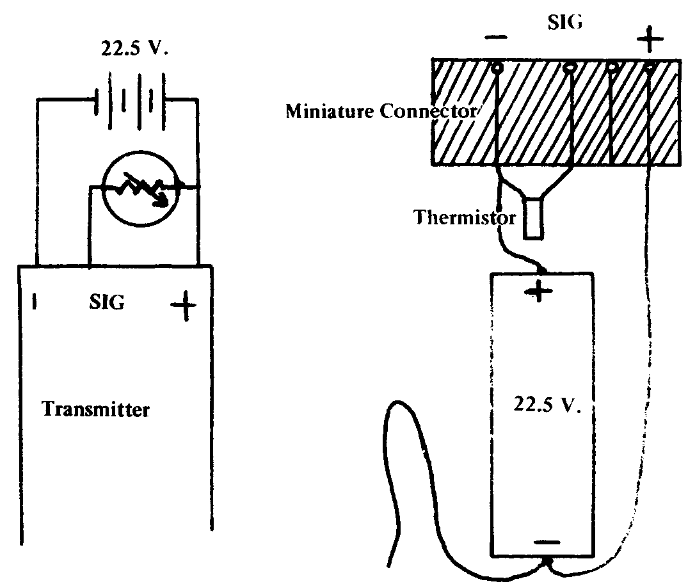
Here is another input device that can be used with the model rocket transmitter described last month....

A Temperature Sensor

by Richard Q. Fox



Temperature Sensor Parts List

B1	Battery, Burgess Y15
TH1	Thermistor, Fenwal GA45P2, 50,000 ohms at 25 degrees C
	Connector, Lafayette No. 99-9091
	Battery Holder, No. 139

TH1 available from Allied Radio, Box 4469, Chicago, Ill. 60680. All other parts available from Lafayette Electronics, 111 Jerico Turnpike, Soyoset, N.Y. 11791

Last month, I described the construction of a 100 m.w. 27 m.c. transmitter for use with model rockets. The transmitter has a range of over 1/2 mile, and is designed to transmit the information from any of a number of sensors. This article describes one such sensor, a temperature sensor, and its applicability to research projects. In addition, a device for calibrating signals sent by the transmitter is also described.

The application of model rockety to meteorology is tempting. In fact, there has been noticable correspondence on this subject sent to this magazine. Model rocketry is well suited to the study of meteorology, and especially to the study of the first 1000 feet of the atmosphere. Research is easy and interesting because the properties of this area change rapidly from one location to another and from one time to another. In fact, the air 1000 feet up is 10 degrees colder than the air at ground level! A model rocket instrumented with a temperature sensor could send back a temperature profile of the atmosphere in the vicinity of the launch field. The daily changes in this temperature profile, and its correlation to other meterological variables would be an excellent area for original research. In addition, the correleation of the temperature profile to the type of terrain being flown over should yield information on the updrafts and inversions in the areas.

On the more practical side, the temperature transmitter could even be used to help win in parachute duration contests. These contests are usually won by the lucky rocket that gets caught in an updraft. An updraft is usually caused by warm air rising. The temperature transmitter could be used to establish which areas of the field normally are warmer, rather than colder, at 500 feet, and the parachute duration vehicle could be launched into these areas.

Construction and Flight

The actual temperature sensor module is simple to prepare for the transmitter. Refer to the schematic and pictorial for details. (The parts are all available from Lafayette Electronics, Syosset, Long Island, N.Y. 11791). The temperature sensing thermistor should be mounted so that the glass bead just barely sticks out of the body tube. The in-flight telemetered signal should be received on the ground and tape recorded. In addition, the rocket's altitude should be tracked and recorded frequently during the rocket's descent. The tracking observations and their relative times should be carefully recorded, as in Table 2.

Next, the recorded tones of the transmitter's flight should be converted into temperature information. (A device for doing this is described in the second part of this article). Finally, the temperature versus time information should be matched with the altitude versus time data to produce a plot of temperature versus altitude.

Transmitter Calibration Device

The output of the transmitter is a tone whose pitch is controlled by the sensor that is plugged into the transmitter. In order to obtain a relationship between the frequency of the tone and the value of the variable being measured, the transmitter-sensor combination must be calibrated. The best ways to calibrate the signal involve test equipment which is too expensive to be considered for this project. However, a good substitute–an audio frequency generator–is suggested here as the calibration device.

The calibration process consists of relating the frequency of the tone transmitted to a specific value of the variable being measured. The human ear is not very good

Table 2
Sample: Telemetered Data Table

Time (sec.)	Measured Altitude	Measured Signal Frequency	Calibrated Temperature
t+8(eject)	800'	8.5	64-degrees
t+10	770'	8.6	65-degrees
t+15	560'	8.8	67-degrees
t+21	465'	9.1	70-degrees
t+26	250'	9.4	73-degrees
t+29	0'	9.6	75-degrees

at determining the absolute value of a tone, but it is the most inexpensive and sensitive tone-comparison devise around. It can sense a difference between two frequencies of about two cycles per second. Given a tone of known frequency generated by an audio frequency generator, the ear can detect accurately whether a second tone is of the same frequency.

