RADIOTRONICS

BULLETIN No. 112 May, 1941

RADIOTRON 13-WATT 6V6-G AMPLIFIER

CIRCUIT A504

The maximum power output obtainable from two 6V6-G valves in Class A1, with plate and screen voltages of 250 volts, is 9 watts as for Radiotron Circuit A501.* If the plate voltage is increased to the maximum rating of 315 volts, it is necessary to decrease the screen voltage to 225 volts in order to prevent the dissipation limits from being exceeded. The power output with Class A_1 operation under these conditions is 11 watts, which is the highest possible power output with Class A_1 operation.

If still higher power output is required it is necessary to adopt Class AB_1 operation, under which conditions the screen voltage may be increased to 250 volts. A power output of 13 watts is obtainable with plate and screen voltages of 315 and 250 respectively, a load resistance of 12,000 ohms plate to plate and cathode bias. The harmonic distortion may be reduced to exceedingly low proportions by means of an efficient negative feedback circuit, and at the same time the output resistance may be reduced so that the damping factor is better than that for a pair of 2A3 valves.

With any Class AB_1 amplifier the plate and screen currents at full output tend to rise above those at zero signal. In extreme cases this may introduce complications in the power supply, since very good regulation is required. The rise of plate current at maximum signal can be avoided by the choice of a suitable plate-to-plate load resistance and as this resistance is increased the plate current at maximum signal may even be made less than that at zero signal. The screen current, however, will rise from its value at no signal to a higher current at maximum signal. In order to avoid having to use a power supply having good regulation a special arrangement has been adopted in this amplifier so that the current drain is practically constant; in fact, the total supply current at maximum signal is slightly lower than that at zero signal. This fact has been brought about by the use of a suitably designed screen voltage divider, which is returned to the cathodes of the 6V6-G valves instead of to earth.

The screen voltage divider is made up of two separate resistors, a dropping resistor of 3000 ohms from the supply to the screens and a bleed† resistor from the screens to the cathodes. This additional current flowing through the cathode bias resistor has the effect of maintaining the grid bias at a fairly constant value, so that satisfactory class AB_1 operation is possible.

The power supply is thus required to deliver a practically steady current of from 100.5 mA at no signal to 98 mA at maximum signal, at a voltage of 330 volts. The arrangement shown in the circuit diagram uses a typical 400-0-400 volt transformer with a 5V4-G rectifier having a resistor of 125 ohms resistance connected in series with each plate. This has the advantage that the life of the rectifier valve is prolonged since it is not subjected to such onerous conditions during the warming-up period each time the set is switched on. The rectifier valve is also less likely to arc over with a heavy surge, and is less likely to be damaged in the case of failure of a filter condenser.

An alternative arrangement is to use a typical 385-0-385 volt transformer without any additional resistors, while a still further combination is a 375-0-375 transformer of low impedance, also without additional resistors. All these arrangements will be found to give very nearly the same output voltage. If allowance is to be made for supplying plate power to a radio tuner it is suggested that the transformer be rated at 425-0-425 volts 150 mA and that a resistor of 125 ohms resistance be connected in series with each plate. The choke would require to be one rated at 150 mA, while the field rating would be 750 ohms at 13 watts.

(Continued overleaf, column 1.)

*Radiotronics 107, page 63.

†The bleed current is the current through the portion of the voltage divider between screen and earth.

RADIOTRONICS

TECHNICAL BULLETIN, No. 112

MAY, 1941.

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(Continued from page 31).

THE CIRCUIT.

The circuit is basically the same as for the 9-watt 6V6-G amplifier A501* and incorporates negative feedback over three stages. The first stage is Radiotron 6J7-G as a high gain pentode with the negative feedback network connected to the screen. The second stage is another Radiotron 6J7-G, used as a phase splitter, exciting the push-pull 6V6-G output stage.

Although the feedback voltage is taken from only one of the plates of the output valves it is effective on both, through the coupling between the two halves of the primary of the loudspeaker transformer. For the best results this transformer should be of good design with the maximum possible coupling between the two halves of the primary. Transformers having a considerable amount of leakage reactance tend to cause instability in the amplifier unless special precautions are taken to avoid it.

In any negative feedback amplifier **with feedback over one stage,** a phase-angle other than 180° between the signal voltage and the voltage which is fed back has the effect of reducing the effective feedback voltage and so tends to increase the stage gain at the frequencies at which phase-angle rotation occurs. In a normal amplifier these frequencies are in the extreme low and extreme high audio frequency region, and therefore usually suffer attenuation in the absence of feedback. If it were possible to construct a feedback amplifier free from phase-angle rotation **in the feedback network,**† the effect of negative voltage feedback would be to give more nearly constant output voltage over the whole audio frequency range. If, however, phase-angle rotation occurs in the feedback network at low and high audio frequencies, the output voltage at these frequencies may be greater than that at the middle frequencies. In no case, however, can the gain at any frequency be higher than the gain at that frequency without feedback.

