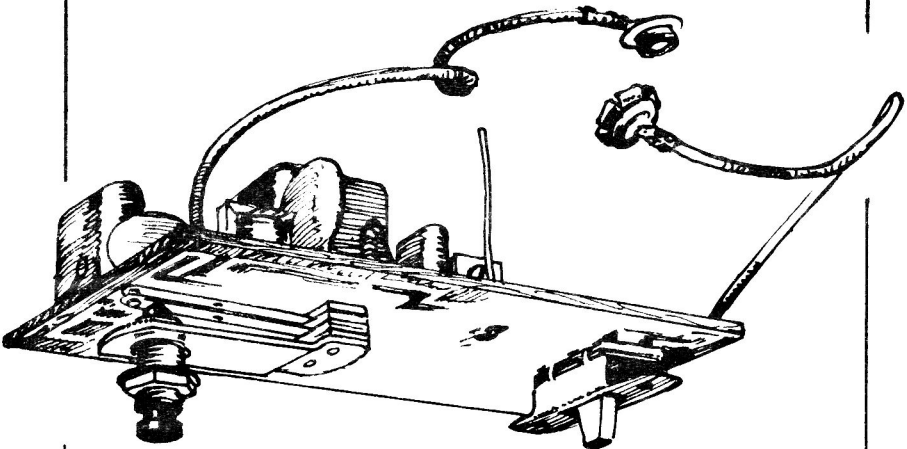


CONTROLAIRE

MARK II MULE

SINGLE CHANNEL TONE TRANSMITTER

Kit Assembly Instructions



Controlaire Electronics Division - World Engines, Inc.

8206 BLUE ASH ROAD - CINCINNATI 36, OHIO

MADE IN U. S. A.

MARK II MULE

TONE TRANSMITTER

INTRODUCTION

Controlaire now introduces the "Mark II Mule" in easy to assemble kit form. Advancements in technology and better transistors have brought about the change. As progress dictates, the original "Mule" has given way to the new "Mark II". General improvements are easier assembly, more power output and increased modulation percentage to 97%. The Mark II is recommended for all Controlaire single channel receivers, including the special purpose SH-100 Superhet.

The instructions are presented in two separate manuals and a small pamphlet entitled "Kit Assembly Tips". One manual is the standard "Operating Instructions" as supplied with factory assembled units and the other manual is the "Assembly Instructions" which you are now reading. It is primary importance that before any assembly work is started that you initially read all three of these items to gain a preliminary understanding of all information involved.

As you study the manual you will notice that assembly is outlined by the step by step procedure and large pictorials which identify all parts and their exact placement to the circuit board. To understand the assembly procedure take notice of the main pictorial, Fig. 2. This is the pictorial about which the assembly text is centered. Notice that this is a top view of the transmitter chassis and that all components are assigned specific hole numbers. The shaded area represents the etched copper circuit pattern and although on the underside of the board, the same pattern can be recognized on the transmitter board by holding it up to a light source where the pattern will show through. By using the light on the actual transmitter board, specific holes can be identified by association with the pattern or individual copper lands as shown in the pictorial.

Assembly of parts to the circuit board is quite conventional. Resistors and most other parts are mounted flush or upright as directed, however, if any specific positioning is required it will be mentioned in the step in which it is installed. As each part is installed, bend its leads over slightly to hold it in position and then, after soldering, clip off the excess lead about 1/16" from the circuit copper.

PRELIMINARY NOTES

After you have studied the pictorials and initially read all of the instructions, unpack your kit carefully and check each part as identified on the check list. By doing this you will become familiar with parts appearance that will help you during assembly. After the check is made, group parts and resistors in one pile, condensers in another, until parts are generally separated for easy identification.

Occasionally we may have to substitute a part to allow an even production of kits when a specific part is not available. This is done to prevent a delay in filling your order and in no way will the substitution effect normal operation. If this has been done in your kit a note, "Parts Substitution", will be included for your identification.

The use of the "unger soldering pencil" equipped with $37\frac{1}{2}$ watt heat element and small chisel pointed tip is considered mandatory in the construction of this kit. Similar irons may be used but none larger and of higher heat. The work on the etched circuit board is somewhat delicate so let a word to the wise be sufficient. If you do not have the small iron it should be purchased at your local radio or hardware store.

