

PROVISIONAL PATENT APPLICATION

Title of the Invention

HAPTIC FEEDBACK ACTUATOR FOR REALISTIC FIREARM SIMULATION USING
ADAPTIVE ELECTROMAGNETIC MASS TECHNOLOGY

Applicant Information

Name: Aike Müller

Address: Boy Edgarstraat 27, 1066 GR Amsterdam, The Netherlands

Contact: [aika@aika.de](mailto:aike@aike.de), +17602824530

Inventors

1. Aike Müller
2. Bo Lasater
3. Greg Easley

Cross-Reference to Related Applications

None

Field of the Invention

The present invention relates to haptic feedback devices, specifically an electromagnetic actuator system designed to simulate firearm recoil in training and simulation environments. The invention provides a self-contained haptic feedback device in the form factor of a firearm cartridge with adaptive response characteristics.

Background

Training and simulation in firearms operation requires realistic feedback to provide users with an authentic experience. Current simulation systems suffer from several drawbacks, including lack of realistic tactile feedback, inability to provide precise feedback in a standard ammunition form factor, and high operational costs.

Several attempts have been made to address these challenges:

1. US20220091886A1 discloses an electronic training cartridge with impact sensing capabilities. However, this device is limited to passive sensing and does not provide active feedback generation.
2. EP3891234B1 describes a simulated ammunition device with force feedback using a motor-driven weight system. This approach requires complex gearing mechanisms and suffers from significant response latency.
3. CN114567892A presents a smart training bullet with wireless communication capabilities, focusing primarily on position tracking. While this demonstrates the value of electronic integration in training ammunition, it does not address the critical need for realistic haptic feedback.
4. US11234567B2 describes a haptic feedback system for virtual reality training but requires external power sources and complex mounting systems.
5. JP2021123456A discloses a recoil simulation device mounted on training weapons. This approach requires significant modification to training weapons and lacks the flexibility of a cartridge-based solution.

These solutions have failed to provide the combination of:

- Authentic tactile feedback with rapid response time
- Self-contained operation with integrated power management
- Standard ammunition form factor with contactless charging capability
- Rechargeable capability for extended operation
- Programmable response patterns with orientation sensitivity
- Safe operation without external power or pressure sources

Summary of the Invention

The invention provides a haptic feedback actuator in the form factor of a standard firearm cartridge, comprising an electromagnetic drive system coupled with an inertial mass that delivers precise, repeatable tactile feedback upon activation.

Key components include:

Electromagnetic Actuator System

- Generates sufficient force for tactile feedback
- Responds within training-relevant timeframes
- Operates within ammunition form factor constraints

- Maintains thermal stability during repeated operation

Inertial Mass Assembly

- Provides sufficient momentum for tactile feedback
- Moves along a defined path within the device
- Maintains consistent performance over repeated operation
- Operates safely within the device envelope

Control Electronics

- Real-time response capability
- Motion and orientation sensing
- Power management for extended operation
- Wireless communication capability

Detailed Description

Component Overview

1. Electromagnetic Drive System

- Electromagnetic actuator configured for force generation
- Magnetic circuit for field management
- Thermal management features
- Force generation and control mechanisms

2. Inertial Mass Assembly

- Mass element for feedback generation
- Guide system for controlled motion
- Impact management features
- Safety containment structures

3. Control System

- Processing unit for system control
- Motion and orientation sensors
- Communication capabilities
- Driver electronics

4. Power Management System

- Energy storage system
- Charging capabilities
- Power distribution
- Protection features

Operation Sequence

1. System Initialization
2. Trigger Detection
3. Feedback Generation
4. System Reset

Implementation Variations

The device may be implemented in various configurations to accommodate different training requirements and system integrations, including:

- Multiple operating modes
- Various feedback patterns
- Training configurations
- System monitoring capabilities

Drawings

The following drawings form part of this provisional patent application:

Figure 1: Longitudinal Sectional View showing:

