RADIOTRONICS

AMALGAMATED WIRELESS VALVE CO. PTY. LTD.

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

TECHNICAL BULLETIN No. 87 **15th JUNE, 1938**

In this issue:—

RADIOTRON 0A4-G GAS TRIODE

Cold-Cathode Starter-Anode Type

The 0A4-G is a cold-cathode, glow-discharge tube. The discharge can be initiated with a very small amount of electrical energy supplied to the starter-anode circuit. This feature makes it practicable to obtain remote control of line-operated electrical devices by means of an electrical impulse generated at radio frequencies and transmitted over the same power line. The 0A4-G may also be used as a voltage regulator or as a relaxation oscillator.

Installation and Application

The base pins of the 0A4-G fit the standard octal socket which may be installed to hold the tube in any position.

As a relay tube the 0A4-G should be operated according to the conditions given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS.

A schematic circuit showing the use of this type is given. In this circuit, full line voltage is applied between anode and cathode. The starter-anode is maintained at a potential just below that required for breakdown by means of the bleeder consisting of R_1 and R_2. The inductance L and the condenser C constitute a tuned circuit in series with the line. When a carrier having the frequency of the tuned circuit is impressed on the power line a resonant voltage appears across L and C. The effect of the voltage across the condenser C is to increase the negative potential peaks on the cathode and thus to increase the potentials between cathode and starter-anode. These peaks start a discharge between cathode and starter-anode. This discharge produces free ions which enable the discharge to transfer to the anode if circuit values are such that sufficient starter-anode current flows. After the discharge occurs between cathode and anode, current flows through the relay S to close the contact of a local circuit. Because a.c. is supplied to the anode the 0A4-G ceases to discharge when the carrier is removed.

If the 0A4-G is to be operated from a D.C. power line, it will be necessary to provide means for reducing the anode voltage to a value under

60 volts (extinction voltage). This can be conveniently done by opening the anode circuit.

It will be noted that most of the voltage on the starter-anode required to cause breakdown is supplied by the bleeder circuit. As a result, the tuned circuit is required to supply only the difference between breakdown voltage and applied A.C. voltage. Precautions should be taken in the design of equipment so that at the highest line voltage the A.C. voltage applied to the starter-anode will not be sufficient to cause the 0A4-G to break down; and so that at the lowest line voltage, the carrier voltage will be high enough to make up for low line voltage. It is recommended therefore that provision be made to supply an R.F. starter-anode voltage having a minimum peak value of 55 volts.

Typical breakdown characteristics of the 0A4-G are shown in Fig. 1, for conditions where the starter-anode and anode are either positive or negative, respectively. The tube is designed to be operated so that the discharge takes place when the starter-anode and anode are both positive (first quadrant). For purposes of illustration, values are also shown in the other quadrants for other polarity combinations. Operation in these quadrants is unstable.

In the first quadrant, it will be noted that the 0A4-G breaks down between cathode and starter-anode when the starter-anode voltage reaches 85 volts approximately. This discharge initiates a discharge between cathode and anode, provided the anode potential is adequate. The required anode potential is a function of the current flowing in the starter-anode circuit. The relationship between anode voltage and starter-anode current is shown in Fig. 2. In practice, it is desirable to have a current of at least 200 microamperes flowing to the starter-anode.

Reading List

Darrow, K. K., *Electrical Phenomena in Gases.* Williams and Wilkins, Baltimore, Md.

Dow Wm. G., *Fundamentals of Engineering Electronics.* John Wiley and Sons, Inc., New York, N.Y.

Thomson, J. J., *Conduction of Electricity Through Gases.* Cambridge University Press, Oxford, England.

