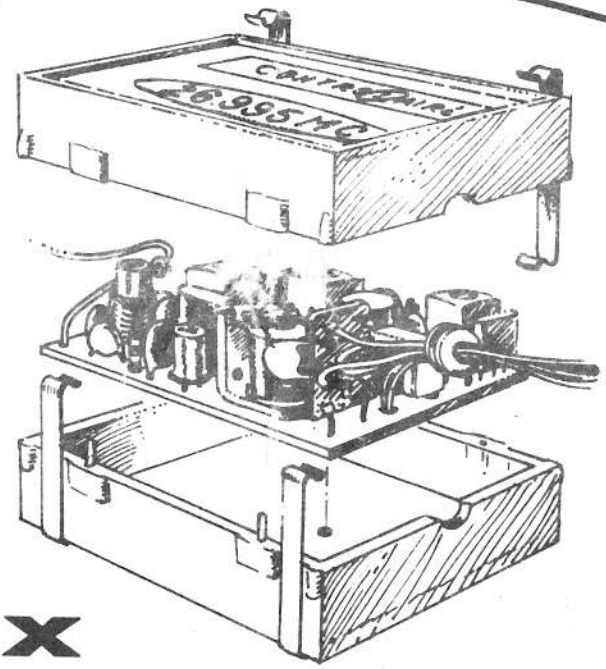
CONTROLAIRE®

Assembly
&
Operating
Instructions

SH 112



Rx

1 CH. RELAY S-HET

INTRODUCTION

The SH–112 is an all-transistorized superhet receiver with its output terminated in the use of a S.P.D.T. relay. This feature allows simple application to pulse or escapement type of control systems. Like it's predecessor the SH–100, the SH–112 exhibits immunity to RF noise interference generated by the electrical control system of your aircraft. This is accomplished by a design feature that allows extreme signal clipping to take place within the receivers I.F. section. By this clipping action noise of reasonable amplitude is eliminated from appearing in the I.F. carrier. If noise does not appear, it cannot be detected as an interference signal to actuate the receivers relay. No superhet can reject all conditions of noise interference, however, the SH–112 presents a definite improvement. Other design features include temperature compensation from 0 degrees to 130 degrees F., a strong protective polypropolene case and 3 volt operation.

Receivers are available in any of the following frequencies. 26.995mc, 27.045mc, 27.095mc, 27.145mc, 27.195mc.

TRANSMITTER REQUIREMENTS

Due to the extreme clipping action that takes place within the receivers I.F. section, the SH–~~100~~ 112 must be operated with a companion transmitter of high modulation percentage. Minimum is 90% and the best 100%. If transmitters of less than 90% are used you may find a nulling or no signal condition exhibited by the receiver at varied distances from the transmitter. For best results we recommend the new Controlaire "Mark II Mule". Other Transmitter requirements are a radiated RF output in excess of 75 millawatts and a tone frequency falling between 400 to 1200 C.P.S.

BATTERY REQUIREMENTS

The SH–~~100~~ 112 receiver is designed and factory adjusted for a nominal 3.0 volt supply.

If you use 2.4 volts, it may be necessary to drop the 330 ohm resistor in holes 75 and 76 to 100 ohms. (Brown, Black Brown) and the emitter resistor of the first I.F. stage from 680 to 330 ohm (Orange, Orange, Brown) in holes 4 and 5.

If you use 3.6 volts, you will need normally to change the ~~470~~ 680 ohm resistor in holes 4 and 5 to 1K (Brown, Black, Red) and 330 ohm resistor in holes 75 and 76 to 680 ohms (Blue, Grey, Brown).

RECEIVER OPERATION

With transmitter turned off, receiver turned on, the receiver should idle at about 2 or 3 ma. This is measured by a 0–50 ma milliampmeter as shown

installed in the receiver circuit. The reading should be steady except if in your testing area you are bothered with electrical disturbances. This could be noisy fluorescent light, electric motor, etc. In this case the idle may be higher and nervous in action. In any case, the idle should quiet down when your transmitter carrier signal is turned on. Presence of the carrier should bring the idle current to a steady 6 or 7 ma. In operation it is the presence of the transmitted carrier that enables the receiver to reject noise and electrical disturbances. With carrier off you may notice noise pick-up. As you key a transmitted tone signal the receiver current should rise from about 6 ma to about 48 ma. This current change actuates the receiver relay and thus in turn you control escapement or servo actuator.

