SUPERCONDUCTIVITY

Powerful Magnets at Last

ANYONE not yet convinced that physics and engineering must face the future hand in hand would have found last week's lecture at the Institution of Electrical Engineers on "Superconducting Materials in Magnets" a very sobering experience. Dr W. T. Norris, of the Central Electricity Research Laboratories at Leatherhead, described his subject as one of the unfinished success stories of science, sparked off by the discovery of superconductivity in 1911 by the Dutch physicist Kamerlingh Onnes and advancing through different levels of understanding to the present day achievement of a vast superconducting magnet for use in the bubble chamber experiments of high energy physics.

For many years the construction of a magnet with superconducting windings was limited by the apparent lack of a metal which could sustain large currents and high magnetic fields without losing its superconducting property. In 1959, however, it was discovered that the compound niobium–stannide and the alloy niobium–titanium remain non-resistive in fields above 100 kG, having critical fields of 140–200 kG at absolute zero, and this started a flurry of activity to produce a large magnet of either material. But all was not well. It was found that whereas small coils would operate satisfactorily, larger ones were again bedevilled by some breakdown process and became resistive.

This breakdown phenomenon, which became known as electrothermal instability, has still not been properly understood, but the problem of how to overcome it in practice was solved in ignorance by the insertion of strips of copper around the windings. This ensured that when for some reason a section of the superconductor heated up and became normal, the current would flow through the copper—which has a much lower resistance than the Nb–Ti alloy in the normal state—and thus allow the superconductor to cool back to its non-resistive state. Dr Norris pointed out that the technical problems of designing copper cased Nb–Ti windings with adequate channelling for the liquid helium coolant are far from trivial, but that they have now been successfully overcome.

Although practical applications in industry are envisaged, the most glamorous use for a magnet which generates a high field over a large volume is in bubble chamber experiments, in which powerful magnetic forces are required to deflect the very fast moving elementary particles that are produced. The costs compare very favourably with the conventional water-cooled copper magnets, and Dr Norris gave some figures for the bubble chamber magnet recently completed at the Argonne Laboratories in the United States. The construction cost of the magnet, 12 feet in diameter and producing a field of 20 kG, was $2·3 million, about the same as for the equivalent copper magnet. The running cost of a copper magnet over a lifetime of ten years would be $4 million, however, whereas that for a superconducting magnet is estimated at $0·4 million, or one tenth the amount. This sort of saving is particularly welcome at a time when nuclear physics budgets are feeling the pinch of Government cuts. The huge expenditure on electric power for high energy experiments can be gauged from the fact that the CERN research centre consumes about one fifth the power of the whole of Geneva.

Dr Norris drew attention to two industrial applications for large superconducting magnets, one already in prospect and the other as yet untried. An experimental magnet with a field of 30–40 kG is under construction for use in a generating station, and he surmised that the technique could also be used for the windings of a homopolar motor. A further application, which has already been developed, is for the "tennis-ball seam" winding used for containing plasmas for thermonuclear reactions.

Looking to the future, Dr Norris speculated that it may be possible to manufacture the ring magnets in synchrotrons with superconducting windings. These would require alternating currents of a frequency of about one cycle per second and, although no application has yet been tried, Dr Norris pointed out that the d.c. magnets can be switched on and off about once a second without any untoward effects. It looks, then, as if superconducting ring magnets may be a real possibility in the not too distant future.

WILDLIFE

Kangaroos Recover

POPULATIONS of red kangaroos that suffered badly in the Australian droughts of 1965–67 now seem to be increasing again. By 1967 there were so few in north-western New South Wales that the Division of Wildlife Research of the Commonwealth Scientific and Industrial Research Organization had to stop regular sampling of the population. When in March that year heavy rain produced the best growth of pasture for many years, an aerial survey showed that, despite the abundance of food, numbers of kangaroos had not been increased, as on previous occasions, by immigrants from surrounding areas. The density of kangaroos in this part of New South Wales was then the smallest since surveying began in 1964. But happily, after more rain in 1967, red kangaroos began breeding again and the population had begun to recover by March 1968. In central Australia, where there had been seven years of severe drought, less than half the red kangaroos present in 1961–62 survived to 1966. Now that the drought has broken, periodic air surveys will be made to measure the recovery of the population.

The plight of the red kangaroo highlights one of the problems of the Division of Wildlife Research, which has just reported on the past three years' progress (*CSIRO Wildlife Research 1966–68*). Some of Australia's wildlife—rabbits, for example—are clearly pests, and others, such as the lyrebird, obviously need protection as unique members of the Australian fauna. But some, such as the kangaroo, are not easily categorized. Some species now being studied are economic pests in some places, at the same time representing a potentially valuable protein resource. Other species are in urgent need of conservation, often because of uncontrolled shooting for meat and skins.

One of Australia's pests is the wedge-tailed eagle (*Aquila audax*) which is a source of many complaints from farmers in Western Australia, who often lose sheep to predators as well as to weather and starvation. The complaints stimulated a study of the habits of the wedge-tailed eagle, and since 1967 work has been in progress in two areas where eagles were common and causing a nuisance. A surprising discovery has been that although these birds usually breed between July