

INSTRUCTION MANUAL

for the

WRL

Screen Modulator

MODEL SM-90

Manufactured by WRL ELECTRONICS, INC.

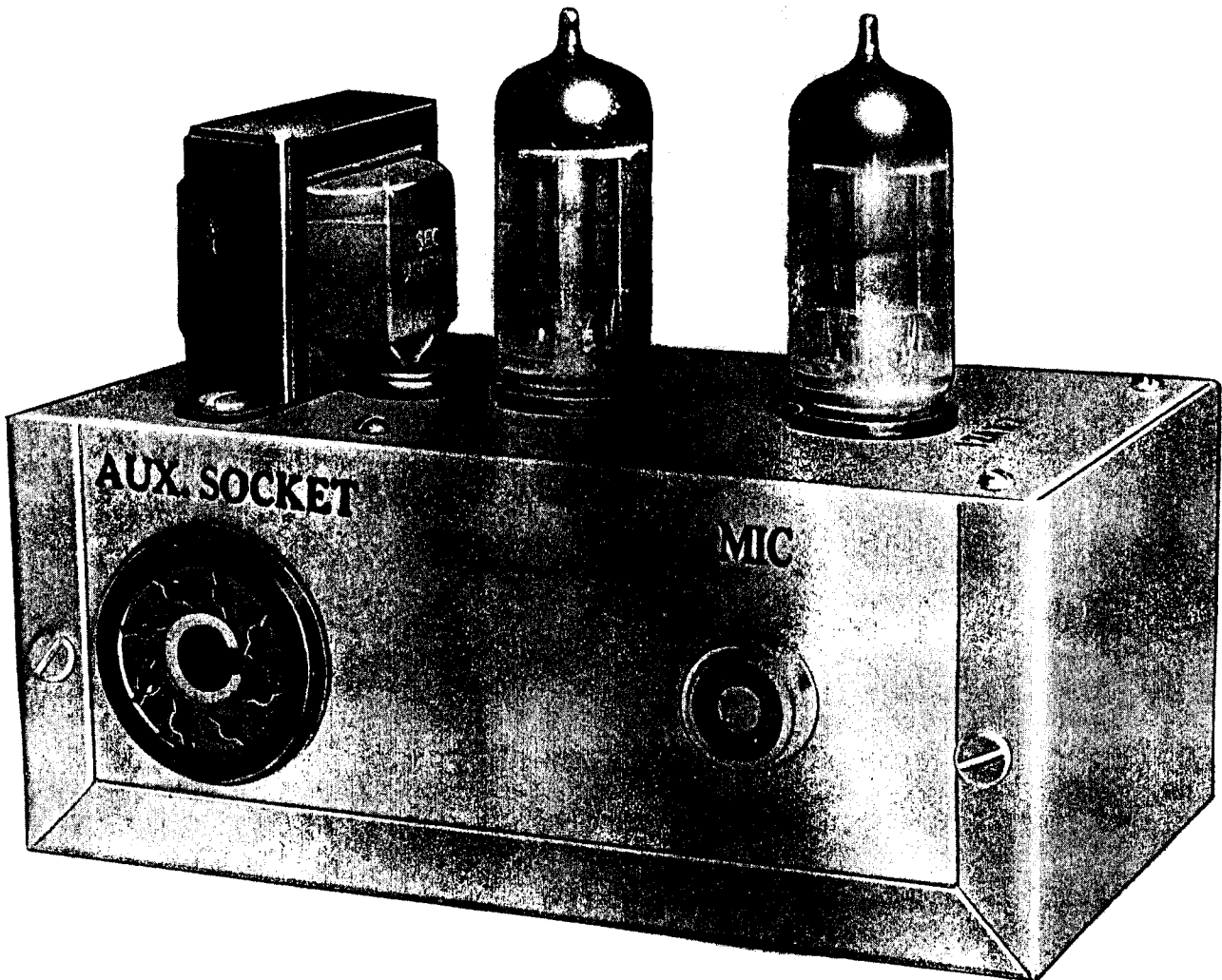
Council Bluffs, Iowa

MANUFACTURERS OF

World Famous Globe Transmitters

TABLE OF CONTENTS

| | |
|---|----|
| SECTION I. General Description of the WRL Screen Modulator, Model SM-90 | 1 |
| SECTION II. Parts Mounting and Wiring Procedure | 1 |
| SECTION III. Transmitter Modifications | 5 |
| SECTION IV. Tune-Up Procedure | 7 |
| SECTION V. Trouble Shooting | 8 |
| SECTION VI. HELPFUL KIT BUILDING INFORMATION | 9 |
| SECTION VII. Parts List. | 13 |



SECTION I
GENERAL DESCRIPTION

1-1. GENERAL.

1-2. The WRL Model SM-90 Screen modulator is made by WRL Electronics, Inc. of Council Bluffs, Iowa. The Screen Modulator is designed specifically for use with the Globe Chief Transmitter, Model 90, but may also be used with any other transmitter such as the Heath AT-1, Johnson Adventurer, Knight 50 Watt Transmitter, etc. using one or two 807 or 6L6 tubes in the final R.F. amplifier, with suitable modifications. The Screen Modulator permits radio-telephone operation of a C.W. transmitter at minimum cost.

1-3. DESCRIPTION.

1-4. The Model SM-90 Screen Modulator is completely self-contained in a $5\frac{1}{4} \times 2-7/8 \times 2-1/8$ " chassis, with the tubes and interstage transformer projecting above the chassis. An octal plug projects from the chassis and plugs into the auxiliary socket on the rear of the Model 90 Globe Chief transmitter, providing all interconnections between the two units and mounting the Screen Modulator on the Globe Chief. Use of a printed circuit board simplifies wiring.

TABLE 1. TUBE COMPLEMENT.

| QUANTITY | TYPE | FUNCTION |
|----------|-------|-----------------------------|
| 1 | 12AX7 | Speech Amplifier |
| 1 | 12AU7 | Driver and Screen Modulator |

1-5. THEORY OF OPERATION.

1-6. The Model SM-90 Screen Modulator operates by virtue of the fact that the screen voltage of a tetrode or pentode tube determines the plate current and power input of that tube. By varying the screen voltage of a tetrode or pentode R.F. amplifier tube at an audio rate, A.M. modulation can be applied to the radio frequency signal. In the Model SM-90 Screen Modulator, the 12AX7 and one section of the 12AU7 serve to amplify the audio voltage from the microphone to a level of approximately 200 volts. This voltage is applied to the second half of the 12AU7, which operates as a cathode follower. The voltage at the cathode of the second half of the 12AU7 provides the modulated D.C. for the screen of the R.F. amplifier tube in the transmitter.

1-7. Power for the Model SM-90 Screen Modulator is obtained from the transmitter with which the Screen Modulator is being used. A plug on the Screen Modulator allows it to be conveniently plugged directly into the AUX. SOCKET of the Globe Chief, Model 90, Transmitter. Modification of the AUX. SOCKET on the transmitter is necessary. (See 3-1.)

