INSTRUCTIONS

FOR

Model ACT-40 Amateur Transmitter

OUTPUT: 40 WATTS

RCA Manufacturing Company, Inc.

Camden, N. J., U. S. A.

A RADIO CORPORATION OF AMERICA SUBSIDIARY

IB—23927

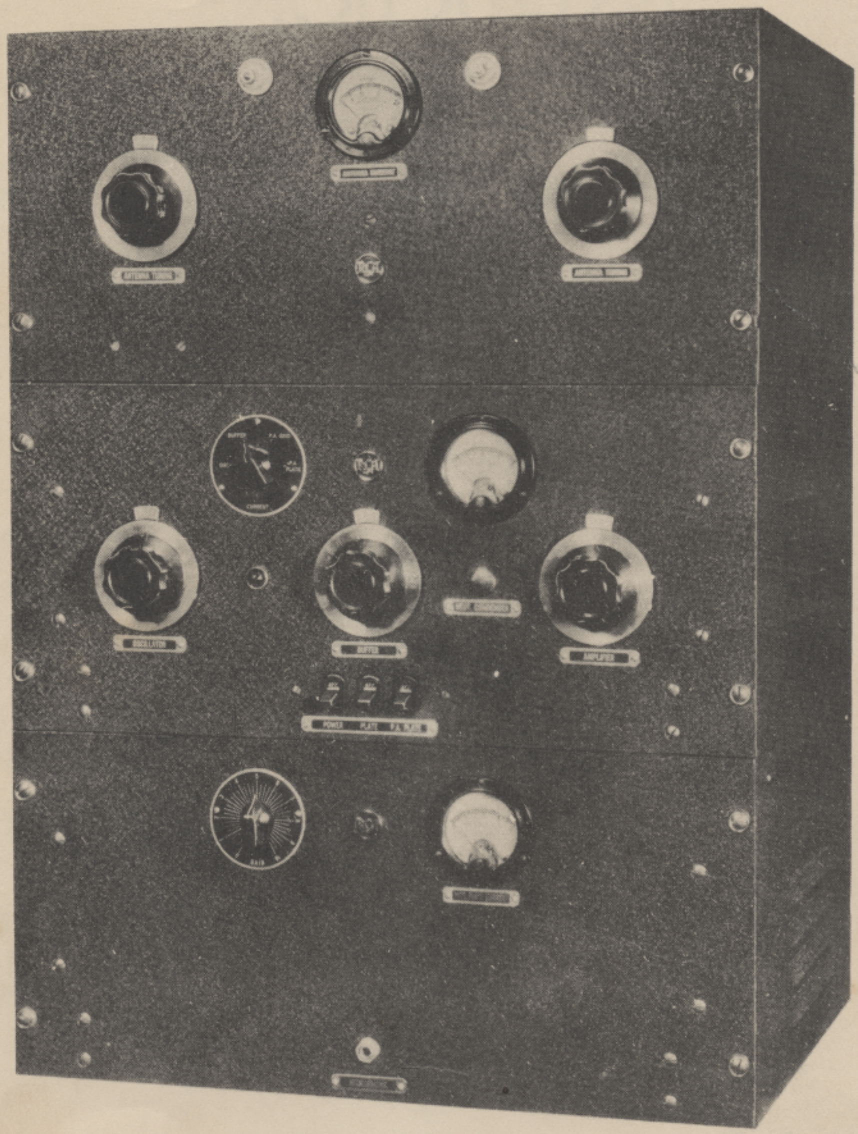

Figure 1—ACT-40 Amateur Transmitter

Installation and Operating Instructions
FOR
ACT-40 AMATEUR TRANSMITTER
Forty Watts Output for C-W or C-W and Phone Operation

INTRODUCTION

This Instruction Book should be carefully read and studied in order that the owner of a Model ACT-40 Amateur Transmitter will become familiar with the proper installation and operation of this equipment to obtain high quality performance. The straight-forward design of this equipment has made possible simple operation, which may be grasped equally as well by the newcomer as by the experienced amateur radio operator. Once the equipment is properly installed, the signal emitted will have qualities desired by the most critical of the amateur radio fraternity.

EQUIPMENT AND ACCESSORIES

(1) Carefully unpack each unit, giving a general inspection to see that nothing has been damaged during shipment or handling. Each unit has been given a thorough test and inspection before leaving the factory. However, a few minutes spent by the owner in inspecting the equipment may safeguard against some unforeseen accident resulting in damage and delay.

(2) The following units make up the 40-watt telegraph and telephone transmitter:

R-F unit and power supply (ACT-40-R).
Modulator unit and power supply (ACT-40-M).
Antenna unit (ACT-40-A).
Cabinet rack (ACT-40-C).
One set of coils (for band specified).

A 40-watt transmitter for C-W telegraph operation only incorporates all the above units with the exception of the modulator unit, a blank panel being supplied in its place. Screws and finishing washers for holding the units in place and neatly laced interconnecting cables are furnished.

(3) The following accessories (not furnished) are required:

R-F Unit:

1—Piezo-electric crystal in a suitable holder having the mounting pins (G. R. type) spaced 3/4 inch apart, such as the RCA Model TMV-135-A.
1—Telegraph key.
1—S. P. S. T. switch for oscillator standby circuit.
1—45-volt battery for grid bias, such as Burgess type No. 5308 or equivalent.

Tube Complement:

1—RCA-47.
1—RCA-83.
2—RCA-80.1.
1—RCA-802.

If it is desired to operate in more than one amateur band, coils can be purchased for the following bands:

1715-2000 K. C., 3500-4000 K. C., 7000-7300 K. C., 14,000-14,400 K. C.

If it is desired to operate in the higher frequency band adjacent to the crystal frequency, only the buffer/doubler and final amplifier coils for this band need be obtained.

Modulator Unit:

1—High-impedance microphone such as a crystal type (see paragraph in General Description).
1—45-volt battery for grid bias, such as Burgess Type No. 5308 or equivalent.
1—22½-volt battery for grid bias, such as Burgess Type No. 5156 or equivalent.

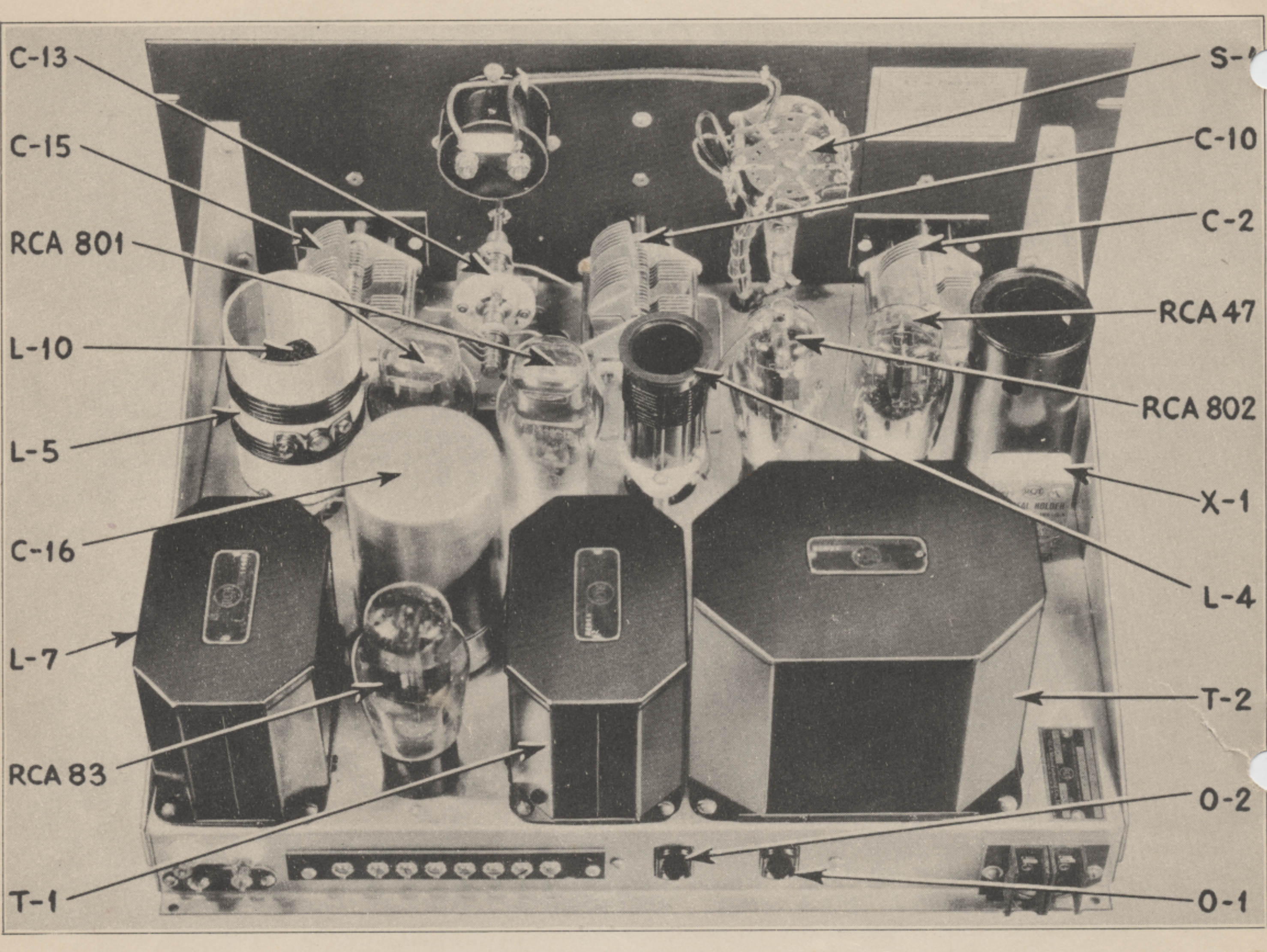

Figure 2—R-F Unit and Power Supply—Top View

Tube Complement:

2—RCA-45.
2—RCA-57.
1—RCA-83.
2—RCA-801.

Antenna Unit:

For antenna suggestions see section on Antenna Requirements.

General Requirements:

The power source should be 115-125-volt, 60-cycle a-c with good voltage regulation. For full power output as a telegraph transmitter, approximately 230 watts are required. For full power output as a phone transmitter at 100% modulation, approximately 420 watts are required. The transmitter should preferably be on or near the operating table to allow accessibility of controls. Sufficient space should be allowed for the operator to open the rear door for adjustments and coil changes.

GENERAL DESCRIPTION

The ACT-40 Amateur Transmitter is housed in ACT-40-C black-crackle finish cabinet rack having overall dimensions of 19 inches wide, 15 inches deep, 26¼ inches high. The weight of the transmitter is approximately 164 pounds. A schematic diagram of the complete transmitter is shown in Figure 19.

