★ ASSEMBLING YOUR

TR 4.5 Transistor Receiver

Before you start assembling your receiver may we pass on some information and a few tips. The TR 4.5 is an all transistor receiver operating on 4½ volts! No expensive B batteries or converters. This is achieved through the use of a low resistance, high current relay. With no signal the receiver idles at approximately 10 to 15 mils. Carrier drops this to about 2 to 5 mils and a 400-500 cycle audio tone of 100% modulation produces a rise to 40 mils for really reliable relay operation. The A01 detector used is equal to or exceeds tube detectors for sensitivity and eliminates the need for high plate voltages and filament batteries.

The printed circuit board for the receiver was designed for maximum ease of construction and reliable trouble free operation. Each component is anchored by its own leads eliminating any need for point to point wiring. Various component locations have been marked directly on top of the printed board as well as on the drawings further reducing the possibility of error in assembly.

CONSTRUCTION

Several important points must be observed in the assembly of the receiver. Use only the low temperature solder included with the kit. Use only enough heat on each joint to assure a good connection. A small pencil type soldering iron of about 35 watts is recommended. Too much heat will cause the copper to blister and peel from the base. Before soldering on the base is begun, the copper side should be polished bright with steel wool to remove grease, dirt and corrosion from the copper to facilitate soldering.

All four transistors should be soldered into place before any other parts are installed on the base. This will allow room to hold the transistor leads with a long nose pliers as they are soldered onto the base. The transistor leads should be pushed through the holes far enough so that about 1/4 inch of lead shows above the base. The leads should be clipped flush with the bottom of the base and the lead being soldered held with the long nose pliers at the base of the transistor to conduct the heat away from the transistor. This is a very important point and extreme care should be used when soldering the transistors onto the board. A small amount of heat can easily damage the transistors. Correct lead orientation is also important when wiring in the transistors. The lead locations are shown on both Figures 1 and 2 as well as on the base itself and should be followed closely. The collector lead (C) of TR1 (AC1) is the lead adjacent to the red line on the side of the base of the transistor. The collector leads (C) of TR2 and TR3 (T0037) are the leads adjacent to the red line or solder dot on the side of the base. The collector lead (C) of TR4 (2N192) is identified by the larger spacing between it and the other two leads. (2N188A)

Next mount the three transformers T1, T2, and T3 and solder their leads into the proper holes. Insert the lugs of the transformers into the holes and clip them flush with the bottom of the base. Solder the mounting lugs to the copper. Clip the transformer leads to about one inch and remove the insulation even with the bottom of the base. Tin the leads and solder them into the correct holes. Be sure to observe correct color coding of the leads as shown on the drawings and on the base.

Insert the lugs of the tuning coil L1 into its holes, clip flush with the bottom of the base and solder. Wind a 2 turn link (L2) directly above L1 and solder the two ends into the holes for L2. Wind this link with the thin flexible wire.

Solder all the resistors and condensers into place on the base. The resistors are mounted on end. One lead is placed into the hole over which the resistor is located and the other lead is bent over and down to fit into the other connecting hole. Be sure to observe correct polarity when soldering the electrolytic into place. Connect the phone jack (17) to the base with about 1/2 inch flexible leads. The relay (20) is mounted on its side as shown in Figure 2. Connect the red flexible wire to B+ hole and the black wire to B- hole. Connect the two foot length of white flexible wire to antenna hole on the base.

After all components have been soldered into place file all solder connections on the copper side of the base to remove rough edges, sharp points and excessive solder. After filing use a stiff brush to remove all solder filings from the base. Remove all the resin from the base with a solvent. Dope thinner works very well for this. Connect the brown wire to the relay armature (frame). Connect the green wire to the normally open contact and the blue wire to the normally closed contact if it is to be used. The receiver is now ready to tune.

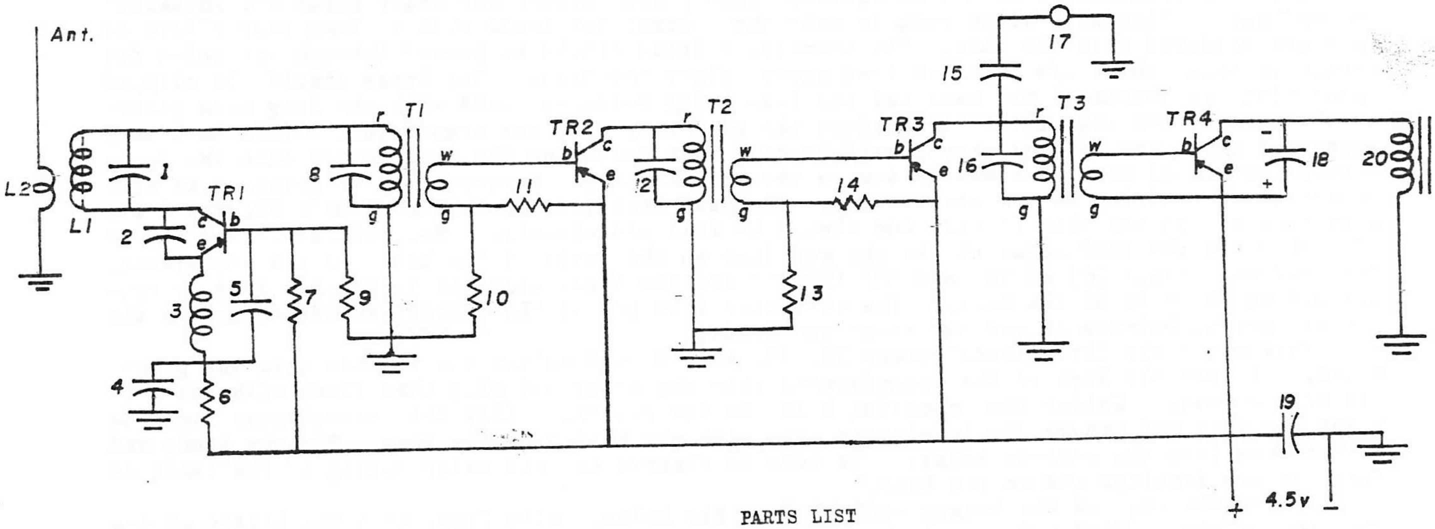
Use of a crystal hearing aid type earphone is recommended for tuning the receiver. Meter leads connected to the receiver may cause it to oscillate and give erroneous readings. Connect the receiver to the batteries making sure to observe correct polarity. Plug the earphone into the phone jack (17) and listen for the conventional hiss or rushing noise. Turn your transmitter carrier on and tune the slug in L1 until the hiss dissappears. Now key the audio tone and you should hear it clearly in the earphone. Range check the receiver at a greater distance and touch up the tuning always adjusting the slug for the loudest tone. When the receiver is at idle (no carrier) the relay may occasionally chatter. This is normal and will stop when the carrier is on. A crystal earphone is also nice for trouble shooting. Merely touch a tip to various stages of the receiver and you can hear the hiss (or tone).

