Replaceable Union Nut

Patent #10,591,094

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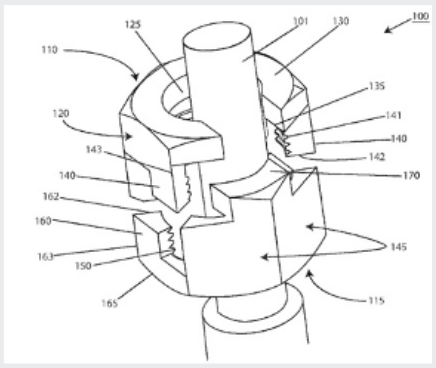
Technology Overview

Replaceable Union Nut – Patent # 10,591,094

The invention is a two-piece union nut designed to replace a compromised or sub-standard union nut without having to replace the entire section of pipe where the union nut was used. The two-piece union nut comprises a top half and a bottom half, each of which are designed to fit around a given pipe section and mate together, forming a complete union nut. The top and bottom halves are machined with a cutout portion to fit around the pipe and notches that mate seamlessly to form a union nut. When the two halves are combined, the union nut is constrained in all directions. In addition, the threads on the inner surface of each half line up and maximize thread coverage on the pipe thread piece.



Capabilities

- When the two halves are combined, the union nut is constrained in all directions.
- In addition, the threads on the inner surface of each half line up and maximize thread coverage on the pipe thread piece.

Benefits

- The replaceable union nut minimizes labor and reduces cost.
- The replaceable union nut can be installed without any special tools.
- Once the new nut is installed, there is no need to clean, flush, or hydrostatically test the system.

Benchmarks

Benchmarks are unique qualities that are used to compare against existing patents, patent filings, and commercially available products in this assessment tool.

Index Number	Title	Description
1	**Minimizes Labor and Reduces Cost**	**Minimizes Labor and Reduces Cost:** With the replaceable union nut, the only “hot work” required is that of cutting the failed union nut from the pipe. This does not affect system integrity or cleanliness.
2	**No Special Tools Required**	**No Special Tools Required:** The replaceable union nut is installed by simply connecting the two halves together around the pipe and threading it together using standard tools.
3	**Preserved System Integrity and Cleanliness**	**Preserved System Integrity and Cleanliness:** Once the new nut is installed, there is no need to clean, flush, or hydrostatically test the system. The system can be put back to use immediately.

Market Research

Executive Summary

This section provides insights into market size, trends, and barriers to entry for the commercial applications of the technology, as well as recommendations for deeper market research. Potential markets include use in Oil and Gas infrastructure, and Nuclear Power, as well as Aircraft Hydraulic Systems and Chemical Processing. The fastest growing market is the Aircraft Hydraulic Systems market with a Compound Annual Growth Rate (CAGR) of 11.3%. Each of these potential markets is quite fragmented, technologies are not mature, and all have many competing companies and significant growth ahead.

Potential Markets	Market Insights
Oil and Gas infrastructure Refers to the collective equipment and processes that make use of high-pressure fluid transfer	**Market Size** • The global Oil and Gas Infrastructure market was valued at $621.8 billion in 2022 and is expected to reach USD $1,117 billion by 2030 with a CAGR of 6.6%. • The market is a consolidated market. **Market Trends** • Rising demand of natural gas (in line with growing exploration and production activities) will have a positive impact on the business scenario. • Required high dependability of resources for power generation, coupled with retirement of coal-fired power substations, will complement the segment. **Barriers to Entry – High** • Proprietary technology forces even those with significant startup capital to face an immediate operating disadvantage upon entering the sector. **Key Players** • Saudi Arabian Oil Co., Exxon Mobil Corp., Shell PLC, TotalEnergies SE, China Petroleum & Chemical Corp.
Nuclear Power Applications include cooling pipes, or any high-pressure pipes used with nuclear facilities	**Market Size** • The global Nuclear Power Plant and Equipment market was valued at $41.1 billion in 2020 and is projected to reach $58.4 billion by 2030, growing at a CAGR of 3.5% from 2021 to 2030. **Market Trends** • Nation states seek clean, efficient ways to produce energy (e.g., nuclear power). • The persistent challenges associated with nuclear waste management have restrained market growth. **Barriers to Entry – High** • The extraordinarily high capital costs involved in building nuclear power plants create tremendous economic barriers for entry. **Key Players** • BWX Technologies, INC, Dongfang Electric Co., Ltd., Doosan Corporation, General Electric, Korea Electric Power Corporation,

