RADIOTRONICS

AMALGAMATED WIRELESS VALVE COMPANY LIMITED

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

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ITEMS OF GENERAL INTEREST

NEW RELEASES

Radiotron 808: A triode suitable for operation on frequencies up to 272 megacycles, having a plate dissipation of 50 watts maximum. Supplies are expected towards the end of February. This valve has the plate brought out at the top and the grid at the side to give utmost efficiency on the higher frequencies.

Radiotron 913: A metal construction cathode ray tube having a screen approximately 1in. diameter. Stocks are expected towards the end of February. This type will be very much cheaper than other cathode ray tubes and should enable much wider use to be made of the advantages of cathode ray oscillographs.

Radiotron 25L6: Beam amplifier valve for AC-DC operation is not yet available, but supplies are expected shortly. Characteristics are available for 110 volt operation, but we hope to be able to give characteristics for higher voltages in a future bulletin.

FIDELITY RECEIVERS

HOW TESTING SHOULD BE DONE—

Tests on 5 Valve Fidelity Circuit.

TESTING FOR FIDELITY

A perfect reproducing system will provide a replica of the original which could be matched against the original without showing any defects. When testing a radio receiver or amplifier for fidelity, an obviously necessary test is to compare the output given by the receiver with the input delivered to its aerial. This is most easily accomplished by modulating a good standard signal generator with a good beat frequency oscillator which will then provide a convenient source of modulated R.F. input to the aerial terminal. The output signal can be compared with the input signal with a cathode ray oscillograph as shown in figure 1. The input and output signals are fed to the X and Y plates respectively. If the output signal is an exact replica of the input, the resulting oscillogram will be a perfectly straight line at 45° to either axis. If one signal is greater or less than the other, the line will be straight, but at a different angle. A difference in phase, which has no effect aurally, causes the straight line to be expanded into an ellipse. If the output signal is distorted, the line will be curved, or the ellipse misshapen. By varying the frequency at the Beat Frequency Oscillator, the audio frequency response may be observed by the slope of the line or the Y dimension of the ellipse. Where the response is level, the Y dimension will remain constant.

The ideal receiver, therefore, would show a perfectly elliptical or linear picture of the same Y dimension at all frequencies and depths of modulation.

After having observed the defects in the reproduction. their magnitude can be measured and plotted

MEASUREMENT OF HARMONIC DISTORTION

To measure distortion and output the wave analyser may be used. It is really a highly selective valve voltmeter, with fine frequency discrimination. In principle it is simply a superheterodyne receiver with a fairly low I.F. either above or below the audible spectrum. By adjusting its oscillator frequency, the audio frequency components of a complex wave may be tuned in, and measured in both frequency and intensity.

In the present application it is connected across the loudspeaker and the fundamental frequencies as well as their harmonics can be read off.

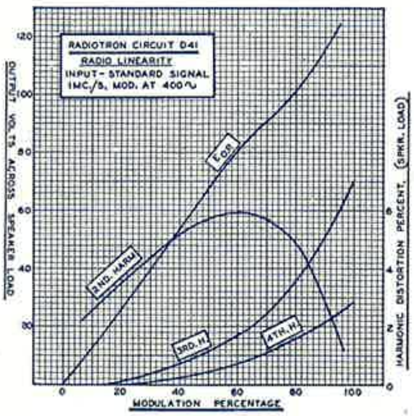


FIG. 3.

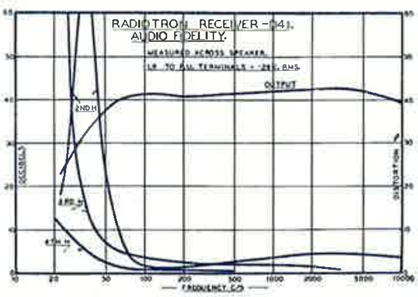


FIG. 4.

