WIEGAND SENSORS

WIEGAND SENSORS

Use Wiegand Sensors not Batteries!

- Wiegand Sensor as Power & Pulse Generator
- No external power required – No batteries
- Longer lifespan
- Operates in harsh environments
- Non contact measurement – No mechanical wear
- For Multiple Applications: Rotary Encoder (Proven Design Concept since 2005), Flow Meter, Contactless Switch

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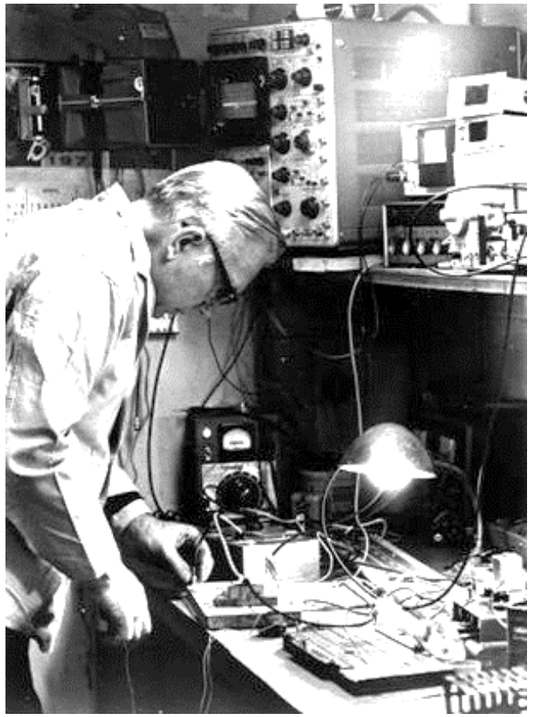
OUTLINE

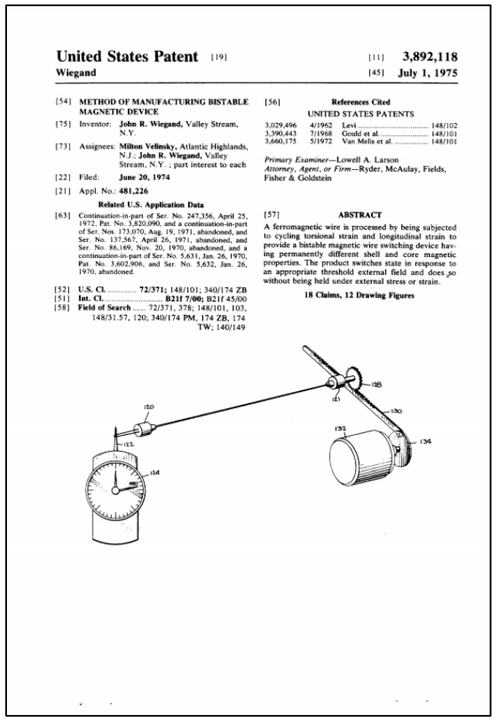
- **Historical Background**
- Principle of Operation
- Version Space
- FAQs

WIEGAND SENSORS

Multiturn Technology/Energy Harvesting Based On Wiegand Effect



John R. Wiegand (born 1912)



United States Patent [19]
Wiegand

[11] 3,892,118
[45] July 1, 1975

[54] METHOD OF MANUFACTURING BISTABLE MAGNETIC DEVICE

[75] Inventor: John R. Wiegand, Valley Stream, N.Y.

[73] Assignees: Milton Velinsky, Atlantic Highlands, N.J.; John R. Wiegand, Valley Stream, N.Y. ; part interest to each

[22] Filed: June 20, 1974

[21] Appl. No.: 481,226

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 247,356, April 25, 1972, Pat. No. 3,820,090, and a continuation-in-part of Ser. Nos. 173,070, Aug. 19, 1971, abandoned, and Ser. No. 137,567, April 26, 1971, abandoned, and Ser. No. 86,169, Nov. 20, 1970, abandoned, and a continuation-in-part of Ser. No. 5,631, Jan. 26, 1970, Pat. No. 3,602,906, and Ser. No. 5,632, Jan. 26, 1970, abandoned.