Market Research (cont.)

Potential Markets	Market Insights
Aircraft Hydraulic Systems Includes high-pressure pipes on an aircraft/ vehicle or in ground-based infrastructure	**Market Size** • The global Aircraft Hydraulic Systems Market size is projected to grow from $9.8 billion in 2022 to $16.6 billion by 2027, at a CAGR of 11.3% from 2022 to 2027. **Market Trends** • Hydraulic systems can offer a higher power-to-weight ratio than a mechanical or electrical system. • Reduced tube/hose diameters result in significant reduction in weight and efficient power transfer. **Barriers to Entry – Medium** • Systems are highly susceptible to hydraulic fluid contamination and can result in the loss of hydraulic system efficiency. **Key Players** • Raytheon Technologies Corporation, Parker-Hannifin Corporation, Safran S.A., Eaton Corporation Plc., Liebherr-International Deutschland GmbH
Chemical Distribution Market All fluid delivering pipes that chemicals run through would be under high pressure	**Market Size** • The Global Chemical Distribution market accounted for $253.1 billion in 2021 and is estimated to achieve a market size of $405.4 billion by 2030, growing at a CAGR of 5.6% from 2022 to 2030. **Market Trends** • Continuing to attract investment from various players—including chemical manufacturers, distributors, and logistics providers—the demand for chemical distribution services is likely to increase. • Artificial Intelligence (AI) and Machine Learning (ML) are transforming the market for chemical distribution, improving supply chain management, and reducing costs. • The growing demand for green chemicals, which are environmentally friendly and sustainable, is increasing. This provides new opportunities for chemical distributors. **Barrier to Entry – Medium** • Environmental concerns, such as pollution and waste management, can limit the growth of the chemical distribution industry, this invention can help. **Key Players** • Lubrizol, Fujifilm Holdings, Mark Iv Industries, ICL, Rockwater Energy Solutions

Market Research (cont.)

Conclusions

- The Oil and Gas market is an attractive market for the replaceable union nut since it presents an expansive use case for this product if the nut geometry can be standardized.
- The Nuclear Power market, especially micro reactors, could be a very attractive market. The desire to set and move reactors if needed requires nuts that can be replaced as needed.
- The Aircraft Hydraulic System market is not as attractive; the existing union nut substitutes may be more applicable.
- The Chemical Distribution market could be attractive for the replaceable union nut. There are numerous aging chemical processing plants that could require maintenance/repairs, and broken union nuts could be replaced with this invention.

Recommendations – Rough order of Magnitude (ROM)

Priority Key:

- **Must:** A critical and time sensitive recommendation to advance technology with respect to the area of focus.
- **Should:** An important recommendation to advance technology but is dependent upon predecessor recommendations or is not time sensitive.
- **Could:** A recommendation that will have insignificant impact on advancing the technology but could be a beneficial consideration.

Recommendations	Priority	ROM Cost	ROM Timeline
Advance TRL and MRL Plan	2	$15,000	4 months
Market Planning and Scouting	3	$35,000	6 months
License technology	1	$15,000	2 months
ROM Total:		**$65,000**	

Level of Market Opportunity

Low----------Moderate----------High

Analyst: DVIRC

TECHNOLOGY VIABILITY ASSESSMENT POWERED BY MILTECH

Competitor Analysis

Competitor Analysis Intent

The intent of this section is to identify potential commercially available, competing technologies and provide conclusions and recommendations based on the information provided at the time of assessment. The resulting information may be used to identify technology strengths or weaknesses in features or claims, as well as potential licensing partners.

