RADIOTRONICS

BULLETIN No. 111 — **April, 1941**

CONVERTER CONSIDERATIONS

The performance of a receiver is largely dependent upon the correct choice of converter valve and upon its operating conditions. A converter valve which is suitable for one receiver is not necessarily the most satisfactory type for another receiver since the choice involves a compromise. For example, in the effort to increase gain it is usually found that the noise level is increased and the frequency stability of the oscillator is sacrificed.

As a basis for the choice of a converter valve it is suggested that its performance should be compared with that of other types on the following points:—

1. Noise level (i.e., signal-to-noise ratio).
2. Oscillator frequency stability with change of supply voltage.
3. Oscillator frequency stability with time during the heating period.
4. Oscillator frequency stability with A.V.C. action.
5. Conversion gain.
6. Oscillator transconductance.
7. Mechanical rigidity.
8. Consistency from valve to valve.

BROADCAST BAND OPERATION.

For operation on the broadcast band only it is usually possible to neglect oscillator stability and oscillator transconductance since all converter valve types now available are satisfactory in this regard. The remaining requirements are those concerning noise, gain, rigidity and consistency.

Noise:

Valve hiss is only of importance in receivers having high gain in the stages following the converter stage, that is, receivers operating with a low signal level at the converter grid. In a straight 3/4 valve or an insensitive 4/5 valve receiver, valve noise may generally be neglected; in sensitive 4/5 valve receivers and particularly in 5/6 valve receivers having two I.F. stages, valve noise may be the factor limiting the performance on weak signals.

The signal-to-noise ratio is merely the ratio of the signal voltage to the noise voltage at the converter grid, and is affected by the converter valve type, its method of operation, and the preceding tuned circuits.

The noise which is audible when the receiver is tuned between stations is usually the result of atmospherics or other electrical interference external to the receiver. It is only in extremely isolated locations, under ideal listening conditions, that the valve hiss is predominant between stations. However, as a result of the total noise between stations, it is generally desirable to limit the I.F. gain, so as to reduce the between-station-noise to a satisfactory low level. A very simple method of obtaining this result is to increase the minimum bias on the I.F. stage, or on one of the I.F. stages if two are used. In dual-wave receivers, this desensitisation is normally only required on the broadcast band and should be removed when switching to the short-wave band. In very elaborate receivers it is possible to use inter-station muting to reduce the excessive noise without decreasing the sensitivity.

The Causes of Valve Noise:

Valve noise is present in all valves, but is only apparent when the signal input voltage is extremely small. It is thus noticed in the R.F. amplifier and converter stages of sensitive receivers. In all cases with normal converter types the converter valve noise is higher than that in the R.F. amplifier; for example, a pentagrid converter valve has about four times the valve noise of a typical R.F. amplifier type. If the R.F. stage gain is high, the converter valve noise may be neglected in comparison with the R.F. amplifier noise, since the converter noise is divided by the R.F. stage gain in order to give the equivalent noise at the grid of the R.F. amplifier. The resultant noise voltage is obtained by taking the square root of the sum of the squares of the individual noise voltages. The following examples may help to clarify this description:—

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Example 1:

Noise on converter grid . . . . . . 4 μV.
Noise on R.F. amplifier grid . . . . 1 μV.
R.F. stage gain . . . . 20 times
The total noise at the R.F. amplifier grid is therefore $\sqrt{1^2 + (4/20)^2} = 1.02\ \mu V$.

Example 2:

Noise on converter grid . . . . . . 4 μV.
Noise on R.F. amplifier grid . . . . 1 μV.
R.F. stage gain . . . . 4 times
The total noise at the R.F. amplifier grid is therefore $\sqrt{1^2 + (4/4)^2} = 1.41\ \mu V$.

It will be seen that if the R.F. stage gain is low, as is possible on the short-wave band, the converter valve noise is important even when an R.F. stage is used. In an extreme case where the R.F. gain is very little above unity the addition of an R.F. stage may actually increase the total effective noise in the receiver.

In a triode valve the valve noise is principally due to what is known as the "Shot Effect" and is a function of the plate current. This noise really occurs in the plate circuit, and is therefore divided by the valve gain when referred to the grid. The ideal valve thus has high gain and low plate current.

In a multi-grid valve there is an additional source of noise due to the fluctuating "sharing factor" of the additional electrodes. The ideal pentagrid converter thus has high gain and low plate, screen and oscillator plate (anode grid) currents. If the oscillator is completely independent of the mixer, as with a triode-heptode, the oscillator plate current has no effect on the noise, and this is one reason why a triode-heptode may have a lower noise level than a pentagrid. Radiotron 6J8-G is a triode-heptode having an extremely low noise level and for this reason is very popular for use in sensitive receivers. This low noise level is due primarily to the low plate and screen currents, the plate current being about half, or less than half, that of most other converter types and the screen current being less than half that of comparative types, with the exception of the pentagrid types. The following table compares the electrode currents of the best known standard converter types:—

	6J8-G	6A8-G	6K8-G	6SA7	
Plate current . . .	1.3	3.5	2.5	3.4	mA.
Screen current . .	2.9	2.7	6.0	8.0	mA.
Oscillator current	*	4.0	3.8	—	mA.
Total current . . .	4.2	10.2	12.3	11.4	mA.