The ACT-40-R (Figures 2 and 3) is the basic unit of this transmitter and is a complete 40-watt C-W telegraph transmitter when used with the required R-F unit accessories as mentioned above and suitable antenna tuning equipment. The chassis is 17 inches long, 14 inches wide and 2 inches high. It is fastened to a panel 19 inches long, 8¾ inches high, ⅛ inch thick and is suitable for mounting in a standard rack.

The R-F portion of the chassis consists of a crystal-controlled oscillator using an RCA-47 pentode, a buffer or doubler employing an RCA-802 pentode and a power amplifier using two RCA-801 triodes in a cross-neutralized push-pull circuit. A filter circuit to minimize key clicks is included in the unit. A 0-200 milliammeter and a four-point selector switch are mounted on the front panel. By operating the selector switch, the oscillator plate current, the buffer plate current, and the power-amplifier grid and plate current may be read. Neutralization is accomplished by means of a "neut" stick or insulated screwdriver inserted through a hole in the front panel. A special neutralizing capacitor is used so both 801's are neutralized simultaneously. A switch on the front panel opens the power-amplifier plate return circuit for neutralization or for preliminary tuning. A combination of battery and grid-leak bias is employed for the buffer/doubler and power-amplifier circuits to keep the plate current at a safe value when excitation is removed. The R-F unit is capable of delivering 40 watts when properly loaded by an antenna. The full carrier output can be modulated 100% with the ACT-40-M Modulator Unit for phone operation. An adustable antenna-coupling coil is an integral part of the final-amplifier tank-coil assembly. Antenna coupling adjustment need be made but once so long as the antenna constants remain fixed.

The power-supply portion of the chassis consists of a plate transformer, filament transformer, an RCA-83 mercury-vapor rectifier tube, filter reactor and capacitor, and "bleeder" resistors to provide proper plate and screen voltages for all the tubes in the R-F unit. The transformers are designed for 115-125-volt, 60-cycle a-c, and the primaries being tapped for these voltages. Connection to the a-c source is made by means of terminals located on the rear apron of the chassis. The main power switch mounted on the front panel closes the primary circuit to the filament transformer. This switch must be closed before power can be made available through the plate transformer switch, also operated from the front panel. Convenient outlets mounted on the rear apron of the chassis are so connected that a-c supply voltage to other units may be plugged in and energized through the main power and plate transformer switches. Thus the plate voltage to the R-F modulator or other circuits cannot be applied prior to turning on all filaments. A green pilot light indicates that the filaments are on and the transmitter is ready for operation.

The ACT-40-M Modulator Unit (Figures 4 and 5) consists of two high-gain stages of speech amplification, each using an RCA-57 as a pentode resistance-coupled audio-amplifier, a push-pull driver stage using two RCA-45's, and a Class B amplifier using two RCA-801's. An RCA-83 is used as a rectifier to deliver plate voltage to the Class B stage, and to the speech amplifier/driver stages by means of a voltage divider. A clamp is provided on the chassis to hold the batteries for the Class B stage bias supply and for the RCA-45 driver stage. Approximately 61½ volts bias is required for the RCA-801 stage and 56 volts for the RCA-45 stage. The overall gain of the modulator unit is 101 db.

The input circuit to the first RCA-57 is of the high-impedance type, a 250,000-ohm potentiometer being used in the grid circuit. This type of circuit is suitable for use with a crystal microphone or any other high-impedance microphone. Since there is no input transformer, chances for hum pickup are minimized. When a carbon microphone or other low-impedance microphone is used, it is necessary to employ an input transformer or some other suitable means of coupling. The audio gain is regulated in this stage. The first stage is resistance coupled to another high-gain stage, which is resistance coupled to the 45 driver stage. A phase inverter circuit across the primary of the driver transformer eliminates the necessity of a transformer to couple the 57 to the 45 tubes. The 45 stage is transformer coupled to the 801 grids. The 801's will deliver approximately 33 watts of audio power to a 4000-ohm load such as is presented by the Class C stage of the R-F unit. The secondary of the modulation transformer is designed to carry 125 milliamperes at 500 volts.

A switch on the input volume-control is connected in series with the primary of the plate transformer, so that when the gain control is turned to the "Off" position the modulator plate and speech-amplifier plate-voltages are removed. A terminal board on the rear apron of the chassis provides a convenient means of connecting the modulator unit to its load. Two cords and plugs are provided, one for the a-c input to the filament transformer primary and one for the plate transformer primary.

The ACT-40-A Antenna Unit (Figure 6) consists of two variable condensers, a 0-2.5 ampere thermocouple R-F ammeter and a special knife switch on the back of the panel. By means of the switch a number of circuits for tuning the antenna may be used as illustrated in Figures 7, 8 and 9. Two stand-off insulators are mounted on the panel so that an antenna and ground, or two-wire transmission line may be connected to the unit. Two heavy copper-wire bus connectors are supplied for connections to the R-F unit.

INSTALLATION AND ADJUSTMENT

ALWAYS TURN THE PLATE POWER OFF BEFORE MAKING ANY ADJUSTMENTS. The interlock will open the plate transformer primary and turn the high voltage off when the door is opened, but it is merely for the time that one forgets to turn the plate power off and should not be used habitually when making adjustments. It is well to form the habit of turning the plate-power switch off as well as an added factor of safety. **THE VOLTAGES USED IN THIS TRANSMITTER ARE DANGEROUS AND CAUTION SHOULD BE EXERTED TO SEE THAT ONE DOES NOT COME IN CONTACT WITH THEM. JUST A FEW HUNDRED VOLTS ARE ALWAYS DANGEROUS WHERE THE SOURCE OF POWER IS LARGE OR THE REGULATION FAIRLY GOOD.**

Place the antenna and R-F units in the cabinet rack as shown in Figure 1. The Modulator Unit (or blank panel) may be put into position later, but now leaves the cabinet clear to allow better observation of all parts of the R-F unit during the initial tune-up.

This transmitter was tested at the factory, using an RCA-TMV-135-A holder and V-cut crystals. The oscillator was tuned by setting the condenser at zero and rotating slowly until the circuit broke into oscillation. The R-F crystal current was measured for several frequencies and the results are as follows:

Frequency (K. C.)	R-F Current (M. A.)
1996	16
3514	25
3994	25
7002.6	60
7227	54

The oscillator can be tuned for greater output, but since the R-F crystal current increases directly as the output there is considerable danger of fracturing the crystal. However, the crystal may be sluggish if loaded too heavily. Crystals in the 160-meter band are not as active as those in the 80-meter band, and if loaded heavily they, too, may fail to respond quickly, but it has been found that by changing the buffer tuning slightly the crystals oscillate more readily. Generally, the crystals were found to oscillate readily when the buffer was tuned to give a maximum P. A. grid current instead of minimum buffer plate current.

40-WATT R-F UNIT

1. Insert an RCA-47 in the five-pin socket, the oscillator coil in the five-pin isolantite socket, and place the coil shield firmly in place on the base around the coil socket.

2. Place an RCA-802 in the seven-pin socket and fasten the clip lead on the cap at the top of the tube. This is the plate connection for the 802. The remaining coils, tubes, and crystal should now be placed in their proper sockets.

   Ordinarily, the oscillator, buffer and P. A. stages are tuned to the same frequency for operation in the 160-80 and 40-meter bands. For the 20-meter band, a 7 M. C. crystal and 7 M. C. oscillator coil are used, and the resulting frequency is doubled to 14 M. C. in the 802 stage. The 802 is a very efficient doubler, and this fact may be taken advantage of when ordering new coils for operation in another band. For example, the operator has a set of coils and a crystal for the 160-meter band, and wishes to operate in the 80-meter band. It is only necessary to buy an additional buffer coil and a P. A. coil. The 160-meter oscillator coil is used with the 160-meter crystal and the frequency is doubled in the 802 stage. The results are practically equal to those obtained by using an 80-meter crystal and oscillator coil.

   Possible combinations of coils and crystals:

Output Frequency	Crystal Frequency	Oscillator Coil	Buffer Coil	P. A. Coil
1760	1760	160 M	160 M	160 M
3520	1760	160 M	80 M	80 M
3520	3520	80 M	80 M	80 M
7040	3520	80 M	40 M	40 M
7040	7040	40 M	40 M	40 M
14080	7040	40 M	20 M	20 M

3. Connect a wire from the ground terminal on the board at the right to a single-pole single-throw standby switch and also to one terminal of a telegraph key if it is desired to use C-W. Connect another wire from the terminal marked "Switch" to the other terminal on the switch and another wire from the terminal marked "Key" to the other terminal of the key.