Mount the receiver in the aluminum box placing the thin sheet of synthane between the bottom of the receiver and the box insulating it from the box. Bolt the relay to the side of the box with the 3/48 x 1/4 inch bolt. Bring the battery and relay wires out through the cable grommet. Bring the antenna lead out through the small hole near the coil. Place the lid on the box so that the hole in it is directly above the slug in the tuning coil.

Most of the conventional tone transmitters of 100% modulation will operate the TR 4.5. The frequency of the audio tone should be in the range from 400 to 500 cycles for best operation. The CG Single Audio may be used. The MarcyTone may be modified for lower cps.

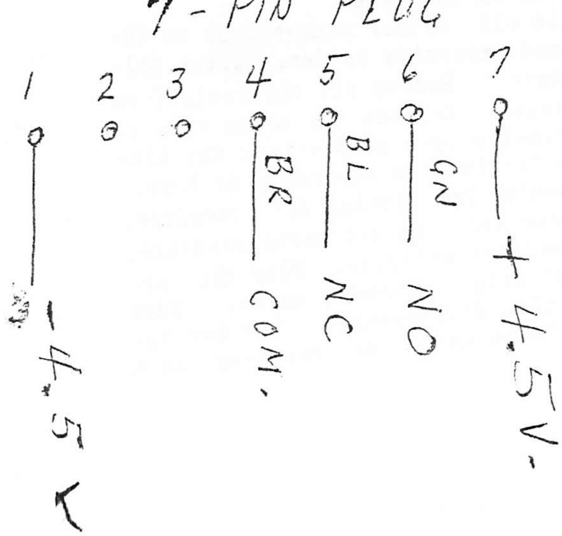
If desired the TR 4.5 may be operated at 3 volts with equally good results. Maximum relay current will be limited to approximately 32 ma with a 3 volt battery supply. This is still well over the required pull in current of the relay. Range will not be decreased by operating the receiver at a lower voltage. This fact together with the operating characteristics at lower battery voltages indicates the ability of the TR 4.5 to cope with an exceptionally large range of dropping battery voltage.

We feel the TR 4.5 will open many new phases of R/C. The 1/4A fan can now build a ship well under ten ounces and the endurance man can really log time due to the low battery drain of the receiver. For just plain R/C fun we think you'll enjoy the economy and ease of operation of this receiver.



PARTS LIST

1 - 22 mmf disc	8 - .02 mfd disc	15 - .002 mfd disc	TR1 - A01 transistor
2 - 10 mmf disc	9 - 47K 1/2 watt	16 - .02 mfd disc	TR2 - T0037 transistor
3 - 300 uhy RFC	10 - 47K 1/2 watt	17 - Phone jack	TR3 - T0037 transistor
4 - .001 mfd disc	11 - 1K 1/2 watt	18 - 60 mfd 6V	TR4 - ~~2N192~~ 2N188A
5 - .001 mfd disc	12 - .02 mfd disc	19 - .005 mfd disc	L1 - 10 turns #28 on CTC SPC2 form
6 - 1.2K 1/2 watt	13 - 47K 1/2 watt	20 - 100 ohm relay	L2 - 2 turn link #26
7 - 10K 1/2 watt	14 - 1K 1/2 watt	T1, T2, T3 - CR60 Xfmr	



Ace Radio Control
BOX 301
HIGGINSVILLE, MO.

