US 20110278364A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2011/0278364 A1**

(43) **Pub. Date: Nov. 17, 2011**

Mullen et al.

(54) **CARDS AND DEVICES WITH MAGNETIC EMULATORS AND MAGNETIC READER READ-HEAD DETECTORS**

(76) Inventors: **Jeffrey D. Mullen**, Pittsburgh, PA (US); **David Lambeth**, Pittsburgh, PA (US); **Bruce Cloutier**, Jeannette, PA (US)

(21) Appl. No.: **13/187,483**

(22) Filed: **Jul. 20, 2011**

Related U.S. Application Data

(63) Continuation of application No. 12/339,071, filed on Dec. 19, 2008.

(60) Provisional application No. 61/016,491, filed on Dec. 24, 2007, provisional application No. 61/026,846, filed on Feb. 7, 2008, provisional application No. 61/027,807, filed on Feb. 11, 2008, provisional application No. 61/081,003, filed on Jul. 15, 2008, provisional application No. 61/086,239, filed on Aug. 5, 2008, provisional application No. 61/090,423, filed on Aug. 20, 2008, provisional application No. 61/097,401, filed on Sep. 16, 2008, provisional application No. 61/112,766, filed on Nov. 9, 2008, provisional application No. 61/117,186, filed on Nov. 23, 2008, provisional application No. 61/119,366, filed on Dec. 2, 2008, provisional application No. 61/120,813, filed on Dec. 8, 2008.

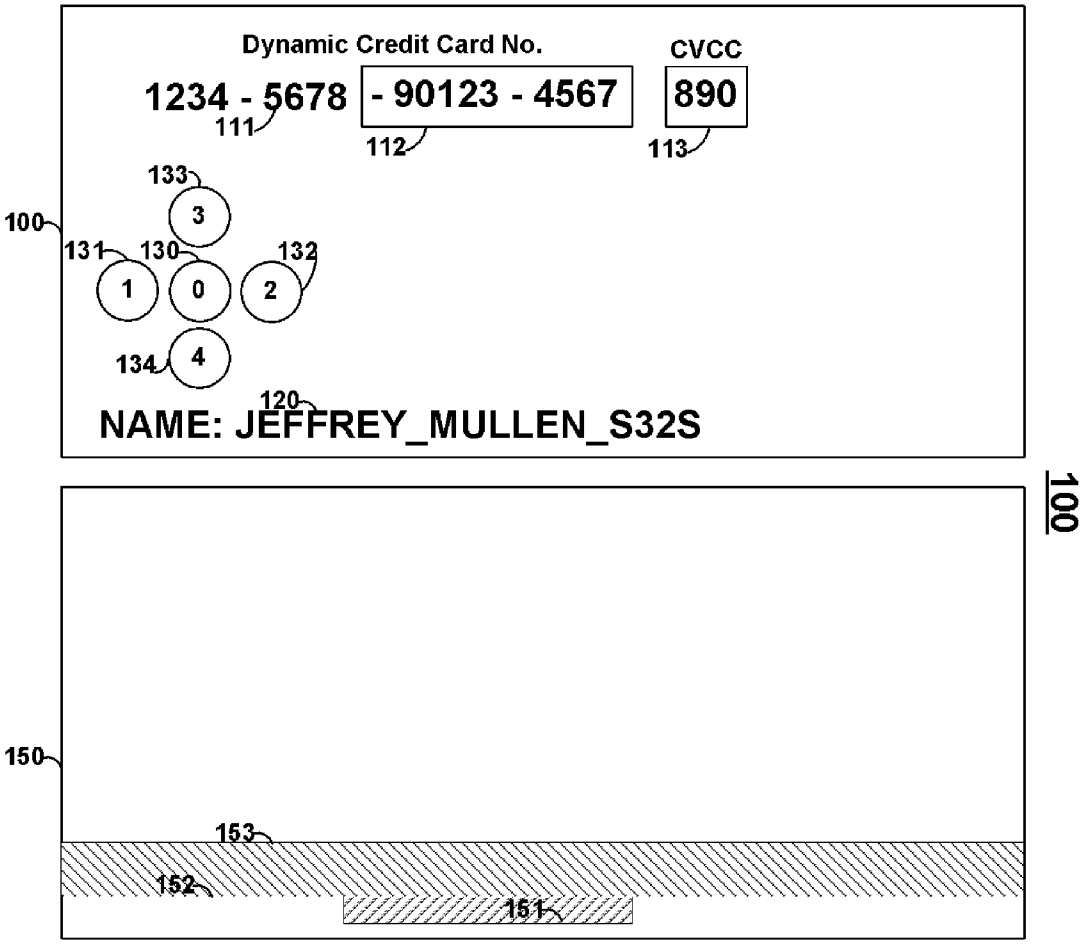
Publication Classification

(51) **Int. Cl.**
G06K 19/073 (2006.01)

(52) **U.S. Cl.** **235/492**

(57) **ABSTRACT**

A payment card (e.g., credit and/or debit card) is provided with a magnetic emulator operable to act as a magnetic stripe read-head detector and a data transmitter. A multiple layer flexible PCB may be fabricated to include multiple magnetic emulators. Layers of the flexible PCB may include magnetic shielding in order to reduce interference from the magnetic emulators to particular read-heads on a magnetic stripe reader.



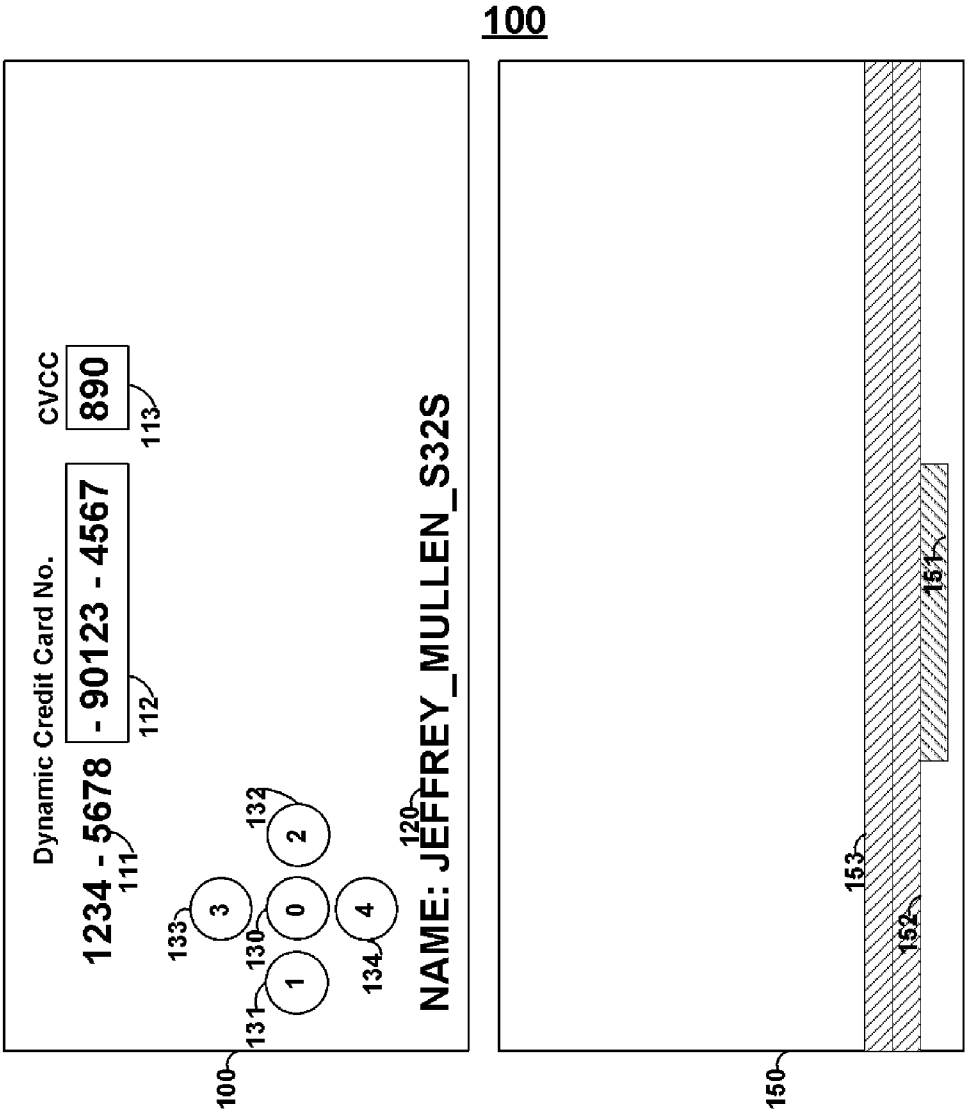

100
Dynamic Credit Card No.
1234 - 5678 - 90123 - 4567
111
112
CVCC
890
113
NAME: JEFFREY_MULLEN_S32S
120
3
0
2
4
1
130
131
132
133
134
100
150
151
152
153

