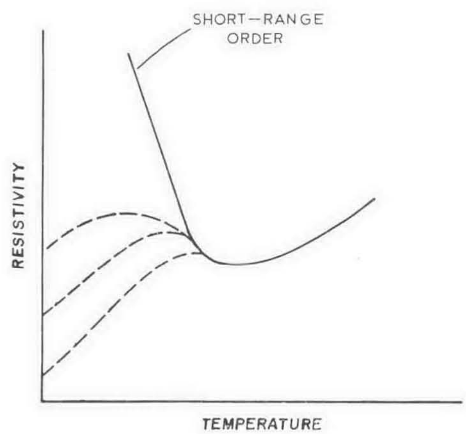
Change 3 is the subsequent decrease in resistivity for the Ni–30 Cr alloy after long-time isothermal anneals.

The observation of a higher resistivity in the ordered state is probably due to decrease in the effective number of electrons associated with the splitting of the Brillouin zone during ordering (Slater 1951) and to the presence of antiphase boundaries. It does not appear likely that trace impurities present would be responsible for the anomaly. In the case where K-state (clustering) is formed prior to quenching, the equilibrium resistivity increases with increasing temperature. The time to establish equilibrium (K-state) increases exponentially with a decrease in temperature, therefore equilibrium is not attained at low temperatures. As a result, the room-temperature resistivity decreases from its equilibrium value, after quenching from above the critical temperature. Experimental curves as shown in fig. 10 can be obtained (Nordheim and Grant 1953).

Fig. 10



Resistivity-temperature curves for short-range order and K-state.

The approach towards the equilibrium resistivity (Change 2) as shown in figs. 2–5 occurs through an ordering reaction. It is noted that the rate of approach towards the equilibrium resistivity was both temperature- and composition-dependent. In discussing the kinetics of order in the Ni–Cr alloys, the data presented indicate that two stages of growth exist. The initial increase in resistivity is due to the nucleation and growth of antiphase domains. This stage results in the establishment of an average domain size within the specimen. The second stage of ordering probably results in the establishment of LRO within the domains. These considerations explain the maximum of fig. 5. The decrease of anneal temperature leads to a decrease of domain size, and therefore to an increase of domain wall scattering and resistance. At low temperatures the domain-wall scattering should be predominant. The contribution from domain wall scattering will peak out at higher temperatures due to an increase in domain size. At higher temperatures, the increased equilibrium LRO will predominate and will further increase resistivity. These two effects lead to an inflection point at 400°C and a decrease in resistivity between 400°–450°C.

Change 3 is marked enough to decrease the resistivity of the Ni–30 Cr alloy after annealing at 400°–450°C for 10^5 min. This change cannot be explained by precipitation of either the chromium rich α phase or impurities. It is noted that change 3 is accompanied by an increase in hardness. The decrease in resistivity of the Ni–30 Cr alloy has also been associated with a large decrease in lattice parameter (Nordheim and Grant 1953). Such a decrease in lattice parameter gives further support to the theory of ordering. It is doubtful whether the long-range order corresponds to Ni_3Cr. The marked increase in hardness suggests that the ordering corresponds to the CuAu type. It is well known that the CuAu ordering involves a marked increase in hardness (Elcock 1956).

4.2. *Discussion of the Shock Deformation Results*

Shock deformation of the furnace cooled Ni–22 Cr and Ni–30 Cr alloys at 90 kbar resulted in a small decrease in resistivity. This change may be interpreted as a decrease in the amount of antiphase-domain wall. In addition to this, since dislocations move in pairs through an ordered domain there is also a decrease of short-range order at the boundaries. At 300 kbar an additional large decrease in resistivity was observed, suggesting the destruction of long-range order within domains. These results show that a substantial degree of order is retained up to a shock pressure of 200 kbar followed by a rapid destruction at 300 kbar.

The resistivity of the disordered alloys decreases continuously with shock pressure. Apparently quenching does not produce a random solid solution since some degree of short-range order was maintained after quenching. Similar decreases in resistivity after deformation by conventional techniques have been reported for alloys containing short-range order (Elcock 1956).

The curve of the resistivity of ordered Ni–Cr as a function of the shock pressure has two distinct parts (fig. 6). The values of resistivity suggest that at shock pressures up to 200 kbars the defects produced are primarily of a structural type with the destruction of LRO a secondary effect. At higher shock pressures, the effects involve a progressive disruption of near-neighbour interactions in the ordered lattice. In addition, the rapid change in resistivity at pressures between 200 and 300 kbars may be indicative of a rapid decrease in the degree of order. The destruction of LRO occurred, however, over a limited region of strain, which is in contrast with normal deformation.

The recovery stages observed for the Ni–22 Cr alloy associates the formation of K-state with Stage V. The formation of K-state is activated