Since the valve noise occurs in the plate circuit the stage gain is extremely important. Type 6J8-G has a fairly low conversion conductance but a very high plate resistance. In order to obtain high gain, and thus low noise level, it is therefore necessary to use an I.F. transformer having a very high dynamic resistance (i.e., high Q and high L/C ratio). With a suitable I.F. transformer a very high gain is obtainable in spite of the low conversion conductance. A high conversion conductance is usually accompanied by high electrode currents and a lower plate resistance and therefore higher noise.

Other Causes of Noise:

The valve is not by any means the only source of noise. A resistance or tuned circuit is also a source of noise which is known as "thermal agitation noise," producing a noise voltage proportional to the square root of the resistance (or dynamic resistance in the case of a tuned circuit at resonance). This noise is considerably greater on the broadcast band than on the short-wave band. On the broadcast band it is normally greater than the valve noise in a receiver having a high gain R.F. stage, and thus forms an ultimate limit to the practicable sensitivity of a receiver. The resultant noise voltage is equal to the square root of the sum of the squares of the equivalent noise voltage and the valve noise voltage.†

Conversion Gain:

High conversion gain is important in a 3/4 valve receiver, since in this case the noise may be neglected and any increase in gain is of real value. In a 4/5 or 5/6 valve receiver, however, an increase of gain in the converter stage is of

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*Completely independent of mixer.
†See the Radiotron Designer's Handbook, pp. 106-107.

very much less importance, and may even be undesirable. In these more sensitive receivers it is the signal-to-noise ratio which is of prime importance, and sensitivity as such has little meaning; merely increasing the sensitivity will increase the noise level between stations without in any way improving the reception of a station, no matter how weak.

Mechanical Rigidity:

Mechanical rigidity is of considerable importance in a converter valve. Microphony is objectionable on the broadcast band but is even more serious on the short-wave band.

Consistency from Valve to Valve:

It is most important that a converter valve type should be consistent from valve to valve, particularly as regards the oscillator performance and capacitances. If this is not so, there will be marked differences from one receiver to another since it is obviously impracticable to make adjustments in individual receivers. Radiotron type 6J8-G is particularly good as regards consistency from valve to valve, while type 6A8-G is also fairly good in this respect. Type 6K8-G is, on account of its one-sided design, inherently variable from valve to valve and is also subject to a change in characteristics of any valve which is subjected to a jar or knock. A valve type having very high conversion gain and very high oscillator transconductance also, as a result of the very close spacing of the electrodes, tends to be less consistent from valve to valve.

SHORT-WAVE BAND OPERATION.

On the short-wave band the requirements are very similar to those on the broadcast band but there are additional requirements to be satisfied, such as oscillator frequency stability and oscillator transconductance.

Noise:

Valve noise is of considerably greater importance on the short-wave band than the broadcast band, since it is generally larger than the "thermal agitation noise" of the tuned circuits and is therefore the controlling factor. Converter valve noise is also important even where an R.F. stage is fitted, since the R.F. stage gain is limited. Radiotron type 6J8-G is well known as a short-wave converter valve having an extremely low noise level. This low noise level is extremely important when no R.F. stage is fitted, but is at least of some value even in conjunction with an R.F. stage.

Oscillator Frequency Stability with Change of Supply Voltage:

As a result of the poor regulation of the power supply of most A.C. and vibrator operated receivers, the voltage applied to the plate of the oscillator (anode-grid) varies as the current drain is varied either as the result of A.V.C. action or changes in the power valve drain. If the converter valve is a type which has poor oscillator frequency stability with change of supply voltage, this may result in a form of instability known as motorboating. This particular effect may be eliminated by the use of heavy filtering between the oscillator plate and the power supply, but there will still be a gradual change of oscillator frequency with a change of supply voltage. Any fluctuation in the supply voltage will therefore result in detuning of the receiver which will give the effect of worse fading than is actually occurring.

Radiotron 6J8-G is almost completely independent of supply voltage fluctuations and may be used satisfactorily even on a supply giving a varying voltage. Type 6K8-G, when used with a common dropping resistor for both screen and oscillator plate, comes second on this count while all pentagrid types are very poor.

