RADIOTRONICS

AMALGAMATED WIRELESS VALVE CO. PTY. LTD.

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

TECHNICAL BULLETIN No. 79 6th SEPTEMBER, 1937

In this issue:—

SHORT-WAVE 1C6 OPERATION.

Improved Conditions for Zero Bias.

Radiotron 1C6 was first suggested for use with zero bias in Radiotronics 57 (24th December, 1935) and since that date the conditions of zero bias operation have been adopted throughout Australasia. Zero bias operation gives lower B Battery drain, together with distinctly higher sensitivity, than operation with a negative bias under similar conditions. While it has been very widely adopted on broadcast frequencies it has been less widely adopted on the short wave band owing to the fear of unsatisfactory performance. As a result of improvements made in the production of the Australian made Radiotron 1C6, this valve is now capable of operating at zero bias on the short wave band with entire satisfaction. In order to enable every user of a Radiotron 1C6 to obtain equally satisfactory results on the short wave band, a set of conditions has been standardised which is recommended for the short wave band of all dual wave receivers. These conditions may also be used in receivers having more than one short wave band.

These new conditions cover a wave band range from 16 to 51 metres and will not only give satisfactory coverage under the conditions specified, but also give a very satisfactory margin of safety so that the valves do not fail to oscillate even with the A Battery run down to 1.8 volts and the B Battery at 90 volts simultaneously. The sensitivity under these recommended conditions is very much superior to that which the 1C6 is capable of giving under negative bias and, as a consequence, the zero bias conditions are much to be preferred. This preference is made even greater since the Australian-made Radiotron 1C6 valves are factory tested under conditions of zero bias simulating the conditions of short wave operation over the band 16 to 51 metres.

In order that satisfactory results may be obtained it is essential to use the best coils which can be designed for the particular application, and a considerable amount of investigation has been made in the laboratory of Amalgamated Wireless Valve Co. Pty. Ltd., with the result that coils made according to the specifications given on this page are satisfactory in every regard. These coils were designed for use with a gang condenser having a capacity of 9-398 $\mu\mu$F. If condensers having other capacity limits are used, it will be necessary to adjust the inductance of the coils so that the correct band coverage is obtained without having to increase the capacity of the trimmer condenser. The coils will cover the correct wave band, provided that the total effective minimum stray capacities, including those of the coil, the wiring, the trimmer condenser and the valve do not exceed 35 $\mu\mu$F. It will be necessary to adopt a layout giving short leads and the minimum of stray capacities in order that this value should not be exceeded. The trimmer condenser used in the tests on these coils had a capacity of 2-20 $\mu\mu$F and was adjusted to as low a capacity setting as possible. In order to obtain the full sensitivity, it is essential that correct tracking should be obtained, and in every differing layout a certain amount of work is necessary in order to obtain this result. Experience has shown that with different layouts (affecting stray capacities and lead inductances) a variation of capacity in the padder condenser may be necessary, even with identical coils and other operating conditions. In the receiver on which tests were made, the

SHORT WAVE 1C6 OPERATION (Continued)

padder condenser had a capacity of 4,000 $\mu\mu$F.

In order to give a slight additional assistance to oscillation at the low frequency end of the band (51 metres) the padder feedback arrangement, as shown in Radiotron circuit A55, described in Radiotronics 75, Page 26, is strongly desirable. Although better feedback is obtainable by the use of a small padder condenser, it is not desirable to use a lower capacity padder than is necessary for correct tracking. If the recommended conditions are followed, there is no necessity for decreasing the capacity of the padder condenser below that for satisfactory tracking in order to obtain increased oscillator strength on 51 metres.

Conditions of Short-Wave Operation.

Radiotron 1C6 (Australian Made).

Wave Band Coverage	16-51 metres.
Gang Condenser	9-398 or 10-390 $\mu\mu$F.
Total Effective Stray Capacities	35 or 34 $\mu\mu$F respectively.
Coils	as shown in diagram.
B Battery	135 Volts (minimum).
Screen Voltage	135 Volts through 60000 ohms. dropping resistor.
Anode Grid Voltage	135 Volts through 20000 ohms. dropping resistor.
Control Grid Bias	0 (fixed).

Under these conditions the operating characteristics of an average valve will be:—

Plate Current	1.5 mA
Screen Current	1.3 mA
Anode Grid Current	1.9 mA
Total	4.7 mA

Oscillator Grid Current for above conditions 120 μA.

