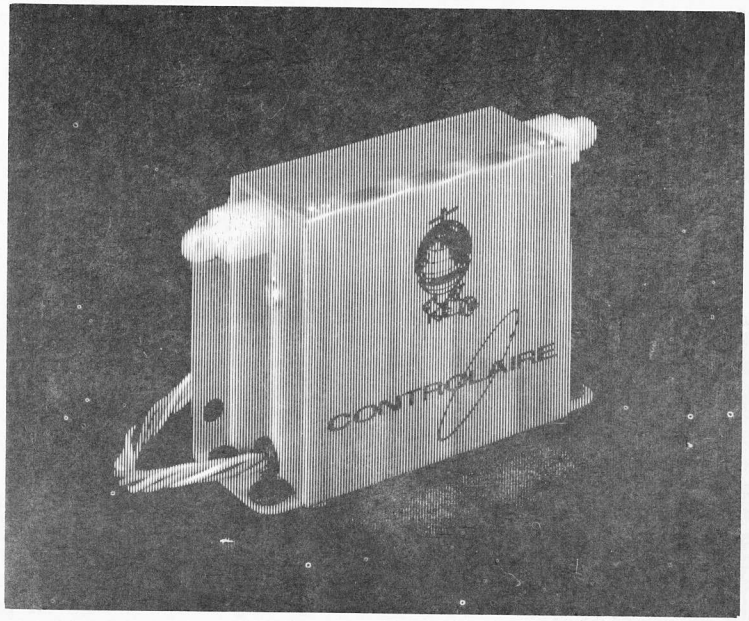
CONTROLAIRE

Reed Multi Channel Servo



ASSEMBLY INSTRUCTIONS

Made In U.S.A.

INTRODUCTION

Controlaire now enters the servo manufacturing field. In development for over one year we now offer as an assembly kit the Controlaire Multi Servo. Its design reveals several very important features. One, its ease of troubleshooting and repair. As with any servo, the rigors of R/C flying and time will eventually introduce a failure. It would be foolish to believe otherwise so we, in our design concept, decided that all internal working parts be centered around and attached to a central "C" frame. To this end the top and bottom case can be removed for complete inspection of internal parts and still the servo is operable. Whether your trouble be mechanical or electrical the troubleshooting effort is eased by operable access to internal parts. A second feature is that the gear train is fully adjustable to any degree of gear mesh clearance by adjustment to the gear support pins. Third, the electrical circuit is an improved version of our earlier 6X amplifier that has already proven itself in thousands of sales and years of use. Other features include strong mechanical design, a 5 pole double brush motor and Cilcon plastic gears and traverse rack.

PRELIMINARY NOTES

The multi servo kit has been supplied to you with the electronic parts and the servo mounting kit packaged within one package and mechanical parts such as top and bottom case, "C" frame, motor and plastic parts packaged as a separate unit. It is suggested that you lay out all parts and check them against the Parts Price List to insure completeness of your kit. Use care when disassembling the mechanical parts that are included within the servo's top and bottom case. Carefully remove the top and bottom and note the "C" frame rack and gears and circuit board that are installed within the case. Be careful when removing the traverse rack from the case so that you do not damage the small contact brushes. A good procedure to do this removal is to use the small black piece of insulator board as a shoe horn forcing it in between the frame and the circuit board thus allowing smooth removal of the traverse rack and thus preventing any possible damage. After you have removed the "C" frame, traverse rack and other parts from the one package assembly, carefully study the general overall assembly picture that is in front of you. Remove the small #2 x 3/16" long screw that attaches the circuit board to the "C" frame. Refer to Fig. 1. This is the pictorial showing the assembly of circuit components to the circuit board. Refer also to the actual circuit board. Notice that the pictorial is a top view of the main circuit chassis and that all components are assigned specific hole numbers to insure their exact placement on the circuit board. The shaded area of Fig. 1 represents the copper circuit lands and although on the under side of the board the same lands can be recognized from the small servo board by holding it up to a light source where the pattern will show through. By using the light on the actual servo board specific holes can be identified by association with the pattern of 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 with the circuit board in an upright position with their bodies standing over the holes as shown. Some parts may have special positioning but in all cases this is brought to your attention during the assembly step as the part is installed. As each part is installed to the circuit board bend its leads over slightly to hold it in position for soldering, then after soldering, clip off excess leads about 1/16" from the etched circuit copper. Do not flush bend any component leads to the circuit copper as, if removal is necessary, it cannot be done without damage to the part. Because of the small close solder work, it is suggested that a small soldering iron be used. The Ungar soldering pencil equipped with no larger than a 37½ watt heat element is best suited for the soldering of this kit. Start construction by referring to the assembly steps. During each step refer to pictorials for necessary parts location and solder the leads of each part as it is installed. Place a check mark in the space provided at the completion of each step. Good luck and may your experience be a pleasant one.

The instruction for both the neutralizing and trim multi servos is identical. You will notice that during the following assembly steps that it will be noted that a certain part is omitted in a trim servo. If you are building a trim servo, just omit the part when specified to do so.

ASSEMBLY INSTRUCTIONS

( ) 1. Assembly is started by first cleaning the circuit board copper so soldering may be done easily and with the least amount of heat. This is best accomplished with a pad of fine steel wool, however, one word of caution. Do the cleaning away from your normal work area. The reason for this is to prevent the steel wool residue from being attracted to the servo motor and other parts of the servo amplifier kit. Scrub the circuit board lightly but thoroughly until it is bright and shiny.

( ) 2. This step is omitted when building a trim servo. Notice the markings on the glass body of the DHD 806 diode. Note that on one end there is a white band. Install diode with white band end going into hole 32 and other lead going into hole 31. Stand body of diode over hole 32.

( ) 3. This step is omitted when building a trim servo. Install another DHD 806 diode with white band end going into hole 10 and other lead going into hole 9. Stand body over hole 10.