In a negative feedback amplifier **with feedback over more than one stage,** there tends to be a similar rise of output voltage at the extreme limits of audio frequency response as the result of phase-angle rotation, but in such a case the rise is no longer limited to the point at which the gain is equal to that without feedback. A poorly designed amplifier having feedback over three stages may actually be unstable since the feedback may be positive at very low or (more usually) very high audio frequencies.

The principle which has been adopted in the design of Radiotron Amplifier A504, is to reduce to a practicable minimum all phase-angle rotation both in the amplifier itself and in the feedback network and then to introduce, at a single point, attenuation of sufficient magnitude to prevent any rise of response over the whole audio frequency range. This attenuation cannot itself result in phase rotation as great as 90°, and the risk of instability is thereby reduced.

In order to investigate the effects of the phase-angle rotation it is necessary to take curves of output against frequency up to frequencies of 30,000 c/s. or higher. Tests on amplifier A504 have been carried up to frequencies of 50,000 c/s. with two output transformers, the first being a typical loudspeaker transformer with the secondary connected to the voice coil of a loudspeaker, the second being a transformer of good design with a constant resistive load.

LOUDSPEAKER LOAD.

The curves of output versus frequency with the typical transformer and speaker loading are given in Fig. 2 and separate curves are shown for selected values of capacitance (C_1) shunting the plate of the first 6J7-G valve. When this capacitance (C_1) is zero there is a rise in output of about 10db at 25,000 c/s., and as the capacitance is increased so the magnitude of the rise is decreased until in the most extreme case, with a capacitance of 1000 $\mu\mu$F., no peak whatever is found. It was decided to adopt a capacitance (C_1) of 700 $\mu\mu$F. for this amplifier-transformer-speaker combination so as to give a rise of just over 1.5 db at 10,000 c/s. In this case the curve cuts the zero line at 14,500 c/s. and reaches the level of -2.db at slightly over 17,000 c/s. This

*Radiotronics 107, page 63.

†It is assumed that no phase-angle rotation occurs in the amplifier, since this is only of one stage.

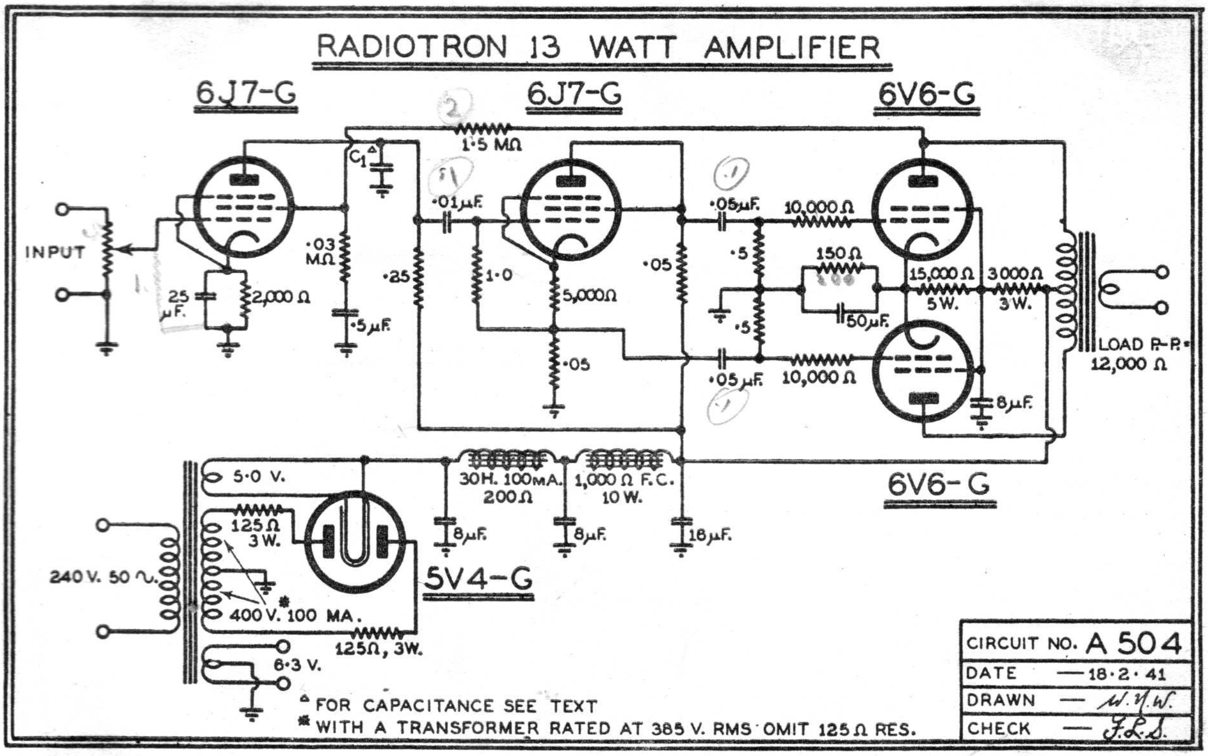


Figure 1.

slight rise in the 10,000 c/s. region may be of some advantage in lifting the top end of the audible frequency response. It would be quite optional to adopt a higher capacitance if an extended high frequency range is not required.