It might be noted during very close-in ground operation your receiver may be affected by an adjacent channel operator if you are close in to his transmitter. This will be more pronounced if your transmitter carrier is off. With transmitter carrier on, your receiver will tend to reject the adjacent channel transmitter. A few field tests with your buddy on the adjacent channel will acquaint you with close-in operation limits. For ground operation you might experience interaction if taxiing closer than 20 feet of your buddy's transmitter, however, beyond this distance and in the air, no interference will be noted.

RECEIVER TUNING

Assembled receivers are tuned at the factory and, assuming no shipping or handling abuse, should still be in perfect order; however, before flying it is best to check. Tuning and sensitivity is checked by operating receiver with antenna-less transmitter and noting the maximum distance operation can be obtained. To do this, point the sub-antenna of your Mark II Mule transmitter, main antenna removed, at the stretched out end of the receiver antenna and key tone signal. If you get good operation out to a distance of 15'' all is in order to fly. If not, accomplish the following check. Install tuning meter and note at the 15'' distance if current is rising to 40 ma. If so, then relay adjustment or cleanliness is reason for non-operation. If small or no rise is noted, receiver tuning is probably at fault. To retune the receiver, use the following procedure.

The tuning tool should be insulated and fabricated to fit slots of both the antenna, coil and IF cans. Do not use metal screwdriver or metal tipped tools. Again, operate receiver with antenna-less transmitter, bringing it close enough to receiver antenna to get a small reading. Start at the mixer IF can (yellow slug) and slowly adjust slug for highest reading on meter. As the slug is peaked and current rises to the maximum level of 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 receiver current at saturation level, back transmitter away to weaken input signal so peak can be obtained. After the mixer has been peaked, go the first IF (white slug) and repeat the above. In sequence, back away transmitter and weaken signal each time adjustment brings current level to saturation. In same manner, peak the second IF (black slug) and last, with receiver lid on, peak slug of antenna coil. Presence of receiver lid will not affect IF tuning, on or off, however, it does affect the antenna coil. You will note while tuning that

adjustments to the mixer and first IF are somewhat critical but tends to broaden out at the second IF and antenna coil. This is normal. When tuning is finished you should get at least a 40 ma reading at the mimimum 15'' distance. The average will be about 24''. This completes the tuning adjustment.

Do not attempt tuning by the distance check method. It cannot be done. You may try a ground distance check for personal satisfaction, if desired. If properly tuned as described above with minimum of 15'' operation, ground range (receiver held head height) will be in excess of one-half mile in open country.

If you experience trouble and cannot get operation at the minimum distance, check transmitter for proper output and battery condition. The distance as expressed above are for companion use with the Controlaire Mark II Mule transmitter only. Other transmitters may give varied distances due to varied output less antenna, etc. Remember, for proper operation of the SH–100 it requires a transmitter capable of 90% or more modulation.

PRELIMINARY ASSEMBLY NOTES

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.

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.

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 and file. To monitor the tuning operation obtain a 0–50 milliampmeter but be sure it is a moving coil type. 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.

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. Componant 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.

( ) 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. Do not clean the circuit board with steel wool or other abrasives as they are silvered and coated with plastic. If by chance there is a spot of corrosion----buff it gently and in that local area only. Also don't worry about the plastic interfering: you can solder right through it. As a result the circuit lands will remain bright and protected.

( ) 3. Refer to Fig. 1 for the illustrated procedure for winding the tuning coil. Initially, clip of one of the four tabs and it's circuit board prong. The wire provided is of the "Solder-Ease" type and requires no scraping to remove the enamel insulation; this burns away during the soldering operation. After soldering the wire to the tabs, the turns may be tightened and a light coat of model cement applied to hold them permanently in place.

( ) 4. Insert the completed tuning coil in holes 43, 44 and 45.

( ) 5. Inspect the interstage transformer and note that one side is marked with 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 93 and 94 and other leads going into holes 90 and 91. Push transformer flush into circuit board with frame tabs going into holes 89 and 92. Bend tabs inward to secure transformer then solder to circuit copper.

( ) 6. 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 orient each transformer with its leads extending down then locate and clip off the unused lead.

( ) 7. Install the mixer IF transformer, yellow coded slug, so that the mounting tabs are in holes 24 and 25 and the leads are in holes 22, 23, 26 and 27. Bend the mounting tabs over and solder them to the circuit board.

( ) 8. Install the first IF transformer, white coded slug, so that the mounting tabs are in holes 8 and 13 and the leads are in holes 9, 10, 11 and 12. Bend the mounting tabs over and solder them to the circuit board.

( ) 9. Install the second IF transformer, black or blue coded slug, so that mounting tabs are in holes 97 and 100 and the leads are in holes 98, 99, 101 and 102. Solder both mounting tabs to their respective hole lands.

( )10. Insert the leads of the 4 pf small disc capacitor in holes 50 and 51.

