately $\frac{1}{G_m (V2)}$ which in most cases will be less than 1000 ohms. This low output impedance, which contrasts with the very much higher output impedance of a conventional diode detector, is an advantage if it is desired to make a connecting link between the output of a tuner (terminating in the diode detector) and an a-f amplifier built on a separate chassis.

The a.v.c. voltage is normally taken from the top of the diode load and since in this case the resistive component of the a.c. impedance of the diode load is 13 megohms it is possible to shunt this with an a.v.c. resistor even as low as say one megohm and still have an a.c./d.c. ratio greater than unity. However, a.v.c. is frequently obtained from a separate source, which removes this type of shunting altogether.

Circuit with Improved Linearity.

An alternative to the circuit of Fig. 3, which has additional advantages, is shown in Fig. 5. In this circuit the functions of most of the components are similar to those of Fig. 3, but direct coupling between the diode load and the amplifier valve V2 has brought about some changes.

Firstly the cathode of the diode detector is connected to a positive potential, in this case 100 volts, although the value is not critical, bypassed to r-f and

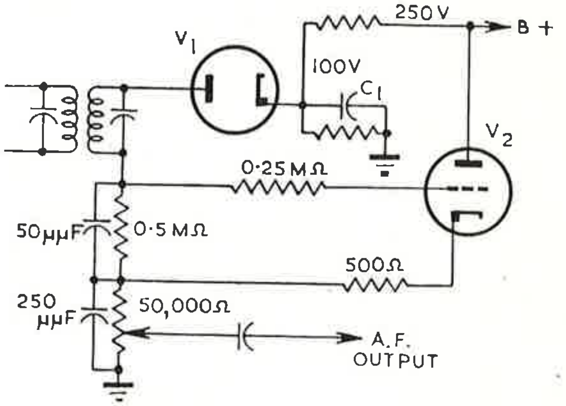


Fig. 5. Circuit with effective a.c./d.c. ratio greater than unity and improved small-signal linearity.

a-f by C_1. Valve V2, for which a triode-connected 6AU6 is suitable, is again cathode-biased, by means of the 500 ohm resistor, to prevent its input impedance being of the same order as that of the 0.5 megohm resistor.

The value of the bias resistor also affects the operation of the detector circuit. If the bias resistor is too large, little current flows through V2 so that the voltage across the 50,000 ohm resistor may be appreciably less than the voltage at the cathode of the diode. Under these conditions the diode will not conduct and detection will not occur.

However, by suitable adjustment of the bias resistor it is possible to apply a slightly negative voltage to the diode plate and thus minimize the non-linearity at the beginning of diode conduction. (The effect in Fig. 2 is to bring the zero-carrier curve closer to a zero d.c. voltage line.)

The value of cathode resistor is not critical (so long as operation too close to diode cut-off is not attempted) as the resistor itself tends to stabilize the cathode current of V2. Moreover, since some of the bias of V2 is due to standing diode current in the 0.5 megohm diode load, the grid of V2 becomes less negative, as the diode tends towards cut-off and draws less current through the resistor. This increases the positive voltage at the diode plate and thus stabilizes the operation of the circuit.

A second advantage of the circuit of Fig. 5 is that its operating characteristics are unaffected as the modulating frequency is reduced even to zero. Because of this the linearity of the circuit can be investigated under static conditions and confirmation of improved linearity has been obtained in this way.

Push-Pull Output.

Although in the above examples the a.c. impedance of the diode load was made much higher than its resistance, the object of the circuit has been achieved so long as the a.c. impedance is at least as high as the resistance. This can be achieved with much less a-f gain than has been obtained from V2 above and the additional gain can be used in other ways.

Firstly, in the circuit of either Fig. 3 or Fig. 5, by the inclusion of a resistor between plate of V2 and B+, of a value equal to the impedance between the cathode of V2 and ground, push-pull output can be obtained from the detector circuit, thus eliminating the need for a special valve or transformer for phase-splitting.

Secondly, since the gain required from the cathode circuit of V2 need only be sufficient to offset any shunting of the diode load that is unavoidable, by keeping this shunting to a minimum very little gain will be required in the cathode circuit of V2. Consequently a comparatively small value of cathode load may be used in conjunction with a normal value of plate load. The a-f output from the detector will then be taken from the plate of V2 as would be the case with a normal a-f amplifier and gain will be obtained from V2.

