

New Intermediate-Power Transmitting Tubes

Types RK-18, 800 and 830 Announced by Manufacturers

By George Grammer, Assistant Technical Editor

WHILE tube manufacturers have been vying with one another to be the first to get into production on the whims of this and that set designer, there is one person who has had to take such crumbs as might come his way — Mr. John Q. Ham. Of the multitudinous types that have been announced in the past three years, those that really filled any need in amateur radio can almost be counted on the fingers of one hand — a few receiving tubes of improved characteristics, the 46 with its versatile heater-type companion, the 59, and some low-voltage mercury-vapor rectifiers. Some of the rest have been useful occasionally, especially the battery-operated varieties for portables, but the great majority have made no dent in the consciousness of amateurs in general, nor is there any good reason why they should have.

But now we have some real news: Three new types that fill the gap between the 10 and the 203-A or 852! Not duplicates, but three different designs all having about the same power output rating as oscillators or r.f. power amplifiers. These are the Raytheon RK-18, the RCA-Radiotron 800, and the Sylvania 830. Unfortunately we can give complete data only on the RK-18 in this issue; the last two were announced just at press time and, aside from the usual filament and plate ratings given farther along, our information on them is incomplete. More about them in later issues.

The Raytheon RK-18, the design of which was decided upon after Raytheon representatives had consulted A.R.R.L. Headquarters on the question of what kind of tube amateurs needed, is a double-ended which looks somewhat like a miniature 204-A, as the photograph shows. The grid and filament connections are brought out to a standard 4-prong base — made of Isolantite to keep down losses at high frequencies — on one end, with the plate connection coming out the other end. The photograph shows a binding post on the plate socket, although there is a possibility that this may be changed to a cap, later. The filament is thoriated

tungsten, which means that the RK-18 is really "hard" and which does away with the grid-emission troubles that make the small tubes with oxide-coated filaments so unstable at 400 volts or more. The plate is sand-blasted molybdenum, which shows some color when the dissipation is nearing the rated value — a good feature in a transmitting tube because it gives a sure indication of overloading or inefficiency.

The ratings on the RK-18 are as follows:

Filament voltage	7.5 volts
Filament current	1.4 amperes
Plate voltage, maximum	1000 volts
Safe Plate Dissipation	40 watts
Amplification factor	18
Plate resistance	6000 ohms
Mutual conductance	3000 micromhos

Inter-electrode Capacitances:

Grid to plate	5 μ fd.
Grid to filament	3.8 μ fd.
Plate to filament	2 μ fd.

The operating data on the tube as a Class-A amplifier are given below. Because of the high μ the undistorted power output is not as great as would be obtained from a lower- μ tube operating at the same plate voltage.

Class A Service

Plate voltage	750	1000 maximum
Grid Bias voltage	-30	-40 volts
Plate current	34	36 ma.
Load resistance	9300	13500 ohms
U. P. O.	5.4	8.5 watts

AS AN OSCILLATOR OR R.F. POWER AMPLIFIER

For r.f. use the following nominal ratings have been put on the tube:

Plate voltage	750 modulated
" "	1000 unmodulated
Plate current	85 milliamperes
Safe plate dissipation	40 watts
Max. r.f. grid current	5 amperes
Typical operation; $E_b = 1000$, $E_c = -150$	
Power Output	50 watts

The recommended grid-leak resistance is 15,000 ohms. Under operating conditions, with the tube delivering power to a load, a d.c. grid current of 10 milliamperes will provide the necessary bias.

The amount of r.f. power that can be taken from a tube depends to a large extent on how the circuit is handled. If the tube is excited properly and the circuit is well designed, the tube effi-



THE NEW
RAYTHEON RK-18

Designed especially for amateur high-frequency transmitters, the RK-18 is featured by low inter-electrode capacities, wide spacing between plate and other elements, ability to stand high voltages, and power output in the vicinity of 50 watts both in radio-frequency circuits and Class-B audio.

ciency can be made quite high — as high as 80% for a separately excited amplifier, somewhat less for a self-excited oscillator. It should be no trick at all to get 50 watts from the tube without exceeding the conservative plate voltage and plate current ratings given above.