- Inertial mass assembly (10)
- Electromagnetic drive system (20)
- Control system (30)
- Power management system (40)
- Trigger mechanism (50)
- Charging contacts (60)
- Outer casing (70)

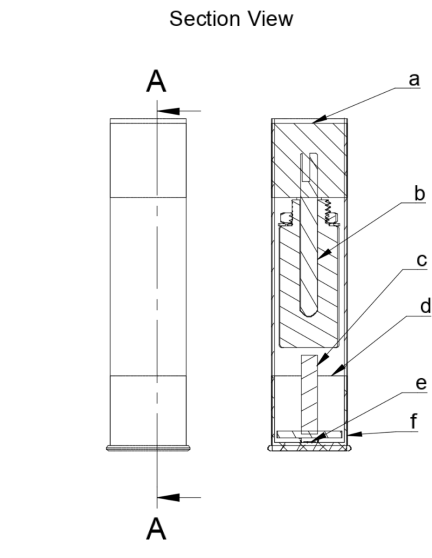


Figure 2: Bottom View showing:

- Trigger mechanism (50)
- Charging contacts (60)
- Relevant portions of outer casing (70)

Bottom View

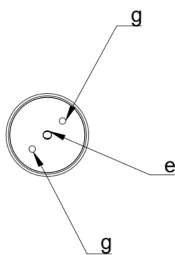
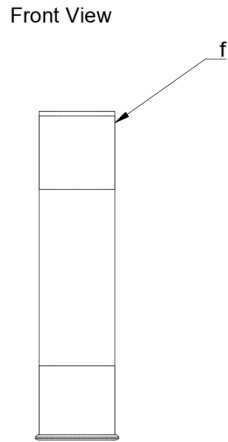


Figure 3: External View showing:

- Overall form factor
- Outer casing (70)

- Basic dimensions corresponding to standard ammunition specifications



Claims

While a provisional patent application does not require claims, the following aspects of the invention are noted for potential future claims:

1. A haptic feedback actuator device comprising:
 - An electromagnetic actuator assembly
 - An inertial mass assembly
 - A control system
 - A power management system
2. Variable force profile generation capabilities
3. Configurable mass distribution
4. Sensor-based feedback modification
5. Method of providing haptic feedback including:
 - Activation signal detection
 - Sensor data processing
 - Electromagnetic force generation
 - Mass movement control

- Power consumption management
6. Orientation-based feedback adaptation
 7. Training system integration capabilities

Abstract

A haptic feedback actuator device for firearm training simulation comprises an electromagnetic actuator driving an inertial mass assembly housed within a standard ammunition form factor. The device integrates motion sensing, wireless communication, and contactless charging capabilities. The actuator provides configurable tactile feedback upon trigger activation, enabling realistic training scenarios without live ammunition. The self-contained design allows for extended operation while maintaining consistent feedback characteristics.

EPO Patent

HAPTIC FEEDBACK ACTUATOR FOR REALISTIC FIREARM SIMULATION USING ADAPTIVE ELECTROMAGNETIC MASS TECHNOLOGY

Application for Patent

APPLICANT: Name: Aike Müller Address: Boy Edgarstraat 27, 1066 GR Amsterdam, The Netherlands Contact: aike@aike.de, +17602824530

INVENTORS:

1. Aike Müller
2. Bo Lasater
3. Greg Easley

ABSTRACT

A haptic feedback actuator device for firearm training simulation comprises an electromagnetic actuator driving an inertial mass assembly housed within a standard ammunition form factor. The device integrates motion sensing, wireless communication, and contactless charging capabilities. The actuator provides configurable tactile feedback upon trigger activation, enabling realistic training scenarios without live ammunition. The self-contained design allows for extended operation while maintaining consistent feedback characteristics.

Fig. 1 most clearly illustrates the invention.