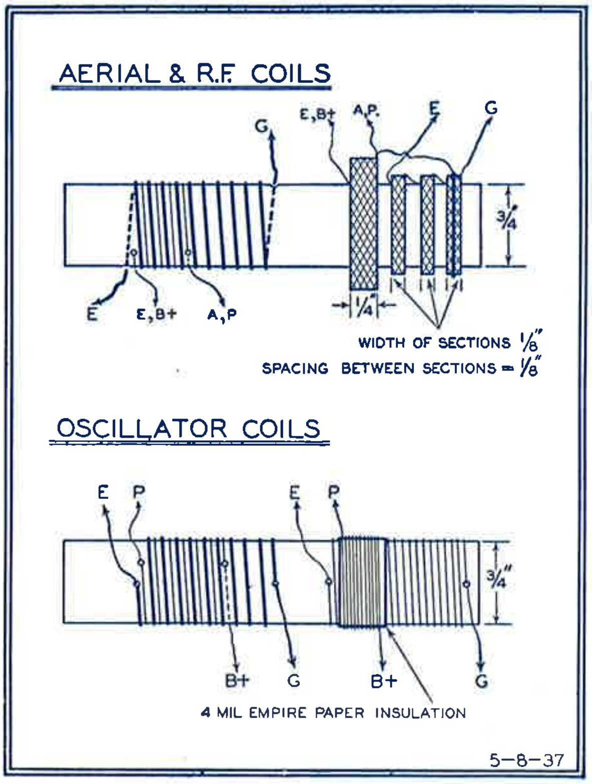
Under conditions in which the oscillator grid current is considerably less than 120 μA (less than about 40 μA) the total current drain will increase. As a guide to those using the Australian-made Radiotron 1C6, the following values are given for typical conditions:—

Average Oscillator Grid Current	120 μA
Maximum " " "	180 μA
Minimum " " "	25 μA

An average valve will draw 60 μA on 51 metres. No valve under correct conditions should draw less than 25 μA on 51 metres. No valve should draw more than 180 μA under any short wave conditions. Individual valves may vary between these two limits and there may also be variations due to the Q of the coils and to other minor details. It is obvious that with an absolute minimum oscillator grid current of 25 μA a large factor of safety is allowed for run-down batteries or for reduced emission in the valve, and it would be very undesirable to permit receivers to be manufactured having a smaller tolerance than that stated. This particular valve is specially interesting in that the oscillator grid current decreases gradually to zero without going suddenly out of oscillation. It is also frequently found that a valve may still oscillate, although very weakly, when the oscillator grid current is zero. This is on account of the contact potential being such that no oscillator grid current flows on zero oscillator grid voltage. It may therefore be possible to use the valve as a converter with an oscillator grid current of zero, although naturally the sensitivity will be very poor.

Under the conditions specified above, no mention was made of the screen voltage or of the anode grid voltage actually applied to the electrodes. This omission has been made on purpose since no value would be served by such a statement and since no advantage is gained by a measurement of these voltages. The valves are factory tested under the conditions given, and although the effective voltages of these electrodes may vary within certain limits, this will not affect their operation.

In cases where it is desired to have a wider short-wave coverage than 16-51 metres it is recommended that more than one short-wave band should be employed. In such cases each band should be limited to a frequency range not exceeding 3:1, and on the highest frequency band it is preferable to reduce the ratio to a still lower figure.



COIL DETAILS.

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 length of leads, the shield cans, and proximity to other components in the case of unshielded coils. The band coverage is affected by the total stray capacities as well as by the capacity of the gang condenser. Using gang condenser B, the band coverage will be wider than with condenser A. Any minor adjustments in the coils should be made in the same proportion to both primary and secondary.

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 three equal sections.
AERIAL 16.0-51 metres	4.25 turns. 28 B. & S. D.S.C. interwound from bottom of secondary.	11.7 turns 22 B. & S. E., 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 three equal sections.
R.F. 16.0-51 metres	8.75 turns 28 B. & S. D.S.C. interwound from bottom of secondary.	11.45 turns 22 B. & S. E., wound in screw cuts 16 T.P.I.
OSCILLATOR 550-1500 KC	30 turns 34 B. & S. E. wound over bottom of secondary.	100 turns 31 B. & S. E.
OSCILLATOR 16.0-51 metres	6.5 turns 44 S.W.G. D.S.C. interwound from bottom of secondary.	10.9 turns 22 B. & S. E., wound in screw cuts 16 T.P.I.

SHIELD CAN: Internal Diameter, $2\frac{1}{8}$ inches.

TUNING CONDENSER:—A. 10– 390 $\mu\mu$F. See note above.
B. 9– 398 $\mu\mu$F.

Max. effective stray capacities: A. 34 $\mu\mu$F. (including valve input, trimmer, wiring & coil).
B. 35 $\mu\mu$F.

Operation on the Broadcast Band.

