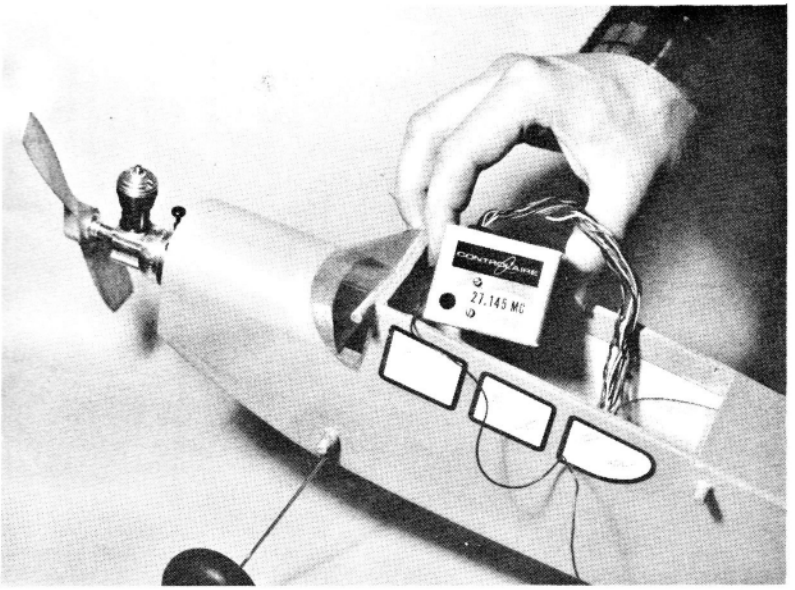
CONTROLAIRE

10 Channel

Superhet

Receiver SH-20



OPERATING INSTRUCTIONS

MADE IN U.S.A.

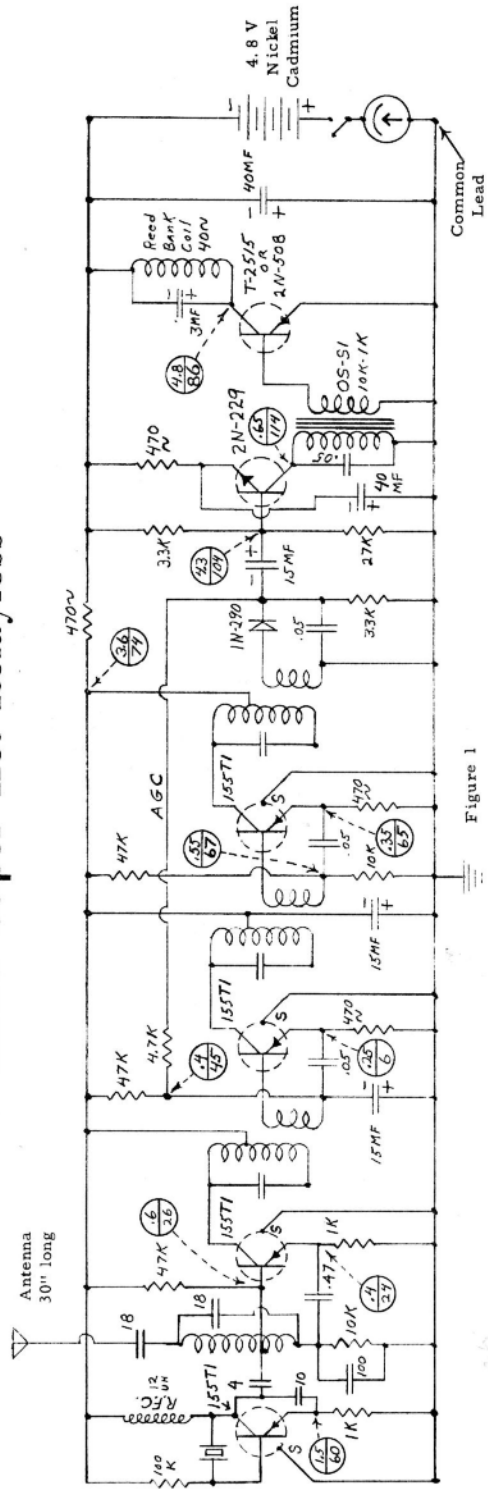


Figure 1

Voltage measurements taken with Heathkit IM-13, V.T.V.M. 5 volt, minus DC scale. Common lead to plus 4.8 volts receiver battery. Receiver idling, no signal from transmitter. Note divided circles on diagram, top No voltage measured, lower No 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.

