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"I told Orville; I told Wilbur-----"

UPOMA

AUTHOR WISHES REMAIN ANONYMOUS

READ IT, YOU'LL KNOW WHY

This article is intended to introduce many of Grid Leaks readers to an entirely new thesis, and concept in the field of radio control model flying. Some of this concept does splash over on the freeflight modellers, as well as control line modellers as will be demonstrated. However, in the main I firmly believe that practically all radio control modellers have seen UPOMA at work if they have attempted to fly a model aircraft by radio control. I feel sure also that some modellers that have not yet attempted to fly an R/C model have seen UPOMA or at least signs of it.

UPOMA is evident in many forms around the home flying field, yet I believe that the average modeller has seen this concept aptly demonstrated most vividly at large contests. It is here that even the experts find UPOMA at work in the advanced stages. One might even make the premise that UPOMA becomes more serious as the number of stages in the receiver increases, also as the number of control surfaces to be moved increases. Generally the mathematical relationship of this increase follows the square of the stage of the receiver. To illustrate, the normal receiver has a detector and one stage of amplification. UPOMA would be given an arbitrary value of 2(two). Now we add one stage. UPOMA automatically assumes the pr[illegible]on of 2 squared or 4 (four). You can see how this [illegible] climbs as stages are added. A rudder only model, with motor control would be given a similar value 2, and when the elevators are added the proportional advance is the geometric mean, by 2, or four. Now we add two ailerons. (who ever adds one), the value of UPOMA is now 6.

Since we have shown the mathematical probability of the concept involved here, it might be well at this point to provide a series of examples of this new theory. We will try to illustrate UPOMA as it affects the various phases of R/C flying as well as C/L and F. F.

One of the first examples that comes to mind is the model that has your pet motor in it. This motor has been used for several years, and always has been reliable, both in power output, general running, extremely easy to get a good low speed setting. It never kicks back and breaks the fingers, and most of all starts with the well known single flip of the prop. You have planned to go to the big meet and figure you have a good chance to place high if not win. Since there are lots of other chaps that have similar larceny in mind, the director of the meet has established a time limit on starting--4 minutes. Confidently you go to the starting line, and when your number comes up you crank for 4 minutes but the motor will not start. It always starts after 4½ minutes. UPOMA of the first order.

You can readily see many examples of this effect, for instance the free flighter that is flying in a large field that has only one huge tree in the middle of it. Any good model will always exhibit UPOMA, by landing guess where, right smack dab in the middle of the highest part of the tree.

The control line flier?? also comes into the picture. Long before I was indoctrinated to R/C I had the opportunity of watching a real close-up picture of UPOMA. I had been flying a Class C speed model for the better part of two years. Was doing real well with it at all of the local meets. Naturally it had withstood the pull test many times. So one weekend the gang took off for a big meet in a town several hundred miles away, so natch I took old Black Maria. Imagine my surprise when the pull test not only pulled out the wires, but the wing, bell, crank and all. The surprise was simply that much greater as the chap doing the pull test and myself slowly picked ourselves up from the dust in the field.

If you think the previous examples of UPOMA are bad, just hang around the radio control group a bit. Here are the lads that really suffer from it. Here's one I've seen. One chap has an R/C model that is flying just great. It is way up high, he has been stunting it all day, with no difficulty at all. He says to a bystander, in this case YOU, "Like to try it a bit?" and hands over the stick. On the first turn the model spins in under power from about 200 feet. Makes everyone happy, just to think about it. How many times have you put together a new receiver and made all the bench tests etc., works fine, right up till the time you try to operate it at the flying field? The trouble is when you get back home everything is working again, and the next time you take the ship out it will work O. K. (or will it??). You have a WAG TTPW rig, working pretty good, and you go to a meet. After two flights, you are in fourth place, but only 10 points behind the leader. So not wanting to stay in number 4 slot, you elect to try again. It looks like you are making up points about midway of the flight, and the neutralizing rubber on the elevator breaks. This just naturally leaves you with only two horizontal control positions, full up, and full down, nothing in between. UPOMA is here again. One of my buddies had a nice flying rudder only pulse ship that performed like a clock every time. He finally tried to improve the pulse motor's mechanical setup, and sure enough you are right, creamed it on the very next flight.

One of the most shining examples of UPOMA I have ever had the distinction of witnessing, occurred to a free flighter friend. Primping up for a contest on the coming weekend, he was test flying and making last minute adjustments one evening, when he hooked a slight riser. No, he did not lose the ship. We watched it a minute or so, and it seemed to be settling out of the riser but over a small hill on the next farm. So my friend took off in the well-known fashion, and was gone for some time. Perhaps 30 minutes later he appeared at the field again with but parts of the ship, ie. motor, landing gear, tank, and timer. These were the only parts of the model that the PIGS in the pen where the model landed did not find digestible. This same chap had UPOMA real bad since he later had a model fly into an Atomic Research Laboratory, the only such place for miles. Fortunately he quit before getting involved in R/C flying, since I hate to think what might have happened to him.

I think I have rambled on now for some time and just remembered that I never did tell you what UPOMA means. It simply stands for UNCANNY PERVERSITY OF MODEL AIRCRAFT. Of course if you slur the pronunciation a bit and add an N it comes out 'U' 'PO' 'MAN'

1-7-2

McGEORGE AUDIO TRANSMITTER

JERRY PRESENTS SOME MEATY MATERIAL

The writer has been interested in the application of LC filters to R/C receiver design for several years. This is an interesting subject because the use of high Q tiny toroids in the receiver's filter section requires audio tone frequencies in the thousand's range for best efficiencies. The full potential of this high frequency area has not been explored completely where the first stage of the receiver is a superregenerative detector.

Most of my early efforts to use high audio frequencies for multi-channel were concentrated on receiver design. Shortcomings with receiver performance regardless of the circuits tried finally suggested a re-examination of the then existing transmitter with particular attention to the character and quality of the audio signals and their modulation of the rf carrier. Scope examination revealed some rather weird looking audio signals and modulation patterns so a decision was made to shelve the receiver project and concentrate on the design of an ideal amplitude modulated transmitter using currently available filament type tubes and components.

Thus began a series of transmitter experiments where seemingly all kinds of rf carrier generators were assembled on breadboard. These carrier generators were in turn modulated with numerous af tone circuits assembled on another board. The results of these experiments were then studied in the light of simplicity, duplicatibility, audio tone character and stability, and ease of modulation adjustment. With due respect for the compromises so necessary in electronic design the writer believes that the circuits described here approach these standards.

The rf section consisting of the crystal oscillator and the rf doubler/amplifier is essentially the one developed by Walt Good for his TTPW system. A few modifications have been made to the doubler/amplifier circuit to facilitate modulation percentage adjustment. Of all the rf carrier generator circuits examined this one is outstanding for many reasons and is highly recommended.

The af tone section, on the other hand, represents a bit of original work on the application of established circuits associated with frequency-stable sine wave generation and distortion-free amplification to the extent required for reliable R/C. Considerable space is devoted to the discussion of this af tone section and the modulation process hoping that the radio-minded R/Cer will find the information helpful in understanding audio tone transmitter circuitry where the rf carrier is grid modulated with a sine wave signal.

It is not intended in "Circuit Adjustment" to suggest that an audio generator, scope and VTVM are absolutely necessary for modulation adjustment or for proper matching of transmitter tones to the receiver filters or reeds. These objectives can be achieved by cut and try methods and the results should be quite satisfactory. The technique of using these instruments is presented as a matter of record and for those fortunate enough to have access to their use.

The parts list shows component values required for 52 mc operation since all experimental work was done on this frequency. The open spaces on the parts list are reserved for values associated with 27.255 mc and they can be determined by **referring** to page 24, American Modeler, March 1957. The 27.255 mc rf circuit requires slightly different treatment but the conversion should not be difficult.

The technique used to describe these circuits is gaining in popularity. Whether or not it is helpful in R C is left to the reader. Experienced old timers could find it superfluous and rank beginners may find it bewildering. Perhaps it will appeal to the experimentally minded middle group."

CIRCUIT DESCRIPTIONS

I. The Crystal rf Oscillator (upper left)

The 3V4 power pentode is connected as a triode in a regenerative crystal oscillator circuit. This circuit is particularly adaptable to the use of overtone crystals and is characterized in this case by the location of the tap on (18) which is positioned to provide just enough regeneration, or feedback, to assure easy crystal starting and satisfactory operation under load.

Resistor (1) is the grid leak. (4) is the plate blocking condenser. (5) is a current limiting resistor. Condenser (17) and inductor (18) in the plate circuit are tuned to 26 mc.

The main function of variable condenser (19) is to control the rf delivered to the grid of the final rf stage which employs a 3B4 beam pentode operating as a:

II. Class C Grid Modulated rf Doubler-Amplifier (upper right).

This 3B4 circuit is perhaps the most important of the four circuits in this R/C transmitter because it is here that the tiny 26 mc rf signal from the crystal oscillator (Section I above) is doubled to 52 mc and also amplified power-wise to the point where a useful rf carrier is radiated from the antenna. And it is here that intelligence-bearing audio tone signals are **superimposed** on the rf carrier. In other words, it is here that the carrier is modulated.