4. A Burgess Type No. 5308, 45-volt "B" battery can be placed in the clamp provided in the top of the

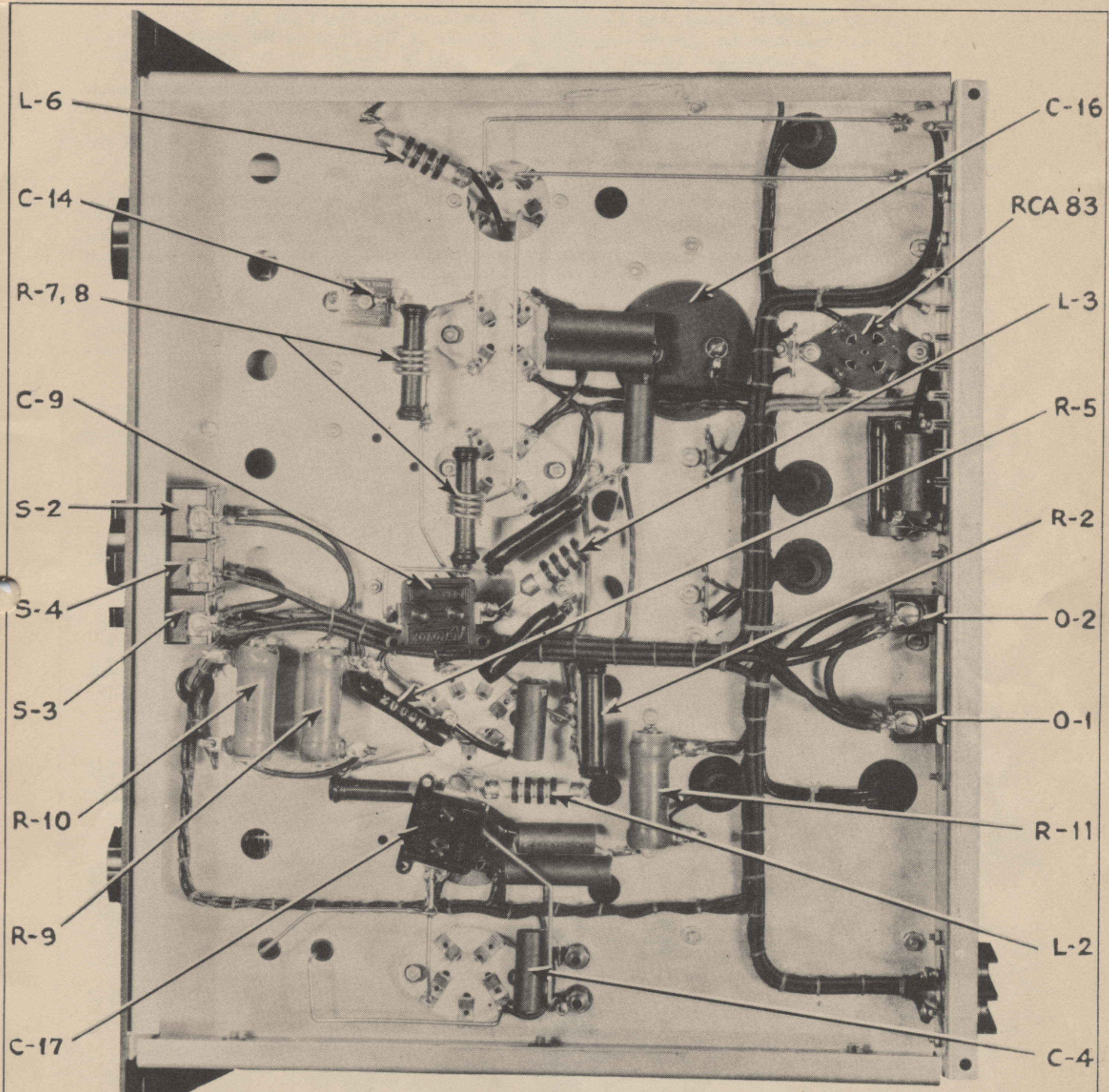

Figure 3—R-F Unit and Power Supply—Bottom View

cabinet for a bias battery for this unit. Connect to the terminals marked "C-" and "C+." Connect a jumper wire between the terminals marked "B+" and Mod.

5. If the a-c supply voltage is greater than 120 volts, the transformer taps under the chassis should be unsoldered and reconnected to the 125-volt taps (the outside ones of the three on the insulated terminal strips). The interlock terminals on the rear of the chassis should be connected to the interlock switch.

6. Throw all of the three switches on the front panel to the "Off" position and connect the a-c terminals to the a-c supply.

7. By closing the switch on the front panel marked "Power," all tube filaments should light. (Shut the cabinet door to close the interlock switch.)

8. After the filaments have been on for about 15 seconds, the center switch marked "Plate" may be closed. When starting up the transmitter for the first time, it is usually advisable to allow the filaments to heat this period of time since the 802 is a cathode-type tube and requires some time to come to operating temperature. The plate voltage should NEVER BE TURNED ON before the 83 filament has heated for at least 15 seconds.

9. The selector switch on the panel should be turned so that the knob pointer is on "Osc. Plate." The oscillator capacitor should be set to zero. The standby switch in the crystal circuit should be closed. The milliammeter should read 50 or 60 M. A. The variable capacitor should be rotated very slowly

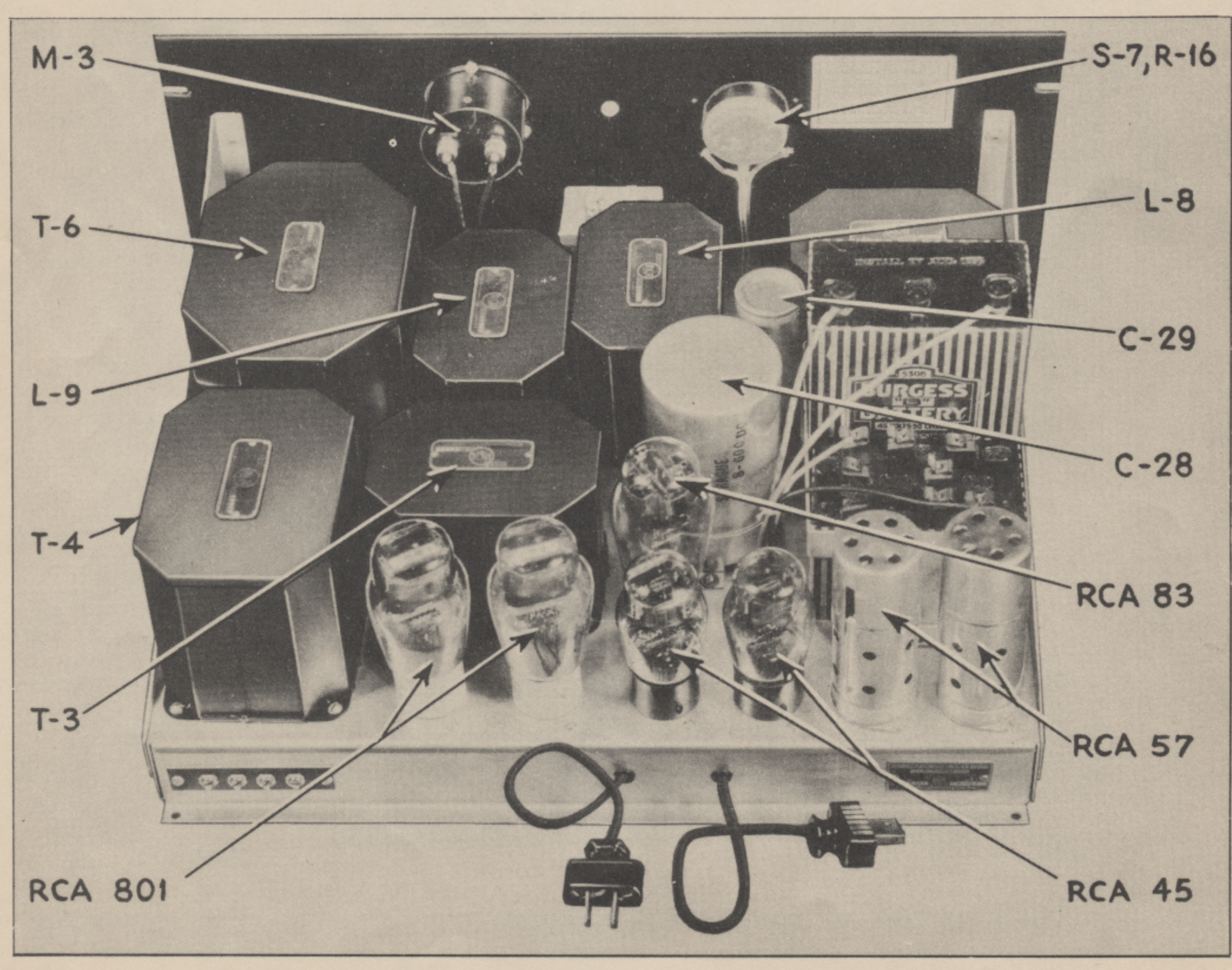

Figure 4—Modulator Unit and Power Supply—Top View

until the plate current dips rather suddenly to a minimum. The capacitor should be left at this point for a while.

10. Shift the meter circuit selector switch to the position marked "Buffer Plate" and remove the plug button from the hole to the right and just below the buffer tuning capacitor. Now set the neutralizing capacitor by means of an insulated screwdriver or "neut. stick" so that the rotor plates are meshed about one-third with the stator plates. Now close the telegraph key and tune the buffer tuning capacitor until the buffer plate current dips to a minimum, then shift the meter circuit selector to the next position so that the milliammeter reads the P. A. grid current. The meter should read 15 to 25 M. A. Rotate the P. A. tuning capacitor, and as the capacitor tunes the circuit through resonance, the grid current will change. As the P. A. tank circuit is tuned through resonance, the neutralizing capacitor should be adjusted slowly until turning the P. A. capacitor does not affect the grid current reading. It may be necessary to retune the buffer tank slightly during the first few adjustments. When the buffer tuning capacitor is tuned so that the P. A. grid current is maximum and rotating the P. A. tuning capacitor does not affect the P. A. grid current, the push-pull stage is neutralized.

11. The milliammeter circuit selector-switch should now be turned to the fourth position so that the P. A. plate current may be read. Close the switch on the right marked "P. A. Plate" and tune the P. A. to resonance quickly. The P. A. plate current will dip to a low minimum at resonance.

12. As a check, pull the crystal out and the P. A. plate current should rise to 50 or 60 M. A. and should not change as the tank capacitor is rotated. Also the buffer and oscillator plate currents should not vary. The oscillator plate current should rise to 50 or 60 M. A. and the buffer should be about 15 to 25 M. A. If the plate currents vary with tuning, the unit is not correctly neutralized.

13. AFTER THE PROPER ADJUSTMENTS HAVE BEEN MADE, THUS FAR, TURN ALL SWITCHES OFF. IT IS ADVISABLE TO FORM THE HABIT OF THROWING THE SWITCHES OFF FROM RIGHT TO LEFT. THIS MINIMIZES THE POSSIBILITY OF TURNING THE PLATE VOLTAGE ON BEFORE THE TUBES HAVE HEATED OR BEFORE THE BUFFER AND P. A. CIRCUITS ARE TUNED.

14. Connect the heavy bus-bar leads from the lower terminals of the switch on the antenna panel to the two isolantite insulators on the rear apron of the chassis.

15. Open both blades of the antenna changeover switch and set the rotor coil for minimum coupling, i. e., the plane of the windings should be perpendicular to the plane of the windings of the P. A. tank coil. If the set is being tuned for operation in the 80- or 160-meter bands, the jumper wires attached to the antenna loading coil should be connected so as to short-circuit about half of the coil.

16. IT IS ADVISABLE TO TUNE THE TRANSMITTER WITH A DUMMY ANTENNA UNTIL THE OPERATOR IS FAMILIAR WITH THE OPERATION OF THE VARIOUS CONTROLS. A 40-WATT, 110-VOLT LAMP CONNECTED ACROSS THE ANTENNA POSTS PROVIDES A CONVENIENT LOAD. THE LAMP CAN BE CONNECTED BY SOLDERING SHORT LEADS DIRECTLY TO THE BASE OF THE LAMP. THE RESISTANCE OF A 40-WATT, 110-VOLT LAMP AT NORMAL BRILLIANCE IS ABOUT 300 OHMS.

17. Throw the power switch to the "On" position, and after about 15 seconds throw the plate voltage switch to the "On" position. Close the crystal standby switch and tune the oscillator as outlined in Paragraph 9. Turn the meter-circuit selector-switch to the position marked "Buffer" and close the telegraph key. Tune the buffer for minimum dip and then turn the meter-circuit selector-switch so that the milliammeter reads P. A. grid current. Retune the buffer slightly for maximum P. A. grid current. Turn the meter switch to the P. A. plate current position and throw the switch marked "P. A. Plate" to "On." Tune the P. A. to resonance as indicated by the minimum dip of the plate current. Note the dial readings, especially that of the P. A. tank capacitor. When the transmitter is loaded into the dummy load or into an antenna, the P. A. dial reading should agree closely with the reading obtained with no load. If it differs very much, reactance is being loaded into the P. A. tank and the antenna load is too tightly coupled, or is not tuned to resonance.