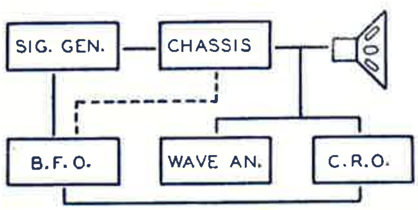
APPLICATION TO 5 VALVE "FIDELITY" CIRCUIT

Tests were made on Radiotron receiver D.41, energising a commercial speaker of a well known make. Output, 2nd, 3rd and 4th harmonics were plotted against (1) frequency and (2) percentage of modulation, in figures 2 & 3 respectively.

In fig. 2, the falling off of response above 1 k.c./sec. is almost entirely due to side band suppression in the I.F. channel of the receiver. Much of the bass loss is due to lack of primary inductance in the output transformer.

Above 100 cycles, the distortion is seen never to rise above 4% total. The rising distortion in the bass end can be attributed to the speaker, as will be appreciated later. In fig. 3, second harmonics are seen to rise steadily to a value of 6% (just audible) at 60% modulation, then to fall off rather more steeply.

There was, very obviously, more than one simple overloading effect in the receiver, causing a partial cancellation of second, and an increase of higher order harmonics at great depths of modulation. The double flex in the output versus modulation curve also confirms this.



BLOCK SCHEMATIC

FIG. 1.

FIG. 2.

In an effort to find the causes of some of the effects, the BFO was connected to the pickup terminals (dotted line in fig. 1) and curves drawn for output and harmonics against both frequency (Fig. 4) and input voltage (Fig. 5).

In the preparation of fig. (4) the frequency was taken down to 20 cycles, in order to measure the effects of the speaker resonance on distortion. Actually, at 35 cycles ($\frac{1}{2}$ speaker resonance) the voltage output at 70 cycles (2nd harmonic) was greater than the fundamental output. The speaker was acting as a harmonic tuned circuit plate load, and the 2A3 as a frequency doubler. It is safe to assume that a pentode, with its high plate resistance, would behave even worse. The same effect is observed at 23 cycles (1/3 speaker resonance) with the 3rd harmonic. The fourth harmonic output is seen to be rising at 20 cycles, and would probably continue to rise to a similar peak at 17 cycles. It is thus evident that signal inputs of frequencies lower than half the speaker bass resonance produce more output around the resonance frequency than they do at their own frequencies. The frequently observed "boom, boom, boom" on one bass note is further evidence of that effect. The solution, of course, is to lower the frequency of the main speaker resonance.

At high frequencies, the output level remains sensibly constant up to well over 10 kc/s, and the distortion at high frequencies never exceeds 4%. The loss of high frequencies was thus due entirely to the R.F. end of the rceiver.

When figs. 5 and 3 are compared, it again becomes obvious that the R.F. end of the receiver (probably the first and second detectors) introduces its own distortion. The output /input line is almost straight, and the distortion is seen steadily to rise to full output, where the total is about 4%.

The curves of fig. 6 are taken to show the effects of A.V.C. and its own share of distortion. At low signal levels, the distortion is entirely due to 2nd harmonics. Above about .1V R.F. input, there is a complete phase reversal of 2nd harmonics, during which they are nullified at one input voltage. The effect is evidently due to interfering factors which cancel at .1V input.

While the A.V.C. is not outstandingly effective, it is much the same as any other receiver using the same system, and in its effect, allows the second detector and audio channel to function without excessive overload, when the receiver is tuned from one local station to another, more powerful. It also serves to minimise fading.

It is evident that these methods of testing are far more revealing than the more usual tests of distortion at 400 c/sec. and fidelity curves taken with a resistive shunt across an ordinary output transformer, with open secondary. They cannot substitute, but only supplement the more usual tests for sensitivity and selectivity.

Even in cases where wave analysers or distortion meters are not available, the cathode ray oscillograph when used as here described, will provide a means of checking the fidelity of amplifiers or receivers.

