THERMAL INSULATION DESIGN PATENT #PDR-2023-089

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ABSTRACT

A thermal insulation system for autonomous mobile robots operating in sub-
environments, comprising a multi-layer composite insulation structure with
active thermal regulation capabilities. The design incorporates proprietary
phase-change materials and vacuum-sealed compartments to maintain optim
internal operating temperatures while preventing thermal transfer between
critical electronic components and extreme external environments ranging fr
-40°C to +50°C.

BACKGROUND OF THE INVENTION

[0001] Autonomous mobile robots operating in cold storage and industrial fr
environments face significant challenges related to component reliability and
battery performance in extreme temperatures. Conventional insulation metho
fail to adequately protect sensitive electronics and power systems in sustaine

sub-zero conditions.

[0002] This invention addresses the limitations of existing thermal managem solutions through an innovative multi-layer approach that combines passive a active thermal regulation systems.

DETAILED DESCRIPTION

1. Technical Field

[0003] The present invention relates to thermal insulation systems for roboti applications, specifically addressing thermal management in autonomous mo robots operating in extreme temperature environments.

2. Component Structure

[0004] The thermal insulation system comprises:

a) An outer shell constructed of high-density polymer composite material;

b) Multiple vacuum-sealed chambers containing proprietary phase-change materials;

c) Active thermal regulation elements including:

- Microprocessor-controlled heating elements
- Temperature sensors distributed throughout critical zones
- Adaptive thermal management software

d) Inner compartmentalization system for electronic component isolation

3. Thermal Management Architecture

[0005] The system utilizes a hierarchical approach to thermal regulation:

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1. Primary Barrier

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Vacuum-sealed external shell

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Thermal reflection coating

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Impact-resistant outer layer

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2. Secondary Systems

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Phase-change material chambers

Active heating elements

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Thermal distribution channels

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3. Component-Level Protection

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Individual component isolation

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Targeted heating zones

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Thermal monitoring sensors

CLAIMS

A thermal insulation system for autonomous mobile robots comprising:

a) A multi-layer composite insulation structure;

b) Vacuum-sealed chambers containing phase-change materials;

c) Active thermal regulation elements;

d) Microprocessor-controlled heating distribution.

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The system of claim 1, wherein the phase-change materials maintain stable i

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The system of claim 1, further comprising distributed temperature sensors pr

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A method for maintaining optimal operating temperatures in autonomous mo

a) Monitoring internal and external temperatures;

b) Activating phase-change materials based on temperature differentials;

c) Adjusting active heating elements according to component requirements.

DRAWINGS

[0006] The accompanying drawings illustrate various embodiments of the invention:

Fig. 1: Cross-sectional view of the multi-layer insulation structure

Fig. 2: Thermal flow diagram showing heat distribution patterns

Fig. 3: Component isolation system schematic

Fig. 4: Phase-change material chamber configuration

TECHNICAL ADVANTAGES

[0007] The present invention provides:

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Extended operational capability in extreme environments

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Reduced power consumption for thermal management

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Enhanced component reliability

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Optimized battery performance in cold conditions

INDUSTRIAL APPLICABILITY

[0008] This invention is particularly applicable to:

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Cold storage facilities

Industrial freezer environments

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Temperature-controlled warehouses

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Pharmaceutical storage facilities

CERTIFICATION

I hereby certify that I am authorized to execute this patent application on behalf of Polar Dynamics Robotics, Inc.

Executed this 15th day of March, 2023

/s/ Marcus Chen

Marcus Chen

Chief Technology Officer

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LEGAL REPRESENTATION

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