SECTION II

MOUNTING AND WIRING PROCEDURE

2-1. GENERAL.

2-2. A printed circuit board is used in the Model SM-90 Screen Modulator, which makes it extremely easy to wire the unit neatly and correctly. However, it is necessary to observe a few simple precautions:

(a) USE ONLY ROSIN CORE OR "RADIO" SOLDER. NEVER USE ACID CORE SOLDER FOR ANY ELECTRONIC WORK.

(b) It is best to use a small pencil-type 25 watt soldering iron. If a larger iron is used, be careful not to apply heat to the printed circuit board for more than a couple of seconds when soldering in a component, as excessive heat may damage the printed circuit board.

(c) In handling the printed circuit board, be careful not to forcibly bend the board, as this may crack the conductive copper coating

and cause an intermittent circuit.

2-3. The printed circuit board is marked to indicate what components go into which holes, simplifying the wiring and parts mounting. Each hole has one and only one wire in it at completion; if any of the holes in the printed circuit board end up with more than one wire or with no wires in them at completion, a wiring error has been made.

2-4. The printed circuit board is mounted on the chassis by means of four screws with nuts and spacers. Also mounted on the chassis are the following: an octal plug, (PL-6), an octal socket, (SO-7), the interstage transformer, (T-1), the microphone jack, (mic) and a solder lug. These parts are mounted on the chassis before the printed circuit wiring begins, as indicated in the step-by-step instructions. When wiring: (S) means solder, (NS) means do not solder yet.

SECTION II

MOUNTING AND WIRING PROCEDURE

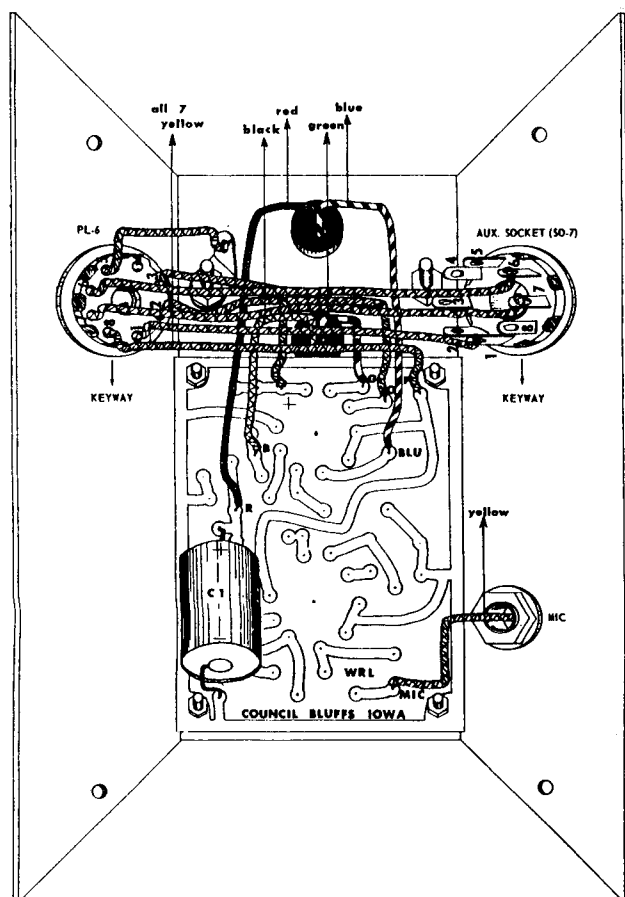


Figure 1. Parts Mounting And Wiring on Chassis.

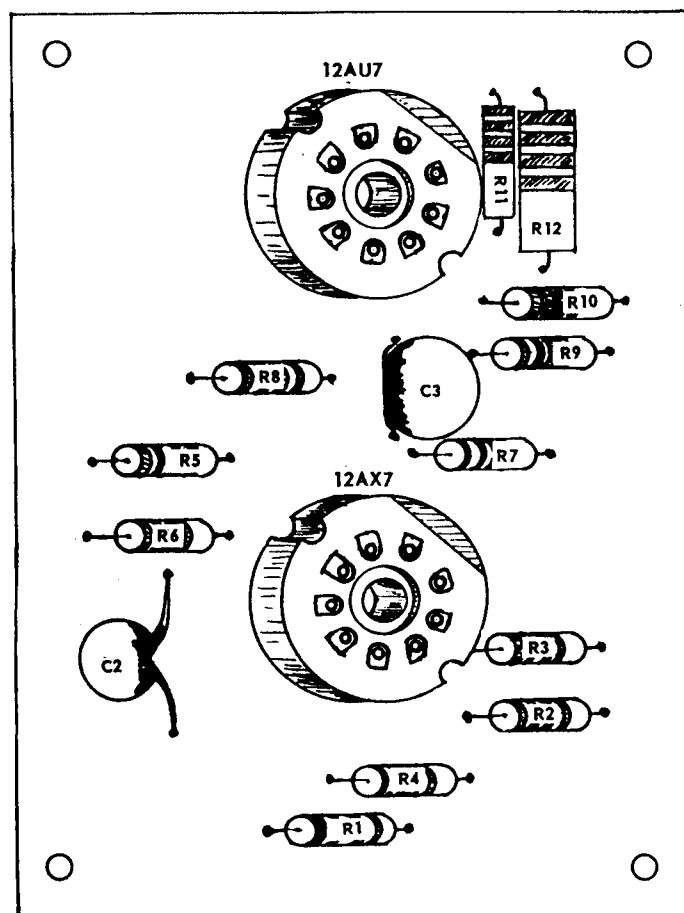


Figure 2. Component Placement on Printed Circuit Board.

MOUNTING AND WIRING PROCEDURE

2-5. STEP BY STEP MOUNTING AND WIRING INSTRUCTIONS.