( ) 4. Inspect the 15 mf electrolytic condensers. Notice that on one end there is a red marking. This is the positive lead of the condenser. Install a 15 mf electrolytic condenser with positive end inserting into hole 24 and negative end into hole 25.

( ) 5. Install another 15 mf electrolytic condenser with positive lead inserting into hole 7 and negative lead inserting into hole 8.

( ) 6. Install a 15 ohm (brown, green, black) resistor in holes 29 and 30.

( ) 7. In this step three identical 100 ohm (brown, black, brown) resistors are installed. Install one in hole 14 and 15, install another in holes 20 and 21, install another in holes 22 and 23.

( ) 8. In this step four identical 1500 ohm (brown, green, red) resistors are installed. Install one in holes 26 and 27, install another in holes 33 and 34, install another in holes 35 and 36, install another in holes 37 and 38.

( ) 9. In this step three identical 1500 ohm (brown, green, red) resistors are installed. Omit this step if building a trim servo. Install one resistor in holes 39 and 40, install another in holes 41 and 42, install the last one in holes 43 and 44.

In the following steps, the transistors will be installed to the circuit board. Refer to the transistor identification pictorial **diagram 1A** identify the collector, base and emitter leads coming from each transistor.

( ) 10. Install a GC-4008 transistor with emitter leads going into hole 13, base lead going into hole 12, collector lead going into hole 11. Stand the body of this transistor about 1/8" above the surface of the circuit board.

( ) 11. Install the remaining GC-4008 transistor with emitter leads going into hole 19, base lead into hole 18 and collector lead into hole 17. Again, stand body of transistor about 1/8" above surface of circuit board.

( ) 12. Refer to both Fig. 1 and Fig. 2 to get correct understanding of the installation of the four 2N2924 transistors. Notice on this transistor that the center lead is the collector. Notice also on Fig. 2 that one transistor has the center lead which is the collector bent away from the flat side of the transistor and three of the transistors have the collector and leads bent toward the flat of the transistor. Install a 2N2924

transistor with base lead going into hole 45, collector lead going into hole 46, and emitter lead going into hole 47. Stand the body of this transistor about 1/8" above the surface of the circuit board.

( ) 13. Install a 2N2924 transistor with base lead going into hole 48 collector lead going into hole 49 and the emitter lead going into hole 50. Push body of transistor down allowing about 1/8" clearance between circuit board and bottom of transistor.

( ) 14. This step omitted when building a trim servo. Install a 2N2924 transistor with base lead going into hole 51, collector into hole 52 and emitter into hole 53. Push body of transistor down allowing about 1/8" clearance between circuit board and bottom of transistor.

( ) 15. This step omitted when building a trim servo. Install a 2N2924 transistor with base lead going into hole 54, collector lead into hole 55 and emitter lead going into hole 56. Again space bottom of transistor about 1/8" from surface of circuit board.

( ) 16. Using bare tinned copper wire such as a clipped off resistor or transistor lead, insert a small piece of wire into each of the following circuit board holes. Holes 1, 2, 3, 4 and 5. Solder wires to copper lands on both sides of the board to make a feed through type of connection at these holes. Clip off extra wire but insure a positive connection.

( ) 17. Refer to figure 3 and notice that this is a view of the copper side of the circuit board showing the installation of the wires to specific copper lands on the board. Notice also the exact routing of the wires from strain relief hole to each copper land. The purpose of the routing is to prevent a solder point from piercing any of the wires. The wires are routed between the solder points to prevent accidental shorting. To install these wires do so using the following procedure. Strip 1/16" insulation from the end of each of the colored wires. Individually and before running wires through strain relief hole No. 28 take each wire separately and solder to the following lands. The black lead to copper land containing hole No. 11. The orange wire to copper land containing holes 25, 31 and 33. The yellow lead to copper land containing holes 8 and 9. The red lead to copper land containing hole No. 7. The green lead to copper land containing hole No. 29. After all leads are soldered to their respective copper lands route them as shown in figure 3 into hole No. 28. Be sure no wire is standing exactly over any solder point. Inspect to insure that you have created no solder shorts. This completes assembly of the main circuit board.

( ) 18. Refer to figure 4 and inspect your C frame and motor assembly for the following conditions. Be sure the motor has been installed with the red dot located at the bottom of the C frame. Notice that there are small red and blue leads that should have been clipped off flush to the surface of the motor. These are not to be used. Next, check the tightness of the motor hold down screws, then proceed to install the 15 ohm (brown, green, black) 1/2 watt resistor. Prebend and form the resistor leads, positioning the resistor body in the lower right hand corner of the motor. Solder the resistor to motor terminals A & B as shown. Use heat-shrink spaghetti tubing to prevent any shorting of the one lead. To insure the resistor body will not interfere with the installation of the servo case, sight along the side of the C frame to see if the body of the resistor is positioned to allow clearance.

( ) 19. Strip 1/8 insulation from one end of the 9 inch white wire and the three inch blue wire. Solder the 9 inch white wire to terminal A as shown. Solder the three inch blue wire to terminal B as shown. Use care when soldering to terminals A & B and do not allow the solder to protrude beyond the height of the plastic cover on the back of the motor. If it does, it will interfere with the proper installation of the servo bottom cover later on.

( ) 20. At this point refer to figure 6. Notice that it is an exploded pictorial showing the mechanical assembly of the servo. Install the circuit board to the C frame using the following procedure. Hook the front section of the board into the front slots of the C frame then slowly push the board down until it is flush against the C frame mounting tab. Use a No. 2 x 3/16" sheet metal screw to secure circuit board to C frame. You might notice that when installing the circuit board that the 2N-2924 transistor nearest the motor tends to interfere with the installation. If it does, push sideways or backwards to allow proper clearance. After the board is installed, inspect the front end of the C frame to insure that in tightening the sheet metal screw that the circuit board did not tend to twist. The ideal condition is to have the front edge of the circuit board aligning exactly to the front edge of the C frame.

