Electro-matic Road Traffic Control Equipment

DEVELOPMENT OF THE PNEUMATIC CONTACTOR

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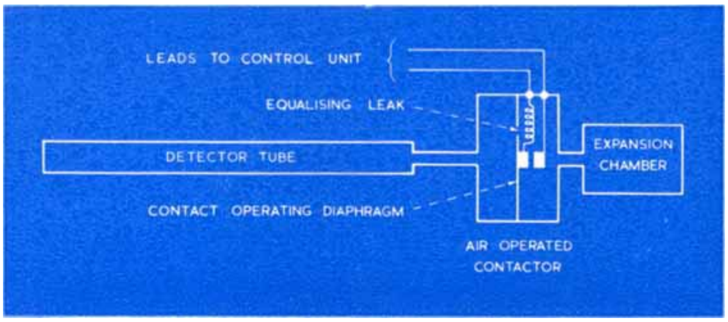
The first vehicle-actuated road signal system in Europe was installed at the junction of Cornhill and Bishopsgate in the City of London some twenty-five years ago. Outwardly it resembled other signal systems already in use, in that indications were given by the familiar red, green and amber light signals. The significant dissimilarity was the inclusion of a rubber mat set into the roadway at each approach to the junction. In performance, however, it was vastly different from previous signal systems. The long, needless delays so commonly experienced at signalled junctions working on the "fixed time" basis were noticeably absent, particularly during periods of light traffic.

The improved performance was soon appreciated, and further installations of vehicle-actuated signals rapidly appeared. Today in Britain at several thousand junctions and dangerous "bottlenecks", vehicle-actuated signals demonstrate their ability to provide positive, reliable and safe control of traffic under an infinite variety of circumstances.

A vehicle-actuated system has three main components: vehicle detectors, signal lanterns and the controller mechanism. The vehicle detector provides the controlling mechanism with an accurate "picture" of all vehicles entering the controlled area. Based on the information received, the mechanism indicates, via the signal lantern, right-of-way periods to each particular movement in relation to the traffic density.

The fundamental arrangement of the Electro-matic detector system is shown in the diagram below. The rubber detector tread or tube is installed in the carriage way, and when traffic passes over and compresses it a pulse of compressed air is sent to the pneumatic contactor or capsule, where it causes an electrical impulse to be transmitted to the control unit.

Two air tubes are used in the detector to provide directional indication of the passage of a vehicle. The sequence of operation of these two tubes is the determining factor; this particular feature ensures that vehicles leaving the junction are not falsely recorded as entering vehicles.



The fundamental arrangement of the road vehicle detector. Traffic passing over and compressing the rubber detector tube gives rise to a momentary increase of pressure which operates the contacts of the pneumatic contactor

Platinum Contacts in Traffic Control

At many thousands of junctions such as this—Westminster Bridge and the Victoria Embankment — vehicle-actuated signals provide safe and reliable control of traffic. In this article, Mr. Wallace describes the pneumatic contactor which converts the air impulse from the detector tread into an electrical impulse for transmission to the controller, and gives a case-history of the platinum contacts used in its construction

The capsule, shown in part section on page 14, consists of a rigid box with a flexible rubber diaphragm and a pair of electrical contacts. One contact is fixed and the other is movable, being attached to the rubber diaphragm. To permit the diaphragm to move with ease and, at the same time, to keep the whole system hermetically sealed, an expansion chamber is provided. This sealing of the system prevents the ingress of dirt and moisture and ensures satisfactory operation even if the components are submerged in water.

Because of the somewhat excessive burning of capsule contacts which was occurring at busy road intersections, it was decided to change the contact material from palladium to platinum. This change was made in 1947. The top contact screw, made of base metal, was then faced with 0.020 inch of platinum. The bottom contact was the head of the special platinum rivet securing the cupped washers to the rubber diaphragm and also anchoring the spring and contact assembly.

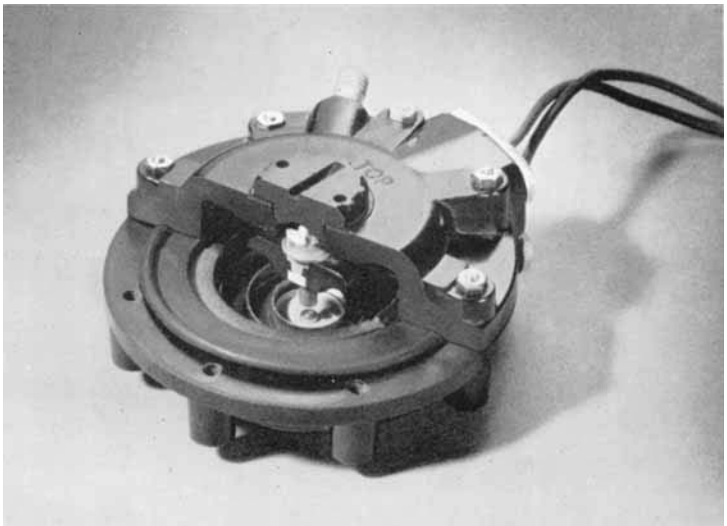
The road relay circuits normally carried one ampere. Although even the platinum contacts were slightly overloaded, the change very considerably reduced trouble due to burnt contacts. The addition of an "Atmite" spark-quench finally disposed of the trouble, and only at very busy intersections was trouble then experienced to any significant extent.

In locations such as the Great West Road, London, it was found, however, that capsules were becoming insensitive to light traffic after two and a half to three years' service. An extensive investigation showed that this decrease in sensitivity was caused by contact wear which increased the contact clearance and consequently decreased the sensitivity.

