HAM TIPS *from* RCA

Published by RCA Manufacturing Company, Inc., Camden, N. J., U. S. A.

VOL. 2—No. 5 CAMDEN, N. J. OCTOBER, 1939

A DOUBLE SCOOP

NEW RCA-811 AND 812 GREATEST TUBE VALUES YET

New Zirconium Coated Anode Gives Astonishing Results

Scene: Meeting room of the local amateur radio club. Two hams, early arrivals, settle themselves comfortably in the second row of chairs, feet propped up on the backs of the chairs in front. The following conversation ensues:

1st Ham: "Say, how's your new 'final' coming along?"

2nd H.: "Not so hot—I had it pretty well under way, but now I've decided to junk the whole works and start all over again—the new tubes, you know."

1st H.: "What? *More* new tubes? What's the dope this time?"

2nd H.: "Haven't you heard? RCA has just announced the new 811 and 812—and they say they're 'head and shoulders' above any other tube now available. Two of 'em in push-pull will take almost 500 watts input, and they cost just a little more than the 809."

1st H.: "Wow! That sounds almost too good to be true."

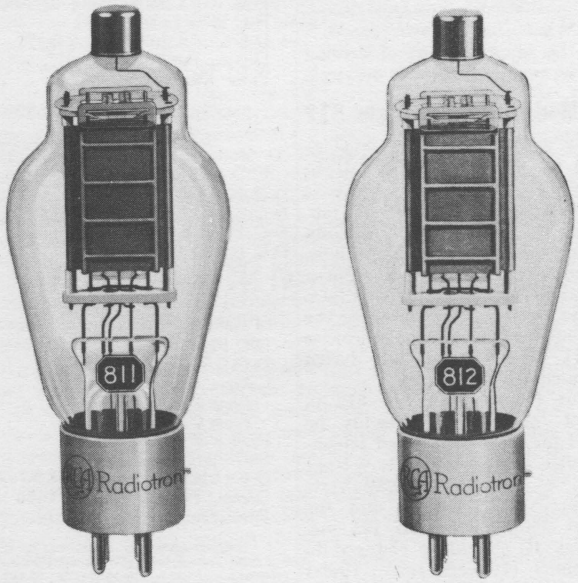
2nd H.: "That's what I thought, at first. But they've worked up some sort of new plate material—'Zirconium coated,' I believe they call it. But here, take this copy of 'Ham Tips'—it tells all about 'em."

A deep silence followed, while Ham No. 1 "boned up" on the new 811 and 812 from the pages of "Ham Tips." Here is what he read:

"The greatest transmitting tube values ever made available to the radio amateur"—that, in the fewest possible words, accurately describes the new 811 and 812, latest additions to the family of RCA high-perveance, easy-to-drive triodes. The RCA power-tube lab has done an outstanding development job on these two new bottles. If, after you have read what follows, you do not agree with this statement, there can be only one conclusion—that the RCA power-tube lab has done a far better job in developing the 811 and 812

(*Continued on page 4, column 1*)

TRULY A MIGHTY PAIR!



RCA-811 **RCA-812**

At their unbelievably low amateur net price of $3.50 each, the new 811 and 812 represent a new high in transmitting-tube development.

NEW DUAL RATING SYSTEM ANNOUNCED BY RCA

Ratings For Amateur Services Are Greatly Increased

An entirely new system of ratings for air-cooled transmitting tubes has been announced by RCA. Instead of one set of maximum ratings for each tube type, *two* sets of maximum ratings are given. These ratings are designated "Continuous Commercial Service" (CCS) and "Intermittent Commercial & Amateur Service" (ICAS).

The CCS ratings are essentially the same as the former maximum ratings. The ICAS ratings, however, are considerably higher, permit the use of much greater power input, and provide a relatively large increase in useful power output. For example, the a-f power output of two 809's in class B is 100 watts at the old maximum plate-voltage rating of 750 volts. At the new ICAS rating of 1000 volts, the power output is 145 watts—an increase of 45 per cent. In plate-modulated telephony service, the r-f output of the 809 is 38 watts with the CCS ratings and 55 watts with the new ICAS ratings—also an increase of about 45 per cent. Operating data for the 811 and 812, including both CCS and ICAS ratings, are given elsewhere in this issue of HAM TIPS. Similar data have also been prepared for the 802, 804, 806, 807, 809, 810, and 814, as well as for the new 828, and can be obtained on request.

The new system provides transmitting-tube ratings which recognize the diversified design requirements of modern transmitter applications. For example, there are numerous applications where the design factors of *minimum size, light weight, low initial cost*, and *maximum power output* are far more important than extremely long tube life. In such cases, the set designer may very properly decide that a small tube operated with ICAS ratings better meets his requirements than a larger tube operated with CCS ratings.

It is self-evident, of course, that

(*Continued on page 5, column 1*)

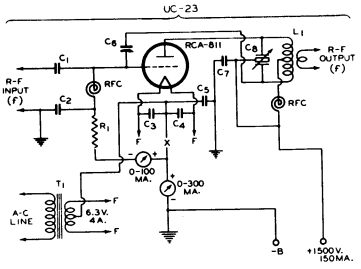
CIRCUIT UC-23 SHOWS SINGLE-ENDED 811 R-F AMPLIFIER FOR CW TELEGRAPHY

A typical 811 single-ended r-f amplifier designed for class C telegraph service is shown in circuit UC-23. Operating at 1500 volts and 150 ma., corresponding to a d-c plate input of 225 watts (ICAS ratings), this amplifier will provide a useful power output of about 170 watts. This output is based on a plate-circuit efficiency of about 75%, which can readily be obtained in a properly designed amplifier stage.

