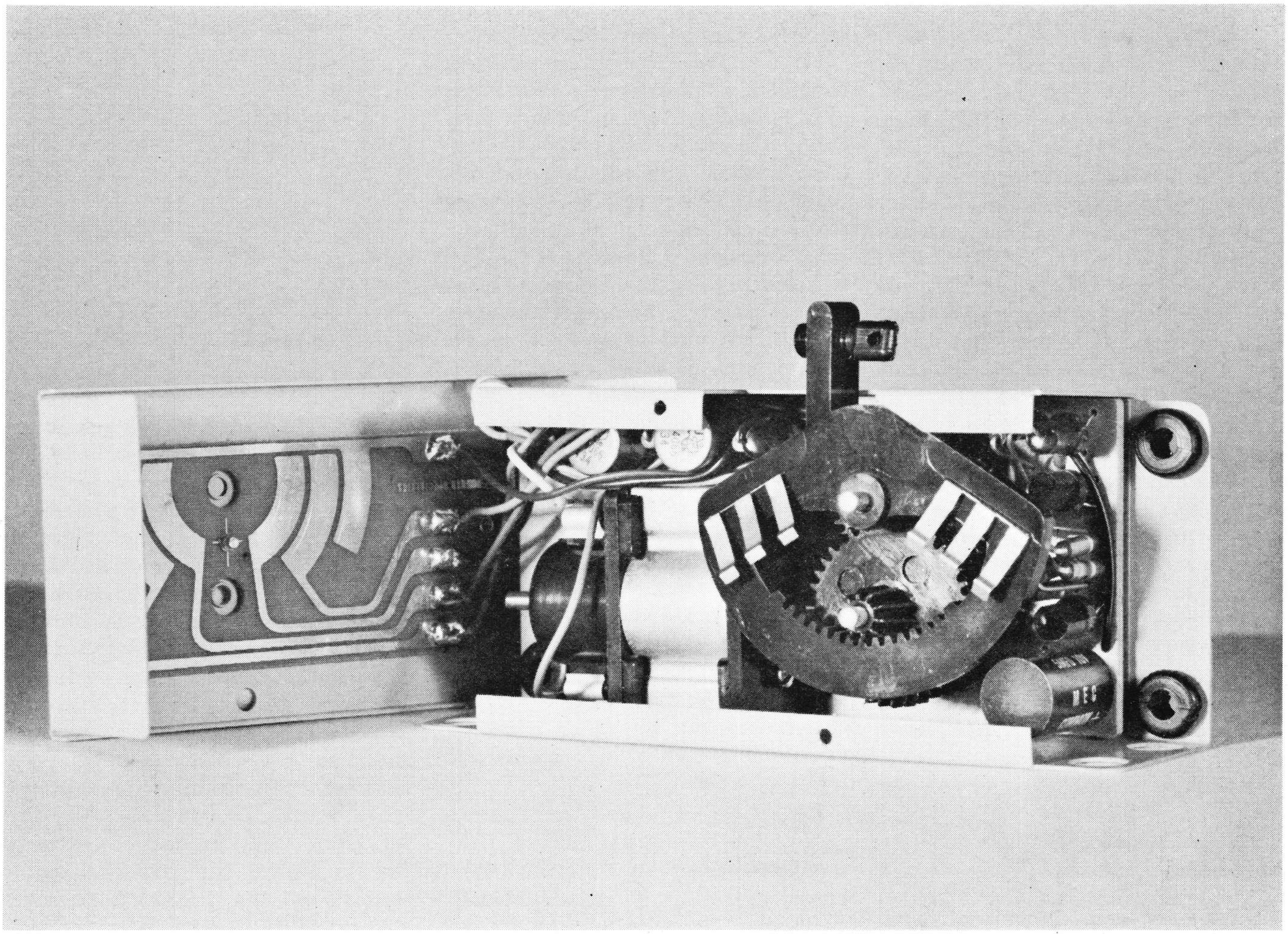


An RCM Special:

THE TRANSMITE SERVO

A Complete Service Reference by

HANK GIUNTA · BILL CAMPBELL · BILL NASH · MAJOR DAVID HATFIELD

During the past few years the Bonner Transmite Servo has unquestionably established itself as the most widely used servomechanism for multi channel reed installations. In the November 1963 (Vol. I, No. 2) issue of R/C Modeler, appeared an article and accompanying repair chart concerning the care and feeding of these radio control workhouses. Since that time, we have published several items pertaining to the operation and servicing of the Transmite. These various items have elicited a steady stream of mail from RCM readers requesting a complete "do-it-yourself" Transmite service article.

In answer to your requests, we are presenting this feature, consisting of a partial reprint of the original Transmite service article by Hank Giunta WA6QEX; a description of the circuitry and principles of operation by Bill Campbell of the McDonnell R/C Club (RCM Vol. I, No. 11); plus a new article on the reconditioning of the Bonner servo motor by Bill Nash; and an excellent feature on the construction of a very practical and useful Transmite Servo Test Console by Major David Hatfield, Base Operations Officer at Walker AFB. This combination of material, edited into one complete article, will enable the reed flyer to maintain his Transmite servos in perfect working condition.

The Transmite Servo: Mechanical Service & Repair

Probably the most widely used single piece of R/C equipment, and yet the least understood, is the Bonner Transmite servo. How many of us take that little box for granted, seldom, if ever, bothering to inspect and clean it, or to proide the normal maintenance it deserves?

