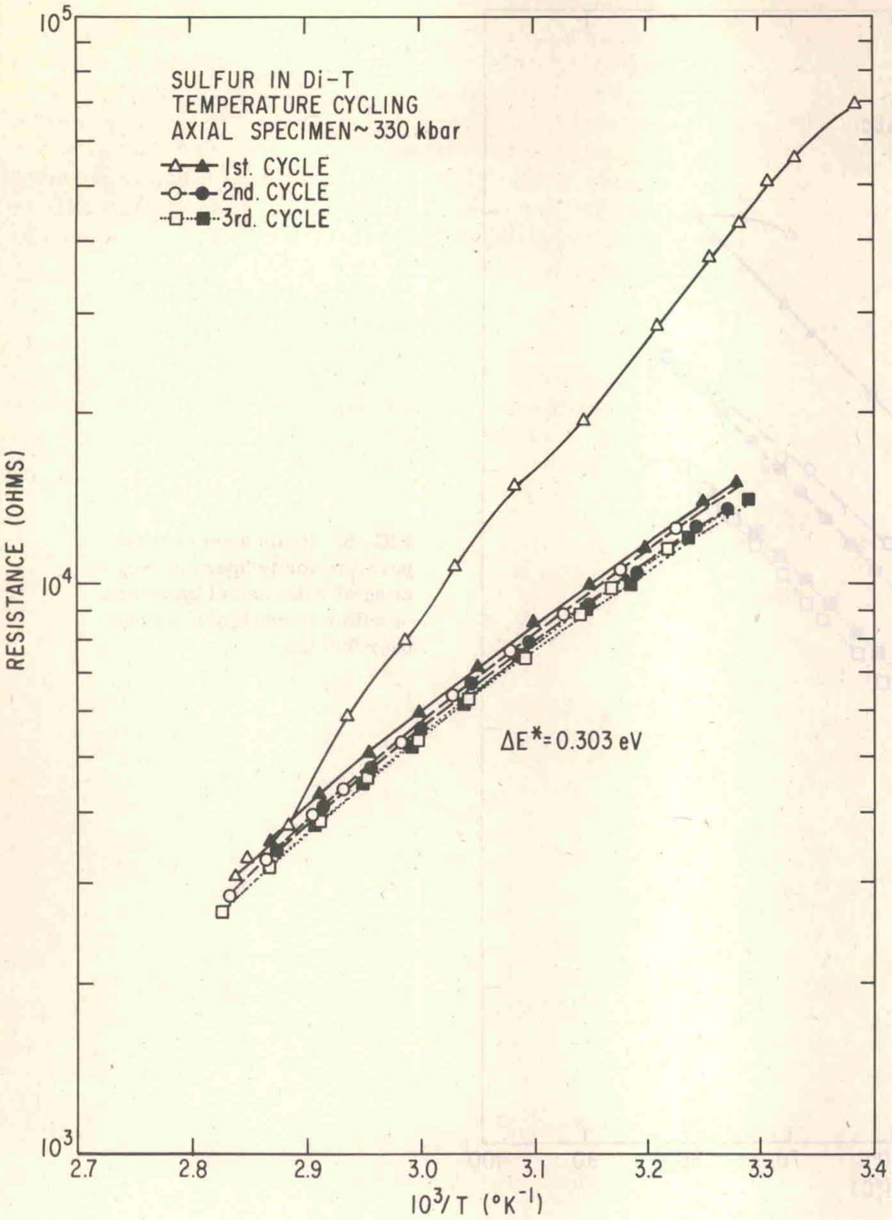

FIG. 4. Log$R$ vs $10^3/T$(°K) plot for temperature-cycling of axial specimen of sulfur 330 kbar pressure.

ric tons ram loading (~330 kbar). The slope of the logR vs $10^3/T$ line on this graph corresponds to an activation energy of conduction, ΔE^*, of 0.303 eV.

Figure 5 shows the resistance versus temperature behavior at about 500 kbar pressure where the specimen is in the semimetallic state. In this state the specimen shows a positive linear increase of resistance with temperature characteristic of a metallic state. In this case the temperature coefficient of resistance is 7.2×10^{-4} $^\circ C^{-1}$, which is about a fifth that of common metals like copper or aluminum.

After carrying out a dozen different temperature cycling experiments at various pressure levels in the semiconducting regime, using both diametral-type and axial-type specimen geometries, the ΔE^* data points obtained cluster around a straight line that crosses the $\Delta E^*=0$ line at roughly 480 kbar, the point at which the specimen goes over into the semimetallic regime, as shown in Fig. 6. The scatter of the data points on this plot is due mainly to the uncertainty of the actual pressure. Even with the greatest care in preparing the gaskets and measuring the G_0 in each case the pressure reproducibility is probably not any better than ± 5%.

