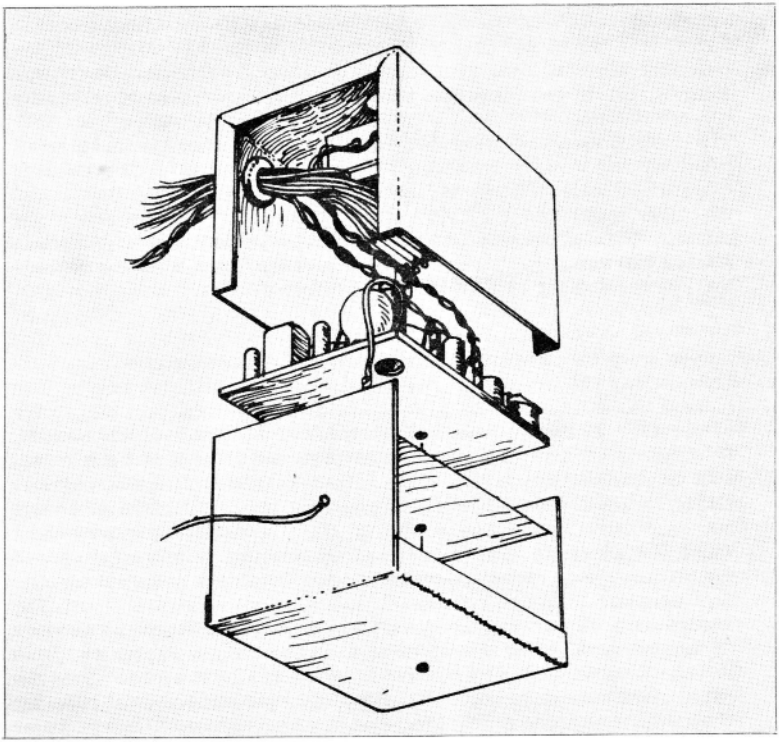
CONTROLAIRE

10 Channel Superhet Receiver

Assembly Kit —— SH-20



ASSEMBLY INSTRUCTIONS

Made In U.S.A.

INTRODUCTION

The SH-20 is the newest in 10 channel superhet receivers to be offered in kit form. It is the successor to our famous SH-10 receiver and offers a sub-miniature case design for easy installation into any aircraft. The circuit is similar but advanced in comparison to the earlier SH-10. Newer type transistors and advanced tecniques have brought about the sub-miniature design. Hundreds of the SH-20 were factory built, sold and used, to gain reliability information. Reports back from users were more than satisfying so now we offer a tried and proven 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 was 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 three 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 step as 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 O-50 milliampmeter 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 milliampmeter while using a very weak tone 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 $37\frac{1}{2}$ 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 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 O-50 milliampmeter 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 it 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

Due to the piggy-back mounting of the receiver chassis to the reed bank it is of great importance that the chassis be no thicker than 5/8" when assembled. This measurement includes the soldered portion of the board and is critical within the chassis area that is mounted under the reed bank. To obtain this in assembly certain precautions should be observed. As componants are installed into the circuit board, push them all the way down so a flush fit can be obtained. After the leads are soldered, clip them off so no connection extends beyond 1/16" from the surface of the circuit copper. The antenna coil may extend 5/8" or more above the board but is not critical as it is not mounted under the reed bank. At the 5/8" thickness measurement there will be a nominal 1/8" clearance between the reed bank and the chassis when assembled together in the case. If your chassis is thicker it will stand taller in the lower case and reduce this clearance to a point of touching, so use care.

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.

( ) 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 the reed bank magnet and other parts and cause untold troubles. After cleaning, blow away any 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 $\frac{1}{2}$'' and carefully insert it into circuit board hole 29. 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 34A and bend it so it touches the coil lug that is located number 2 from bottom of coil. Solder the wire both at the number 2 lug and at the circuit copper.

( ) 6. Inspect the interstage transformer and note that one side is marked with either a red dot or the letter ''S''. 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 118 and 119 and other leads into holes 114 and 115. Push transformer flush into circuit board with frame tabs going into holes 116 and 117. Bend tabs inwardly to secure transformer, then solder to circuit copper.

( ) 7. Notice that there are a total of 3 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 13. Balance of leads insert into holes 14, 15, 9 and 10 with mounting tabs going into holes 11 and 12. 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 39. Balance of leads insert into holes 41, 42, 40 and 44 with mounting tabs going into holes 38 and 43. 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 38 to land at hole 43.