In most cases the Transmite will give excellent performance without such care, but it is certain that it was not intended to be used in this manner. With a little effort on our parts, the life of the servo can be greatly extended, and at $30 each, the savings can be very rewarding.

The first consideration is the mechanical condition of the servo. If there is excessive bind, caused by improper gear mesh, bent cases, etc., the amplifier is forced to work much harder than necessary in order to make the servo move. This results in higher battery drain, greater power dissipation in the output transistors, and a general loss of power at the control surface where it is needed the most.

The maintenance procedure can be broken down into five steps:

1. Disassembly and cleaning.
2. Visual inspection of gears, case, and amplifier.
3. Repair of amplifier, if necessary.
4. Reassembly and mechanical adjustment.
5. Operational checkout.

After removing the servo from your individual installation, remove the grommets from the case. This makes the subsequent removal of the amplifier and case cover much easier. Take out the two sheet-metal screws which hold the cover on the servo, and carefully remove the cover by first sliding in an upward direction, the end opposite the motor. This enables the cover to move enough so that it can be removed from the motor side. Be careful not to exert too much force at this point in order to avoid breaking the wires from the amplifier board which are connected to the switch plate in the cover.

The next step is to remove the sector gear, being sure **not** to lose the two washers which ride against the switcher board in the cover. If you only see one of them, you will find the other stuck to the switcher board. This may be an indication of mechanical bind, so keep this in mind during reassembly. Remove the other two gears and spacer washers. It is a good idea to keep all parts in a suitable container as they are removed.

Remove the three screws holding the motor and amplifier to the bottom of the case, and carefully slide them out of the case. The motor will have to be lifted slightly upwards, and partially rotated, to clear the two gear posts.

The Transmite Servo: Reconditioning the Bonner Motor

If your servos are not running as fast as they used to, it could be the first sign of potential servo trouble. If the motors are drawing too much current, the transistors are working unnecessarily hard and may fail under a heavy starting load. Drag in the oilite bearings is the most common cause of motor failure. Attempts to lubricate with light machine oil is only a temporary measure and can be successful only if the motor is thoroughly cleaned. This may be done more easily by the use of Q-tip (cotton swab on a stick), soaked in radio-TV control cleaner solvent. The latter is recommended inasmuch as it does not leave a film of residue when it dries.

Before carefully disassembling the motor, mark magnet position. The complete magnet assembly can be removed as a unit if caution is used. Swab metal particles out of the end bells with the soaked Q-tip and use a string (or Q-tip shaft) to clean inside of the brush holders. A pencil eraser is then used to clean the face of the armature commutator. Now, use an X-Acto blade to remove the dirt from between these segments. Be careful not to leave a sharp edge on these segments. A thin strip of solvent-soaked cloth is then used to clean and polish the armature end shafts, shoeshine method. A small vise is helpful in order to hold the armature for this operation.

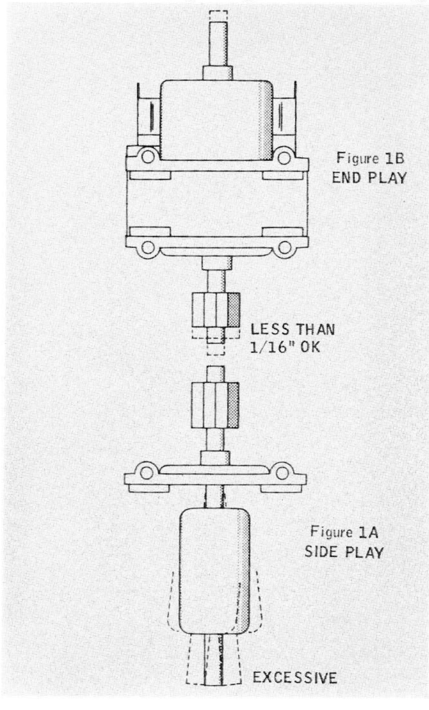


Figure 1B END PLAY

Figure 1A SIDE PLAY

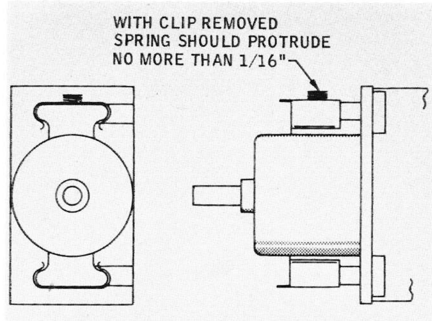


Figure 2

Now insert the armature shaft back into the bell housing. (See Fig. 1). Place flat on the workbench and mark the centerline of the shaft. Mark extreme sideward slop in both directions. If in excess of one shaft diameter, replacement is indicated. Because the bearing and other major parts (except for springs, brushes, and clips) are not available from the manufacturer, substitution of Pittman Oilite Bearings (part number 15-1 for .092 shaft) may be made by driving the old bearing nut and then gently reaming out the hole for a press fit of the slightly larger O.D. of the new bearing. If the bearings are not worn out, it may be possible to restore their lubricating ability by boiling in castor oil.

Reverse the disassembly process and take care that the magnets are replaced in the original position. A pair of tweezers is handy for picking up small parts. If not available, however, pick up the springs by the side, not endways, with your fingertips, as they will invariably spring off into space to be lost forever!

Brushes should slide freely in their holders with no gumminess to bind them. Spring tension increases brush wear. Check brush height as per Fig. 2. It should be no more than shown, and will work well with less. Brush springs are **not** adjusted to proper length by the factory. Compress as needed. If trouble is encountered in replacing the clip over the spring, the spring is still protruding too much.