Oscillator Frequency Stability with Time during the Heating Period:

On the broadcast band a good receiver may be tuned in as soon as the valves commence to operate, and the tuning need not be further adjusted so long as the set is operating. The position on the short-wave band is entirely different, and it is usually necessary to adjust the tuning several times during the first half-hour, and occasionally thereafter. There are many causes of this frequency drift, all unfortunately additive. They may, for convenience, be separated into:

(a) Internal valve changes, and
(b) Changes in other components.

In most cases the valve is only a minor cause of the drift, which is largely the result of the use of bakelite and other unsuitable materials in the oscillator circuit. If all the unsatisfactory insulating materials are removed from the oscillator circuit and replaced by trolitul, steatite, isolantite or other good ceramics, the frequency drift will be much reduced. Further improvement is possible by removing, as far as possible, all sources of heat likely to raise the temperature of the oscillator coil, the condensers in the tuned circuit, the wave-change switch or the valve socket. Some elaborate receivers even go to the extent of removing the power supply completely from the receiver chassis so as to eliminate the major sources of heat. Even if this is not done, it is possible to make considerable improvements to the components and the chassis layout as indicated below*:—

(a) Increase the efficiency of the power transformer so as to decrease the losses which must be dissipated as heat.
(b) Mount the power transformer on light legs so as to give minimum metallic heat conduction and maximum air circulation.
(c) Mount all heat dissipating components above the chassis, with allowance for air circulation.
(d) Mount all valves at the rear of the chassis so as to have the best possible air circulation.
(e) Mount the converter valve in a special can designed for maximum air circulation. In many cases it will be found possible to omit any top cover of this can, and so improve the air circulation.
(f) Mount the valve socket so as not to be in direct contact with the chassis, e.g., on rubber grommets.
(g) Avoid the use of bakelite and similar materials in the coils, wave-change switch and valve socket.
(h) Avoid the use of insulated "hook-up" wire in the oscillator circuit. Bare wire is to be preferred.
(i) Reduce to the minimum all heat dissipation in voltage dividers and dropping resistors.
(j) Reduce the heat dissipation in the rectifier valve by using a low impedance type (e.g., 6X5-GT for small receivers and 5V4-G in large receivers).
(k) Reduce the heat dissipation in the power valve by using a type having small heater dissipation (e.g., 6V6-G) and reduce the plate dissipation as far as practicable.

*For a detailed discussion of many of these points, see the article entitled "Effect of Temperature on Frequency of 6J5 Oscillator," in Radiotronics 110, pages 15-19.

It will be seen that some of these improvements are not practicable in a small table-model receiver, but all are worthy of consideration by a receiver designer.

When these matters have been dealt with, it will probably be found that the valve is then an important cause of frequency drift and the logical step is to make such improvements as are practicable. It seems that the whole of the frequency drift due to the converter valve is the result of heat

(a) from the heater
(b) from the electrodes
(c) from the socket, and
(d) from surrounding components.

The choice of a converter valve should be influenced by items (a) and (b) while the heat from the socket and surrounding components should be reduced as much as possible. It may be noted that a considerable proportion of the total valve drift is due to the heating of the base, and any cooling of the valve pins through contact with cool socket contacts is very effective in reducing the drift.

The following table shows the heat dissipation of several popular converter types under typical conditions:—

Dissipation Watts	6J8-G	6A8-G	6K8-G	6SA7
Plate	0.33	0.88	0.63	0.85
Screen	0.29	0.27	0.60	0.80
Oscillator	0.23	0.20	0.11	—
Heater	1.89	1.89	1.89	1.89
Total	2.74	3.24	3.23	3.54

In the calculations of the oscillator dissipation it is assured that 70% of the input is converted into oscillatory power, and 30% is dissipated as heat in the valve. Even if this assumption is not quite accurate it will not make much difference to the final result.

It will be seen that the heater dissipation is the controlling factor, and for this reason valves having a higher heater current than 0.3 ampere at 6.3 volts are undesirable for short-wave operation. Although valves have been produced with a heater current lower than 0.3 ampere, these have not been found to be entirely satisfactory on the short-wave band on account of emission difficulties. Thus a heater current of 0.3 ampere is a good compromise.

Radiotron 6J8-G has somewhat less total heat dissipation than the other types shown in the table, and this is to its advantage as regards frequency stability.