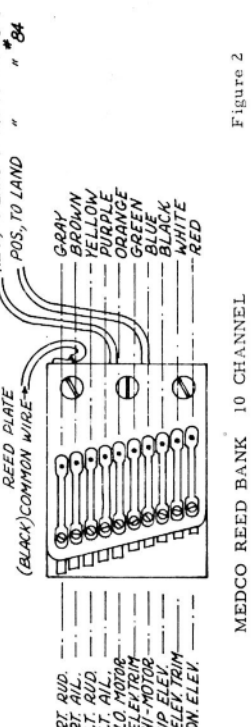


Figure 2

MEDCO REED BANK 10 CHANNEL

INSTRUCTIONS

SUPERHET RELAYLESS RECEIVER
MODEL SH-20

INTRODUCTION

The equipment you have purchased has been painstakingly factory adjusted. Please read this manual before you tinker with it. The receiver is of rugged design, however, certain knowledge and maintenance attention must be exercised to keep it in top order. RC flying is full of hard knocks and for this reason we have prepared this set of instructions. Read and digest its contents before any attempt is made to install or operate your unit.

For best results both a transmitter and receiver should have been purchased as a matched pair. Matched units are factory adjusted for both RF, (radio frequency) and tone frequency to insure proper channel operation. If your receiver was purchased separately it will be your responsibility to effect proper tone match to your transmitter. Receivers are supplied at any of the six spot frequencies for radio control use. Operating frequency is stamped on top of local oscillator crystal in receiver. RF output from transmitter must match this frequency. All receivers are intended for relayless operation and employ the "COMMON" type reed plate in the reed bank. Because of this the BONNER TRANSMITE or similar transistorized servos must be used.

CIRCUIT DESCRIPTION: THEORY OF OPERATION

There is a great difference between the superhet and the super-regen type receivers used in radio control. The superhet is superior in channel selection (selectivity) and is less affected by noises created by servos and other sources. Inherent internal noises also are not a problem. Selectivity of a superhet is attained by use of more tuned circuits known as intermediate frequency amplifiers (IFT coils). Where the standard super-regen receiver used only one tuned circuit to select operating frequency, your superhet uses four. The super-regen was broad tuning, but the superhet, with its increased efficiency of four tuned circuits, has very narrow bandpass characteristics and tuning is very sharp. Because of this, it is very selective and can reject the unwanted signals of others operating on the citizens band.

In operation the transmitted carrier signal is picked up by the receiver antenna, fed to antenna tuned circuit and thus to the base of the mixer IF stage. This in-put signal is combined with a signal from the receivers local oscillator, which is crystal controlled, and through the process of mixing the two signals a third is created for use in the intermediate frequency amplifiers. In this case we have controlled the frequencies of the in-put signals to produce a third or 455KC IF frequency. The reason to effect a change to a lower frequency, for IF amplification, is that greater efficiency can be obtained in the tuned circuits. Since the IF amplifiers are tuned to pass and amplify only the 455KC signal, the two original signals disappear. From the mixer and through the first and second IF stages we have great amplification of our IF signal but it is still only an RF carrier with no tone information. The tone signal

originates in the transmitter when it is keyed. This is known as amplitude modulation of the basic carrier. Amplitude modulation is the process of varying the strength of the carrier at an audio tone frequency and this, in turn, is presented to the mixer of the receiver. If the input to the mixer is amplitude modulated so will the resultant IF carrier be modulated. From here, and at the last IF stage, we detect the audio tone with a diode and discard the IF carrier. The tone is presented to the input of two stages of audio amplification and the total gain is such that it turns power on and off at the reed bank at an amplitude to drive the reeds. If the tone frequency matches that of any particular reed, the reed vibrates and in so doing conducts the signal to the servo transistor amplifier. This operates the servo. Separate channel selection is attained by use of tuned metal reeds, each of which are tuned to vibrate at a specific audio tone frequency. Although brief, this would complete description except for one very important addition-what is AUTOMATIC GAIN CONTROL or, abbreviated, AGC?