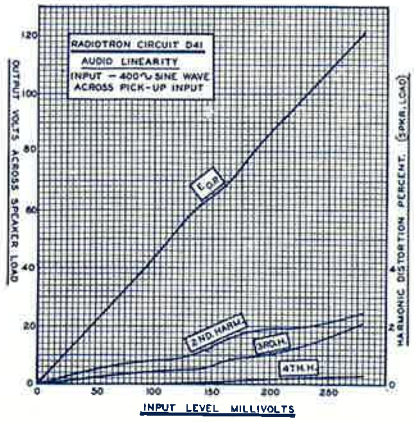


FIG. 5.

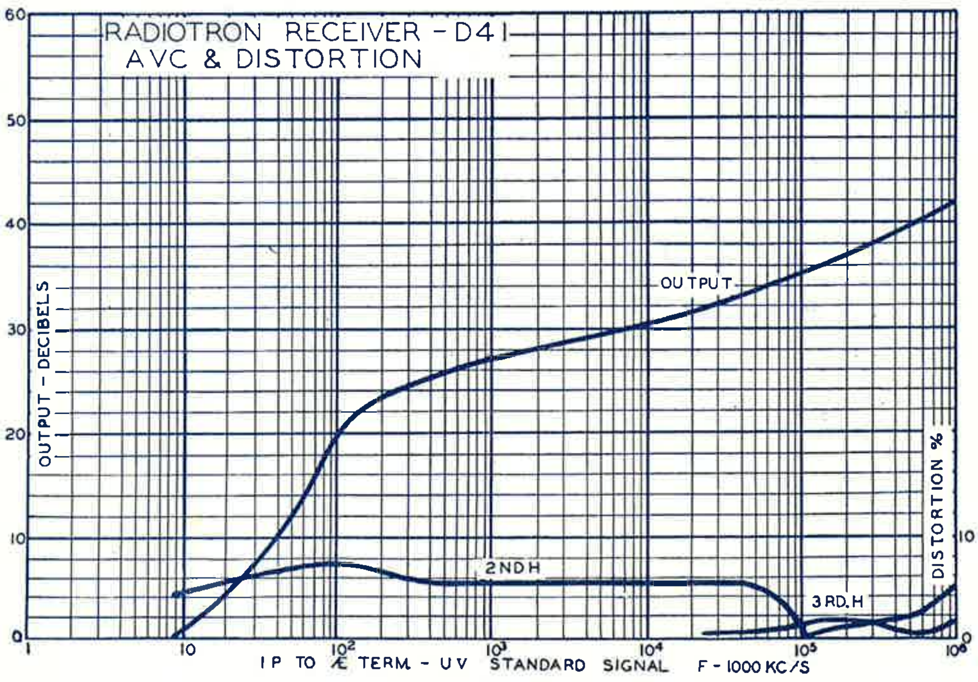
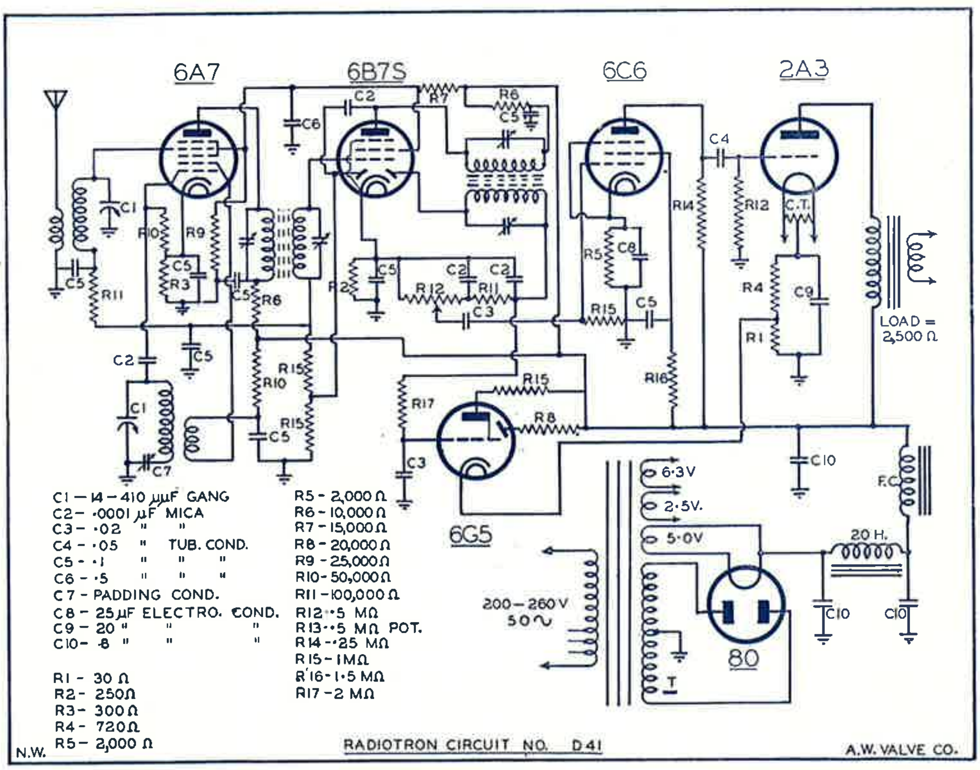