The conditions given for the short-wave band hold equally for the broadcast band, and may be used without the slightest hesitation. At the same time, it is realized that economy may be made by operating the valve with a lower total B battery drain, which is possible, since the conditions under which the valve is working are much easier. It is recommended that no change should be made to the grid bias or to the screen voltage but that, if desired, the anode grid dropping resistor may be increased to 50,000 ohms. in place of 20,000 ohms. This will bring about a reduction of B battery drain from 4.7 to 3.8 mA total. Under these conditions and with the coils as specified in the diagram, the oscillator grid current should be within the limits of 90-200 μA.

It is strongly recommended that in order to obtain the best results, the conditions as specified should be adhered to in every detail. There are circumstances in which it may be necessary as a temporary measure to operate a receiver with unsatisfactory coils, and under these conditions it is possible to obtain a slight increase in oscillator strength by omitting the 20,000 ohm. anode grid dropping resistor. When this is short-circuited the total drain will increase to 5.5 mA, and a slight increase in oscillator grid current will be noted. The improvement given is so slight that the increase in battery drain does not appear to be warranted. It is suggested that this method should not be adopted, except as a temporary expedient under special circumstances.

PUSH-PULL TRIODE AMPLIFIERS.

This article clarifies the action of a push-pull triode amplifier and enables the designer to predict with reasonable precision by graphical means the power output, load resistance, grid bias, cathode resistor, input current at various output levels, and distortion. It is shown that with Class AB1 operation the ripple voltage may modulate the signal, even though there is perfect matching between the two valves. The total supply current will increase as the output is increased, particularly with Class AB1 operation. No instability can be caused by feed-back from a push-pull stage. In order to obtain the maximum power output it is necessary to work the valves under Class AB1 conditions so that each valve reaches cut-off at the peak grid voltage. The correct operating conditions may readily be calculated from the characteristic curves. The "load line" on each valve is very much curved, but the "plate to plate load line" is straight and this is therefore used as the basis for calculations. With self-bias it sometimes happens that under ideal conditions for maximum power output the self bias resistor is so low as to cause the valve to exceed its permissible dissipation on zero signal. It is therefore necessary to choose other conditions so as to reduce the dissipation on zero signal and, as a consequence, some of the maximum power output must be sacrificed (*e.g.*, 2A3).

The plate current—grid volts—characteristic of any valve may be expanded into a series—

$$i_p = a_o + a_1\,e_i + a_2\,e_i^2 + a_3\,e_i^3 + \ldots\ldots\ldots + a_n\,e_i^n + \ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where i_p = plate current

e_i = grid signal input voltage

and $a_o, a_1, \ldots\ldots a_n \ldots\ldots$ are numerical co-efficients depending on the characteristic of the valve.

a_o represents the plate current at the working point, and $a_1 e_i$ is the principal term of the fundamental output current. The instantaneous fundamental power output is, of course, $(a_1 e_i)^2 R_L$. All higher order terms represent distortion components, and it can be shown that the even power terms $a_2 e_i^2$, $a_4 e_i^4$, $a_6 e_i^6$, etc., are responsible for the even harmonics, while the odd power terms $a_3 e_i^3$, $a_5 e_i^5$, $a_7 e_i^7 \ldots$ $a_{2n+1} e_i^{2n+1}$ introduce the odd harmonics.

In a push-pull amplifier, the two grid voltages are equal and opposite, and the two plate current i_{p1} and i_{p2} (fig. 1) thus become:

$$i_{p1} = a_o + a_1 \frac{e_i}{2} + a_2 \frac{e_i^2}{2^2} + a_3 \frac{e_i^3}{2^3} + \ldots\ldots\ldots + a_n \frac{e_i^n}{2^n} + \ldots\ldots\ldots\ldots$$

$$\text{and } i_{p2} = a_o - a_1 \frac{e_i}{2} + a_2 \frac{e_i^2}{2^2} - a_3 \frac{e_i^3}{2^3} + \ldots\ldots\ldots + a_n \frac{(-e)^n}{2^n} + \ldots\ldots\ldots\ldots$$

As the plate currents are fed in phase opposition to the output load, the net output current becomes i_o where $i_o = i_{pi} - i_{p2}$

$$\text{i.e., } i_o = 2a_1\,e_i + 2a_3 \frac{e_i^3}{2^3} + 2a_5 \frac{e_i^5}{2^5} + \ldots\ldots\ldots + 2a_{2n-1} \frac{e_i^{2n-1}}{2^{2n-1}} + \ldots\ldots\ldots\ldots \quad (2)$$

Both the D.C. components and all the even harmonic terms are seen to have been cancelled, only the fundamental and odd harmonic terms remaining. In a well designed amplifier the series i_o tends to converge rapidly and the third becomes the dominant harmonic.