AGC is the heart of a good operating superhet. It is needed because the total gain through the IF amplifiers is not self-limiting. The stronger the input signal from the transmitter the stronger the total gain at the IF coils, such that when using any transmitter with less than 100% modulation a condition of clipping and signal distortion takes place to the point of elimination of modulated or tone signal within the IF's. This is called "OVERLOADING" and can prevent operation of the receiver. Good simultaneous operation is dependent on linear amplifier response (no clipping) throughout all stages. If overloading is present, distortion and harmonics are generated which destroy good reed bank operation. Because of this, AGC is introduced to limit the total overall gain proportional to amount of input signal received. This is accomplished by rectifying part of the IF signal at the last IF stage and presenting it as a DC bias to input of first IF. In effect, when the IF carrier reaches a dangerous amplitude in the second IF which could cause overloading and clipping, enough reverse bias is presented to first IF to reduce its gain and control overall response. In a nutshell, this is how a superhet operates. Although brief, possibly we have planted a seed for future learning.

INSTALLATION NOTES

Installation of the receiver in your aircraft will vary with room available. However, one very important item. To reduce your engines vibration effect on the reed bank, the receiver should be positioned so the long axis of the reeds lie in a parallel to the axis of your engines piston travel. For a normal upright engine installation, the receiver should lay in the fuselage on one of its small ends with the reed bank facing the front of the aircraft. By facing reed bank toward the front, damage to the receiver is lessened in the event of a crash.

To protect the unit from shock or crash damage, it should be mounted by sponge rubber or, better still, encased in sponge in its fuselage compartment. Mounting should be firm, however, not so rigid that engine vibration can be transmitted to the reeds and cause unwanted operation. If you experience this, either the tension of mounting is too firm or you have excessive engine vibration. The latter is most often the case, so try balancing the propeller or change prop pitch or size to peak engine at different speeds. The reed bank used is not prone to vibration troubles, but there are limits.

Poorly planned wiring, bad solder joints, defective socket combinations, open type slide switches, are the major causes of RC failures. Less than 5% can be attributed to basic radio malfunction and some of this to improper tuning. Take your time and plan your installation. Wiring should be harnessed together and tied down to fuselage structure. No wire should be left to the mercy of engine vibration. If it is, it will fatigue and break, especially at a connection. Disconnect plugs and sockets should be chosen for firmness of contact. The best we can recommend are those made by CANNON or AMPHENOL. All solder joints should be secure and shiny (not grainy) and covered with insulated sleeving to add protection and strength to the connection. Any frosted appearing solder joint should be remade as this denotes a possible cold solder joint which can fail or become electrically resistant. Use only rosin core or radio type solders and remember to solder any joint correctly--the flux or rosin is equally important at the joint as solder and heat. Flux cleanses the joint and allows solder adhesion. Do not use slide switches for aircraft installations. Instead, select a good grade toggle type.

Serious trouble can be experienced if the radio gear is not protected from balsa dust infiltration, during the building of your aircraft. Balsa dust or any foreign matter in the reed or servo contacts or servo gearing can cause malfunction. So many inexperienced model builders have crashed airplanes because of this that we feel it is worth mentioning. If possible, before installation of RC gear, use air blast to rid your fuselage of dust and shavings.

RELAYLESS SERVOS

This receiver, because it is a relayless unit must be operated in conjunction with servos designed for relayless operation. This type of servo contains a transistorized amplifier that takes the place of relays to operate the servo motor. An example of the proper servo is the "TRANSMITE" manufactured by Bonner Industries. This is available in either neutralizing or trim types. Five servos would be required in a ten channel installation. Three would be "neutralizing" for the control surfaces of elevator, rudder and aileron and two "trim" for motor and elevator trim. Other fine servos are those made by Don Steeb, the GM "Genie" and "MK". The last two are foreign made but of very high quality. All of the above servos operate on the common reed plate system and their voltages and lead color coding compatable to those described on our receiver-servo wiring diagram. Do not use servos requiring higher voltages.

RECEIVER AND SERVO WIRING - COMMON NICKLE CADMIUM BATTERIES

Receiver operating voltage is 4.5 to 4.8 volts and our best recommendation is the use of rechargeable nickle cadmium batteries to best provide this supply. If batteries of at least 500 mah capacity are used both the receiver and your servos can be operated from one common supply. As a common supply battery and because of field tests we have conducted, we recommend the use of the German Deac 5 cell pack. This provides a total of 6 volts and can be voltage tapped to provide proper supply voltages to both receiver and servos. To use this or any other similar battery pack refer to receiver-servo wiring pictorial for

detailed hook-up. Make provisions in the receiver minus power lead to install a tuning meter disconnect jack. The O-50 ma meter (moving coil type) is used to measure receiver current flow during the tuning and adjustment or troubleshooting operation. When meter is not in use, a shorting plug is installed in this jack to complete the circuit. Mount this jack for easy access.

