Electrical Properties of Wires of High Permeability

IN the course of an investigation into the properties of wires of the high permeability nickel-iron alloys of the mumetal group, we have found some interesting results when such wires are made to carry alternating current at audio-frequencies.

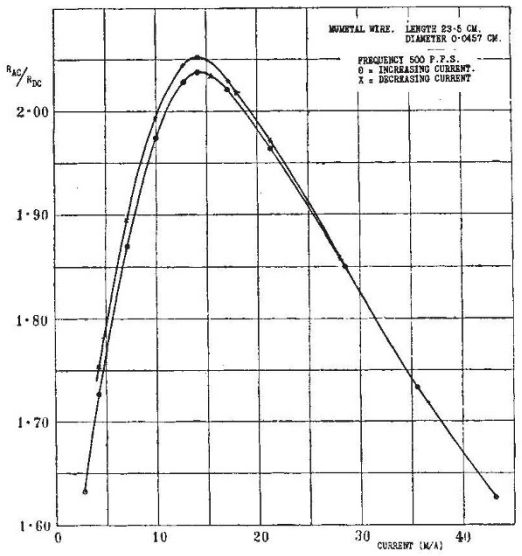

FIG. 1.

There is a pronounced 'skin effect' even in fine wires, owing to their abnormal permeability, at frequencies as low as 50 periods per second, at present the limit of our experiments. In addition, the application to the wire of a small external axial magnetic field of the order of that of the earth, causes a strikingly large change in its impedance.

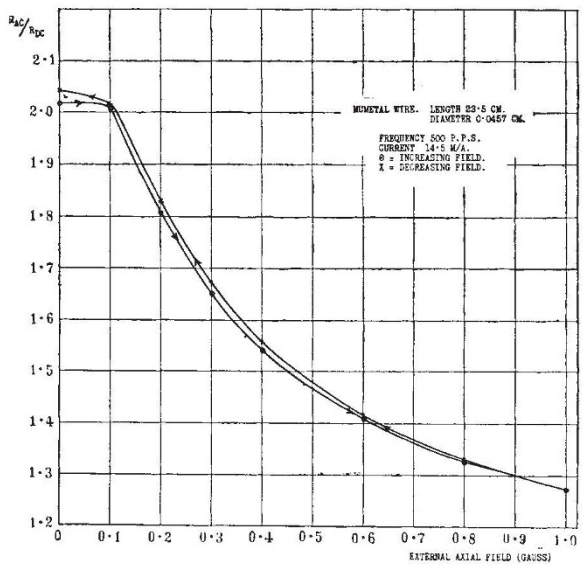

FIG. 2.

When the external field is constant it is found that the effective (A.C.) resistance varies with the value of the alternating current in the wire, and for any frequency always comes to a maximum for some particular current which for convenience we may call the optimum current for the wire at that frequency. As an example, in a mumetal wire, 23·5 cm. long and 0·0457 cm. in diameter (dimension ratio 510) suitably heat-treated, the variation of effective resistance with current at a frequency of 500 p.p.s. is shown in Fig. 1. It will be observed that there is a slight but appreciable hysteresis effect.

When the current in the wire is kept constant at the 'optimum' value of 14·5 milli-amperes, and the external axial magnetic field is varied, the variation of effective resistance is shown in Fig. 2. A small hysteresis effect is again noticeable. For currents either larger or smaller than the optimum, the corresponding field-resistance curves lie below that shown in Fig. 2, and their maximum gradients are smaller.

Changes in reactance as current or external field is varied also occur, but are in general smaller than those of effective resistance.

By using a wire with a larger dimension ratio, the changes of effective resistance in fields less than 0·2 gauss may be considerably increased. As an example, a wire of length 15·25 cm. and diameter 0·0179 cm. (dimension ratio 850) carrying A.C. at 500 p.p.s. and lying horizontally at right angles to the magnetic meridian, suffered a decrease in effective resistance of about 18 per cent when turned through 90° in the horizontal plane. This, combined with a power factor in the wire of 0·97, means an impedance change of about 17 per cent, if the small reactance change be ignored.

A detailed account of these experiments will shortly be published elsewhere.

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Thermal Oxidation of Formaldehyde

CARRUTHERS and Norrish[1] have observed that the polymerisation of formaldehyde is induced by formic acid, produced in the photochemical oxidation. An induced polymerisation apparently accompanied by an induced decomposition occurs in the thermal oxidation, at temperatures as high as 317°. This reaction possesses many features of interest from the point of view of the theory of chain reactions. Direct analysis has shown that the rate changes with time as predicted by the theory for chains with degenerate branching[2]. Furthermore, in a series of mixtures, the initial rate depends on the third power of the formaldehyde concentration and is independent of oxygen concentration down to pressures of a few millimetres. In a single experiment, however, these conditions do not hold good, and with a sufficiently high initial velocity, good unimolecular constants can be obtained over a large range.

It is not easy to explain this effect by a catalysis due to the final products, but Semenoff[3] has shown that such behaviour is to be expected in reactions where there is a mutual interaction of chains. Perhaps the most unusual feature occurs in the experiments with vessels of different diameter. No considerable