- ☐ 1. One side of the chassis has a large hole and a small hole in it. Mount the microphone connector (mic) in the small hole and the octal socket (SO-7) in the large hole. Position the socket as in Figure 1, with the keyway pointing toward the microphone connector.
- ☐ 2. Mount the octal plug (PL-6) in the large hole on the opposite side of the chassis. Position the plug so its keyway points the same way as the octal socket (SO-7), as shown in Figure 1.
- ☐ 3. Mount a grommet in each of the 13/32 holes on top of the chassis.
- ☐ 4. Leads of transformer T-1 should now be trimmed to length as follows: Green lead, 2". Black lead, 3". Blue lead, 3½". Red lead, 4½". Strip the insulation from the ends of the leads, leaving about 1/8 inch of bare wire.
- ☐ 5. Mount the transformer on top of the chassis, bringing the green and black leads through the grommet nearest the center of the chassis, and the red and blue leads through the other grommet. (See Fig. 1 for correct lead placement.) Use 6-32 screws and nuts to mount the transformer, with a lock-washer under the nut nearest the octal socket (SO-7) and a ground lug under the nut nearest the octal plug (PL-6).
- ☐ 6. Connect a yellow wire from pin 6 of the octal socket (SO-7) (S) to pin 6 of the octal plug (PL-6) (S). See Figure 8, page 11, on how to make a good solder connection.
- ☐ 7. Connect a yellow wire from pin 7 of the octal socket (SO-7) (S) to pin 7 of the octal plug (PL-6) (S).
- ☐ 8. Connect a yellow wire from pin 5 of the octal plug (PL-6) (S) to the ground lug. (S).
- ☐ 9. Set the chassis aside for the time being and take out the printed circuit board, the resistors, the condensers, and the small 9-pin tube sockets.
- ☐ 10. Mount the tube sockets in the appropriate holes as in Figure 2. One or two of the pins may be bent slightly to hold the sockets in place. Turn the printed circuit board over on your workbench so the tube sockets are on the bench and the printed-circuit side of the board is up. Solder the tube socket pins to the board, being careful to use enough heat to make a firm joint to the copper of the board, but not enough heat to burn the board. We advise the use of a small pencil type soldering iron.
- ☐ 11. Prepare the resistors for mounting and soldering. The easiest way to mount the resistors in the printed circuit board is this: Bend the leads of the resistor at right angles to the body of the resistor and insert through the proper holes in the board, then bend each lead down against the board and cut the lead off short right next to the hole. Then solder each lead to the board.
- ☐ 12. Note that the board is marked so as to identify which resistors go into which holes. Begin with the 22K resistor (R1) (red-red-orange.) Mount it and solder as explained in step #11.
- ☐ 13. Mount and solder the 100K resistor (R4) (brown-black-yellow).
- ☐ 14. Mount and solder the 390K resistor (R2) (orange-white-yellow).
- ☐ 15. Mount and solder a 2200 ohm resistor (R3) (red-red-red) in the holes near the 390K resistor just mounted.
- ☐ 16. Mount and solder the small (½ watt) 47 K resistor (R7) (yellow-purple-orange). This is the next resistor back from the 2200 ohm resistor mounted in step 15.
- ☐ 17. Mount and solder a 2200 ohm resistor (R9) (red-red-red) in the marked holes just back of the 47K resistor mounted in step 16.
- ☐ 18. Mount and solder a 1 megohm resistor (R10) (brown-black-green) in the marked holes just back of the 2200 ohm resistor mounted in step 17.
- ☐ 19. Mount and solder the 47K, 1 watt resistor (R12) (yellow-purple-orange) in the marked holes just to the rear of the 1 megohm resistor mounted in step 18.
- ☐ 20. Mount and solder the 2.2 megohm resistor (R11) (red-red-green) adjacent to the 47K, 1 watt mentioned in step 19.
- ☐ 21. Mount and solder the remaining 2200 ohm resistor (R6) (red-red-red).
- ☐ 22. Mount and solder the 1 megohm resistor

SECTION II

MOUNTING AND WIRING PROCEDURE

(R5) (brown-black-green) adjacent to the 2200 ohm resistor mounted in step 21.

- ☐ 23. Mount and solder the remaining 1 meg-ohm resistor (R8) (brown-black-green).
- ☐ 24. Mount and solder the 500 MMF (.0005MF) condenser (C2) in the holes marked .0005. This is the smallest condenser. Bend it flat against the board.
- ☐ 25. Mount and solder the .005 MFD condenser (C3) in the holes marked .005. Bend this condenser over so that it lies on top of the 47K resistor. R7.

CAUTION

For a neater job it is advisable to remove from the printed circuit board any rosin that may have been deposited while soldering. A cloth moistened with carbon tetrachloride or alcohol or similar solvent may be used to wipe away the rosin. Do this before mounting the 8 mfd at 450 volt electrolytic condenser (C-1), as this condenser will make it difficult to get at certain portions of the board.

- ☐ 26. Find the holes marked 8/450. The 8 mfd at 450 volt electrolytic condenser (C-1) mounts in these holes, but it mounts underneath the board as in Fig. 1. Mount this condenser so that the MINUS end (the silver-colored end) is closest to the end of the board and the PLUS end (brown end) is closest to the center of the board. (S).
- ☐ 27. The printed circuit board may now be mounted in the chassis, using the 4 long screws, the 4 metal standoffs, and 4 nuts. The easiest way to do this is to set the chassis rightside up, put the screws in the holes, and then secure the screw heads with tape (scotch tape, adhesive tape, electrical tape, etc.—anything that will hold the screws in place for a few minutes without marking the chassis.) Then turn the chassis upside down, drop a metal standoff on each screw, and put the printed circuit board on the screws as in Fig. 1. Then put the nuts on the screws. Tighten the nuts securely enough to hold solidly, but be sure not to over-

tighten, as this might crack the board. Remove the tape which was used to hold the screws in place.

- ☐ 28. Connect a wire from the insulated center post of the mike jack (S) to the dot on the circuit board marked "MIC". (S).
- ☐ 29. Connect the green lead from the transformer to the dot on the circuit board marked "G". (S).
- ☐ 30. Connect the black lead from the transformer to the dot on the circuit board marked "B". (S).
- ☐ 31. Connect the blue lead from the transformer to the dot on the circuit board marked "BLU". (S).
- ☐ 32. Connect the red lead from the transformer to the dot on the circuit board marked "R". (S).
- ☐ 33. Connect a wire from pin 3 of the octal plug (PL-6) (S) to the dot on the circuit board marked + (plus) (S).
- ☐ 34. Connect a wire from pin 2 of the octal plug (PL-6) (S) to the dot on the circuit board marked "O". (S).
- ☐ 35. Connect a wire from pin 8 of the octal plug (PL-6) to the dot on the circuit board marked "FIL". (S).
- ☐ 36. Connect a wire from pin 1 of the octal plug (PL-6) (S) to pin 1 of the octal socket (SO-7). (S).

2-6. This completes the wiring of the Model SM-90 Screen Modulator. Slide the top half of the chassis into the bottom half of the chassis and insert and tighten the four self-tapping screws. Insert the 12AU7 tube into the socket nearest the transformer. Insert the 12AX7 tube into the other socket.

2-7. The unit is now ready to connect to the transmitter and operate. All that is left is to modify the transmitter. Instructions for modifying the WRL Globe Chief Model 90, the Heath Model AT-1, Johnson Adventurer and the Knight 50 Watt Transmitter are given in Section III.

SECTION III

TRANSMITTER MODIFICATIONS

of terminal strip X-6 (S) to pin 3 of socket X-4. (S).

3-8. This completes the internal modifications of the Adventurer. For CW operation: Connect a wire from pin 3 to pin 6 of an octal plug and plug it into socket X-4. For phone operation with the WRL Screen Modulator Model SM-90, an adapter cord is necessary. Parts needed for the adapter cord are: 1 octal plug, 1 octal socket, and several feet of wire (length of wire depending on how you wish to locate or mount the screen modulator. Any length up to five feet of cable is satisfactory.) The following steps may be followed to make the adapter cord.