To do the actual wiring involves the identification of the wires coming from the receiver. Protruding through the small rubber grommet is a total of 13 varied colored wires. Two wires, red and black, are twisted together and are the receiver power input wires. Red is plus 4.8 volts and black is minus. If traced into the receiver case, you will note these going into the circuit board just above the small transformer. The remaining eleven wires are attached to the reed bank and are for connection to the servos. Ten of these wires attach to the top of the reed bank contact plate and if you refer to Fig. 2 you will note that each color denotes the function of its contacting reed. For example, the red contact wire denotes that particular reed is for down elevator and another wire, gray, is for right rudder. This function color coding also matches the channels of your Controlaire transmitter and denotes which reed is supposed to function when a particular channel is keyed.

The purpose of the color coding is to identify each reeds function with respect to its operation and connection to the proper servo. This identifies all reed contact wires. The last wire coming from the grommet is the reed plate common wire and it is also color coded black. If traced, you will note it is soldered to a common point at the end of the reed plate. The point in wiring is to identify each wire then connect as shown on the receiver-servo wiring diagram.

RECEIVER SERVO WIRING - DRY PASTE BATTERIES

Regular 1.5 volt pen cells may also be used to power your installation, however, do not use a common battery supply to power both the receiver and servos. Instead use three pen cells to provide 4.5 volts for the receiver and another five pen cells to power the servos. Common supply operation will invite receiver malfunction due to the lesser current capacities of dry batteries and the large current demand of the servos. If used in separate supplies, pen cells will give 25 to 40 flights on the receiver but less on the servos.

To wire this type of installation refer to the receiver-servo wiring diagram and make the following changes in hook-up. Disconnect the receiver reed bank common wire as shown attached to receiver red power input wire at pin 1 of the 15 pin plug. Omit connection of the wires from pins 1 and 2 shown going to and at the black and red common terminal tie points. This isolates the receiver red and black power wires from the servo batteries. Reconnect the receiver power wires from pins 1 and 2 to a separate 4.5 volt set of batteries. Red is plus, black is minus. In the black minus lead install an additional receiver on-off switch and meter disconnect similar in manner as shown on diagram. Reconnect receiver reed bank common wire to pin 13 of plug and extend an additional wire down to the red common terminal tie point. This connects the reed bank common wire to the servo batteries as required. At this point, substitute five 1.5 volt pen cells for the five nickle cadmium batteries then proceed to wire up the servos as the balance of the diagram shows.

RECEIVER-SERVO - WIRING DIAGRAM - NOTES

This diagram has been prepared to help a beginner with the complete wiring of a multi installation. It shows the use of a 5 cell, 500 mah Deac battery pack to supply power to both receiver and servos. This usually will provide power for over four hours of solid flight. If more capacity is needed in a flying session, install a disconnect plug at point "C" in diagram and plug in a spare pack when needed.

The 5 cells of the Deac battery pack are contained within one singular plastic sheath and all internal connections are welded. To use the pack involves connection of four wires. These are voltage taps. The green and red are easily soldered to the battery end tabs. The following explains the connection of the black and white wires.

