TECHNICAL BULLETIN No. 96   **15th MARCH, 1939**

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R.C.A. APPLICATION NOTE
INPUT LOADING OF RECEIVING VALVES AT RADIO FREQUENCIES

The input resistance of an r-f amplifier valve may become low enough at high radio frequencies to have appreciable effect on the gain and selectivity of a preceding stage. Also, the input capacitance of a valve may change enough with change in avc bias to cause appreciable detuning of the grid circuit. It is the purpose of this Note to discuss these two effects and to show how the change in input capacitance can be reduced.

Input Conductance.

In this Note, it is convenient to discuss the input loading of a valve in terms of the valve's input conductance, rather than input resistance. The input conductance, g_i, of commercial receiving valves can be represented approximately by the equation.

$$g_i = k_c f + k_h f^2 \qquad (1)$$

where f is the frequency of the input voltage. A table of values of k_c and k_h for several r-f valve types is shown on the next page. The approximate value of a valve's input conductance is micromhos at all frequencies up to those in the order of 100 megacycles can be obtained by substituting in Eq. (1) values of k_c and k_h from the table. In some cases, input conductance can be computed for conditions other than those specified in the table. For example, when all the electrode voltages are changed by a factor n, k_h changes by a factor

which is approximately $n^{-\frac{1}{2}}$. The value of k_c is practically constant for all operating conditions. Also, when the transconductance of a valve is changed by a change in signal-grid bias, k_h varies directly with transconductance over a wide range. In the case of converter types, the value of k_h depends on oscillator-grid bias and oscillator voltage amplitude. In converter and mixer types, k_h is practically independent of oscillator frequency.

In Eq. (1), the term $k_c f$ is a conductance which exists when cathode current is zero. The term $k_h f^2$ is the additional conductance which exists when cathode current flows. These two terms can be explained by a simple analysis of the input circuit of a valve.

Cold Input Conductance.

The input impedance of a valve when there is no cathode current is referred to as the cold input impedance. The principal components of this cold impedance are a resistance due to dielectric hysteresis, and a reactance due to input capacitance and cathode-lead inductance. Because these components are in a parallel combination, it is convenient to use the terms admittance, the reciprocal of impedance, and susceptance, the reciprocal of reactance. For most purposes, the effect of cathode-lead inductance is negligible when cathode current is very low. The cold input admittance is,

INPUT LOADING OF RECEIVING VALVES (Cont.)

Table of Approximate Values k_c and k_h for Several Valve Types

Valve Type	Heater Volts	Plate Volts	Screen Volts	Signal-Grid Bias Volts	Suppressor Volts	k_c Micro-mhos/Mc	k_h Micro-mhos/Mc²
6A8	6.3	250	100	−3	−	0.3	−0.05*
6J7	6.3	250	100	−3	0	0.3	0.05
6K7	6.3	250	100	−3	0	0.3	0.05
6K8	6.3	250	100	−3	−	0.3	−0.08†
6L7	6.3	250	100	−3	−	0.3	0.15‡
6SA7 (Self-excited)	6.3	250	100	0	−	0.3	−0.03§
6SA7 (Separately excited)	6.3	250	100	−2	−	0.3	−0.03§
6SJ7	6.3	250	100	−3	0	0.3	0.05
6SK7	6.3	250	100	−3	0	0.3	0.05
954	6.3	250	100	−3	0	0.0	0.005
1851	6.3	250	150	−2	0	0.3	0.13
1852	6.3	250	150	−2	0	0.3	0.13
1853	6.3	250	200	−3	0	0.3	0.065

* For oscillator-grid current of 0.3 ma. through 50000 ohms.
† For oscillator-grid current of 0.15 ma. through 50000 ohms.
‡ For wide range of oscillator-grid currents.
§ For grid No. 1 current of 0.5 ma. through 20000 ohms.

therefore, a conductance in parallel with a capacitive susceptance. The conductance due to dielectric hysteresis increases linearly with frequency. Hence, the cold input conductance can be written as $k_c f$, where k_c is proportional to the power factor of grid insulation and is the k_c of Eq. (1).

Hot Input Conductance.

The term $k_h f^2$, the input conductance due to the flow of electron current in a valve, has two principal components, one due to electron transit time and the other due to inductance in the cathode lead. These two components can be analysed with the aid of Fig. 1. In this circuit, C_h is the capacitance between grid and cathode when cathode current flows, C_g is the input capacitance due to capacitance between grid and all other electrodes except cathode, g_t is the conductance due to electron transit time, and L is the cathode-lead inductance. Inductance L represents the inductance of the lead between the cathode and its base pin, together with the effect of mutual inductances between the cathode lead and other leads near it. Analysis of the circuit of Fig. 1 shows that, with L small as it generally is, the input conductance, g_h, due to the presence of cathode current in the valve, is approximately

$$g_h = g_m \omega^2 L C_h + g_t$$

where $\omega = 2\pi f$. The term $g_m \omega^2 L C_h$ is the conductance due to cathode-lead inductance. It can be seen that this term varies with the square of the frequency. In this term, g_m is the grid-cathode transconductance because the term is concerned with the effect of cathode current flowing through L. In a pentode, and in the 6L7, this transconductance is approximately equal to the signal-grid-to-plate transconductance multiplied by the ratio of d-c cathode current to d-c plate current. In the

converter types 6A8, 6K8 and 6SA7, the signal-grid-to-cathode transconductance is small. Cathode circuit impedance, therefore, has little effect on input conductance in these types.

