Platinum-Clad Anodes in the Cathodic Protection of Ships

FURTHER PROGRESS REPORTS FROM THE U.S. NAVY

An intensive programme of research on cathodic protection to reduce the corrosion damage to underwater hulls of ships is being carried out by the Bureau of Ships of the U.S. Navy Department, and two further papers from this source have now been published. Both deal with impressed current installations using platinum-clad anodes, but in one a departure from the conventional hull-mounted system is described.

Installation on a Submarine

A paper by E. E. Nelson on " An Impressed Current Cathodic Protection System Applied to a Submarine " (*Corrosion*, 1957, **13**, (Feb.), 122t) records the results of ten months' operation of a unit comprising hull-mounted anodes of a 20 per cent palladium-platinum alloy clad on copper. Eleven anodes, consisting of copper rods $\frac{1}{8}$ inch in diameter and 48 inches long clad with 0.005 inch of platinum alloy, were distributed over the hull of the submarine, nine below the normal water line and two above. The areas around the anodes were shielded from large currents by an insulating coating of neoprene $\frac{1}{16}$ inch thick.

An earlier installation had used small anodes $\frac{1}{4}$ inch in diameter and 2 inches long at the high current density of 4 amperes per square inch. This was operated for a year with no deterioration of the platinum, but the high concentration of chlorine produced at the anodes damaged the neoprene seals and vinyl paint shielding, while a further disadvantage lay in the relatively high resistance of the anodes. Modification of this installation resulted in the use of longer anodes to reduce the resistance and the applied current density.

Inspection of the submarine after a ten-month period of active duty showed the hull to be in excellent condition; the small areas that were bare of paint were almost completely free from corrosion. The use of platinum anodes, the author concludes, appears economically feasible, as the cost of the anodes constitutes only a small part of the total cost of the installation. Further, since platinum is apparently a completely inert anode material under the conditions of operation, some economic gain can be expected from extended anode life. The optimum use of such anodes requires, however, some further attention to mechanical design in order to avoid breakage in service.

A further modification, suggested by laboratory tests, is the replacement of copper cores by silver, since in the event of any perforation of the platinum cladding silver should corrode much less rapidly because of the protection afforded by the silver chloride formed.

Use of a Trailing Anode

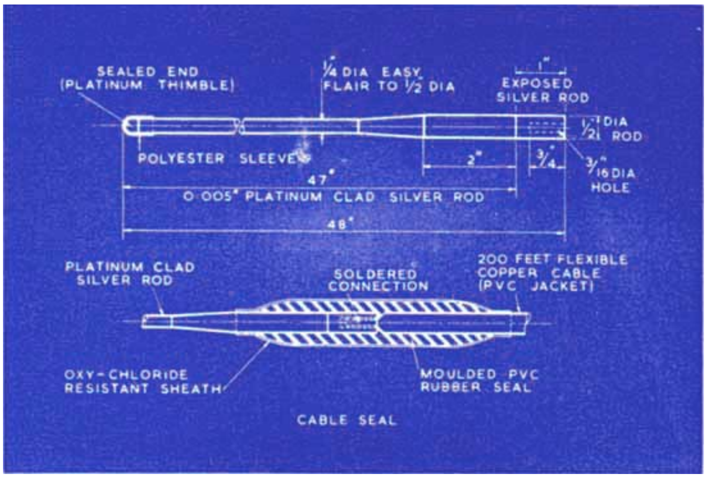
In hull-mounted cathodic protection systems a serious difficulty that arises is how to obtain an even distribution of current over the ship's hull. The current distribution is dependent on several factors, the most difficult to control being the distance between anode and cathode. This difficulty has been overcome in an installation described by H. S. Preiser and F. E. Cook in their paper " Cathodic Protection of an Active Ship using a Trailing Platinum-clad Anode" (*Corrosion*, 1957, **13**, (Feb.), 125t). By using a trailing anode at a sufficient distance from the hull the resistance to earth is increased, thus producing essentially uniform current paths to all parts of the hull.

The anode consisted of a 10 per cent copper-silver alloy rod 48 inches in length clad with 0.005 inch of a 10 per cent palladium-platinum alloy, as shown in the diagram below. The rod was $\frac{1}{4}$ inch in diameter, flaring gradually to $\frac{1}{2}$ inch at one end, where it was attached to the 200 feet of cable which trailed it behind the ship. In order that this unit could be towed smoothly through the water it was necessary that the anode was made an extension of the towing cable by designing the weight per foot of the rod to approach that of the cable and having no abrupt change in cross-section. An anode of this design will trail smoothly at a fixed depth depending on the speed of the ship.

This unit was installed in a trial boat in October 1955, together with four silver-silver chloride reference electrodes, two attached to the hull and two trailing behind the ship on 50 foot leads. Tests were carried out with the ship at rest and under way. A uniform open-circuit polarisation on the hull of —0.82 volt was maintained by a current output of 5 amperes with the ship at rest, but this had to be increased as the speed of the ship increased. At nine knots the current output required was 12 amperes if the hull was polarised at rest, and 15 amperes if it was polarised after attaining the desired speed.

The results of these tests demonstrate the ability of the trailing platinum anode to protect a small ship with comparative simplicity both in port and at sea. In the authors' opinion the installation may not be well suited to high-speed warships but should lend itself to the protection of naval auxiliaries and merchantmen. Its advantages include simplicity of installation and maintenance and also cheapness. A cost of $1,000 is estimated for a 100 ampere current capacity installation capable of protecting an ocean-going cargo ship; this is about one-tenth of that estimated for an equivalent hull-mounted system. The life of the trailing platinum-clad anode is estimated to be longer than that of the ship itself.

Further tests are planned at sea with larger and faster ships to determine the anode's effectiveness in polarising greater hull areas and to investigate anode trailing characteristics at higher speeds. Should these tests prove successful arrangements will be made for the anode to trail from an access pipe and to be retrieved automatically.



Details of the platinum-clad trailing anode and cable seal