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THE EFFECT OF PRESSURE ON THE ELECTRICAL RESISTANCE OF RUBIDIUM[1]

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ABSTRACT

By using helium in both the solid and the fluid state as a pressure-transmitting medium, it has been possible to measure the resistance of rubidium over the temperature range from 2° K. to room temperature at pressures up to 2500 atmospheres. In particular the effect of pressure on the transition at ~200° K., on the low temperature ideal resistivity, and on the residual resistivity was examined.

INTRODUCTION

Until recently there have been scarcely any measurements on the effect of volume change on the electrical resistance of materials at very low temperatures. Fischer (1930) made measurements on some metals down to liquid hydrogen temperatures at pressures up to about 150 atm. Bridgman (1932) made measurements down to liquid oxygen temperatures up to 7000 atm. pressure using a gaseous transmitting medium. Sizoo and Kamerlingh Onnes (1925) studied superconductivity under small pressures and since then there has been considerable work on the change with pressure of the superconducting transition temperature. Hatton (1955), using solid hydrogen as the pressure-transmitting medium, has measured changes of residual resistance under pressures up to 5000 atm. in the helium temperature range. For further references, the reader is referred to a recent review by Lawson (1956) of the effects of hydrostatic pressure on the resistivity of metals.

Because of the great theoretical interest in the alkali metals we wished to make measurements on the properties of this group of metals over a wide temperature range under pressure. Pressure measurements of the resistance of these metals have hitherto been confined to the neighborhood of room temperature and above. The present apparatus is designed for measuring electrical resistance down to low temperatures (~2° K.) under moderately high pressures (up to 3000 atm.). With such a temperature range available, it now becomes possible to determine (assuming Matthiessen's rule) the effect of pressure both on the residual resistivity and on the "ideal" thermal component of resistance of the same specimen.

At low temperatures and under sufficient pressure all substances become solid so that a major problem of studying pressure effects at low temperatures is to find a suitable pressure transmitting medium. We have chosen helium since at a given pressure it retains its ideal fluid properties to a lower temperature than any other substance. Furthermore even in the solid state it is a useful pressure medium. In the pressure range with which we are concerned

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the equation of state of
shows that at constant
temperature dependent.
are known, the pressur
applying the pressure a
system can be cooled at
serious loss of pressure. T
in the fluid state at the
in the solid after it has l
quarter of the pressure

Filling pressure atm.
3000
2500
2000
1500
1000
500

The pressure bomb, *A*
its high pressure input
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dewar. A copper braid (
tube about 30 cm. from
vacuum space. This ser
helium or nitrogen bath
vacuum space, *C*, to pro
so cool the bomb; the te
constantan heater woun

The specimen tempera
resistance thermometer (
shielded from external ra

The pressure-seal betw
steel lens ring, *F*. A seal
to pressures of helium u
steel (e.g., Vasco "Speed
tacting surfaces of the
included angle of 60° an
of the bomb body and ca
chrome–molybdenum ste
soldered into the cap of t
by the application of a s
the seal.*

*This method was originall
University. We are indebted t