FIG. 6.

TONE COMPENSATION & BASS BOOSTING

A very great number of methods have been used in the application of Bass-boosting and other forms of tone compensation. Two circuits are shown illustrating popular methods of obtaining effective bass-boosting without undue complication. Figure 7 shows a method using a volume control tapped at approximately one quarter way from the earthed end. If such volume control is available, it is very easily adapted as shown in the circuit. The constants given are to be regarded as typical and may be varied considerably depending on the conditions and requirements. The operation can best be understood by considering the moving contact first at the top end of the volume control. The small condenser (.0002μF) is short-circuited and has no effect; the condenser from the tapping point is effectively in series with a high resistance, and it does not have much effect. The result is that there is no appreciable frequency discrimination in this part of the circuit.



Considering now the operation of the moving contact when at the tapping point, it will be seen that there is a condenser (.004μF) across the input to the amplifying valve and there is also a high resistance in series with the input. The result is that the higher audio frequencies are very much attenuated. Since this effect increases with the frequency, it is necessary to have some means of opposing its effect for the higher audio frequencies. The small condenser (.0002μF) by-passes the higher audio frequencies direct to the grid and gives the desired effect. It will be seen that this method gives smooth control, and is effective for settings of the volume control between full volume and approximately one-quarter Voltage input. For lower settings its effectiveness decreases.

Figure 8 shows a method which does not require a tapped volume control. A high resistance pentode valve such as a 6C6 is used with two sections of the plate load resistor having resistances of 0.05 and 0.2 megohm respectively. From the junction a condenser of 0.02 μF is taken to earth through a switch. With the switch open all frequencies are amplified uniformly, but with the switch closed it is obvious that the higher audio frequencies are by-passed thus giving a greater response to low frequencies than to high frequencies. If desired the condenser may be replaced by a series resonant circuit tuned to 1,000 cycles. This will have the effect of increasing the response of lower frequencies in relation to 1,000 cycles without having a deleterious effect on the higher audio frequencies. Other modifications are possible, and information on any particular application will be given on request. We hope to publish further methods for bass-boosting at a later date.

It should be noted that these methods for bass-boosting really attenuate the higher frequencies, or at least a portion of the higher frequencies, so as to make the ratio of response between bass and higher frequencies greater than it would otherwise be. It is important to remember that with bass-boosting the maximum power is handled at low frequencies and the power output possible on the higher audio frequencies is much reduced. The normal application of bass-boosting is in cases where the volume control is turned down to a low level and in such cases it provides more correctly balanced tone than would otherwise be obtained. As the volume is increased so the bass-boosting should be removed either automatically or manually.