Samples of worn contacts and of unused contacts submitted for examination showed that the wear was associated with mechanical battering, with a small degree of electrical erosion.

On examining the contacts in unused capsules it was found that, due to the different method of manufacture and construction, the bottom contact was twice as hard as the flat top contact. The bottom contact was a solid platinum rivet with a round head of 0.068 inch radius, while the top contact was a composite contact of brass faced with 0.020 inch of platinum. This difference in hardness was one of the major factors causing wear.

As a result of a full discussion of the problem with the contact manufacturers it was decided that the best means of reducing the depth of the indentation on the flat top



A pneumatic contactor partly sectioned to show the contacts

contact, caused by the hammering of the bottom contact for 24 hours a day, were first to redesign the bottom contact, and secondly to select a harder contact material.

In order to reduce the indentation caused by the hammering of the contacts the radius of the bottom contact surface was increased from 0.068 to 0.50 inch. In the revised design a composite contact is used and the backing material is copper. The redesigned contact is much larger than the original platinum rivet, but due to the lower specific gravity of copper now used for backing, the redesigned contact is only slightly heavier than the original—a very important point. The original and revised designs are shown in the sketch on page 15.

The table, taken from Hunt's " Electrical Contacts ", gives the chief characteristics of both platinum and 20 per cent iridium-platinum, and allows a ready comparison to be made. Consideration of these figures shows the superiority of 20 per cent iridium-platinum for the requirements. Although the resistivity has increased and the thermal conductivity decreased, the design of the contacts and the condition of working are such that these factors are relatively of little importance.

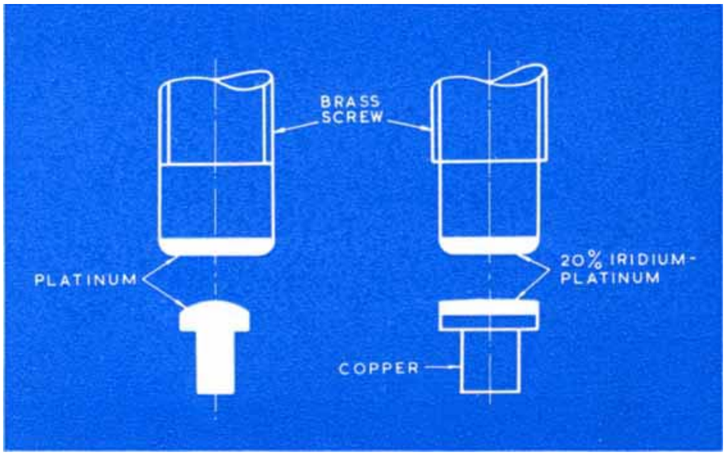
Before changing over to iridium-platinum contacts for mass production, 180 capsules fitted with these contacts were manufactured and installed in the London area and observed over a period of nine months. During that time there were no failures. A few capsules which were opened and examined were found to be in a very satisfactory condition.

At the request of a government department a check was kept on all capsules with iridium-platinum contacts for a period of six months in 1955, by which time 2,400 had been installed. During the six months not a single fault occurred for which contacts were responsible.

A capsule on a very busy intersection such

Contact Properties of Platinum and 20 per cent Iridium-Platinum

	Platinum	20% Iridium-Platinum
Density, *gm per cc* ..	**21.3**	**21.7**
Vickers hardness, *annealed*	**65**	**200**
Melting point, °C *(solidus)*	**1770**	**1815**
Resistivity, *microhms per cm cube*	**11.6**	**30.0**
Thermal conductivity, *CGS units*	**0.17**	**0.042**



The original design of the contacts (left) and the revised design employing a larger iridium-platinum-faced copper contact

as Piccadilly Circus would probably be operated about five million times a year. The figure for the average intersection would be more in the order of two and a half millions. As a life of ten years is expected from a capsule, the contacts and all other parts are required to be capable of standing up to at least fifty million operations.

On a laboratory life-test which is still in progress these capsules have done over a hundred and ten million operations without failure. However, the only real life-test is that obtained in actual service, and time alone will confirm that the decision to use iridium-platinum contacts has been sound. All that can be said at the present time is that to date some fourteen thousand capsules having iridium-platinum contacts are operating in many parts of the world and are giving satisfactory service.

Oxide Films on Platinum Electrodes

Platinum, equally with gold, serves to typify the ideal of a noble metal. It neither rusts nor tarnishes in air whether it is kept for centuries in industrial or marine atmospheres or in clean country air, or whether it is heated in air to high temperatures for long periods. In all these conditions, it is normally considered that a platinum surface will remain clean and bright and free from any tendency to scale, tarnish or develop protective surface oxide films as do the base metals.

Similarly, a platinum anode is commonly considered to present always a clean metallic surface to the electrolyte in which it is immersed, so that electrons can pass freely between the metal and the liquid unimpeded by any oxide barrier.

However, when the conditions at the anode are strongly oxidising, a platinum electrode sometimes behaves as if it were protected by "a film of platinum oxide, which prevents more than superficial oxidation of the platinum and yet permits electron transfer processes". In a recent contribution from the Department of Chemistry at Harvard University (*J. Amer. Chem. Soc.*, 1957, **79** (18), 4901–4904), F. C. Anson and J. J. Lingane have provided some most convincing evidence that such films really exist. They have succeeded in stripping the films chemically from oxidised anodes and in determining their weight and composition. The films are comprised of PtO and PtO_2 in a molar ratio close to 6 to 1.

These data constitute the first direct chemical proof of the formation of platinum oxide films. J.C.C.