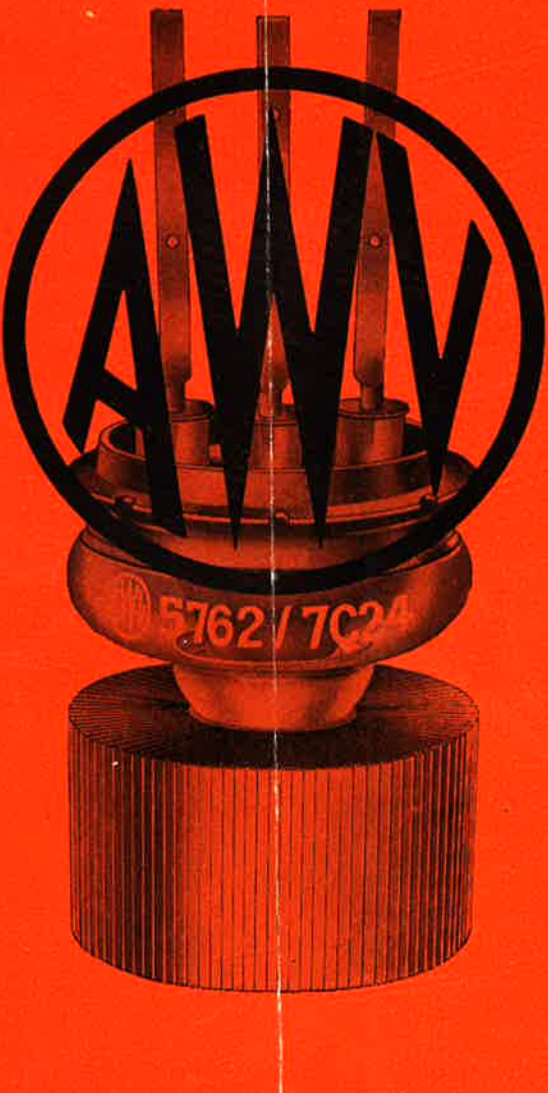
RADIOTRONICS

Registered at the General Post Office, Sydney, for transmission by post as a periodical. Single Copy, One Shilling

VOL. 21 JULY 1956 NO. 7



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AMALGAMATED WIRELESS VALVE COMPANY PTY. LTD.

EDITORIAL

A new and improved Ionization Vacuum Gauge, Radiotron AV26, is described in this issue. It has thirty times higher sensitivity than the earlier type AV10A.

A wattage rating chart for resistors is published, with a popular descriptive article, "How much will a resistor take?" This article will well repay reading.

The effect of grid coupling capacitors on the voltage output of a conventional RC coupled network is given in brief and handy form for reference or memorising. This is put in the form of percentage error from unity when the resistance is so many times the reactance.

Finally, there is an article by one of the R.C.A. engineers on the determination of typical operating conditions for valves used as linear R.F. power amplifiers.

Arthur J. Gabb.

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Editor .. .. A. J. Gabb, B.Sc.

Radiotronics is published twelve times a year by The Wireless Press for Amalgamated Wireless Valve Company Pty. Ltd. The Annual subscription rate in Australasia is 10/-; in U.S.A. and dollar countries $1.50, and in all other countries 12/6. Price of a single copy is 1/-.

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RADIOTRON AV26

Ionization Vacuum Gauge

*By V. C. Anthony, B.Sc.**

The ionization vacuum gauge is a thermionic device consisting of three electrodes mounted in an envelope, which can be connected to a vacuum system by means of a glass tube. It supplements Radiotron AV-34 Thermocouple Vacuum Gauge, being most useful when measuring extremely high vacua below, say, 1 micron.

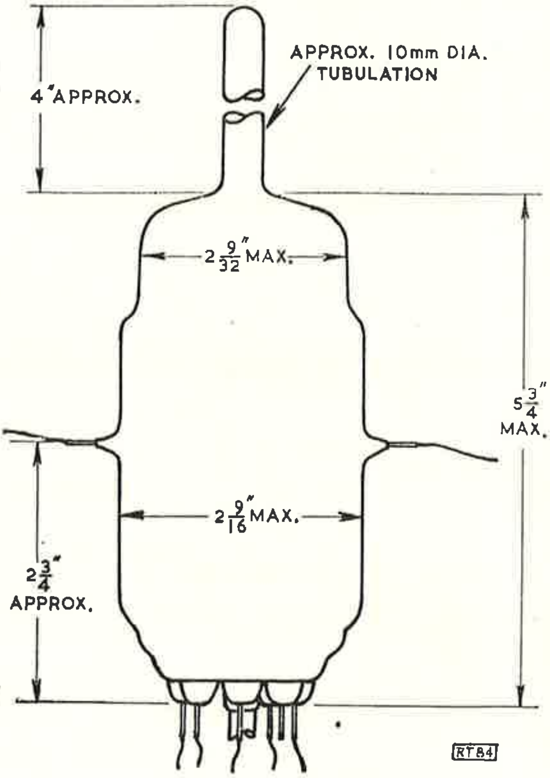

Fig. 1. Outline and dimensions of Radiotron AV26 (RT84).

In an ordinary triode the negative grid (gas) current is roughly proportional to the gas pressure but the sensitivity is not great and electrical leakage within the valve may cause errors.

The ionization gauge, however, is designed to give the maximum sensitivity under the conditions of operation whilst reducing errors to a minimum.

Radiotron AV10A is an Australian-made ionization vacuum gauge which has been on the market for a number of years. The newer type AV26, also Australian-made, is notable because of its thirty times higher sensitivity.

Radiotron AV-26 is basically a triode valve with a "grid" operating at a positive potential and a "plate", here called an ion collector, operating at a negative potential with respect to the filament. Electrons are emitted from this centrally mounted filament and are attracted towards the positive helical grid. Before being finally collected by the grid these electrons may oscillate through the open grid structure many times. The long paths travelled by these electrons greatly increases the probability of an ionizing collision with the surrounding gas molecules. Positively charged ions so formed are collected by the negative collector which consists of a conductive platinum coating on the inside bulb wall.