Condenser (19) is variable from 2.3 to 14.2 mmfd and its setting determines the rf excitation of the 3B4 grid. (This is a key point in the modulation process and reference is made to it in "CIRCUIT ADJUSTMENTS"). Rfc (20) in conjunction with capacitor (25) effectively keeps the 26 mc signal above ground. Automatic grid bias for the 3B4 is developed across resistor (9). (10) is the screen rf bypass condenser (11) is the screen voltage dropping resistor. Condenser (12) is the plate blocking condenser. (21) is the plate circuit tuning condenser--Note: the rotor is grounded making for easy construction and less critical tuning. (23) is the antenna pickup coil located close to the lower end of the plate circuit inductor (22). Variable condenser (24) permits antenna resonance adjustment.

The intelligence-bearing audio tone modulating signals are applied at (M). These low frequency audio tone signals originate in the:

III. Audio Tone Oscillator (lower left).

Which in this case is a two-tube arrangement known as a Franklin oscillator. The circuit produces high quality sine wave audio signals with good frequency stability. A 3A5 double triode is used.

The principal frequency determining components in this circuit are inductors (48) and capacitors (49). Each Inductor (L) has a companion capacitor (C) and this LC combination is called the **"resonator"**. When L and C are teamed together in the manner shown then the frequency in cycles per second (cps) is expressed as follows:

$$\text{FREQUENCY} = \frac{1,000}{2\,\text{pi}\sqrt{L \times C}}$$

Where, L is in henries and C is in microfarads

The Franklin oscillator is relatively simple and is noted for its frequency stability. The good features of this two-tube af tone oscillator might be better appreciated if you examine the **basic** requirements for <u>any</u> LC electronic oscillator when only <u>one</u> tube is used.

In order to obtain a sine wave output signal an audio oscillator circuit must have the following elements: an LC resonator, an amplifier, a load, a 360 degree phase reversal loop from input to output back to input, and a dc power supply. Thus, an LC oscillator might be called an energy converter which if fed dc power will convert some of it to ac power at a given frequency with sine wave character. When only <u>one</u> tube is used in an LC audio oscillator circuit some method must be established whereby a bit of energy from the plate of the tube is fed back to the grid <u>in phase with</u> the input grid signal at a particular instant. (Like pushing a kid on a swing). And most single tube LC audio oscillators used in R/C employ somewhere in their circuit a tapped transformer which provides <u>half</u> of this 360 degree turnaround service. The additional 180 degree flip required for turnaround is provided by the tube itself. The Hartley circuit is a good example. It uses an inductive voltage divider, or center tap. Another example if the Colpitts circuit which uses a capacitive voltage divider across the transformer. In either case the **"center tap"** used for feedback purposes provides a relatively easy means for conversion of dc power to ac power. But frequency stability is sometimes sacrificed. This serious shortcoming could be due to the intimate relationship, or loading effect, between the grid and plate signals in the **"tapped"** transformer. The two-tube Franklin oscillator shown here avoids this shortcoming **nicely** because the first tube flips the signal 180 degrees in normal fashion and this signal in turn is fed to the second tube which again flips it 180 degrees making a total of **360**. This completely turned around signal is then sent back to the grid of the first tube thereby "giving the kid on the swing a push," but note that no transformer is used to accomplish this full turnaround.

So, the second tube in a Franklin oscillator has only one simple assignment, namely to send a bit of in-phase signal back to the grid of the first tube to sustain oscillation. And it does this in a friendly manner because this second tube is isolated load-wise from the all important first tube whose only job is to oscillate at the frequency dictated by the LC resonator (48) and (49).

Resistor (30) and capacitor (29) establish grid bias for the 3A5 first-half and also serve to adjust the feedback power from the second-half automatically so that the amplitude of oscillation remains essentially constant. (32) is the plate load resistor.

In the second-half, capacitor (36) introduces the first-half output signal to the second-half grid #5. Resistor (37) provides proper bias for the second-half.

Resistor (33) provides second-half plate load. Condenser (34) and resistor (31) comprise the feedback circuit.

When all keys are "up" the 6.8 meg resistor (28) affects a slight positive charge on first-half grid #3 and stops any tendency of the oscillator to "motorboat". This is a highly **desirable feature** because it permits installation of the LC resonators in the transmitter box and rather long leads out to the hand held control box. Ordinarily when long lines are extended from the grid of an af oscillator some trouble can be expected with low frequency "put-putting".

It is easily avoided by doing two things: First, use a shielded multi-wire cable between the control box and the transmitter and connect the shield to the chassis of both units. Be sure to install rf chokes (51) and (52). Second, experiment with the value of resistor (28) after the control box and cable assembly has been connected. Something more or less than 6.8 meg may be necessary to stabilize grid #3. In general the value should be made as high as possible.

Resistor (35) serves as a voltage dropper in the B plus line to the af oscillator. Capacitor (38) permits development of the Franklin oscillator output signal across potentiometer (39). The position of the slider on pot (39) determines the level of af tone signal fed to the next af stage which is a:

IV. <u>Class A Audio Amplifier-Modulator (lower right).</u>

This 3V4 power pentode operates as a Class A audio amplifier which means that its purpose is to reproduce faithfully an <u>amplified</u> version of the sine wave signal presented to it by the Franklin oscillator.

To do this, the grid of the 3V4 is biased 7 1/2 volts by C battery (42). The incoming signal at grid #6 swings entirely in the negative grid region. As a result the <u>amplified</u> output signal voltage developed across plate load resistor (43) is a faithful reproduction of the Franklin oscillator signal voltage.

The input signal voltage level at **grid #6** is determined by the setting of pot (39). Capacitor (40) introduces this af voltage to the grid. (44) is the screen dropping resistor. (45) is the screen bypass capacitor. Capacitor (8) couples the output of this af amplifier-modulator to the control grid of the 3B4 rf doubler-amplifier at point M.

<u>CIRCUIT ADJUSTMENTS</u>

I. If 100 ohm 1/2 watt resistors are installed at points A, B, C, and D with provision to connect a milliameter across each of them, then the B plus current flowing in the four separate circuits may be read. Simple phone tip jacks at both ends of each of these four resistors brings this information to the transmitter panel. (See insert drawing).

II. Set condenser (10) at about 1/3 mesh. Tune the slug of (18) to the point of plate current dip as read at B and set it on the stable, or shallow part of the curve. The current at B should be in the order of 3.5 to 5.0 mils.

With full antenna connected and condenser (24) fully meshed, next tune condenser (21) to the lowest point indicated by the current reading at D. This should be between 10.0 and 15.0 mils. Tune condenser (24) to maximum radiation as indicated on a field strength meter. Now, jockey these two condenser (21) and (24) to completely satisfy the above mentioned conditions. Meanwhile in the audio section the current at A should stand still at between 4.0 and 6.0 mils and that at C between 5.0 and 7.0 mils. The above described conditions are with "no tone".

III. Now set pot (39) at about mid-point and apply any one of the tones. Readings at A, B, and C may drop slightly but D should drop to about one-half of "no tone" reading and you'll note that the field strength meter does likewise. These negative deflections indicate that modulation of the carrier is taking place. A quick check on the uniformity of modulation for all of the tones in the resonator section is indicated if each tone depresses these readings approximately the same amount. This shows that the ac voltage developed across pot (39) is approximately the same for each tone.

Only two **controls** are involved in the modulation percentage adjustment. They are: Condenser (10) for adjustment of rf excitation of the control grid #3 of the 3B4 and pot (39) for the adjustment of the ac tone voltage developed across the 3B4 grid resistor (9) and thereby superimposed on the rf carrier. We've chosen to **modulate** control grid #3 because only a tiny bit of af power is required to do the job. But by this choice of modulation methods, which is favorable to R/C lightweight construction, we've inherited the task of balancing rf excitation against af tone imposition. These conditions in the 3B4 circuit are controlled by conden-

1-7.3

ser (10) and pot (39) respectively.

IV. Space permits only a modest discussion of modulation theory and techniques. Details will be found in the texts and handbooks but a practical appreciation of the modulation process can be developed if we use the "back door" approach, meaning, let's start with the audio tone receiver whether it be reed or filter type and work back to the transmitter.

An audio tone type receiver demodulates or "detects" the modulated carrier, lifting out the audio signal for presentation to the reeds or filters. The front end of an audio receiver is interested only in the variations of the carrier and NOT in the carrier itself. It discards the carrier in fact as a useless thing at the detector stage and passes on to the amplifier stages and thence to the reeds of filters only those variations which it has recognized and which we call audio tones. They are in the low frequency audible range and are presentable to low frequency discriminating devices such as reeds or filters. Since the carrier has been rejected the only useful power in our audio tone system lies in these carrier variations. And the power in these variations with respect to carrier is expressed as per cent modulation, a numerical ratio.

The front end of an audio tone type receiver "sees" nothing in an un-modulated carrier; there's nothing to lift out and send on to the reeds or filters. Such a condition is labeled zero per cent modulation. On the other hand, it does indeed "see" something in a 100% modulated carrier and if properly tuned the detector circuit lifts out of this perfectly formed amplitude modulated wave a full-powered audio tone signal having exactly the same wave form as the carefully formed modulating signal generated in the af section of the transmitter.

