RADIOTRONICS

AMALGAMATED WIRELESS VALVE COMPANY LIMITED

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

TECHNICAL BULLETIN No. 74 **31st MARCH, 1937**

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Items of General Interest:

For the Radio Engineer:

Experimenters' Section:

ITEMS OF GENERAL INTEREST.

RADIOTRON 806: New transmitting triode valve with tantalum plate 150 watts dissipation. Australian price £12 nett. Stocks will not be available until the end of April.

RADIOTRONS 807, 808, 913: Stocks of these new types are now available.

Radiotron Type	Description	Australian Nett Price £	s.	d.
807	21 watt Beam Tetrode	2	2	0
808	50 watt H.F. Triode	4	5	0
913	1in. Metal Cathode Ray Tube	2	2	0

RADIOTRON PHOTO-TUBES:

868	Medium sensitivity gaseous type	2	5	0
917	General purpose vacuum type	3	0	0
918	High sensitivity gaseous type	2	15	0
919	Low leakage vacuum type	3	0	0
920	Twin gaseous type	3	10	0

DID YOU KNOW THAT: Delayed A.V.C. actually gives better selectivity on weak signals than is usually measured. This is because measurements of selectivity are usually made on strong signals with the A.V.C. diode in operation, while on weak signals the A.V.C. diode does not operate and the selectivity improves as a consequence. This effect is much more pronounced when the A.V.C. diode is fed from the plate of the I.F. valve.

THE PLATE-TO-PLATE LOAD RESISTANCE for Class "A" triodes is equal to, or slightly less than, twice that for a single valve. In the case of Class "B" triodes, the plate-to-plate load is four times that on each single valve. The reason is that the Class "B" valves each only operate during one half cycle. Owing to so many factors having to be considered in push-pull operation, it is preferable to follow the specific data provided for such cases.

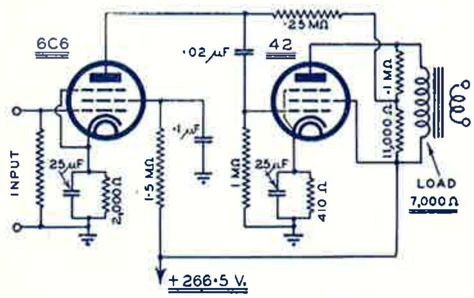
FOR THE RADIO ENGINEER

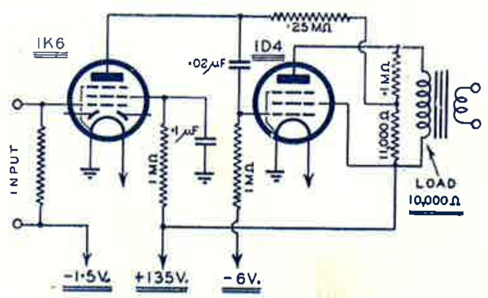
"SERIES" INVERSE FEEDBACK WITH RESISTANCE COUPLING

NEW CIRCUIT GIVES RESULTS EQUIVALENT TO TRANSFORMER COUPLING. The operation of Inverse Feedback has been very widely described and it is not necessary to go into further detail regarding the general principle of this system, the application of which results in the reduction of distortion and improvement in the general performance of an amplifier. In the past it has been customary to use transformer coupling in order to obtain the best results from Inverse Feedback. There have been applications, some of which have been described in previous Bulletins, in which resistance coupling could be used in a conventional manner, but the output load of the preceding valve was shunted by a comparatively low impedance which reduced its gain and tended to cause overloading. "Series" Inverse Feedback may be used with resistance coupling as shown in figures 1 and 2 for battery and A.C. circuits respectively. It is obvious from these diagrams that the inverse voltage is injected in series with the plate load resistor, and it therefore has no shunting effect on the grid circuit of the power valve.

This new circuit makes possible a very much wider application of resistance coupled Inverse Feedback amplifiers. In these two cases it would have been possible with Shunt Inverse Feedback to obtain satisfactory results, but considerably higher gain is given by the Series circuit. For example, in the battery valve case the sensitivity of the arrangement with Series Inverse Feedback is increased about 40%.