[52] U.S. Cl. ..... 72/371; 148/101; 340/174 ZB
[51] Int. Cl. B21f 7/00; B21f 45/00
[58] Field of Search ..... 72/371, 378; 148/101, 103, 148/31.57, 120; 340/174 PM, 174 ZB, 174 TW; 140/149

[56] References Cited
UNITED STATES PATENTS

3,029,496	4/1962	Levi	148/102
3,390,443	7/1968	Gould et al.	148/101
3,660,175	5/1972	Van Melis et al.	148/101

Primary Examiner—Lowell A. Larson
Attorney, Agent, or Firm—Ryder, McAulay, Fields, Fisher & Goldstein

[57] ABSTRACT

A ferromagnetic wire is processed by being subjected to cycling torsional strain and longitudinal strain to provide a bistable magnetic wire switching device having permanently different shell and core magnetic properties. The product switches state in response to an appropriate threshold external field and does so without being held under external stress or strain.

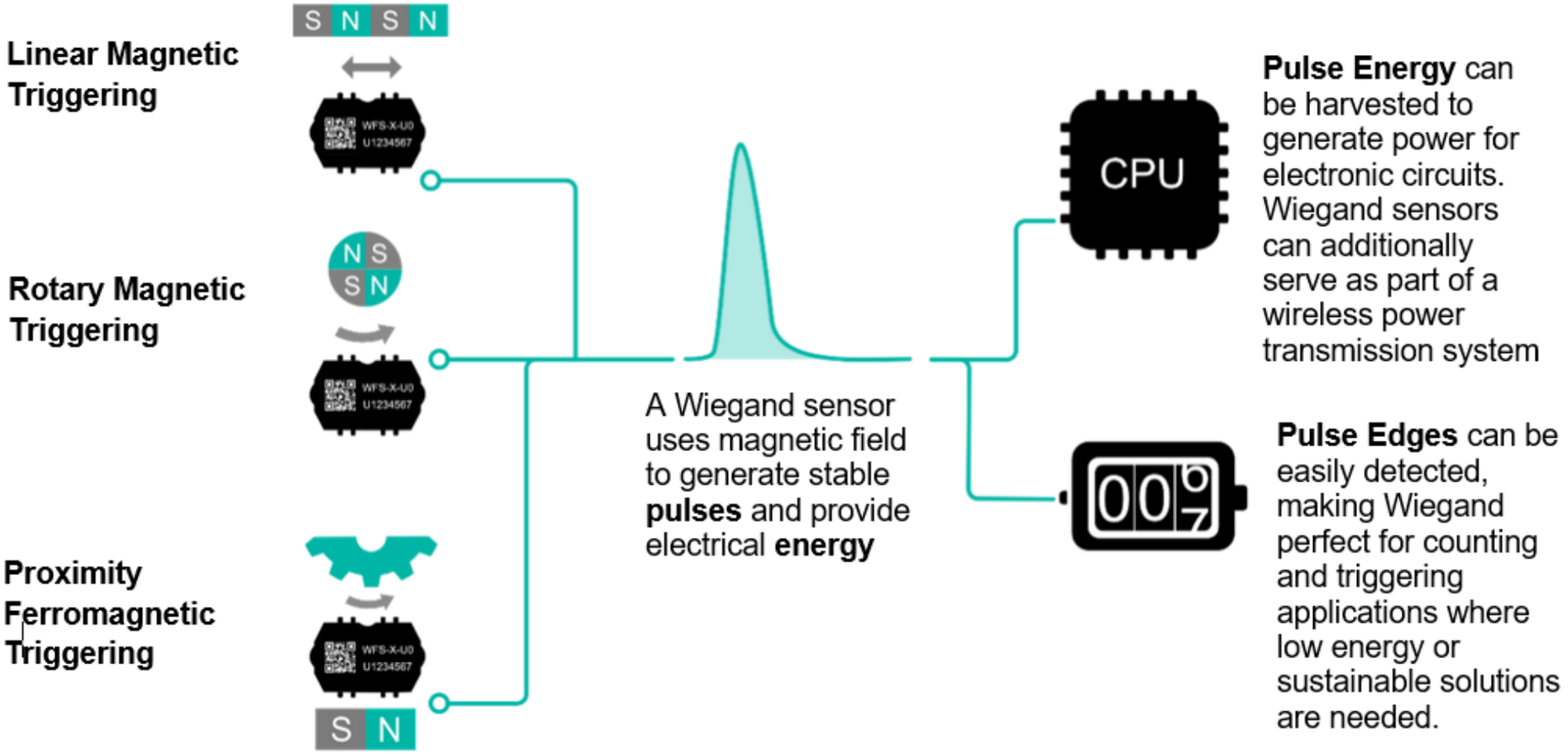
18 Claims, 12 Drawing Figures

Patent 1974

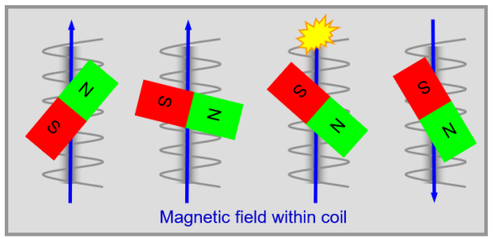
APPLICATIONS – MAGNETIC SENSORS / PULSERS

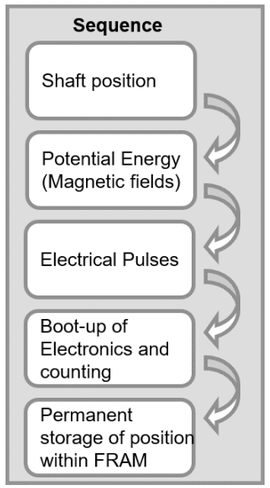
- Characteristics For a Better Sensor In Many Metering Applications:
  - Pulse Signal Output
  - High Signal to Noise Ratio (Compared to Sinusoidal)
  - Lower Sensitivity
  - Non Speed-dependent Slope/Pulse Height
  - Non Mechanical – Zero Wear
  - High Triggering Frequency
  - Distinct Pulse ‘Events’ Make it Ideally Suited to Event Counting

FUNCTIONAL DUALITY - PULSE EDGES AND/OR ENERGY



FUNCTIONAL DUALITY - PULSE EDGES AND/OR ENERGY

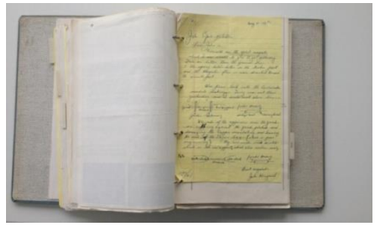