Common tools required are a small pair of dykes (wire snippers), long nose pliers, screwdriver, penknife, file, pad of steel wool. Other items are a hexagon shaped tuning tool and a 0-100 ma meter to be used for tuning purposes. The meter is available from World Engines for \$4.95 and the tool at 50¢.

Start construction by referring to the assembly steps. During each step refer to the pictorials for necessary parts location and solder the lead of each part as it is installed. Place a check mark in the space provided after completion of each step. Good luck and may your experience be a pleasant one.

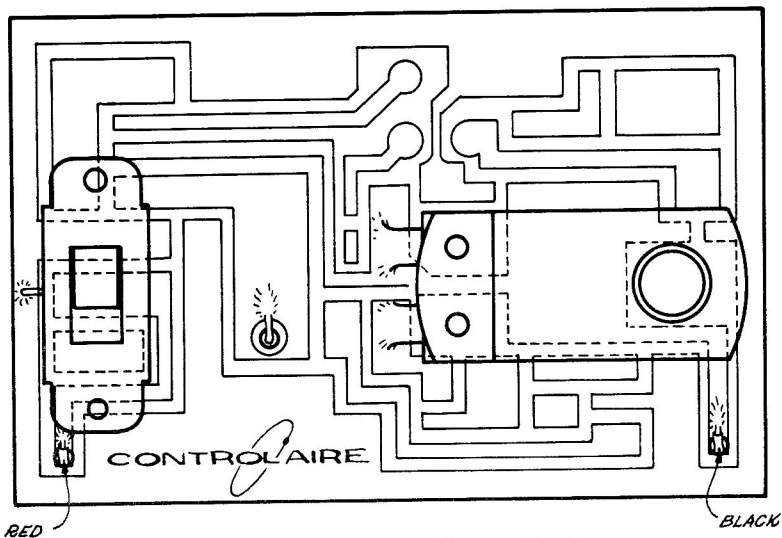
ASSEMBLY INSTRUCTIONS

As parts are installed to the circuit board, bend over the leads only enough to hold the parts in place, then solder, unless otherwise noted in text. Do not flush bend lead to the circuit copper as, if removal is necessary, it cannot be done without damage to the part. After soldering, clip off excess leads about $1/16$ " from circuit copper.

- () 1. Inspect the etched circuit board to see if the silverplated copper pattern is bright and clean. Sometimes in storage the finish will tarnish or become oxidized. If this is apparent on your board clean it by scrubbing with steel wool until it is bright and shiny. A dirty copper pattern will not solder properly so be sure your board is clean before any soldered connection is made.
- () 2. Prepare the push-button switch for mounting by first bending the tabs so they fit properly into circuit board slots 25 and 26. Next, disassemble the switch by removing the two hold-down screws and discard the metal plate that was installed directly under the screw heads. Reassemble the switch to the circuit board by inserting screws through holes 23 and 24. Align the switch so it is parallel with bottom edge of circuit board and tighten screws moderately.
- () 3. Install a 4-40 x $5/16$ " binder head screw, nut and lockwasher to the antenna mount bracket as shown. When tightening do not apply a twisting torque to bracket without support as this can loosen the attaching eyelets.
- () 4. Solder eyelet at hole 52 to both the circuit copper and antenna mount bracket to insure proper electrical contact. Do not allow a pile up of solder on the bracket as this will prevent proper antenna attaching clearance when it is installed later on.
- () 5. Inspect the 10K to 1K interstage transformer and note that one side is marked with either a red dot or the letter "S". This means the leads extending from this side are of the secondary winding. Install the transformer with the secondary

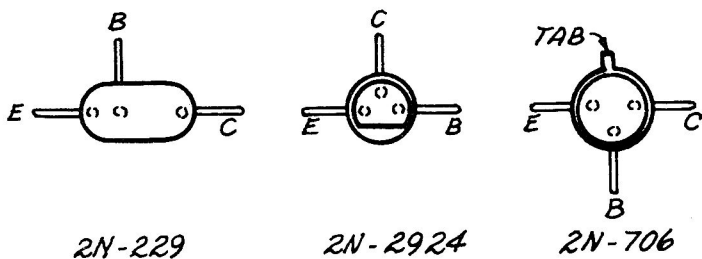
leads going into holes 31 and 32 and other leads in holes 28 and 29. Push transformer all the way down with frame tabs going into holes 27 and 30. Bend tabs inwardly to secure transformer but do not solder to the circuit copper.