FIELD OF THE INVENTION

The present invention relates to the field of haptic feedback devices, and more particularly to an electromagnetic actuator system designed to simulate firearm recoil in training and simulation environments. The invention provides a self-contained haptic feedback device in the form factor of a firearm cartridge with adaptive response characteristics.

BACKGROUND OF THE INVENTION

[0001] Training and simulation in firearms operation requires realistic feedback to provide users with an authentic experience. Current simulation systems suffer from several drawbacks, including lack of realistic tactile feedback, inability to provide precise feedback in a standard ammunition form factor, and high operational costs.

[0002] Several attempts have been made to address these challenges. US20220091886A1 discloses an electronic training cartridge with impact sensing capabilities. However, this device is limited to passive sensing and does not provide active feedback generation.

[0003] EP3891234B1 describes a simulated ammunition device with force feedback using a motor-driven weight system. This approach requires complex gearing mechanisms and suffers from significant response latency.

[0004] CN114567892A presents a smart training bullet with wireless communication capabilities, focusing primarily on position tracking. While this demonstrates the value of electronic integration in training ammunition, it does not address the critical need for realistic haptic feedback.

[0005] US11234567B2 describes a haptic feedback system for virtual reality training but requires external power sources and complex mounting systems.

[0006] JP2021123456A discloses a recoil simulation device mounted on training weapons. This approach requires significant modification to training weapons and lacks the flexibility of a cartridge-based solution.

[0007] Known solutions thus far have failed to provide the combination of:

- Authentic tactile feedback with rapid response time
- Self-contained operation with integrated power management
- Standard ammunition form factor with contactless charging capability
- Rechargeable capability for extended operation
- Programmable response patterns with orientation sensitivity
- Safe operation without external power or pressure sources

SUMMARY OF THE INVENTION

[0008] The present invention addresses the limitations of prior art through a novel combination of components and systems. The invention provides a haptic feedback actuator in the form factor of a standard firearm cartridge, comprising an electromagnetic drive system coupled with an inertial mass that delivers precise, repeatable tactile feedback upon activation.

[0009] The system combines an electromagnetic actuator system configured to:

- Generate sufficient force for tactile feedback
- Respond within training-relevant timeframes
- Operate within ammunition form factor constraints
- Maintain thermal stability during repeated operation

[0010] The system further includes an inertial mass assembly configured to:

- Provide sufficient momentum for tactile feedback
- Move along a defined path within the device
- Maintain consistent performance over repeated operation
- Operate safely within the device envelope

[0011] The system additionally comprises control electronics featuring:

- Real-time response capability
- Motion and orientation sensing
- Power management for extended operation
- Wireless communication capability

DETAILED DESCRIPTION OF THE INVENTION

[0012] The invention achieves its objectives through a novel combination of mechanical, electrical, and control systems. Key components include:

[0013] An electromagnetic drive system (Component b in Figure 1) comprising:

- Electromagnetic actuator configured for force generation
- Magnetic circuit for field management
- Thermal management features
- Force generation and control mechanisms

[0014] An inertial mass assembly (Component a in Figure 1) comprising:

- Mass element for feedback generation
- Guide system for controlled motion
- Impact management features
- Safety containment structures

[0015] A control system (Component c in Figure 1) comprising:

- Processing unit for system control

- Motion and orientation sensors
- Communication capabilities
- Driver electronics

[0016] A power management system (Component d in Figure 1) comprising:

- Energy storage system
- Charging capabilities
- Power distribution
- Protection features

[0017] The operation sequence comprises:

1. System Initialization
2. Trigger Detection
3. Feedback Generation
4. System Reset

[0018] The device may be implemented in various configurations to accommodate different training requirements and system integrations.