These results apply only to the particular transformer and loudspeaker which were used. With any other transformer-speaker combination, it would be necessary to adjust the value of C_1 until the response is approximately level or slightly falling at a frequency of 10,000 c/s. In some cases, a capacitance of 100 μμF. will be sufficient, while in other cases a higher capacitance is desirable. This is a test which can easily be carried out with the aid of a beat frequency oscillator and output voltmeter. In all cases, it is desirable for the adjustment to be made to suit the conditions rather than to accept any particular value of C_1 which, although suitable under other conditions, may be totally unsuitable for the actual conditions of operation.

RESISTIVE LOAD.

On a resistive load with a good quality transformer the position is different. The load resistance remains constant and there is no rise of impedance in the high audio frequency region, as with a speaker load, and any capacitance shunted from the plate of the 6J7-G to earth tends to decrease the high frequency response below zero level. With a good transformer and resistive

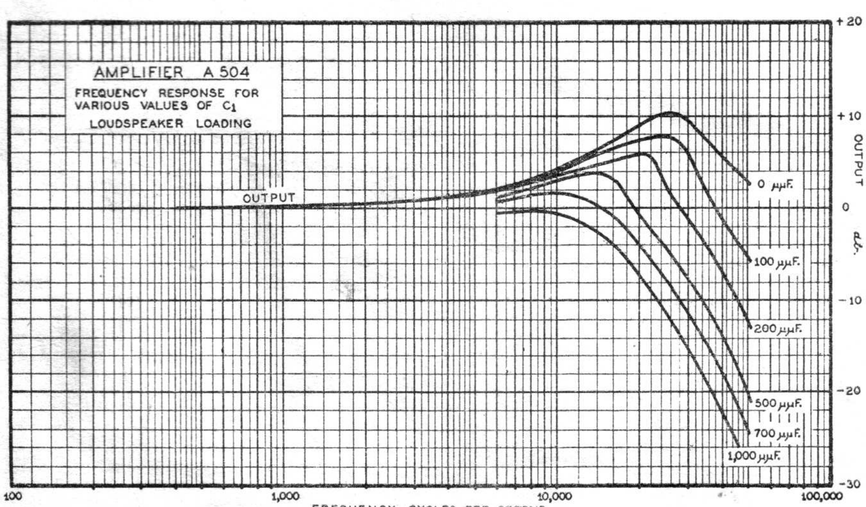


Figure 2. Frequency response with loudspeaker loading.

load there is no necessity for this condenser, which should, therefore, be omitted. Under these conditions the response curve will be as shown in Fig. 3 and curve marked $C_1 = 0$. When this capacitance is increased to the values of 100 and 700$\mu\mu$F. the response will be as shown by the corresponding curves. It will be seen that the curve for $C_1 = 0$ has a peak reaching slightly over 0 db at a frequency of about 10,000 c/s., this peak indicating some degree of phase-angle rotation but not sufficient to cause any bad effects.

In no case was any appreciable rise noticed at the low frequency end of the audible range and it is likely that the attenuation is sufficient to reduce such an effect to negligible proportions.

These curves probably hold for other similar amplifiers previously described in Radiotronics, and in any case, the principles are the same.

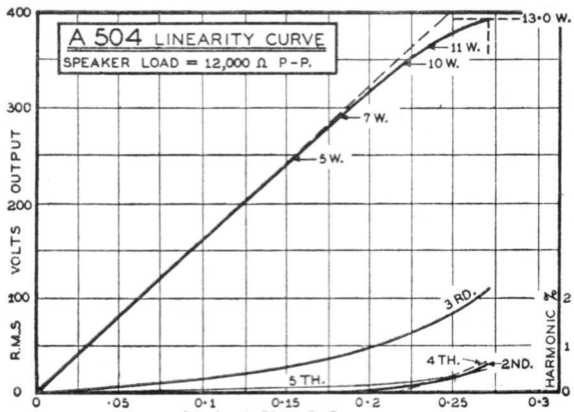


Figure 4.