( )11. Insert the leads of the 10 pf small disc capacit r in holes 37 and 38.

( )12. Insert the leads of the .01 mfd disc capacitor in holes 39 and 40.

( )13. Insert the leads of the 250 pf disc capacitor in holes 54 and 55.

( )14. Two identical .47 mfd disc capacitors are installed in this step; one in holes 6 and 7 and the other in holes 64 and 65.

( )15. Two identical 18 pf disc capacitors are installed in this step; one in holes 41 and 42 and the other in holes 46 and 47.

( )16. Two identical .001 mfd disc capacitors are installed in this step; one in holes 111 and 112 and the other in holes 62 and 63.

( )17. Two identical .05 mfd disc capacitors are installed in this step; one in holes 87 and 88 and the other in holes 95 and 96.

( )18. 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 81 and negative (–) lead in hole 80.

( ) 19. Two identical 15 mfd tantalytic capacitors are in this step. Inspect the bodies of these capacitors and note that one end is marked with a (+); (this end is usually color coded red also). Bend the leads from the positive ends over and install one capacitor standing up-right over hole 18 with its positive lead in hole 19. Install the other capacitor standing up-right over hole 83 with it's positive lead in hole 84.

( )20. Install a piece of scrap lead wire between holes 85 and 86 as a jumper wire; lay it flush with the circuit board.
Note: All resistors and the RFC are mounted vertically. In preparation for these steps, bend one lead of these components over and parallel to the component bodies.

( )21. Install the RF choke (RFC) in holes 35 and 36; standing over hole 35.

( ) 22. Install an 680 ohm resistor (Blue, Gray, Brown) in holes 4 and 5; standing over hole 4.

( )23. Install a 1K ohm resistor (Brown, Black, Red) in holes 66 and 67; standing over hole 66.

( )24. Install a 330 ohm resistor (Orange, Orange, Brown) in holes 75 and 76; standing over hole 76.

( )25. Install a 1K ohm resistor (Brown, Black, Red) in holes 31 and 32; standing over hole 31.

( )26. Install a 100K ohm resistor (Brown, Black, Yellow) in holes 20 and 21; standing over hole 20.

( ) 27. Two identical 10k ohm resistors (Brown, Black, Orange) are installed in this step; one in holes 52 and 53; standing over hole 53; one in holes 16 and 17; standing over hole 17.

( ) 27A One 15K resistor (Brown, Green, Orange) is now installed in holes 71 and 72; standing over hole 72.

( ) 28 Three identical 47K ohm resistors (Yellow, Violet, Orange) are installed in this step: one in holes 33 and 34; standing over hole 33: one in holes 14 and 15, standing over 14; one in holes 73 and 74, standing over 73.

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.

( )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 2N2188 transistor in holes 59, 60 and 61 with the collector lead in 59, base lead in 60 and emitter lead in 61.

( )31. Install a 2N3325 transistor in holes 28, 29 and 30 with the collector lead in 28, the base lead in 29 and the emitter lead in 30.

( )32. Install a 2N3325 transistor in holes 1, 2 and 3 with the emitter lead in 1, the base lead in 2 and the collector lead in 3.

( )33. Install a 2N3325 transistor in holes 68, 69 and 70 with the emitter lead in 68, the base lead in 69 and the collector in 70.

( )34. Install the 2N229 transistor in holes 103, 104 and 105 with the emitter lead in 103, the base lead in 104 and the collector lead in 105.

( )35. Install the 2N508 transistor in holes 77, 78 and 79 with the collector lead in 77, the base lead in 78 and the emitter lead in 79.

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.

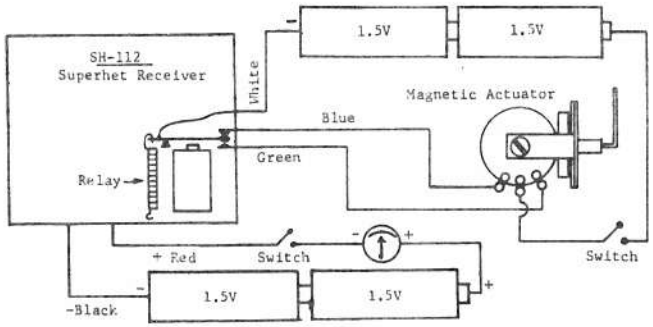
( )37. Strip 1/8" insulation from one end of the white, blue, green wires. Pre-tin each wire then attach and solder to the proper terminals as shown. Each wire should be at least 9" in length. Inspect after soldering to insure no shorts exist between terminals.