With the motor completely reassembled, apply 1.32 VDC to the clips as shown in Fig. 3. The motor should start immediately and run at a good clip in a clockwise direction. Run for several minutes in order to seat the brushes. This is necessary even if they have not been replaced with new ones.

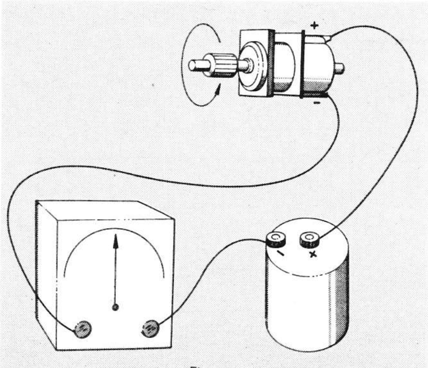


Figure 3

Insert a milliameter, set to the 500 Ma scale, in series with the battery and motor and note the current drain. It should be no more than 225 ma, and preferably, around 180 ma. If the bearings need lubrication, place a small amount of light sewing machine oil on each end of the shaft with the motor running. A marked increase in RPM will result, with a corresponding decrease in current drain, if the oil was needed. This decrease in drag and current drain is what we've been looking for. Put the motor back in the servo if the current cannot be reduced to less than 225 ma — the output transistors will not stand the added drain caused by the load of the motor driven control surfaces.

If the drain cannot be reduced any more with the foregoing methods, the only thing left to do is to have the motor remagnetized. This can be done at any slot racing track that has the remagnetizer. The cost will generally be about 50c per motor. Check polarity again, and if the motors run the wrong way, turn the entire magnet assembly over so the top is the bottom, and vice versa.

By following the above directions and exercising reasonable care, any PM motor can be put into top condition. The cost of replacement of the motor makes it worth the effort.

The Transmite Servo: Reassembly

Assuming that the servo was operating satisfactorily before the cleaning and service, you are now ready for the reassembly of the unit. A small brush and a cloth moistened in isopropyl alcohol will enable you to thoroughly clean the inside and outside of the servo case. Be exceptionally meticulous about cleaning the gear posts, as grit on these parts will wear down the pylon gears.

Place a **light** film of oil on both gear posts, then place a small washer on the crown gear post, followed by the crown gear itself. Slide the amplifier and motor into the case (don't forget the insulating board under the amplifier), and replace the two screws which hold the motor. Do not tighten these screws yet. Line the motor up so that its shaft is in line with the crown gear post, then tighten the motor screws. Check for smooth mesh between the pinion and crown gear. Differential tightening of the motor holddown screws will enable you to make slight adjustments in gear mesh. Mount the amplifier securely with the small screws.

Reassemble the spur gears on their respective posts, then slide the cover in place. If the method used for disassembly is reversed, the cover will go on with no trouble. Be certain that the two large washers do not get knocked off the gear posts while installing the cover. Gently pull back the slack in the wires through the grommet, and secure the cover with the two sheet metal screws. If you have done everything correctly, the servo is ready for service.

The Transmite Servo: Amplifier Circuit Operation and Repair

If the servo was inoperative at the onset of the general maintenance and cleaning, or motor reconditioning, and the trouble did not reveal itself during the preceding service (broken wire, etc.), the amplifier will have to be checked. First, however, it is important that you have at least a basic understanding of the function and operation of the Transmite amplifier.

An important link in the resonant reed bank multi system in use is the servo amplifier. The amplifier receives an average of 3 ma of pulsed DC current from a reed and must amplify this signal to over 1 ampere as required by a starting, or stalled, servo motor. The amplifier is necessary because the resonant reed cannot handle the required 1 ampere motor current for any length of time before it would become pitted or even welded inoperative.

Prior to 1961, the most commonly used amplifier was a SPDT (single pole-double throw) relay. In 1961 Bonner introduced his Transmite servo amplifier which replaced the relay type amplifier with solid state circuitry which has proven to be much more reliable, vibration resistant, and trouble free. A slight cost increase, less space required, and nearly the same overall weight of the control system is also noted.

The schematic, shows the electronic interconnections of the components which make up the Transmite amplifier. Electrical connections are shown by conspicuous dots. Wires are color coded as they appear in the Transmite servo. A (C) by the color code means the wire is found in the cable exiting through the grommet at the motor end of the servo. An (SW) means the wire is attached to the switcher board located inside the cover of the servo. An (AMP) means the wire ties to the "L" shaped amplifier board from the component shown.

The amplifier board illustration shows the approximate component location as viewed from the component side of the amplifier board.

The switching board shows the arrangement of the printed circuit switches and the spring finger wipers (W1 & W2) which comprise the travel limit switches and neutral return switches required by the amplifier The wipers are mechanically tied together, but are electrically isolated. See the quadrant output gear in the Transmite for details.

