RADIOTRONICS

AMALGAMATED WIRELESS VALVE COMPANY LIMITED

Technical Bulletin No. 63

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In this issue:-

5 VALVE BATTERY RECEIVER

Illustrating special arrangements for preventing distortion on large aerial input signals. Only a single I.F. stage is used and the sensitivity and selectivity are improved by the use of high efficiency iron-core I.F. transformers.

In Technical Bulletin No. 61 two circuits were described, each using two I.F. stages in order to prevent distortion due to overloading. As a natural consequence of the use of two I.F. stages the sensitivity and selectivity were found to be exceptionally good and the design is to be recommended in every way. There is, however, a demand for receivers with only a single I.F. stage, even though it is admitted that the performance to be expected is not so good as that with two I.F. stages. One problem which has confronted the designer of a battery receiver with a single I.F. stage, has proved extremely serious. Even where a compromise on sensitivity and selectivity can be permitted, the high distortion with large aerial input signals is sufficiently serious to discourage the use of such a receiver.

In Technical Bulletin No. 57, on page 5, there are given the characteristics of Radiotron 1C4 with special screen and bias voltages. These are repeated for convenience in reference.

Radiotron 1C4

Plate voltage	135 volts
Screen voltage	90 volts
Grid voltage	–3 volts
Plate Current	1.5 mA
Screen Current	0.5 mA
Amplification Factor	1300
Mutual Conductance	700 micromhos
Plate Resistance	1.85 megohms

If desired, the screen voltage may be obtained from the 135-volt supply through a dropping resistor. This results in a longer grid-base, which is particularly desirable for the I.F. stage when A.V.C. is applied.

A disadvantage of this longer grid-base is that the A.V.C. characteristic is not nearly as level as with normal operation on a screen supply voltage of 67.5 volts. This is not usually regarded as a fault of the same magnitude as the distortion due to overloading in the I.F. stage and consequently where a compromise with a single I.F. stage must be adopted this arrangement appears to be most suitable. Ideally, the *R.F. Valve* (*Radiotron* 1C4) should have its screen supply from a 90-volt tapping, while the I.F. valve should have its screen supplied through a dropping resistor, but in practice there does not appear to be any necessity for this elaboration. It will be found that although the A.V.C. characteristic is far from the ideal, it is nevertheless sufficiently satisfactory to prevent overloading under any normal receiving conditions even with only two controlled stages. This is, of course, partly due to the lower sensitivity of the receiver with the single I.F. stage, since a higher sensitivity would result in a more powerful input to the grid of the I.F. valve.

As a consequence it has been found unnecessary to apply A.V.C. to the converter stage even on the broadcast band. There is no doubt that a better A.V.C. characteristic could be obtained by using A.V.C. on the 1C6 on the broadcast band, and some designers may prefer to do so, but the receiver described in this bulletin is shown with only two controlled stages in order to demonstrate the performance which can be obtained with the simpler arrangement. It will be observed that Circuit A51 incorporates no switching beyond that necessary for coil changing and the usual battery switching, none being required for the valves or A.V.C.

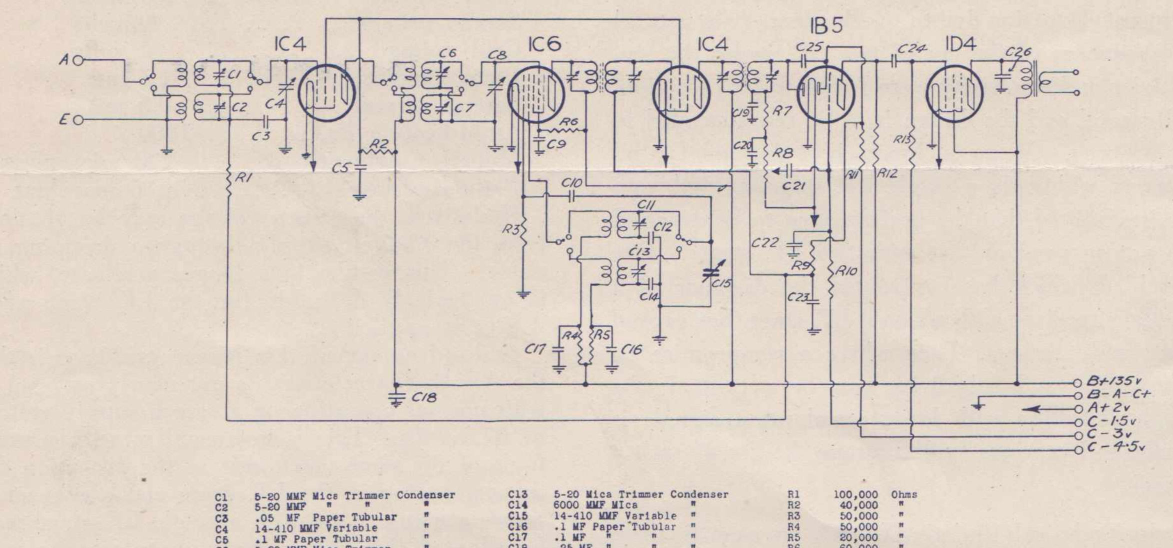
If additional sensitivity in the R.F. stage is desired, this may readily be obtained at the expense of rather higher plate and screen currents. The screen voltage may be increased to 135 volts if the higher plate current (3.6mA) is permissible, or any intermediate screen voltage may be employed through the use of a suitable dropping resistor. The R.F. stage gain may be taken as proportional to the mutual conductance, which is 1160 micromhos at Ep = 135, Eg2 = 135, Eg1 = –3. Consequently the R.F. stage gain will be increased by 65% through this arrangement.