The normal maximum operating pressure is 1 micron,† although the positive ion current is directly proportional to both the surrounding gas pressure and the grid electron current at pressures up to 10 microns. Higher pressures up to 10 microns may be measured provided that the grid current is reduced to 2 milliamperes, otherwise the life of the filament would be shortened. Under normal circumstances, for pressures up to 1 micron, the valve is operated at a grid current of 20 milliamperes to obtain a large ion current and hence good pressure sensitivity.

By applying 7 volts to the two grid leads the tungsten grid helix may be heated to about 1000°C. This bakes the gauge, driving out absorbed and adsorbed vapours and gases from internal surfaces. Usually five minutes of such "degassing" is sufficient, but when the gauge has been exposed to high pressure or when low pressures (say below 0.01 micron) are to be read further degassing is required. Degassing at pressure exceeding 10 microns is not advisable due to the risk of grid burn-out or the formation of films on internal glass surfaces. Leakage films so deposited can cause incorrect readings of the ion current meter. The AV-26 is constructed with shading discs in the stem leads which minimise this effect.

A hard glass tubulation is provided on the gauge

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* Power Valve Section, Valve Works, Ashfield.

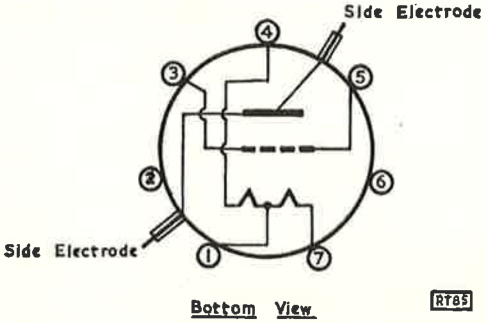
† 1 micron = 10^{-3} mm of mercury pressure.

but connection to vacuum systems of other materials is still possible by use of a wax seal, graded glass seal, or a glass-to-metal joint. A spare filament is provided, for use in case of burn-out.

ELECTRODE CONNECTIONS (RT85)

Leads

1	Heater (common)
2	No connection
3	Grid
4	Heater 1
5	Grid
6	No connection
‡7	Heater 2
	Side Electrodes ion collector



‡ N.B. Spare filament provided, in case of burn-out.

ELECTRICAL RATINGS AND CHARACTERISTICS

Maximum Ratings

Filament Voltage	3.3 max. Volts
Grid Degas Voltage	8 max. Volts
■ Operating Pressure	1 max. Micron

Typical Operation

Filament Voltage	3.1 Volts
Approx. Filament Current	4.7 Amperes
Grid Voltage	+ 150 Volts D.C.
● Grid Current	20 mA
★ Grid Degas Voltage	7 Volts
★ Grid Degas Current	11 Amperes
Ion Collector Voltage	—40 Volts D.C.
Approx. Gauge Sensitivity	50 μA/Micron/mA

(i.e., 50 μA grid current per micron pressure per milliampere grid current.)

Notes:

■ 1 micron = 10^{-3} mm of mercury pressure. The max. operating pressure limit of 1 micron is at a grid current of 20 mA. Higher pressures up to 10 microns may be read if the grid current is reduced to 2 mA.

● For normal operation with pressures not exceeding 1 micron.

★ The grid consists of a tungsten helix which may be degassed by applying 8 volts to the two external grid leads provided. Five minutes of such heating is usually necessary to degas the gauge after exposure to high pressures. To attain the lowest pressures, however, further degassing may be needed.

(*Continued on page* 77)

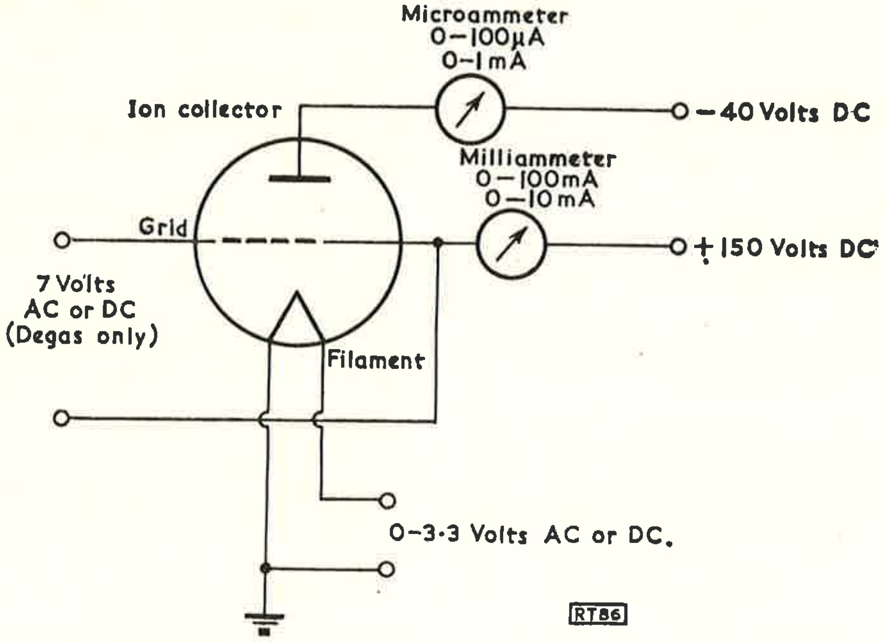


Fig. 2. Basic circuit for AV26 Vacuum Ionization Gauge (RT86).