Under-modulation, meaning less than 100%, can be tolerated and is indeed quite useful in R/C systems if the power residing in the upper and lower side bands (carrier variations) satisfies the reeds or filters. Over-modulation, meaning more than 100%, can not be tolerated under any circumstances since such practice violates FCC rules. Our objective then is to learn how to adjust our transmitter for maximum radiated useful power which occurs at 100% modulation.

V. When the control grid of an rf amplifier is employed as the modulating electrode, the desirable carrier variations radiated by the transmitting antenna are in accordance with the variations applied to the control grid bias voltage of the rf amplifier. This establishes our objective.

In this 3B4 rf amplifier circuit the fixed negative grid voltage, or bias at the #3 electrode, is obtained entirely from the voltage drop across grid resistor (9) caused by the flow of rectified #3 grid current when the 3B4 is being driven by the preceding rf stage, which in our set-up is the 3V4 crystal oscillator. The setting of variable condenser (19) affects this fixed dc grid bias voltage of the 3B4. (See again CIRCUIT DESCRIPTIONS II). Now that a fixed dc grid bias has been established the trick is to vary it, as mentioned above, in a desirable audio frequency manner. This is accomplished by introducing at point M an audio frequency (tone) current which developes an ac voltage across this same resistor (9). Thus, an ac voltage is superimposed on the fixed dc bias voltage at this point and the net result is a variation of grid bias which will appear similarly as a carrier variation at the antenna. This is the theory of control grid modulation as applied to our 3B4 rf amplifier.

VI. The only reliable method for modulation percentage adjustment of an AM transmitter involves the use of an oscilloscope. The reason is that the scope presents an immediate, precise picture story of circuit conditions in the rf amplifier. A scope will plot instantaneously for our observation the rf conditions on the Y axis against the af conditions on the X axis. Since (10) controls the Y axis and (39) controls the X axis the proper setting of the two controls for 100% modulation can be observed. The test should be conducted with antenna fully loaded. The insert drawing shows the scope connections for this observation and a typical 100% modulation pattern. It is an isosceles triangle with one point to the right. A small pickup loop of 3 turns of hookup wire is placed near the plate end of (22). Thence through two .005 capacitors the leads are connected directly to the vertical plates of the cathode ray tube at its socket. The ground of the scope is connected to the ground of the transmitter. The horizontal input of the scope is connected to E. This so-called trapezoidal modulation demonstration is discussed in several popular texts including the ARRL Handbook and Rider Electronic Technology Series Booklet No. 166-9, "Amplitude Modulation".

VII. The schematic shows five LC resonators in the Franklin oscillator circuit, one LC combination for each channel. For the purpose here five channels can be considered typical for multi-channel work although many more than five may be used depending on the designer's ability to build an equal number of reed or filter channels into his receiver. Admittedly the LC resonators shown here are deluxe class since the inductors are variable providing fine tuning of each channel. They are UTC variable inductors, type VIC and are available in 22 values ranging from .0085 mean henries to 130 mean henries. The term "mean henries" suggest the ideal point for which the inductor is designed but the set screw adjustment permits a range of 85% above mean to 45% below mean thus permitting practical latitude for matching transmitted tones to the fixed channels in the receiver's audio discriminator section. This can be a highly desirable feature in R/C audio tone systems.

A resonant condition exists in an LC circuit when the inductive reactance XL equals the capacitive reactance XC. So, when the formulas for these two reactances are set against each other and reduced to simplest terms the frequency in cycles per second is,

$$f = \frac{1{,}000}{2\,\text{pi}\,\sqrt{LC}}, \quad \text{where, } L = \text{henries}, \quad C = \text{microfarads}$$

This may be rewritten several ways,

$$f^2 = \frac{25{,}330}{LC} \qquad f = \sqrt{\frac{25{,}330}{LC}} \qquad LC = \frac{25{,}330}{f^2} \qquad C = \frac{25{,}330}{f^2 L}$$

$$L = \frac{25{,}330}{f^2 C}$$

Thus, when any two values are known the third may be found. For example; if an inductance of 2.5 henries and a capacitor of .01 mfd are teamed together the frequency of the resonator will be,

$$f = \sqrt{\frac{25{,}330}{2.5 \times .01}} = \sqrt{\frac{25{,}330}{.025}} = \sqrt{1{,}013{,}200} = 1{,}007 \text{ cps.}$$

The formulas are useful in the design of a transmitter resonator section if allowances are made for the usual tolerances assigned to values of inductors and capacitors. The number of frequencies (tones) that may be had is entirely up to the designer. The writer prefers a separate resonator, that is, one inductor and capacitor for each tone and again with preference for VIC variable inductor. However, other types of fixed inductors or chokes may be used. The least costly arrangement would consist of a single inductor having several selective capacitors in parallel, one for each tone. Page 25 of UTC Catalog 56C shows a reactance-frequency chart whereby inductance, reactance, capacitance and frequency may all be equated by using a straight edge.

VIII. The problem of matching the several tones in the receiver's discriminator to the resonators in the transmitter's af section can be solved rather easily with the aid of a scope, an audio generator and a VTVM (ac).

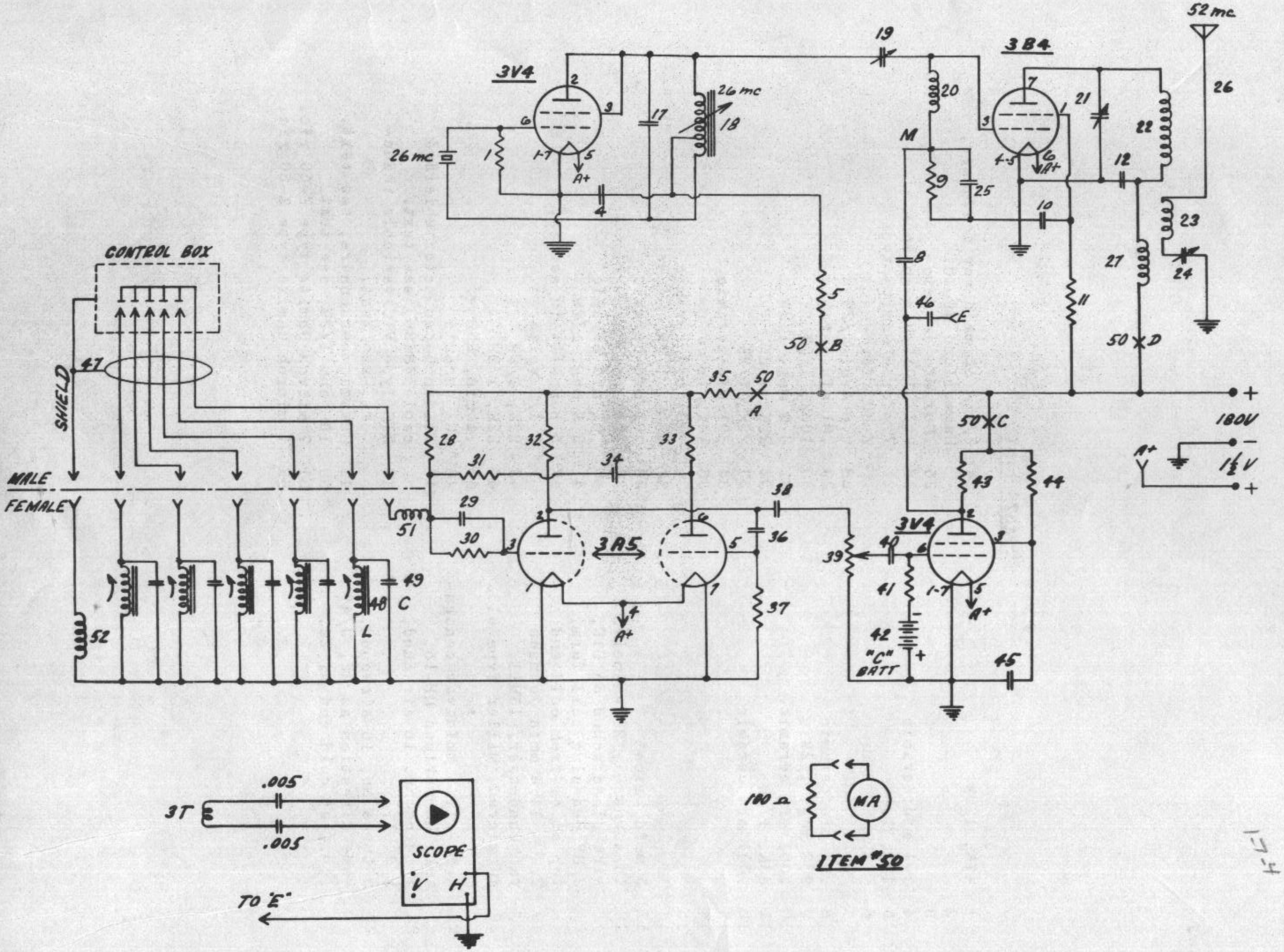
We will have to assume that a discriminator of one type or another has been installed on the down stream end of our receiver's audio amplifier section. If we inject somewhere into the receiver's audio section ac signals from an audio generator the resonant points of the several channels in the discriminator can be read directly on the dial of the audio generator. These readings should be recorded on paper for future reference. The injection ac voltage from the generator should be of the same order as that to be expected in the receiver circuit at point of injection. The VTVM can be used here to good advantage. The trick in this examination process is to try to simulate by means of the audio generator the ac voltage values that would normally exist if detection (demodulation) of the carrier was taking place. This suggests the desirability of working with minimum rather than maximum ac voltages from the audio generator. When the discriminator channels have been adjusted to desirable frequency targets and these readings have been recorded the next step is to match the frequencies in the transmitter resonator section to these receiver targets. This involves the use of an audio generator and a scope and is really quite simple.