Since the r-f power dissipated by the grid of the 811 is approximately 8 watts, the output of the driver stage should be about 16 watts (using the usual multiplying factor of 2). Some surplus power must be available from the driver in order to provide good regulation of the r-f exciting voltage and to compensate for circuit losses. The required grid bias can be obtained from a 3500-ohm grid leak. The d-c grid current should be about 35 ma., and should never be allowed to exceed 50 ma.

A single 6L6, 6L6-G, or 6V6-G is suitable for the driver stage. Any of these tubes can be connected as a high-mu triode, if desired, with the *screen* tied to the *control grid*. With this convenient arrangement, the oscillator stage can be keyed for "break-in" operation. No *fixed* bias is required for the triode-connected 6L6 or for the 811, due to the fact that their mu is high enough to cause their d-c plate current to drop to a low value when the key is up in the oscillator stage. Grid leak bias is satisfactory. This statement does not apply to the 812, because of its relatively low mu (29). For this reason, the 811 is somewhat preferable to the 812 in cw transmitters where "break-in" operation is contemplated.

The 812 can be used in circuit UC-23 with only two minor changes. The grid leak (R_1) should be changed to 7000 ohms (10 watts), and the neutralizing condenser C_6 may have to be very slightly readjusted. For "break-in" operation with the 812, a partial fixed bias of −45 to −50 volts should be used in conjunction with a grid-leak resistor of 5000 ohms. About the same amount of driving power is required (in cw service).



CW R-F POWER AMPLIFIER

Class C Telegraphy Power Output 170 Watts*

C_1 = 0.0005 μf mica, 1000 V.
C_2, C_3, C_4 = 0.005 μf mica.
C_5, C_7 = 0.002 μf mica, 5000 V.
C_6 = 5.5 μμf,* 6000 V.
C_8 = 0.6 μμf/meter/section,† 2000 V.
R_1 = 3500 ohms, 10 watts.
RFC = R-f choke.
T_1 = Filament transformer, 2000 V. insulation.
L_1 = Tune to frequency "f."
f = Operating frequency.

* Approximate.

† Capacitance in actual use.

NOTE: Rotor shaft of C_8 is at the high d-c plate potential. An insulated coupling shaft must be inserted between the rotor shaft of C_8 and its control dial.

Plate Modulation of Single 812

The 812 is somewhat preferable to the 811 for plate-modulated telephony service. The reason for this is that a tube having a very high mu, like the 811, requires considerably more driving power than a medium-mu tube in order to provide a linear modulation characteristic. This fact, of course, explains the reason for the development of the 812, as otherwise the 811 would meet all design requirements.

Circuit UC-23, using an 812 in place of the 811, can readily be changed for plate-modulated telephony service. The plate supply voltage should be reduced to 1250 volts (maximum ICAS rating) and the full-load plate current to 125 ma. Grid leak R_1 should be changed to 5000 ohms (10-watt size). Under these conditions, and with a driver-stage power output of about 12 watts, a carrier power output of approximately 120 watts can be ob-

(*Continued on page 5, column 4*)

RCA-811

TENTATIVE CHARACTERISTICS and RATINGS

FILAMENT VOLTAGE (A-C or D-C)	6.3	Volts
FILAMENT CURRENT	4	Amperes
AMPLIFICATION FACTOR	160	
DIRECT INTERELECTRODE CAPACITANCES:		
Grid-Plate	5.5	μμf
Grid-Filament	5.5	μμf
Plate-Filament	0.6	μμf
BULB	ST-19	
CAP	Medium Metal	
BASE	Medium 4-Pin "Micanol," Bayonet	

MAXIMUM CCS and ICAS RATINGS with TYPICAL OPERATING CONDITIONS

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

AS A-F Power Amplifier and Modulator—Class B

	(CCS)	(ICAS)	
D-C PLATE VOLTAGE	1250 *max.*	1500 *max.*	Volts
MAX.-SIGNAL D-C PLATE CURRENT*	125 *max.*	125 *max.*	Milliamperes
MAX.-SIGNAL PLATE INPUT*	125 *max.*	150 *max.*	Watts
PLATE DISSIPATION*	40 *max.*	50 *max.*	Watts
TYPICAL OPERATION:			
Unless otherwise specified, values are for 2 tubes			
D-C Plate Voltage	1250	1500	Volts
D-C Grid Voltage#	0	−9	Volts
Peak A-F Grid-to-Grid Voltage	140	160	Volts
Max.-Signal D-C Grid Current	38	38	Milliamperes
Zero-Sig. D-C Plate Current	48	20	Milliamperes
Max.-Sig. D-C Plate Current	200	200	Milliamperes
Load Resistance (Per tube)	3750	4500	Ohms
Effective Load Resistance (Plate-to-Plate)	15000	18000	Ohms
Max.-Sig. Driving Power (Approx.)	3.8	4.2	Watts
Max.-Sig. Power Output (Approx.)	175	225	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

	(CCS)	(ICAS)	
D-C PLATE VOLTAGE	1000 *max.*	1250 *max.*	Volts
D-C GRID VOLTAGE	−200 *max.*	−200 *max.*	Volts
D-C PLATE CURRENT	105 *max.*	125 *max.*	Milliamperes
D-C GRID CURRENT	50 *max*	50 *max.*	Milliamperes
PLATE INPUT	105 *max.*	155 *max.*	Watts
PLATE DISSIPATION	27 *max.*	40 *max.*	Watts
TYPICAL OPERATION:			
D-C Plate Voltage	1000	1250	Volts
D-C Grid Voltage:	−100	−125	Volts
From a grid resistor of	2000	2500	Ohms
Peak R-F Grid Voltage	195	230	Volts
D-C Plate Current	105	125	Milliamperes
D-C Grid Current (Approx.)**	50	50	Milliamperes
Driving Power (Approx.)**	9	11	Watts
Power Output (Approx.)	82	120	Watts