Mechanical

Mounting Position	any
Bulb	T-20
Base	None

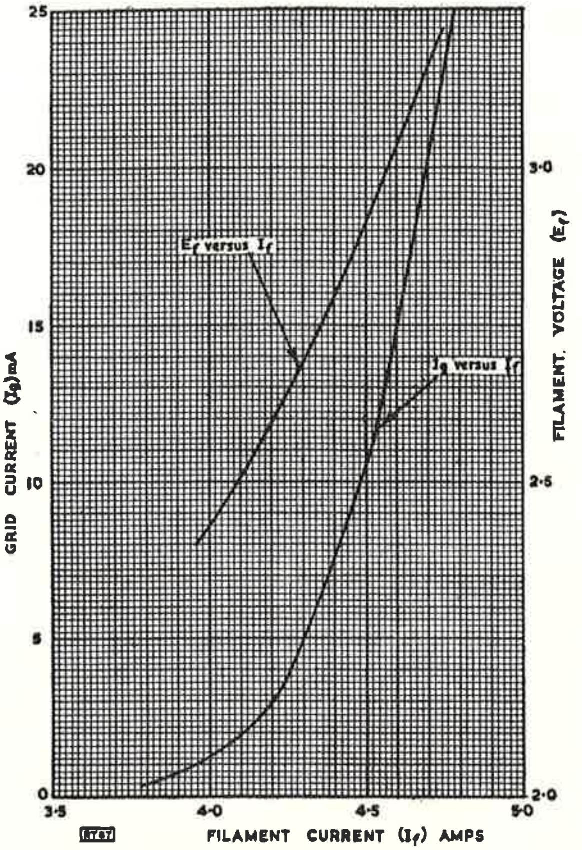


Fig. 3. Radiotron AV26, curves of grid current and filament voltage versus filament current (RT87).

EFFECT OF GRID COUPLING CAPACITORS ON VOLTAGE OUTPUT

If a voltage, here called the input voltage, is applied to *C* and *R* in series, and the output voltage is defined as the voltage across *R*, then the output voltage is approximately equal to the input voltage with an error not greater than:

1% when $R = 7X_c$
2% when $R = 5X_c$
5% when $R = 3X_c$
11% when $R = 2X_c$
29% when $R = X_c$
where X_c = reactance of capacitor *C*.

It is often convenient to memorise one or more of these approximations for use in design work.

HOW MUCH WILL A RESISTOR TAKE?

by H. P. Manly *

At 4.45 p.m. the new flyback transformer was in place, connections checked, joints soldered, leads dressed where they belonged. Less than 30 seconds after turning on the power a picture appeared and it didnt look bad. At 4.48 p.m. the picture flickered, and smoke curled up through ventilating holes around the power rectifier.

It happens to all of us sooner or later, maybe both times. One of the hundred-odd resistors under the chassis burn out. Locating the victim isn't too difficult. We may look for the black and blistered remains, feel for the heat, smell around for the unmistakable aroma of a burnout or, as a last resort, use the ohmmeter.

There is just one reason why a resistor burns out. Of course, the contributing cause may have been a shorted capacitor; the coating may have dropped off a cathode and landed against the plate of a rectifier; some tube might have gone suddenly gassy — but none of these are the direct reason for the burnout. The burnout occurred only because the resistor carried too much current. It carried too much current because it was subjected to too much voltage.

Let's consider what actually might happen. Assume that a short or some other fault applies 200 volts across an 8,200-ohm resistor. That resistor then carries about 24 mA. (Volts multiplied by 1,000 and the product divided by ohms, equals milliamperes.) When that much current is forced to flow against that much resistance, heat is produced. In this case, nearly 5 watts of electric power is being used in the production of heat. (Current squared, and multiplied by resistance, equals power.)

A resistor of good quality, rated at 5 watts, will stand that heating indefinitely, although running moderately warm. An 8,200-ohm unit rated at only 2 watts, in which heat is produced at the rate of 5 watts, starts to darken all over in about one

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minute. At two minutes it would fry an egg. At four minutes the colour-code markings are all but illegible, and resistance may rise by about 10%. But there is no smoke and usually the 2-watt resistor carries the overload almost indefinitely.

Although a resistor which is over-heated to a temperature as high as 350°F may not be damaged, heat radiated from it may do a lot of damage to nearby components. Wax-impregnated paper capacitors, and electrolytics too, may be ruined.

Should 200 volts get across an 8,200-ohm resistor rated at only ½ watt there is blistering, blackening of coding colours and smoking begins within a minute. At three minutes the whole unit is black, there is a great deal of smoke and the resistance is dropping sharply. At four minutes the resistance is down around 4,000 ohms and, if the voltage holds up, current increases to around 50 mA. Then heat is produced at the rate of 10 watts and the end of the resistor is near.

If you find a resistor badly discoloured and showing unmistakable signs of having been overheated, measure its resistance. You are likely to find such things as a unit coded for 8,200 ohms measuring something like 3,500 ohms — and causing trouble difficult to locate.

Selecting the right resistor

There is no use installing a new resistor until the contributing cause for the burnout has been determined and removed — we all know that. Neither is there any use putting in a new resistor whose wattage rating is too small for the current it must carry. The chart shows how much current may flow without overheating a resistor of any standard wattage rating, also what wattage rating is needed for any current flowing in a resistor of any standard value from 10 ohms to 1 megohm.

Extra-heavy horizontal lines are for resistances of 10 ohms and multiples of 10 up to 1 megohm. In between are medium-heavy lines for values of each resistor regularly made with 20% tolerance. Light lines are for all values added when tolerance is 10%. All the lines together take in every resistance value regularly used for service replacements. For still other values added in the 5% series imagine lines approximately midway between those drawn on the chart.

Three quick steps allow selecting a resistor of wattage rating just right for the job: not so small that you take chances on a burnout, not so large that you pay for a unit bigger than needed:

1. Locate the horizontal line for resistor ohms.
2. Locate on the bottom scale a vertical line for resistor current.
3. Find the intersection of these lines.

Any resistor whose wattage rating is equal to or greater than the value marked on any diagonal line above the intersection will not overheat unless tightly boxed in by surrounding parts. The higher you go in wattage rating, the cooler the resistor will run. But lower on the chart, at lesser wattage ratings, resistor temperature will go up as wattage goes down.

Ratings vs. actual dissipation

It seems illogical to many beginners that the number of ohms in a composition resistor is not related to its physical size. They see an 820,000-ohm unit only about one-tenth the bulk of another providing only 82 ohms, or a 22-megohm resistor may have but one-tenth the bulk of a 2.2-ohm unit. It's all a matter of wattage ratings.

