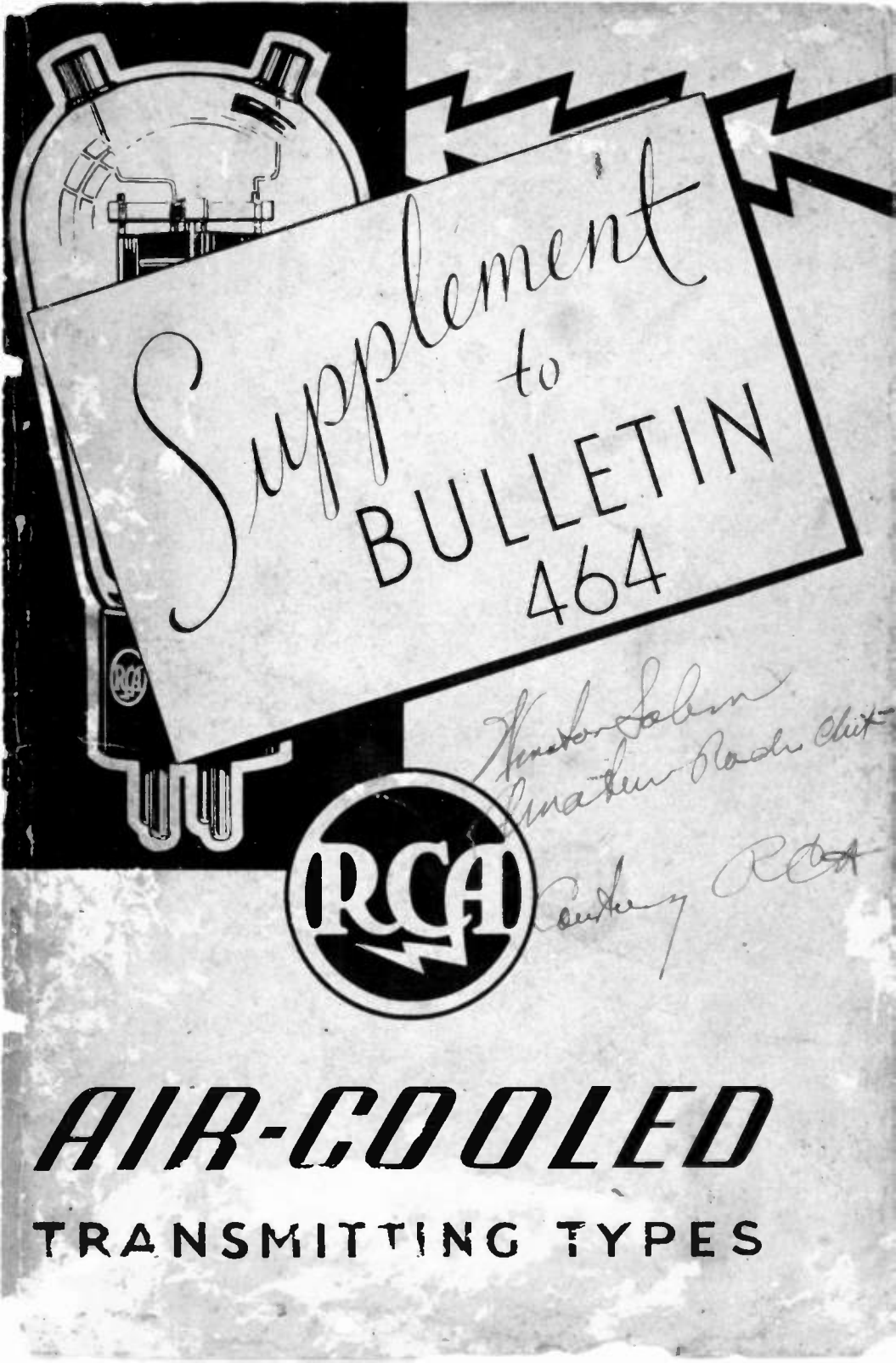

AIR-COOLED

TRANSMITTING TYPES

The sale of tubes described in this booklet carries a license under patent claims on the tubes themselves but only for (1) radio amateur uses, (2) radio experimental uses, (3) radio telephone broadcast reception, (4) one-way radio telephone broadcast transmission of entertainment or educational programs or police information, (5) electric phonograph uses, and (6) for use in connection with talking picture apparatus for the electrical reproduction of sound from records thereof, to be heard in the immediate vicinity of the reproducing apparatus.

The sale does not carry a license under patent claims on combinations of the tubes with other devices or elements, as for example in various circuits and hook-ups, except only for legitimate renewals and repairs in apparatus and systems already licensed for use under such patent claims on combinations.

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RCA MANUFACTURING COMPANY, INC.
CAMDEN, N.J.

801

Oscillator, R-F and A-F Power Amplifier, Modulator

RCA-801 is a three-electrode transmitting tube well suited for use as a radio-frequency amplifier and oscillator at high radio frequencies. It may also be used as an audio-frequency amplifier and modulator. The internal structure of this tube, together with the use of a ceramic base provides for operation at full rating at frequencies as high as 60 megacycles.

CHARACTERISTICS

FILAMENT VOLTAGE (A.C. or D.C.)	7.5	Volts
FILAMENT CURRENT	1.25	Amperes
AMPLIFICATION FACTOR	8	
DIRECT INTERELECTRODE CAPACITANCES (Approx.):		
Grid-Plate	6	μμf
Grid-Filament	4.5	μμf
Plate-Filament	1.5	μμf
BULB (For dimensions, see page 8)	ST-16	
BASE (For socket connections, see page 8)	Medium 4-Pin Ceramic, Bayonet	

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

As A-F Power Amplifier and Modulator - Class A

D-C PLATE VOLTAGE			600 *max.*	Volts
PLATE DISSIPATION			20 *max.*	Watts
TYPICAL OPERATION and CHARACTERISTICS:				
Filament Voltage (A.C.)	7.5	7.5	7.5	Volts
D-C Plate Voltage	425	500	600	Volts
D-C Grid Voltage #	-40	-45	-55	Volts
Peak A-F Grid Voltage	35	40	50	Volts
D-C Plate Current	18	24	30	Milliamperes
Plate Resistance	5000	4600	4300	Ohms
Mutual Conductance	1600	1725	1840	Micromhos
Load Resistance	10200	8000	7800	Ohms
Undistorted Power Output	1.6	2.3	3.8	Watts

As A-F Power Amplifier and Modulator - Class B

D-C PLATE VOLTAGE	600 *max.*	Volts
MAX-SIGNAL D-C PLATE CURRENT *	70 *max.*	Milliamperes
MAX-SIGNAL PLATE INPUT *	42 *max.*	Watts
PLATE DISSIPATION *	20 *max.*	Watts

* Averaged over any audio-frequency cycle.

\# Grid voltages are given with respect to the mid-point of filament operated on a.c. If d.c. is used, each stated value of grid voltage should be decreased by 3.75 volts and be referred to the negative end of the filament.

TYPICAL OPERATION - 2 Tubes:

Unless otherwise specified, values are for 2 tubes

Filament Voltage (A.C.)	7.5	7.5	7.5	Volts
D-C Plate Voltage	400	500	600	Volts
D-C Grid Voltage #	-50	-60	-75	Volts
Peak A-F Grid-to-Grid Voltage	270	290	320	Volts
Zero-Sig. D-C Plate Current	8	8	8	Milliamperes
Max-Sig. D-C Plate Current	130	130	130	Milliamperes
Load Resistance (Per tube)	1500	2000	2500	Ohms
Effective Load Resistance (Plate-to-plate)	6000	8000	10000	Ohms
Max-Sig. Driving Power (Approx.)	3	3	3	Watts
Max-Sig. Power Output (Approx.)	27	36	45	Watts

As R-F Power Amplifier - Class B Telephony

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

D-C PLATE VOLTAGE		600 *max.*	Volts
D-C PLATE CURRENT		50 *max.*	Milliamperes
R-F GRID CURRENT		4 *max.*	Amperes
PLATE INPUT		30 *max.*	Watts
PLATE DISSIPATION		20 *max.*	Watts
TYPICAL OPERATION:			
Filament Voltage (A.C.)	7.5	7.5	Volts
D-C Plate Voltage	500	600	Volts
D-C Grid Voltage #	-60	-75	Volts
Peak R-F Grid Voltage	85	90	Volts
D-C Plate Current	45	45	Milliamperes
D-C Grid Current (Approx.) **	0.2	0.2	Milliampere
Driving Power (Approx.) ** o	2.2	2.3	Watts
Power Output (Approx.)	6	7.5	Watts

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

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

D-C PLATE VOLTAGE		500 *max.*	Volts
D-C PLATE CURRENT		60 *max.*	Milliamperes
D-C GRID CURRENT		15 *max.*	Milliamperes
R-F GRID CURRENT		4 *max.*	Amperes
PLATE INPUT		30 *max.*	Watts
PLATE DISSIPATION		13.5 *max.*	Watts
TYPICAL OPERATION:			
Filament Voltage (A.C.)	7.5	7.5	Volts
D-C Plate Voltage	400	500	Volts
D-C Grid Voltage	-150	-190	Volts

\# Grid voltages are given with respect to the mid-point of filament operated on a.c. If d.c. is used, each stated value of grid voltage should be decreased by 3.75 volts and be referred to the negative end of the filament.

** 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 be capable of delivering considerably more than the required driving power.

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

Peak R-F Grid Voltage	260	300	Volts
D-C Plate Current	55	55	Milliamperes
D-C Grid Current (Approx.) **	15	15	Milliamperes
Driving Power (Approx.) **	4	4.5	Watts
Power Output (Approx.)	14	18	Watts

As R-F Power Amplifier and Oscillator - Class C Telegraphy
Key-down conditions per tube without modulation ##

D-C PLATE VOLTAGE		600 *max.*	Volts
D-C PLATE CURRENT		70 *max.*	Milliamperes
D-C GRID CURRENT		15 *max.*	Milliamperes
R-F GRID CURRENT		5 *max.*	Amperes
PLATE INPUT		42 *max.*	Watts
PLATE DISSIPATION		20 *max.*	Watts
TYPICAL OPERATION:			
Filament Voltage (A.C.)	7.5	7.5	Volts
D-C Plate Voltage	500	600	Volts
D-C Grid Voltage	-125	-150	Volts
Peak R-F Grid Voltage	235	260	Volts
D-C Plate Current	65	65	Milliamperes
D-C Grid Current (Approx.) **	15	15	Milliamperes
Driving Power (Approx.) **	3.5	4	Watts
Power Output (Approx.)	20	25	Watts

** See page 2.

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

INSTALLATION

The *base* pins of the RCA-801 fit the standard, four-contact socket, which should be installed to hold the tube in a vertical position with the base down. If it is necessary to place the tube in a horizontal position, the socket should be mounted with the filament-pin openings one vertically above the other so that the plate will be in a vertical plane (on edge). If the tube is subjected to vibration or shock, a shock-absorbing suspension must be employed.

The *bulb* of this tube becomes very hot during continuous operation. Free circulation of air, therefore, should be provided. Care should be taken that the bulb does not come in contact with any metallic object nor be subjected to the drops or spray of liquid. The installation of all wires and connections should be made so that they will not be close to or touch the bulb in order to avoid puncture of the glass due to peak-voltage effects.

The *filament* of the 801 is of the thoriated-tungsten type. It may be operated either from an a-c or a d-c source. Except where a d-c source is necessary to avoid hum, an a-c filament supply is generally used because of its convenience. A suitable voltmeter should be connected permanently across the tube filament terminals to provide a ready check of the filament voltage. In cases where d.c. is used on the filament, these returns should be connected to the negative

filament terminal. This voltage should not vary more than plus or minus 5% from the rated value; otherwise, a loss of filament emission may result. When the apparatus in which the tube is used is idle for short periods of time, the filament should be maintained at its rated voltage during the "standbys".

The plate dissipation of the 801 (the difference between plate input and power output) should never exceed the maximum value given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. The plate should not show color under any condition of operation. In order to prevent overheating due to improper circuit adjustments, to overloading, or to loss of grid bias, the plate circuit should be provided with a protective device such as a fuse. This device should instantly remove the plate voltage when the d-c plate current reaches a value 50% greater than normal.

Overheating of the 801 by severe overload may decrease filament emission. Unless the overload has liberated a large amount of gas, the activity of the filament can sometimes be restored by operating the filament at rated voltage for ten minutes or more with no voltage on the plate or grid. This process may be accelerated by raising the filament voltage to 9 volts (not higher) for a few minutes.

Heavy leads and conductors together with suitable insulation should be used in all parts of the r-f plate tank circuit so that the losses, due to the r-f voltages and currents, may be kept at a minimum. Since proper circuit design becomes very important at the higher frequencies, it is essential that short, heavy leads and circuit returns are used in order to minimize lead inductance and losses.

In order that the maximum ratings given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS will not be exceeded, changes in plate and filament voltages due to line-voltage fluctuation, load variation, and manufacturing variation of the associated apparatus, must be determined. An average value of plate and filament voltage should then be chosen so that under the usual voltage variations the maximum rated voltages will not be exceeded.

When a new circuit is tried or when adjustments are made, the plate voltage should be reduced in order to prevent damage to the tube or associated apparatus in case the circuit adjustments are incorrect. It is advisable to use a protective resistance of about 3000 ohms in series with the plate lead during such adjustments. Suitable meters should be provided for measuring tube voltages and currents. In addition to their use in indicating suitable operating conditions, they are also of value in making initial transmitter adjustments. However, to assist in the making of final adjustments for optimum performance, it is recommended that a cathode-ray oscillograph be used. Under no conditions should the maximum values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS be exceeded.

The rated plate voltage of this tube is high enough to be dangerous to the user. Care should be taken during the adjustment of cir-

cuits, especially those in which the exposed circuit parts are at the high d-c plate potential.

APPLICATION

As a *Class A audio-frequency amplifier or modulator,* the RCA-801 is capable of delivering 3.8 watts of audio-frequency power with very low distortion. Typical operating conditions are shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid bias for Class A service may be obtained from a separate voltage source or by means of a cathode-bias resistor shunted by a condenser. This condenser should be large enough to minimize degenerative effects at low audio frequencies. When the cathode-bias method is used, the proper value of the cathode resistor for a single tube is 1875 ohms at a plate voltage of 500 volts, and 1835 ohms at a plate voltage of 600 volts.

In cases where the input circuit to the 801 is resistance-coupled, the resistance in the grid circuit should not be made too high. A resistance value of 0.5 megohm for one 801 is the recommended maximum when cathode-bias is used. Without cathode-bias, the grid resistance should not exceed 100000 ohms.

An output device should be used to transfer audio power efficiently from the RCA-801 to the voice coil of the reproducing unit, to the next audio stage, or to the modulated r-f amplifier stage.

If more audio output is desired than can be obtained from a single 801, two or more 801's may be operated in parallel or in push-pull. The parallel connection provides twice the output of a single tube without an increase in grid-signal voltage. The push-pull connection will give slightly more than double the power output of a single tube but requires twice the grid-signal voltage. The push-pull arrangement has the advantage of balancing out the even-order harmonics from the output. With either connection the grid bias required is the same as for a single tube. When a group of 801's is operated in Class A parallel, it may be necessary to provide individual adjustment of grid bias to insure that the plate dissipation of each tube does not exceed the maximum value of 20 watts. This may be accomplished by means of a tapped "C" supply or by means of a variable cathode-bias resistor for each tube. Separate filament windings are necessary, of course, for each tube that is self-biased. If cathode bias is used, each cathode resistor should be shunted by a condenser large enough to minimize degenerative effects at low audio frequencies. Furthermore, when the tubes are operated in parallel, a non-inductive resistance of 10 to 100 ohms should be placed in series with each grid lead, next to the tube socket, to prevent parasitic oscillations. When two RCA-801's are operated in Class A push-pull, it is usual practice to obtain the grid-bias voltage from a common cathode-bias resistor. In this service the by-pass condenser is not necessary and the value of the resistor is equal to one-half the value recommended for single-tube operation. If the plate dissipation rating for either tube is exceeded under these conditions, the size of the bias resistor should be increased sufficiently to prevent overloading.

As a *Class B modulator or audio-frequency amplifier,* two RCA-801's are used in a balanced circuit, each tube amplifying only half the time. The d-c plate current should never exceed 70 milliamperes per tube. Grid bias for the 801 in Class B a-f service should be obtained from a battery or other d-c source of good regulation. It should not be obtained from a high-resistance supply such as a grid leak, nor from a rectifier, unless the latter has exceptionally good voltage regulation.

If an output transformer efficiency of 90% is assumed, two tubes operating under the conditions shown for a 600-volt plate supply, are capable of modulating 100% an input of approximately 80 watts to a Class C radio-frequency amplifier.

The input transformer should be designed to give good frequency response when operated into an open circuit, such as that represented by the grid circuit of the Class B stage when the signal amplitude is small. It should also be designed to handle the required input power for a strong signal. The output transformer should be so designed that the resistance load presented by the modulated Class C amplifier is reflected as a plate-to-plate load of 10000 ohms in the Class B stage for the 600-volt conditions. Since two 801's will modulate 80 watts, a convenient Class C amplifier would be one operating at 600 volts and approximately 133 milliamperes. These conditions represent a resistance of approximately 600 ÷ 0.133, or 4510 ohms. The ratio of the output transformer is then $\sqrt{10000 \div 4510}$, or 1.49 to 1, step-down. If a Class C amplifier operating at 1000 volts and 80 milliamperes is desired, the equivalent resistance is 12500 ohms; in this case the transformer ratio is 1 to 1.12, step-up. The transformer should be designed with a core sufficiently large to avoid saturation effects which would impair the quality of the output. If the secondary is to carry the d-c plate current of the modulated amplifier, the core should be made larger and include an air gap to compensate for the d-c magnetization current.

As a *Class B radio-frequency amplifier*, RCA-801 should be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. In this service the plate is supplied with unmodulated d-c voltage and the grid is excited by r-f voltage modulated at audio frequency in one of the preceding stages. It is important to note that in this service the plate dissipation is greatest when the carrier is unmodulated. The plate dissipation, therefore, should not exceed 20 watts for unmodulated carrier conditions. Grid bias for Class B r-f service should be obtained in the same manner as for Class B a-f service.

As a *plate-modulated Class C radio-frequency amplifier*, the 801 should be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid bias for this service may be obtained from a grid leak of about 10000 ohms (15-watt size), or from a suitable combination of either grid leak and fixed supply of good regulation or grid leak and cathode-bias resistor. The cathode-bias resistor should be by-passed for audio and radio frequencies. The combination methods are particularly desirable because distortion effects are minimized by bias-supply compensation. Since the grid-bias voltage for Class C service is not particularly critical, correct adjustment may be obtained with values differing widely from those indicated for this service.

As a *Class C radio-frequency amplifier and oscillator for telegraph service*, RCA-801 may be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid bias for this service may be obtained from a grid leak of 10000 ohms, from a battery, from a rectifier, or from a cathode-bias resistor (preferably variable) suitably by-passed for radio frequencies. The cathode-bias method is advantageous due to the fact that the grid bias is automatically regulated in direct proportion to the sum of the plate and grid current and that there is little chance of the plate current becoming dangerously high, even if the r-f grid excitation is removed. The grid-leak bias method has the advantage of simplicity and of automatically biasing the grid in proportion to the excitation voltage available. Special care must be observed with the use of the latter system because the accidental removal of the excitation will cause the grid bias to fall to zero so that the plate current, and consequently the plate dissipation, will rise to excessive values. The use of a protective device designed to open the plate circuit on excessive rises of plate

current will minimize the danger of overload (see INSTALLATION). Grid-bias voltage for Class C service is not particularly critical so that correct adjustment may be obtained with widely different values.

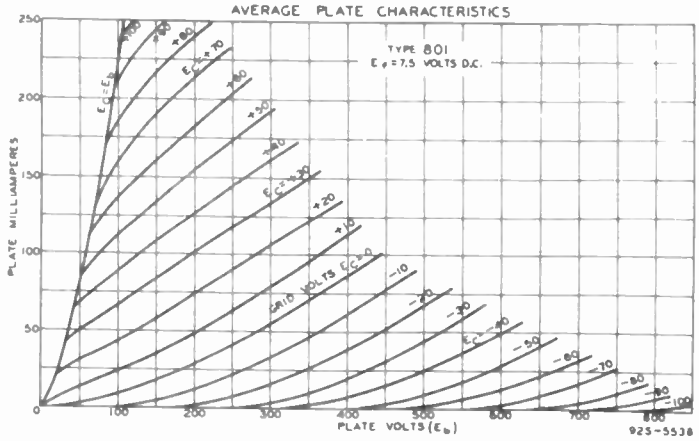
The *d-c grid current* will vary with individual tubes. Under any condition of operation the maximum value should not exceed 15 milliamperes.

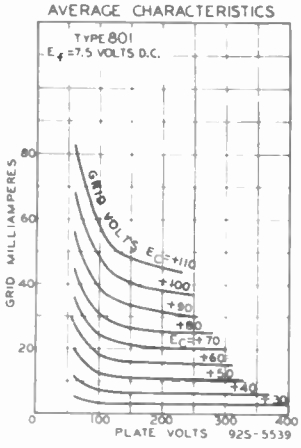
RCA-801 may be operated at maximum ratings in all classes of service at frequencies as high as 60 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced as the frequency is raised (other maximum ratings are the same as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS). The tabulation below shows the highest percentage of maximum plate voltage and power input that can be used at 60, 75 and 120 Mc for any class of service. Special attention should be given to adequate ventilation and the maintenance of normal ambient temperatures at these frequencies.

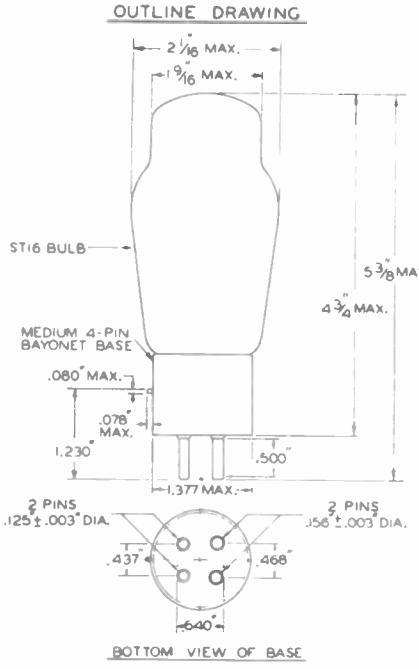
FREQUENCY	60	75	120	Megacycles
PERCENTAGE of MAX. RATED PLATE VOLTAGE and PLATE INPUT	100 *max.*	75 *max.*	50 *max.*	Per Cent

With the grid connected to the plate through the shortest possible connection, the resonant frequency of the grid-plate circuit is approximately 170 megacycles and the power output approximately zero.

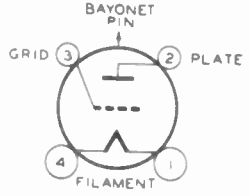
If more radio-frequency power output is required than can be obtained from a single 801, the push-pull or the parallel connection may be used. For example, two tubes connected in push-pull or in parallel will give approximately twice the power output of one tube. The parallel connection requires no increase in exciting voltage; the push-pull connection requires twice the r-f excitation voltage necessary to drive a single tube. With either connection the driving power required is approximately twice that for single tube operation while the grid bias is the same as for a single tube. The push-pull arrangement has the advantage of cancelling the even-order harmonics from the output and of simplifying the balancing of high-frequency circuits. When two or more RCA-801's are operated in parallel, a non-inductive resistance of 10 to 100 ohms should be placed in series with the grid lead of each tube, close to the socket terminal, to prevent parasitic oscillations.







Tube Symbol and Top View of Socket Connections



802

R-F Power Amplifier Pentode

RCA-802 is a pentode transmitting tube of the heater-cathode type for use as an r-f amplifier, frequency-multiplier, oscillator, and suppressor- or grid-modulated amplifier. The plate connection is brought out through a separate seal at the top of the bulb to maintain low grid-plate capacitance. Neutralization to prevent feed-back and self-oscillation is generally unnecessary in adequately shielded circuits. The suppressor and the special internal shield of the 802 are connected to individual base pins.

CHARACTERISTICS

HEATER VOLTAGE (A.C. or D.C.)	6.3	Volts
HEATER CURRENT	0.9	Ampere
MUTUAL CONDUCTANCE, For plate cur. of 20 ma.	2250 *approx.*	Micromhos
DIRECT INTERELECTRODE CAPACITANCES:		
Grid-Plate (With internal shielding)	0.15 *max.*	μμf
Screen-Plate	0.5 *max.*	μμf
Input	12	μμf
Output	8.5	μμf
BULB (For dimensions, see page 16)	ST-16	
CAP (For connection, see page 16)	Small Metal	
BASE (For socket connections, see page 16)	Medium 7-Pin Bayonet	

As R-F Power Amplifier - Class B Telephony

Carrier Conditions per tube; for use with a Modulation Factor up to 1.0

D-C PLATE VOLTAGE		500 *max.*	Volts
D-C SCREEN VOLTAGE (Grid No.2)		250 *max.*	Volts
D-C SUPPRESSOR VOLTAGE (Grid No.3)		40 *max.*	Volts
D-C PLATE CURRENT		30 *max.*	Milliamperes
PLATE INPUT		15 *max.*	Watts
PLATE DISSIPATION		10 *max.*	Watts
SCREEN DISSIPATION		4 *max.*	Watts
TYPICAL OPERATION:			
D-C Plate Voltage	400	500	Volts
D-C Screen Voltage	150	200	Volts
Suppressor	Connected to cathode at socket*		
D-C Grid Volt. (Grid No.1), Approx.	-22	-28	Volts
Peak R-F Grid Volt. (Approx.)**	35	32	Volts
Internal Shield	Connected to cathode at socket		
D-C Plate Current	25	25	Milliamperes
D-C Screen Current	6.5	7	Milliamperes
D-C Grid Current	1	0	Milliampere
Screen Resistor	38500	43000	Ohms
Driving Power (Approx.)**	0.5	0.18	Watt
Power Output (Approx.)	2.75	3.5	Watts

* Applying a positive voltage (40 volts max.) to the suppressor gives slightly increased output.

** At crest of a-f cycle.

As Suppressor-Modulated R-F Power Amplifier - Class C Telephony

Carrier Conditions per tube; for use with a Modulation Factor up to 1.0

D-C PLATE VOLTAGE			500 *max.*	Volts
D-C SCREEN VOLTAGE (Grid No.2)			200 *max.*	Volts
D-C PLATE CURRENT			30 *max.*	Milliamperes
D-C GRID CURRENT			7.5 *max.*	Milliamperes
PLATE INPUT			15 *max.*	Watts
PLATE DISSIPATION			10 *max.*	Watts
SCREEN DISSIPATION			6 *max.*	Watts
TYPICAL OPERATION:				
D-C Plate Voltage	400	500	500	Volts
D-C Screen Voltage	150	200	200	Volts
D-C Suppressor Voltage (Grid No.3), Approx.	-40	-53	-45	Volts
D-C Grid Volt. (Grid No.1), Approx.	-85	-90	-90	Volts
Peak R-F Grid Volt. (Approx.)	125	125	125	Volts
Peak A-F Suppressor Volt. (Approx.)	40	53	65	Volts
Internal Shield	Connected to cathode at socket			
D-C Plate Current	18	20	22	Milliamperes
D-C Screen Current	28	28	28	Milliamperes
D-C Grid Current (Approx.)	7.5	5	4.5	Milliamperes
Screen Resistor	9000	10700	10700	Ohms
Driving Power (Approx.)	0.9	0.6	0.5	Watt
Power Output (Approx.)	2	3	3.5	Watts

As Grid-Modulated R-F Power Amplifier - Class C Telephony

Carrier Conditions per tube; for use with a Modulation Factor up to 1.0.