The fidelity obtained with Inverse Feedback Pentodes using the percentage of feedback commonly employed is definitely not so good as that given by triode valves, particularly in response to transients. It is, however, a very marked improvement over the performance given by pentodes without the use of Inverse Feedback.





FIGS. 1 & 2.

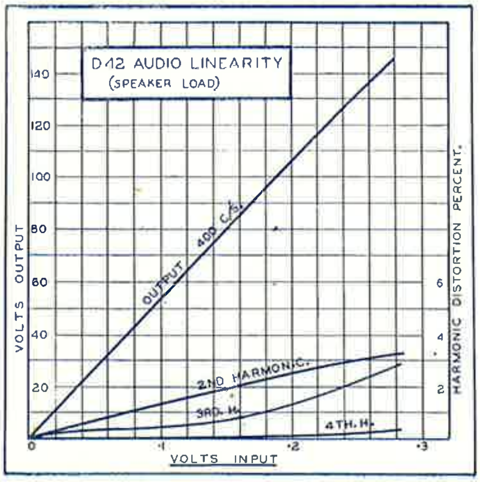
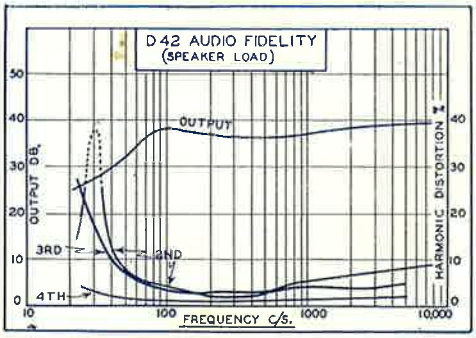


FIG. 3. *(See opposite page.)* FIG. 4.



FOR THE RADIO ENGINEER

A.C. CIRCUIT USING INVERSE FEEDBACK 42

IMPROVED PERFORMANCE FROM PENTODE POWER AMPLIFIER. It is widely accepted that a Class A triode power valve provides practically perfect reproduction. A circuit employing Radiotron 2A3 has already been described (Circuit D41, Radiotronics 72) which delivers 3.5 watts of audio power, having an excellent response to transients and being above criticism as regards harmonic distortion. Unfortunately, with a triode valve it is necessary to use a higher transformer voltage, due to the greater grid bias voltage, and it is also essential to incorporate improved smoothing, such as is given by an additional filter choke.

A pentode or beam tetrode valve possesses the distinct advantages of low bias voltage and high plate efficiency, and is also to be preferred, since it does not generally require any more smoothing than is given by the speaker field. The disadvantage of such types of valves is in the excessive distortion produced when feeding a loudspeaker, the distortion sometimes exceeding 30%. The introduction of Inverse Feedback enables a pentode valve to be used with a very marked improvement in quality without any appreciable increase in cost. The new Series Inverse Feedback circuit using resistance coupling is employed in Radiotron Circuit D42 shown below. The audio linearity curve (Fig. 3) is almost perfectly straight up to the full output of 3 watts, indicating excellent quality. The output curve (Fig. 4) is linear within ± 2 db. from 100 to 10,000 ~, the falling response at lower frequencies being due to the loudspeaker. The audio harmonic distortion is negligible, while the damping on the loudspeaker is equivalent to 3000 ohms across 7000 ohms load, this being only slightly inferior to the 2A3. In this circuit the screens of the 6A7 and 6B7S should be adjusted to 100 volts, the anode-grid of the 6A7 to 200 volts and the target of the 6G5 to 250 volts.