Another fact not at all illogical, yet sometimes not appreciated, is that there need be no relation at all between the wattage rating of a resistor and actual power in watts changed to heat within the unit.

The rating of a resistor specifies only the number of watts or fraction of a watt of power that the unit is designed to get rid of (dissipate) without heating to a temperature which may harm the resistor and nearby circuit components.

On the other hand, the number of watts of electric power actually changed into heat depends only on the number of ohms of resistance and on the current in this resistance, nothing else. If you locate any combination of ohms and current on the chart, the diagonal line for watts at that intersection shows how much power will be transformed into heat.

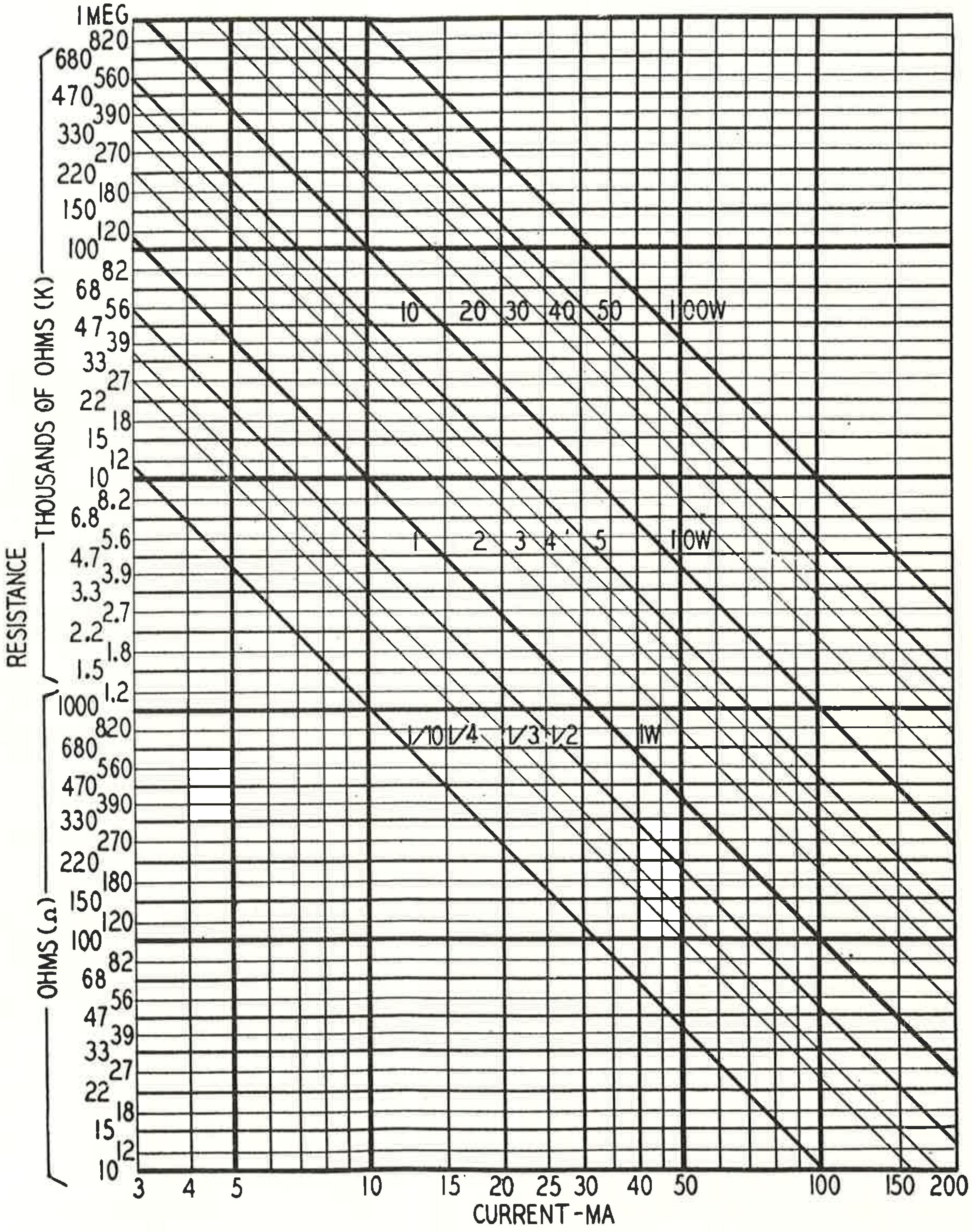
How much heat may be produced and safely dissipated depends chiefly on surface area of the resistor and to a minor extent on bulk and kind of material in the insulation. That's why higher wattage ratings require bigger resistors.

A resistor retains within itself only a negligible part of the heat produced. The rest must be gotten rid of or dissipated into the surroundings just as fast as produced, or else the resistor would burn up. Heat is dissipated into surrounding air only while the resistor is hotter than the air, and rate of dissipation is proportional to temperature difference. Unfortunately, we canont get rid of much extra heat by increasing the temperature difference, because we don't want hot resistors.

However, we may increase heat dissipation and hold resistor temperature down by increasing the surface area from which heat is dissipated. Composition resistors rated for ½-watt dissipation commonly have total surface areas of about 0.20 square inch. A 1-watt unit has a total area of about 0.45 square inch. The 2-watt sizes have about 0.85 square inch. These areas are so closely proportional to wattage ratings that, were all the resistors to run at the same temperature, the 2-watt surface would dissipate about twice as much heat to surrounding air as would the 1-watt size, and the 1-watt surface would dissipate about twice as much heat as the ½ watt.

If resistor surfaces are to dissipate heat into the surrounding air, they should not be pushed tightly together, shutting off part of the area. Furthermore, crowding prevents heated air from moving away to be replaced by cooler air. Placing a resistor close to chassis metal might appear to be good practice, because heat flows into and through steel better than into and through air, assuming the air to be still. But heated air circulates and floats the heat away, while the chassis doesn't — at least not in the present designs.

