Effects of Organic Vapours on Platinum Metal Contacts

ACTIVATION BY CARBON DEPOSITS

The importance of surface films on the behaviour of electrical contacts is now widely appreciated, and in the July issue of *Platinum Metals Review* L. B. Hunt dealt in some detail with the possibility that relatively unstable films of oxide may alternately be formed and be dissociated on the surfaces of precious metal contacts containing palladium and ruthenium by the heating action of the arc during service.

Another more subtle form of surface contamination occurs when platinum metal contacts are operated in the presence of small amounts of some organic vapours, and this has in particular been observed in relay contacts in telephone plant. The effects of organic vapours were first recognised in about 1945 by Dr. L. H. Germer of the Bell Telephone Laboratories, and since then the phenomena have been investigated in considerable detail. An up-to-date assessment of the results of all this work has recently been published in the Bell System Technical Journal by L. H. Germer and J. L. Smith under the title " Activation of Electrical Contacts by Organic Vapours ". (*Bell System Tech. J.*, 1957, **36**, (3), 769)

Decomposition of Adsorbed Organic Molecules

The term " activation " is used to describe in particular the deposition of a thin layer of carbon on the electrode surfaces by decomposition of adsorbed organic molecules. These deposits have so far been found to form only on platinum metals, gold or silver, and only from unsaturated ring compounds. Experiments carried out at the Bell Telephone Laboratories make it clear that the deposits of carbon are formed by the heating action of the arc once the surface of the contact metals has been cleaned from all dirt. They believe that " activation " by such an organic compound as benzene vapour is the result first of firm adsorption of benzene molecules on the electrode surfaces, and then of the decomposition of these molecules on the electrode surfaces, and then of the decomposition of these molecules by the heat of the arc into carbon and hydrogen rather than of their evaporation as undamaged molecules. It is believed that the necessity for the initial strong adsorption of the benzene molecules explains why it is only noble metals that exhibit the phenomena of activation. Metals which are normally covered with even the thinnest oxide films cannot adsorb the benzene molecules sufficiently firmly and so cannot be activated.

Cleaning Effects of Arcing

Even with palladium some cleaning by arcs seems to be necessary before benzene molecules can be adsorbed. On this argument, it would seem that platinum might be rather more susceptible to activation than palladium, but this point is not discussed by the authors, who have done most of their experiments on palladium contacts.

Once a surface has become active, the amount of carbon formed by each subsequent arc is considerably increased, but the situation, at least in contacts operating in air, is much complicated by burning of carbon and by the impedance of air to diffusion of molecules to the electrode surfaces.

The effects of the layers of carbon produced on noble metal contacts by this mechanism are very striking. In the first place, when carbon is present on the surfaces the amount of arcing in any given electrical circuit is usually appreciably increased. The carbon particles which produce activation permit breakdown at contact separations which would normally be too great to permit any arcing at all to take place. Evidence is quoted which suggests that the carbon particles may, in many instances, move under the electrostatic force and so physically change the length of the contact path. These effects may be considered to be injurious as they may increase the total loss of contact material during operation. In many circuits, it may also be impossible to protect activated contacts against severe arcing by the conventional arc-suppression net-works.

On the other hand, activation may actually improve the performance of a pair of noble metal contacts by altering the distribution of wear. When carbon is absent, the usual effect of arcs at the making and breaking of clean contacts produces transfer of metal from one contact to the other in such a manner as to form a pit on one contact and a corresponding mound on the other. The arc tends to strike at the same region at each operation, and in some conditions the mound may lock in the crater and cause the contacts to seize together. When carbon is present on the surfaces, however, successive arcs occur at different places and the resulting erosion tends to be smooth, the electrodes being worn down uniformly all over their surfaces. This is because each arc burns off carbon at its centre and at the same time produces more carbon around its periphery where the metal is cooler. The next arc then strikes on a newly carbonised surface.

The conclusions reached from this work are of considerable practical and theoretical importance. The understanding they give of the mechanism of the contact behaviour of the platinum metals is likely to assist greatly in improving the performance of such contacts in service. They provide for the first time an understanding of the nature and origin of the mysterious black deposits which sometimes form on platinum metal contacts.

In low duty contacts, where these black deposits may be harmful by increasing contact resistance, it would appear that the deposits can be avoided by taking steps to keep all possible sources of unsaturated ring organic compounds away from the neighbourhood of the contacts and possibly also by providing free circulation of air. In contacts carrying heavier currents, where black deposits are less likely to interfere, a small amount of carbon formation may be helpful in encouraging uniform contact wear and preventing the formation of " spikes ".

Platinum Alloy Permanent Magnets

The Director of Research of the Permanent Magnet Association, Mr. J. E. Gould, has written to point out that Columax, which has been in production in this country for some years, has a higher value of $(BH)_{max}$ (7 to 8×10^6) than any of the commercial permanent magnet materials quoted in the table accompanying the article on "Platinum Alloy Permanent Magnets" in our last issue. It thus can be said to provide permanent magnets as powerful as those which can be made from cobalt-platinum alloys.

Columax is the name given to Alcomax magnets which have been cast (by special foundry technique) in such a way that columnar crystals are developed oriented in the preferred axis of magnetisation.

It is fair to emphasise that the coercive force of cobalt-platinum permanent magnets, 4000 oersteds, is well above that of Columax (840 oersteds) and that the cobalt-platinum alloys, unlike any of the cast materials, are ductile before hardening and so can be readily fabricated.