CURRENT SCIENCE—FIFTY YEARS AGO

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HOW CAN SUPER-CONDUCTIVITY BE EXPLAINED?

L. BRILLOUIN, in *Comptes Rendus*, 196, 1088, 1933, has given an interesting discussion as to the manner in which super-conductivity can arise. The curve connecting the energy with the momentum of the electrons in crystals shows discontinuities for certain values of the momentum p, but in general the energy E is an increasing function of the momentum. It can, however, happen in the case of certain crystals with a face-centred cubic lattice—and superconductivity has been observed only in such materials—that at two symmetrical points A, A′ the curve shows minima. In this case most of the electrons will be in states represented by the rising portions of the curve (which are symmetrical about the energy axis) B, B′, but there will also be a small number in the states represented by A, A′. The current is given by $(\delta E/\delta P)$ (*R. Peierls, Eregebnisse der Exakten Naturwissenschaften*, p. 274, 1932). The total current is zero because of the symmetry of the curve giving $(\delta E/\delta P)$. But if by some agency as for example, a sufficiently strong electric field, the numbers n_A and n_A' of electrons in the states A and A′ are made unequal, there will be a resultant current. This current will persist for a long time since the electrons cannot go from the state A to A or to B since they will then have to pass through a state of maximum energy and at extremely low temperatures the vibrations of the crystal lattice cannot impart the requisite energy to them. If the temperature is increased to the point when the lattice vibrations can give the necessary energy, the super-conductivity is destroyed. The fact that the current in a state of superconductivity has a maximum value is explained by the fact that the difference $n_A - n_A'$ has an upper limit. If can electric or magnetic field having a magnitude above a certain limit be applied, the electrons will be made to pass from A to A′ or B and the symmetrical distribution being restored, the super-conductivity vanishes, as is actually observed. Since a thermal gradient cannot take the electrons from one state to another so as to produce the required inequality of n_A and n_A', the fact that there is no thermal super-conductivity finds a ready explanation.