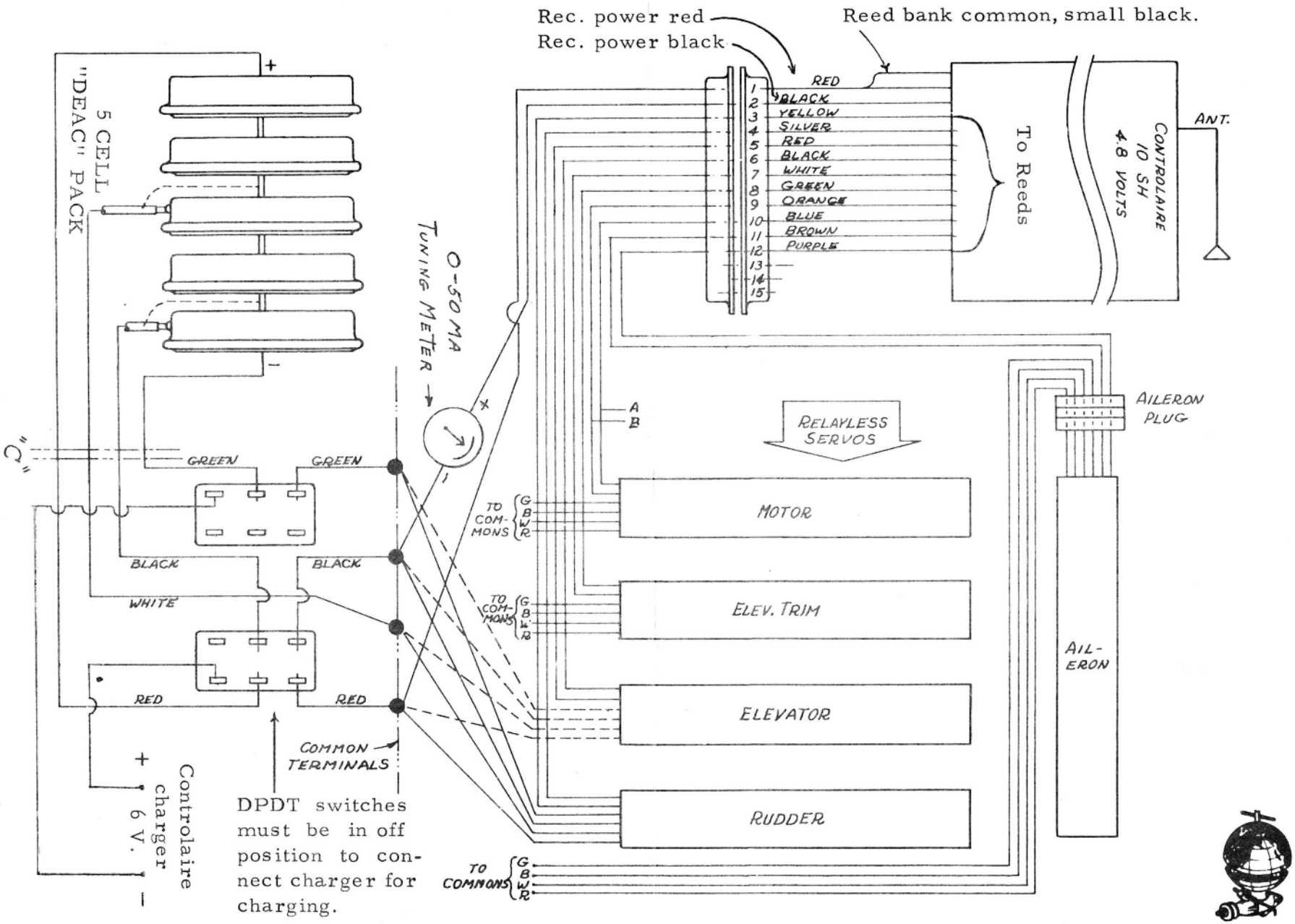
Notice that the connections are made to the outer edge of the battery jacket. To do this cut away a little 1/4" square window in the plastic sheath then solder the leads to the cells as shown. Use a hot iron to do the soldering as low heat can result in a poor connection and possible damage to the battery. After all leads are soldered use plastic electrical tape and fully wrap batteries and connection to provide additional insulation and a strain relief for the attached wires. The result is a neat, small size battery pack that takes up a minimum of space. It should be mounted by encasing it in sponge rubber then packing it into a fuselage compartment.

The Controlaire 6 volt charger is recommended as a companion unit to charge the battery pack. The charge rate is a nominal 30 to 35 mills and usually a 6 to 12 hour charge period, depending on previous use, will bring battery up to full charge. Other components needed and suggested are available from World Engines.

1 ea. Controlaire 6 V Charger & Deac 5 cell pack	$19.95
1 ea. Cannon 15 Pin Plug & Socket Set	4.50
2 ea. DPDT Toggle Switches	1.75 ea.
2 ea. Phono-plug & sockets for charge & meter disconnect	.30 ea.
1 ea. Orbit or Deans 6-8 pin plug & socket for aileron disconnect	1.10
1 ea. 4 terminal strip for common terminal tie points	.30
1 ea. O-50 MA Controlaire tuning meter	4.95

As shown, each servo has six color coded wires. Four are colored; Green, Black, White, Red. These connect to the common terminal tie points and supply battery power to each servo. The remaining two wires are color coded yellow and orange and are the signal input wires. These ultimately attach to the reed function wires, however, to do this properly, let us take one servo and go through the actual hook-up. For an example, we will connect the aileron servo which is a neutralizing type. The servos are marked, orange - input to create a definite travel position one way and yellow - the opposite. The point, depending on your particular installation linkage, is to determine which colored input creates correct aileron travel. After this is known and assuming for our example that orange gave left aileron and yellow right, we

Receiver - Servo Wiring Diagram



WORLD ENGINES INC.

