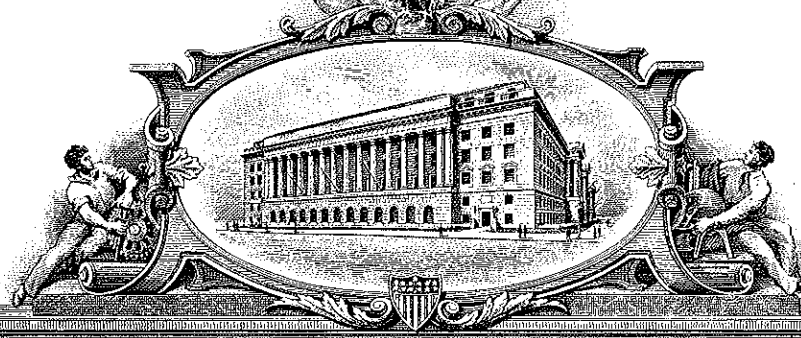


# EXHIBIT 5

U 7608123



# THE UNITED STATES OF AMERICA

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U.S. PATENT: 7,928,348  
ISSUE DATE: *April 19, 2011*

By Authority of the  
Under Secretary of Commerce for Intellectual Property  
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Certifying Officer



US007928348B2

(12) **United States Patent**  
**Neal**

(10) **Patent No.:** **US 7,928,348 B2**  
(45) **Date of Patent:** **Apr. 19, 2011**

(54) **ELECTROMAGNETIC DEVICE WITH INTEGRATED FLUID FLOW PATH**

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(75) Inventor: **Griffith D. Neal**, Alameda, CA (US)

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(73) Assignee: **Encap Technologies Inc.**, Alameda, CA (US)

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(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1171 days.

*Primary Examiner* — Quang T Van

(74) *Attorney, Agent, or Firm* — Brinks Hofer Gilson & Lione; Steven P. Shurtz

(21) Appl. No.: **11/489,911**

(22) Filed: **Jul. 19, 2006**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2008/0029506 A1 Feb. 7, 2008

Electromagnetic components are provided with a heat exchange mechanism. For example, a fluid-cooled electromagnetic field-functioning device, such as a motor, generator, transformer, solenoid or relay, includes one or more electrical conductors. A monolithic body of phase change material substantially encapsulates the conductors or an inductor. At least one liquid-tight coolant channel is also substantially encapsulated within the body of phase change material. The coolant channel may be part of a heat pipe or cold plate. The coolant channel may be made by molding a conduit into the body, using a "lost wax" molding process, or injecting gas into the molten phase change material while it is in the mold. The coolant channel may also be formed at the juncture between the body and a cover over the body.

(51) **Int. Cl.**  
**H05B 6/10** (2006.01)  
**H02K 9/20** (2006.01)

(52) **U.S. Cl.** ..... 219/628; 310/54; 310/43

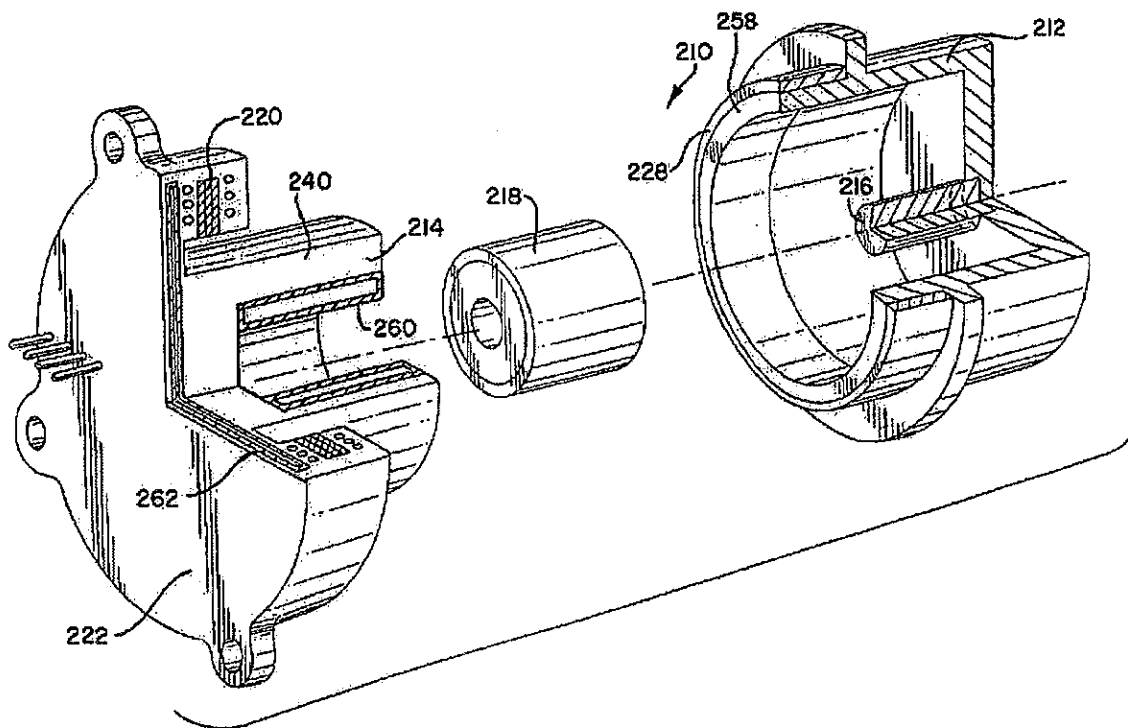
(58) **Field of Classification Search** ..... 219/628; 310/43, 54, 55, 67 R, 89, 90, 156.23; 165/104.14, 165/212, 214, 272.4, 285, 311; 62/101  
See application file for complete search history.