- ☐ 1. Cut 4 pieces of wire to the same length (any length from six inches to five feet). Strip the insulation from the ends of the wires.
- ☐ 2. Connect a wire from pin 2 of the octal plug (S) to pin 5 of the octal socket. (S).
- ☐ 3. Connect a wire from pin 5 of the octal plug (S) to pin 3 of the octal socket. (S).
- ☐ 4. Connect a wire from pin 6 of the octal plug (S) to pin 2 of the octal socket. (S).
- ☐ 5. Connect a wire from pin 7 of the octal plug (S) to pin 8 of the octal socket.

3-9. This completes the Adapter Cord. To op-

erate on phone: Plug the WRL Screen Modulator Model SM-90 into the socket on the adapter cord. Remove the plug from socket X-4 of the Adventurer and insert the plug of the adapter cord instead.

3-10. MODIFICATION OF THE KNIGHT 50 WATT TRANSMITTER TO USE THE WRL SCREEN MODULATOR MODEL SM-90.

- ☐ 1. Remove the two leads from pin 2 of J4 and connect them to pin 8 of J4.
- ☐ 2. Remove lead from pin 6 of J4 and connect to pin 3 of J4.
- ☐ 3. Remove wire lead from pin 7 of J4 and connect to pin 3 of J4.
- ☐ 4. Remove the two leads from pin 1 of J4 and connect them to pin 5 of J4.
- ☐ 5. Remove the end of resistor R5 from pin 7 of J4 and connect it to pin 4 of J4.
- ☐ 6. Connect a lead from pin 2 of V2 to pin 2 of J4.
- ☐ 7. Modify P-1 as follows: Remove the jumper wire from pins 6 and 7 and install jumper from pin 3 to pin 4.

3-11. This completes the necessary modifications and operation on phone may be accomplished by removing P-1 from J4 and inserting PL-6 of the screen modulator into J4. For CW operation reverse the above procedure.

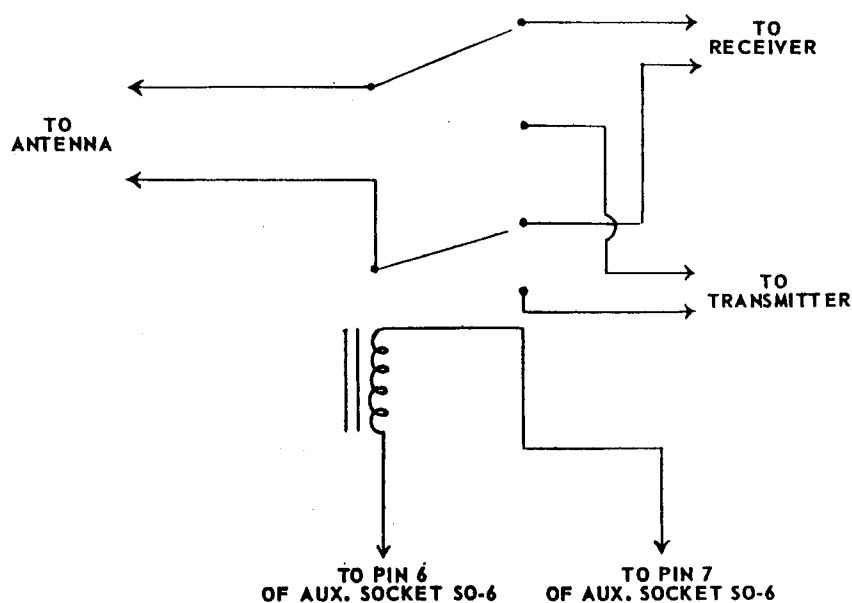


Figure 3. Antenna Relay. (DPDT Relay, Ceramic Insulation, 115 V. A.C. Coil).

SECTION III

TRANSMITTER MODIFICATIONS

3-1. MODIFICATION OF WRL GLOBE CHIEF MODEL 90 TO USE THE WRL SCREEN MODULATOR MODEL SM-90.

3-2. These modifications are listed in section 4-9 of the Globe Chief Instruction Manual but are repeated here for your convenience.

- ☐ 1. Connect a 5" piece of wire from lug 1 of tie-lug strip TS-5 (S) to pin 3 of Aux. Socket (SO-6). (S).
- ☐ 2. Remove the following 2 orange/white wires: from pin 2 of SO-4 to lug 5 of TS-5 and from pin 2 of SO-3 to lug 5 of TS-5.
- ☐ 3. Connect a 3" piece of wire from pin 2 of SO-4 (S) to lug 2 of TS-5. (NS).
- ☐ 4. Connect a 3" piece of wire from pin 2 of SO-3 (S) to lug 2 of TS-5. (NS).
- ☐ 5. Connect a 6" piece of wire from lug 2 of TS-5 (S) to pin 2 of Aux. Socket (SO-6). (S).
- ☐ 6. Connect a 6" piece of wire from lug 5 of TS-5 (S) to pin 4 of Aux. Socket (SO-6). (S).
- ☐ 7. Connect a 2½" piece of wire from pin 5 of Aux. Socket (SO-6) (S) to the nearest solder lug. (S).
- ☐ 8. Connect a 5½" piece of wire from pin 8 of Aux. Socket (SO-6) (S) to pin 1 of SO-3. (S).

3-3. This completes the modification of the Globe Chief Model 90 for use with the WRL Screen Modulator Model SM-90. To return the Globe Chief to C.W. operation, connect pins 2 and 4 of an octal plug together and plug into Transmitter Aux. Socket (SO-6).

3-4. Should it be desired to use an antenna relay and "one-switch" operation, the following additional modifications must be included.

- ☐ 1. Connect an 11½" piece of wire from lug 2 of keyjack J-1 (S) to pin 1 of Aux. Socket (SO-6). (S).
- ☐ 2. Connect the contacts of an antenna relay as shown in Fig. 3. Connect the coil wires of the relay to pins 6 and 7 of an octal plug.
- ☐ 3. Connect the coil leads of a SPST normally open 115 VAC relay to the coil of the antenna relay. Connect the contacts of this relay to pins 1 and 5 of the octal plug mentioned in step 2.
- ☐ 4. Plug the octal plug into the socket

(SO-7) on the WRL Screen Modulator Model SM-90.

- ☐ 5. The TUNE-TRANSMIT switch on the Globe Chief Transmitter Model 90 will now control the relays and the modulator for one switch operation.

3-5. MODIFICATION OF THE HEATHKIT AT-1 TRANSMITTER TO USE THE WRL SCREEN MODULATOR MODEL SM-90.

- ☐ 1. Refer to Heathkit Model AT-1 instruction manual for the following connections. Connect a wire from pin 2 of socket D (S) to pin 8 of socket E. (S).
- ☐ 2. Connect a wire from pin 5 of socket E (S) to the nearest ground connection of socket E. (S).
- ☐ 3. Remove the 22K 2 watt resistor (red-red-orange) which is connected from lug 3 of terminal strip TC to pin 4 of socket B.
- ☐ 4. Connect this 22K 2 watt resistor from pin 1 of socket E (S) to pin 4 of socket E. (NS).
- ☐ 5. Connect a wire from pin 4 of socket B (S) to pin 2 of socket E. (S).
- ☐ 6. Connect a wire from pin 3 of socket E (S) to pin 4 of socket E. (S).
- ☐ 7. Remove the cap from the octal plug which is plugged into socket E. Connect a wire from pin 2 of the plug (S) to pin 1 of the plug. (S).