Typical dial settings and meter readings for unloaded condition:

Output Frequency	Oscillator Dial	Oscillator Plate M. A.	Buffer Dial	Buffer Plate M. A.	Power Amplifier Dial	Power Amplifier Grid M. A.	Power Amplifier Plate M. A.
1710 K. C.	46	37	45	43	32	26	10
1996	73	32	66	43	58	27	10
3504	61	32	47	45	35	25	17
3995	82	32	66	45	57	25	15
7003	40	43	51	46	53	23	23
7200	48	33	56	46	58	23	23
14006	38	40	75	55	82	15	32
14400	45	32	78	52	86	15	33

Typical voltage readings, operating conditions:

	Plate	Screen
Oscillator	300*	170*
Buffer	510	225
P. A.	510	

* Varies slightly with tuning.

ANTENNA UNIT

The circuit of Figure 7 is a convenient one for matching the load presented by the lamp. An observation of this circuit shows that the voltage across the load resistance is inversely proportional to the capacitance, or it is directly proportional to the reactance of C_{18}. This circuit may be used to feed a low-resistance antenna or a relatively high-resistance one. It is also possible to use this circuit to match a transmission line. When C_{18} is set for maximum capacity (zero dial) the voltage developed across it and the load is small, and as the capacitance is decreased the reactance increases as does the voltage across it. When the load impedance at the antenna posts 1 and 2 is equal to the impedance of the circuit C_{18}, L, C_{19} the maximum transfer of energy to the antenna load occurs. The impedances are matched by varying C_{18}, L, C_{19}, and the coupling can also be varied by the position of the rotor coil. It is evident from the figure that when the capacitance of C_{19} is near a maximum, especially so at the higher frequencies, its reactance is fairly small, and in order to tune the circuit to resonance, C_{18} must have high reactance or low capacitance. The circuit is then suitable for feeding a high-resistance load or for voltage feed for a rather high-impedance antenna. For very high-impedances or voltage feed, the parallel connection of Figure 8 should be used. For low-impedance antennas or loads, the series-tuned connection, as shown in Figure 9, is usually easier to tune than other methods. In the case of the 80- or 160-meter bands, it is advisable to keep the inductance in the antenna-loading coil as small as possible and to use the condensers with as much capacity as possible. This minimizes chances for sparking over of the antenna capacitors where high voltages are developed in some cases, due to the high reactance of the circuits used.

1. Throw the plate-voltage switch to the "Off" position and throw the right-hand arm of the antenna changeover switch so as to make contact with the upper right switch-jaw. Throw the left-hand blade down so as to make contact with lower left-jaw. This gives the circuit of Figure 7.

2. Now close the cabinet door and throw the plate-power switch on. Set C_{18}, the capacitor on the right, so that its dial reads 100 and rotate the left-hand dial (C_{19}) until the antenna circuit is resonated as indicated by the lamp. The P. A. should be tuned for minimum current also, since its adjustment is liable to be disturbed by the antenna tuning process.

3. Gradually increase the capacity of C_{18} (the right-hand dial) (turn towards zero) and at the same time retune the other antenna capacitor and the P. A. tank capacitor. After a few adjustments, a condition will be found where maximum brilliance of the lamp is obtained with the P. A. dial reading at the same setting as it was when unloaded, or very nearly so. As a rule, the right-hand capacitor dial reading will be nearly 100 at the higher frequencies, while at the lower frequencies it may be between zero and fifty.

4. With the lamp at maximum brilliance and the P. A. plate current at a minimum, the coupling can be tightened by means of the rotor coil. Throw the plate voltage switch to the "Off" position and turn the rotor slightly for more coupling. At the higher frequencies this adjustment is quite critical and turning the rotor a very small amount greatly increases the coupling. At the lower frequencies, the adjustment is not so critical and with a high-resistance load it is sometimes difficult to load the transmitter to 125 M. A. plate current in the final stage. This is true in the 1715 K. C. band, where the coupling of the rotor coil is least. However, it is hardly likely that an antenna of very high-resistance will be encountered at this frequency.

5. After the coupling has been increased by means of the rotor coil, slight readjustments of the tuning capacitors may be required. The P. A. should be loaded up to about 125 M. A. If the crystal standby

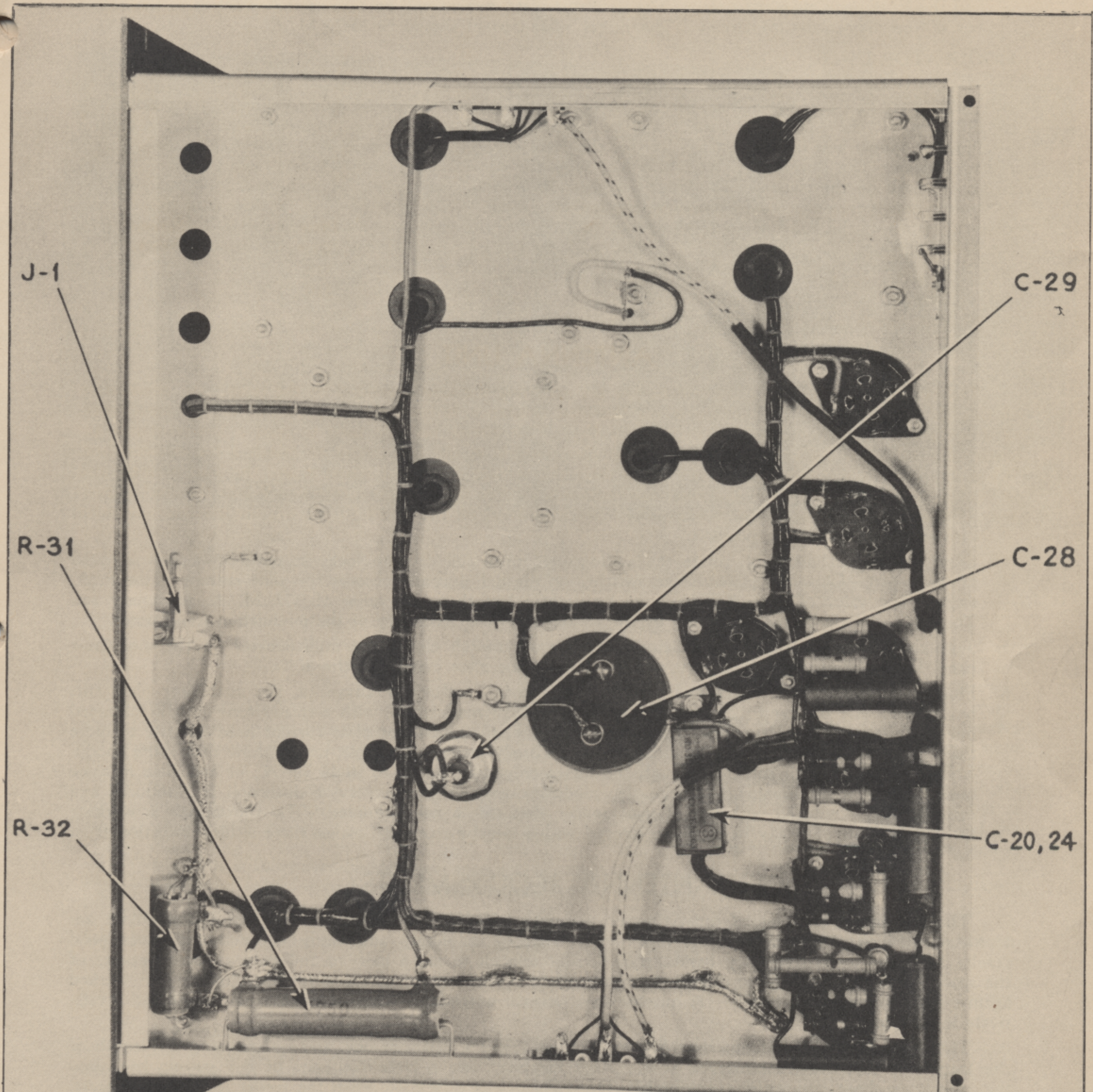

Figure 5—Modulator Unit and Power Supply—Bottom View

switch is opened, all R-F output should stop, the P. A. plate current should drop to about 50 or 60 M. A. and the P. A. grid current to zero. The oscillator plate current will be zero as the switch is in the center tap of the filament-return circuit. The buffer plate current should be 15-25 M. A.

MODULATOR UNIT

The Modulator Unit (Figures 4 and 5) is now ready for testing and setting up. The unit should be examined to see that it is in good shape and has not been damaged due to handling, or any wiring grounded, etc. Looking at the Modulator Unit from the rear, the connector cord and plug on the right is the one for the filament supply and the one on the left for the plate supply. (See Figure 10.) Insert the tubes in their proper sockets. The Burgess No. 5308 and No. 5156 (or equivalent) bias batteries should be placed in the clamp provided on the chassis. The black ground wire is connected to the plus of the No. 5308 battery. The –45-volt terminal is connected to the plus terminal of the No. 5156 battery. The yellow-red tracer wire is the grid return of the RCA-45's and should be connected to the –55½-volt tap, which is the –10½-volt tap on the No. 5156 battery. The yellow-blue tracer wire is the grid return of the RCA-801's and should be connected to the –61½-volt tap, which is the –16½-volt tap on the No. 5156 battery.

1. Turn off all power in the R-F unit.
2. Remove the connecting wire between the "B+" and modulator terminals on the R-F unit and connect the three-wire cable supplied with the modulator to the R-F unit. The **RED** wire goes to the terminal marked "B+", the **RED AND BLACK** wire goes to the terminal marked "MOD.", the **BLACK** wire to "Ground." Insert the connector cords and plugs in convenience outlets in the R-F unit. The arrangement of the cords and plugs and the convenience outlets is such that the outlets for the filament-supply cord and plate-supply cord are directly above each other.
3. Close the main power switch on the R-F unit and all tubes should light. If the filaments all light properly, place the tube shields over the two 57's. The grid leads to the two 57's are brought through the chassis at one opening and the grid lead with the red dot is for the RCA-57 at the end of the chassis. This tube also has a red dot beside it on the chassis. After the grid leads have been attached, the shield caps should be placed in position.
4. Close the cabinet door and rotate the audio-gain control full counter-clockwise until the switch is heard to snap open. Close the plate-voltage switches on the R-F unit and observe the plate current of the P. A. stage. The value of current is likely to be slightly less than the value of 125 M. A. previously set. The small drop in current is caused by the resistance of the secondary of the modulation transformer.
5. Turn the gain control of the modulator and when the switch closes, the milliammeter on the modulator panel should show about 8 M. A., which is the static plate current of the 801's.
6. Plug a microphone in the jack and with the gain control sufficiently advanced, the modulator plate current should rise to about 120 or 125 M. A. for 100% modulation, with a steady tone such as obtained by whistling into the microphone. However, for speech, the modulator plate current need not rise to more than 30 to 50 M. A. for 100% modulation. If an oscillograph is available, it will show that 100% modulation is obtained with speech although the meter only kicks up to 30 to 50 M. A., or even less in some cases. There is no advantage in trying to modulate over 100% since severe distortion is introduced and intelligibility is reduced, although it may appear that the signal is louder. The transmitter is working throughout now and may be easily monitored with a nearby receiver because there is little radiation from the lamp load.