For an explanation of the conductance, g_t, due to electron transit time, it is helpful to consider the concept of current flow to an electrode in a valve. It is customary to consider that electron current flows to an electrode only when electrons strike the surface of the electrode. This concept, while valid for static conditions, fails to account for observed high-frequency phenomena. A better concept is that, in a diode for example, plate current starts to flow as soon as electrons leave the cathode. Every electron in the space between cathode and plate of a diode induces a charge on the plate; the magnitude of the charge induced by each electron depends on the proximity of the electron to the plate. Because the proximity changes with electron motion, there is a current flow to the plate through the external circuit due to the motion of electrons in the space between cathode and plate.

Consider the action of a conventional space-charge-limited triode as shown in Fig. 2. In this triode, the plate is positive with respect to cathode and the grid is negatively biased. Due to the motion of electrons between cathode and grid, there is a current I_a flowing into the grid. In addition, there is another current I_b flowing out of the grid due to the motion of electrons between grid and plate receding from the grid. When no alternating voltage is applied to the grid, I_a and I_b are equal and the net grid current (I_g) is zero.

Suppose, now, that a small alternating voltage (e_g) is applied to the grid. Because the cathode has a plentiful supply of electrons, the charge represented by the number of

INPUT LOADING OF RECEIVING VALVES (Cont.)

electrons released by the cathode (Q_k) is in phase with the grid voltage, as shown in Figs. 3a and 3b. The charge induced on the grid (Q_g) by these electrons would also be in phase with the grid voltage if the charges released by the cathode were to reach the plane of the grid in zero time, as shown in Fig. 3c. In this hypothetical case, the grid current due to this induced charge (Fig. 3d) leads the grid voltage by 90 degrees, because by definition, current is the time rate at which charge passes a given point. However, the charge released by the cathode actually propagates toward the plate with finite velocity; therefore, maximum charge is induced on the grid at a time later than that corresponding to maximum grid voltage, as shown in Fig. 3e. This condition corresponds to a shift in phase by an angle θ of Q_g with respect to e_g; hence, the grid current lags behind the capacitive current of Fig. 3d by an angle θ, as shown in Fig. 3f. Clearly, the angle θ increases with frequency and with the time of transit τ. Expressed in radians, $\theta = \omega\tau$.

The amplitude of Q_g is proportional to the amplitude of the grid voltage; the grid current, which is the time rate of change of Q_g, is thus proportional to the time rate of change of grid voltage. For a sinusoidal grid voltage, $e_g = E_g \sin\omega t$, the time rate of change of grid voltage is $\omega E_g \cos\omega t$. Therefore, for a given valve type and operating point, the amplitude of grid current is

$$I_g = KE_g\omega$$

and the absolute value of grid-cathode admittance due to induced charge on the grid is (3)

$$Y_t = \frac{I_g}{E_g} = K\omega$$

The conductive component (g_t) of this admittance is

$g_t = Y_t \sin\theta = Y_t\theta = K\omega\theta$ (for small values of θ) Because $\theta = \omega\tau$, this conductance becomes, for a given operating point,

$$g_t = K\omega^2\tau \qquad (4)$$

Thus, the conductance due to electron transit time also varies with the square of the frequency. This conductance and the input conductance, $g_m\omega^2 LC_h$, due to cathode-lead inductance, are the principal components of the term $k_h f^2$ of Eq. (1).

This explanation of input admittance due to induced grid charge is based on a space-charge-limited valve, and shows how a positive input admittance can result from the induced charge. The input admittance due to induced grid charge is negative in a valve which operates as a temperature-limited valve, that is, as a valve where cathode emission does not increase when the potential of other electrodes in the valve is increased. The emission of a valve operating with reduced filament voltage is temperature limited; a valve with a screen interposed between cathode and grid acts as

a temperature-limited valve when the screen potential is reasonably high. The existence of a negative input admittance in such a valve can be explained with the aid of Fig. 4.