3-6. This completes the modification of the AT-1 for use with the WRL Screen Modulator Model SM-90. For phone use, remove the octal plug from socket E and plug in the modulator. For CW use, unplug the modulator and plug the octal plug into socket E.

3-7. MODIFICATION OF THE JOHNSON ADVENTURER TO USE THE WRL SCREEN MODULATOR MODEL SM-90.

- ☐ 1. Refer to the Johnson Adventurer instruction manual for the following connections: Disconnect R-11 (20K, 10 watt) from pin 2 of socket X-2, the 807 socket.
- ☐ 2. Connect the free lead of R-11 (the lead just disconnected from X-2) to lug 4 of terminal strip X-6. (NS).
- ☐ 3. Connect an 8½" piece of wire from pin 2 of socket X-2 (S) to pin 6 of socket X-4. (S).
- ☐ 4. Connect a 7" piece of wire from lug 4

SECTION IV

TUNE-UP PROCEDURE

4-1. GENERAL

4-2. Tuning up with the screen modulator is slightly different from the tune-up procedures for CW operation. In general, the pattern is the same as for CW operation except for lower meter readings.

4-3. TUNE-UP PROCEDURE WHEN USING THE WRL SCREEN MODULATOR MODEL SM-90 WITH THE GLOBE CHIEF MODEL 90 TRANSMITTER.

- ☐ 1. Place transmitter controls as follows: A.C. POWER to ON. TUNE-TRANSMIT to TUNE. Bandswitch to desired band of operation. OSC. TUNING, PLATE TUNING, and ANTENNA LOADING all pointing to the left side of the transmitter.
- ☐ 2. Plug in a suitable crystal for the desired band as per Table II, page 4, of Globe Chief instruction manual.
- ☐ 3. Plug into keyjack J-1.
- ☐ 4. Close key and adjust OSC. TUNING for maximum meter reading. This will be less than for C.W. operation, and may even be less than one dial division. Be certain that the arrow on the OSC. TUNING control is to the left of center on all bands except 15 meters. On 15 meters it must be to the right of center.
- ☐ 5. Open the key. Connect antenna to the proper antenna terminal. See the C.W. tune up procedure for details.
- ☐ 6. Place the TUNE-TRANSMIT switch in TRANSMIT position. Close key. The meter should rise to between 110 and 150 ma.
- ☐ 7. Rotate PLATE TUNING control for minimum reading. Advance the ANTENNA LOADING control toward maximum until the meter returns to its original reading. Retune the PLATE TUNING for minimum reading, which will now be higher than it was at first. Repeat the process until there is very little difference between the minimum reading and the maximum, i.e., the meter reading at the "dip" point should be within 10 milliamperes of the reading with the PLATE TUNING tuned away from the "dip" point. With any form of screen grid or control grid modulation, very heavy loading is essential if good audio quality is to be obtained.
- ☐ 8. Connect a crystal or hi-impedance dynamic microphone to the connector on the modulator. Speak into the microphone. A slight movement of the meter indicates full modulation. The meter should not move more than 10, or at

the most, 20 milliamperes.

- ☐ 9. To standby, simply open the key. To transmit, close the key. If an antenna relay is being used, it will also be necessary to operate the TUNE-TRANSMIT switch in order to operate the antenna relay, just the same as in C.W. operation.

4-4. If the antenna relay is being used and it is desired to have truly "one-switch" operation, this can be obtained by adding a SPST 115 volt A.C. relay as follows:

- ☐ 1. Connect a 11½" piece of wire from lug 2 of keyjack J-1 (S) to pin 1 of SO-6. (S).
- ☐ 2. Connect the leads from the coil of the SPST 115 VAC relay to pins 6 and 7 of the plug that plugs into SO-6.
- ☐ 3. Connect the leads from the normally open contacts of the relay to pins 1 and 5 of this plug.
- ☐ 4. After tuning up the transmitter as detailed in paragraph 4-3, the key may be left open or may be removed entirely. Setting the TUNE-TRANSMIT switch to TRANSMIT will cause the SPST relay to close, shorting the keyjack and turning on the transmitter. Setting the TUNE-TRANSMIT switch to TUNE will open the relay and turn the transmitter off, thus allowing complete control of the transmitter with one switch.

4-5. TUNE-UP PROCEDURE WHEN USING THE WRL SCREEN MODULATOR MODEL SM-90 WITH OTHER TRANSMITTERS.

4-6. Tuning up a transmitter with the screen modulator attached is almost the same as tuning up for CW operation. Follow the CW tune-up procedure except for the amount of plate current when fully loaded. It will be found that the plate current will be from ½ to 2/3 as much as on CW. Also, for best results, it is necessary to load up as heavily as possible. There should be hardly any dip in plate current when tuning through resonance. If an output indicator is used (such as a neon bulb), the loading should be increased just past the point of maximum output for best audio quality. A crystal or high-impedance dynamic microphone should be attached to the microphone connector of the screen modulator before tuning up. Speaking into the microphone after tuning up should cause a slight increase in the plate current of the transmitter. If the plate current decreases, try loading more heavily. An output indicator should show an increase in output when speaking into the microphone.

SECTION V

TROUBLE SHOOTING

5-1. TROUBLE SHOOTING

5-2. In trouble-shooting for any possible errors in wiring or faulty components, the following chart will be of great help. All re-

sistances in this chart are measured from a socket pin to chassis ground, with no tubes in the unit and the unit unplugged from the associated transmitter.

TABLE II. RESISTANCE READINGS

| PIN No. | LOCATION 12AX7 Socket | LOCATION 12AU7 Socket | LOCATION Octal Socket | LOCATION Octal Plug |
|---------|--------------------------|--------------------------|--------------------------|------------------------|
| 1 | * | * | open circuit | open circuit |
| 2 | 1 megohm | 900 K | open circuit | open circuit |
| 3 | 2200 ohms | open circuit | open circuit | open circuit |
| 4 | 0 (zero) | open circuit | open circuit | open circuit |
| 5 | 0 (zero) | open circuit | open circuit | 0 (zero) |
| 6 | * | * | open circuit | open circuit |
| 7 | 390 K | 1 megohm | open circuit | open circuit |
| 8 | 2200 ohms | 2200 ohms | | |
| 9 | open circuit | 0 (zero) | | |

* This circuit is connected to the electrolytic condenser. If the negative lead of the ohmmeter is grounded, the meter should start

at some low resistance value and show a gradually increasing reading up to 1/2 megohm or more as the condenser charges.

SECTION VI

HELPFUL KIT BUILDING INFORMATION

6-1. GENERAL.

6-2. This section contains information useful in building or testing any radio or electronic equipment. The information included will enable identification of capacitors, resistors, transformer leads, the new schematic symbols, etc.