D-C PLATE VOLTAGE			500 *max.*	Volts
D-C SCREEN VOLTAGE (Grid No.2)			250 *max.*	Volts
D-C SUPPRESSOR VOLTAGE (Grid No.3)			40 *max.*	Volts
D-C PLATE CURRENT			30 *max.*	Milliamperes
PLATE INPUT			15 *max.*	Watts
PLATE DISSIPATION			10 *max.*	Watts
SCREEN DISSIPATION			4 *max.*	Watts
TYPICAL OPERATION:				
D-C Plate Voltage	400	500		Volts
D-C Screen Voltage	150	200		Volts
Suppressor	Connected to cathode at socket*			
D-C Grid Volt. (Grid No.1), Approx.	-105	-130		Volts
Peak R-F Grid Volt. (Approx.)	125	145		Volts
Peak A-F Grid Volt. (Approx.)	40	50		Volts
Internal Shield	Connected to cathode at socket			
D-C Plate Current	25	25		Milliamperes
D-C Screen Current	7.5	8		Milliamperes
D-C Grid Current (Approx.)	2	1		Milliamperes
Screen Resistor	33400	37500		Ohms
Driving Power, (Approx.)**	1	0.8		Watt
Power Output (Approx.)	3	4		Watts

* Applying a positive voltage (40 volts max.) to the suppressor gives slightly increased output.

** At crest of a-f cycle.

As R-F Power Amplifier and Oscillator - Class C Telegraphy
Key-Down Conditions per tube without Modulation#

D-C PLATE VOLTAGE			500 *max.*	Volts
D-C SCREEN VOLTAGE (Grid No.2)			250 *max.*	Volts
D-C SUPPRESSOR VOLTAGE (Grid No.3)			40 *max.*	Volts
D-C PLATE CURRENT			60 *max.*	Milliamperes
D-C GRID CURRENT			7.5 *max.*	Milliamperes
PLATE INPUT			25 *max.*	Watts
PLATE DISSIPATION			10 *max.*	Watts
SCREEN DISSIPATION			6 *max.*	Watts
TYPICAL OPERATION:				
D-C Plate Voltage	400	500	500	Volts
D-C Screen Voltage	200	200	250	Volts
D-C Suppressor Voltage	0	0	40	Volts
D-C Grid Volt. (Grid No.1), Approx.	-100	-100	-100	Volts
Peak R-F Grid Volt. (Approx.)	155	155	135	Volts
Internal Shield	Connected to cathode at socket			
D-C Plate Current	45	45	45	Milliamperes
D-C Screen Current	25	22	12	Milliamperes
D-C Grid Current (Approx.)	7	6	2	Milliamperes
Screen Resistor	8000	13700	20000	Ohms
Driving Power (Approx.)	1.1	0.9	0.25	Watt
Power Output (Approx.)	10	14	16	Watts

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

INSTALLATION

The *base* pins of the RCA-802 fit the seven-contact (0.855-inch pin-circle diameter) socket which may be installed to hold the tube in any position. The plate lead of the tube is brought out at the top of the bulb to a metal cap. A flexible lead should be used to make connection to the plate cap so that a strain will not be placed on the glass at the base of the cap. Likewise, the cap should not be made to support coils, condensers, chokes, etc. Under no circumstances should anything be soldered to the cap, as the heat of soldering may crack the glass seal.

The *bulb* of this tube becomes very hot during continuous operation. For this reason it should not come in contact with any metallic body nor be subjected to drops or spray of any liquid. Free circulation of air should be provided.

The *heater* of the 802 is designed to operate at 6.3 volts. The heater supply may be either a.c. or d.c. A.c. is usually employed because of its convenience. The voltage across the tube heater terminals should be checked periodically. In radio transmitters during "standby" periods, the heater should be maintained at its rated voltage for convenience in promptly resuming transmission.

The *cathode* circuit of the RCA-802 should be connected to the electrical mid-point of the heater circuit when the heater is operated from an a-c supply. If cathode-bias is used, the cathode circuit

should be connected to the same point through the cathode-bias resistor. When the heater is operated from a d-c source, the cathode circuit is tied to the negative heater supply lead. In circuits where the cathode is not directly connected to the heater, the potential difference between them should not exceed 100 volts. If the use of a large resistor is necessary between heater and cathode in some circuit designs, it should be by-passed by a suitable filter network to avoid the possibility of hum.

The *plate dissipation of the 802 (the difference between plate input and power output) should never exceed the maximum value given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS.* At these maximum values, the plate shows no color.

A d-c milliammeter should always be used in the plate circuit to provide a ready check of the plate current. Under no condition should the d-c plate current exceed the maximum values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS.

The *screen voltage* may be obtained either from a separate source, from a potentiometer, or from the plate supply through a series resistor. In the latter case, the resistor should have a value sufficient to drop the high voltage to a value which is within the maximum screen voltage rating given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Suitable values of screen resistors are shown in these tabulations. The correct value of screen series resistor for any installation may be determined by dividing the difference between the plate-supply voltage and the rated screen voltage by the corresponding screen current. For example, under Class C Telegraphy, page 3, a series resistor value of 8000 ohms is shown for the 400-volt plate-voltage condition. For this condition, the d-c screen current is 0.025 ampere (25 milliamperes). Since the plate-voltage supply must be dropped 200 volts to obtain 200 volts for the screen, the value of the screen resistor is 200 ÷ 0.025, or 8000 ohms.

Suppressor voltage for the RCA-802 may be obtained from any suitable d-c supply. In cases where the suppressor draws current, the supply should be a battery or other d-c source of good regulation.

The *internal shield* is brought out of the tube to its own separate base pin. The internal shield should be tied to a terminal operating at zero r-f and/or a-f potential. In most cases, this connection will be made to the cathode or suppressor terminal.

Adequate *shielding* and isolation of the input circuit and the output circuit are necessary if optimum results are to be obtained. If an external shield is employed with the 802, it should be designed to enclose the base end of the tube and extend up to a point level with the bottom of the internal shield. Clearance between the glass bulb and external shield should be at least 1/16". The impedance between the screen and cathode must be kept as low as possible by the use of a by-pass condenser. The capacity value of this condenser should be about 0.1 μf.

In order that the maximum ratings given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS will not be exceeded, changes in electrode voltages due to line-voltage fluctuation, load variation, and manufacturing variation of the associated apparatus, must be determined. An average value of voltage for each electrode should then be chosen so that under the usual voltage variations the maximum rated voltages will not be exceeded.

When a new circuit is tried or when adjustments are made, the plate voltage should be reduced in order to prevent damage to the tube or associated apparatus in case the circuit adjustments are incorrect. It is advisable to use a protective resistance of about 3000 ohms in series with the common negative high-voltage lead during such adjustments.

The rated plate voltage of this tube is high enough to be dangerous to the user. Great care should be taken during the adjustment of circuits, especially those in which the exposed circuit parts are at the d-c plate potential.

APPLICATION

As a *Class B radio-frequency amplifier*, RCA-802 may be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid No.1 is the control-grid; grid No.2 is the screen; and grid No.3 is the suppressor, which is usually tied to the cathode. The internal shield is connected to cathode. In Class B r-f service, the plate is supplied with unmodulated d-c voltage and the grid is excited by r-f voltage modulated at audio frequency in one of the preceding stages. The plate dissipation for this class of operation should not exceed 10 watts. Grid bias for the 802 as a Class B r-f amplifier should be obtained from a battery or other d-c source of good regulation. It should not be obtained from a high-resistance supply such as a grid-leak, nor from a rectifier, unless the latter has exceptionally good voltage regulation.

As a *suppressor-modulated Class C r-f amplifier*, RCA-802 may be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid No.1 is the control grid; grid No.2 is the screen; and grid No.3 is the suppressor. The internal shield is connected to cathode at the socket. Suppressor bias may be obtained from a battery or from a bleeder tap on the high-voltage supply. Grid bias for this service may be obtained from a grid leak of 5000 to 50000 ohms (5-watt size), depending upon the amount of available grid excitation; from a battery; from a rectifier; or from a cathode-bias resistor (preferably variable) suitably by-passed for audio and radio frequencies. The cathode-bias method is advantageous due to the fact that the grid bias is automatically regulated in direct proportion to the sum of the plate and grid current and that there is little chance of the plate current becoming dangerously high, even if the r-f grid excitation is removed. The grid-leak bias method has the advantage of simplicity and of automatically biasing the grid in proportion to the excitation voltage available. Special care must be observed with the use of this

system because the accidental removal of the excitation will cause the grid bias to fall to zero and the plate current to rise to an excessive value. Since the grid-bias voltage for Class C service is not particularly critical, correct circuit adjustment may be obtained with widely different values.

As a *grid-modulated Class C r-f amplifier*, RCA-802 may be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid No.1 is the control grid; grid No.2 is the screen; and grid No.3 is the suppressor which is usually tied to the cathode. The internal shield is connected to cathode at the socket. In this class of service the plate is supplied with unmodulated d-c plate voltage and the grid bias is modulated at audio-frequency. Grid bias for this service should be obtained from a battery or other d-c source of good regulation. It should not be obtained from a high-resistance supply.

As a *Class C r-f amplifier or oscillator for telegraph service*, RCA-802 may be operated as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid bias for this service may be obtained in the same manner as for suppressor-modulated Class C r-f service. When the 802 is used as a Class C r-f power amplifier (telegraph service), plate voltage as high as 500 volts may be used provided the d-c plate current is reduced so that the maximum plate input rating of 25 watts is not exceeded. Likewise, the d-c plate current may be raised to 60 milliamperes, provided the plate voltage is reduced so that the maximum input rating is not exceeded.

The *d-c grid current* will vary with individual tubes. Under any condition of operation, the maximum recommended values shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS should not be exceeded.

The 802 may be used in all recommended classes of service at full ratings as high as 30000 kc. At higher frequencies the d-c plate voltage, and consequently the d-c plate input, should be reduced as the frequency is raised. Special attention should be given to adequate ventilation and the maintenance of normal ambient temperatures. The tabulation below shows the maximum plate voltage values to be used at frequencies between 30 and 60 mc. (10 to 5 meters).

FREQUENCY	30	45	60	Mc
MAX. PLATE VOLTAGE	500	350	275	Volts
MAX. PLATE INPUT:				
Class C telegraph service	25	18	14	Watts
All other services	15	10.5	8.25	Watts

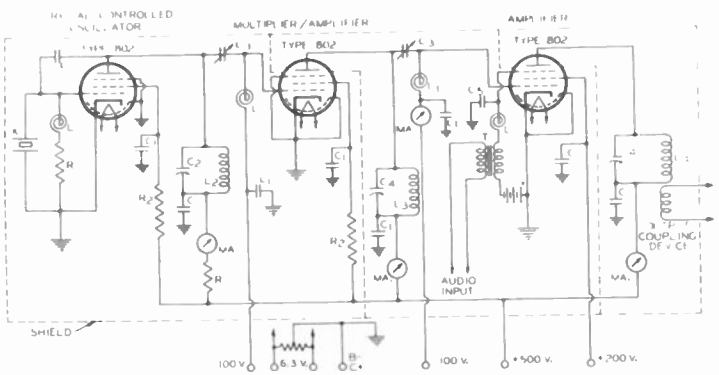
If more power output is required than can be obtained from a single 802, the push-pull or the parallel connection may be used. For example, two tubes connected in push-pull or in parallel will give approximately twice the power output of one tube. The parallel con-

nection requires no increase in exciting voltage; the push-pull connection requires twice the r-f excitation necessary to drive a single tube. With either connection the driving power required is approximately twice that for single-tube operation while the grid bias is the same as for a single tube. The push-pull arrangement has the advantage of cancelling the even-order harmonics from the output and of simplifying the balancing of high-frequency circuits. When two or more RCA-802's are operated in parallel, a non-inductive resistance of 10 to 100 ohms should be placed in series with the grid leak of each tube, close to the socket terminal, to prevent parasitic oscillations.

As a *pentode oscillator (crystal or self-excited)*, the 802 should be connected the same as in amplifier service with its suppressor and internal shield tied to the cathode. Because the internal shielding, in general, is unusually effective, it is usually necessary in this service, where feed-back depends on the control-grid-to-plate capacity, to introduce external feed-back. This may be done by the use of a small condenser not larger than 2 to 3 μμf connected between control grid and plate.

RCA-802 is not recommended for use as a Class A triode amplifier, Class B a-f triode amplifier, or Class C plate-modulated tetrode amplifier, because it is inadvisable to operate either grid No.2 or grid No.3 at the maximum rated plate voltage.

TRANSMITTING CIRCUIT DIAGRAM
SHOWING USES OF TYPE 802 R F POWER PENTODE

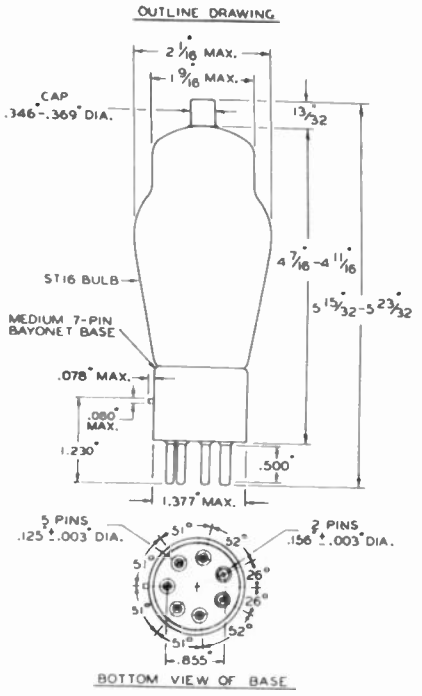


C = 3 μμf (APPROX.) FOR FEEDBACK
C1 = .01 μf
C2 = 100 μμf (MAX.)
C3 = 30 μμf (MAX.)
C4 = 50 μμf (MAX.)
C5 = .0001 μf
L, L1 = R F CHOKES

L2, L3, L4 VALUE DEPENDENT ON FREQUENCY
R 40000 OHMS, 2 WATTS
R1 4000 OHMS, 10 WATTS
R2 = 20000 OHMS, 10 WATTS
T MODULATION TRANSFORMER
X = CRYSTAL

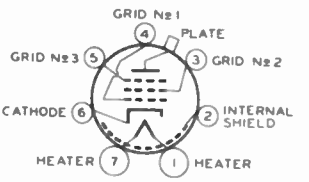
NOTE GROUND CONNECTIONS MADE TO SHIELD

92C 4385

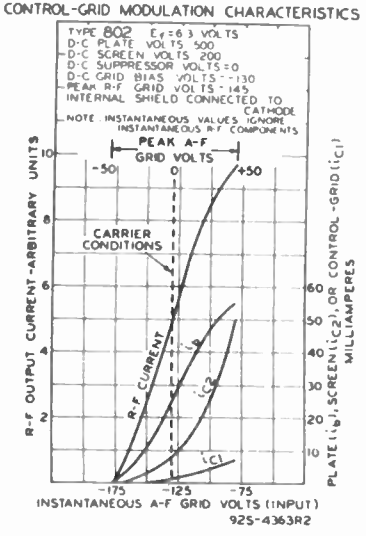


92C-4364

Tube Symbol and Top View of Socket Connections

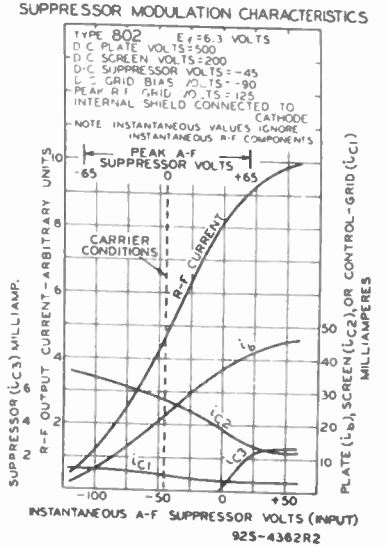


CONTROL-GRID MODULATION CHARACTERISTICS



92S-4363R2

SUPPRESSOR MODULATION CHARACTERISTICS



92S-4362R2

803

R-F Power Amplifier Pentode

RCA-803 is a pentode transmitting tube of the filament type for use as an r-f amplifier, frequency-multiplier, oscillator, and suppressor-, grid- or plate-modulated amplifier. The plate connection is brought out through a separate seal at the top of the bulb to insure high insulation and low interelectrode capacitances. In adequately-shielded circuits, neutralization to prevent feed-back and self-oscillation is generally unnecessary. The suppressor is connected to its individual base pin. The maximum rated plate dissipation of the 803 is 125 watts.

TENTATIVE CHARACTERISTICS

FILAMENT VOLTAGE (A.C. or D.C.)	10	Volts
FILAMENT CURRENT	5	Amperes
MUTUAL CONDUCTANCE, For plate cur. of 62.5 ma.	4000	Micromhos
DIRECT INTEPELECTRODE CAPACITANCES:		
Grid-Plate (With external shielding)	0.15 max.	µpf
Input	17.5	µpf
Output	29	µpf
BULB (For dimensions, see page 28)	T-20	
CAP (For connection, see page 28)	Medium Metal	
BASE (For socket connections, see page 28)	Giant 5-Pin Ceramic, Bayonet	

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

As R-F Power Amplifier - Class B Telephony

Carrier Conditions per tube; for use with a Modulation Factor up to 1.0

D-C PLATE VOLTAGE			2000 max.	Volts
D-C SUPPRESSOR VOLTAGE (Grid No.3)			60 max.	Volts
D-C SCREEN VOLTAGE (Grid No.2)			600 max.	Volts
D-C GRID VOLTAGE (Grid No.1)			-500 max.	Volts
D-C PLATE CURRENT			90 max.	Milliamperes
PLATE INPUT			180 max.	Watts
PLATE DISSIPATION			125 max.	Watts
SCREEN DISSIPATION			20 max.	Watts
TYPICAL OPERATION:				
Filament Voltage (A.C.)	10	10	10	Volts
D-C Plate Voltage	1250	1500	2000	Volts
D-C Suppressor Voltage	40	40	40	Volts
D-C Screen Voltage	600	600	600	Volts
D-C Grid Voltage (Approx.)	-40	-40	-40	Volts
Peak R-F Grid Voltage (Approx.)	60	55	55	Volts
D-C Plate Current	80	80	80	Milliamperes
D-C Screen Current	20	20	20	Milliamperes
D-C Grid Current	3	3	3	Milliamperes

Driving Power (Approx.)*	1.5	1.5	1.5	Watts
Power Output (Approx.)	33	40	53	Watts

As Suppressor-Modulated R-F Power Amplifier - Class C Telephony
Carrier Conditions per tube; for use with a Modulation Factor up to 1.0

D-C PLATE VOLTAGE			2000 *max.*	Volts
D-C SCREEN VOLTAGE (Grid No.2)			600 *max.*	Volts
D-C GRID VOLTAGE (Grid No.1)			-500 *max.*	Volts
D-C PLATE CURRENT			90 *max.*	Milliamperes
D-C GRID CURRENT			50 *max.*	Milliamperes
PLATE INPUT			180 *max.*	Watts
PLATE DISSIPATION			125 *max.*	Watts
SCREEN DISSIPATION			30 *max.*	Watts
TYPICAL OPERATION:				
Filament Voltage (A.C.)	10	10	10	Volts
D-C Plate Voltage	1250	1500	2000	Volts
D-C Grid Voltage (Approx.)	-100	-100	-100	Volts
D-C Suppressor Voltage (Grid No.3) Approx.	-80	-90	-110	Volts
Peak R-F Grid Volt. (Approx.)	170	170	170	Volts
Peak A-F Suppressor Voltage (Approx.)	120	130	150	Volts
D-C Plate Current	80	80	80	Milliamperes
D-C Screen Current	55	53	48	Milliamperes
D-C Grid Current	15	15	15	Milliamperes
Grid Resistor	7000	7000	7000	Ohms
Screen Resistor (Approx.)**	16000	22000	35000	Ohms
Driving Power (Approx.)	2.3	2.3	2.3	Watts
Power Output (Approx.)	33	40	53	Watts

As Grid-Modulated R-F Power Amplifier - Class C Telephony
Carrier Conditions per tube; for use with a Modulation Factor up to 1.0

D-C PLATE VOLTAGE			2000 *max.*	Volts
D-C SUPPRESSOR VOLTAGE (Grid No.3)			60 *max.*	Volts
D-C SCREEN VOLTAGE (Grid No.2)			600 *max.*	Volts
D-C GRID VOLTAGE (Grid No.1)			-500 *max.*	Volts
D-C PLATE CURRENT			90 *max.*	Milliamperes
PLATE INPUT			180 *max.*	Watts
PLATE DISSIPATION			125 *max.*	Watts
SCREEN DISSIPATION			20 *max.*	Watts
TYPICAL OPERATION:				
Filament Voltage (A.C.)	10	10	10	Volts
D-C Plate Voltage	1250	1500	2000	Volts
D-C Suppressor Voltage	40	40	40	Volts
D-C Screen Voltage	600	600	600	Volts
D-C Grid Voltage (Approx.)	-80	-80	-80	Volts
Peak R-F Grid Volt. (Approx.)	100	100	100	Volts
Peak A-F Grid Volt. (Approx.)	50	50	50	Volts
D-C Plate Current	80	80	80	Milliamperes

* At crest of audio-frequency cycle.
** Screen voltage taken from plate-voltage supply through resistor.

D-C Screen Current	20	20	20	Milliamperes
D-C Grid Current (Approx.)	4	4	4	Milliamperes
Driving Power (Approx.)*	2	2	2	Watts
Power Output (Approx.)	33	40	53	Watts

As Plate-Modulated R-F Power Amplifier - Class C Telephony
(Pentode Connection)
Carrier Conditions per tube; for use with a Modulation Factor up to 1.0

D-C PLATE VOLTAGE		1600 *max.*	Volts
D-C SUPPRESSOR VOLTAGE (Grid No.3)		500 *max.*	Volts
D-C SCREEN VOLTAGE (Grid No.2)		500 *max.*	Volts
D-C GRID VOLTAGE (Grid No.1)		-500 *max.*	Volts
D-C PLATE CURRENT		160 *max.*	Milliamperes
D-C GRID CURRENT		50 *max.*	Milliamperes
PLATE INPUT		250 *max.*	Watts
PLATE DISSIPATION		85 *max.*	Watts
SCREEN DISSIPATION		20 *max.*	Watts
SUPPRESSOR DISSIPATION		20 *max.*	Watts
TYPICAL OPERATION:			
Filament Voltage (A.C.)	10	10	Volts
D-C Plate Voltage	1250	1600	Volts
D-C Screen Voltage°°	400	500	Volts
D-C Suppressor Voltage	100	100	Volts
D-C Grid Voltage (Approx.)	-80	-80	Volts
Peak R-F Grid Voltage (Approx.)	180	180	Volts
D-C Plate Current	150	150	Milliamperes
D-C Screen Current	55	55	Milliamperes
D-C Grid Current (Approx.)	20	20	Milliamperes
Screen Resistor (Approx.)°°	16000	20000	Ohms
Driving Power (Approx.)	4	4	Watts
Power Output (Approx.)	125	155	Watts

As Plate-Modulated R-F Power Amplifier - Class C Telephony
(Tetrode Connection - Grids No.2 and 3 tied together)
Carrier Conditions per tube; for use with a Modulation Factor up to 1.0

D-C PLATE VOLTAGE		1600 *max.*	Volts
D-C SCREEN VOLTAGE (Grids No.2 & 3)		500 *max.*	Volts
D-C GRID VOLTAGE (Grid No.1)		-500 *max.*	Volts
D-C PLATE CURRENT		160 *max.*	Milliamperes
D-C GRID CURRENT		50 *max.*	Milliamperes
PLATE INPUT		250 *max.*	Watts
PLATE DISSIPATION		85 *max.*	Watts
SCREEN DISSIPATION (Grids No.2 & 3)		30 *max.*	Watts
TYPICAL OPERATION:			
Filament Voltage (A.C.)	10	10	Volts
D-C Plate Voltage	1250	1600	Volts
D-C Screen Voltage	130	130	Volts
D-C Grid Voltage (Approx.)	-180	-180	Volts
Peak R-F Grid Voltage (Approx.)	305	320	Volts

* At crest of audio-frequency cycle.

°° Screen voltage taken from modulated plate-voltage supply through resistor.

D-C Plate Current	150	150		Milliamperes
D-C Screen Current	75	75		Milliamperes
D-C Grid Current (Approx.)	45	45		Milliamperes
Screen Resistor (Approx.)**	15000	20000		Ohms
Grid Resistor	4000	4000		Ohms
Driving Power (Approx.)	15	15		Watts
Power Output (Approx.)	125	155		Watts

As R-F Power Amplifier and Oscillator - Class C Telegraphy
Key-down Conditions per tube without Modulation##

D-C PLATE VOLTAGE			2000 *max.*	Volts
D-C SUPPRESSOR VOLTAGE (Grid No.3)			60 *max.*	Volts
D-C SCREEN VOLTAGE (Grid No.2)			600 *max.*	Volts
D-C GRID VOLTAGE (Grid No.1)			-500 *max.*	Volts
D-C PLATE CURRENT			175 *max.*	Milliamperes
D-C GRID CURRENT			50 *max.*	Milliamperes
PLATE INPUT			350 *max.*	Watts
PLATE DISSIPATION			125 *max.*	Watts
SCREEN DISSIPATION			30 *max.*	Watts
TYPICAL OPERATION:				
Filament Voltage (A.C.)	10	10	10	Volts
D-C Plate Voltage	1250	1500	2000	Volts
D-C Suppressor Volt.(Approx.)	40	40	40	Volts
D-C Screen Voltage	500	500	500	Volts
D-C Grid Voltage (Approx.)	-30	-30	-30	Volts
Peak R-F Grid Volt. (Approx.)	100	100	100	Volts
D-C Plate Current	160	160	160	Milliamperes
D-C Screen Current	45	45	45	Milliamperes
D-C Grid Current	12	12	12	Milliamperes
Screen Resistor	17000	22000	33000	Ohms
Driving Power (Approx.)	1	1	1	Watt
Power Output (Approx.)	130	160	210	Watts

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

** Screen voltage taken from unmodulated plate-voltage supply through resistor.

INSTALLATION

The *base* pins of the RCA-803 fit a special 5-pin transmitting socket which should be installed to hold the tube in a vertical position with the base down. If the tube is subjected to vibration or shock, a shock-absorbing suspension must be employed. Because of the relatively heavy filament current taken by this tube, the socket should make firm, large-surface contact with the filament-base pins. Heavy, well-soldered leads should be used for the filament-circuit wiring.

The *bulb* of this tube becomes very hot during continuous operation. Free circulation of air, therefore, should be provided. Care should be taken that the bulb does not come in contact with any metallic object nor be subjected to the spray of any liquid. The in-

stallation of all wires and connections should be made so that they will not be close to or touch the bulb in order to avoid puncture of the glass.