8206 BLUE ASH ROAD CINCINNATI 36, OHIO

would connect the orange servo wire to the purple reed bank wire and yellow servo wire to the brown reed bank wire. The linkage hook-up from servo to control surface governs selection of orange or yellow to give correct surface travel. This applies to all servos.

RECEIVER OPERATION

To check operation, temporarily install the tuning meter and turn receiver on. With no carrier or signal from transmitter, the unit should idle at approximately 5 ma and have a rather steady needle reading. Some units when operating at maximum voltage input may be slightly nervous but is normal due to increased sensitivity and atmospheric noises. Turn transmitter on and key the different channels. Note when keying the down elevator channel (highest tone) the current rises to about 40 ma and with right rudder to about 50 ma. These values are approximate and will vary with input voltage. As each channel is keyed, assuming transmitter tone pots to be in tune, each corresponding reed should vibrate and, if turned on, the servo should operate. Needle nervousness, if present, will disappear when transmitter carrier is turned on. For close in bench operation, do not expect best simul operation. Operation of the superhet can be quite different with transmitter carrier off than when on, especially on the workbench and in a confined area that has a lot of electrical noise present. The reason for this is that the receiver is in its most sensitive state when no carrier is on. With carrier on AGC is supplied and operation should be normal.

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, however, do not purposely operate right on top of an 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.

When adjusting your tone pots for best simul operation, do so with your aircraft placed about 10 feet from transmitter antenna. Simul operation closer than 10 feet may be affected due to overloading the receiver with powerful signal. This causes distortion of the mixed tones within the IF section and good simul is hard to obtain. Beyond the approximate 10 foot distance, simul operation will not be affected by overloading.

While flying with your buddy on the adjacent or any channel, do not get too close to him in the excitement. Keep your transmitter antennas separated by at least 10 feet. The meaning behind this is that another transmitter, if close enough, can plate modulate your carrier signal by pick up of his modulated RF power by your antenna. This can modulate your carrier by his tone up to a point of about 1% to 5%. The superhet can pick up this low percentage within reasonable range so use care. Tests show no problem at 10 feet, however, some flyers have bumped antennas in the excitement.

Receiver operating frequency is determined by frequency of crystal in local osciallator. It is a third overtone type and cut to a frequency of 455KC lower than receiver input operating signal. Replacement should be of the same type and are available from the Controlaire Division of World Engines at $4.95 each net.

When ordering, specify RC spot frequency desired - 26.955 mc, 27.045, 27.095, 27.145, 27.195, or 27.255. To replace crystal in receiver, solder into place. Use care and do not overheat. After replacement, receiver tuning and sensitivity should be checked and readjusted, if necessary, as outlined under "RECEIVER TUNING"

RECEIVER TUNING

The receiver was 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 the Controlaire 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 at least two feet, all is in order to fly. If not, accomplish the following check. Install tuning meter and note at the two foot distance if current is rising to at least 20 ma. If so, then reason for non-operation is mistuned tone pots. If small or no rise is noted, receiver tuning is probably at fault. 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 and slowly adjust slug for highest reading on meter. As the slug is peaked and current rises to the maximum level of about 50 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 and repeat the above. In sequence, back away transmitter and weakens signal each time adjustment brings current level to saturation. In same manner, peak the 2nd IF 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 1st IF are somewhat critical but tends to broaden out at the 2nd IF and antenna coil. This is normal. When finished you should get at least 20 ma reading at the minimum two foot distance. The average will be about three feet.

During the above sensitivity check, it will be noted that the high frequency tone channels operate at a slightly further distance than do the low channels. The 2' minimum distance is in reference to the high channel. Assuming tones to be in tune, simul will operate but not at maximum distance.

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 2' operation, ground range (receiver held head height) will be in excess of 1/2 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 distances expressed above are for companion use with Controlaire transmitters only. Other transmitters will give varied distances due to varied output, less antenna, etc.

TRANSMITTER TONE ADJUSTMENT

Tone channels of the Controlaire transmitters are adjustable through a small frequency range for each channel. If you find some of the channels do not operate the intended reed properly, these channels must be retuned. Remove back cover from transmitter to gain access to tone adjustment pots. The correct pot for a particular channel is identified in your transmitter instruction book.