In some recent electronic equipment, there has been a trend toward the use of resistors wrapped in a metal band and fastened to the chassis. Reports indicate that this procedure, depending upon the size of the band, may increase the wattage rating of the unit as much as 100%.



Wattage rating chart. Wattage is read on nearest diagonal line above intersection of current and resistance lines.

Reprinted, with diagrams, in July '58, P107.

DETERMINATION OF TYPICAL OPERATING CONDITIONS FOR VALVES USED AS LINEAR RF POWER AMPLIFIERS

*By A. P. Sweet**

During the past several years there has been a tremendous increase in the use of single-sideband, suppressed-carrier transmission in amateur-radio radiotelephony. This type of transmission offers several advantages over the widely-used amplitude modulation methods. These advantages include reduced band-width and the elimination of heterodyne-interference problems. More useful power can be obtained with the same tubes and power supplies or, conversely, smaller tubes and power supplies can be used to deliver the same useful power.

With high-level amplitude modulation, a carrier and two groups of sideband frequencies are generated. The total power in the two sidebands at 100 per cent. modulation is equal to one half of the carrier power. Thus, for every 100 watts of total transmitted power, 67 watts is in the carrier and 16.5 watts is in each sideband. Yet, one sideband contains all of the necessary intelligence for communication (provided certain receiver requirements are met).

Half the Bandwidth.

Single-sideband, suppressed-carrier transmission utilizes only one sideband. By the elimination of the other sideband the bandwidth is cut in half. By suppression of the carrier, heterodyne interference is eliminated. Only 16.5 watts of power is required to convey the same intelligence. Conversely, if the original 100 watts of power is transmitted in a single sideband, six times the former useful power will be obtained.

The literature contains considerable information on various methods of generating single-sideband, suppressed-carrier signals. However, little information is available on the choice of tubes for amplifying these signals and the methods of calculating typical operating conditions for these tubes.

Linear RF Amplifiers.

Single-sideband signals must be amplified by linear rf amplifiers. These amplifiers are identical to af power amplifiers except that resonant tank circuits are used in the grid and plate circuits instead of audio-frequency transformers. Consequently, the tube manufacturer's ratings for af power amplifier and modulator service for class A, AB$_1$, AB$_2$, and class B and typical operating conditions will apply, provided the tube is also capable of operating at the higher frequencies involved. The same derating factors for plate voltage and input versus frequency shown by the manufacturer for class-C telegraphy ratings should be applied to single-sideband operation at the frequencies where they become applicable.

Because the tank circuits act as energy-storage systems, it is not necessary (as in case of audio work) to use two tubes in push-pull in class-AB or class-B, linear, rf amplifiers. However, if only one tube is used, the rf harmonics will be higher thereby making the TVI problems more severe.

Although the manufacturer's ratings are based on 100 per cent. modulation with sinewave signals, normal voice modulation reaches this condition only on the peaks of modulation. The ICAS ratings shown by RCA have taken this factor into account. Consequently, no attempt should be made to operate these maximum ratings. Such operation will result in shorter tube life and the possibility of early tube damage during transmitter adjustment or unexpected overloads such as microphone "howl".

Since only rf power amplifiers are being considered, class A operation will not be discussed further. Of the remaining classes, AB$_1$ operation with tetrodes or pentodes is the simplest since only the plate- and screen-voltage supplies require good regulation.

Table I includes the maximum ratings and typical operating conditions for several RCA tubes used as linear rf power amplifiers. If it is desired to operate at conditions other than those given, typical conditions can be calculated by means of the following procedure:

1. Make sure E_b is within tube ratings.
2. Refer to the published curves. On the average plate characteristics curves, select a point on the zero grid-voltage curve near the "knee", and record i'_b,† and e_{bmin}; from the average screen-grid characteristics curves, determine i'_{c2} for this point.
   (E$_{c2}$ equals the value shown for the curves used.)
3. Calculate I_{bms}: $I_{bms} = i'_b/3$.
4. Calculate PD:

$$PD = \frac{I_{bms}}{4}(E_b + 3e_{bmin}).$$

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* Power Tube Engineering, Lancaster, Pa.

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†

E_b	*Dc plate voltage.*
e_{bmin}	*Minimum plate voltage for the required peak current (from the characteristic curves).*
E_{c2}	*Dc screen voltage.*
E_{c1}	*Dc control grid voltage.*
e_{cm}	*Maximum grid-voltage drive to obtain the required peak plate current at a given minimum plate voltage.*
E'_g	*Peak value of grid-voltage swing.*
I_{bms}	*Maximum-signal, dc plate current.*
I_{bo}	*Zero-signal, dc plate current.*
i'_b	*Instantaneous peak plate current.*
I_{c2}	*Maximum-signal, dc screen current.*
i'_{c2}	*Instantaneous peak screen current.*
i'_{c1}	*Instantaneous peak grid current.*
PD	*Plate dissipation at maximum signal.*
PI	*Plate power input at maximum signal.*
PO	*Power output at maximum signal.*
DP	*Driving power at maximum signal.*
SI	*Screen input at maximum signal.*

5. Calculate SI: $SI = E_{c2}i'_{c2}/4$.
6. Calculate PI: $PI = E_bI_{bms}$.
7. Check the values found in steps 4, 5, and 6 to determine whether they are within tube ratings. Normally, they will be within ratings for AB_1 operation. If they are not, a lower value of $i'b$ (either in the negative-grid region or at a lower screen voltage) must be selected and steps 2 through 7 repeated.
8. Calculate PO: $PO = PI - PD$.
9. Calculate I_{bo}: $I_{bo} = I_{bms}/5$.
10. E_{c1} can now be found on the plate characteristics curces as the grid voltage where the plate voltage is E_b and the plate current is I_{bo}.
11. $E'_g = [E_{c1}] + e_{cm}$.
    This value of E'_g is the absolute value of E_{c1} (the brackets mean ignore the sign) plus the algebraic value of e_{cm} (include the sign). If the original point in step 2 was selected on the zero grid-voltage curve, then e_{cm} is equal to zero and
    $$E'_g = [E_{c1}].$$
12. Calculate I_{c2}: $I_{c2} = i'_{c2}/4$.
13. Calculate DP: $DP = \frac{E'_gi'_{c2}}{2}$ (for AB_1 operation, $i'_{c1} = 0$ so DP is zero).