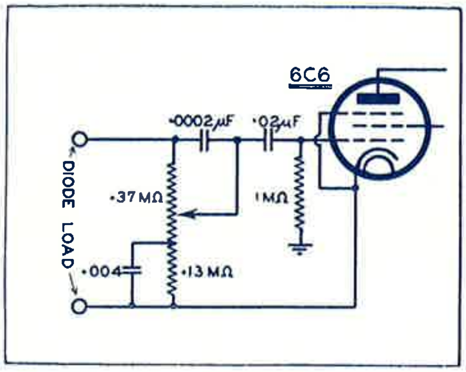


FIG. 7.

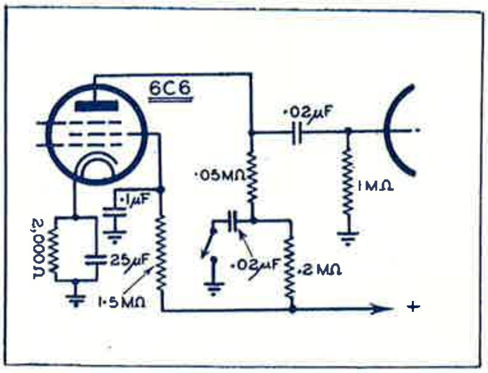


FIG. 8.

INVERSE FEEDBACK —*Applied to Radiotron 1D4*

INCREASED POWER OUTPUT FOR DECREASED BATTERY DRAIN

Tests made in our laboratory have shown that Inverse Feedback may be applied to Radiotron 1D4 so as to give increased power output for the same or even for less battery drain than under standard conditions. No difficulty is experienced in applying this circuit to any battery set using Radiotron 1K6 to drive the 1D4, but valves having lower gain than the 1K6 will not be found very satisfactory for this application. The only addition necessary to the usual circuit is provision for feeding back a fraction of the audio voltage from the plate circuit to the grid circuit of the 1D4.

An output of 0.5 watt is obtainable from Radiotron 1D4 when used with Inverse Feedback, for a distortion of 10% total. It is possible to operate the 1D4 under over-biased conditions so as to reduce the static current to 3.6 mA; on an output of 0.5 watt, the plate current rises to 6.6 mA. The average plate current for a peak output of 0.5 watt will be somewhat lower than 6 mA. In order to obtain the full advantages of the Inverse Feedback circuit, it has been found necessary to reduce the load resistance to 10,000 ohms in place of the usual 15,000 ohms.

Due to the degenerative effect on the 1K6, the stage gain of the 1K6 is reduced by about 4 times, but is still of the same order as that given by type 1B5 or similar valves. The circuit is shown in Fig. 9 for operation from either 135V. "B" batteries or higher voltages delivered by a vibrator. When used with a vibrator, the power output of the 1D4 will be about 0.75 watt, the actual power depending on the voltage delivered. An alternative arrangement is shown in Fig. 10, where either Radiotron 1K6 or 1K4 may be used as a triode driving the 1D4 through a step-up transformer. In both these circuits the power output and distortion are approximately the same.

OPERATING CONDITIONS FOR INVERSE FEEDBACK 1D4

Plate Voltage	135V.
Screen Voltage	135V.
Control Grid Voltage	–6V.
Plate Current (Static)	3.6 mA
Screen Current (Static)	0.9 mA
Plate Current (Full Output)	6.6 mA
Screen Current (Full Output)	3.3 mA
Power Output (10% distortion)	0.5 watt
Feedback	10%
Load Resistance	10,000 Ohms

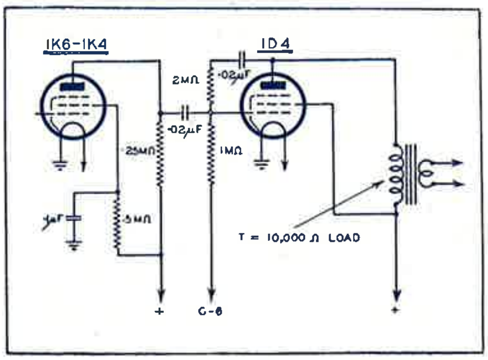


FIG. 9.