( ) 21. Cut the blue wire that attaches to terminal B of the motor to a length of 1 3/4 inches. Remove 1/8 inch insulation from the end of this wire, pretin, and insert into hole 16 of circuit board. Solder the connection.

( ) 22. Inspect the brush contact land on the top of the circuit board for a dirty condition. If they appear dirty or corroded, use a common pencil eraser, scrubbing the lands until they are bright and shiny.

( ) 23. Install the plastic gears as shown in the pictorial. As each gear is installed, check it for free running clearance. If it appears that any one gear binds or has excessive gear-mesh clearance, this can be remedied by using the following procedure. Study the riveted idler shafts and note that if they are bent closer to or farther away from one another, the clearance will be increased or decreased accordingly. Normally no adjustment should be required, however if yours is a severe case of binding or excessive clearance, you may bend the pins to eliminate the condition.

( ) 24. Inspect the contact springs located on the plastic traverse rack. Notice that the two outboard springs (Neutralizing contacts) have a round hemispherical kink bent into them. This is intentional and as you will later learn is used to adjust the neutral center of the servo. The point though in this inspection is to see if any one spring is twisted or bent out of shape in reference to the others. If any appear so, carefully re-align till all appear even. Do not remove the kink from the neutralizing contacts.

( ) 25. Do not completely install but place the traverse rack into position even with the rack slots in the front of the C frame. Notice that the contact springs extend down close to the bottom surface of the circuit board. The point here is to adjust proper contact spring pre-load. All springs should extend at least even to the bottom surface of the board. If they do, it would mean that when the rack is fully installed the springs would be compressed the thickness of the board or about .045". Proper pre-load is .045" to .060". Adjust your springs accordingly.

( ) 26. To install the traverse rack, use the black phenolic insulator board as a shoe horn to prevent damage to the springs. Place the board on the contact land side of the circuit board, then put rack into position compressing the springs against smooth surface of insulator board, then carefully slide rack into position. Remove shoe horn but always use this procedure when removing or installing traverse rack.

( ) 27. At this point, the servo is ready for test operation and adjustment. To do this requires a battery power source. Use your 6 volt receiver-servo power pack and through its output plug or wiring, make output connectors to Fahnstock clips or other connectors to facilitate connecting to the servo power wires. Refer to figure 5 for hookup information. Notice that the servo signal input wires, orange and yellow are not connected to the battery. Instead when testing these wires, one at a time, are touched to the 6 volt plus terminal of the battery to obtain a keying signal to drive the servo either one direction or the other. Do not at this time hook up your servo but rather get your battery power source ready.

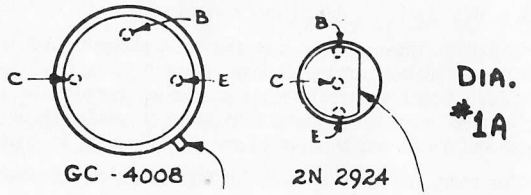
cont'd on Page 12

CONTROLAIRE MULTI SERVO

PARTS PRICE LIST

QUANTITY	DESCRIPTION	PRICE EACH
	ELECTRONIC PARTS	
( ) 2 ea.	GC-4008 Transistor	$ 1.50
( ) 4 ea.	2N-2924 Transistor (*2 ea.)	1.50
( ) 2 ea.	15 MF at 15 volt Electrolytic Condenser	.90
( ) 3 ea.	100 ohm (brown, black, brown) ¼ watt resistor	.12
( ) 7 ea.	1500 ohm (brown, green, red) ¼ watt resistor (*3 ea.)	.12
( ) 1 ea.	15 ohm (brown, green, black) ¼ watt resistor	.12
( ) 1 ea.	15 ohm (brown, green, black) ½ watt resistor	.10
( ) 2 ea.	DHD Silicon Diodes (*2 ea.)	.35
( ) 1 ea.	1" length spaghetti tubing 1/16"	.02
( ) 1 ea.	9" length of red, white, black, green, orange, yellow wire	.01
( ) 1 ea.	3" length of blue wire	.01
( ) 1 ea.	Circuit Board	1.75
( ) 1 ea.	Insulator Pad for Circuit Board	.15
	MECHANICAL PARTS	
( ) 4 ea.	#2 x 1/8" Sheet metal screws	.02
( ) 3 ea.	#2 x 3/16" sheet metal screws	.02
( ) 1 ea.	Signature or Top Case Part S7	1.95
( ) 1 ea.	"C" Frame with gear mount pins Part S6	1.95
( ) 1 ea.	Traverse Rack Part S5	1.50
( ) 2 ea.	Nylon Gear — 1st and 3rd — Part S3	.25
( ) 1 ea.	Nylon Gear — 2nd — Part S4	.25
( ) 1 ea.	Pinion Gear, Part S2	.25
( ) 1 ea.	Servo Motor w/mounting Screws — Part S1	5.50
( ) 1 ea.	2' length of Solder	.10
( ) 1 ea.	Bottom Case — Part S8	1.95
( ) 1 ea.	1/8" x 1/4" Rubber Grommet	.02
( ) 1 ea.	Servo Mounting Kit — CS-MK1	.25

*Parts omitted in trim Servo kit.