The output of the transmitter af section is "stolen" from point E on the schematic. E is connected to the vertical input of the scope. The ground of the scope is connected to the ground of the transmitter. The output of the audio generator (2 wires) is connected to the horizontal input of the scope and the scope is set for external horizontal frequency input. With this set-up we are going to plot the af frequency of the transmitter's resonator section on the Y axis against the variable frequencies offered by the audio generator on the X axis. Thus, at some point a condition will be found where X matches Y and this is indicated when an O appears on the screen.

So, hold down any one of the tone buttons and rotate the dial of the audio generator until this O appears. At this point the frequency of the particular resonator can be read directly on the dial of the audio generator. In this manner all of the resonator frequencies in the transmitter af section may be observed and recorded. The next step is to adjust these channel frequencies, by varying L or C of the resonators, to match the frequencies previously recorded in the receiver discriminator examination outlined above.

This process requires a modest amount of practice with the generator and scope but once mastered the transmitter and receiver can be lined up to perfection. In all instances the examination should be conducted without driving either the vertical amplifier of the scope too hard or the horizontal drive of the scope as represented by the setting of pot (39). Much can be learned about class A audio amplification (and distortion) in the 3V4 amplifier-modulator by observing the shape of the O as pot (39) is adjusted. Ideally a perfect circle should be observed but it is seldom obtained in actual practice. The objective should be a closed loop with a minimum of deviation from a perfect circle. Deviations indicate distortion of the perfect sine wave and should be judged in the light of the final results desired for the total R/C system.

The writer wishes to express his appreciation to Robert Grabowski and Howard McEntee for their many suggestions and helpful criticism.


3V4
3B4
3A5
3V4
26 mc
52 mc
CONTROL BOX
SHIELD
MALE
FEMALE
180V
1½ V
A+
"C" BATT
SCOPE
V
H
TO "E"
3T
.005
.005
100 Ω
MA
ITEM #50

17-4

PARTS LIST

1	47K, 1/2W
2	
3	
4	.01 mfd ceramic
5	15K, 1W
6	
7	
8	.01 mfd ceramic
9	2.2 meg, 1/2W
10	.001 mfd ceramic
11	33K, 1/2W
12	.001 mfd ceramic
13	
14	
15	
16	
17	5 mmfd, mica
18	16 turns No. 22 enameled wire close wound on CTC, 3/8" red slug coil form, tap at 4T from cold end.
19	2.3 - 14.2 mmfd Johnson var condenser, 15M11.
20	20 microh, Miller Type 6152 rfc.
21	2.8 - 17.5 mmfd var condenser, Hammarlund HF-15.
22	6 turns No. 16 airwound, 1/2" I. D.
23	3 turns No. 16 airwound, same direction as 22, 3/4" I.D., at cold end of 22.
24	3/7 - 52 mmfd var condenser, Hammarlund HF-50.
25	.001 mfd ceramic
26	9' - 10' whip antenna
27	7 microh Ohmite type Z-50 rfc.
28	6.8 meg, 1/2W
29	.01 mfd ceramic
30	100K, 1/2W
31	3.9 meg, 1/2W
32	22K, 1/2W
33	22K, 1/2W
34	.01 mfd ceramic
35	10K, 1W
36	.001 mfd ceramic
37	100K, 1/2W
38	.01 mfd ceramic
39	100K pot
40	.01 mfd ceramic
41	3.9 meg, 1/2W
42	5 pencells in series, 7 1/2 volts.
43	22K, 1/2W
44	22K, 1/2W
45	.1 mfd, 200 v.
46	.01 ceramic
47	Belden 6-conductor shielded cable #8426, see text.
48	UTC Type VIC variable inductors, see text.
49	Ceramic condensers, see text.
50	100 ohm 1/2W, see text.
51	7 microh Ohmite type Z-50 rfc.
52	7 microh Ohmite type Z-50 rfc.

Servicing RC Equipment

BY DALE SPRINGSTED

The day was, when the novice R/Cer took a magazine article to the nearest radio supply store, plunked it down and asked, "Would you please fill this list of parts?" A handful of condensers, resistors and the like was handed over, none of which bore any resemblance to the current submini parts, now so familiar. After returning home, and struggling for a while, maybe you had a workable receiver. That some did have workable equipment via this method is attested to by the results today, in what appears to be the fastest growing hobby today.

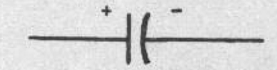
The approach at present to R/C activity has changed somewhat. The license free spot of 27.255, (now expanded) brought to light new circuits, techniques, and equipment of all sorts. You can now walk into a store and emerge with a practically built model, almost ready to fly. Conversely you can also purchase the same equipment in kit form consisting of instructions, good quality components, tested circuits, with varied amounts of the more difficult tasks completed.

Notwithstanding all this, the kit manufacturer can not place at your disposal the little special techniques necessary to assure success every time. Perhaps the most flagrant error made by the kit builder, is to NOT follow the instructions to the letter. Conversely there are some instances where you follow the instructions too thoroughly. More on this later. After several years of repairing and servicing the results of many builders, the following items are prime examples of the what to do, and what not to do.

First on the list, must come soldering know how. I would be rehashing the subject, since an article on how to do this appeared in the first issue of GRID LEAKS, Volume I Number 1. There is no real way to learn this other than practice. Appearance of the joints should tell you if they are right or not. If it is all lumps and gobs it is obviously a cold, poorly soldered joint. An estimate by me would place 50% of the failures to operate because of poor soldering. Consequently it would seem that prior to attempting construction of an R/C kit, it would behoove the modeller to practice up a bit on his soldering technique.

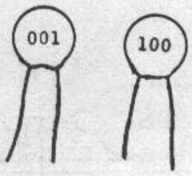
A couple of observed examples might be interesting, for instance. A glob of solder shorting the positive filament connection to the adjacent pin, which places B plus on the filament. The brilliant white light that appears momentarily is the tube filament burning out and only hurts the eyeballs for a second, but the impression on the pocketbook remains. The glob of solder that runs down the pin and permanently solders the tube in place, then when you try to remove the tube, poof, no pin any more. Result, new tube. The glob that runs down to the chassis from a B plus connection and shorts the battery to ground. This keeps the battery manufacturers in business, the easy way.

Inverted components. This is another bugaboo for the beginner. It is done in two manners. Easiest and most common is to place paper and electrolytic capacitors in the circuit with the wrong polarization. Paper and electrolytics are marked clearly either positive or negative sometimes with a plus sign, more commonly with a band of contrasting color on one end. The band denotes the ground end, or negative end of the part.



As the sketch shows, the common paper has the band, and directly below this is the correct symbol for such a capacitor. Not always are the small plus and minus signs shown, but the proper practice is to show the symbol with one straight bar, and one bar curved. The curved bar is always the negative or ground end. It is then a simple matter to note where this end goes and place it properly in the circuit. Some circuits need proper positioning like this to provide electrical balance.

When using the common small disc ceramic or mica capacitors, there is no polarity to concern one. Here the inversion is accomplished in a different manner. The physical appearance of a 100 mmfd. disc, and a .001 mfd disc is just about the same. Certainly it is easy to transpose the two, but not if the capacitor value is read correctly. As the sketch shows, the leads should be held at the bottom, and the value noted. By turning the sheet upside down we reverse these values, but not the capacitors. Inverting these in a receiver leads to disaster. A simple error, but a repetitious one.



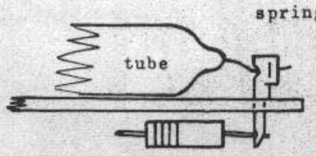
If you have completed?? building the kit and have parts left over, it is pretty generally true that you goofed. The prime example of this is the number of Commander Transmitters that turn up, with two small fibre washers missing, from a location under the lug of the binding post that supports the tank coil and capacitor assembly. This is another method of making the battery people happy, since it results in the battery being shorted to ground. After this occurs and the set refuses to function, the builder probes around a bit and further damage results. The moral here is to check the building list carefully and be sure all the parts that should be used are used.

Parts substitution is one more error that is too easily made. Since certain circuits simply refuse to operate if only minor changes are made, it is important that if you so much as change even a small screw be sure it is replaced with an exact duplicate. Does this sound a bit rough? Perhaps, but a first class example will illustrate. In the Commander Receiver kit, the quench coil is held in place on a dowel which is in turn fastened to the chassis via a brass wood screw. The simple act of replacing this brass screw with one made of steel renders the set useless. Everything else is perfect, but one little measly piece of steel 1/8" in diameter 3/8" long is added and the builder is cursing the kit manufacturer for producing faulty gear.