FIG. 1

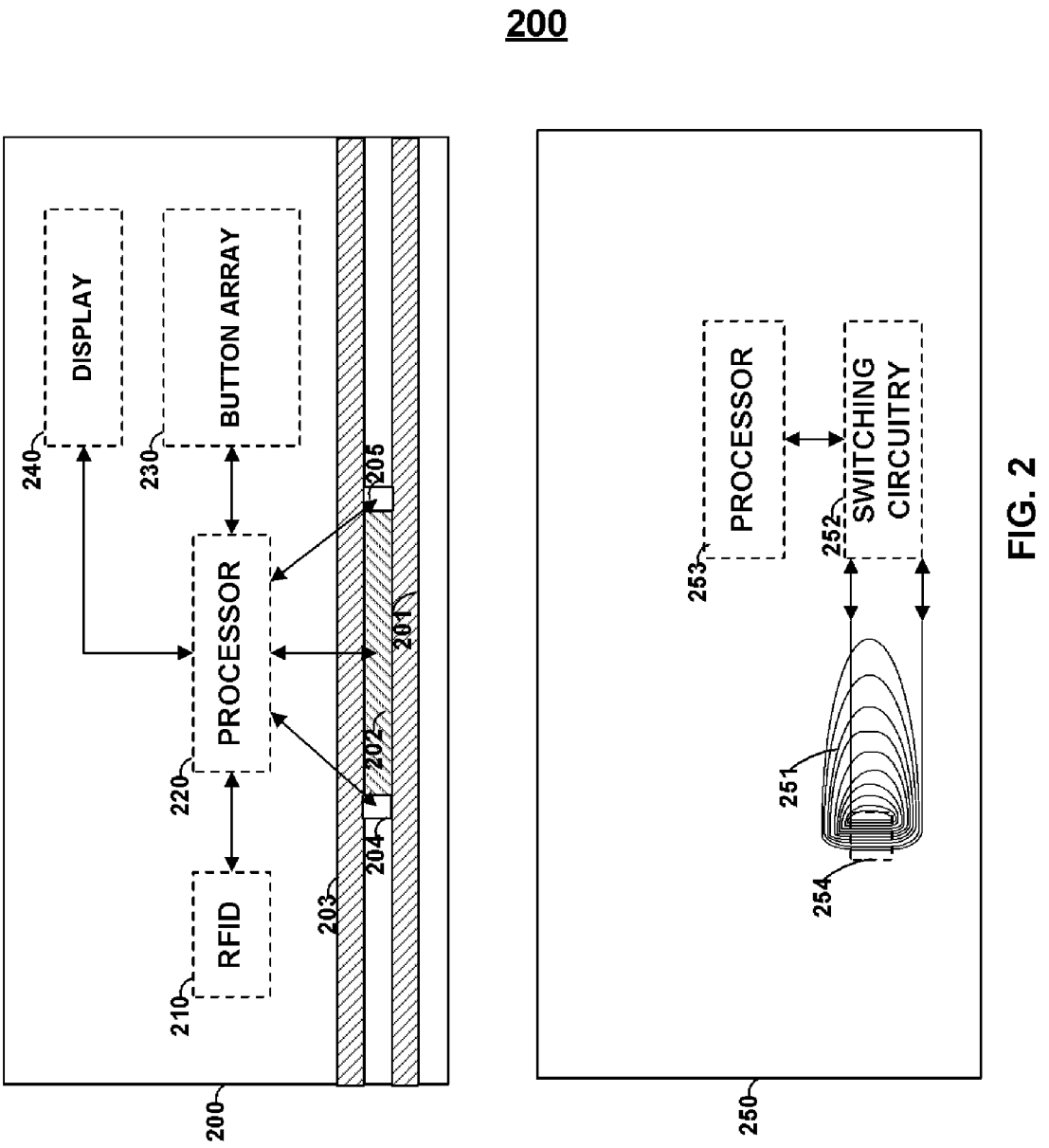

200
DISPLAY
240
BUTTON ARRAY
230
PROCESSOR
220
RFID
210
205
201
202
204
203
200
PROCESSOR
253
SWITCHING CIRCUITRY
252
251
254
250

