Final Notes On

The Foxmitter

by Richard Q. Fox

The May through October issues of this magazine contain six articles on the construction and use of a transmitter designed to operate in a model rocket. The articles contained information on how to use the transmitter to send information on the rocket's acceleration, spin rate, physical position, on the temperature of the air surrounding the rocket and on the noises generated inside the rocket during flight. A large number of people have built the transmitter and its associated sensors and some of these people have written Model Rocketry magazine with questions and with suggestions. This final installment in the first series of articles answers some of the questions raised by the readers and passes on some information that has come to light during the six months that the series was published.

The process of developing an electronic device and publishing its design is a complex one and inevitably some errors are committed between the construction of the final prototypes and the publication of their design. A few such errors crept into this series. The May issue parts list for the basic transmitter assigns values to R2, R3 R4, and R5 which are not readily available. These resistors should have the following values:

R2	4,700,000 ohms
R3	4,700 ohms
R4	470 ohms
R5	47 ohms

In the same parts list, C4 is listed as 2 picofarads. The value of this part is not critical and any value between 2 and 4 picofarads may be substituted. The antenna is listed as 6' 0" of thin hook-up wire. This is incorrect. The length should be 26" of thin hook-up wire but the exact length depends on the neatness of the wiring job done on the transmitter. This subject is covered in more detail in another part of this article. The extra capacitor represented by dotted lines on the schematic is not necessary if the antenna is installed properly. Inductor L2 has been a source of problems and a replacement for it is suggested in another section of this article.

In the July issue, the section which describes the use of the direction sensitive antenna contains an error. The direction sensitive antenna is a length of stiff wire formed into a circle, with two eight inch lengths of hook-up wire attached to the ends of the stiff wire. One of these pieces of hook-up wire is supposed to be attached to the metal case of the walkie-talkie receiver. The other piece is supposed to be clipped to the antenna, with the antenna fully contracted into the walkie-talkie, not fully extended out of the walkie-talkie.

The August issue of Model Rocketry describes an Accelerometer Module for use with the transmitter. Unfortunately, the parts list was left out of the article. The correct parts list is as follows:

Lo .570mh - 2.80mh "Adj. r. f. coil"; Miller no. 9003
Ca 100 pfds
Cb 3.0 mfds, 25 v.d.c.
B1 22.5 volt battery, Burgess no. Y15
Battery Holder Lafayette no. 34H5005
Plug Lafayette no. 99H9091 (Ultraminiature r.c. connector)

All parts except the battery holder and plug are available from Burstein-Applebee, Kansas City, Missouri. The battery holder and plug are available from Lafayette Radio, Syosset, L.I., N.Y.

The left hand illustration in figure 5 is supposed to indicate the use of a battery holder to support the battery. The battery holder is mounted to the perforated board by means of the semi-circle of wire indicated at the top of the drawing. Figure 4 shows a washer at the bottom of the inductor assembly. The washer can be made from either metal or fibre.

Improving Inductor L2

Correspondence indicated that one problem plagued builders of the transmitter more than any other and that was extreme sensitivity to the position of the antenna. The prototype transmitters did not demonstrate this effect and the problem remained a mystery until Michael Mallinger and David Kindler of Pittsburgh sent their transmitters to the author. Mike and David had elected not to follow the wiring diagram and as a result the inductances and capacitances of the internal circuitry varied from those of the prototypes. Mike and Dave's problem was solved by replacing inductor L2 of the basic transmitter with a Nytronics no. SWD–10 10 uh. r.f. choke available from Allied Radio, Chicago Illinois. The Nytronics choke has a much higher Q than the Miller choke listed in the May article. Further testing has indicated that the Nytronics choke makes a noticeable improvement on any transmitter's signal and it is suggested that all owners of the transmitter make this substitution.

Adjusting the Antenna for Maximum Power Output

The circuit used in the Model Rocket Transmitter has a low number of components, small size and light weight. However, these features were obtained at the expense of having the RF oscillator coupled directly to the antenna. As a result, the transmitter is sensitive to the position and length of the antenna.

In electrical terminology, the antenna is referred to as the load of the radio frequency transmitter. How much the antenna loads down the transmitter is a function of the antenna length, thickness, direction, position with respect to the transmitter circuit board and especially how close it is to any conducting objects such as the ground or metal. The antenna and transmitter were designed for use in model rockets flying through the air, hundreds of feet away from the ground and any metallic objects. As a result, when the antenna is brought near a conducting object, it can change its loading properties so drastically that the r.f. oscillator output drops to practically nothing. Those modelers that have already built the transmitter have experienced this effect.

The instructions in the May issue warn that the antenna may have to be lengthened or shortened in order for the transmitter to develop full output. If the antenna length is far from what it should be, the r.f. oscillator will put out no signal at all. There are some simple tests for determining if the antenna length is preventing the transmitter from working. First, turn the transmitter on and plug in a sensor module. Place a crystal earphone between the collector and emitter of transistor Q4. If an audio tone is heard, the audio section of the circuit is operating properly. Next, take a walkie-talkie and collapse its antenna all the way into the case. Turn the transmitter on and touch the walkie-talkie antenna tip to the negative side of the terminal on the battery holder. If the tone is given off by the walkie-talkie, the r.f. oscillator is in working condition and the only problem is the antenna length, provided the nytronics inductor is used for L2. If the walkie-talkie does not give off the tone, check the wiring, the battery voltage under load and the crystal. The best check for the crystal is to plug it into a walkie-talkie that works and try to transmit with it. One other source of trouble could be the use of parts which are slightly different from those called for by the article. In some cases the substitutions may not make much difference but substitutions of inductors and transistors probably will lead to trouble. Even though some all purpose transistors claim to be replacements for the RCA 40080, they do not work properly in the circuit.

