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Compact 2-Meter Civil-Defense Transmitter Employs RCA Miniatures and Popular 2E26

By

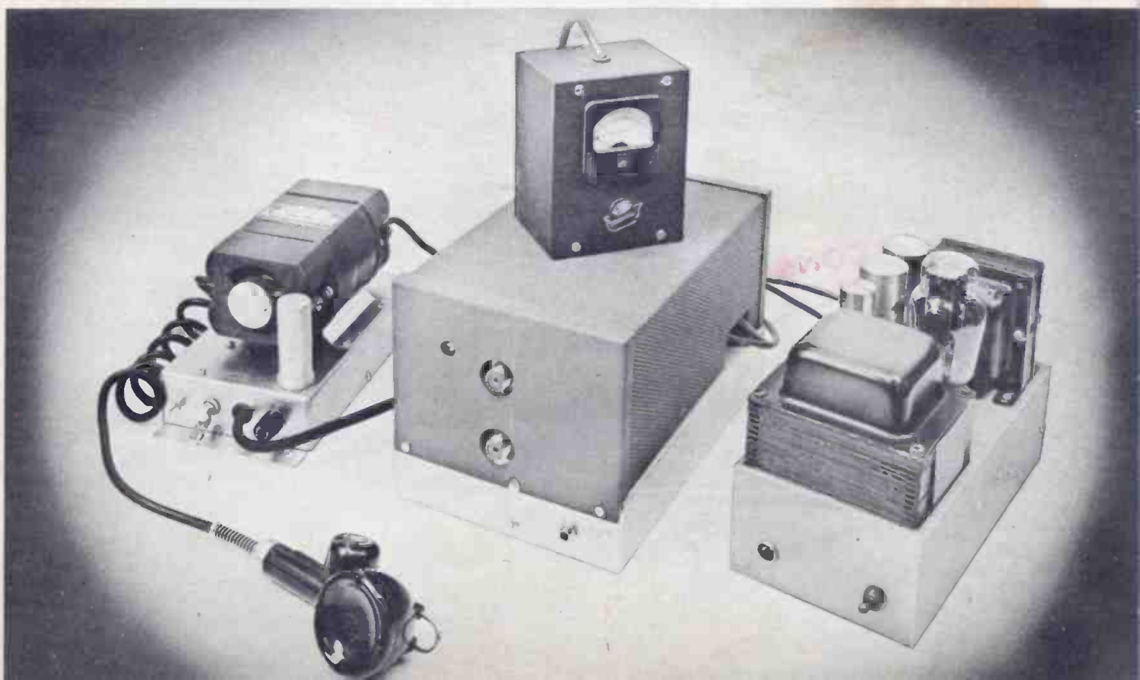
George D. Hanchett, Jr., W2YM*

When the FCC reserved sections of the two-meter and other bands for Civil-Defense operations in the event of war, public-spirited amateurs recognized the need for compact mobile and fixed-station equipment. In order to help fill this need, the transmitter described in this article was designed and constructed. This versatile two-meter transmitter meets the requirements of extreme reliability, minimum stand-by power consumption, ease of adjustment, and portability. It may be operated either from a 117-volt ac line or from a 6-volt storage battery; this transmitter provides an output of approximately 10 watts.

As SHOWN in the schematic diagram on *pg. 4*, a 6AK6 is employed as a crystal oscillator-tripler stage. Starting with an 8-Mc crystal, this stage provides a 24-Mc signal to the second 6AK6 which triples to 72 megacycles. A 5763 miniature beam-power amplifier is used as a doubler and a 2E26 operates as the final amplifier at 144 megacycles. For maximum power efficiency, a 1635 is used as a class B modulator. A 6N7-GT may be employed to obtain the same modulator output, but the 1635 has the advantage of requiring less heater power and a lower zero-signal plate current. The first audio amplifier utilizes one half of

*RCA Tube Dept., Harrison, N. J.