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

Key-down conditions per tube without modulation##

	(CCS)	(ICAS)	
D-C PLATE VOLTAGE	1250 *max.*	1500 *max.*	Volts
D-C GRID VOLTAGE	−200 *max.*	−200 *max.*	Volts
D-C PLATE CURRENT	125 *max.*	150 *max.*	Milliamperes
D-C GRID CURRENT	50 *max.*	50 *max.*	Milliamperes
PLATE INPUT	155 *max*	225 *max.*	Watts
PLATE DISSIPATION	40 *max.*	55 *max.*	Watts
TYPICAL OPERATION:			
D-C Plate Voltage	1250	1500	Volts
D-C Grid Voltage:			
From a fixed supply of	−87.5	−113	Volts
From a grid resistor of	2500	3500	Ohms
From a cathode resistor of	550	600	Ohms
Peak R-F Grid Voltage	180	225	Volts
D-C Plate Current	125	150	Milliamperes
D-C Grid Current (Approx.)**	35	35	Milliamperes
Driving Power (Approx.)**	7	8	Watts
Power Output (Approx.)	115	170	Watts

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

Grid voltages are given for either a-c or d-c filament operation. When a-c is used, the circuit returns are made to the mid-point of the filament circuit. When d-c is used, the returns are made to the negative filament terminal.

** 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.

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

RCA-812

TENTATIVE CHARACTERISTICS and RATINGS

FILAMENT VOLTAGE (A-C or D-C)	6.3	Volts
FILAMENT CURRENT	4	Amperes
AMPLIFICATION FACTOR	29	
DIRECT INTERELECTRODE CAPACITANCES:		
Grid-Plate	5.3	μμf
Grid-Filament	5.3	μμf
Plate-Filament	0.8	μμf
BULB	ST-19	
CAP	Medium Metal	
BASE	Medium 4-Pin "Micanol," Bayonet	

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

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

As A-F Power Amplifier and Modulator—Class B

	(CCS)	(ICAS)	
D-C PLATE VOLTAGE	1250 *max.*	1500 *max.*	Volts
MAX.-SIGNAL D-C PLATE CURRENT*	125 *max.*	125 *max.*	Milliamperes
MAX.-SIGNAL PLATE INPUT*	125 *max.*	150 *max.*	Watts
PLATE DISSIPATION*	40 *max.*	50 *max.*	Watts

TYPICAL OPERATION:

Unless otherwise specified, values are for 2 tubes

D-C Plate Voltage	1250	1500	Volts
D-C Grid Voltage#	−36	−46	Volts
Peak A-F Grid-to-Grid Voltage	210	232	Volts
Max.-Signal D-C Grid Current	18	25	Milliamperes
Zero-Sig. D-C Plate Current	48	42	Milliamperes
Max.-Sig. D-C Plate Current	200	200	Milliamperes
Load Resistance (Per tube)	3750	4500	Ohms
Effective Load Resistance (Plate-to-Plate)	15000	18000	Ohms
Max.-Sig. Driving Power (Approx.)	4.3	4.7	Watts
Max.-Sig. Power Output (Approx.)	175	225	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

	(CCS)	(ICAS)	
D-C PLATE VOLTAGE	1000 *max.*	1250 *max.*	Volts
D-C GRID VOLTAGE	−200 *max.*	−200 *max.*	Volts
D-C PLATE CURRENT	105 *max.*	125 *max.*	Milliamperes
D-C GRID CURRENT	25 *max.*	25 *max.*	Milliamperes
PLATE INPUT	105 *max.*	155 *max.*	Watts
PLATE DISSIPATION	27 *max.*	40 *max*	Watts

TYPICAL OPERATION:

D-C Plate Voltage	1000	1250	Volts
D-C Grid Voltage:	−100	−125	Volts
From a grid resistor of	4000	5000	Ohms
Peak R-F Grid Voltage	180	245	Volts
D-C Plate Current	105	125	Milliamperes
D-C Grid Current (Approx.)**	25	25	Milliamperes
Driving Power (Approx.)**	4.5	6	Watts
Power Output (Approx.)	82	120	Watts

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

Key-down conditions per tube without modulation##

	(CCS)	(ICAS)	
D-C PLATE VOLTAGE	1250 *max.*	1500 *max.*	Volts
D-C GRID VOLTAGE	−200 *max.*	−200 *max.*	Volts
D-C PLATE CURRENT	125 *max.*	150 *max.*	Milliamperes
D-C GRID CURRENT	35 *max.*	35 *max.*	Milliamperes
PLATE INPUT	155 *max.*	225 *max.*	Watts
PLATE DISSIPATION	40 *max.*	55 *max.*	Watts

TYPICAL OPERATION:

D-C Plate Voltage	1250	1500	Volts
D-C Grid Voltage:			
From a fixed supply of	−125	−175	Volts
From a grid resistor of	5000	7000	Ohms
From a cathode resistor of	835	1000	Ohms
Peak R-F Grid Voltage	215	285	Volts
D-C Plate Current	125	150	Milliamperes
D-C Grid Current (Approx.)**	25	25	Milliamperes
Driving Power (Approx.)**	5	6.5	Watts
Power Output (Approx.)	116	170	Watts

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

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 3.2 volts and the circuit returns made 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.

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

CIRCUIT UC-24 SHOWS PUSH-PULL PLATE-MODULATED 812'S

A typical push-pull 812 r-f amplifier designed for plate-modulated telephony service is shown in circuit UC-24. Operating at 1250 volts and 250 ma. (maximum ICAS ratings), corresponding to a d-c plate input of 312 watts, two 812's are capable of delivering a carrier power of almost ¼ kilowatt. A plate-circuit efficiency of about 75% is assumed, a value which can usually be obtained in practice.

