HAM TIPS from RCA

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NEW HIGH-POWER TRIODE HAS BROAD FIELD OF USES

RCA-8000 is Rated at 620 Watts Input (ICAS) for CW Service

RCA-8000 is the new outstanding high-power triode added to the line of famous RCA Air-cooled transmitting tubes. Special feature of the tube is its construction which provides high insulation resistance between electrodes. This design enables the tube to withstand high peak voltages.

Mu Lower Than 810

Similar in appearance to the popular 810, the 8000 also has a similar maximum plate dissipation of 150 watts (ICAS) but has a lower mu of 16.5. Grid-driving requirements also are lower than the 810. RCA-8000 is particularly suitable for use as an r-f amplifier and class B modulator. Because of its high perveance, it can be operated at high plate efficiency with low driving power and relatively low plate voltage. *Two 8000's in class C telegraph service (ICAS) will take a power input*

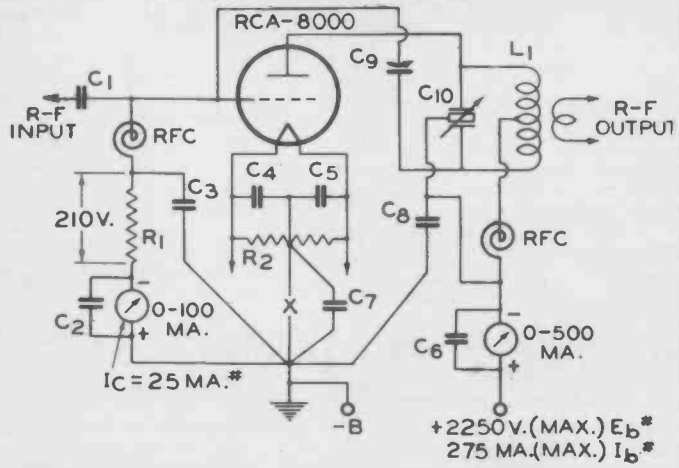
(*Continued on page 4, column 1*)

POWER PLUS

Rated at 275 ma. and 2250 volts (ICAS) and with internal construction designed for higher-than-ordinary voltages, RCA-8000 stands ready to take it in any field. Amateur Net Price is only $13.50.

R-F POWER AMPLIFIER USING RCA-8000

Power Output 475 Watts, ICAS



C_1=0.0005 μf, mica, 1500 v.
C_2 to C_6=0.002 μf, mica
C_7=0.002 μf, mica, 2500 v.
C_8=0.002 μf, mica, 5000 v.
C_9=4.8 μμf (approx.), 7500 v.
C_{10}=0.75 μμf/meter/section†
R_1=8400 ohms, 20 watts
R_2=50 ohms, c.t., wire-wound
L_1=Select for band desired
RFC=R-f choke
X=Insert keying relay here

† Approximate capacitance in actual use at resonance.

For ICAS plate-modulated telephony service, reduce E_b to 1800 v., I_b to 250 ma., and decrease I_c to 20 ma. The power output is approximately 335 watts.

SIMPLE CURVES MAKE CORRECT RECTIFIER FILTER DESIGN EASY

Unique Method By RCA Engineers Safeguards Rectifier Tubes, Predetermines Ripple

Rectifier filters are often a neglected part of a transmitter—bogey-men of the shack. It isn't that there is a dearth of information on the subject of filters. Quite the reverse is true—and that is often the hitch. By the time a fellow has waded through the volumes of engineering treatises on filters, combed popular articles on LC ratios, peak currents, ripple voltages and swinging chokes, the chances are he will have given up in despair and reach once again for his old reliable "brute-force" smoother.

In the curves, page 2, RCA engineers have gone a long way toward taking the fuss and muss out of rectifier filter design problems. To use these curves, it is only necessary to decide how much ripple voltage you wish to tolerate in the output, then pick from the curve a suitable combination of choke and condenser values that will meet this requirement. The LC combination you chose automatically limits to a safe value the peak plate current and average plate current flowing through the rectifier tubes. Moreover, it pre-

(*Continued on page 3, column 1*)

DID YOU KNOW THAT . . .

The filaments of RCA battery-operated tubes are finer than a pin point? For example, filament diameter of the RCA-958 Acorn tube is approximately 0.001 inch—that of the 957 and 959 Acorns, only 0.0006 inch!