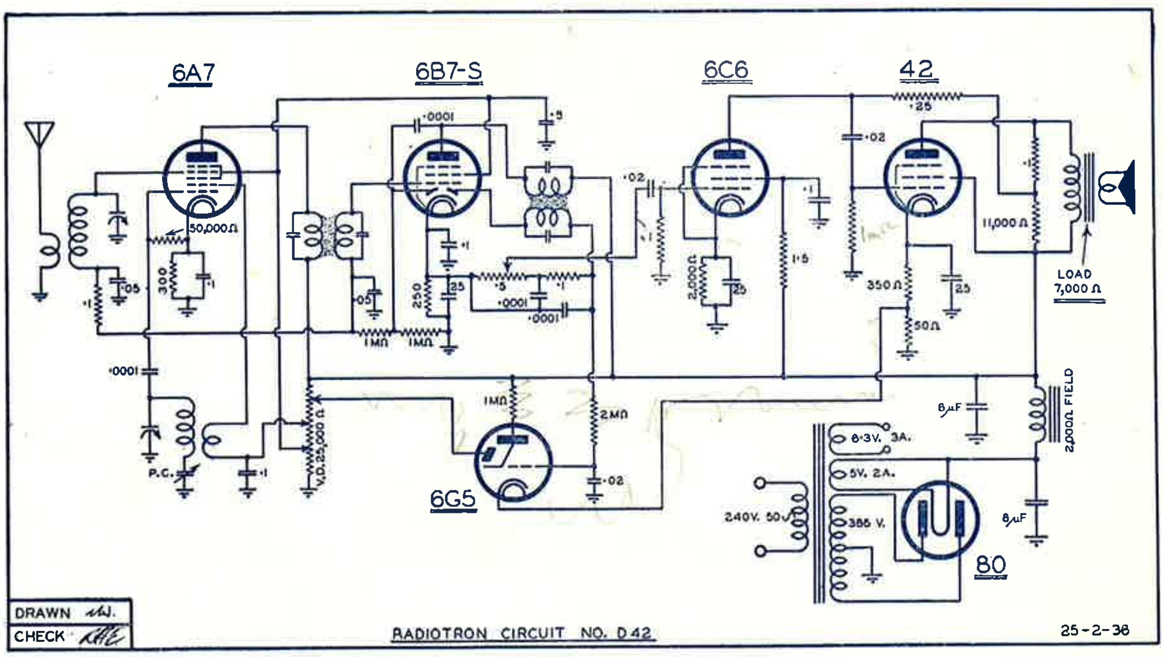


FIG. 5.

FOR THE RADIO ENGINEER

DISTORTION IN DIODE DETECTORS

Under ideal conditions the distortion in a diode detector may be very slight. Curve B in Figure 6 shows that the distortion under certain conditions is only 2.8% at 100% modulation. This curve is taken under conditions in which the effective A.C. load is identical with the D.C. load resistance, that is to say there is no A.C. load shunted across the D.C. load resistance. Curve A is taken under similar conditions except that an A.C. load of 1 megohm is shunted across the D.C. load of 0.5 megohm. In both these curves the peak voltage input is 10 volts, and the distortion decreases in both cases as the input voltage is increased.

There are consequently two important factors to be considered. Firstly, the voltage input to the diode should be as high as possible (provided that there is no overloading in the preceding valve), and secondly, the A.C. shunt loading should be reduced so as to have negligible effect. The former is controlled by factors largely outside the diode itself, and in any case distortion on weak signals is less serious than on strong signals. In almost all A.C. receivers fitted with A.V.C. the input voltage to the diode on strong signals is over 10 volts peak, and this distortion in such cases is reduced. In manually controlled receivers where the control is on the R.F. amplifier, and where a high gain audio amplifier is used, this form of distortion becomes serious. In such cases the distortion may be reduced by the addition of an audio volume control which is set so as to allow the input to the diode to reach about 10 volts peak.

The second factor is a very serious one, and is frequently overlooked. As shown by the curves the distortion at 100% modulation is increased from 2.8% to 23% due to this shunting effect. Heavier shunting results in even greater distortion. Now, with a low gain audio stage, it is necessary to turn up the volume control in order to obtain full output, and in such a case the grid resistor of the following valve acts as an A.C. shunt, and causes serious distortion. On the other hand, with a high gain audio stage, it is only necessary to turn up the volume control slightly for full volume when tuned to a reasonably strong station. In this case the shunting effect of the load resistor of the following valve is only across a small portion of the diode load resistance and its effect on the total A.C. impedance is much reduced. With a diode load resistor of 0.5 megohm and with a 1.0 megohm grid resistor (these being fairly typical values) the shunting effect is very slight, provided that the volume control is not turned about one-fifth of its maximum. On very weak signals it may be necessary to turn up the volume control above this position, in order to obtain full output, but in such cases the distortion can generally be tolerated. This, therefore, is the simplest solution to the problem. It is necessary to use an audio amplifier having at least five times the gain normally required, and to reduce the setting of the volume control accordingly. Such high gain is provided by Radiotron type 6B7S driving type 42 or by type 6C6 (pentode) driving type 2A3 or inverse feedback 42. In the 2-volt battery series a similar result is given by Radiotron type 1K6 driving type 1D4.

