

"Brushless DC Motors: Improving Underwater Propulsion — An Update"

by Robert White

During the late 1970s and early '80s, Industrial Drives (ID) began applying its experience in electronically commutated motors to submersibles, a market which deviated from its traditional machine tool base.

International Underwater Contractors (IUC) was one of the first to replace hydraulic and brush-type thruster systems with permanent magnet brushless motors and controllers. Since then, ID has tackled a variety of new applications which has broadened the technology available to submersible vehicle builders.

High energy magnet material use allows us to offer a smaller, lighter weight product in applications where space is a premium. Samarium cobalt and neodymium-iron-boron magnets are used exclusively in the design and manufacture of the submersible motors supplied by ID. These high energy magnets keep the diameter as small as possible, thus reducing both size and weight compared to similar motor designs using lower energy magnets, such as ceramics or low-grade rare earths.

Careful attention has been paid to the type of materials used to allow continued operation even if flooded with seawater. The windings are protected in an encapsulation process, which acts as an excellent heat conductor. The sleeve bearings are designed to be operated with seawater as lubrication. Other components are either non-corrosive, stainless steel or specially anodized aluminum. The motors have been designed with seawater operation in mind. This design concept has led to an extremely reliable product capable of operating in the most adverse conditions.

Surface mounted technology has led to the development of integral brushless motor and control electronics capable of deep ocean depths. The pressure tolerant components used in the switching and control electronics allows operation in a MIL-H-5606 type hydraulic fluid, eliminating the need for a one-atmosphere housing. Combining this technology with reliable submersible design and a high-power density motor,

provides a complete, compact package ready to operate in deepsea applications. This product has been successfully proven on the Jason, Jr. ROV developed by the Woods Hole Oceanographic Institute and which was used in the *Titanic* survey mission. Industrial Drives has expanded its capability in integral motor/controller packages up to the five horsepower (3.7 kw) continuous rating.

Control electronics of the one-atmosphere variety are available in two distinct styles. Using the conventional 3-phase, 6-transistor bridge concept and PWM technology, efficient control of either speed or torque is available with Industrial Drives' ECC systems. Commutation is aided by the use of Hall-effect devices within the motor. This rugged and reliable product has found use in small manned research vehicles, as well as the large tourist submarines. Power capabilities exceed 25 hp (19 kw) using a 240 volt DC power source. Accurate positioning capabilities are capable with ID's high performance sine wave technology, the BDS3 system. Using a shaft-mounted resolver, this system offers precise speed or torque control and can be used in conjunction with positioning systems for accurate position control.

For applications requiring extremely low noise output (acoustic, structure-borne, EMI/RFI), ID has put together a variety of electronic schemes to reduce substantially all types of noise emanating from the drive system. Combining filtering and power control circuits, noise levels are reduced without sacrificing overall efficiencies.

In summary, the technologies available for the submersible vehicle designer include:

- Lightweight, compact, efficient brushless motor designs for submersible applications.
- Seawater-compatible designs for extremely high reliability.
- Integral motor/controller packages for deepsea operation.
- Variety of control packages to meet a large cross section of applications.

**AT THESE DEPTHS
YOU NEED
A RELIABLE MOTOR**

INDUSTRIAL DRIVES

Brushless Permanent Magnet Propulsion Motors provide reliability at critical depths; they feature:

- Continuous speed control from stall conditions
- High power efficiency — 90%
- High volumetric efficiency
- Extra lightweight with pressure compensation
- Low noise emissions
- Military standards
- Standard and custom designs

Contact **INDUSTRIAL DRIVES** for solving your Underwater Motion Control needs.

ID INDUSTRIAL DRIVES

201 Rock Road, Radford, Virginia 24141
(703) 639-2493 / TWX 710-875-3743
A KOLLMORGEN DIVISION

- Low noise capabilities for military-type requirements.

Industrial Drives continues development of new products and refinement of present products to offer submersible vehicle designers flexibility in choosing the right kinds of technology to meet their needs. Future development of manned vehicles, ROVs and AUVs will create the need for highly reliable, adaptable brushless systems to meet the increasingly demanding requirements of the brushless markets.

[Robert White is Sales Manager, Advanced Systems for Industrial Drives]

INTERVENTION '88 will take place next month, April 18-20, in Bergen. An Advance Program has been printed and distributed to an international mailing list. If you have not received a copy and want one, please contact one of these addresses:

North, Central & South America, Australia & Asia:

ROV'88, P.O. Box 261149, San Diego, California 92126. Tel: (619) 465-2262; Fax: (619) 453-2390; Tlx: 530111 WE INC UD.