W3BKX/3 USING RCA TUBES WINS FIELD DAY CONTEST

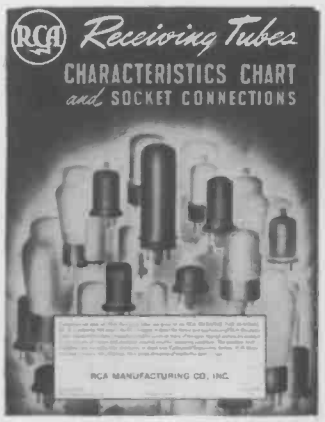
Frankford Radio Club Xmtrs Feature 807's and VR-150's

For the second consecutive issue of Ham Tips, we can boast with pardonable pride to the fact that the winner of major national contest used RCA tubes—and plenty of them. The Frankford Radio Club of Philadelphia, operating under the call of W3BKX/3 gathered in 8406 points with 601 contacts during the 1940 A.R.R.L. Field Day jamboree. This is a record if ever there was one. Congratulations, F. R. C. During the 26 hours of contest in which the seven stations of the club were on the air nearly continuously, every one of the 43 RCA tubes gave 100% uninterrupted service.

The tube line-ups in the seven transmitters at W3BKX/3 are straightforward. They signify that careful planning contributed in no

(*Continued on page 4, column 4*)

YOURS FOR THE ASKING



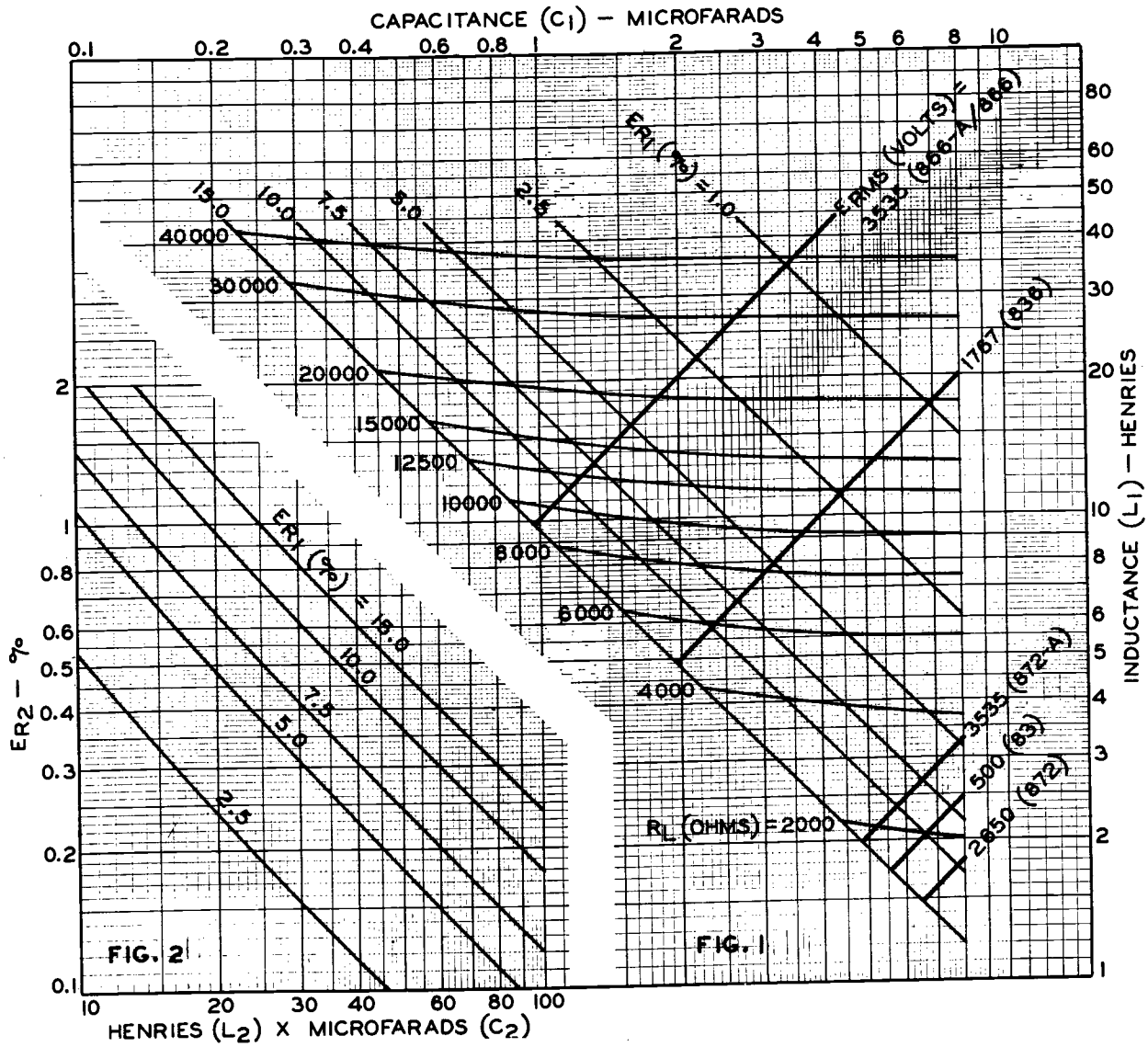
A brand new 16-page Receiving Tube Chart is now available for amateurs, servicemen, and engineers. This chart, known as the 1275-B, contains the salient characteristics, socket connections, and a special classification index of the complete line of RCA receiving tubes, including the famous Miniature types. Ask your RCA tube dealer or write to the Commercial Engineering Section of the RCA Manufacturing Co., Inc., Harrison, N. J. for your copy.