ABOVE VIEWS ARE FROM ON TOP WITH LEADS EXTENDING DOWN. (TO ORIENT TRANS. POSITION)

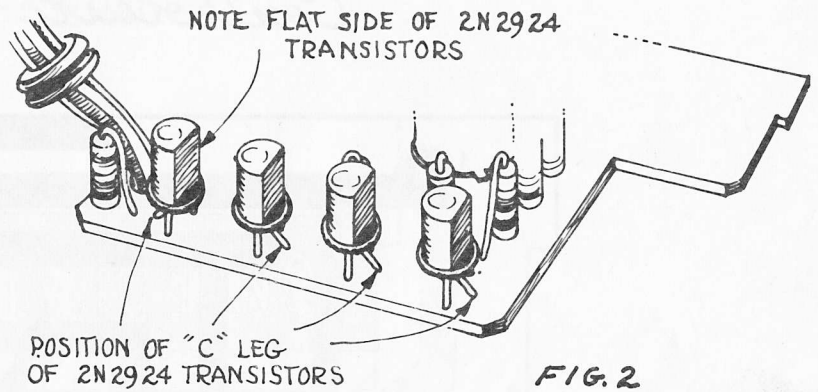


FIG. 2

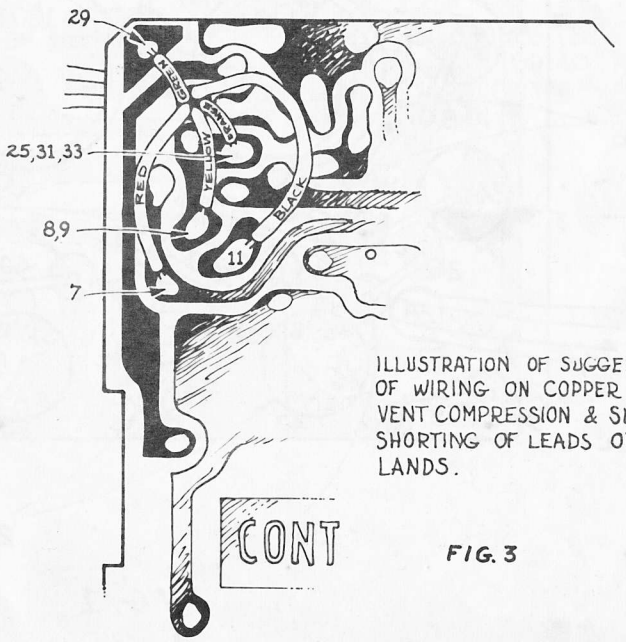
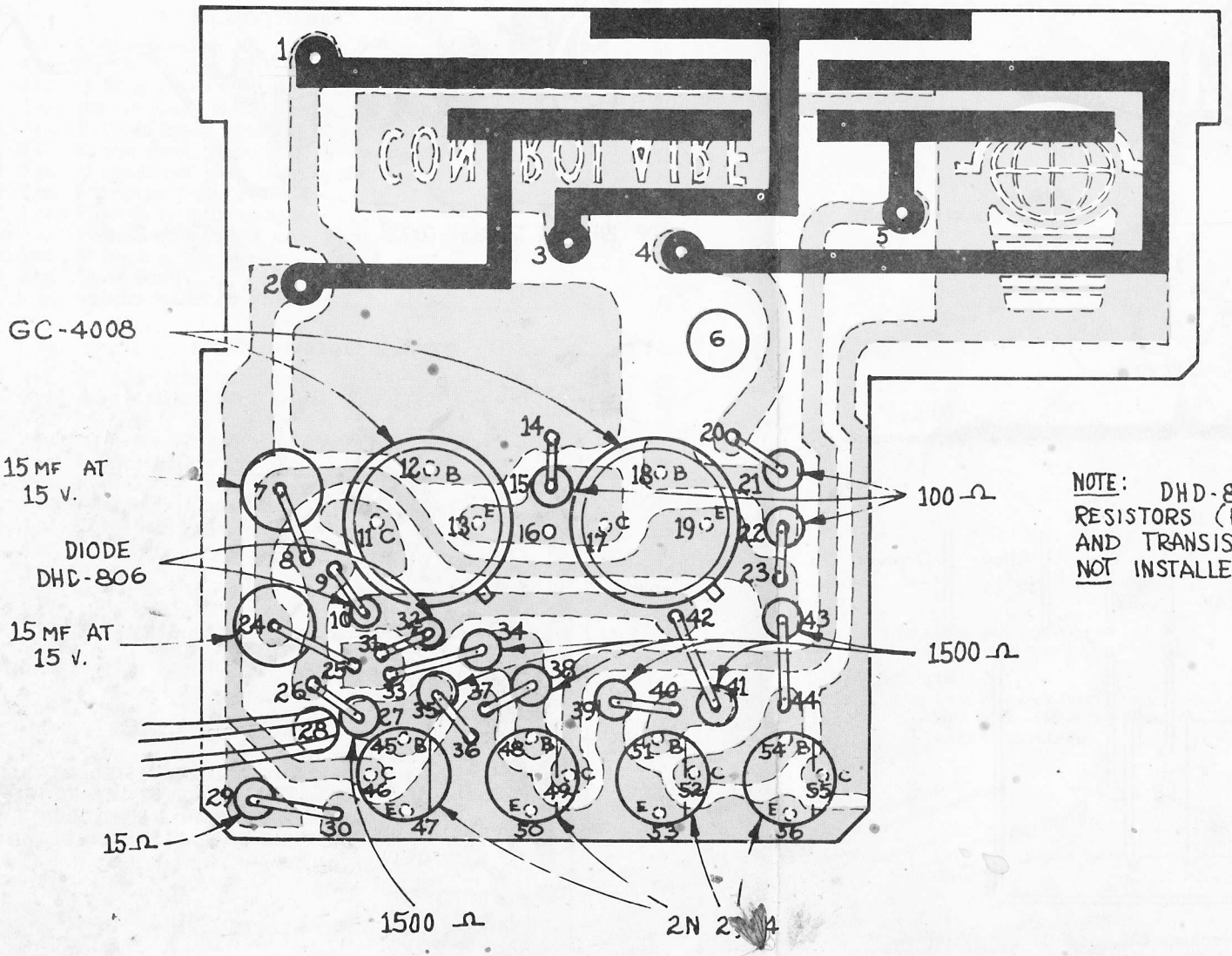


ILLUSTRATION OF SUGGESTED ROUTING OF WIRING ON COPPER SIDE TO PREVENT COMPRESSION & SUBSEQUENT SHORTING OF LEADS ON SOLDERED LANDS.