It is emphasised that the circuits in this article have had only static tests carried out on them and that component values, where specified, are suggested only. However, it seems probable that a substantial reduction in detection distortion should be possible by the methods described, and it is hoped to publish test results at some later date.

• • • •

RCA Power Tube Chart for Amateur Transmitters

CW, FM, AND PHONE TO 30 Mc.

Final Amplifier				Buffer, Doubler, or Oscillator To Drive Final Amplifier	Modulator		
Input Power Watts		Tube Type			Tube Type		
CW & FM	Phone	Qty.	Desig.	Quantity and Tube Types as Shown	Qty.	Desig.	Class of Service
17	15	1	5763	5763 5618 6C4 6AK6	2 1	6AQ5 6N7	AB_1 B
34	30	2	5763	5763 5618 6AG7 6N7	2 2	6F6 6L6	AB_1 AB_1
40	27	1	2E26				
40	27	1	2E24				
50	36	1	832-A				
75	60	2	2E26	2E26 5763 6L6 6AG7	2 2 1 1	6L6 2E26 829-B 6524	AB_1 AB_1 AB_1 AB_1
75	60	1	807				
85	55	1	6524				
90	67.5	1	6146				
150	120	2	807	2E26 5763 6L6 6V6	2 2	807 6146	AB_2 AB_2
180	135	2	6146				
260	175	1	811-A	6146 807 2E26 6L6	2 2	807 6146	B AB_2
260	175	1	812-A				
300	240	1	8005	6146 807 2E26	2 2	811-A 6146	B AB_1
345	270	1	4-65A	807 2E26 6L6	4 2	807 811-A	AB_1 B
500	400	1	813				
500	380	1	4-125A/ 4D21				
520	350	2	812-A	6146 807 2-2E26	2 2 2	811-A 812-A 8005	B B B
600	480	2	8005				
750	500	1	8000				
1000	675	1	4-250A/ 5D22	6146 807 2E26	2	810	B
1000	760	2	4-125A/ 4D21		2	813	AB_1
1000	800	2	813		2	8000	B
1000	1000	1	833-A	2-6146 2-807 814	4	8005	B
1000	1000	2	8000				

CHARTS FOR AMATEURS

Reprinted from RCA "Headliners for Hams" with acknowledgments to RCA Tube Division, Harrison, N.J.

FREQUENCY MULTIPLIERS

Values shown are for Intermittent Commercial and Amateur Service (ICAS), unless otherwise indicated.

RCA Type	Multiplier Service	Max. Plate Ratings			Max. DC Grid-No. 1 Volts	Max. DC Grid-No. 1 Current Ma.	Typical Operation								
		DC Volts	DC Current Ma.	Dissipation Watts			Plate DC Volts	Plate DC Current Ma.	Grid No. 2 DC Volts	Grid No. 2 DC Current Ma.	Grid No. 1 DC Volts	Grid No. 1 DC Current Ma.	Grid No. 1 Peak RF Volts	Approx. Driving Power Watts	Approx. Power Output Watts
2E26	Doubler to 15 Mc	600	85	13.5	−175	3.5	600	55	185	11	−75	3	92	0.23	20
807	Doubler to 15 Mc	750	100	30	−200	5	750	90	250	5.5	−90	5	110	0.45	40
5618	Doubler to 80 Mc	300	30	5	−125	3	300	25	75	5.5	−125	1.85	160	0.75	4.2
	Tripler to 80 Mc	300	30	5	−125	3	300	25	75	5.5	−125	1.85	160	0.75	3.4
5763	Doubler to 175 Mc♦	300	50	12	−125	5	300	40	250	4	−75	1	95	0.6	3.6
	Tripler to 175 Mc♦	300	50	12	−125	5	300	35	237.5	5	−100	1	120	0.6	2.8
6417	Same as 5763 except for 12.6-volt/0.375-amp. heater														
6146	Doubler to 60 Mc	750	130	25	−150	4	750	90	150	7	−138	3	158	0.45	45
6524	Tripler to 462 Mc	400	115	25	−200	4	300	110	250	6.5	−148	2.9	—	4	8.5

♦ Values shown are for Continuous Commercial Service (CCS).