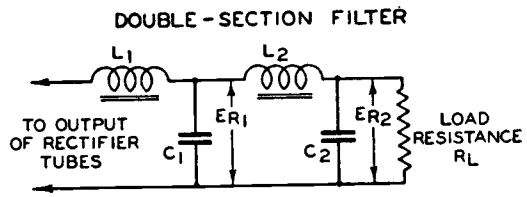
FILTER DESIGN CURVES

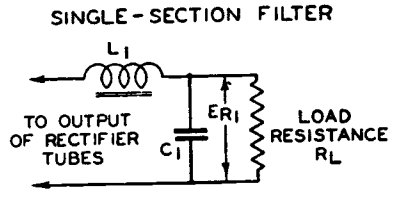
For Full-Wave, Single-Phase Circuits Only—60-Cycle Sine-Wave Supply

(When the supply is a 50-cycle source, multiply the selected values of inductance and capacity by 1.2. When the supply is a 25-cycle source, multiply the filter values by 2.4.)

Fig. 1—Curves for choice of filter values for (1) the first section of a double-section filter, or (2) a single-section filter.
Fig. 2—Curves for choice of filter values for second section of a double-section filter.







E_{RMS}=Maximum volts (RMS) per plate applied to rectifier tube.
R_L=Load Resistance.
E_{R1}=Per cent ripple in D-C output voltage from (1) the first section of a double-section filter, or (2) a single-section filter.
E_{R2}=Per cent ripple in D-C output voltage from second section of a double-section filter.

Simple Curves Make Correct Rectifier Filter Design Easy

(*Continued from page 1, column 4*)

cludes the possibility of encountering serious circuit instability and impairment of filtering caused by 120-cycle resonance.

Choke-Input Filters Desirable

The curves are based on the use of a choke-input filter. This type of filter has many advantages. It provides good voltage regulation, it limits current surges during switching, and also limits the peak plate current during rectifier operation. Its use is preferable from the standpoint of obtaining the maximum continuous d-c output from a rectifier tube under the most favorable conditions. It is especially recommended for use with mercury-vapor rectifier tubes and with high-vacuum rectifier tubes having closely-spaced electrodes. Lastly, the performance of a good choke-input filter can be calculated accurately.

What R_L, E_{r1} and E_{rms} Mean

In Fig. 1, the R_L curves give the minimum inductance and capacitance values that should be used with any specified load resistance. Combinations above R_L may be used with a decrease in output ripple voltage. However, lower than the recommended inductance and capacitance values as indicated by the R_L curve may result in overloading of the rectifier tubes under steady operating conditions as well as in poor regulation. The value of R_L for any specific design is obtained by dividing the required rectifier d-c output voltage by the desired load current (in amperes). The d-c output voltage used for this calculation is taken as 90% of the RMS voltage per rectifier tube plate. It does not take into consideration the regulation of the power transformer, filter choke (s), or rectifier tube (s).