FIG. 3

Controlaire MULTI - SERVO



NOTE: DHD-806 DIODES (HOLE* 9-10 & 31-32), RESISTORS (HOLE* 39-40, 41-42, & 43-44), AND TRANSISTORS (HOLE* 51 THRU 56 ARE NOT INSTALLED IN TRIM SERVO.

FIG. 1

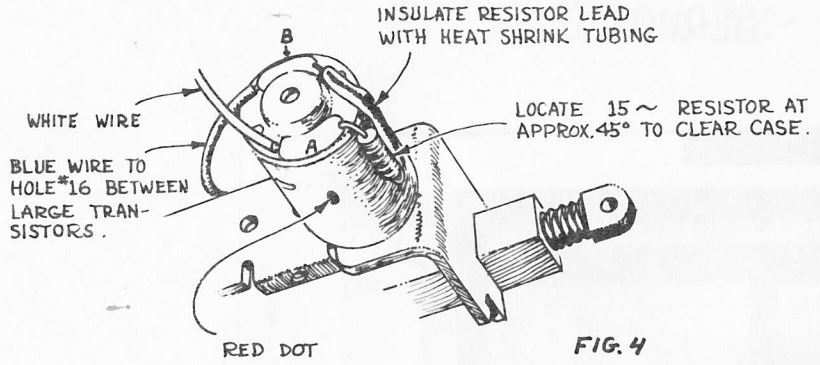
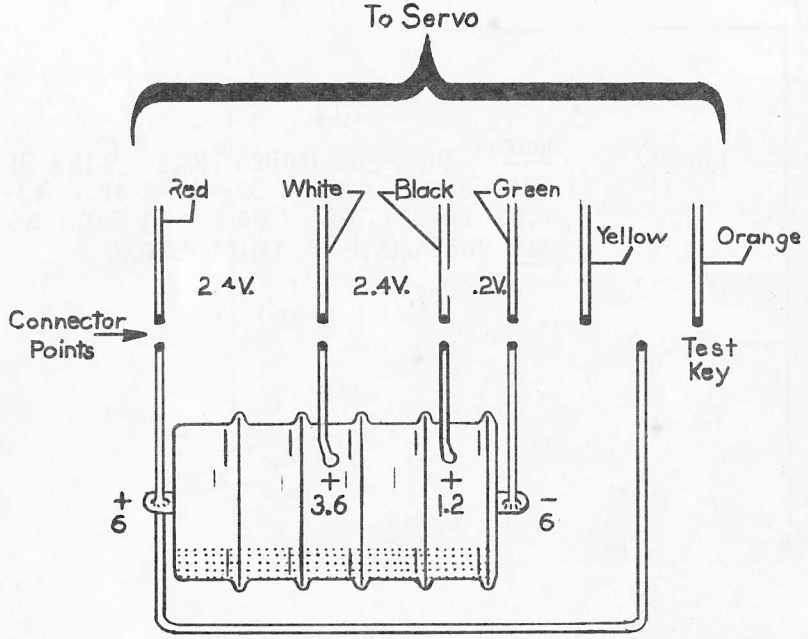
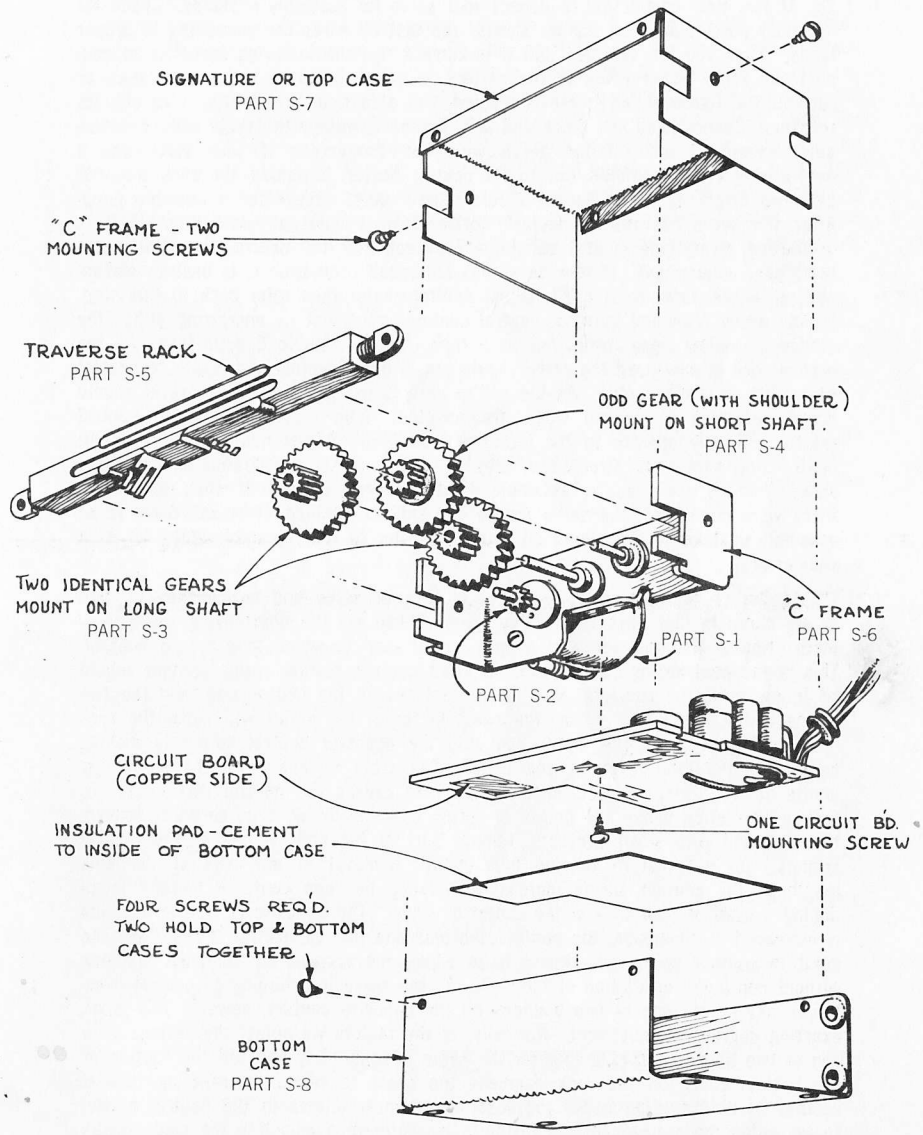


FIG. 4



Test Wiring Hookup 6V. Receiver
Servo Nicad Battery Pak.

