INSTALLATION
and
OPERATING
INSTRUCTIONS

for the
successful
operation of
the

TWIN TUBE
RECEIVER

INTRODUCTION

The "Twin-Tube" receiver is physically a conventional single tube circuit with the addition of a booster or amplifying stage to improve performance. The arrangement is not complicated and may be better understood if a simplified explanation of its operation is studied:

A receiver antenna receives a tiny bit of electrical energy sent out by a transmitter and passes it into a tuned circuit which acts as a frequency filter. If the transmitted signal is of the frequency to which the circuit is tuned it passes easily; if not, it is blocked. In the usual receiver, the tuned circuit is connected between the Plate and the Grid of a triode vacuum tube.

The Filament of the tube releases energy which is attracted to the Plate and causes a current flow within the tube. The Grid, which is between the Filament and the Plate, acts to control the flow in that if the tuned circuit passes energy from the antenna it goes into the Grid to oppose the Plate attraction and so reduce or stop the flow within the tube. Thus, when the receiver is on, but no transmitted signal is received, it "idles" with a comparatively large current flow through its Plate circuit which pulls in and holds the armature of a sensitive relay.

Upon receipt of a transmitted signal of the correct frequency, this current flow is reduced or stopped altogether by the relatively tiny current passed into the Grid and the armature drops out. This action of the relay switches on or off an actuator circuit. Because the average relay requires a minimum current of one milliampere or more for reliable operation, the idling current of a single tube receiver must be twice or three times that desired for maximum tube life, consistency of operation and sensitivity.

In the "Twin-Tube" receiver, however, the relay is not in the first tube Plate circuit and this tube may be idled at a current value which is very low but sufficient to control the Grid of a second tube so that both tubes idle low simultaneously. In fact, the total idling current of both tubes is less than that of the single tube receiver!

Receipt of a transmitted signal drops the first tube current and the Grid of the second tube loses control so that the second tube Plate current jumps up to its maximum. This action is intermittent and higher current value may be tolerated without harmful effects to the tube than that which would be possible with the high steady idling of a single tube receiver. The boosting or amplification nature of this action is applied to a relay connected into the second tube Plate circuit and the result is more positive operation due to the greater current change obtained.

This is an advantage which, with several others obtained, more than makes up for the slightly added complication and cost of the extra tube and components. Relay adjustment is less delicate and less sensitive to vibration, tube and battery life is considerably extended, and overall reliability of receiver operation is improved.

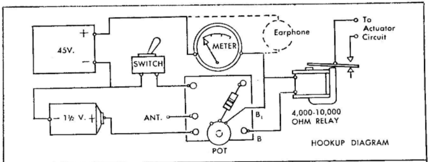
Further, with the reduction of vibration problems, the receiver may be installed without the usual suspension mounting and may be used in smaller models because less space is needed. No weight penalties are incurred since the "Twin-Tube" receiver is as light as the usual single tube units. In fact, the overall installation may weigh less due to the low current requirements which permit more practical use of hearing-aid batteries.

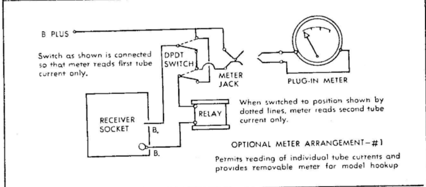
Duplicate "A" and "B" batteries are not required, despite the extra tube, and batteries no larger than those previously used are satisfactory. As a further weight reduction, subminiature relays may be used with reliability and without regard for engine vibration. The possibilities of using radio control in small models are obvious. Half-A payload and cargo class models have proven their ability to carry loads similar to those required of small radio control designs. Now, with the reduction of installation requirements, the practicability of controlling such craft is assured.

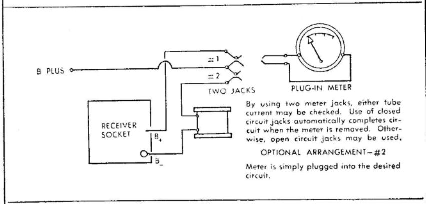
The "Twin-Tube" receiver arrangement has a fail-safe feature since the relay is not operated except when triggered by a transmitted signal, as compared with that type receiver which causes the relay to operate if the current drops. Since one set of batteries serves the "Twin-Tube" receiver, complete loss of current affects both tubes simultaneously and no relay operation occurs.