TOP VIEW OF BASE SHOWING THE LOCATION OF COMPONENT HOLES

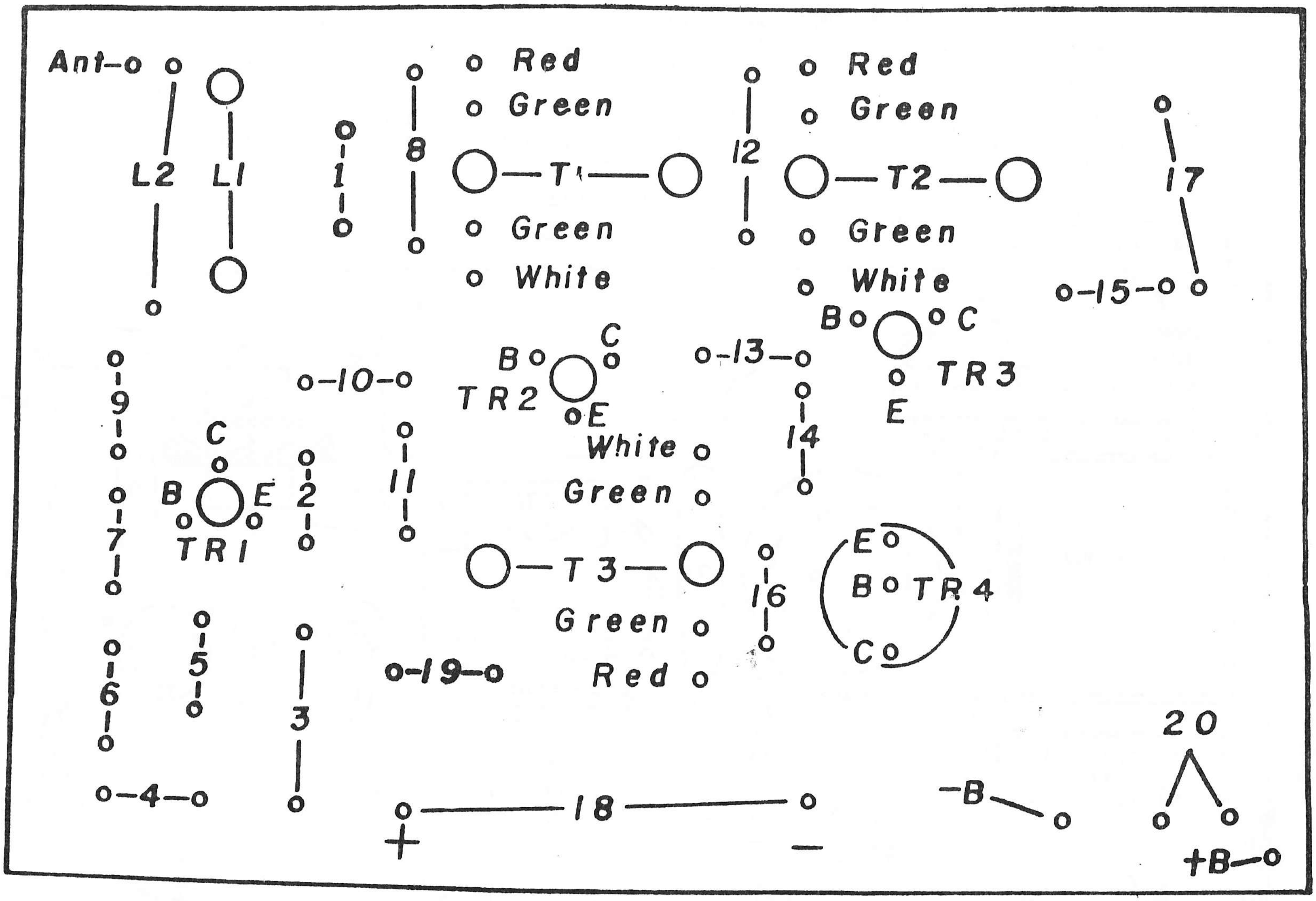


Fig. 1

PARTS LIST

1 – 22 mmf disc	8 – .02 mfd disc	15 – .002 mfd disc	TR1 – A01 transistor
2 – 10 mmf disc	9 – 47K 1/2 watt	16 – .02 mfd disc	TR2 – T0037 transistor
3 – 300 uhy RFC	10 – 47K 1/2 watt	17 – Phone jack	TR3 – T0037 transistor
4 – .001 mfd disc	11 – 1K 1/2 watt	18 – 60 mfd 6V	TR4 – ~~2N192~~ 2N168A
5 – .001 mfd disc	12 – .02 mfd disc	19 – .005 mfd disc	L1 – 10 turns #28 on CTC SPC2 form
6 – 1.2K 1/2 watt	13 – 47K 1/2 watt	20 – 100 ohm relay	
7 – 10K 1/2 watt	14 – 1K 1/2 watt	T1, T2, T3 – CR60 Xfmr	L2 – 2 turn link #26