The kit manufacturer does a lot of work for you, such as winding coils etc. Did you notice that the terminal connection, although bared of insulation was left unsoldered? Did you solder it? Good! Others did not. This goof results in intermittent operation. The transmitter tank coil is supplied wound, you have counted off the correct number of turns and bent the leads out properly. Did you half-heartedly clean the formvar insulation for a poor joint, or did you really scrape the coating off for a good one???

A small item that is sudden death to the proper operation of any receiver, is to bring the antenna lead out from the set in the same bundle of wires as the power leads. It is commonly done by many. Practically any receiver will refuse to function, or if it does, likely will have relatively poor range from this practice. It is proper to bring the antenna lead from the receiver out away from all metalic objects, and in particular the rest of the model wiring.

A little point that is commonly missed on building printed circuit board type items. Where there are small eyelets crimped through the chasses, and touching some portion of the copper laminate, this point should be touched with solder for a good electrical connection. If not soldered, it will only be a short time before the copper oxidizes a bit and the contact that was there disappears. This could occur for instance when the model is 200 feet up. Sometimes tubes holding flea clips go through the P. C. Board, and these also should be hit with a bit of solder.



Speaking of flea clips. How many of you solder the tubes in place rather than using the clips as the diagram shows, which is the proper way? Why not solder them, you ask? Several reasons. It makes tube changing difficult. It very frequently results in permanent damage being done to a tube or transistor as the case may be. To explain, the glass is sealed around the tube leads where these leads pass through the base of the tube. This is done with heat and pressure. Since many materials expand with heat and glass and metal pins are among those that do, a bit too much heat near the tube base opens the seal and allows the gas or vacuum to escape. With transistors, too much heat while soldering is ruination itself. If you must solder the leads as certain circuits require, use a heat dissipator called a heat sink. Check the soldering article mentioned previously.

Getting along to transistors, one of the best ways to damage these is simply to reverse the battery polarity. The only trouble with this is that as in the case of tube filaments, there is no bright light to tell you that something happened. Make sure you do not reverse. If you are not sure of the basing diagram, take the pains to look it up. Supposing you have 4 transistors at $1.90 each, the result of inversion only is costing you $7.60.

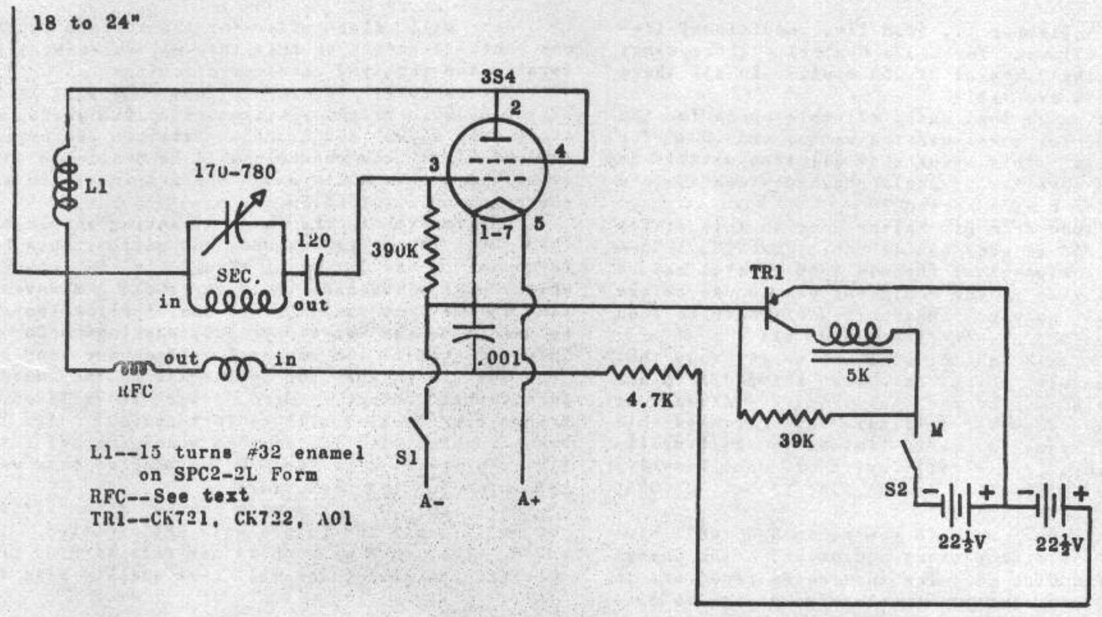
I mentioned that points come up where instructions are too well followed. Our friend the PC board is in this one. The directions say to clean off the excess solder and roughness with a file, after the job is complete. This means that you should merely take off the high spots, not grind the joints down to within 1/32" of the board. When you take this much solder and lead material off, nothing is left to hold the component in place, much less to make a connection.

Alright you have built a kit, and it does not work. How far should you go in trouble shooting yourself? This one is a toughie. It pretty much depends on how much you know about the circuit you are dealing with, but as a service manager my answer is send it in then, not after attempting to resolder and change parts. Let me put it another way.

If you have the following items you have it made. A 1000 ohms per volt multimeter, a VTVM, an oscilloscope, a grid dip oscillator, and perhaps an audio oscillator as well, fine. Of all of these instruments the two which will have the most uses are the multimeter, and the GDO or grid dipper. With the multimeter, you can check tube filaments and check tubes for internal shorts as well. You can determine if the circuit is functioning properly by current measurements. You can check battery voltages, under load please. The grid dipper checks for resonant circuit values, and doubles as a test transmitter, and will check crystal activity, in addition to other uses which are not quite so common. This will just about do it for you as long as you are sticking with straight R. F. carrier gear. If, however you happen to be using tone, then for trouble shooting, the oscilloscope is a must for picking out the trouble. Here the visual aid of the voltage picture on the scope screen quickly determines the problem stage.

How do you go about checking for trouble? I can only gloss over the high spots. To give a complete description would fill a book. Briefly the basic checks are these. First determine if all the components that can be removed, tubes, crystals, transistors and the like, are good. Next check the circuit in question for continuity. Resistors, coils, chokes and the like. Apply batteries and check for voltages as far as the circuit with all parts installed. This is the point when experience counts, since from here on it becomes a test of skill at picking out a leaky capacitor, or a shorted one, a bad choke, that may have a shorted turn in it, or any one of a myriad other things that can go wrong. This is when it pays to have a company service representative look over the job for you.

TRANSISTORIZING HARD TUBE RECEIVERS



Transistorizing hard tube receivers seems to be a popular pastime with the R/C fraternity judging from reports that we're getting here at Grid leaks. Volume 1 #2 of Grid Leaks showed how the Commander might be simply modified for a current rise.

Because of the extreme interest in this circuit and excellent reports that are coming from all over the country, Tucson Train Shop at Tucson, Arizona, Frank's Model Shop in Roswell, New Mexico, Joe's Hobby Shop in St. Charles, Illinois, Brumbeloe's Hobby Shop in Augusta, Georgia, and countless individuals, we have been besieged for copies of that particular issue.

However, all back issues of Grid Leaks now are finally exhausted and rerun is just currently not possible. Due to many requests we are presenting the circuit again on the transistorized Commander which could apply to many hard tubers. The circuit features an extremely low idle through the relay which goes up to about 5 mils. upon receipt of signal. As mentioned in the original article where the sensitivity is lacking the rf choke may need to be changed, many go to a higher inductance, although many people write us that they have had to make no changes whatever.

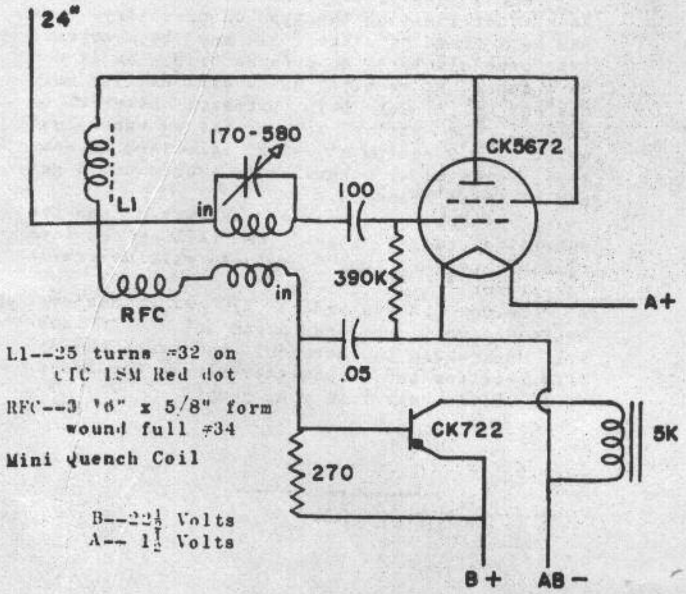
In Volume 1 #4 of Grid Leaks, one of our correspondents mentioned the fact that he tried the 3Q4 instead of the 3S4 with even better results. However, the 3S4 is seeming to give excellent results for many users.