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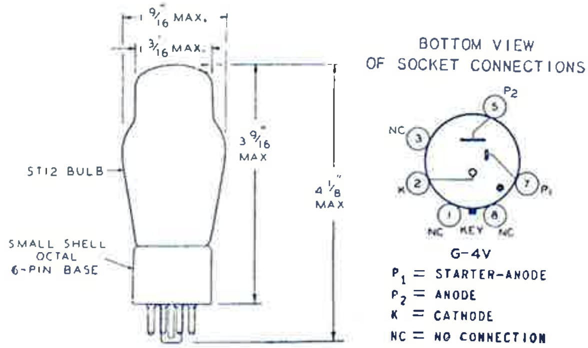
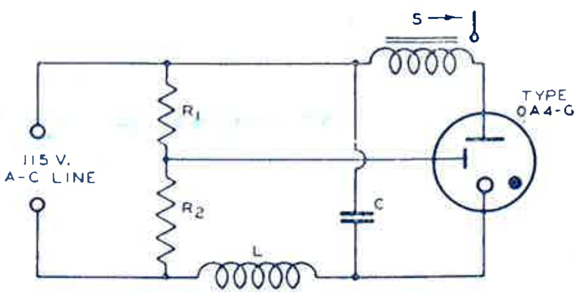


SCHEMATIC RELAY CIRCUIT USING TYPE 0A4-G
A-C OPERATION



C, L = HIGH-Q TUNED CIRCUIT FOR R-F SIGNAL
R_1 = 15000 OHMS (1/2 WATT)
R_2 = 10000 OHMS (1/2 WATT)
S = RELAY — CHOSEN FOR DESIGN REQUIREMENTS
● = GAS TUBE TYPE

TYPICAL BREAKDOWN CHARACTERISTICS FOR DIFFERENT ELECTRODE POLARITIES

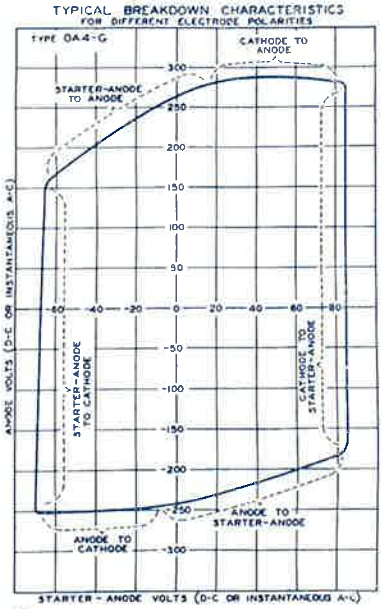


FIG. 1

AVERAGE TRANSITION CHARACTERISTIC

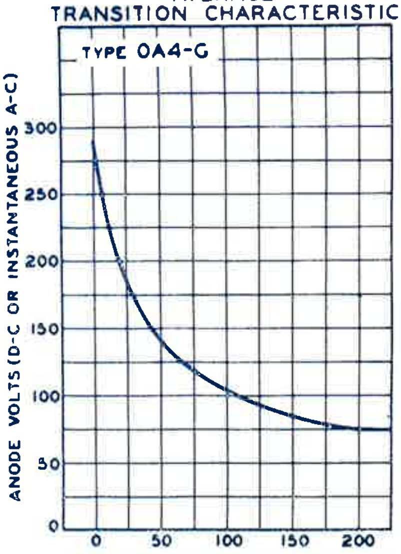


FIG. 2

AVERAGE ANODE-DROP CHARACTERISTIC

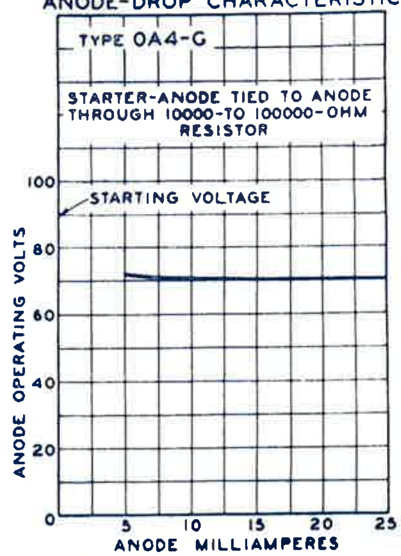


FIG. 3

RADIOTRON OA4G GAS-TRIODE

Tentative Data

MAXIMUM OVERALL LENGTH	$4\text{-}\frac{1}{8}$ in.
MAXIMUM DIAMETER	$1\text{-}\frac{9}{16}$ in.
BULB	ST-12
BASE	Small Shell Octal 6-Pin