Class-AB_2 Tetrode or Class-B Triode Operation.

Class-AB_2 tetrode and class-B triode operation provide more power than class-AB_1 operation, but have the disadvantage of placing stiffer requirements on the driver and grid-bias supply regulation.

Calculation of typical operating conditions other than those given in the tube data sheets is slightly more complicated for class-AB_2 and class-B operation than for class-AB_1, but is still relatively simple with the procedure outlined below:*

1. Make sure E_b is within tube ratings.
2. Assume a value of I_{bms}. A good starting point is at
   $$I_{bms} = \frac{3\text{ (rated PD)}}{E_b}.$$
   Check this value to see whether it is within ratings. If it is not, use the maximum rated value of I_{bms}.
3. Calculate i'_b: $i'_b = 3I_{bms}$.
4. From the plate characteristics curves, select a value of e_{bmin} near the "knee" of the curves at which i'_b can be obtained. Also record E_{c2}, e_{cm}, i'_{c1} and i'_{c2} for this point.
5. Calculate PD:
   $$PD = \frac{I_{bms}}{4}(E_b + 3e_{bmin}).$$
6. Calculate SI: $SI = \frac{E_{c2}i_{c2}}{4}$.
7. Calculate PI: $PI = E_bI_{bms}$.

Check the values found in steps 5, 6, and 7 to determine whether they are within the maximum ratings for the tube type. If the calculated values exceed the maximum ratings, choose a lower value of I_{bms} and repeat steps 3 through 7.

If the plate dissipation and input are below the maximum ratings but the screen input is high, it may be possible to choose a higher value of e_{bmin} in step 4 (and repeat steps 5, 6, and 7) to get all values within ratings. The reverse case can also be applied.

If all the values are well below maximum ratings a higher value of I_{bms} can be chosen in step 2, and steps 3 through 7 repeated to see whether the operation is still within ratings. If so, this latter set of operating conditions will provide slightly more power output.

When values that are slightly below the maximum ratings are obtained for plate dissipation, screen input, and plate input, the corresponding value of I_{bms} represents the maximum value which can be used at the original plate voltage selected. Lower values of I_{bms}, which give more conservative operation but less power output, can also be used.

Once the value of I_{bms} is selected, the remainder of the calculation follows steps 8 through 13 shown for class AB_1 operation. The driving power (DP) calculated does not include the rf tube and circuit losses. Consequently, for adequate performance, at least ten times this value of power should be available from the driver.

The following example illustrates the calculation of "typical operation" conditions for the class-AB_2, CCS operation of the type 807 with an E_b of 600 volts:

1. The maximum plate voltage rating is 600 v.
2. Determine I_{bms}:
   $$I_{bms} = \frac{3\text{ (rated PD)}}{E_b} = \frac{3\ (25)}{600} = .125\text{ amp.}$$
   This value is about the maximum-signal, dc plate-current rating (from tube handbook or tube bulletin); therefore, the maximum rated value of 120 ma will be used as a first approximation.
3. $i'_b = 3I_{bms} = 3\ (120) = 360$ ma.
4. From the 300-v E_{c2} curves, *Fig. 1,* select $e_{bmin} = 90$ v, and read e_{cm} (= + 12 v). From *Figures 2* and *3,* read $i'_{c1} = 12$ ma, and $i'_{c2} = 35$ ma, respectively.
5. $$PD = \frac{I_{bms}}{4}[E_b + 3(e_{bmin})]$$
   $$= \frac{120}{4}[600 + 3(90)] = 26\text{ w.}$$
6. $$SI = \frac{E_{c2}i_{c2}}{4} = \frac{300(.035)}{4} = 26\text{ w.}$$
7. $PI = E_bI_{bms} = 600(.120) = 72$ w.

PD and PI are both above ratings, and a lower value of e_{bmin} at the required current cannot be found on the curves. Therefore, a lower value of I_{bms} must be chosen; try a value of 100 ma, and repeat steps 3 through 7:

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* Calculation for tetrodes is discussed; the triode case is the same except for the omission of the calculation of screen input.