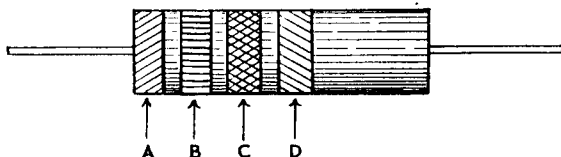
6-3. Standard color codes are used to mark values on such items as resistors and capacitors, and to identify the leads on transformers. The resistor-capacitor color code is given in Table III.

TABLE III. RESISTOR-CAPACITOR COLOR CODE.

| Color | Significant Figure | Decimal Multiplier | Tolerance % | Voltage Rating* |
|---------|--------------------|--------------------|-------------|-----------------|
| Black | 0 | 1 | — | — |
| Brown | 1 | 10 | 1* | 100 |
| Red | 2 | 100 | 2* | 200 |
| Orange | 3 | 1000 | 3* | 300 |
| Yellow | 4 | 10,000 | 4* | 400 |
| Green | 5 | 100,000 | 5* | 500 |
| Blue | 6 | 1,000,000 | 6* | 600 |
| Violet | 7 | 10,000,000 | 7* | 700 |
| Gray | 8 | 100,000,000 | 8* | 800 |
| White | 9 | 1,000,000,000 | 9* | 900 |
| Gold | — | 0.1 | 5 | 1000 |
| Silver | — | 0.01 | 10 | 2000 |
| Nocolor | — | — | 20 | 500 |

*Capacitors only.

6-4. Composition resistors are color coded as shown in Figure 4. These bands of color refer to the resistor-capacitor color code, Table III. If the first band is of double width, it means the resistor is a wire-wound unit. Here is an example: First band, green. Second band, blue. Third band, orange. Fourth band, silver. This would be a 56,000 ohm 10% resistor; the first band, green, means the first figure is a 5; the second band, blue, means the second figure is a 6; the third band, orange, means "multiply by 1000". 56 multiplied by 1000 is 56,000. The fourth band, silver, means the actual resistance is within 10% of the marked value. If there were no fourth band, it would indicate that the resistor was within 20% of the marked value.



A - FIRST SIGNIFICANT FIGURE OF RESISTANCE IN OHMS.
 B - SECOND SIGNIFICANT FIGURE.
 C - DECIMAL MULTIPLIER.
 D - RESISTANCE TOLERANCE IN PER CENT. IF NO COLOR IS SHOWN, THE TOLERANCE IS $\pm 20\%$.

Figure 4. Fixed Composition Resistor Code.

6-5. Ceramic capacitors of the general purpose type use the same color code with regard to significant figures and multipliers as do resistors. See Figure 5. The fourth band indicates tolerance.

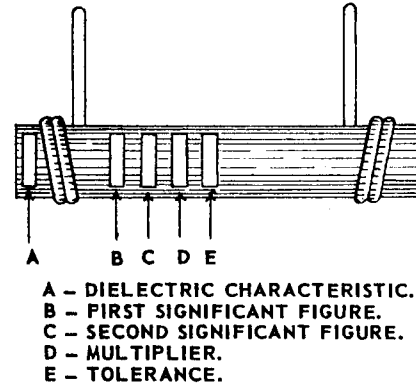


Figure 5. Tubular Ceramic Capacitor Code.

6-6. Mica capacitors have been marked with many different color codes in the past. Shown here are the three codes most likely to be encountered. Most of the mica capacitors used in WRL kits have the actual numerical value stamped on the capacitor, making the use of a color code unnecessary in such cases.

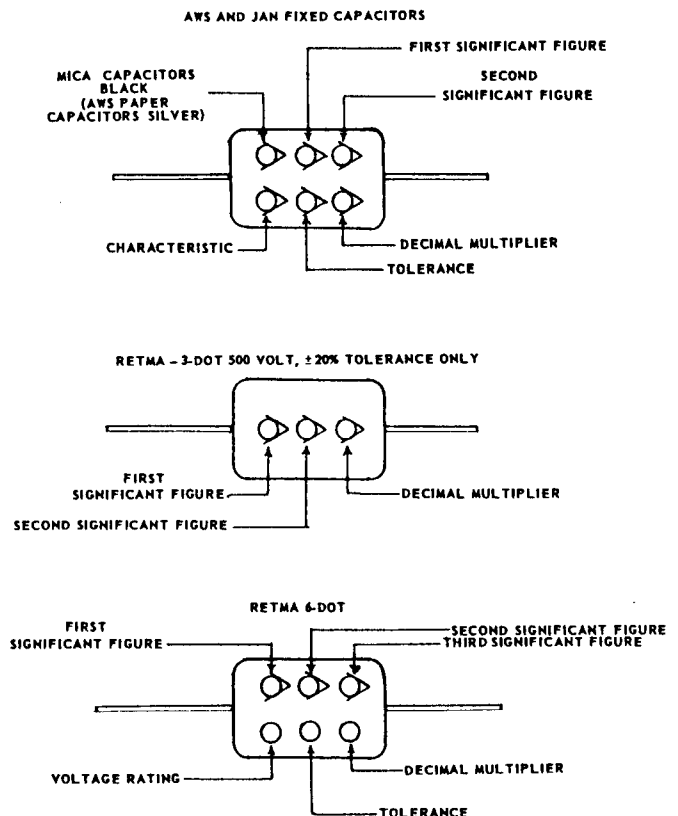
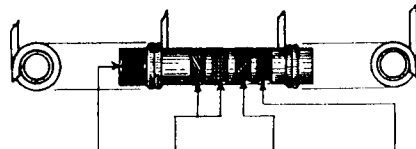


Figure 6. Mica Capacitor Color Code.

SECTION VI

HELPFUL KIT BUILDING INFORMATION

6-7. With the increasing use of variable frequency oscillators in amateur transmitters, temperature compensating (TC) capacitors are being used with increasing frequency. The color code for temperature compensating capacitors is the same as for resistors in regards significant figures and multipliers, but differs in the tolerance reading and in the showing of temperature coefficient. See Figure 7.



| TEMPERATURE COEFFICIENT | | CAPACITY SIGNIFICANT FIGURES | | MULTIPLIER | MMF. | TOLERANCE PERCENT |
|-------------------------|------------|------------------------------|--|------------|-------|-------------------|
| BLACK | ZERO (TCZ) | 0 | | 1 | ± 2.0 | ± 20% |
| BROWN | | 1 | | 10 | | ± 1% |
| RED | N080 | 2 | | 100 | | ± 2% |
| ORANGE | N150 | 3 | | 1,000 | | ± 2 1/2% |
| YELLOW | | 4 | | 10,000 | | |
| GREEN | N330(TCA) | 5 | | | ± .5 | ± 5% |
| BLUE | | 6 | | | | GMV |
| VIOLET | N750 (TCN) | 7 | | | | |
| GREY | | 8 | | .01 | ± .25 | |
| WHITE | | 9 | | .1 | ± 1.0 | ± 10% |
| ORANGE-ORANGE | N1500(TCL) | | | | | |

Figure 7. Color Coding For TC Type Ceramic Capacitors.