With fair transmitted signal (antenna installed, but collapsed) start keying each channel separately and in the following manner, swing the tone slowly from high frequency to low noting the point where the reed started, then going slightly lower for best reliability. For fast keying and starting characteristics, reeds should be tuned slightly on the low frequency side of maximum drive. On each pot, the tone is at its highest frequency with full counter-clockwise knob adjustment. Start at this point and rotate pot clockwise to swing frequency from high to low. For simul operation, each channel may require more exact adjustment. The point is to key both channels and tough up as necessary. Remember, for best simul the aircraft should be at least 10' from transmitter to prevent overloading. Adjust by noting operation of control surfaces.

MAINTENANCE NOTES

Due to the compact physical design of the SH-20 receiver, certain care should be exercised in removing the top lid. Unlike older receivers the circuit board is mounted in the lower case and the reed bank, piggy back, in the top lid. When removing the lid, do so slowly so as not to break any connecting wires from the reed bank to the circuit board. The best procedure is to slowly remove top lid then, as it comes up, push the red and black power wires inward through grommet to present more wire slack. With little trouble the lid can be opened to gain access to reed bank or circuit componants. When reinstalling the lid, do so with the same gentle case. Be sure that the wires attached to the reed bank are spaced evenly and flat and do not interfere with the complete closing of the top lid when installed. If you experience an oil can effect to the complete closing, reopen and check bunching of wires inside the case. When wires are properly spaced and flat there is a nominal 1/8'' clearance between internal componants. After the lid is reinstalled, pull slightly on the red and black power wires to remove internal slack. Use small rubber band around case to secure assembly.

Periodically inspect the reed bank for general condition. Look for dirt residue that tends to collect because of exhaust fume oil contamination. Inspect the reeds for oxidation or rust, connections for firmness, bent frame or uneven reed spacing and last, if doubtful about contact cleanliness, burnish lightly with contact burnishing tool. However, other than the inspection and necessary cleaning, do not attempt specific adjustment unless malfunctioning is evident. In other words, do not fiddle. Aside from shipping and handling abuse, the reed bank can be knocked out of adjustment by the rigors of general R/C flying. To allow you to make touch-up adjustments, the following information is presented in its entirety. Make sure you understand the principles before any part or complete adjustment is started. To prevent damage to servos, on any major adjustments, insure that power is off.

The reed plate to coil pole piece clearance should be initially set to about 3/64''. This means each reed should be positioned above the magnetic pole piece 3/64''. If any reed is closer, its drive will be greater and vice-versa. To accomplish this, first back off the reed contact screw so it is flush with micarta board, then with small blunt tool, apply pressure at base of reed to bend it either up or down to get the 3/64'' measurement.

With fair transmitted signal (antenna installed, but collapsed) operate each channel and note the drive of each reed as it begins to vibrate. Adjust each reed contact screw to limit the arc of vibration to about 1/16'' on highest frequency reed and increasing this arc up to 5/64'' on lowest frequency reed. This is the arc created by the reed tip while it is vibrating. Transmitter tone pot adjustment will need touch-up as each reed is adjusted. Remember to swing the frequency from high to low slowly, noting point where reed first started, then going slightly lower to guarantee good starting and fast keying. Never tune a reed at point of maximum drive.

After this adjustment, you should get good single channel operation, however, inspect closely as each channel is keyed and note if the adjacent reeds are being tickled. Note this at the instant of keying action and during sustained vibration.

A slight action of the adjacent reed or reeds can be tolerated but not to the extent of operating, even momentarily, the unwanted channel. At the above adjustment clearances, you should not experience this but, if you do, increase the reed plate to pole piece clearance to lessen drive.

Reed bank drive and adjustment for single channel operation is somewhat a minor problem; however, for dual simultaneous, certain facts should be understood. The first is that, during simul, the signal power available in the reed coil divides between the two reeds and only half as much power is available for each reed as compared to single reed operation. This means each reed has reduced drive and because of this becomes more critical to its exact tuned frequency. Second, adjustment clearances and contact cleanliness become more important. Reed drive is a product of the signal power available in the reed coil and the reed to pole piece clearance. This initially was set to about 3/64''. If set closer, drive increases and vice-versa.