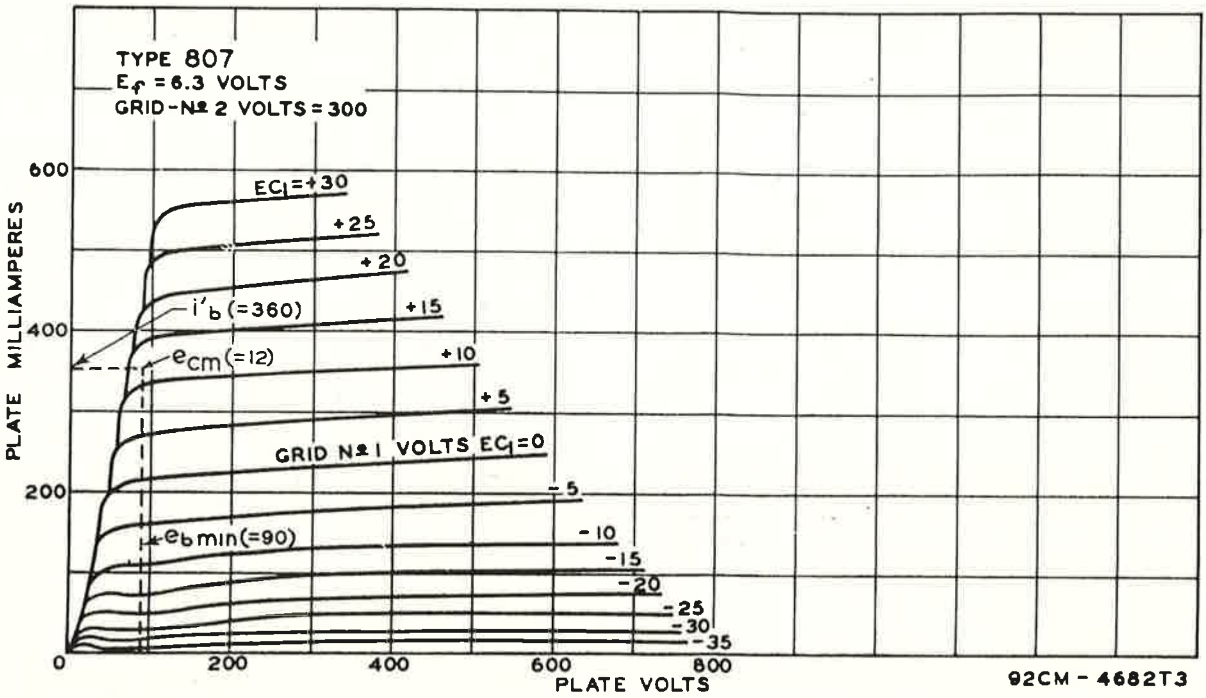

Fig. 1. Average plate characteristics for the type 807 tube (grid-No. 2 voltage = 300).

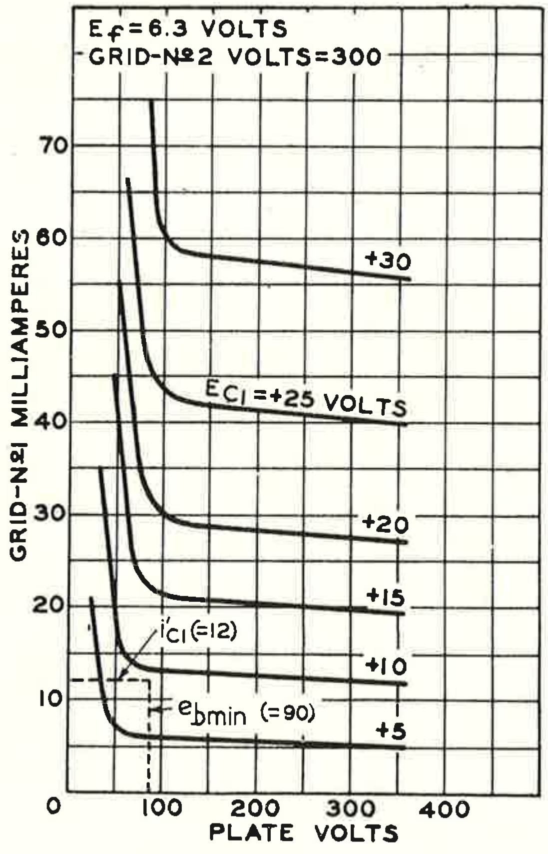

Fig. 2. Average control-grid characteristics for the type 807 tube grid-No. 2 voltage = 300).

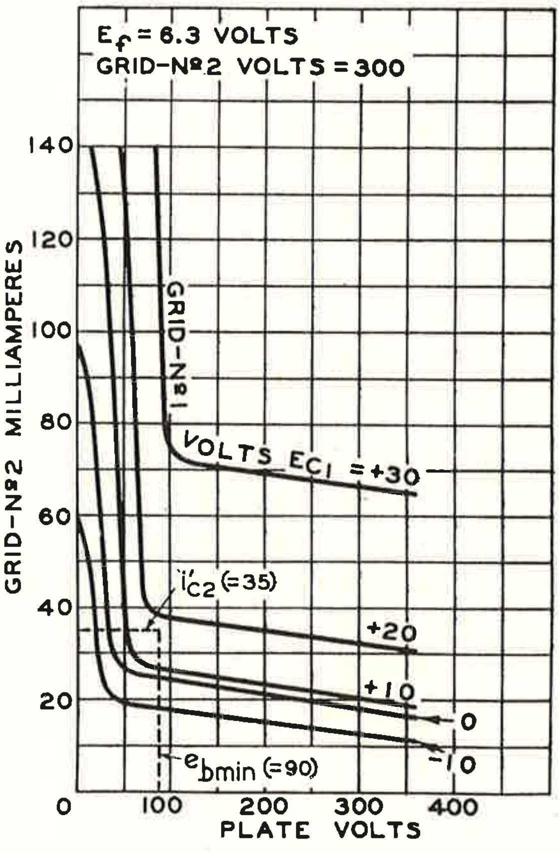

Fig. 3. Average screen-grid characteristics for the type 807 tube grid-No. 2 voltage = 300).

Table I—Ratings and Operating Conditions for RCA Tubes Used as Linear RF Power Amplifiers