When the value of E_{c2} in Fig. 4 is sufficiently high, the current drawn from the cathode divides between G_2 and plate; any change in one branch of this current is accompanied by


FIG. 1   FIG. 2   FIG. 3
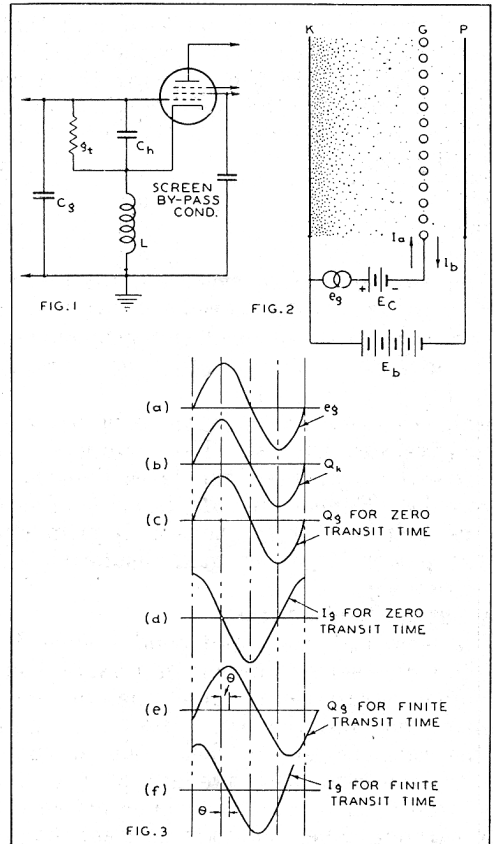
an opposite change in the other. As a first approximation, therefore, it is assumed that the current entering the space between G_2 and G_3 is constant and equal to ρv, where ρ is the density of electrons and v is their velocity. G_2 may now be considered as the source of all electrons passing to subsequent electrodes.

Suppose now, that a small alternating voltage is connected in series with grid G_3, as shown in Fig. 4. During the part of the cycle when e_g is increasing, the electrons in the space between G_2 and G_3 are accelerated and their velocities are increased. Because the current (ρv) is a constant, the density of electrons (ρ) must decrease. In this case, therefore, the charge at G_2 is 180 degrees out of phase with the grid voltage, as shown at A and B of Fig. 5. This diminution in charge propagates toward the plate with finite velocity and induces a decreasing charge on the grid. Because of the finite velocity of propagation, the maximum decrease in grid charge occurs at a time later than that corresponding to the maximum positive value of e_g, as shown in Fig. 5c. The current, which

INPUT LOADING OF RECEIVING VALVES (Cont.)

is the derivative of Q_g with respect to time, is shown in Fig. 5d. If there were no phase displacement ($\theta = 0$), this current would correspond to a negative capacitance; the existence of a transit angle θ, therefore, corresponds to a negative conductance. By reasoning similar to that used in the derivation of Eqs. 3 and 4, it can be shown that the absolute value of negative admittance due to induced grid charge is proportional to ω, and that the negative conductance is proportional to ω^2. These relations are the same as those shown in Eqs. 3 and 4 for the positive admittance and positive conductance of the space-charge-limited case.

FIG. 4   FIG. 5

FIG. 6
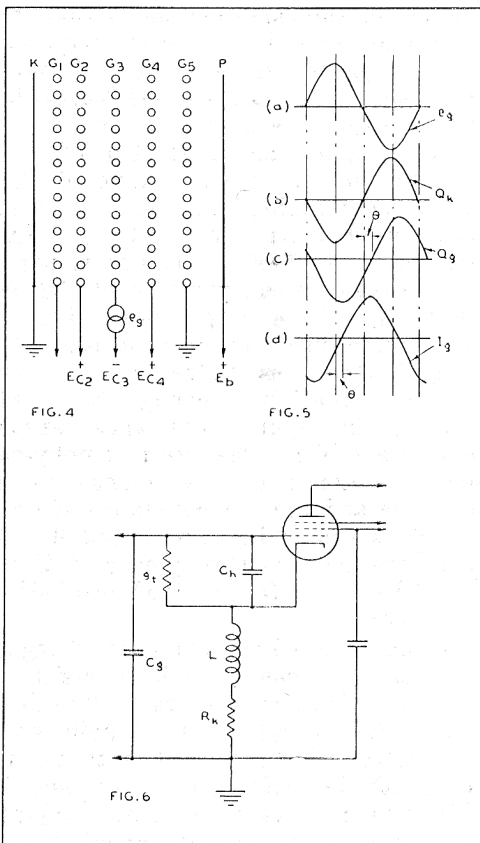
A negative value of input conductance due to transit time signifies that the input circuit is receiving energy from the "B" supply. This negative value may increase the gain and selectivity of a preceding stage. If this negative value becomes too large, it can cause oscillation. A positive value of input conductance due to transit time signifies that the signal source is supplying energy to the grid. This energy is used in accelerating electrons toward the plate and manifests itself as additional heating of the plate. A positive input conductance can decrease the gain and selectivity of a preceding stage.

It should be noted that, in this discussion of admittance due to induced grid charge, no mention has been made of input admittance due to electrons between grid and plate. The

effect of these electrons is similar to that of electrons between grid and cathode. The admittance due to electrons between grid and plate, therefore, can be considered as being included in Eq. (3).