The E_{R1} lines represent the percentage ripple for any single-section filter combination. Always select inductance and capacitance values along the desired E_{R1} line.

The E_{rms} lines show the various combinations of minimum filter inductance and maximum first-section filter capacitance that will limit the surge current to the maximum peak plate current rating of the particular tube it represents, at the maximum peak inverse voltage rating of the tube. An E_{rms} line is given for each rectifier tube type. Always select filter constants along E_{rms} or to the left of E_{rms}.

Lower Voltage, Lower Inductance

When lower than the rated maximum peak inverse voltage is used for a tube type, lower inductance and higher capacitance values may be used without exceeding the peak current rating of the tube. In this case, the filter combination is selected to the left of a new E_{rms} line, the points of which are determined from the equation.

$$L_1 = \left(\frac{E_{RMS}}{I_{MAX.} \times 1110}\right)^2 C_1$$

where

C_1 = First filter condenser capacitance in microfarads
L_1 = First filter choke inductance in henries
$I_{max.}$ = Peak plate current rating of tube in amperes
E_{rms} = RMS transformer voltage per tube

2 Sections Often More Economical

When more filtering is required than can be obtained economically by means of a single filter section, a second filter section may be added to the first. The size of L_2 and C_2 for the second section may be easily determined from Fig. 2. Since E_{R1}, is known for the first section, the values of L_2 and C_2, as a product, may be read from the appropriate E_{R1} curve for any desired value of percentage ripple E_{r2}. Practically any values of L_2 and C_2 forming the product read from the curve can be used for the second section. However, in order to avoid serious circuit instability and impairment of filtering due to 120-cycle resonance, L_2 (in henries) must always be greater than $3\ (C_1 + C_2) \div 2C_1C_2$, where C_1 and C_2 are in microfarads.

Simply Follow These Rules

When designing a single-section filter, use Fig. 1 and observe the following rules: *Always select inductance values, (1) above the proper R_L curve. (2) to the left of the proper E_{rms} curve, and (3) along the desired E_{R1} curve. Use the corresponding value of filter capacitance for each selected value of inductance.* When designing the second section of a double-section filter, use Fig. 2 and observe the following rules: *(1) Select desired percentage of output ripple voltage E_{r2} on appropriate curve of E_{R1}. (2) Read corresponding L_2C_2 product. (3) Satisfy this product by choosing convenient values of L_2 and C_2. (4) Check the chosen value of L_2 to insure that it is greater than 3 $(C_1 + C_2) \div 2C_1C_2$.*

Where the load resistance varies over a wide range, good regulation may be obtained by (1) connecting a husky bleeder resistance across the filter output to restrict the range over which the effective load varies, (2) using an input choke with sufficient inductance to meet all values of load resistance up to the highest attained, or (3) using a swinging input choke. The last method is the more economical.

The inductance of a well-designed swinging-choke rises from its normal value at rated load current to a high value at low load current. The required minimum and maximum values of swinging-choke inductance can be determined from Fig. 1 at the intersection of the E_{R1} curve and the desired capacitance value line to the left of the E_{RMS} line. The maximum inductance value then will be found at the intersection of this same capacitance value line and load curve R_L at maximum load. It is generally more economical to select low values of swinging-choke inductance and to depend on additional filter sections to provide the required smoothing.

EXAMPLE No. 1

Problem: Given a d-c output voltage of 3180 volts (corresponds to a peak inverse voltage of 10,000 volts) from a 60-cycle full-wave rectifier employing two 866-A/866's, design a single-section filter of the choke-input type which will limit the ripple voltage to 5% at a load current equal to the combined maximum d-c load-current rating of the tubes (500 ma.), and still prevent the peak plate current of either tube from rising higher than the maximum peak plate-current rating of the 866-A/866.

Procedure: E_{rms} is equal to 3180 x 1.11, or 3535 volts (see January 1941 Ham Tips). R_1 is equal to 3180/0.5 ampere, or 6360 ohms. From Fig. 1, R_1 = 6360 lies below curve E_{rms} = 3535 (as shown for the 866-A/866). Hence, any combination of inductance and capacitance along the curve E_{R1} = 5% and to the left of the curve E_{rms} = 3535 will satisfy the requirements. A suitable combination is a filter section employing a 25-henry choke and a 1-microfarad condenser. Another suitable combination would be a 17-henry choke and a 1.5-microfarad condenser.