TOP VIEW OF BASE SHOWING LOCATION OF COMPONENTS

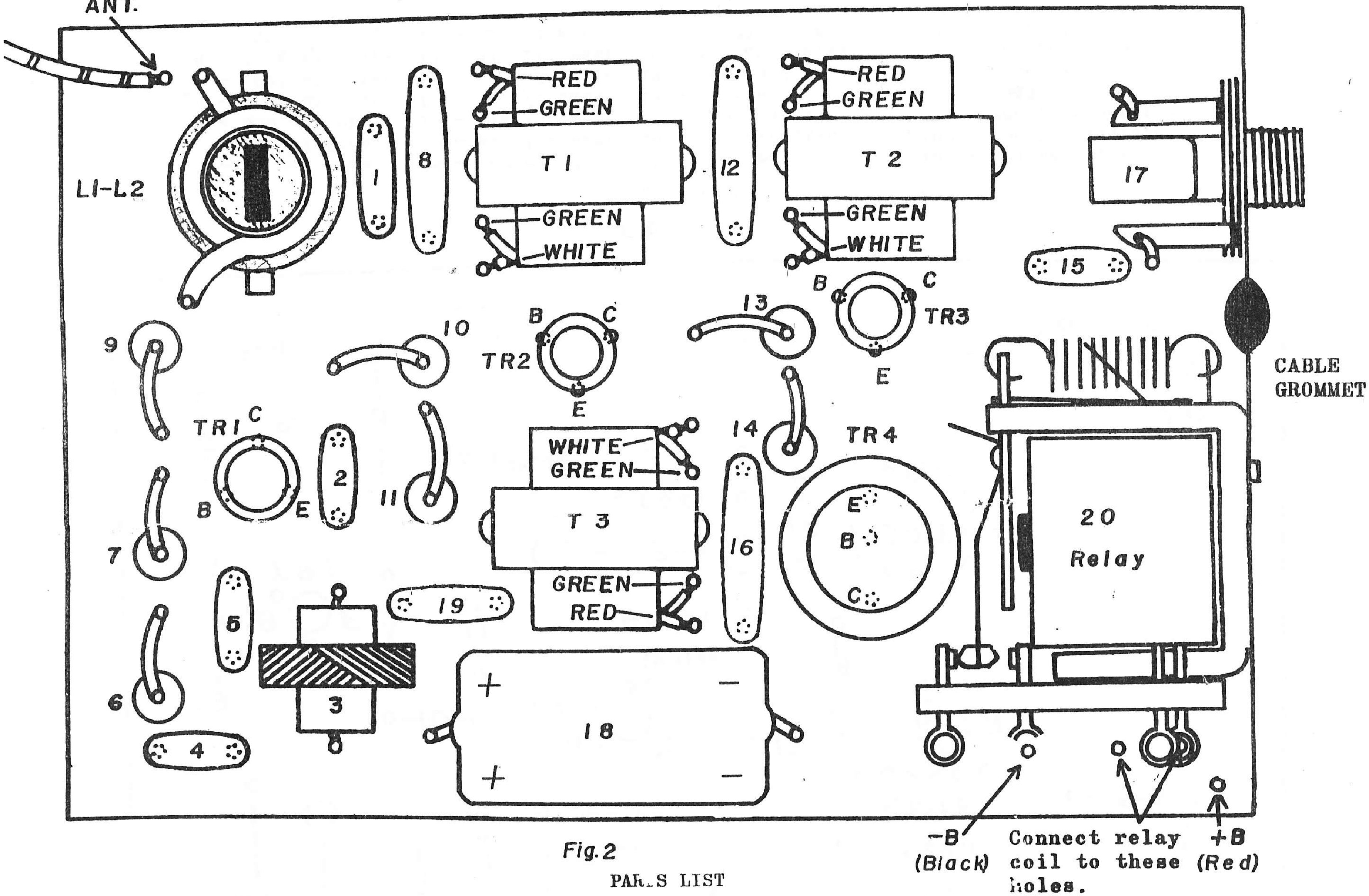


Fig. 2

PARTS LIST

1 - 22 mmf disc	8 - .02 mfd disc	15 - .002 mfd disc	TR1 - A01 transistor
2 - 10 mmf disc	9 - 47K 1/2 watt	16 - .02 mfd disc	TR2 - T0037 transistor
3 - 300 uhy RFC	10 - 47K 1/2 watt	17 - Phone jack	TR3 - T0037 transistor
4 - .001 mfd disc	11 - 1K 1/2 watt	18 - 60 mfd 6V	TR4 - ~~2N192~~ 2N168A
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6 - 1.2K 1/2 watt	13 - 47K 1/2 watt	20 - 100 ohm relay	
7 - 10K 1/2 watt	14 - 1K 1/2 watt	T1, T2, T3 - CR60 Xfmr	L2 - 2 turn link #26

TR 4.5 TiPS

BY RED COSTLOW

In the short time that the "45" has been out, many modellers have built the receiver from a kit or the circuit in Grid Leaks. The following notes are for those who may encounter difficulties or the experimenter who wishes to branch out in another direction.

On construction, we have some techniques that might be of interest. Strip and check all primary and secondary leads of the transformer for continuity. It is quite easy while stripping the leads to open the transformer. This can be a real bother later on. Scrape all resistor and condenser leads. Also the lugs on the transformers. This makes it a lot easier to solder to the PC board. Check to see that all the enamel is off the ends of L2 before soldering to the lugs. After the construction is done, install the transistors with the leads full length. Tack in the A01 and with the crystal earphone connected from the collector to ground through a .002 capacitor tune for the tone. This will be very faint. Repeat this step with the two audio stages and the tone should get louder. With the relay transistor in, the relay should operate. A scope substituted for the earphone makes it much easier. File off the high points of solder being careful not to damage the PC board or to open any of the connections.

Now you can install the transistors permanently. Leave the leads long enough so you can get at them for heat sinking. We use an old tooth brush and a small amount of dope thinner to remove the flux and filings.

The TR 4.5 is not fussy on voltage. The best current change and temperature stability will be with a 4.5 volt supply. We also use 3 Nicads with very good results. On some range checks we were still hearing the tone with only 1.5 volts. The following figures were made on several receivers for a comparison. The idle current will vary on all receivers but the carrier and tone values will be similar to these:

4.1 volts--idle 5.5 ma, carrier 2 ma, tone 42 ma.
3 volts--idle 1.4 ma, carrier 1.2 ma, tone 32 ma.
2.1 volts--idle .7 ma, carrier .6 ma, tone 20 ma.