RECTIFIERS, THYRATRONS

RCA Type	Cathode Volts	Cathode Amp.	Max. Dimensions Inches Length	Max. Dimensions Inches Diam.	Max. Plate or Anode Ratings Peak Inverse Volts	Peak Amperes	Average Amperes
RECTIFIERS							
5R4-GY	5	2	5$\frac{5}{16}$	2$\frac{1}{16}$	2800†	0.65†°	0.175†
816	2.5	2	4$\frac{11}{16}$	1$\frac{9}{16}$	7500	0.5	0.125
866-A	2.5	5	6$\frac{9}{16}$	2$\frac{7}{16}$	10000 2000	1 2	0.25 0.5
THYRATRONS							
2D21	6.3	0.6	2$\frac{1}{8}$	$\frac{3}{4}$	1300▲	0.5•	0.1•
2050	6.3	0.6	4$\frac{1}{8}$	1$\frac{9}{16}$	1300▲	1•	0.1•
5696	6.3	0.15	1$\frac{3}{4}$	$\frac{3}{4}$	500▲	0.1•	0.025•

† Design-Center Values. ° Per Plate. • Cathode Current.

GLOW-DISCHARGE TUBES

RCA Type	Max. Dimensions Inches Length	Max. Dimensions Inches Diam.	Approx. DC Starting Volts	Operating Conditions Min. DC Anode—Supply Volts	Approx. DC Operating Volts	Regulation for Specified Current Range Ma.	Regulation for Specified Current Range Volts
VOLTAGE-REGULATOR TYPES							
OA2	2$\frac{5}{8}$	$\frac{3}{4}$	156	185	151	5 to 30	2
OA3	4$\frac{1}{8}$	1$\frac{9}{16}$	100	105	75	5 to 40	5
OB2	2$\frac{5}{8}$	$\frac{3}{4}$	115	133	108	5 to 30	1
OC3	4$\frac{1}{8}$	1$\frac{9}{16}$	115	133	108	5 to 40	2
OD3	4$\frac{1}{8}$	1$\frac{9}{16}$	160	185	153	5 to 40	4
VOLTAGE-REFERENCE TYPES							
5651	2$\frac{1}{8}$	$\frac{3}{4}$	107	115	87	1.5 to 3.5	3

▲ Max. Peak Forward Anode Volts for 2D21 & 2050 is 650 volts; for 5696, 500 volts.

CATHODE-RAY TUBES

OSCILLOGRAPH TYPES

RCA Type	Heater Rating Volts	Heater Rating Amp.	Max. Overall Length Inches	Min. Useful Screen Diam. Inches	Max. Final Anode Volts	Deflection Factor Volts DC/In. DJ$_1$ & DJ$_2$†	Deflection Factor Volts DC/In. DJ$_3$ & DJ$_4$‡
Electrostatic Focus & Deflection Types							
2BP1	6.3	0.6	7$\frac{13}{16}$	1$\frac{3}{4}$	2500	230 to 310	148 to 200
3RP1	6.3	0.6	9$\frac{3}{8}$	2$\frac{3}{4}$	2500	146 to 198	104 to 140
5UP1	6.3	0.6	15$\frac{1}{8}$	4$\frac{1}{2}$	2500	56 to 77	46 to 62

† Deflecting electrodes nearer base ‡ Deflecting electrodes nearer screen

CAMERA TYPES

RCA Type	Heater Rating Volts	Heater Rating Amp.	Max. Image or Pattern Size Inches	Max. High-Voltage Supply Volts	Resolution Capability Lines
5527	6.3	0.6	Image Size 1.4 Diagonal Electrostatic Focus and Deflection	900	250
6198	6.3	0.6	Image Size 0.62 Diagonal Magnetic Focus and Deflection	350	600

VIDICON

MODULATORS OR RF LINEAR AMPLIFIERS (Single-Sideband)

Values shown are for Intermittent Commercial and Amateur Service (ICAS), unless otherwise indicated.
Tube types in italics are receiving types useful in amateur transmitters.