The *filament* of the 803 is of the thoriated-tungsten type. It may be operated from either an a-c or a d-c source. Except where a d-c source is necessary to avoid hum, an a-c filament supply is generally used because of its convenience. A suitable voltmeter should be connected permanently across the tube filament terminals to provide a ready check of the filament voltage. This voltage should not vary more than plus or minus 5% from the rated value; otherwise, a loss of filament emission may result. When an a-c source is used, rheostat control should be placed in the primary circuit of the filament transformer. When the apparatus in which the tube is used is idle for periods not exceeding two hours, the filament should be maintained at its rated voltage during the "standbys".

The *grid return and the plate return* should be connected to the center tap on the filament winding of the transformer, or to the midpoint of a center-tapped resistor across the filament terminals. When cathode-bias is used, the returns are connected to the same points through the cathode-bias resistor. In cases where d.c. is used on the filament, these returns should be connected to the negative filament terminal.

The plate dissipation of the 803 (the difference between plate input and power output) should never exceed the maximum values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. The maximum values are indicated by a barely perceptible red color on the plate. To determine this, all power switches should be opened with the tube operating in the dark. This procedure avoids reflections from the lighted filament which would otherwise interfere with the observation.

A d-c milliammeter should always be used in the plate circuit to provide a ready check of the plate current. Under no condition should the d-c plate current exceed the maximum values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS.

The *screen voltage* may be obtained either from a separate source, from a potentiometer, or from the plate supply through a series resistor, depending on the service in which the tube is used (see APPLICATION). When the screen-resistor method is used, the resistor should have a value sufficient to drop the high voltage to a value which is within the maximum screen-voltage rating given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Suitable values of screen resistors are shown in these tabulations. In those classes of service where screen-voltage regulation is not an important factor, the series-resistance method for obtaining screen voltage is desirable since it serves to maintain the proper screen current. With this method, however, it is important that the high-voltage supply switch be opened before the filament circuit is opened; otherwise, full

supply voltage will be placed on the screen. If the screen voltage is obtained from a separate source, or from a potentiometer, plate voltage should be applied before the screen voltage, or simultaneously with it; otherwise, with voltage on the screen only, the screen current may be large enough to cause excessive screen dissipation. A d-c milliammeter should be used in the screen circuit so that the screen current can always be known. The screen should never be allowed to attain a temperature corresponding to more than a barely perceptible red color. This temperature corresponds to the screen dissipation values shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS.

Suppressor voltage for the RCA-803 may be obtained from any fixed d-c supply. In cases where the suppressor draws current, the supply should be a battery or other d-c source of good regulation.

The negative high-voltage supply lead of the RCA-803 should be provided with a protective device, such as a fuse, to prevent the tube from drawing excessive plate and screen current. This device should open the high-voltage supply when the d-c plate current and d-c screen current reach a value 50% greater than normal.

Adequate *shielding* and isolation of the input circuit and the output circuit are necessary if optimum results are to be obtained. If an external shield is employed with the 803, it should be designed to enclose the base end of the tube and extend up to a position level with the circular shield disc located at the bottom of the plate. Clearance between the glass bulb and external shield should be at least 1/16". The impedance between the screen and filament must be kept as low as possible by the use of a by-pass condenser. When screen voltage is obtained from a series resistance, the screen by-pass condenser should have a voltage breakdown rating high enough to withstand the full plate voltage of the tube. The capacity value of the condenser should be about 0.01 μf. Values larger than this may cause excessive a-f by-passing; smaller values may cause excessive r-f feedback from plate to control grid, depending on circuit layout, frequency, and gain.

Heavy leads and conductors together with suitable insulation should be used in all parts of the r-f plate tank circuit so that the losses, due to r-f voltages and currents, may be kept at a minimum. Since proper circuit design becomes very important at the higher frequencies, it is essential that short, heavy leads and circuit returns are used in order to minimize lead inductance and losses.

In order that the maximum ratings given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS are not exceeded, changes in electrode voltages due to line-voltage fluctuation, load variation, and manufacturing variation of the associated apparatus must be determined. An average value of voltage for each electrode should then be chosen so that under the usual voltage variations the maximum rated voltages will not be exceeded.

When a new circuit is tried or when adjustments are made, the plate voltage should be reduced in order to prevent damage to the tube or associated apparatus in case the circuit adjustments are incorrect. It is advisable to use a protective resistance of about 3000 ohms in series with the negative high-voltage supply lead during such adjustments. Suitable meters should be provided for measuring tube voltages and currents. In addition to their use in indicating suitable operating conditions, they are also of some value in making initial transmitter adjustments. However, to assist in the making of final adjustments for optimum performance, it is recommended that a cathode-ray oscillograph be used. Under no conditions should the maximum values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS be exceeded.

The rated plate voltage of this tube is high enough to be dangerous to the user. Great care should be taken during the adjustment of circuits, especially those in which the exposed circuit parts are at the high d-c plate potential.

APPLICATION

As a *Class B radio-frequency amplifier*, RCA-803 may be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid No.1 is the control-grid; grid No.2 is the screen; and grid No.3 is the suppressor. In Class B r-f service, the plate is supplied with unmodulated d-c voltage and the grid is excited by r-f voltage modulated at audio-frequency in one of the preceding stages. In this service the plate dissipation is greatest when the carrier is unmodulated. It is important, therefore, that the plate dissipation for this class of operation should not exceed 125 watts for unmodulated conditions. In this service the screen voltage should be obtained from a separate source or from a potentiometer connected across the plate supply. The suppressor voltage should be obtained by the method discussed under INSTALLATION. Grid bias for the 803 as a Class B r-f amplifier should be obtained from a battery or other d-c source of good regulation. It should not be obtained from a high-resistance supply such as a grid-leak, nor from a rectifier, unless the latter has exceptionally good voltage regulation.

As a *suppressor-modulated Class C r-f amplifier*, RCA-803 may be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid No.1 is the control grid; grid No.2 is the screen; and grid No.3 is the suppressor. In this class of service the plate is supplied with unmodulated d-c plate voltage and the d-c suppressor voltage is modulated at audio frequency. The screen voltage should be obtained through a resistor in series with the plate supply (see INSTALLATION). The d-c suppressor voltage may be obtained from any fixed supply. Grid bias for this service may be obtained from a grid leak of 7000 ohms (25-watt size); from a battery; from a rectifier; or from a cathode-bias resistor (preferably variable) suitably by-passed for audio and radio frequencies. The cathode-bias method is advantageous due to the fact that the grid bias is automatically regulated in

direct proportion to the sum of the plate and grid current and that there is little chance of the plate current becoming dangerously high, even if the r-f grid excitation is removed. The grid-leak bias method has the advantage of simplicity and of automatically biasing the grid in proportion to the excitation voltage available. Special care must be observed with the use of this system because the accidental removal of the excitation will cause the grid bias to fall to zero so that the plate current, and consequently the plate dissipation, will rise to excessive values. The use of a protective device designed to remove the screen and plate voltages on excessive rises of plate current will minimize the danger of overload (see INSTALLATION). Since the grid-bias voltage for Class C service is not particularly critical, correct circuit adjustment may be obtained with widely different values.

As a *grid-modulated Class C r-f amplifier*, RCA-803 may be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid No.1 is the control grid; grid No.2 is the screen; and grid No.3 is the suppressor. In this class of service the plate is supplied with unmodulated d-c plate voltage and the grid bias is modulated at audio frequency. The screen voltage should be obtained from a separate source or from a potentiometer connected across the plate supply. The suppressor voltage may be obtained from any fixed supply. Grid bias for this service should be obtained from a battery or other d-c source of good regulation. It should not be obtained from a high-resistance supply.

As a *plate-modulated Class C r-f amplifier (pentode connection)*, RCA-803 is capable of being modulated 100%. Operating conditions are shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid No.1 is the control grid; grid No.2 is the screen; and grid No.3 is the suppressor. The screen voltage may be obtained from a fixed supply, or through a voltage-dropping resistor in series with the plate supply. The screen voltage should be modulated with the plate voltage so that the percentage changes in both voltages are approximately equal. When a fixed screen-voltage supply is used, modulation of the screen voltage can be accomplished either by connecting the screen to a separate winding on the modulation transformer, or by connecting it to a tap on the modulation transformer or choke, through a blocking condenser. With the latter method, an a-f choke of suitable impedance should be connected in series with the screen-supply lead. When the series-resistor method is used, the screen should be connected through the series screen resistor to the *modulated* plate supply. Typical values of series screen resistors are given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. The suppressor voltage for this service may be obtained from any fixed supply. Grid bias should be obtained in the same manner as for suppressor-modulated Class C r-f service.

As a *plate-modulated Class C r-f amplifier (tetrode connection)*, RCA-803 is capable of being modulated 100%. Operating conditions for this service are shown under MAXIMUM RATINGS and TYPICAL OPERATING

CONDITIONS. Grid No.1 is the control grid; grids No.2 and No.3 are connected together as the screen. The screen voltage should be obtained through a voltage-dropping resistor in series with the *unmodulated* portion of the plate-voltage supply. In this case, the series resistor develops its own modulating voltage. Typical values of screen resistors are given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. The screen voltage may also be obtained from a separate source, or from a potentiometer across the plate-voltage supply, provided the screen voltage is modulated as discussed under plate-modulated Class C r-f amplifier service (pentode connection) for a fixed screen supply. The suppressor voltage for this service may be obtained from any fixed supply. Grid bias should be obtained in the same manner as for suppressor-modulated Class C r-f service.

As a *Class C r-f amplifier or oscillator for telegraph service*, RCA-803 may be operated as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid No.1 is the control grid; grid No.2 is the screen; and grid No.3 is the suppressor. The screen and suppressor voltages may be obtained by any of the methods shown under INSTALLATION. Grid voltage considerations are the same as those for suppressor-modulated Class C r-f amplifier service.

The *d-c grid current* will vary with individual tubes. Under any condition of operation, the maximum recommended values shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS should not be exceeded.

RCA-803 may be operated at maximum ratings in all classes of service at frequencies as high as 20 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced as the frequency is raised (other maximum ratings are the same as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS). The tabulation below shows the highest percentage of maximum plate voltage and power input that can be used at 20, 35 and 70 Mc for any class of service.

FREQUENCY	20	35	70	Megacycles
PERCENTAGE OF MAX. RATED PLATE VOLTAGE AND PLATE INPUT	100 *max.*	75 *max.*	50 *max.*	Per Cent

Special attention should be given to shielding and to r-f bypassing at these frequencies. When shielding is used, care should be taken to insure adequate tube ventilation and the maintenance of normal ambient temperature.

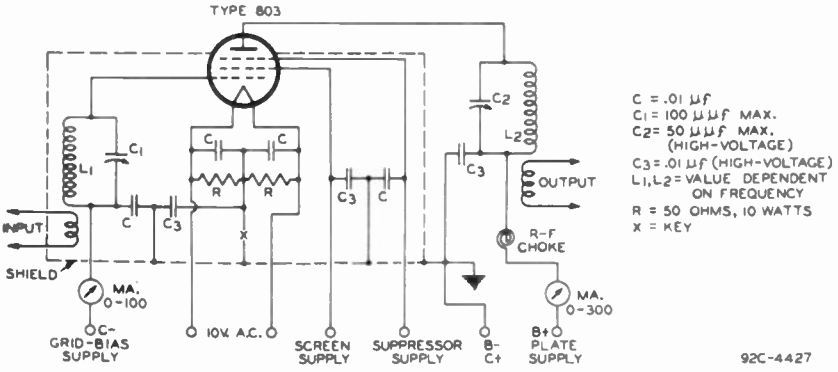
With the grid connected to the plate through the shortest possible connection, the resonant frequency of the grid-plate circuit is approximately 115 megacycles and the power output approximately zero.

If more radio-frequency power output is required than can be obtained from a single 803, the push-pull or the parallel connection

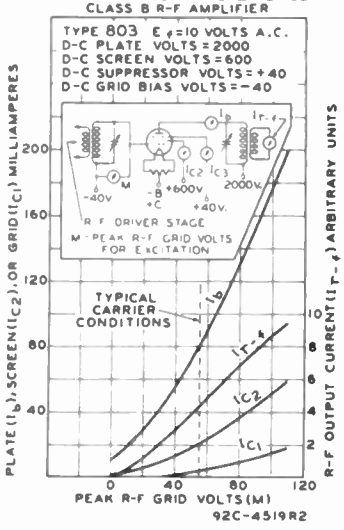
may be used. For example, two tubes connected in push-pull or in parallel will give approximately twice the power output of one tube. The parallel connection requires no increase in exciting voltage; the push-pull connection requires twice the r-f excitation necessary to drive a single tube. With either connection the driving power required is approximately twice that for single-tube operation while the grid bias is the same as for a single tube. The push-pull arrangement has the advantage of cancelling the even-order harmonics from the output and of simplifying the balancing of high-frequency circuits. When two or more RCA-803's are operated in parallel, a non-inductive resistance of 10 to 100 ohms should be placed in series with the grid lead of each tube, close to the socket terminal, to prevent parasitic oscillations.

As a *pentode oscillator*, the 803 should be connected the same as in amplifier service. Because the internal shielding, in general, is unusually effective, it is generally necessary in this service where feedback depends on the control-grid-to-plate capacity, to introduce external feedback. This may be done by the use of a small condenser connected between control grid and plate.

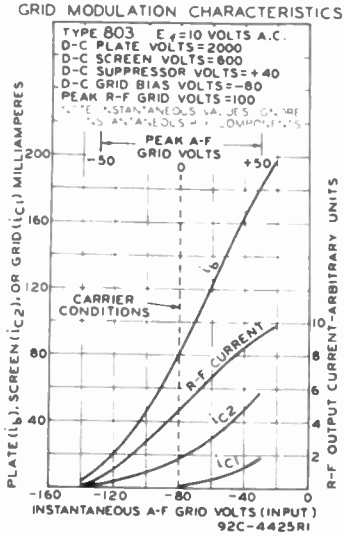
R-F POWER AMPLIFIER OR FREQUENCY MULTIPLIER



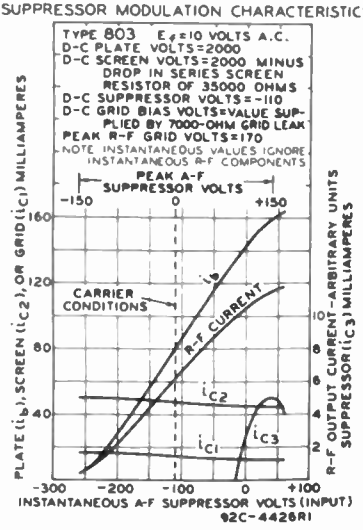
OPERATION CHARACTERISTICS
CLASS B R-F AMPLIFIER



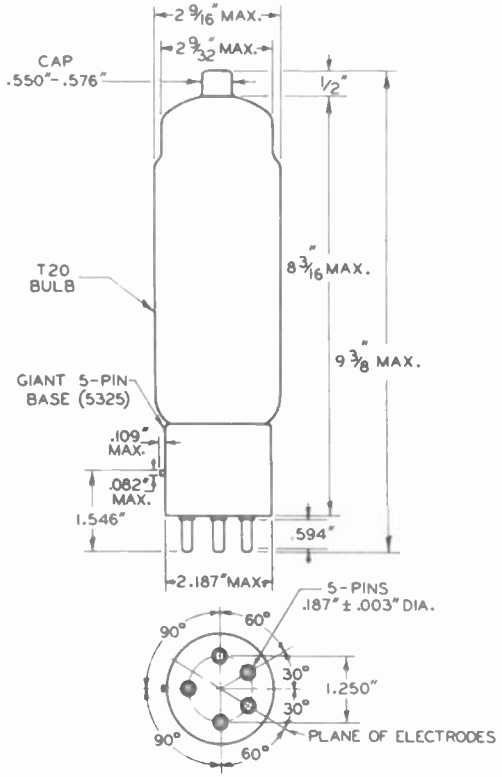
GRID MODULATION CHARACTERISTICS



SUPPRESSOR MODULATION CHARACTERISTICS



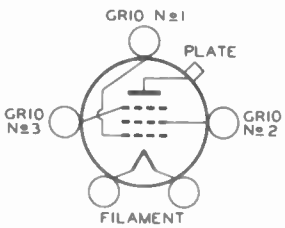
OUTLINE DRAWING



BOTTOM VIEW OF BASE

92C-4424RI

Tube Symbol and Top View of Socket Connections



804

R-F Power Amplifier Pentode

RCA-804 is a pentode transmitting tube of the filament type for use as an r-f amplifier, frequency-multiplier, oscillator, and suppressor-, grid- or plate-modulated amplifier. The plate connection is brought out through a separate seal at the top of the bulb to insure high insulation and low interelectrode capacitances. In adequately-shielded circuits, neutralization to prevent feed-back and self-oscillation is generally unnecessary. The suppressor is connected to its individual base pin. The maximum rated plate dissipation of the 804 is 40 watts.

TENTATIVE CHARACTERISTICS

FILAMENT VOLTAGE (A.C. or D.C.)	7.5	Volts
FILAMENT CURRENT	3.0	Amperes
MUTUAL CONDUCTANCE, For plate cur. of 32 ma.	3250	Micromhos
DIRECT INTERELECTRODE CAPACITANCES:		
Grid-Plate (With external shielding)	0.01 *max.*	μμf
Input	16	μμf
Output	14.5	μμf
BULB (For dimensions, see page 40)	T-16	
CAP (For connection, see page 40)	Small Metal	
BASE (For socket connections, see page 40)	Medium 5-Pin Ceramic	

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

As R-F Power Amplifier - Class B Telephony

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

D-C PLATE VOLTAGE			1250 *max.*	Volts
D-C SUPPRESSOR VOLTAGE (Grid No.3)			60 *max.*	Volts
D-C SCREEN VOLTAGE (Grid No.2)			300 *max.*	Volts
D-C PLATE CURRENT			50 *max.*	Milliamperes
PLATE INPUT			60 *max.*	Watts
PLATE DISSIPATION			40 *max.*	Watts
SCREEN DISSIPATION			10 *max.*	Watts
TYPICAL OPERATION:				
Filament Voltage (A.C.)	7.5	7.5	7.5	Volts
D-C Plate Voltage	1000	1000	1250	Volts
D-C Suppressor Voltage	0	45	45	Volts
D-C Screen Voltage	300	300	300	Volts
D-C Grid Voltage [o]	-20	-20	-20	Volts
Peak R-F Grid Voltage	30	30	27	Volts

[o] Grid voltages are given with respect to the mid-point of filament operated on a.c. If d.c. is used, each stated value of grid voltage should be decreased by 3.75 volts and be referred to the negative end of the filament.

D-C Plate Current	45	45	45	Milliamperes
D-C Screen Current	12	11.5	11	Milliamperes
D-C Grid Current (Approx.)	1	1	1	Milliampere
Driving Power (Approx.) *	0.35	0.3	0.25	Watt
Power Output (Approx.)	11	12	16	Watts

As Suppressor-Modulated R-F Power Amplifier - Class C Telephony

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

D-C PLATE VOLTAGE			1250 *max.*	Volts
D-C SCREEN VOLTAGE (Grid No.2)			300 *max.*	Volts
D-C GRID VOLTAGE (Grid No.1)			-300 *max.*	Volts
D-C PLATE CURRENT			50 *max.*	Milliamperes
D-C GRID CURRENT			15 *max.*	Milliamperes
PLATE INPUT			60 *max.*	Watts
PLATE DISSIPATION			40 *max.*	Watts
SCREEN DISSIPATION			15 *max.*	Watts
TYPICAL OPERATION:				
Filament Voltage (A.C.)		7.5	7.5	Volts
D-C Plate Voltage		1000	1250	Volts
D-C Grid Voltage		-100	-100	Volts
D-C Suppressor Voltage (Grid No.3)		-35	-50	Volts
Peak R-F Grid Voltage		140	140	Volts
Peak A-F Suppressor Voltage		60	70	Volts
D-C Plate Current		45	48	Milliamperes
D-C Screen Current		33.5	35.5	Milliamperes
D-C Grid Current (Approx.)		5.5	7	Milliamperes
Grid Resistor		18000	15000	Ohms
Screen Resistor **		21000	27000	Ohms
Driving Power (Approx.)		0.7	0.85	Watt
Power Output (Approx.)		16	21	Watts

As Grid-Modulated R-F Power Amplifier - Class C Telephony

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

D-C PLATE VOLTAGE				1250 *max.*	Volts
D-C SUPPRESSOR VOLTAGE (Grid No.3)				60 *max.*	Volts
D-C SCREEN VOLTAGE (Grid No.2)				300 *max.*	Volts
D-C GRID VOLTAGE (Grid No.1)				-250 *max.*	Volts
D-C PLATE CURRENT				50 *max.*	Milliamperes
PLATE INPUT				60 *max.*	Watts
PLATE DISSIPATION				40 *max.*	Watts
SCREEN DISSIPATION				10 *max.*	Watts
TYPICAL OPERATION:					
Filament Voltage (A.C.)	7.5	7.5	7.5		Volts
D-C Plate Voltage	1000	1000	1250		Volts
D-C Suppressor Voltage	0	45	45		Volts
D-C Screen Voltage	300	300	300		Volts
D-C Grid Voltage	-115	-115	-115		Volts
Peak R-F Grid Voltage	140	135	135		Volts
Peak A-F Grid Voltage	35	35	35		Volts
D-C Plate Current	45	45	45		Milliamperes

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

** Screen voltage taken from unmodulated plate-voltage supply through resistor.

D-C Screen Current	15	11	11	Milliamperes
D-C Grid Current (Approx.)	2	2	2	Milliamperes
Driving Power (Approx.)*	1.1	0.85	0.85	Watt
Power Output (Approx.)	14	16	21	Watts

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

(Pentode Connection)

Carrier conditions per tube for use with a max. modulation factor of 1.)

D-C PLATE VOLTAGE	1000 *max.*	Volts
D-C SUPPRESSOR VOLTAGE (Grid No.3)	100 *max.*	Volts
D-C SCREEN VOLTAGE (Grid No.2)	300 *max.*	Volts
D-C GRID VOLTAGE (Grid No.1)	-300 *max.*	Volts
D-C PLATE CURRENT	80 *max.*	Milliamperes
D-C GRID CURRENT	15 *max.*	Milliamperes
PLATE INPUT	80 *max.*	Watts
PLATE DISSIPATION	27 *max.*	Watts
SCREEN DISSIPATION	10 *max.*	Watts
SUPPRESSOR INPUT	5 *max.*	Watts
TYPICAL OPERATION:		
Filament Voltage (A.C.)	7.5	Volts
D-C Plate Voltage	1000	Volts
D-C Suppressor Voltage	50	Volts
Peak R-F Grid Voltage	130	Volts
D-C Plate Current	75	Milliamperes
D-C Screen Current	20	Milliamperes
D-C Grid Current (Approx.)	6	Milliamperes
Grid Resistor	15000	Ohms
Screen Resistor #	37000	Ohms
Driving Power (Approx.)	0.65	Watt
Power Output (Approx.)	50	Watts

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

(Tetrode Connection - Grids No.2 and 3 tied together)

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

D-C PLATE VOLTAGE	1000 *max.*	Volts
D-C SCREEN VOLTAGE (Grids No.2 & 3)	200 *max.*	Volts
D-C GRID VOLTAGE (Grid No.1)	-300 *max.*	Volts
D-C PLATE CURRENT	80 *max.*	Milliamperes
D-C GRID CURRENT	15 *max.*	Milliamperes
PLATE INPUT	80 *max.*	Watts
PLATE DISSIPATION	27 *max.*	Watts
SCREEN INPUT (Grids No.2 & 3)	15 *max.*	Watts
TYPICAL OPERATION:		
Filament Voltage (A.C.)	7.5	Volts
D-C Plate Voltage	1000	Volts
Peak R-F Grid Voltage	145	Volts
D-C Plate Current	75	Milliamperes
D-C Screen Current	28	Milliamperes
D-C Grid Current (Approx.)	8	Milliamperes
Screen Resistor ##	30000	Ohms

* At crest of audio-frequency cycle.

\# Connected to modulated plate-voltage supply.

\## Connected to unmodulated plate-voltage supply.

Grid Resistor	10000	Ohms
Driving Power (Approx.)	1.1	Watts
Power Output (Approx.)	50	Watts

As R-F Power Amplifier and Oscillator - Class C Telegraphy
(Pentode Connection)
Key-down conditions per tube without modulation [oo]

D-C PLATE VOLTAGE			1250 *max.*	Volts
D-C SUPPRESSOR VOLTAGE (Grid No.3)			60 *max.*	Volts
D-C SCREEN VOLTAGE (Grid No.2)			300 *max.*	Volts
D-C GRID VOLTAGE (Grid No.1)			-300 *max.*	Volts
D-C PLATE CURRENT			95 *max.*	Milliamperes
D-C GRID CURRENT			15 *max.*	Milliamperes
PLATE INPUT			120 *max.*	Watts
PLATE DISSIPATION			40 *max.*	Watts
SCREEN DISSIPATION			15 *max.*	Watts
TYPICAL OPERATION:				
Filament Voltage (A.C.)	7.5	7.5	7.5	Volts
D-C Plate Voltage	1000	1250	1250	Volts
D-C Suppressor Voltage	45	0	45	Volts
D-C Screen Voltage	300	300	300	Volts
D-C Grid Voltage	-100	-100	-100	Volts
Peak R-F Grid Voltage	150	145	150	Volts
D-C Plate Current	92	80	92	Milliamperes
D-C Screen Current	29	33	27	Milliamperes
D-C Grid Current (Approx.)	7	7	7	Milliamperes
Driving Power (Approx.)	0.9	0.9	0.9	Watt
Power Output (Approx.)	60	64	80	Watts

As R-F Power Amplifier and Oscillator - Class C Telegraphy
(Tetrode Connection - Grids No.2 and 3 tied together)
Key-down conditions per tube without modulation [oo]

D-C PLATE VOLTAGE	1250 *max.*	Volts
D-C SCREEN VOLTAGE (Grids No.2 & 3)	200 *max.*	Volts
D-C GRID VOLTAGE (Grid No.1)	-300 *max.*	Volts
D-C PLATE CURRENT	95 *max.*	Milliamperes
D-C GRID CURRENT	15 *max.*	Milliamperes
PLATE INPUT	120 *max.*	Watts
SCREEN INPUT (Grids No.2 & 3)	15 *max.*	Watts
PLATE DISSIPATION	40 *max.*	Watts
TYPICAL OPERATION:		
Filament Voltage (A.C.)	7.5	Volts
D-C Plate Voltage	1250	Volts
D-C Screen Voltage (Grids No.2 & 3)	180	Volts
D-C Grid Voltage	-100	Volts
Peak R-F Grid Voltage	160	Volts

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

D-C Plate Current	92	Milliamperes
D-C Screen Current (Grids No.2 & 3)	23	Milliamperes
D-C Grid Current (Approx.)	8	Milliamperes
Driving Power (Approx.)	1.2	Watts
Power Output (Approx.)	80	Watts

INSTALLATION

The *base* pins of the RCA-804 fit the standard, five-contact socket, which should be installed to hold the tube in a vertical position with the base down. If it is necessary to place the tube in a horizontal position, the socket should be mounted with the filament-pin openings one vertically above the other so that the plate will be in a vertical plane (on edge). If the tube is subjected to vibration or shock, a shock-absorbing suspension must be employed.

