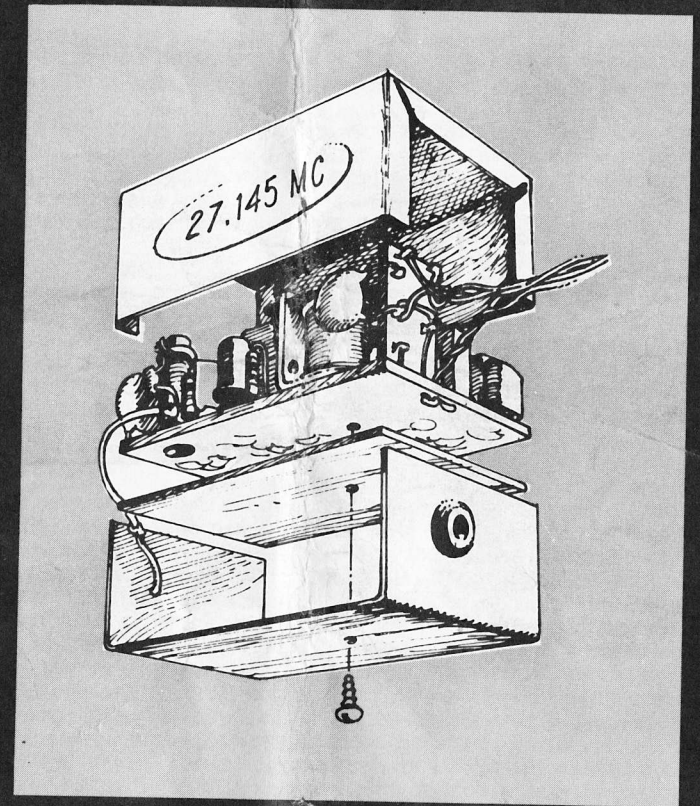


CONTROLAIRE

SH-100

Single Channel Superhet Receiver



**ASSEMBLY
INSTRUCTIONS**

Made In U.S.A.

ASSEMBLY INSTRUCTIONS

SH-100 SINGLE CHANNEL SUPERHET

INTRODUCTION

The SH-100 is the newest in single channel superhet receivers to be offered in kit form. It is the successor to our famous SH-1 and offers a new subminiature case design for easy installation into any aircraft. Unlike the SH-1 the SH-100 is not convertible to 10 channel at a later date. The design was specifically for single channel work and certain features such as extreme signal clipping which has a definite advantage for single channel is not the best for multi channel reed application. Past experience in trying to produce an all purpose superhet design ruled out the convertible feature. It is a special purpose design for single channel type application. It is to be used in conjunction with either a simple escapement, advanced pulse or Mickey Mouse type control system. At this point we offer a tried and proven single channel design in kit form.

Parts used in the kit and the factory assembled units are the same. The completed receivers should be the same and if any differences were involved it would be quality of assembly work; so, do not rush the assembly project. Take your time to understand each operation before doing it. Do so and yours will be a rewarding experience of reliability and satisfaction.

The instructions are presented in two separate manuals and a small pamphlet titled "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 of primary importance that before any assembly work is started that you initially read all of these items to gain a preliminary understanding of all information involved.

As you study the assembly manual you will notice the exacting care with which it was prepared. Work procedure is presented by the step-by-step method and to illustrate the exact placement of every part, a large page of receiver pictorials have been included in the center of this booklet. It is intended that you remove this page and place it at a convenient spot on your workbench thus eliminating the confusion of turning pages to clarify a point when accomplishing a step. Study all of the pictorials but especially take notice of Fig. 2. This is the main pictorial about which the assembly text is centered. Notice that this is a top view of the main receiver chassis and that all components are assigned specific hole numbers to insure their exact placement on the circuit board. The shaded area represents the etched copper circuit pattern and although on the underside of the board, the same pattern can be recognized from the small receiver board by holding it up to a light source where the pattern will show through. By using the light on the actual receiver 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 to the circuit board in an upright position with their bodies standing over the holes as shown. Some parts have special positioning but in all cases this is brought to your attention during the steps it is installed. As each part is installed,

bend its leads over slightly, except IF transformers, to hold it in position for soldering. After soldering has been completed, clip off the excess lead about 1/16" from the circuit copper.

Tuning procedure is the essence of simplicity. No special instruments are needed except your companion transmitter to furnish a signal and a simple 0-50 milliammeter to measure total current flow in the receiver. Each of the four adjustments, one antenna coil and three IF transformers, are peaked in the same manner to obtain highest current reading on milliammeter while using a very weak signal from your transmitter. Complete instructions follow in the text.