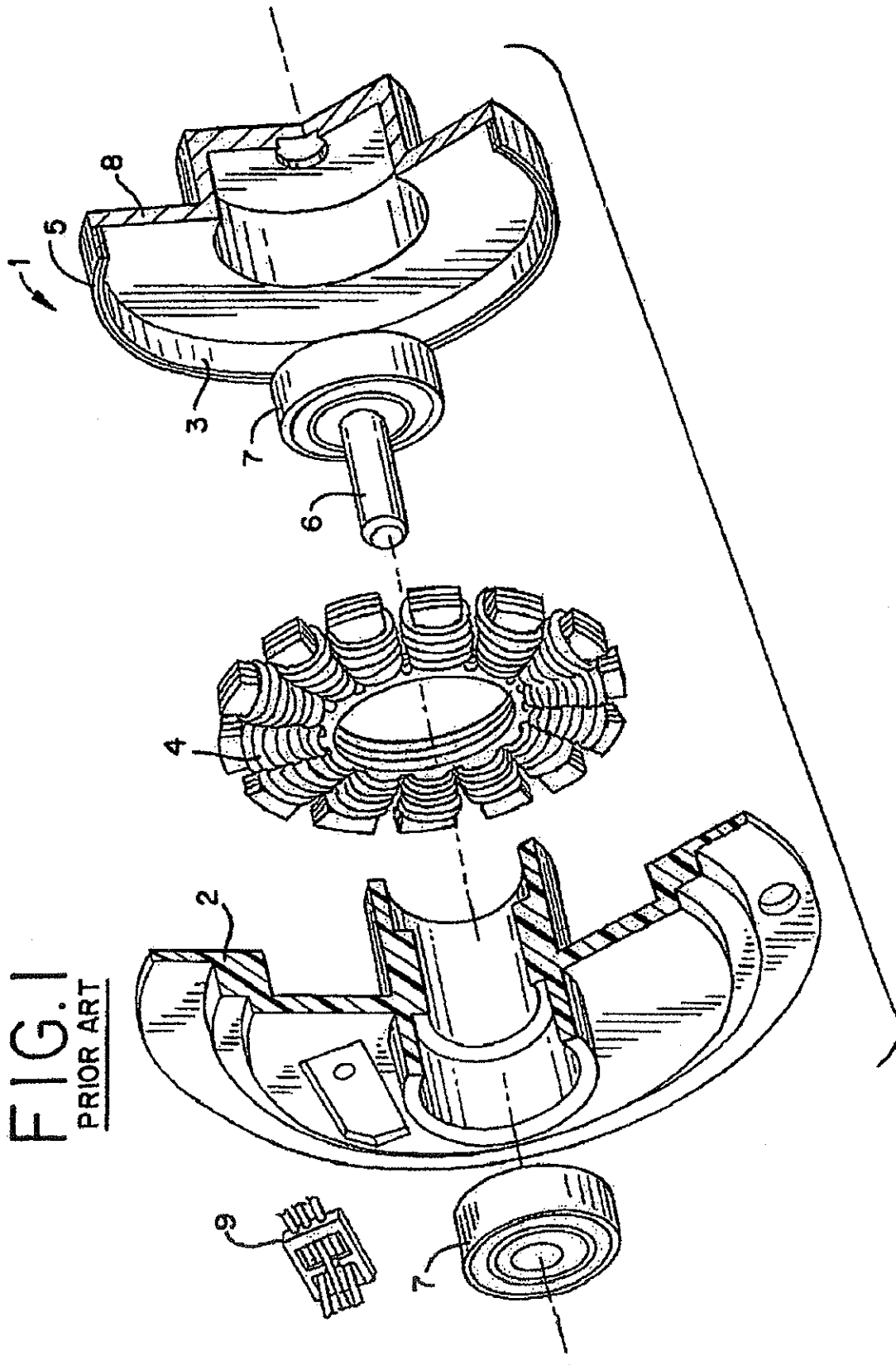
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**27 Claims, 14 Drawing Sheets**