Characteristics

PEAK ANODE BREAKDOWN VOLTAGE (Starter-anode tied to cathode)	225 min.	Volts
PEAK POSITIVE STARTER-ANODE BREAK-DOWN VOLTAGE	70 min.	Volts
	90 max.	Volts
STARTER-ANODE CURRENT (For transition of discharge to anode at 140 volts peak)	100 max.	Microamperes
STARTER-ANODE DROP	60 approx.	Volts
ANODE DROP	70 approx.	Volts

Maximum Ratings and Typical Operating Conditions

Relay Service

PEAK CATHODE CURRENT	100 max.	Milliamperes
D-C CATHODE CURRENT	25 max.	Milliamperes
TYPICAL OPERATION WITH A-C SUPPLY:		
Anode-Supply Voltage (RMS)	105-130	Volts
A-C Starter-Anode Voltage (Peak)	70 max.	Volts
R-F Starter-Anode Voltage (Peak)	55 min.	Volts
Sum of A-C and R-F Starter—Anode Voltages (Peak)	110 min.	Volts

RCA APPLICATION NOTE ON HUM IN HEATER-TYPE VALVES.

A high-gain audio-frequency amplifier is usually critical as to hum because a small hum voltage on the grid of the first valve is amplified by all the stages in the amplifier. To reduce the hum output of such an amplifier to a very low level, it may be necessary to observe special precautions in the design of the first stage. Hum voltage introduced by the heater to the grid of the second valve is of secondary importance, although hum-reducing precautions may also be observed in the design of this stage.

This Note discusses, first, various causes of hum introduced by A.C. operated heaters in heater-type valves and, second, practical methods for reducing this hum. It will be assumed that valves and associated wiring are adequately shielded and that the power-supply unit is adequately filtered.

There are several instances when special circuit precautions may not prove adequate to reduce hum. In high-gain amplifiers, for example, the effects of possible variations between valves of the same type are greatly magnified by the gain of the amplifier. The type 1603 is recommended for use in such cases. This valve type is a sharp cut-off pentode having characteristics similar to those of the 6J7 or 6C6, and is especially designed for applications which are critical as to hum or microphonics. Only one special precaution need be observed in using the 1603: connect a 100- to 500-ohm potentiometer across the heater and ground the adjustable arm. With screen connected to plate (triode arrangement), the 1603 has characteristics similar to to those of the 6C5.

Sources of Hum

Hum may be introduced by an A.C. operated heater because of: (1) the presence of a magnetic field; (2) capacitive coupling between heater and other electrodes; (3) leakage through heater-cathode insulation; and (4) emission from the heater to other electrodes. It should be noted that the effects of magnetic fields, capacitive coupling, and heater emission are appreciable only when the gain of the amplifier is high. In a medium-gain amplifier, such as used in a radio receiver, only the effects of heater cathode-leakage may be important.

(1) Hum Due to Magnetic Field

When the heater is fed from a source of alternating voltage, the alternating current that flows through the heater may set up an alternating magnetic field of appreciable magnitude. Because this magnetic field accelerates the electrons in a direction at right angles to that of the electrostatic fields, electrode currents are modulated. Fig. 1 shows one manner in which an alternating magnetic field may introduce hum in the plate circuit. Consider the usual direction of electron flow as that shown by A. Then, during one half of the heater-current cycle, the beam is deflected upward (B); if part of the beam leaves the plate, the plate current is reduced. Similarly, during the second half of the cycle, the beam is deflected downward (C), to reduce the plate current again. This change of beam position gives rise to a hum current having a large double-frequency component. This hum current flows through the load, and causes hum voltage on the grid of the succeeding valve.