Change in Input Capacitance.

The hot grid-cathode capacitance of a valve is the sum of two components, the cold grid-cathode capacitance, C_c, which exists when no cathode current flows, and a capacitance, C_t, due to the charge induced on the grid by electrons from the cathode. The capacitance C_t can be derived from Eq. (3), where it is shown that the grid-cathode admittance due to induced grid-charge is

$$Y_t = K\omega$$

The susceptive part of this admittance is $Y_t\cos\theta$. Since this susceptance is equal to ωC_t, the capacitance C_t is

$$C_t = K\cos\theta = K \text{ (for small values of } \theta)$$

Hence, the hot grid-cathode capacitance C_h is

$$C_h = C_c + K$$

The total input capacitance of the circuit of Fig. 1, when the valve is in operation, includes the capacitance C_h and a term due to inductance in the cathode lead. This total input capacitance, C_i, can be shown to be approximately

$$C_i = C_g + C_h - g_m g_t L \qquad (5)$$

where the last term shows the effect of cathode-

1851, 1852

TYPICAL CHARACTERISTICS

$E_f = 6.3$ VOLTS
PLATE VOLTS = 250
SUPPRESSOR VOLTS = 0
SCREEN VOLTS = 150
GRID VOLTS = VARIED
FREQUENCY = 40 Mc
UNBY-PASSED CATHODE RESISTOR = R_k (OHMS)

INPUT LOADING—MICROMHOS
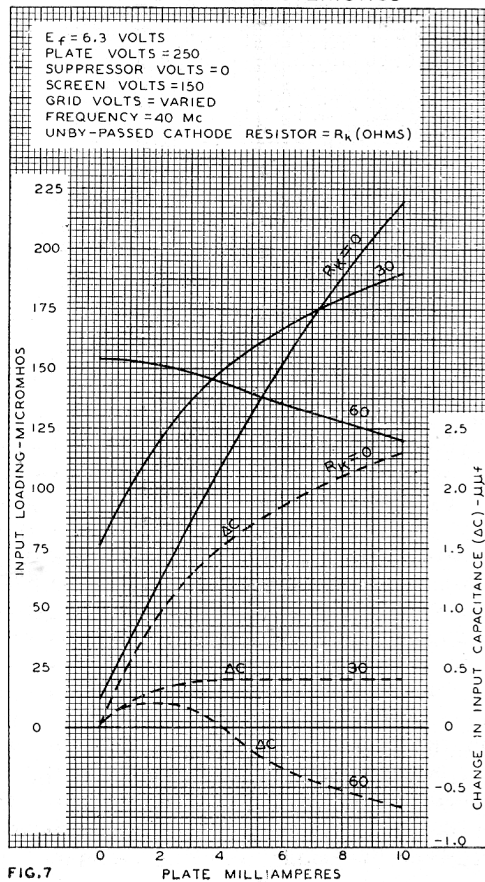CHANGE IN INPUT CAPACITANCE (ΔC)—μμf

FIG.7   PLATE MILLIAMPERES

INPUT LOADING OF RECEIVING VALVES (Cont.)

lead inductance. This last term is usually very small. It can be seen that if this last term were made equal in magnitude to $C_g + C_h$, the total input capacitance would be made zero. However, the practical application of this fact is limited because g_m and g_t change with change in electrode voltages, and g_t changes with change in frequency.

When cathode current is zero, the total input capacitance is practically equal to $C_g + C_c$. Subtracting this cold input capacitance from the hot input capacitance given by Eq. (5), we
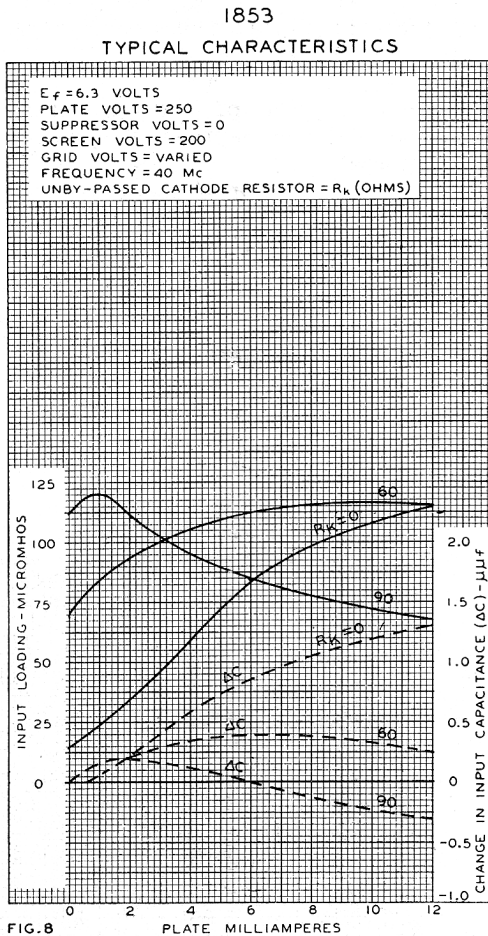
1853
TYPICAL CHARACTERISTICS