Fig. 1. A compact Civil-Defense transmitter for fixed-station or mobile operation.



a 12AU7 as a grounded-grid stage to obtain a good match to the carbon microphone, and also to provide a convenient source of voltage for the microphone.

Meter Circuit

Metering the grid circuits of the frequency multipliers and the final amplifier, and the plate circuits of both the final amplifier and the class B modulator is accomplished by means of an external test meter. This arrangement permits the use of a single meter for adjusting all of the transmitters in a Civil-Defense network.*

As shown in *Fig. 2*, the test-meter circuit consists of a 0-1 ma meter, a two-section six-position switch, and two resistors. Connection of the test meter to the transmitter is made by means of a cable and plug.

When the meter switch is set to any one of the first three positions shown in *Table I*, the 3,900-ohm multiplier resistor and the milliammeter are connected in series between ground and a point on a voltage divider in the grid circuit. The meter deflection is proportional to the flow of grid current.

In positions 4 and 5 of the meter switch, the meter and the 910-ohm resistor, in series, are connected across a 10-ohm shunt (R_{21} for position 4, or R_{22} for position 5) to indicate the final-amplifier or modulator plate current, respectively. The test meter is connected between ground and a 1N34 rectifier in the antenna-coupling circuit in position 6 of the meter switch.

Construction

The transmitter is constructed on a 7 by 11 by 2-inch chassis; it is so arranged that the rf section is on one side of the chassis (refer to *Fig. 3*) and the modulator and power plugs on the other side. Separating these two sections, on the underside of the chassis, is a strip of aluminum to which a resistor board is fastened. All of the resistors, with the exception of the 5763 grid resistor, R_{10}, are mounted on this board. Such mechanical support of the resistors provides the necessary ruggedness for mobile operation.

By-passing in the frequency multipliers and the final amplifier is accomplished with single-and dual-section ceramic capacitors. The metering leads are brought to an octal meter jack for connection to the external test meter. Transformer T_1 is a standard RCA TV sound if unit, 206K1, and L_1 is a stagger-tuned video if coil, 202L1.

Each unmetered transmitter may be monitored during transmission by a pair of headphones connected to monitor jack J_5 in the antenna-coupling circuit.

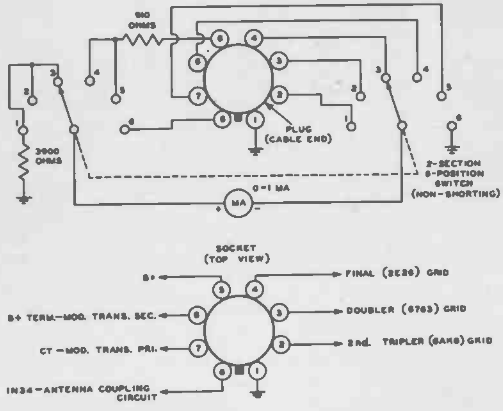


Fig. 2. Test-meter circuit.

Table I — Test-Meter Calibration Data

Switch Position	Indication	Full-scale Deflection
1	2nd tripler (6AK6) grid current	5 ma
2	Doubler (5763) grid current	5 ma
3	Final (2E26) grid current	5 ma
4	Final (2E26) plate current	100 ma
5	Class B mod. plate current	100 ma
6	RF power output	15 watts

The arrangement of the components in the output tank circuit is shown in *Fig. 5*. The bracket for this tank circuit is made from a 4 by 5-inch piece of aluminum. The output link coil is connected to a coaxial relay so that in the non-energized position, the antenna will be connected to the associated receiver.

Adjustment

The tuning of the transmitter is a simple process. With only the two 6AK6's in place, connect the transmitter to the 300-volt supply. Connect the test meter to the unit and set the selector switch to the second tripler-grid position. Vary the inductance of L_1 to obtain oscillation, and then adjust the primary and secondary of T_1 for maximum meter deflection. The grid current of the second 6AK6 should be approximately 2 ma.