The *bulb* becomes very hot during continuous operation so that free circulation of air should be provided. Care should be taken that the bulb does not come in contact with any metallic object nor be subjected to the spray of any liquid. The installation of all wires and connections should be made so that they will not be close to or touch the bulb in order to avoid puncture of the glass.

The *filament* of the 804 is of the thoriated-tungsten type. It may be operated from either an a-c or a d-c source. Except where a d-c source is necessary to avoid hum, an a-c filament supply is generally used because of its convenience. If d.c. is used on the filament, the grid and plate returns should be made to the negative filament terminal instead of the mid-tap. A suitable voltmeter should be connected permanently across the tube filament terminals to provide a ready check of the filament voltage. This voltage should not vary more than plus or minus 5% from the rated value; otherwise, a loss of filament emission may result. When the apparatus in which the tube is used is idle for short periods of time, the filament should be maintained at its rated voltage during the "standbys".

The plate dissipation of the 804 (the difference between plate input and power output) should never exceed the maximum values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. *The plate should not show color under any condition of operation.*

The *screen voltage* may be obtained either from a separate source, from a potentiometer, or from the plate supply through a series resistor, depending on the service in which the tube is used (see APPLICATION). When the screen-resistor method is used, the resistor should have a value sufficient to drop the high voltage to a value which is within the maximum screen-voltage rating given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Suitable values of screen resistors are shown in these tabulations. In those classes of service where screen-voltage regulation is not an important factor, the series-resistance method for obtaining screen voltage is desirable since it serves to maintain the proper screen current. With this method, however, it is important that the high-voltage supply switch be opened before the filament circuit is opened; otherwise, full supply voltage will be placed on the screen. If the screen voltage is obtained from a separate source, or from a potentiometer, plate voltage should be applied before the screen voltage, or simultaneously with it; otherwise, with voltage on the screen only, the screen current may be large enough to cause excessive screen dissipation. A d-c milliammeter should be used in the screen circuit so that the screen current will always be known. The screen should never be allowed to attain a temperature corresponding to more than a dull red color. This temperature corresponds to the screen dissipation values shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS.

Suppressor voltage for the RCA-804 may be obtained from any fixed d-c supply. In cases where the suppressor draws current, the supply should be a battery or other d-c source of good regulation.

The negative high-voltage supply lead of the RCA-804 should be provided with a protective device, such as a fuse, to prevent the tube from drawing excessive plate and screen current. This device should open the high-voltage supply when the d-c plate current and d-c screen current reach a value 50% greater than normal.

Adequate *shielding* and isolation of the input circuit and the output circuit are necessary if optimum results are to be obtained. If an external shield is employed with the 804, it should be designed to enclose the base end of the tube and extend up to a position 1/4 inch above the lowest edge of the internal shielding. Clearance between the glass bulb and external shield should be at least 1/16". The impedance between the screen and filament must be kept as low as possible by the use of a by-pass condenser. When screen voltage is obtained from a series resistance, the screen by-pass condenser should have a voltage breakdown rating high enough to withstand the full plate voltage of the tube. The capacity value of the condenser should be about 0.01 μf. Values larger than this may cause excessive a-f by-passing; smaller values may cause excessive r-f feedback from plate to control grid, depending on circuit layout, frequency, and gain.

Heavy leads and conductors together with suitable insulation should be used in all parts of the r-f plate tank circuit so that the losses, due to r-f voltages and currents, may be kept at a minimum. Since proper circuit design becomes very important at the higher frequencies, it is essential that short, heavy leads and circuit returns are used in order to minimize lead inductance and losses.

In order that the maximum ratings given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS are not exceeded, changes in electrode voltages due to line-voltage fluctuation, load variation, and manufacturing variation of the associated apparatus must be determined. An average value of voltage for each electrode should then be chosen so that under the usual voltage variations the maximum rated voltages will not be exceeded.

When a new circuit is tried or when adjustments are made, the plate voltage should be reduced in order to prevent damage to the tube or associated apparatus in case the circuit adjustments are incorrect. It is advisable to use a protective resistance of about 5000 ohms in series with the negative high-voltage supply lead during such adjustments. Suitable meters should be provided for measuring tube voltages and currents. In addition to their use in indicating suitable operating conditions, they are also of value in making initial transmitter adjustments. However, to assist in the making of final adjustments for optimum performance, it is recommended that a cathode-ray oscillograph be used. Under no conditions should the maximum values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS be exceeded.

The rated plate voltage of this tube is high enough to be dangerous to the user. Great care should be taken during the adjustment of circuits, especially those in which the exposed circuit parts are at the high d-c plate potential.

APPLICATION

As a *Class B radio-frequency amplifier*, RCA-804 may be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid No.1 is the control-grid; grid No.2 is the screen; and grid No.3 is the suppressor. In Class B r-f service, the plate is supplied with unmodulated d-c voltage and the grid is excited by r-f voltage modulated at audio-frequency in one of the preceding stages. In this service the plate dissipation is greatest when the carrier is un-

modulated. It is important, therefore, that the plate dissipation for this class of operation should not exceed 40 watts for unmodulated conditions. In this service the screen voltage should be obtained from a separate source or from a potentiometer connected across the plate supply. The suppressor voltage should be obtained by the method discussed under INSTALLATION. Grid bias for the 804 as a Class B r-f amplifier should be obtained from a battery or other d-c source of good regulation. It should not be obtained from a high-resistance supply such as a grid-leak, nor from a rectifier, unless the latter has exceptionally good voltage regulation.

As a *suppressor-modulated Class C r-f amplifier*, RCA-804 may be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid No.1 is the control grid; grid No.2 is the screen; and grid No.3 is the suppressor. In this class of service the plate is supplied with unmodulated d-c plate voltage and the d-c suppressor voltage is modulated at audio frequency. The screen voltage should be obtained through a resistor in series with the *unmodulated* plate supply (see INSTALLATION). The d-c suppressor voltage may be obtained from any fixed supply. It is recommended that grid bias for this service be obtained from a fixed supply such as a battery, or from a rectifier of good regulation, although it may also be obtained from a grid leak (10-watt size) or from a cathode-bias resistor. The cathode-bias method is advantageous due to the fact that the grid bias is automatically regulated in direct proportion to the sum of the plate, grid, and screen currents and that there is little chance of the plate current becoming dangerously high, even if the r-f grid excitation is removed. The cathode-bias resistor should be by-passed for audio and radio frequencies. The grid-leak bias method has the advantage of simplicity and of automatically biasing the grid in proportion to the excitation voltage available. Special care must be observed with the use of this system because the accidental removal of the excitation will cause the grid bias to fall to zero so that the plate current, and consequently the plate dissipation, will rise to excessive values. The use of a protective device designed to remove the screen and plate voltages on excessive rises of plate current will minimize the danger of overload (see INSTALLATION). Since the grid-bias voltage for Class C service is not particularly critical, correct circuit adjustment may be obtained with widely different values.

As a *grid-modulated Class C r-f amplifier*, RCA-804 may be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid No.1 is the control-grid; grid No.2 is the screen; and grid No.3 is the suppressor. In this class of service the plate is supplied with unmodulated d-c plate voltage and the grid bias is modulated at audio frequency. The screen voltage should be obtained from a separate source or from a potentiometer connected across the plate supply. The suppressor voltage may be obtained from any fixed supply. Grid bias for this service should be obtained from a battery or other d-c source of good regulation. It should not be obtained from a high-resistance supply.

As a *plate-modulated Class C r-f amplifier (pentode connection)*,

RCA-804 is capable of being modulated 100%. Operating conditions are shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid No.1 is the control grid; grid No.2 is the screen; and grid No.3 is the suppressor. The screen voltage may be obtained from a fixed supply, or through a voltage-dropping resistor in series with the plate supply. The screen voltage should be modulated with the plate voltage so that the percentage changes in both voltages are approximately equal. When a fixed screen-voltage supply is used, modulation of the screen voltage can be accomplished either by connecting the screen to a separate winding on the modulation transformer, or by connecting it to a tap on the modulation transformer or choke, through a blocking condenser. With the latter method, an a-f choke of suitable impedance should be connected in series with the screen-supply lead. When the screen-resistor method is used, the screen should be connected through the series screen resistor to the *modulated* plate supply. Typical values of series screen resistors are given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. The suppressor voltage may be obtained from any fixed supply. Grid-leak bias is generally recommended for this service. If fixed bias or cathode bias is used, considerations are the same as those given under suppressor-modulated Class C r-f service.

As a *plate-modulated Class C r-f amplifier (tetrode connection)*, RCA-804 is capable of being modulated 100%. Operating conditions for this service are shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid No.1 is the control grid; grids No.2 and No.3 are connected together as the screen. The screen voltage should be obtained through a voltage-dropping resistor in series with the *unmodulated* portion of the plate-voltage supply. In this case, the series resistor develops its own modulating voltage. Typical values of screen resistors are given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. The screen voltage may also be obtained from a separate source, or from a potentiometer across the plate-voltage supply, provided the screen voltage is modulated as discussed under plate-modulated Class C r-f amplifier service (pentode connection) for a fixed screen supply. The suppressor voltage may be obtained from any fixed supply. Grid-leak bias is generally recommended for this service. If fixed bias or cathode bias is used, considerations are the same as those given under suppressor-modulated Class C r-f service.

As a *Class C r-f amplifier or oscillator pentode for telegraph service*, RCA-804 may be operated as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid No.1 is the control grid; grid No.2 is the screen; and grid No.3 is the suppressor. The screen and suppressor voltages may be obtained by any of the methods shown under INSTALLATION. Grid voltage considerations are the same as those for plate-modulated Class C r-f amplifier services.

As a *Class C r-f amplifier or oscillator tetrode for telegraph service*, the RCA-804 may be operated as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid No.1 is the control grid; grids No.2 and No.3 are connected together as the screen. The screen

voltage may be obtained by any of the methods shown under INSTALLATION. Grid voltage considerations are the same as those for plate-modulated Class C r-f amplifier services.

RCA-804 is well-suited for use as a crystal-controlled oscillator to give large r-f power output. Typical operating conditions are: d-c plate voltage, 1250 volts; d-c suppressor voltage, zero; d-c screen voltage, 300 volts; grid-leak resistance, 30000 ohms; d-c plate current, 42 milliamperes; and d-c screen current, 24 milliamperes.

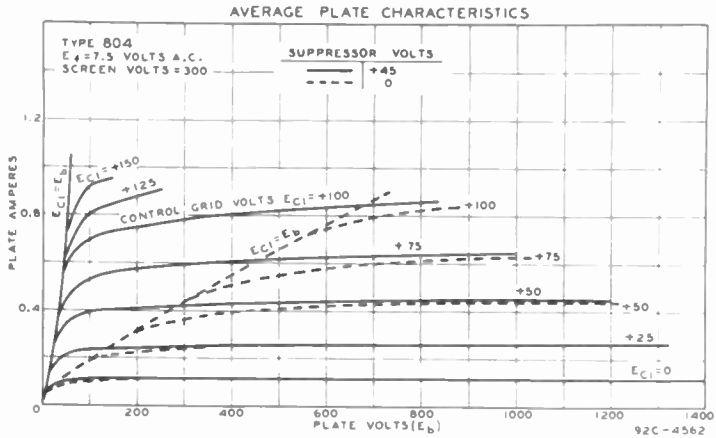
The *d-c grid current* will vary with individual tubes. Under any condition of operation, the maximum recommended values shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS should not be exceeded.

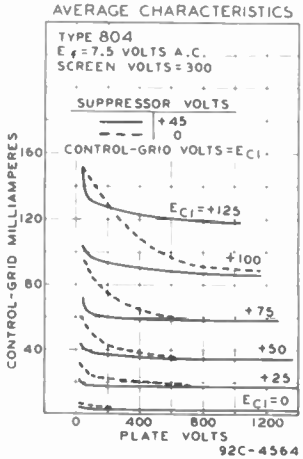
RCA-804 may be operated at maximum ratings in all classes of service at frequencies as high as 15 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced as the frequency is raised (other maximum ratings are the same as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS). The tabulation below shows the highest percentage of maximum plate voltage and power input that can be used at 15, 35 and 80 Mc for any class of service. Special attention should be given to shielding and to r-f by-passing at these frequencies. When shielding is used, care should be taken to insure adequate tube ventilation and the maintenance of normal ambient temperature.

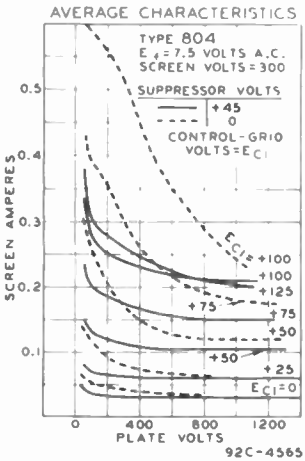
FREQUENCY	15	35	80	Megacycles
PERCENTAGE of MAX. RATED PLATE VOLTAGE and PLATE INPUT	100 *max.*	75 *max.*	50 *max.*	Per Cent

With the grid connected to the plate through the shortest possible connection, the resonant frequency of the grid-plate circuit is approximately 140 megacycles and the power output approximately zero.

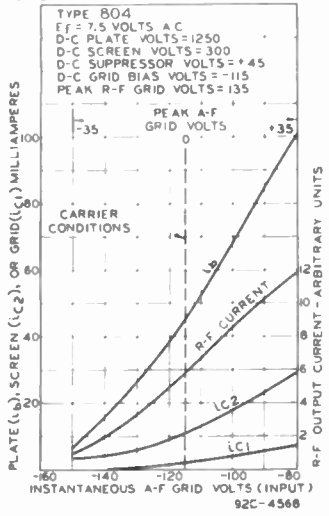
If more radio-frequency power output is required than can be obtained from a single 804, the push-pull or the parallel connection may be used. For example, two tubes connected in push-pull or in parallel will give approximately twice the power output of one tube. The parallel connection requires no increase in exciting voltage; the push-pull connection requires twice the r-f excitation necessary to drive a single tube. With either connection the driving power required is approximately twice that for single-tube operation while the grid bias is the same as for a single tube. The push-pull arrangement has the advantage of cancelling the even-order harmonics from the output and of simplifying the balancing of high-frequency circuits. When two or more RCA-804's are operated in parallel, a non-inductive resistance of 10 to 100 ohms should be placed in series with the grid lead of each tube, close to the socket terminal, to prevent parasitic oscillations.


AVERAGE PLATE CHARACTERISTICS
TYPE 804
E_f = 7.5 VOLTS A.C.
SCREEN VOLTS = 300
SUPPRESSOR VOLTS
+45
0
PLATE AMPERES
CONTROL GRID VOLTS E_{C1} = +100
E_{C1} = E_b
+150
+125
+100
+75
+50
+25
E_{C1} = 0
PLATE VOLTS (E_b)
92C-4562

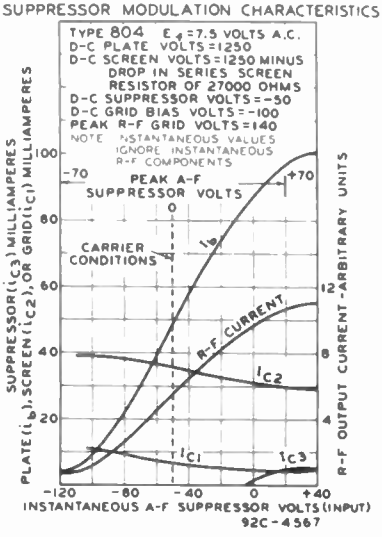

AVERAGE CHARACTERISTICS
TYPE 804
E_f = 7.5 VOLTS A.C.
SCREEN VOLTS = 300
SUPPRESSOR VOLTS
+45
0
CONTROL-GRID VOLTS = E_{C1}
CONTROL-GRID MILLIAMPERES
E_{C1} = +125
+100
+75
+50
+25
E_{C1} = 0
PLATE VOLTS
92C-4564


AVERAGE CHARACTERISTICS
TYPE 804
E_f = 7.5 VOLTS A.C.
SCREEN VOLTS = 300
SUPPRESSOR VOLTS
+45
0
CONTROL-GRID VOLTS = E_{C1}
SCREEN AMPERES
E_{C1} = +100
+100
+125
+75
+75
+50
+50
+50
+25
E_{C1} = 0
PLATE VOLTS
92C-4565

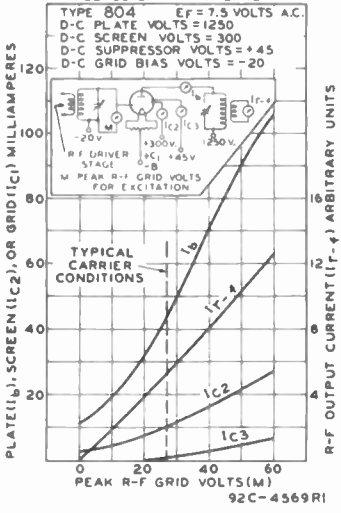
GRID MODULATION CHARACTERISTICS



SUPPRESSOR MODULATION CHARACTERISTICS

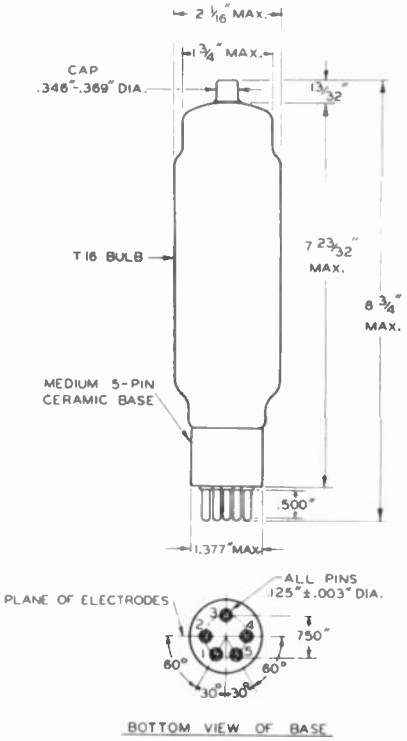


OPERATION CHARACTERISTICS
CLASS B R-F AMPLIFIER



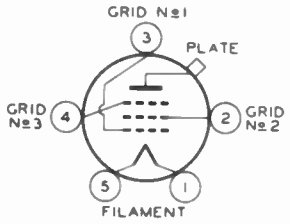
804

Outline Drawing



92C-4547

Tube Symbol and Top View of Socket Connections



805

R-F Power Amplifier, Oscillator, Class B Modulator

RCA-805 is a three-electrode tube of the high-mu type for use as a radio-frequency amplifier, oscillator and Class B audio-frequency amplifier. The plate connection is brought out through a separate seal at the top of the bulb to insure high insulation. As an r-f amplifier or oscillator the 805 may be used at maximum ratings for frequencies as high as 30 megacycles. The grid is designed so that the amplification of the tube varies with the amplitude of the input signal. This feature facilitates the design of Class B amplifiers to give high output with low distortion. The maximum plate dissipation of the RCA-805 is 125 watts for Class C telegraph and Class B services.

TENTATIVE CHARACTERISTICS

FILAMENT VOLTAGE (A.C. or D.C.)	10	Volts
FILAMENT CURRENT	3.25	Amperes
DIRECT INTERELECTRODE CAPACITANCES (Approx.):		
Grid-Plate	6.5	μμf
Grid-Filament	8.5	μμf
Plate-Filament	10.5	μμf
BULB (For dimensions, see page 48)	T-18	
CAP (For connection, see page 48)	Medium Metal	
BASE (For socket connections, see page 48)	Jumbo 4-Large Pin	

As A-F Power Amplifier and Modulator - Class B

D-C PLATE VOLTAGE		1500 *max.*	Volts
MAX-SIGNAL D-C PLATE CURRENT*		210 *max.*	Milliamperes
MAX-SIGNAL PLATE INPUT*		315 *max.*	Watts
PLATE DISSIPATION*		125 *max.*	Watts
TYPICAL OPERATION - 2 Tubes:			
Unless otherwise specified, values are for 2 tubes			
Filament Voltage (A.C.)	10	10	Volts
D-C Plate Voltage	1250	1500	Volts
D-C Grid Voltage oo	0	-16	Volts
Peak A-F Grid-to-Grid Voltage	235	280	Volts
Zero-Sig. D-C Plate Current	148	84	Milliamperes
Max-Sig. D-C Plate Current	400	400	Milliamperes
Load Resistance (Per tube)	1675	2050	Ohms
Effective Load Resistance (Plate-to-plate)	6700	8200	Ohms
Max-Sig. Driving Power (Approx.)	6	7	Watts
Max-Sig. Power Output (Approx.)	300#	370##	Watts

* Averaged over any audio-frequency cycle.

oo Grid voltages are given with respect to the mid-point of filament operated on a.c. If d.c. is used, each stated value of grid voltage should be decreased by 5.0 volts and be referred to the negative end of the filament.

\# Approximately 4% harmonic distortion.

\## Approximately 3% harmonic distortion.

As R-F Power Amplifier - Class B Telephony

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

D-C PLATE VOLTAGE		1500 *max.*	Volts
D-C PLATE CURRENT		150 *max.*	Milliamperes
PLATE INPUT		185 *max.*	Watts
PLATE DISSIPATION		125 *max.*	Watts
TYPICAL OPERATION:			
Filament Voltage (A.C.)	10	10	Volts
D-C Plate Voltage	1250	1500	Volts
D-C Grid Voltage [oo]	0	-10	Volts
Peak R-F Grid Voltage	75	70	Volts
D-C Plate Current	135	115	Milliamperes
D-C Grid Current (Approx.) [**]	15	15	Milliamperes
Driving Power (Approx.) [**] [o]	11	7.5	Watts
Power Output (Approx.)	55	57.5	Watts

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

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

D-C PLATE VOLTAGE		1250 *max.*	Volts
D-C GRID VOLTAGE		-500 *max.*	Volts
D-C PLATE CURRENT		175 *max.*	Milliamperes
D-C GRID CURRENT		70 *max.*	Milliamperes
PLATE INPUT		220 *max.*	Watts
PLATE DISSIPATION		85 *max.*	Watts
TYPICAL OPERATION:			
Filament Voltage (A.C.)	10	10	Volts
D-C Plate Voltage	1000	1250	Volts
D-C Grid Voltage	-155	-160	Volts
Peak R-F Grid Voltage	295	300	Volts
D-C Plate Current	160	160	Milliamperes
D-C Grid Current (Approx.) [**]	60	60	Milliamperes
Driving Power (Approx.) [**]	16	16	Watts
Power Output (Approx.)	110	140	Watts

As R-F Power Amplifier and Oscillator - Class C Telegraphy

Key-down conditions per tube without modulation [***]

D-C PLATE VOLTAGE	1500 *max.* Volts
D-C GRID VOLTAGE	-500 *max.* Volts
D-C PLATE CURRENT	210 *max.* Milliamperes
D-C GRID CURRENT	70 *max.* Milliamperes
PLATE INPUT	315 *max.* Watts
PLATE DISSIPATION	125 *max.* Watts

[oo] Grid voltages are given with respect to the mid-point of filament operated on a.c. If d.c. is used, each stated value of grid voltage should be decreased by 5.0 volts and be referred to the negative end of the filament.

[**] 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 he capable of delivering consioerably more than the required driving power.

[o] 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.

TYPICAL OPERATION:

Filament Voltage (A.C.)	10	10	10	Volts
D-C Plate Voltage	1000	1250	1500	Volts
D-C Grid Voltage	-95	-100	-105	Volts
Peak R-F Grid Voltage	225	230	235	Volts
D-C Plate Current	200	200	200	Milliamperes
D-C Grid Current (Approx.)**	40	40	40	Milliamperes
Driving Power (Approx.)**	8.5	8.5	8.5	Watts
Power Output (Approx.)	130	170	215	Watts

** 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 be capable of delivering considerably more than the required driving power.

INSTALLATION

The *base* pins of the RCA-805 fit the standard transmitting four-contact socket, such as the RCA type UT-541. The socket should be installed so that the tube will operate in a vertical position with the base down. If the tube is subjected to vibration or shock, a shock-absorbing suspension must be employed. Because of the relatively heavy filament current taken by this tube. The socket should make firm, large-surface contact with the filament-base pins. Heavy, well-soldered leads should be used for the filament-circuit wiring.

The *bulb* becomes very hot during continuous operation so that free circulation of air should be provided. Care should be taken that the bulb does not come in contact with any metallic object nor be subjected to the drops or spray of liquid. The installation of all wires and connections should be made so that they will not be close to or touch the bulb in order to avoid puncture of the glass due to peak voltage effects.

The *filament* of the 805 is of the thoriated-tungsten type. It may be operated either from an a-c or a d-c source. Except where a d-c source is necessary to avoid hum, an a-c filament supply is generally used because of its convenience. If d.c. is used on the filament, the circuit returns should be connected to the negative filament terminal. A voltmeter should be connected permanently across the filament terminals to provide a ready check of the filament voltage. This voltage should not vary more than plus or minus 5% from the rated value; otherwise a loss of filament emission may result. When the apparatus in which the tube is used is idle for periods not exceeding two hours, the filament should be maintained at its rated voltage during the "standbys".

The plate dissipation of the RCA-805 (the difference between plate input and power output) should never exceed the values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. *The maximum values are indicated by a barely perceptible red color on the plate under actual operating conditions.*

Overheating of the 805 by severe overload may decrease filament emission. Unless the overload has liberated a large amount of gas,

the activity of the filament can sometimes be restored by operating the filament at rated voltage for ten minutes or more with no voltage on the plate or grid. This process may be accelerated by raising the filament voltage to 12 volts (not higher) for a few minutes.

Heavy leads and conductors together with suitable insulation should be used in all parts of the r-f plate tank circuit so that the losses, due to the r-f voltages and currents, may be kept at a minimum. Since proper circuit design becomes very important at the higher frequencies, it is essential that short, heavy leads and circuit returns are used in order to minimize lead inductance and losses.

In order to prevent overheating due to improper circuit adjustments, or to overloading, the plate circuit should be provided with a protective device such as a fuse. This device should instantly remove the plate voltage when the d-c plate current reaches a value 50% greater than normal.

In order that the maximum ratings given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS will not be exceeded, changes in plate and filament voltages due to line-voltage fluctuation, load variation, and manufacturing variation of the associated apparatus, must be determined. An average value of plate and filament voltage should then be chosen so that under the usual voltage variations the maximum rated voltages will not be exceeded.

When a new circuit is tried or when adjustments are made, the plate voltage should be reduced in order to prevent damage to the tube or associated apparatus in case the circuit adjustments are incorrect. It is advisable to use a protective resistance of about 3000 ohms in series with the plate lead during such adjustments. Suitable meters should be provided for measuring tube voltages and currents. In addition to their use in indicating suitable operating conditions, they are also of value in making initial transmitter adjustments. However, to assist in the making of final adjustments for optimum performance, it is recommended that a cathode-ray oscillograph be used. Under no conditions should the maximum values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS be exceeded.

The rated plate voltage of this tube is high enough to be dangerous to the user. Care should be taken during the adjustment of circuits, especially those in which the exposed circuit parts are at the high d-c plate potential.