- () 6. Inspect the terminals of the R.F. slug tuned coil assembly. Note that one terminal has a red coding mark. Install the coil into holes 18, 19, 20, 21 with red marked terminal inserting into hole 19. Make it a point to align the coil body so it is exactly perpendicular to the surface of the circuit board. The reason for this is that in a later step a shield can is installed over the coil. If the coil is installed crooked you might experience trouble in inserting a tuning coil tool through hole in can and aligning it with slug opening in R.F. coil assembly. This makes tuning difficult so use care. Notice that there is a pre-installed 62 mmfd condenser on terminals 18 and 20 of the coil. Use caution when soldering the leads of the coil that you do not accidentally unsolder the leads of this condenser. Inspect to see that it is secure.
- () 7. Insert the leads of a 4.7K ohm resistor (yellow, violet, red) into holes 6 and 7. Note that the body of this resistor lays flat against surface of circuit board.
- () 8. Insert the leads of a 27K ohm resistor (red, violet, orange) into holes 8 and 9.
- () 9. Insert the leads of a 100 ohm resistor (brown, black, brown) into holes 13 and 14.
- () 10. Insert the leads of a 15K ohm resistor (brown, green, orange) into holes 36 and 37.
- () 11. Insert the leads of a 47K ohm resistor (yellow, violet, orange) into holes 45 and 46.
- () 12. Insert the leads of a 10K ohm resistor (brown, black, orange) into holes 40 and 41.
- () 13. Insert the leads of a 1.5K ohm resistor (brown, green, red) into holes 50 and 51.
- () 13 a. Insert the leads of a 100 ohm resistor (brown, black, brown) into holes 71 and 72.
- () 14. Insert the leads of a 100 mmfd condenser into holes 60 and 61.
- () 15. Three identical .02 mf disc condensers are installed in this step. Install the leads of one in holes 4 and 5. Install another in holes 15 and 16 and the last in holes 38 and 39.
- () 16. Insert the leads of a .05mf disc condenser into holes 34 and 35.
- () 17. Notice the eyelets installed at hole positions 62 through 67. To insure a positive electrical contact to the circuit copper solder each eyelet to the copper at its outside perimeter. Do not allow solder to flow within eyelet hole. To do so will prevent later installation of the slide switch.