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E_f = 6.3 VOLTS
PLATE VOLTS = 250
SUPPRESSOR VOLTS = 0
SCREEN VOLTS = 200
GRID VOLTS = VARIED
FREQUENCY = 40 Mc
UNBY-PASSED CATHODE RESISTOR = R_k (OHMS)
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FIG.8   PLATE MILLIAMPERES

obtain the difference, which is $K - g_m g_t L$. In general, K is greater than $g_m g_t L$. Therefore, in a space-charge-limited valve, where K is positive, the hot input capacitance is greater than the cold input capacitance. In a temperature-limited valve, where K is negative, the hot input capacitance is less than the cold input capacitance. In both valves K changes with change in trans-conductance. Because of this change, the input capacitance changes somewhat with change in avc bias. In many receivers, this change in input capacitance is negligible because it is small compared to the tuning capacitances connected in the grid circuits of the high-frequency stages. However, in high-frequency stages where the tuning capacitance is small, and the resonance peak

of the tuned circuit is sharp, change in avc bias can cause appreciable detuning effect.

Reduction of Detuning Effect.

The difference between the hot and the cold input admittances of a space-charge-limited valve can be reduced by means of an unby-passed cathode resistor, R_k in Fig. 6. The total hot input admittance of this circuit is made up of a conductance and a capacitive susceptance, $\omega C_i'$. Analysis of Fig. 6 shows that, if cathode-lead inductance is neglected, the total hot input capacitance, C_i', is approximately

$$C_i' = C_g + C_c \frac{1 + K/C_c}{1 + g_m R_k} \tag{6}$$

Inspection of this equation shows that if K is positive and varies in proportion with g_m, the use of the proper value of R_k will make C_i' independent of g_m. In a space-charge-limited valve, K is positive and is found by experiment to be approximately proportional to g_m. It follows that the proper value of R_k will minimize the detuning effect of avc in a space-charge-limited valve. Eq. (6) is useful for illustrating the effect of R_k but is not sufficiently precise for computation of the proper value of R_k to use in practice. This value can be determined by experiment. It will be found that this value, in addition to minimizing capacitance change, also reduces the change in input conductance caused by change in avc bias. The effect of unby-passed cathode resistance and input conductance of an 1852 and 1853 is shown in Figs. 7 and 8. These curves were taken at a frequency of 40 megacycles. The curves for the 1852 also hold good for the 1851.

It should be noted that, because of degeneration in an unby-passed cathode resistor, the use of the resistor reduces gain. The reduced gain is $1/(1 + g_m R_k)$ times the gain with the same electrode voltages but with no unby-passed cathode resistance. The hot input conductance of a valve with an unby-passed cathode resistor can be determined by modification of the values of k_h in the table on page 2. The value of k_h in the table should be multiplied by $g_m/(1 + g_m R_k)$. The resultant value of k_h, when substituted in Eq. (1), with k_c from the table, gives the input conductance of a valve with an unby-passed cathode resistor. In the factor $(1 + g_m R_k)$, g_m is the grid-cathode transconductance when R_k is by-passed.

When an unby-passed cathode resistor is used, circuit parts should be so arranged that grid-cathode and plate-cathode capacitances are as small as possible. These capacitances form a feedback path between plate and grid when there is appreciable impedance between cathode and ground. To minimize plate-cathode capacitance, the suppressor and the screen by-pass condenser should be connected to ground rather than to cathode.

RADIOTRONS 957, 958, 959
1.4 VOLT ACORN VALVES

Radiotrons 957, 958, 959 are Acorn valves having filaments rated at 1.25 volts and intended for operation from a single flashlight dry cell without series resistance. The filament current of types 957 and 959 is 50mA., while that for type 958 is 100mA.

Type 957 is a general purpose triode having a medium amplification factor which may be used as detector, amplifier, or oscillator. Type 958 is a larger triode, especially designed for transmitter service as an oscillator or R.F. amplifier. It may also be used as an audio frequency power valve to operate a sensitive loudspeaker. Type 959 is a sharp cut-off pentode intended for use as an R.F. amplifier or detector, but it may also be used as a resistance coupled A.F. amplifier having moderate gain.

The centre filament terminal of each type is connected within the valve to the negative side of the filament. The suppressor of type 959 is internally connected to the negative filament terminal.

Types 957 and 959 may be operated with filaments in series, but series parallel connection of either of these types with type 958 is not recommended owing to the excessive voltage which would be developed across the remaining valve if one filament should become open-circuited. Series operation of all types is permissible if a resistor of 25 ohms is shunted across the filaments of types 957 and 959.