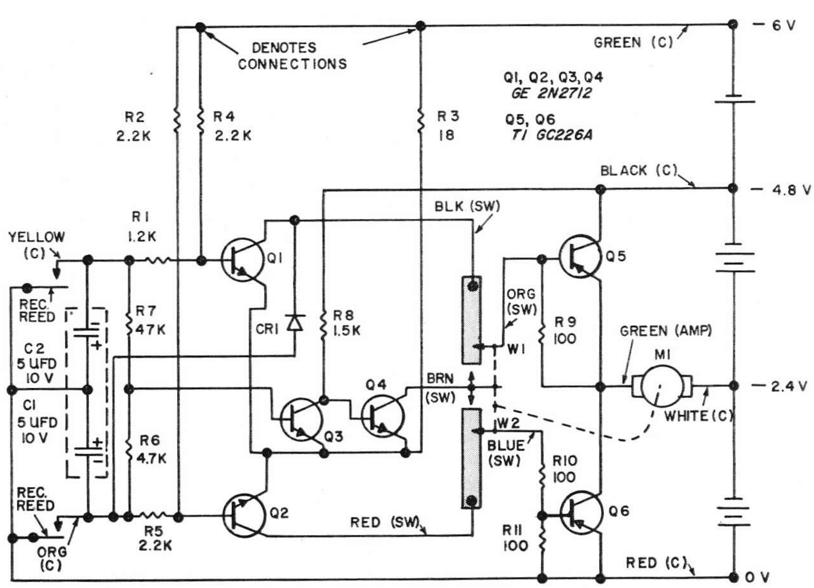
The transistor identity shows the lead location of various transistors which have been used in the Transmite amplifiers since their introduction. All transistors are viewed as though you are looking at the top of the transistor case with the leads extending down and away from you.

All sketches were developed from a 1963 manufactured Transmite and uses the transistors called out in the schematic.

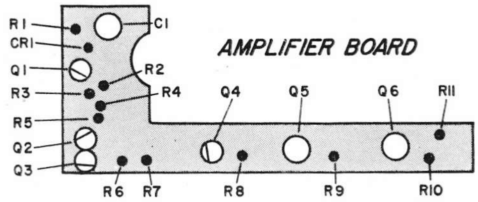
Earlier Transmites used either the Sylvania 2N306 or 2N229 in place of the 2N2712 and used the Philco 2N223 in place of the TIGC26A. They did not contain CR1, this prevents damage in case both input reeds are closed at the same time diode, or R10. R3 was 47 ohms and a 2.2K resistor was tied between 0 volts and the junction of the emitters of Q1, Q2, Q3 & Q4. R1 was 2.2K and C1 and C2 were two separate capacitors housed individually instead of being in a common case.

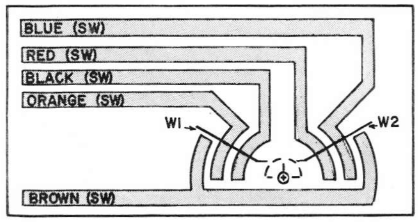
DC pulses, when received on the yellow signal wire from a resonant reed, are filtered by C2 & R1 for 1; and by C2 and R7 for Q3. DC pulses, when received on the orange signal wire, are filtered by C1 & R5 for Q2 and by C1 & R6 for Q3. Q3 conducts when either the yellow or orange wire is carrying a signal and cuts off neutralizing transistor Q4. Q4 is normally

BONNER TRANSMITE SERVO SCHEMATIC

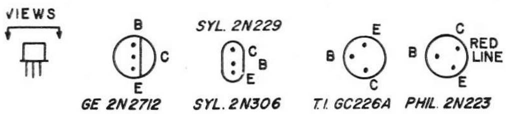


SCHEMATIC





SWITCHING BOARD



TRANSISTOR IDENTITY

turned on (no signal) and supplies base current (approx. 50 ma) to either Q5 or Q6 to neutralize the servo when no signal is coming in on the yellow or orange signal wires. Q1 amplifies the filtered 3 ma signals which arrive on the yellow signal wire and supplies approximately 50 ma to the base of motor power transistor Q5 which in turn supplies up to 1 ampere to the motor. Q2 amplifies the filtered 3 ma signals which arrive on the orange signal wire and supplies approximately 50 ma to the base of motor power transistor Q6 which in turn supplies up to 1 ampere to the motor. Of course the direction of motor rotation depends upon whether Q5 or Q6 is conducting. R2 and R4 bias Q1 and Q2 off when no signals are incoming on the yellow or orange signal wires. R3 limits the current which Q1, Q2, Q3 & Q4 carry and also helps R1, R2, R4, R5, R6 & R7 to keep Q1, Q2 & Q3 cut off at higher temperatures, since any leakage current passing through R3 increases the reverse bias on Q1, Q2 & Q3. R8 is the load resistor for Q3. R9 & R11 bias Q5 & Q6 off during neutral conditions and are especially helpful at higher temperatures. R10 limits Q6 base current.

SYMPTOM	PROBABLE CAUSES	VERIFICATION
Servo drives in one direction only. Does not neutralize.	(1) Broken orange or yellow wire. (2) Defective TR1 or TR2. (3) Broken orange or blue wire from TR5 or TR6 to switcher board.	A, B, C, E, F
Servo drives in one direction only and neutralizes.	(1) Broken orange or yellow wire. (2) Filter capacitor open or broken loose from board. (3) TR1 or TR2 defective.	A, B, E, G
Servo drives in both directions, but will not neutralize.	(1) You may be attempting to obtain neutralizing action from a trim servo. (2) Outermost contact fingers on sector gear not making contact with switcher board. (3) Brown wire to board broken. (4) Defective Flip-Flop.	
Servo drives in both directions, but is much faster in one direction.	(1) Batteries not charged, or one cell weak. (2) Low gain in driver or output transistors. (3) Leaky output transistor (opposite side).	A, B, B
Servo does not drive, and heavy load is placed on batteries.	(1) Orange and yellow wires shorted together. (2) Two reeds driving at once, attempting to drive servo both ways at once. (3) Shorted output transistors. (4) Shorted driver transistors.	A, B, D, E
Servo drives when orange or yellow wire is touched directly to +6V supply (red wire) but will not drive from vibrating reed.	(1) Filter capacitor open. (2) Reed contacts dirty.	Clean reed contacts A, B, G
Servo drives in one direction without a command, and stays at full throw.	(1) Shorted filter capacitor. (2) Shorted driver transistor.	A, D, E, H
Servo drives hard in one direction and does not stop at full throw. (Usually results in a bent case).	(1) Shorted output transistor.	D