( ) 10. Install the second IF transformer, black or blue coded slug, so clipped off lead is positioned at hole 90. Balance of leads insert into holes 92, 93, 95 and 91 with mounting tabs going into holes 89 and 94. Solder both mounting tabs to their respective hole lands.

( ) 11. Insert the leads of the 4 mmfd, small disc condenser, in holes 30 and 31.

( ) 12. Insert the leads of the 10 mmfd disc condenser in holes 54 and 55. This condenser may be alternately marked 10.5 mmfd.

( ) 13. Insert the leads of the .47 mf disc condenser in holes 32 and 33.

( ) 14. Insert the leads of the 100 mmfd disc condenser in holes 36 and 37. This condenser may be alternately marked with a red colored dab of paint.

( ) 15. Four identical .05 mf disc condensers are installed in this step, one in holes 7 and 8, another in holes 64 and 66, another in holes 96 and 97 and the last one in holes 112 and 113.

( ) 16. In this step three identical 15 mf electrolytic condensers are installed. Observe lead polarity and note that there is a plus sign on the body of the condenser nearest the positive lead. Install one condenser with its plus lead going into hole 47 and negative lead into hole 46. Install another with plus hole in 48 and negative in hole 49. Install the last with plus in hole 106 and negative in 107.

( ) 17 Observe lead polarity as pointed out in step 16 and install a 40 mf electrolytic condenser with plus lead going into hole 81 and negative into hole 80.

( ) 18. Install a 40 mf electrolytic condenser with plus lead going into hole 76 and negative into hole 77.

( ) 19. Install a 3 mf electrolytic condenser with plus lead going into hole 84 and negative into hole 83.

( ) 20. Notice the 4.7K ohm (yellow, violet, red) resistor that is installed flat against board in holes 45 and 100. To easily install this resistor pre-bend one lead 90 degrees at a point 3/16'' from end of the resistor body. Pre-bend the other lead 9/16'' from other end of resistor body. Note body location then install into circuit board. After soldering leads, inspect lead going into hole 45 to insure it does not short against body of IF can. If so, bend to allow clearance.

( ) 21. Install 10K ohm (brown, black, orange) resistor in holes 34 and 35.

( ) 22. Install a 1K ohm (brown, black, red) resistor in holes 23 and 24.

( ) 23. Install a 1K ohm (brown, black, red) resistor in holes 60 and 61.

( ) 24. Install a 100K ohm (brown, black, yellow) resistor in holes 50 and 51.

( ) 25. Install a 47K ohm (yellow, violet, orange) resistor in holes 25 and 26.

( ) 26. Install a 47K ohm (yellow, violet, orange) resistor in holes 16 and 17.

( ) 27. Install a 47K (yellow, violet, orange) resistor in holes 72 and 73.

( ) 28. Install a 470 ohm (yellow, violet, brown) resistor in holes 2 and 6.

( ) 29. Install a 470 ohm (yellow, violet, brown) resistor in holes 63 and 65.

( ) 30. Install a 10K ohm (brown, black, orange) resistor in holes 62 and 67.

( ) 31. Install a 470 ohm (yellow, violet, brown) resistor in holes 74 and 75.

( ) 32. Install a 470 ohm (yellow, violet, brown) resistor in holes 78 and 79.

( ) 33. Install a 3.3K ohm (orange, orange, red) resistor in holes 108 and 109.

( ) 34. Install a 27K ohm (red, violet, orange) resistor in holes 110 and 111.

( ) 35. Note the color code markings on the glass body of the In-290 diode. There are bands of red, white and black. Insert the lead from the black band end into hole 101 and the other lead into hole 102. Use care in bending the one lead that goes into hole 102 as if bent too close or sharp at glass junction the diode may break. Position the diode body about 1/8'' above surface of circuit board to lessen the transfer of heat during the soldering operation.

( ) 36. Install a 3.3K ohm (orange, orange, red) resistor in holes 98 and 99.

( ) 37. Install the leads of the R.F.C. choke in holes 27 and 28. This is a resistor-like component with wire coil on body.

( ) 38. Install the leads of the local oscillator crystal in holes 52 and 53. 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.

( ) 39. 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 108. This is the negative input land. To this land at hole position 108 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 at the transformer mount hole 116. After both wires have been soldered, thread them through hole 85 and twist for the balance of their length.

( ) 40. 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 R.F. radiation.

( ) 41. To prepare for an easier installation, clip all leads of all transistors to an initial length of 1''. Straighten any lead if bent.