The total plate current i_t to the two valves from the H.T. supply may be expressed—

$$i_t = i_{p1} + i_{p2}$$

$$= 2a_o + 2a_2 \frac{e_i^2}{2^2} + 2a_4 \frac{e_i^4}{2^4} + \ldots\ldots\ldots + 2a_{2n} \frac{e_i^{2n}}{2^{2n}} + \ldots\ldots\ldots\ldots \quad (3)$$

from which it is seen that the D.C. components *plus* the even harmonic terms are present, so that *the total current will only remain constant with increasing signal input when the characteristic of the valve has no even harmonic terms.* An approach to this is found in pure class A operation, where each valve operates on a substantially linear portion of its characteristic, and though 5% of 2nd harmonic distortion is tolerated, the higher order harmonics are much smaller.

If the plate supply or grid voltage is changed slightly in a pure class A push-pull stage, both plate currents will change together, and the output current i_o will remain unchanged even though the total supply current i_t varies. Ripple in the power supply does not then appear in the output.

When the ripple is large enough to shift the working point of the valve to a more curved part of the characteristic, or where the valves themselves are operated on curved parts, *the ripple voltage may modulate the signal input voltage.* This may be seen from the first three terms of the expression.(1).

By making the two input voltages equal to $E_r \cos pt + E_s \cos qt$, and $E_r \cos pt - E_s \cos qt$, respectively where E_r and E_s are the peak ripple and signal voltages, we have—

$$i_{p1} = a_o + a_1\,(E_r \cos pt + E_s \cos qt) + a_2\,(E_r \cos pt + E_s \cos qt)^2$$

$$= a_o + a_1\,E_r \cos pt + a_1\,E_s \cos qt + a_2\,E_r^2 \cos^2 pt + a_2\,E_s^2 \cos^2 qt + 2a_2\,E_r\,E_s \cos qt \cos pt.$$

Similarly,

$$i_{p2} = a_o + a_1\,E_r \cos pt - a_1\,E_s \cos qt + a_2\,E_r^2 \cos^2 pt + a_2\,E_s^2 \cos^2 qt - 2a_2\,E_r\,E_s \cos qt \cos pt.$$

Now,

$$i_o = i_{p1} - i_{p2} = 2a_1\ E_s\ cos\ qt + 4a_2\ E_r\ E_s\ cos\ qt\ cos\ pt$$

$$= 2a_1\ E_s\ cos\ qt \left(1 + 2\ \frac{a_2}{a_1}\ E_r\ cos\ pt\right)$$

which has the form of a carrier, ($2a_1\ E_s\ cos\ qt$) modulated to the depth $2\ \frac{a_2}{a_1}\ E_r$ by a ripple frequency *cos pt*. Changes in plate voltage have a similar effect. It should be noted that these modulation components appear in single ended amplifiers to the same extent in combination with the fundamental and harmonics of the ripple, so that *push-pull operation tends always to reduce the effects of supply ripple.*

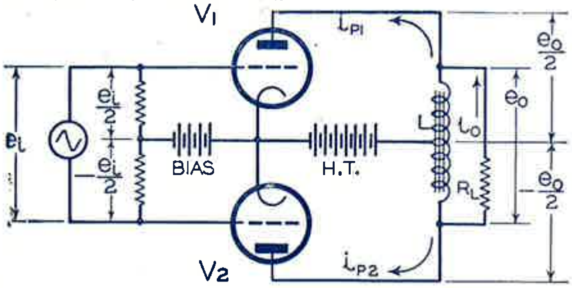


Fig. 1—Circuit diagram of generalised push-pull stage.
e_i = instantaneous signal input voltage.
V_1, V_2 = *matched* triode valves.
i_{p1} = instantaneous plate current to V_1.
i_{p2} = instantaneous plate current to V_2.
e_o = total instantaneous output voltage.
L = output transformer or choke.
R_L = "plate to plate" load resistance.

The fact that no fundamental component is found in the total plate current i_t prevents the feeding back of fundamental signal to earlier stages through the power supply. As the even harmonics are fed back, each will again result in higher order harmonics, so that *there can be no instability caused by feedback around a push-pull stage.*

Because the D.C. components of the plate currents cancel each other, no steady flux is maintained in the core of the output transformer or choke (L in fig. 1), obviating the necessity for an air gap, and thus reducing the weight and cost of the transformer, as less iron and/or copper is required for similar inductance.