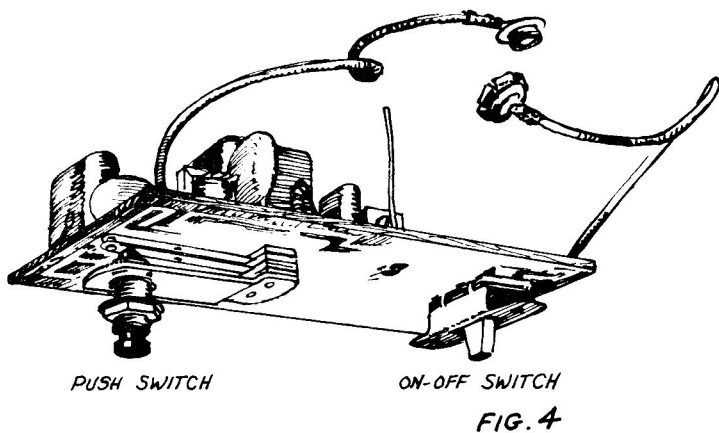
BOTTOM VIEW -
FIG. 1

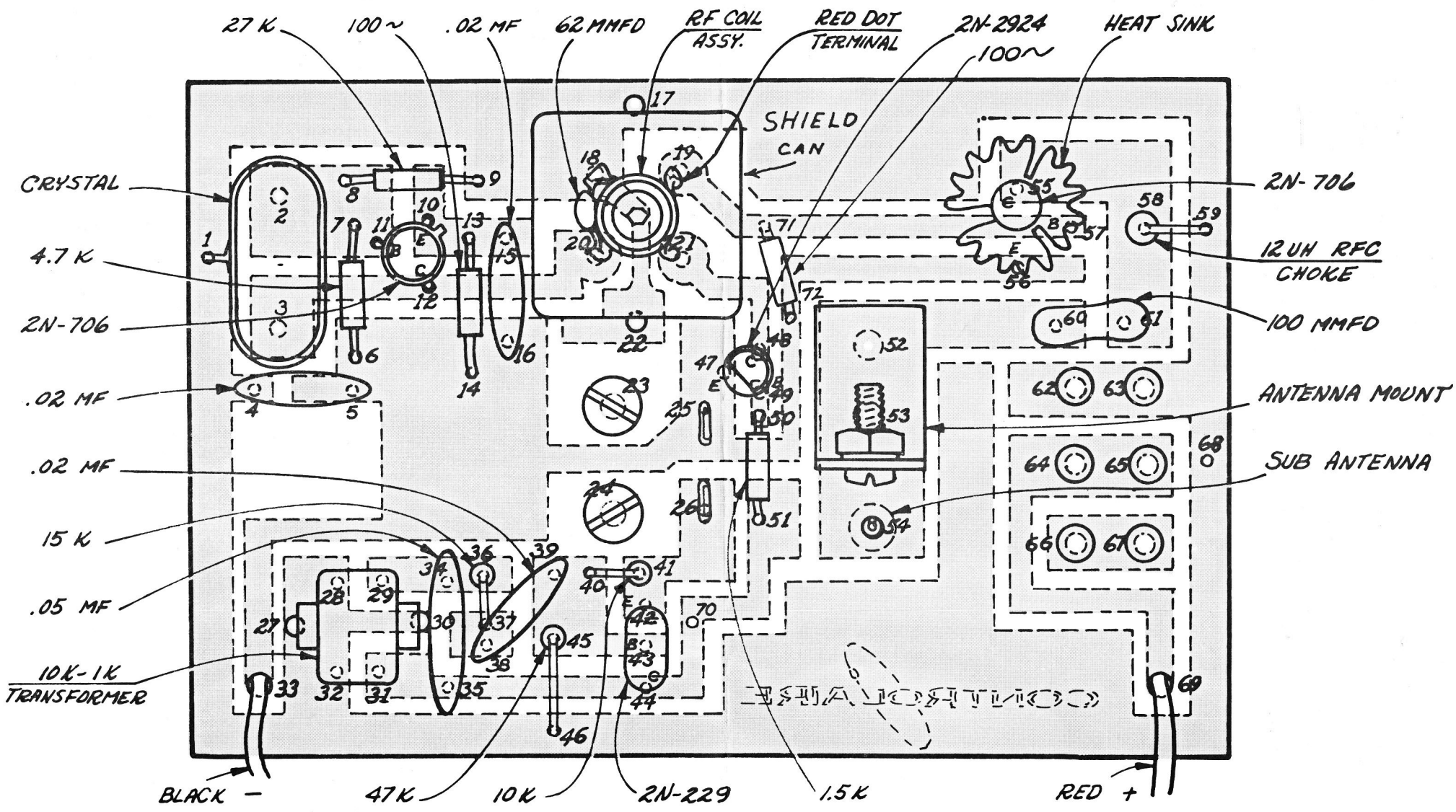
MARK II MULE



TRANSISTORS ~ VIEWED FROM TOP WITH LEADS
EXTENDING DOWN

FIG. 3





TOP VIEW ~
FIG. 2

MARK II "MULE"