FOR THE RADIO ENGINEER

DISTORTION IN DIODE DETECTORS (continued)

There are other shunting effects on the diode load resistor, all of which must be considered. For example, if a 6G5 Magic Eye is connected to the detector diode circuit, the resistor to its grid acts as an A.C. shunt. If good fidelity is required, this resistor should be greater than 1 megohm, and a value of 2 megohms is suggested, together with a filter condenser of 0.02 microfarad. If simple A.V.C. is used, there is additional shunting, which is unavoidable with this arrangement. It can be reduced by increasing the A.V.C. resistor to 1.5 or 2.0 megohms, but a limit is set to the value of this resistance, due to grid emission in the controlled valves. The better method is to avoid the use of simple A.V.C., either by amplified A.V.C. or by the special arrangement of low-distortion delayed A.V.C. shown in Radiotron Circuits D41 and D42.

There are other methods for the reduction of distortion due to A.C. shunting, and a very interesting circuit, providing practically distortionless detection together with A.V.C., is shown in Figure 7.

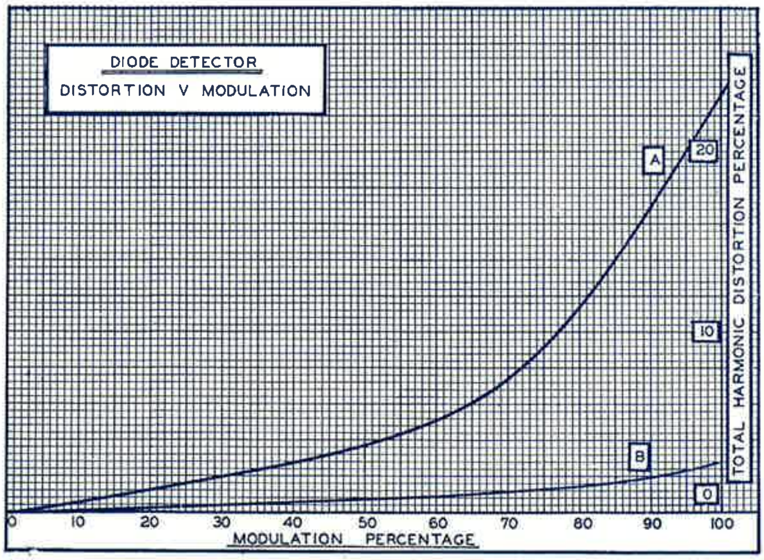


FIG. 6.

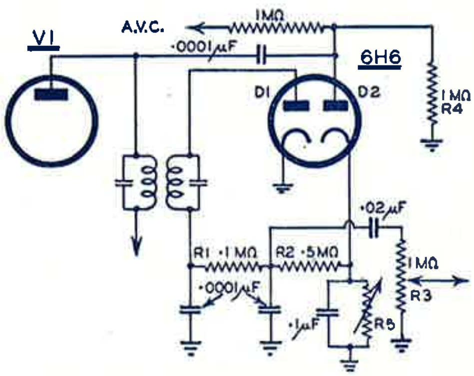


FIG. 7.

COMPENSATED DIODE DETECTOR

FOR THE RADIO ENGINEER

TONE COMPENSATION

In previous Radiotronics Technical Bulletins the application of "bass-boosting" has been described. While bass-boosting may be used to give a more satisfactory balance of tone between low and middle frequencies at very low volume, it does not give any compensation for the higher frequencies at low volume. The circuit in Fig. 8 shows the application of one method of tone compensation with a tuned circuit resonating at approximately 1000 ~. The effect of this arrangement is shown in Fig. 9, in which curves A and C refer to settings approaching the two extremes and curve B to one in a central position, as marked in Fig. 8. Curve "C" shows the marked rise of response at 100 cycles in relation to that given at 1000 ~, which is the best basis of comparison. The rise at higher frequencies is not so marked, but is fairly close to the compensation required for average conditions. When the control is taken to the extreme ends of the potentiometer, it will be found to have no effect whatever in one direction (beyond A) and to give a severe "trough" in the response curve at about 1000 cycles in the other extreme (beyond C). This latter extreme is not normally of value and could be avoided by the use of a small fixed resistor at the top end of the potentiometer.