ANTENNA REQUIREMENTS

The transmitter is designed especially for use with a half- or full-wave doublet or Zeppelin-type antenna at the higher frequencies, since this type of antenna is simply and easily adjusted and gives good results. For the lower-frequency bands, it is usually difficult to use a half- or full-wave antenna because of the space required. A sixth- to quarter-wave antenna (preferably a vertical one—see Figure 11) worked against ground gives good results. A quarter-wave vertical antenna is non-directional and radiates at a relatively low angle.

The doublet type of antenna (see Figures 12 and 13) is a balanced one, and by choosing the length of the feeders so that the transmitter is at a current maxima there is little likelihood of R-F getting back into the speech amplifier and causing feedback. The efficiency is very good when the feeder length is not great, i. e., a hundred or a hundred and fifty feet. When the length of the system is such that a current maxima or loop appears at the transmitter, the system is easily tuned and the current reading of the R-F ammeter is fairly high, and maximum output is obtained without critical adjustments. Should the length of the system be such that there is a voltage maxima at the transmitter, the current as read by the ammeter is very low, and in some cases barely perceptible. Hot sparks can be drawn off the antenna posts with an insulated screwdriver or other insulated metallic object. The low current does not necessarily mean that there is less power being put into the antenna, but it is more difficult to tell whether the system is tuned correctly and whether maximum energy is being transferred.

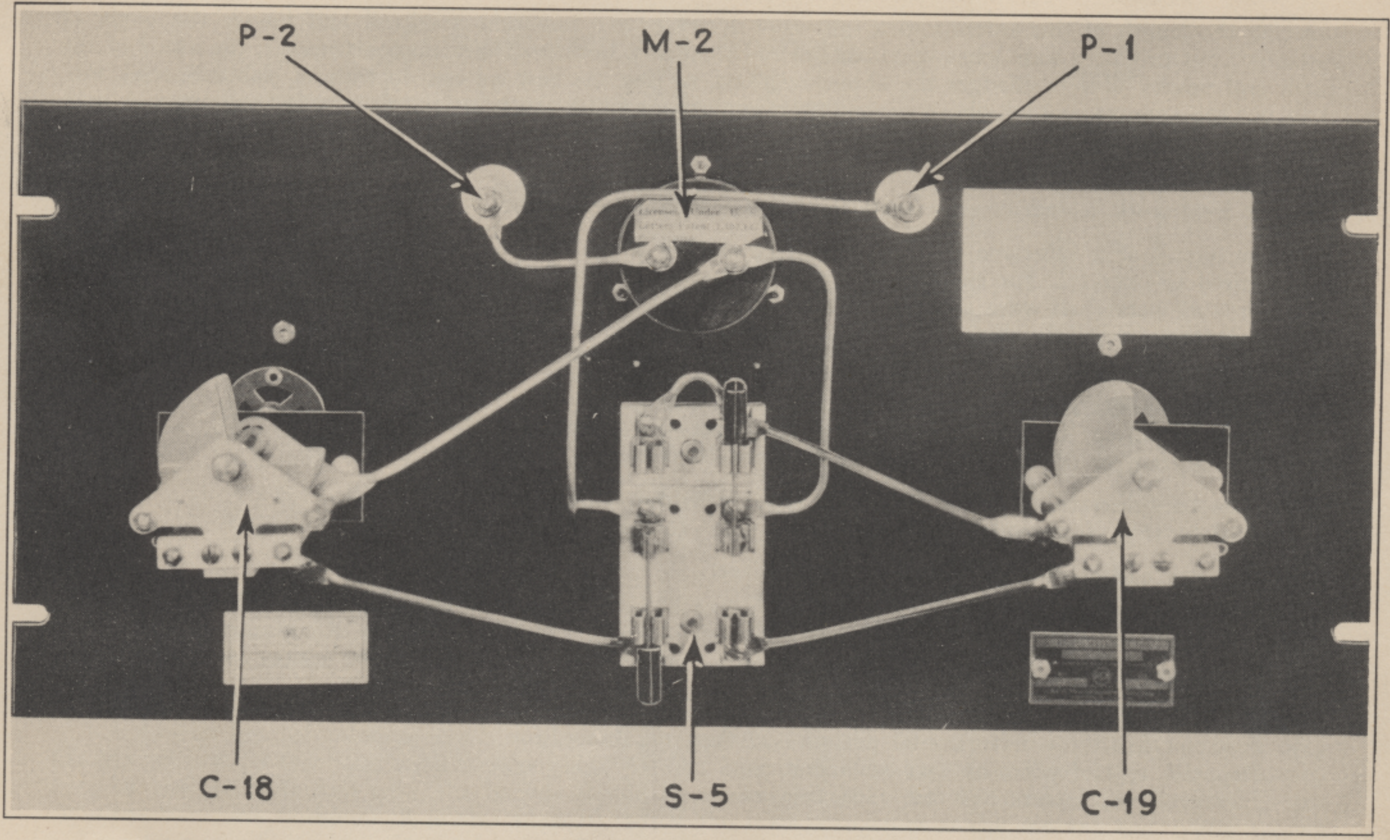

Figure 6—Antenna Unit

When using a half-wave doublet-type antenna, the feeder system should be an even number of quarter-wave lengths long in order to have a current maxima at the transmitter. When the feeders are an odd number of quarter-wave lengths long, a voltage maxima appears at the transmitter and very high voltages are induced, necessitating voltage feed. There is another disadvantage of having a point of high voltage at the transmitter since it necessitates very good insulation of the feeders in the room and where they pass out of the building. With high current and low voltage, the insulation need not be as good in the room and the losses are less. Also there is less danger from R-F burns if any one should come in contact with a feeder.

When using a full-wave doublet-type antenna, the feeder system should be an odd number of quarter-wave lengths long in order to have a current maxima at the transmitter.

The voltage-fed Zeppelin type of antenna (see Figure 14) requires feeders an odd number of quarter-wave lengths long in order to have a current maxima at the transmitter.

A Marconi type of antenna worked against ground has its points of current maxima at odd quarter-wave lengths.

Characteristics of antennas are affected greatly by objects in the field and the character of the earth, etc., so that a definite performance cannot be predicted except for a theoretical case where the earth is a perfect conductor and there are no nearby objects in the field of the antenna. Generally, raising the height of a horizontal antenna above ground lowers the angle of radiation with respect to the horizontal. Also, increasing the length of the antenna lowers the angle of radiation. It is possible to control the directivity of the antenna by adjusting the length as well as by orientation of the axis of the wire. For distance work it is desirable to have a low angle of radiation. As a rule, where it is desired to work distant points, the horizontal type of antenna should be erected as high as possible and at least a wave length long. For theoretical conditions, a half-wave antenna at a height of a quarter-wave above ground has its maximum effectiveness at right angles to the axis of the wire. It is a good type of antenna to use, but has the disadvantage of radiating a large portion of its energy skyward, where it does no good. Raising the height of the antenna above ground to a half-wave length lowers the angle of radiation and decreases the energy radiated directly overhead. Increasing the length of this antenna to a full wave decreases the radiation overhead and lowers the angle of radiation, but produces four lobes of maximum radiation in a horizontal direction. However, the effect of the earth and nearby objects changes the above relations, so that the best we can do without elaborate tests, etc., is to put the antenna as high above ground as is convenient and make it at least a wave length long. A half-wave length antenna gives excellent results, too, so do not be discouraged if you do not have space to put up a longer one.

For local work, a quarter-wave vertical grounded antenna gives a strong ground wave.

The length of a full-wave antenna in meters roughly corresponds to the wave length in meters at which it is desired to operate. For example, a length of 66 feet is usually satisfactory for a 20-meter full-wave antenna or a 40-meter half-wave antenna. This length is slightly less than the actual wave length in meters. A few dimensions will be given for various antenna and feeder systems where a current maxima will appear at the transmitter. The feeder spacing is not critical, a separation of 5 to 10 inches being satisfactory.

(1) 20-meter half-wave. Horizontal portion 33 feet long.
Voltage-fed, or Zeppelin type, feeders 16½ feet—49½ feet, etc. (See Figure 14.)
Current-fed, or doublet type, feeders 33 feet—66 feet, etc. (See Figure 12.)

(2) 20-meter full-wave, Zeppelin or doublet type. Horizontal portion 66 feet.
Feeders 16½ feet—49½ feet—82½ feet, etc. (See Figures 13 and 15.)

(3) 40-meter half-wave. Horizontal portion 66 feet.
Zeppelin type, feeders 33 feet—99 feet, etc.
Doublet type, feeders 66 feet—132 feet, etc.

(4) 40-meter full-wave. Horizontal portion 132 feet.
Zeppelin or doublet type, feeders 33 feet—99 feet, etc.

(5) 80-meter half-wave. Horizontal portion 132 feet.
Zeppelin type, feeders 66 feet—198 feet, etc.
Doublet type, feeders 132 feet—264 feet, etc.

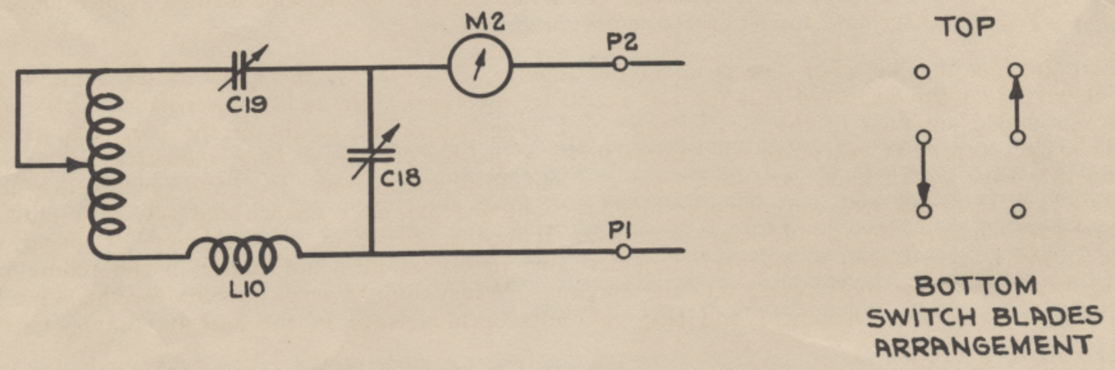

Figure 7—Combination Connection for Antenna Unit

When space limitations do not permit the erection of half-wave antenna for longer wave lengths, a quarter-wave Marconi type antenna can be used. The efficiency of this antenna type is greatly dependent on the effectiveness of the ground termination. To obtain a satisfactory grounding system it is recommended that copper wires be buried several inches below the earth surface and spread in a radial fashion beneath the antenna. The connection between the ground system and the transmitter should be kept as short and direct as possible, using a conductor of No. 10 gauge or greater.