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 has been made, group the parts - 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 37½ 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 small close 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, small screwdriver, penknife, file and pad of steel wool. To monitor the tuning operation obtain a 0-50 milliammeter but be sure it is a moving coil type. This is available from World Engines at \$4.95 each. Do not use cheap vane type meters of high internal resistance as improper readings will result. Solder is supplied in the kit.

Start construction by referring to the assembly steps. During each step refer to the pictorials for necessary parts location and solder the leads 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

To insure that your completed receiver chassis will fit properly into the housing case, make it a point to flush mount all components unless otherwise directed. Items such as resistors, condensers and IF cans should be pushed all the way down against the circuit board so a flush fit can be obtained. Component leads can be bent slightly on the copper side to hold the part in place for soldering but do not completely bend lead over to circuit copper for soldering. If this is done and you have made an assembly mistake you cannot remove the part without damaging it. In each step, solder in the part as it is installed and then clip off each lead so no connection extends beyond 1/16" from the surface of the circuit copper.

- () 1. Try the circuit board for a proper fit into the bottom half of housing case. If it is too tight, use a file and clean up the edges so a fit can be obtained.
- () 2. Assembly is started by first cleaning the circuit board copper so soldering may be done easily and with the least amount of heat. To do this involves a certain procedure as the board is supplied to you with the tuning coil pre-installed. The best way is to lay the board flat against your work bench with the coil overhanging the edge. Hold board firm then scrub vigorously with steel wool until copper is bright and shiny. Do the scrubbing away from your general work area as the steel wool residue can be attracted to other parts and cause untold troubles. After cleaning, blow away wool residue that may have entered coil form or remained on board.
- () 3. Sometimes in the factory operation of cementing the coil to the board epoxy cement clogs some of the circuit board holes near the coil. Inspect your board and if any are clogged use a straight pin to clear.
- () 4. Notice the twisted and presoldered tapped coil lead extending from the near bottom of the antenna coil. Cut this lead to a length of 1/2" and carefully insert it into circuit board hole 46. Do not break the lead at the coil and be sure it does not short out to any other portion of the coil.
- () 5. Insert a piece of bare wire from the bottom or copper side of board through hole 49 and bend it so it touches the coil lug that is located No. 2 from bottom of coil. Solder the wire both at the No. 2 lug and at the circuit copper.
- () 6. Inspect the interstage transformer and note that one side is marked with either the letter "S" or a red dot. This means that the leads extending from this side of the transformer are of the secondary winding. Install the transformer with secondary leads going into holes 92 and 93 and other leads going into holes 89 and 90. Note that hole 93 is not located directly below transformer and this lead must be bent and performed to route it directly to its hole. Push transformer flush into circuit board with frame tabs going into holes 88 and 91. Bend tabs inward to secure transformer then solder to circuit copper.
- () 7. Notice that there are a total of three IF cans or transformers. One lead on each of the transformers is to be clipped off as shown in Fig. 4. Refer to Fig. 4 and carefully orientate each transformer with its leads extending down then locate and clip off the unused lead. Since no connection is made to this lead we have used the circuit board space where it would attach for a copper land extending to another connection on the transformer. As you install the transformers you will note a hole in the circuit board for the clipped off lead. This is a clearance hole only and is to allow the clipped off lead, if not cut exactly flush, to extend into the board to allow flush mounting of the transformer. It is not intended that the lead connect to the copper land.
- () 8. Install the mixer IF transformer, yellow coded slug, so the

clipped off lead is positioned at hole 20. Balance of leads insert into holes 21, 22, 18 and 24 with mounting tabs going into holes 19 and 23. Solder both mounting tabs to their respective hole lands.