( )38. Attach relay to circuit board with attaching screw going through hole 109. Screw is supplied initially installed in bottom of relay.

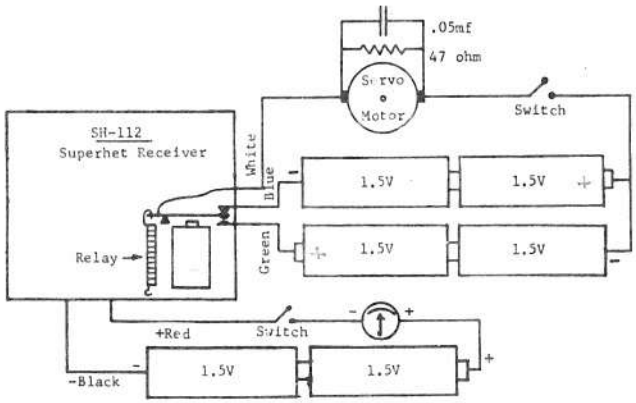
( )39. Noting again Fig. 5, connect a solid bare wire (excess resistor lead), between hole 107 of circuit board and right lower terminal of relay.

SUGGESTED SYSTEM WIRING UTILIZING INDEPENDENT BATTERY SUPPLIES FOR RECEIVER & ACTUATOR

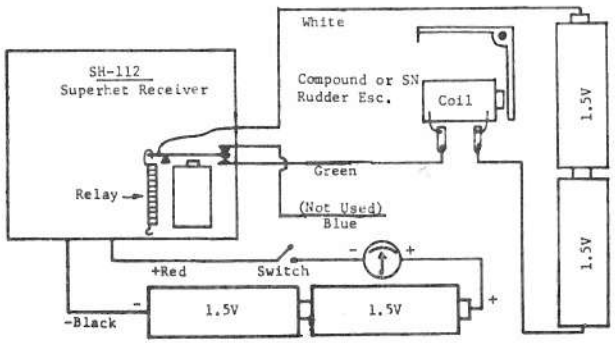
MAGNETIC ACTUATOR HOOK-UP