Type	Class of Service	Max. Plate Ratings†			Typical Operating Conditions (Two Tubes, Except Where Shown)								
		DC Volts	DC Input Watts	Dissipation Watts	DC Plate Volts	DC Grid-No. 2 Volts	DC Grid-No. 1 Volts	Peak AF Grid-No. 1 to Grid-No. 1 Volts	Zero-Signal DC Plate Current Ma.	Max.-Signal DC Plate Current Ma.	Plate-to-Plate Load Ohms	Approx. Max.-Sig. Driving Power Watts	Approx. Max.-Sig. Power Output Watts
6AQ5	AB$_1$	250	—	12	250	250	−15	30	70	79	10000	—	10
6N7	B°	300	—	11	300	—	0	82	35	70	8000	—	10
6V6	AB$_1$	315	—	12	285	285	−19	38	70	92	8000	—	14
6L6	AB$_1$ AB$_2$	360	—	19	360 360	270 270	−22.5 −22.5	45 72	88 88	132 205	6600 3800	— —	26.5 47
829-B	AB$_1$°◆	750	100	30	600	200	−18	36	40	110	13750	0	44
2E24	AB$_2$	500	37.5	13.5	500	125	−15	82	20	150	9000	0.46	54
2E26	AB$_2$	500	37.5	12.5	500	125	−15	60	22	150	8000	0.36	54
6524	AB$_2$°	600	85	25	600	200	−26	76	21	135	11400	0.1	57
807	AB$_2$ B△	750 750	90 90	30 30	750 750	300 0	−35 0	96 555	30 15	240 240	7300 6650	0.2 5.3	120 120
6146	AB$_2$	750	90	25	750	165	−46	108	22	240	7400	0.04	131
811-A	B	1500	235	65	1500	—	−4.5	170	32	313	12400	4.4	340
813	AB$_1$#	2500	450	125	2500	750	−95	180	50	290	19000	0	490
810	B	2750	510	175	2250	—	−60	380	70	450	11600	13	725

Grid No. 3 connected to filament center-tap.

† All ratings are Absolute Maximum values except for types in italics for which Design-Center values are given.

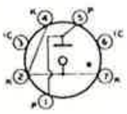
◆ Values shown are for Continuous Commercial Service (CCS).

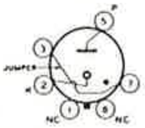
△ Audio driving signal fed to Grid No. 2. Grid No. 1 tied to Grid No. 2 through 20,000-ohm, 2-watt resistor.

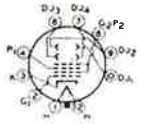
° Values are for both units.

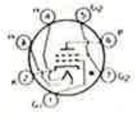
BOTTOM VIEWS OF SOCKET CONNECTIONS

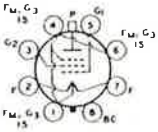
BC = Base Sleeve
DJ = Deflecting Electrode
F = Filament
F_M = Filament Mid-Tap
G = Grid
H = Heater
H_M = Heater Mid-Tap
IC = Internal Connection—Do not Use
IS = Internal Shield
K = Cathode
NC = No Connection
● = Gas-Type Tube
P = Plate (Anode)
S = Shell
SJ = Signal Electrode
U = Unit

