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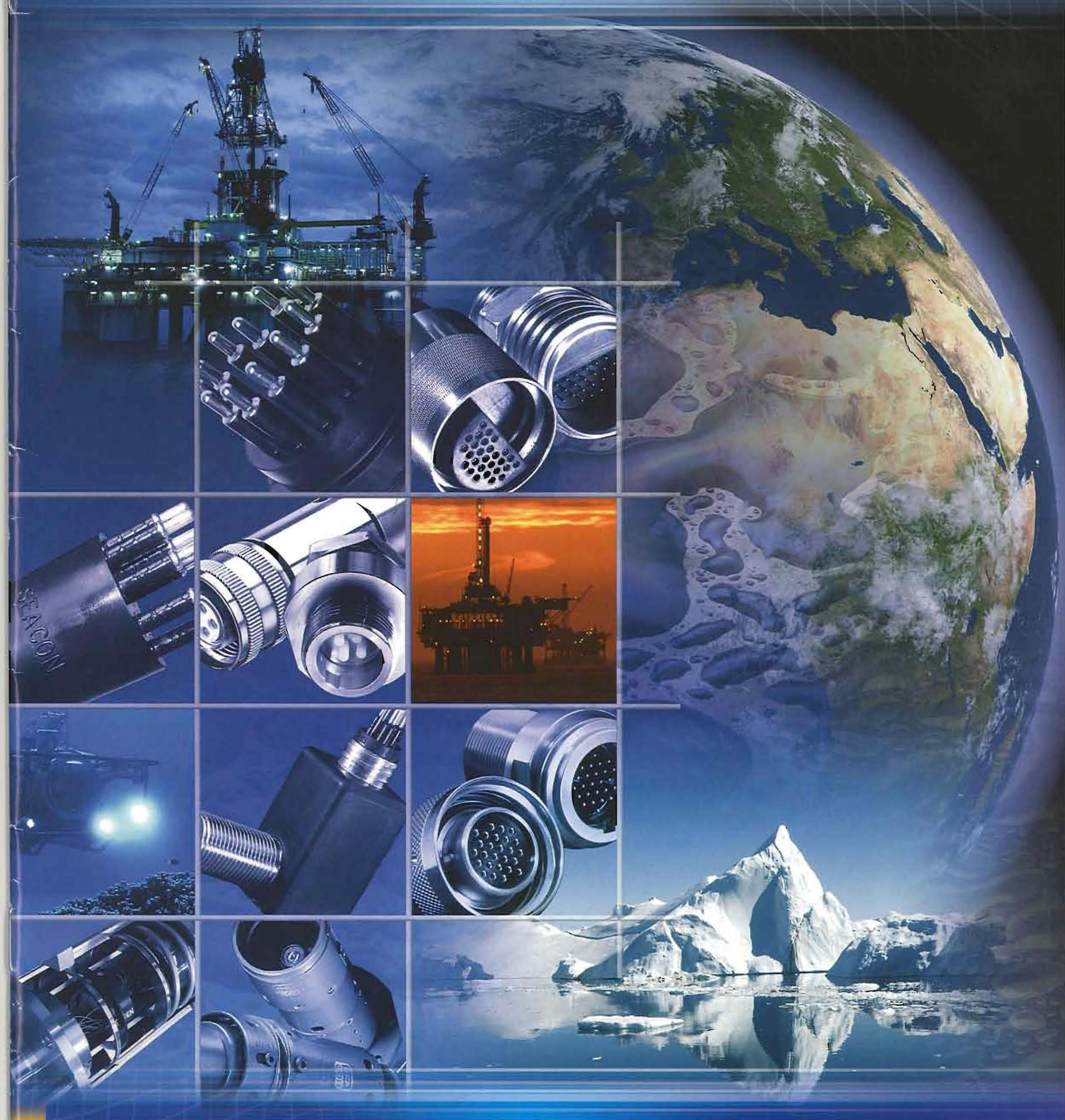
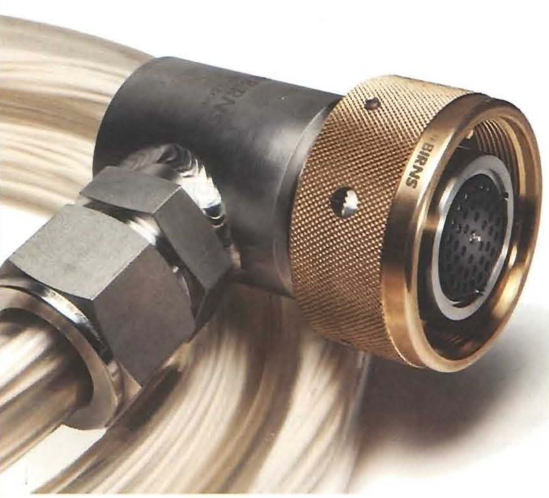