APPLICATION

As a *Class B modulator or audio-frequency amplifier,* two 805's are used in a balanced circuit, each tube amplifying only half the time. The d-c plate current should never exceed 210 milliamperes per tube. The output transformer should be designed so that the resistance load presented by the modulated Class C amplifier is reflected as a plate-to-plate load of 6700 ohms in the Class B a-f stage for the 1250-volt condition. If an output transformer efficiency of 90% is assumed, two 805's operated under conditions shown for a 1250-volt plate supply, are capable of modulating 100% an input

of approximately 540 watts to a Class C r-f power amplifier. Since two 805's will modulate 540 watts, a convenient Class C amplifier would be one operating at 2000 volts and 270 milliamperes. These conditions represent a resistance of approximately 7400 ohms. The ratio of the output transformer is then $\sqrt{7400 \div 6700}$, or 1 to 1.06, step up. The transformer should be designed with a core sufficiently large to avoid saturation effects which would impair the quality of the output. If the secondary is to carry the d-c plate current of the modulated amplifier, the core should be made larger and include an air gap to compensate for the d-c magnetization current. The input transformer can be designed for operation under approximately uniform loading conditions to give excellent results since, due to the low grid-bias characteristic of the 805, grid current is drawn on practically any input signal. Grid bias for Class B service should be obtained from a battery or other d-c source of good regulation. It should not be obtained from a high-resistance supply such as a grid leak, nor from a rectifier, unless the latter has exceptionally good voltage regulation. When a plate-supply of 1250 volts, or less, is used, the 805 may be operated with zero bias.

In special cases where it is desirable to keep the audio-frequency distortion below 3%, the use of a small amount of grid-bias voltage at reduced plate voltage is advantageous. Typical operating conditions are approximately the same as those for the 1250 plate-voltage condition. The exceptions are: grid-bias voltage, -14 volts; peak a-f grid-to-grid voltage, 250 volts; and zero-signal d-c plate current, 60 milliamperes (two tubes).

As a *Class B radio-frequency amplifier*, RCA-805 should be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. In this service the plate is supplied with unmodulated d-c voltage and the grid is excited by r-f voltage modulated at audio frequency in one of the preceding stages. It is important to note that in this service the plate dissipation is greatest when the carrier is unmodulated. The plate dissipation, therefore, should not exceed 125 watts for unmodulated carrier conditions. Grid bias for Class B r-f service should be obtained in the same manner as for Class B a-f service. When the 805 is used as a Class B r-f amplifier, plate voltage as high as 1500 volts may be used provided the d-c plate current is reduced so that the plate-input rating of 185 watts is not exceeded. Likewise, the d-c plate current may be raised to 150 milliamperes, provided the plate voltage is reduced so that the maximum input rating is not exceeded.

As a *plate-modulated Class C radio-frequency amplifier*, the 805 should be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid bias for this service may be obtained from a grid leak of about 3000 ohms (50-watt size), or from a suitable combination of either grid leak and fixed supply of good regulation, or grid leak and cathode-bias resistor. The cathode-bias resistor should be suitably by-passed for audio and radio frequencies. The combination-bias methods are particularly desirable because distortion effects are minimized by bias-supply compensation. Since the grid-bias voltage

for Class C service is not particularly critical, correct adjustment may be obtained with values differing widely from those indicated for this service.

As a *Class C radio-frequency amplifier and oscillator for telegraph service,* RCA-805 may be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid bias for this service may be obtained from a grid leak of 3000 ohms, from a battery, from a rectifier, or from a cathode-bias resistor (preferably variable) suitably by-passed for radio frequencies. The grid-leak-bias method has the advantage of simplicity and of automatically biasing the grid in proportion to the excitation voltage available. When the tube is operated at a plate voltage of 1250 volts, or less, the grid-leak method is particularly useful, for even when the grid excitation is accidently removed, the probability of tube damage is small because of the high amplification factor of the tube and its resultant low zero-bias plate current. Since the grid-bias voltage for Class C service is not particularly critical, correct adjustment may be obtained with widely different values.

The *d-c grid current* will vary with individual tubes. Under any condition of operation the maximum value should not exceed 70 milliamperes.

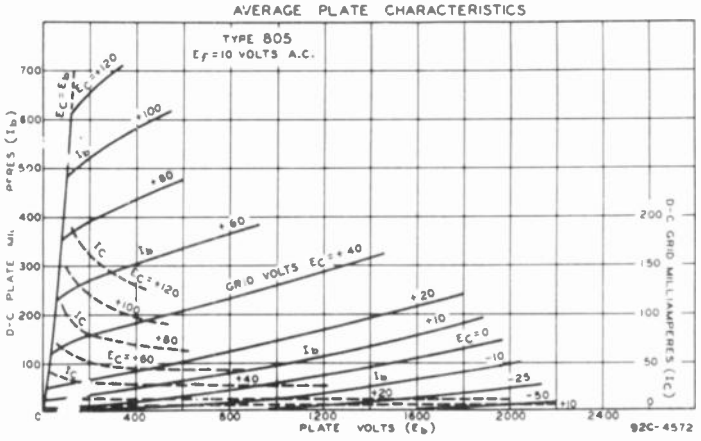
RCA-805 may be operated at maximum ratings in all classes of service at frequencies as high as 30 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced as the frequency is raised (other maximum ratings are the same as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS). The tabulation below shows the highest percentage of maximum plate voltage and power input that can be used at 30, 45 and 85 Mc for any class of service. Special attention should be given to adequate ventilation and the maintenance of normal ambient temperatures at these frequencies.

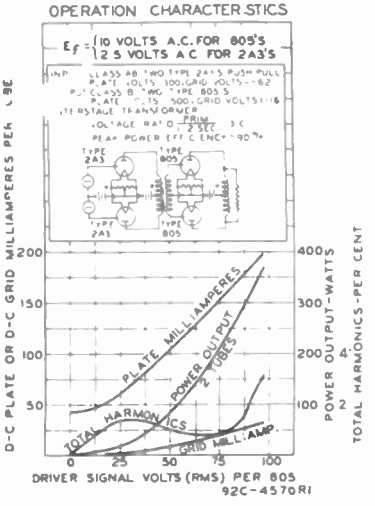
FREQUENCY	30	45	85	Megacycles
PERCENTAGE of MAX. RATED PLATE VOLTAGE and PLATE INPUT	100 *max.*	75 *max.*	50 *max.*	Per Cent

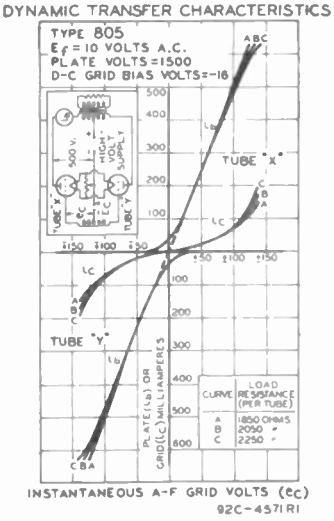
With the grid connected to the plate through the shortest possible connection, the resonant frequency of the grid-plate circuit is approximately 115 megacycles and the power output approximately zero.

If more radio-frequency power output is required than can be obtained from a single 805, the push-pull or the parallel connection may be used. For example, two tubes connected in push-pull or in parallel will give approximately twice the power output of one tube. The parallel connection requires no increase in exciting voltage; the push-pull connection requires twice the r-f excitation necessary to drive a single tube. With either connection the driving power required is approximately twice that for single-tube operation while the grid bias is the same as for a single tube. The push-pull arrangement has

the advantage of cancelling the even-order harmonics from the output and of simplifying the balancing of high-frequency circuits. When two or more RCA-805's are operated in parallel, a non-inductive resistance of 10 to 100 ohms should be placed in series with the grid lead of each tube, close to the socket terminal, to prevent parasitic oscillations.

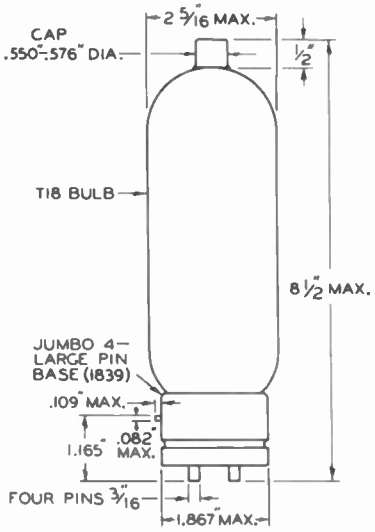


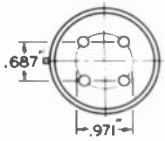




805

OUTLINE DRAWING

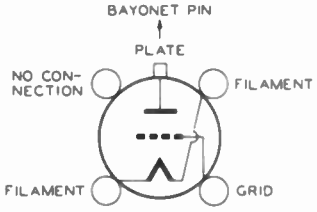




BOTTOM VIEW OF BASE

92S-4323

Tube Symbol and Top View of Socket Connections



830-B

Class B Modulator, R-F Power Amplifier, Oscillator

RCA-830-B is a three-electrode transmitting tube for use as a Class B modulator, radio-frequency amplifier, and oscillator. The plate lead is brought out through a separate seal at the top of the bulb. As a radio-frequency amplifier or oscillator, the 830-B can be operated at maximum rated conditions at frequencies as high as 15 megacycles. The plate dissipation for Class C telegraph and Class B services is 60 watts. In Class B audio service two tubes of this type are capable of delivering an output of 175 watts.

TENTATIVE CHARACTERISTICS

FILAMENT VOLTAGE (A.C. or D.C.)	10	Volts
FILAMENT CURRENT	2	Amperes
AMPLIFICATION FACTOR	25	
DIRECT INTERELECTRODE CAPACITANCES (Approx.):		
Grid-Plate	11	μμf
Grid-Filament	5	μμf
Plate-Filament	1.8	μμf
BULB (For dimensions, see page 56)	T-16	
CAP (For connection, see page 56)	Small Metal	
BASE (For socket connections, see page 56)	Medium 4-Pin Bayonet	

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

As A-F Power Amplifier and Modulator - Class B

D-C PLATE VOLTAGE	1000 *max.*	Volts
MAX-SIGNAL D-C PLATE CURRENT *	150 *max.*	Milliamperes
MAX-SIGNAL PLATE INPUT *	150 *max.*	Watts
PLATE DISSIPATION *	60 *max.*	Watts

TYPICAL OPERATION - 2 Tubes:

Unless otherwise specified, values are for 2 tubes

Filament Voltage (A.C.)	10	10	Volts
D-C Plate Voltage	800	1000	Volts
D-C Grid Voltage (Approx.) #	-27	-35	Volts
Peak A-F Grid-to-Grid Voltage (Approx.)	250	270	Volts
Zero-Sig. D-C Plate Current	20	20	Milliamperes
Max-Sig. D-C Plate Current	280	280	Milliamperes
Load Resistance (Per tube)	1500	1900	Ohms
Effective Load Res. (Plate-to-plate)	6000	7600	Ohms
Max-Sig. Driving Power (Approx.)	5	6	Watts
Max-Sig. Power Output (Approx.)	135	175	Watts

* Averaged over any audio-frequency cycle.

\# Grid voltages are given with respect to the mid-point of filament operated on a.c. If d.c. is used, each stated value of grid voltage should be decreased by 5.0 volts and be referred to the negative end of the filament.

As R-F Power Amplifier - Class B Telephony

Carrier conditions per tube for use with a max. modulation fact. of 1.0

D-C PLATE VOLTAGE		1000 *max.*	Volts
D-C PLATE CURRENT		100 *max.*	Milliamperes
PLATE INPUT		90 *max.*	Watts
PLATE DISSIPATION		60 *max.*	Watts
TYPICAL OPERATION:			
Filament Voltage (A.C.)	10	10	Volts
D-C Plate Voltage	800	1000	Volts
D-C Grid Voltage (Approx.)#	-27	-35	Volts
Peak R-F Grid Voltage (Approx.)	85	85	Volts
D-C Plate Current	95	85	Milliamperes
D-C Grid Current (Approx.)**	7	6	Milliamperes
Driving Power (Approx.)** o	9	6	Watts
Power Output (Approx.)	23	26	Watts

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

Carrier conditions per tube for use with a max. modulation fact. of 1.0

D-C PLATE VOLTAGE		800 *max.*	Volts
D-C GRID VOLTAGE		-300 *max.*	Volts
D-C PLATE CURRENT		100 *max.*	Milliamperes
D-C GRID CURRENT		30 *max.*	Milliamperes
PLATE INPUT		80 *max.*	Watts
PLATE DISSIPATION		40 *max.*	Watts
TYPICAL OPERATION:			
Filament Voltage (A.C.)	10	10	Volts
D-C Plate Voltage	600	800	Volts
D-C Grid Voltage (Approx.)	-140	-150	Volts
Peak R-F Grid Voltage (Approx.)	255	265	Volts
D-C Plate Current	95	95	Milliamperes
D-C Grid Current (Approx.)**	30	20	Milliamperes
Driving Power (Approx.)**	7	5	Watts
Power Output (Approx.)	38	50	Watts

As R-F Power Amplifier and Oscillator - Class C Telegraphy

Key-down conditions per tube without modulation ##

D-C PLATE VOLTAGE	1000 *max.*	Volts
D-C GRID VOLTAGE	-300 *max.*	Volts
D-C PLATE CURRENT	150 *max.*	Milliamperes
D-C GRID CURRENT	30 *max.*	Milliamperes
PLATE INPUT	150 *max.*	Watts
PLATE DISSIPATION	60 *max.*	Watts

\# Grid voltages are given with respect to the mid-point of filament operated on a.c. If d.c. is used, each stated value of grid voltage should be decreased by 5.0 volts and be referred to the negative end of the filament.

** 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 be capable of delivering considerably more than the required driving power.

o 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.

TYPICAL OPERATION:

Filament Voltage (A.C.)	10	10	10	Volts
D-C Plate Voltage	600	800	1000	Volts
D-C Grid Voltage (Approx.)	-95	-105	-110	Volts
Peak R-F Grid Voltage (Approx.)	235	245	250	Volts
D-C Plate Current	140	140	140	Milliamperes
D-C Grid Current (Approx.)**	30	30	30	Milliamperes
Driving Power (Approx.)**	7	7	7	Watts
Power Output (Approx.)	45	70	90	Watts

** 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 be capable of delivering considerably more than the required driving power.

INSTALLATION

The *base* pins of the RCA-830-B fit the standard four-contact socket. The socket should be installed so that the tube will operate in a vertical position with the base down. If the tube is subjected to vibration or shock, a shock-absorbing suspension must be employed.

The *bulb* of this tube becomes very hot during continuous operation. Free circulation of air, therefore, should be provided. Care should be taken that the bulb does not come in contact with any metallic object nor be subjected to the spray of any liquid. The installation of all wires and connections should be made so that they will not be close to or touch the bulb in order to avoid puncture of the glass due to peak-voltage effects.

The *filament* of the 830-B is of the thoriated-tungsten type. It may be operated either from an a-c or a d-c source. Except where a d-c source is necessary to avoid hum, an a-c filament supply is generally used because of its convenience. A voltmeter should be connected permanently across the tube filament terminals at the socket to provide a ready check of the filament voltage. This voltage should not vary more than plus or minus 5% from the rated value; otherwise, a loss of filament emission may result. When an a-c source is used, rheostat control should be placed in the primary circuit of the filament transformer. When the apparatus in which the tube is used is idle for periods not exceeding two hours, the filament should be maintained at its rated voltage during the "standbys".

The *grid return and the plate return* should be connected to the center tap on the filament winding of the transformer, or to the midpoint of a center-tapped resistor across the filament terminals. When cathode bias is used, the returns are connected to the same points through the cathode-bias resistor. In cases where d.c. is used on the filament, these returns should be connected to the negative filament terminal.

The plate dissipation of the RCA-830-B (the difference between plate input and power output) should never exceed the values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. The maximum

values are indicated by a barely perceptible red color on the plate under actual operating conditions.

Overheating of the 830-B by severe overload may decrease filament emission. Unless the overload has liberated a large amount of gas, the activity of the filament can sometimes be restored by operating the filament at rated voltage for ten minutes or more with no voltage on the plate or grid. This process may be accelerated by raising the filament voltage to 12 volts (not higher) for a few minutes.

A d-c milliammeter should always be used in the plate circuit to provide a ready check of the plate current. Under no condition should the d-c plate current exceed the maximum values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS.

In order to prevent overheating due to improper circuit adjustments, to overloading, or to loss of grid bias, the plate circuit should be provided with a protective device such as a fuse. This device should instantly remove the plate voltage when the d-c plate current reaches a value of 50% greater than normal.

Heavy leads and conductors together with suitable insulation should be used in all parts of the r-f plate tank circuit so that the losses, due to the r-f voltages and currents, may be kept at a minimum. Since proper circuit design becomes very important at the higher frequencies, it is essential that short, heavy leads and circuit returns are used in order to minimize lead inductance and losses.

In order that the maximum ratings given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS will not be exceeded, changes in plate and filament voltages due to line-voltage fluctuation, load variation, and manufacturing variation of the associated apparatus, must be determined. An average value of plate and filament voltage should then be chosen so that under the usual voltage variations the maximum rated voltages will not be exceeded.

When a new circuit is tried or when adjustments are made, the plate voltage should be reduced in order to prevent damage to the tube or associated apparatus in case the circuit adjustments are incorrect. It is advisable to use a protective resistance of about 3000 ohms in series with the negative high-voltage supply lead during such adjustments. Suitable meters should be provided for measuring tube voltages and currents. In addition to their use in indicating suitable operating conditions, they are also of value in making initial transmitter adjustments. However, to assist in the making of final adjustments for optimum performance, it is recommended that a cathode-ray oscillograph be used. Under no conditions should the maximum values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS be exceeded.

The rated plate voltage of this tube is high enough to be dangerous to the user. Great care should be taken during the adjustment

of circuits, especially those in which the exposed circuit parts are at the higher d-c plate potential.

APPLICATION

As a *Class B modulator or audio-frequency amplifier*, two 830-B's are used in a balanced circuit, each tube conducting only half the time. The d-c plate current should never exceed 150 milliamperes per tube. If an output transformer efficiency of 90% is assumed, two 830-B's operated under conditions shown for an 800-volt plate supply, are capable of modulating 100% an input of approximately 240 watts to a Class C r-f power amplifier. The input transformer should be designed to give good frequency response when operated into an open circuit, such as that represented by the grid circuit of the Class B stage when the signal amplitude is small. It should also be designed to handle the required input power for a strong signal. The output transformer should be designed so that the resistance load presented by the modulated Class C amplifier is reflected as a plate-to-plate load of 6000 ohms in the Class B stage for the 800-volt conditions. Since two 830-B's will modulate 240 watts, a convenient Class C amplifier would be one operating at 800 volts and 300 milliamperes. These conditions represent a resistance of approximately 2670 ohms. The ratio of the output transformer is then $\sqrt{6000 \div 2670}$, or 1.5 to 1, step-down. The transformer should be designed with a core sufficiently large to avoid saturation effects, which would impair the quality of the output. If the secondary is to carry the d-c plate current of the modulated amplifier, the core should be made larger and include an air gap to compensate for the d-c magnetization current. Grid bias for the 830-B in Class B a-f service should be obtained from a battery or other d-c source of good regulation. It should not be obtained from a high-resistance supply such as a grid leak, nor from a rectifier, unless the latter has exceptionally good voltage regulation.

As a *Class B radio-frequency amplifier*, RCA-830-B should be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. In this service the plate is supplied with unmodulated d-c voltage and the grid is excited by r-f voltage modulated at audio frequency in one of the preceding stages. It is important to note that for Class B r-f operation the plate dissipation is greatest when the carrier is unmodulated. It is necessary, therefore, that the plate dissipation should not exceed 60 watts for unmodulated conditions. Grid bias for Class B r-f service should be obtained in the same manner as for Class B a-f service. When the 830-B is used as a Class B r-f amplifier, plate voltage as high as 1000 volts may be used, provided the d-c plate current is reduced so that the maximum plate-input rating of 90 watts is not exceeded. Likewise, the d-c plate current may be raised to 100 milliamperes, provided the plate voltage is reduced so that the maximum input rating is not exceeded.

As a *plate-modulated Class C radio-frequency amplifier*, the 830-B should be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid bias for this service may be obtained from a grid leak of about 5000 ohms (10-watt size), from a suitable combination

of grid leak and fixed supply of good regulation, or from a cathode-bias resistor suitably by-passed for audio and radio frequencies. The combination method is particularly desirable because distortion effects are minimized by bias-supply compensation. Since the grid-bias voltage for Class C service is not particularly critical, correct adjustment may be obtained with values differing widely from those indicated for this service.

As a *Class C radio-frequency amplifier and oscillator for telegraph service*, RCA-830-B may be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid bias for this service may be obtained from a grid leak of 5000 ohms, from a battery, from a rectifier, or from a cathode-bias resistor (preferably variable) suitably by-passed for radio frequencies. The cathode-bias method is advantageous due to the fact that the grid bias is automatically regulated in direct proportion to the sum of the plate and grid current and that there is little chance of the plate current becoming dangerously high, even if the r-f grid excitation is removed. The grid-leak bias method has the advantage of simplicity and of automatically biasing the grid in proportion to the excitation voltage available. Special care must be observed with the use of the latter system because the accidental removal of the excitation will cause the grid bias to fall to zero so that the plate current, and consequently the plate dissipation, will rise to excessive values. The use of a protective device designed to open the plate circuit on excessive rises of plate current will minimize the danger of overload (see INSTALLATION). Since the grid-bias voltage for Class C service is not particularly critical, correct adjustment may be obtained with widely different values.

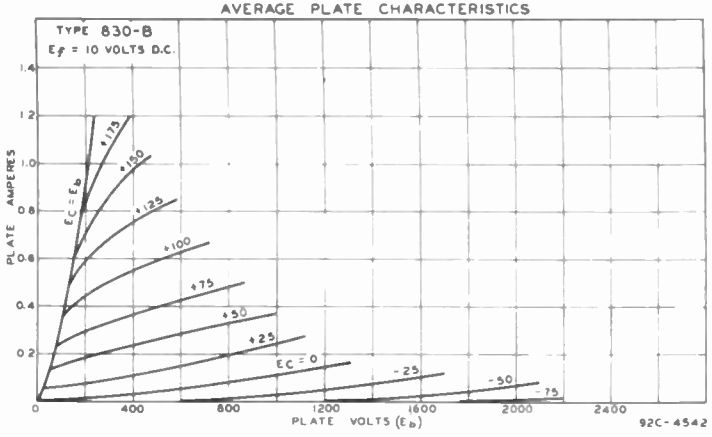
The *d-c grid current* will vary with individual tubes. Under any condition of operation, the maximum value should not exceed 30 milliamperes.

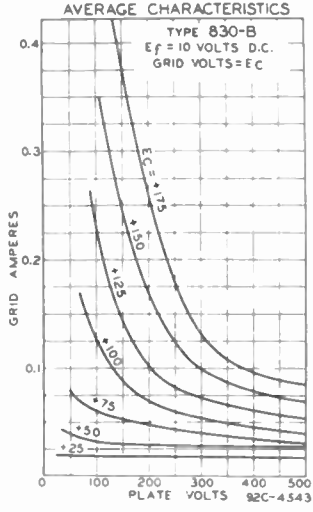
RCA-830-B may be operated at maximum ratings in all classes of service at frequencies as high as 15 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced as the frequency is raised (other maximum ratings are the same as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS). The tabulation below shows the highest percentage of maximum plate voltage and power input that can be used at 15, 30 and 60 Mc for any class of service. Special attention should be given to adequate ventilation and the maintenance of normal ambient temperatures at these frequencies.

FREQUENCY	15	30	60	Megacycles
PERCENTAGE of MAX. RATED PLATE VOLTAGE and PLATE INPUT	100 *max.*	75 *max.*	50 *max.*	Per Cent

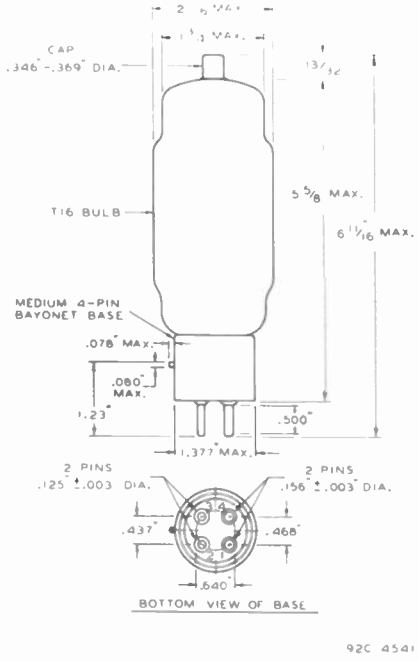
With the grid connected to the plate through the shortest possible connection, the resonant frequency of the grid-plate circuit is approximately 90 megacycles and the power output approximately zero.

If more radio-frequency power output is required than can be obtained from a single 830-B, the push-pull or the parallel connection may be used. For example, two tubes connected in push-pull or in parallel will give twice the power output of one tube. The parallel connection requires no increase in exciting voltage; the push-pull connection requires twice the r-f excitation necessary to drive a single tube. With either connection the driving power required is approximately twice that for single tube operation while the grid bias is the same as for a single tube. The push-pull arrangement has the advantage of cancelling the even-order harmonics from the output and of simplifying the balancing of high-frequency circuits. When two or more RCA-830-B's are operated in parallel, a non-inductive resistance of 10 to 100 ohms should be placed in series with the grid lead of each tube, close to the socket terminal, to prevent parasitic oscillations.

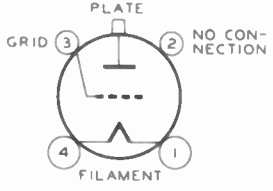




Outline Drawing



Tube Symbol and Top View of Socket Connections



834

Radio-Frequency Power Amplifier and Oscillator

RCA-834 is a three-electrode transmitting tube for use as a radio-frequency amplifier and oscillator, particularly at the higher radio frequencies. The grid and plate are supported from the top of the glass bulb by individual leads which are brought out of the tube through separate seals. This construction insures low interelectrode capacities and minimum lead inductance. RCA-834 may be operated at maximum ratings at frequencies as high as 100 megacycles; it may be operated at reduced plate voltage and input up to 350 megacycles. The maximum plate dissipation for Class C telegraph and Class B services is 50 watts.

TENTATIVE CHARACTERISTICS

FILAMENT VOLTAGE (A.C. or D.C.)	7.5	Volts
FILAMENT CURRENT	3.25	Amperes
AMPLIFICATION FACTOR	10.5	
DIRECT INTERELECTRODE CAPACITANCES (Approx.):		
Grid-Plate	2.6	μμf
Grid-Filament	2.2	μμf
Plate-Filament	0.6	μμf
BULB (For dimensions, see page 64)	S-21	
BASE (For socket connections, see page 64)	Medium 4-Pin, Bayonet	

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

As R-F Power Amplifier - Class B Telephony

Carrier conditions per tube for use with a max. modulation fact. of 1.0

D-C PLATE VOLTAGE			1250 *max.*	Volts
D-C PLATE CURRENT			100 *max.*	Milliamperes
PLATE INPUT			75 *max.*	Watts
PLATE DISSIPATION			50 *max.*	Watts
TYPICAL OPERATION:				
Filament Voltage (A.C.)	7.5	7.5	7.5	Volts
D-C Plate Voltage	750	1000	1250	Volts
D-C Grid Voltage (Approx.)	-70	-90	-115	Volts
Peak R-F Grid Voltage (Approx.)	90	100	115	Volts
D-C Plate Current	50	50	50	Milliamperes
D-C Grid Current (Approx.) **	1	0.5	0	Milliampere

** 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 be capable of delivering considerably more than the required driving power.