The dominant harmonic produced by a single triode is the second, and to limit its introduction, the steady plate current of a single ended stage is increased until the valve operates on a portion of its curve removed from the cut-off region. In pushpull stages, where the second harmonic is naturally suppressed, such a precaution is unnecessary, and the grid bias may be increased (and the load R_L reduced) until the amplifier delivers its maximum output.

Power Output and Optimum Load

The optimum load for a single ended triode stage is set by the curvature of the characteristic. It is really a compromise between output and distortion. At the point of maximum output the distortion is usually too high to be tolerable, and the plate load must be increased accordingly (reducing the output) until the distortion is within the permissible limit of 5%. The load is plotted generally as a straight line on the E_p/I_p family for the valve.

Push-pull amplifiers are normally terminated by a transformer or a centre tapped choke, and *the alternating plate voltages are equal and opposite regardless of the individual plate currents.* Even though one valve may have cut off completely, its plate voltage may continue to rise. The ratio of change of plate voltage to change of plate current is then infinite and the other valve has all the load.

Neglecting loss in the transformer, the power input to the primary must be equal to the secondary power output.

$$\text{i.e.,}\quad \frac{e_o^2}{R_L} = \frac{e_o}{2}\ i_1 - \frac{e_o}{2}\ i_2$$

$$\text{so that}\quad \frac{2e_o}{R_L} = i_1 - i_2$$

where i_1 and i_2 are the instantaneous signal currents.

But i_1 and i_2 may be defined as—

$$i_1 = \frac{e_o}{2R'_L},\qquad i_2 = -\frac{e_o}{2R''_L}$$

where R'_L= Instantaneous Effective Load on V_1
R''_L= Instantaneous Effective Load on V_2

$$\text{so that}\quad \frac{2e_o}{R_L} = \frac{e_o}{2R'_L} + \frac{e_o}{2R''_L}$$

$$\text{from which}\quad \frac{4}{R_L} = \frac{1}{R'_L} + \frac{1}{R''_L} \quad \ldots\ldots (4)$$

throughout the cycle.

To find the effects of the valves' characteristics on R'_L and R''_L the voltages developed in V_1 and V_2 may be taken as $-\mu\frac{e_i}{2}$ and $\mu\frac{e_i}{2}$ in series with the respective plate resistances R_{p1} and R_{p2}. By Kirchhoff's law, the algebraic sum of the input and output voltages and the voltage across R_p of each valve must be zero.

i.e.—

$$i_1\ R_{p1} = -\mu\ \frac{e_i}{2} - \frac{e_o}{2}$$

also—

$$i_2\ R_{p2} = \mu\ \frac{e_i}{2} + \frac{e_o}{2}$$

From which—

$$\frac{i_1}{i_2} = -\frac{R_{p2}}{R_{p1}}$$

PUSH-PULL TRIODE AMPLIFIERS (Continued)

Putting—

$$\frac{e_o}{2R'_L} \text{ and } -\frac{e_o}{2R''_L} \text{ for } i_1 \text{ and } i_2$$

$$\frac{R'_L}{R''_L} = \frac{R_{p1}}{R_{p2}} \text{ so that } R''_L = R'_L\,\frac{R_{p2}}{R_{p1}}$$

Substituting in (4),

$$\frac{4}{R_L} = \frac{\left(1 + \frac{R_{p1}}{R_{p2}}\right)}{R'_L}$$

so that—

$$R'_L = \frac{R_L}{4}\left(1 + \frac{R_{p1}}{R_{p2}}\right) \;\ldots\ldots\ldots\ldots\; (5)$$

this being the effective load on V_1.

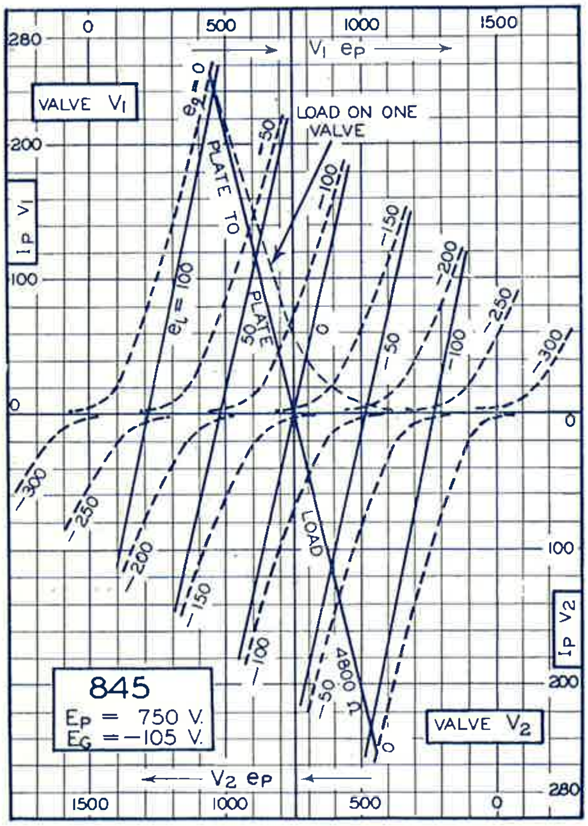


Fig. 2—Composite E_pI_p curves for push-pull 845's. $E_p = 750$V.