The r-f grid power dissipated by two 812's is about 12 watts, or 6 watts per tube. This means that the actual power output of the r-f driver stage should be in the order of 24 watts. Thus, a single 6L6, or an 807 operating considerably below its maximum ratings, is suitable for the driver stage. An 807 is preferable to a 6L6 because the latter usually requires neutralization in r-f amplifier circuits. In addition, the 807 is capable of delivering the necessary driving power even when it is used as a plate-circuit doubler—a fact which may mean the elimination of an extra doubler stage.

The required grid bias can be obtained from a 2500-ohm, 10-watt grid leak. The d-c grid current should be adjusted to 50 ma., or 25 ma. per tube, the value which is the maximum rating. In order to protect the final amplifier against accidental loss of bias (due to failure of the grid excitation) or accidental plate-circuit detuning, a d-c overload relay set to operate at 375 ma. should be employed. The holding coil of the relay can conveniently be placed between the −B lead and ground, provided the 812's are the only tubes operated from the 1250-volt plate supply. Otherwise, the relay coil should be placed between the 500-ma. plate meter and ground (see circuit UC-24); in this position, the relay should be by-passed by an electrolytic condenser large enough for low audio frequencies.

Connected as shown, the plate meter will read only the d-c plate current, and not the *sum* of plate current and grid current. Moreover, the plate meter is at ground potential and does not represent a high-voltage hazard such as it does when it is placed in the +B lead.

To modulate the 812's 100%, an a-f power of about 160 watts is required. A pair of 811's operating in class B at a plate voltage of 1250 volts (zero bias) will deliver 175 watts, and are, therefore, well suited for the modulator stage. A pair of 6L6's in class AB_1 are recommended for the audio driver stage in an inverse feedback circuit (see the circuit and curves of Fig. 1). An a-f driving voltage of only 12 volts RMS per grid will drive the 6L6's to the point required for full output from the class B 811's. A pair of 809's in class B, with their new ICAS ratings, will deliver 145 watts of a-f power. They will, therefore, also do a very good job of modulating two 812's.

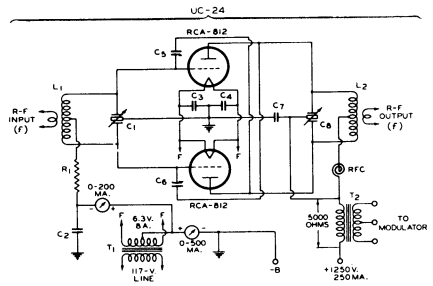


PLATE-MODULATED R-F POWER AMPLIFIER

Class C Telephony Power Output 240 Watts*

C_1 = 1.5 μμf/meter/section.*
C_2, C_3, C_4 = 0.005 μf mica.
C_5, C_6 = 5.3 μμf,* 6000 V.
C_7 = 0.002 μf, 5000 V.
C_8 = 1.2 μμf/meter/section,† 3500 V.
R_1 = 2500 ohms, 10 watts.
RFC = R-f choke, 250 ma.
T_1 = Filament transformer.
T_2 = Modulation transformer, 155 watts.
L_1, L_2 = Tune to frequency "f."
f = Operating frequency.
* Approximate.
† Capacitance in actual use.

NOTE: Rotor shaft of C_8 is at the high d-c plate potential. An insulated coupling shaft must be inserted between the rotor shaft of C_8 and its control dial.

CW Telegraph Operation of 812's

If the 812's in circuit UC-24 are to be used for cw service, the plate voltage may be increased to 1500 volts and the total plate current to 300 ma. The grid leak (R_1) should be increased to 3500 ohms (15- or 20-watt size). The grid current should be 50 ma., as before. Slightly more driving power is required, due to the higher bias and higher plate voltage. The

(Continued on page 5, column 3)

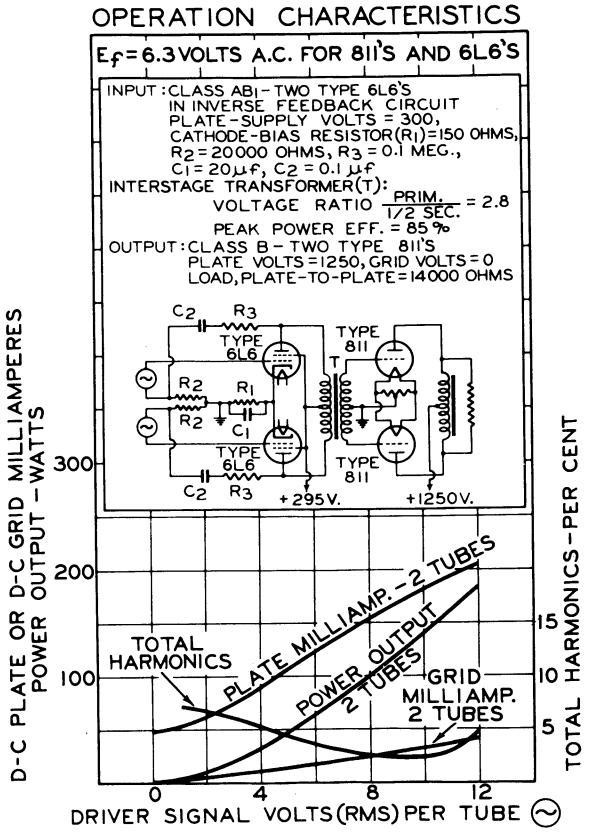


Figure 1

husky triodes with a maximum plate dissipation of *55* watts for class C telegraph service. Operating at 1500 volts (ICAS rating), two tubes of either type can be used in a push-pull circuit with a d-c plate input of *450 watts*, and with the unusually low driving-power requirement of only *13 to 16 watts*. The 811 and 812 may be operated at maximum ratings in r-f services at frequencies up to 60 Mc. and at reduced ratings up to 100 Mc.