Suggested Dimensions for Marconi Type Antennas

Figure 11 (vertical type), 80-meter operation, 66 feet No. 12 to No. 14 wire (total length from ground termination to free end of antenna). 160-meter requires 132 feet total length.

Figure 16 (inverted L type), 80-meter operation, No. 12 to No. 14 wire, 33 feet vertical section and 66 feet flat top. This antenna has approximately 780-ohm inductive reactance, which must be balanced out (resonated) by series tuning capacity. The same antenna may be used for 160-meter operation, in which case it has approximately 230-ohm capacitive reactance that must be balanced out (resonated) by series inductance (loading).

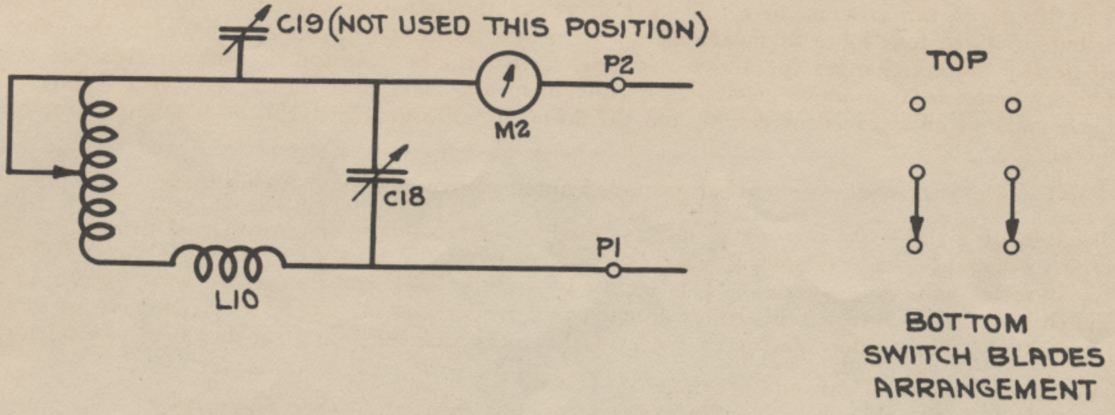

Figure 8—Parallel Connection for Antenna Unit

Figure 17 (T type), 80-meter operation, No. 12 to No. 14 wire, 33 feet high with overall length of 66 feet. Approximately 250 ohms inductive reactance. For 160-meter operation this antenna presents approximately 340 ohms capacitive reactance. A grounded type of antenna can be used on the higher frequencies if desired.

A doublet type of antenna, which works well for operation in the 20- or 40-meter bands, consists of a flat top portion 66 feet long with feeders about 49 feet long or 82 feet long (see Figure 1). If the antenna is to be used as a Marconi type, the feeders should be tied together at the transmitter and fastened to the right-hand antenna bushing. It is also advisable to tie the feeders together at the antenna end. When using a Zeppelin type of antenna, the feeders should be connected together in the same manner as mentioned above when it is worked against ground for 80 or 160 meters.

If there are buildings or other objects under the antenna, or close by, the effect is the same as if the antenna height had been decreased and the loss resistance increased. The radiation resistance is also lowered. As a rule, grounded antennas of the vertical type or L type, where the height of the horizontal portion is not too low, have capacitive reactance for lengths up to a quarter of a wave long; inductive reactance from quarter- to half-wave length long, capacitive from one-half to three-quarters, etc. At points close to one-quarter, one-half, three-quarters wave lengths long, the antenna has no reactance and acts as a pure resistance. For better efficiency, we should have an antenna at least a quarter of a wave length or longer, at the frequency at which it is desired to operate. It is desirable to use as little inductance in the tuning unit as possible in order to get the most power into the antenna. When using a small antenna for the wave length used (having low radiation resistance) and large amounts of inductance in the antenna tuning system, an

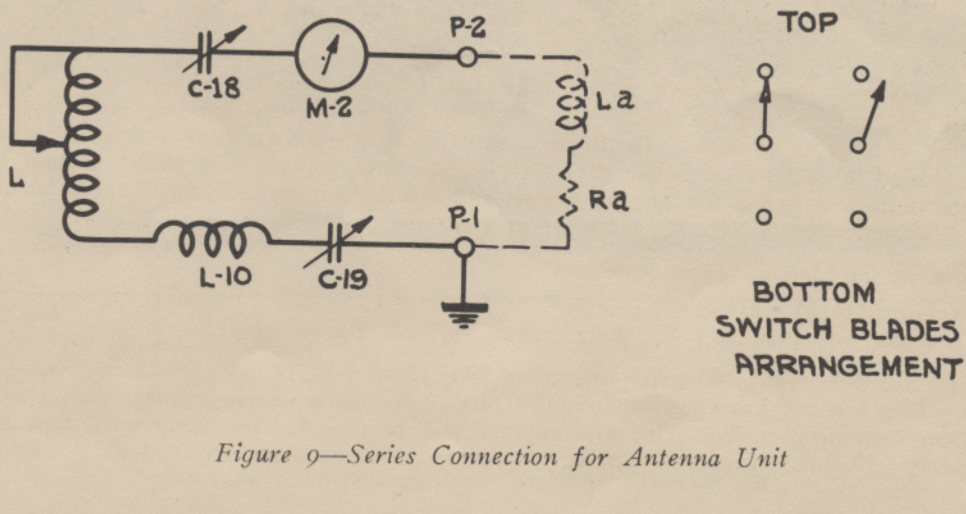

Figure 9—Series Connection for Antenna Unit

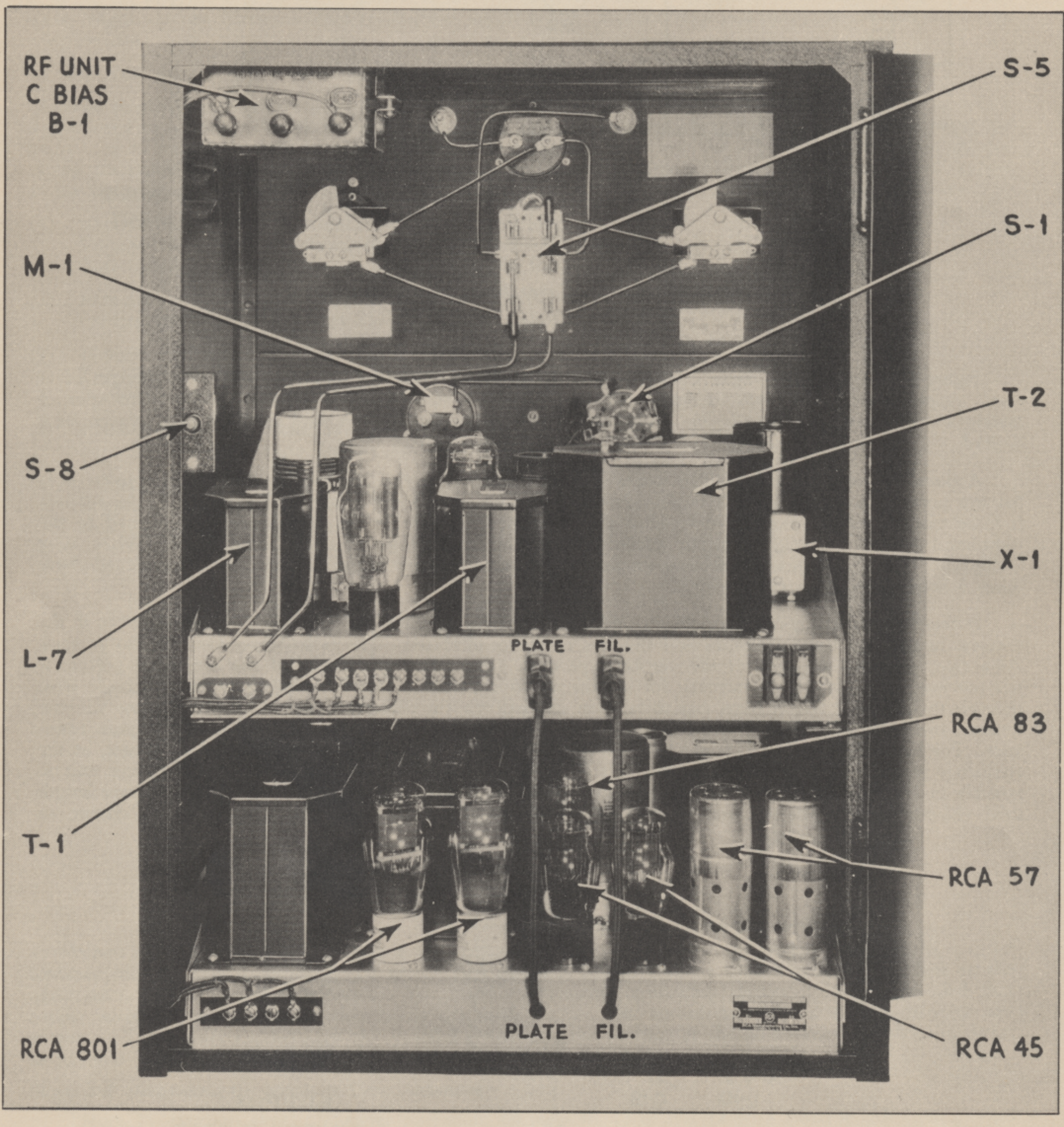

Figure 10—ACT-40 Amateur Transmitter—Rear View

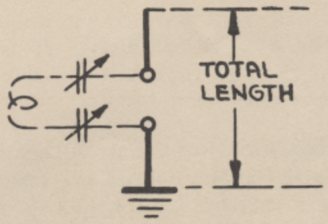

Figure 11—Vertical Marconi Type Antenna

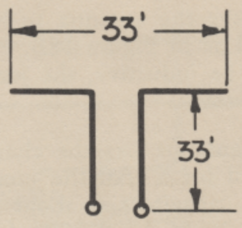

Figure 12—20-Meter, ½-Wave Doublet Antenna

appreciable amount of power is wasted in heating the coils. This is because with an antenna of low radiation resistance, the resistance of the coils, capacitors and other circuit elements is a large percentage of the total antenna and circuit resistance. For example, assume that we have an antenna with 9 ohms radiation resistance and our circuit resistance is 1 ohm. If we are putting two amperes into the system, the total power is 2 x 2 x 10 equals 40 watts, of which 4 watts, or 10% of the total power, is used up in heating the circuit. If we had an antenna with 19 ohms radiation resistance and a circuit resistance of 1 ohm with a current of 1.414 amperes, we would have 1.414 x 1.414 x 20, which equals 40 watts, of which 2 watts are lost in the circuit. This loss is only 5% of the total power. However, there is no advantage in an increase of 5 to 10% or so in power if it costs anything to do it, i. e., if it results in shortened life for tubes or other component parts. The gain in signal strength at the receiving point is not noticeable.