FIG. 2

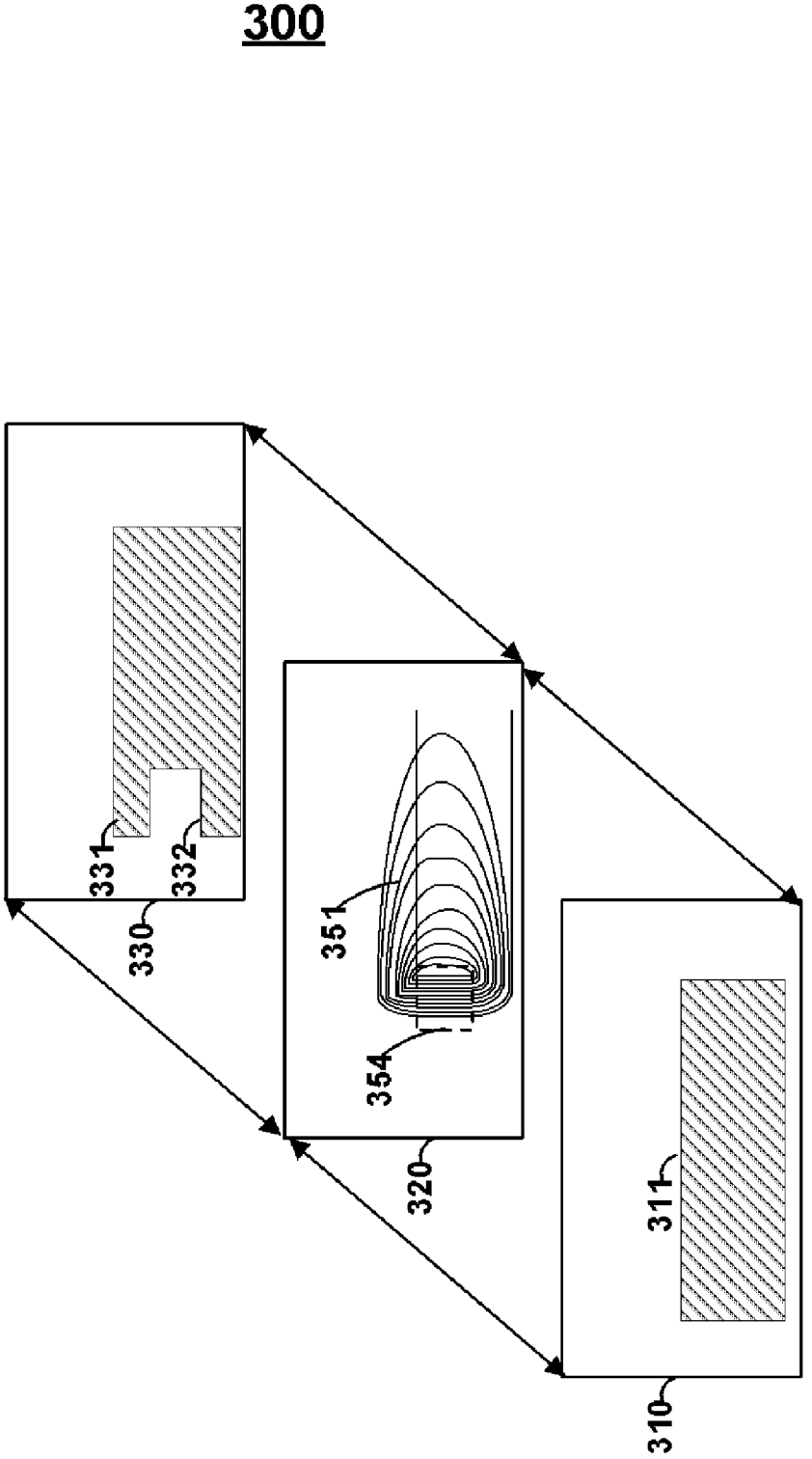


FIG. 3

400

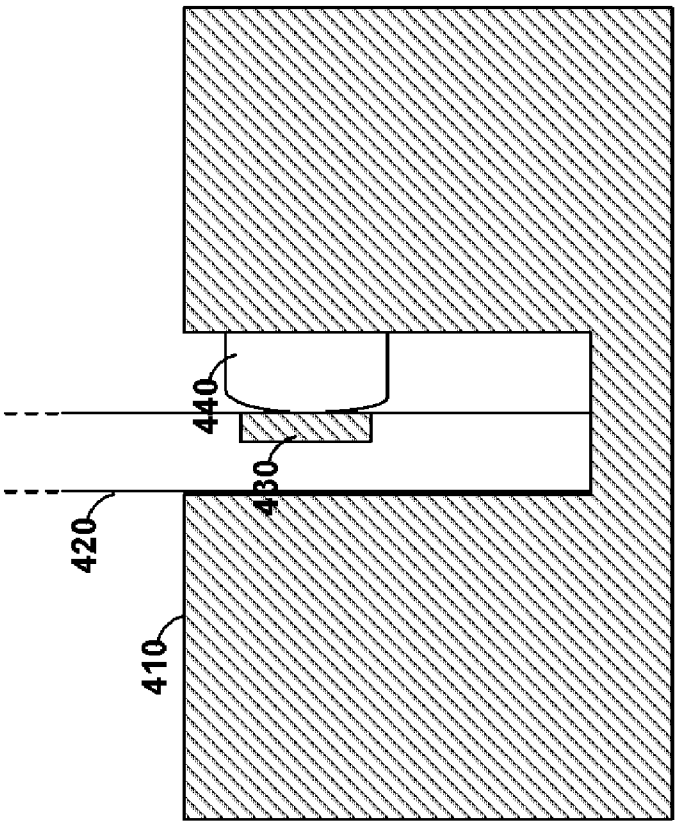


FIG. 4

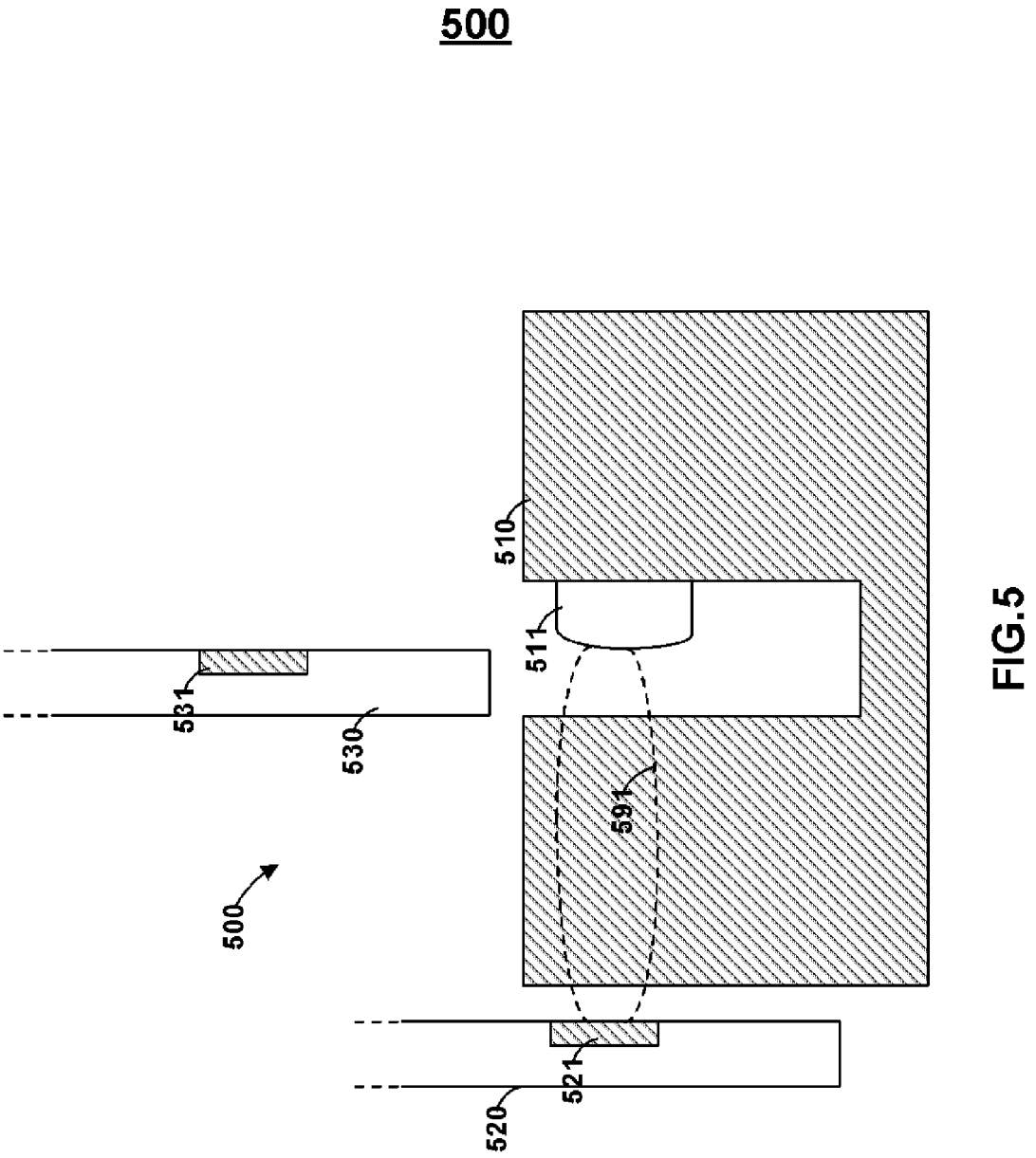


FIG.5

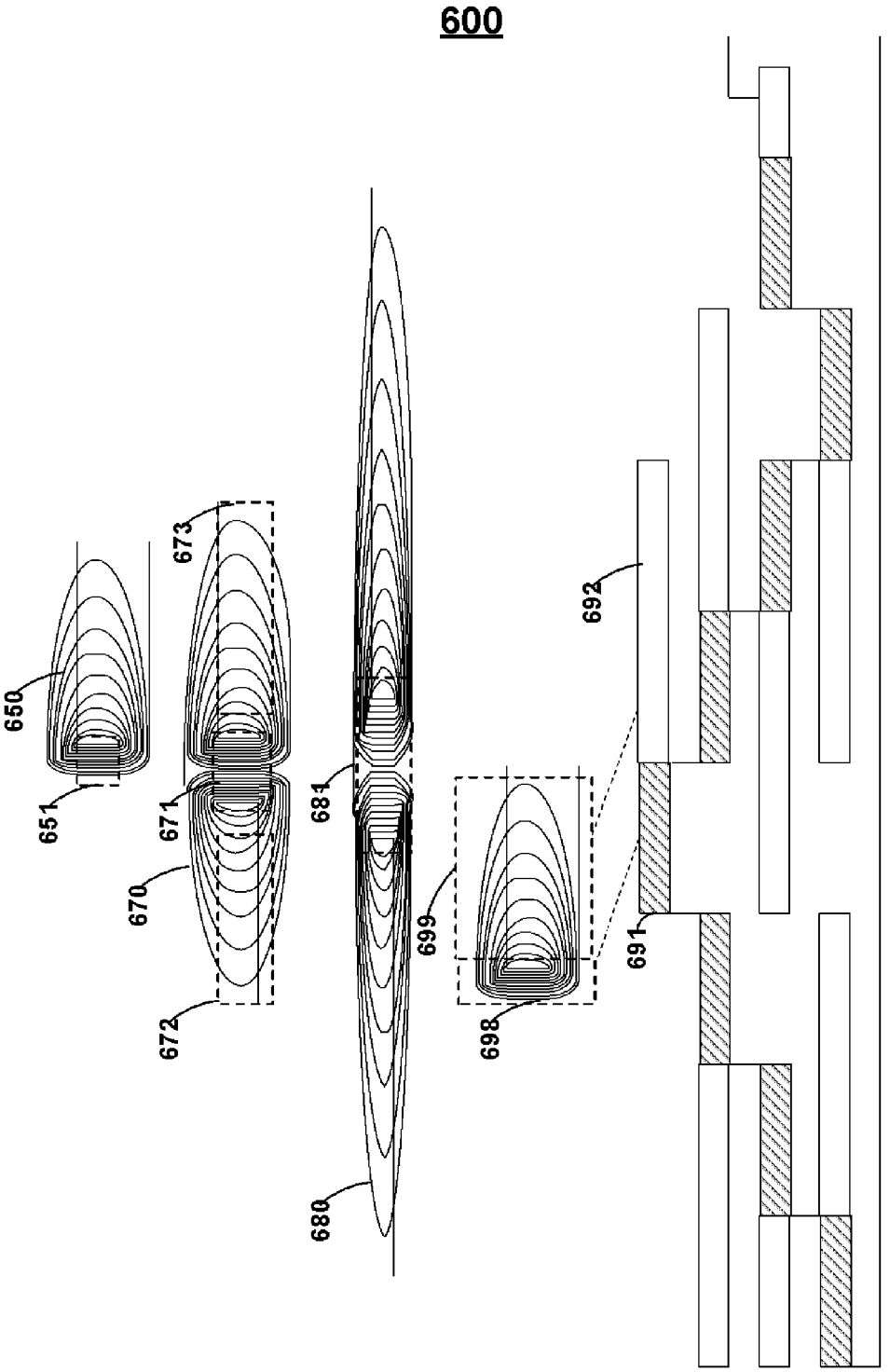


FIG. 6

700

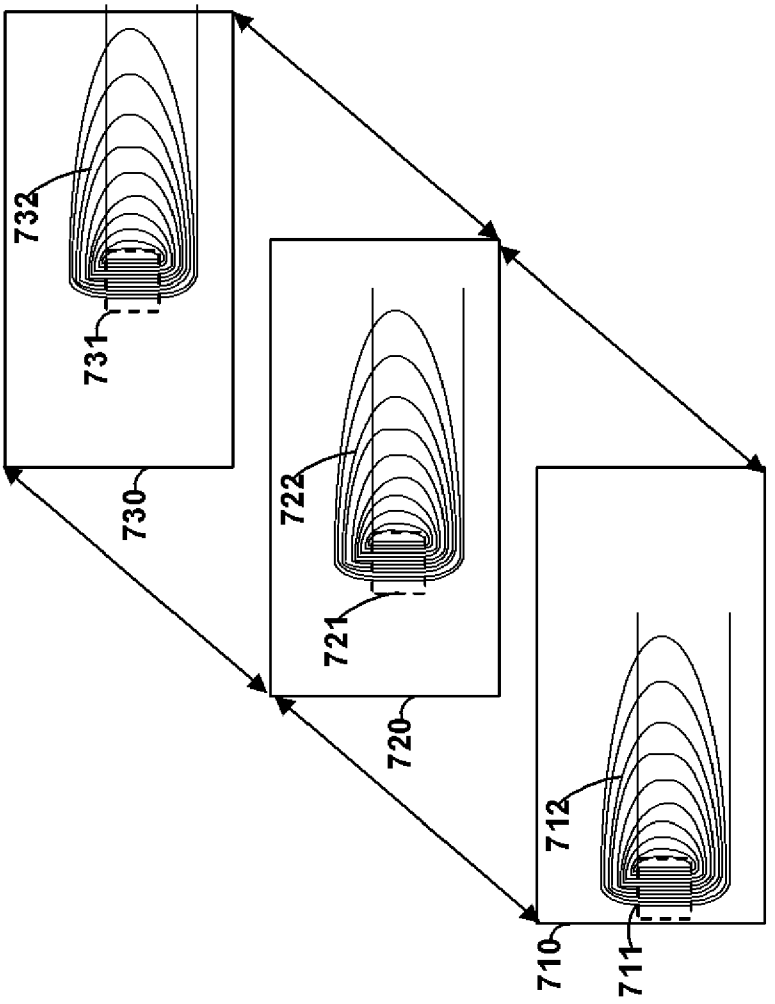


FIG. 7

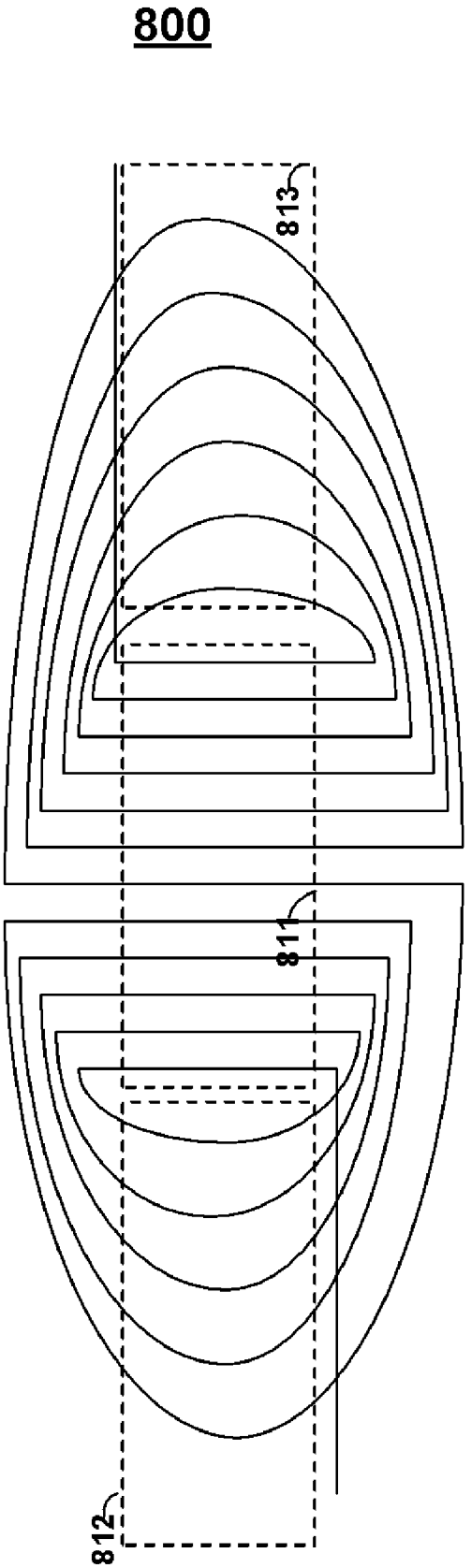


FIG. 8

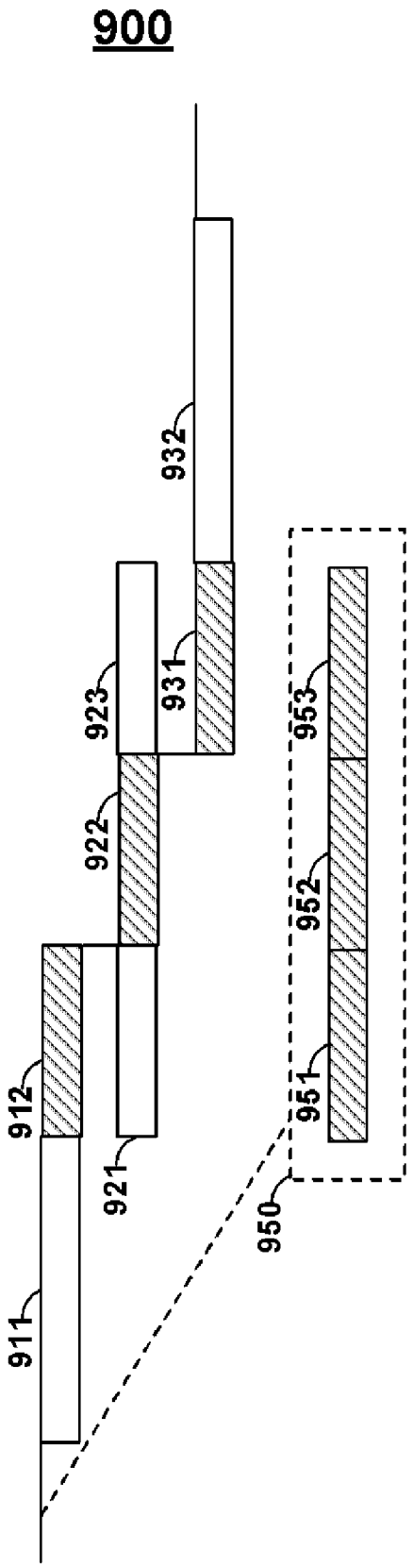


FIG. 9

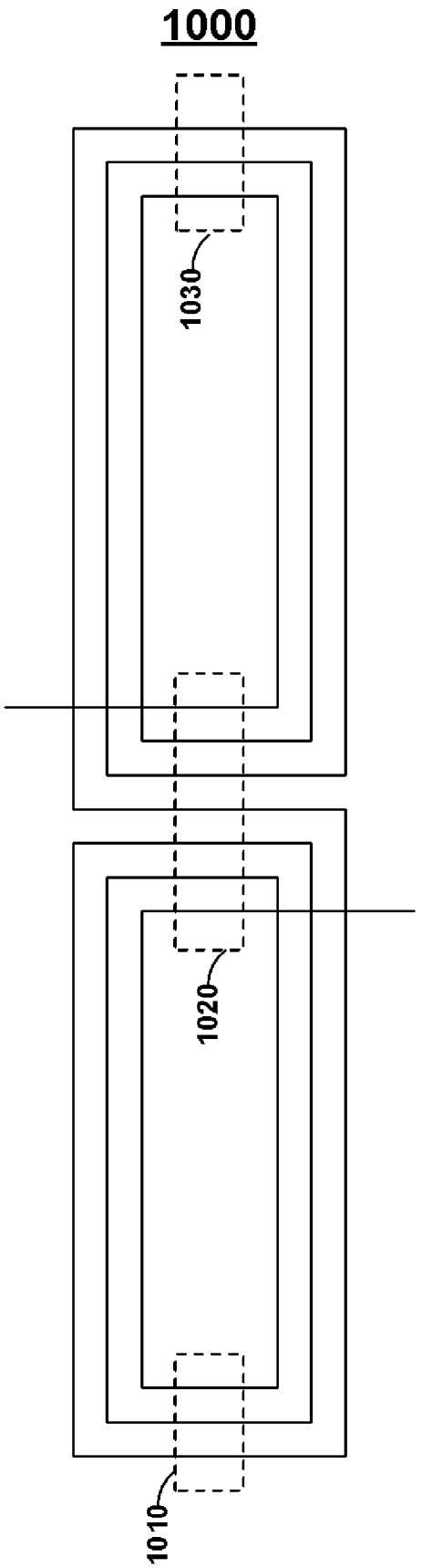