Research Methods

Various resources to uncover information about different companies that perform similar functions.

Markets	Competitors
Oil and Gas infrastructure	• **Petro Piping:** Manufactures multiple bolting types, as well as nuts for a given size in a package. • **SSP:** Unions come with a nut that creates a seal between the pipes. This design allows for easy installation and removal on fixed pipe components. • **FMC Technologies:** Complete line of standard service and sour gas wing unions, with sizes ranging from 1- to 12-inches in diameter for working pressures up to 20,000 psi.
Nuclear Power	• **BWXT Advanced Nuclear Reactor:** Developing a transportable microreactor that can thrive in off-grid applications. Will focus on optimizing new manufacturing technologies that could reduce the cost of microreactors by half. • **eVinciTM Microreactor:** Westinghouse Electric Company is also pursuing a transportable microreactor that can be installed on-site in less than 30 days. • **Holtec SMR-160 Reactor:** Boasts excellent manufacturing capabilities and can fabricate the majority of the components in the United States.
Aircraft Hydraulic Systems	• **The Lee Company:** Components are tested under a rigorous quality management system and designed for high reliability, allowing them to stand up against demanding applications. • **Circle Valve Technologies Inc.:** Broad range of pressure regulators including brass, stainless steel, Monel, high-pressure, corrosion-resistant, back-pressure, dome-loaded, vaporizing, and cylinder models. • **Mako Products LLC:** Fittings are easy to assemble and feature an ultra-high-purity metal-to-metal seal for leak-free operation in high-vacuum and positive-pressure applications
Chemical Distribution Market	• **SHF:** Products are manufactured from robust, sanitary, and corrosion-resistant stainless steel, which improves equipment and process media transfer line performance and durability. • **SSP:** Unions come with a nut that creates a seal between the pipes. This design allows for easy installation and removal on fixed-pipe components. • **Mako Products LLC:** Fittings are easy to assemble and feature an ultra-high-purity metal-to-metal seal for leak-free operation in high-vacuum and positive-pressure applications.

Competitor Analysis (cont.)

Markets	Competitors
	Substitutes
Pipe Couplings	• **Latrobe Foundry Machine & Supply Co.:** National pipe threads in accordance with ANSI/ASME B1.20.1. Fittings are random tested at 120 pounds of air pressure under water, for a normal surface condition rating of 150 pounds of pressure. • **Morris Coupling Co.:** ALL ROUND COUPLINGS are quick, easy, and economical one-piece couplings to join or repair system piping. Spanner-type combination is intended for repairing or joining water lines. • **World Wide Metric, Inc.:** Repair clamps are designed to stop leaks that occur due to faulty weld joints, pitting holes, and short cracks with minimal down time. With a split-gasket design, repair clamps can be wrapped around the pipe and installed without disassembling any pipe. • **SSP Fittings Corp.:** Quick connects are designed to provide a convenient way to connect and disconnect fluid lines, creating a leak-tight seal without the use of tools for grab sample systems, laboratories, and other applications requiring rapid or frequent connections and disconnections. • **Parker Hannifin Instrumentation Products Div.:** Quick couplings are designed to provide reliable, leak-free connections for virtually every application. A range of sizes in high-grade materials, valve styles, pressure ratings, and end ports.

Conclusions

The markets above hold the potential for the proposed union nut to deliver better results than existing solutions. Pipe Couplings are the most noteworthy substitute, due to their reusability.