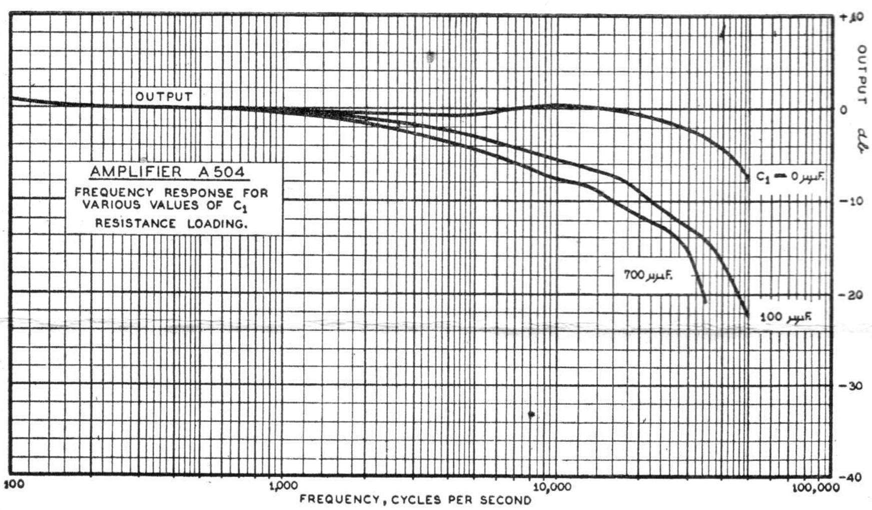


Figure 3. Frequency response with resistive loading.

EFFECT OF TRANSFORMER INDUCTANCE.

In this amplifier, irrespective of the negative feedback circuit, a plate-to-plate load of 12,000 ohms is necessary. This loading is obtainable with typical loudspeaker transformers and is quite satisfactory under normal conditions. If, however, it is desired to extend the low frequency range it will be found that there is difficulty in obtaining sufficient inductance on the transformer primary. The effect of this is to reduce the output voltage at frequencies below 50 c/s., or alternatively, the distortion will be high if the amplifier is pushed to full output at these frequencies. This is a disadvantage which is fairly general with small push-pull pentodes and beam power amplifier valves and therefore limits their usefulness to applications in which the low frequency response does not require to be exceptionally good. Push-pull triodes or large beam power amplifier valves are more satisfactory in this respect since the plate-to-plate load is considerably less and the transformer inductance need not be so high. A plate-to-plate load resistance of 6,000 or 7,000 ohms is the highest for which a transformer can readily be constructed to give really good low frequency response, combined with reasonable size and good high frequency response.

LINEARITY.

The linearity curve is shown in figure 4, from which it will be seen that the linearity is extremely good up to an output of 5 watts and is very close to the ideal up to an output of 11 watts. Above 11 watts and up to 13 watts the curve deviates somewhat markedly from the ideal line, although no more than for similar amplifiers approaching maximum output.

The second and fourth harmonics are shown to decrease to zero at half the output power, while the third and fifth harmonics decrease according to a power law, only reaching zero at zero output. At an output of 7 watts, the total harmonic distortion is less than 1%.

FIDELITY WITH LOUDSPEAKER LOAD.

The fidelity curves of amplifier A504 on a loudspeaker load are shown in figure 5. The output voltage, measured at the primary of the speaker transformer with a value $C_1 = 700$ $\mu\mu$F, is −3.2 db at 30 c/s., −2 db at 37 c/s., and level within ± 2 db from 37 c/s. to 17,000 c/s.

The harmonic distortion is mainly third harmonic over the whole range and this is below 3% from 75 to 4,000 c/s. The second harmonic is negligibly small at all frequencies above 100 c/s. but rises sharply to 5% at 50 c/s. This rise is due to selective harmonic distortion at a frequency approaching half the bass resonant frequency. The fifth harmonic is below 1% over the whole audio frequency range.

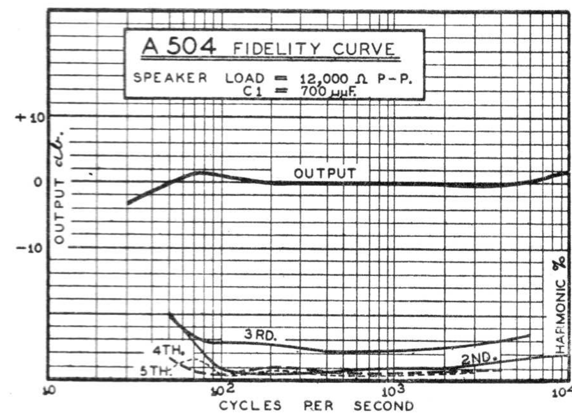


Figure 5.

FIDELITY WITH RESISTIVE LOAD.

The fidelity curves of amplifier A504 with a constant resistive load are shown on figure 6. The capacitance C_1 was taken as zero for these curves. It will be seen that the response is -3.0 db at 30 c/s., -2 db at 37 c/s. and constant within +1 and -2 db from 30 c/s. to 29,000 c/s.