FIG. 10

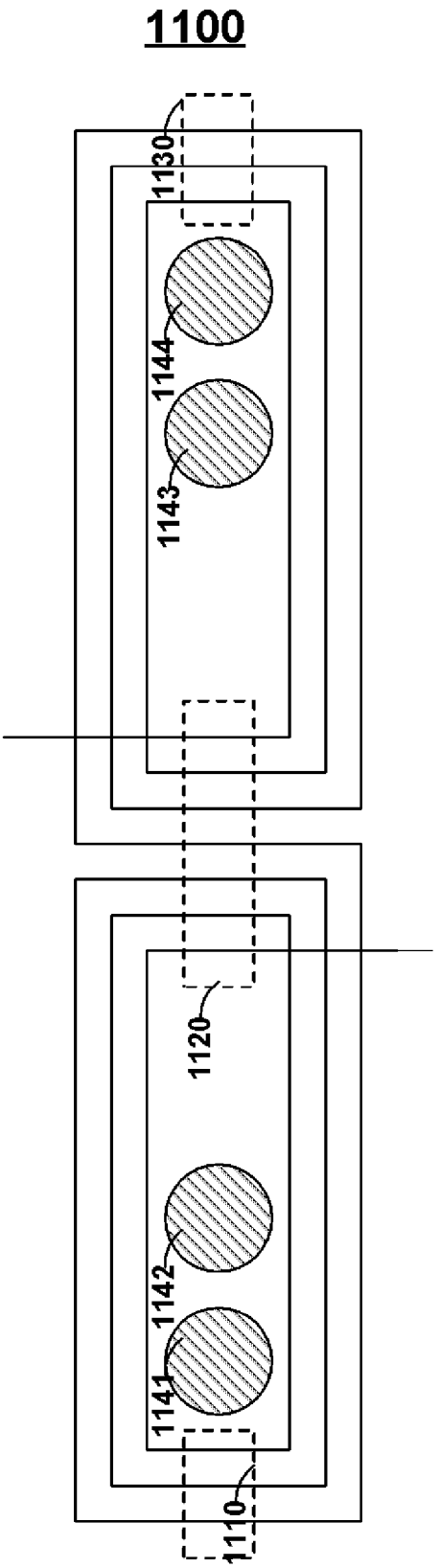


FIG. 11

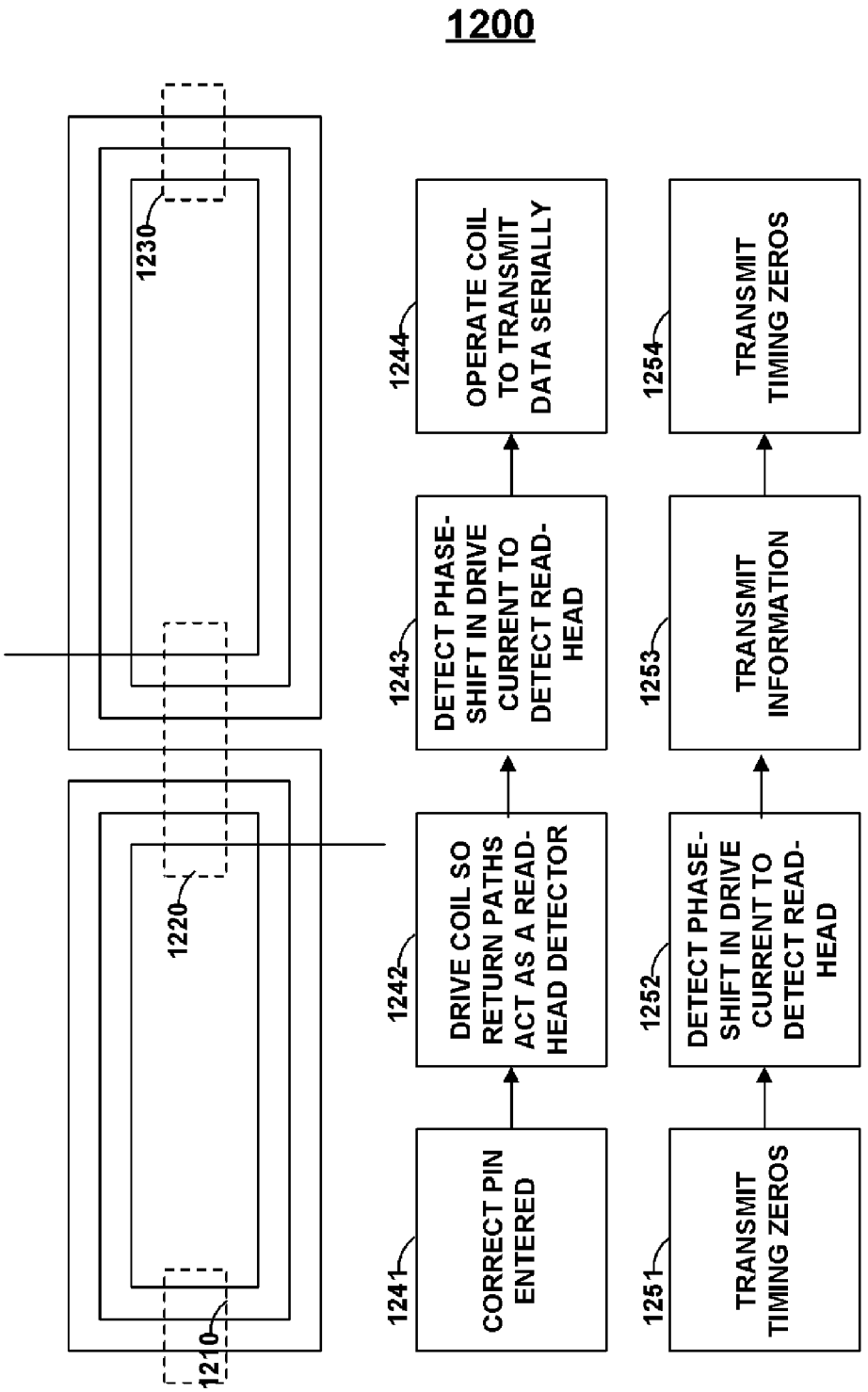

1200
1230
1220
1210
1241
CORRECT PIN ENTERED
1242
DRIVE COIL SO RETURN PATHS ACT AS A READ-HEAD DETECTOR
1243
DETECT PHASE-SHIFT IN DRIVE CURRENT TO DETECT READ-HEAD
1244
OPERATE COIL TO TRANSMIT DATA SERIALLY
1251
TRANSMIT TIMING ZEROS
1252
DETECT PHASE-SHIFT IN DRIVE CURRENT TO DETECT READ-HEAD
1253