Technology Readiness Level – Hardware

Technology Readiness Level Intent	Current TRL
The intent of this document is to determine the level of effort required to advance the technology from its current state to a desired future state. Project tasks may be proposed to assist in technology advancement. The *Technology Readiness Level (TRL) Deskbook* version July 2009 served as the reference document for the TRL assessment. TRLs run from 1 to 9.	**8**

Research Methods

TRL determination has been conducted on applicable levels as seen below. The assessment was conducted by reviewing the following materials:

- Technology Overview
- Patent No. 10,591,094
- Q&A call with inventor

Findings

The Replaceable Union Nut was designed to replace a failed union nut on a piping union without cutting pipe or rewelding the union tailpiece. The two pieces fit around the pipe and mate using machined notches to form a complete union nut that is constrained in all directions and dimensionally equivalent to a standard union nut. Prototypes have been built and tested in 10 different pipe sizes ranging from 1/8" to 2" IPS and 4 different materials. At present, believe the Replaceable Union Nut to be a TRL 8. A Technical Data Package (TDP) and Bill of Materials (BoM) are available, as well as a cost model that was associated with manufacture of prototypes. This adaptation of the invention has been developed and prototyped, tested, and multiple variations have been made. Testing revealed limitations in some combinations of size and material. The technology has been tested and manufactured by a third-party company, but additional modifications would have to be made to the geometry of the nut to ensure proper use in a commercial setting.

Conclusions

In terms of the current state of the invention, the Replaceable Union Nut is approaching a TRL of 9, as it already has been tested and manufactured by a third party, validating the overall design and applicability. Due to the limitations revealed during testing, additional steps are needed to optimize combinations of size and material to create a more widely applicable model for common pipes. Validation of prototypes in an operational setting remains essential.

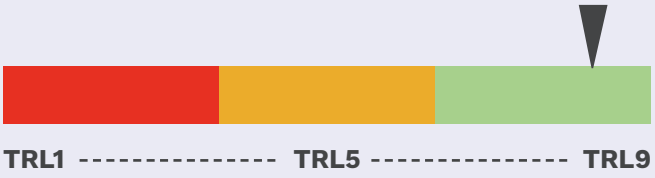
Technology Readiness Level – Hardware (cont.)

Recommendations

Priority Key:

- **Must:** A critical and time sensitive recommendation to advance technology with respect to the area of focus.
- **Should:** An important recommendation to advance technology but is dependent upon predecessor recommendations or is not time sensitive.
- **Could:** A recommendation that will have insignificant impact on advancing the technology but could be a beneficial consideration.

Recommendations to advance TRL to 9	Priority	ROM Cost	ROM Timeline
Finalize manufacturer search	Must	$1,500	1 month
Test prototypes with other geometries	Should	$3,500	3 months
Validate prototypes in operational setting	Must	$3,500	3 months
Rough Order of Magnitude (ROM) Total		**$8,500**	**6–7 mos.**



Analyst: DVIRC

Manufacturing Readiness Level

Manufacturing Readiness Level Intent	Current MRL
The intent of this assessment is to determine the level of effort required to advance the technology from its current state to desired future state. Project tasks may be proposed to assist in the advancement of the technology. The *Manufacturing Readiness Level (MRL) Deskbook* version 2.0 served as the reference document for the MRL assessment. MRLs run from 1 to 10.	**7**

Research Methods

Although a contractor has not been identified, an MRL determination has been conducted on applicable levels as seen below. The assessment was conducted with the following events and materials:

- Technology Overview
- Patent No. 10,591,094
- Q&A call with inventor

Findings

The MRL will generally track with the TRL but be slightly lower. The following is an assessment of the technology's current MRL and reasoning for the rating.

The Replaceable Union Nut has been developed and prototyped, tested, and multiple different variations have been made. This establishes the device as MRL 7. The purpose of the Replaceable Union Nut is to make it possible to replace a failed union nut on a piping union without cutting pipe or rewelding the union tailpiece.

The Replaceable Union Nut machined from bar stock has been prototyped and has been built and tested in 10 different pipe sizes ranging from 1/8" to 2" IPS and 4 different materials. Testing revealed limitations in some combinations of size and material. A Technical Data Package (TDP) and Bill of Materials (BoM) have been created for the Replaceable Union Nut along with a cost model built from the manufacture of prototypes.