R.F. bypassing of these valves at the socket terminals by means of high quality condensers is essential in order to provide the shortest possible circuit returns and to realise the full capabilities of the valves at the ultra-high frequencies. Conventional bypassing methods are not adequate. One convenient method of bypassing is to use ribbon leads to the clips and to insulate these by mica spacers to form bypass condensers right at the valve terminals. It is important that the grid, plate and screen circuits be bypassed to the negative filament terminal in order to avoid R.F. interaction through common return circuits. It may
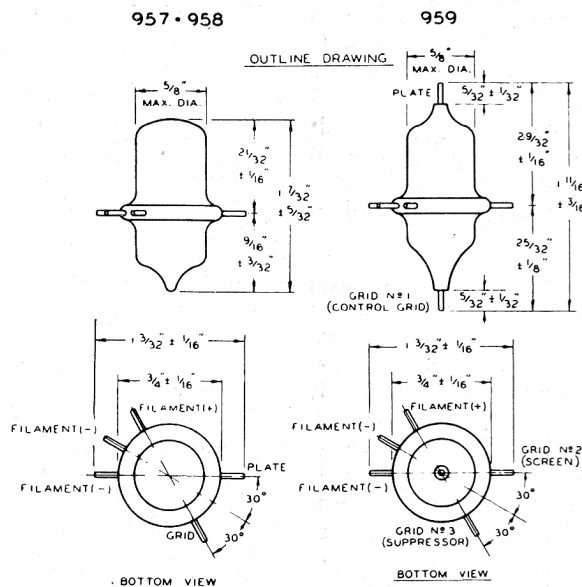
TENTATIVE RATINGS AND CHARACTERISTICS.

	957 Small Triode	958 Larger Triode	959 Sharp Cut-off Pentode	
FILAMENT VOLTAGE (D.C.)	1.25	1.25	1.25	Volts
FILAMENT CURRENT	0.05	0.10	0.05	Ampere
PLATE VOLTAGE	135 max.	135 max.	135 max.	Volts
SUPPRESSOR	—	—	**	
SCREEN VOLTAGE	—	—	67.5 max.	Volts
GRID VOLTAGE #	–5	–7.5	–3	Volts
PLATE CURRENT	2	3	1.7	Milliamps
SCREEN CURRENT	—	—	0.4	Milliamps
PLATE RESISTANCE (Approx.)	24,600	10,000	800,000	Ohms
AMPLIFICATION FACTOR	16	12	480	
TRANSCONDUCTANCE	650	1200	600	Micromhos
BULB	T–4½	T–4½	T–4½	
TERMINAL MOUNTING	Special	Special	Special	

\# Maximum resistance in the grid circuit should not exceed 0.5 megohm.

** Connected to minus filament at mounting.

also be advisable in some applications to supplement the action of the bypass condensers by R.F. chokes placed close to the condensers in the returns or in the electrode supply leads.

HIGH IMPEDANCE GRID CIRCUIT

SPECIAL CONDITIONS FOR MICROPHONE PRE-AMPLIFIERS

When crystal microphones are used a load impedance of about 5 megohms is frequently specified. As is well known, the maximum resistance normally permissible in the grid circuit of a valve is 1 megohm, which may be increased to 2 megohms for certain valve types when resistance coupling is used. Arrangements showing a voltage divider across the microphone, so arranged as to give a grid circuit resistance not exceeding 2 megohms, have been described in earlier issues of Radiotronics (see Radiotronics 83, page 100).

It has been found possible to increase the grid circuit resistance still further with certain valves provided that the heater voltage is decreased and that resistance coupling is employed. Radiotron 6J7-G (6C6) has completed extended life tests with a heater voltage of 4.5 volts. Although under these conditions the mutual conductance shows a slight decrease, this is comparatively unimportant, and the life of the valve when used with limited plate current is extremely good. No other valve types are at present recommended for this application since their operation with reduced voltages may be unsatisfactory. It is recommended that the plate supply voltage should not exceed 250 volts, that the plate load resistor should not be less than .25 megohm and that the screen voltage be derived from a screen dropping resistor of 1.5 megohm from the plate supply voltage. Under these conditions the cathode bias resistor should be 2,000 ohms. Smaller values of plate load resistor may be used provided that the plate current does not under any circumstances exceed 1 mA. A plate supply voltage lower than 250 volts in desirable in such cases. The stage gain may be taken as being approximately the same as for full heater voltage.