- Self-powered Event Counting Applications Are a Perfect Match for Duality of Function
- For Example, Rotation Counting Even at Very Low Speeds
- Other Event-counting Applications Also Exist:
  - E.g Condition Monitoring and Preventative Maintenance
- With Passive Wireless Communication Advances, Real-time Transmission of Event Data Becomes Possible

EXPERIENCE WITH WIEGAND SENSORS

15 Years Application Experience – 6 Years Production Experience



Laboratory book of John Wiegand

In-house wire processing machinery

2004: First Wiegand Sensor design

2006: Series production of rotary encoders with Wiegand Technology. Partial assembly of Wiegand Sensors
(part of production outsourced to subcontractor)

2012: Discontinuation of wire production at HID

2013: Acquisition of 2 Wiegand Wire production lines from HID incl. technical documentation. Consulting contracts with experts to ensure knowledge transfer

2014: Wiegand Technology Center opened in Aachen (Germany), Start of wire production in Aachen

2015: Assembly of Wiegand Sensors 100% insourced

2016: Production volume of 120000 Wiegand Sensors

2016: Second production line for wire in US

2016: Second assembly line for Wiegand Sensors in Asia

2021: More than 800k POSITAL Wiegand Sensors operating effectively ‘in the field’

EXPERIENCE WITH WIEGAND SENSORS

10+ Years Experience & Dual Production Lines

We carefully manage the entire production chain all the way from the smelting of Vicalloy through to the final production of Wiegand sensors and assemblies with integrated Wiegand technology.

