

CHAPTER X

COPPER-WIRE-CARD DETECTORS

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SECTION I - DESCRIPTION

Card Design.- Each copper-wire-card detector consisted of a winding of fine wire mounted to a 1.45- by 7.00-inch rectangular card. Two wire sizes were used - 2-mil and 3-mil (fourteen 2-mil cards and thirty-two 3-mil cards). The total exposed effective area was about 1.2 square feet (0.11 square meters). A sketch of a detector is shown in figure X-1. These detectors are similar to the detectors flown on previous satellites.

Quadrant Design.- The 36 cards are arranged in four groups of 12 cards each with four pairs of 3-mil cards in parallel and four single 2-mil cards in parallel. Each group is mounted on a fiber-glass support that can readily be removed from the payload for repairs or replacements with appropriate spares. Individual cards can be replaced readily if necessary. The assembly of the quadrants is shown in figure II-2.

Temperature-Balance Experiment.- The grids for the temperature-balance experiment were wound with insulated wire. The thermal balance of such a

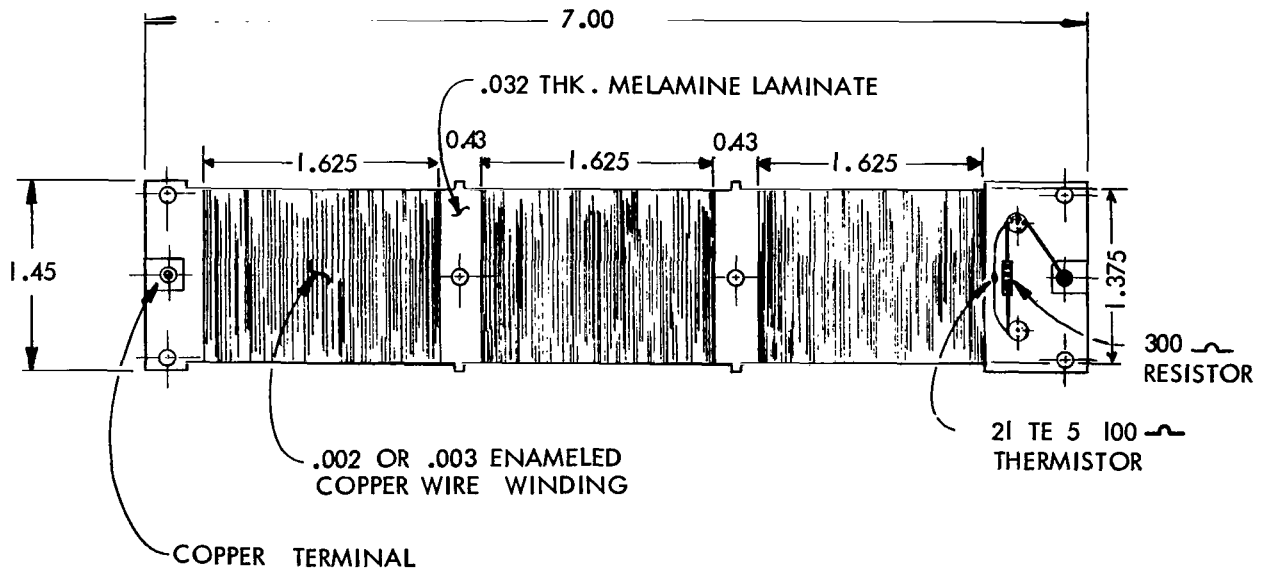


Figure X-1.- Copper-wire card detector. All linear dimensions are in inches.

winding has been examined under conditions approximating flight environment. One card of 3-mil wire with a thermistor attached was enclosed in a bell jar and exposed to the sun after evacuation. External radiation was reduced by shading the bell jar except for a window which allowed the sun's rays to strike the winding. The temperature of the thermistor was recorded at intervals. Figure X-2 shows that the temperature does not rise beyond 65° C in 20 minutes of continuous exposure to the sun. Complementary tests made by Dr. Roger E. Gaumer of Lockheed Aircraft Corp. give a ratio of absorptivity to emissivity of 1 for this type of enamel insulated wire.