The *converter valve* is a 1C6 operated with zero bias and slightly over 45 volts screen voltage. In the circuit diagram the screen voltage is shown as being obtained through 60,000 ohm dropping resistor from 135 volts. This arrangement avoids the use of a separate tapping on the B battery. The zero bias on Radiotron 1C6 is thoroughly recommended as giving higher sensitivity and more satisfactory performance than under biassed conditions. It should be noted that the dropping resistor in the anode-grid circuit is changed from 50000 ohms on the broadcast band to 20000 ohms on the short-wave band without additional switching.

The *I.F. valve* is another Radiotron 1C4 operated, as already explained, with A.V.C. and a screen dropping resistor from 135 volts to reduce distortion. No appreciable reduction in plate and screen currents is possible without a serious decrease in stage gain. In this receiver iron-core I.F. transformers were used in order to increase the sensitivity and selectivity. Although these are still considerably below the results obtainable with two I.F. stages, the performance is very much better than with a single I.F. stage and air core I.F. transformers. Air core I.F. transformers may be used if desired, without any alteration in the circuit or constants.

The *Second Detector* is Radiotron 1B5 arranged to give a delay of about 4 volts in the A.V.C. action. In the circuit diagram the control grid of the 1B5 is shown biassed –1.5 volts, but it may quite well be biassed –3.0 volts if it is desired to decrease the number of taps on the C battery.

The *Output Valve* is Radiotron 1D4, giving an audio output of about 300 milliwatts. Note the addition of an impedance compensating condenser effectively across the primary of the loudspeaker transformer. In place of the pentode output valve a class B stage, using Radiotrons 30 as driver and 19 as power output, may be employed as described in Technical Bulletin No. 61.



C1	5-20 MMF Mica Trimmer Condenser	C13	5-20 Mica Trimmer Condenser	R1	100,000 Ohms
C2	5-20 MMF " " "	C14	6000 MMF MIca "	R2	40,000 "
C3	.05 MF Paper Tubular "	C15	14-410 MMF Variable "	R3	50,000 "
C4	14-410 MMF Variable "	C16	.1 MF Paper Tubular "	R4	50,000 "
C5	.1 MF Paper Tubular "	C17	.1 MF " " "	R5	20,000 "
C6	5-20 MMF Mica Trimmer "	C18	.25 MF " " "	R6	60,000 "
C7	5-20 MMF " " "	C19	200 MMF Mica "	R7	100,000 "
C8	14-410 MMF Variable "	C20	250 MMF " "	R8	500,000 " Potemtiometer
C9	.1 MF Paper Tubular "	C21	.05 MF Paper Tubular "	R9	1 Megohm
C10	100 MMF Mica "	C22	100 MMF Mica "	R10	1 "
C11	5-20 MMF Mica Trimmer "	C23	.05 MF Paper Tubular "	R11	1 "
C12	400 MMF Mica Condenser + 10-50 Mica Trimmer Condenser	C24	.05 MF " " "	R12	250,000 Ohms
		C25	1000 MMF Mica "	R13	500,000 "
		C26	2000 MMF " "		

INTERMEDIATE FREQUENCY 465 K.C.

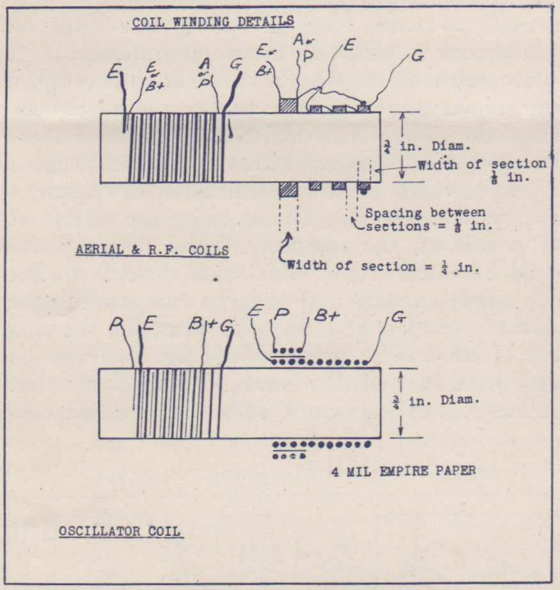
RADIOTRON CIRCUIT A51 — 2 VOLT DUAL WAVE BATTERY RECEIVER.

AMALGAMATED WIRELESS VALVE Co. LTD., SYDNEY

Coil Details

The coil details given here are only to be regarded as explanatory and not necessarily to be used as a standard. It is hoped that designers will make comparative sensitivity and stage gain calculations, and from these determine the reason for any differences in overall sensitivity. Considerable latitude is possible in coil design, but it should be remembered that poor coils are the most frequent cause of low sensitivity and high noise level.

These coils are wound on formers ¾-inch diameter in place of 1-inch, as used for the receivers in Technical Bulletin No. 61. All coils for the short-wave band have the primary and secondary interwound, so as to give more nearly optimum



coupling over the band. The overall sensitivity on each waveband is very nearly constant over the whole band, this being due to the design of the coils.