# Taking new depths to new heights



By Amy Brown and Eric Birns, BIRNS, Inc., California, USA

**The subsea industry is pushing connector technology to greater heights and to depths never before imagined**

Underwater connectors first became commercially available in the 1950s – right about the time that Birns & Sawyer first opened its doors. Back then, Birns & Sawyer was developing underwater camera housings with 400-foot (122-metre) magazines for the US Navy, which were used to film tests of the secret Polaris submarine-launched ballistic missile's underwater ejection system.

During this period, with the continued international interest in submarines as defensive weapons, subsea technology became more focused and diverse. While the key initial drivers for evolution of underwater connectivity were military applications, the market expanded further and even more rapidly with the advent of the offshore oil industry.

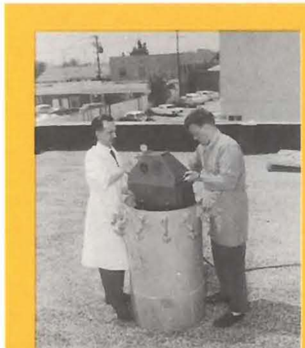
Many of the early electrical dry mated connectors were made of rubber – thanks to synthetic rubber products like neoprene becoming available after WWII – with silicon grease creating a waterproof seal. Of course, today's connectors are advancing exponentially, with high-performance capabilities like high-voltage, deep-submergence electro-optical/electro-coax hybrids packed into increasingly miniaturised profiles – a far cry from those initial models. BIRNS developed rapidly over the years, as well, with profound contributions along the way to the advancement of connector technology.

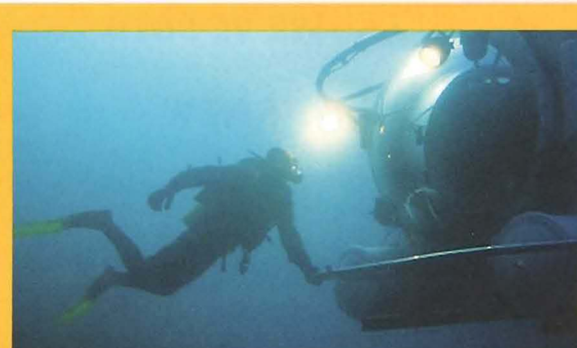
## TO BOLDLY GO...

By the early 1960s Birns & Sawyer began developing underwater lighting solutions, including a speciality light for the first explorations in open-sea saturation diving with the US Man-In-The-Sea Program, used for SEALAB I, II and III. That first incarnation was square, with a penetrator versus a connector, and went down to about 92 metres. This was the precursor to the BIRNS Snooper, a three-kilometre rated 3200K light so durable and dependable that many from the 1960s are still in use today.

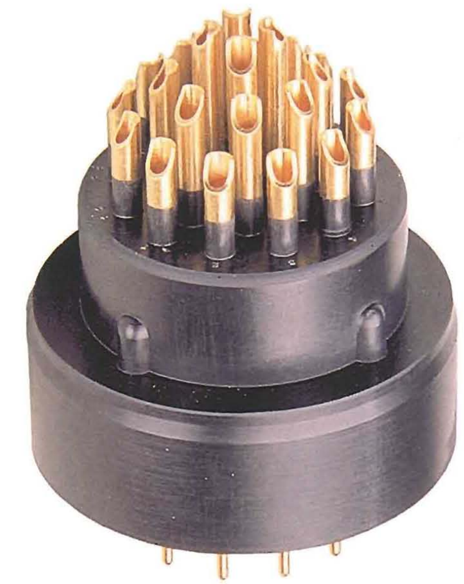
By the mid-1960s, Birns & Sawyer began producing more advanced underwater connectors for its diving lights, with bulkhead connectors and mating rubber moulded cable connectors. The company began developing its specialised underwater diving lights for navy divers in Vietnam who perilously searched for underwater mines in those pre-ROV days. The lights had a separate battery pack, which needed cable assemblies and connectors to transmit power to the hand held units, a system requiring two power conductors and a ground. The bulkhead connectors had different genders and were armoured in thermosetting plastic shrouds, with cables retained with captivated plastic locking sleeves.

In 1968 the growing company received the largest contract for underwater lighting that had ever been awarded by the US Navy for its BIRNS Snoopers. (2010 marks the 50th anniversary of the company's partnership with the American naval programme.) Today, BIRNS continues to work with the US Navy, as well as those of Canada, the UK, Israel, Chile, Sri Lanka and Brazil.