The reason for presenting this circuit is that another such circuit came in using a sub-miniature tube which has half the filament of the 3S4 and also it is a simpler hook-up. We have not had the opportunity of an experiment with this circuit but it comes to us from Donald G. Leoliger, Wooster, Ohio, and Don says of his circuit, "The circuit is one I've just completed. I've ground checked it at ¼ mile with no noticeable decrease in plate current change. I'm using a Kurman relay that has been modified to increase contact ridigity. The relay is set to pull in at 1.5 mils. and drop out at 1 mil, the current change being from practically zero to over 2 mils. I have the meter in the ground circuit and use a SPST switch in the common A-, B- lead to turn the receiver on and off.

"Tuning procedure is the same used on hard tube receivers, simply working the padder until the idling current drops then key the transmitter and tune the receiver in with the coil.

"This is my answer to h[illegible] the receiver with a current rise instead of a decrease. I have the equipment in a three foot ½A airplane. The relay really bangs when the transmitter is keyed. The receiver idle current is very low and the collector current jumps to over 2 mils. when the first stage drops. Since the receiver operates on only 22½ volts, it is not necessary to carry two batteries for the B supply.

"The performance of this receiver is as good if not better than any receiver I have ever used. There are undoubtedly many improvements that could be made, but I find the receiver very satisfactory. It has no unusual characteristics and is very easy to tune. After all what do you need beside: range, large current rise, and easy tuning?"



NEW RC FREQUENCIES

Effective September 11, 1958 five additional frequencies were allowed for Radio Control. These range from 26.995 to the present 27.255 spot. In all there are 6 channels now available.

Also effective on that date, all tolerances for the crystals are .01 for power under 3 watts, and .001 for power over 3 watts. This means that all transmitters in use will need to have the crystals checked since the old tolerance was .04--a wide spread.

Additional info from Dr. Walter Good on this states that all old 27.255 mc gear usable until June 15, 1963--all transmitter equipment of the old .04% crystal may be used until this time if the equipment was in use before September 1, 1958, so your customers don't have to rush right out and buy the new tolerance crystals.

Our checks with Wright crystal engineers, show that all Wright crystals which have been shipped from Ace Radio Control within the past two years are already at the .005 tolerance. However in single tube circuits this is only true if crystal drive is limited to 6 milliwats. If more then crystal will drift off considerably.

Frequencies allocated are 26.995, 27.045, 27.095, 27.145, 27.195, and 27.255.

What does all this mean to you as an R/C fan? Simultaneous operation with present equipment? The answer to that is a resounding no. The superregen receivers in common use today are simply not selective enough to discriminate between even the two extremes of the 6 channels--26.995 and 27.255.

With present transmitters it does not pose too much of a problem, only slight retuning is needed. This applies only if the transmitter is one of the more stable types.. It is quite possible to "pull" a transmitter away from crystal frequency in the wrong type of circuit.

Super-regen detectors which are used in almost 100% of the receivers used today tune roughly 600 to 800 KC broad. Since the spots we have cover only 250 KC or so, it is readily apparent why the channels do not mean simultaneous operation. If this is the case, did the FCC really do us a favor by granting the extra channels at the cost of tightening up tolerance?

We feel they did--for the future. The R/Cer's in the USA are a sharp bunch, and the answers won't be long in coming. We hear one of our competitors is working on a super het receiver. Also the Wright Electronic engineers are working on a crystal pre-selector which would couple into your present receiver to provide the selection. This would consist of a tuned crystal circuit which would increase the selectivity to the required selectivity.

It is also possible that other answers will be forthcoming. For the time being Ace R/C will offer only two crystals, 26.995 and 27.255, and follow developments closely before announcing the receivers or pre-selector. We feel the FCC has definitely helped the situation for future R/C use and it is one of the best things to have happened to R/C in its almost 6 year Citizen's Band life.

Walt Good suggests "It might be well to first encourage work on receivers which will separate 26.995 mc. from 27.255 mc. and fill in the other frequencies later. In addition, modelers having interference trouble on 27.255 mc may find relief in switching to 26.995 mc simply by plugging in a new crystal in the transmitter and retuning the receiver."

For the time being, all transmitter kits coming from Ace will be 27.255 mc unless ordered otherwise. To change frequency it will only be necessary to change crystal and retune. Many builders will probably mount the crystal socket on the front panel so that frequencies may be shifted quickly.

Ace will also offer for the serious experimenter one other frequency so that they may experiment and help develop the required receiver circuitry.

Prices will be as follows: Wright Electronics 27.255 $2.95. Wright Electronics 26.995 $3.95. We will stock only 26.995 and 27.255. Petersen Z9A crystals for any of five new channels will be available on special order only. We will stock the Z9A in 27.255 at a consumer net price of $5.50.

One important change on licensing should be noted. Form 505 is being revised, but until it has been, old forms may be used. Main change is in notary section which details licensee is 18 years old. However, important is the fact that ALL license applications now must be sent to the Secretary, FCC, Washington 25, D.C. Do NOT send them to the regional offices any longer.

New vistas open up to the R/C in the immediate and foreseeable future. More power is allowed, so new transmitter designs will be forthcoming. Age limit has been lowered to 12, so that means many of the younger fry can get in on the R/C fun they've been wanting to get in on for the past years.

We feel R/C has made another giant stride. With you we'll await the future with anticipation. Rest assured, too, that as soon as new receivers or pre-selectors are available, Ace will have quality kits for them.

FLASH!

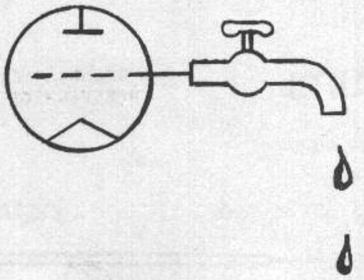
As an incentive to the serious R/C experimenter Grid Leaks is offering to the first person to come up with a selective circuit which will provide use of any one or more of the five additional channels available to the R/C fraternity, a complete WAG TTPW receiver and transmitter kit.

Conditions of the contest are very simple. We are not limiting the type of circuitry. It may be a tuned rf stage, it may be a crystal type pre-selector, an antenna trap, or it may be a super het receiver which will utilize only one channel. Our main purpose, however, in this is to strive to see if we cannot use existing R/C equipment with selectors of some type, crystal or otherwise to enable us to get use of these channels.

Postmarks of submitted schematics and the submitted gadget itself as well as complete reliability when run under tests will determine the winner.

So come on you ardent R/C experimenters! Let's see what you can dream up! Grid Leaks will spear-head the movement and award the WAG TTPW receiver and transmitter kit as the incentive. Let's hear from you, gang!

Grid Leaks At Play



We were highly pleased to receive in the mail recently a copy of "Quick Blips", a publication of Joe's Hobby Center, 9810 Wyoming, Detroit 4, Michigan. It's a sprightly three page mimeograph paper containing much information of a local nature and giving a sort of preview of kits and new R/C items in the Detroit area. The thing that pleased us most highly and flattered us was the comment in the beginning, the reasons for starting this magazine "we wanted a sort of local 'GRID LEAKS' ".

With this issue we feel we are bringing you many exciting new things. There's a very extensive article by Jerry McGeorge on his super-duper audio transmitter which has seen years of developmental work. It is presented in its entirety since we feel that the serious R/C'er sometimes is neglected by having to wait for the magazine to appear with a "to be continued" type article. At the risk of leaving out a lot of general nature, we felt that it was best to present this material in this manner so that the serious R/C fan would have the complete article to digest. There is much in the article itself about the theory and the development of audio work, the use of a scope in checking modulation which makes good reading for all R/C fans be they beginner, medium, or expert.

The article on servicing by Dale Springsted should find a ready welcome for those who experience difficulties. Red Costlow came through with some tips on building and servicing the TR 4.5.

We feel Grid Leaks will present another first in an article by Ed Lorenz next issue. This is one of two articles which will appear on this important subject. We've been receiving many requests on making printed circuit bases and when Ed volunteered the article we were most delighted because he knows his way around PC.

With reference to the new R/C frequencies, we feel it advisable to point out that the new tolerances, while they are not absolutely required until 1963, cannot be observed even with the new tolerance crystals in many of the existing circuits. Crystal drive must be limited to 5 or 6 milli watts. This is the consensus of the opinion of both Petersen and Wright Electronics engineers. This means that many existing circuits which have a greater drive than this begin to heat the crystal and as soon as heat is in evidence, the crystal begins to drift frequency wise and is considerably off tolerance. It will pay you to check your circuit.

MOPA circuits, it would seem, will come to the fore in the new spots. It is not nearly as necessary to drive the master oscillator as high to get relatively good output out of an MOPA. Also, the 13 mc type doubler rocks will be used to a much greater extent for the simple reason that the quartz is heavier and drift is virtually no problem at all because it will take quite a bit of drive to go off tolerance, according to Wright.

We invite your attention to the contest Grid Leaks is sponsoring with reference to the receiver or pre-selector design to enable us to use the five additional frequencies allocated by the FCC.