Oscillator Frequency Stability with A.V.C. Action:

An ideal converter valve is not affected as regards oscillator frequency during fading periods, even with A.V.C. applied to its grid. Type 6K8-G has excellent characteristics in this direction and is the best of the popular types. Type 6J8-G is less satisfactory in this regard, although A.V.C. may be successfully applied on the short-wave band. At the highest frequencies, however, it is found that positive grid current tends to flow in the signal grid circuit and this has the effect of producing a negative bias across the A.V.C. resistor and thus desensitising the receiver through interaction on the other controlled valves as well as on the converter. The effect on the other controlled valves may be reduced by using independent or parallel A.V.C. circuits, but there will still be the effect on the converter gain. For this reason, A.V.C. is often not applied to type 6J8-G on the highest wave band, e.g., below 20 metres. If A.V.C. is not applied for this reason, the fading of a station will have no effect on the oscillator A.V.C. be not applied to type 6J8-G on the highest frequency. In general, it is recommended that short-wave range. Type 6A8-G is most unsatisfactory as regards oscillator frequency stability and it may result in serious de-tuning when a strong station fades badly. For this reason, if for no other, type 6A8-G should not be used with A.V.C. on the short-wave band and in general this type is not used in the better class of short-wave receiver.

Conversion Gain:

Conversion gain is of more value on the short-wave band than on the broadcast band since the noise level is lower and the additional gain may be really advantageous. This is more marked in the case of receivers having no R.F. stage and a low I.F. stage gain. Types 6J8-G, 6K8-G and 6A8-G are very closely comparable as regards conversion gain when used with an I.F. transformer having high dynamic impedance.

Oscillator Transconductance:

The coil design and construction is considerably simplified, particularly in the case of receivers covering a high ratio of maximum to minimum frequency, by the use of a converter valve having high oscillator transconductance. Type 6K8-G has an extremely high transconductance and is ideal for this purpose. This type is largely used at frequencies of the order of 30 Mc/s, where other types prove difficult. Type 6J8-G comes next in order and is satisfactory on frequencies up to about 22 Mc/s. Radiotron 6J8-G is at present being produced with an average oscillator transconductance considerably higher than the published value and this has proved of material assistance in the design of the short-wave coils. Type 6A8-G has the lowest oscillator transconductance of the three types and, for this reason also, is the least desirable on the short-wave band.

Other Features of Converter Valves:

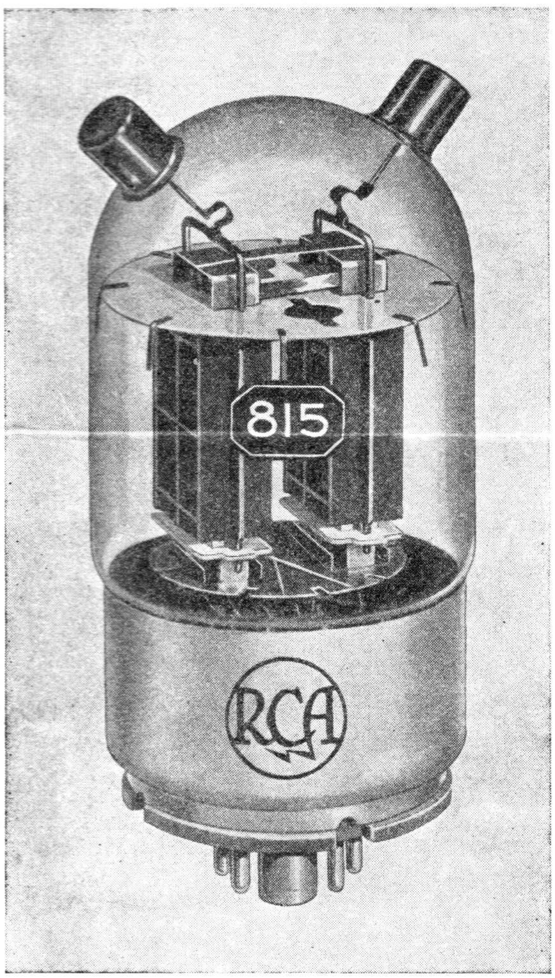
The points so far discussed are not by any means complete but they are of considerable interest at the present time. One further point which deserves mention is the operation of a converter valve with less than the optimum oscillator grid current. Types 6A8-G and 6K8-G are inclined to be damaged if operated for any length of time on less than the minimum oscillator grid current since the dissipation of the electrodes may exceed the safe maximum. Type 6J8-G as well as all other triode-heptode valves has the advantage that it may safely be operated at a low value of oscillator grid current. Although this is not normally to be recommended on account of the loss of sensitivity and the decrease of the signal-to-noise ratio, it may be permissible at the low frequency end of the short-wave band, provided that none of the important international broadcast bands are in this range. For example, a receiver covering from 13.6 to 42 metres is generally only required to give good performance on the 16, 19, 25, and 31 metre bands and the region between the 31 metre band and the low frequency end of the scale is of less importance.

Although the remarks in this article have been illustrated by examples of Radiotron types, they may be taken as applying to all converter types.