- () 9. Install the first IF transformer, white coded slug, so the clipped off lead is positioned at hole 12. Balance of leads insert into holes 13, 14, 15 and 16 with mounting tabs going into holes 11 and 17. Solder both mounting tabs to their respective hole lands. Solder well as it is the function of the tabs to make a circuit connection between land at hole 11 to land at hole 17.
- () 10. Install the second IF transformer, black or blue coded slug, so clipped off lead is positioned at hole 71. Balance of leads insert into holes 72, 73, 75 and 76 with mounting tabs going into holes 74 and 77. Solder both mounting tabs to their respective hole lands.
- () 11. Insert the leads of the 4 mmfd, small disc condenser, in holes 47 and 48.
- () 12. Insert the leads of the 10 mmfd disc condenser in holes 56 and 57. This condenser may be alternately marked 10.5 mmfd.
- () 13. Insert the leads of the .01 mf disc condenser in holes 44 and 45.
- () 14. Insert the leads of the 100 mmfd disc condenser in holes 52 and 53. This condenser may be alternately marked with a red colored dab of paint.
- () 15. Four identical .47 mf disc condensers are installed in this step, one in holes 9 and 10, another in holes 63 and 64, another in holes 28 and 29 and the last one in holes 85 and 86. Note when installing the last condenser that the condenser lead at hole 86 and the transformer lead at hole 93 are very close together. Inspect after installation that the leads do not touch one another. If so, bend the transformer lead to clear.
- () 16. Insert the leads of the .05 mf disc condenser into holes 83 and 84.
- () 17. In this step the large black 70 mf electrolytic condenser is installed. Look at the condenser body and note that near one lead there is a plus sign and near the other a negative mark. This identifies the polarity of the leads. Install the condenser with the plus (+) lead going into hole 82 and negative (-) lead in hole 81.
- () 18. Two identical 10K ohm resistors (brown, black, orange) are installed in this step. Install one with leads going into holes 50 and 51, install the other in holes 104 and 105.
- () 19. Three identical 1000 ohm resistors (brown, black, red) are installed in this step. Install one with leads going into holes 62 and 62A, install another in holes 42 and 43 and the last in holes 65 and 66.
- () 20. Insert the leads of a 10K ohm resistor (brown, black, orange)

into holes 7 and 8. Note that this resistor is installed with its body laying flat against circuit board.

- () 21. Three identical 47K ohm resistors (yellow, violet, orange) are installed in this step. Install one with leads going into holes 36 and 37, another in holes 26 and 27 and the last in holes 102 and 103.
- () 22. Insert the leads of a 100K ohm resistor (brown, black, yellow) into holes 32 and 33.
- () 23. Insert the leads of a 330 ohm resistor (orange, orange, brown) into holes 30 and 31.
- () 24. Insert the leads of a 470 ohm resistor (yellow, violet, brown) into holes 1 and 2.
- () 25. Insert the leads of the R.F.C. choke into holes 34 and 35. This is a resistor like component with wire coil wrapped on its body.
- () 26. Install the leads of the local oscillator crystal in holes 54 and 55. Push crystal down carefully so it is mounted flush to surface of circuit board. When soldering the leads do not prolong the soldering operation as excess heat can damage the crystal.
- () 27. In this step the receiver power input wires are installed. Cut two pieces of No. 26 stranded insulated wire, one red and one black, to a length of 9". From these wires strip 1/8" insulation from one end and 1/2" from the other. Refer to Fig. 2 and notice the copper land at hole position 100. This is the negative input land. To this land near hole position 100 and from copper side of board, solder, the small stripped end of the black wire. The small stripped end of the red wire solders to the positive ground land near the transformer mount hole 91. After both wires have been soldered, thread them through hole 99 and twist for the balance of their length.
- () 28. For the antenna, cut a piece of No. 26 stranded insulated wire to a length of 30". Strip 1/8" insulation from one end and solder to the bottom terminal of the antenna coil. Note antenna installation as shown in Fig. 2.

TRANSISTOR INSTALLATION

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 1/8" above the surface of the circuit board. The extra lead length gives some heat protection to the transistor while soldering. Refer to Figs. 2 and 3 for lead identification and exact transistor location. Notice that the 155T1 transistor has four leads instead of the customary three. The fourth lead is connected to the transistor case and serves as a ground shield to prevent RF radiation.

- () 29. To prepare for an easier installation, clip all leads of all transistors to an initial length of 1". Straighten any lead that is bent.
- () 30. Install a 155T1 transistor (local oscillator) with shield lead

going into hole 60, emitter in hole 61, base in hole 58 and collector in hole 59.

- () 31. Install a 155T1 transistor (mixer IF) with shield lead going into hole 38, emitter in hole 41, base in hole 40 and collector in hole 39.
- () 32. Install a 155T1 transistor (1st IF) with shield lead going into hole 5, emitter in hole 4, base in hole 3 and collector in hole 6. Due to the irregular hole location for this transistor the shield lead bends over to the edge of the board for hole 5. To install, start all of the leads in the correct holes then gently push transistor down. The shield lead will then automatically bend itself for proper alignment. When installed, be sure there is no shorting between leads.
- () 33. Install a 155T1 transistor (2nd IF) with shield lead going into hole 68, emitter in hole 67, base in hole 70 and collector in hole 69.
- () 34. Install a 2N-229 transistor (detector, 1st audio) with emitter in hole 78, base in hole 79 and collector in hole 80.
- () 35. Install a T-2515 or 2N-508 transistor (relay driver) with emitter in hole 95, base in hole 96 and collector in hole 94.

In the following steps the relay is wired and prepared for installation to the circuit board. Refer to Fig. 5 for pictorial information.