All receivers built were temperature checked and were still working at 15 degrees and at 130 degrees. The heat checks were in an electric range and the relay was heard clacking with the door shut. Whenever making any current measurements it may be necessary to put a 50 to 100 mf capacitor across the meter. Otherwise the receiver may break into oscillation.

Antenna length does not seem to be critical and we have used from 24" to none at all. The latter was in a Sterling American Scout. Some high gain receivers show a tendency to swamp near the transmitter. To date this hasn't shown up on the TR 4.5. Even wrapping the antenna around a 4 watt transmitter whip did not affect operation.

Relay settings will depend on the supply voltage. This is not critical but we prefer a pull in at about 18 ma. This seems to work fine for both 3 and 4.5 volt operation. Check to make sure the braid on the armature is free. When making any adjustments on the relay with a battery, pot and meter it is a good idea to disconnect one side of the relay from the circuit. This lessens any chance of damaging the transistors. In some instances the relay will chatter when the tone is released. This indicates that the armature is touching the pole piece. We make it a standard practice to slip a piece of vinyl or cellophane between the two and gluing the ends to the coil with contact cement.

We couldn't wait to try the receiver out on pulse. No changes were needed and followed a WAG pulser on all speeds. It continued to track even when the voltage was dropped to 2.4 volts (two Nicads). Pulsing the receiver for two and three house had no effect on the supply voltage. The transmitter batteries did give out. The actuator used is from Grid Leaks Vol. 1 Number 6 by Jim Martin.

At the time of this writing we haven't had a chance to put one on 6 meters. Preliminary checks showed that the A01 was still super-regening on 52 mc. With SB 103's etc. available at a reasonable price this should do the job.

Noise (electrical and mechanical) has on occasion posed a problem. The changing of the .005 across T3 to a .02 seems to have taken care of this. On some actuators and escapements the brush noise of collapsing field will trip the receiver and set up a "chain reaction". This may happen if the receiver and actuator are very close together. A .01 capacitor on the relay points and a diode across the escapement should cure this. This is a good practice and should be used on all installations. On the Mighty Midget we use a .01 which seems to do the job. For pulse we use two .01s and a 10 ohm resistor on the relay. We might mention here that a common supply for receiver and actuator is to be avoided.

Since the kit has come out some builders have found the receiver oscillates on 4.5 volts but not on 3 volts. (It may be on the threshold on 3 volts.) Reversing the primary leads (red and green) of T3 will cure this. In one case we found that we had to reverse the primary leads on T2 instead.

If grabbing the transmitter antenna with tone on causes the receiver current to go way down look for a weak first audio transistor. The third and fourth stages don't seem to be critical and just about any transistors work here. We have yet to see a bad A01 and all we've checked on a commercial checker showed very low leakage and extremely high gain. The T0037's as a rule show high leakage but very high gain. Some are really phenomenal. To the "scratch builder" the Philco 2N223 shows great promise, both in the audio stages and in the relay stage. It is low priced and appears to be quite uniform. While on the subject of "scratch builders" if you substitute parts, you're on your own. In general you will have to tailor the tank circuit to the particular type of transistor you use (SB100's, 2N47's, etc.). The RFC may vary from 200 to 500 uh.

Max Boal and Dale Springsted have made countless tests in the field on the TR 4.5. The data they collected enabled us to make more accurate comparisons. Dale has done a great deal of work on various forms of biasing. One is the use of a 200 to 470 ohm resistor in the emitter of the audio stages. This will cut the gain a little but tends to stabilize the stage. This biasing can be carried further and we might refer you to the GE transistor Manual 3rd edition. This has an excellent section devoted to biasing.

We would like to extend our deepest gratitude to Dale Springsted, Max Boal, and Paul Runge for their assistance on the TR 4.5.

Editor's Notes - It has been found that faulty connections between any of the transistor and board will cause oscillations.

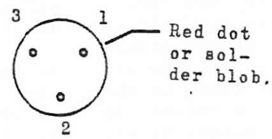
Max Boal has had phenomenal success with this circuit. First in Intermediate at the NATS and two firsts in Regional contests since.

In kits all transistors are tested for gain and so cannot be replaced. The A01 is checked for super-regen activity and also cannot be replaced. Ordinary care when soldering should be used. Heat sinks of wet cotton of the old reliable method of using a pliers is a must.

For the convenience of readers we show a reproduction of the base view of the T0037.

Bottom View

1. Collector
2. Base
3. Emitter



The GE 2N188, 2N188A, 2N234, and Philco 2N223 also make excellent relay transistors since GE has discontinued the 2N192.

MORE NOTES ON THE TR 4.5

BY RED COSTLOW

EDITOR'S NOTE

Grid Leaks has presented service articles before. However, we felt the need for specific and special service techniques as evolved for equipment that is more than a little out of the ordinary. We commissioned Red Costlow, one of the designers of the TR 4.5, to give us such a service article to show you how the pros do it. Our question to you is, "Would you like to see other articles of this nature in Grid Leaks on other equipment?"

Quite a bit of interest has been created in the TR 4.5 since it first appeared in Grid Leaks (Volume I, Number 5). Reports have come in from all over the country from modellers who are using this receiver. The information that has been gathered is passed on here for the benefit of those interested.

I. Inoperative or erratic performing receiver:

Probably is due to improper soldering or cold solder joints, the most common being the transistor leads. Either the solder didn't flow, the PC base isn't clean, or when the high spots are filed off some connections are broken. In most cases just hitting suspected joints with an iron will cure these ills. This is a tough one to locate for most of the connections look all right. Some of the erratic conditions are: sensitivity to hand capacity, inconsistent level of the receiver tone, or unstable tuning.