RADIOTRON 815

PUSH-PULL BEAM POWER AMPLIFIER

Radiotron 815 is a new push-pull beam transmitting valve designed especially for use on wavelengths from 160 meters to 2½ meters. It can be used with maximum ratings at frequencies as high as 150 megacycles, and at reduced ratings at frequencies as high as 225 megacycles. Neutralization is generally unnecessary in properly shielded circuits. The 815 contains in one envelope two beam power units whose total maximum plate dissipation is 25 watts. The high efficiency and exceptional power sensitivity of the 815 permit its operation at rated maximum input



with very low driving power. For example, a single 815 operated in push-pull class C telegraph service is capable of handling a power input of 75 watts (ICAS) with less than 0.2 watt of driving power.

The two units of the 815 may be used in push-pull arrangement as modulater, oscillator, or r-f amplifier, or separately, as single-ended amplifiers. Thus, the valve is well suited for use as a frequency multiplier and driver for another 815.

The exceptional efficiency of the 815 at the ultra-high frequencies is made possible by the balanced and compact structure of the beam units, excellent internal shielding, and close electrode spacing. Internal leads are short in order to minimize internal lead inductance and resistance. The plate leads are brought to standard small metal caps; and the other leads are brought to an octal base utilizing a low-loss "MICANOL" wafer and metal sleeve. The heaters are arranged to allow operation from either a 12.6- or 6.3-volt supply.

TENTATIVE CHARACTERISTICS AND RATINGS.

Unless otherwise specified, values are for both units.

HEATER (A.C. or D.C.):		
Voltage per Unit	6.3	Volts
Current per Unit	0.8	Ampere
TRANSCONDUCTANCE, for plate current of 25 ma. . .	4000	Micromhos
GRID-SCREEN MU-FACTOR	6.5	
DIRECT INTERELECTRODE CAPACITANCES (Each unit):		
Grid-Plate (with external shielding)	0.2 max.	μμf
Input	13.3	μμf
Output	8.5	μμf
BULB	T-16	
BASE (with "MICANOL" wafer)	Large Wafer Octal 8-Pin, Sleeve	
CAPS (two)	Small Metal	

MAXIMUM CCS AND ICAS RATINGS WITH TYPICAL OPERATING CONDITIONS.

CCS = Continuous Commercial Service.
ICAS = Intermittent Commercial and Amateur Service.

As Push-Pull A-F Amplifier and Modulator—Class AB_2.

	CCS	ICAS	
D-C Plate Voltage ...	400 max.	500 max.	V.
D-C Screen Voltage (Grid No. 2)	200 max.	200 max.	V.
Max.-Sig. Plate Curr. . .	150 max.	150 max.	mA.
Max.-Sig. Plate Input . .	60 max.	75 max.	W.
Max.-Sig. Screen Input .	4 max.	4 max.	W.
Plate Dissipation	20 max.	25 max.	W.
Typical Operation			
D-C Plate Voltage . .	400	500	V.
D-C Screen Voltage .	125	125	V.
D-C Grid Voltage . .	−15	−15	V.
Peak A-F G-G Volts	60	60	V.
Zero-Sig. Plate Curr.	20	22	mA.
Max.-Sig. Plate Curr.	150	150	mA.
Max.-Sig. Screen Curr.	32	32	mA.
Load Res. (Per Plate)	1550	2000	Ω
Effective Load Resis. (Plate-to-plate) ..	6200	8000	Ω
Max.-Sig. Driving Power*	0.36	0.36	W.
Max.-Sig. Power Output	42	54	W.

As Push-Pull R-F Power Amplifier — Class B Telephony.

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

	CCS	ICAS	
D-C Plate Voltage	400 max.	500 max.	V.
D-C Screen Voltage ...	200 max.	200 max.	V.
D-C Plate Current	75 max.	75 max.	mA.
Plate Input	30 max.	37.5 max.	W.

	CCS	ICAS	
Screen Input	2.5 max.	2.5 max.	W.
Plate Dissipation	20 max.	25 max.	W.
Typical Operation:			
D-C Plate Voltage	400	500	V.
D-C Screen Voltage	125	125	V.
D-C Grid Voltage	–25	–25	V.
Peak R-F G-G Volts	50	50	V.
D-C Plate Current	75	75	mA.
D-C Screen Current	4	3	mA.
D-C Grid Current	Negligible		mA.
Driving Power†	0.8	0.7	W.
Power Output	10.5	13	W.

As Grid-Modulated Push-Pull R-F Power Amplifier —Class C Telephony.