The harmonic distortion, as for the loudspeaker load, is mainly third harmonic, which is less than 3% from 55 c/s. to 6,000 c/s. The rise of third and fifth harmonics below 60 c/s. is believed to be due to the output transformer employed in the test. The fourth harmonic is approximately 1% over the whole audio frequency range. The fifth harmonic is below 1% for all frequencies above 90 c/s., but rises with the third harmonic at lower frequencies. The second harmonic is negligible over the whole audio frequency range.

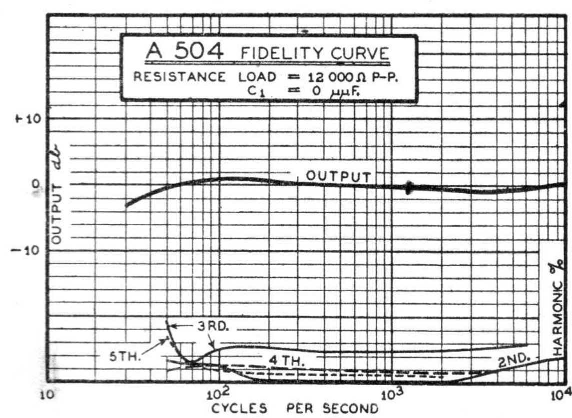


Figure 6.

SUMMARY OF TEST RESULTS.

1. Power Stage and Power Supply:

	No Load.	Full Load.
Plate current‡	76.5	70.0 mA
Screen current‡	4.9	10.5 mA
Current through screen dropping resistor‡	21.5	26.5 mA
Current through screen bleed resistor‡	16.6	16.0 mA
Current through filter choke	100.5	98.0 mA
Voltage plate to cathode‡	314.5	321 volts
Voltage screen to cathode‡	249.5	242 volts
Grid voltage‡	15.6*	15.0* volts
Supply voltage at input to filter choke	450.5	453.5 volts
Supply voltage at input to speaker field	430	434 volts
Plate dissipation‡	24.0	— watts
Screen dissipation‡	—	2.75 watts

2. Overall:

Input voltage for 13W. output	.38 volt peak .27 volt RMS.
Overall voltage gain**	1600
Negative feedback:—	
Gain reduction factor	3.5
Gain reduction	-10.9 db
Feedback factor	-.134
Voltage gain in 6V6-G stage	18.66
Output resistance (R_o)	
Plate to plate	1960 ohms
One valve	980 ohms
Damping factor (R_L/R_o)	6.13
Maximum power output (400 c/s.):—	
For 2.5% total harmonics	13 watts
For 10% total harmonics	15.3 watts
For unlimited distortion	21 watts
Harmonic distortion at full output (13 watts), 400 c/s:—	
Second harmonic	0.6%
Third harmonic	2.2%
Fourth harmonic	0.65%
Fifth harmonic	0.5%
Total harmonic distortion for output of 13 watts without negative feedback	2.45%
Hum (reference level 13 watts)	-70 db

‡For both 6V6-G valves.
*The measured value of the cathode resistor as used is 155 ohms.
**Output voltage (plate-to-plate) divided by input voltage to first stage, at low input voltages.

INTERSTAGE COUPLING CONDENSERS

In Radiotronics 101 and on page 63 of the Radiotron Designer's Handbook a family of curves was given showing the low frequency attenuation to be expected when using various values of interstage coupling condensers with a following grid resistor of 1.0 megohm. In each case instructions were appended showing how to interpret the curves for different values of grid resistor.

It is usually satisfactory to assume that the lowest frequency which an amplifier is required to reproduce is of the order of 30 c/s. Furthermore, it is generally agreed that the smallest change in level which can be detected by an average person under favourable listening conditions is approximately 2 decibels. On these assumptions it will therefore be seen that the requirements in a single resistance coupled stage would be met by a capacitance of, say, .007 μF. and a resistor of 1 megohm, or .014 μF. and .5 megohm.

When two or more resistance-capacitance networks are used the attenuation is additive and the individual networks must be so designed that the total attenuation does not exceed the permissible amount. The capacitance of the various coupling condensers in an audio amplifier preferably should not be greater than the value necessary to give the desired response. Excessively large coupling condensers may cause "grid blocking" and may increase the tendency towards "motor-boating" with given filter constants. In addition, d-c leakage is likely to be higher, with obvious results.

RADIOTRON 8003

100 WATT TRANSMITTING TRIODE*

Radiotron is a transmitting triode suitable for use as a power amplifier, modulator, and oscillator. In class C telegraph service, it has a typical power output of 250 watts. In self-rectifying oscillator circuits such as those used in therapeutic applications, two 8003's are capable of delivering a useful power output (at 75% circuit efficiency) of 375 watts. The 8003 is rated for operation at frequencies as high as 30 megacycles but it may be used with reduced plate voltage and input at higher frequencies up to 50 megacycles.

