CHAPTER VI

CONCLUSIONS

As we have already mentioned, the transport current is carried mainly by the s-electrons. The main role of the d-band is that of providing a sea into which the s-electrons can be scattered into. For instance, the resistance is mainly due to scattering process in which the electron makes a transition from the s- to the d-band. The existence of this type of scattering process leads to a T^3 temperature dependence in the resistivity which was seen by Webb[29].

It is generally accepted that the mechanism most likely responsible for superconductivity is the electron-phonon interaction between pairs of electrons having opposite spins. Therefore, the mechanism for superconductivity in the transition metals should be the electron-phonon interaction between d-electrons since they are localized about the nuclei located on the lattice sites and would therefore be affected by the motion of the nuclei more than the freely moving s-electrons. Furthermore the density of states of the d-electrons at the Fermi surface is much larger than the density of states of the s-electrons. Theories based on this assumption have been worked out and appear to be able to explain many of the observed thermodynamical properties of the pure transition metal superconductors. In these d-band theories of superconductivity, the transport currents are carried by the BCS pairs formed by the d-electrons when the transition metals go into the superconducting state. We would therefore expect that the transport currents would show an abrupt change at the critical temperature T_c since the s-electrons are the carriers when the transition metals are in the normal phase. However, the observed behavior of the transport currents[30] show the changes to be continuous at T_c. This points to the fact that the same set of electrons are the transport carriers in both the normal and superconducting phases.

Yamvong[31] has shown that the s-electron current density in a d-band superconductor is proportional to a vector potential A(r). In one of the first theoretical studies of superconductivity, London showed that if a current is proportional to a vector potential, the current is a supercurrent, i.e., the current can exist without there being an applied voltage (or an electric field present). Then in the transition metals having some overlap of the s- and d-bands (most of the transition metals fall into this category), the electric current composed of s-electrons goes into the supercurrent state even though the mechanism for superconductivity in the transition metals is the BCS electron-phonon interaction between d-electrons.

In this work we use Kubo's formula to calculate the thermal conductivity of the transition metal superconductors. This formula cam be written in terms of Green's function. We have used the Green's function for s-electrons and the result for thermal conductivity is in agreement with the result obtained by Carlson and

Satterthwaite. Hence this work confirms the idea that s-electrons remain as the carriers of heat as the transition metal goes into the superconducting state.