Two types of experiments were carried out heating the specimen while in the semimetallic state by passing heating current through it. First, by passing direct current through it continuously under steady state thermal conditions;—and second, by application of a very short single pulse of direct current the duration of which was of the order of the thermal relaxation time of the cell. In the first type experiment temperatures up to about 300 °C were generated in the specimen as estimated from the power input, the dimensions of the specimen and the cell, and the thermal conductivity of pyrophyllite. In the second case the thermal transient characteristics of the cell had to be established and a spe-

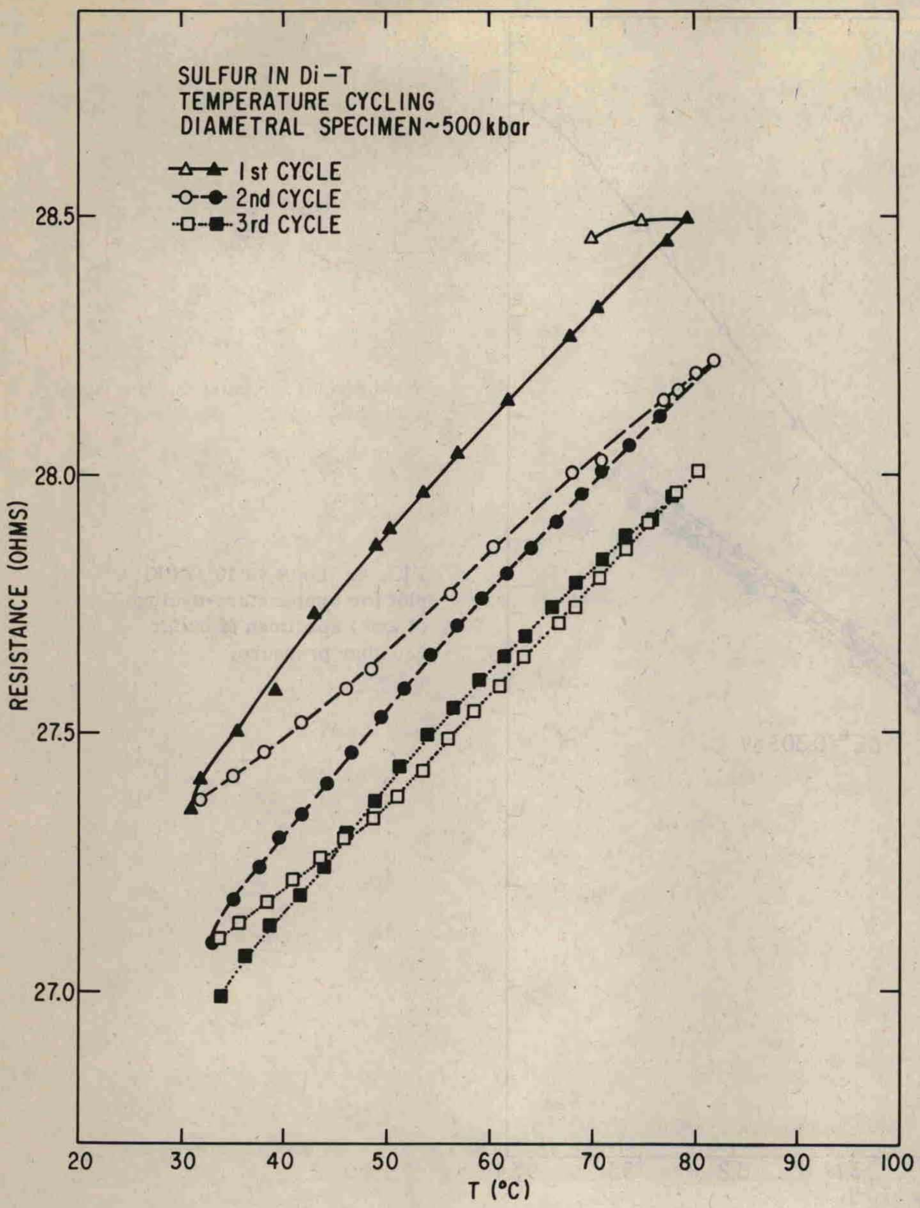

FIG. 5. Resistance vs temperature for temperature-cycling of a diametral specimen of sulfur (metallic) at a little over 500 kbar.

cial pulse-heating circuit devised to match, so that the heating energy could be inserted in a time period of the order of the thermal relaxation time of the cell.

The thermal relaxation time of the cell was established approximately by application of the classical solution of the "hot slab in a cold medium" heat diffusion problem. In the calculation the heat capacity and thermal conductivity of pyrophyllite measured at about 50 kbar were used, together with the cell dimensions, to find the temperature distribution versus time. The results indicated that the "half cool-off time" of the specimen slab is about 25 μsec in this case. Because of this fast heat leakage the input heating pulse needs to be less than 50–100 μsec.

The electric circuitry for the single pulse heating is illustrated in Fig. 7. R_s is the specimen to be heated inside the pressure cell. R_i is a noninductive "current resistor," the IR_i drop of which gives the current signal to the oscilloscope. The oscilloscope is a two-channel, chopped-beam, unit in which the single sweep is triggered by the onset of the pulse, and the dual trace is photographed by an appropriate camera. The power for the pulse is provided by a 45 V "B" battery with a large capacitor in parallel to minimize the terminal voltage drop during the pulse. The "switch" is a silicon transsistor (D44H11) capable of switching up to 80 V and a maximum current of 20 A. The trigger pulse generator is adjustable to give pulses of desired voltage and duration, single or repetitive. In an experiment the specimen in the apparatus is brought up to the desired pressure and resistance state, then connected into the pulse circuit and pulsed once to approximately the desired temperature peak, the camera film recording the voltage and current on the specimen against time. From the oscillogram the instantaneous resistance and power can be determined from E/I and $E \times I$ derived from the E and I readings. The $E \times I$ versus time curve is integrated to give the accumulated input energy, Q, versus time, τ. Then R can be plotted against Q as shown in