- () 36. Install the two .01 mf disc (arc suppressor) condensers as shown. Notice the condenser on the right side of relay has a small piece of insulation on its bottom lead. This is obtained by stripping a 3/8" length of insulation from any of the other wires supplied and installing it on the condenser lead. At this time do not solder the relay terminal to which the bottom leads of the condensers are attached. It is to be soldered when the third connection to the terminal is made.
- () 37. Strip 1/8" insulation from one end of the white, blue, green wires. Pre-tin each wire then attach and solder to the proper terminals as shown. Each wire should be at least 9" in length. Inspect after soldering to insure no shorts exist between terminals.
- () 38. Attach relay to circuit board with attaching screw going through hole 98. Screw is supplied initially installed in bottom of relay.
- () 39. Noting again Fig. 5, connect a solid bare wire (excess resistor lead), between hole 100 of circuit board and right lower terminal of relay.
- () 40. Connect a solid bare wire between hole 101 of circuit board and lower left relay terminal.
- () 41. Screw tuning slug into tuning coil until it is about flush with top of coil form. If slug appears very tight rotate it back and forth to gradually loosen its threads.

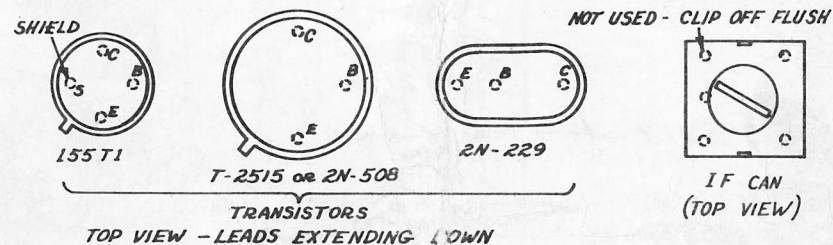
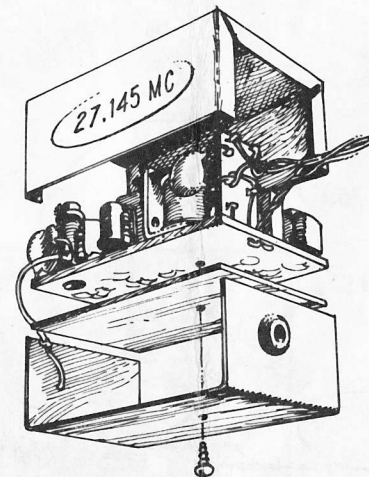
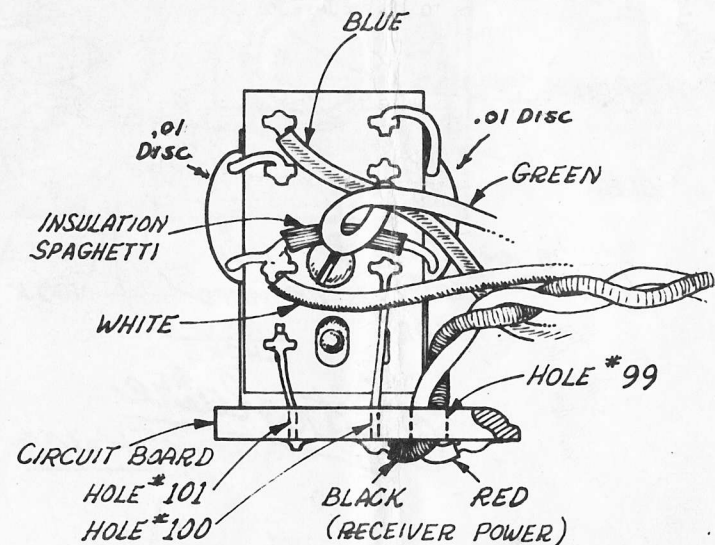