Coil.	Primary.	Secondary.
Aerial 550-1500 Kc.	375 turns 40 S.W.G.; S.S.E. with one turn over hot end of secondary.	120 turns 5/44 Litz in 3 sections.
Aerial 19-50 metres	4 turns 28 B. & S.; D.S.C., interwound from bottom of secondary.	11¼ turns 22 B. and S. Enamel wound in screw-cuts 16 T.P.I.
R.F. 550-1500 Kc.	950 turns 40 S.W.G.; S.S.E. with one turn over hot end of secondary.	120 turns 5/44 Litz in 3 sections.
R.F. 19-50 metres	10 turns 28 B. & S., D.S.C., interwound from bottom of secondary.	11⅛ turns 22 B. and S. Enamel wound in screw-cuts 16 T.P.I.
Oscillator 550-1500 Kc.	30 turns 34 B. & S. Enamel wound over bottom of secondary.	100 turns 31 B. and S. Enamel.
Oscillator 19-50 metres	7½ turns 44 S.W.G., D.S.C., interwound from bottom of secondary.	10 turns 22 B. and S. Enamel wound in screw-cuts 16 T.P.I.

N.B.—SHIELD CAN, Internal Diameter 2⅛ inch.

Summary of Performance

Sensitivity.—2.0 – 2.9 microvolts (broadcast). 15 – 19 microvolts (short-wave).

Selectivity.—1000 to 1 ratio; 35 k.c. width at 600 k.c; 45 k.c. width at 1400 k.c.

Noise Level.—Signal to noise voltage ratio at 5 microvolts input: 20-28% (broadcast).

Battery Drain.—A battery: .66 amperes; B battery: 15.2 milliamperes (broadcast), 16.2 milliamperes (short-wave).

Harmonic Distortion at constant output of 100 milliwatts.

Input to Aerial: 1000 k.c.

Input.	Distortion %
30 μV	3.0%
100,000 μV	3.0%
200,000 μV	7.0%
400,000 μV	8.2%
700,000 μV	15.0%
1 volt	17.0%

Battery Drain

Stage.	Valve.	Current (mA)	
		B.C.	S.W.
R.F.	1C4	2.0	2.0
Converter	1C6	3.5	4.5
I.F.	1C4	2.0	2.0
2nd Det.	1B5	0.2	0.2
Output	1D4	7.5	7.5
Total Drain	—	15.2	16.2

Sensitivity

Position.	Frequency	Sensitivity	Stage Gain	5μV Noise Level*
I.F. Grid	465 k.c.	9300 μV		
Converter Grid	465 k.c.	150 B.C. / 120 S.W.	62 / 77.5	
	600 k.c.	170	54.5	
	1000 k.c.	170	54.5	
	1400 k.c.	190	49	
	6 M.C.	160	58	
	10 M.C.	170	54.5	
	15 M.C.	150	62	
R.F. Grid	600 k.c.	15	11.3	
	1000 k.c.	20	8.5	
	1400 k.c.	24.1	7.9	
	6 M.C.	60	2.65	
	10 M.C.	45	3.8	
	15 M.C.	69	2.2	
Aerial Terminal	600 k.c.	2.0	7.5	28%
	1000 k.c.	2.9	6.8	20%
	1400 k.c.	2.7	8.9	24%
	6 M.C.	15	4.0	
	10 M.C.	16	2.8	
	15 M.C.	19	3.6	

* Voltage Ratio.

RCA APPLICATION NOTE ON RECEIVER DESIGN

This note from R.C.A. discusses a variety of topics, some of which are not directly applicable to Australian conditions, but is reprinted as received.

The power output characteristics of the 6R7, the remarks on rectifier sputter and the increased rating of the 6H6 should be noted, while the description of special arrangements in battery receiver circuits is interesting even though particularly applicable to American conditions.

Power Output Characteristics of the 6R7

(a) When the triode section of the 6R7 is operated as a Class A amplifier, an output of about 300 milliwatts at 6 per cent. distortion can be obtained. This output was measured under the following conditions: Plate voltage, 250 volts; grid bias, –9 volts; a-c plate load, 8500 ohms; d-c plate load, nearly zero. These conditions are easily satisfied in practice, since the low plate impedance of this valve permits coupling it to the following valve by a transformer. Another desirable characteristic of the 6R7 is that power output and distortion are not critically dependent on plate load. Output measurements show that a decrease in load impedance from 20000 ohms to 6000 ohms produces an increase in power output from 260 to 275 milliwatts, respectively; the maximum output of about 300 milliwatts is obtained with a load of 8500 ohms. The distortion, which increases with decreasing load impedance, is 3 per cent. with a 20000-ohm load and 8 per cent. with a 6000-ohm load.

Voltage Rating on Valves

(b) It is common practice to design the power-supply system of a radio receiver to deliver recommended maximum voltages to the plates and screens of the valves at a specified line voltage. When the line voltage exceeds the specified value, the electrode voltages may rise high enough to shorten valve life appreciably. As a remedy, it is suggested that the equipment provide recommended heater voltage for a line voltage of 117 volts and maximum plate and screen voltages for a line voltage of 125 volts. The design of heaters is such that a rise in line voltage from 117 to 125 volts does not seriously reduce valve life.