( ) 42. Install a 155T1 transistor (local oscillator) with shield lead going into hole 59, emitter in hole 58, base in hole 57 and collector in hole 56.

( ) 43. Install a 155T1 transistor (mixer I. F.) with shield lead going into hole 20, emitter in hole 22, base in hole 21 and collector in hole 19.

( ) 44. Install a 155T1 transistor (1st I. F.) with shield lead going into hole 1, emitter in hole 3, base in hole 4 and collector in hole 5. Due to the irregular hole location for this transistor the shield lead bends over to the edge of the board for hole 1. 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.

( ) 45. Install a 155T1 transistor (2nd I. F.) with shield lead going into hole 69, emitter in hole 68, base in hole 70 and collector in hole 71.

( ) 46. Install a 2N-229 transistor (1st audio) with emitter in hole 103, base in hole 104 and collector in hole 105.

( ) 47. Install a T-2515 or 2N-508 transistor (reed driver) with emitter in hole 88, base in hole 87 and collector in hole 86. This completes assembly of the chassis.

MEDCO REED BANK

The reed bank supplied in this kit has had only initial test and adjustment by the manufacturer. It still requires further adjustment and inspection for best operating results. To do this and also prepare the reed bank for installation to the receiver chassis, accomplish the following steps.

( ) 48. Inspect the reed bank contact screw heads for a condition of slot burrs that may create shorts between the screw heads. If any exist remove with small penknife.

( ) 49. Inspect reed bank for a condition of cleanliness in and around contact screw lands and also between reed plate and pole pieces for metal or steel dust that may have been attracted by its magnet.

( ) 50. Inspect each individual reed for alignment and proper reed to pole piece clearance. Each reed should be positioned and in alignment with one another about 3/64'' above the reed coil pole piece. If it is not, loosen the affected reed contact screw until it is flush with bottom of contact board then with small probe bend the reed, applying pressure at base of reed, until this clearance is obtained. If clearance is greater the reed bank will have reduced drive and vice versa, greater drive if clearance is less. This is a preliminary adjustment inspection required due to shipping and handling

which may have changed factory adjustments. Final adjustment is done in a later step.

( ) 51. There are ten No. 26 flexible wires that are to be soldered to the terminals on top of the reed contact plate. Refer to Fig. 5 and notice that each wire is a different color and this denotes the function of its contacting reed. Cut each wire to a length of 9'' then strip away 1/8'' insulation from one end of each wire. To do the soldering, first pre-tin each wire and its terminal then reheat the terminal joint and add the wire. It is not necessary that the wire be inserted into the terminal hole but it can be if you desire and have the soldering skill. One word of caution, do not overheat or prolong the soldering at the terminals. If this is done the terminals may become loose.

( ) 52. In this step the reed bank coil wires are connected to the receiver chassis. Refer to Fig. 5 and notice the two wires coming from the rear of the reed bank. These are marked "negative" and "positive". Cut both wires to extend $3\frac{1}{4}$'' from the end of the reed bank then remove 1/16'' insulation. Notice the wires are not color coded but, as shown in Fig. 5, select the negative lead and thread it through hole 85 from the top of the circuit board. The end of the negative lead is then soldered to the copper land containing and at hole 108. The positive lead is now threaded through hole 85 and solders to land 84. Do not accidently reverse polarity when connecting the reed bank coil wires. To do so will reduce reed drive 50%. After wires are connected pull them lightly to remove slack then twist reed bank to twist coil wires together.

RECEIVER OPERATING TEST

At this point we have completed assembly of the receiver chassis also inspected and attached the reed bank. Before installing these units into the receiver case an initial operating test is to be accomplished. It involves connecting the receiver power input wires to the batteries and viewing test results by the readings of a O-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 Controlaire multi transmitter is used. Be sure its R. F. 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.

( ) 53. 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.

( ) 54. Procure a tuning tool and fabricate it to fit the slots in the slugs of both the antenna coil and I.F. 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.

( ) 55. Clean off your workbench of wire clippings and solder splotches 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.

( ) 56. Refer to Page 5 of the Operating Instructions and read the paragraph entitled "Receiver and Servo Wiring". With the information contained therin and additional reference to the "Receiver-Servo Wiring Diagram" connect the receiver red and black power input wires to the batteries. If standard pen cells are used connect three in series to obtain $4\frac{1}{2}$ volts and if nickle cadmium batteries are used connect four in series for 4.8 volts.

( ) 57. 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 4 to 6 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 15 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 I.F. cans. This is done with transmitter turned on.