Actual tests show that the RK-18 is an excellent high-frequency tube. A sample tube used as a

plate current of about 100 milliamperes. The same input on 14 mc. lighted up a 60-watt lamp used as a dummy load almost to normal brilliancy, with the tank circuit still plenty "hot." The grid current was 15 milliamperes, bias approximately 200 volts, a combination which works the tube at high efficiency.

CLASS-B MODULATOR CHARACTERISTICS

Figs. 1 and 2 are curves indicating the performance of the RK-18 as a Class-B audio amplifier at plate voltages of 750 and 1000 with various values of load resistance. A study of the curves shows that the tubes are not hard to excite — the driving power required at the optimum operating conditions is well within the capabilities of a single 2A3 or a pair of 45's in push-pull — and that large outputs can be obtained. This is the natural result of the high plate voltages at which the tube can be used. It is possible to obtain 100 watts of audio power from a pair of tubes while still working within the plate current and plate dissipation ratings. Hardly any 'phone man needs to be told that 100 watts of audio power will fully modulate 200 watts of r.f. input — and 200 watts input on the modulated stage makes a transmitter that will do some business on the air.

The table below gives some suggested operating conditions. In the first column, the tubes are worked at their full plate-current rating at 750 volts, the output power being slightly more than 70 watts. In the second column, an output of 65 watts is obtained at the same plate voltage with a greater step-down ratio in the input transformer, which lessens the grid distortion. This set of conditions is just about right to modulate a pair of RK-18's in an r.f. amplifier drawing maximum plate current at the same plate voltage. The third column is for operation with 1000 volts on the plate.

CLASS-B OPERATION

Plate voltage	750	750	1000 volts
Grid bias voltage	-35	-35	-45 "
Load resistance per tube *	2000	2000	3000 ohms
Power output (two tubes)	71	65	100 watts
Peak grid voltage	+63	+58	+60 volts
Peak grid swing	98	93	105 "
Peak plate current (two tubes)	267	255	258 ma.
Average plate current at full output (two tubes)	170	162	164 "
No-signal plate current (two tubes)	20	20	24 "
Average grid current at full output (two tubes)	11	9	15
Driver input transformer turns ratio; pri. to 1/2 sec.:			
With one 2A3	2:1	2.5:1	2:1
With p.p. 45's	4:1	5:1	4:1

The output transformers now available for the smaller Class-B tubes probably are not capable of handling the larger power output of a pair of RK-18's, certainly not at the 1000-volt rating.

(Continued on page 68)

* Multiply by 4 for two tubes.

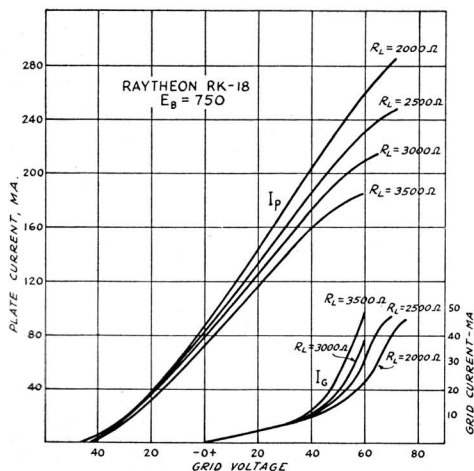


FIG. 1 — TYPICAL LOAD CURVES OF THE RK-18 AS A CLASS-B AUDIO AMPLIFIER WITH 750 VOLTS ON THE PLATE

At this plate voltage an audio output of 70 watts can be obtained from two tubes by proper choice of load conditions.

neutralized doubler on 28 mc. gave an output of more than 30 watts with 700 volts on the plate — all that was available at the moment — at a