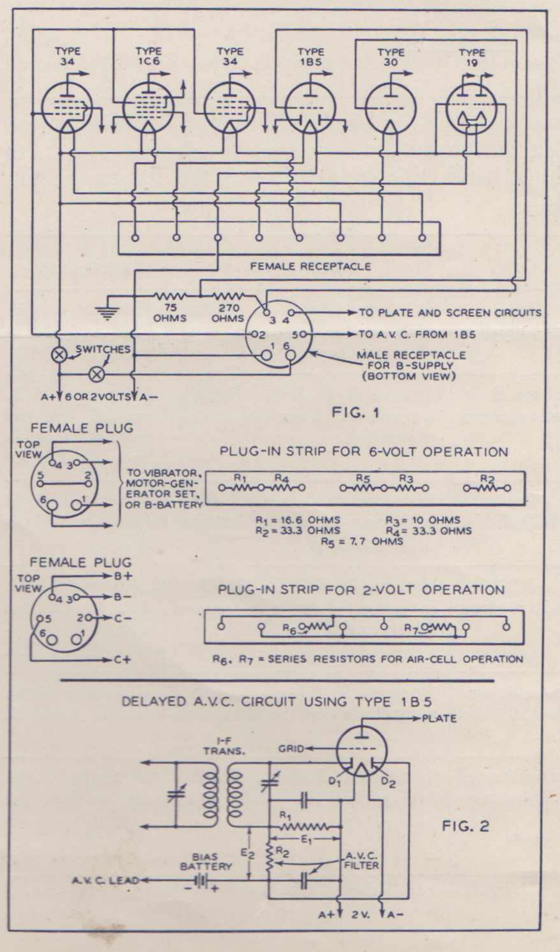
Series-Filament Operation of 2-Volt Valves

(c) Series-filament operation of the 2-volt series is recommended, provided certain precautions are taken to insure normal life performance. First, the filament circuit should be arranged so that removal of a single valve does not cause excessive rise in the filament voltage of the remaining valves. Second, shunt resistors should be employed across certain filaments in order to by-pass the plate current flowing in the filament circuit.

(d) Some six-volt, series-filament receivers that employ mechanical B-supply units use a separate rectifier valve to obtain bias voltage for the output valve. When such a circuit arrangement is used, it is suggested that the filament of this rectifier be connected in series with that of the output valve. This arrangement insures that the output valve is inoperative when the rectifier is removed from the circuit. If this precaution is not observed, the plate current of the output valve may rise to an abnormally high value when the rectifier is removed from the circuit.

(e) The grid biases for certain valves in most 6-volt, series-filament receivers are obtained by connecting grid-return leads to appropriate points in the filament circuit. If the comparatively large plate current of the output valve flows through a filament circuit to which grid-return leads are connected, the potential of all these grid-return leads will vary in accordance with the plate current of the output valve. Thus, regeneration or degeneration may be present. To minimize the effects of this condition, the filament of the output valve should be connected in series with that of another valve whose input signal is large compared to the possible variation in bias. For example, the filament of the output valve should be connected in series with that of the final i-f amplifier valve. The filament of the second detector should be con-

SCHEMATIC CIRCUIT OF "UNIVERSAL" RECEIVER



nected in series with that of the oscillator-mixer valve.

(f) By means of a suitable switching scheme, a receiver that employs the 2-volt series of valves can be designed to operate from several types of A- and B-voltage sources. For example, the switching scheme can easily permit series-filament operation from a 6-volt storage battery or parallel-filament operation from a 2-volt air cell. If B-voltage is furnished by a mechanical B-supply unit, the switching scheme can also connect the grid-return leads to the proper points in the filament circuit in order to obtain bias. Thus, a single switching arrangement can provide for the operation of a receiver from either a 6-volt storage battery and mechanical B-supply unit or a 2-volt air cell and dry B and C batteries. Fig. 1 shows a plug-in switching scheme that has been installed in several receivers in order to facilitate operation from these typical voltage sources. The exclusive use of filament-type valves will insure low power consumption, regardless of the source of filament power.

(g) Fig. 2 is the diagram of a simple a-v-c circuit that delays a-v-c action until the carrier voltage at the detector exceeds a certain value. This circuit uses the filament voltage of the 1B5 as the delay voltage; hence, no separate battery is required for delay purposes. When no signal is received, diode D_2 is positive with respect to the negative side of the filament; therefore, current flows through R_1, R_2, and the D_2-filament circuit. When the carrier voltage at the detector exceeds $(E_1 + E_2)$, the a-v-c diode (D_2) does not conduct; the full a-v-c voltage is then applied to the controlled valves. No a-v-c action occurs until the carrier voltage at the detector equals $(E_1 + E_2)$. The voltage drop across R_1 and R_2 must be considered when the bias applied to the controlled valves is determined.

Rectifier-Valve Sputter

(h) If a close-spaced rectifier valve is connected between a power-supply line of low impedance and a condenser-input filter, the initial charging current of the first filter condenser may be high enough to damage the cathode of the valve. This effect is also present when plate voltage is applied repeatedly while the cathode is emitting electrons. To remedy this condition, it is necessary to limit the initial charging current to a safe value. A receiver that employs a power transformer is not subject to such rectifier-valve failures, because the leakage inductance and resistance of the usual power transformer is great enough to limit the initial charging current to a safe value. However, the effect is prevalent in 220-volt receivers that do not use transformers. The remedy in this case is to insert a 100-ohm resistor in series with each plate of the rectifier valve. This connection has the advantage of retaining the current-limiting action of 100 ohms of resistance for each half of the rectifier; yet, it produces the same line-voltage drop as only 50 ohms connected in a circuit that is common to both rectifier plates.

Increased Current Rating of the 6H6

(i) The direct-current output rating of the 6H6 has been increased to 4 milliamperes, maximum, for either full- or half-wave operation. The a-c voltage per plate remains at 100 volts (RMS), maximum. This higher current rating permits the use of the 6H6 in a wider variety of circuits than was heretofore possible. The use of this tube as a power rectifier to furnish a fixed C bias to a power amplifier is suggested.