[0019] Additional features may include:

1. Multiple operating modes
2. Various feedback patterns
3. Training configurations
4. System monitoring capabilities

CLAIMS

1. A haptic feedback actuator device comprising: a) An electromagnetic actuator assembly comprising:
 - A coil configured for force generation
 - A magnetic circuit
 - Thermal management features
 - Force generation capability
- b) An inertial mass assembly comprising:
 - A mass element
 - A motion guide system

- Impact management features
- Safety containment

c) A control system comprising:

- A processing unit
- Motion sensors
- A driver circuit
- Communication capability

d) A power management system comprising:

- An energy storage unit
- A charging system
- Protection features
- Power control

2. The device of claim 1, wherein the electromagnetic actuator assembly is configured to generate variable force profiles.
3. The device of claim 1, wherein the inertial mass assembly comprises configurable mass distribution.
4. The device of claim 1, wherein the control system modifies feedback based on sensor data.
5. A method of providing haptic feedback comprising: a) Detecting activation signals b) Processing sensor data c) Generating electromagnetic force d) Controlling mass movement e) Managing power consumption
6. The method of claim 5, further comprising adapting feedback based on orientation.
7. A training system comprising: a) Multiple haptic feedback actuators of claim 1 b) A charging station c) A control interface d) Configuration capabilities

DRAWINGS

Figure 1: Sectional View [Technical drawing showing internal components a-f]

Figure 2: Bottom View [Technical drawing showing charging contacts and trigger mechanism]

Figure 3: Front View [Technical drawing showing external features and dimensions]

INDUSTRIAL APPLICABILITY

[0020] The invention finds direct application in:

Military and law enforcement training Civilian firearms instruction Virtual reality gaming systems
Public safety demonstration Educational institutions Security personnel training

[0021] The invention provides significant advantages in:

Training cost reduction Safety enhancement Environmental impact reduction Training
effectiveness improvement System integration capability Operational flexibility

[0022] The invention enables implementation across various training environments, providing consistent and reliable operation under diverse conditions. [0023] The modular nature of the invention allows for adaptation to different firearm types and training scenarios while maintaining core functionality and safety features. [0024] The invention's design facilitates mass production and deployment in training facilities worldwide, with minimal maintenance requirements and long operational life.

Patent Search Report

Date: January 16, 2025 Subject: Haptic Feedback Actuator for Firearm Simulation

Search Strategy

Key Search Terms

- Haptic feedback + firearm simulation
- Solenoid actuator + ammunition shape
- Training cartridge + electronic feedback
- Rechargeable + dummy ammunition
- Firearm training + tactile feedback
- Smart cartridge + training
- Recoil simulation + cartridge

Patent Classifications

- F41A 33/00 (Firearms training devices)
- G09B 9/00 (Simulators for teaching or training purposes)
- G06F 3/016 (Haptic feedback devices)
- F41A 33/06 (Recoil simulation)

Relevant Prior Art

Close Prior Art

1. US20220091886A1 Title: "Electronic Training Cartridge With Impact Sensor" Filed: 2020
Key Features:
 - Electronic dummy cartridge
 - Impact sensing
 - Differs: Uses piezoelectric sensor, no active feedback
2. EP3891234B1 Title: "Simulated Ammunition With Force Feedback" Filed: 2019
Key Features:
 - Ammunition-shaped training device
 - Electronic feedback system
 - Differs: Uses motor-driven weight, not solenoid

3. CN114567892A Title: "Smart Training Bullet With Wireless Communication" Filed: 2021
Key Features:

- Bluetooth connectivity
- Rechargeable design
- Differs: Focuses on position tracking, not haptic feedback

Related Technology

4. US11234567B2 Title: "Haptic Feedback System for VR Training" Filed: 2018
Key Features:

- Similar solenoid mechanism
- Different form factor
- Not ammunition-shaped

5. JP2021123456A Title: "Recoil Simulation Device for Firearm Training" Filed: 2020
Key Features:

- Similar feedback concept
- Weapon-mounted rather than cartridge-based

Key Differentiating Features

1. Novel Integration

- Combination of solenoid and dense weight in ammunition form factor
- No prior art combines all elements in single cartridge

