Letters to the Editor

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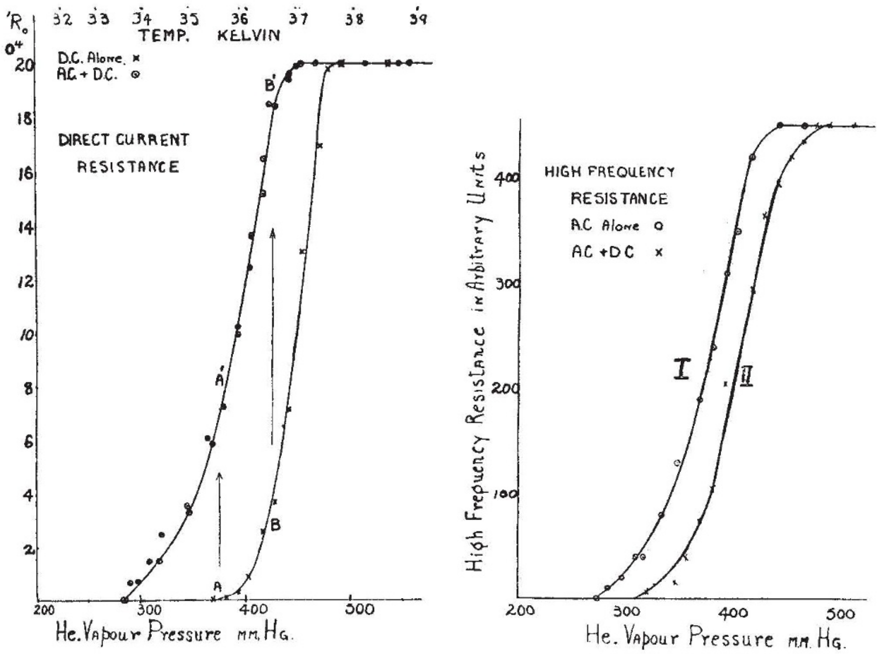
Superconductivity with High-Frequency Currents

FURTHER experiments have been carried out by us in this laboratory on the phenomena of superconductivity with alternating currents of high frequency,



(*a*) (*b*)

FIG. 1.

following those already reported.[1] In these experiments, observations have been made on the resistance of a conductor at low temperatures when both alternating (frequency 12×10^6) and direct currents were flowing simultaneously. The curves show the variation of the resistance with the temperature; the temperature was controlled and estimated by the vapour pressure of liquid helium.

The experiments may be divided into two sets:

(*a*) The resistance offered to direct currents by the metal (tin) was measured both with and without accompanying high frequency currents.

(*b*) The resistance offered by the same sample to high frequency currents was measured both with and without accompanying direct currents.

The resistances of the conductor to direct currents and to high frequency currents were measured by independent methods, as indicated in the paper referred to above.

The results may be stated thus:

(1) (Fig. 1 (*a*)). Curve *AB* represents the relation of R/R_0 and temperature (Kelvin) for direct current. When, in addition to the direct current, high frequency currents were induced in the same conductor, the resistance to the d.c. changed so as to shift the curve towards lower temperatures (*A'B'*). The switching on and off of the high frequency generator changed the resistance reversibly from the point *A* to *A'*, from *B* to *B'*, and so on. The position of the displaced curve was found to depend upon the ratio of the magnitudes of the high frequency to the direct current in the specimen. When this ratio was decreased by decrease of the induced high frequency currents or by increase of the direct current, curves were obtained lying between those shown in the graph.

(2) (Fig. 1 (*b*)). Curve I represents the relation of the high frequency resistance and the temperature. When, in addition to the alternating current, direct current was applied to the specimen, curve II resulted.

When both currents were flowing, the critical point for the high frequency resistance was the same as the critical point for the direct current resistance; the position of this common critical point on the temperature scale is determined by the ratio of the magnitude of the direct to that of the alternating current. Thus, when the superconducting state had been established at this common critical temperature, resistance was offered neither to direct nor to alternating currents.

Two effects have therefore been established, the depression of the critical point for the direct current resistance by the application of high frequency currents, and the raising of the critical point for the high frequency resistance in the presence of a direct current. Full details of the experiments are in preparation for publication elsewhere.

These experiments confirm the reality of the frequency disturbance of the superconducting point found in our early experiments, and it follows that any theory of the nature of superconductivity that may be advanced must include an explanation of this new phenomenon.

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[1] *Proc. Roy. Soc.*, A, **136**, 52; 1932.

Inter-Diffusion of Metals

WE have recently applied high precision X-ray analysis to the study of the inter-diffusion of two metals in the solid state. Although the experimental work so far has been confined to mixtures of copper and zinc particles (heated *in vacuo*), enough data have been obtained to show that this new method has distinct advantages over the methods hitherto employed, and that it admits of wide application. Its two principal features are: (*a*) the direct measurement of a fundamental quantity, namely, lattice parameter (or mean atomic volume), while, in other methods employed to study this phenomenon, mean values of such quantities as chemical composition, width of zones, electric resistance, thermoelectric effect have been determined; and (*b*) each phase present at any time gives its own X-ray reflection lines independently, from which its composition can be readily found from standard composition-parameter curves.

In Fig. 1, a series of prints from portions of X-ray