Start by keying both the elevator down channel (highest frequency reed) and right rudder (lowest frequency reed). Note the drive of each reed and adjust the fine tuning of the reed that appears weak. This may be just one or both but the point is to peak tuning on both reeds where each will drive simultaneously with the other. Note if corresponding control surfaces are operating. If not, it might be necessary to close in the reed contact screw slightly. Continue by again keying down elevator and this time left rudder. Adjust fine tuning and contact screw, if necessary, then alternate the keying while holding down elevator between right and left rudder. This time, key up elevator and alternate right and left rudder, adjusting fine tuning as necessary. Continue the test until up and down elevator is working simultaneously with right and left rudder and aileron. There is no point in attempting simultaneous engine speed with aileron. The procedure you must follow when adjusting a reed bank for simul depends upon the results that you get as you pursue the adjustment. If the drive on a reed appears to be limited, you then decrease the reed to pole piece clearance. Be careful that you do not decrease this clearance to the extent that, when operating on single channel, you get interaction between this reed and others. If a reed appears to be driving properly but surface does not operate, check the contact clearance in the reed bank, and also the contact cleanliness. Use a burnishing tool to clean these contacts.

In extreme cases, it may be necessary to change the frequency of a particular reed. You can recognize this if a reed seems to be affected by a beat note during simultaneous operation. These beat notes are developed by multiples of sums and differences between the frequencies and, occasionally, you will get a troublesome beat note that just cannot be tuned out. There are numerous beat notes, however, most of them are of extremely low power. The troublesome ones are from 1-5 cycles per second and this will cause a reed to drive in and out and will create the same intermittent effect upon the control surface. To change a reeds operating frequency you can place a tiny spot of solder on the reed to lower its frequency or you can clip the reed to increase its frequency.

Dry pen cell batteries when used should be replaced when voltage under load is less than 3.8 volts. Operation is possible down to 3 volts, however, sensitivity and range will be reduced accordingly.

Temperature operating range is conservative when expressed as from O-120 degrees F., however, do not intentionally allow your aircraft exposure to excess sun and heat if shade can be provided. In 90 degree sunny weather, it is possible for temperature to exceed 150 degrees in cabin of aircraft. This is due to radiation absorption and poor ventilation. If you must operate continually above the 120 degree F. point, then try a heat soak test in your aircraft and recheck operation and sensitivity. If, at the higher temperatures, sensitivity is reduced to less than 2 feet, retune RF and IF stages to operate at higher temperatures.

In the event of severe shock to the receiver it is possible to fracture the local oscillator crystal. If your receiver appears completely inoperative a voltage check should be made at circuit land 60 as prescribed by circuit diagram information. If voltage is in excess of 2 volts you may assume crystal is broken.

PRE-FLIGHT TEST

Before the first flight of the day or any time you would suspect improper operation as a result of hard landing or crash, complete the sensitivity test. In other words, operate receiver with antenna-less transmitter and note the maximum distance of operation. This should be the same distance as you determined on your initial receiver tuning test. (At least 2' and possibly greater as receivers will vary slightly.) Basically, it tells you your receiver is operating as before, that batteries are O. K. and that tuning is O. K. If distance changes drastically, or a particular channel does not operate properly, then something is wrong. It requires just two minutes time and will prevent flying with a malfunction.

DO'S AND DON'T'S

Do your best to make a secure and neat installation, with attention to solder joints and harnessed wiring. Don't be in a hurry.

Don't use slide switches, instead select a good toggle type.

Don't change antenna length unless you repeak antenna coil and do so with receiver lid on. Desired antenna length is 24 to 36 inches.

Do use insulated tuning tools. Don't use screwdriver or metal tools.

Don't use tuning meter lead length in excess of 5".

Do use a moving coil type tuning meter, o-50 ma. Vane types can give inaccurate readings.

Don't expect perfect simultaneous with transmitter on top of receiver, separate by at least 10 feet.

Do perform the pre-flight sensitivity and operational check before first flight of day, two minutes time is worth cost of aircraft.

Don't hug your buddy while flying. Remember powerful transmitters can modulate one another.

Don't fiddle with reed bank unless malfunction is evident, then understand adjustment before attempting same.

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 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 mis-understandings result.

SERVICE

The minimum fee for inspection and repair is $6.50. Include this amount with receiver. If inspection reveals charges to be in excess of $25.00 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. 8206 Blue Ash Road, Cincinnati, Ohio 45236. Do not return repair work to your dealer.

Controlaire Electronics Division

World Engines, Inc.

8206 Blue Ash Road

Cincinnati 36, Ohio