6-8. The leads of a power transformer are of different colors of wire. The wire color indicates to which winding the lead is connected, as follows:

TABLE IV. POWER TRANSFORMER CODING.

| Winding | Color Code |
|--|---|
| Primary Leads if tapped: Common Tap Finish | Black Black Black/Yellow Black/Red |
| High Voltage Center Tap | Red Red/Yellow |
| Rectifier Filament Center Tap | Yellow Yellow/Blue |
| Filament No. 1 Center Tap | Green Green/Yellow |
| Filament No. 2 Center Tap | Brown Brown/Yellow |
| Filament No. 3 Center Tap | Slate Slate/Yellow |

6-9. In the past, the electronic and electric portions of the industry used different, and sometime mutually confusing, symbols. Recently, a single set of symbols have been adopted. Those most applicable to electronics and radio are shown in Figure 9.

6-10. KIT ASSEMBLY. WRL kits come with all holes prepunched, so that a minimum number of tools will be needed for assembly of the kit. The following are recommended as suitable:

- 1-small knife for scraping off enamel insulation.
- 1-small screwdriver.
- 1-medium screwdriver.
- 1-long nose pliers.
- 1-diagonal or side-cutting pliers ("dikes").
- 1-small-tip soldering iron, at least 100 watts, or.....
- 1-soldering gun, at least 100 watts.

Rosin core solder, the amount depending on the kit. DO NOT USE ACID CORE SOLDER. USE ONLY ROSIN CORE OR "RADIO" SOLDER.

Additional tools which are helpful, but not absolutely necessary.

- 1set-"Spintite" or socket wrenches.
- 1-6 inch crescent wrench.
- 1-Wire stripper.

In mounting the components of the kit, follow the instructions closely and consult the pictorial diagrams for positioning. You will find in many cases a glance at the diagram will explain far better than several paragraphs of words. Route wires as shown in the pictures, as wire placement may be important. Be sure that socket keyways are positioned as in the pictures, so that the proper pin numbers will be in the proper location.

6-11. SOLDERING. A poor solder joint may cause faulty operation of the equipment. The importance of a good soldering job cannot be overstated. The secret of a good solder joint is simple: GET THE JOINT ITSELF HOT ENOUGH TO MELT THE SOLDER. It is not sufficient to melt the solder with the soldering iron and let it drip upon the joint; the joint itself must be hot enough to melt solder. Only in this way will the solder flow onto the joint and make a secure bond. Also, make a secure mechanical connection before applying solder, as the solder should be depended on only for an electrical connection and not for mechanical strength, i.e., twist the wire around a terminal so that the twist will hold even before solder is applied. Again, USE ONLY ROSIN CORE OR "RADIO" SOLDER. ACID CORE SOLDER WILL EAT AWAY THE WIRING AND IN TIME CAUSE FAILURE OF THE EQUIPMENT. DO NOT USE SOLDERING PASTE

HELPFUL KIT BUILDING INFORMATION

OR FLUX, AS IT WILL TEND TO BREAK DOWN INSULATION. Be sure that the surfaces to be soldered are clean and bright. Scrape any tarnish or enamel insulation off any wires or terminals which are to be soldered. Keep

the tip of the soldering iron clean and bright and well-tinned with solder. A piece of steel wool is an excellent item with which to clean a soldering iron tip, even when the iron is on and hot.

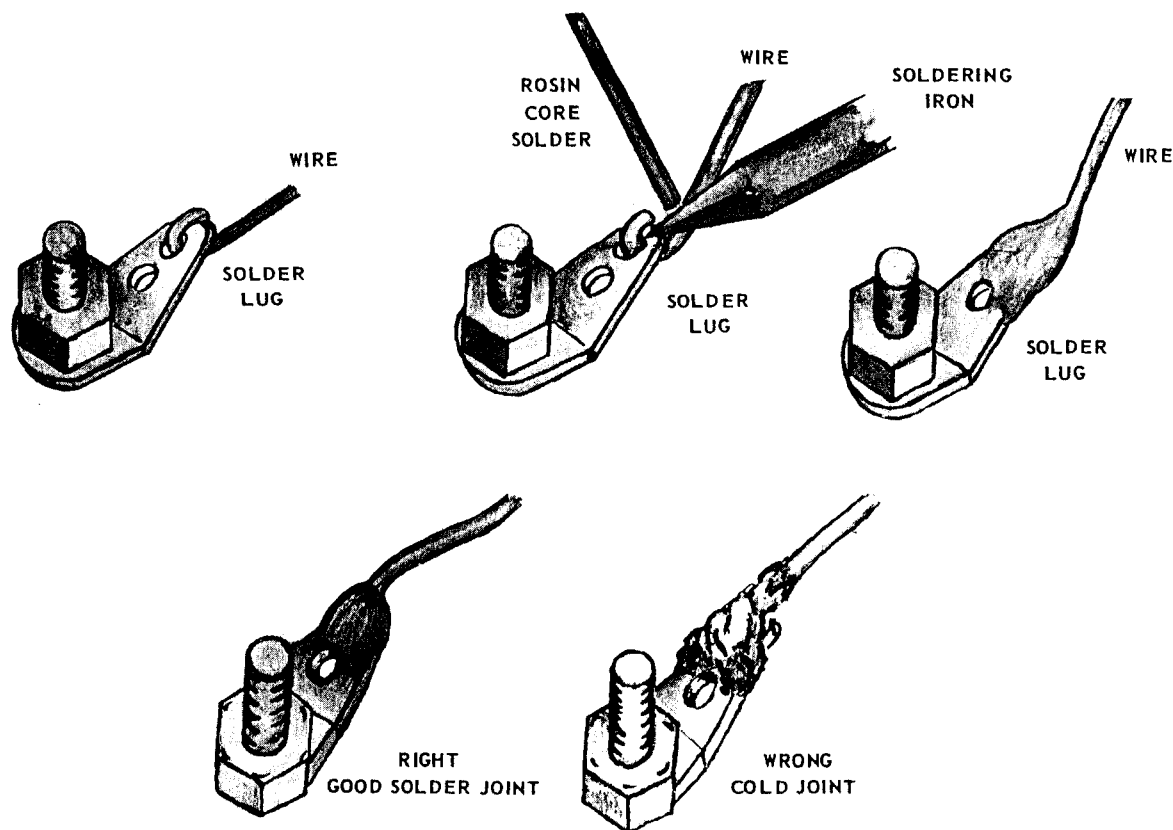


Figure 8. How To Make A Good Solder Joint.