We have been corresponding with Al Doig, of Los Angeles, who has developed a triple proportional receiver being test flown by Howard Bonner with exceptional luck. Rights on the schematic are restricted so we can't reproduce it here. But suffice it to say the receiver uses 30 transistors and the price of the transistors alone is $90.00. It requires three special Bonner servos, the use of toroids and a number of diodes so we could definitely say it is not a kit type project.

We'll keep you posted on developments. This is essentially the same circuit as was block diagramed in the previous issue of Grid Leaks and is a move in the direction that many R/C'ers are seeking. In the mean time if any of you have any circuits of this nature that you wish to share with our readers, we'd be most happy to receive them.

That reminds us, this is definitely your magazine. It is designed for the exchange of R/C information and circuitry among the R/C crowd in the U. S. A. and in the world. Why not drop us that favorite circuit or that favorite design of yours and let us share it with our other readers.

Until another time

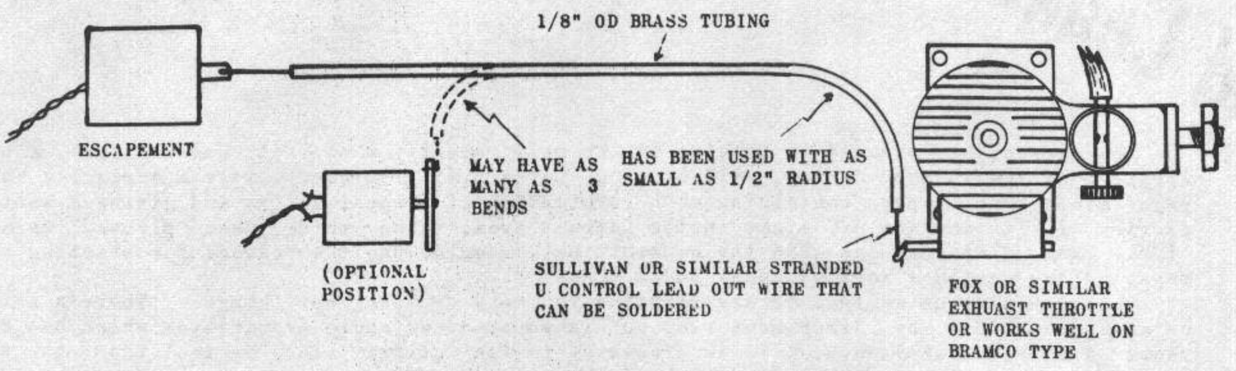
Yours sincerely,

Paul F. Runge
ACE RADIO CONTROL

SHORT CIRCUITS

A REGULAR FEATURE OF GRID LEAKS, THIS PAGE PRESENTS SHORT NOTES OF IMPROVEMENTS DEVELOPED BY OUR READERS. SEND US YOUR BRAIN CHILD!

MOTOR CONTROL LINKAGE



This hookup will work with an escapement on 1/8" rubber or a servo. Has been tried with Bonner Single SN Escapement and DeBolt 3P3NA.

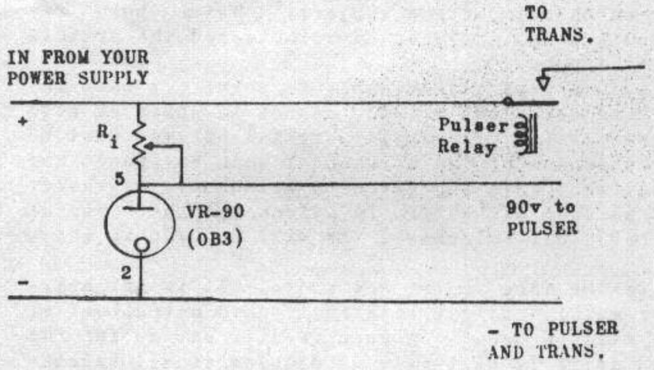
The last 1/2" to 1" of the leadout should be filled with solder for stiffness where it is out of the tube.

The brass tube bends much easier if heated first over burner on stove and then cooled.

This idea originally came from the Badaco bunch at Shreveport but they were using 1/64" music wire in 1/16" tubing with a Bonner Servo. This will not work on escapement though, not enough power; hence the flexible stranded wire.

Dick Thompson, Alma, Arkansas

VR FOR PULSERS



In looking in Vol. 1 #4, I noticed an answer on 3V4 pulser on power supply. They recommend use of batteries, not so, unless you like to buy them. My transmitter has operated a lot of days, four to five hours at a time, without a skip. The following may be of use to others, being easy and inexpensive to use, the VR-90 (OB3) is reliable.

Size of resistor Ri will depend on input voltage from power supply. Grandpa Ohms gives formula for finding right size.

$$R = \frac{1000 \times (Es - Erv)}{I}$$

Es - Voltage from the power supply.
Erv - Regulated voltage - 90.
I - Maximum tube Milliamps. (which is 40 ma)

Adjust tube to steady glow, also check with voltmeter with vibrator on. Be sure to use heavy enough resistor Ri to carry the large voltage drop.

$$\text{Watts} = .040^2 \times Ri$$

KEEP GRID LEAKS COMING.

Best Regards,

Dr. W. R. Hatton
Vevay, Indiana

CONTROL BOX SENSITIVITY?

Regarding Tom Caruthers', Raleigh, North Carolina, letter to G/L, asking for a geared stick box for TTPW because the 60 degree pots are too sensitive.

I have had quite a season of flying a TTPW and experimenting with different actuators.

I find that sensitivity of controls is not in the box, but in the actuators. Gear them down more.

At present I am flying a L/W Cruiser with Bonner Servos on TTPW. Couple them close with short control horns and put plenty of rubber on to limit the throw. Don't let them travel too far or they will be too slow.

Lots of fellows are complaining about sensitive control boxes on proportional systems. I hear it often in our area. You people at G/L should mention this in your next issue and set the fellows straight.

The actuator in G/L Volume 1 #6, by Jim Martin, is one of the best I have seen and sensitivity can be adjusted by varying the length of the control horns.

My next project for this winter is the new L/W Custom Bi-Plane on TTPW with Jim Martin's actuators. This should be a dream.

I also fly Galloping Ghost in a L/W Trainer. It's sure a lot of fun.

Keep G/L coming, it's wonderful.

Happy Landings,

J. C. Lucas

COMMANDER ON 50 MC.

From E. Paul Johnson of Des Moines comes word about the Commander working beautifully on 50 mc. This should work equally well with the transistorized versions shown in this issue.

Here is the quote from Paul, "I bought one of your Commander receivers at the hobby shop at the nationals. When I got home I converted it to 52 mc and it really works swell. It's hard to find a receiver that doesn't interact with my drop out system for intermediate but the Commander really does the trick. I just removed 8 turns from the coil and put a 5 mmf in series with the antenna. On 67½ volts it idles at 6 mils, and drops to below 2 mils. on signal."

SIMPLE TRANSISTOR TESTER

CHECKS LEAKAGE AND RELAY STAGE OPERATION

Transistors are coming to the fore in R/C. This is as it should be because they afford economy of operation and now with lower prices and better dependability and stability they offer many applications in R/C.

However, transistors vary widely in their internal characteristics even from the specification sheets given by the manufacturers. Most of the transistors that are used in R/C are low cost audio frequency types which means that they are probably rejects or at least inferiors of a more expensive type branded with that particular number.

While the manufacturers are making every effort to make the characteristics of the transistors more uniform many builders are finding that virtually all transistors need to be checked before they are placed into R/C circuits. This was particularly true when Marcy Inkman was developing the MarcyTone Receiver. Marcy developed the circuit shown right to show how much relay current rise he could expect or if there would be leakage in the relay stage.

The good hot TO037, in this particular checker, will rise up to 4 to 5 mils. depending, while a mediocre one will only go to 2.

With the button up, that is with the push-switch off this checker also tests leakage in an idle condition.

If the idle is high it means the relay will idle higher than the customary .2 of a milliamp.

We have built this checker and found it an extremely handy gadget as well as very inexpensive. While there are many commercially available checkers on the market, we feel this unit as designed by Marcy provides the perfect answer to see how much of a relay current change the given transistor will provide. While the figures given above are for the T0037 other figures can be developed by experiment. For instance with the CK722 in this particular circuit the best rise you will get is from 2 to 2½ mils on a good hot CK722.

To construct this we used the Bud CU3002 box which is 4" long, 2 1/8" wide, 1 5/8" high.

It was drilled as shown on the drawing. The box holds the 30 volt battery with the socket on the top lid so that the transistors may be easily inserted, tested, and removed.

A Switchcraft 203 switch is used although only one position of this switch is used as in SPST.