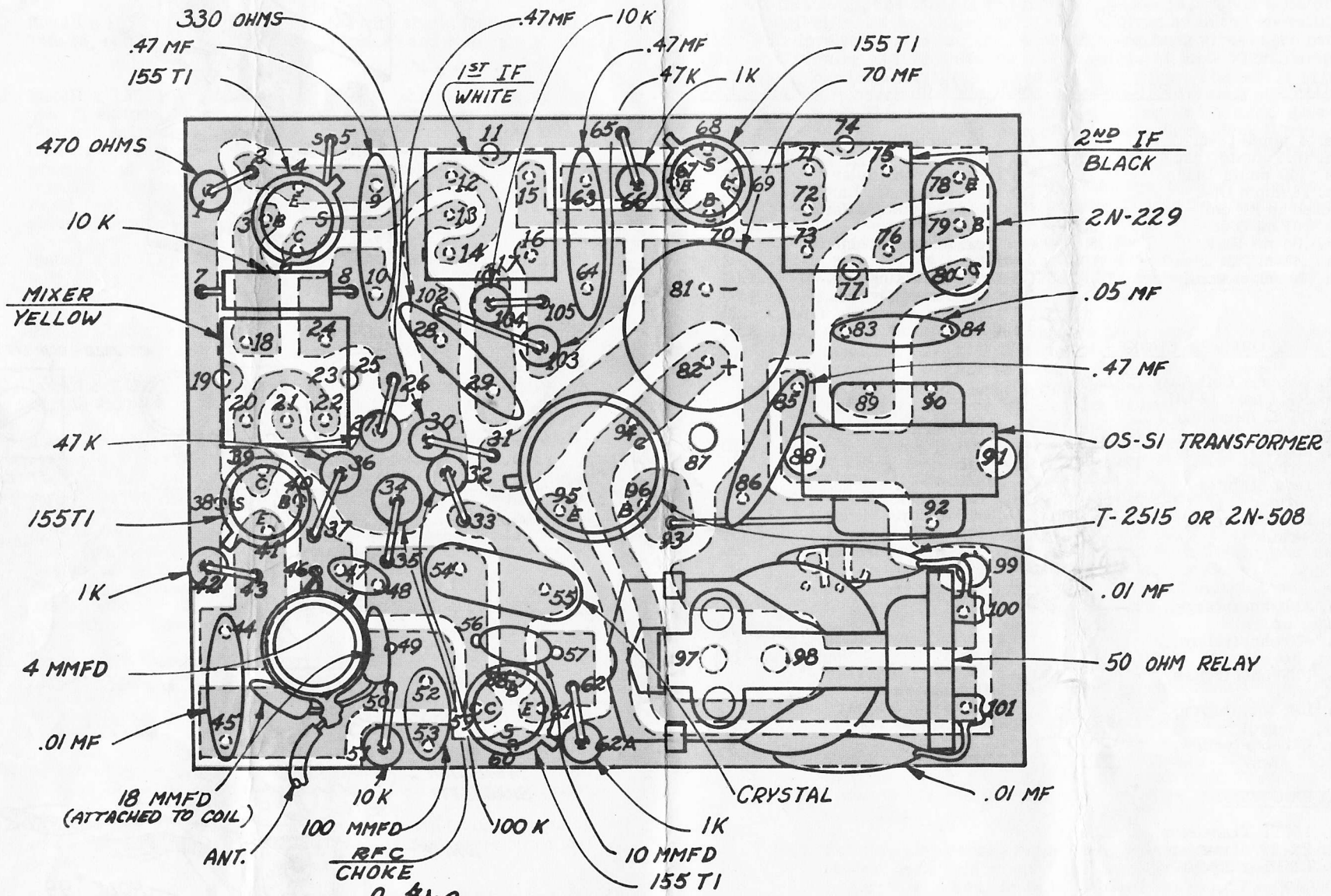
Figure 3

Figure 4



RELAY FIG-5

2



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FIG-2

PARTS CHECK AND PRICE LIST

SH-100

<u>CAPACITORS</u>	<u>PRICE EA.</u>	<u>MISC. PARTS</u>	<u>PRICE EA.</u>
() 1 ea. 4 mmfd Disc.	.25	() 1 ea. Etched Circuit Board	2.50
() 1 ea. 10.5 mmfd Disc	.25	() 1 ea. 50 ohm Relay	2.95
() 1 ea. 100 mmfd Disc.	.25	() 1 ea. Frequency Emblem	.10
() 2 ea. 18 mmfd Disc attached to RF coil	.25	() 1 ea. Chassis Insulator Board	.35
() 3 ea. .01 mf Disc	.30	() 1 ea. Rubber Grommet 1/8 x 1/4	.03
() 1 ea. .05 mf Disc	.35	() 1 ea. Operating Inst.	1.00
() 4 ea. .47 mf, 3v Disc	.45	() 1 ea. Assembly Inst.	1.50
() 1 ea. 70 mf electrolytic	1.00	() 1 ea. Kit Assembly Tips	.20
		() 1 ea. Crystal	4.95

COIL, TRANSFORMERS, CHOKES

() 1 ea. Antenna Coil Assy.	1.90
() 1 ea. RF Choke 12 UH	.35
() 1 ea. OS-S1 Interstage Transformer	1.20
() 1 ea. Mixer IF (yellow) Transformer	1.50
() 1 ea. 1st IF (white) Transformer	1.50
() 1 ea. 2nd IF (black) Transformer	1.50

