

ARCTIC-READY JOINT DESIGN PATENT

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TITLE OF INVENTION

System and Method for Temperature-Resistant Robotic Joint Assembly with
Integrated Thermal Management

INVENTORS

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ABSTRACT

A temperature-resistant robotic joint assembly system designed for operation in extreme cold environments, comprising a thermally-isolated actuator housing with integrated heating elements, and a proprietary lubricant delivery system. The

design enables consistent mechanical performance in ambient temperatures ranging from -40°C to +25°C while maintaining precision movement control and reduced energy consumption.

TECHNICAL FIELD

[001] This invention relates generally to robotic joint assemblies and, more particularly, to joint systems designed for reliable operation in sub-zero environments while maintaining precise positional control and mechanical efficiency.

BACKGROUND

[002] Traditional robotic joint assemblies face significant operational challenges in extreme cold environments, including lubricant viscosity changes, thermal contraction of materials, and reduced battery performance. This invention addresses these challenges through novel thermal management and

material selection approaches.

DETAILED DESCRIPTION

[003] The joint assembly comprises:

A. Thermal Management System

[004] A multi-layer thermal isolation system including:

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Vacuum-sealed chamber surrounding critical components

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Proprietary aerogel insulation layer (composition detailed in Appendix A)

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Active heating elements with temperature feedback control

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Thermal monitoring sensors placed at critical points

B. Mechanical Components

[005] The joint assembly includes:

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Titanium-alloy outer housing with low thermal expansion coefficient

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Carbon fiber reinforced composite internal structure

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Ceramic ball bearings with special cold-resistant coating

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Flexible seal system maintaining integrity at extreme temperatures

C. Lubrication System

[006] Proprietary features include:

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Self-regulating lubricant viscosity control

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Pressure-compensated delivery system

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Temperature-activated flow regulators

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Contamination prevention barriers

CLAIMS

[007] What is claimed is:

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A cold-environment robotic joint assembly comprising:

a. A thermally-isolated actuator housing

b. Integrated heating elements

c. Temperature monitoring system

d. Adaptive lubrication delivery mechanism

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The joint assembly of claim 1, wherein the thermal isolation system maintains

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The joint assembly of claim 1, wherein the lubrication system automatically

ADVANTAGES AND NOVEL FEATURES

[008] The invention provides:

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Consistent operation in extreme cold environments

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Reduced energy consumption compared to existing solutions

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Extended maintenance intervals

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Improved precision in sub-zero conditions

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Enhanced reliability and durability

INDUSTRIAL APPLICABILITY

[009] This invention is particularly applicable to:

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Autonomous mobile robots in cold storage facilities

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Industrial automation in temperature-controlled environments

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Logistics operations in extreme climate conditions

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Pharmaceutical cold chain applications

REFERENCE DRAWINGS

[010] The following drawings form part of this patent:

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Figure 1: Exploded view of joint assembly

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Figure 2: Thermal management system schematic

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Figure 3: Lubrication flow diagram

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Figure 49 Control system architecture

CERTIFICATION AND EXECUTION

[011] The undersigned inventors hereby certify that they are the original inventors of the described technology and have the right to file this patent application.

EXECUTED this 15th day of March, 2021

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