TRANSMIT INFORMATION
1254
TRANSMIT TIMING ZEROS

FIG. 12

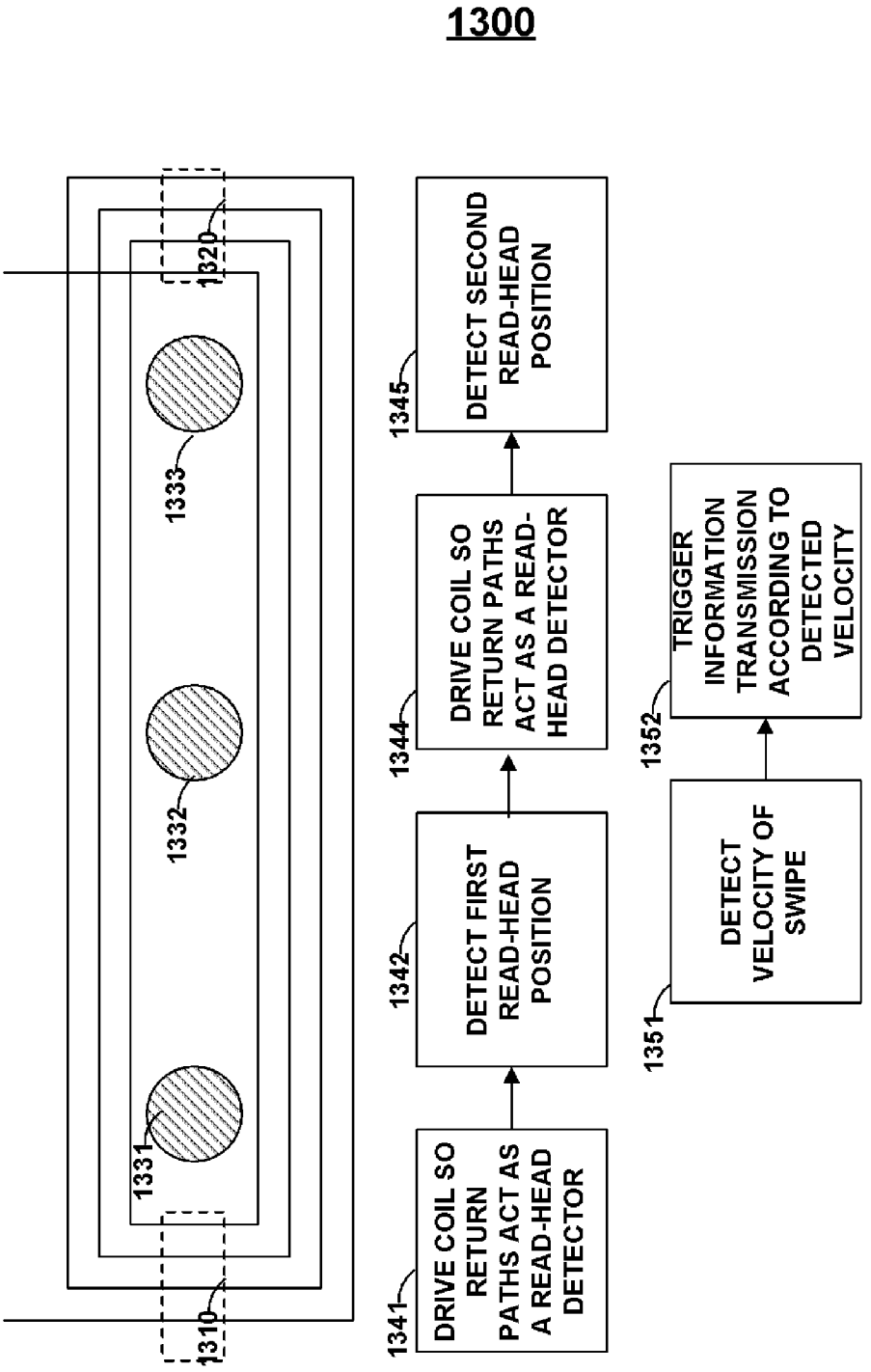

1300
1310
1320
1331
1332
1333
1341
DRIVE COIL SO RETURN PATHS ACT AS A READ-HEAD DETECTOR
1342
DETECT FIRST READ-HEAD POSITION
1344
DRIVE COIL SO RETURN PATHS ACT AS A READ-HEAD DETECTOR
1345
DETECT SECOND READ-HEAD POSITION
1351
DETECT VELOCITY OF SWIPE
1352
TRIGGER INFORMATION TRANSMISSION ACCORDING TO DETECTED VELOCITY