The ideal remedy for high hum due to a magnetic field is to use D.C. on the heater. With A.C. heater excitation, it is possible to reduce hum by reducing the value of load resistance, but this expedient is accompanied by a loss in gain. When it is not practicable to use D.C. on the heater, the type 1603 is recommended in preference to other valve types.

(2) Hum Due to Capacitive Coupling

Fig. 2A is a simplified circuit of an A.F. amplifier showing capacitive coupling between control grid and each terminal of the heater. When one side of the heater (B) is grounded, heater voltage (E_h) is applied to C_1 and R_g in series. The fraction of E_h that appears across the grid resistor, R_g, is amplified by the valve and passed on to the succeeding stages. Because the reactance of C_1 is very high compared to the resistance of R_g, the hum voltage that appears across R_g is E_{gh}:

$$E_{gh} = E_h R_g \omega C_1$$

For example, in a triode let $R_g = 2$ megohms, $\omega = 2\pi f$ or 377 radians per second for $f = 60$ cps, $C_1 = 0.5\ \mu\mu f$, and $E_h = 6.3$ volts (rms). Under these conditions, E_{gh} equals 2.38 millivolts. When this small hum voltage is multiplied by the gain of the amplifier, the output hum voltage is appreciable.

Two simple remedies are available when the capacitance of C_2 is very small: (1) reduce the value of R_g, or (2) ground terminal A of the heater instead of terminal B. However, when the capacitance of C_2 is appreciable, changing the ground terminal of the heater may not reduce the hum to an acceptable level. In this case, it is necessary to balance out the hum voltage by connecting a potentiometer across the heater. The bridge circuit for this connection is shown in Fig 2B. In this circuit, ($R_1 + R_2$) is the potentiometer, C_1 represents the capacitance of the grid to one terminal of the heater, and C_2 represents the capacitance of the grid to the other terminal of the heater. When the bridge is balanced, the hum voltage across R_g is zero.

Most of the grid-heater capacitance is due to the close proximity of the grid lead and the heater leads in the stem press (in glass-type valves) and in the base; only a small amount of grid-heater capacitance exists between the electrodes themselves. Hence, grid-heater capacitances of top-cap valves are comparatively low. Of the valve types that have the control-grid lead terminating at a base pin, metal valves have lower grid-heater capacitance than the corresponding glass types, because there is no stem press in metal valves.

When it is feasible to ground one terminal of the heater in order to reduce hum, ground that terminal which is nearest the control-grid lead. Moreover, low hum due to capacitive coupling can be expected from a valve type which has its cathode lead between control-grid and heater leads, because the shielding action of the cathode lead reduces grid-heater capacitance.

Capacitive coupling from heater to plate causes plate-circuit hum. When grid-heater capacitance is low, the recommendations for

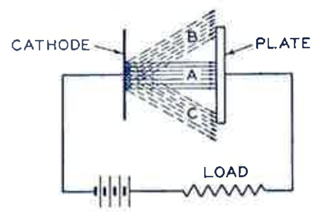


FIG. 1

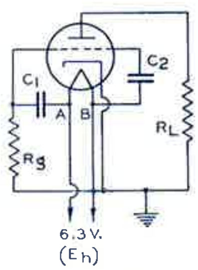


FIG. 2A

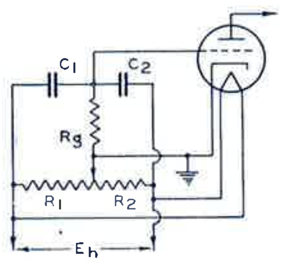


FIG. 2B

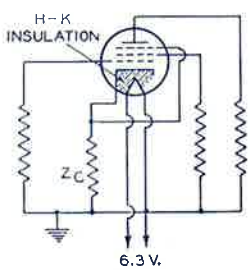


FIG. 3

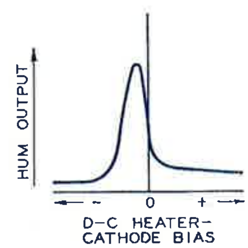


FIG. 4

reducing plate-circuit hum are the same as those discussed for grid-heater capacitance. However, it is not desirable to reduce the value of load resistance in order to reduce plate-circuit hum, because the gain of the amplifier decreases with load.