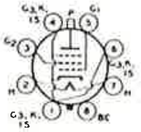

OA2 OB2 5651

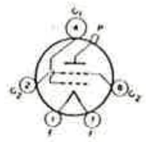

OA3 OC3 OD3

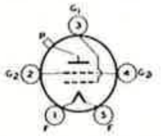

2BP1 3RP1 5UP1

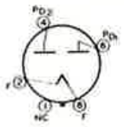

2D21 5696

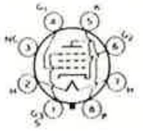

2E24

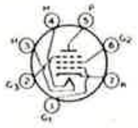

2E26 6146

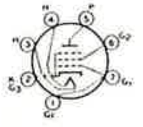

4-65A

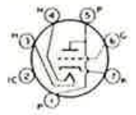

4-125A/4D21 4-250A/5D22

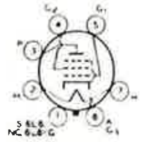

5R4GY

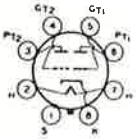

6AG7

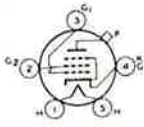

6AK6

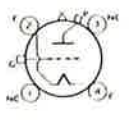

6AQ5

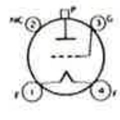

6C4

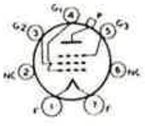

6F6 6L6 6V6

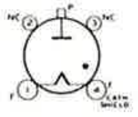

6N7

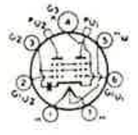

807

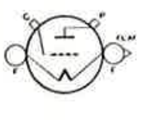

810 8000

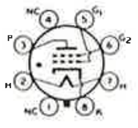

811-A 812-A 8005


813

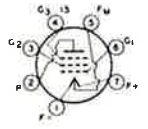

816 866-A

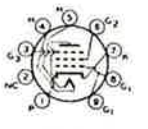

829-B 832-A

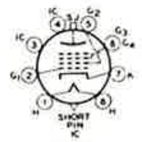

833-A

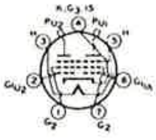

2050


5527


5618


5763 6417


6198


6524

CLASS C AMPLIFIERS AND OSCILLATORS

Values shown are for Intermittent Commercial and Amateur Service (ICAS), unless otherwise indicated.
Tube types in italics are receiving types having Class C ratings exclusively for amateur service.

RCA Type	Class of Service	Max. Plate Ratings☐			Max. Frequency for Full Input Mc	Cathode		Amplification Factor*	Interelectrode Capacitances (Approx.) μμf			Max. Dimensions Inches		Typical Operating Conditions						
		DC Input Watts	DC Volts	Dissipation Watts		Volts	Amp.		C_{gp}	C_{in}	C_{out}	Length	Diam.	DC Plate Volts	DC Grid-No. 3 Volts	DC Grid-No. 2 Volts	DC Grid-No. 1 Volts	DC Plate Current Ma.	Approx. Driving Power Watts	Approx. Power Output Watts
TRIODES																				
6C4	CW	8	350	5	60	6.3	0.15	18	1.6	1.8	1.3	2⅛	¾	350	—	—	−100	25	—	5.5
6N7	CW●	10.3	350	5.5	30	6.3	0.8	35	—	—	—	3¼	1 5/16	350	—	—	−100	30	—	7.25
811-A	CW Phone	260 175	1500 1250	65 45	30	6.3	4	160	5.6	5.9	0.7	6 21/32	2 7/16	1500 1250	—	—	−70 −120	173 140	7.1 10	200 135
812-A	CW Phone	260 175	1500 1250	65 45	30	6.3	4	29	5.5	5.4	0.77	6 9/16	2 7/16	1500 1250	—	—	−120 −115	173 140	6.5 7.6	190 130
8005	CW Phone	300 240	1500 1250	85 75	60	10	3.25	20	5	6.4	1	6 11/16	2 7/16	1500 1250	—	—	−130 −195	200 190	7.5 9	220 170
8000	CW Phone	750 500	2500 2000	175 125	30	10	4.5	16.5	6.4	5	3.3	8¾	2¼■	2500 2000	—	—	−240 −370	300 250	18 20	575 380
833-A	CW Phone	1000 1000	3300 3000	350 250	30	10	10	35	6.3	12.3	8.5	8 13/16	4 9/32	3000 3000	—	—	−160 −240	335 335	20 26	800 800
BEAM POWER TUBES AND PENTODES																				
6AK6	CW	5.5	375	3.5	60	6.3	0.15	9.5	0.12	3.6	4.2	2⅛	¾	375	—	250	−100	15	—	4
5618	CW	7.5	300	5	100	3 6	0.46 0.23	5.4	0.24	7	5	2⅝	¾	300	0	75	−45	25	0.2	5.4
6AG7	CW	10.5	375	9	30	6.3	0.65	22	0.06	13.0	7.5	3¼	1 5/16	375	—	250	−75	30	—	7.5
6AQ5	CW	15.7	350	8	60	6.3	0.45	10	0.35	8.3	8.2	2⅝	¾	350	—	250	−100	47	—	11
6V6	CW	15.7	350	8	30	6.3	0.45	9	0.3	10.0	11	3¼	1 5/16	350	—	250	−100	47	—	11
5673	CW Phone	17 15	350 300	13.5 12	50	6	0.75	16	0.3	9.5	4.5	2⅝	⅞	350 300	0 0	250 250	−28.5 −42.5	48.5 50	0.1 0.15	12 10
6417	Same as 5763 except for 12.6-volt/0.375-amp. heater.																			
6F6	CW	20	400	12.5	30	6.3	0.7	7	0.26	6.5	13.5	3¼	1 5/16	400	—	275	−100	50	—	14
6L6	CW	40	400	21	30	6.3	0.9	8	0.4	10	12	4 5/16	1⅝	400	—	300	−125	100	—	28
2E24	CW Phone	40 27	600 500	13.5 9	125	6.3	0.65	7.5	0.12	9.5	7	3 21/32	1 5/16	600 500	—	195 180	−50 −45	66 54	0.21 0.16	27 18
2E26	CW Phone	40 27	600 500	13.5 9	125	6.3	0.8	6.5	0.2	12.5	7	3 21/32	1 5/16	600 500	—	185 180	−45 −50	66 54	0.17 0.15	27 18
832-A	CW° Phone°	50 36	750 600	20 15	200	6.3 12.6	1.6 0.8	6.5	0.07	8.0	3.8	3 5/16	2⅜	750 600	—	200 200	−50 −70	65 60	0.24 0.21	35 26
807	CW Phone	75 60	750 600	30 25	60	6.3	0.9	8	0.2	12	7	5¾	2 1/16	750 600	—	250 300	−45 −85	100 100	0.3 0.4	54 44
6524	CW° Phone°	85 55	600 500	25 16.7	100	6.3	1.25	8.5	0.11	7	3.4	3 9/16	1 13/16	600 500	—	200 200	−44 −61	120 100	0.2 0.2	56 40
6146	CW Phone	90 67.5	750 600	25 16.7	60	6.3	1.25	4.5	0.22	13.5	8.5	3 13/16	1 23/32	750 600	—	160 150	−62 −87	120 112	0.2 0.4	70 52
829-B	CW° Phone°	120 90	750 600	40 28	200	6.3 12.6	2.25 1.12	9	0.12	14.5	7	4 5/16	2⅜	750 600	—	200 200	−50 −60	160 150	0.4 0.5	90 70
4-65A	CW◆ Phone◆	345 275	3000 2500	65 45	50	6	3.5	5	0.08	8.0	2.1	4⅜	2⅜	3000 2500	—	250 250	−100 −135	115 110	1.7 2.6	280 230
4-125A/ 4D21	CW◆ Phone◆	500 380	3000 2500	125 85	120	5	6.5	5.9	0.05	10.8	3.1	5 11/16	2⅞	3000 2500	—	350 350	−150 −210	167 152	2.5 3.3	375 300
813	CW Phone	500 400	2250 2000	125 100	30	10	5	8.5	0.25	16.3	14.0	7½	2 9/16	2250 2000	0 0	400 350	−155 −175	220 200	4 4.3	375 300
4-250A/ 5D22	CW◆ Phone◆	1000 675	4000 3200	250 165	110	5	14.5	5.1	0.12	12.7	4.5	6⅜	3 9/16	4000 3000	—	500 400	−225 −310	312 225	2.46 3.2	1000 510