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

	CCS	ICAS	
D-C Plate Voltage	400 max.	500 max.	V.
D-C Screen Voltage	200 max.	200 max.	V.
D-C Grid Voltage	–175 max.	–175 max.	V.
D-C Plate Current	75 max.	75 max.	mA.
Plate Input	30 max.	37.5 max.	W.
Screen Input	2.5 max.	2.5 max.	W.
Plate Dissipation	20 max.	25 max.	W.
Typical Operation:			
D-C Plate Voltage	400	500	V.
D-C Screen Voltage	125	125	V.
D-C Grid Voltage	–40	–40	V.
Peak R-F G-G Volts	80	80	V.
Peak A-F Grid Volts	19	17	V.
D-C Plate Current	75	75	mA.
D-C Screen Current	3	3	mA.
D-C Grid Curr. (approx)	0.4	0.4	mA.
Driving Power (approx) †	0.32	0.28	W.
Power Output (approx.)	10.5	13	W.

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

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

	CCS	ICAS	
D-C Plate Voltage	325 max.	400 max.	V.
D-C Screen Voltage	200max.	200 max.	V.
D-C Grid Voltage	–175 max.	–175 max.	V.
D-C Plate Current	125 max.	150 max.	mA.
D-C Grid Current	6 max.	6 max.	mA.
Plate Input	40 max.	60 max.	W.
Screen Input	2.7 max.	2.7 max.	W.
Plate Dissipation	13.5 max.	20 max.	W.
Typical Operation:			
D-C Plate Voltage	325	400	V.
D-C Screen Voltage‡			
From a fixed supply of	165	175	V.
From a series res. of	10000	15000	Ω
D-C Grid Voltage of	–45	–45	V.
From a grid res. of§	11250	15000	Ω
Peak R-F G-G Voltage	112	116	V.
D-C Plate Current	123	150	mA.
D-C Screen Current	16	15	mA.
D-C Grid Curr. (approx.)	4	3	mA.
Driving Power (approx.)	0.2	0.16	W.
Power Output (approx.)	30	45	W.

As Push-Pull R-F Power Amplifier and Oscillator —Class C Telegraphy.

Keydown conditions per valve without modulation.**

	CCS	ICAS	
D-C Plate Voltage	400 max.	500 max.	V.
D-C Screen Voltage	200 max.	200 max.	V.
D-C Grid Voltage	–175 max.	–175 max.	V.
D-C Plate Current	150 max.	150 max.	mA.
D-C Grid Current	6 max.	6 max.	mA.
Plate Input	60 max.	75 max.	W.
Screen Input	4 max.	4 max.	W.
Plate Dissipation	20 max.	25 max.	W.
Typical Operation:			
D-C Plate Voltage	400	500	V.
D-C Screen Voltage			
From a fixed supply of	145	200	V.
From a series res. of	15000	17500	Ω
D-C Grid Voltage			
From a fixed supply of	–45	–45	V.
From a cathode res. of	260	265	Ω
From a grid res. of§	10000	13000	Ω
Peak R-F G-G Voltage	116	112	V.
D-C Plate Current	150	150	mA.
D-C Screen Current	17	17	mA.
D-C Grid Current (approx.)	4.5	3.5	mA.
Driving Power (approx.)	0.23	0.18	W.
Power Output (approx.)	44	65	W.

Radiotron 815 may be operated at maximum ratings in all classes of service at frequencies as high as 150 megacycles. The tabulation below shows the highest percentage of maximum plate voltage and power input that can be used up to 225 megacycles for any class of service. Special attention should be given to shielding, cooling, and r-f by-passing at these frequencies.

FREQUENCY	120	200	225 Mc/s.
MAX. PERMISSIBLE PERCENTAGE of MAX. RATED PLATE VOLTAGE and PLATE INPUT:			
class B r-f amplifier	100	85	75 %
grid-mod. class C r-f amplifier	100	85	75 %
plate-mod. class C r-f amplifier	100	80	70 %
Class C r-f telegraphy	100	80	70 %

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

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

‡ Fixed supply, modulated simultaneously with the plate supply, is recommended. Series resistor connected to modulated plate-voltage supply may also be used.

§ The grid-circuit resistance should never exceed 15000 ohms (total) per valve, or 30000 ohms per unit. If additional bias is necessary, a cathode resistor or a fixed supply should be used.

* Driver stage should be capable of supplying the grids of the class AB_2 stage with the specified driving power at low distortion. The effective resistance per grid circuit of the class AB_2 stage should be kept below 500 ohms and the effective impedance at the highest desired response frequency should not exceed 700 ohms.

RADIOTRON 930

GAS PHOTOTUBE

The 930 is a new, high-sensitivity, gas phototube for use in sound reproduction and relay applications. Electrically, the 930 is like the Radiotron 923, with its high sensitivity to red radiation; physically, the 930 is like the 929 with its simple, rugged, short construction and octal base. This combination of features makes the 930 an outstanding phototube of particular interest to designers of new equipment utilizing phototubes.