PARTS CHECK and PRICE LIST
Mark II Mule

<u>CAPACITORS</u>	<u>PRICE EACH</u>	<u>MISC. PARTS</u>	<u>PRICE EACH</u>
() 1 ea. 62 mmfd Disc. attached	.25	() 1 ea. Etched Circuit Board ---	1.75
to RF Coil -----	.25	() 1 ea. Center Loaded Antenna--	6.95
() 1 ea 100 mmfd -----	.25	() 1 ea. 1/2" Rubber Grommet --	.04
() 3 ea. .02 MF Disc. -----	.30	() 1 ea. 1/4" Rubber Grommet ---	.04
() 1 ea. .05 MF Disc. -----	.35	() 1 ea. 6" length Black Wire ----	.01
		() 1 ea. 5" length Red Wire -----	.01
		() 1 ea. Operating Instructions ---	.15
		() 1 ea. Kit Assembly Tips -----	.10
		() 1 ea. Assembly Instructions ---	.25
		() 1 ea. Frequency emblem -----	.10
		() 1 ea. Transmitter Crystal ----	3.95
		() 1 ea. 3" length #16 solid -----	.02
		bare wire -----	.02
<u>COIL, TRANSFORMERS, CHOKE</u>			
() 1 ea. R. F. Coil Assembly - - -	1.90		
() 1 ea. R. F. Choke -----	.35		
() 1 ea. 10K to 1K Transformer --	1.20		
<u>RESISTORS</u>			
() 2 ea 100 ohm (brown, black, brown) -----	.12		
() 1 ea. 1.5 K ohm (brown, green, red) -----	.12		
() 1 ea. 4.7 K ohm (yellow, violet, red) -----	.12		
() 1 ea. 10. ohm (brown, black, orange) -----	.12		
() 1 ea. 15K ohm (brown, green, orange) -----	.12		
() 1 ea. 27K ohm (red, violet, orange) -----	.12		
() 1 ea. 47K ohm (yellow, violet, orange) -----	.12		
<u>TRANSISTORS</u>			
() 2 ea. 2N-706 Transistors -----	2.75		
() 1 ea. 2N-229 Transistor -----	.90		
() 1 ea. 2N-2924 Transistor -----	1.65		
<u>HARDWARE</u>			
() 1 ea Transmitter Case Front and Back -----	4.95		
() D. P. D. T. Slide Switch -----	.50		
() 1 ea Push Switch -----	.75		
() 6 ea No 6 X 1/4" S.M. Screws ---	.02		
() 3 ea 4/40 X 5/16" binder head screws -----	.01		
() 1 ea. 4/40 Nut and Lockwasher --	.02		
() 2 ea. Battery Snaps, Male and Female -----	.12		
() 1 ea. 3/8" Nut and Washer -----	.04		
() 1 ea. Transistor Heat Sink -----	.65		
() 1 ea. Shield Can -----	.30		
() 1 ea. 2' Length 60/40 Solder ----	.15		

- () 18. Install the slide switch with its terminals going into eyelet holes 62 through 67. Push the terminals through the eyelets until they protrude exactly $1/32''$ above eyelets on top side of circuit board. Be sure that the switch is installed straight and parallel with respect to surface of circuit board. If it is crooked it will prevent proper installation of chassis into housing case. Soldering to the eyelets and switch terminals is done from the top of the board. Allow solder to flow into the eyelets thus securing the terminals.
- () 19. Solder a bare wire, clipped off resistor or condenser lead, between hole 68 of circuit board and metal body of slide switch.
- () 20. Insert the leads of the R.F.C. choke into holes 58 and 59. This is a resistor like component with a wire coil wrapped on its body.
- () 21. Insert the terminal pins of the transmitter crystal into holes 2 and 3. Do not push all the way in but rather allow pins to protrude only about $1/16''$ through copper. Solder quickly and avoid excessive heating.
- () 22. Solder a bare wire between hole 1 in circuit board and the metal case of the crystal. Again do not overheat crystal.
- () 23. Cut a piece of number 16 solid bare tinned wire to a length of $2\frac{1}{4}''$. Insert one end of this wire into hole 54 from top of circuit board allowing it to protrude about $1/16''$ through copper then solder it securely. Align the wire so it is straight and installed perpendicular to the surface of the circuit board. This is the sub-antenna and it will be trimmed to an exact length later on when chassis is installed into housing case.

In the following steps the transistors are installed. They are not necessarily delicate but do not apply excess heat when soldering the leads. When installing, position the bottom of all transistors about $3/16''$ above surface of the circuit board. The extra lead length gives some heat protection to the transistor while soldering. For lead identification and exact transistor location refer to Figs. 2 and 3.

- () 24. Install a 2N-706 transistor with emitter lead going into hole 10, base in hole 11 and collector in hole 12.
- () 25. Install the heat sink, which is a press fit, over the top of the remaining 2N-706 transistor. If the fit is too tight and trouble is encountered, use a screw driver to wedge the heat sink open by inserting it at its split side. Install the transistor with emitter lead going into hole 56, base to hole 57 and collector to hole 55.
- () 26. Install a 2N-229 transistor with emitter lead going into hole 42, base in hole 43 and collector in hole 44.
- () 27. Install a 2N-2924 transistor with emitter lead going into hole 47, collector into hole 48 and base into hole 49.
- () 28. Install the R.F. shield can over the top of the R.F. coil

assembly by inserting mounting tabs in holes 17 and 22. After installation solder tabs to circuit copper to hold can in place.