II. Receiver breaks into audio oscillation:

This is characterized by a loud howl in the earpiece, relay pulling in with no signal, and maximum current drawn. This may happen with or without carrier. The receiver may not oscillate on a lower voltage or with fresh batteries. Old batteries may throw the receiver into oscillation so check these or substitute fresh ones. Another characteristic is excessively high idle current, indicating the threshold of oscillation. Later on we will see how to handle this situation.

III. Some receivers quit at cold temperatures:

This is surprising for all the original receivers responded well at all temperatures. Symptoms are: no range, lowered relay current, or the receiver is completely inoperative. Investigating this problem provided the answer and is the main reason for this article. At the same time the overall performance can be improved.

IV. Oscilloscope traces:

The photographs of the scope traces are of a receiver in normal working condition. The conditions that existed at the time the scope traces were made are: supply voltage 4.3V, receiver idle current 5 ma, with carrier 3 ma, and with tone 43 ma. The transmitter was sine wave modulated at 450 cycles. A 0-50 ma meter (with a 100 mfd capacitor across the terminals) monitored the receiver current. A Heathkit VTVM took care of the voltage measurements. All tests were made with full transmitter power (just under 2 watts) and with a dummy load to simulate a range of 1500 feet. Relay current should remain fairly constant with full power or with a dummy load. Three patterns are shown for each stage measured from collector to ground (See Fig. 1) These patterns are: no signal, carrier, and with tone. Modulation percentages were also checked and it was observed that the receiver current rise remained constant with modulation percentages of 70% to 100%. Below 70% the rise current started to fall off. Figures 5A and 5B show the transmitter carrier and modulated carrier. Figure 4 is a special shot of the actual carrier and modulated carrier. Figure 3A shows the simultaneous waveforms of no signal conditions at the collectors of the two T0037's and Figure 3B shows the same conditions with modulation. The upper trace is TR2 and the lower trace is TR3.

V. Temperature tests:

Extensive research revealed that temperature stability depended on the transistors and the biasing conditions. In germanium transistors as the ambient temperature goes up the collector current increases. Since collector current is proportional to the bias current it is logical that as the collector current increases we want to decrease the bias current. The converse is true as the temperature drops. There are other complex factors involved in the physical nature of the transistor but are beyond the scope of this article. Again we are dealing with the extreme conditions.

Continually changing the biasing resistors for temperature tests is a slow process so two 100K pots are substituted for R10 and R13. A third 100K pot is connected from the collector of TR3 to the junction of R13 and R14. (See Figure 2). This is marked Ra. Cardboard discs are fastened to the pots and pointers attached to the shafts. The pots are then calibrated in 10K steps with an ohmeter. Tak-solder the pots into the circuit on stiff wire standoffs long enough to clear the other components. Start any adjustments with the pots set at mid-scale. Conduct the tests at the temperature you are concerned with. At average temperatures the settings are not critical. It is a good idea to also observe the receiver current at all times. This gives an indication that the receiver is responding properly. At the same time you will be able to adjust for the best current idle and current rise. Whenever the pots are changed, check the operation with and without signal and with range checks. Some settings give good operation but kill the range. A simple way of checking range is to ground the transmitter antenna with your hand. If the current rise drops off when you do this, try other pot settings. There should be little or no difference. It takes a little while for the "parts" in the receiver to adjust to a large change in temperature so don't rush any observations.

An example of one such setup is as follows. The receiver started acting up at about 30 degrees and oscillated on 4.5V. Reducing R10 to 22K, leaving R13 at 47K, and setting Ra at 63K the receiver worked perfectly from room temperature to below zero. However, as the temperature was raised above 80 degrees performance dropped off. It became apparent that no one biasing condition would cover from extreme cold to extreme heat. The R/C man, therefore, will have to take into consideration the conditions in which he will be using the receiver. You may find that the value of Ra will have to be increased to more than 100K for operation at high temperatures. Resistor Ra will cure any audio oscillation but overall performance should be checked after inserting this resistor. It may even be necessary to adjust R10 and R13. Once the proper settings of the pots are determined note the readings on the cardboard scales. (Try and get these readings in the vicinity of standard resistor values.) Remove the pots from the circuit and substitute equivalent resistors. Drill holes in the PC lands of the collector of TR3 and the junction of R13 and R14. (Caution! Drill the holes from the bottom side of the base. It is easy to push the foil away from the base when drilling from the top.) Stand resistor Ra on end in the holes drilled.

Those who are concerned with low battery drain or improved performance can get idle currents in the microamp range while still retaining a high current rise.