The many processes necessary to create the highest-quality Wiegand wire sensors and assemblies are controlled and optimized by our engineering and logistics teams.

Currently, FRABA has Wiegand wire production lines in Europe and the US and has Wiegand sensor assembly lines in Europe and Asia.

OUTLINE

- Historical Background
- **Principle of Operation**
- Version Space
- FAQs

WIEGAND SENSORS

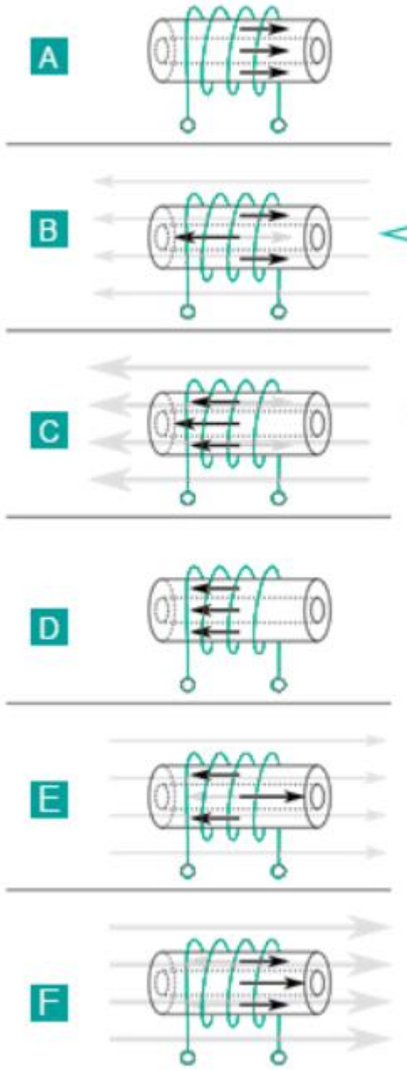
The Wiegand Effect

The Wiegand effect is making use of the unique magnetic property of a specially processed, small ferromagnetic wire made of Vicalloy.

John Wiegand discovered a way to cause the magnetic field of this specially processed wire to suddenly reverse.

When the magnetic field of this wire, called a Wiegand Wire, is reversed a sharp uniform voltage pulse can be generated.

This pulse is referred to as a Wiegand Pulse, which can be used as a power source in an energy self-sufficient revolution counter.



A → B Applying a reverse field switches the core's polarity, producing a large voltage spike.

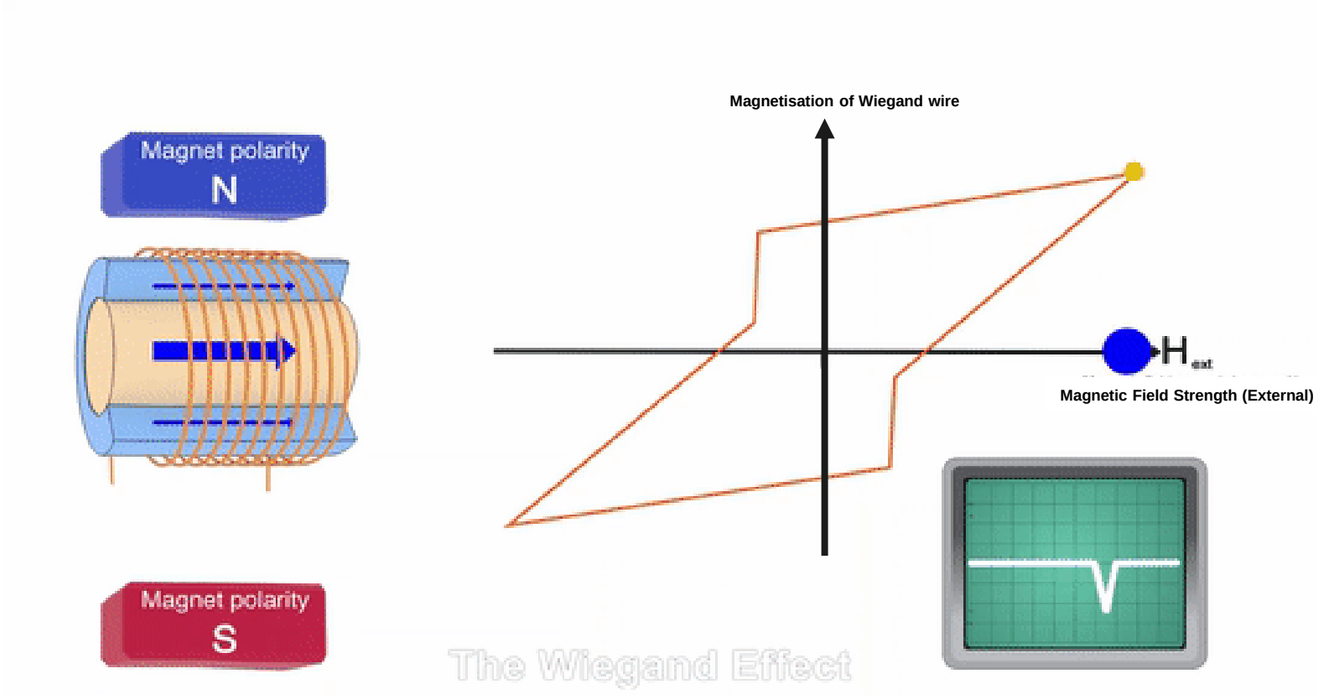
B → C As the reverse field continues to increase, the shell eventually switches polarity, giving rise to a smaller pulse in the same direction.