FIG. 5



Controlaire SERVO

FIG. 6

To gain a preliminary understanding of the testing information contained in steps 28 and 29 carefully read both steps before applying power to your servo.

( ) 28. At this time completely re-inspect your servo for assembly mistakes. Check for improper parts placement, solder shorts, and that all wires are connected to proper lands. When you are satisfied that it is correct, use the following sequence to connect the servo power wires to the battery. First connect the white wire, then as each of the following wires are connected, one at a time, watch the servo and its reaction. Connect Red and Black and last, Green. Generally the servo should remain quiet except at moment the green wire was connected. If your servo was a neutralizing type, it should run to its neutral center, assuming the rack was not centered originally. Trim servos should remain quiet except for a possible jump. After the servo has run to neutral, notice if it is quiet or oscillating. If it is oscillating, everything is still satisfactory except that the neutralizing spring contacts need adjustment. If your servo has continued oscillation it is best to disconnect all wires, refer to step 29, adjust neutral center then refer back to this step. If your servo remained quiet at neutral continue your test by energizing either the orange or yellow signal wires one at a time. Touch them to 6 volts Plus. As the orange wire is energized the servo should run in one direction and return to neutral when wire is disconnected. As the yellow wire is energized, opposite travel should occur, returning to neutral when disconnected. Trim servos, having no neutral return, will only operate to the direction called for. Adjust neutral center on all neutralizing servos as directed in step 29. If your servo operated as described above, you are now ready to assemble it into its case, however if when any of the wires were connected, the servo ran to one side or jammed, it means there is an assembly mistake so disconnect all wires and refer to your assembly steps to catch your error.

( ) 29. To adjust neutral center, look closely at your servo and notice the outboard spring contacts that have the kink in them. These are the neutralizing spring contacts. Notice also the outboard copper circuit land to which they are to contact. This is the neutralizing circuit land. In exact neutral, neither spring contact should be touching the neutralizing land. If in reference to the neutralizing land the two spring contacts are very close, the coast factor of the motor will make the rack overtravel and before the motor can stop the opposite neutral spring is making contact to the land reversing the motor. The close dimension of the contacting points of the springs in reference to the land causes the neutral oscillation. To reduce oscillation widen the points of spring contact. To do this, carefully remove the rack and with small tweezers, remove part of the kink in one of the neutral springs. Do not disturb tension adjustment. Removal of any part of the kink lengthens the contact spring increasing distance between contacts thereby introducing a dead or trim area in the center of travel. The opposite is true if the kink is increased in dimension, the contact shortens and trim at neutral is reduced. The point in contact spring adjustment is to adjust the springs for minimum distance without continued oscillation of the rack. As the servo is returning to neutral overtravel may create one or two bounces off the opposite contact, however this is an exacting degree of adjustment. Normally, at the factory we adjust the springs so a one or two bounce occurs then after the servo is completely encased the friction of the bottom cover on the rack dampens the coast to where an exacting neutral occurs. If on the other hand, you wish a certain trim area in the neutral of the servo, widen the spring contacts further. Use care when adjusting the contacts, as they are delicate.

As you have tested your servo using only the receiver-servo battery pack the signal input wires, orange and yellow, were energized with pure DC current. Under normal conditions with servo being operated by a reed bank, the input signal is pulsating DC. Each input is filtered by a 15 MF condenser. It is very doubtful, but there may

be a rare case where a servo will not key properly from the reed bank. Assuming reed bank to be adjusted and operating OK, check the installation of your filter condensers. Replace if necessary.

( ) 30. To finalize assembly of your servo, refer to figure 6. With plastic 'shoe horn', remove traverse rack and all gears. Do this carefully and set them aside. Check mechanical orientation of C frame to top case then install C frame chassis into top case as shown. Group all wires together then slide the rubber grommet onto the wires aligning all wires and grommet into case slot as pictured. Next, align the front edge of C frame to the front edge of the side panels of the top case. Secure C frame to top case with two #2 x 3/16" sheet metal screws. It may be noted that on some servos that the screw holes do not align perfectly when the C frame is aligned to front edge of top case side panels. If hole alignment creates a minor problem, use an X-Acto knife to elongate the top case screw holes to get proper alignment.

( ) 31. Inspect the rack slots now that the top cover is installed. In some cases the slots in the top case do not allow proper clearance to the slots in the C frame. This could create a binding condition to rack travel if it were installed. Again using an X-Acto knife, trim away any part of the top case slot that could cause interference. Do not allow any trimming chips to get into the servo case.

( ) 32. Re-install all gears, then again with 'shoe horn', re-install traverse rack. Be careful not to damage, mis-align, or reduce tension adjustment to the contact springs. After rack is installed, inspect the surface contact of the springs to the circuit board lands. Contact should be square and not riding on the twisted edge of a spring.

( ) 33. Use "Plio-Bond" or similar contact cement, then proceed to cement the black insulator board to the inside of the bottom case cover. Use the cement lightly, aligning insulator board in the center of the case bottom.

( ) 34. Carefully install bottom cover to the assembly. Use four #2 x 1/8# sheet metal screws to secure bottom cover.