The 8003 has a construction which provides high insulation resistance between its electrodes. This feature enables the valve to withstand high peak voltages.

CHARACTERISTICS AND RATINGS.

FILAMENT VOLTAGE (A.C. or D.C.)	10.0	Volts
FILAMENT CURRENT	3.25	Ampere
AMPLIFICATION FACTOR	12	
DIRECT INTERELECTRODE CAPACITANCES:		
Grid-Plate	11.7	μμf
Grid-Filament	5.8	μμf
Plate-Filament	3.4	μμf
BULB	T-20	
CAP	Medium Metal	
BASE	Jumbo 4-Large Pin	

MAXIMUM CCS RATINGS WITH TYPICAL OPERATING CONDITIONS.

CCS = Continuous Commercial Service.

As A-F Power Amplifier and Modulator—Class B.

D-C PLATE VOLTAGE	1350 max.	Volts
MAX.-SIGNAL D-C PLATE CURRENT†	250 max.	Milliamps.
MAX.-SIGNAL PLATE INPUT†	330 max.	Watts
PLATE DISSIPATION†	100 max.	Watts

TYPICAL OPERATION:

Unless otherwise specified, values are for 2 valves.

D-C Plate Voltage	1350	Volts
D-C Grid Voltage‡	−100	Volts
Peak A-F Grid-to-Grid Voltage	480	Volts
Zero-Signal D-C Plate Current	40	Milliamps.
Max.-Signal D-C Plate Current	490	Milliamps.
Load Resistance (per valve)	1500	Ohms
Effective Load Resistance (Plate-to-Plate)	6000	Ohms
Max.-Signal Driving Power (approx.)	10.5	Watts
Max.-Signal Power Output (approx.)	460	Watts

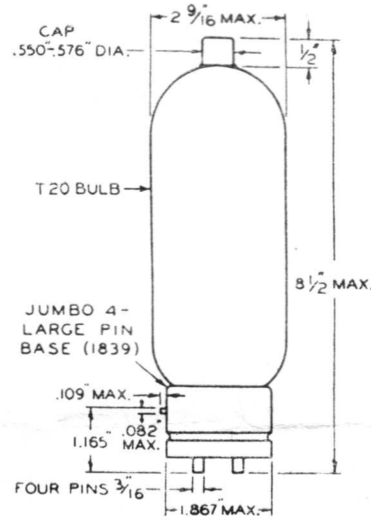
As R-F Power Amplifier—Class B Telephony.

Carrier conditions per valve for use with a max modulation factor of 1.0.

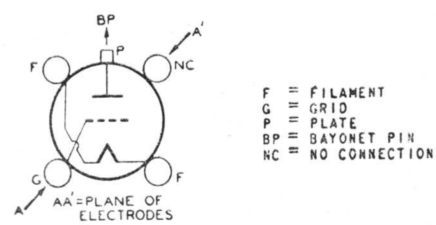
D-C PLATE VOLTAGE	1350 max.	Volts
D-C PLATE CURRENT	150 max.	Milliamps.
PLATE INPUT	150 max.	Watts
PLATE DISSIPATION	100 max.	Watts

TYPICAL OPERATION:

D-C Plate Voltage	1350	Volts
D-C Grid Voltage‡	−110	Volts
Peak R-F Grid Voltage	135	Volts
D-C Plate Current	110	Milliamps.
D-C Grid Current (approx.)	1.5	Milliamps.
Driving Power (approx.)§ °	8	Watts
Power Output (approx.)	50	Watts



BOTTOM VIEW of SOCKET CONNECTIONS



As Plate-Modulated R-F Power Amplifier—Class C Telephony.

Carrier conditions per valve for use with a max. modulation factor of 1.0.

D-C PLATE VOLTAGE	1100 max.	Volts
D-C GRID VOLTAGE	−400 max.	Volts
D-C PLATE CURRENT	200 max.	Milliamps.
D-C GRID CURRENT	50 max.	Milliamps.
PLATE INPUT	220 max.	Watts
PLATE DISSIPATION	67 max.	Watts

TYPICAL OPERATION:

D-C Plate Voltage	1100	Volts
D-C Grid Voltage	−260	Volts
From a grid resistor of	6500	Ohms
Peak R-F Grid Voltage	430	Volts
D-C Plate Current	200	Milliamps.
D-C Grid Current (approx.)§	40	Milliamps.
Driving Power (approx.)§	15	Watts
Power Output (approx.)	167	Watts

*Announced in Radiotronics 107, page 64.