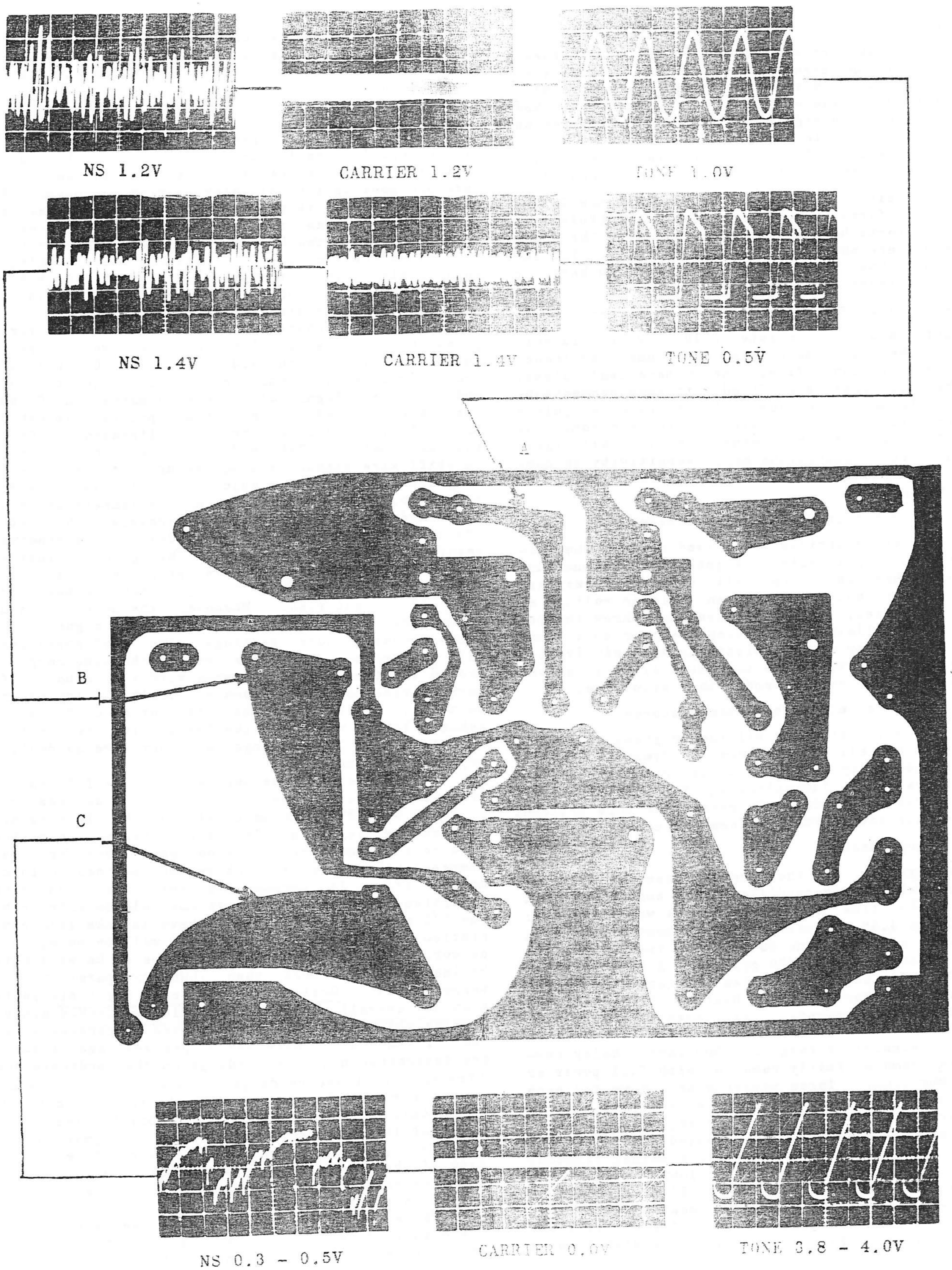

NS 1.2V
CARRIER 1.2V
TONE 1.0V
NS 1.4V
CARRIER 1.4V
TONE 0.5V
A
B
C
NS 0.3 - 0.5V
CARRIER 0.0V
TONE 3.8 - 4.0V

FIG 1

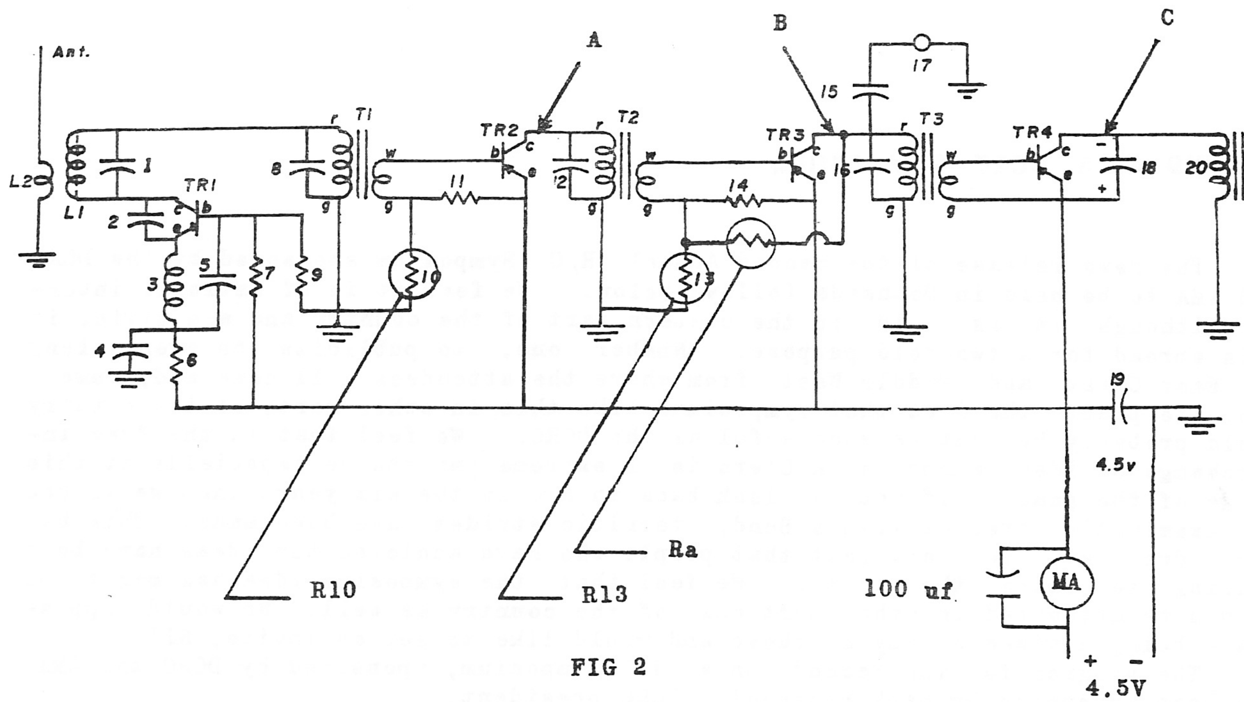


FIG 2

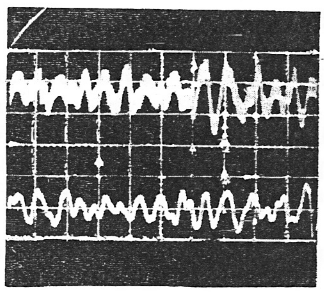


FIG 3A

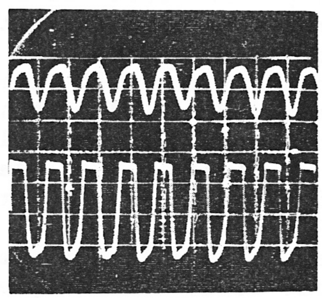


FIG 3B

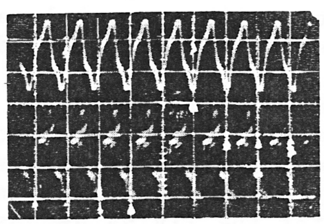


FIG 4

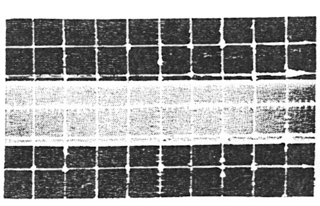


FIG 5A

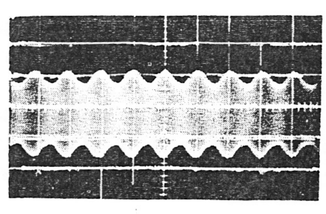


FIG 5B

SECOND AMA DCRC SYMPOSIUM

The news release of the Second Annual R/C Symposium sponsored by the DCRC and AMA to be held in Bethesda follows below. We feel it is of national interest although it is held in the eastern part of the country and are giving it this spread for a two-fold purpose. Number one, to publicize the event along the East Coast and Middle West from where the attendees will come and, number two, to plant the idea that symposiums like this in other parts of the country would probably be just as successful as the DCRC. We feel that in the free interchange of ideas among top R/C'ers is of extreme importance especially at this stage of the game. If you'll look back in R/C in the six years that we've had the examination free Citizen's Band, terrific strides have been made. This has been due only to the fact that people who have achieved the ideas have been willing to share the ideas. We feel that the symposium idea has merit and should be attempted in other portions of the country as well. We would appreciate being advised of any of these and would like to get an invite, HI!

The program for the Second Annual R/C Symposium, sponsored by DCRC and AMA, has been announced by Hank Bourgeois, DCRC president.

On Saturday, April 11, two technical sessions will be held at the Perpetual Building Assn., Wisconsin and Montgomery Aves., Bethesda, Md., starting at 10 a. m. The symposium dinner will be held Saturday night, and there will be flying demonstrations on Sunday.