C → D After saturating the Wiegand wire the reverse field is withdrawn.

D → E Applying a magnetic field with the original polarity of the wire switches the core once again generating a large pulse in the opposite direction.

E → F Increase of the eternal field will also switch shell polarity. The wire is back in the original state **A** and a full cycle completed.

THE WIEGAND EFFECT – ‘FAST REVERSALS’



- Magnetic Hysteresis Leads to Fast Reversals of Wire Magnetisation
- Fast Reversals Induce Pulses in a Pickup Coil
- Pulse Voltage and Width Consistent Even at Frequencies Close to Zero
- Consistent, Frequency Independent Pulses Are Valuable in Metering and Counting Applications

WIEGAND SENSORS

Use of the Wiegand Effect in Multiturn Encoders

POSITAL multiturn encoders with Wiegand sensors since 2006

The sensor needs no external power source and has no moving parts

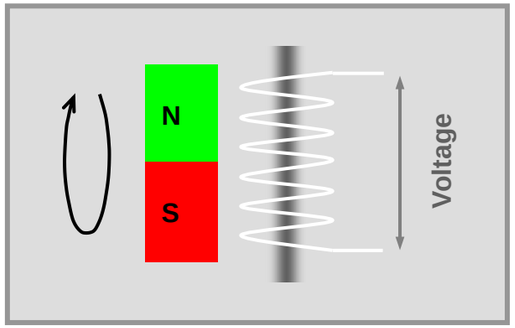
This energy harvesting system generates short, powerful voltage pulses sufficient to power the rotation-counting electronic circuit, even when the speed of rotation is very low.

Hence, reliable measurement of multi-turn absolute positions without requiring access to an external power supply is enabled