EXAMPLE No. 2

Problem: Given a d-c output voltage of 3180 volts (corresponds to a peak inverse voltage of 10,000 volts) from a 60-cycle full-wave rectifier employing two type 866-A/866's, design a double-section filter which will limit the output ripple voltage to 0.5% at a load current equal to the combined maximum d-c load-current rating of the tubes (500 ma.) and still prevent the peak plate current of either tube from rising higher than its maximum peak plate-current rating. The input choke is to be of the swinging type and the voltage regulation is to be good from no-load to full load.

Procedure: E_{rms} is equal to 3180 x 1.11, 3535 volts. At maximum load, $R_1 = 3180/0.5$ ampere, or 6360 ohms. Therefore, any combination of inductance and capacitance along E_{R1} and to the left of $E_{RMS} = 3535$ will be suitable. A value of 10% ripple at the output of the first filter section will be assumed to be satisfactory. The minimum value of swinging-choke inductance and corresponding value of capacitance for the first-section filter condenser, therefore, may be selected along curve E_{R1} = 10% and to the left of curve E_{rms} = 3535 volts (for 866-A/866). Suitable values are 13.5 henries and 1 microfarad. The maximum value of swinging-choke inductance to be used with a condenser having a capacity of 1 microfarad should be as high as practical. Assume that this value is 40 henries. Then, with a capacitance value of 1 microfarad the maximum value of R_1 is approximately 44,000 ohms. Therefore, a bleeder resistance of 44,000 ohms is required to keep the d-c output from "soaring" at transmitter no-load conditions. With a load resistance of 44,000 ohms, the bleeder current is 2385/44000 = 0.073 ampere, or 73 milliamperes. The total useful d-c output current is then 500-73, or 427 milliamperes.

Considerations for 2nd Section

The design of the second filter section should now be considered. It must be capable of reducing the ripple voltage from 10% in the first section to 0.5% in its own output. From Fig. 2, the value of the product L_2C_2 is 37 as read on the curve E_{r1} = 10% when E_{R2} = 0.5%. If C_2 is chosen to be 2 microfarads, L_2 = 37/2, or 18.5 henries. This value of L_2 is greater than $3\ (C_1 + C_2) \div 2\ C_1C_2 = 3\ (1 + 2) \div 2\ (1 \times 2)$, or 2.25, and therefore is of ample size to avoid resonance effects.

The curves are satisfactory for all ham applications as well as for many commercial filter installations. A little practice working with the curves will be convincing that they are material time savers and simple to use. The performance of a filter chosen from them can be predetermined accurately provided, of course, that the filter equipment employed is of good design and is properly rated.

HAM TIPS from RCA

New High-Power Triode Has Broad Field of Uses

(*Continued from page 1, column 1*)

of 1240 watts and require only 18 watts of driving power. In class B modulator service, two 8000's will modulate 100% nearly 1½ kilowatts of power.

In self-rectifying oscillator circuits, such as are used in therapeutic applications, two 8000's are capable of delivering a useful power output of 550 watts (85% circuit efficiency). In this application, as well as in general radio transmitter applications, the 8000 may be operated at maximum ratings at frequencies as high as 30 Mc and with reduced plate voltage and input as high as 100 Mc.

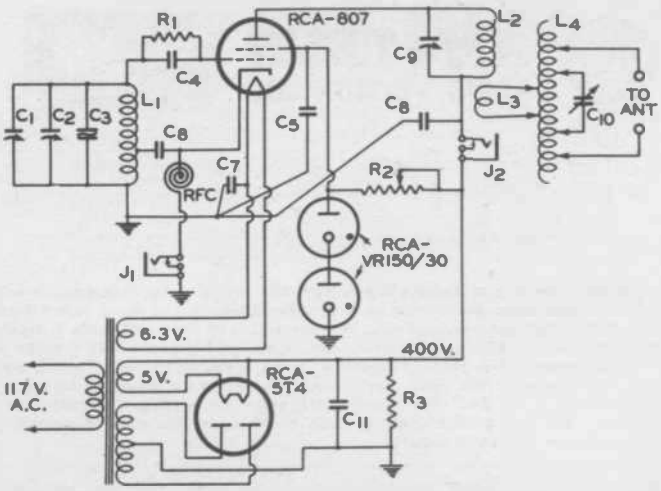
RCA-8000 is designed with a heavy-duty 45-watt filament which is shielded at each end. This feature increases power output by eliminating losses from bulb bombardment and stray electrons. The tube has a large graphite anode, specially processed, to insure high thermal radiation and a minimum of gas. The plate and grid leads are brought out to rugged terminals at the top and side of the bulb respectively. This design provides very low lead inductance and permits compact circuit layout for r-f installations.