Driving Power (Approx.)** °	3.3	3.1	3	Watts
Power Output (Approx.)	11	16	20	Watts

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

Carrier conditions per tube for use with a max. modulation fact. of 1.0

D-C PLATE VOLTAGE			1000 *max.*	Volts
D-C PLATE CURRENT			100 *max.*	Milliamperes
D-C GRID CURRENT			20 *max.*	Milliamperes
PLATE INPUT			100 *max.*	Watts
PLATE DISSIPATION			35 *max.*	Watts
TYPICAL OPERATION:				
Filament Voltage (A.C.)		7.5	7.5	Volts
D-C Plate Voltage		750	1000	Volts
D-C Grid Voltage		-290	-310	Volts
Peak R-F Grid Voltage		415	435	Volts
D-C Plate Current		90	90	Milliamperes
D-C Grid Current (Approx.)**		20	17.5	Milliamperes
Driving Power (Approx.)**		7.5	6.5	Watts
Power Output (Approx.)		42	58	Watts

As R-F Power Amplifier and Oscillator - Class C Telegraphy

Key-down conditions per tube without modulation##

D-C PLATE VOLTAGE				1250 *max.*	Volts
D-C PLATE CURRENT				100 *max.*	Milliamperes
D-C GRID CURRENT				20 *max.*	Milliamperes
PLATE INPUT				125 *max.*	Watts
PLATE DISSIPATION				50 *max.*	Watts
TYPICAL OPERATION:					
Filament Voltage (A.C.)	7.5	7.5	7.5		Volts
D-C Plate Voltage	750	1000	1250		Volts
D-C Grid Voltage	-175	-200	-225		Volts
Peak R-F Grid Voltage	300	325	350		Volts
D-C Plate Current	90	90	90		Milliamperes
D-C Grid Current (Approx.)**	20	17.5	15		Milliamperes
Driving Power (Approx.)**	5.5	5	4.5		Watts
Power Output (Approx.)	42	58	75		Watts

** 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 be capable of delivering considerably more than the required driving power.

° 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.

INSTALLATION

The *base* pins of the 834 fit the standard four-contact socket which should be installed to hold the tube in a vertical position. The filament terminals are connected to the two large base pins; the grid and plate leads are brought out through separate seals at the top of the bulb (for connections, see page 81). Because of the relatively heavy filament current taken by this tube, the socket should make firm, large-surface contact with the filament base pins. Heavy, well-soldered leads should be used for the filament-circuit wiring.

Connections to the grid and plate leads must be flexible enough so that normal expansion will not place a strain on the glass at the seals, yet heavy enough to carry the high circulating r-f current. It is also necessary to provide a means for cooling the lead tips and their seals. A recommended method of doing this is to increase the radiating surface of each lead by means of a copper clamp connector having a cross-sectional area of at least 3/4 square inch. (See page 7 for constructional details). Each lead wire should be connected to its copper clamp before the clamp is placed on the terminal tip. The clamp should be slightly sprung so that it can easily be slipped over its terminal. When the clamp is in place, carefully tighten the smaller bolt to insure good electrical contact. Connections should never be soldered directly to the tube terminal tips as the heat of the soldering operation may result in the cracking of the lead seals. The tube terminal tips should not be used to support coils, condensers, chokes, or other circuit parts.

The *bulb* becomes very hot during continuous operation so that free circulation of air should be provided. When the 834 is operated at frequencies higher than 60 megacycles, forced cooling of the tube is recommended. This may be done by means of a small electric fan. Under any condition of operation the maximum bulb temperature should not exceed 175°C (347°F) as measured by a thermometer placed against the glass at the top of the tube, midway between the grid and plate leads. Care should be taken that the bulb does not come in contact with any metallic object nor be subjected to the spray of any liquid. The installation of all wires and connections should be made so that they will not be close to or touch the bulb in order to avoid puncture of the glass due to peak voltage effects.

The *filament* of the 834 is of the thoriated-tungsten type. It may be operated either from an a-c or a d-c source. Except where a d-c source is necessary to avoid hum, an a-c filament supply is generally used because of its convenience. A suitable voltmeter should be connected permanently across the tube filament terminals to provide a ready check of the filament voltage. This voltage should not vary more than plus or minus 5% from the rated value; otherwise, a loss of filament emission may result. When an a-c source is used, rheostat control should be placed in the primary circuit of the filament transformer. When the apparatus in which the tube is used is idle for short periods of time, the filament should be maintained at its rated voltage during the "standbys".

The *grid return and the plate return* should be connected to the center tap on the filament winding of the transformer, or to the midpoint of a center-tapped resistor across the filament terminals. When cathode-bias is used, the returns are connected to the same points through the cathode-bias resistor. In cases where d.c. is used on the filament, these returns should be connected to the negative filament terminal.

The plate dissipation of the 834 (the difference between plate input and power output) should never exceed the maximum values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. These values are indicated by a barely perceptible red color on the plate under actual operating conditions.

Overheating of the 834 by severe overload may decrease filament emission. Unless the overload has liberated a large amount of gas, the activity of the filament can sometimes be restored by operating the filament at rated voltage for ten minutes or more with no voltage on the plate or grid. This process may be accelerated by raising the filament voltage to 9 volts (not higher) for a few minutes.

Heavy leads and conductors together with suitable insulation should be used in all parts of the r-f plate tank circuit so that the losses, due to the r-f voltages and currents, may be kept at a minimum. Since proper circuit design becomes very important at the higher frequencies, it is essential that short, heavy leads and circuit returns are used in order to minimize lead inductance and losses.

A d-c milliammeter in the plate circuit is necessary in order that the plate current will always be known. Under no condition should the d-c plate current exceed the maximum values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. In order to prevent overheating due to improper circuit adjustments, to overloading, or to loss of grid bias, the plate circuit should be provided with a protective device such as a fuse. This device should instantly remove the plate voltage when the d-c plate current reaches a value of 50% greater than normal.

In order that the maximum ratings given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS will not be exceeded, changes in plate and filament voltages due to line-voltage fluctuation, load variation, and manufacturing variation of the associated apparatus must be determined. An average value of plate and filament voltage should then be chosen so that under the usual voltage variations the maximum rated voltages will not be exceeded.

When a new circuit is tried or when adjustments are made, the plate voltage should be reduced in order to prevent damage to the tube or associated apparatus in case the circuit adjustments are incorrect. It is advisable to use a protective resistance of about 5000 ohms in series with the plate lead during such adjustments. Suitable meters should be provided for measuring tube voltages and currents. In addition to their use in indicating suitable operating conditions, they are also of value in making initial transmitter adjustments. However, to assist in the making of final adjustments for optimum performance, it is recommended that a cathode-ray oscillograph be used. Under no conditions should the maximum values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS be exceeded.

The rated plate voltage of this tube is high enough to be dangerous to the user. Care should be taken during the adjustment of cir-

cuits, especially those in which the exposed circuit parts are at the high d-c plate potential.

APPLICATION

As a *Class B radio-frequency amplifier*, RCA-834 should be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. In this service the plate is supplied with unmodulated d-c voltage and the grid is excited by r-f voltage modulated at audio frequency in one of the preceding stages. It is important to note that in this service the plate dissipation is greatest when the carrier is unmodulated. The plate dissipation, therefore, should not exceed 50 watts for unmodulated carrier conditions. When the 834 is used as a Class B r-f amplifier, plate voltage as high as 1250 volts may be used provided the d-c plate current is reduced so that the maximum plate-input rating of 75 watts is not exceeded. Likewise, the d-c plate current may be raised to 100 milliamperes, provided the plate voltage is reduced so that the maximum input rating is not exceeded. Grid bias for the 834 in Class B service should be obtained from a battery or other d-c source of good regulation. It should not be obtained from a high-resistance supply such as a grid leak, nor from a rectifier, unless the latter has exceptionally good voltage regulation.

As a *plate modulated Class C radio-frequency amplifier*, the 834 should be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid bias for this service may be obtained from a grid leak of about 15000 ohms (15-watt size), from a suitable combination of grid leak and fixed supply of good regulation, or from a cathode-bias resistor suitably by-passed for audio and radio frequencies. The combination method is particularly desirable because distortion effects are minimized by bias-supply compensation. Since the grid-bias voltage for Class C service is not particularly critical, correct adjustment may be obtained with values differing widely from those indicated for this service.

As a *Class C radio-frequency amplifier and oscillator for telegraph service*, RCA-834 may be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid bias for this service may be obtained from a grid leak of 10000 ohms, from a battery, from a rectifier, or from a cathode-bias resistor (preferably variable) suitably by-passed for radio frequencies. The cathode-bias method is advantageous due to the fact that the grid bias is automatically regulated in direct proportion to the sum of the plate and grid current and that there is little chance of the plate current becoming dangerously high, even if the r-f grid excitation is removed. The grid-leak bias method has the advantage of simplicity and of automatically biasing the grid in proportion to the excitation voltage available. Special care must be observed with the use of the latter system because the accidental removal of the excitation will cause the grid bias to fall to zero so that the plate current, and consequently the plate dissipation, will rise to excessive values. The use of a protective device designed to open the plate circuit on excessive rises of plate

current will minimize the danger of overload (see INSTALLATION). Since the grid-bias voltage for Class C service is not particularly critical, correct adjustment may be obtained with widely different values.

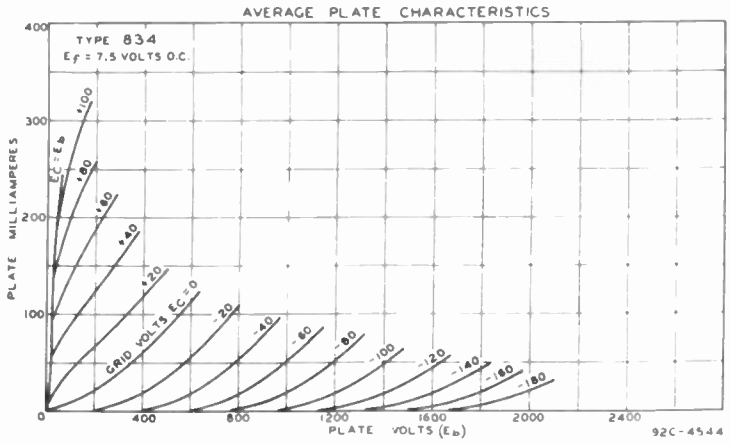
The *d-c grid current* will vary with individual tubes. Under any condition of operation, the maximum value should not exceed 20 milliamperes.

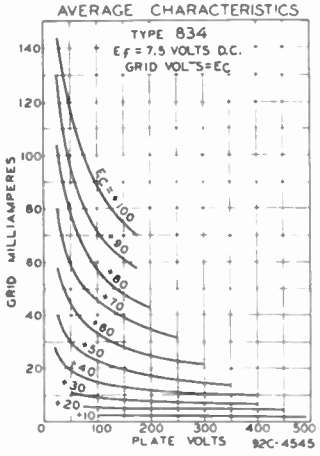
RCA-834 may be operated at maximum ratings in all classes of service at frequencies as high as 100 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced as the frequency is raised (other maximum ratings are the same as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS). The tabulation below shows the highest percentage of maximum plate voltage and power input that can be used at 100, 170 and 350 Mc for any class of service. *Special attention should be given to adequate ventilation and the maintenance of normal ambient temperatures at these frequencies. See INSTALLATION.*

FREQUENCY	100	170	350	Megacycles
PERCENTAGE of MAX. RATED PLATE VOLTAGE and PLATE INPUT	100 *max.*	75 *max.*	50 *max.*	Per Cent

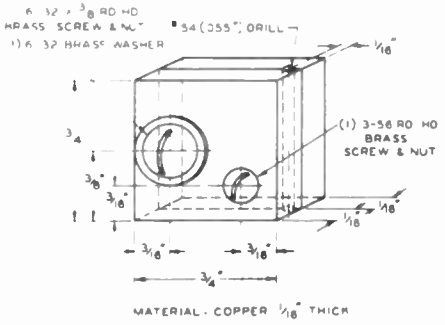
With the grid connected to the plate through the shortest possible connection, the resonant frequency of the grid-plate circuit is approximately 500 megacycles and the power output approximately zero.

If more radio-frequency power output is required than can be obtained from a single 834, the push-pull or the parallel connection may be used. For example, two tubes connected in push-pull or in parallel will give approximately twice the power output of one tube. The parallel connection requires no increase in exciting voltage; the push-pull connection requires twice the r-f excitation necessary to drive a single tube. With either connection the driving power required is approximately twice that for single-tube operation while the grid bias is the same as for a single tube. The push-pull arrangement has the advantage of cancelling the even-order harmonics from the output and of simplifying the balancing of high-frequency circuits. When two or more RCA-834's are operated in parallel, a non-inductive resistance of 10 to 100 ohms should be placed in series with the grid lead of each tube, close to the socket terminal, to prevent parasitic oscillations.



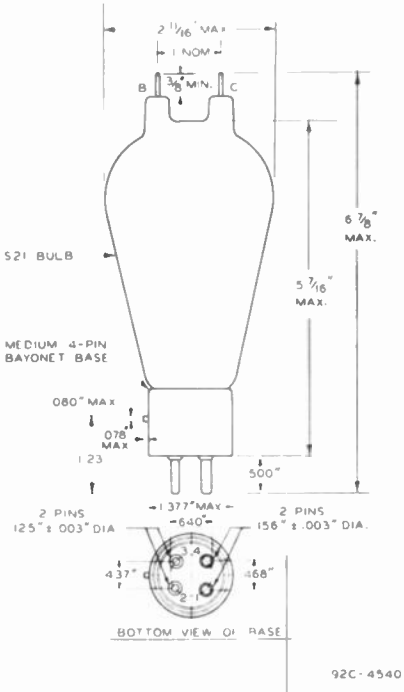


RADIATING CONNECTOR

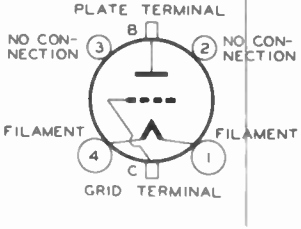


834

OUTLINE DRAWING



Tube Symbol and Top View of Socket Connections



838

Class B Modulator, R-F Power Amplifier, Oscillator

RCA-838 is a three-electrode type of tube designed primarily for use as a zero-bias Class B audio-frequency power amplifier. The grid is designed so that the amplification factor of the tube varies with the amplitude of the input signal. This feature facilitates the design of Class B amplifiers to give high output with low distortion. In Class B audio service, two tubes of this type are capable of giving an output of 260 watts with less than 5% distortion. The 838 may also be used as a radio-frequency power amplifier and oscillator at maximum ratings for frequencies as high as 30000 kilocycles. For any class of service, the maximum plate dissipation of RCA-838 is 100 watts.

CHARACTERISTICS

FILAMENT VOLTAGE (A.C. or D.C.)	10	Volts
FILAMENT CURRENT	3.25	Amperes
DIRECT INTERELECTRODE CAPACITANCES (Approx.):		
Grid-Plate	8	μμf
Grid-Filament	6.5	μμf
Plate-Filament	5	μμf
BULB	T-18	
BASE (For connections and tube dimensions, see page 8)	Jumbo 4-Large Pin	

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

As A-F Power Amplifier and Modulator - Class B

D-C PLATE VOLTAGE	1250 max.	Volts
MAX.-SIGNAL D-C PLATE CURRENT*	175 max.	Milliamperes
MAX.-SIGNAL PLATE INPUT*	220 max.	Watts
PLATE DISSIPATION*	100 max.	Watts

TYPICAL OPERATION:

Unless otherwise specified, values are for 2 tubes

Filament Voltage (A.C.)[00]	10	10	Volts
D-C Plate Voltage	1000	1250	Volts
D-C Grid Voltage	0	0	Volts
Peak A-F Grid-to-Grid Voltage	200	200	Volts
Zero-Sig. D-C Plate Current	106	148	Milliamperes
Max.-Sig. D-C Plate Current	320	320	Milliamperes
Load Resistance (Per tube)	1725	2250	Ohms
Effective Load Res. (Plate-to-plate)	6900	9000	Ohms
Max.-Sig. Driving Power (Approx.)	7	7.5	Watts
Max.-Sig. Power Output (Approx.)#	200	260	Watts

* Average over any audio-frequency cycles.

\# Approximately 4% harmonic distortion.

[00] Grid voltages are given with respect to the mid-point of filament operated on a.c. If d.c. is used, each stated value of the grid voltage should be decreased by 5.0 volts and the circuit returns made to the negative end of the filament.

As R-F Power Amplifier - Class B Telephony

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

D-C PLATE VOLTAGE			1250 *max.*	Volts
D-C PLATE CURRENT			150 *max.*	Milliamperes
R-F GRID CURRENT			6 *max.*	Amperes
PLATE INPUT			150 *max.*	Watts
PLATE DISSIPATION			100 *max.*	Watts
TYPICAL OPERATION:				
Filament Voltage (A.C.) ^{oo}	10	10		Volts
D-C Plate Voltage	1000	1250		Volts
D-C Grid Voltage	0	0		Volts
Peak R-F Grid Voltage	70	60		Volts
D-C Plate Current	130	106		Milliamperes
D-C Grid Current (Approx.) **	15	15		Milliamperes
Driving Power (Approx.) ** ^{o}	8	6		Watts
Power Output (Approx.)	40	42.5		Watts

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

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

D-C PLATE VOLTAGE			1000 *max.*	Volts
D-C PLATE CURRENT			175 *max.*	Milliamperes
D-C GRID CURRENT			70 *max.*	Milliamperes
R-F GRID CURRENT			6 *max.*	Amperes
PLATE INPUT			175 *max.*	Watts
PLATE DISSIPATION			67 *max.*	Watts
TYPICAL OPERATION:				
Filament Voltage (A.C.)	10	10		Volts
D-C Plate Voltage	750	1000		Volts
D-C Grid Voltage	-100	-135		Volts
Peak R-F Grid Voltage	220	255		Volts
D-C Plate Current	150	150		Milliamperes
D-C Grid Current (Approx.) **	60	60		Milliamperes
Driving Power (Approx.) **	14	16		Watts
Power Output (Approx.)	65	100		Watts

As R-F Power Amplifier and Oscillator - Class C Telegraphy

Key-down conditions per tube without modulation §§

D-C PLATE VOLTAGE			1250 *max.*		Volts
D-C PLATE CURRENT			175 *max.*		Milliamperes
D-C GRID CURRENT			70 *max.*		Milliamperes
R-F GRID CURRENT			7.5 *max.*		Amperes
PLATE INPUT			220 *max.*		Watts
PLATE DISSIPATION			100 *max.*		Watts
TYPICAL OPERATION:					
Filament Voltage (A.C.)	10	10	10		Volts
D-C Plate Voltage	750	1000	1250		Volts
D-C Grid Voltage	-80	-85	-90		Volts
Peak R-F Grid Voltage	190	195	200		Volts
D-C Plate Current	150	150	150		Milliamperes
D-C Grid Current (Approx.) **	30	30	30		Milliamperes
Driving Power (Approx.) **	6	6	6		Watts
Power Output (Approx.)	65	100	130		Watts

** 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 positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

° At crest of audio-frequency cycle.

INSTALLATION

The *base* pins of the RCA-838 fit the standard transmitting four-contact socket, such as the RCA type UT-541. The socket should be installed so that the tube will operate in a vertical position with the base down. If the tube is subjected to vibration or shock, a shock-absorbing suspension must be employed. Because of the relatively heavy filament current taken by this tube, the socket should make firm, large-surface contact with the filament-base pins. Heavy, well-soldered leads should be used for the filament-circuit wiring.

The *bulb* of this tube becomes very hot during continuous operation. Free circulation of air, therefore, should be provided. Care should be taken that the bulb does not come in contact with any metallic object nor be subjected to the drops or spray of liquid. The installation of all wires and connections should be made so that they will not be close to or touch the bulb in order to avoid puncture of the glass due to peak voltage effects.

The *filament* of the 838 is of the thoriated-tungsten type. It may be operated either from an a-c or a d-c source. Except where a d-c source is necessary to avoid hum, an a-c filament supply is generally used because of its convenience. A voltmeter should be connected permanently across the filament terminals to provide a ready check of the filament voltage. This voltage should not vary more than plus or minus 5% from the rated value. Deviation from the rated voltage may result in a loss of filament emission. When an a-c source is used, rheostat control should be placed in the primary circuit of the filament transformer. When the apparatus in which the tube is used is idle for periods not exceeding two hours, the filament should be maintained at its rated voltage during the "standbys".

The *grid return and the plate return* should be connected to the center tap on the filament winding of the transformer, or to the mid-point of a center-tapped resistor across the filament terminals. When cathode-bias is used, the returns are connected to the same points through the cathode-bias resistor. In cases where d.c. is used on the filament, these returns should be connected to the negative filament terminal.

The plate dissipation of the RCA-838 (the difference between plate input and power output) should never exceed the values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. The maximum values are indicated by a barely perceptible red color on the plate under actual operating conditions.

Overheating of the 838 by severe overload may decrease filament emission. Unless the overload has liberated a large amount of gas, the activity of the filament can sometimes be restored by operating the filament at rated voltage for ten minutes or more with no voltage on the plate or grid. This process may be accelerated by raising the filament voltage to 12 volts (not higher) for a few minutes.

A d-c milliammeter should always be used in the plate circuit to provide a ready check of the plate current. Under no condition should the d-c plate current exceed the maximum values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS.

In order to prevent overheating due to improper circuit adjustments, or to overloading, the plate circuit should be provided with a protective device such as a fuse. This device should instantly remove the plate voltage when the d-c plate current reaches a value 50% greater than normal.

Heavy leads and conductors together with suitable insulation should be used in all parts of the r-f plate tank circuit so that the losses, due to the r-f voltages and currents, may be kept at a minimum. The importance of minimizing these losses increases at the higher frequencies.

In order that the maximum ratings given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS will not be exceeded, changes in plate and filament voltages due to line-voltage fluctuation, load variation, and manufacturing variation of the associated apparatus, must be determined. An average value of plate and filament voltage should then be chosen so that under the usual voltage variations the maximum rated voltages will not be exceeded.

When a new circuit is tried or when adjustments are made, the plate voltage should be reduced in order to prevent damage to the tube or associated apparatus in case the circuit adjustments are incorrect. It is advisable to use a protective resistance of about 3000 ohms in series with the plate lead during such adjustments.

The rated plate voltage of this tube is high enough to be dangerous to the user. Great care should be taken during the adjustment of circuits, especially those in which the exposed circuit parts are at high d-c plate potential.

APPLICATION

As a *Class B modulator or audio-frequency amplifier*, two 838's are used in a balanced circuit, each tube conducting only half the time. The d-c plate current should never exceed 175 milliamperes per tube. Due to the zero-grid bias characteristic of the 838, grid current is drawn on any input signal. Therefore, the input transformer can be designed for operation under approximately uniform loading conditions to give excellent frequency response. It should also be designed to handle the required input power for a strong signal. The

output transformer should be designed so that the resistance load presented by the modulated Class C amplifier is reflected as a plate-to-plate load of 7600 ohms in the Class B stage for the 1000-volt conditions. If an output transformer efficiency of 90 per cent is assumed, two 838's operated under conditions shown for a 1000-volt plate supply are capable of modulating 100% an input of 360 watts to a Class C r-f power amplifier. Since two 838's will modulate 360 watts, a convenient Class C stage amplifier would be one operating at 2000 volts and 180 milliamperes. These conditions represent a resistance of approximately 11110 ohms. The ratio of the output transformer is then $\sqrt{11110 \div 7600}$, or 1 to 1.21, step-up. The transformer should be designed with a core sufficiently large to avoid saturation effects which would impair the quality of the output. If the secondary is to carry the d-c plate current of the modulated amplifier, the core should be made larger and include an air-gap to compensate for the d-c magnetization current. Because of the unusual design of the 838, it can be operated with zero bias on the grid in Class B service. With zero-bias operation, the grid circuit should be connected directly to the filament (see INSTALLATION).

In special cases where it is desirable to keep the audio-frequency distortion of the Class B a-f amplifier or modulator to a value lower than 4%, the use of a small amount of grid-bias voltage is advantageous. Typical operating conditions are approximately the same as those for zero-bias operation. With a plate-supply voltage of 1250 volts, the exceptions are: grid-bias voltage, -15 volts; peak a-f grid voltage, 105 volts; and zero-signal d-c plate current, 25 milliamperes (per tube).

As a *Class B radio-frequency amplifier*, RCA-838 should be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. In this service the plate is supplied with unmodulated d-c voltage and the grid is excited by r-f voltage modulated at audio frequency in one of the preceding stages. It is important to note that for Class B r-f operation the plate dissipation is greatest when the carrier is unmodulated. The plate dissipation, therefore, should not exceed 100 watts for unmodulated conditions. Grid bias can be obtained in the same manner as for Class B a-f service.

As a *plate-modulated Class C radio-frequency amplifier*, RCA-838 may be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid bias for this service may be obtained from a grid leak of about 3000 ohms (50-watt size), from a battery, from a rectifier, or from a cathode-bias resistor (preferably variable) suitably bypassed for audio and radio frequencies. The grid-leak-bias method is particularly useful in this service because it has the advantage of simplicity and of automatically biasing the grid in proportion to the excitation voltage available. With the grid-leak method, even when the grid excitation is accidently removed, the probability of tube damage is small because of the high amplification factor of the tube and its resultant low zero-bias plate current. Since the grid-bias voltage for Class C service is not particularly critical, correct adjustment may be obtained with widely different values.

As a *Class C r-f amplifier for telegraph service,* RCA-838 may be operated as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Grid bias for this service can be obtained in the same manner as for plate-modulated Class C r-f service.

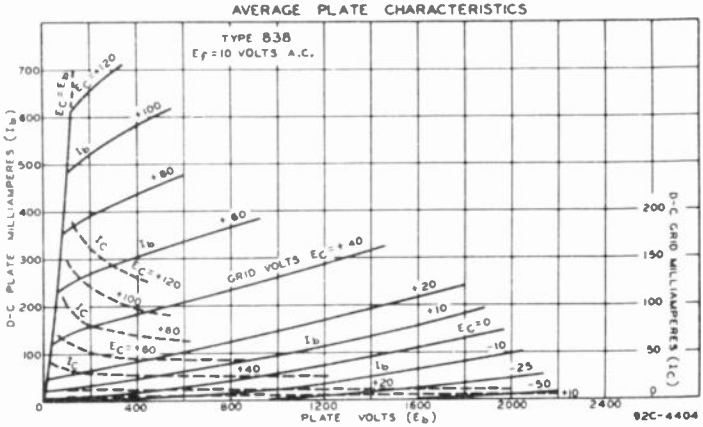
The *d-c grid current* will vary with individual tubes. Under any condition of operation the maximum value should not exceed 70 milliamperes.

RCA-838 may be used at maximum ratings at frequencies as high as 30 mc. Although the general use of this tube is not recommended above 30 mc., it is feasible to operate the tube in carefully-tuned and well-designed trial circuits at the higher frequencies provided the plate voltage is reduced in accordance with the following table. At these frequencies, special attention should be given to adequate ventilation and the maintenance of normal ambient temperatures.