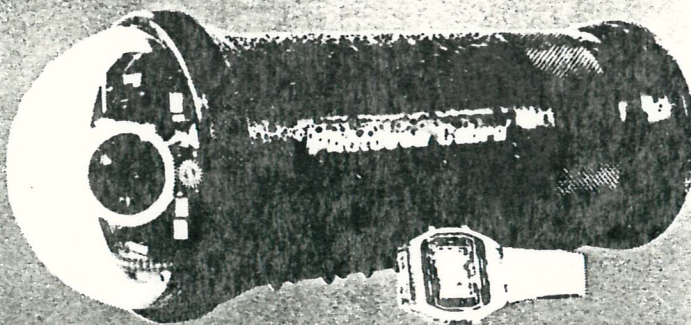
Europe, Africa, Middle East, India: Norwegian Petroleum Society, P.O. Box 95, N-5049 Sandsli, Norway. Tel: +47 5 224885; Fax: +47 5 224836; Tlx: 42183 UTECH N.

The Advance Program details this combined event of the 6th annual ROV conference & exposition and the 5th biannual Underwater Technology Conference. Over 70 firms and organizations will display their products and services in Bergen's famed Grieghallen. Over 45 technical papers will be presented by authors from Norway, France, United Kingdom, West Germany, Holland, Italy, Australia, Japan and the United States. Subjects range from AUVs, deepwater ROVs, subsea sensors and control systems and major subsea field developments. Two papers will even cover telerobotics applications in space.

NDT/LCROV TRAINING

The Divers Institute of Technology, Inc., Seattle, is offering a new high tech course called **Advanced Diving Technology**. It will train commercial divers to operate an underwater inspection service using low-cost ROVs, NDT equipment and underwater

PAN, TILT, ROTATE with no external moving parts



PHOTOSEA 'Cobra'

The most innovative underwater television systems developed in many years.

The COBRA's include remotely controlled optics in a package significantly smaller than similar cameras available. Full hemispherical viewing can be achieved with no distortion, and all moving optical components are internal (including an optional lighting system for tube/pipe inspection applications). There are NO external moving parts, and for many applications the COBRA can replace a camera/Pan & Tilt combination.

Photosea®
SYSTEMS INC.

6377 NANCY RIDGE DRIVE • SAN DIEGO, CALIFORNIA 92121
TELE (619) 452-8003 • TELEX 181797 (PHOTOSEA SDG)

TV and photo cameras. It runs for 26 weeks at 30 hours per week with a total program hours of 780. The course has a strong emphasis on electronics, underwater photography and video, plus the important, but often overlooked process of compiling and preparing written and visual inspection reports.

Applicants must meet all requirements of Divers Institute and be a graduate of a recognized commercial deepsea diving course. Tuition for the course is \$6,950. ADT 1-88 starts March 28th and graduates September 23rd, 1988. ADT 2-88 starts on July 11th and ADT-3 starts on October 24th.

For more information, contact the Divers Institute or circle 104.

INNERSPACE 1002 & 1004B

THRUSTERS are now using specially adapted motors produced in-house which provide a light and smooth configuration. These motors, based on technology developed by FPD, Inc. which Innerspace Corporation acquired on January 1, 1987, are used on the SUPER SCORPIO, PIONEER, TRITON, GEMINI and other vehicles. Innerspace has informed *SUBNOTES*

that it will soon be supplying a modified motor capable of running at 5000 psi (350 bars). The current maximum pressure differential is 3000 psi (200 bars). Circle 105.

MORE SEL MANIPULATORS ORDERED BY SUB SEA

Sub Sea Dolphin A/S, Norway, has ordered a TA-33 9-function spatially correspondent manipulator and a standard TA-16 5-function manipulator from Slingsby Engineering Ltd. These will be installed on the ROV system Pioneer 20, which is Sub Sea Dolphin's third Pioneer ROV fitted with SEL manipulators. SEL has now sold 24 manipulators to Sub Sea Dolphin and their associate company, Sub Sea Offshore, Aberdeen.

SEL's Robotics Division designed the TA-33 manipulator around the 7-function TA9 model, which is used by many ROVs working in the offshore oil sector, as well as for subsea telecommunications cable operations. The TA-33 gives increased reach and improved dexterity in production platform inspection and cleaning operations and in subsea intervention tasks. Circle 106.