A typical single-ended r-f amplifier circuit using the 8000 is shown on p. 1. Keying is shown in the filament-to-ground return lead. If it is desired to key the oscillator for break-in operation, a fixed bias of –90 volts should be used in conjunction with a grid leak (R_1) of about 5000 ohms (10 watts). This amount of fixed bias will protect the 8000 against removal of grid excitation when the key is open. An RCA-809 operated at reduced ratings or an 807 is suitable for the driver stage. For 10-meter operation with an 80-meter crystal, a practical tube line up is an 807 or 6L6 "Tritet" crystal oscillator-quadrupler, an 807 buffer-amplifier and an 809 doubler. The 809 is needed only for 10-meter operation; it may be omitted for the other bands. With a 10-meter crystal and a 6J5-G triode oscillator, an 807 can be used to drive the 807 directly, thereby providing a 3-stage, 10-meter transmitter of respectable power output. This r-f amplifier circuit may also be plate modulated by reducing the d-c plate voltage to 1800 volts and the d-c plate current to 250 ma. These are ICAS values.

With its relatively low plate-voltage requirement for high power output, RCA-8000 is ideal for use in radio transmitter installations as well as being a logical choice in self-rectifying oscillator circuits such as are often used in therapeutic applications. Priced at a net of $13.50 it offers economy not only in initial tube cost but also in cost of the final-stage tank condenser, the high-voltage power supply, and the number of exciter stages required.

For additional technical information on the RCA-8000, write to the Commercial Engineering Section, Harrison, N. J.

W3BKX/3 7-Mc PORTABLE TRANSMITTER



C_1=35 μμf. Max. (Main tuning cond.)
C_2=Air-padder, 235 μμf. Max.
C_3=65 μμf. fixed (Neg. Coeff. Type)
C_4=0.0001 μf. mica
C_5 C_6 C_7 C_8=0.01 μf. mica
C_9=100 μμf. max.
C_{10}=140 μμf. max.
C_{11}=40 μf. electrolytic
R_1=18,000 ohms. 2-watt
R_2=5,000 ohms. 25-watt
R_3=90,000 ohms. 10-watt
L_1=Tuned to 3.5 Mc. 16 Turns No. 16 B. & S. on 1⅜" form winding length. 1⅜". Cathode tapped 4 turns above ground.
L_2=Same as L_1 but without tap.
L_3=3 turns No. 24 enamel wound between lower turns of L_2
L_4=B. & W. type 40-B. 20 turns
J_1=Key jack
J_2=Plate-meter jack
RFC=2.5 mh. choke

MODERNIZED

21 more pages and 40 new tube type descriptions have just been added to the RC-14. This book is now a virtual encyclopedia of receiving tubes, containing 240 pages covering 283 different receiving tube types. An up-to-date RC-14 may be obtained from your RCA tube dealer, or by sending 25 cents to the Commercial Engineering Section, RCA Manufacturing Company, Inc., Harrison, N. J.

W3BKX/3 Using RCA Tubes Wins Field Day Contest

(*Continued from page 1, column 3*)

small way to the final success of the club. The line-ups are as follows:

Transmitter No. 1—1.8-Mc Phone
RCA-802 electron-coupled oscillator, RCA-807 final amplifier, RCA-56's speech amplifier, RCA-46's class B modulator. RCA-83 and RCA-5Z3 rectifiers. Input to final, 20 watts.

Transmitter No. 2—3.5 to 3.6-Mc CW
RCA-6L6 crystal or electron-coupled oscillator, RCA-807 final amplifier, 2 RCA-VR-150's as ECO voltage regulators, RCA-83 rectifier. Input to final, 30 watts.