As R-F Power Amplifier and Oscillator—Class C Telegraphy Key-down conditions per valve without modulation.**

D-C PLATE VOLTAGE	1350 max.	Volts
D-C GRID VOLTAGE	–400 max.	Volts
D-C PLATE CURRENT	250 max.	Milliamps.
D-C GRID CURRENT	50 max.	Milliamps.
PLATE INPUT	330 max.	Watts
PLATE DISSIPATION	100 max.	Watts
TYPICAL OPERATION:		
D-C Plate Voltage	1350	Volts
D-C Grid Voltage:		
From a fixed supply of	–180	Volts
From a grid resistor of	5000	Ohms
From a cathode resistor of	630	Ohms
Peak R-F Grid Voltage	350	Volts
D-C Plate Current	245	Milliamps.
D-C Grid Current (approx.)§	35	Milliamps.
Driving Power (approx.)§	11	Watts
Power Output (approx.)	250	Watts

As Self-Rectifying Oscillator.

A-C PLATE VOLTAGE (RMS)	1500 max.	Volts
D-C GRID VOLTAGE	–400 max.	Volts
PEAK R-F GRID VOLTAGE	550 max.	Volts
D-C PLATE CURRENT	200 max.	Milliamps.
D-C GRID CURRENT	30 max.	Milliamps.
PLATE INPUT	330 max.	Watts
PLATE DISSIPATION	100 max.	Watts

TYPICAL OPERATION in push-pull circuit at 25Mc:
Unless otherwise specified, values are for 2 valves.

A-C Plate Voltage (RMS)	1500	Volts
Grid Resistor	5000	Ohms
D-C Plate Current	400	Milliamps.
D-C Grid Current (approx.)	40	Milliamps.
Power Output (approx.)	500	Watts
Circuit Power Output (75% circuit efficiency)	375	Watts

†Averaged over any audio-frequency cycle of sine-wave form.

‡Grid voltages are given with respect to the midpoint of filament operated on a.c. If d.c. is used, each stated value of grid voltage should be decreased by one-half the filament voltage and the circuit returns made to the negative end of the filament.

°At crest of audio-frequency cycle with modulation factor of 1.0.

§Subject to wide variations depending on the impedance of the load circuit. High-impedance load circuits require more grid current and driving power to obtain the desired output. Low impedance circuits need less grid current and driving power, but plate-circuit efficiency is sacrificed. The driving stage should have a tank circuit of good regulation and should be capable of delivering considerably more than the required driving power.

**Modulation essentially negative may be used if the position peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

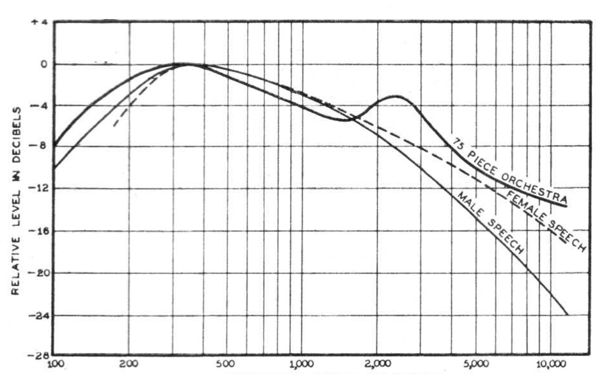
Radiotron 8003 can be operated at maximum ratings in all classes of service at frequencies as high as 30 megacycles. The tabulation below shows the highest percentage of maximum plate voltage and power input that can be used up to 50 megacycles for the various services.

Frequency.	30	50	Mc.
MAX. PERMISSIBLE PERCENTAGE of MAX. RATED PLATE VOLTAGE and PLATE INPUT:			
Class B r-f telephony	100	90	Per cent.
Class C plate-mod. telephony	100	83	Per cent.
Class C telegraphy	100	83	Per cent.
Self-rectifying oscillator	100	83	Per cent.

SPEECH AND MUSIC

Relative Energy Distribution

Information on the relative energy distribution, with respect to frequency, of speech and music, is very scanty and the curves which are given below will be of general interest.



Both male and female speech curves show a maximum energy level in the region from 300 to 400 c/s., but the curve of female speech does not show so great attenuation at the higher frequencies, being 6 db above the curve of male speech at 1000 c/s. As would be expected, the curve of female speech drops rapidly below 300 c/s. These curves are averaged over a large number of individuals, and considerable variations from the average are to be expected. They indicate, however, that it is in the region of 230 to 800 c/s. that overloading of an amplifier on speech is likely to occur.

The curve for a 75 piece orchestra shows a maximum at about 300 c/s. with a smaller peak at about 2300 c/s. It is interesting to note that the energy level is down by 8 db at a frequency of 100 c/s., so that overloading is not likely to occur at very low frequencies.

The curves of male and female speech are based on information given by H. K. Dunn and S. D. White in an article entitled "Statistical Measurements on Conversational Speech," in the Journal of the Acoustical Society of America, Vol. II., page 278, 1940.