Of course, it is good practice to get the maximum possible results out of any piece of equipment, but the gains obtained should be weighed against results at the receiving end and cost to the operator. If a 10% increase in power can be obtained by careful adjustment and operation of the transmitter, it is well to take advantage of it, but not by any means which will cause premature deterioration of the component parts.

ANTENNA TUNING

The preceding data gives an idea of the size of antenna to put up and some indication of what to expect. For example, we wish to load the transmitter into an L type Marconi antenna for 80-meter operation. It is 33 feet high and has a 66 feet flat top. It has an inductive reactance of 750 ohms, which is equivalent to an inductance of approximately 33 microhenries (μh) at 80 meters. The antenna appears to the transmitter as an inductance of 33 μh and a series resistance R_a (Radiation Resistance + Loss Resistance).

When the impedance of the combination of L, L_{10}, C_{18}, C_{19} (Figure 9) is equal to the impedance of $L_a + R_a$, but of opposite sign, the system is properly tuned and the maximum energy is transferred to the antenna, for the degree of coupling used. Under these conditions, the resistance of the antenna circuit is reflected back to the P. A. as a pure resistance and is equivalent to adding a series resistance directly in the P. A. tank circuit. The value of this reflected resistance is adjusted by the degree of coupling until the P. A. draws about 125 milliamperes. The dial setting of the P. A. should be close to that obtained when tuned but unloaded, because the frequency of a circuit is dependent on the value of L and C and is not affected appreciably by resistance in the circuit. The series tuning circuit of Figure 9 is probably the simplest to tune for either an inductive, resistive or capacitive antenna. An inspection of Figure 18 shows that it is possible to use practically any portion of the loading coil by shifting the position of the shorting wire.

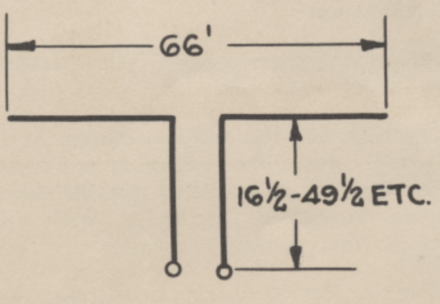

Figure 13—20-Meter, Full-Wave Doublet Antenna

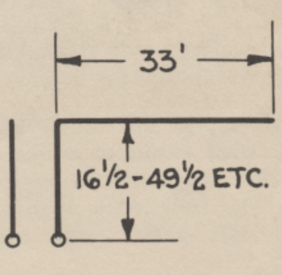

Figure 14—20-Meter, ½-Wave Zeppelin Antenna

If we believe the antenna to be capacitive, adjust the jumper wire so it will short circuit about half of the loading coil as in Figure 18B. This allows nearly all of the coil to be used if necessary. If we believe the antenna to be inductive, the jumper should be connected as in Figure 18A, so that only a few turns may be used if necessary.

Since our antenna has the characteristics of an inductance and a resistance, we connect the coil as in Figure 18A, and for a trial the jumper wire should be connected so as to use about half of the coil. Set the antenna tuning capacitors at about 10 or 15 on the dial and set the rotor so that the windings are at an angle of about 30 to 45 degrees from vertical. Ground the left-hand antenna bushing and attach antenna to right-hand bushing. Rotate the variable capacitors (preferably together) until maximum antenna current is indicated with the P. A. tuned for minimum current. If the antenna capacitors read at the higher end of the scale, more inductance should be shorted out of the loading coil and the circuits resonated again. These adjustments should be continued until the circuits are tuned with the antenna condensers in the lower half of the dial, i. e., from zero to 50. The coupling should be adjusted until the P. A. plate current reads about 125 M. A. When the coupling is changed, slight retuning of all variables may be necessary. With all circuits properly tuned, disconnecting the antenna or short circuiting the antenna posts should cause the P. A. plate current to fall back to a rather low minimum. If reactance has been loaded into the P. A. tank, the plate current may stay the same, rise, or drop slightly. ***However, in the latter case, the power input to the last stage is dissipated largely in heating the plates of the tubes, and they should not be allowed to operate this way for any length of time.***

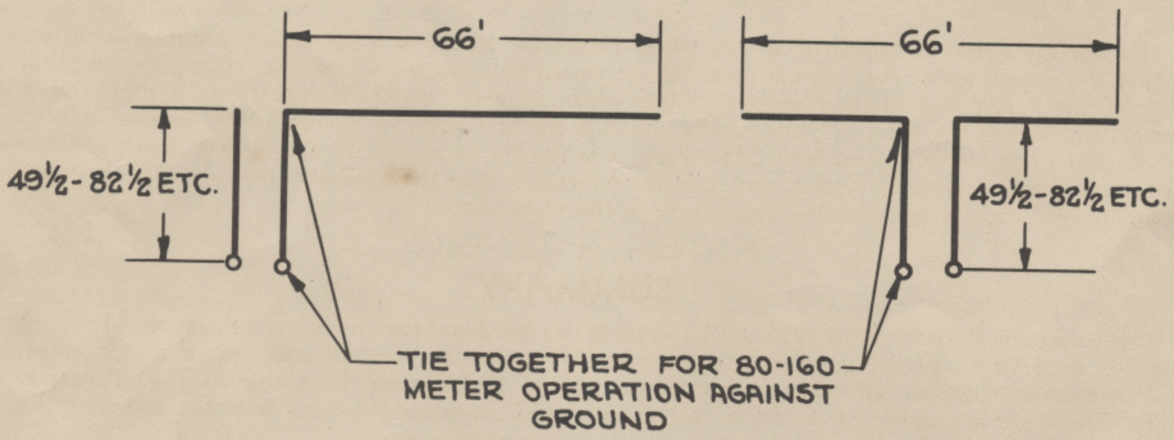

Figure 15—20-Meter, Full-Wave Zeppelin, Doublet Antenna

For tuning a doublet or Zeppelin type of antenna, the procedure is about the same, where the transmitter is located near a current maxima. The feeders are attached to the two antenna posts and the antenna capacitors rotated together until resonance is secured as indicated by maximum antenna current, the P. A. being tuned for plate current. For the 20- and 40-meter bands, there is no loading coil and the coupling can be very tight, so the position of the rotor will be such that the plane of the windings will be only a few degrees from the vertical. The capacitors are rotated together until maximum antenna current is indicated with the P. A. drawing about 125 M. A. when tuned to resonance.

If the transmitter is not located at a current maxima but rather at a current node, then parallel tuning, Figure 8, or the potentiometer arrangement (Figure 7) should be used.

For parallel tuning, the voltages across the antenna posts are high and the antenna current is very low. The rotor is set near minimum coupling and the right-hand capacitor rotated for maximum antenna current, if readable, or for a position where the sparks drawn from the feeders with an insulated metallic object appear to be hottest. The coupling is then adjusted until the P. A. plate current is 125 M. A. with all circuits resonated. The left-hand antenna capacitor is out of the circuit for the parallel connection.

If the impedance of the antenna feeders is too low for efficient transfer of energy by parallel tuning and the circuits cannot be resonated for the series connection, the potentiometer arrangement (Figure 7) should be used. Set the switches for this position and the right-hand capacitor at about 100. The coupling should be loose. Rotate the left-hand capacitor until maximum antenna current is indicated with the P. A. tuned for

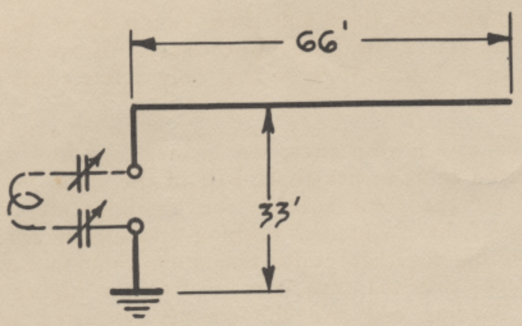

Figure 16—Inverted "L" Type Marconi Antenna

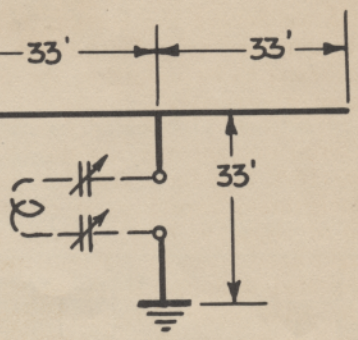

Figure 17—"T" Type Marconi Antenna

minimum plate current. Then gradually increase the capacity of the right-hand capacitor and at the same time readjusting the other antenna capacitor and the P. A. tank capacitor for resonance. After several adjustments a point will be found for maximum antenna current with the P. A. tuned for minimum plate current. The P. A. dial setting should be nearly the same as for the unloaded condition. The coupling is then adjusted for the proper P. A. plate current.

The potentiometer arrangement is also quite handy for matching a non-resonant transmission line. It is seen that the impedance at the antenna posts can be varied by adjusting C_{18} and resonating the circuit with the other capacitor. A non-resonant transmission line when properly matched appears as a pure resistance so the impedance across the antenna posts can be adjusted by first using a non-inductive resistance of a value equal to that of the transmission line. However, it is usually quite difficult to properly match a non-resonant transmission line and antenna system, and it is recommended that the resonant (tuned) type be used unless the antenna is located a considerable distance from the transmitter.

SUMMARY

The foregoing instructions should not be regarded as hard-and-fast rules to adhere to. It is obviously impossible to describe all the conditions encountered in amateur communication practice. However, it is hoped that the suggestions will assist in getting the desired performance from the ACT-40 Amateur Transmitter. There are a number of textbooks which can be of considerable assistance to the owner of this equipment. The two books that contain the most pertinent information are:

"The Radio Amateur's Handbook."
Published by the American Radio Relay League, West Hartford, Conn.

"The Radio Handbook for Amateurs and Experimenters."
Published by "Radio," Pacific Building, San Francisco, Calif.