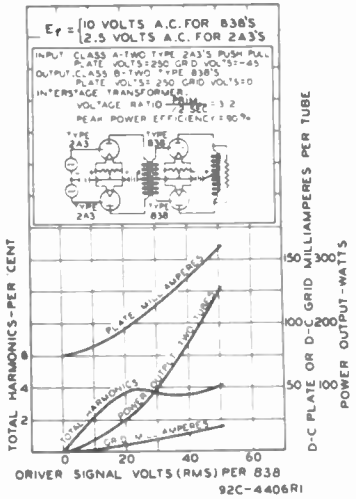
FREQUENCY	30	60	90	Megacycles
PLATE VOLTAGE (Max.)				
Class B Telephony	1250	800	600	Volts
Class C Telegraphy	1250	800	600	Volts
Class C Telephony	1000	650	450	Volts

If more power output is required than can be obtained from a single 838, the push-pull or the parallel connection may be used. For example, two tubes connected in push-pull or in parallel will give approximately twice the power output of one tube. The parallel connection requires no increase in exciting voltage; the push-pull connection requires twice the r-f excitation necessary to drive a single tube. With either connection the driving power required is approximately twice that for single-tube operation while the grid bias is the same as for a single tube. The push-pull arrangement has the advantage of cancelling the even-order harmonics from the output and of simplifying the balancing of high-frequency circuits. When two or more RCA-838's are operated in parallel, a non-inductive resistance of 10 to 100 ohms should be placed in series with the grid lead of each tube, close to the socket terminal, to prevent parasitic oscillations.

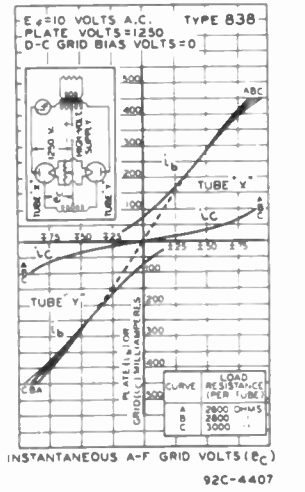
AVERAGE PLATE CHARACTERISTICS



OPERATION CHARACTERISTICS

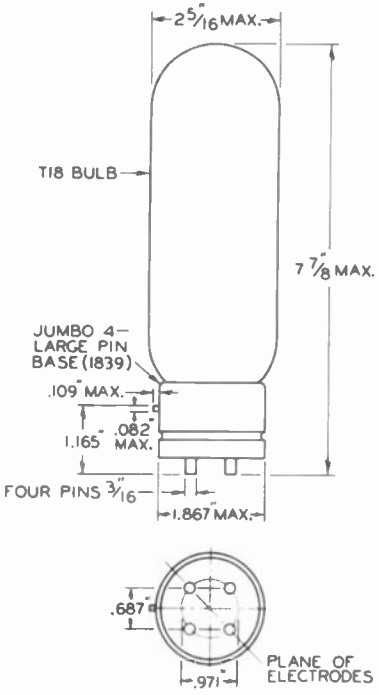


DYNAMIC TRANSFER CHARACTERISTICS



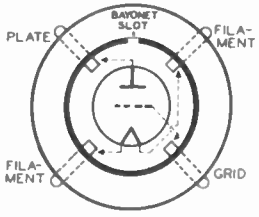
838

OUTLINE DRAWING



BOTTOM VIEW OF BASE

Tube Symbol and Top View of Socket Connections



850

Screen Grid R-F Power Amplifier

The RCA-850 is a screen grid tube for use primarily as a radio-frequency amplifier at frequencies up to 13 megacycles. Its control grid is brought out through the separate seal at the top of the bulb. Neutralization to prevent feedback and self-oscillation is generally unnecessary when this tube is used in adequately shielded circuits.

CHARACTERISTICS

FILAMENT VOLTAGE (A.C. or D.C.)	10.0	Volts
FILAMENT CURRENT	3.25	Amperes
AMPLIFICATION FACTOR	550	
MUTUAL CONDUCTANCE (For plate current of 19.5 ma.)	2750	Micromhos
GRID-PLATE CAPACITANCE	0.25 *max.*	μμf
INPUT CAPACITANCE	17	μμf
OUTPUT CAPACITANCE	25	μμf
BULB (For dimensions, see page 80)	T-18	
CAP (For connection, see page 78)	Medium Metal	
BASE (For socket connections, see page 78)	Jumbo 4-Large Pin	

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

As R-F Power Amplifier - Class B (Telephony)

Carrier Conditions; for use with a Modulation Factor up to 1.0

D-C PLATE VOLTAGE		1250 *max.*	Volts
D-C PLATE CURRENT		150 *max.*	Milliamperes
PLATE DISSIPATION		100 *max.*	Watts
SCREEN DISSIPATION		10 *max.*	Watts
R-F GRID CURRENT		6 *max.*	Amperes
TYPICAL OPERATION:			
Filament Voltage (A.C.)	10	10	Volts
D-C Plate Voltage	1000	1250	Volts
Screen Voltage (approximate)	175	175	Volts
Grid Voltage (approximate)	-13	-13	Volts
D-C Plate Current	100	110	Milliamperes
Peak Power Output (approximate)	120	160	Watts
Carrier Power Output (approximate)	30	40	Watts

As Plate-Modulated R-F Power Amplifier - Class C (Telephony)

Carrier Conditions; for use with a Modulation Factor up to 1.0

D-C PLATE VOLTAGE	1000 *max.*	Volts
D-C PLATE CURRENT	150 *max.*	Milliamperes
PLATE DISSIPATION	70 *max.*	Watts
SCREEN DISSIPATION	7 *max.*	Watts
R-F GRID CURRENT	6 *max.*	Amperes
D-C GRID CURRENT	40 *max.*	Milliamperes

TYPICAL OPERATION:				
Filament Voltage (A.C.)	10	10		Volts
D-C Plate Voltage	750	1000		Volts
Screen Voltage (approximate)	125	140		Volts
Grid Voltage (approximate)	-100	-100		Volts
D-C Plate Current	140	125		Milliamperes
D-C Grid Current*	40	40		Milliamperes
Driving Power*	10	10		Watts
Power Output (approximate)	50	65		Watts

As R-F Power Amplifier and Oscillator - Class C (Telegraphy)
(Key Down Conditions)

D-C PLATE VOLTAGE			1250 *max.*	Volts
D-C PLATE CURRENT			175 *max.*	Milliamperes
PLATE DISSIPATION			100 *max.*	Watts
SCREEN DISSIPATION			10 *max.*	Watts
PLATE INPUT			220 *max.*	Watts
R-F GRID CURRENT			7.5 *max.*	Amperes
D-C GRID CURRENT			40 *max.*	Milliamperes
TYPICAL OPERATION:				
Filament Voltage (A.C.)	10	10	10	Volts
D-C Plate Voltage	750	1000	1250	Volts
Screen Voltage (approximate)	175	175	175	Volts
Grid Voltage (approximate)	-150	-150	-150	Volts
D-C Plate Current	160	160	160	Milliamperes
D-C Grid Current*	35	35	35	Milliamperes
Driving Power*	10	10	10	Watts
Power Output (approximate)	55	100	130	Watts

*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.

INSTALLATION

The *base* pins of the RCA-850 fit the standard four-contact socket. A clip is used for connection to the control-grid cap. The socket should be installed so that the tube will operate in a vertical position. If the tube is subjected to vibration or shock, a shock-absorbing suspension must be employed.

The *bulb* of this tube becomes very hot during continuous operation. Free circulation of air, therefore, should be provided. If it is necessary to mount an 850 in a place where natural ventilation is poor, forced air cooling should be used. Care should be taken that the bulb does not come in contact with any metallic object nor be subjected to the drops or spray of liquid. The installation of all wires and connections should be made to allow at least several inches of free space around the tube in order to avoid puncture of the glass due to peak-voltage effects.

The *filament* of the 850 should be operated preferably from an a-c source, although a d-c supply may be used. A voltmeter should be connected permanently across the filament circuit at the socket terminals so that the filament voltage can be maintained at 10 volts. This voltage should not vary more than plus or minus five per cent from the rated value. When an a-c source is used, rheostat control should be placed in the primary circuit of the filament transformer. Deviation from the rated voltage may result in a loss of filament emission. In radio transmitters during "standby" periods, the filament should be maintained at its rated voltage.

The *grid return and the plate return* should be connected to the center tap on the filament winding of the transformer, or to the midpoint of a center-tapped resistor across the filament terminals. In cases where d.c. is used on the filament, these returns should be connected to the negative filament terminal.

Overheating of the 850 by severe overload may decrease filament emission. Unless the overload has liberated a large amount of gas, the activity of the filament can sometimes be restored by operating the filament at rated voltage for ten minutes or more with no voltage on the plate, screen, or grid. This process may be accelerated by raising the filament voltage to 12 volts (not higher) for a few minutes.

A d-c milliammeter should be used in the plate circuit in order that the plate current can always be known. Under no condition should the d-c plate current exceed the maximum values given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS.

Heavy leads and conductors together with suitable insulation should be used in all parts of the r-f plate tank circuit, in order that the losses, due to the r-f voltages and currents, be kept at a minimum. These losses are especially troublesome at the higher frequencies.

The *screen voltage* for this tube may be obtained either from a separate source or from the plate supply through a series resistance of 50-watt rating. When the series-resistance method is used, the value of the series resistance should be chosen to reduce the high-voltage supply to a screen voltage approximately one-sixth to one-fourth the plate voltage. A d-c milliammeter should be used in the screen circuit so that the screen current, and consequently the screen dissipation, can always be known. The screen should never be allowed to attain a temperature corresponding to more than a dull red color (approximately 10 watts dissipation). The following tabulation gives the *minimum* values of resistance (ohms) for various supply voltages.

SUPPLY VOLTS	500	750	1000	1250
SERIES RESISTOR (Ohms)	7000	15000	25000	40000

The resistance method for obtaining screen voltage is generally

to be preferred since it serves to maintain the proper screen current. With this method, however, it is important that the high-voltage-supply switch be opened before the filament circuit is opened; otherwise, full supply voltage will be placed on the screen. If the screen voltage is obtained from a separate source, or from a potentiometer, plate voltage should be applied before the screen voltage or simultaneously with it; otherwise, with voltage on the screen only, screen current may be large enough to cause excessive screen dissipation.

A protective device should be placed in the common negative plate and screen lead of the RCA-85C to prevent the tube from drawing excessive plate and screen current. This device should preferably open the high-voltage supply when the d-c plate current and d-c screen current reach a value 50 per cent greater than normal.

Adequate *shielding* and isolation of the input circuit and the output circuit are necessary if optimum results are to be obtained. The impedance between the screen and filament must be kept as low as possible by the use of a by-pass condenser. This condenser should have a voltage break-down rating high enough to withstand the full plate voltage of the tube. The capacity value of the condenser will depend upon circuit design. See APPLICATION.

In order not to exceed the maximum ratings given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS, changes in plate and filament voltages due to line-voltage fluctuation, load variation, and manufacturing variation of the associated apparatus must be determined. An average value of plate and filament voltage should then be chosen so that under the usual voltage variations, the maximum rated voltages will not be exceeded.

When a new circuit is being tested or when adjustments are being made, the plate voltage should be reduced in order to prevent damage to the tube or associated apparatus in case the circuit adjustments are incorrect. It is advisable to use a protective resistance of about 3000 ohms in series with the common negative plate and screen lead during such adjustments.

The rated plate voltage of this tube is high enough to be exceedingly dangerous to the user. The greatest care should be taken when handling or adjusting circuits, especially those in which the plate tank coil and condenser are at the d-c plate potential.

APPLICATION

As a *Class B or a Class C radio-frequency amplifier,* the RCA-85C may be used as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS.

In *Class B* radio-frequency service, the plate is supplied with unmodulated d-c voltage and the grid is excited by r-f voltage modulated at audio frequency in one of the preceding stages. The plate

dissipation should not exceed 100 watts for unmodulated carrier conditions.

Grid bias for the 850 as a Class B r-f amplifier should be obtained from a battery or other d-c source of good regulation. It should not be obtained from a high-resistance supply such as a grid-leak, nor from a rectifier, unless the latter has exceptionally good voltage regulation. For *Class C (telegraph) service*, grid bias may be obtained from a grid leak of about 5000 ohms, from a battery, from a rectifier of good regulation, or from a self-biasing resistor (preferably variable) by-passed with a suitable condenser. The self-biasing method is especially desirable due to the fact that the grid bias is automatically regulated and that there is little chance of the plate current becoming dangerously high either with or without r-f grid excitation. When the grid-leak method of obtaining grid bias is used, bias is on the tube *only when r-f grid excitation is applied*. Since grid-bias values are not particularly critical, correct circuit adjustment may be obtained with widely different values. For *Class C (telephone) service*, fixed bias is recommended because it eliminates the problems of degeneration caused by a-c voltage variation developed across the biasing system.

The *d-c grid current* will vary with individual tubes. Under any condition of operation, the maximum value should not exceed 40 milliamperes.

RCA-850 may be operated at full input at frequencies up to 13 megacycles (23.5 meters). The tube may be used at frequencies as high as 30 megacycles (10 meters) with reduced input. When the 850 is operated at frequencies in excess of 13 mc., the plate voltage, plate current, plate dissipation, and d-c grid current should be reduced as the frequency is raised, so that at 30 mc., these values will be less than approximately 50 per cent of the MAXIMUM RATINGS.

If more power output is required than can be obtained from a single 850, two of these tubes may be used either in parallel or in push-pull. The parallel connection provides approximately twice the power output of a single tube without an increase in exciting voltage, while the push-pull connection gives twice the output but requires twice the r-f excitation voltage; with either connection, the grid bias is the same as for a single tube. The push-pull arrangement is advantageous in reducing the shunting effect of the inter-electrode capacities, inasmuch as these capacities are in series. This reduction is especially desirable when the tubes are operated at the higher frequencies.

When two or more RCA-850's are operated in parallel, a non-inductive resistance of 10 to 100 ohms should be placed in series with the grid lead of each tube, close to the socket terminal, to prevent parasitic oscillations.

As a *plate-modulated amplifier*, the 850 is capable of being modulated 100 per cent. Best results can usually be obtained by using

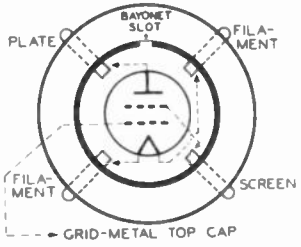
a separate source of screen voltage of about one-sixth of the plate voltage. The screen voltage should be modulated with the plate voltage so that the percentage changes in both voltages are approximately equal. This can be done by connecting the screen to a separate winding on the modulation transformer or, through a blocking condenser, to a tap on the modulation transformer or choke. In the latter case an a-f choke should be connected in the screen-supply lead.

The series-resistance method for supplying the screen voltage to the modulated tube may also be used, provided the screen is connected through the series resistor directly to the unmodulated d-c voltage supply.

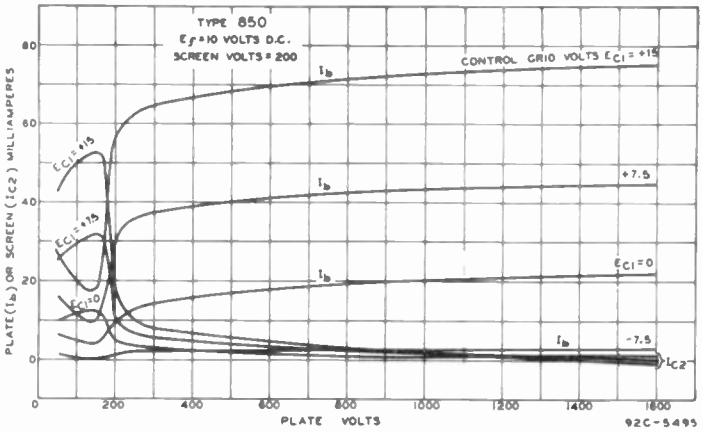
The screen by-pass condenser should be about 0.1 μf. Values larger than this may cause excessive a-f by-passing; smaller values may, depending on circuit layout, frequency, gain, and desired fidelity, cause excessive r-f feed back from plate to grid.

As an *oscillator*, the 850 should have its screen connected the same as in amplifier operation.

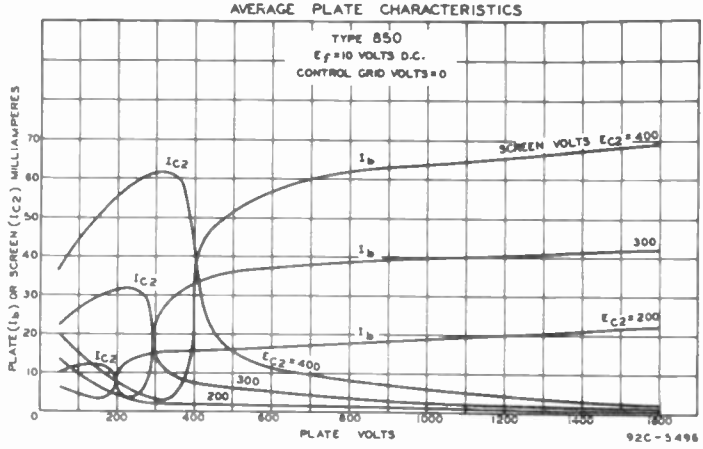
Tube Symbol and Top View of Socket Connections



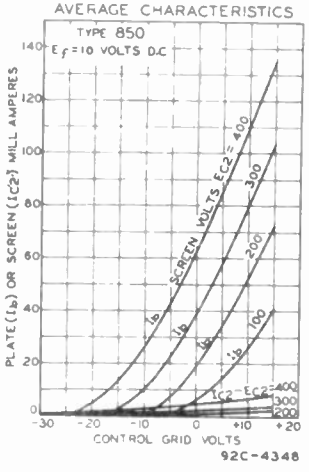
AVERAGE PLATE CHARACTERISTICS



AVERAGE PLATE CHARACTERISTICS

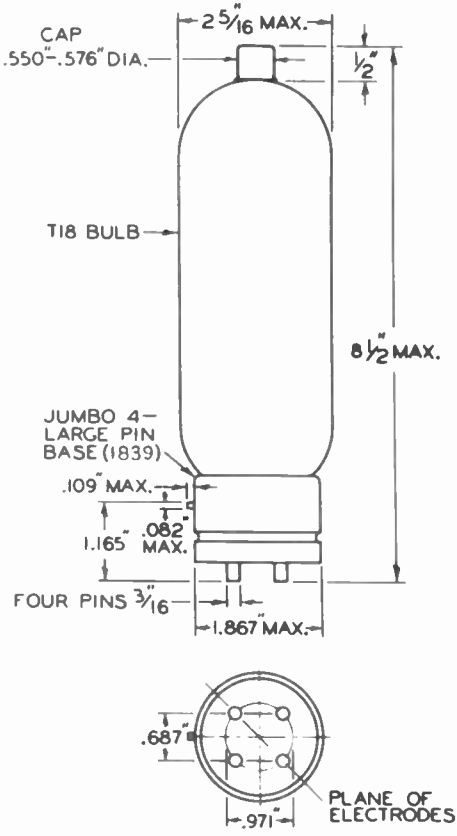


AVERAGE CHARACTERISTICS



850

OUTLINE DRAWING



BOTTOM VIEW OF BASE

866

Half-Wave Mercury-Vapor Rectifier

RCA-866 is a half-wave, mercury-vapor rectifier tube of the hot-cathode type. It is intended for use in high-voltage rectifying devices designed to supply d-c power of uniform voltage. In single-phase circuits, full-wave rectification is accomplished by using two 866's.

CHARACTERISTICS

FILAMENT VOLTAGE (A.C.)	2.5	Volts
FILAMENT CURRENT	5.0	Amperes
PEAK INVERSE VOLTAGE *		
For ambient temp. of 0° to 50°C	7500 *max.*	Volts
PEAK PLATE CURRENT	1.0 *max.*	Ampere
AVERAGE PLATE CURRENT	0.25 *max.*	Ampere
TUBE VOLTAGE DROP (Approx.)	15	Volts
BULB (For dimensions, see page 82)	S-19	
CAP (For connection, see page 82)	Medium Metal	
BASE (For socket connections, see page 82)	Medium 4-Pin Bayonet	

* For supply frequency up to 150 cycles.

INSTALLATION

The *base* pins of the 866 fit the standard four-contact socket which should be installed to hold the tube in a vertical position with the base down. Only a socket making very good filament contact and capable of carrying 5 amperes continuously should be used with the 866.

The *ambient* temperature of the 866 should be maintained between 0°C (32°F) and 50°C (122°F). The ambient temperature is the temperature of the air which comes in contact with the tube and carries off the heat. This temperature is to be measured by means of several thermometers placed at a distance of one-half inch from the base. If the tube is used in a location where the circulation of air is restricted, the temperature should be taken adjacent to the filament base and with the thermometer shielded so that the effects of direct-radiated heat are eliminated. When operated under load, the 866 has a characteristic blue glow. In service, the bulb will eventually darken. This darkening is normal and is not an indication of the end of tube life.

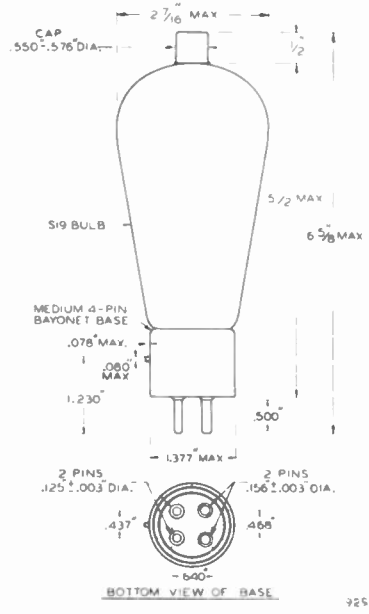
The filament of the 866 should be allowed to come up to operating temperature before the plate voltage is applied. For average conditions, the delay should be approximately 30 seconds.

Filter-Constants Table for Use with RCA-866

CIRCUIT	A-C INPUT VOLTS (RMS)	MAX. D-C OUTPUT VOLTS TO FILTER	CHOKE INPUT ONE-SECTION FILTER		MAX. D-C LOAD CURRENT AMPERES
			MIN. CHOKE (L) HENRYS	MAX. CONDENSER (C) µf	
SINGLE-PHASE FULL-WAVE (2-tubes)	2650 max. per tube	2385	6.0	1.6	0.5
	2000 per tube	1800	4.9	1.8	0.5
	1500 per tube	1350	3.3	2.8	0.5
	1000 per tube	900	2.1	4.2	0.5
SINGLE-PHASE FULL-WAVE (4-tubes)	5300 max. total	4770	12.0	0.8	0.5
	4500 total	4050	10.0	1.0	0.5
	4000 total	3600	8.4	1.2	0.5
	3000 total	2700	6.8	1.5	0.5
THREE-PHASE HALF-WAVE (3-tubes)	3065 max. per leg	3585	2.2	1.8	0.75
	2500 per leg	2925	1.7	2.4	0.75
	2000 per leg	2340	1.0	3.0	0.75
	1500 per leg	1755	0.8	4.0	0.75
THREE-PHASE PARALLEL DOUBLE-Y (6-tubes)	3065 max. per leg	3585	1.5	0.7	1.5
	2500 per leg	2925	1.2	0.9	1.5
	2000 per leg	2340	1.0	1.1	1.5
	1500 per leg	1750	0.7	1.5	1.5
THREE-PHASE FULL-WAVE (6-tubes)	3065 max. per leg	7175	1.5	0.84	0.75
	2500 per leg	5850	1.2	0.9	0.75
	2000 per leg	4680	1.0	1.0	0.75
	1500 per leg	3510	0.8	1.3	0.75
SINGLE-PHASE FULL-WAVE (2-tubes) Condenser Input	2650 max. per tube	3000	-	-	0.25
	2000 per tube	2260	-	-	0.25
	1500 per tube	1700	-	-	0.25
	1000 per tube	1150	-	-	0.25

* Based on 60-cycle a-c voltage supply.

OUTLINE DRAWING



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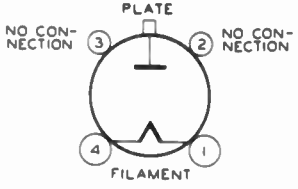
Tube Symbol and Top View of Socket Connections



954

Detector, Amplifier Pentode

(Acorn Type)

The 954 is a heater-cathode type of pentode designed primarily for radio amateurs and experimenters working with wavelengths as short as 0.7 meter. As an r-f amplifier at a wavelength of one meter, the 954 is capable of gains of three or more in circuits of conventional design. Higher gains are, of course, attainable at longer wavelengths. Operation at short wavelengths is made possible by means of unconventional tube structure having small size, close electrode spacing, and short terminal connections.

CHARACTERISTICS

HEATER VOLTAGE (A.C. or D.C.)	6.3	Volts
HEATER CURRENT	0.15	Ampere
DIRECT INTERELECTRODE CAPACITANCES:		
Grid-Plate (with shield baffle)	0.007 *max.*	μμf
Input	3	μμf
Output	3	μμf
BULB (For dimensions, see page 86)	Special	
TERMINAL MOUNTING (For connections, see page 89)	Special	

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

As Amplifier - Class A

D-C PLATE VOLTAGE		250 *max.*	Volts
D-C SCREEN (Grid No.2) VOLTAGE		100 *max.*	Volts
D-C SUPPRESSOR (Grid No.3) VOLTAGE		100 *max.*	Volts
TYPICAL OPERATION AS R-F AMPLIFIER:			
D-C Plate Voltage	90	250	Volts
D-C Screen Voltage	90	100	Volts
D-C Grid Voltage	-3	-3	Volts
Suppressor	Connected to cathode at socket		
Plate Current	1.2	2.0	Milliamperes
Screen Current	0.5	0.7	Milliampere
Amplification Factor	1100	Greater than 2000	
Plate Resistance	1.0	Greater than 1.5	Megohms
Mutual Conductance	1100	1400	Micromhos

As Detector

D-C PLATE VOLTAGE	250 *max.*	Volts
D-C SCREEN (Grid No.2) VOLTAGE	100 *max.*	Volts
D-C SUPPRESSOR (Grid No.3) VOLTAGE	100 *max.*	Volts
TYPICAL OPERATION AS BIASED DETECTOR:		
D-C Plate-Supply Voltage	250	Volts
D-C Screen Voltage	100	Volts
D-C Grid Voltage (Approx.)	-6	Volts
Suppressor	Connected to cathode at socket	

Plate Current	Adjusted to 0.1 ma. with no input signal
Plate Load*	250000 Ohms, or Equivalent Impedance

* For resistance load, voltage at the plate will be less than the plate-supply voltage by an amount equal to the voltage drop in the load resistor caused by the plate current.

INSTALLATION

The *terminals* of the 954 require a special method of mounting by means of clips supplied with each tube. The two small clips are for the control grid and the plate terminal at the bottom and top of the bulb, respectively. The five large clips may be fastened to a supporting insulator. For minimum losses, it is desirable to clip circuit parts directly to the control-grid terminal and to the plate terminal. Since the circumferential tube terminals are located symmetrically, a stop of insulating material should be placed between the screen clip and the suppressor clip so that the cathode terminal will prevent insertion of the heater terminals in the screen and suppressor clips. This stop is identified on the Terminal Mounting Template (page 89) as Alignment Plug. *Do not attempt to solder connections to the terminals.* The heat of the soldering operation is almost certain to crack the bulb seal.

