An Overview of the Current State of US Permanent Magnet Production

Neodymium Magnet Workshop
ALMA Symposium
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President, USMMA
Thomas & Skinner, Inc.

1901
Company founded by John Esterline, EE professor at Purdue University

1923
James Thomas & O.H. Skinner acquired magnetics division
Thomas & Skinner, Inc.

Today

Employee-owned manufacturer of magnetic materials headquartered in Indianapolis, Indiana.

Markets:

- Aerospace
- Industrial
- Defense
- Oil Exploration
- Medical
Mission

The mission of the United States Magnetic Materials Association is to promote domestic production of the entire supply chain of materials used in magnet systems production to serve our nation’s defense needs.
Four Types of Permanent Magnets Commercially Available Today

<table>
<thead>
<tr>
<th>Alnico</th>
<th>Samarium Cobalt</th>
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<tbody>
<tr>
<td>Ferrites</td>
<td>Neodymium Iron Boron</td>
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Improvements in Magnet Strength

Other Important Characteristics
- Required Magnetizing Field
- Thermal Stability
- Mechanical Properties
- Corrosion Resistance
- Manufacturability
- Cost

Metallic Magnets:
- SmCo 1-5 and 2-17
- BONDED ISOTROPIC NdFeB
- SINTERED FERRITE
- COLUMNAR ALNICO
- SINTERED ALNICO

Rare Earth Magnets:
- Nd-Fe-B

KS STEEL
MK STEEL
ALNICO 5

1/14/12
Four Types of Permanent Magnets Commercially Available Today

- **Highest Temperature**
  - Alnico
  - Samarium Cobalt

- **Lowest Cost**
  - Ferrites
  - Neodymium Iron Boron

- **High Temp / High Max Energy Product**
- **Highest Maximum Energy Product**
Four Types of Permanent Magnets

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Rare Earth

Not Domestically Produced
Specialty Metals Clause

**Defense Federal Acquisition Regulation Supplement**
(or DFARS 252.225-7014)

The purpose of this law is to maintain and support the defense industrial base for those items it covers.
Specialty Metals Clause Applies to Some Magnet Materials, Not All

Hard (Permanent) Magnets

- Four general types:
  - Alnico
  - Rare Earth
    - SmCo
    - NdFeB
  - Hard Ferrites

Covered by the Specialty Metals Clause

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## Current State of US Magnet Production

### U.S. Manufacturers in 1990s

**NdFeB (dense) Magnets**
- Ugimag (IG Tech.)
- Hitachi
- Crucible
- Magnequench

**Sintered Ferrite Magnets**
- Arnold
- Hitachi (Edmore, China Grove)
- TDK
- Crucible Magnetics
- General Magnetic
- Sumitok
- Kane (Stackpole)

### U.S. Manufacturers in 2011

**NdFeB (dense) Magnets**
- (none)

**Sintered Ferrite Magnets**
- Hitachi (China Grove)
- TDK
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China Dominates Magnet Materials

2010 Worldwide Total Market Size for Magnet Materials = $7.5B

- Projected $8.8B 2015
- Projected $15.5B 2020

Produce over 75% of world’s NdFeB magnets
- Japan produces 22%

Rare Earth Oxide Ore production = 94% of global demand
- Well over 50% of global reserves

Starting in the late 1990’s, Japan, US and European producers close plants and move production to China

Over 50% of worldwide Alnico & SmCo production
REE Production Trends

Monazite-placer era | Mountain Pass era | Chinese era
Strategic Economic Weaponry

“There is oil in the Middle East; there are rare earths in China. We must take full advantage of this resource.”

President Deng Xiaoping 1992

“Improve the development and applications of rare earth, and change the resource advantage into economic superiority.”

President Jiang Zemin 1999
China: Controlling the RE Market

“Rare Earths Industry Development Plan in 2009-2015”

• Drafted by China’s Ministry of Industry and Information Technology.
  – “Mining of rare earths should seriously abide by production quotas.”
  – Beijing will also restrict exports of rare earths in the next six years,
    • annual export quota will be below 35,000 tpy and exports of dysprosium, terbium, thulium, lutetium and yttrium will be prohibited
China: Controlling the RE Market

“We think prices rising this year (2006) is the comprehensive effect of many factors. *It is the result of macro control of Chinese government* and stable growth of Chinese economy. Self-adjustment of the RE industry and other factors from Chinese and oversea markets have a conjunct effect to the prices as well.”

Source: China Rare Earth Information Center (September 2006)
Neo Magnets in Energy and Defense Applications

- Wind Turbines
  - Generator
- Hybrid Vehicles
  - Generators and Drive Motors
- Guidance systems
  - JDAM
- Computer Hard Drives
Impact of Offshoring Neo Production on US Innovation is Clear

- Current technology for neo magnet windmills came from Europe
  - They are years ahead of us in terms of installations
  - Europe has maintained neo magnet production

- Current hybrid car technology using neo magnets comes from Japan
  - They are years ahead of US producers
  - Japan has maintained neo magnet production
Innovation

• Critical to US economy
  – Innovation is a key trait of the companies listed in the Business Week 50, an annual ranking of the top-performing companies in America (BW, 6/17/10)

For the US magnet industry to be relevant, it has to be a part of innovative activity.
An Important Study

  - Analyzed how offshoring affects the rate of innovation
    - *Looked at results from R&D efforts conducted collectively by firms at their home location.*
  - Specifically cited the departure of the rare earth magnet manufacturing base from the US as an example of innovation capability that has been lost.
Offshoring Manufacturing: *Immediate Impact*

Optimizing global production

Round-the-clock shifts and lower costs

Expanded markets, lower prices for consumers and the creation of new business opportunities for existing firms and new entries.

*Source: Fifarek, Veloso and Davidson*
Offshoring Manufacturing: *Long-term Effects?*

Manufacturing moves overseas

Engineering work and R&D follow

Jeopardizing the ability of home economies to maintain economic growth and leadership.

*Source: Fifarek, Veloso and Davidson*
Neo Magnet Production: The Clock is Ticking

- Last neo production was in 2005
  - Hitachi Edmore, Michigan plant
- The longer the gap between the end of production and a restart, the more difficult the startup will be
  - Capital assets are gone.
  - Human capital is drifting away
What’s Happening Now

• December 21, 2011
  – Hitachi Announced New US Neo Magnet Plant
    • China Grove, NC
    • To produce sintered neo magnets from imported powder
      – Will not produce alloy
    • At mass production capacity, will produce 40 tons/month
    • Built to service the automotive market

• Focus of mining efforts on Heavy Rare Earths
  – Dysprosium
The Bottom Line

• Segments like the Loudspeaker Industry need a diversified and healthy magnet value chain
  – Innovation in the industry depends on it.

• What can the Loudspeaker Industry do?
  – Buy local
    • Innovation efforts will be enhanced by using a value chain that is close, can respond quickly, and is able to assist you with design
  – Compensate and reward for a secure, diversified value chain, and not just the lowest cost
Reference Information

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