The 811 is a zero-bias, high-mu class B modulator, as well as an excellent r-f tube. Two 811's in class B provide 225 watts of a-f power, which will do a good job of modulating a ½ kw. 'phone transmitter. A typical class B modulator stage using two 811's driven by two 6L6's, with inverse feedback, is shown in Fig. 1. Operating characteristics are shown in the curves of Figs. 1 and 2. Because of its high perveance and high mu (160), the 811 makes an efficient plate-circuit frequency doubler.

The 812, especially designed for r-f services, has a medium mu of 29. It requires slightly less driving power than the 811 in cw telegraph service. In plate-modulated telephony service, however, the 812 requires much less driving power than the 811 (about one-half).

Both the 811 and 812 are equipped with the new low-loss "Micanol" base, which has excellent insulating qualities at high radio frequencies together with low moisture-absorption characteristics. The plate lead is brought out to a metal top cap to provide high insulation.

The remarkable performance characteristics of both tubes are due in large measure to the use of a new type of anode. The plate, which is Zirconium-coated, has unusually high heat-dissipating qualities and in addition functions as an exceptionally effective "getter." Thus, any gas produced by overloads is cleaned up by the plate coating. As a result of this "getter" action of the Zirconium-coated anode, the 811 and 812 are capable of withstanding relatively heavy temporary overloads without damage to their filament emission. This is one virtue in a transmitting tube which most amateurs fully appreciate.

In an actual operating test, two 811's were used in a push-pull circuit on 14 megacycles under heavy overload conditions. The plate-tank condenser was repeatedly de-tuned from resonance so that the plate current and plate dissipation rose to excessive values. This intentional abuse was continued until finally *large holes were melted in the plates of both tubes.* The amplifier was then adjusted to rated operating conditions (with maximum ICAS values of plate voltage and current) and was found to operate quite normally.

Destructive overload tests have brought out one peculiarity of a Zirconium-coated anode. When a plate dissipation of about 150 to 160 watts is reached, the high plate

(Continued on page 6, column 1)

New RCA-811 and 812 Greatest Tube Values Yet

(Continued from page 1, column 1)

than the editors of "Ham Tips" have done in describing them. To avoid this possibility, the editors are going to digress from the 811 and 812 for just a moment.

Most of you, when you are thinking of building a new rig or of rebuilding an old one, generally decide first how much *power input* you would like to use. The state of the old pocketbook very often influences this decision to a large degree. You will, therefore, other factors being equal, choose a tube (or tubes) which will take the *largest power input* compatible with the total cost involved. The tube chosen must, in other words, have a high "figure of merit" expressed in terms of *power input watts* per *unit cost* ($W_{in}/\$$). Because this term completely ignores *tube life performance*, the true, intrinsic worth of a tube is better expressed by a term which includes life; namely, *power input watt-hours* per unit cost. From a practical viewpoint, however, the first term is more convenient and you must necessarily depend on the integrity and reputation of the tube manufacturer to insure that you will obtain reasonable tube life under the rated operating conditions which he recommends.

Another useful figure of merit is the *power sensitivity* of a tube, which is a measure of how easy the tube is to drive. This factor, for convenience, can be expressed as the ratio of useful class C power output to the required grid driving power.

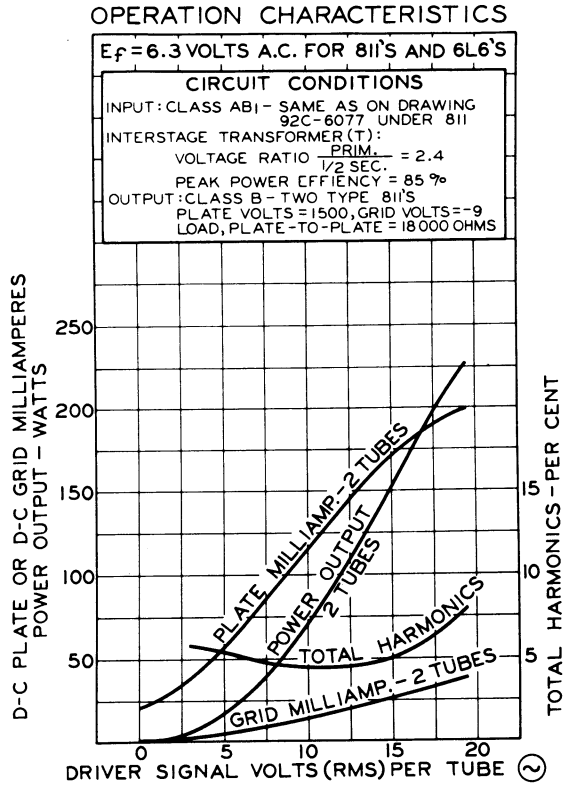
In order to show vividly the outstanding performance of the new 811 and 812, we have prepared the table shown below. Tubes A, B, C, and D represent four competitive tubes which were chosen because they had relatively *high* figures of merit. The data given in the table are interesting as well as informative.

Tube Type	*Initial Cost Factor* $W_{in}/\$$*	*Power Sensitivity Factor* W_{out}/W_g*
RCA-812	64	26
RCA-811	64	21
A	40	22
B	37	23
C	33	17
D	32	23

* Approximate.

The significance of the high $W_{in}/\$$ factor for the 811 and 812 can best be appreciated if you will stop to think that it is now possible to construct a final amplifier having a rated input of almost ½ kilowatt, using two tubes whose total cost is only $7.00!