CLASS AB OPERATION OF TYPE 6F6 VALVES CONNECTED AS PENTODES

N.B.—The information given is also directly applicable to type 42.

The operating conditions for obtaining optimum performance from two type 6F6 valves when they are connected as pentodes and operated as a Class AB amplifier depend upon permissible distortion, desired power output, limitations of plate and screen dissipation, the efficiencies of available input transformers, and practical values of equivalent resistance in plate and screen circuits. The usual considerations for optimum Class AB operation are based on the assumption that the equivalent series resistance in the plate and screen circuits is nearly zero. Because this assumption is seldom justifiable in practice, it is the purpose of this Bulletin to discuss the effect of plate and screen resistance on the operation of two type 6F6 valves when they are connected as pentodes and operated as a Class AB amplifier.

Description of Circuit

Fig. 1 is the schematic diagram of the circuit used in these tests. A 6F6, connected as a triode, was used as a driver and was coupled to the output stage by means of a suitable interstage transformer. Power for plate and screen circuits was furnished by a high-voltage battery (E) of nearly zero resistance. The voltage of this battery and the current through the bleeder were adjusted before each test to give the voltages indicated on the diagram. The plate voltage for the driver and the screen voltage for the output valves were obtained from the same point on the power-supply unit. The driver valve was self-biassed throughout the tests; the bias for the output valves was obtained either from a battery or from a self-biassing resistor, depending upon the nature of the test.

The circuit shown is similar to that used in practice. Resistor R_d may be replaced by a choke whose resistance equals R_d; resistor R_b represents the resistance of the power transformer, rectifier valve, and any choke that may be used in the first filter section. In general, however, the plate voltage of pentode output valves need not be choke-filtered because of the high plate resistance of these types.

Plate and Screen Regulations

The total resistance in the plate circuit of the 6F6 output valves consists of: (1) r_p, the plate resistance of the valves; (2) R_p, the load resistance; (3) R_c, the series resistance common to grid and plate circuits; and (4) R_b, the equivalent series resistance of that section of the power-supply unit common to the plate circuit. The total resistance in the screen circuit consists of: (1) r_d, the screen-cathode resistance of the valves; (2) R_c, the series resistance common to grid and plate circuits; and (3) R, the equivalent series resistance of the entire power-supply unit. It should be noted that R_c in self-biassed circuits is the value of the bias resistor.

If a plate-voltage source of nearly zero resistance is used in place of a regular power-supply system, and if resistance is then introduced in series with this source until it has the same voltage regulation as the regular power-supply system, the resistance added to the source is the equivalent series resistance of the regular power supply. In practice, the equivalent series resistance is determined by measuring the slope of the line joining the voltage outputs at zero and maximum power output. These voltages correspond to minimum and maximum current drain. Referring to Fig. 1, it is noted that plate regulation is determined by measuring the voltage across points 1 and 2 corresponding to zero output and to maximum output; similarly, screen regulation is determined by measuring the voltages across points 3 and 2 for the same conditions.

It is evident that the screen regulation is always greater than the plate regulation in the circuit of Fig. 1. However, for the purpose of this note, it is convenient to refer to plate regulation as the value of R_b and to screen regulation as the additional resistance R_d. This is also desirable from a practical point of view, since R_d usually represents the resistance of the field coil of a loudspeaker.

Description of Tests

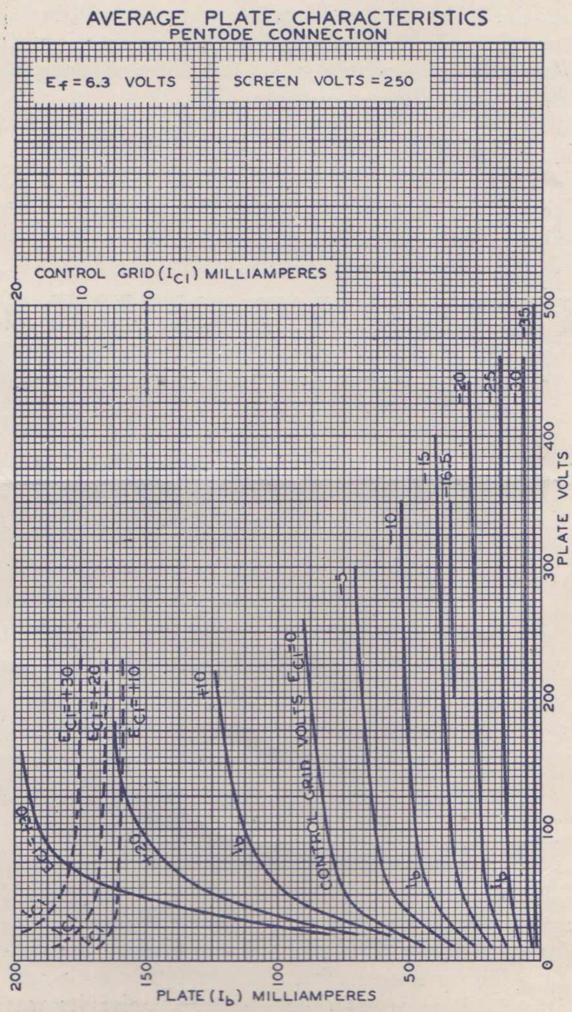
With the circuit of Fig. 1, preliminary tests were conducted in order to determine the optimum input-transformer ratio and the optimum plate-to-plate load for both fixed- and self-bias conditions and for practical values of plate and screen regulation. The results of these tests show that the optimum plate-to-plate load is substantially independent of plate regulation, screen regulation, or the method of obtaining bias; the value of the load depends upon the power output desired, the permissible distortion, and the allowable plate and screen dissipation. The optimum input-transformer ratio was found to be dependent on plate and screen regulation and as to whether the bias is obtained from a battery or from a self-biassing resistor.