Among the speakers who will give technical talks, keyed to the average R/C builder, are: Woody Blanchard, NASA, Hampton, Va., aerodynamics of R/C models; Maynard Hill, Pittsburgh, Pa., metallurgy for R/C; John Worth, NASA, Hampton, Va. Simpl-Simul; Larry Herzog, RCA, feedback applied to dual proportional; Howard McEntee, Norwood, New Jersey, R/C transmitters and antennae; and Harold DeBolt, Buffalo, N. Y., R/C engines.

Other presentations will also be made, and there will be displays of new commercial and home-built R/C equipment.

Attending the symposium can be a family affair, according to DCRC, as the weekend is also the date for the famous Cherry Blossom Festival in Washington. A committee has been formed to assist wives and families who want to go sightseeing while the men attend the meetings.

The symposium dinner on Saturday night will be a church supper, family style, at a cost of $2 per person, with a special rate for children. There will be an after-dinner speaker and entertainment, including skits by the R/C fraternity.

On Sunday, the flying demonstrations will be held at 10 a. m. at the DCRC flying site. Similar maneuvers such as rolls, spins, etc. will be accomplished for comparative purposes by models having free ailerons, coupled rudder-ailerons, dual proportional, reeds, simple simul and other systems. Flight-line flying will be allowed before and after the flying demonstrations for those who would like to bring their models.

The symposium fee is $2, and includes a copy of each of the papers presented at the technical sessions. Those attending are expected to make their own reservations. Motels in the Bethesda and Silver Spring, Md. areas will be most convenient.

DCRC advises that the Washington area will be crowded with tourists during this Cherry Blossom weekend, and strongly urges that reservations be made as soon as possible.

A copy of the program and a map of the area showing meeting sites and motels has been sent to eastern R/C clubs. This information is also obtainable by writing to George Wells, 10004 Thornwood Rd., Kensington, Md.