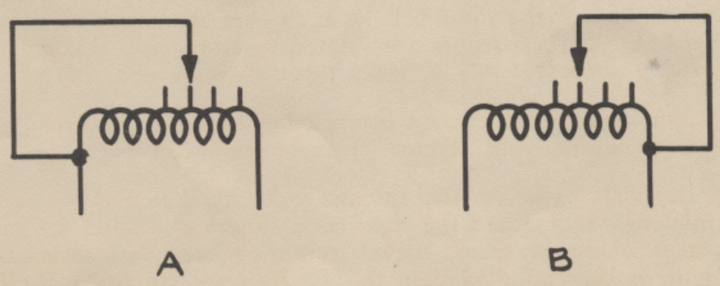

Figure 18—Loading Inductance

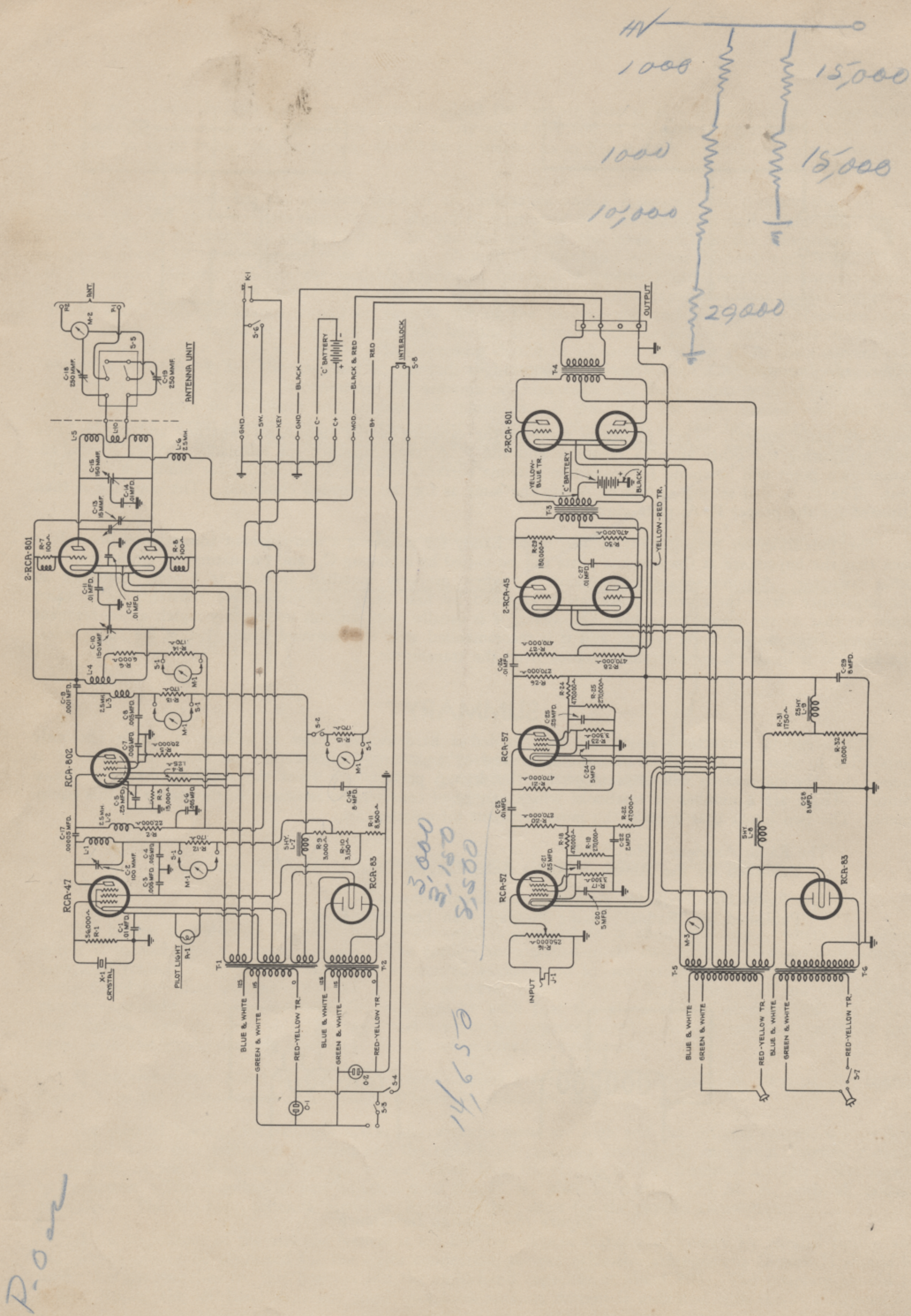

Figure 19—Schematic Diagram—T-606591

40 WATT AMATEUR TRANSMITTER
REPLACEMENT PARTS

When ordering replacement parts it is necessary to include all information as included in the list below to make the identification complete, and assure you of getting the correct parts.

Stock No.	DESCRIPTION	Dwg. Ref. No.
	Resistor, 56,000 ohms, 2 watt, carbon (R-1)	K-72354 P83
	Resistor, 22,000 ohms, 2 watt, carbon (R-2)	K-72354 P78
	Resistor, 15,000 ohms, 10 watt, Ohmite Brown Devil (R-3)	
11921	Resistor, 1.25 ohms, 10 watt, + 5% (R-4)	
	Resistor, 20,000 ohms, 10 watt, Ohmite Brown Devil (R-5)	
	Resistor, 6,000 ohms, 10 watt, Ohmite Brown Devil (R-6)	
	Resistor, 100 ohms, 2 watt, carbon (R-7, 8)	K-72354 P50
11923	Resistor, 25 watt, 3,000 ohms, H and H 2 P5 3,000 (R-9)	
11922	Resistor, 25 watt, 3,150 H and H 2 P5 3150 (R-10)	
11924	Resistor, 25 watt, 8,500 ohms, H and H 2 P5 8500 (R-11)	
11919	Meter Shunts for 0-5 M. A. Triplett Meter, to read 200 M. A. (R-12 13, 14, 15)	BM-501109 P55
4882	Capacitor, 0.01 mfd., 1,000 volts (C-1, 11, 12)	K-72017 G513
	National TMS, 100 Variable Condenser, 1,000 volts (C-2)	
4838	Capacitor, .005 mfd., 1,000 volts (C-3, 4, 6, 7, 8)	K-72017 G507
5170	Capacitor, 0.25 mfd., 300 volts (C-5)	K-72017 G535
	Capacitor, .0001 mfd., Aerovox type 1456 (C-9)	
11912	Capacitor, National TMS 150 D, 1,000 volts (C-10)	
11913	Neutralizing Capacitor, K-827486—1 Special National (C-13)	BM-501109 P35
	Capacitor, .0.01 mfd., 700 volts (C-14)	K-36026 G523
11912	Capacitor, National TMS 150 D, 1,000 volts (C-15)	
	Filter Capacitor, Sprague P1259-8M8D, 600 volts (C-16)	
	Capacitor, 0.00005 mfd., Aerovox type, 1456 (C-17)	
	Capacitor, National TMS 250, 205 mmf., 1,000 volts (C-18, 19)	
11918	Meter, Triplett Model 221 0-5 M. A., with scale calibrated 0-200 (mark case "Use with External Shunt") (M-1)	BM-501109 P52
	Meter, O-2.5 amp., Triplett Model No. 241, internal thermocouple (M-2)	
	Choke, National type 100 (L-2, 3, 6)	
11914	Filament Transformer (T-1)	BM-501109 P37
11915	Plate Transformer (T-2)	BM-501109 P43
11916	Reactor, 5 Hy, 0.25 amp. (L-7)	BM-501109 P48
11920	Switch, two-gang, non-shorting type (S-1)	BM-501109
	Switch, Bryant 1L-1317, except black (S-2, 3, 4)	BM-501109 P65
	Convenience Outlet, 15 amp., 125 volts	BM-501109 P64
	Antenna Change Switch (S-5)	BM-501101 P12
	Insulators, Birnbach No. 4125, white (P-1, 2)	
	Switch, interlock, similar to Bryant No. 2836 (S-8)	
11931	Potentiometer, with switch, 250,000 ohms, tapered (S-7, R-16)	K-76391 P37
	Resistor, 3,300 ohms, ½ watt (R-17)	
5202	Resistor, 470,000 ohms, carbon ½ watt (R-18)	K-72352 P94
11958	Resistor, 270,000 ohms, carbon ½ watt (R-19)	K-72352 P91
11958	Resistor, 270,000 ohms, carbon ½ watt (R-20)	K-72352 P91
5202	Resistor, 470,000 ohms, carbon ½ watt (R-21)	K-72352 P94
12073	Resistor, 47,000 ohms, 1 watt (R-22)	K-72353 P82
12330	Resistor, 3,300 ohms, ½ watt (R-23)	K-72352 P68
5202	Resistor, 470,000 ohms, ½ watt (R-24)	K-72352 P94

REPLACEMENT PARTS (Continued)

Stock No.	DESCRIPTION	Dwg. Ref. No.	Stock No.	DESCRIPTION	Dwg. Ref. No.
11958	Resistor, 270,000 ohms, ½ watt (R-25)	K-72352 P91	11925	Modulation Transformer (T-4)	BM-501110 line 11
11958	Resistor, 270,000 ohms, ½ watt (R-26)	K-72352 P91	11914	Filament Trans. (T-3)	BM-501110 line 108
5202	Resistor, 470,000 ohms, ½ watt (R-27)	K-72352 P94	11915	Plate Trans. (T-6)	BM-501110 line 24
5202	Resistor, 470,000 ohms, ½ watt (R-28)	K-72352 P94		Junior Jack Circuit Closing, Yaxley No. 702 (J-1)	
11959	Resistor, 180,000 ohms, ½ watt (R-29)	K-72352 P89	7956	Capacitor, 5 mfd., 25 volts, Dual (C-20, 24)	K-68508 P2
5202	Resistor, 470,000 ohms, ½ watt (R-30)	K-72352 P94		Capacitor, 0.25 mfd., 300 volts (Exciter) (C-21)	K-72017 G535
11929	Resistor, 1,750 ohms, 3½ L5-1750, 55 watt (R-31)		11930	Capacitor, 2 mfd., 300 volts (C-22)	M-281289 G504
11928	Resistor, 15,000 ohms, 2P5-15,000, 25 watt (R-32)		4882	Capacitor, .01 1,000 volts (C-23, 26, 27)	K-72017 G513
	Triplett, 0-200 M. A. (M-3)			Capacitor, 0.25 mfd., 300 volts (Modulator) (C-25)	K-72017 G533
11916	Reactor, 5 Hy, 250 M. A. (L-8)	BM-501110 line 32	11917	Capacitor, 8 mfd., 600 volts, Sprague P1259 (C-28)	BM-501109 P50
11927	Reactor, 25 Hy, 100 M. A. (L-9)	BM-501110 line 42	11497	Capacitor, 8 mfd., 415 volts, Electrolyler (C-29)	K-68597 P4
11926	Driver Transformer (T-3)	BM-501110 line 18			