FIG. 13

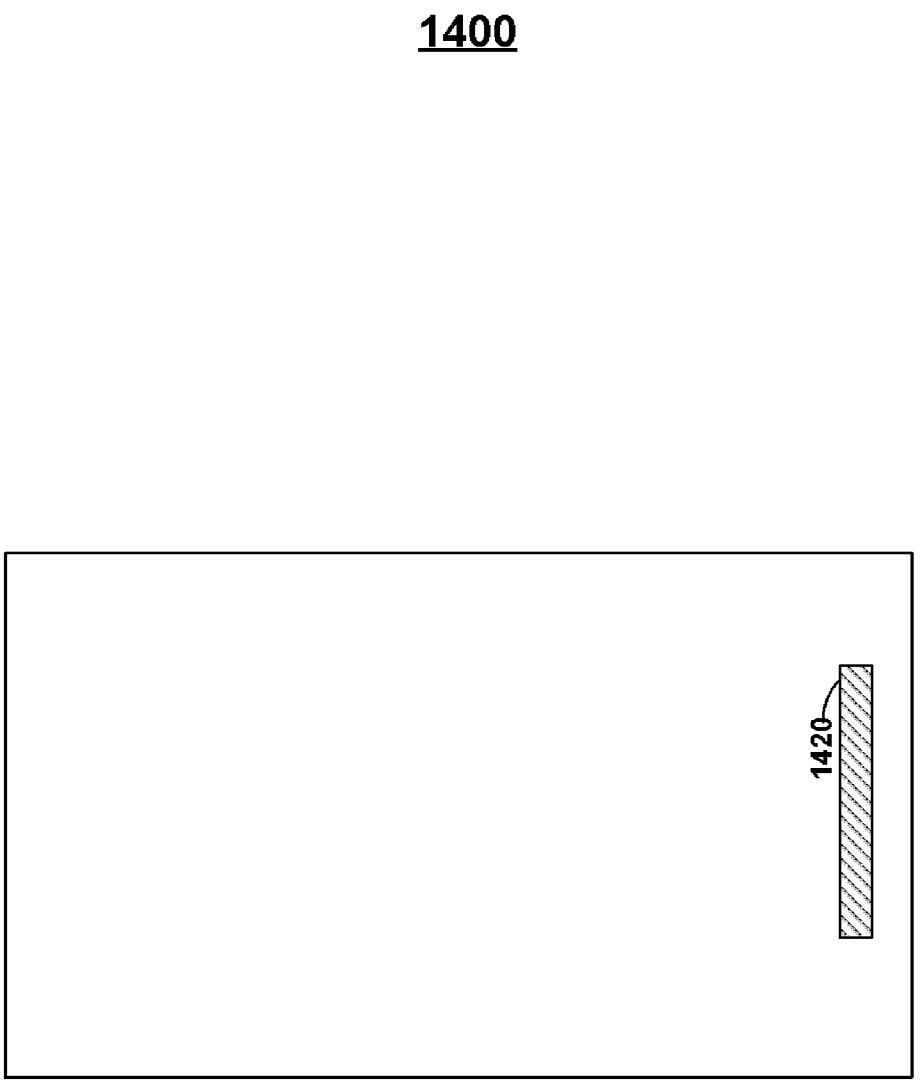


FIG. 14

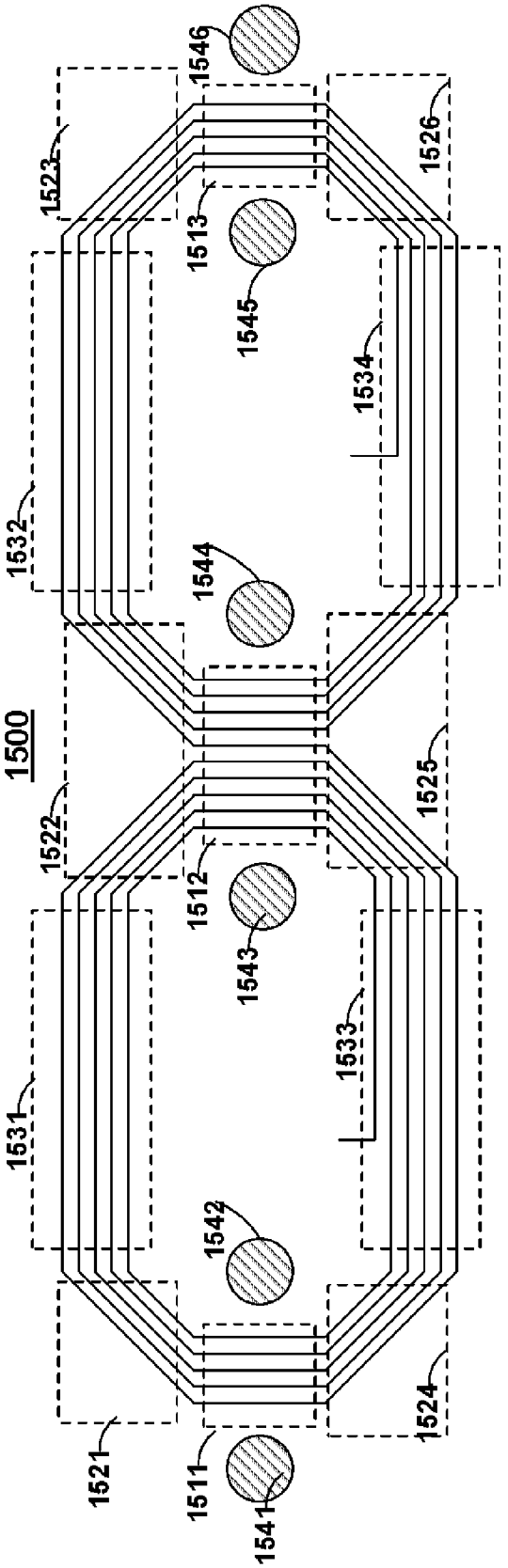

1500
1521
1522
1523
1524
1525
1526
1511
1512
1513
1531
1532
1533
1534
1541
1542
1543
1544
1545
1546