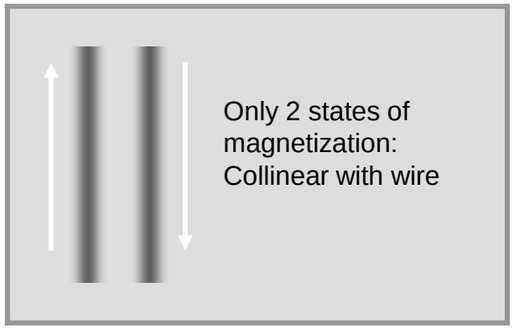
WIEGAND MULTITURN TECHNOLOGY

Smart Multiturn Technology

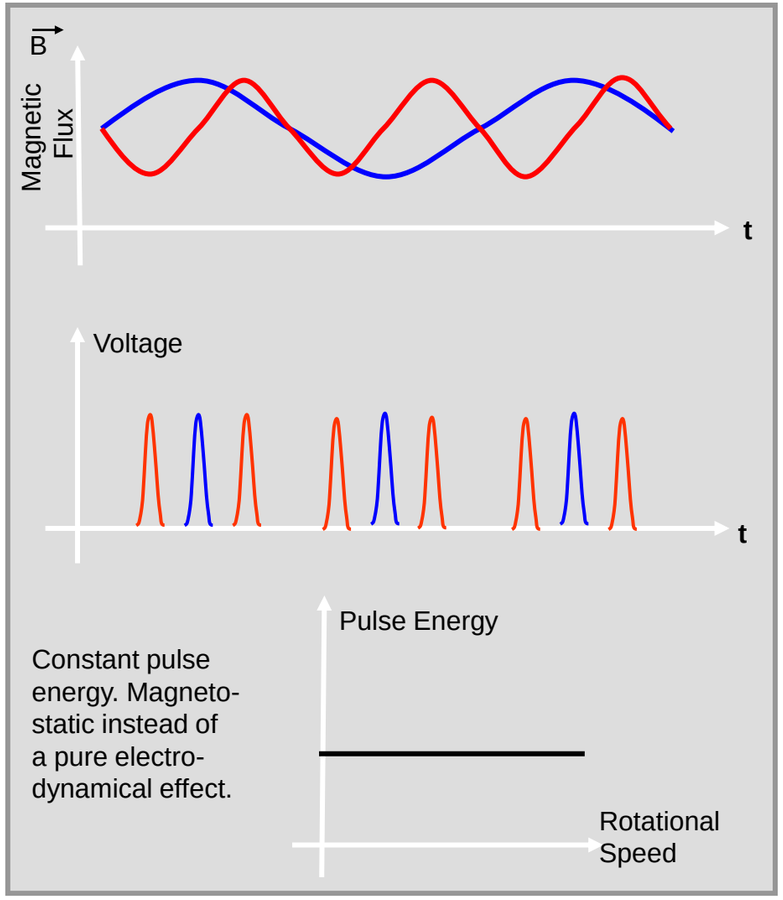
Rotating Magnet & Coil
Wiegand Wire Inside



Wiegand wire prevents a continuous change of the magnetic field within the coil.

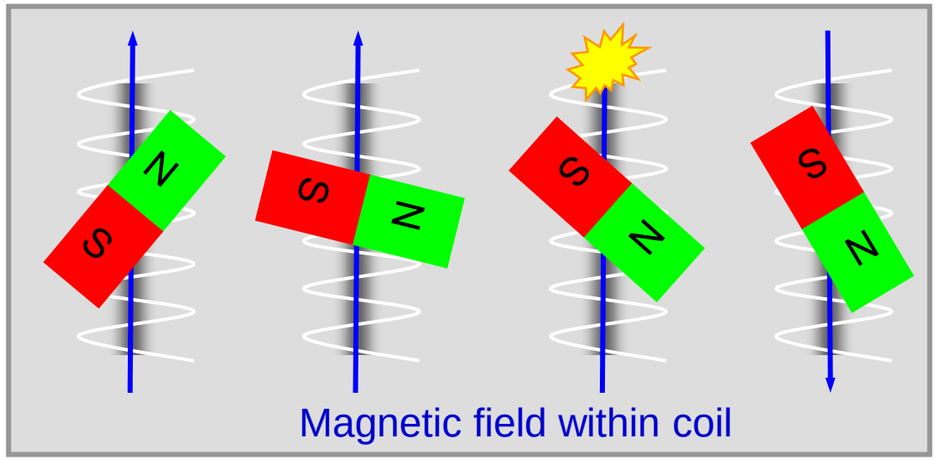


Only 2 states of magnetization: Collinear with wire



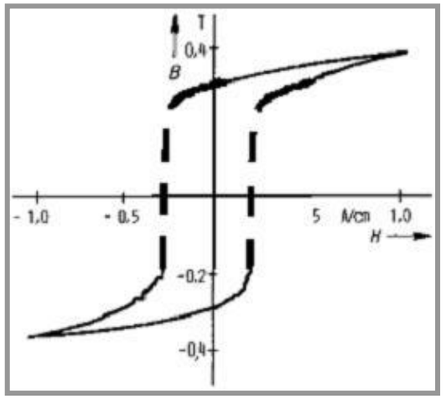
WIEGAND MULTITURN TECHNOLOGY

Smart Multiturn Technology



Magnetic field within coil

As soon as the potential energy between the external magnetic field and the inner magnetic field becomes too high, the inner magnetic field will flip to the opposite direction generating an electrical pulse.