Now for some detailed information. The RCA-811 and RCA-812 are



New Dual Rating System Announced by RCA

(*Continued from page 1, column 4*)

the harder a tube is worked the shorter will be its useful life. Although no rule can be set up which will accurately predict the life performance of an individual tube under specified operating conditions, it is practical to make an estimate of tube life on the basis of average results from a large number of tubes. In average amateur service, a tube operated at the higher ratings can normally be expected to give about 50 per cent of the life obtainable with CCS ratings.

It has been estimated that an active amateur does not have his carrier on the air more than 300 hours per year. Therefore, a tube lasting 1000 to 1500 hours when used with CCS ratings would give him at least 3½ to 5 years of service. The amateur, because he is usually most interested in *low initial cost* and *maximum power output*, may consequently decide that the ICAS ratings are better suited for his purpose.

The engineer designing a broadcast transmitter has quite a different problem. A broadcast station may operate tubes on an average of 18 hours a day. Tube failures are expensive both in themselves and in advertising revenue lost because of interrupted programs. Consequently, since *reliability* is his main concern, he should operate tubes at the CCS ratings, or perhaps even lower. Only in this way can he obtain the long tube life required for continuous commercial services.

In airplane transmitters, tubes may be operated only a few minutes a day. In addition, mechanical failure of tubes may occur prematurely, due to the severe vibration and shock to which they are frequently subjected. For these reasons, operation of tubes at ICAS ratings, especially where maximum power output for a minimum size and weight are essential, should be considered. On the other hand, there are installations where it is imperative that the tubes be ready for operation at all times, because failures at the wrong moment may mean damage to an expensive airplane or even loss of human life. The choice of tube-operating conditions for any service must, therefore, be based on a careful consideration of all factors.

In view of the fact that the ICAS ratings are considerably higher than the former maximum ratings, an explanation of the basis on which these new ratings are established is desirable. The old method of rating transmitting tubes has been based on the assumption that tubes would always be used under the most severe operating conditions possible for each class of service. Although it was recognized that this method was not representative of actual operating conditions, it did provide a very large factor of safety. In recent years, rapid progress in tube design, tube manufacture, transmitter design, and operating technique has made it practical to refine the method of rating transmitting tubes so that it more closely represents actual operating requirements.

For example, in class C telegraph service, the old ratings were set up on the basis of continuous, key-down operation. In practice, however, all class C stages which are keyed are not under load when the key is up, as it is during spacing intervals. The average load on the tube is, of course, much less than it is under steady, key-down conditions.

In class C plate-modulated telephony service, the old ratings were based on steady, 100 per cent, sine-wave modulation. Under this condition, the total plate input (d.c. and a.c.) is 1.5 times the unmodulated d-c plate input. In practice, a broadcast transmitter (for example) modulates its carrier on the average only 25 to 30 per cent. Under these conditions, the average plate power input is only 5 per cent higher than the unmodulated d-c plate input.

Similarly, the old class B a-f amplifier ratings were based on steady, full-signal operating conditions with a sine-wave signal. Actually, the average signal is much smaller than the maximum value and the average d-c plate current and power input varies continuously between no-signal and full-signal values. In addition, it is well known that speech signals place a much lighter load on the class B amplifier than signals having sinusoidal waveform.

In class B r-f amplifier service, the old ratings were based on *carrier* conditions where the carrier output represents ⅓ of the d-c plate input and the other ⅔'s is dissipated by the plate. At 100 per cent modulation, however, the efficiency of the amplifier increases to approximately 50 per cent, so that the plate dissipation is reduced about 25 per cent. However, because the average decrease in plate dissipation is rather small, the ICAS ratings for this class of service have to be more conservative than for the other services.

It is apparent from the foregoing considerations that increased transmitting-tube ratings are practical for many applications. The new ICAS ratings, together with the CCS ratings, make it possible for the radio amateur and the radio engineer to choose the operating conditions best suited for the job at hand. Undoubtedly, the introduction by RCA of this new system of dual ratings for transmitting tubes represents a most important contribution to the art.

Because of the interest RCA's new Dual Rating System is certain to excite, especially among radio amateurs, a 16-page booklet has been prepared giving ICAS maximum ratings and typical operating conditions for the tube types: 802, 804, 806, 807, 809, 810 and 814. This booklet may be obtained on request from RCA Manufacturing Co., Inc., Commercial Engineering Section, Harrison, N. J. Abbreviated data on the types listed above are shown on page 6, column 2; both CCS and ICAS values are given for purposes of comparison.

Circuit UC-24 Shows Push-Pull Plate-Modulated 812's

(*Continued from page 3, column 4*)

power output can be increased to 340 watts from the 240 watts obtainable in plate-modulated telephony service.

If 100% grid-leak bias is used, as described above, the 812's can be keyed in the filament-to-ground circuit. An extra filament by-pass condenser is needed, and the filament circuit (transformer and by-pass condensers) should be changed to the arrangement shown in circuit UC-23. The filament-circuit connections shown in circuit UC-24 are for 'phone work only.

Where the *oscillator* or other *preceding* stage is to be keyed, as for "break-in" operation, a partial fixed bias of −45 to −50 volts should be employed in conjunction with a 2500-ohm, 10-watt grid leak. With this amount of fixed or battery bias, the d-c plate current of the 812's will remain near cut-off when the key is up (that is, when the grid excitation is removed). With grid-leak bias only, the d-c plate current would rise to an excessive value as is always the case with medium-mu tubes.

In cw service, the neutralizing condensers (C_5 and C_6)shown in circuit UC-24 can have a peak voltage rating of only 3000 volts, instead of the 6000 volts needed for telephony service. Similarly, the voltage rating of C_8 can be reduced to 2000 volts.