Insert the 5763 into the transmitter and adjust L_2 to resonance as indicated by maximum 5763 grid current when the test meter is set in position 2. At resonance the grid current of the 5763 should be approximately 1 ma. Adjust-

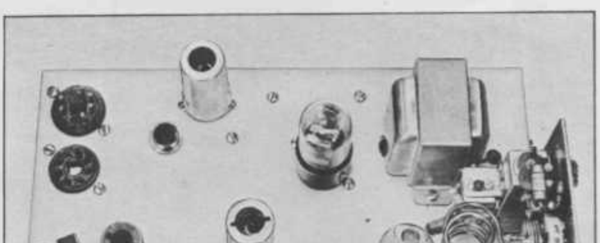


Fig. 3. Top view of the transmitter.

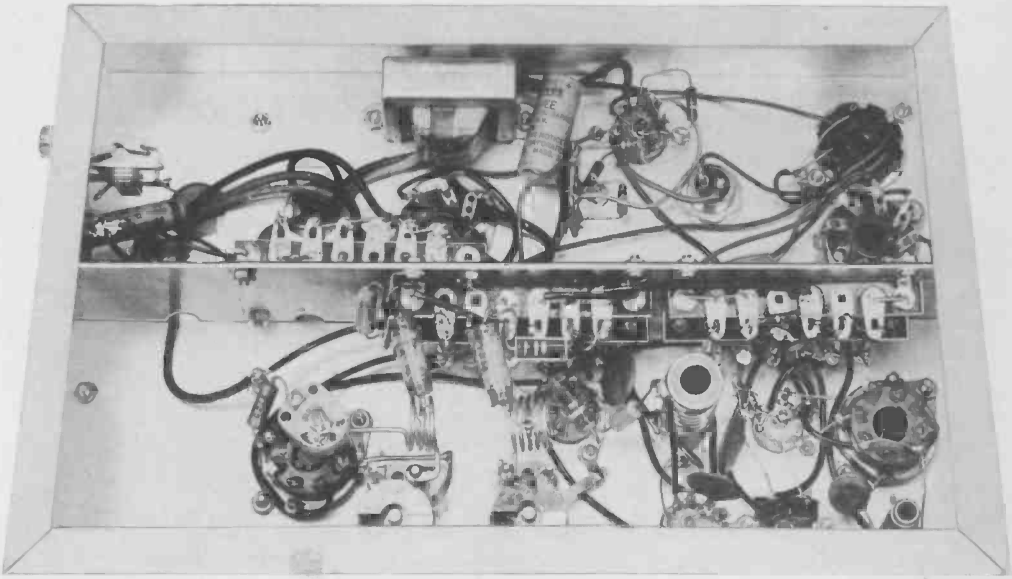


Fig. 4. Bottom view of the transmitter. The resistor board provides the necessary mechanical support for mobile operation.

ment of L_2 should be made as rapidly as possible, so that the 5763 plate circuit (which will probably not be in resonance) does not draw excessive current for a sustained period.

Switch the test meter to the 2E26 grid position (3) and plug in the 2E26. To protect the 2E26 during the initial tune-up, disconnect the series screen resistor, R_{16}, from the plate supply. Then adjust C_{14} and C_{18} for maximum grid current in the 2E26; the 2E26 grid current should be approximately 1.5 to 2.0 ma.

At this point in the initial tuning procedure, the final amplifier should be neutralized as follows: rotate C_{20} through its entire range and observe the downward kick of the test meter (switch set in position 3, the 2E26 grid-current position). Then adjust neutralizing capacitor C_N until the downward deflection of the meter needle is minimized when C_{20} is rotated through its range. Reconnect the screen-grid resistor to the plate supply and set the meter selector switch to the 2E26 plate-current position (4). Capacitor C_{20} should then be adjusted for resonance.