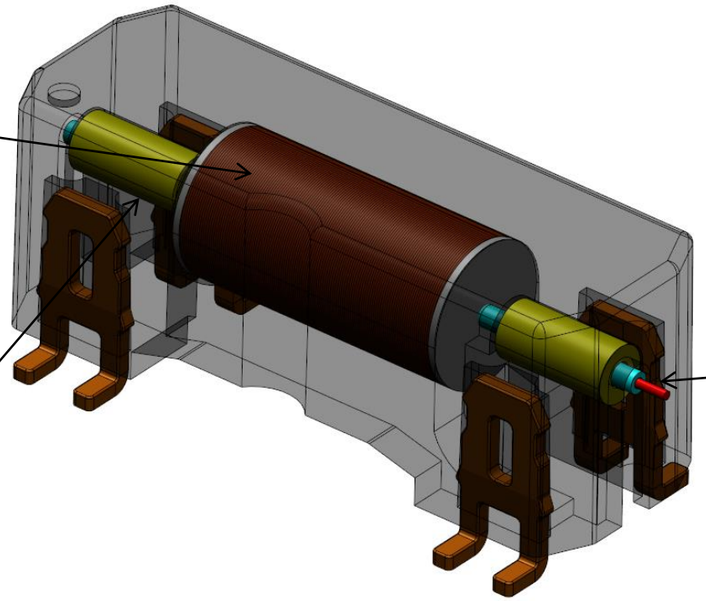
Sequence

- Shaft position
- Potential Energy (Magnetic fields)
- Electrical Pulses
- Boot-up of Electronics and counting
- Permanent storage of position within FRAM

WIEGAND SENSORS

Sensor Design

Coil
- ➢ No of windings
- ➢ Dimensions
- ➢ Coil Diameter
- ➢ Wire Diameter



General Considerations
- ➢ Positioning Tolerances
- ➢ Temperature Range
- ➢ Signal Requirements
- ➢ Packaging

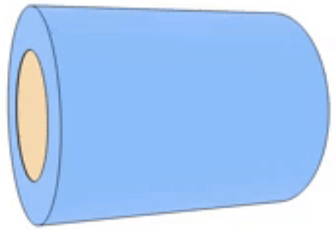
Wiegand Wire
- •Length
- •Diameter
- •Material
- •Processing

Ferrites
- ➢ Ferrite Material
- ➢ Ferrite Dimensions

(concentrates field &
reduces wire end effects)

Magnets & Shielding
- ➢ Magnet material &design
- ➢ Magnetization
- ➢ Distance to Hall Sensor
- ➢ Influence of External Housing

WIEGAND WIRE



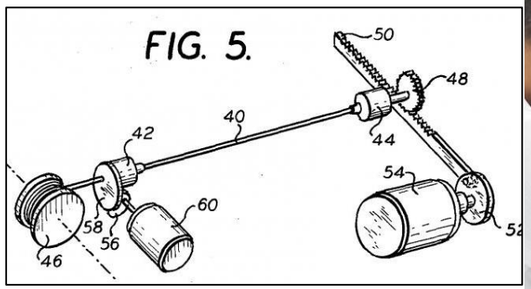


Image from original patent, J R Wiegand

- Aggressive Cold-working Induces Torsional Strain in Vicalloy Wire
- Crystal Structure of Material is Impacted by The Processing
- Creating Two Regions of Significantly Different Magnetic Coercivity
- Interaction of These Regions Creates Magnetic Hysteresis in The Wire
- Manufacturing Process Has Been Automated and Optimised