( ) 35. Final Checkout — Again as directed in steps 28 and 29, check your servo for proper operation. It may be necessary that you again touch up neutral center, however this depends on your skill during original assembly. Inspect that the addition of the bottom cover does not bind the travel of the rack slowing down and loading excessively the speed of the motor. Mis-alignment of the front edge of the C frame in reference to the top cover can introduce a pressure that is exerted against the front surface of traverse rack by the bottom cover because it does not have proper clearance. Minor correction can be obtained by loosening C frame attachment screws, pressing on front section of case at traverse rack then re-tightening screws. This completes assembly and test of your servo.

For information on the use of the servo mounting kit refer to the separate sheet of instructions titled "Information and Instructions."

CIRCUIT DESCRIPTION

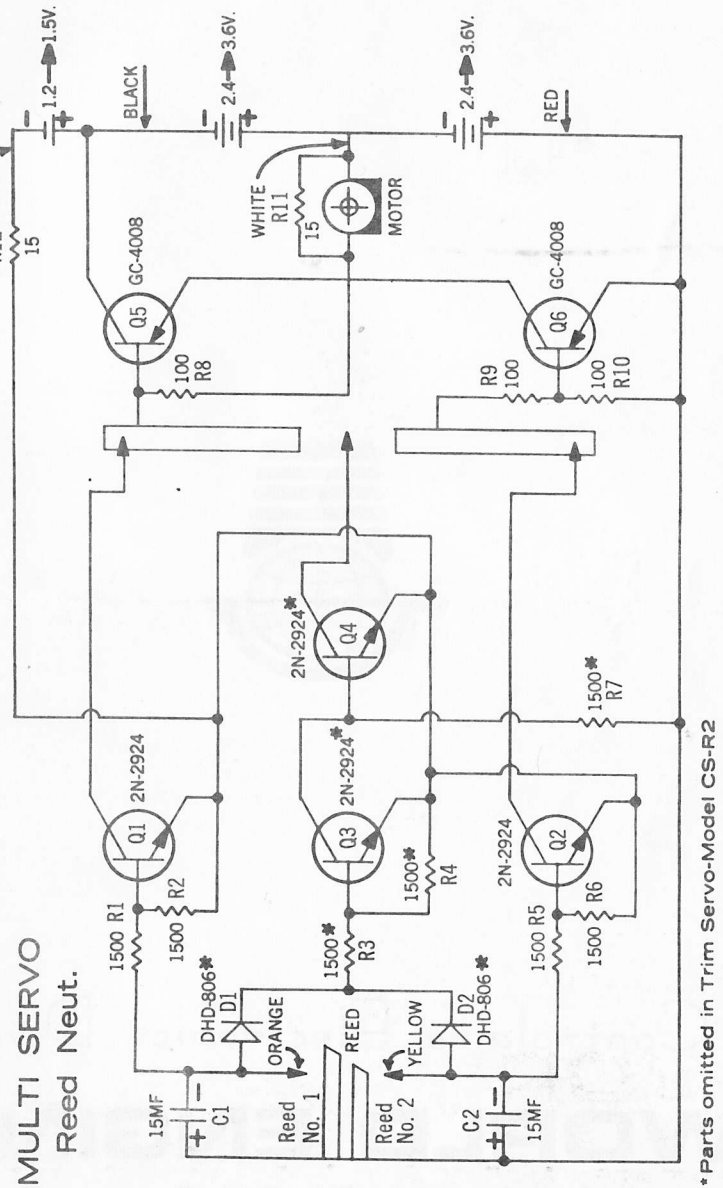
The purpose of this description is to ease the troubleshooting operation by giving the builder some knowledge of circuit operation. The circuit is a solid state switching amplifier that is used to replace relay switches that were used originally to operate motor driven servo devices. The rigors of R/C flying created many relay failures as they were subjected to vibration, abuse and dirt. None of these affects the operation of a solid state amplifier, so reliability increased one hundred fold. To understand operation of the circuit, we will start at the receiver reed bank.

When a command is received by the receiver it will, depending on frequency, vibrate a certain reed. For description purposes, let us say it is vibrating the No. 1 reed of our circuit. Due to electrical hook-up this will apply a pulsating positive going signal to the orange input lead of our servo. Because the signal is pulsating, it has an AC component and to be used properly it must be smoothed out. This is the function of C1. C1 filters out the pulsations thus presenting a smooth positive going signal to the base of Q1, which is an input amplifier. Q1, being an NPN transistor, sees this positive signal at its base and turns on. When it turns on its collector goes negative and presents a negative signal to the base of Q5. Q5, being a PNP transistor, accepts this negative going signal at its base and turns on. When Q5 is turned on it completes the battery power circuit to the motor and the motor starts to run in one direction. As long as the reed is vibrating, the motor will run until the mechanical limit switching is broken at the base of Q5. When the switch opens, the original signal is no longer at the base of Q5 so the transistor turns off, thus stopping motor. To sum up the foregoing, the vibrating reed started the motor running until the limit switching turned it off.