☐ All ratings, including those shown for receiving-type tubes, are Absolute Maximum Values.

° Values are for both units.

● Values are for each unit.

* For beam power tubes and pentodes the values shown are for mu factor, Grid No. 2 to Grid No. 1.

◆ Values shown are for Continuous Commercial Service (CCS).

■ Maximum Radius.

Note: For types shown in italics —

Plate Modulated Service: Reduce plate voltage 20%; increase Grid-No. 1 voltage as follows: Divide plate volts by amplification factor and multiply by three.

Doubler Service: Increase Grid-No. 1 voltage as follows: Divide plate volts by amplification factor and multiply by three.

144-MEGACYCLE TRANSMITTER

Part II: Operation and Adjustment

*By R. M. Mendelson,** **W2OKO**

* RCA Tube Division, Harrison, N.J.

Reprinted with acknowledgments to RCA

Operation

After all wiring has been checked, insert RCA's 5763 crystal oscillator-tripler (V_3) and 5763 doubler (V_4). Use an 8-Mc crystal that will put the final signal near 146 Mc. If the coils are peaked for this frequency there will be adequate drive at both ends of the band. (A grid-dip meter to tune the coils roughly is a help. It is not essential, however.) Plug a 1- or 2-ma meter into J_1, apply 250 volts to the oscillator circuit and tune the plate of the oscillator (L_6) for a maximum reading. Approximately ½ to 1 ma should be obtained easily.