The reason why high values of grid circuit resistance are restricted is that in all valves there is a certain negative grid current flowing under normal operating conditions. The two main causes of this negative grid current are, firstly, "gas current," and, secondly, "grid emission current." Gas current is approximately proportional to the plate current, and when the plate current is reduced, as with resistance coupling and a high value of plate load resistance, the gas current will be quite small. Grid emission is caused by the emission of electrons from the control grid due to the combined heating by cathode and plate. By reducing the voltage across the heater the cathode temperature is considerably reduced and the grid heating reduced with it. Heating due to the plate is reduced, due to the low plate current brought about by the high load resistance. Consequently by a combination of resistance coupling with a high value of plate load resistance and a low heater voltage it is possible to increase the grid circuit resistance to a maximum of 5 megohms with Radiotron types 6J7-G or 6C6. It is suggested that this should only be done in the first stage following the microphone where the audio level is necessarily low. It is not recommended for operation at a high audio level or with other valve types.

SCREEN DROPPING RESISTORS

RESTRICTIONS WITH SUPER CONTROL VALVES

When a sharp cut-off pentode is used as a resistance coupled amplifier a screen dropping resistor may be used very effectively to supply the optimum screen voltage and at the same time to give screen decoupling and filtering. This method, however, is not satisfactory in general with valves having super-control characteristics. It has been found that the screen current of a super-control valve is more variable than the screen current of a sharp cut-off valve, the result being due largely to a focusing effect between the control grid and the screen grid. Due to this focusing effect an electron stream emerging from between the more open spacings on portion of the control grid may just strike or may just fail to strike one of the turns on the screen grid. Under certain conditions, therefore, it is possible to have a quite fortuitous change of screen current which cannot be controlled.

In addition to the foregoing effect there is also the effect that, due to the curvature of the characteristics, the optimum operating point, particularly with resistance coupling, is more critical than with sharp cut-off valves. Due therefore to the combination of a more variable screen current and a more critical operating position, the use of a high resistance dropping resistor from the plate supply voltage is not recommended for general use. It may be used, if so desired, provided that individual adjustments are made with each valve in order to obtain the correct operating point. With radio receiver production this would not be practicable, and the use of a dropping resistor is therefore undesirable. For valves of the super control class, such as the 6U7-G or 6G8-G it is suggested that the screen voltage be

Screen Dropping Resistors (Cont.)

obtained from some form of voltage divider and not from a dropping resistor. When it is desired to have some form of A.V.C. it may be desirable to extend the point of cut-off by using a screen voltage divider having poor regulation. This will give a result intermediate between a fixed screen supply voltage and one obtained through a dropping resistor from the plate supply voltage. For the 6G8-G a voltage divider having values of 1 megohm from the plate supply voltage to screen and 0.25 megohm from screen to earth has been found a very satisfactory compromise for use with audio A.V.C.

When there is no D.C. resistance in the plate circuit and when the valve is used purely as an R.F. or I.F. amplifier a suitable value of screen dropping resistance may be employed, since in this case the operation is no longer critical. With reflex amplifiers or with resistance coupled audio amplifiers the dropping resistor is, however, undesirable.

HUM

TWO CAUSES AND THEIR DIAGNOSIS

Hum is sometimes experienced due to valves being placed in close proximity to an A.C. field such as a power transformer, filter choke or speaker field. This form of hum may be diagnosed by mounting the valve on a flexible cord adaptor so that it may be moved in or out of the magnetic field. If it is found that the hum is affected by the position of the valve the cure is obvious.

Hum due to heater-to-cathode leakage or similar effects within the valve may be diagnosed by applying an additional large cathode bypass condenser in parallel with the existing condenser. All hum of this nature is reduced as the capacitance between cathode and earth is increased. In order to obtain sufficiently distinctive indication it is advisable to apply a condenser of 25μF. or more. If the existing condenser is of the order of 25μF. the effect on hum voltage may not be readily detected by ear, and it is preferable to use some form of output meter for indicating the hum voltage. This method is particularly valuable since it should not have any effect on the signal.

RADIOTRON NEWS

Radiotron 1G4-G is a general purpose triode having 1.4 volt filament.
Radiotron 1G6-G is a Class B twin triode having 1.4 volt filament.

Although both these types have been announced, technical data are not yet available, but will be published at a later date. It is not yet known when stocks will be available.

The release of a complete series of **A.C./D.C. valves, having 0.15 amp. heaters,** has been announced, but complete details were not available at the time of going to press. This series includes a range of Bantam glass valves having octal bases and also a range of single ended metal valves also operating with a heater current of 0.15 amp. These valves are intended for use in midget receivers operating from 110 volt mains without the necessity for any series dropping resistor or barretter. For this reason their application to 200-250 volt mains offers fewer attractive features. In the next issue of Radiotronics it is hoped to list the various types in this series for any interest they may have, but it is not expected that they will be used in Australian receivers.

FLUTTER
METHOD FOR REDUCTION

In some receivers where the expense of eliminating flutter on short waves is not considered warranted, it is possible to obtain more satisfactory performance by purposely reducing the audio frequency response below say 60 c/s. by some convenient means such as by the use of a small grid coupling condenser. Flutter generally occurs at a frequency well below 60 c/s. and by this means its effects are made less prominent.