RESISTORS

() 1 ea. 330 ohm (orange, orange, brown)	.12
() 1 ea. 470 ohm (yellow, violet, brown)	.12
() 3 ea. 1000 ohm (brown, black, red)	.12
() 3 ea. 10K ohm (brown, black, orange)	.12
() 1 ea. 470 ohm (yellow, violet, brown)	.12

SEMI CONDUCTORS

() 4 ea. 155T1 Transistor	1.50
() 1 ea. 2N-229 Transistor	.90
() 1 ea. T2515 or 2N-508 Transistor	1.50

HARDWARE

() 1 ea. Receiver Case Top and Bottom	2.10
() 1 ea. Controilaire Emblem	.35
() 1 ea. No. 2 x 1/4 Panhead Sheet Metal Screw	.01
() 1 ea. 3' Length Solder	.20

WIRING

All No. 26-19/36	
() 1 ea. 30" any color for antenna	.15
() 5 ea. 10" lengths of following colors: Red, Black, Yellow, Blue, Green	.04

RECEIVER OPERATING TEST

At this point, assembly of the receiver chassis is complete. Before it is installed in its housing case it must be given an initial operating test. This involves connecting the receiver power input wires to the batteries and viewing test results by the readings of an 0-50 milliampmeter which monitors the current used by the receiver. The test is primarily intended to check operation of the superhet receiver and not one of final adjustment. This is done later when unit is installed in case. As a signal device to tune and operate the receiver a Controilaire Mark II transmitter is used. Be sure its RF output frequency matches the frequency printed on top of the receiver crystal. If it does not, no complete test can be performed. To acquaint you with receiver operation and the tuning procedures involved if you have not already read the standard Operating Instructions we strongly advise that you do so now! It will prepare you for a better overall understanding of the information to follow. The manual makes reference to a factory assembled receiver, yours is home built and not pre-tuned. The following steps describe an orderly procedure in which to accomplish this test.

- () 42. Inspect the receiver chassis to insure all components are installed properly. If any doubt exists, refer to Fig. 2 and with receiver in hand check each component for assembly into the proper circuit holes. If a magnifying glass is available use it to inspect the soldered side of circuit board. Inspect that all joints are secure and that no shorts exist between the copper lands. Two points in particular that require inspection are the circuit lands at hole 12 and 20. These are the clearance holes for the clipped off leads of the mixer and first IF transformers. Sometimes when these holes are drilled the circuit land is broken because of the close tolerance of the lands at these points. The main idea is to inspect for such land breakage and only if apparent lightly reconnect with a solder bridge over the hole. Be careful not to accidentally flow solder down the hole and in turn make contact to IF terminal. It is not meant to be connected to the land. When applying a solder bridge do so quickly with a minimum amount of heat.
- () 43. Procure a tuning tool and fabricate it to fit the slots in the slugs of both the antenna coil and IF cans. It should be at least 10" long and made from plastic, hard rubber or wood dowelrod. Do not use metal screwdrivers or metal tipped tools.
- () 44. Clean off your workbench of wire clippings and solder splashes then lay down a clean sheet of paper over which you will lay receiver for testing. Antenna should be stretched out and in a clear area.
- () 45. Refer to the operating instructions and from the wiring diagram presented therein, connect the receiver power input wires to the tuning meter and, in turn, to the batteries. Two pencil leads are best recommended for receiver power.
- () 46. Turn the receiver on and observe the following readings on the milliampmeter. With no signal from the transmitter the idle current flow should be from 2 to 3 ma. Also, the meter needle should have a rather steady reading. If your receiver tests within these current limits all is well, however, if the idle

current rises to 25 ma or more or even pegs the meter needle, immediately turn the receiver off and refer to the troubleshooting section of these instructions. If your idle readings are normal you are now ready to tune and adjust the receiver's antenna coil and three IF cans. This is done with transmitter turned on.