(3) Hum Due to Heater-Cathode Leakage

The resistance of the insulation between heater and cathode is finite and non-linear.

Therefore, leakage current of peculiar waveform flows from heater through heater-cathode insulation and cathode-circuit impedance Z_c to ground. When Z_c is appreciable, the hum voltage across Z_c is applied to other electrodes in the valve and appears in the output. (See Fig. 3).

Three remedies are suggested for this type of hum: (1) reduce Z_c to a low value by adequate by-passing, (2) obtain bias from a source that is not common to heater and cathode, and (3) bias the heater either positive or negative with respect to cathode by about 10 volts. The value of suggestions (1) and (2) is generally appreciated, but that of (3) may require further explanation. The success of (3) depends on a resistance characteristic peculiar to heater cathode insulation. Curves showing the relation between hum voltage and D.C. heater bias indicate that maximum hum occurs at biases between ±1 volt on the heater; that hum voltage falls rapidly with increasing bias; and that hum voltage remains at a constant low value for heater cathode biases greater than approximately ±10 volts. The general shape of a hum curve is shown in Fig. 4.

(4) Hum Due to Emission from the Heater

In the process of valve manufacture, it is possible for a portion of the heater to be coated with a small amount of electron-emitting material. When the potential of any electrode in the valve is positive with respect to the heater, emission from the heater to that electrode may take place.

There are two practical remedies for reducing hum due to heater emission: (1) reduce the value of impedance in the electrode circuit that is most critical as to hum (usually the control-grid circuit) and (2) bias the heater more positive with respect to cathode than any other electrode in the valve. In most cases, however, the control grid is the most critical electrode; it is only necessary, therefore, to bias the heater more positive than the control grid in order to reduce hum caused by heater emission to a low value. Instances do arise, however, when it is necessary to bias the heater as much as +50 volts with respect to cathode in order to reduce hum to an acceptable level. In such cases, it is suggested that the bias be held to the lowest acceptable value.

In some instances emission from cathode to heater causes hum. The remedy in this case is to apply a negative bias to the heater. Whether hum is caused by cathode emission to heater or by heater emission can be determined from the polarity of the heater bias that is necessary to reduce the hum. This bias should not be too high, because the effects of heater emission increase with negative heater bias.

RADIOTRON 6K8

Revised Characteristics

The tentative characteristics of the 6K8 given in Radiotronics 85, have been revised, and a table of the new characteristics is given below. It will be seen that the plate resistance has been increased and the conversion transconductance decreased, together with certain minor alterations in electrode currents. The transconductance (mutual conductance) of the oscillator has been increased from 2400 to 3000 micromhos.

RADIOTRON 6K8

Typical Operation:

Heater Voltage** .	6.3	6.3	Volts
Hexode Plate Voltage	100	250	Volts
Hexode Screen Voltage	100	100	Volts
Hexode Control-Grid Voltage ..	–3	–3	Volts
Triode Plate Voltage	100	100	Volts
Triode Grid Resistor	50000	50000	Ohms
Hexode Plate Resistance (approx.)	0.4	0.6	Megohm
Conversion Transconductance ..	325	350	Micromhos
Hexode Control-Grid Bias (approx.) for Conversion Transductance = 2 micromhos	–30	–30	Volts
Hexode Plate Current	2.3	2.5	Milliamperes
Hexode Screen Current	6.2	6.0	Milliamperes
Triode Plate Current	3.8	3.8	Milliamperes
Triode Grid and Hexode Grid No. 1 Current	0.15	0.15	Milliamperes

The transconductance of the oscillator portion (not oscillating) of the 6K8 is approximately 3000 micromhos when the Triode Plate Voltage is 100 volts, and the Triode Grid Voltage is 0 volts.