*Left: Early Birns & Sawyer personnel testing underwater camera housings. Right: Sub Antipodes, circa 1980, equipped with three-kilometre rated 3200K BIRNS Snooper lights. Top: BIRNS MSSP-40-CP-OFRA (Metal Shell Series Size "P" 40-Contact Cable Plug Oil-Filled Right Angle) cable assembly with unique double ferrule design. Picture: BassImages.com*



*BIRNS solder pots with 15-degree lead-in O-ring chamfer built into insert. Each solder pot is insulated part of its length with a layer of moulded GRE. After wire termination, heat-shrink tubing covers the insulated GRE area, ensuring a completely insulated termination and eliminating possible electrical interference between pins*

## SETTING THE GOLD STANDARD

While manufacturing technology was still in its relative infancy, the company set out to determine the best solutions for contact materials for pins and sockets, along with developing innovative plating methods. Early connectors had silver plated pins, and although they became tarnished, even the resulting black silver-oxide corrosion products were still highly conductive. By 1978, the company became BIRNS, Inc. and ultimately standardised on contacts with 50 microns of hard gold plating over 50 microns of hard nickel underplate to minimise voltage drop. (That's 250% more gold than is required to fulfill US Military Standard MIL-G-45204, which specifies gold plating as thin as 20 microns.)

BIRNS went on to research a range of different contact materials before settling on heat-treated beryllium copper (BeCu) in the early 1990s. Its engineers and technicians experimented with copper, tellurium copper, leaded nickel copper and free turning brass, an alloy to which lead is added to make it easier to machine. However, BeCu for sockets proved to be superior, as it provides the best 'memory' to keep the socket tines able to retain their positions.

## HEAVY METAL HIGH PERFORMANCE

When metal shell connectors became more advanced, BIRNS faced another set of design challenges; the increasingly high pin counts demanded a huge number of small pins in a diminutive space. This required precision alignment of all pins to mating sockets – both of which were permanently embedded in the metal shell's inserts. Thus, each set of contacts, pins and sockets had to be aligned to its own shell, and both shells precisely aligned when they joined, which demanded exact tooling designs and fabrications, not to mention precise keying methodology to provide 'pinpoint' accuracy for alignment.

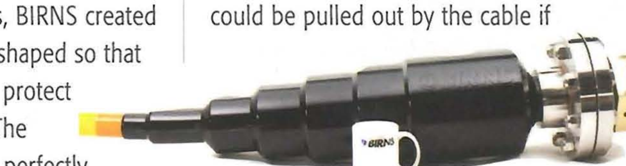
Inherent challenges included ensuring that the mould tooling set would remain perfectly aligned throughout the entire process, because even thousandths of an inch discrepancies can be problematic with high-density pin connectors. Connector inserts are often moulded in cylindrical tooling sets, which align with a cylindrical cavity in the moulding press; technicians discovered in the early days that the clamping process of the tooling into the press could rotate one end of the tooling slightly relative to the opposite end, causing misalignment. Thus, BIRNS created precision pieces of tooling shaped so that they fit together, pinned to protect against lateral movement. The team ultimately designed a perfectly cylindrical insert devoid of parting lines – such lines can interfere with the sealing of a radial O-ring, which can result in it being cut and leaking.

BIRNS later created an insert that wouldn't damage the sealing O-ring during the installation of the insert into the metal shell by moulding a 15-degree O-ring chamfer directly into the insert. The result was a 'starting' insert OD smaller than the relaxed ID of the O-ring, which then expanded out to seal seamlessly over the entire sealing surface.

## HIGH PIN DENSITY IN EXTREME APPLICATIONS

By 1998, BIRNS was called upon to provide complex solutions for applications that were more hazardous and extreme than anywhere on the planet. RedZone Robotics commissioned the company to design and build 186 conductor electro-mechanical connectors and cable terminations for its Pioneer robot – designed to go into the Chernobyl Unit 4 sarcophagus, a 20-storey, 300,000-ton concrete shell created over the plant as a containment effort. Pioneer was designed to take cement core samples and compile a 3D map of radiation levels and structural strength 12 years after the initial nuclear disaster to aid in managing the deadly site.

Previous robots sent into the wreckage, which was full of highly radioactive water and cement, lasted less than ten minutes before radiation decimated their computers. The Pioneer needed a cable assembly with 6000 pounds (2.7 tons) of load strength in any direction so the robot could be pulled out by the cable if



*BIRNS hybrid electro-opto-mechanical work-class ROV tether cable assembly tested to support more than 15,000lbs (6800kg). Picture: BassImages.com*