After these adjustments have been made, connect the antenna to the transmitter and set the test meter switch to the output position (6). Capacitor C_{21} should be adjusted for maximum output. When a 52-ohm coax cable is used, a meter reading of approximately 0.4 ma indicates 10 watts of rf power. Finally, readjust L_1, T_1 C_{14}, C_{15}, and C_{20} for maximum power output.

The 1635 class B modulator tube and the 12AU7 speech-amplifier tube should then be plugged in and the microphone connected to the transmitter.

AC Power Supply

The power supply for ac operation is shown to the right of the transmitter unit in *Fig. 1;* the schematic diagram for this supply is shown in *Fig.* 7. This supply is constructed on a 5 by 10 by 3-inch chassis. It employs a conventional full-wave rectifier and filter circuit, plus a selenium rectifier which supplies 6 volts dc for relay operation. The relay shown in *Fig.* 7 is a control relay which simultaneously grounds the center tap of the high-voltage winding of the power transformer and applies energizing voltage to the antenna relay when the microphone switch is closed.

Genemotor Power Supply

For mobile and emergency operation, the power unit shown in the upper left-hand corner of *Fig. 1* should be connected to the octal chassis

Fig. 5. Closeup view of the tank circuit.

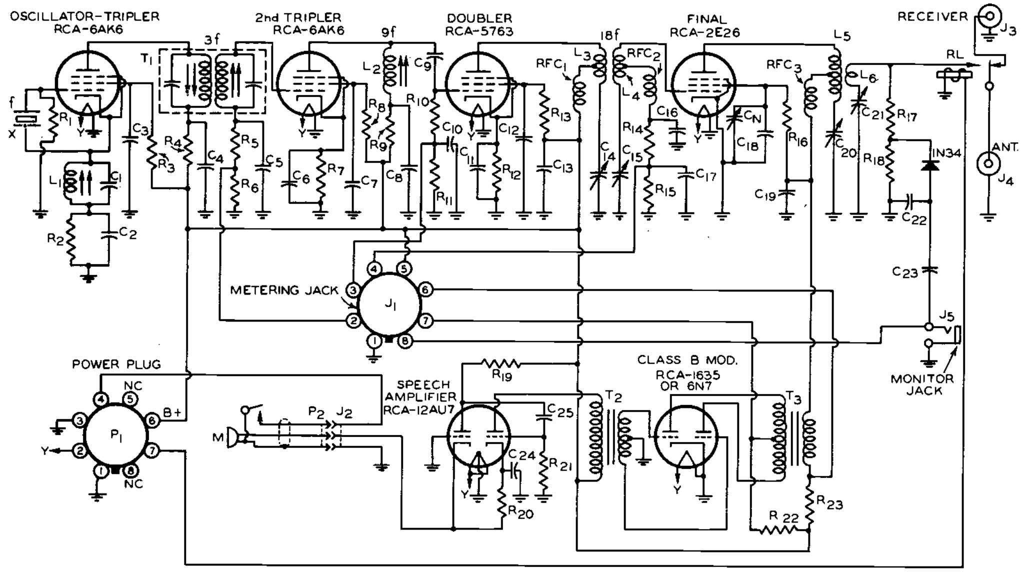


Fig. 6. Schematic diagram of the transmitter.

connector P_1, located on the transmitter. This supply employs a Genemotor which operates from a 6-volt storage battery to provide a plate voltage of 300 volts. The output of the Genemotor is filtered with a single 4-μf capacitor. A control relay is also included in this supply as shown in the schematic diagram, *Fig. 8*. When the microphone switch is pressed, this relay connects the ungrounded input terminal of the Genemotor to the "hot" side of the storage battery, and simultaneously applies energizing voltage to the antenna relay. A 5 by 9½ by 2-inch chassis is required for the construction of this power supply.

Installation Notes (Mobile Operation)

For mobile operation, the transmitter and the Genemotor supply should be fastened securely to a shock-mounted support. A piece of ¾-inch plywood and four shock mounts will serve as a simple vibration-proof mounting.

