Platinum Metals in Electrical Contacts

PAPERS AT THE GRAZ INTERNATIONAL SYMPOSIUM

Platinum metals and alloys as wrought solids, as bimetals, as powder metallurgy products, and as electrodeposited and evaporated layers were among the contact materials discussed at the International Symposium on Electric Contact Phenomena held at Graz in May this year. The official proceedings were formidable; forty-seven papers were presented to a gathering of over 300, but fortunately there were good opportunities for some lively informal discussions which ranged widely over the subject.

The types of contacts for which noble metals and alloys have always been particularly fitted are those which need to remain bright and free from surface films so as to provide a low-resistance contact path for feeble currents. For some years now a committee of the American Society for Testing Materials has been conducting 'field tests' of crossed-rod contacts and samples of metal foils in closed shelters at a marine site at Kure Beach and an industrial site at Newark, New Jersey. The results of exposures of up to two years, reported by B. E. Blake of the Components Division of International Business Machine Corp, Poughkeepsie, New York, are so surprising that further investigation is being actively undertaken. The specimens were housed in a louvered aluminium shelter, provided with a glass wool filter one inch thick to retain dust particles and yet to permit free circulation of air; in these conditions palladium rapidly formed a brown-grey film at Kure Beach and a grey coating at New Jersey; and even gold surfaces developed a very high contact resistance at both sites after 28 months. Tin-lead alloy surfaces, on the other hand, remained unexpectedly clear.

It may be significant (*a*) that a bulky switching unit was included with the test pieces in the cabinet and (*b*) that the insulation on the magnet wire connections in the cabinet had degraded within a year. Some hitherto unrecognised conditions certainly contributed to the unexpectedly rapid formation or deposition of poorly-conducting films on the metal surfaces.

A type of low voltage contact which is fast growing in importance is that of the miniaturised multi-blade connectors involved in the inter-connection of one telephone with another. This group includes static separable connectors which are not normally operated more than the few times necessary to replace a failed component in an electronic package. It is important to recognise, however, that as many as 300 insertions may be required during production testing prior to installation. With these considerations in mind, an extensive series of field tests on electrodeposited noble contact metals on a copper base have been made by the Bell Telephone Laboratories in louvered cabinets similar to those used by the ASTM exposed in New York City, an industrial marine location, in Kure Beach, North Carolina, a marine environment, and at Steubenville, Ohio, a heavy industrial city. The results were reported by Richard B. Baker. These, unlike those of the ASTM tests show no unexpected features and mainly bring out the point that thin gold coatings over thick silver coatings are not nearly as satisfactory as thin rhodium coatings over thick silver coatings in maintaining a low contact resistance. The reason is that silver sulphide formed at the pores of a gold coating tends to migrate and spread over a large area around each pore. With rhodium, very little spreading is observed. The most satisfactory

composite coating so far observed is that formed by depositing first about 7·5μ of nickel, followed by 0·5μ of rhodium and finally 0·5μ of gold. This has outstanding wear-resisting properties.

The use of platinum metal electrodeposits for such applications as brush and slip rings, plugs and sockets, and reed relays, was described by H. C. Angus of The International Nickel Company (Mond) Limited, London.

Electrodeposited coatings of palladium, rhodium and ruthenium all benefit from a treatment in boiling distilled water after plating. This relieves an appreciable proportion of the internal stresses and removes traces of trapped electrolyte which may otherwise cause insulating films to develop in service. Ruthenium plating is suggested as better wearing than rhodium for slip rings; rhodium for semi-permanent contacts, and palladium or ruthenium for reed relays.

The use of evaporated coatings of noble metals for contacts was described by G. F. P. Muller of W. C. Hereaus, Hanau. Large numbers are coated at one time, about 2·5μ being deposited per minute. The process is said to be cheaper than electrodeposition for gold and silver, and slightly more expensive for the platinum metals, with their higher melting point.

A theoretical paper by J. A. Greenwood and J. B. P. Williamson, of the Burndy Corporation, Norwalk, Connecticut, described a mathematical investigation using a computer to evaluate the results of the dispersion of asperities on nominally flat surfaces. It was found that while the great majority of surfaces as prepared give mainly plastic deformation of asperities on contact, it is easy to prepare surfaces which will give purely elastic contact the first time they are loaded together. An interesting conclusion arising from these studies is that owing to the chance distribution of high asperities two surfaces of large diameter will have a mean separation greater than that between two small surfaces under the same load.

Extensive studies on the indentation and deformation of contacts operated with and without the presence of a lubricating film were described by Dr Alan Fairweather, D. G. M. Shirley and R. E. Fudge, of the British Post Office Research Station, with particular reference to their effect on contact resistance. In a further paper from the same laboratory, Fairweather, F. Lazenby and A. E. Parker examined the development of resistance and microphonic noise produced by vibration of nominally closed contacts. Attention was given to the effects of vibration in breaking tarnish films, then piling them up and finally dispersing the debris.

Two contributions from the University College of Swansea by Professor Llewellyn Jones and Dr M. R. Hopkins respectively reviewed our present knowledge on the function of the molten metal bridge in causing material transfer between electrical contacts. In Dr Hopkins' contribution a description was given of the use of radioactive tracer techniques for measuring accurately the movement of metal from one contact electrode to the other.

Progress in the development of noble metal contact materials to meet specific contact requirements was described by R. F. Vines, of the Development and Research Department of The International Nickel Company Inc., New York. This paper showed photomicrographs of one new contact material described as 'ductilised ruthenium'. This consists of rounded ruthenium particles bonded by a gold-palladium alloy, the composite being produced by liquid phase sintering.

Finally, reference may be made to a paper by J. Spergel and E. Godwin, of the United States Army Electronic Research and Development Laboratories, Fort Monmouth, New Jersey, and Dr Jack Anderson, of Standard Research Institute, in which an organic monomolecular film formed from octadecylamine-hydrochloride is put forward as a new and unusually effective boundary lubricant for gold (and presumably other noble metal) surfaces in sliding contacts. J. C. C.