** In circuits where the cathode is not directly connected to the heater, the potential difference between heater and cathode should be kept as low as possible.

RADIOTRON 1851

Radiotron 1851 television amplifier pentode, described in Radiotronics 86, is now available from stock at an Australian net price of £1/2/6.

NOTES ON "C" BATTERIES

The Use of Discharge Resistors

In battery receivers trouble is experienced due to the gradual drop in the voltage of the "B" batteries. This drop in the voltage not only results in a decrease of power output, but also in increased distortion due to the power valves not having the optimum bias for the lower plate voltage. In the ideal arrangement the grid bias would be decreased in accordance with the drop of plate voltage and under these conditions the best possible results would be obtained from the "B" battery, which could then be used until entirely exhausted. If an ordinary fixed bias voltage is employed, the power valve becomes so seriously over-biased that the "B" battery is frequently discarded, although further use could be made of it, if the bias voltage were decreased. In cases where the receiver is handled by a competent person, it is sometimes permissible to change the bias voltage as the "B" battery deteriorates, but this is a practice not generally to be recommended. It is preferable to arrange so that the bias voltage automatically decreases in the ideal relationship. This may be accomplished by the addition of a discharge resistance in the receiver, so connected that it is only in operation during the time that the set is switched on. It will therefore be seen that the "B" battery and the "C" battery are both discharging all the time that the set is in use, and if the discharge resistor is suitably proportioned, the drop between the two batteries may be matched for optimum performance from the "B" battery.

It has been found that the best all-round performance is obtained when the voltage of the "C" battery falls in accordance with the following table:—

"B" BATTERY VOLTAGE. Nominal	"B" BATTERY VOLTAGE. End of Life	"C" BATTERY VOLTAGE. Nominal	"C" BATTERY VOLTAGE. End of Life
180	96	22.5	16
135	72	4.5	3.2
90	48		
45	24		
22.5	12		

In order to give the desired discharge to the "C" battery, a resistance as shown in the following table should be switched across the "C" battery while the set is in operation:—

Receiver drain (mA with nominal plate voltage).	Resistance in ohms per volt "C" Battery.	Resistance for 4.5 volt "C" Battery.
12	1600	7200
16	1020	4590
20	800	3600

These values apply to heavy duty "B" batteries and large (No. 126 or equivalent) "C" batteries.

In calculating the receiver drain, the average current under normal receiving conditions should be used. In the case of a Class B stage using type 19 or 1J6G with a load of 20,000 ohms, the average plate current may be taken as 4 mA.

RUN-DOWN B BATTERIES.

Internal Resistance Affects Operation

Radio receivers are usually tested for sensitivity, power output and distortion with new B batteries supplying the full voltage. In order to check the performance of the receiver with a run down B battery, tests are sometimes made on a new battery simply by tapping down to a lower voltage. Although this results in the receiver operating at a lower voltage, it does not check the performance of the receiver under normal conditions with a run-down battery. When a B battery drops in voltage there is also developed an internal resistance which may be sufficient to cause motor-boating, oscillation or various other results of feedback. It is suggested that new receivers should be tested with a low voltage in series with an equivalent internal resistance.

Tests which have been conducted on a large number of B batteries indicate that the internal resistance of a battery will never normally exceed the values given in the following table. These values of voltages and resistances refer to a B battery of 135 volts.

When Battery Drops to:	Equivalent Highest Internal Resistance is:
120 V.	60 ohms
102 V.	300 ohms
90 V.	660 ohms
72 V.	1500 ohms

In order to obtain the best results from B batteries, it is desirable that the receiver should still function, even with a B battery voltage of 72 volts and an internal resistance of 1500 ohms. Such a test is easy to apply and is a valuable check on the performance of the receiver and will ensure that the converter valve continues to oscillate and that all valves are in a reasonable working condition. In certain cases, particularly where a wide wave band is covered, it may not be possible to obtain short wave operation under these conditions, but the test will indicate to what limit the B battery may be discharged before the set becomes unusable.