Circuit UC-24 with Push-Pull 811's

Two 811's can be substituted for the two 812's in circuit UC-24 if two changes are made. In plate-modulated telephony service, grid leak R_1 should be changed to 1250 ohms (25-watt size). In addition, the driver-stage power output must be increased to about 45 watts.

For push-pull 811's in cw telegraph service, grid leak R_1 should be changed to about 1600 ohms (10-watt size). The driver-stage power output for this service should be approximately 32 watts. Due to the extremely high mu of the 811's, they can be used for "break-in" operation (oscillator-stage keying) with grid-leak bias only; partial fixed bias is not necessary. When grid excitation is removed from the 811's, their plate current drops to a very low value. This characteristic is an advantage not possessed by medium-mu tubes, such as the 812. If, however, "center-tap" keying of the push-pull final amplifier stage is employed, there is little difference on which to base a choice between the 811 and the 812. With center-tap keying, the connections of the filament transformer and by-pass condensers should be changed to the arrangement shown in circuit UC-23.

A transmitter using push-pull 811's or 812's is capable of offering real competition to one-kw stations on any of the popular amateur bands. If a good two- or three-element beam antenna is used on the higher-frequency bands, a rig of this type will put through a strong signal with excellent consistency.

Circuit UC-23 Shows Single-Ended 811 R-F Amplifier For CW Telegraphy

(*Continued from page 2, column 2*)

tained from a well-designed amplifier stage.

To modulate the 812, operating with an input of about 155 watts, an a-f power of approximately 80 watts is required. This can economically be obtained from a pair of 809's in class B, driven by push-pull 2A3's in class A. The modulation resistance presented by the 812 across the secondary of the modulation transformer is 1250/0.125, or 10000 ohms.

The plate-tank condenser (C_8) shown in circuit UC-23 is rated for 2000 volts peak. For plate modulation, C_8 should be rated for twice this value, or 4000 volts peak. A split-stator condenser having an air gap of 0.07″ (not less) between adjacent rotor and stator plates is adequate. If the frame and rotor of C_8 were not tied to +B, an air gap of 0.140″ would be necessary. The 6000-volt peak rating shown for neutralizing condenser C_6 is adequate for either cw or 'phone. A 3000-volt rating would do for cw alone.

A carrier power of 170 watts (cw) or 120 watts ('phone) is capable of giving excellent results in the amateur high-frequency bands. At a price of $3.50 for the 811 or 812, such a transmitter is hard to beat on a basis of performance versus cost.

HAMS PLEASE NOTE!

WIN $5.00!

Does your transmitter use RCA tubes throughout?

If so, send us a photograph and a brief description of it. Photos of final amplifier stages are also suitable. We should like to publish one or more such photos in each issue of HAM TIPS. Those published win $5.00 cash. "Commercial type" rigs are *not* given preference—what have you?

(This offer good in Western Hemisphere, Hawaii, and the Philippine Islands.)

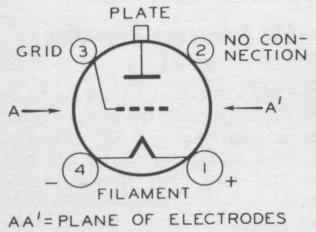
New RCA-811 and 812 Greatest Tube Values Yet

(*Continued from page 4, column 4*)

temperature causes the plate to *alloy* with the Zirconium coating. This action produces an oval-shaped shiny spot in the middle of the plate. The bright spot, once formed, remains permanently, but does not necessarily affect the operation or efficiency of the tube in subsequent normal operation. If the excessive overload is allowed to persist long enough, a silvery coating may form on the interior surface of the glass bulb.

In order to avoid excessive plate overloads, with the attendant "spotting" of the plate and darkening of the bulb, the amateur need only observe the usual precaution of using either a suitable d-c overload relay or a protective resistor in series with the plate supply lead. A 100-watt, 10000-ohm resistor will protect an 811 or an 812 during "tuning up" operations when a new circuit is being adjusted for the first time (before the correct setting of the plate condenser, for resonance, is determined). The resistor should, of course, be shorted or taken out of the circuit during normal operation of the transmitter. A d-c overload relay is preferable to a protective resistor, because a relay can be left in the circuit at *all times* and offers permanent protection. The relay should be set to open the primary circuit of the high-voltage supply when the d-c plate current reaches a value 50% greater than normal—that is, a value of 225 ma. for a single 811 or 812.

Many radio amateurs may feel that the use of such protective devices is not necessary for home-built transmitters. It should be remembered, however, that a protective device will not only protect the r-f amplifier tubes but may also prevent the destruction of meters, power transformers, rectifier tubes, and other circuit components. Just *one* heavy overload removed in time may represent a saving many times the cost of an inexpensive overload relay. But here, we're digressing again from our original purpose. That was, if you remember, to tell you that the new RCA-811 and RCA-812 are a mighty swell pair of tubes!



Top View of Socket Connections for the New RCA-811 and 812

THUMB-NAIL DATA SHOWING CCS AND ICAS COMPARISONS

802—R-F AMPLIFIER PENTODE

Class C Telegraphy	*CCS*	*ICAS*
Max. plate voltage	500	600 V.
Max. plate current	60	60 Ma.
Max. plate dissipation	10	13 W.
Max. plate input	25	33 W.
Grid driving power	0.25	0.3 W.
Carrier power output	16	23 W.

$3.50 Amateur Net.

804—R-F AMPLIFIER PENTODE

Class C Telegraphy	*CCS*	*ICAS*
Max. plate voltage	1250	1500 V.
Max. plate current	95	100 Ma.
Max. plate dissipation	40	50 W.
Max. plate input	120	150 W.
Grid driving power	0.95	1.95 W.
Carrier power output	80	110 W.

$15.00 Amateur Net.