Now insert the push-pull tripler 5763's (V_5 and V_6) but do not connect them to B+. Move the meter to J_2 and add the doubler (V_4) to the B+ line. Tune doubler coil L_7 for maximum reading — between .75 and 2 ma. Spread or squeeze the tripler grid coils (L_{10}) for the highest maximum reading. If this reading is still too low, it may be necessary to couple link L_8 closer to the doubler coil. Moving this link will necessitate a touch-up of the doubler slug.

Insert the RCA-5894 final without B+ and let it warm up for 2 minutes. While waiting, set the screen bypass trimmer to the middle of its range. B+ should then be applied to all the multipliers but not to the final. Set excitation control R_{17} to maximum. Tune for maximum final grid-current by adjusting the plate-tank capacitor of the push-pull tripler. At least 5 ma should be indicated. Values of 8 ma have been obtained easily on the transmitter built. Back down R_{17} to give a reading of 4 to 5 ma.

Before applying high voltage to the final, it is wise to check for parasitics. Remove excitation by pulling out tripler tubes V_5 and V_6. Apply about 100 volts to the 5894 plate and screen circuit. Tune the final and push-pull tripler tuning capacitors through their ranges. If any combination of settings shows grid current, it indicates parasitic oscillation in the final stage. The usual procedure for hunting parasitics at VHF apply, but first make certain that the rotor of the final tuning capacitor is ungrounded. Adjustment of this screen bypass trimmer also may help. This trimmer setting is not critical, but in the absence of parasitics it should be set for maximum final grid current.

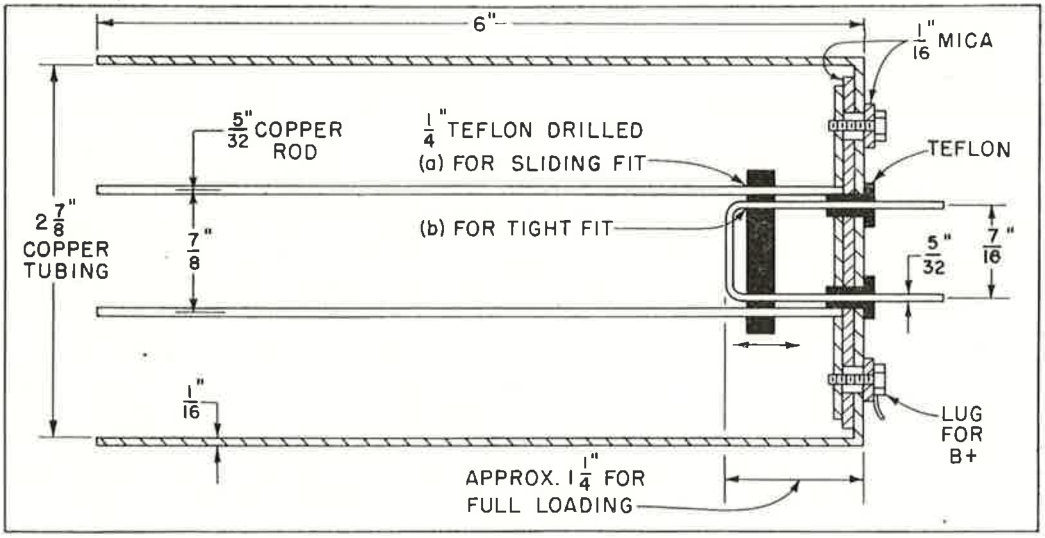


Fig. 1. Construction details for the 144-Mc final tank assembly.

The tripler tubes may now be reinserted and their plate circuit returned for maximum final grid current. Next, a 100-watt lamp dummy load should be attached to the antenna tuner output. Pull the coupling link full out and set the antenna tuner for maximum capacitance. Apply high voltage to the final, then immediately tune tank capacitor C_{31} for a dip in plate current. Adjust the antenna tuner for a maximum plate-current reading. The load bulb should light brightly.

With 450 volts on the plate, the current should be kept below 160 ma. If plate current is much less than this value, the loading may be increased by moving the antenna link a bit further in on the tank files. (*First, turn off the power.*) Little movement is neccessary to obtain full load.