Test procedures for the Transmite amplifier consist of the Transmite Service Chart and accompanying verification procedures, plus the use of the Transmite Servo Test Console. Test procedures are listed A, B, C, D, etc., on the chart. The latter should be used as follows:

1. Locate the trouble you are experiencing in the **Symptom** column.
2. Under the column **Probable Causes,** read the information given, and make whatever visual checks you can.
3. Under the **Verification** column, you will see groups of letters — these letters designate the procedure to be used, and in what order to use them. Be sure to follow the order given.

In order to complete the circuits for these tests, the sector gear switch fingers must be making contact with the switcher board in the cover. A simple way to accomplish this is to place the shank of a #42 drill through the hole in the sector gear and the servo cover, using a clothespin to hold the gear against the switcher board. It is recommended that a separate sector gear be purchased for use in this manner, in order that the original sector gear switch fingers will retain the proper factory tension adjustment. Neutral positioning of the sector gear may be ascertained by visually locating the sector gear at center, and checking the position of the switch fingers on the switcher board.

The Transmite Servo: Service Console

Insofar as the Test Console is concerned, and if you decide to construct it, the list of malfunctions one is able to determine from the tester is dependent upon his technical knowledge and understanding of the Transmite design. The console is designed for use with any good standard multimeter.

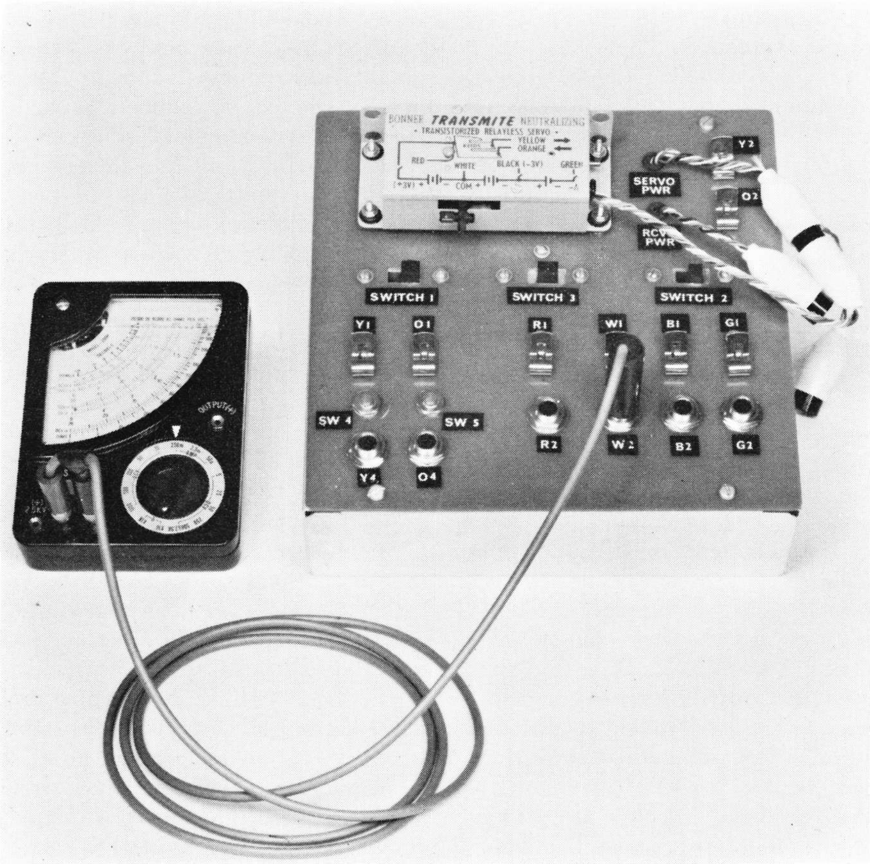
As an example in using the Test Console, let's assume that a Transmite runs one way only and centers, as per the second symptom on the Service Chart. By mounting the servo on the Console and plugging it into the Servo plug, then depressing Switch 4 and Switch 5, one at a time, the servo should run either way. If it does, hook up the receiver to the Fahnstock clips by color coded wires, placing the yellow and orange wires in the clips marked 0-2 and Y-2. With Switch 3 closed and Switch 1 open, transmit a signal to check servo for operation in both directions. If it still malfunctions, open Switch 3 and close Switch 1. Now you have injected an external capacitor into the system. The Transmite should operate both ways on signal. Trouble — a bad, or broken, capacitor. With a meter in Y-4 or 0-4, you will read about 3 ma when depressing Switch 3 or Switch 4. Using the transmitter, you will read only about one-half ma.

As another example, assume that the servo drives one way but does not center and will not drive in the opposite direction, as per Symptom #1 on the Service Chart. This trouble is usually spotted immediately as a defective drive transistor. This can be readily verified on the Console by setting your multimeter on the 0-500 ma scale and inserting into W-2. Depress Switch 4 or Switch 5. If the meter reads backward, throw Switch 2 to the other side. The meter will normally read 250-300 ma. (Readings over 300 ma in R-2, B-2, or W2 usually indicate that your motor is in need of cleaning or replacing). No reading will be noted on the dead side of the servo. If you open your servo and attach the top of the case to the Console, then apply the quadrant output gear (the unit with the spring fingers) to its centered position, you will be able to use your meter to measure the voltage. The reading is not important at this time, but the polarity is. Once you determine which motor wire carries plus or minus, you can determine which drive transistor is malfunctioning. Example: Q5 carries positive while Q6 carries negative in the green wire.

