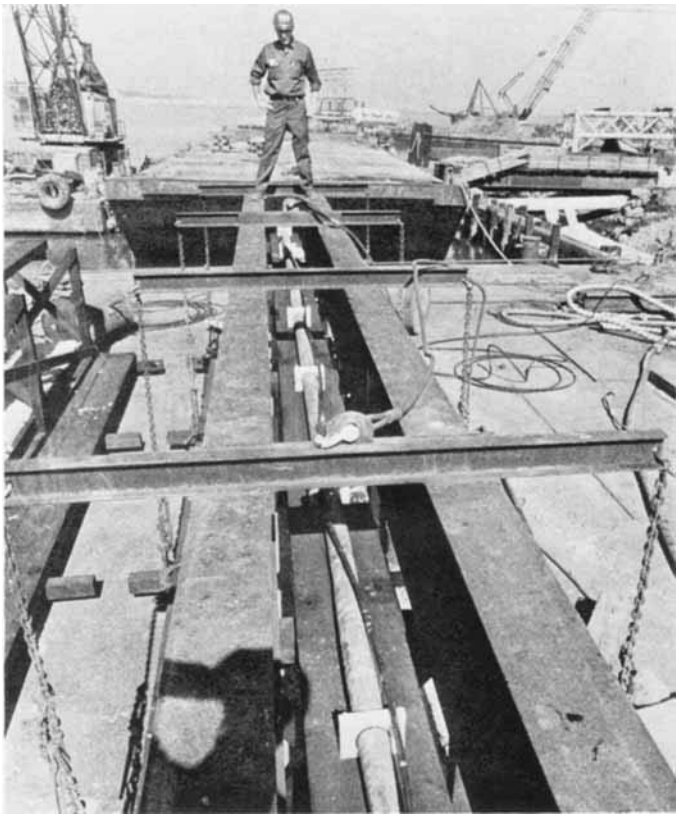
Cathodic Protection of Rapid Transit System

EXTENSIVE USE OF LEAD-PLATINUM BIELECTRODES

The Bay Area Rapid Transit System (BART), connecting San Francisco, Alameda and Contra Costa counties in California, is to cover some 75 miles and boasts many innovations, among them the use of 5 ft 6 in. gauge track with long-welded rails to obtain more room in the luxuriously appointed cars and to ensure greater stability.

The main link of the BART system is a 3½ mile tube, the longest in the world, that crosses under San Francisco Bay to connect San Francisco with Oakland. The train tube is made up of 57 prefabricated concrete-lined steel shells. These sections were placed in a 56 ft wide trench dredged in the bottom of the bay to a maximum depth of 130 ft below the surface of the water. Lead-platinum anodes are used to protect the steel shells against corrosion.

Cathodic protection has been demonstrated to be the most efficient and economical method of providing underwater steel structures with protection from corrosive attack. Small pieces of platinum inserted into surfaces of lead or lead alloy anodes cause a remarkable change in their behaviour as electrodes, making them suitable for cathodic protection (1). Since such lead-platinum bielectrodes



A lead-platinum anode array mounted on its platform ready for installation under San Francisco Bay. (Courtesy of Lead Industries Association, Inc.)

are inexpensive, robust and easily fabricated, they have been widely and successfully adopted for the cathodic protection of marine structures, for example offshore drilling rigs, cooling water culverts at power stations, jetties, and large ships (2).

The system used by BART on the tube consists of 16 lead-platinum anode arrays placed along either side of the tube at about 300 ft from the steel shell. With the exception of two platforms which are buried 20 ft below the ship channel all the anode-bearing platforms are located on the sea bottom.

Each lead-platinum anode array consists of a creosoted wood platform 30 ft long by 5 ft deep. Ballast for the platform is concrete. A lead anode 30 ft long by 3 in. diameter and weighing 1,048 lb is mounted on the platform. Each lead anode contains 75 platinum inserts spaced about 5 in. apart and these are 0.040 in. diameter by 1 in. long. The inserts extend ¾ in. into the lead anode. Rectifiers inside the tube feed 24 volt d.c. to the anode and the negative terminal is connected to the steel train tube. The lead-platinum anode supplies a current that cancels out or neutralises the local corrosion currents occurring on the steel train tube in its sea-water environment. In effect the tube becomes a cathode and acts as the pole of a large battery which then corrodes only very slowly.

References

1 L. L. Shreir, *Platinum Metals Rev.*, 1959, **3**, (2), 44–46
2 *Ibid.*, 1968, **12**, (2), 42–45

Detection of Methane and of Oxygen Deficiency

CATALYTIC TRANSDUCERS FOR USE IN MINES

The Safety in Mines Research Establishment showed two new detectors at the 1971 Physics Exhibition in London. A reliable device for measuring the methane present in coal mine atmospheres has been developed and also a system for the detection of oxygen deficiency, from which a compact personal alarm has been evolved.

Hitherto methane detection has been based on the SMRE catalytic transducer comprising a minute coil of platinum wire embedded in a bead of alumina whose outer surface is coated with a palladium-thoria catalyst. Methane present is oxidised catalytically on the palladium, thereby changing the electrical resistance of the transducer to give a measure of methane concentration. Unfortunately at high methane concentrations the amount of oxygen available is reduced and an ambiguously low signal is obtained. This problem has now been overcome by combining the signal from the palladium-thoria catalyst with that from a pure platinum catalyst at a suitable temperature. The latter element gives a signal which slowly increases with rising methane concentration until at a critical concentration the signal increases sharply. Further rises in methane concentration then cause a slow decrease in signal owing to lack of oxygen. The instrument uses a Wheatstone bridge circuit with catalytic "pellistor" elements resistant to the catalyst poisons found underground forming two arms of the bridge. It can measure both high and low concentrations of methane and other gases combustible in air.

A similar transducer measures partial pressure of oxygen by diffusing air from the atmosphere under test into a chamber into which methanol is evaporated. The latter is oxidised catalytically on a platinum element and the heat liberated is measured by a thermocouple. Excess of methanol vapour ensures that the temperature of the bead depends only on the partial pressure of oxygen present. This instrument measures this pressure in the range 5 to 80 kN/m^2 to about 3 per cent accuracy, it is stable and it is resistant to catalyst poisons.

The resistance of this detector to gases which poison the catalyst by adsorbing on it and impeding the reaction makes it possible to apply its principle to measuring catalyst-poisoning gases. By choosing suitable catalysts with suitable surface areas toxic gases such as chlorine and hydrogen sulphide can be detected in concentrations near their lower toxic value levels.