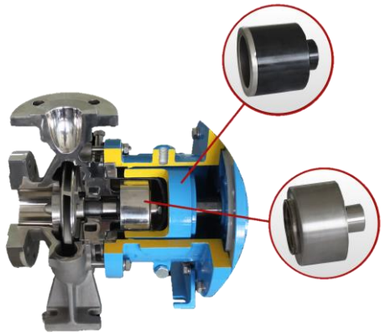
OUTLINE

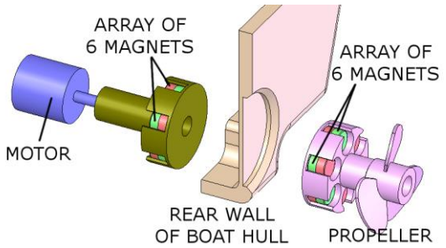
- Historical Background
- Principle of Operation
- **Version Space**
- FAQs

APPLICATIONS – THE FUTURE / TRENDS

- Trends Across Industries Open up New Application Opportunities
  - Internet of Things
  - Collection of Data
  - Sustainability
- Huge Demand for Power-Autonomous Systems
- Battery Life Extension, Offset or Even Replacement
- New Wiegand Sensor Variants Optimised for Energy Harvesting and Power Transmission Present Further Possibililties

APPLICATIONS – FROM SENSOR TO HARVESTER





- Anywhere There Are Changing Magnetic Fields
- Anywhere There Are Limitations/Dependencies on Low Frequencies
- E.g. Magnetic Couplings, Implantable Devices and More

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TAKE-HOME-MESSAGE

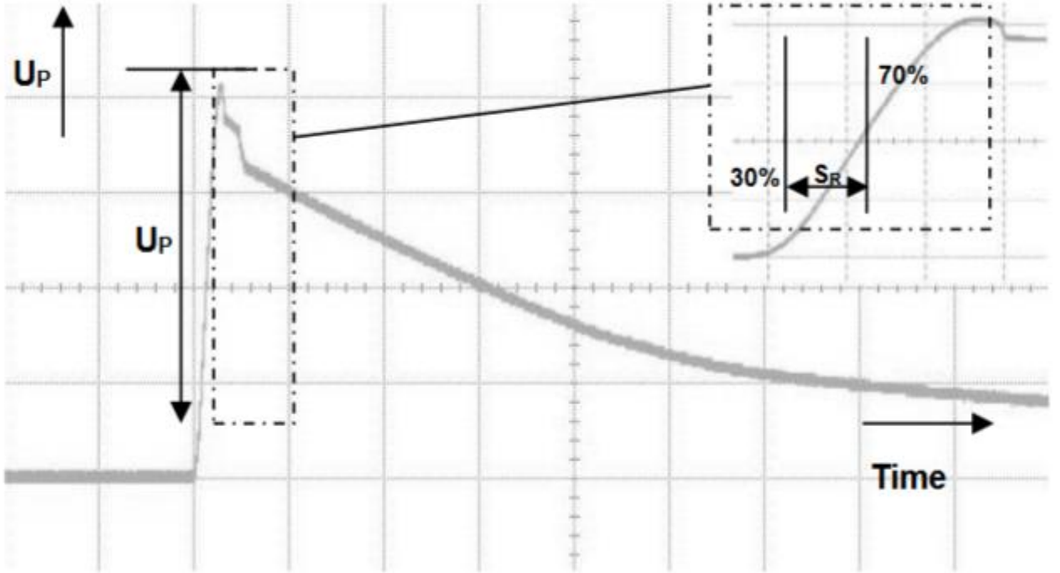
Use Wiegand Sensors not Batteries!

- Wiegand Sensor as Power & Pulse Generator
- No external power required – No batteries
- Longer lifespan
- Operates in harsh environments
- Non contact measurement – No mechanical wear
- For Multiple Applications: Rotary Encoder (Proven Design Concept since 2005), Flow Meter,

OUTLINE

- Business Overview
- Version Space
- Interfaces and Applications
- **FAQs**

Which conditions must be considered to make maximum use of Wiegand sensors?



Comply with the operation conditions noted in the datasheets

- Use specified magnets
- Check distance of magnets to Wiegand wire
- Avoid stray magnetic fields
- Be in accordance with assembly tolerances

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THANK YOU FOR YOU ATTENTION!

ANY QUESTIONS?