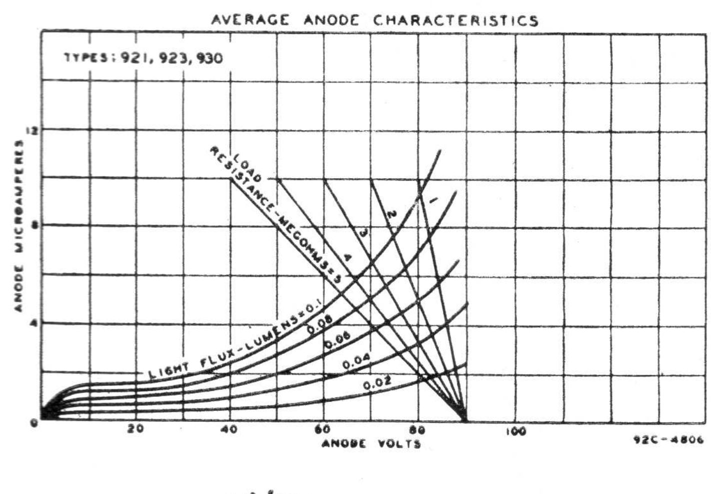
TENTATIVE DATA

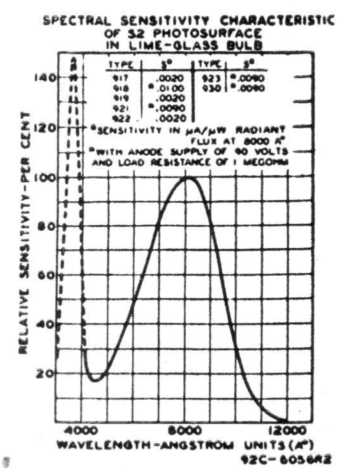
Cathode Photosurface	S2
Cathode Window Area	0.6 sq. in.
Direct Interelectrode Capacitance	2.5 $\mu\mu$F.
Maximum Overall Length	3 1/16 in.
Maximum Seated Height	2 1/2 in.
Maximum Diameter	1 5/16 in.
Bulb	T-9
Base	Intermediate Shell Octal 5-Pin
Mounting Position	Any

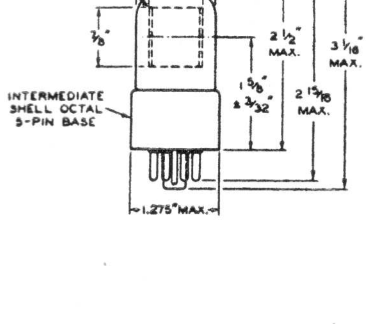
Maximum Ratings and Characteristics

Anode-Supply Voltage (D.C. or Peak A.C.)	90	Volts
Anode Current°	20	Microamperes
Ambient Temperature	100	°C.
Sensitivity:*		
At 0 cycles	100	Microamp./lumen
At 1000 cycles	94	Microamp./lumen
At 5000 cycles	87	Microamp./lumen
Gas Amplification Factor**	Not over 9	
D-C Resistance of Load:		
With anode-supply voltage of 90 volts:		
For d-c currents below 2 microamperes	1 min.	Megohm
For d-c currents above 2 microamperes	4 min.	Megohms
With anode-supply voltage up to 75 volts:		
For d-c currents below 3.5 microamperes	No minimum	
For d-c currents above 3.5 microamperes	0.1 min.	Megohm

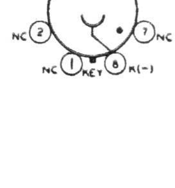
° On basis of the use of a sensitive cathode area ½in. in diameter.
* Sensitivity values are measured with a light input varied sinusoidally about a mean value from zero to a maximum of twice the mean. The sensitivity values shown are the ratio of the amplitude of variation in the current output to the amplitude of variation in the light input. The light source was a Mazda Projection Lamp operating at a filament color temperature of 2870°K. Sensitivity was measured with a 90-volt supply, a 1-megohm load, and a mean light input of 0.015 lumen.
** Ratio of sensitivity at maximum anode voltage to sensitivity at a voltage sufficiently low (approximately 25 volts) to eliminate gas ionization effects.







Bottom View of Socket Connections



K = CATHODE
NC = NO CONNECTION
P = ANODE
• = GAS TYPE

RADIOTRON NEWS

The following types have been added to the Radiotron range and are listed for reference. These types are not at present available from stock. Complete characteristics appear in the new Radiotron characteristics chart.