806—TANTALUM-PLATE TRIODE

Class C Telegraphy	*CCS*	*ICAS*
Max. plate voltage	3000	3300 V.
Max. plate current	200	300 Ma.
Max. plate dissipation	150	225 W.
Max. plate input	600	1000 W.
Grid driving power	20	34 W.
Carrier power output	450	780 W.

$22.00 Amateur Net.

807—BEAM POWER TETRODE

Class C Telegraphy	*CCS*	*ICAS*
Max. plate voltage	600	750 V.
Max. plate current	100	100 Ma.
Max. plate dissipation	25	30 W.
Max. plate input	60	75 W.
Grid driving power	0.22	0.22 W.
Carrier power output	37.5	50 W.

$3.50 Amateur Net.

809—HIGH-MU TRIODE

Class C Telegraphy	*CCS*	*ICAS*
Max. plate voltage	750	1000 V.
Max. plate current	100	100 Ma.
Max. plate dissipation	25	30 W.
Max. plate input	75	100 W.
Grid driving power	2.5	3.8 W.
Carrier power output	55	75 W.

$2.50 Amateur Net.

810—HIGH-MU TRIODE

Class C Telegraphy	*CCS*	*ICAS*
Max. plate voltage	2000	2250 V.
Max. plate current	250	275 Ma.
Max. plate dissipation	125	150 W.
Max. plate input	500	620 W.
Grid driving power	12	12 W.
Carrier power output	375	475 W.

$13.50 Amateur Net.

814—BEAM POWER TETRODE

Class C Telegraphy	*CCS*	*ICAS*
Max. plate voltage	1250	1500 V.
Max. plate current	150	150 Ma.
Max. plate dissipation	50	65 W.
Max. plate input	180	225 W.
Grid driving power	1.5	1.5 W
Carrier power output	130	160 W.

$17.50 Amateur Net.

828—POWER AMPLIFIER PENTODE

Class C Telegraphy	*CCS*	*ICAS*
Max. plate voltage	1250	1500 V.
Max. plate current	160	180 Ma.
Max. plate dissipation	70	80 W.
Max. plate input	200	270 W.
Grid driving power	2.1	2.2 W.
Carrier power output	150	200 W.

$17.50 Amateur Net.

NEW RCA-828 BEAM POWER TUBE DESIGNED FOR A-F SERVICE — ALSO EXCELLENT FOR R-F APPLICATIONS

Tow 828's in AB_1 deliver 300 watts of a-f power with only 1% distortion!

RCA-828 is a new multi-electrode transmitting tube with a maximum plate dissipation rating of 80 watts (ICAS) for class AB_1 and class C telegraph services. The 828 contains a suppressor and has beam power features. This tube is designed particularly for use as a class AB_1 modulator and audio-frequency power amplifier; it is also well-suited for use in radio-frequency applications as an r-f power amplifier, frequency multiplier, oscillator, and grid- or plate-modulated amplifier. Two 828's in class AB_1 service (CCS ratings) are capable of delivering 300 watts of audio power with only 1% distortion! Because of its high power sensitivity, RCA-828 can be operated in r-f services to give full power output with very little driving power and, consequently, with a minimum number of driver stages. Neutralization is unnecessary in adequately shielded circuits. The 828 is ideal for use in transmitters where quick band change without neutralizing adjustments is required. The tube may be operated at maximum ratings at frequencies as high as 30 Mc. and at reduced ratings up to 75 Mc. RCA-828 is equipped with the new "MICANOL" base which has excellent insulating qualities at high radio frequencies together with low moisture-absorption characteristics. The plate connection of the tube is brought out through a separate seal at the top of the bulb to provide high insulation.

In class AB_1 audio service, the 828 is operated so that no grid current flows during any part of the input signal cycle. Fixed bias should be employed. Cathode bias is unsuitable because, in a push-pull class AB_1 circuit, two 828's have a d-c plate-current variation of from 50 to well over 200 ma. Obviously, such a plate-current swing would cause an excessive bias shift if self-bias were used. Since no grid current is drawn, a power driver stage is not required. A push-pull voltage amplifier using small receiving tubes such as the 6J7 is suitable for the driver stage. At the maximum ICAS plate-voltage rating of 2000 volts, two 828's are capable of delivering up to 385 watts of audio power with low distortion.

RCA 828

This new transmitting pentode is designed especially for class AB_1 service. It is also an excellent r-f amplifier. Amateur net price, $17.50.

In r-f amplifier service (class C telegraphy), an 828 will deliver an output of approximately 200 watts with a d-c plate-voltage of 1500 volts (maximum ICAS rating for r-f service). The power output of the driver stage should be about 5 watts. Thus, almost any small a-f or r-f power amplifier tube is suitable for the driver stage. A 6V6-G or a 6L6 as a "Tritet" crystal oscillator will drive an 828 very nicely, even if frequency doubling is used in the oscillator plate circuit.

In many respects, the 828 is similar to the RCA-804. Although the 828 has a suppressor grid, this new tube is not recommended for suppressor-modulated telephony service. The suppressor - voltage / power - output characteristic is not linear when the suppressor is operated with a negative bias.

A subsequent issue of HAM TIPS will describe the 828 at greater length; circuits for both a-f and r-f applications will be shown. A technical bulletin on the 828 is now available and may be obtained on request.

BE SURE TO SEE YOUR RCA POWER-TUBE DISTRIBUTOR NEXT MONTH FOR YOUR COPY OF NOVEMBER "HAM TIPS". IT WILL INCLUDE A CONSTRUCTIONAL ARTICLE ON A PUSH-PULL 811 AMPLIFIER, WITH AN 807 DRIVER STAGE ON THE SAME CHASSIS.

Form 1G1290 Printed in U.S.A.