

PATENT SPECIFICATION

Arctic-Grade Servo Motor Design

Patent No. US 11,487,XXX B2

Filing Date: March 15, 2019

Issue Date: September 22, 2022

ABSTRACT

A servo motor system specifically designed for operation in extreme cold environments, comprising a thermally-isolated motor housing, integrated heating elements, and temperature-compensating control algorithms. The system maintains precise positional control and operational reliability in ambient temperatures as low as -40 C through novel thermal management and specialized lubricant delivery systems.

BACKGROUND OF THE INVENTION

[0001] Conventional servo motors face significant operational challenges in sub-zero environments due to increased mechanical resistance, lubricant viscosity changes, and thermal contraction of components. This invention addresses these limitations through innovative design elements and control methodologies specifically engineered for extreme cold operations.

[0002] Prior art solutions have failed to adequately address the combined challenges of thermal management, positional accuracy, and long-term reliability in arctic conditions. Existing cold-weather servo systems typically rely on external heating elements or require frequent maintenance intervals, limiting their practical application in autonomous systems.

SUMMARY OF THE INVENTION

[0003] The present invention provides a servo motor system comprising:

- A thermally-isolated motor housing with multi-layer insulation
- Integrated heating elements with predictive temperature control
- Specialized low-temperature lubricant circulation system
- Arctic-grade bearing assemblies with thermal compensation
- Advanced position feedback mechanisms maintaining accuracy at extreme temperatures
- Microprocessor-controlled thermal management system

DETAILED DESCRIPTION

[0004] Referring to Fig. 1, the servo motor assembly (100) includes:

[0005] A primary motor housing (101) constructed of aerospace-grade aluminum alloy with specialized thermal coating. The housing incorporates multiple insulation layers (102, 103) creating air-gap thermal barriers.

[0006] Heating elements (104) are strategically positioned within the housing, controlled by temperature sensors (105) providing real-time feedback to the thermal management system (106).

[0007] The bearing assembly (107) utilizes custom-formulated lubricants maintaining optimal viscosity between -40 C and +25 C, circulated through microchannels (108) within the motor structure.

[0008] Position feedback is maintained through a redundant system of optical encoders (109) and magnetic position sensors (110), with temperature compensation algorithms ensuring accuracy across the operating range.

CLAIMS

A servo motor system for extreme cold environments comprising:

- a. A thermally-isolated motor housing;
- b. Integrated heating elements;
- c. Temperature sensors providing feedback control;
- d. Arctic-grade bearing assemblies;
- e. Specialized lubricant circulation system;
- f. Position feedback mechanisms with thermal compensation.

The servo motor system of claim 1, wherein the thermal isolation system maintains internal operating temperature within 5 C of optimal range while external temperatures vary between -40 C and +25 C.

The servo motor system of claim 1, wherein the position feedback system maintains accuracy within 0.1 degrees across the full operating temperature range.

DRAWINGS

[Fig. 1 - Cross-sectional view of servo motor assembly]

[Fig. 2 - Thermal management system schematic]

[Fig. 3 - Lubricant circulation pathway]

[Fig. 4 - Control system architecture]

INVENTORS

Dr. Elena Frost

Marcus Chen

Dr. James Barrett

ASSIGNEE

Polar Dynamics Robotics, Inc.

1200 Arctic Way

Dover, Delaware 19901

ATTORNEY OF RECORD

Sarah Johnson, Reg. No. 65,432

Frost & Johnson LLP

Patent Attorneys

100 Innovation Drive

Boston, MA 02110

FIELD OF INVENTION

[0009] This invention relates to servo motor systems designed for extreme environment operation, specifically addressing the challenges of maintaining precise positional control and operational reliability in sub-zero temperatures for autonomous robotic applications.

PRIOR ART REFERENCES

- US Patent 10,XXX,XXX
- US Patent 9,XXX,XXX
- EP Patent 2,XXX,XXX

CERTIFICATION

I hereby certify that this patent document and all statements made herein of my own knowledge are true, that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

/s/ Sarah Johnson

Registration No. 65,432

Date: September 22, 2022