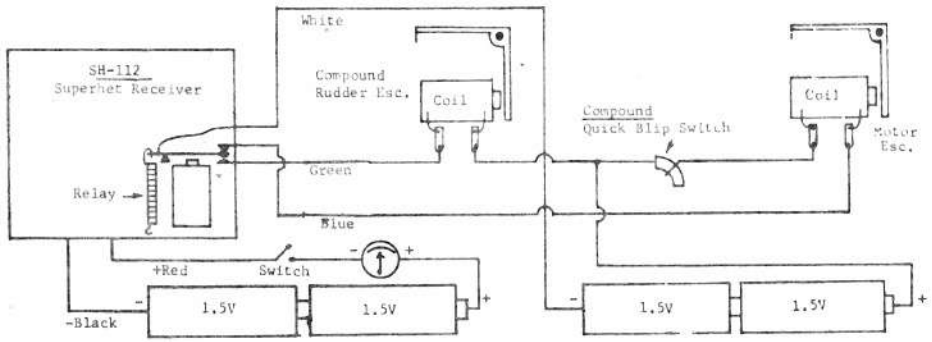
MOTORIZED PULSE ACTUATOR HOOK-UP

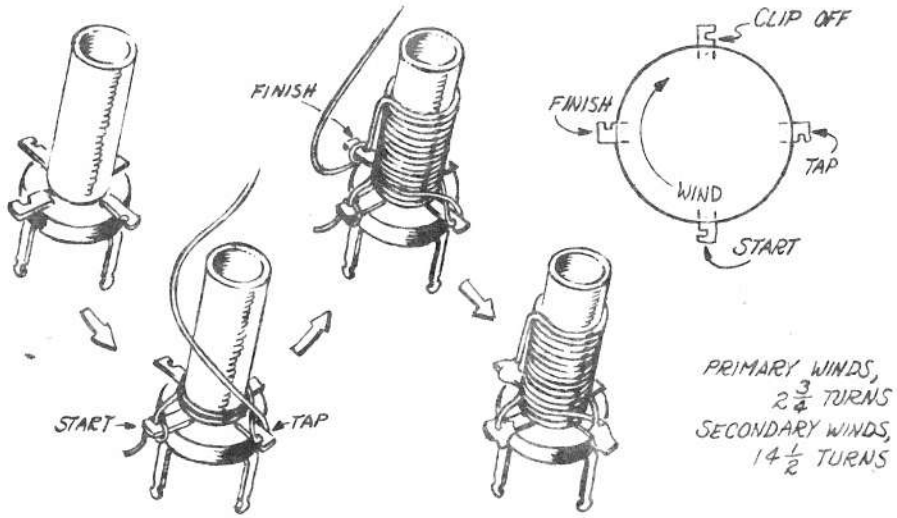


SINGLE ESCAPEMENT HOOK-UP



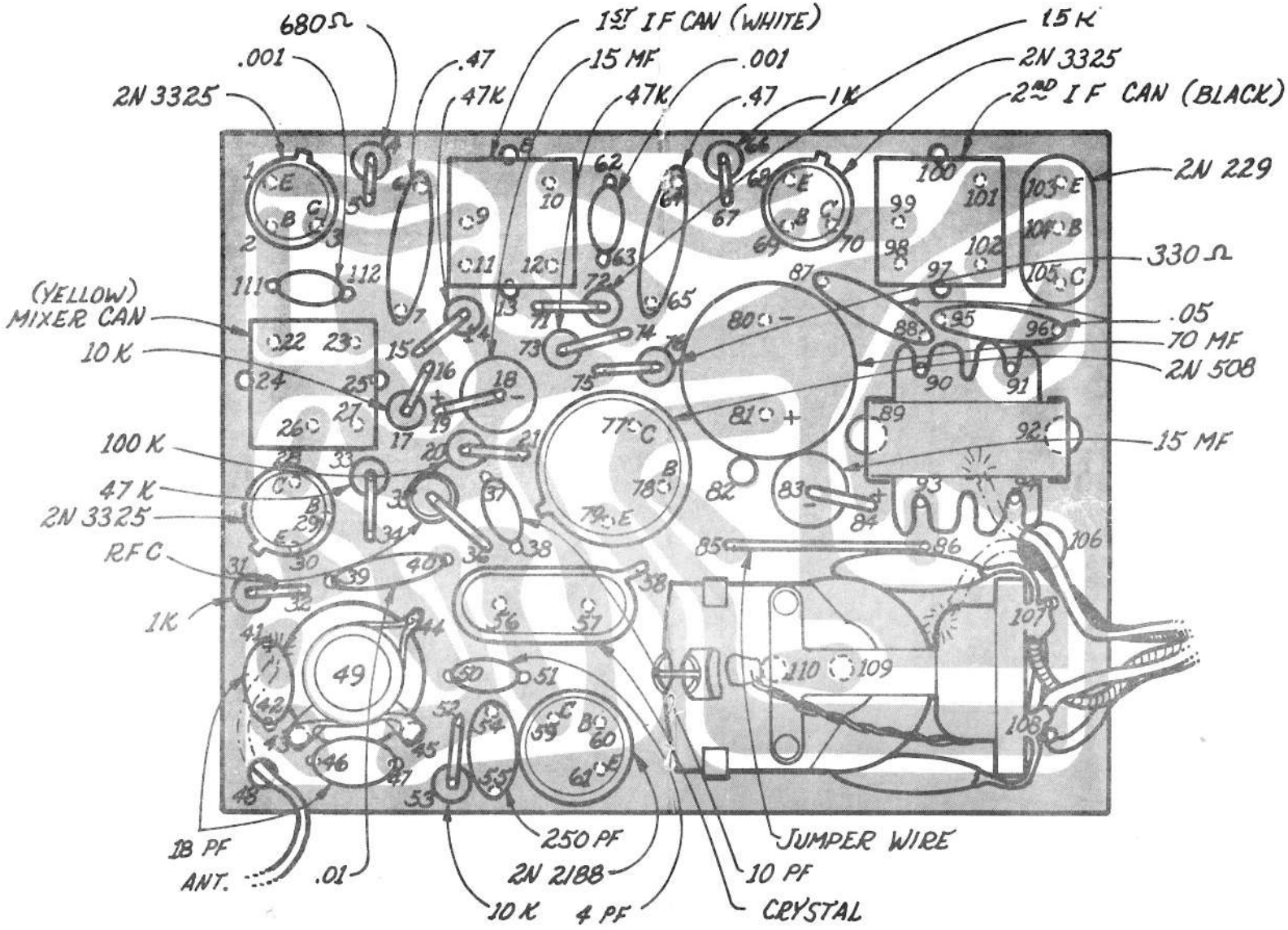
TWO ESCAPEMENT HOOK-UP FOR RUDDER & QUICK-BLIP MOTOR CONTROL





SH-112 COIL

FIG. 1


680Ω
.001
2N 3325
1ST IF CAN (WHITE)
15 MF
.47
47K
.001
47K
.47
1K
15K
2N 3325
2ND IF CAN (BLACK)
2N 229
330Ω
.05
70 MF
2N 508
15 MF
(YELLOW)
MIXER CAN
10K
100K
47K
2N 3325
RFC
1K
18 PF
ANT.
.01
250 PF
2N 2188
10K
4 PF
10 PF
CRYSTAL
JUMPER WIRE