Although the above two examples are the most common malfunctions, others may occur such as the servo failing to drive either way. Most commonly, this is caused by a broken wire at the motor post. Again, a servo may drive one way and return, but not drive the other way. Immediately, you

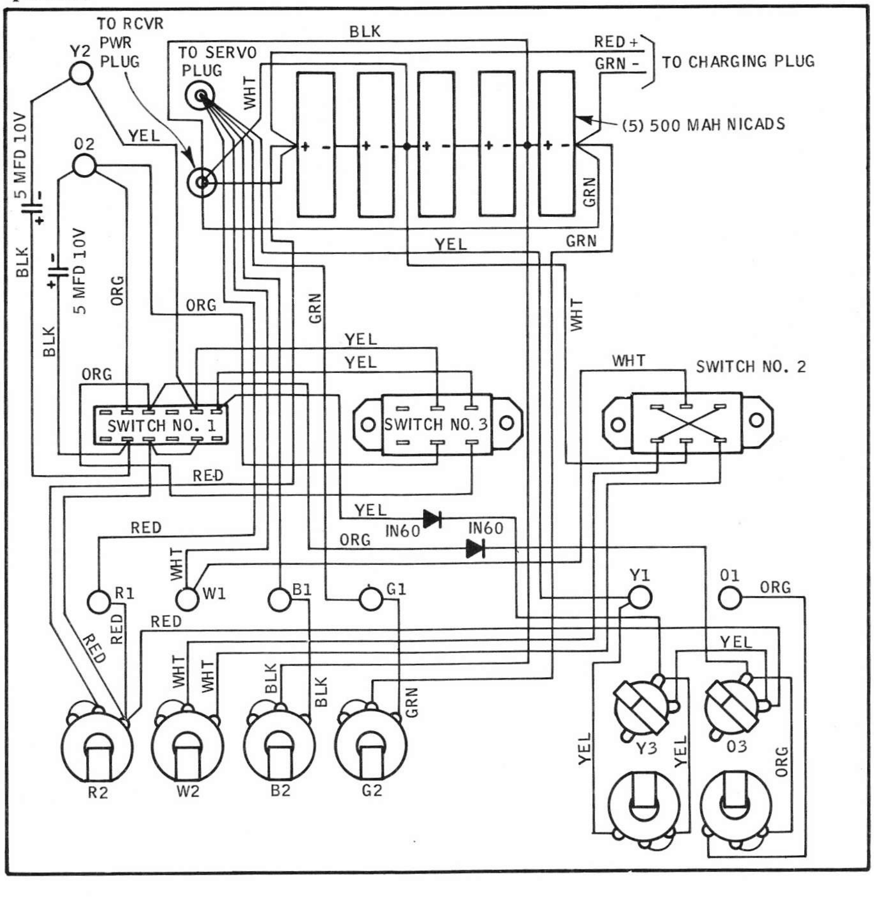
TRANSMITE SERVICE CHART — **VERIFICATION PROCEDURES (FOLLOW CHART ORDER)**

A.	Set sector gear to neutral (no rotation of motor).
B.	Apply power.
C.	Temporarily connect a 47 ohm resistor from the base of TR5 to the —6V supply (green wire). If the transistor is okay, the motor will run as long as the resistor is connected. If the motor does not run, replace TR5. Repeat this test on TR6. The motor should run in the opposite direction as long as the resistor is connected. If the motor does not run, replace TR6. After replacement, verify proper operation by making the test once more.
D.	Short the base of the conducting output (TR5 or TR6) to its emitter. If the trouble is in a *previous* stage, the motor will stop. If the motor does not stop, replace the output transistor.
E.	Connect the base of TR1 to its collector with a temporary jumper. The motor should run. If it does not, replace TR1. Repeat the test on TR2. After replacement, if any, repeat the test. The motor should *stop* when the jumper is removed. If not, replace TR1 or TR2.
F.	Check Flip-Flop circuit by manually rotating the sector gear slightly off neutral. If the flip-flop circuitry is okay, the motor will run. Check both sides of neutral, ascertaining that the motor changes its direction of rotation when the sector gear is moved from one side of neutral to the other. If the motor does *not* run when the above test is done, proceed with the following tests: (1) Disconnect batteries. (2) Rotate the sector gear to either side of neutral. (3) Unsolder TR3 and remove from board. (4) Reconnect power: The motor should run. If it does, replace TR3. If it does not, replace TR4. If the motor still doesn't run when TR4 is replaced, the 1.5K resistor which connects the base of TR4 to the —4.8V supply (long black wire) is probably open. (5) As a final check, temporarily connect a 4.7K resistor from the base of TR3 to the +6V supply (red wire). The motor should stop. If it does, the flip-flop is okay.
G.	If the filter capacitor is open, the servo will operate for all these tests, but will *not* operate when it is driven from a vibrating reed. Temporarily connect another capacitor (15 uf) across the unit on the board and check for proper operation. Observe polarity.
H.	Disconnect power and remove one filter capacitor. Reconnect power. If the motor does not run, the capacitor you have just removed is shorted and should be replaced. If the motor still runs, repeat the test with the other capacitor. If the motor still runs, the trouble is most likely a defective driver transistor.



