Magnetically Attached Multifunction Maintenance Rover

This robot could move along a ferromagnetic structure in any orientation.

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A versatile mobile telerobot, denoted the magnetically attached multifunction maintenance rover (MAGMER), has been proposed for use in the inspection and maintenance of the surfaces of ships, tanks containing petrochemicals, and other large ferromagnetic structures. As its name suggests, this robot would utilize magnetic attraction to adhere to a structure. As it moved along the surface of the structure, the MAGMER would perform tasks that could include close-up visual inspection by use of video cameras, various sensors, and/or removal of paint by water-jet blasting, laser heating, or induction heating.

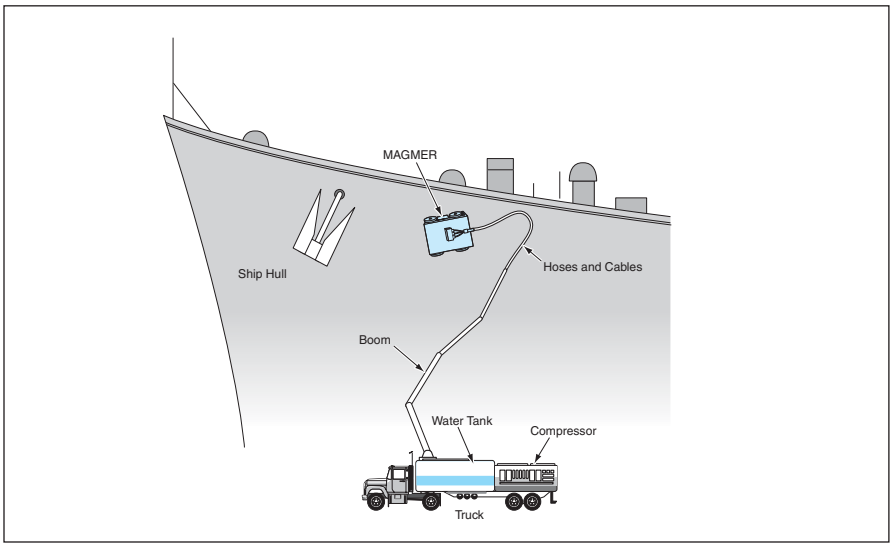

Figure 1. The **MAGMER, Deployed From a Truck**, would move along a ship hull surface. It would adhere to the hull by magnetic attraction.

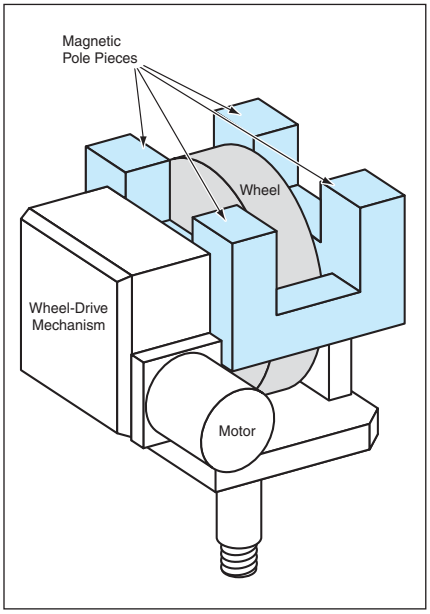

Figure 2. **One of the Four Wheel Assemblies** of the MAGMER is depicted here with the surface-adhering ends of the magnetic pole pieces facing upward.

The water-jet nozzles would be mounted coaxially within compressed-air-powered venturi nozzles that would collect the paint debris dislodged by the jets. The MAGMER would be deployed, powered, and controlled from a truck, to which it would be connected by hoses for water, compressed air, and collection of debris and by cables for electric power and communication (see Figure 1). The operation of the MAGMER on a typical large structure would necessitate the use of long cables and hoses, which can be heavy. To reduce the load of the hoses and cables on the MAGMER and thereby ensure its ability to adhere to vertical and overhanging surfaces, the hoses and cables would be paid out through telescopic booms that would be parts of a MAGMER support system.

The MAGMER would move by use of four motorized, steerable wheels, each of which would be mounted in an assembly that would include permanent magnets and four pole pieces (see Figure 2). The wheels would protrude from between the pole pieces by only about 3 mm, so that the gap between the pole pieces and the ferromagnetic surface would be just large enough to permit motion along the surface but not so large as to reduce the magnetic attraction excessively. In addition to the wheel assemblies, the MAGMER would include magnetic adherence enhancement fixtures, which would comprise arrays of permanent magnets and pole pieces that could be adjusted to maximize or minimize the overall attractive magnetic force.

Even with a paint thickness of 2 mm, a preliminary design provides a safety factor of 5 in the magnetic force in the upside-down, water-jets-operating condition, in which the total load (including the weight of the MAGMER and cables and the water-jet force) would be about 260 lb (the weight of 118 kg). Optionally, the MAGMER could carry magnetic shielding and/or could be equipped with a demagnetizing module to remove residual magnetism from the structure.

The MAGMER would carry four charge-coupled-device cameras for visual inspection, monitoring of operation, navigation, and avoidance of collisions with obstacles. The control system of the MAGMER would include navigation and collision-avoidance subsystems that would utilize surface features as landmarks, in addition to direct images of obstacles.

This work was done by Yoseph Bar-Cohen and Benjamin Joffe of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*

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