Connection to the car battery should be made through a heavy conductor to minimize voltage drop. If the transmitter is installed in the trunk of the car, a No. 4 flexible cable is recommended; a No. 6 conductor is adequate if the length is four feet or less.

Check the polarity of the auto battery and determine the polarity of the grounded terminal. As shown in *Fig. 8*, the negative input terminal of the Genemotor is grounded. *If the positive terminal on the battery is grounded, reverse the input connections to the Genemotor.*

Since the details of the mobile installation will vary with the type of vehicle and also with individual preferences, the control circuit for the application of heater voltage has not been included in the dc supply. Heater voltage should be controlled by means of a 6-volt, SPST relay with ¼-inch contacts connected in series with the "A hot" input terminal of the Genemotor supply and the ungrounded battery terminal. Energizing voltage to the coil of this relay may be controlled by a SPST toggle switch located at the operating position.

Operation

With the ac power supply connected to P_1, heater voltage will be applied to the tubes in the transmitter when the power supply switch is turned on. Closing the microphone push-to-talk switch will simultaneously apply plate voltage to the transmitter tubes and cause the antenna-transfer relay to operate, regardless of the power supply employed.

Table II — Currents and Voltages for Normal Operation*

Meter Indication	Oscillator Tripler (6AK6)	Second Tripler (6AK6)	Doubler (5763)	Final (2E26)	AF Amp (½ 12AU7)	Driver (½ 12AU7)	Modulator (1635)
E_b (v)	275	265	300	300	300	300	300
I_b (ma)	12	15	35	60	4	7	6 (min.) 40 (max.)
I_{c2} (ma)	2.3	3.0	2.5	5.0	—	—	—
E_{c2} (v)	195	165	250	200	—	—	—
I_{c1} (ma)	0.7	2	0.9	1.6	—	—	—
E_k (v)	12	20	1.5	0	4	11	0

* *For rf output of 10 watts.*

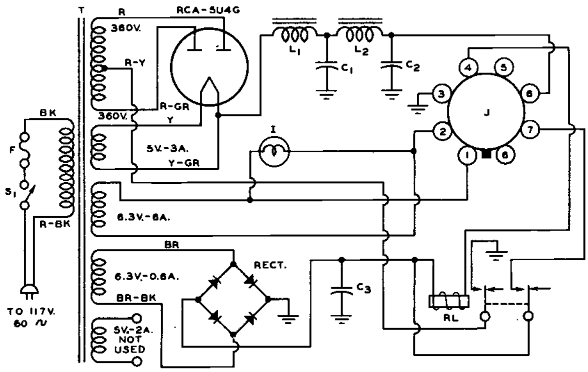


Fig. 7. Schematic diagram of the power supply for the fixed-station installation.

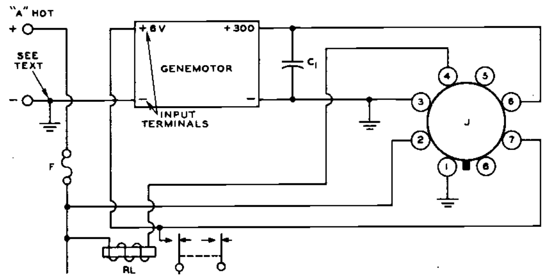


Fig. 8. Schematic diagram of Genemotor power supply for the mobile installation.