The Transmite Service Console with multi-tester in place. Simple, efficient test unit.

Wiring the Console. Follow the point-to-point drawing and refer to full-size photos.



should know that both drive transistors are good. The problem lies most probably in Q2. Check it on a transistor tester and see if it doesn't leak badly.

Many other possibilities exist with the Transmite Console to determine various malfunctions of the servo, and you will discover them as you get used to using this simple but very useful tool. Along with the Transmite Servo Chart, the information given is more than adequate for most Transmite service problems.

Construction

Construction of the Transmite Servo Console is quite simple, and consists of several switching functions to test various operations of the Transmite Servo. In addition, plugs are provided for external meter readings at each function.

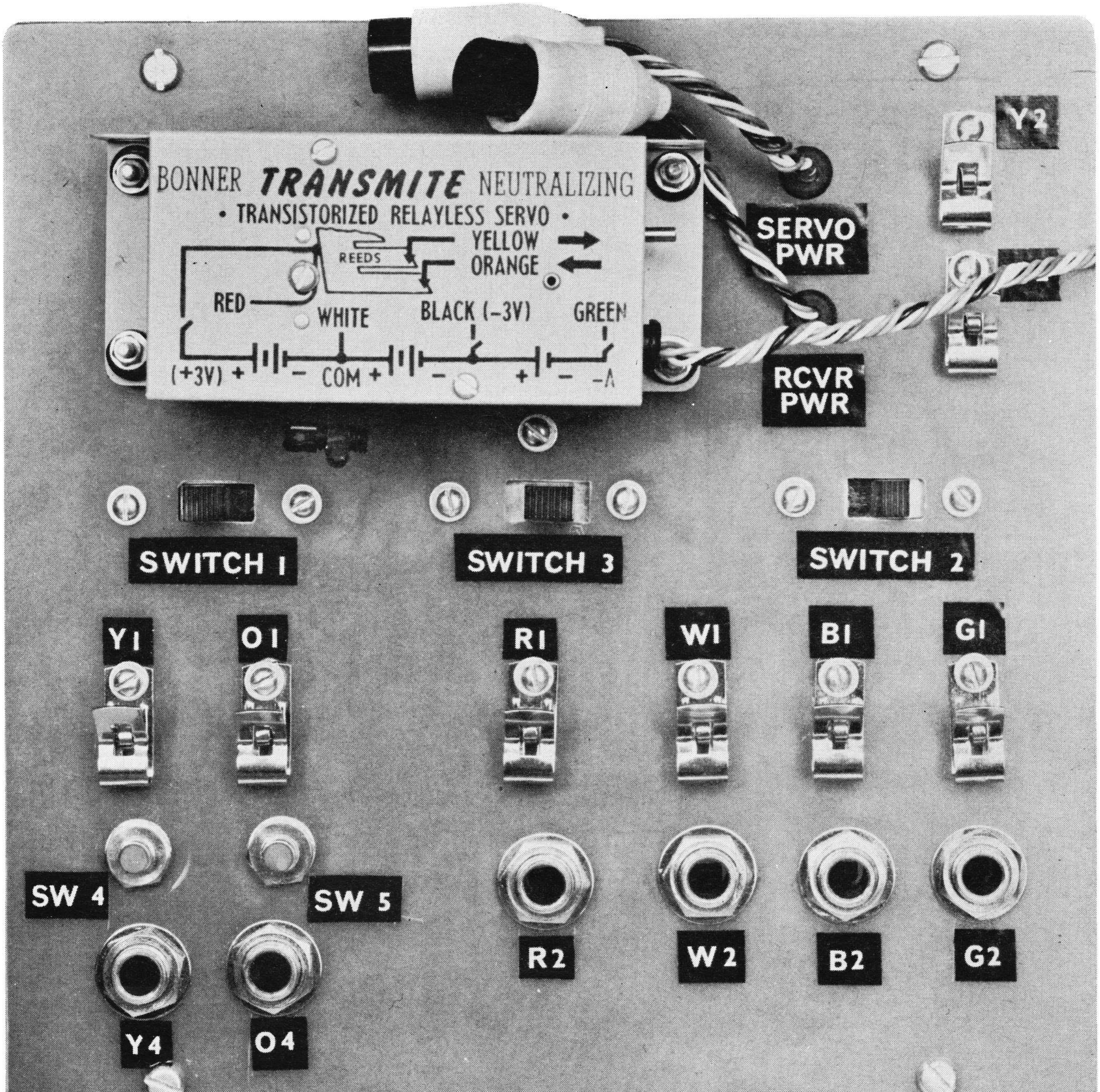
Parts List

1—7″ x 7″ x 2″ aluminum chassis
1—phenolic chassis faceplate, 7″ x 7″ x 1/16″
6—¼″ closed circuit jacks
1—DPDT slide switch (Switch #2)
1—4PST slide switch (Switch #1)
1—DSPT slide switch (Switch #3)
2—NO pushbutton switches (Switch #4 and #5)
8—Fahnstock clips
2—1N60 or 1N91 or other small current diodes
1—500 mah or 600 mah 6V nicad pack
3—Orbit connectors (or connectors you normally use in your multi installations)
1—phone plug for ¼″ jacks with 3′ shielded cable (for meter test)
2—jacks for meter connection
2—5 mfd 10V electrolytic capacitors
hook-up wire, 3-48 x ½″ machine screws, nuts, star washers, washers, sheet metal screws (#6).