FIG. 15

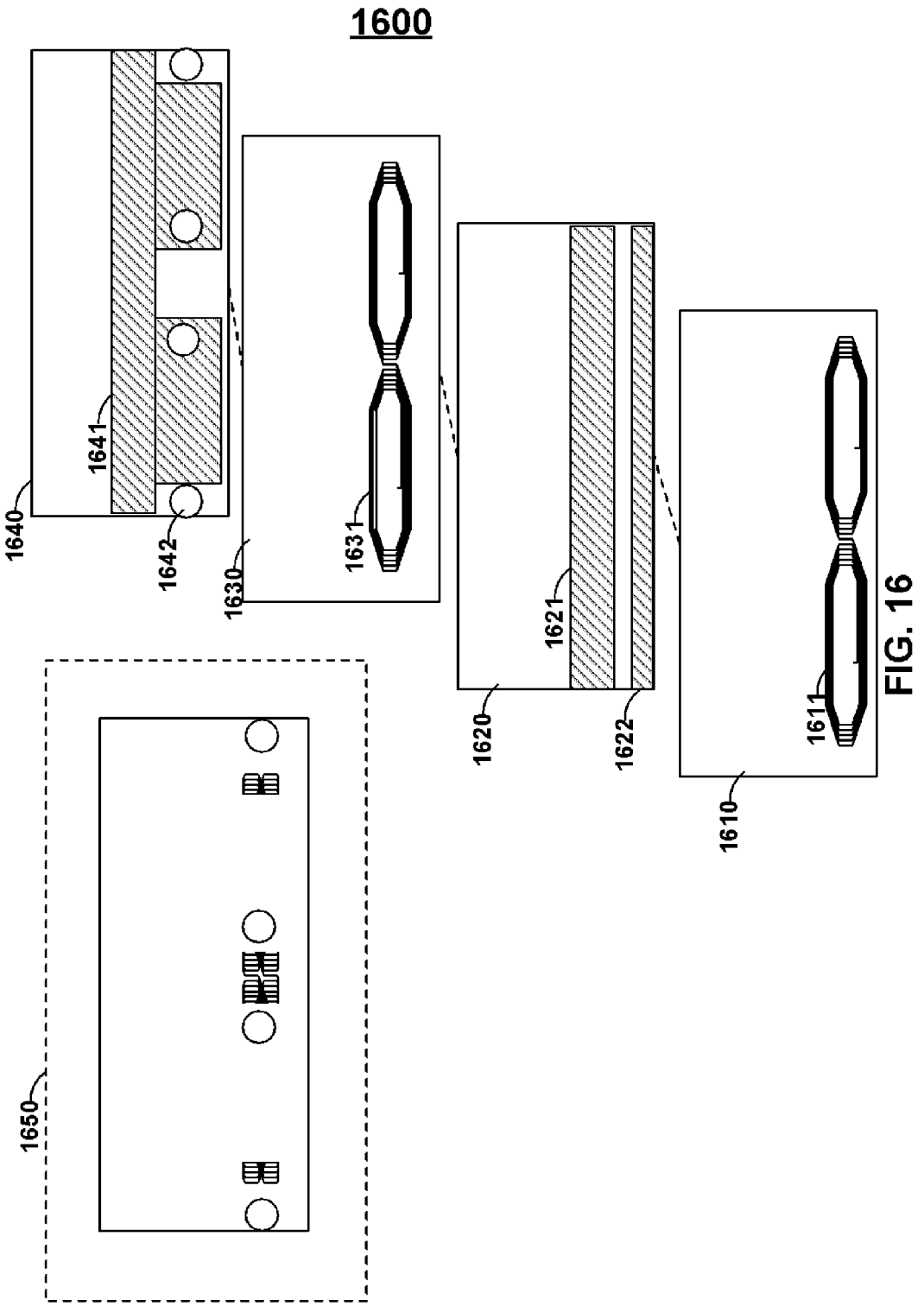


FIG. 16

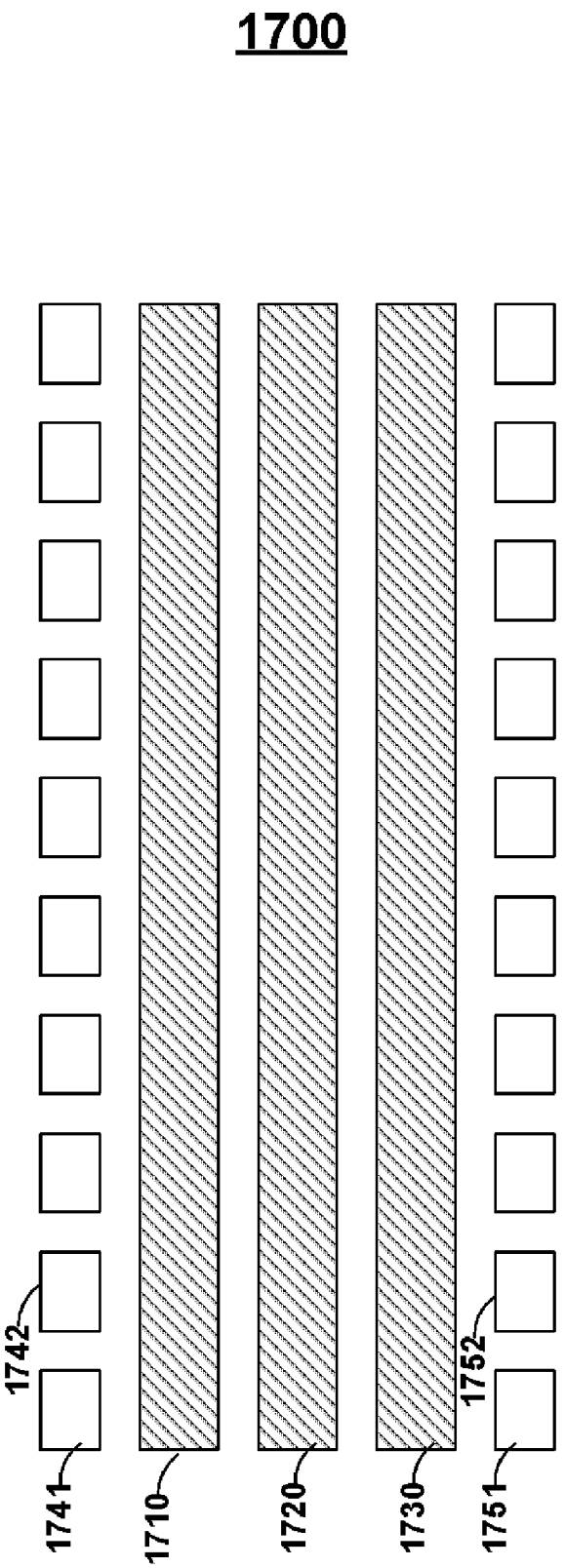


FIG. 17

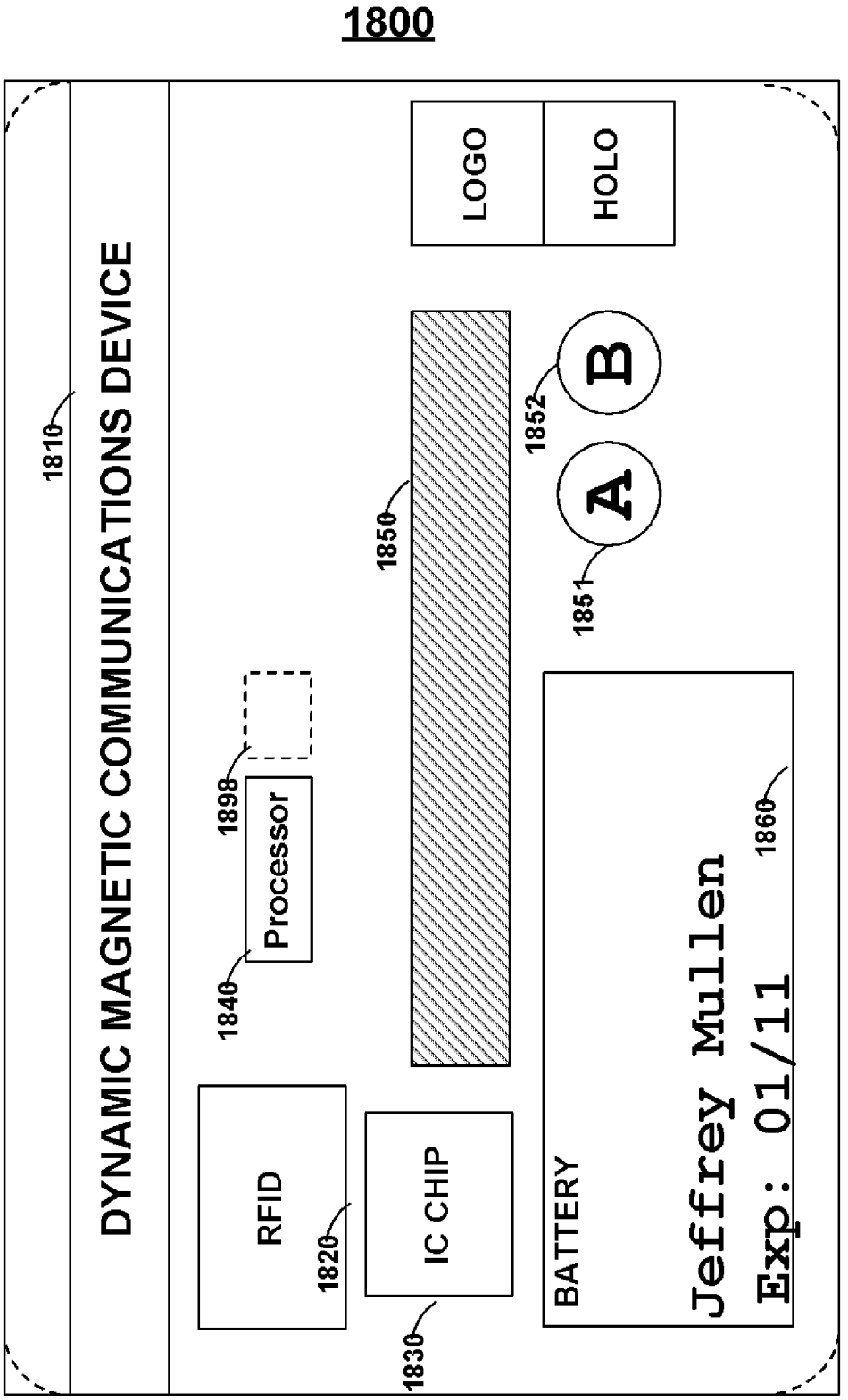

1800
DYNAMIC MAGNETIC COMMUNICATIONS DEVICE
1810
LOGO
HOLO
1850
1852
B
A
1851
1898
Processor
1840
RFID
1820
IC CHIP
1830
BATTERY
Jeffrey Mullen
Exp: 01/11
1860