- () 47. Receipt of a tone signal by the receiver will be noted by an increase in meter reading up to a saturation level of about 48 ma. The initial response of an untuned receiver will be dependent on transmitted signal strength and to get an initial reading you may have to install transmitter antenna to obtain a signal strong enough. The point is, after an initial response try operating receiver on a weaker signal. This time operate receiver with antenna-less transmitter bringing sub-antenna in close enough to the receiver antenna to get a small reading. Start the tuning adjustment at the mixer IF can, (yellow slug), and slowly adjust slug for highest reading on meter. As the slug is peaked and the current rises to the saturation level, about 48 ma, back transmitter away to drop the current so an exact peak can be obtained. Do not try to peak any adjustment with current at saturation level, the input signal must be reduced so a peak can be realized. After the mixer has been peaked, go to the first IF (white slug), and repeat the above. In turn, back and weaken transmitted signal each time adjustment brings current level to saturation. In same manner peak the second IF (black or blue slug) and last peak slug of antenna coil. While tuning you will note that adjustment to the mixer and first IF is somewhat critical but tends to broaden out at the second IF and antenna coil. This is normal.
- () 48. If you have tuned your receiver with a companion Controilaire Mark II transmitter you should get at least a 40 ma reading at a minimum distance of 15" from receiver antenna. This indicates receiver is of proper sensitivity and will give more than adequate range in the air. If your transmitter was of a different make the principles of tuning the receiver remain the same except that the sensitivity distances may vary from less than 15" up to 20' as signal output will vary when such transmitters are used antenna-less. One last bit of tuning information. Be sure your transmitter is in top operating order, batteries are good and tuning peaked for best RF output. If it has weak output the sensitivity distance expressed may vary slightly. If in doubt, check and repeak your transmitters output with a field strength meter as per manufacturers instructions. This completes the Receiver Operating Test.
- () 49. As pointed out earlier, all tuning is accomplished with reference to change in current flow through the receiver. This change in flow normally should operate the receiver's sensitive relay but only if it is properly adjusted. As supplied in your kit the relay has had an initial adjustment but may require further adjustment assuming contact operation is not normal. For information on relay operation or adjustment refer to the Operating Instructions.

FINAL ASSEMBLY

After initial operation has been checked the receiver chassis may be installed into its housing case. Refer to Fig. 6 for pictorial information.

- () 50. Tie a simple one loop knot in the antenna at a point about 1" from where antenna attaches to antenna coil.
- () 51. Install small rubber grommet in hole provided in lower housing case.
- () 52. Mount chassis to lower housing case by initially threading five wire cable into grommet. Then, as wires are pulled through, slide chassis into case.
- () 53. Slide insulator board under receiver chassis then secure chassis to case with a No. 2 x 1/4" sheet metal screw. Do not over tighten screw.
- () 54. Thread antenna into hole provided. The simple one loop knot serves as a strain relief.
- () 55. Inspect wiring at relay to insure no shorts or wire breakage was created by installing receiver into case. If O.K., install top lid.
- () 56. Peel protective backing from both the Controilaire emblem and frequency label and attach to top of receiver case. This completes assembly of the receiver.

FINAL TUNING

Final receiver tuning is to be accomplished after the unit has been installed in its housing case. The adjustments made earlier under "Initial Operating Test" are close but the addition of the receiver case and its loading effect necessitate a recheck to insure unit is peak tuned. To do this, temporarily remove top lid and repeak the IF's using same procedure as described earlier. Before peaking the antenna coil, re-install top lid. The presence of the lid on or off does not effect the tuning of the IF's but does effect the antenna coil slightly.

Once your receiver has been properly tuned to your transmitter it should remain so indefinitely barring no physical accident such as crash damage, etc. Because the design of the receiver is stable, do not become a "TUNING ADDICT". To become such will only wear out slug friction pressure and they will become loose in the coils.

TROUBLESHOOTING PROCEDURE

Whenever trouble is encountered on a newly assembled receiver, the first order of action is a complete recheck of your assembly steps to see if a mistake has been made. Sometimes to prevent overlooking the same mistake a friend can do the recheck to help you out. Inspect for solder shorts between copper lands, mislocation of a resistor, improper solder joints, electrolytic condensers installed with wrong polarity, transistors misplaced or leads reversed. The point is to inspect the receiver to insure assembly is correct. If, after the recheck, the trouble cannot be located, then proceed with the following.

Most troubles, according to symptoms of malfunction, can be separated into three groups. The first are those that make the receiver nearly or completely inoperative such as very little or no pick-up of signal. The second is marginal operation such as good but insufficient sensitivity,

or intermittent operation and the third are those isolated to relay operation and adjustment.

To find your trouble you must first classify your symptoms. If it is other than relay operation and adjustment, a voltage check of the receiver's test points is required to isolate the trouble to a particular transistor stage. To do this a Vacuum Tube Voltmeter will be required. Accomplish voltage check with receiver turned on but idling. Do not use a signal from your transmitter unless otherwise directed.