Transmitter

C_1 100 $\mu\mu$f.
C_2 0.005 μf, disc ceramic.
C_3, C_4 Twin 0.004 μf, disc ceramic.
C_5 0.005 μf, disc ceramic.
C_6, C_7 Twin 0.004 μf, disc ceramic.
C_8 0.005 μf, disc ceramic.
C_9 10 $\mu\mu$f.
C_{10} 0.005 μf, disc ceramic.
C_{11}, C_{12} Twin 0.004 μf, disc ceramic.
C_{13} 0.005 μf, disc ceramic.
C_{14} 25 $\mu\mu$f, air padding.
C_{15} 25 $\mu\mu$f, air padding.
C_{16} 100 $\mu\mu$f.
C_{17} 0.005 μf, disc ceramic.
C_{18} 47 $\mu\mu$f.
C_{19} 470 $\mu\mu$f, feed-through type.
C_{20} 25 $\mu\mu$f, air padding.
C_{21} 25 $\mu\mu$f, air padding.
C_{22} 0.005 μf, disc ceramic.
C_{23} 0.01 μf, 400 wv.
C_{24} 25 μf, 25 wv, electrolytic.
C_{25} 0.005 μf, disc ceramic.
C_N 4-30 $\mu\mu$f, ceramic.

J_1 8-pin octal socket.
J_2 Amphenol connector PC2F.
J_3 Coaxial connector type N } part of coax relay R_L.
J_4 Coaxial connector type N }
J_5 Phone jack.

L_1 RCA 202L1, TV picture if coil.
L_2 5 turns 14E on ½-in. diam, spaced to fill winding space of 11/16 in. on National XR50 form.
L_3 5 turns 14E on ½-in. diam; space between turns equal to wire diam.
L_4 3 turns 14E on ½-in. diam; space between turns equal to wire diam.
L_5 3 turns 10E on ¾-in. diam; spaced to occupy 1½ in.
L_6 Single turn 10E on 1-in. diam.

M Carbon microphone with "push-to-talk" switch.

P_1 8-pin octal plug.
P_2 Amphenol connector MC2M.

R_1 100,000 ohms, ½ watt.
R_2 1,000 ohms, ½ watt.
R_3 47,000 ohms, ½ watt.
R_4 1,000 ohms, ½ watt.
R_5 33,000 ohms, ½ watt.
R_6 1,000 ohms, ½ watt.
R_7 1,000 ohms, ½ watt.
R_8 47,000 ohms, ½ watt.
R_9 1,000 ohms, ½ watt.
R_{10} 82,000 ohms, 1 watt.
R_{11} 1,000 ohms, ½ watt.
R_{12} 68 ohms, ½ watt.
R_{13} 22,000 ohms, 1 watt
R_{14} 33,000 ohms, 1 watt.
R_{15} 1,000 ohms, ½ watt.
R_{16} 20,000 ohms, 1 watt.
R_{17} 15,000 ohms, ½ watt.
R_{18} 10,000 ohms, ½ watt.
R_{19} 47,000 ohms, ½ watt.
R_{20} 1,000 ohms, ½ watt.
R_{21} 470,000 ohms, ½ watt.
R_{22}, R_{23} 10 ohms, ½ watt.

RFC_1, RFC_2, RFC_3 40-in. length of 32E wound on ¼-in. diam. form.

R_L Advance 8500, 6-volt type or equivalent.

T_1 RCA 206K1, TV sound if transformer.
T_2 Thordarson T20D76 or equivalent.
T_3 Thordarson T21M52 or equivalent.

AC Power Supply

C_1 40 μf, 450 wv, electrolytic.
C_2 80 μf, 450 wv, electrolytic.
C_3 3,000 μf, 15 wv, electrolytic.
F 5-ampere fuse.
I 6-v, 150-ma pilot lamp.
J 8-contact octal socket.
L_1 Choke, 3 henrys at 225 ma, Peerless C-315-X or equivalent.
L_2 Choke, 5 henrys at 200 ma, Stancor C-1646 or equivalent.
R_L Relay, 6v (dc), Advance 500 or equivalent.
RECT Selenium rectifier, 600 ma, 25v, Federal 1017.
S_1 SPST Toggle Switch.
T Power transformer, RCA 201T8.

Genemotor Power Supply

C_1 4 μf, 450 wv, electrolytic.
F 30-ampere fuse.
G Carter Genemotor 325-A or equivalent: input 6v, 21 amp; output 300v, 250 ma.
J 8-contact octal socket.
R_L Relay, 6v(dc), Advance 500.