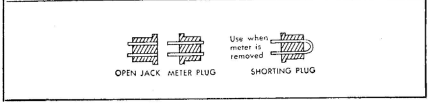
Consideration has been given to the utility and construction problems of equipment design with the result that the "Twin-Tube" receiver incorporates such features as, printed circuit wiring and plug-installation. By eliminating the relay from the receiver package, the flexibility of receiver installation is improved and greater protection is provided with the reduction in mass. The "Twin-Tube" receiver has evolved from a blending of modern techniques and practical experience to set a new standard in the radio control field.

The "Twin-Tube" receiver is engineered for use with any transmitter which has an output of at least one watt and which otherwise meets the simplified licensing requirements for operation on the Citizen's Service radio control frequency of 27¼ megacycles.









INSTRUCTIONS

Follow these step-by-step instructions for initial operation of the "Twin-Tube" receiver Check off each step as it is accomplished. If, at any step, your results do not agree with these instructions, check the trouble-shooting chart to correct the difficulty before proceeding to the next step. Later, as familiarity is gained with the operating procedure, some of the steps may not be necessary, but they should be observed at first to insure proper adjustment.

A. *With receiver unplugged*:

1. Connect wiring to receiver socket terminals as shown in hookup diagram. **Be sure that plus and minus connections are correct to batteries and meter.**
2. Disconnect No. 2 tube Plate lead (don't connect till Step 6).
3. Disconnect A minus B minus lead.

B. *With receiver plugged in*:

1. Set variable resistor ("pot") at maximum resistance (full clockwise when connected as in hookup diagram).
2. Momentarily, connect A minus B minus lead and observe if:
   a. Meter needle indicates Plate current less than 1. ma. (if not, check: all wiring hookup, tube installation, proper connection of pot).
   b. Meter needle not fluctuating excessively (slight meter needle "wobble" desired, but not over .1 ma range).
3. Reconnect A minum B minus if Step 2 checks ok.

4. Adjust pot, if necessary, to obtain .5 ma Plate current.
5. With transmitter keyed, check receiver current drop:
   a. If drop is to .1 ma, or less, operation is satisfactory. If drop is not to .1 ma, tuning slug may be adjusted. Note first the position of the slug before changing adjustment, then readjust with screwdriver to obtain proper current drop. If a metal screwdriver is used, a slight difference may be noted in current reading with and without the screwdriver in contact with the adjusting screw. A non-metallic screwdriver is preferred. In either case, adjust slug in or out so that drop is lowest with screwdriver removed.
6. Reconnect No. 2 Plate lead and observe for following:
   a. Meter reading does not increase more than .1 ma (for an instant upon connecting, needle may jump but should immediately return).
   b. Meter reading does not increase after idling steadily for at least 30 seconds.
7. Hold transmitter keyed and observe for following:
   a. Meter reading jumps to at least 1.5 ma, less than 2.5.
   b. Meter reading holds steady at maximum current.
8. Rapidly key transmitter-receiver must follow without lag.
9. Check operation at range—retune slightly, if necessary.

OPERATING NOTES

Current Adjustment:

In order to limit the current of the first tube to desired values, a maximum of 30,000 ohms resistance is provided by the combination of variable and fixed resistors. This combination is selected so that the variable resistance will provide a satisfactory range of current adjustment while the fixed resistance assures that the maximum current obtained will not exceed that for which the tube is rated, even though the variable resistance might be set at minimum.

Without the limiting resistor in series with the pot, minimum resistance setting of the latter would result in flashing the tube with excessive current. Flashing usually alters the characteristics of the tube so that it will not operate properly in the first stage unless the plate voltage is raised or the circuit is modified to compensate for the changed tube condition.

There is a basic relationship between the Plate currents of both tubes that is most important. In general, the first tube should idle at from .3 to .5 ma and when a signal is received from the transmitter the current should drop to about .1 ma. The second tube should ilde at about .1 ma, or less, and upon signal should jump to at least 1.3 ma.