1.4 VOLT SERIES
FILAMENT VOLTAGE LIMITS

It has been brought to our notice that the voltage of a new dry cell on load is approximately 1.58 volt, which is above the maximum tolerance of the 1.4 volt series. While it is probable that most valves will stand up to this voltage without failure, there may be a percentage which fail due to open-circuited filaments caused by this excessive voltage during the first few minutes of operation. Valves failing due to excessive voltage of this kind are not covered by guarantee and it is suggested that receiver manufacturers should make any necessary tests in order to protect themselves against failure. **In order to bring the filament voltage within the tolerances of the valve manufacturers we strongly recommend the use of a series resistor to give a drop of about 0.08 volt with the full current drain of the receiver.**

RADIOTRON
RECOMMENDED STANDARD G TYPES FOR RADIO RECEIVERS

HEAVY FACE TYPE SIGNIFIES AUSTRALIAN MANUFACTURE (e.g. 6U7-G)

A.C. Receivers

R.F. Amplifier			**6U7-G**
Converter	**6A8-G,**	**6K8-G,**	6J8-G
I.F. Amplifier			
(a) Straight			**6U7-G**
(b) With Diodes			**6G8-G**
(c) Reflex		**6B8-G,**	**6G8-G**
Diode Detector and Audio Amplifier			
(a) Duo-diode Pentode		**6B8-G,**	**6G8-G**
(b) Duo-diode High-mu Triode			**6B6-G**
A.F. Amplifier when diodes are incorporated in I.F. Amplifier (with negative feedback)			**6J7-G**
Power Amplifier			
(a) Pentode			**6F6-G**
(b) Beam Power Tetrode			**6V6-G**
Rectifier			
(a) Small, Directly Heated			**5Y3-G**
(b) Indirectly Heated			**5V4-G**
(c) Larger Receivers			**5V4-G**

A.C./D.C. Receivers

R.F. Amplifier			**6U7-G**
Converter	**6A8-G,**	**6K8-G,**	6J8-G
I.F. Amplifier			
(a) Straight			**6U7-G**
(b) With Diodes			**6G8-G**
Diode Detector and Audio Amplifier			
(a) Duo-diode Pentode		**6B8-G,**	**6G8-G**
(b) Duo-diode High-mu Triode			**6B6-G**
A.F. Amplifier when diodes are incorporated in I.F. Amplifier (with negative feedback)			**6J7-G**
Power Amplifier			25A6-G
Rectifier			25Z6-G

Automobile Receivers

R.F. Amplifier			**6U7-G**
Converter			**6A8-G**
I.F. Amplifier			**6U7-G**
Diode Detector and Audio Amplifier			
(a) Duo-diode Pentode		**6B8-G,**	**6G8-G**
(b) Duo-diode High-mu Triode			**6B6-G**
Power Amplifier			
(a) Pentode			**6F6-G**
(b) Beam Power Tetrode			**6V6-G**
Rectifier			6X5-G

RADIOTRON
RECOMMENDED STANDARD G TYPES
FOR RADIO RECEIVERS (Continued)

HEAVY FACE TYPE SIGNIFIES AUSTRALIAN MANUFACTURE (e.g. **6U7-G**)

2 volt Battery Receivers

R.F. Amplifier	**1M5-G,**	**1D5-G**
Converter		**1C7-G**
I.F. Amplifier		
(a) Single Stage	**1M5-G,**	**1D5-G**
(b) Two Stages		**1D5-G**
Diode Detector and Audio Amplifier		**1K7-G**
Power Amplifier		
(a) Pentode		**1L5-G**
(b) Larger Pentode		1G5-G
(c) Class B Driver	**1K5-G,**	**1K7-G**
Output		**1J6-G**

6 volt Vibrator Battery Receivers (5 or 6 valves)

R.F. Amplifier*	**1M5-G**
Converter	**1C7-G**
I.F. Amplifier	
(a) Single Valve	**1M5-G**
(b) Two Valves	**1D5-G**
Diode Detector and Audio Amplifier	**1K7-G**
Power Amplifier	**1L5-G**

1.4 volt Battery Receivers

R.F. Amplifier (if any)	1N5-G
Converter	1A7-G
I.F. Amplifier (one or two valves)	1N5-G
Diode High-mu Triode	1H5-G
Power Amplifier	
(a) Small Pentode	1A5-G
(b) Larger Pentode	1C5-G
(c) Class B Driver	1G4-G
Output	1G6-G

6 volt Battery Receivers

(for operation from a heavy-duty 6 volt accumulator)

R.F. Amplifier	6S7-G
Converter	6D8-G
I.F. Amplifier	6S7-G
Duo-diode Triode	6T7-G
Power Pentode	6G6-G

*If no R.F. stage, 2/1M5-G's may be used as I.F. Amplifiers. These valves are suitable for arrangement with series parallel filament connections, drawing a total filament current of 0.24A.