Keying the Beam-Power Phone Final*

By

J. H. Owens, W2FTW**

By the installation of a single control tube and a few resistors, practically any beam-power phone transmitter can be converted for cw operation. And when the key is down, the final is just as suitable for plate-and-screen modulation as it was before the keying system was added.

In addition to providing a clean-cut cw signal that is free from chirps, thumps, and key clicks, this unique system offers worthwhile advantages over some of the keying systems presently in use.

BASICALLY, the new method is simply an adaptation of the well-known cathode-return keying system popularly used in triode finals. It differs by the use of a unique method of preventing the screen-grid voltage from exceeding tube ratings when the key is in the up position. With this system, the screen-grid voltage is reduced below the cathode voltage, thereby completely cutting off the plate current in the final amplifier; consequently, the back-wave signal is not transmitted.

For purposes of illustration, this keying system is described here as applied to a typical low-power final employing a single 807. The circuit diagram is shown in *Fig. 1.* A 6AQ5 miniature beam-power tube is used in the control-tube circuit.

The dc plate resistance of the 6AQ5 can be made either very low or practically infinite, depending upon whether the key is up or down, respectively. Because the plate of the 6AQ5 is tied directly to the screen-grid of the final-amplifier tube, the 6AQ5 performs electronically and instantly the service of a relay without the delay, sparking, and other difficulties sometimes encountered with relays in high-speed circuits.

Key-down Position

The operation can best be understood by examining the circuit in the key-down position. The cathode of the final is at ground potential, being bypassed for rf through C_2, while the dc return is through R_5 (a few ohms) and the key. The plate current of the 6AQ5 is practically cut off because the screen-grid of this tube is connected to the same ground-return circuit. The control-grid of the 6AQ5 is connected through an isolating and filtering resistor to the grid side of the grid-bias resistor of the final amplifier, a negative-voltage point. The combined effects of high negative bias on the control-grid and substantially ground potential on the screen-grid raise the dc plate resistance of the 6AQ5 to near infinity. Thus, for all practical purposes, the 6AQ5 has absolutely no effect on the final amplifier which operates as if the control-tube were out of the circuit. Obviously, when the key is down, the final amplifier can be plate-and-screen modulated the same as before the control circuit was installed.

Key-up Position

When the key is in the up position, entirely different conditions prevail. The open key removes the dc ground return from the final-amplifier cathode and the 6AQ5 screen-grid, and both of these electrodes become positive as a result of voltage being applied through R_3. At the same time, the control-grid of the 6AQ5 becomes slightly positive because it is connected to the final amplifier cathode through isolating resistor R_2, the grid-bias resistor R_{11}, and the grid milliammeter M_1. Although grid current continues to flow through the final amplifier grid-bias resistor, the negative voltage across this resistor is con-

*The system is also applicable to both phone and cw transmitters employing tetrodes or pentodes.