After optimum conditions for each test were determined, signal was applied to the input of the driver; the grids of the output valves were driven positive during a portion of the input-voltage cycle in order to obtain high output. Power output, distortion, plate current, screen current, and control-grid current were then measured. In each test, maximum signal input to the driver was that which just caused driver grid current to flow.

(A) Fixed-Bias Operation

The curves of Fig. 2 show the variation of screen current, plate current, control-grid current, and distortion vs. power output for two operating conditions: (1) zero plate regulation and zero screen regulation; and (2) 1000-ohm plate regulation and 2000-ohm screen regulation. The control-grid bias was fixed throughout this test. As mentioned previously, a different optimum input-transformer ratio was required for each operating condition; these optimum ratios are shown in the figure and in the Summary Table.

Curves for conditions (1) and (2) show that the same power output (approximately 19 watts at 5 per cent. distortion) can be obtained from either operating condition if the input-transformer ratio is optimum in each case. The data in Fig. 2 and in the Summary Table also show that driver grid current started to flow with a smaller input signal



Radiotron 6F6

SCHEMATIC DIAGRAM OF TEST CIRCUIT FOR 6F6'S OPERATED AS CLASS AB PENTODES

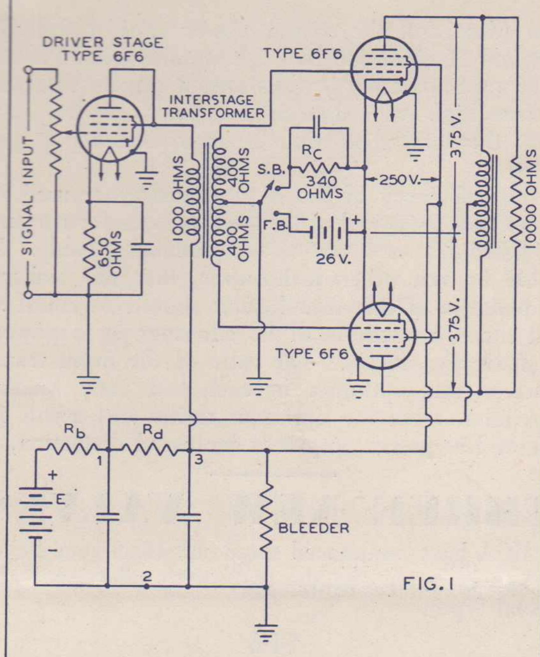


FIG. 1

S.B. = SELF-BIAS CONNECTION
F.B. = FIXED-BIAS CONNECTION
R_b = EQUIVALENT SERIES RESISTANCE OF POWER-SUPPLY IN PLATE CIRCUIT
R_d = ADDITIONAL EQUIVALENT SERIES RESISTANCE OF POWER-SUPPLY IN SCREEN CIRCUIT

Radiotron 6F6

OPERATION CHARACTERISTICS
PENTODE CONNECTION—CLASS AB OPERATION

E_f = 6.3 VOLTS

INPUT STAGE: CLASS A DRIVER—ONE TYPE 6F6 AS TRIODE
PLATE VOLTS = 250
SELF-BIAS RESISTOR = 650 OHMS
OUTPUT STAGE: CLASS AB—TWO TYPE 6F6'S AS PENTODES
ZERO-SIGNAL PLATE VOLTS = 375, FROM SOURCE HAVING RESISTANCE (R_b) SHOWN IN TABLE
ZERO-SIGNAL SCREEN VOLTS = 250, FROM THE ABOVE 375-VOLT PLATE SUPPLY THROUGH RESISTANCE (R_d) SHOWN IN TABLE
ZERO-SIGNAL BIAS VOLTS = −26, FROM GRID-BIAS SUPPLY HAVING ZERO RESISTANCE
OUTPUT LOAD, PLATE TO PLATE = 10000 OHMS

				DRIVER STAGE		INTERSTAGE TRANSFORMER	
CONDITION	CURVE	R_b Ohms	R_d Ohms	Input-Sig. Volts* (RMS)	Plate Load Ohms	Voltage Ratio Prim.:1/2 Sec.	Peak Power Efficiency %
1	———	0	0	14.5	58500	3.33:1	40.3
2	– – –	1000	2000	10.1	21800	1.54:1	73.5