The *heater* is designed to operate on either a.c. or d.c. When a.c. is used, the winding which supplies the heater circuit should operate the heater at its recommended value for full-load operating conditions at average line voltage. When d.c. is used on the heater, the heater terminals should be connected directly across a 6-volt battery. Under any condition of operation, the heater voltage should not deviate more than plus or minus 10% from the normal value of 6.3 volts. Series heater operation of the 954 is not recommended.

The *cathode* of the 954, when operated from a transformer, should preferably be connected directly to the electrical mid-point of the heater circuit. In the case of d-c operation from a 6-volt storage battery, the cathode circuit is tied in either directly or through bias resistors to the negative battery terminal. In circuits where the cathode is not directly connected to the heater, the potential difference between heater and cathode should be kept as low as possible. If the use of a large resistor is necessary between heater and cathode in some circuit designs, it is essential that this resistor be by-passed by a suitable filter network or objectional hum may develop.

The *screen* voltage may be obtained from a fixed tap on the B-battery, or from a potentiometer across the B-supply. The screen voltage may be obtained from the B-supply through a series resistor when the tube is self-biased by means of a cathode resistor. The latter method is not recommended if the B-supply exceeds 250 volts

Shielding of each r-f amplifier stage employing the 954 is required in order to prevent interstage coupling. A convenient method of shield construction is illustrated on page 89. The control-grid end of the tube is inserted through a hole in a metal plate so that the metal edge of the hole is in close proximity to the internal

shield in the control-grid end of the tube. It may be desirable, depending upon circuit requirements, to provide a small collar on the baffle hole in order to increase the shielding effect.

R-F grounding by means of condensers placed close to the tube terminals is required if the full capabilities of the 954 are to be realized at the ultra-high frequencies. Conventional by-passing methods and grounding are not adequate. One convenient method is to use ribbon lead-ins to the clips and to insulate the ribbon lead-ins and the terminal clips from the grounding plate by mica spacers to form by-pass condensers right at the tube terminals. It is important in the cases of the plate and control-grid circuits that separate r-f grounding returns be made to a common point in order to avoid r-f interaction through common return circuits. It may also be advisable in some applications to supplement the action of the by-pass condensers by r-f chokes placed close to the condensers in the return or supply lead for the control-grid, the screen, the suppressor, the plate, and the heater.

APPLICATION

As an *amplifier*, the 954 is applicable to the audio- or the radio-frequency stages of short-wave receivers, especially those operating at wavelengths as short as 6.7 meter. Typical operating conditions for this service are given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS.

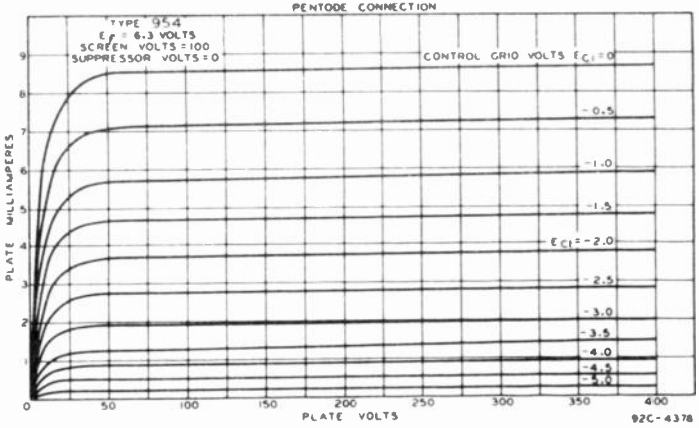
For a-f amplifier circuits, typical operating conditions are as follows: Plate-supply voltage, 250 volts; screen voltage, 50 volts; grid voltage, -2.1 volts; suppressor, connected to cathode at socket; plate-load resistor, 250000 ohms; and plate current, 0.5 milliampere. The grid resistor may be made as high as 1.0 megohm. Under these conditions, an undistorted voltage output of 40 to 50 volts RMS may be obtained. The voltage amplification is approximately 100.

As a *grid-bias detector*, the 954 may be operated under the conditions given under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. The grid bias may be supplied from the voltage drop in a resistor between cathode and ground. The value of this resistor is not critical, 20000 to 50000 ohms being suitable.

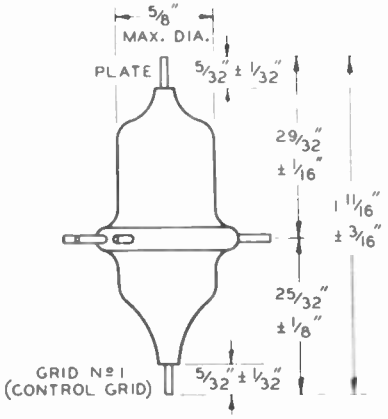
For *miscellaneous applications* in the laboratory, the 954 offers important features. For instance, its small size permits the design of vacuum-tube voltmeters such that the tube itself can be placed at the point of measurement. Thus, long leads and high input capacitances are avoided with the desirable result that measurements can be made at radio frequencies with a minimum effect on the constants of the circuit under measurement.

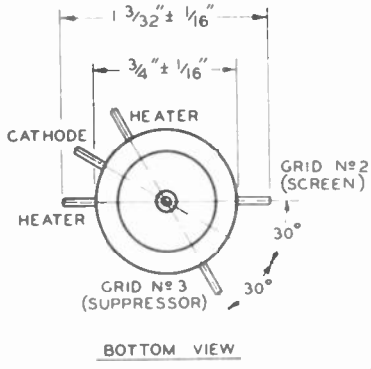
AVERAGE PLATE CHARACTERISTICS

PENTODE CONNECTION



OUTLINE DRAWING

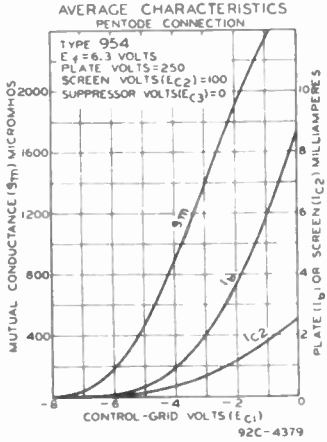




BOTTOM VIEW

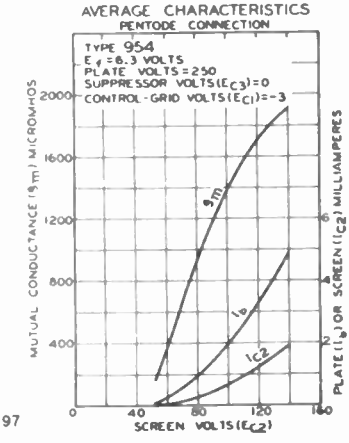
AVERAGE CHARACTERISTICS

PENTODE CONNECTION

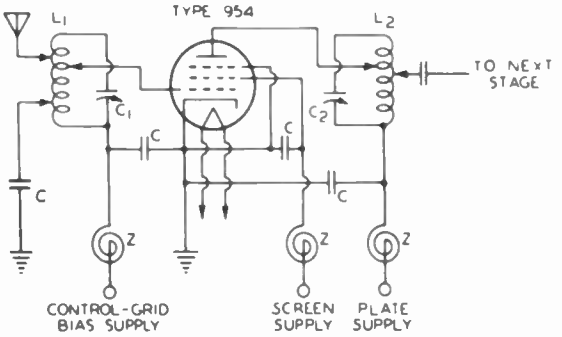


AVERAGE CHARACTERISTICS

PENTODE CONNECTION



TYPICAL R-F AMPLIFIER CIRCUIT



WAVE-LENGTH RANGE		2.75 TO 5.3 METERS APPROX.	1 TO 3 METERS APPROX.	0.8 METER APPROX.
L_1, L_2	TURNS	10	4	5
	WIRE	N°16 B.C.*	N°16 B.C.*	N°30 B.C.*
	OUTSIDE DIA.	3/8"	3/8"	1/8"
	LENGTH	3/4"	5/16"	1/8"
C_1, C_2 (VARIABLE)		3 TO 25 μμf	3 TO 25 μμf	3 TO 4 μμf
C		100 TO 500 μμf	100 TO 500 μμf	100 TO 500 μμf
Z	TURNS	15	15	15
	WIRE	N°30	N°30	N°30
	OUTSIDE DIA.	1/4"	1/4"	1/4"
	WINDING	S.L.[D]	S.L.[D]	S.L.[D]

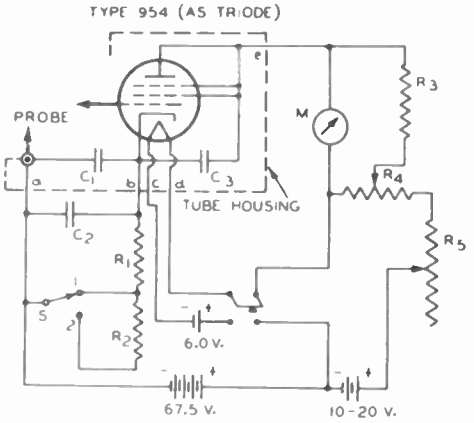
*B.C. = BARE COPPER [D]S.L. = SINGLE LAYER

NOTE: THE ABOVE DATA ARE NECESSARILY APPROXIMATE

FOR ULTRA-HIGH FREQUENCIES, COILS L_1 AND L_2 MAY BE TAPPED AT SUITABLE POINTS DETERMINED BY TEST TO REDUCE EFFECT OF TUBE LOADING ON CIRCUIT IMPEDANCES. SINCE ELECTRONIC PLATE LOADING IS NOT SERIOUS IN A PENTODE, THE USE OF COIL L_2 WITH TAPPED PLATE CONNECTION MAY NOT BE NECESSARY TO GIVE SATISFACTORY RESULTS. THE CONDENSERS SHOULD ALL BE OF HIGH QUALITY AND BE DESIGNED FOR ULTRA-HIGH FREQUENCY OPERATION.

92C-4386

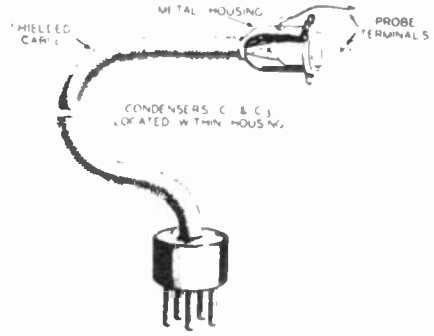
TYPICAL TUBE-VOLTMETER CIRCUIT
SPECIALLY ADAPTED FOR PROBE ARRANGEMENT



C_1 = 500 μμf CONDENSER (MICA)
C_2 = 16 μf COND. FOR CALIBRATION WITH AND MEASUREMENT OF LOW FREQUENCIES
C_3 = 500 μμf CONDENSER (MICA)
M = MICROAMMETER (50 OHMS APPROX.)
R_1 = 2000 OHM RES. (WIRE WOUND)
R_2 = 50000-OHM RES. (WIRE WOUND)
R_3 = 10000-OHM RES. (WIRE WOUND)
R_4 = 40000-OHM POTENTIOMETER FOR COARSE ADJUSTMENT IN BALANCING OUT PLATE CURRENT
R_5 = 2000-OHM RES. (VARIABLE)
S { ON POSITION 1 GIVES RANGE OF 2 VOLTS RMS; ON POSITION 2 GIVES RANGE OF 14 VOLTS RMS }

NOTE: LEADS b, c, d AND e RETURN INSIDE CABLE. LEAD a IS CONNECTED TO GROUNDED HOUSING.

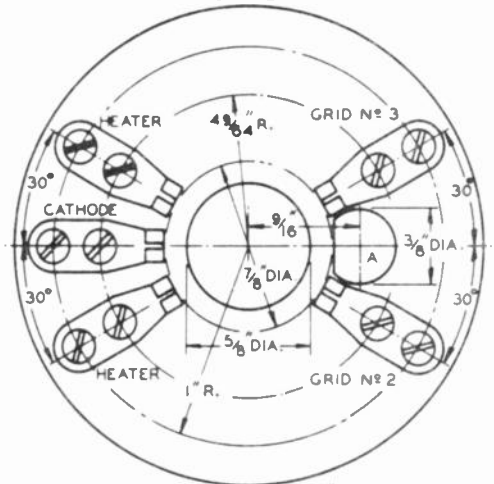
CONSTRUCTION OF PROBE



92C-4387R1

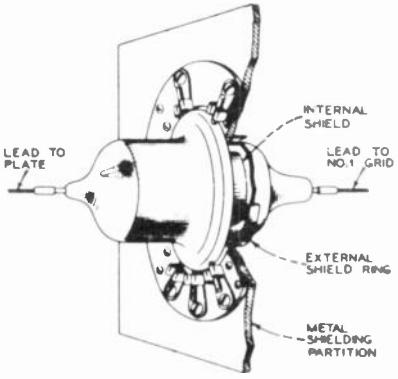
TERMINAL MOUNTING TEMPLATE

TOP VIEW



A = ALIGNMENT PLUG 1/4" HIGH

NOTE: INSERT TUBE IN CLIPS SO THAT SHORT END OF TUBE RESTS IN THE MOUNTING HOLE



955

Detector, Amplifier, Oscillator
(Acorn Type)

The 955 is a heater-cathode type of triode designed primarily for radio amateurs and experimenters working with wavelengths between 0.5 meter and 5 meters. Operation at these short wavelengths is made possible by means of an unconventional tube structure having small size, close electrode spacing, and short terminal connections.

TENTATIVE CHARACTERISTICS

HEATER VOLTAGE (A.C. or D.C.)	6.3	Volts
HEATER CURRENT	0.15	Ampere
AMPLIFICATION FACTOR	25	
GRID-PLATE CAPACITANCE	1.4	μμf
GRID-CATHODE CAPACITANCE	1.0	μμf
PLATE-CATHODE CAPACITANCE	0.6	μμf
BULB (For dimensions, see page 93)	Special	
TERMINAL MOUNTING (See page 93)	Special	

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

As R-F or A-F Amplifier - Class A

PLATE VOLTAGE			180 *max.*	Volts
TYPICAL OPERATION AND CHARACTERISTICS:				
Heater Voltage			6.3	Volts
Plate Voltage	90	135	180	Volts
Grid Voltage*	-2.5	-3.75	-5	Volts
Plate Current	2.5	3.5	4.5	Milliamperes
Plate Resistance	14700	13200	12500	Ohms
Mutual Conductance	1700	1900	2000	Micromhos
Load Resistance	-	-	20000	Ohms
U.P.O.	-	-	135	Milliwatts

* The d-c resistance in the grid circuit should not exceed 0.5 megohm.

As R-F Power Amplifier and Oscillator - Class C
(Plate Modulated or C.W.)

D-C PLATE VOLTAGE	180 *max.*	Volts
D-C PLATE CURRENT	8 *max.*	Milliamperes
D-C GRID CURRENT	2 *max.*	Milliamperes
TYPICAL OPERATION:		
Heater Voltage	6.3	Volts
D-C Plate Voltage	180	Volts
Grid Voltage (Approximate)	-35	Volts
D-C Plate Current	7	Milliamperes
D-C Grid Current (Approximate)	1.5	Milliamperes
Power Output (Approximate)**	0.5	Watt

**At 5 meters. Only moderate reduction in this value will be found for wavelengths as low as 1 meter. Below 1 meter, the power output decreases as the wavelength is decreased.

INSTALLATION

The *terminals* of the 955 require a special method of mounting by means of clips supplied with each tube. The clips may be fastened to a supporting insulator of glass, mica, or other suitable low-loss material, but for minimum losses, it is desirable to clip circuit parts directly to the grid terminal and to the plate terminal. Since the tube terminals are located symmetrically, a stop of insulating material should be placed between the grid and plate terminals so that the cathode terminal will prevent insertion of the heater terminals in the grid and plate clips. This stop is identified on the Terminal Mounting Template (page 93) as Alignment Plug. *Do not attempt to solder connections to the terminals.* The heat of the soldering operation is almost certain to crack the bulb seal.

The *heater* is designed to operate on either a.c. or d.c. When a.c. is used, the winding which supplies the heater circuit should operate the heater at its recommended value for full-load operating conditions at average line voltage. When d.c. is used on the heater, the heater terminals should be connected directly across a 6-volt battery. Under any condition of operation, the heater voltage should not deviate more than plus or minus 10% from the normal value of 6.3 volts. Series operation of the 955 is not recommended.

The *cathode* of the 955 operated from a transformer, should preferably be connected directly to the electrical mid-point of the heater circuit. In the case of d-c operation from a 6-volt storage battery, the cathode circuit is tied in either directly or through bias resistors to the negative battery terminal. In circuits where the cathode is not directly connected to the heater, the potential difference between them should be kept as low as possible. If the use of a large resistor is necessary between heater and cathode in some circuit designs, it is essential that this resistor be by-passed by a suitable filter network or objectional hum may develop.

R-F grounding by means of condensers placed close to the tube terminals is required if the full capabilities of the 955 for ultra-high-frequency uses are to be obtained. Conventional by-passing methods and grounding, such as are employed in broadcast receivers, are not adequate. The grounding plate of the chassis should be of heavy copper. Figure 3 illustrates one form of by-passing where the ribbon leads to the terminal clips are insulated from the grounding plate by mica spacers to form r-f by-pass condensers right at the tube terminals.

APPLICATION

As an *amplifier*, the 955 is applicable to the audio- or the radio-frequency stages of short-wave receivers, especially those operating below 5 meters. Typical operating conditions for this service are given under the corresponding heading on page 90.

For a-f amplifier circuits utilizing resistance coupling, typical operating conditions are as follows: Plate-supply voltage, 180

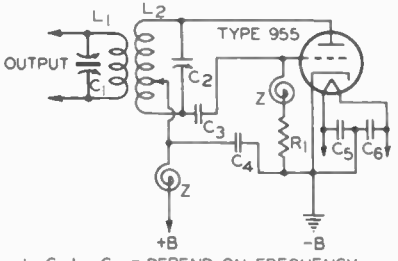
volts; grid-bias voltage, -3.5 volts; plate-load resistor, 250000 ohms; and plate current, 0.42 milliamperes. The grid resistor may be made as high as 0.5 megohm. With these values, an undistorted voltage output of 45 volts RMS may be obtained. The voltage amplification is approximately 20.

As a *detector*, the 955 may be of the grid-leak-and-condenser type or of the grid-bias type. The plate voltage for the grid-leak-and-condenser method should be about 45 volts. A grid leak of from 1 to 5 megohms with a condenser of 0.00025 μf is satisfactory. For the grid-bias method of detection, a plate-supply voltage of 180 volts may be used together with a negative grid-bias voltage of approximately -7 volts. The plate current should be adjusted to a little less than 0.2 milliampere with no input signal voltage. The grid-bias voltage may be supplied from the voltage drop in a resistor between cathode and ground. The value of this self-biasing resistor is not critical, 50000 ohms being suitable.

As an *oscillator or r-f power amplifier (Class C)*, the 955 should be operated as shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS. Typical oscillator circuits are shown in Figures 1 and 2. When bias is obtained by means of a grid resistor, a value of 20000 to 25000 ohms may be used. The use of a choke in series with this resistor is required in single-tube oscillator circuits to increase the r-f impedance of the input circuit. In push-pull oscillator circuits, the choke is not required.

In *miscellaneous applications* in the laboratory, such as vacuum-tube voltmeters, the 955 because of its small size, can be placed at the point of measurement. This feature, combined with that of low input capacitance, makes possible vacuum-tube voltmeter measurements with a minimum effect on the constants of the circuit under measurement.

ULTRA-HIGH-FREQUENCY HARTLEY OSCILLATOR



L_1C_1, L_2C_2 = DEPEND ON FREQUENCY RANGE DESIRED

C_3 = 0.00005 μf

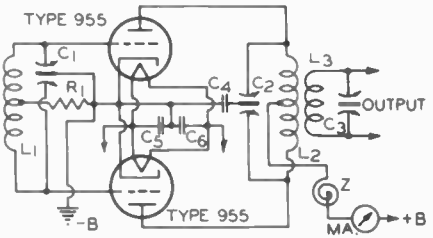
C_4, C_5, C_6 = 0.0001 μf

R_1 = 20000 TO 25000 OHMS, 1/2 WATT

Z = R-F CHOKE

FIG. 1

PUSH-PULL OSCILLATOR
TUNED-PLATE TUNED-GRID TYPE



L_1C_1, L_2C_2, L_3C_3 = DEPEND ON FREQUENCY RANGE DESIRED

C_4, C_5, C_6 = 0.0001 μf

R_1 = 10000 TO 12500 OHMS, 1/2 WATT

FIG. 2

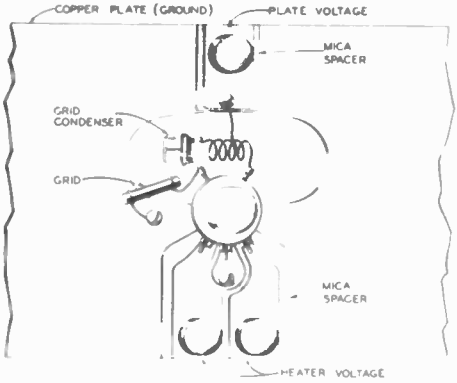
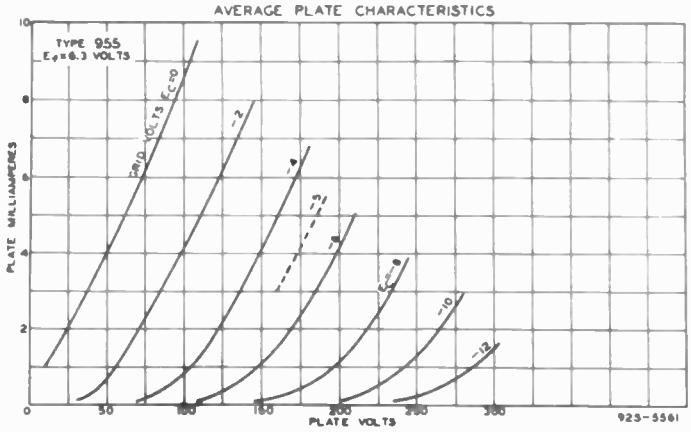
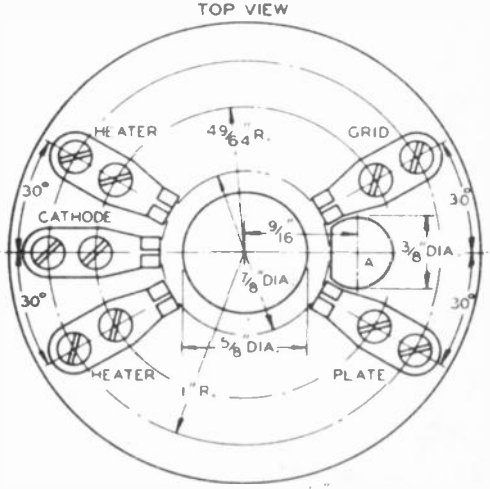


Figure 3



TERMINAL MOUNTING TEMPLATE

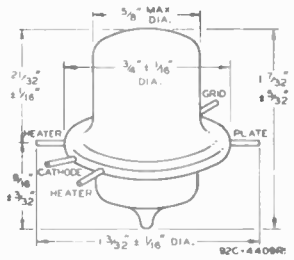
TOP VIEW

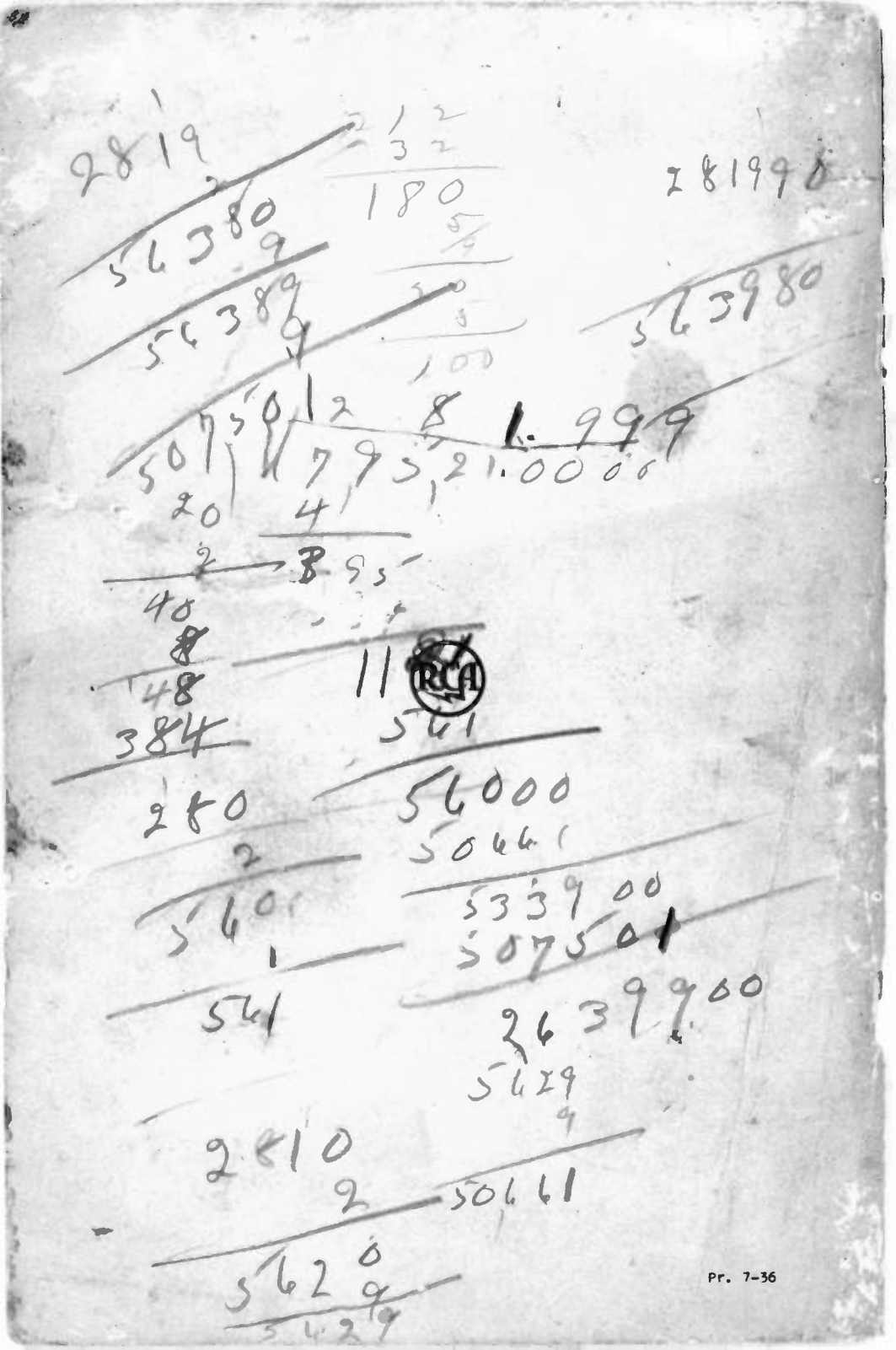


A - ALIGNMENT PLUG 1/4" HIGH

NOTE INSERT TUBE IN CLIPS SO THAT SHORT TIPPED END OF THE BULB RESTS IN THE MOUNTING HOLE

OVERALL DIMENSIONS




RCA