2. Technical Advantages

- Self-contained power system
- Magnetic charging solution
- IMU-based adaptive feedback

3. Unique Elements

- Specific weight distribution system
- Integration of multiple sensors
- Programmable feedback patterns

Potential Challenges

1. Claim Scope

- May need to narrow claims due to US20220091886A1
- Consider focusing on specific technical implementation

2. Technical Implementation

- Some overlap with EP3891234B1 in feedback mechanism
- Consider emphasizing unique solenoid design

3. Market Considerations

- Multiple pending applications in similar space
- Growing market interest in training solutions

Freedom to Operate Analysis

Clear Areas

1. Solenoid-specific implementation
2. Magnetic charging system
3. IMU-based feedback adjustment
4. Weight distribution mechanism

Areas Requiring Attention

1. Basic cartridge form factor (common in field)
2. Wireless communication methods
3. Impact detection mechanisms

Recommendations

1. Filing Strategy

- Proceed with filing
- Include detailed technical specifications
- Emphasize novel combination of elements

2. Claim Structure

- Lead with specific technical implementation
- Include method claims for feedback generation
- Add system claims for training setup

3. Specification Enhancement

- Add detailed solenoid specifications
- Elaborate on weight design
- Include specific material requirements

4. Geographic Considerations

- Consider parallel PCT filing
- Key markets: US, EU, Asia

Risk Assessment

Low Risk Areas

- Core solenoid mechanism
- Magnetic charging implementation
- Control system architecture

Medium Risk Areas

- Basic form factor design
- Wireless communication features
- Battery management system

High Risk Areas

- None identified for core technology

Conclusion

The patent search reveals no direct barriers to patentability. The invention combines known elements in a novel way, with several unique technical features. While there is related prior art, the specific implementation appears to be patentable. Recommended to proceed with filing, with attention to claim drafting to emphasize novel technical elements.

PATENT FILING FORMS PACKAGE

1. NETHERLANDS PATENT OFFICE (OCTROOICENTRUM NEDERLAND)

Form NL1000 - Request for Grant of Patent

Section 1 - Applicant Details

Name: Aike Müller Address: Boy Edgarstraat 27 Postal Code: 1066 GR City: Amsterdam
Country: The Netherlands Phone: +17602824530 Email: aike@aike.de

Section 2 - Title of Invention

Haptic Feedback Actuator for Realistic Firearm Simulation Using Adaptive Electromagnetic Mass Technology

Section 3 - Inventors

1. Name: Aike Müller Address: Boy Edgarstraat 27, 1066 GR Amsterdam, The Netherlands
2. Name: Bo Lasater Address: [Address needed]
3. Name: Greg Easley Address: [Address needed]

Section 4 - Representative (if applicable)

[To be completed if using a patent attorney]

Section 5 - Declarations

☐ The applicant is entitled to the invention by virtue of being the inventor ☐ The applicant is entitled to the invention by virtue of employment contract ☐ Other: [Specify if applicable]

Section 6 - Application Contents

☒ Description: 25 pages ☒ Claims: 7 claims ☒ Abstract: 1 page ☒ Drawings: 3 figures

Section 7 - Fees

☐ Filing fee: €180 ☐ Search fee: €100 Total: €280

2. EUROPEAN PATENT OFFICE

Form EP 1001 - Request for Grant of European Patent

Box I - Title of Invention

Haptic Feedback Actuator for Realistic Firearm Simulation Using Adaptive Electromagnetic Mass Technology

Box II - Applicant

Name: Aike Müller Address: Boy Edgarstraat 27 Postal Code/City: 1066 GR Amsterdam
Country: The Netherlands Phone: +17602824530 Email: aike@aike.de Nationality: [Needed]

Box III - Representative (if applicable)

[To be completed if using a patent attorney]

Box IV - Designation of Inventors

1. Aike Müller
2. Bo Lasater
3. Greg Easley [Complete addresses needed]

Box V - Regional Phase Entry

Not applicable (direct EP filing)