HEATER AND FILAMENT VOLTAGES

The tolerance in voltage on indirectly heated valves of all types is ±10%. In the case of 2.5 volt valves this is equivalent to voltage limits of 2.25-2.75 volts. In the case of 6.3 volt valves this is equivalent approximately to 5.7-6.9 volts. These tolerances apply to the worst possible conditions and the voltages should be measured actually at the base pins. The 10% upper limit is a very critical one in many cases and if this is increased there is liable to be damage to the valves in certain cases together with grid emission which may cause distortion or seriously affect the operation of the receiver. This upper limit is particularly critical in the case of power valves, especially when fixed bias is used. The use of self-bias gives slightly greater latitude and greater safety, but even in this case it is very rarely permissible to exceed an increase of 10% in voltage. A further effect due to increased voltage is that the temperature of the heater is considerably increased with the result that the leakage between heater and cathode becomes pronounced, and may in certain cases result in hum. The question of hum is, of course, not so important in the case of output valves as in those operating at a low level.

In the case of 2 volt filament valves the tolerance is also ±10%, giving voltages on the filament between 1.8 and 2.2 volts. It is, however, undesirable to operate the filaments for any length of time above 2 volts and it is therefore preferable that the operating voltage of the valve should be between the limits of 1.8 and 2.1 volts. When three valves are operated in series the voltage across the same would be 5.4-6.3 volts. A freshly charged accumulator will exceed these maximum voltages for a short length of time, but the voltage rapidly drops down to a satisfactory level and good operation of these valves is obtained with the normal changes of voltages due to accumulator supply. It has been found that the effective voltage at the filament, after allowing for drop in the leads, is between 1.9 and 1.95 volts during the greater part of the effective life of the accumulator charge. It is not desirable to operate the valves permanently at any voltage below about 1.9 volts.

When an air cell is used for the supply of voltage to 2-volt filament valves, it is necessary to insert a series resistance in order to decrease the voltage to the desired level. The following values of resistances are recommended for use with Radiotron valves supplied by air cells.

Nominal Drain	Series Resistor (including load resistance)
600 mA	.595 ohm
540 mA	.685 ohm
480 mA	.81 ohm
420 mA	.96 ohm
360 mA	1.10 ohm

When used with these values of resistances the voltages on the valves during the greater part of the life of the air cell will be between 1.9 and 2 volts so that the best results may be obtained both from valves and from the air cell. With these resistors the voltage on the filaments of the valves does not drop to 1.8 volts until the air cell has become practically exhausted and no appreciable additional life could be expected by any variation of the resistance.

REPLACING 6G5 BY 6U5

Radiotron 6U5 is electrically identical with type 6G5 and these two types may therefore be interchanged without any effect on the receiver. The principal difference between these two types is that the 6U5 is fitted into a tubular bulb of smaller maximum diameter than that of the 6G5. This does not affect the mounting, since the overall length and the diameter of the portion of the bulb around the fluorescent target are similar. The basing of the 6U5 is identical to that of the 6G5.

There is an advantage in using the 6U5, since all of this type incorporate the space charge grid, thereby providing greater reliability. The 6U5 is being very widely used this season and is recommended to manufacturers and also to radio suppliers for replacement purposes. The 6U5 may be used to replace either 6G5 or 6U5, while the reverse does not always hold.

MATCHING MICROPHONES AND PICKUPS

Confusion is sometimes caused through the use of the term "matching" in relation to the output loads of microphones and pickups. The output load into which either of these devices should work does not bear any definite relationship to the internal impedance of the unit. A microphone, for example, may have an internal impedance of 20,000 ohms and be worked into a load of 5 megohms. Data on most devices of this nature are provided by the manufacturers, and attention should be paid in the design of any equipment to the correct load into which they should work. For the purpose of such applications, the internal resistance may be treated as having no bearing on the working conditions. The output voltage or level of the device is usually given when operating into the correct or recommended load resistance.