SH 112

FIG. 2

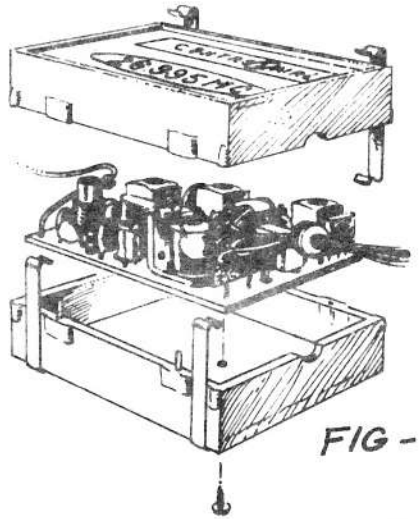


FIG-6

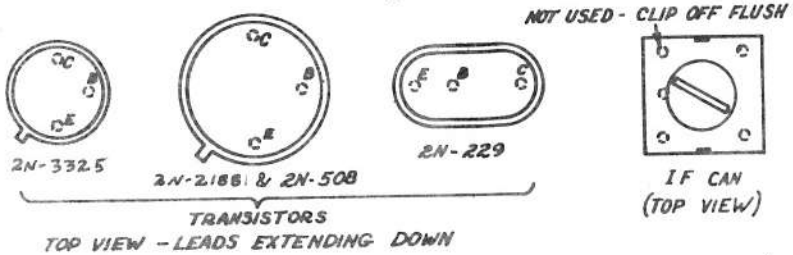
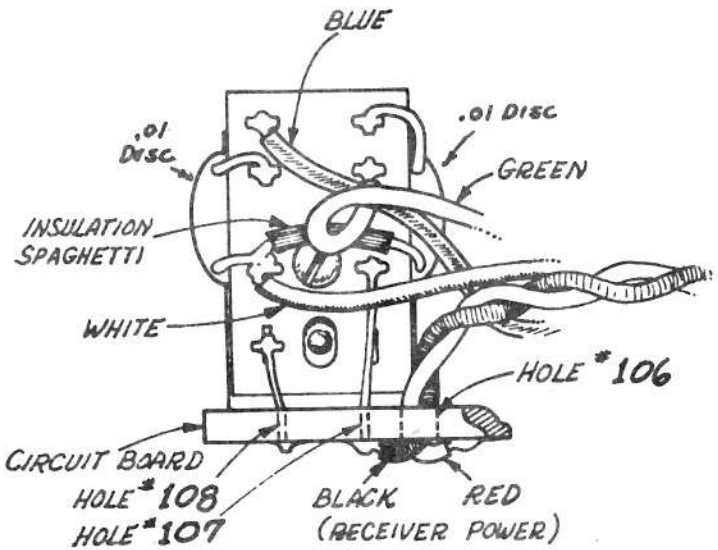