( ) 58. Receipt of a tone signal by the receiver will be noted by an increase in meter reading up to a saturation level of 40 to 50 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 it in close enough to the receiver antenna to get a small reading. Start the tuning adjustment at the mixer I.F. 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, 40 to 50 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 I.F. (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 I.F. (black or blue slug), and last peak slug of antenna coil. While tuning you will note that adjustment to the mixer and first I.F. is somewhat critical but tends to broaden out at the second I.F. and antenna coil. This is normal.

( ) 59. If you have tuned your receiver with a companion Controlaire transmitter you should get at least a 20 ma reading at a minimum distance of two feet 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 two feet 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 R.F. output. If it has weak output the senistivity 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.

FINAL ASSEMBLY

Handle the chassis and reed bank with care during the following steps as they are attached together and undue strain can easily break reed bank coil wires.

( ) 60. Install the micarta insulator board into the bottom of receiver case. Insert rubber grommet into side hole of top case.

( ) 61. Refer to Fig. 1 for an exploded view of the chassis and reed bank installation. Notice the exact placement and routing of all wires but pay particular attention to the reed bank coil wires. Note that these are routed to the side of the reed bank but behind the reed function wires that go through the grommet. This routing is given to prevent entanglement and proper alignment of the wires when receiver top lid is installed. With this in mind proceed to mount the reed bank to the top lid using the following procedure. First, and from the inside of top lid, thread all reed bank function and reed bank common wires into the rubber grommet. As the wires pass through the grommet and slack is removed slide the reed bank into place and align its mounting holes with those in the top lid. When in place use two No. 2 x 1/4" sheetmetal screws and secure reed bank to the top lid. After the reed bank is secured inspect and align the multi colored function wires so they lay flat against the rear of the reed bank and follow a natural curve into and through the grommet. Do not allow the wires to bunch up in one spot as it may interfere with the natural closing of the top lid.

( ) 62. Install receiver chassis into lower housing case using one

No. 2 x 1/4'' sheetmetal screw to secure. Be sure chassis is flush mounted to bottom of case but do not over-tighten screw.

( ) 63. As a strain relief, tie a simple one loop knot in the antenna at a point $1\frac{1}{4}$'' from where antenna attached to the bottom terminal of antenna coil. After knotting, thread antenna through small hole in the end of receiver case.

( ) 64. Thread the receiver red and black power input wires through rubber grommet as pointed out in Fig. 1.

( ) 65. Inspect again that the reed function wires are laying flat against back of reed bank then fit and proceed to close receiver case. As top lid is being closed down pull slightly on the red and black power wires to remove internal slack then close case. Inspect that closing is complete and without a spongy effect. If bumping or a spongy effect is felt, inspect to find the cause. This can be caused by improper assembly of chassis (too thick) an improper fit chassis or bunching of wires from the reed bank. When properly assembled there will be a nominal clearance of about 1/8'' between receiver chassis and reed bank and no spongy effect can be felt.

( ) 66. Peel backing from the Controlaire name plate and install on top lid as pictured on front page of operating instructions. Also, install the frequency label. This completes final assembly.

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 I.F.s using same procedure as described earlier. Before peaking the antenna coil, reinstall top lid. The presence of the lid on or off does not effect the tuning of the I.F.s but does effect the antenna coil slightly.

REMEMBER, to get a peak on any coil requires that you weaken transmitted signal power to a point where meter current registers less than saturation. With current at this level a peak can be obtained.

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.

NOISE RECEPTION

Be reminded that a high gain superhet receiver is most susceptible to noise pick-up when operated or tuned with a weak signal. Carrier input signal strength controls the AGC of the receiver and thus the gain. When a very weak or no transmitted carrier is present, gain is at its highest point and noise, if present, can cause erratic meter readings. Some kit builders have been confused in the testing of their receivers because of the noise level in their workshop, fluorescent lights, motors, etc.

If you experience any erratic meter readings investigate electrical noise sources and try operation elsewhere. Normally, with a stronger signal, all traces of noise reception such as meter wobble should disappear. Noise reception, except for erratic meter readings, can cause no trouble because the reed bank is a natural filter.