If the walkie-talkie test does generate a tone, the only step necessary to make the transmitter operational is the adjustment of First, the antenna and transmitter must be hung in the air, away from other objects, the antenna length. This is done by preparing five ten inch lengths of insulated hook-up wire. Strip one-half inch of insulation off of each end of the wires and bend the exposed ends into small hooks. Take one piece of the wire and tie a one foot length of string to one end. Secure the other end of the string to an overhead lamp. Now connect the free bare end of the wire to the antenna side of inductor L2. (No other antenna should be connected to L2 at this time.) Allow the whole arrangement to hang from the lamp. This arrangement simulates the transmitter in free air with a ten inch antenna. Turn the transmitter on and turn on a sensitive receiver. Listen for the transmitter's audio tone to be picked up by the receiver. Probably none will be heard. Now stand away from the operating transmitter and slowly extend your hand toward the battery and battery holder to the point where you finally are touching the battery Placing your hand near the battery changes the loading of the antenna and has the effect of increasing the effective length of the antenna. If the receiver picks up the transmitter's tone as you bring your hand near the battery, the antenna needs to be slightly longer. If this test did not cause the receiver to pick up the tone, extend the antenna to twenty inches by using two lengths of wire, one hanging from the other. Again listen for the signal from the receiver and try moving your hand near the battery With a twenty inch antenna and your hand about one-half inch from the battery, the transmitter's tone should come through loud and clear. If not try thirty, forty and fifty inch antennas.

Once you have established that the antenna should be between, say, twenty and thirty inches, try different length antennas between those two extremes until you find the length which allows the transmitter to put out full output with no objects near it. If you followed the wiring diagram in the May issue, your antenna length should be very close to 26 inches, however, home transmitters have needed antennas as short as 10 inches and others have needed antennas as long as 4 feet.

Your transmitter should now have a range of between a third and a half a mile on the ground. One additional improvement which can be made is to stabilize the signal by using the payload carrier described in the September issue. The payload carrier is designed to minimize changes in the loading of the antenna caused by its whipping around in the wind during the flight. However, if the payload carrier is used, the antenna length must be corrected by the above procedure while the payload carrier holds the transmitter circuit board.

The problem of transmitter antenna loading has one additional side-effect. When an operating rocket transmitter vehicle is placed on a metal launch rod, the presence of the metal rod is frequently enough to change the load of the antenna so that the transmitter stops. This is inconvenient at times but as soon as the transmitter is lifted off the pad and away from the launch rod, the transmitter will start right up.

Sources of Parts for the Transmitter

The parts for the Model Rocket Transmitter and its associated sensor modules are available from three large mail-order firms. The catalogues of all three firms are necessary to build the project, but they can be obtained by simply writing. The addresses are:

Allid Radio
100 N. Western Ave.
Chicago, Ill. 60680

Burstein-Applebee
3199 Mercier St.
Kansas City, Missouri 64111

Lafayette Radio
111 Jerico Turnpike
Syosset, L.I.
N.Y. 11791

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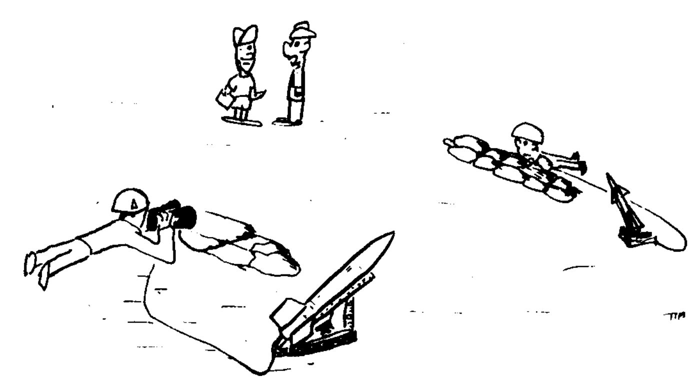
Model Rocketry Magazine has received a number of letters from people who indicate that they have no experience with electronics but that they would like to build the transmitter. They request that Model Rocketry print a pictorial diagram of the transmitter construction. Unfortunately, the response we have received indicates that people who are experienced with electronics are not always completing the transmitter without some trouble, and it would seem that publishing such a pictorial article would only create a large number of non-operational wastes of money. Those model rocketeers who are sincerely interested in building the transmitter should contact someone in their area who is familiar with electronics for assistance.

Modifications

Some readers have proposed modifications to the transmitter circuit. The most common proposal is the replacement of the three transistor Darlington audio amplifier with a single transistor or with an integrated circuit, as described in the October *Technical Notes.* The three transistor circuit was used because of its extremely high gain and because of its superior performance over single transistor modulation circuits. There are some integrated circuits on the market which can do the same job as the three transistor circuit and do it in a much smaller space, however one of the objectives of this project was to use only inexpensive, readily available components and the integrated circuits needed do not fall in this classification yet.

Model Rocketeers are encouraged to experiment with the design and to send any suggestions to me in care of Model Rocketry.

This article is the last in the series on the construction of the transmitter and its associated sensors. It is hoped that this series encourages some origional work in the area of instrumenting model rockets and hopefully produces some more articles for Model Rocketry Magazine. How about write-ups on the results of science fair projects based on the transmitter and how about proposals for additional sensors? One possibility that needs development is a pressure sensor that can be used either as an altimeter for model rockets or as a device for measuring the barometric pressure changes in the first 1000 feet. The trick is to develop a small light weight pressure sensor which does not have to be recalibrated after every flight. How about it?



"They're both top contenders for the space-systems event."