FIG. 3

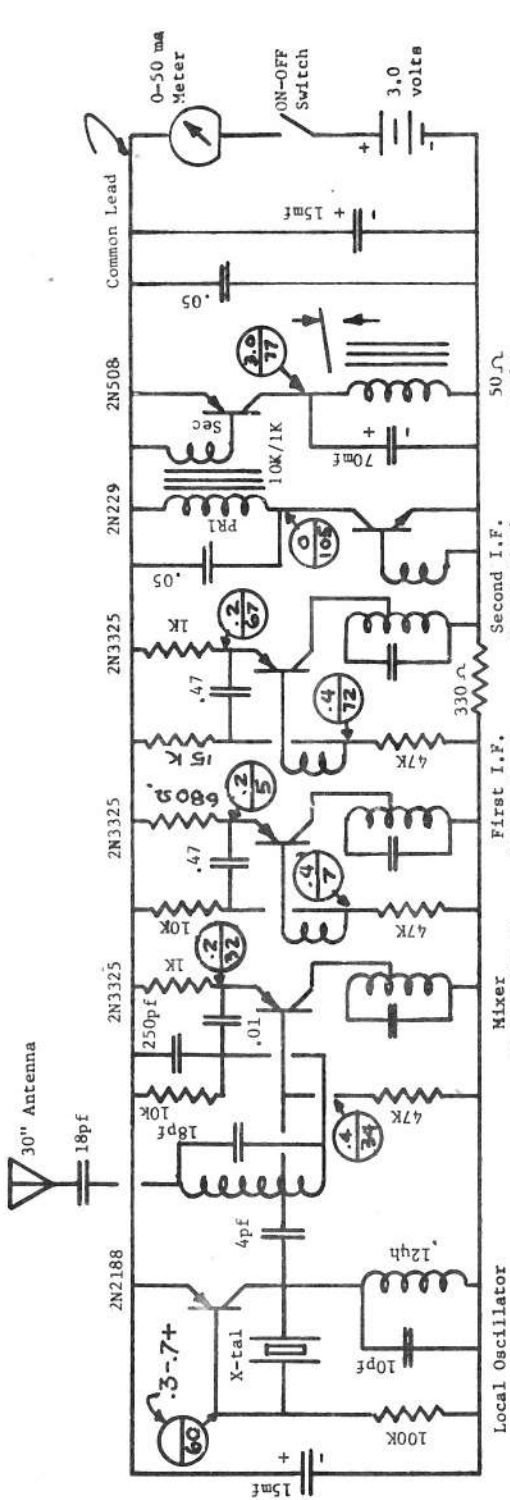
FIG. 4



RELAY

FIG-5

SH-112 SINGLE CH. SUPERHET RELAY RX.



Voltage measurements taken with Heathkit IM-13, V.T.V.M. 5 volt, minus DC scale, except for test point 60. For measurements at test point 60, the V.T.V.M. should be set to the plus DC scale. Common lead to plus 3 volts receiver battery. Receiver idling, no signal from transmitter. Note divided circles on diagram, top no voltage measured, lower number is circuit board hole that identifies copper land to which place DC probe. Normal measurement can vary plus or minus 20% due to component tolerances.

( )40. Connect a solid bare wire between hole 108 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.

( )42. Install the leads of the local oscillator crystal in holes 56 and 57. 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.

( )43. 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 107. This is the negative input land. To this land near hole position 107 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 92. After both wires have been soldered, thread them through hole 106 and twist for the balance of their length.

( )44. 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 circuit land containing hole 41. Note antenna installation as shown in Fig. 2.

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 Controlaire 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.

( )45. 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.

one in holes 14 and 15; standing over hole 14; and one in holes 73 and 74; standing over hole 73.

( )46. 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.

( )47. 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.

( )48. 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 pencells are recommended for receiver power.

( )49. 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.

( )50. 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.

( )51. If you have tuned your receiver with a companion Controlaire Mark 11 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.

( )52. 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 "Relay Contacts & Adjustment" section.

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.

( )53. Tie a simple knot in the antenna at a point about 1" from where the antenna passes thru the circuit board.

( )54. Mount the chassis to the lower case half with the # 2x¼ self-tap screw provided.

( )55. Thread the power and relay wires thru the ¼" rubber grommet and position the grommet in the case notch provided for it. Position the antenna in it's notch, (the knot acts as a strain relief) and install the upper case half.

( )56. Peel protective backing from both the Controlaire 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 probably still in order but it is a good idea to give the unit a final check. To do this, temporarily remove top lid and repeak the IF's using same procedure as described earlier. After peaking the antenna coil you may wish to put a drop of bee's wax on the slug to prevent shifting from vibration. 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 intermittant 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 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 32 in the circuit you will be measuring the voltage difference across the emitter resistor of the 2N3325 mixer transistor. If the voltage difference between plus and point 32 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 75 and 77 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. 15 mfd condenser in holes 83 and 84 or .05 u.f. in holes 87 and 88 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 60 indicating inoperative local oscillator.	Broken or inactive crystal. Open RF choke. Improperly installed or defective2N2188|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 250 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 75 and 76. Try 470 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 75 and 76. Decrease to not less than 100 ohms.

RELAY CONTACTS & ADJUSTMENT

Occasionally, clean the relay contacts with a contact burnisher or real fine emery paper. Dust or dirt in the contacts can really bug you so use common sense with respect to cleanliness.

As supplied, the 50 ohm relay has been adjusted to pull in at about 35 ma and drop out about 20 ma. Under normal conditions it should remain in adjustment, however, after a hard knock you may have to readjust assuming operation is affected. In practice the relay is first adjusted by bending armature contact so a condition of pull-in allows the armature contact to strike the lower fixed contact before the main armature contacts the coil pole piece. In practice actuate the armature lightly with your finger or small tool and notice that when the contacts are just closing that a small air gap is visible-about .001 between main armature and coil pole piece. After this is adjusted lightly hold the relay in a pulled-in condition and adjust clearance between moving contact and upper contact to be about .003". This is done by bending upper contact. Generally, after these fixed adjustments are made the actual pull-in and drop out can be adjusted by increasing or decreasing armature coil spring tension. Increase tension to increase pull-in point and vice versa.