The calibration procedure for the temperature sensor would be as follows: With the transmitter operating, the sensor is dipped in a glass of water. The tone generated by the transmitter is then matched with the audio frequency generator tone that is closest to it. The temperature of the water is recorded along with the setting of the generator needed to produce the matching tone. Next, the temperature of the water is changed slightly. This will change the transmitted tone slightly. The auido frequency generator is rematched by ear with the new tone, the new temperature of the water, and the setting of the generator which produces the closest match to the frequency of the tone are recorded. This process is repeated until data covering the entire range of temperatures of interest is collected. This calibration data should be plotted on a graph.

Now, when the temperature sensor is sent into flight and its output recorded, the various tones of the recording can be compared with the tones of the audio frequency generator, and the settings of the audio frequency generator necessary to generate the matching tones can be converted directly into temperatures.

Construction

Construction of the audio frequency generator is straight-forward. The design does not contain any critical features. Mount the parts in a container and wire them together. Place markings from 0 to 10 on the box, around the shaft of the variable resistor. Mount a pointer on the shaft of the variable resistor.

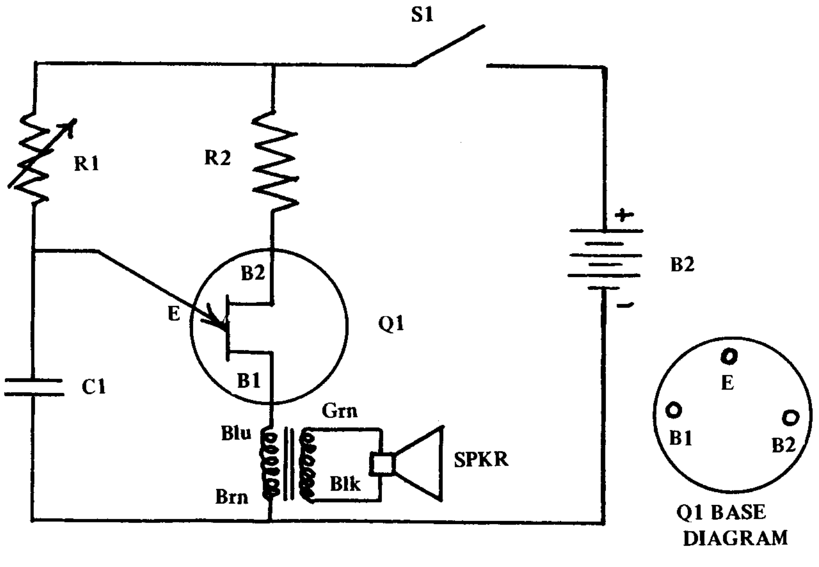
Next month, a spin rate sensor, and a direction finder for locating lost rockets with transmitters on board.

Transmitter Changes

The following substitutions can be made in last month's transmitter design if the resistors mentioned are unavailable:

R_2= 4.7 megohms
R_3= 4,700 ohms
R_4= 470 ohms
R_5= 47 ohms

27 m.c. Model Rocket Transmitter Sensor Calibrator



Parts List

R1	Variable resistor, linear 0-100K ohms
R2	220 ohms
C1	.02 ufds.
Q1	2N2646
S1	SPST on-off switch
T1	Argone AR-174 transistor output transformer
SPKR	Speaker, 2 1/2", 3.2 ohms
B2	any 9 volt battery

Th
Clustered

by Lawrence Brown

The design of the Centaur-B is intended more as an inspiration than as a blueprint. I have built a working model using a 1.8" diameter tubing, but the Centuri 2.00" tubing is more readily available here in Canada so I have "scaled up" the design. The distinctive features of this design are the combination of an accelerometer and a payload capsule and the parallel three-engine cluster. If flown with a one ounce payload, the rocket is capable of about 625 feet altitude, if three C6-5 engines are used. The rocket can also be flown with three B4-2 engines.

With an ST-20 body tube, the lightest engine mounting system would be to purchase an EM-20 and replace the engine holder tube with the longer ST-76. The long end of the ST-76 projects downwards and contains the central engine. Two ST-73 tubes are placed on either side of the ST-76 and glued to the base of the EM-20. Two slits are cut out of the ST-20 main body tube to receive the booster engines. An "Atlas type" streamlined skirt is added on each side. Vernier-like balsa fin supports are employed to brace the fins mounted perpendicular to the cluster line.

A band of chrome tape and a red, black, and white paint job take care of the aesthetics. Parachute selection should be based on the payload and local wind conditions. For initial test flights, three A8-3 engines can be employed.

The parallel cluster design has a lot to offer. Rocketeers could profitably experiment with such combinations as two B14-0 outboard boosters with a long burning type E sustainer.