RADIOTRON 809

Application of Series Modulation

Series modulation was described in some detail in Radiotronics No. 77 and a number of typical applications were tabulated. Radiotron 809 has been released subsequent to this publication, and the necessary operating conditions for this type are given below.

A suitable modulator may be built, using four type 50 valves in parallel, fed from an audio transformer. The plate supply voltage should be 1350 volts, and the plate current should be adjusted to 100 mA. The cathode bias resistor should be 1700 ohms, the power input to the final amplifier 50 watts, the R.F. driving power being 2.5 watts.

Under these conditions the voltage across the 809 would be 500 volts, and the carrier output 30 watts. The peak audio input volts will be 180 volts approximately, and it should be noted that resistance coupling is not practicable owing to the low resistance necessary in the grid circuit of the modulator valves.

The method of calculation is identical with that described in Radiotronics 77, to which reference should be made for further information.

ADVANTAGES OF SELF BIAS.

Self-bias has many advantages over fixed or back bias and is particularly valuable in the case of output valves where it provides a distinct measure of protection and more consistent performance. There are certain smaller valves which also are more satisfactory when operated with self-bias, these including all the high mu triodes such as types 2A6, 75, 6B6G, 6F5, 6F5G. These valves have such a small margin between the point at which grid current commences and the point at which distortion becomes severe due to curvature of the characteristic that care must be taken to adjust the operating point between these two limits. Due to variations between the valves, it is far more satisfactory to operate high mu triodes with self-bias than with any form of fixed bias. When only a small output voltage is required it is not so essential to employ self-bias but in all cases it is desirable.

Any valve which is being operated at or near its maximum output should be operated on self-bias so that correct adjustment is made for variations in plate current during life or between different valves. This is not so important when the valve is being operated under low output conditions since in such cases a slight misadjustment will not cause any appreciable effect.

WHAT "OUTPUT" MEANS

Allowance for Losses

When the output of a power valve is given as 3.0 watts, it is understood that this is the output into the correct load through an ideal transformer, having a ratio of 1:1. When applied through a transformer having appreciable losses, these will, of course, be subtracted from the rated output so that the actual output may be considerably less. Transformers, such as are used for the input to loudspeakers, may have an efficiency of the order of 75% and in some cases even less, so that the output measured across the secondary will always be less than the true output of the valve. When it is desired to measure the true output of the valve, it is desirable to insert a high quality choke of low D.C. resistance and low loss between B+ and plate and to apply the load through a large blocking condenser of negligible impedance directly between plate and cathode.

In the case of driver valves for class B stages the loss in the transformer should always be considered. In this case the efficiency should not be on the basis of average power but on peak power drawn by the grids, and the efficiency under these conditions may be between 50% and 70%. For this reason it is necessary to employ a driver valve, having considerable reserve of power. Good design usually indicates that the driver valve should supply a peak power of two to three times the peak power drawn by the grids of the output stage. The peak power given by the driver valve is twice the average power.

LONG LIFE FROM MAGIC EYE TUNING INDICATORS

It has been found that long life is obtainable from the new Radiotron 6U5 Magic Eye Tuning Indicator, provided that the target voltage is maintained at the optimum value. The space-charge grid in this type provides uniform target current and prevents excessively high current such as sometimes occurred in older types, and the use of a series dropping resistor is therefore not absolutely essential.

A good compromise is found by operating the 6U5 with a target voltage of between 180 and 200 volts, lower voltages giving decreased brilliancy and higher voltages tending to decrease the life. This voltage may be obtained by means of a voltage divider, but preferably by means of a dropping resistor of 25,000 ohms from a 250 volt supply or 15,000 ohms from a 220 volt supply.

In the case of older type Tuning Indicators which are not fitted with the space-charge grid, it is highly desirable to employ a dropping resistor in order to limit the target current. In such cases a resistance of 10,000 ohms will generally be found satisfactory.

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