Radiotron Type.	Description.
1B7-GT	1.4 volt pentagrid converter.
1D5-GT	2.0 volt super-control R-F tetrode. (G-type construction).
1LA4‡	1.4 volt power pentode (similar 1A5-GT).
1LA6‡	1.4 volt pentagrid converter (similar 1A7-GT).
1LB4‡	1.4 volt power pentode.
1LH4‡	1.4 volt diode high-mu triode (similar 1H5-GT).
1LN5‡	1.4 volt R-F pentode.
6B4-G	Power amplifier triode similar electrically to type 2A3 but equipped with a 6.3 volt filament and an octal base.
6C5-GT*	General purpose triode.
6SF5-GT*	High-mu triode (single ended).
6SJ7-GT*	R-F amplifier pentode (single ended).
6V7-G	Duo-diode low-mu triode. (Octal-based equivalent of type 85).
7B4‡	High-mu triode.
7H7‡	Super-control R-F pentode.
7Q7‡	Pentagrid converter.
12A5	Power amplifier pentode.
12SF5-GT*	High-mu triode (single ended).
12SJ7-GT*	R-F amplifier pentode (single ended).
14A7/12B7	Super-control R-F pentode.
25A6-GT*	Power amplifier pentode.
25A7-GT*	Half-wave rectifier, power pentode.
25C6-G	Beam power amplifier.
25Y5	Full-wave rectifier or voltage doubler.
50Z7-G	Full-wave rectifier or voltage doubler.

*Types marked with an asterisk are "GT" equivalents of existing types.

‡Fitted with a locking-type base.

Radiotron 6SG7 is a super-control R-F amplifier pentode having a mutual conductance under ordinary conditions of more than 4000 micromhos. The 6SG7 is equipped with a 6.3 V. 0.3A heater and is of single-ended metal construction. This type is not at present available from stock.

Radiotron 12SG7 is electrically and physically identical to type 6SG7, except that it is equipped with a 12.6 volt .15 amp. heater. This type is not at present available from stock.

Radiotron 930 is a new gaseous phototube having electrical characteristics similar to those of type 923 and being physically similar to type 929. The 930 is not at present available from stock.

(See article elsewhere in this issue.)

A tentative announcement has been made regarding the release of three types specially intended for use in aircraft equipment. These types are not at present available from stock.

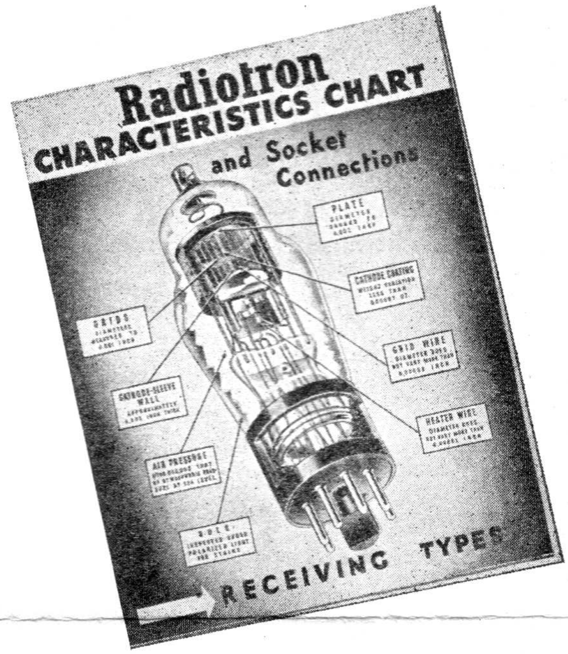
Radiotron 1631, a beam power amplifier having characteristics similar to those of type 6L6, but equipped with a 12.6 volt heater.

Radiotron 1632, a beam power amplifier having characteristics similar to those of type 25L6, but equipped with a 12.6 volt heater.

Radiotron 1633, a twin triode amplifier having characteristics similar to those of type 6F8-G, but equipped with a 12.6 volt heater.

RADIOTRON CHARACTERISTICS CHART

In Radiotronics 110 it was announced that a new characteristics chart was in course of preparation. This chart is now complete and copies are available free on request at the Head Office of the Company or at the cost of threepence posted.



Comprising 20 pages in all, the chart illustrated above gives complete electrical and physical details of the entire Radiotron range of valves. A special section is devoted to the Australian-made range; in this section much more than the usual amount of information is given, including resistance coupled data for the various pentode amplifier valves.

All inquiries should be addressed to the Unified-Sales-Engineering Service, Amalgamated Wireless Valve Company Pty. Limited, Box 2516 BB, G.P.O., Sydney.

RADIOTRON 6X5-GT

AUSTRALIAN MANUFACTURE

Radiotron 6X5-GT is now being made in Australia, and should shortly be available in quantity. This full-wave rectifier is particularly suitable for use in small A.C. receivers, in which its small size and low heat dissipation are advantageous. It may also be used very satisfactorily in automobile receivers, where the low heater current and low plate impedance are valuable features.

Type 6X5-GT has a heater current of 0.6 ampere at 6.3 volts. With a condenser input filter, a d-c voltage of 370 volts is obtainable with the maximum current of 70 mA., using a 325-0-325 volt transformer.

The maximum seated height is only 2⅝in., and the maximum diameter 1-5/16 in., as for other GT types.