**Manager, Test and Measuring Equipment, Renewal Sales, RCA Tube Dept., Harrison, N. J.

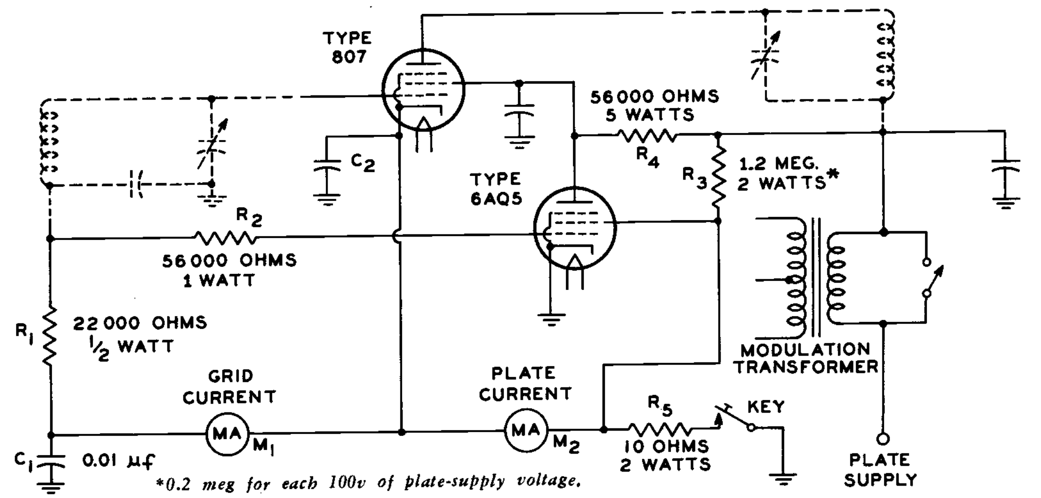


Fig. 1. Schematic diagram of a typical beam-power phone final and the 6AQ5 control tube which prevents excessive screen voltage on the 807 final in the key-up position.

siderably less than the positive voltage between the final-amplifier cathode and ground; therefore, the net potential at the top of the grid-bias resistor is positive.

This voltage is applied to the control-grid of the 6AQ5 through isolating resistor R_2, but the low resistance of the positive 6AQ5 grid and the high resistance of the isolating resistor cause a relatively large voltage drop; hence the grid of the 6AQ5 is slightly positive. The combined effects of slightly positive bias on the control-grid, and the substantial positive voltage on the screen-grid reduce the dc plate resistance of the 6AQ5 to a low value. The plate of the 6AQ5, being tied to the final-amplifier screen grid, puts a heavier load on the screen-grid dropping resistor R_4 than does the screen grid of the final amplifier; therefore, the voltage on this screen is greatly reduced when the key is in the up position. In fact, it is reduced below the cathode voltage, and this, plus the negative bias applied between cathode and the control-grid, serves to cut off the final-amplifier plate current. The overall effect is that the screen-grid of the final amplifier is protected and the rf signal is interrupted.

Circuit Details

Note the location of the grid and plate meters in the circuit. This arrangement provides the least amount of interaction without having the plate-current meter in the high-voltage circuit. As connected, milliammeter M_2 indicates the sum of the plate and screen currents. The grid meter, M_1, indicates the dc grid current. (As previously mentioned, grid current continues to flow when the key is up.) The grid current is practically the same when the key is down.

The values for the three added resistors (R_2, R_3, and R_5) are given in the schematic diagram; actual values are not critical. Resistor R_2 is simply an isolating resistor to keep rf off the 6AQ5 control-grid. Resistor R_5 is a key-click suppressor. Resistor R_3 applies positive voltage to the final cathode and 6AQ5 screen-grid; its value may be halved or doubled for experimental trials. Resistor R_4 is the screen-grid dropping resistor.

A 6AQ5 keying tube is satisfactory for an 807 or 829-B. If one or two 813's are used in the final rf amplifier, a 6V6-GT or 6F6-G should be substituted for the 6AQ5. The actual resistance and power rating of R_3 will vary with the plate-supply voltage.

It is good practice to short out the secondary of the modulation transformer when a phone transmitter is keyed. Switch S_1 is included in the circuit for this purpose.

TVI BIBLIOGRAPHY (Part II)

A comprehensive listing of articles on TVI and related topics. Although the articles appearing in the non-amateur publications contain only brief mention of the amateur and TVI, they have been included to supply the advanced amateur with a complete set of references. A few important articles on interference from sources other than amateur transmitters as well as some editorials have been listed. Radio amateur groups will find the editorial articles valuable references for discussions. Note that the articles are listed in chronological order; this has been done to facilitate retrospection, and to permit easy cross reference to TV reception techniques and improvements.

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Joseph Pastor, Jr., W2KCN
Editor