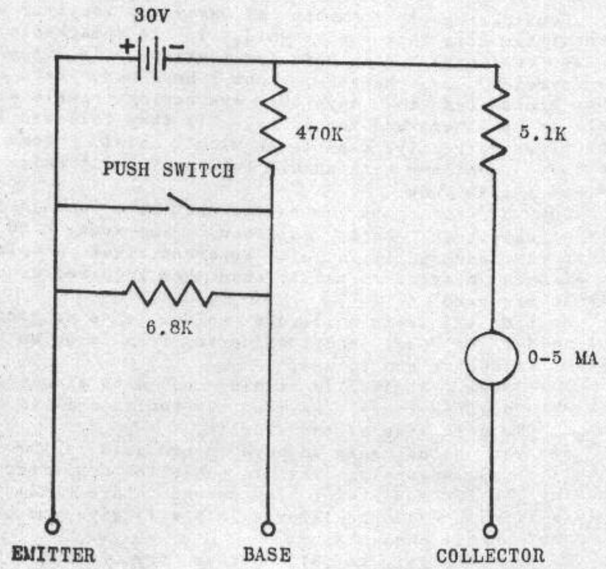
Two 4/40 x 1 bolts and nuts protrude from one end which are colored red and black so that the bench multitester may be hooked on in the 0 to 10 milliamp. scale. These are insulated by fiber washers.

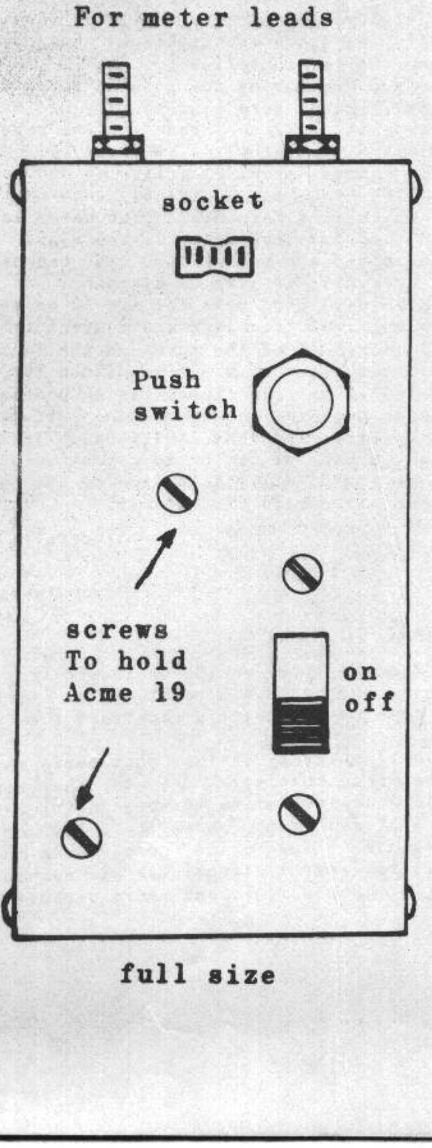
It was deemed advisable to have this unit less meter so that the existing meters could be used to help keep down the cost.

Cost for this circuit is very negligible since the barest minimum of components are used. An Acme #19 box is inside the case holding the 30 volt battery, the switch 203, and the 5 prong sub-mini socket, the bud mini box, an SPST, and a few assorted resistors and you're in business.

We believe this little transistor checker will do much to help you spot faulty transistors or transistors not up to par in the making of your R/C equipment and will provide a valuable audition to your test kit of R/C instruments.

One word of caution--turn off the switch before inserting the transistor. Always make sure the SPST slide switch is in an off position before transistor is inserted in the socket for test. This prevents accidental wrong hole application and also gives the transistors a better break.





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MARCYTONE TIPS

Considering the number of MarcyTone receiver and transmitter kits that you've sold, it is remarkable to me how few I have had in here for service. In view of the service jobs, however, that I have had, here are some hints for the boys that are having trouble with their transmitters and receivers. If they followed instructions correctly, trouble shouldn't exist. Some of the boys who buy kits should buy ready built units as you and I both know.

50% of the jobs or better that have come in for service have been poorly soldered. The wrong kind of solder was used and it is quite apparent that a solder gun of much heavier capacity than that required or desirable was used.

We find the Ersin multicore solder to be an excellent solder and Ungar pencil soldering iron to be an excellent woldering gun to use.

For best results in tuning on both single and multi-channel receivers, we find the tuning coil to adjust on the grid side of the slug in.

If you do not seem to have enough gain in the six channel on all channels, try to boost the amplifier by removing the 15K resistor in the second stage (TR2) and replace it with a 10K resistor. This will give you over all boost on all channels.

If you lose gain in cold weather try adding a 6.8 or 10 meg resistor from the CK722 (TR1) base to B minus. Leave the 100K resistor as is.

On the six channel, it has been found desirable to place the P0037's on the outside of the case to prevent them from over heating. It is quite alright to lay them down on the board, too.

As in any kit when you are assembling the receiver and transmitter, do not make the leads too short. This will pull the leads too tight and thus crack or damage parts when they're installed.

When you are tuning the pots on the single or multi transmitter, make sure that you are not on a harmonic. If the transmitter is too close to the receiver you can make a mistake in tuning the VFO control. For example, the single channel receiver filter is 5400 cps. By tuning the VFO you may accidently tune past 5400 cps to 2700 cps which is a harmonic. The meter may show a 3-4 mil gain if the receiver is too near. As you range check you should strive for 5400 cps because a harmonic will not carry for as great a distance.

We also have good news for the 50 mc boys. Take a single or multi R/C receiver and convert it to 50 mc by taking off one-half of the turns on the tank coil of the receiver, but remember the transmitter for 50 mc has to be modulated 100%. So there is no problem get the MarcyTone to work for the 50 mc men. If receiver lacks sensitivity, try different 1AG4 tubes. This is particularly true in case of the 50 mc not so much on the 27¼.

I hope this will help some of the boys, so until another time take care of yourself.

Sincerely,

Marcy Inkman

"TR 4.5 HERE TO STAY"

We thought you would be interested in our bench test results on the TR 4.5 receiver as it appears to be one of the most flexible receivers that we have ever tested.

We shall start by saying that performance may vary widely between receivers due to the broad spread of transistor characteristics between individual units.

The enclosed graph shows the relay current vs. relay resistance. The solid curve shows the calculated current if the output transistor is considered to be a switch. (ie. open circuit and short circuit alternately) (In other words no, or very low, internal resistance with signal and infinite resistance without signal). The above statement holds true with relay resistance of 500 to 600 ohms or greater, however, relays with resistances of the transistor becomes significant. The lower the relay resistance, the more significant the internal resistance of the transistor becomes as shown by the dashed curve which is actual measured relay current at several different relay resistances below 700 ohms. Relays with resistance above 700 ohms fall on top of the solid line for all practical purposes.

As will be noticed, the graph is a double scaled one with the figures on the bottom representing relays with resistance of 1000 to 5000 ohms, relay current to be read on the scale on the left hand side of the graph.

If you know the current that you want to flow through the relay you just pick out that line and follow straight across to the proper curve, then down to the bottom of the graph and read the relay resistance that will give you this current.

Example

1 ma	use solid curve	5000 ohm relay
5 ma	use solid curve	1000 ohm relay
10 ma	use dashed curve	400 ohm relay
20 ma	use dashed curve	210 ohm relay
30 ma	use dashed curve	130 ohm relay

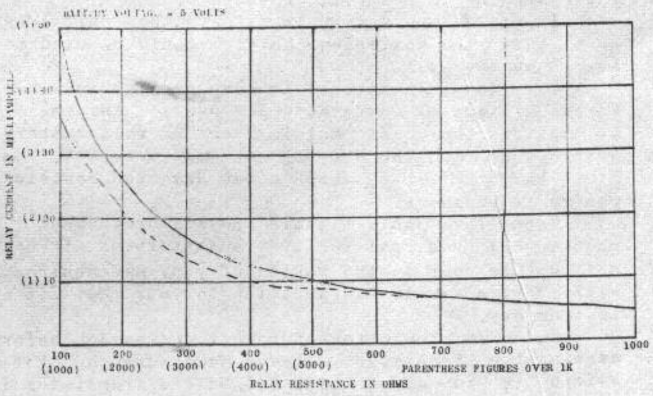
If you have a relay of known resistance and want to know the current that will flow through it just reverse the above procedure.

The amazing thing about this receiver is its ability to work on a wide range of relay resistance. In fact, we have had it operating with good reliability with relays from 3500 ohms down to values much lower than 100 ohms (3500 ohm relay draws 1.4 ma). Our pet version is now using a Sigma 4F 2000 ohm relay. The on signal current through the relay is 2.5 ma which gives the relay a hefty whack and the signal off current is in the low micro amp. range. Total receiver drain is with no signal 1.2 ma (with or without carrier). With signal total drain is 3.7 ma. At the above drain you can practically forget about your batteries, in fact, pen cell units should last their normal shelf life.

All the above readings were made with 5 volts applied to the receiver. In conclusion we say "It looks like the TR 4.5 is here to stay."

Sincerely,

Jim Conklin
Owensboro, Kentucky



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 xcope 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 crit[illegible]l 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 enable 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 [illegible]n. 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.

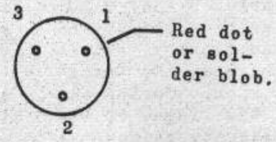
Max Boal has had phenomenal success with this circuit. First in Intermediate at the NATS and two firsts in Regional contests since.

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.