Maximum Ratings - Absolute Values										Typical Operation								
Tube Type	Class of Operation	Service	Plate Voltage (E$_b$)	Screen Voltage (E$_{c2}$)	Max-Signal Plate Current (I$_{bms}$)-ma	Max-Signal Plate Input (PI)-watts	Max-Signal Screen Input (SI)-watts	Plate Dissipation (PD)-watts	Grid Resistance -ohms	Plate Voltage (E$_b$)	Screen Voltage (E$_{c2}$)	Grid Voltage (E$_{c1}$)	Peak Grid Voltage (E'$_g$)	Zero-Signal Plate Current (I$_{bo}$)-ma	Max-Signal Plate Current (I$_{bms}$)-ma	Max-Signal Screen Current (I$_{c2}$)-ma	Drive Power (DP) -watts	Max-Signal Power Output (PO)-watts
2E26	AB$_1$	CCS	400	200	75	30	2.5	10	30 K	400	200	-25	25	9	45	10		12
		ICAS	500	200	75	37.5	2.5	12.5	30 K	500	200	-25	25	9	45	10		15
	AB$_2$	CCS	400	200	75	30	2.5	10		400	125	-15	30	10	75	16	0.2	20
		ICAS	500	200	75	37.5	2.5	12.5		500	125	-15	30	11	75	16	0.2	25
4-65A	AB$_1$									1000	500	-85	85	15	85	12		40
		CCS	3000	600	150		10	65	250 K	1500	500	-85	85	15	90	7		70
										1750	500	-90	90	10	85	9		85
	AB$_2$									1000	250	-30	105	30	150	22	2.5	85
		CCS	3000	600	150		10	65		1500	250	-35	105	30	125	15	1.5	125
										1800	250	-35	90	25	110	13	1.0	135
4-125A	AB$_1$									1500	600	-90	90	30	110	9		80
		CCS	3000	600	225		20	125	250 K	2000	600	-94	94	25	120	3		115
										2500	600	-96	96	25	115	4		165
	AB$_2$									1500	350	-41	141	44	200	17	5.0	175
		CCS	3000	400	225		20	125		2000	350	-45	105	36	150	3	3.0	175
										2500	350	-43	139	47	130	3	2.5	200
4-250A	AB$_1$									2000	500	-88	88	55	200	11		230
		CCS	4000	600	350		35	250		2500	500	-90	90	60	215	7		310
										3000	500	-93	93	60	205	5		370
	AB$_2$									2000	300	-48	100	60	255	13	5.5	325
		CCS	4000	600	350		35	250		2500	300	-51	100	60	250	12	5.0	420
										3000	300	-53	100	62	236	16	4.5	520
807 1625	AB$_1$									500	300	-32	32	22	70	8		23
		CCS	600	300	120	60	3.5	25	100 K	600	300	-34	34	18	70	8		28
		ICAS	750	300	120	90	3.5	30	100 K	750	300	-35	35	15	70	8		35
	AB$_2$									500	300	-30	43	30	120	10	0.2	38
		CCS	600	300	120	60	3.5	25		600	300	-32	40	24	100	9	0.1	40
		ICAS	750	300	120	90	3.5	30		750	300	-35	48	15	120	10	0.2	60
811A	B									750		0	100	16	175		10	90
		CCS	1250		175	165		45		1250		0	78	25	130		4	120
										1000		0	93	22	175		7.5	125
		ICAS	1500		175	235		65		1250		0	88	27	175		6	155
813	AB$_1$									2000	750	-90	80	25	130	20		165
		CCS	2250	1100	180	360	22	100		2250	750	-95	85	25	125	26		190
		ICAS	2500	1100	225	450	22	125		2500	750	-95	90	25	145	27		245
829B Natural Cooling	AB$_1$									500	200	-20	40	20	100	20		35
		CCS	750	225	250	100	7	30	100 K	600	200	-18	36	40	100	18		44
		ICAS	750	225	250	120	7	40	100 K	750	200	-21	42	20	100	20		55
	'B$_2$									500	200	-18	50	30	180	26	0.6	60
		CCS	750	225	250	100	7	30		600	200	-20	50	26	155	22	0.4	65
		ICAS	750	225	250	120	7	40		750	200	-19	50	32	160	25	0.5	85
832A	AB$_1$									500	180	-30	60	14	70	7		22
		CCS	750	250	90	36	5	15	100 K	600	150	-30	60	12	60	7		23
		ICAS	750	250	115	50	5	20	100 K	750	150	-32	64	12	60	7		30
833A	B	ICAS	3300		500	1300		350		3300		-80	190	60	300		20	710
6146 6159	AB$_1$									400	190	-40	40	32	114	13		27
		CCS	600	250	125	60	3	20	100 K	500	185	-40	40	29	108	13		35
										600	180	-45	45	13	100	12		40
										600	200	-50	50	14	115	14		47
		ICAS	750	250	135	85	3	25	100 K	750	195	-50	50	12	110	13		60
	AB$_2$									400	175	-41	48	17	116	9	0.2	31
		CCS	600	250	125	60	3	20		500	175	-44	51	14	121	9	0.3	41
										600	165	-44	49	11	104	9	0.2	45
										600	190	-48	55	14	135	10	0.3	55
		ICAS	•750	250	135	85	3	25		750	165	-46	54	11	120	10	0.4	65
6524	AB$_2$									400	200	-23	72	25	145	10	0.1	39
		CCS	500	300	150	70	3	20	30 K	500	200	-26	70	20	116	10	0.1	40
										500	200	-25	76	25	145	10	0.1	50
		ICAS	600	300	150	85	3	20	30 K	600	200	-26	76	21	135	13	0.1	57

3. $i'_b = 3(100) = 300$ ma.

4. From the 300-v E_{c2} curves: $e_{bmin} = 70$ v, $e_{cm} = +7$ v, $i'_{c1} = 8$ ma, $i'_{c2} = 35$ ma.

5. $PD = \frac{.100}{4}[600 + 3(70)] = 20.3$ w.

6. $SI = \frac{300(.035)}{4} = 2.6$ w.

7. $PI = 600(.100) = 60$ w.

These values are within ratings; therefore, the remainder of the calculations can be completed:

8. $PO = PI - PD = 60 - 20.3 = 39.7$ w.

9. $I_{bo} = \frac{I_{bms}}{5} = \frac{100}{5} = 20$ ma.

10. E_{c1} (from *Fig. 1*) $= -35$ v.

11. $E'_g = [E_{c1}] + e_{cm} = 35 + (+37) = 42$ v.

12. $I_{c2} = \frac{i'_{c2}}{4} = \frac{35}{4} = 8.7$ ma.

13. $DP = \frac{2}{E'_{g}i'_{c2}} = \frac{2}{42(.008)} = .17$ w.

These values compare reasonably well with the published values.

Table 1 shows the maximum ratings and typical operating conditions for several popular RCA tubes in linear rf amplifier service for single-sideband, suppressed-carrier transmission.

It should be remembered that the typical operating conditions shown by the manufacturer (or calculated by the preceding methods) are approximate only. Minor adjustments are usually made in actual operation by varying the grid-bias or screen voltage slightly. In linear rf amplifier circuits for single-sideband, suppressed-carrier transmission, it is particularly important to check the actual operating conditions when the transmitter is first set up to assure that linear operation within the maximum tube ratings is being obtained.

CORRECTION

An error occurred on page 60 of the May issue under the heading 5AS4 Tentative Data in line 13 of column 1, where 990 volts should read 290 volts.

Copy corrd.


AWV