When it is realised that R_{p1} increases while R_{p2} decreases as V_1 tends to cut-off, the inaccuracy of applying a straight load line to the E_pI_p family to study the push-pull operation of a valve becomes immediately evident. If a composite is made by placing two families of E_pI_p curves as in fig. 2 the graphical sums of the ordinates show $i_1 - i_2$ in terms of E_g and E_p. A straight load line may be applied to such a set of curves, and a dynamic curve plotted as in fig. 3, curve A.

For the sake of efficiency, the mean plate current must be as low as possible. To reduce distortion each valve is made to cut-off just at the negative peak of its grid swing. The peak plate current for each valve then becomes the peak A.C. plate current, and occurs as each grid voltage becomes zero (approximately). Triodes at zero bias obey (very nearly) the Langmuir 3/2 power law.

i.e., $i_p = Ke_p^{3/2}$ *where K is a constant.*

But at zero grid voltage i_p becomes I_p, the peak output current. The power output W becomes $W = \frac{I_pE}{2}$ where I_p *and* E are peak A.C. values.

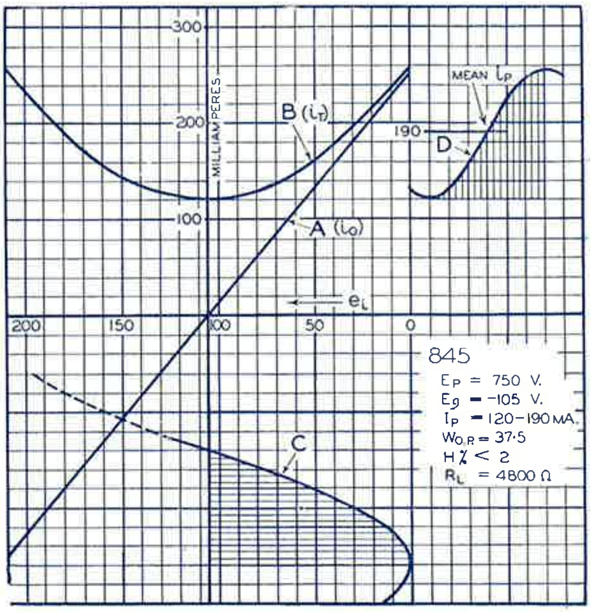


Fig. 3—Dynamic characteristics of push-pull 845's.
Curve A — signal output current (dynamic) — i_o.
Curve B — total plate current — i_t.
Curve C — sine wave signal input voltage.
Curve D — total periodic plate current.

But $E = E_b - E_p \ldots\ldots\ldots\ldots\ldots\ldots$ Fig. 4

$$\therefore\; W = \frac{(E_b - E_p)\;E_p^{3/2}\;K}{2}$$

and $\log W = \log\,(E_b - E_p) + \frac{3}{2}\log E_p + \log\frac{K}{2}$

Differentiating with respect to e_p—

$$\frac{dW}{dE_p}\cdot\frac{1}{W} = \frac{3}{2E_p} - \frac{1}{E_b - E_p}$$

The power output, W, becomes minimum and maximum—

$$\text{when } \frac{dW}{dE_p} = 0$$

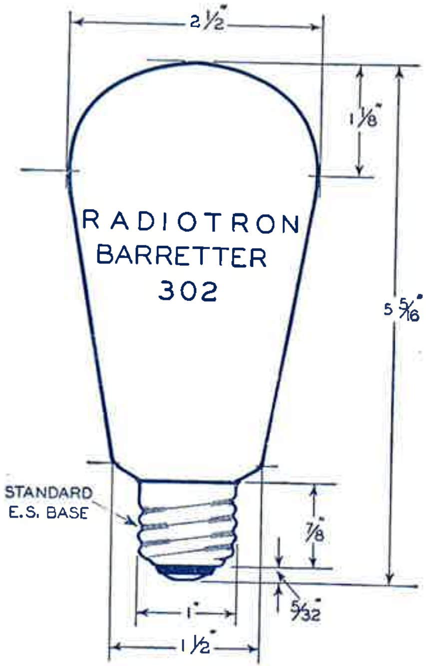
i.e., when $W = 0 \ldots\ldots\ldots\ldots$ *(minimum)*

and $\frac{2}{3}E_p = E_b - E_p$

(Continued at foot of next column)

RADIOTRON 302 BARRETTER.