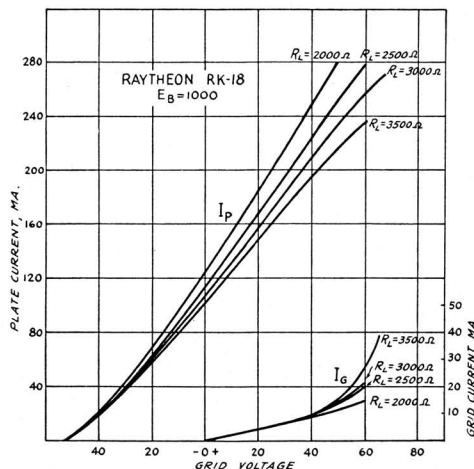


FIG. 2 — CLASS-B LOAD CURVES AT 1000 VOLTS

With a load impedance of 3000 ohms per tube the audio output is 100 watts with a peak grid swing of 105 volts. The maximum instantaneous driving power required is slightly more than 2 watts. No negative kinks in these grid-current curves.

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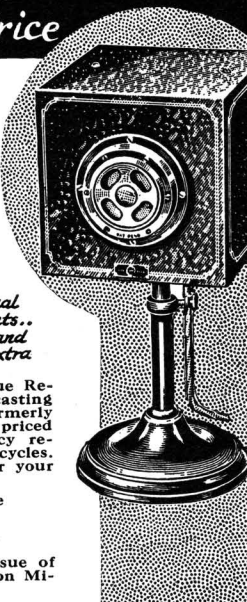
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New Intermediate-Power Transmitting Tubes

(Continued from page 34)

Transformers can be made at home by following the procedure outlined in December, 1931, *QST*,¹ the turns ratio being determined by the load into which the transformer is to work. The input transformers have to handle only a few watts and will present no particular difficulty. The design given in December, 1931, *QST* for a pair of 45 drivers can be used by reducing the secondary turns to conform to the ratios given above.

The Sylvania 830

The 830 is a husky tube which looks a good deal like a 203-A but has a standard four-prong base, the pin connections being the same as those of the 10. The characteristics are in fact a good deal like those of the 10—but the tube is built to stand higher voltages and higher plate currents. To make this possible the 830 has a heavy thoriated filament and an Isolantite base. The plate is graphite—the same type of construction that is a feature of the newer 203-A—211—845 group of tubes. Here are the ratings:

Filament voltage	10.0 volts	Amplification factor	8
Filament current	2.15 amps	Plate resistance	4000 ohms
Plate voltage	750 volts	Mutual conductance	2000 micromhos

Interelectrode capacitances:

Grid to plate	9.9 $\mu\text{fd.}$	Plate to filament	2.2 $\mu\text{fd.}$
Grid to filament	4.9 $\mu\text{fd.}$		

As a Class-C r.f. power amplifier or oscillator the following ratings have been placed on the 830:

Plate voltage (max. modulated)	750 volts	Maximum r.f. grid current	6 amps.
Maximum plate current	110 ma.	Typical operation: $E_b=750$; $E_c=-150$;	
Maximum d.c. grid current	18 ma.	Power output	55 watts

The RCA-800

The RCA-800 is a smaller edition of the 852. Although it has an ordinary pear-shaped bulb, only the filament connections are brought out to the standard 4-prong base. The plate and grid leads go to a pair of caps set like horns on the top of the bulb. As a result of this construction the interelectrode capacities are very low and the tube can stand fairly high voltages. The filament is thoriated tungsten. The following tentative ratings have been placed on the 800:

Filament voltage	7.5 volts	Max. plate dissipation	35 watts
Filament current	3.25 amps.	Amplification factor	15
Max. plate voltage	1000 volts	Mutual conductance	2300 micromhos
Max. plate current	75 ma.	Plate resistance	6800 ohms

Interelectrode capacitances:

Grid to plate	2.5 $\mu\text{fd.}$	Plate to filament	1.0 $\mu\text{fd.}$
Grid to filament	2.7 $\mu\text{fd.}$		

The tube has been rated conservatively at 35 watts output on frequencies up to 60 megacycles. It will oscillate at 200 mc. (1.5 meters) in regular circuits. From the characteristics it appears that the 800 also will be well suited to Class-B audio; no curves are available at this writing, however, so definite design information will have to be left for a later issue.

¹"High-Power Performance from the Small 'Phone Transmitter," *QST*, December, 1931.