parts ready to rent to industries interested in working under the sea. The robot costs $40,000 a month, which probably makes him the highest paid diver in the world.

Human divers, however, remain indispensable to industry and great improvements have been made in their techniques. The use of oxyhelium equipment now enables them to remain as deep as 525 feet for up to 30 minutes. Research with Sealab may lead to far greater descents for considerably longer periods of time. Depths of 2,000 feet or even more are seen possible in the near future.

Other significant equipment includes new well-head designs that make it possible to complete and control wells at sea bottom at considerable depths.

One of the big problems of these oil rigs, Mr. Cameron reports, is the need for improving the means for holding floating drilling equipment in position in deep water, so as not to entangle the drilling lines or move away from the site.

In relatively shallow water various anchoring systems have been successfully used. In the deep water conditions where the industry is now working, however, floating rigs need to employ a dynamic positioning system.

One method, developed by Shell, utilizes constant, varying thrusts to hold a vessel in a fixed position against the forces of wind, wave and current. The automatic position equipment uses two propellers, each of which can apply a variable thrust to and from any direction. By changing the power and direction of thrusts from these units, drilling vessels can be held in exact position in relation to the well location on the bottom.

Another important development for drilling rigs is the system of microwave transmission from drilling platforms to shore headquarters of the electric log of a well while it is actually being dug.

Submersible Oil Barge

One more new innovation by the Murphy Corporation's ODECO firm is a new submersible oil storage barge with a capacity of 24,000 barrels. Such a vessel can be used as an undersea collecting station, storing oil pumped from wells under the bottom of the ocean.

The submersible oil storage barge —nicknamed S.O.B. No. 1—is more than 90 feet long with an 80-foot beam. Its lower hull will consist of four tubular tanks, each 16 feet in diameter, forming a square with an open center from which concrete ballast will be suspended.

Extending upward from each corner of the lower hull will be hollow columns, each with a diameter of 20 feet. These four columns will support the main deck some 93 feet above the bottom of the lower hull.

Mounted on the main deck will be the power plant, processing machinery and living quarters for 22 hands. The barge will also be equipped with a heliport and boat-landing facilities to provide easy access.

The tubular tanks that form the lower hull will provide approximately one-third of the total storage area.

Mohole, the project to drill in some 3,000 fathoms of water at a position where the earth's crust is thinnest through about 20,000 feet of rock is expected to provide even more new concepts in design and development of drilling equipment.

Innovations so far include:

A completely automated pipe handling system to store 38,000 feet of drill pipe and 18,000 feet of riser casing.

Changes in the steels of drill pipe to give added strength, and a possibility of using a titanium alloy because of its light weight and greater resistance to corrosion.

All these things, and the unknown wonders yet to come, will ultimately push the search for black gold to the deepest parts of the sea. Undersea oil exploration already has moved out from the tidewater areas. There seems little doubt that the search will turn increasingly to exploration of further offshore regions of the world.

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OCEANOGRAPHY

Arms Reach to Sea With Research Subs

➤ A LONG THIN metallic claw will be picking objects as delicate as a sea urchin or as heavy as a 150-pound treasure chest, off the sea floor.

This mechanical arm, with a 14-inch, long reach, is one of the longest undersea arms in existence. It can pick up flat, round or irregularly shaped objects, and can be fitted with a variety of attachments such as a cable cutter or a power nut-driver.

The mechanical claw is a feature of the modern research submarine, Star III, which, with its companion sub, Star II, has been launched by the Electric Boat division of General Dynamics at the U.S. Navy's Underwater Sound Laboratory, New London, Conn.

Star III, one of the more sophisticated undersea research vehicles yet built, is 25 feet long and designed to carry a ton of scientific equipment for operation at depths as low as 2,000 feet. The two-man crew can maneuver it in all directions, and let it hover in water much like a helicopter hovers in air. Driven by a 7.5 horsepower motor, it can travel at a speed of six knots.

The second submarine, Star II, is nearly 18 feet long and operates at depths of 1,200 feet. It can stay submerged for eight hours.

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