The curve for a 75 piece orchestra is based on information given by Harvey Fletcher in an article entitled "Some Physical Characteristics of Speech and Music," in the Journal of the Acoustical Society of America, Supplement to Vol. 3, No. 2, October, 1931.

RADIOTRON NEWS

In order to avoid needless complication of stocks, a number of "GT" types in the Radiotron range are in future to be branded with a composite type number indicating that the valve will replace either the "G" or "GT" version. The valves included in the following list have no top-caps and are normally used without a valve shield so that no difficulty should be experienced when replacing a "G" type valve with one bearing the composite type number.

1A5-GT/1A5-G	6X5-GT/6X5-G
1C5-GT/1C5-G	6AC5-GT/6AC5-G
1G4-GT/1G4-G	25Z6-GT/25Z6-G
1G6-GT/1G6-G	35L6-GT/35L6-G
1Q5-GT/1Q5-G	35Z5-GT/35Z5-G
3Q5-GT/3Q5-G	117Z6-GT/117Z6-G.

Radiotron KT32/25L6-G and KT66/6L6-G: Advice has been received from U.K. that export of these types has been prohibited. The present stocks are very small and will shortly be exhausted, but it is hoped to import limited quantities for replacement purposes only from U.S.A.

NOTE ON MAXIMUM D-C GRID CIRCUIT RESISTANCE

For types 1B5/25S, 1D8-GT (triode unit), 1H4-G, 1H5-GT, 1H6-G, 1J6-G, 1K4, 1K5-G, 1K6, 1K7-G, 1N5-GT, 6B6-G, 6B7, 6B8-G, 6C6, 6J7-G, 30, 57, 75, 77, 85 and 1603, the maximum d-c grid resistance may be as high as 10 megohms provided that the circuit is so arranged that the plate current cannot exceed 1 mA. In the case of pentode operation it is advisable for the screen voltage to be derived through a high-resistance dropping resistor. The d-c grid resistance should not exceed 10 megohms unless the heater or filament voltage is reduced, but this reduction may require the selection of individual valves. Radiotron 6J7-G or 6C6 valves may be used with a heater voltage as low as 4.5 volts without requiring individual selection and under these conditions a d-c grid circuit resistance higher than 10 megohms may be used.

THE MEASUREMENT OF DAMPING USING Q METER

An Improved Method

A common method employed in measuring dielectric loss is by placing the dielectric between two metal plates which are connected across a tuned circuit, the Q of which is measured by a Q meter. This method is very satisfactory provided that the Q of the tuned circuit is high enough to show an appreciable change of reading as the dielectric is inserted.

In most cases a tuned circuit Q in excess of 200 is difficult to obtain, particularly at the higher frequencies. A very much higher value of Q may be obtained* by connecting a source of negative resistance across the tuned circuit so as to obtain a value of Q which may be as high as several thousands. By this means it is possible to compare two dielectrics, each having extremely low loss.

*Electrotechnical Journal of Japan, Volume 4, No. 9, page 215, September, 1940.

RADIOTRON MANUALS

In view of the urgent necessity for conserving credit overseas, the department responsible has requested that the importation of technical books be limited to absolute necessities. To meet this request it has been decided that no further importations will be made of the following:—

"The Radiotron Receiving Valve Manual" (RC14).

"The Radiotron Transmitting Valve Manual" (TT3).

"The Radiotron Cathode-Ray Tube Manual" (TS2).

The Unified Sales-Engineering Service will, however, continue to furnish all possible information, and data for any individual type will gladly be supplied on request.

CORRECTION NOTE

Attention is drawn to a slight error on sheet 1 of the 5Y3-G data issued in September, 1940. The pin connection diagram is quite correct, but an error occurred in the notes relating thereto. The note "Pin 5—Plate # 2" should read, "Pin 4—Plate # 2."

DATA SHEETS

Four data sheets are released concurrently with this issue. These include two new sheets of "Receiving Valve Outlines" which supersede the existing sheet dated October, 1937. The latter should be removed from the data book.

The third sheet is a classification of all Australian-made Receiving Valves and shows, at a glance, the various valves available for any particular class of service. Furthermore, it indicates valves in the various ranges which are electrically identical or electrically similar.

The "List of Contents" sheet shows in detail the sheets which should be included in the Handbook at the date of issue (May, 1941). **In order**

to ensure the maximum utility from the Handbook the sheets should be arranged exactly as shown in the index and out-of-date sheets removed. Retention of the out-of-date sheets in the Handbook will inevitably lead to confusion between up-to-date and superseded information. Adequate information on all Radiotron types not normally included in the Handbook is given in the new Radiotron Characteristics Chart announced in Radiotronics 111. (Price 3d. posted). Missing data sheets may be obtained free on application to the Head Office of the Company.