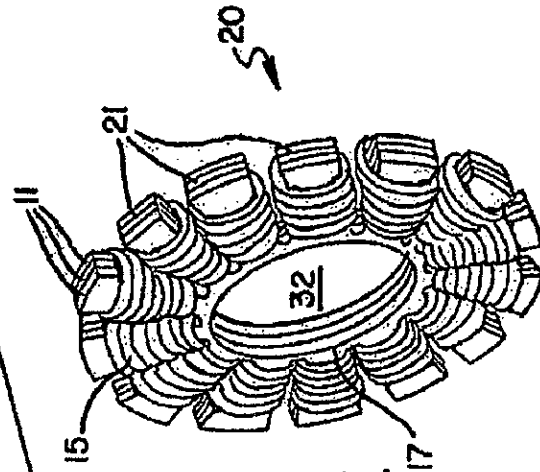
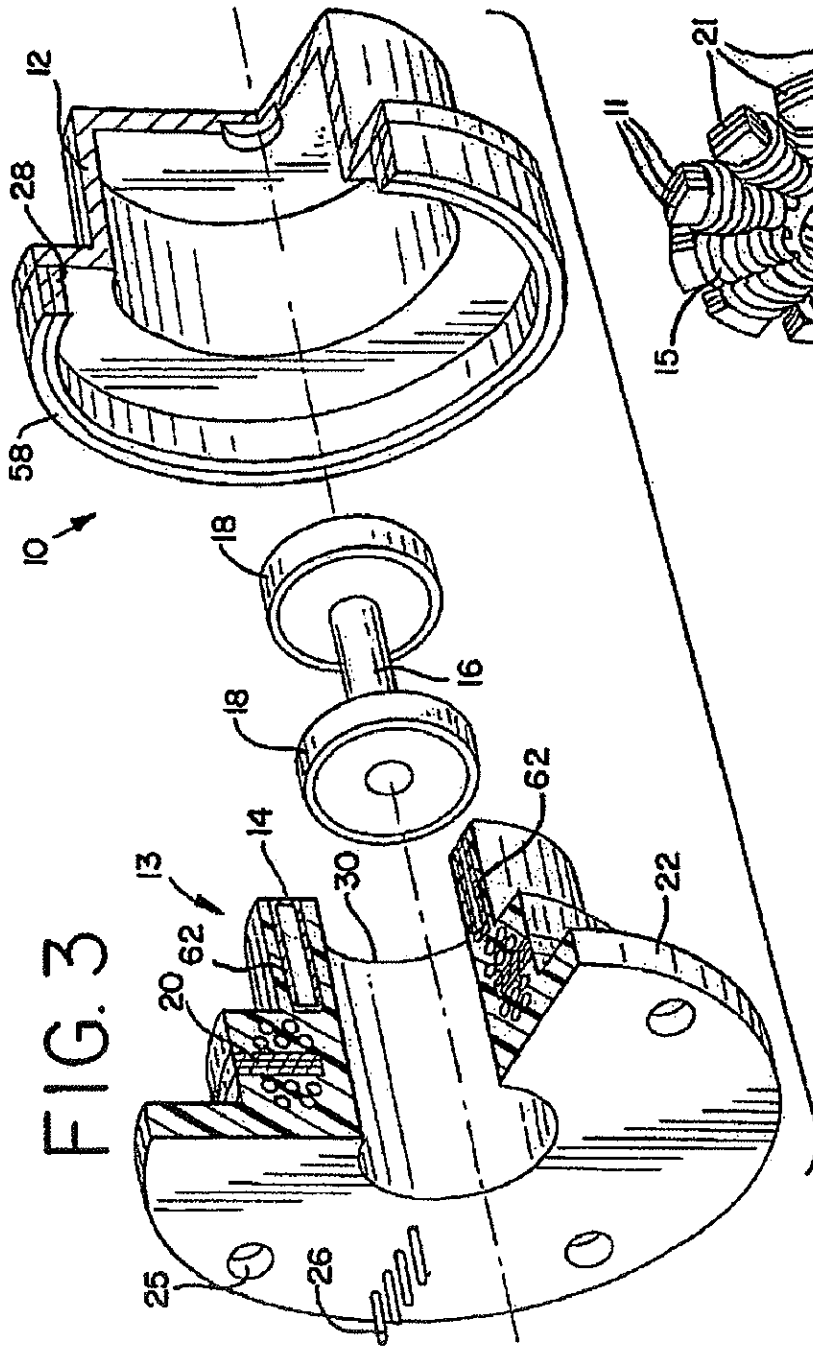


FIG. 2

FIG. 3

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