This particular application is a typical one and many circuits can be arranged in similar manner, provided that a high plate resistance pentode, such as the 6C6, is used for the controlled valve. Any type of power valve may be used and no alteration is required in the tone compensation portion of the circuit.

FIG. 8.

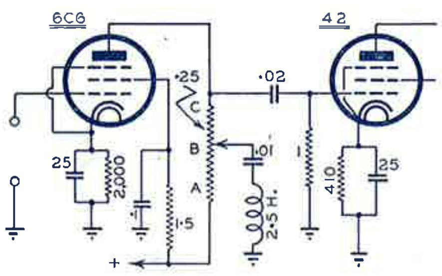
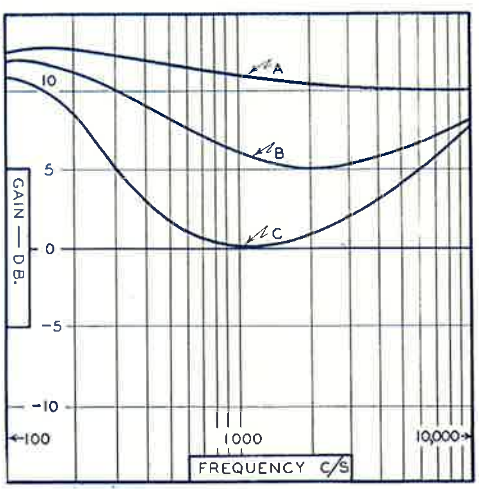


FIG. 9.



TONE COMPENSATION

FOR THE RADIO ENGINEER

SELF COMPENSATING PENTODES

The advantages of self-bias as commonly used with any indirectly heated valves are so well-known that there is no point in attempting to explain the reason why this method confers a degree of stability and consistency which is not obtained with fixed bias. Self-bias at least partially compensates for failing emission or fluctuations of supply voltage and is a very real safeguard which should be employed wherever possible. With resistance capacity coupled pentode valves, an additional compensation is possible through the use of a dropping resistor for the screen voltage supply. When, for example, a valve exhibits failing emission, it will tend to operate with lower plate and screen currents, and if no compensation were made it would tend to operate on the curved portion of its characteristic and so give distortion. When a screen dropping resistor is used, the tendency of the screen current to fall naturally produces a rise of screen voltage through the screen dropping resistor. This increased voltage tends to cause an increase of screen current and therefore of plate current, the two being definitely related, thereby at least partially compensating for the lower emission. Actually, the original operating point will not be reached, but a new operating point will be found on a portion of the characteristic, which is considerably straighter than that which would occur with fixed screen voltage supply. Other examples could be taken in addition to that of failing emission, one being that of fluctuating or falling supply voltage. In all such cases a screen dropping resistor tends to compensate for any variation of constants in the circuit.

When both self-bias and screen dropping resistor are used in conjunction, a very much more stable situation is obtained than with either separately. Such an arrangement may be regarded as self-protecting under any normal circumstances and is full guarded against unsatisfactory operation, whatever may be the actual source of the trouble. With ordinary commercial tolerances on resistance limits of cathode bias resistor or screen dropping resistor or plate load resistor, valves will be operated with a reasonable degree of safety even under the most extreme conditions.

On account of this very valuable self-compensating function of a screen dropping resistor, its use is strongly recommended in all cases of resistance coupled audio amplifiers, in place of a tapping on a voltage divider. A slight error in the adjustment of a voltage divider may cause distortion of a serious character, while no compensation is given for failing emission or for other variations in the circuit.

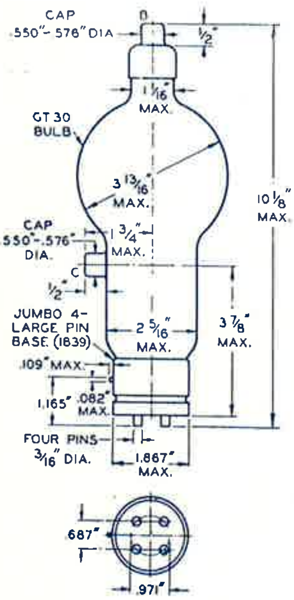
AMATEUR RECEIVER. Owing to the final adjustments and tests of the Radiotron Amateur Receiver not having been completed in time for this issue, the circuit and description have been held over until the next issue on 28th April.