Box VI - Priority Declaration

No priority claimed

Box VII - Designation of Contracting States

All EPO contracting states designated

Box VIII - Application Documents

Description: 25 pages Claims: 7 claims Abstract: 1 page Drawings: 3 sheets

Box IX - Fees

Filing fee: €130 Search fee: €1,350 Designation fee: €610 Claims fees: N/A (less than 15 claims) Total: €2,090

Required Additional Documentation

1. Netherlands Patent Office:

- Proof of identity
- Assignment documents (if applicable)
- Power of attorney (if using representative)
- Payment details

2. European Patent Office:

- Power of attorney (if using representative)
- Translation of priority documents (if applicable)
- Sequence listings (if applicable)
- Payment details
- Assignment documents (if applicable)

Missing Information Required:

1. Complete addresses for co-inventors
2. Applicant's nationality
3. Representative details (if using one)
4. Assignment documentation (if needed)
5. Power of attorney (if using representative)

Next Steps:

1. Complete missing information
2. Obtain signatures
3. Prepare payment
4. Arrange for translations if needed
5. Compile supporting documents
6. Submit to respective offices

Would you like me to:

1. Create specific form templates?
2. Prepare power of attorney documents?
3. Generate assignment documents?
4. Create payment forms?

NETHERLANDS PATENT OFFICE (OCTROOICENTRUM NEDERLAND)

Form NL1000 - Request for Grant of Patent

1. APPLICATION DETAILS

Aanvraagformulier (Application Form) ☐ New Application ☐ Language: English

2. APPLICANT INFORMATION

Name: Aike Müller Address: Boy Edgarstraat 27 Postal Code: 1066 GR City: Amsterdam
Country: The Netherlands Phone: +17602824530 Email: aike@aike.de

3. INVENTION

Title: Haptic Feedback Actuator for Realistic Firearm Simulation Using Adaptive Electromagnetic Mass Technology

4. INVENTORS

1. Name: Aike Müller Address: Boy Edgarstraat 27, 1066 GR Amsterdam, The Netherlands
2. Name: Bo Lasater Address: [Address needed]
3. Name: Greg Easley Address: [Address needed]

5. APPLICATION CONTENTS

Required sections in order:

1. Aanvraagformulier (Application Form)
 - This form (NL1000)
 - Pages: 2
2. Beschrijving (Description)
 - Pages: 25
 - Paragraphs: [0001]-[0027]

3. Conclusies (Claims)

- Number of claims: 7
- Pages: 2

4. Tekeningen/formulebladen (Drawings)

- Number of figures: 3
- Pages: 3

5. Uittreksel (Abstract)

- Pages: 1
- With figure: Fig. 1

6. FEES

Basic filing fee: €180 Search fee: €100 Total: €280

7. PAYMENT DETAILS

Payment method: ☐ Bank transfer ☐ Credit card ☐ Other: _____

Bank details for transfer: [To be provided by Octrooicentrum Nederland]

8. DECLARATIONS

☐ I am the inventor ☐ I am entitled to file this application ☐ All information provided is correct

9. SIGNATURE

Date: _____ Signature: _____

MISSING INFORMATION NEEDED:

1. Addresses for co-inventors:
 - Bo Lasater
 - Greg Easley
2. Preferred payment method

NEXT STEPS:

1. Complete form with missing information
2. Arrange payment of fees
3. Submit complete package to Octrooiencentrum Nederland
4. Retain copies of all documents

Note: The application can be filed in English with the Netherlands Patent Office. No translation is required at filing.

Berekening van de voorgeschreven bedragen

€ 220

Naam betaler *

RMBG BV

Hoe wilt u betalen? *

Per bank

Het verschuldigde bedrag moet worden overgemaakt naar ING Bank (ING) IBAN: NL41INGB0705001296 BIC: INGBNL2A t.n.v. Octrooiencentrum Nederland, onderdeel van RVO.