* For maximum output

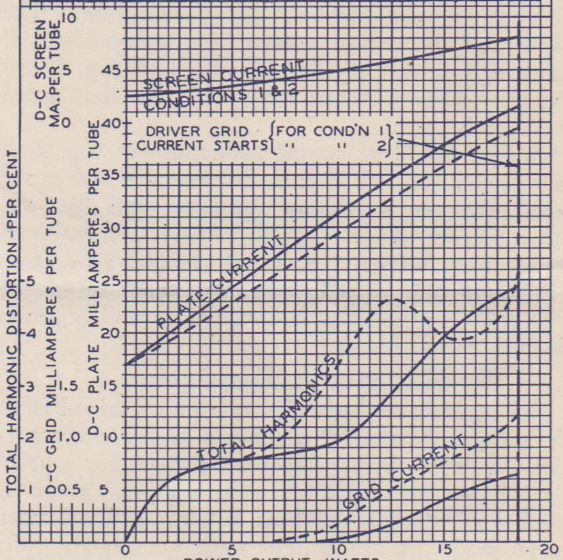


FIG. 2

Radiotron 6F6

OPERATION CHARACTERISTICS
PENTODE CONNECTION—CLASS AB OPERATION

E_f = 6.3 VOLTS

INPUT STAGE: CLASS A DRIVER—ONE TYPE 6F6 AS TRIODE
PLATE VOLTS = 250
SELF-BIAS RESISTOR = 650 OHMS
OUTPUT STAGE: CLASS AB—TWO TYPE 6F6'S AS PENTODES
ZERO-SIGNAL PLATE VOLTS = 375, FROM SOURCE HAVING RESISTANCE (R_b) SHOWN IN TABLE
ZERO-SIGNAL SCREEN VOLTS = 250, FROM THE ABOVE 375-VOLT PLATE SUPPLY THROUGH RESISTANCE (R_d) SHOWN IN TABLE
ZERO-SIGNAL BIAS VOLTS = VALUE FROM GRID-BIAS RESISTOR (R_C) OF 340 OHMS
OUTPUT LOAD, PLATE TO PLATE = 10000 OHMS

				DRIVER STAGE		INTERSTAGE TRANSFORMER	
CONDITION	CURVE	R_b Ohms	R_d Ohms	Input-Sig. Volts* (RMS)	Plate Load Ohms	Voltage Ratio Prim.:1/2 Sec.	Peak Power Efficiency %
1	———	0	0	14.6	51100	2.50:1	47.7
2	– – –	1000	2000	10.3	33100	1.74:1	64.4

* For maximum output

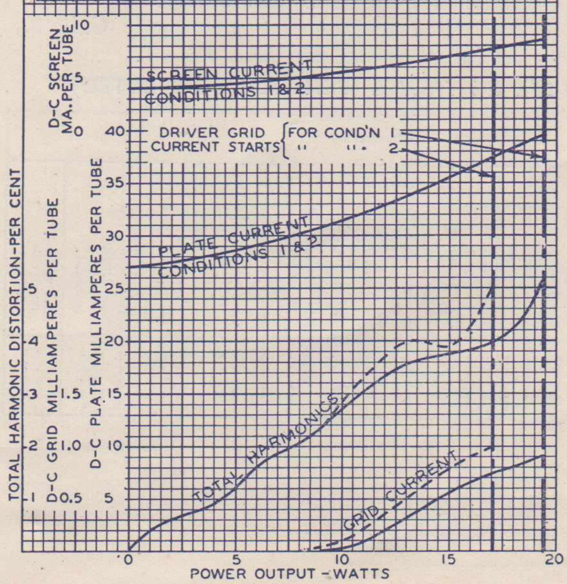


FIG. 3

Radiotron 6F6

OPERATION CHARACTERISTICS
PENTODE CONNECTION—CLASS AB OPERATION

E_f = 6.3 VOLTS

INPUT STAGE: CLASS A DRIVER—ONE TYPE 6F6 AS TRIODE
PLATE VOLTS = 250
SELF-BIAS RESISTOR = 650 OHMS
OUTPUT STAGE: CLASS AB—TWO TYPE 6F6'S AS PENTODES
ZERO-SIGNAL PLATE VOLTS = 375, FROM SOURCE HAVING RESISTANCE (R_b) SHOWN IN TABLE
ZERO-SIGNAL SCREEN VOLTS = 250, FROM THE ABOVE 375-VOLT PLATE SUPPLY THROUGH RESISTANCE (R_d) SHOWN IN TABLE
ZERO-SIGNAL BIAS VOLTS = VALUE FROM GRID-BIAS RESISTOR (R_C) OF 340 OHMS
OUTPUT LOAD, PLATE TO PLATE = 10000 OHMS

		DRIVER STAGE		INTERSTAGE TRANSFORMER	
R_b Ohms	R_d Ohms	Input-Signal Volts* (RMS)	Plate Load Ohms	Voltage Ratio Prim.:1/2 Sec.	Peak Power Efficiency – %
1000	2000	10.3	33100	1.74:1	64.4

* For maximum output

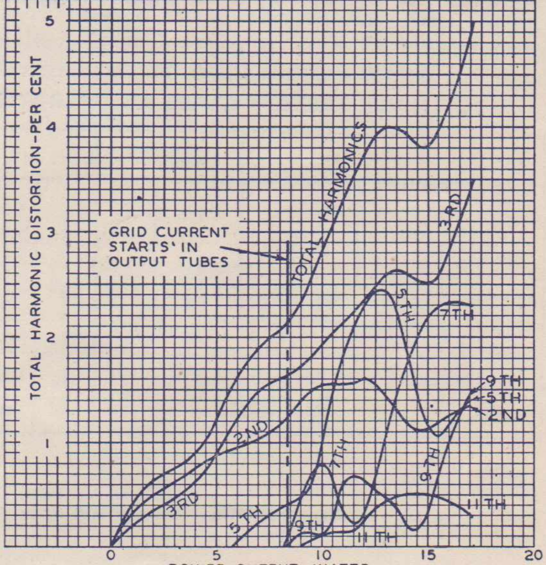


FIG. 4

in (2) than in (1), even though the maximum power output was the same for each test. This is due, of course, to the effect of the screen regulation (R_d) in reducing the driver plate voltage and, hence, the driver bias.