VOLTAGE TEST

Refer to the Operating Instructions and notice the test points and divided circles on the receiver circuit diagram. These are voltage checkpoints and indicate the proper voltage at the points indicated in the circuit. In each circle there are two numbers, the top number indicating proper voltage and the bottom number identifying to which copper land the measurement should be taken. The theory in the voltage check system of trouble isolation is that if a particular stage is functioning properly a certain amount of current will be flowing through the circuit at this point. Most points shown indicate the emitter side of each voltage dropping resistor that is installed in the emitter of each transistor stage. Since we cannot conveniently break the circuit and install a milliammeter to measure the flow through each stage we associate current flow by knowing the voltage change across the emitter resistor. If the current flowing is less than normal the voltage will be low at this point. If the voltage is higher, the current that is flowing will also be higher. If you examine the circuit closer, you will notice that the common lead from your vacuum tube voltmeter is installed at the plus terminal of the receiver battery supply which is common to all transistor stages. If your voltage probe (DC) is connected to point 43 in the circuit you will be measuring the voltage difference across the emitter resistor of the 155T1 mixer transistor. If the voltage difference between plus and point 43 is .2 volts, it indicates normal current flow and that this stage is operating properly. If, on the other hand, the voltage was lower or higher exceeding the 20% tolerance you should suspect the current was improper and something is wrong with this stage. Now, one other point. To what degree of tolerance from the listed voltages should you assume is improper operation? In most cases this should be 50% from the listed values to be of a serious nature. The exception to this is at points 32 and 94 where the tolerance should be limited to 20% the receiver is designed to accept tolerances and still give normal operation. In pursuit of your trouble, measure the voltage at all checkpoints, mark them down for future reference then consult the troubleshooting chart for further information.

TROUBLESHOOTING CHART

SYMPTOMS GROUP 1 AND 2

PROBABLE CAUSE

1. High current at idle or the meter pegged indicating serious short.	Receiver leads to batteries reversed. Solder short between copper lands. .47 condenser in holes 85 and 86 shorted.
2. Same as 1 above except idle current limited to not more than 15 ma. Receiver inoperative.	Accomplish voltage check to isolate trouble. Check affected stage for land shorts and proper installation of components.
3. Receiver inoperative but idle current O.K. All voltages O.K. except at point 62 indicating inoperative local oscillator.	Broken or inactive crystal. Open RF choke. Improperly installed or defective 155T1 transistor.
4. Same as above except trouble developed as result of severe shock damage.	Broken crystal.
5. Receiver very insensitive or inoperative. All voltages O.K. EXCEPT AT ONE CHECKPOINT WHICH IS HIGHER THAN NORMAL TOLERANCE. Tuning has been peaked.	Check affected stage for excessive current flow. Shorts between copper lands. Proper installation of components. Replace transistor if all other parts O.K.
6. Same as 5 above. All voltages O.K. except at one checkpoint which is lower than normal tolerance.	Check affected stage for low current or open condition. Proper installation of components. Open IF or audio transformer depending on stage. Replace transistor if all other parts O.K.
7. Same as 5 above except all voltages check O.K.	Check for open or improperly installed coupling and filter condensers in all stages. This would be the 100 mmf and .01 mf disc in mixer stage and .47 mf disc in 1st and 2nd IF stages. Use oscilloscope as signal tracer to find where signal disappears.
8. Operation O.K. except receiver appears oversensitive at idle with meter wobble up to about 20 ma. Wobble or nervous condition disappears with transmitted carrier signal turned on.	Condition O.K. up to about 10 ma and if excessive nervousness not caused by noise interference of close electrical devices sensitivity can be reduced by increasing value of resistor located in holes 30 and 31. Try 680 or 1000 ohms and recheck receiver sensitivity.
9. Operation O.K. except receiver appears slightly insensitive, less than 15" sensitivity as outlined under "Sensitivity Check". Batteries O.K. Tuning peaked and O.K.	Accomplish voltage check and if not isolated to one stage, decrease value of resistor located in holes 30 and 31. Decrease to not less than 100 ohms. Operate receiver at increased voltage, 3.6 volts.

RELAY TROUBLESHOOTING CHART

SYMPTOMS GROUP 3

PROBABLE CAUSE

1. Receiver operation and current change O.K. with signal but relay fails to respond.	Check relay armature for binding or jammed condition. Inspect for proper adjustment as outlined in operating instructions.
2. Relay response and adjustment seem O.K. except escapement or servo does not operate.	Dirty relay contacts. Clean with burnishing tool. Recheck adjustments and for open circuit condition from relay to escapement.
3. Relay does not pulse well at rate above 25 CPS.	Condition normal due to mass of relay armature. Reduce pulse rate.
4. Same as 3 above except relay tends to stay in attracted condition only at high pulse rates.	Possibility that 70 mf filter condenser actually measures higher capacitance. Try reducing capacitance by replacing to about 40 or 50 mf.
5. Engine vibration causes erratic or unwanted relay operation.	Receiver mounting too tight in aircraft or unbalanced propeller causing rough engine operation. Mount receiver so relay armature assumes vertical position in aircraft.



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