Compensation for Resistance Changes.- Temperatures at the wire-card surfaces were expected to extend from -10° C to a maximum of 60° C. Since copper has a thermal coefficient of resistance of 0.33 percent per °C, the resistance of the wire would change 22 percent and a compensator had to be provided. A

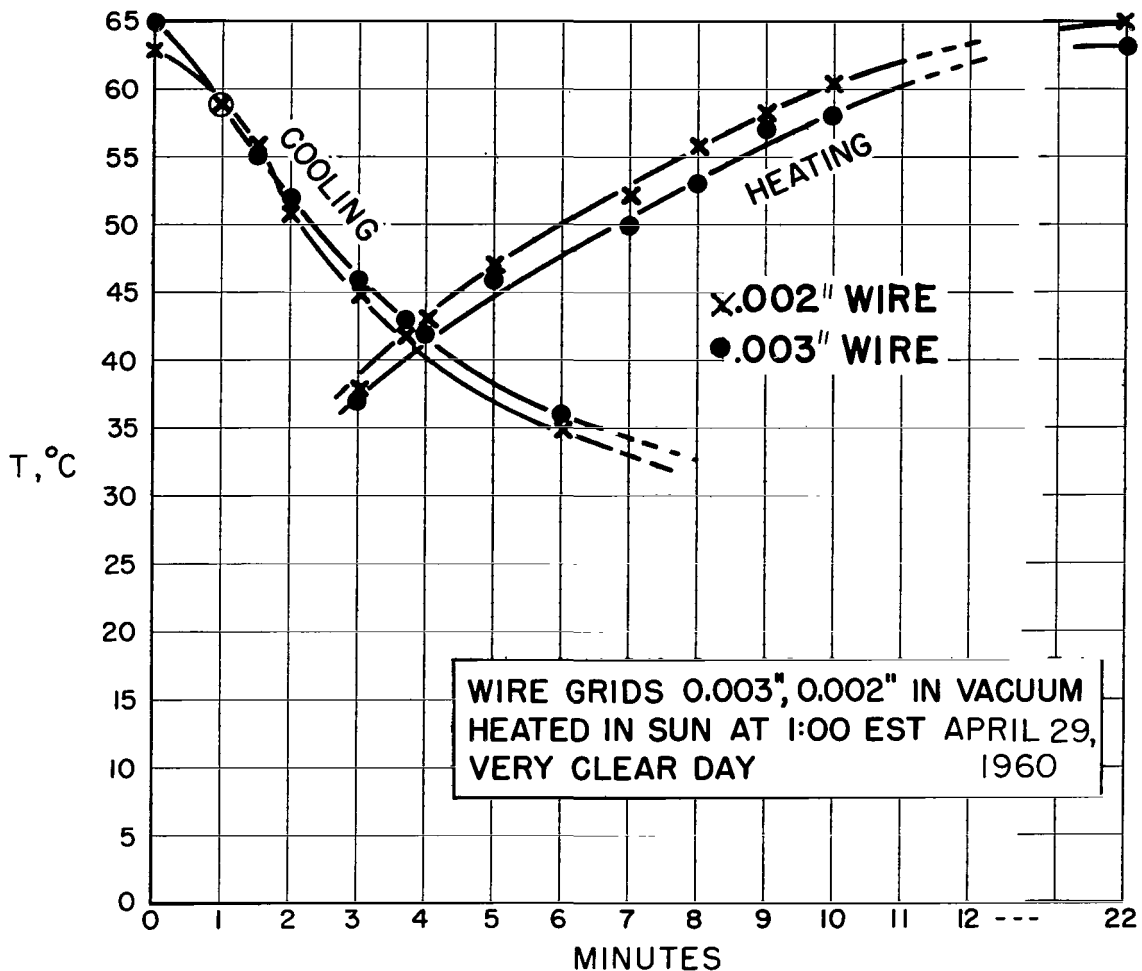


Figure X-2.- Thermal cycles of wire grids in sun.

100-ohm thermistor with a negative coefficient of -3.9 percent per $^{\circ}\text{C}$ was selected, wired in parallel with a 300-ohm fixed resistor and installed in series with each 2-mil card and with each pair of 3-mil cards. The effective resistance of 2-mil and 3-mil compensated cards is shown in figure X-3 for various temperatures and compared with the resistance of uncompensated copper. The increase in resistance from 20°C to 60°C is 12 ohms or 2.7 percent. Below 20°C the effective resistance also increases and the curve is similar to that obtained for high temperatures.