Transmitter No. 3—3.6 to 3.9-Mc CW
RCA-6AG7 electron-coupled oscillator, RCA-807 final amplifier, 2 RCA-VR-150's as ECO voltage regulators, 2 RCA-6X5G rectifiers. Input to final, 30 watts.

Transmitter No. 4—7.0 to 7.15-Mc CW
RCA-807 electron-coupled oscillator, 2 RCA-VR-150's as ECO voltage regulators, RCA-5T4 rectifier. Input, 30 watts.

Transmitter No. 5—7.15 to 7.3-Mc CW
RCA-807 electron-coupled oscillator, 2 RCA-VR-150's as ECO voltage regulators, 2 RCA-6X5G rectifiers. Input, 27 watts.

Transmitter No. 6—14-Mc CW
RCA-802 electron-coupled oscillator, RCA-VR-105 and RCA-VR-150 as ECO voltage regulators, 2 RCA-6X5G rectifiers. Input, 27 watts.

Transmitter No. 7—28- and 56-Mc Phone
RCA-6L6 tritet oscillator, RCA-6L6 doubler, RCA-807 final amplifier, 2 RCA-6L6 modulators, and 2 RCA-5Z3 rectifiers. Input, 30 watts.

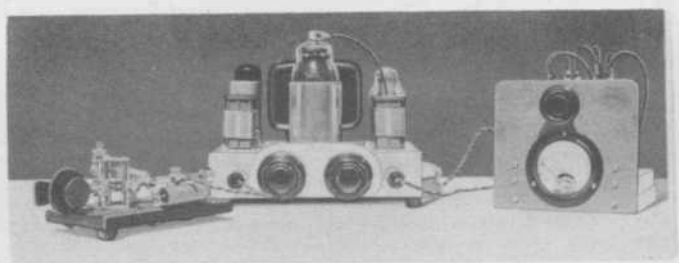
AR-77 PRICES REVISED

Markedly improved design together with increased manufacturing costs necessitates a slight revision of prices on the new-production AR-77's. Beginning March 1, Amateur Net Prices are: AR-77 only, $162.50; AR-77 with 8" Table. Speaker, $170.50; AR-77 with Extended-Range Speaker Mi-8314-A, $177.50.

RCA-8000 TENTATIVE CHARACTERISTICS and RATINGS

FILAMENT VOLTAGE (A.C. or D.C.)		10	Volts
FILAMENT CURRENT		4.5	Amperes
AMPLIFICATION FACTOR		16.5	
DIRECT INTERELECTRODE CAPACITANCES:			
Grid-Plate		6.4	μμf
Grid-Filament		5.0	μμf
Plate-Filament		3.3	μμf
As R-F Power Amplifier—Class C Telegraphy			
Key-down conditions per tube without modulation			
	CCS	ICAS	
D-C PLATE VOLTAGE	2000 *max.*	2250 *max.*	Volts
D-C GRID VOLTAGE	–500 *max.*	–500 *max.*	Volts
D-C PLATE CURRENT	250 *max.*	275 *max.*	Ma.
D-C GRID CURRENT	40 *max.*	40 *max.*	Ma.
PLATE INPUT	500 *max.*	620 *max.*	Watts
PLATE DISSIPATION	125 *max.*	150 *max.*	Watts
TYPICAL OPERATION:			
D-C Plate Voltage	2000	2250	Volts
D-C Grid Voltage:			
From a fixed supply of	–195	–210	Volts
From a grid resistor of	8100	8400	Ohms
From a cathode resistor of	710	700	Ohms
Peak R-F Grid Voltage	370	400	Volts
D-C Plate Current	250	275	Ma.
D-C Grid Current (Approx.)	24	25	Ma.
Driving Power (Approx.)	8	9	Watts
Power Output (Approx.)	375	475	Watts

PRIZE-WINNING PORTABLE



W3BKX/3's transmitter for the 7000-7150 kc. channel consists of an 807 as E.C.O. Self-contained power supply uses a 5T4 rectifier and two VR-150 voltage regulator tubes. Size of the chassis is only 7" x 9" x 2". Antenna coupler is shown to the right of the photograph. Circuit appears above.