A Barretter drawing a current of 0.3A is now available in the newly released Radiotron 302. This Barretter is fitted with a standard Edison screw base, which will fit a standard lamp fitting, giving rigid support as well as good electrical contact. Radiotron 302 is capable of operating over a range of voltage drop from 112 to 195 volts. This will cover all normal cases of receivers operating on mains voltages between 200 and 260 volts A.C. or D.C. while still allowing a large margin beyond these limits of voltage for fluctuations in the voltage actually delivered to the receiver. A circuit employing Radiotron 302 Barretter is given elsewhere in this issue. The outline and dimensions of the 302 are shown on the drawing.



MAXIMUM OVERALL LENGTH = 5½″
MAXIMUM DIAMETER —— = 2⅝″

PUSH-PULL TRIODE AMPLIFIERS (Continued)

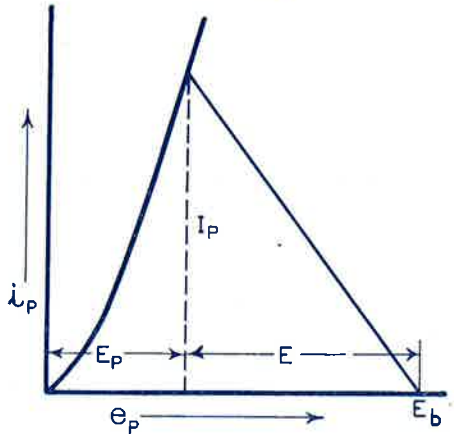


Fig. 4—Determination of working constants for maximum power output.
i_p = plate current.
I_p = peak plate current.
e_p = plate voltage.
E_p = minimum plate voltage.
E = peak (negative) output voltage.
E_b = plate supply voltage.

$$\text{or } E_p = 0{\cdot}6\, E_b \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$$\text{so that } W = I_p E_b \frac{(1 - 0{\cdot}6)}{2} = \frac{I_p E_b}{5}$$

$$(\mathit{maximum}) \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

When V_2 cuts off, R_{p2} becomes infinite,

$$\text{making } R'_L = \frac{R_L}{4}$$

$$\text{and } R_L = 4\, \frac{(E_b - E_p)}{I_p} = 1{\cdot}6\, \frac{E_b}{I_p} \ldots\ldots (8)$$

(Part 2 of this article, dealing with the graphical application, will be given in Radiotronics 80)

Radiotron 6D6 Greater Stability

The *maximum* capacity between control grid and plate of the Radiotron 6D6 has been decreased from .010 to .007 $\mu\mu$F. This improvement enables more stable I.F. amplifiers to be constructed since there is no danger of instability under any normal conditions or operation. It is emphasized that the capacity of the average valve is well below this figure, and every Radiotron valve can be depended upon to have an inter-electrode capacity of less than this amount.

A.C/D.C. RECEIVER.

In the past there has been difficulty in the design of A.C./D.C. receivers, due to the absence of a suitable barretter. As described elsewhere in this issue, the Radiotron 302 barretter is now available and a circuit showing its application is given below. This circuit incorporates a number of points of good design which are not always included in receivers of this class, which have frequently been looked upon as being distinctly inferior to A.C. receivers. Due to the high power output of the 43 power pentode, it is possible to obtain with this circuit an output almost identical with that given by a 42 in a standard A.C. circuit. In order to reduce harmonic distortion, "Series Inverse Feedback" has been included, and the performance of the receiver is therefore of a very high class. The input to the audio-amplifier is 0.24 Volt RMS for an output of 2.5 Watts,

RADIOTRON A.C./D.C. RECEIVER (Continued)

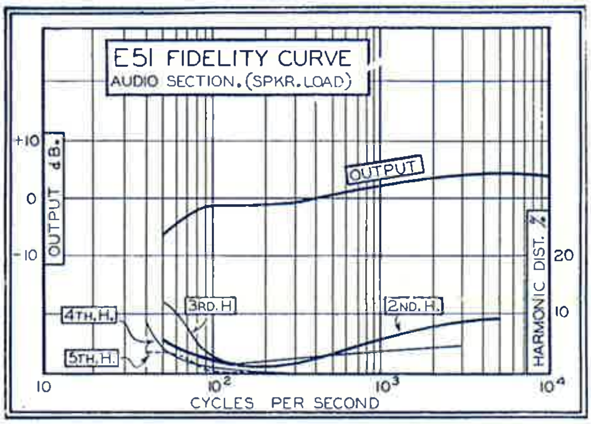
with a total harmonic distortion of 3.5% at full output.