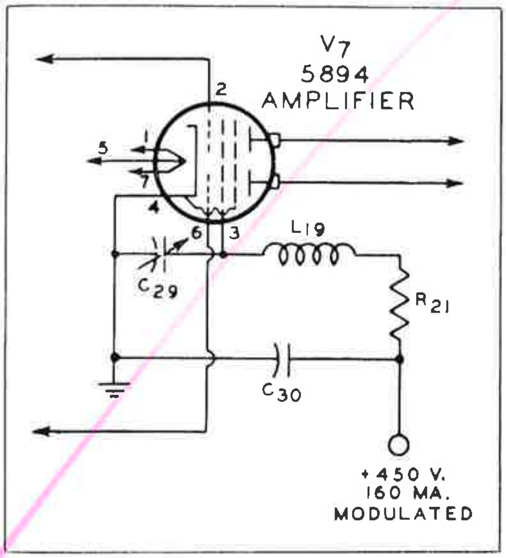


Fig. 2. Original circuit user R_{21} without additional 5894 screen-lead choke, but addition of L_{19} (Ohmite Z-50) allows more complete neutralization of the final.

To check the antenna-coil tap spacing, replace the dummy load with the antenna coaxial feed-line and repeat the tuning procedure — starting with minimum coupling to the final tank. Begin with the antenna coil taps about $\frac{1}{2}$ turn from each end. If peaking the antenna tuner changes plate tuning, move the taps about $\frac{1}{8}$ turn. Repeat the tuning procedure until the correct tap points are found. You are now "on the air", crystal controlled.

VFO Adjustment

To start the VFO, remove power from final and multiplier stages and insert RCA's 6AU6 oscillator and 5763 buffer (V_2). Set the panel selector switch to "VFO" and apply B+ to the 6AU6. It should now be oscillating and its range may be checked on any communications receiver. For complete two-meter-band coverage, the oscillator should tune from 8.00 to 8.22 Mc. Use C_1 to set the band edge. Calibration may be done either with the fundamental, on the low-frequency receiver or, later, on a two-meter receiver.

With the oscillator running, it is now only necessary to tune the buffer plate to 8 Mc. Set the VFO to mid-band (8.11 Mc) and apply high voltage to all stages except the final. (The final may not have sufficient excitation until the buffer is adjusted.) Tune the buffer coil for maximum grid current at the final. The 5894 may now be fired up.

There will be a slight drop in final grid current when the VFO is tuned away from the centre of the band, but adequate drive (4-5 ma) can always be obtained by proper setting of excitation control R_{17}.

Some thought was given to protecting the 5894 against loss of excitation. The use of a clamp tube on a modulated final is difficult at 144 Mc, where wires easily become quarter-wave lines. In the end, no protective devices were added here. No trouble has been encountered — so far.

Acknowledgment

The author wishes to thank James A Shiels, K2DI, and Frank Maraguglio, W2LXB, for their ideas and aid in constructing the final tank and antenna tuner.

Addenda

In Part I, the centre-to-centre measurement for the antenna link (L_{15}) was incorrectly noted as $\frac{19}{32}$". The correct dimension is $\frac{7}{16}$".

Also in Part I it was noted that R_{21} served both as resistor and rf choke. It has been found, however, that the addition of an actual rf choke allows more complete neutralization of the final. (See Figures 2 and 3.)

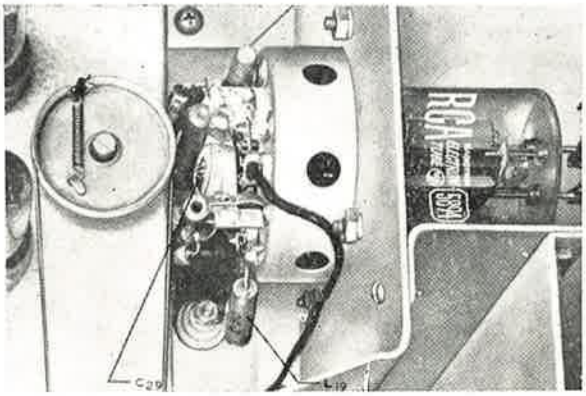


Fig. 3. Close-up of the 5894 socket. L_{19} runs directly from screen pin to feed-through that connects with R_{21}.


AWV