Using new tubes and good batteries, the second tube should be held down easily with the first tube idling as low as .3 ma, but older tubes may require more first tube current to hold the second tube. In any case, the idling of the first tube need not be any higher than necessary to prevent unsteady idling of the second tube.

The amount of current change of the second tube depends upon three factors: condition of tube, amount of resistance in the second tube Plate circuit, and the amount of "B" voltage. Using a new tube at 45 volts with a relay resistance of 8,000 ohms, a maximum current rise upon signal to about 2.5 ma may be expected, slightly more in some cases. Similarly, a relay with a resistance of only 5,000 ohms will usually result in a current rise to about 3. ma. These figures are average and slight differences may be noted with various receivers. The basic rule is that reducing resistance in the second tube Plate circuit will result in greater current change and vice versa.

The maximum current should not exceed 2.5 ma for reasonable tube life and a better figure is 2. ma. It is recommended that additional resistance be provided in the Plate circuit of the second tube if the maximum current obtained is over 2. ma. The exact value required may be found by using a pot in the circuit to adjust the No. 2 tube current as desired. The setting of the pot may be measured with an ohm-meter to find the resistance value.

A fixed resistor of equal value may then be substituted for the pot, but keeping the latter in circuit has advantages. Tube changing should occur less frequently than with previous receivers, but types of tubes may be switched occasionally. Leaving the pot in the circuit permits a permanent installation which may be easily adjusted to compensate for different tubes, relays, or changing voltage.

Relay Adjustment:

A current rise to 1.8 ma is more than sufficient for completely reliable operation of a properly adjusted relay. At such operation, the relay may be set to pull-in at about 1.5 ma and drop-out at about 1. ma. There is a very visible difference between the actions of a relay set to pull-in at this value and one set to pull-in at 1.1 ma, or less, which is the usual setting of relays used in most receivers.

This slight increase in pull-in value results in a relay action that is very snappy and truly positive. No longer is the contact gap set in thousandths of an inch adjustments through necessity—instead, it is sufficient to adjust the relay points so that in the pull-in position the armature just does not touch the pole piece, and in the opposite position an armature travel of about 1/32 inch is obtained.

With the transmitter keyed so that the No. 2 current jumps to its normal maximum rise, the relay spring may be slowly adjusted until the armature just pulls in. Then, the spring tension should be reduced a bit more. This procedure is usually all that is necessary, but for those who prefer a precise adjustment, a meter should be used for checking the exact spring tension adjustment.

By varying the resistance of the second tube Plate circuit, the current may be adjusted to 1.5 ma, after which the spring tension may be carefully adjusted so that the armature just pulls in at this value. Then, the resistance should be varied to check the drop-out value—if not at about 1. ma, adjustment of the lower contact point may be made. Increasing the gap will widen the range between pull-in and drop-out values and vice versa. Any readjustment of the gap may require a slight readjustment of the spring tension.

The relay, when properly adjusted, will respond snappily to extremely rapid keying and in either pull-in or drop-out position no fluttering or chatter of the armature will be in evidence. A sluggish or uncertain relay action should not be tolerated since the result may be intermittent actuator action. To be assured of reliable relay operation, patience during the adjusting procedure is required. Once a relay has been adjusted correctly, the mystery commonly associated with relay operation is lifted and attention may be concentrated upon receiver operation.

Operating Hints:

The antenna is an actual part of the tuned circuit and it should be attached for all operation. The particular length used will determine the slug tuning adjustment—the longer the antenna, the further out of the tank coil will be the slug; the shorter the antenna, the more the slug becomes part of the tuned circuit. By varying antenna length, adjustment of receiver sensitivity is provided. The idea is to get the slug positioned for best operation with the antenna long enough to pick up a good signal yet short enough so that it will not cause loading effects in the tank circuit.

"B" battery voltage, too, may affect sensitivity. Too high a voltage on a new tube usually decreases sensitivity, yet an old tube requires higher voltage to prevent instability and erratic operation. Initially, the use of 45 volts is recommended, but optimum operation with older tubes may require 50 to 55 v. A 60 volt "B" supply may eventually be employed with very old tubes to obtain continued reliable operation long after their "normal" useful life.