(B) Self-Bias Operation

The results of the self-bias test, shown by curves for conditions (1) and (2), in Fig. 3, indicate that approximately 17 to 19 watts at 5 per cent. distortion can be realised if the input-transformer ratio is optimum for each operating condition. The plate and the screen current are independent of plate and screen regulation, although the distortion for a given power output is dependent upon regulation.

Comparing these curves with those of Fig. 2, it is seen that the rise in cathode current was less for self- than for fixed-bias operation and that the effect of regulation was to reduce the optimum power output from 19.4 to 17.1 watts, a decrease of only about 12 per cent. The introduction of regulation in the fixed-bias test did not change the power output.

Harmonic Distortion

A harmonic analysis of the output obtained from the set-up of test (B), was made in order to ascertain the nature of the distortion present for a practical operating condition. The optimum plate-to-plate load was 10,000 ohms, the input transformer ratio was 1.74, the valves were completely self-biassed, and plate and screen regulation were 1000 and 2000 ohms, respectively. The results are shown in Fig. 4. Only second and third harmonics are present at low signal levels, after which fifth, seventh, ninth, and eleventh harmonics appear. At high signal levels, high-order odd harmonics form an appreciable part of the total distortion. The lack of high-order even harmonics is due, of course, to the cancellation of these harmonics in the plate circuit of the push-pull stage. The second harmonic shown is introduced by the driver stage; a smaller driver will increase this distortion for the same power output.

Conclusion

Two 6F6's, when connected as pentodes in a push-pull circuit and operated beyond the grid-current point, can provide power outputs up to approximately 19 watts at 5 per cent. distortion; the actual output depends upon the regulation of the plate and the screen power supply and the method of obtaining bias. It should also be noted that approximately 8 watts output can be obtained before high-order distortion appears; at this output, the total distortion is approximately 2 per cent.

The efficiency of the input transformer used in these tests is typical of the average transformer and is listed for each test in the Summary Table. It must be remembered, however, that the leakage inductance of this transformer should be small at all times, regardless of its efficiency as a power-transferring device. The ratio of the input transformer was optimum in each test; any serious deviation from the optimum ratios will result in either less power output or increased distortion.

THREE NEW VALVES

RCA have announced three new types, one being a battery valve and the two others additional all-metal types.

1F6

This valve is a 2-volt battery duo-diode pentode corresponding to the 6B7S in the A.C. series.

6N7

The 6N7 is an all-metal valve having characteristics identical with type 6A6 in the glass series.

5W4

The 5W4 is an all-metal rectifier having characteristics somewhat similar to the 80.

Filament 5.0 volts: 1.5 Amps.
Plate Volts R.M.S.: 350 maximum.
D.C. output Current: 110 mA. max.

Errata in Technical Bulletin No. 61

You are requested to make the following corrections to your copy of Radiotronics Technical Bulletin No. 61:—

Pages 2 and 3:

In the two circuit diagrams A61 and A71 the 1B5 grid return should go to C –1.5 volts instead of to earth.

Page 7:

In the table at the head of Column 1 the values for 15 M.C. should read:—
R.F. Grid 15 M.C. 6.6 μV. Stage Gain 2.2.
Aerial Terminal 15 M.C. 3.3 μV.

SUMMARY TABLE — CLASS AB OPERATION OF TYPE 6F6 VALVES (PENTODE CONNECTED)

INDEX	DRIVER STAGE[1]				INTERSTAGE TRANSFORMER[2]		OUTPUT STAGE[3]												
	Tube Type	Input-Signal Volts (RMS)	Plate Load Ohms	Max. Power Output Milliwatts	Primary / 1/2 Secondary	Peak Power Efficiency Per Cent	Resistance (R_b) of Plate-Supply Source Ohms	Additional Resistance (R_d) of Screen Supply Ohms	Grid-Supply Resistance (R_c) Ohms	Grid-Input Peak Power Milliwatts	Grid-Input Peak Voltage Volts (per tube)	D-C Grid Current Milliamperes (per tube)	Zero-Signal D-C Plate Current Milliamperes (per tube)	Max.-Signal D-C Plate Current Milliamperes (per tube)	Zero-Signal D-C Screen Current Milliamperes (per tube)	Max.-Signal D-C Screen Current Milliamperes (per tube)	Power Output Watts (2 tubes)	Total Harmonic Distortion Per Cent
Fig.2	6F6#	14.5	58500	290	3.33:1.0	40.3	0	0	0*	117	37.3	0.65	17	41.5	2.5	8.0	18.5	4.9
Fig.2	6F6#	10.1	21800	288	1.54:1.0	73.5	1000	2000	0*	210	47.4	1.2	17	39.5	2.5	8.0	18.5	5.1
Fig.3	6F6#	14.6	51100	365	2.50:1.0	47.7	0	0	340	174	52.3	0.9	27	39.5	4.0	8.5	19.4	5.1
Fig.3	6F6#	10.3	33100	261	1.74:1.0	64.4	1000	2000	340	168	50.5	1.0	27	37.5	4.0	7.5	17.1	5.0

Screen connected to plate. * Fixed bias of –26 volts.

[1] Zero-signal plate voltage, 250 volts; zero-signal plate current, 31 ma., self-bias resistor, 650 ohms; plate resistance (rp), 2600 ohms.

[2] Primary resistance, 1000 ohms; secondary resistance, 400 ohms each half, equivalent core loss resistance, 100000 ohms.

[3] Zero-signal plate voltage, 375 volts; zero-signal screen voltage, 250 volts, plate-to-plate load, 10000 ohms.