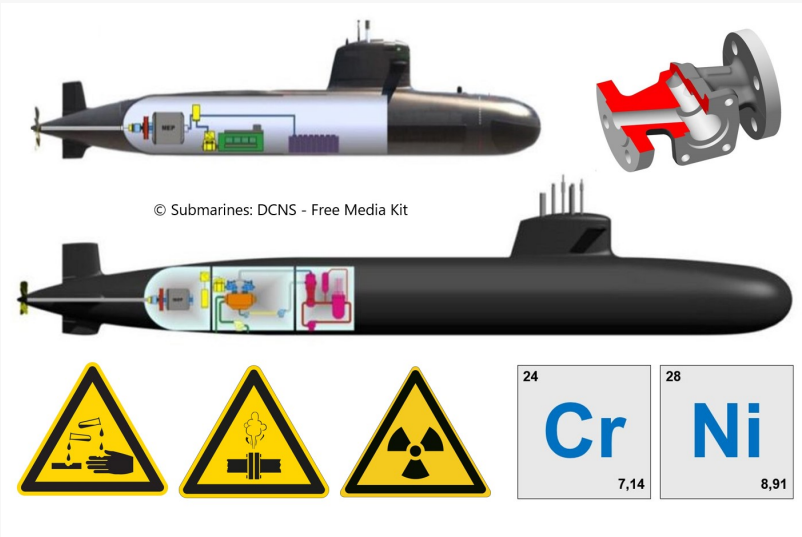
Hydrogen and Nuclear Valves in Submarine Propulsion

Critical Forged Components of Chromium-Nickel Steels for Military, Naval & Defence: Non-Embrittling Pressurised Forgings in Modern Submarines.



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HAGEN, GERMANY, March 6, 2025 /EINPresswire.com/ -- Hydrogen fuel cells generate electricity by combining hydrogen and oxygen, leading to pure water as the only exhaust by-product-a technology that, despite high hopes, hasn´t made it into the automobile industry yet but has powered German submarines since 2005, followed by Sweden, Japan, China, Spain, and South Korea. Crucial to this application are pressure vessels and pipe systems, as well as forged valves, flanges, and fittings made from certain chromium-alloy steels and non-embrittling nickel alloys (https://drop-forge.com/non-embrittling-nickel-alloys-corrosion-cryo-resistant), engineered to withstand ultra-cold and highly compressed gases. This is another article in a series on remarkable applications of steel forgings, covering both industrial and everyday uses, following "Nickel Steel Forgings: Essential for Cryogenic Cooling" (https://wissenschaft.pr-gateway.de/nickel-steel-forgings-essential-for-cryogenic-cooling/).

Silent Depths: How Hydrogen Valves Power Modern Submarines

Submarines rely on cutting-edge technology for stealth to operate effectively beneath the waves. Diesel-electric submarines equipped with Air-Independent Propulsion (AIP) systems use hydrogen fuel cells to generate electricity, ensuring near-silent operation when submerged. This advanced propulsion system is central to reducing detectability, with forged stainless steel hydrogen valves playing a crucial role.
Handling hydrogen in a confined, high-pressure submarine environment presents significant engineering challenges. Hydrogen valves must meet stringent standards for leak prevention, corrosion resistance, and structural integrity to ensure safety and reliability under extreme

conditions. These valves face intense stresses, including high-pressure differentials and the risk of hydrogen embrittlement. To withstand the harsh marine environment and ensure long-term performance, materials such as F316L, duplex, Monel®, and Hastelloy® are commonly used. Beyond military applications, cryogenic and hydrogen valve technology is also shaping civilian industries, including green energy storage, cooling, hydrogen filling stations, medical technology (e.g. MRI), and food processing. Please visit the author´s blog for more info about forged valves for cryo, hydro and nuclear (https://drop-forge.com/forged-valves-cryo-hydro-nuclear-forgings-steel-nickel-alloys) applications.

Nuclear Submarines: Reactor-Powered Turbines & Critical Forgings

The largest fleets of nuclear-powered submarines are held by the USA and Russia, followed by France, China, the UK, and India. Most of these are strategic, meaning they carry large payloads of nuclear weapons or ballistic missiles. This is why they require the immense energy output from their nuclear reactors. In this regard, they are almost as quiet as the previously mentioned hydrogen-powered submarines.

Nuclear-powered submarines generate steam directly from their reactor cores, which then drives turbines to produce propulsion and electrical power. Unlike AIP submarines, mentioned above, which require external oxygen sources, these vessels even generate their own oxygen for the crew, giving them virtually unlimited underwater endurance. In fact, nuclear submarines can operate autonomously without refueling for 20 years!

One of the most interesting aspects of nuclear valves is that they often use the same materials as those used in cryogenics and hydrogen processing, namely certain nickel steels and alloys. Due to security concerns and *criticality*, nuclear technology is often mentioned alongside military and defense because of its strategic importance. Here you can find out more about military forgings and dual use (https://drop-forge.com/military-ordnance-forgings-submarine-naval-dual-use) in the author"s blog.

Seawater Capable Valves

The ballast tanks of a submarine are controlled by specialised valves that are essential for safe ascent and descent. Shut-off valves regulate the water flow in and out of the tanks, while compressed air valves introduce compressed air to bring the submarine to the surface. Safety valves prevent overpressure, and check valves prevent water from flowing back into the tanks. These valves are made from corrosion-resistant steels and alloys to withstand extreme underwater conditions. All these valves are subject to either the Pressure Equipment Directive (PED) or nuclear codes such as ASME or RCC-M, and they are always forged. A FAQ about "Why Forging" (https://drop-forge.com/precision-forgings-accuracy-efficiency-strength) is also a chapter in the author"s blog.

Source: All information in this article is derived from publicly available sources such as press

releases and websites from General Dynamics/Electric Boat, Naval Group (former DCNS), Saab, ThyssenKrupp Marine Systems; Siemens Energy; the Undersea Defence Technology (UDT) Exhibition and Wikipedia.

About the Author

After his military service as a guard commander at an airport of the German Federal Armed Forces, Thomas Henneke studied solid-state physics and mathematics, with a focus on energy-related topics and complex analysis. Following professional roles in research, education, and engineering, he has been the Technical Managing Director and co-partner of the German forging company KB Schmiedetechnik GmbH since 2010.

On his blog at drop-forge.com, which complements the company´s website, you can also find further information about the forging equipment, certifications, services, and additional materials such as FAQs and more.

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