It is most important, however, that the voltage be steady to assure that current or relay adjustments need not be changed continually. The largest practical size battery should be used to reduce the need for readjustment to a minimum. If hearing-aid type batteries are used, a battery charger should be employed to keep them operating reliably. Batteries that are recharged before complete rundown will last for many times the life of those used until dead. A regular "touch-up" on a battery charger after a battery is used will keep the power supply in best condition.

The use of one or a pair of earphones connected in parallel with the meter, when checking the first stage, gives a good indication of receiver sensitivity. A loud ragged rushing noise together with a slightly unsteady meter reading indicates best operation. Little noise or whistling usually accompanies very steady idling and indicates poor sensitivity. By varying antenna length and battery voltage, a wide range of sensitivity adjustment may be obtained. The earphone check need not be used on the field except for occasional spot checks or in trouble shooting.

A tube which will not perform satisfactorily in the first stage will usually operate perfectly in in the second. Old tubes are usually completely reliable in the second tube position, unless so far gone that they will not rise high enough when signalled.

Installation:

It is very satisfactory to install the "Twin-Tube" receiver by rigidly mounting the plug-in socket and chocking the assembly with pads of airfoam type rubber. Several variations of socket mounting are shown elsewhere in the instructions. The relay may be mounted separately by the usual rubber band method, mounted on a a small 1/6 inch micarta or plywood base and suspended in the manner used for previous type receivers.

In many cases, depending upon the type relay used, no shock mounting at all may be required for the relay. To prevent damage to the relay in an impact, however, it may be better to use rubber bands to hold the relay on a pad of 1/2 inch thick airfoam type rubber. The relay may also be mounted on a small "Lord" mount for a neater installation that is equally protective. A relay installed in either of these ways is relatively free to absorb engine vibration, but firm enough to stay in place in an impact.

For best results, it is recommended that the receiver be installed in the "Receiver Chassis and Actuator Unit", manufactured exclusively by NORTH AMERICAN MODEL PRODUCTS. This unit is designed especially for the "Twin-Tube" receiver and features a sensitive relay, an actuator,, two control pots, meter jack, and battery box. The unit complete is ready for installation.

Field Operation:

There is no satisfactory substitute for a range check. In other words, the only way to be sure that the receiver will operate far away from the transmitter is to take it far away, have the transmitter operated, and check the receiver response. A minimum distance of 300 yards is recommended.

Common practice is to check the receiver at range with the meter in the circuit. This is recommended provided operation is also checked without the meter in the circuit. Long leads (over 6 inches) attached to the meter can cause some difference in tuning with and without the meter hooked up. The difference is not usually evident at short range. The procedure, therefore, should be to check with the meter first to make any current or tuning adjustments, then remove the meter and retune slightly, if necessary, to obtain snappy relay and actuator action.

Besides checking battery voltage, making proper tuning adjustment, varying antenna length, or interchanging tubes, obtaining good receiver operation at range is more concerned with the performance of the transmitter used. Experience has indicated that most so-called "out of range" flights are caused by transmitter difficulties. The most common faults are incorrect antenna loading and weak batteries.

Some hints for proper transmitter operation are as follows:

The transmitter is best used on the earth or on a car roof. The roof acts as the ground and the extra height minimizes the effect of radiation interference which may be caused by the close proximity of people, trees, or other objects. It is best to stay away from the antenna as much as possible and to keep a remote keying cable, if used, away from the antenna mast.

A transmitter may be satisfactory if adjusted for correct loading while held in the hand provided that it is used only in that condition. Loading is likely to change if a normally hand-held transmitter is used on the ground. Loading for bench checking, likewise, may be expected to be different than that required if the transmitter is used on the ground for field use. A change from earth to concrete may also require readjustment. The use of a concrete runway as a base for transmitter operation is not recommended.

The basic rule is to adjust the transmitter according to its location during operation. In other words, the final adjustment should be made with the transmitter situated exactly as it is to be operated and the transmitter should not be moved, once adjusted for a particular location.