Since the telemetry was conceived so that the failure of one detector in a group of four would change the signal length (time coded data) by 10 percent of full-scale value, a resistance change of 3 percent resulting from temperature extremes would not cause a spurious signal. The resistance of individual cards varied somewhat from card to card, and the resistance of one of the 2-mil cards was only approximately equal to that of two 3-mil cards in series. Uniformity was obtained by adjusting all the cards of one quadrant to a common resistance value of ± 1 percent by adding small fixed resistors.

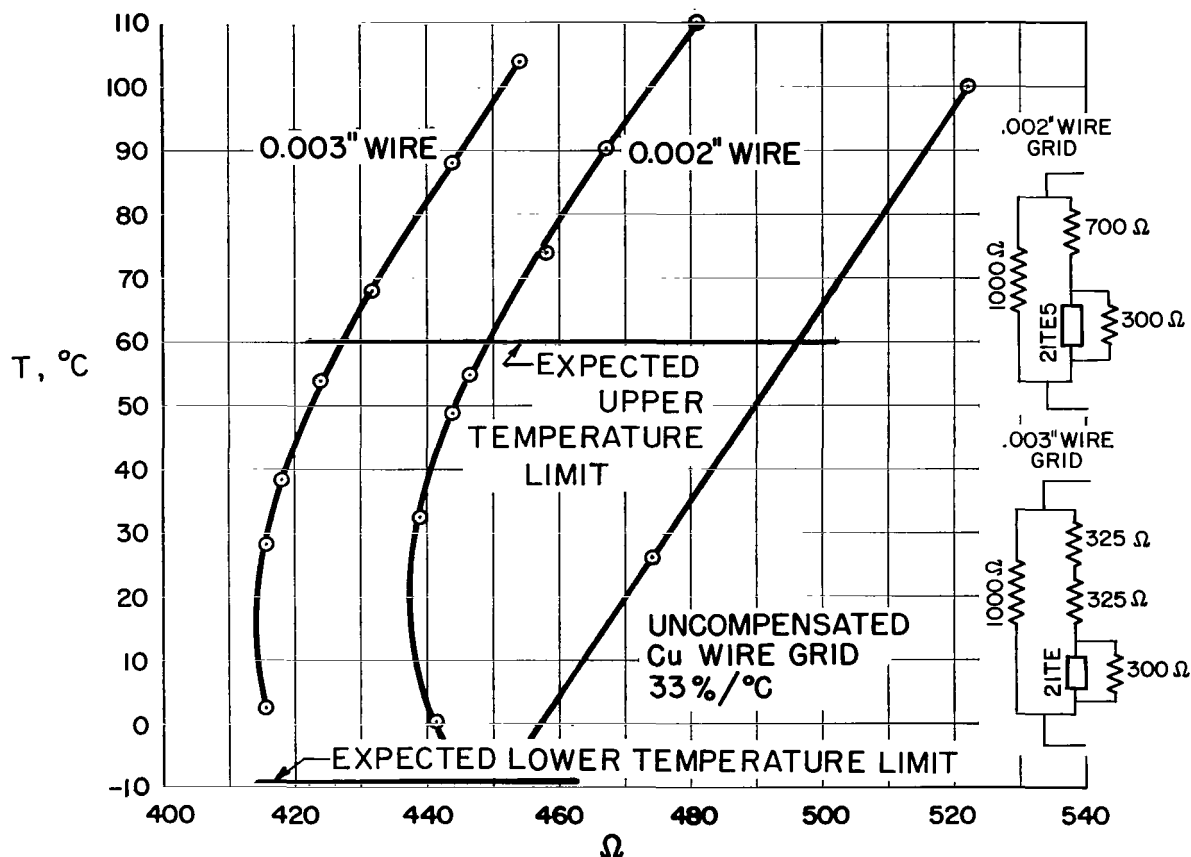


Figure X-3.- Resistance-temperature charts for wire grids.

SECTION II - RESULTS

The particle size required to break a wire was estimated to be one-half the size of the wire. Based on current estimates of the meteoroid influx rate, the required time for one break would be 24 days for the 2-mil wire cards and 120 days for the 3-mil cards. During the short life of the Explorer XIII, no hits were recorded in the $2\frac{1}{2}$ -day exposure to the space environment.