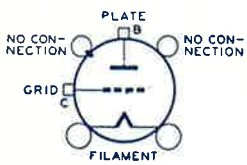
EXPERIMENTERS' SECTION

RADIOTRON 806

Radiotron 806 is a triode transmitting valve having a tantalum plate and rated with a maximum plate dissipation of 150 watts. The plate connection is brought out through a separate seal at the top of the bulb; the grid connection is brought out through a separate seal in the lower part of the bulb.

Radiotron 806 may be operated at maximum ratings at frequencies as high as 30 megacycles. At 50 megacycles it may be operated at 75% of the maximum rated plate voltage and plate input. At 100 megacycles it may be operated at 50% of the maximum rated plate voltage and plate input. Australian price—£12 net.





RADIOTRON 806.
Top View of Socket Connections.

TENTATIVE CHARACTERISTICS

Filament Voltage (A.C. or D.C.)	5.0 volts
Filament Current	10 amperes
Amplification Factor	12.6
Direct Interelectrode Capacitances (Approx.)	
Grid-plate	3.4 $\mu\mu f$
Grid-Filament	6.1 $\mu\mu f$
Plate-Filament	1.1 $\mu\mu f$

MAX. RATINGS AND TYPICAL OPERATING CONDITIONS

AS A-F POWER AMPLIFIER AND MODULATOR—CLASS B.

D-C Plate Voltage	3000 max. volts
Max.-Signal D-C Plate Current	200 max. ma.
Max.-Signal Plate Input	500 max. watts
Plate Dissipation	150 max. watts

Typical Operation (2 Valves)

D-C Plate Voltage	2000	3000 volts
D-C Grid Voltage	−150	−240 volts
Max.-Sig. D-C Plate Current	390	330 milliamps
Effective Load Res. (Plate-to-Plate)	11500	21500 ohms
Max.-Sig. Driving Power (Approx.)	14	10 watts
Max.-Sig. Power Output (Approx.)	500	660 watts

AS R-F POWER AMPLIFIER—CLASS B TELEPHONY
Carrier conditions per valve (max. modulation factor of 1.0.)

D-C Plate Voltage	3000 max. volts
D-C Plate Current	150 max. milliamps
Plate Input	225 max. watts
Plate Dissipation	150 max. watts

Typical Operation:

D-C Plate Voltage	2000	3000 volts
D-C Grid Voltage	−150	−240 volts
D-C Plate Current	110	70 milliamps
Driving Power (Approx.)	8	5 watts
Power Output (Approx.)	70	70 watts

AS PLATE-MODULATED R-F POWER AMPLIFIER—CLASS C TELEPHONY.
Carrier conditions per valve (max. modulation factor of 1.0.)

D-C Plate Voltage	2500 max. volts
D-C Grid Voltage	−1000 max. volts
D-C Plate Current	200 max. milliamps
D-C Grid Current	50 max. milliamps
Plate Input	500 max. watts
Plate Dissipation	110 max. watts

Typical Operation:

D-C Plate Voltage	2000	2500 volts
D-C Grid Voltage	−500	−600 volts
D-C Plate Current	195	195 milliamps
Driving Power (Approx.)	28	32 watts
Power Output (Approx.)	300	390 watts

AS R-F POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY. *(Key-down conditions per valve without modulation.)*

D-C Plate Voltage	3000 max. volts
D-C Grid Voltage	−1000 max. volts
D-C Plate Current	200 max. milliamps
D-C Grid Current	50 max. milliamps
Plate Input	600 max. watts
Plate Dissipation	150 max. watts

Typical Operation:

D-C Plate Voltage	2000	2500	3000 volts
D-C Grid Voltage	−400	−500	−600 volts
D-C Plate Current	195	195	195 Ma.
Driving Power (Approx.)	15	17	20 watts
Power Output (Approx.)	280	370	450 watts