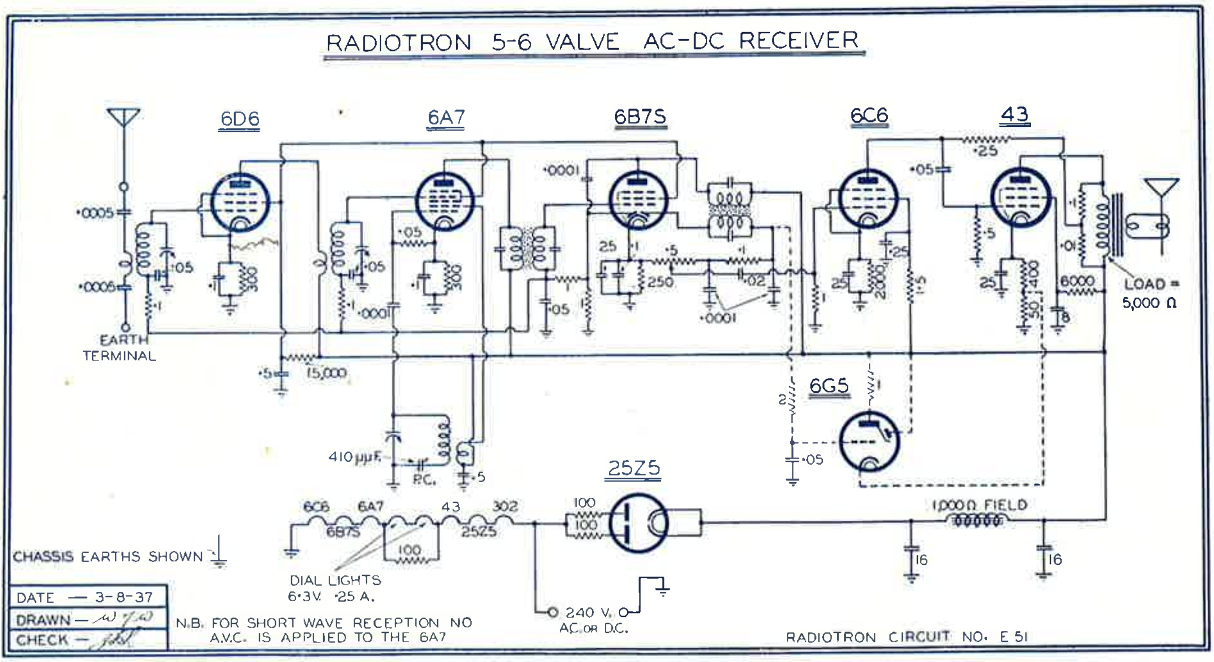
The Radiotron 302 barretter is capable of accommodating all line voltages between 200 and 260 volts (nominal), while allowing considerable fluctuations to occur above and below these nominal voltages. It is therefore not necessary to use any tappings for different mains voltages within this range.

Radiotron 25Z5, under its new ratings with 100 ohms. in series with each plate, is capable of delivering a very high current with a voltage of 250 Volts RMS applied to the circuit. The function of the resistances in series with each plate is, firstly, to bring about a correct distribution of current evenly between the two halves of the rectifier, and secondly, to limit the peak currents charging the first filter condenser to a value within the capabilities of the valve. Without such resistances, the rectifier would discharge for portion of the cycle into a load of very nearly zero impedance, and the peak current would therefore be excessive. It is recommended that the first filter condenser should not exceed 16 μF. When used as described, Radiotron 25Z5 is capable of giving good service even with a higher current output than is used in this receiver. It is rated at a maximum current of 170 mA DC, whereas in this receiver the total current drain is only 60 mA on a 250 Volt supply.

The heaters of the various valves are arranged so that those more critical to hum are at the lower end, and the barretter is at the higher end. The heater-cathode voltages in the various valves are kept quite low and no trouble should be experienced in this regard. A 6G5 Magic Eye tuning indicator is shown as an optional addition, but if this is desired to be omitted the lines shown dotted should be neglected.

A sample of this receiver has been operating continuously for a number of weeks and has stood up to repeated surges under onerous conditions of operation, and with valves withdrawn and then plugged in again without any detriment whatever to the valves or to the receiver. It appears to be sufficiently rugged to withstand even the severe conditions imposed by badly fluctuating supply voltages on either AC or DC mains, and its use should eliminate the all too frequent complaints regarding AC/DC receivers in the past.


E51 FIDELITY CURVE
AUDIO SECTION. (SPKR. LOAD)


RADIOTRON 5-6 VALVE AC-DC RECEIVER

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