Start construction by laying out the phenolic faceplate. Arrangement of the various fahnstock clips, servo and receiver plugs, phone jacks, and pushbuttons is up to the individual. The unit shown in the photographs has proved to be efficient and convenient. Mount the fahnstock clips with 3-48 machine screws and secure to the rear of the panel with star washers and nuts. Clip off the protruding end of the screws and make sure they are tight, as solder connections will be made to these mounting screws.

Determine the location of the Transmite servo that will be tested, then

TRANSMITE SERVICE CONSOLE: Front Panel

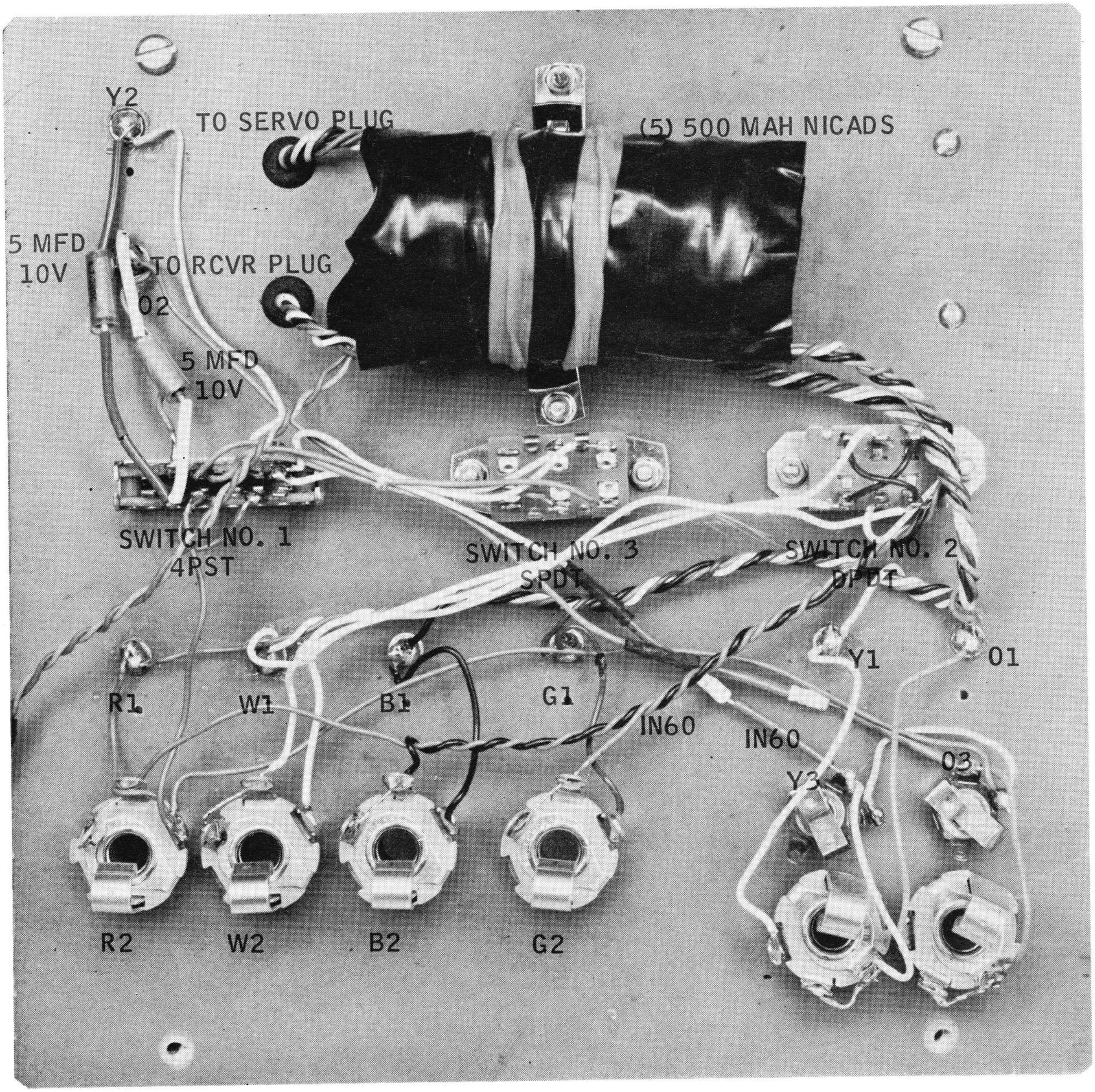


insert permanent mounting bolts for ease of handling the servo. Install the nicad pack directly under this area. Any type of hold-down may be used on the nicad pack — we simply installed two fahnstock clips and held the battery pack down with a double looped rubber band.

Point to point wiring of the Console is much easier if colored hook-up wire, corresponding to the clip or jack being wired, is used. As you will notice, each Fahnstock clip, and each plug, is labeled according to the color code of the wire from the receiver or servo — for example, Y-2 (yellow), 0-1 (orange), etc.

Following the schematic and the

TRANSMITE SERVICE CONSOLE: Rear of Panel



photographs, plus checking off each wire on the hook-up diagram will be of some help to those not familiar with electronic assembly. Another aid is to position all closed circuit jacks and pushbuttons in the same manner, to avoid having to check each lug on each unit to determine which wire goes where!

Mount the phenolic cover plate on to the aluminum chassis with 4-#6 sheet metal screws, and you're in business. The Transmite Servo Console will not only help you to determine wherein the trouble lies in a malfunctioning servo, but its construction will aid in a better understanding of the operation of the Transmite servo.