- () 29. Cut a piece of red insulated wire to a length of $3\frac{1}{2}$ " and from each end of the wire remove $\frac{1}{4}$ " insulation. From the copper side of the etched circuit board and at the copper land containing hole 69, slightly above the hole, solder one end of the red wire. After wire has been soldered thread the red wire through hole 69. To the other end of this wire solder and crimp the female battery snap.
- () 30. In same manner as described in Step 29, cut a piece of black insulated wire to a length of $5\frac{1}{2}$ ". Remove $\frac{1}{4}$ " insulation from each end of the wire. Solder one end to the copper land containing hole 33 then thread balance of wire through hole 33. Solder and crimp male battery snap on other end of the wire.

At this point, assembly of the transmitter chassis is complete. It is now to be installed in its housing case. Before doing so, inspect all solder joints and recheck your assembly steps to insure assembly is correct.

- () 31. To install chassis into housing case, place it into position then secure slide switch with two 4-40 x $5/16$ " binder head screws. Secure the push switch with a $3/8$ " nut and washer.
- () 32. Fit rubber grommet to the hole in top of the transmitter case. The antenna is then passed through grommet and threaded down on the antenna bracket screw.
- () 33. Install small rubber grommet in the hole provided in the rear case cover. Fit the cover to the front case by threading the sub-antenna wire through the grommet. Be sure rear cover is seated firmly against front case then clip off excess sub-antenna wire that would extend beyond the surface of the rubber grommet. In conclusion the sub-antenna wire should extend flush to the outside surface of rubber grommet. To be longer or shorter will proportionally effect sub-antenna signal radiation.

GENERAL INFORMATION

This completes assembly of your transmitter. At this time it must be tuned. In accordance with docket 12902 of the Federal Communications Commission, the tuning adjustment of this transmitter must be made either under the direct supervision of, or by, a person holding a valid commercial radio operators license. You, personally, are not allowed to make this adjustment unless you hold a valid license as stated above. This may create some minor problem but usually in a radio control area such a person can be located. It is a matter of contacting your R/C acquaintances for such information. If you cannot locate a valid licensee you may return your completed unit to the factory for this service. Fee for tuning transmitter is \$2.00 plus return postage. This does not include repair service if required. Before any attempt is made to tune or operate this transmitter the standard operating instructions should be read.

- () 34. After the transmitter has been tuned, and battery installed,

secure rear case cover with 6 ea. No. 6 x $\frac{1}{4}$ " sheet metal screws.

You may notice that one circuit board hole, hole 70, was not used in the assembly of the transmitter. This is a substitute hole that in some kits may be used when a substitute transistor is used. When it is to be used a notice to this effect will be included with the kit.

WARRANTY

Controlaire Divison, World Engines, Inc. warrants that parts supplied in this kit be free of defect for a period of 60 days from date of purchase. We do not warrant that you can assembly it troublefree as we have no control over the quality of your workmanship. Parts warranty does not imply that Controlaire will assume troubleshooting costs to find a defective part or assembly mistakes in a completed unit. If you have a defective part, return it with full particulars, and if in our opinion it was not ruined by improper assembly, it will be replaced. No other warranty is expressed or implied.

SERVICE

If service is required you may return your transmitter for factory service. Return all units to CONTROLAIRE and not to your dealer. To save you additional troubleshooting costs, enclose a letter giving full particulars of why the unit is unsatisfactory. (Symptoms of mal-function). Enclose these particulars along with minimum service fee of \$3.00 in same package with reparable unit and mail to CONTROLAIRE DIVISION, WORLD ENGINES, INC. 8206 BLUE ASH ROAD, CINCINNATI, OHIO 45236. Do not return unit to your dealer as in most cases valuable particulars are lost along with the time of additional handling and misunderstandings result. All labor and parts are quoted net to the customer and no dealers discount is offered on service work.