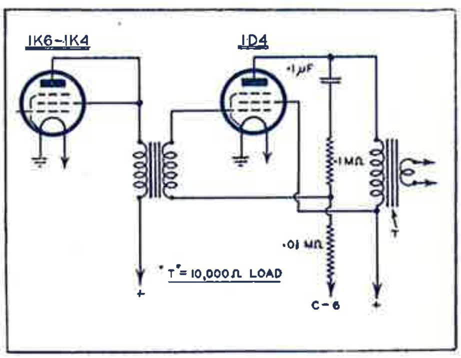


FIG. 10.

TESTS FOR ABSOLUTE SENSITIVITY

In receivers of poor sensitivity and having therefore low noise level the standard method for measurement of sensitivity is entirely satisfactory. This method is to test for the minimum carrier voltage input modulated 30% to give a power output of 50 milliwatts in a load resistance of standard impedance. When this method is used with receivers having sensitivities of the order of 10 microvolts or less, the noise level gives an output comparable with the output of the signal. With ordinary methods of testing, the output meter reads the combined output of noise and signal and the result obtained is therefore in error and the true sensitivity is less than the apparent sensitivity.

A number of methods of measuring sensitivity have been used in the case of receivers having appreciable noise level. While none of these can be regarded as being satisfactory in all respects, the one which appears most satisfactory and which has now been adopted by the English R.M.A. is the measurement of Absolute Sensitivity. In this method the input voltage is adjusted until the difference of reading between the output with 30% modulation and the output with no modulation is equal to 50 milliwatts. It will be seen that the sensitivity figures given by this method are true sensitivity values and are not appreciably affected by the increase or decrease in noise level.

Tests now made in the Laboratory of Amalgamated Wireless Valve Co. Ltd. are on the basis of Absolute Sensitivity. We commend its wide usage to all Radio Engineers in place of the older method which gives misleading results.

The measurement of Absolute Sensitivity gives no indication of noise level and a separate measurement of noise is necessary. The oscillographic method of measuring output and of distinguishing between output of noise will be covered in a later Bulletin.

MATCHING OF OUTPUT VALVES

IS IT NECESSARY ?

A question has been asked, "Why is matching necessary and when is it possible to use valves from stock without special matching?"

The answer is that for most purposes matching is not required. Radiotron valves are tested to a very high degree of precision and when used as ordinary class A, class AB1, or class AB2 amplifiers with voltages within the rated maxima, no matching is normally necessary.

With high efficiency triodes, notably types 2A3, 50 and 845, matching for push pull operation is usually desirable. Matched pairs of Radiotron valves are obtainable at a slight additional cost and are recommended in cases where fidelity is of extreme importance. Matched Radiotrons have all been stabilized in their characteristics before being matched, and this means that the valves should remain matched over the length of their useful life.

With pentodes, a very easy way out of the difficulty is available. In cases where accurate matching is necessary, it is usually quite sufficient to adjust the screen voltage on each valve individually until the plate currents of the two are identical. The adjustment of screen voltage can usually be made through the use of separate contacts on the voltage divider.

With Class 'B' amplifiers, where the plate current is biased down to very low values, it is essential that individual adjustment should be made for each valve, and checked up on fairly frequent occasions throughout the life of the valves. The operation of Class 'B' valves close to the point of cut off is not recommended owing to this difficulty.

EXPERIMENTERS' SECTION

AMATEUR COMMUNICATIONS RECEIVER

In our next issue we hope to give the circuit of a good Amateur Communications Receiver which should be of interest to all experimenters.

NEW RELEASES

See page 1 for further details of Radiotrons 808 and 913.

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