Now what happens in the circuit to return servo to neutral? To best answer this question we must understand the functions of Q3 and Q4 in the circuit. These two transistors form a circuit known as a Schmidt trigger and by their action we create a negative going signal at the base of Q6 to turn it on when reed stops vibrating. When Q6 turns on, it energizes the motor at an opposite polarity thus reversing it and running servo back to neutral. Let's see how it works. At the same time Reed No. 1 is supplying a signal to Q1, it is also supplying a positive going signal to the base of Q3 via the steering diode D1 and limiting resistor R3. This signal turns Q3 on thus making its collector go negative. Since the collector of Q3 is tied to the base of Q4 this means Q4's base goes negative, offsetting the positive biasing path of R7. When Q4's base is negative Q4 turns off, thus making its collector positive. Q4 has its collector tied to the neutralizing contact land of Q6, but since this signal is positive, Q6 remains turned off, thus not opposing the action of Q5 in running the motor in a certain direction. When Reed No. 1 stops vibrating the bases of Q1 and Q3 go negative through R2 and R4 thus turning these transistors off. When Q1 is off there is no signal to Q5 thus it turns off but Q4 turns on because Q3 turned off. Q4 is turned on by the biasing path of R7 which supplies a positive signal to base of Q4. By the above action Q4 turns on as long as no reed is vibrating. Q4 has its collector, which is now negative, tied to the neutralizing contact land which directs a negative signal to base of Q6. Q6, being a PNP transistor, turns on thus supplying an opposite polarity battery power to run motor back to neutral. By the arrangement of the neutralizing contacts when the servo reaches the center position of rack travel the mechanical switching of the neutralizing contacts open thus removing Q4's signal from base of Q6 and it turns off stopping motor. To sum up the foregoing, when Reed No. 1 is vibrating it turns Q1 and Q5 on making servo run until limit switches turns Q5 off. Servo is now in an extreme position. When Reed No. 1 stops vibrating Q1, Q5 and Q3 turn off and Q4 and Q6 turn on. Motor now runs in opposite direction back to neutral where limit switches turn it off.

I realize there are a lot of Q's, ons and offs, but this is what happens. To run the servo in the other direction Reed No. 2 must vibrate. When it does, it turns Q2, Q3 and Q6 on but Q4 and Q5 remain off. The servo runs to its opposite limit, then returns to neutral when reed stops vibrating. When Reed No. 1 stops, all the aforementioned transistors reverse their condition of on and off and servo return is accomplished.

Other components in the circuit accomplish the following functions. Resistors R1, R3, R5, R7, R9 and R12 are current limiting resistors used to adjust gain and sensitivity of their respective amplifiers. Resistors R2, R4, R6, R8 and R10 are used for base stabilization of their amplifiers so temperature change least affects their operation. Diodes D1 and D2, hooked back to back, prevent any interaction of a signal from Reed No. 1 or No. 2 getting into opposite amplifiers. Diodes conduct only in the direction of the arrow and give complete isolation. Resistor R11 is used to reduce the coast factor of the motor and to minimize RF noise generation.



Controlaire Electronics Division

WORLD ENGINES

INCORPORATED

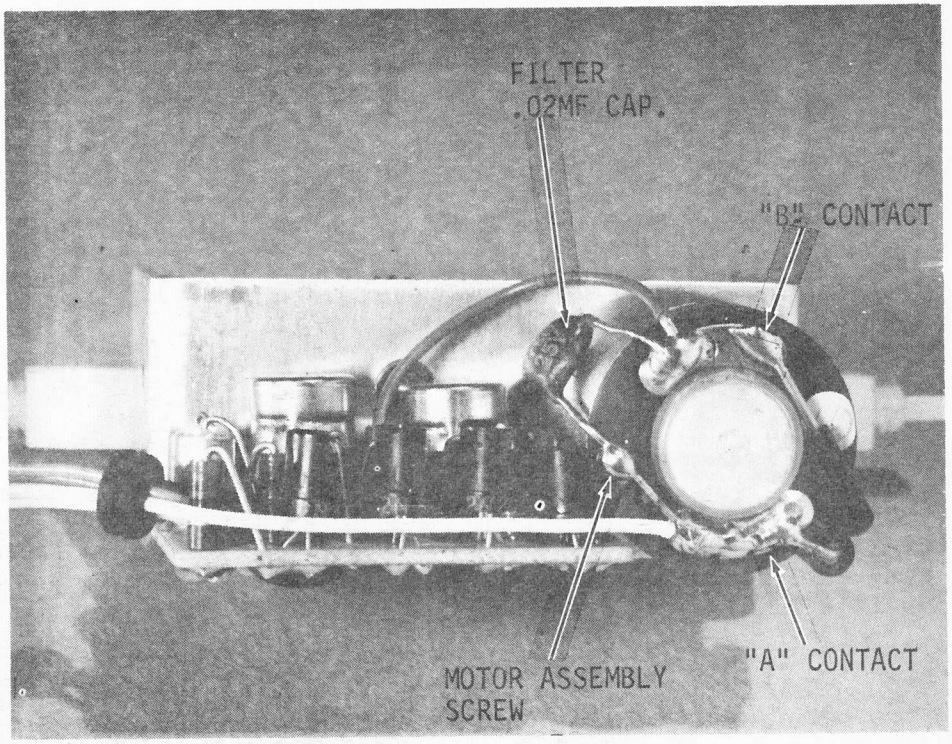
8206 BLUE ASH ROAD CINCINNATI, OHIO 45236

NOTE: Use .02 or .05 capacitor supplied in kit. These values are interchangeable for this usage.

REVISION

CONTROLAIRE MULTI SERVO KIT

PURPOSE - Installation of .02mf filter capacitor to motor of servo to eliminate the effect of RF noise generation.



It has been noted that after a period of operation some servo motors generate more RF noise than others. To filter out the effects of this noise it is the purpose of this revision to add a .02mf capacitor to the motor. All servo kits now include the .02mf capacitor.

1. ( ) During kit assembly stop at Step 27 and proceed to install the capacitor as directed below. If you are modifying an earlier servo remove top and bottom case to gain access to the motor.

2. ( ) Notice the painted head of the motor assembly screw as pointed out in the above pictorial. Scrape away the paint with a sharp instrument then proceed to solder tin the head of the screw.

3. ( ) Notice the positioning of the capacitor then proceed to cut and trim its leads so it will fit into position on the motor as shown. One lead of the capacitor is then soldered to both the head of the motor assembly screw and contact "A" of the motor. The other lead of the capacitor is soldered to contact "B" of the motor. Dress the capacitor and its leads as shown in the pictorial making sure the lead going to contact "B" does not short out to case of motor or top servo case when it is installed. This completes the revision. Continue with your servo assembly if you had stopped with Step 27.