Loading may also change if a keying cable is used with a transmitter previously adjusted to operate without the cable. A keying cable may even require the use of an RF Choke or a change in length to help prevent any tendency to self-resonation. In either case, the principle is to eliminate any straying of power from the antenna into the cable.

Cases of receivers operating with no apparent signal source have been traced to transmitters which radiated energy even though switched off! Only upon removal of the crystal from the circuit was this radiation eliminated. This effect was most noticeable with hard tube receivers, but could be observed affecting those using gas tubes also.

The point is that unreliable receiver operation may be encountered which is due to causes separate from the receiver itself. With a properly adjusted transmitter, the importance of these sources of trouble is minimized. To obtain the best results, therefore, in terms of utmost reliability and satisfaction, proper receiver operation largely depends upon the operation of the transmitter.

A concluding recommendation is made that once the receiver operation is regarded as proper and satisfactory no further experimenting or curiousity seeking be indulged in. A "Twin-Tube" receiver, after initial adjustment, should provide many trouble free hours of operation if not abused. It is the product of many years of continuous equipment improvement.

TROUBLE SHOOTING

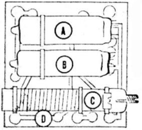
Symptom	Probable Cause	Remedy
Very sensitive to body capacity, Range very limited, Tuning critical	Weak "A" batteries, sometimes "B". Poor No. 1 Tube.	Replace batteries. Replace tube.
Unsteady Plate currents	Weak No. 1 Tube Weak "B" batteries, sometimes "A".	Replace tube. Replace batteries.
No. 2 current rise to less than 1.5 ma.	Weak No. 2 Tube Excessive resistance in No. 2 circuit. Low "B" voltage.	Replace tube. Use lower resistance relay. Increase voltage.
No. 2 current rise to more than 2.5 ma.	Insufficient resistance in No. 2 circuit.	Add resistance by pot, resistor, or different relay.
Normal No. 2 current rise initially, but falls off as signal is held on.	Weak No. 2 tube. Weak "B" batteries. Slightly untuned.	Replace tube. Replace batteries. Retune slug.
No. 2 idling over .1 ma	No. 1 idling low. Antenna loading.	Increase No. 1 idle current to .8 ma, or replace tube. Vary ant. length.
Relay chatters	Incorrect relay adjustment. Currents unsteady	Adjust to operate in No. 2 cur. range. See above on chart.
No idling on No. 1 tube, No. 2 idles at maximum	No. 1 tube not secure. Poor No. 1 tube.	Reposition tube. Replace tube.

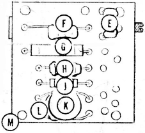
In case of any difficulty not covered by the above or the general instructions, please contact:

NORTH AMERICAN MODEL PRODUCTS, INC.
9802 Warwick Road
(Warwick Branch)
Newport News, Virginia

REPLACEMENT PARTS LIST

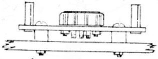
a.	RK-61 Second Stage Tube	$3.50
b.	RK-61 First Stage Tube	3.50
c.	Tuning Coil Assembly	1.10
d.	Printed Circuit Base: Etched, Eyeletted, with Flea Clips & Socket Pins	2.75
e.	Plate Condenser	.30
f.	Tank Condenser	.30
g.	RF Choke	.40
h.	Grid Condenser	.30
j.	Grid Resistor	.20
k.	Bypass Condenser	.30
l.	Coupling Condenser	.30
m.	Set of Socket Pins (5)	.15
	Socket Assembly: with "Pot" & Limiting Resistor	2.75
	25,000 ohm "Pot"	1.50
	Limiting Resistor	.20
	Set of Flea Clips (10)	.25
	Set of Instructions	.25



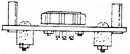


METHODS OF MOUNTING SOCKET ASS'Y IN MODEL

If desired to mount socket flat on model floor or bulkhead, resistor and pot may be removed and installed elsewhere in model.



Spacers used to raise Pot clear of floor



Socket assembly bolted to model cross braces

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9802 Warwick Road, Warwick Branch
Newport News, Va.