Although machining of the bar stock is a standard practice, the eventual manufacturer will be required to provide high-precision machining to meet the complexities of the technology. The nut will not require any custom manufacturing capabilities or processes. K-Monel has proved to be the most promising of four materials tested, but the raw material may have a long lead time. In terms of commercial off-the-shelf parts (COTS), the current Replaceable Union Nut design was specific to a pipe union system unique to Navy applications; a COTS nut is not possible at present, and creating a COTS nut would require significant redesign. Design changes would require additional testing to supplement and ensure that the Union Nut had been tested to the specifications. Specific shock testing would not be needed for nonmilitary applications. Other industries may have specific testing requirements, however; these would have to be considered on a case-by-case basis.

Conclusions

This Replaceable Union Nut exists at an advanced MRL. Next steps would include additional prototyping and testing to allow for expanded use cases. The main challenge would be the time and cost required to build additional prototypes and complete the testing to make this invention viable in more than one application. Another MRL assessment should be completed when the steps listed above are completed and an evaluation can be made in a production environment.

Manufacturing Readiness Level (cont.)

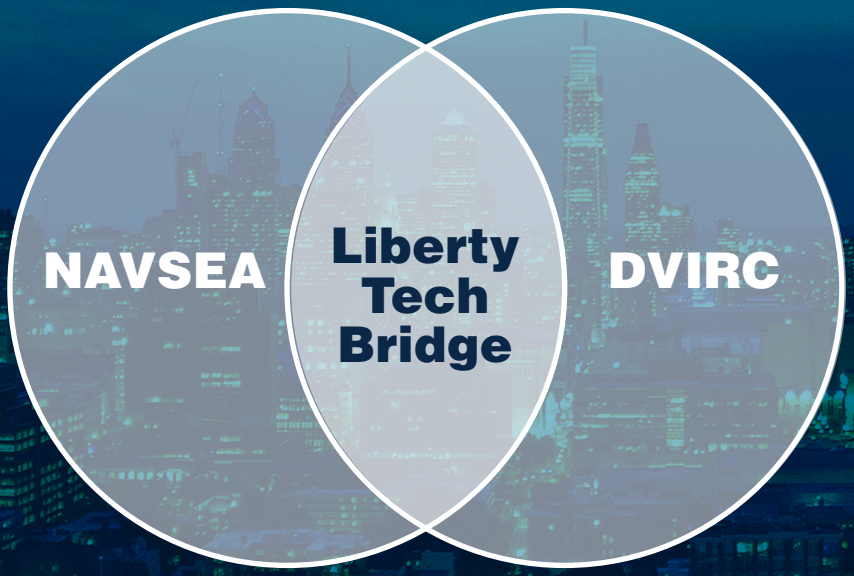
Recommendations

Priority Key:

- **Must:** A critical and time sensitive recommendation to advance technology with respect to the area of focus.
- **Should:** An important recommendation to advance technology but is dependent upon predecessor recommendations or is not time sensitive.
- **Could:** A recommendation that will have insignificant impact on advancing the technology but could be a beneficial consideration.

Recommendations to advance MLR	Priority	ROM Cost	ROM Timeline
Additional prototype with broader applications	Must	$5,000	3 months
Finalize manufacturer search	Must	$1,500	1 month
Additional validation Testing	Must	$3,500	3 months
ROM Total:		**$10,000**	**7 months**

Analyst: DVIRC



The result of an innovative partnership between the Naval Surface Warfare Center Philadelphia Division (NSWCPD) and the Delaware Valley Industrial Resource Center (DVIRC), Liberty Tech Bridge seeks to strengthen ties between the region's defense and industrial sectors. Together, NSWCPD and DVIRC are accelerating and expanding competitiveness among America's warfighters.

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