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.

NOISE SUPRESSION

As expressed earlier, the SH-112 is a special purpose unit that has a certain immunity to noise reception, however, in any receiver there is a limit as to the amount the receiver can reject. To guide you in the assembly of a clean installation we pass on to you the following information.

Just what is a noise condition and how will it affect the receiver? First, the effect is a chattering or unwanted intermittent operation of the receiver. This is caused by noise signals generated within the aircraft. One noise condition is the RF signal generated by the sparking of an electric servo motor. This is best eliminated or minimized by use of an .05 to .1 mf condenser installed across the motor brush terminals. Additional noise supression may be gained by adding a resistor of about 47 ohms across the motor brush terminals and using small RF chokes in each motor lead.

Other sources of noise are intermittent battery box connections and switch contacts and the antenna effect noise created by use of long metal torque rods to operate control surfaces.

PARTS CHECK AND PRICE LIST

SH-112

CAPACITORS	PRICE EA.
( ) 1 ea. 4 mmfd Disc.	.25
( ) 1 ea. 10 mmfd Disc	.25
( ) 1 ea. 250 mmfd Disc.	.25
( ) 2 ea. 18 mmfd Disc	.25
( ) 2 ea. .001 mf Disc	.25
( ) 3 ea. .01 mf Disc	.30
( ) 2 ea. .05 mf Disc	.35
( ) 2 ea. .47 mf, 3v Disc	.45
( ) 1 ea. 70 mf electrolytic	1.00
( ) 2 ea. 15 mf electrolytic	1.00

COIL, TRANSFORMERS, CHOKES	
( ) 1 ea. Antenna Coil Assy.	1.90
( ) 1 ea. RF Choke 12 UH	.35
( ) 1 ea. 10K/1K 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
( ) 2 ea. 1K ohm (brown, black, red)	.12
( ) 2 ea. 10K ohm (brown, black, orange)	.12
( ) 3 ea. 47K ohm (yellow violet, orange)	
( ) 1 ea. 100K ohm (brown, black, yellow)	.12
( ) 1 ea. 15K (brown, green, orange)	.12
( ) 1 ea. 680 ohm (blue, gray, brown)	.12

MISC. PARTS	PRICE EA.
SEMI CONDUCTORS	
( ) 1 each 2N2188 Transistor	1.90
( ) 3 ea. 2N3325 Transistor	1.50
( ) 1 ea. 2N-229 Transistor	.90
( ) 1 ea. 2N-508 Transistor	1.50
( ) 1 ea. Etched Circuit Board	2.50
( ) 1 ea. 50 ohm Relay	2.95
( ) 1 ea. Frequency Emblem	.10
( ) 1 ea. Rubber Grommet 1/8 x 1/4	.03
( ) 1 ea. Kit Assembly Tips	.20
( ) 1 ea. Crystal	4.95
HARDWARE	
( ) 1 ea. Receiver Case Top and Bottom	2.10
( ) 1 ea. Controlaire 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 Strand**	
( ) 1 ea. 30'' any color for antenna	.15
( ) 5 ea. 10'' lengths of following colors: Red, Black, White, Blue, Green	.04

WARRANTY

Guarantee is extended that factory assembled receivers, not kits, be free of workmanship and parts defect for a period of 60 days from date of purchase. This is valid only if receiver is operated within scope of instructions presented and used with a companion CONTROLAIRE MARK II MULE transmitter. We reserve the right of inspection to determine abuse or improper operation and if evident in our opinion, guarantee is void. No responsibility is assumed for damage inflicted by shipping or handling organizations. When returning a receiver for guarantee service, state this fact, along with full particulars of why you think unit is defective. Enclose particulars in carton, pack well, and send direct to Controlaire Division, World Engines, Inc. Do not return to your dealer as in most cases details and particulars are omitted and misunderstandings result.

SERVICE

The minimum fee for inspection and repair is $4.50. Include this amount with receiver. If inspection reveals charges to be in excess of $10.00 you will be notified for approval of intended repair.

Include all symptoms of malfunction to lessen our troubleshooting time and costs to you. Parts are quoted net and no dealers discount is offered. In no case will repair exceed 50% of the original selling price. Print name and address, pack well, and attach or enclose letter of particulars in return carton. Allow two weeks for receipt, repair and return. Send repair work to CONTROLAIRE DIVISION, WORLD ENGINES, INC. 8960 Rossash Avenue, Cincinnati, Ohio 45236. Do not return repair work to your dealer.

Controlaire Electronics Division

WORLD ENGINES

INCORPORATED

8960 ROSSASH AVE. CINCINNATI, OHIO 45236