SECTION VI

HELPFUL KIT BUILDING INFORMATION

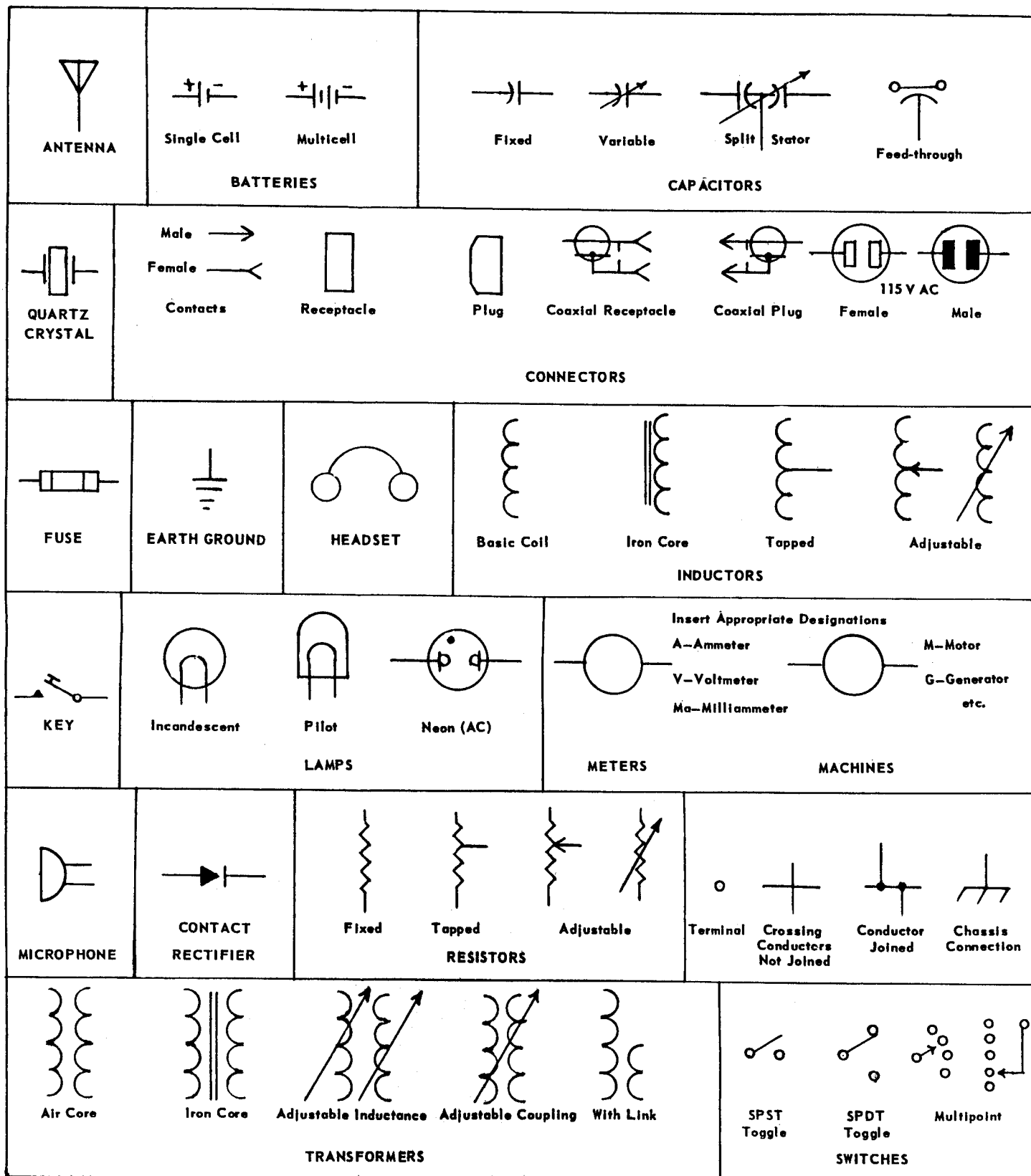


Figure 9. Electronic Symbols.

SECTION VII

PARTS LIST

| Quan. | Description | Circuit Designation | WRL Part No. |
|-------|---|---------------------|--------------|
| 1 | Capacitor, 8mfd, 450 volt, electrolytic | C-1 | 1106-013 |
| 1 | Capacitor, 500 mmfd, Disc ceramic | C-2 | 1101-005 |
| 1 | Capacitor, .005mfd, Disc ceramic | C-3 | 1101-003 |
| 1 | Connector, microphone | MIC | 2000-005 |
| 1 | Plug, Octal | PL-6 | 2001-009 |
| 1 | Resistor, 22K, $\frac{1}{2}$ watt | R-1 | 1000-008 |
| 1 | Resistor, 390K, $\frac{1}{2}$ watt | R-2 | 1000-015 |
| 1 | Resistor, 2200 ohm, $\frac{1}{2}$ watt | R-3 | 1000-006 |
| 1 | Resistor, 100K, $\frac{1}{2}$ watt | R-4 | 1000-009 |
| 1 | Resistor, 1meg., $\frac{1}{2}$ watt | R-5 | 1000-014 |
| 1 | Resistor, 2200 ohm, $\frac{1}{2}$ watt | R-6 | 1000-006 |
| 1 | Resistor, 47K, $\frac{1}{2}$ watt | R-7 | 1000-002 |
| 1 | Resistor, 1meg., $\frac{1}{2}$ watt | R-8 | 1000-023 |
| 1 | Resistor, 2200 ohm, $\frac{1}{2}$ watt | R-9 | 1000-006 |
| 1 | Resistor, 1meg., $\frac{1}{2}$ watt | R-10 | 1000-014 |
| 1 | Resistor, 2.2meg., $\frac{1}{2}$ watt | R-11 | 1000-005 |
| 1 | Resistor, 47K, 1 watt | R-12 | 1001-009 |
| 1 | Socket, 9-pin miniature | 12AU7 | 1600-017 |
| 1 | Socket, 9-pin miniature | 12AX7 | 1600-017 |
| 1 | Socket Octal | SO-7 | 1600-002 |
| 1 | Transformer | T-1 | 1203-007 |

| Quantity | Description | WRL Part No. |
|-----------|--------------------------------------|--------------|
| 1 | Chassis | 1700-007 |
| 2 | Grommet, 3/8" O.D. | 3200-001 |
| 1 | Lockwasher, No. 6 | 3101-002 |
| 4 | Nut, hex., 4-40 | 2901-001 |
| 2 | Nut, hex., 6-32 | 2901-003 |
| 1 | Printed Circuit Board | 3300-036 |
| 4 | Screw, machine; 4x40x3/4" | 2900-020 |
| 2 | Screw, machine; 6-32x 5/16" | 2900-004 |
| 4 | Screws, self-tapping, #6x 1/4" | 2900-017 |
| 1 | Solder lug, No. 6 bent | 2006-004 |
| 4 | Stand-off bushings, metal, 3/8" long | 3300-037 |
| 1 | Tube, 12AU7 | |
| 1 | Tube, 12AX7 | |
| 2 1/2 Ft. | Wire, hook-up | 2700-001 |

HELPFUL TOOLS AND SUPPLIES

| Item | Price |
|--|-------|
| Long nose pliers | 2.64 |
| Side cutting pliers (Diagonals) | 2.64 |
| Solder, Rosin Core, 3 oz. | .17 |
| Soldering Iron, Handle for 25 watt element | 1.12 |
| 25 watt element and tip for above | 1.00 |

ACCESSORIES

| Item | Price |
|----------------------------|-------|
| JT-30 microphone and stand | 10.17 |
| Octal Plug | .20 |
| Octal Socket | .20 |
| Antenna Change-Over Relay | 3.75 |