TRANSMITTER TONE ALIGNMENT

To finalize the adjustment to the reed bank an operational check must be accomplished to test operation of each reed. To do this, it will be necessary for you to align the tone channels of your transmitter so it is compatible with the reed frequencies of the Medco bank. The Medco bank has a respone of about 350 CPS on the longest reed, with a separation of about 30 cycles between reeds, up to a top frequency of about 650 CPS on the shortest reed. If you are using a companion Controlaire transmitter that is compatible to the Medco bank, only minor alignment is involved to take care of slight reed bank differences. The instructions for doing this are included with the transmitter. If you are using a transmitter of another make alignment may be more difficult, however, it can be done. Because of the amount of text and illustrations involved we cannot in these instructions give complete details on the alignment of every multi transmitter, however, we do present the following information for your guidance.

Most multi transmitters, including Controlaire, have for tone stability, only a small adjustable frequency range for each channel. This range is controllable by a trim potentiometer and is about 30 CPS on the high frequency channel down to about 15 CPS on the low. To center the frequency of any channel so the trim potentiometer will be within range to operate a specific reed, a padder condenser is used. This condenser is installed on each channel and is in parallel with the main condenser and coil that governs the highest tone frequency of the tone oscillator. As different channels are keyed, the key switch connects the padder condenser of that channel in parallel with the main condenser and the resultant tone frequency is a product of the total capacitance in the tone oscillator circuit. In principal, on any channel to lower its center frequency more padding capacitance must be added and vice versa capacitance reduced to increase the frequency.

One last point, the main problem in aligning brand X transmitter is the actual physical location of the padder condenser for each channel and the amount of capacitance to add or subtract to center the channel where you want it. Because the chassis layout of all transmitters vary and we cannot supply illustrations we can only suggest you contact the top radio control man in your area for further information. In conclusion, where there there is a will there is a way.

FINAL REED BANK ADJUSTMENT

After you have aligned your transmitter to operate the reeds of the bank, refer to Page 13 of the ''Operating Instructions'' and adjust reed bank as per information contained there in.

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 intermittant operation and the third are those isolated to reed bank operation and adjustment.

To find your trouble you must first classify your symptoms. If it is other than reed bank 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 Page 2 of 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 milliampmeter 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 24 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 24 is .4 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 74 and 86 where the tolerance should be limited to 20%. This superhet 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. 40 mf electrolytic condensers installed with reversed polarity.
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 60 indicating inoperative local oscillator.	Broken or inactive crystal. Open R. F. 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 condensers in all stages. This would be the .47 mf disc in the mixer stage, the .05 mf disc in both the 1st and 2nd IFs and the 15 mf and 40 mf electrolytics in 1st audio stage. Open or defective IN-290 diode.
8. Operation OK except receiver appears oversenistive 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 15 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 74 and 75. Try 1000 ohms and recheck receiver senistivity.
9. Operation O.K. except receiver appears slightly insensitive, less than 24" 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 74 and 75. Decrease to not less than 100 ohms. Operate receiver at increased voltage.
10. Receiver tends to give erratic operation with strong signal from transmitter indicating extreme overloading.	IN-290 diode installed backwards. Check AGC voltage at point 45. Should reduce to zero or become negative with transmitted carrier signal turned on.

REED BANK TROUBLESHOOTING CHART

SYMPTOMS GROUP 3	PROBABLE CAUSE
1. Receiver appears normal but reed bank is hard to drive.	Excessive reed to pole piece clearance. Channel tuning improper at transmitter. Drive signal weak or distorted from receiver, check for signal shape with oscilloscope. If distorted, replace 3 mf reed bank filter condenser. Reed bank coil wires reversed.
2. Poor simultaneous drive but single channel drive O.K.	Same as in 1 above. Poor simul mixing of tones in transmitter or unbalanced mixing. Specific reed frequencies require changing.
3. Interaction between adjacent reeds, tends to drive with one tone.	Readjust transmitter tone as reed may be tuned on high frequency side or peak. Reed to pole piece clearance too close, readjust with more clearance. Frequency of reeds spaced too close.
4. Reed drives O.K. but servo does not operate.	Readjust reed contact clearance. Reed contacts dirty, clean with burnishing tool. Trouble not in reed bank.
5. Third reed starts to vibrate during normal simultaneous operation. Caused by harmonic of simul tones.	Readjust simul tones at transmitter to tune out unwanted third reed. Increase reed to pole piece clearance of offending reed. Extreme cases will require changing reed frequencies of one or more reeds by leading or clipping.
6. Two servos operate with only one reed vibrating.	Shorts between reed contact springs. Check for foreign matter. Trouble not in reed bank.
7. Engine vibration causes unwanted reed operation.	Receiver mounting too tight in aircraft, or unbalanced propeller causing rough engine operation. Receiver should be mounted so reed bank reeds assume vertical position in aircraft.