FIG. 18

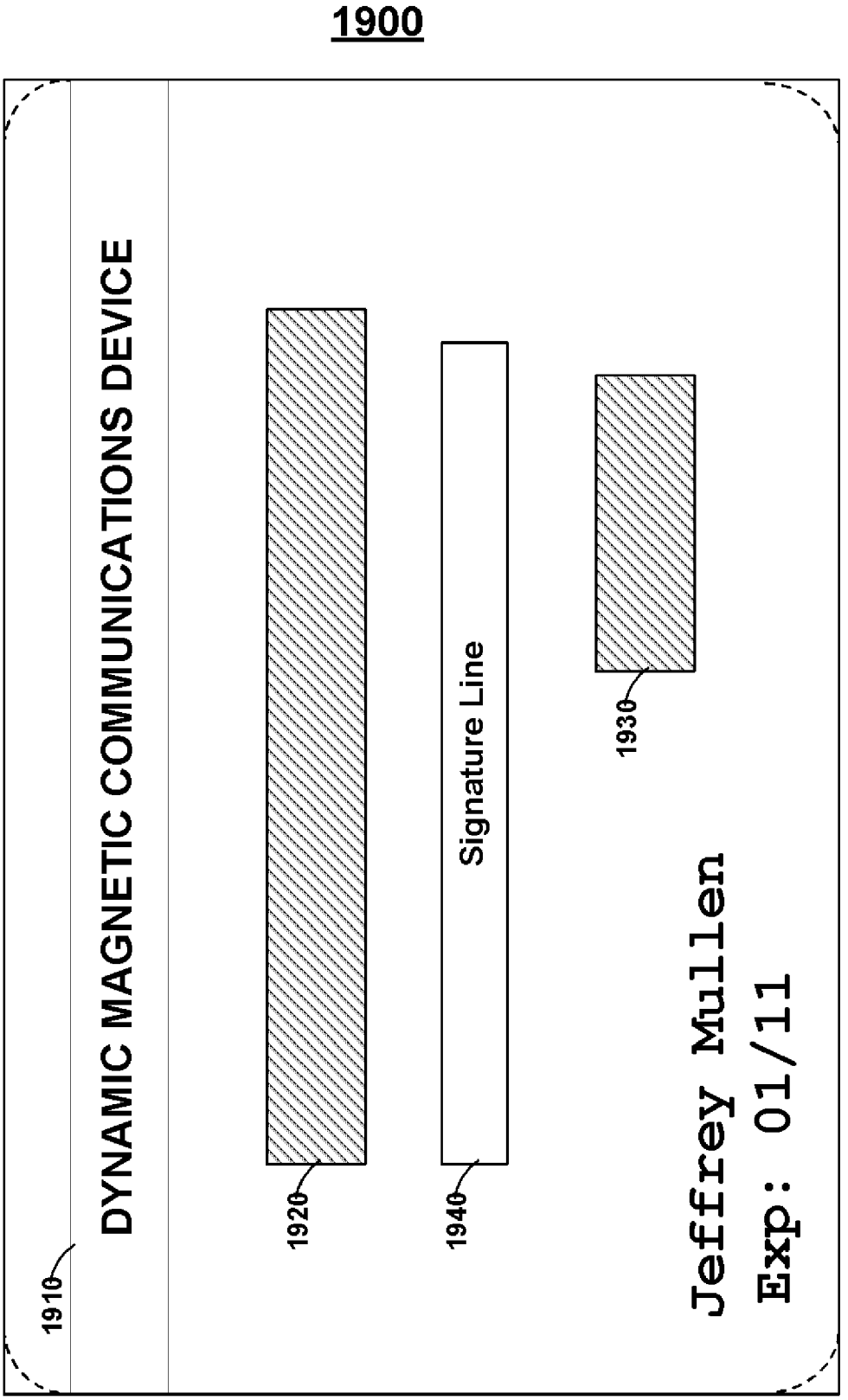

1900
DYNAMIC MAGNETIC COMMUNICATIONS DEVICE
1910
1920
Signature Line
1940
1930
Jeffrey Mullen
Exp: 01/11

FIG. 19

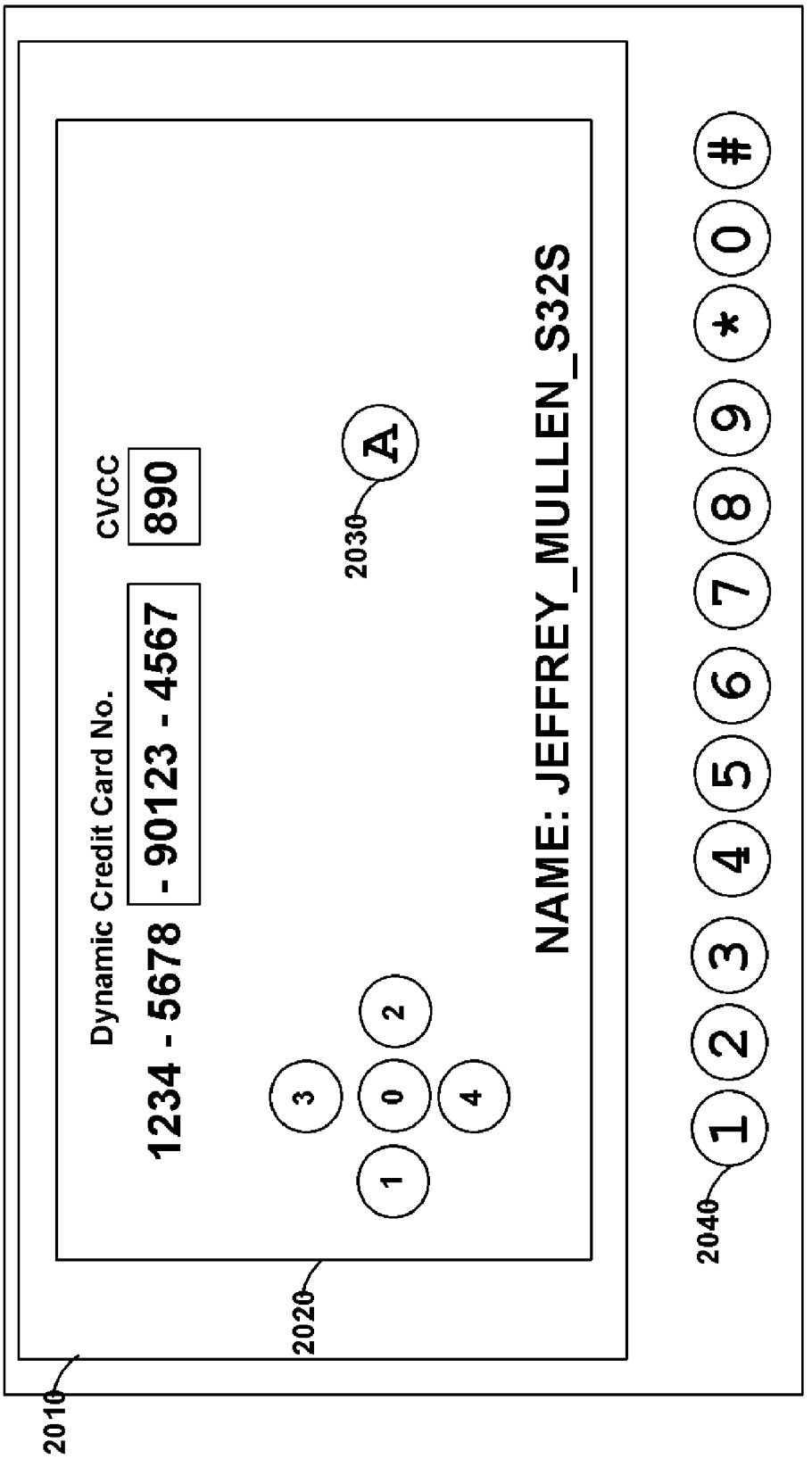

2000
Dynamic Credit Card No.
1234 - 5678 - 90123 - 4567
CVCC
890
NAME: JEFFREY_MULLEN_S32S
A
2030
3
0
2
1
4
1 2 3 4 5 6 7 8 9 * 0 #
2040
2020
2010

FIG. 20

CARDS AND DEVICES WITH MAGNETIC EMULATORS AND MAGNETIC READER READ-HEAD DETECTORS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 61/016,491 filed on Dec. 24, 2007 (Docket No. JDM/019 PROV), 61/026,846 filed on Feb. 7, 2008 (Docket No. JDM/019PROV2), 61/027,807 filed on Feb. 11, 2008 (Docket. No. JDM/020 PROV), 61/081,003 filed on Jul. 15, 2008 (Docket No. D/005 PROV), 61/086,239 filed on Aug. 5, 2008 (Docket No. D/006 PROV), 61/090,423 filed on Aug. 20, 2008 (Docket No. D/007 PROV), 61/097,401 filed Sep. 16, 2008 (Docket No. D/008 PROV), 61/112,766 filed on Nov. 9, 2008 (Docket No. D/009 PROV), 61/117,186 filed on Nov. 23, 2008 (D/010 PROV), 61/119,366 filed on Dec. 2, 2008 (Docket No. D/011 PROV), and 61/120,813 filed on Dec. 8, 2008, all of which are hereby incorporated by reference herein in their entirety.

BACKGROUND OF THE INVENTION

[0002] This invention relates to magnetic cards and payment systems.

SUMMARY OF THE INVENTION

[0003] A card is provided, such as a credit card or security card, that may transmit information to a magnetic stripe reader via a magnetic emulator. The magnetic emulator may be, for example, a circuit that emits electromagnetic fields operable to electrically couple with a read-head of a magnetic stripe reader such that data may be transmitted from the circuit to the magnetic stripe reader. The emulator may be operated serially such that information is transmitted serially to a magnetic stripe reader. Alternatively, for example, portions of a magnetic emulator may emit different electromagnetic fields at a particular instance such that the emulator is operated to provide physically parallel, instantaneous data. Alternatively still, a magnetic medium may be provided and a circuit may be provided to change the magnetic properties of the magnetic medium such that a magnetic stripe reader is operable to read information written on the magnetic medium.

[0004] A processor may be provided on a card, or other device, that controls a magnetic emulator. The processor may be configured to operate the emulator such that the emulator transmits serial or parallel information. Particularly, the processor may decouple portions of an emulator from one another such that different portions of the emulator may transmit different information (e.g., transmit data in a parallel operation). The processor may couple portions of an emulator together (or drive the portions together) such that all portions of the emulator transmits the same information (e.g., transmit data in a serial operation). Alternatively, the processor may drive a portion of the emulator to transmit data using one method (e.g., serially) while the processor drives another portion of the emulator using a different method (e.g., in parallel).

[0005] The processor may drive an emulator through a switching circuit. The switching circuit may control the direction and magnitude of current that flows through at least a portion of an emulator such that the switching circuit controls the direction and magnitude of the electromagnetic field created by at least that portion of the emulator. An electromagnetic field may be generated by the emulator such that the emulator is operable to electrically couple with a read-head from a magnetic stripe reader without making physical contact with the read-head. Particularly, for example, an emulator that is driven with increased current can be operable to couple with the read-head of a magnetic stripe reader even when placed outside and within the proximity of (e.g., 0.25 inches) the read-head.

[0006] A processor may detect, for example, the presence of a read-head of a magnetic stripe reader by receiving signals from a magnetic stripe reader detector and, in response, the processor may drive a magnetic emulator in a manner that allows the emulator to couple with the magnetic stripe reader. More than one emulator may be provided on a card or other device and a processor may drive such emulators in a variety of different manners.

[0007] A circuit may be provided on a credit card that is operable to receive data from a device, such as a magnetic stripe. In this manner, a card, or other device, may communicate bi-directionally with a device.

[0008] An emulator may communicate with a magnetic stripe reader outside of, for example, the housing of a magnetic stripe reader. Accordingly, for example, the emulator may be provided in devices other than cards sized to fit inside of the reading area of a magnetic stripe reader. In other words, for example, the emulator may be located in a device that is thicker than a card—yet the emulator can still communicate with one or more read-heads located in a magnetic stripe reader. Such a device may be, for example, a security token, a wireless communications device, a laptop, a Personal Digital Assistant (PDA), a physical lock key to a house and/or car, or any other device.

[0009] Dynamic information may be provided by a processor located on the card, or other device, and communicated through a magnetic emulator. Such dynamic information may, for example, change based on time. For example, the dynamic information may be periodically encrypted differently. One or more displays may be located on a card, or other device, such that the dynamic information may be displayed to a user through the display. Buttons may be provided to accept input from a user to, for example, control the operation of the card or other device.

[0010] Dynamic information may include, for example, a dynamic number that is used as, or part of, a number for a credit card number, debit card number, payment card number, and/or payment verification code. Dynamic information may also include, for example, a student identification number or medical identification number. Dynamic information may also, for example, include alphanumeric information such that a dynamic account name is provided.

[0011] Magnetic emulation circuits may be provided that generate electromagnetic fields. The emulation circuits may have active regions operable to be read by a read-head of a magnetic stripe reader. The emulation circuits may also have, for example, non-active regions that are not operable to be read by a read-head of a magnetic stripe reader. Multiple emulation circuits may be provided on different layers such that the active regions of multiple emulation circuits provide a read-head of a magnetic stripe reader continuous visibility to active regions while a card is swiped.

[0012] Magnetic emulation circuits may extend across multiple tracks. However, the areas of such magnetic emulation circuits that extended to undesired tracks may be config-

ured to be invisible to the read-heads for those tracks. For example, a magnetic emulator may produce magnetic fields that are not oriented properly to be picked up by unintended read-head(s) but that are oriented properly to be picked up by intended read-head(s).

[0013] Read-head detectors may be provided to determine, for example, when a card is being swiped and/or when a read-head is located over a particular portion of a card (e.g., a magnetic emulation circuit). A magnetic emulation circuit may be provided as, for example, a coil. Portions of such a coil may be utilized to detect a read-head while in other portions of the coil may be utilized to communicate information electromagnetically to a read-head. Accordingly, a coil may be utilized to detect a read-head and, after a read-head is detected, the coil may be utilized to, for example, serially transmit information to a magnetic stripe reader.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The principles and advantages of the present invention can be more clearly understood from the following detailed description considered in conjunction with the following drawings, in which the same reference numerals denote the same structural elements throughout, and in which:

[0015] FIG. **1** is an illustration of cards constructed in accordance with the principles of the present invention;

[0016] FIG. **2** is an illustration of cards constructed in accordance with the principles of the present invention;

[0017] FIG. **3** is an illustration of a card constructed in accordance with the principles of the present invention;

[0018] FIG. **4** is an illustration of a card and a reader constructed in accordance with the principles of the present invention;

[0019] FIG. **5** is an illustration of a card and a reader constructed in accordance with the principles of the present invention;

[0020] FIG. **6** is an illustration of a circuit constructed in accordance with the principles of the present invention;

[0021] FIG. **7** is an illustration of a circuit constructed in accordance with the principles of the present invention;

[0022] FIG. **8** is an illustration of a circuit constructed in accordance with the principles of the present invention;

[0023] FIG. **9** is an illustration of a circuit constructed in accordance with the principles of the present invention;

[0024] FIG. **10** is an illustration of a circuit constructed in accordance with the principles of the present invention;

[0025] FIG. **10** is an illustration of a circuit constructed in accordance with the principles of the present invention;

[0026] FIG. **11** is an illustration of a circuit constructed in accordance with the principles of the present invention;

[0027] FIG. **12** is an illustration of a circuit and flow charts constructed in accordance with the principles of the present invention;

[0028] FIG. **13** is an illustration of a circuit and flow charts constructed in accordance with the principles of the present invention;

[0029] FIG. **14** is an illustration of a card constructed in accordance with the principles of the present invention;

[0030] FIG. **15** is an illustration of a circuit constructed in accordance with the principles of the present invention;

[0031] FIG. **16** is an illustration of a card constructed in accordance with the principles of the present invention;

[0032] FIG. **17** is an illustration of a circuit constructed in accordance with the principles of the present invention;

[0033] FIG. **18** is an illustration of a card constructed in accordance with the principles of the present invention;

[0034] FIG. **19** is an illustration of a card constructed in accordance with the principles of the present invention; and

[0035] FIG. **20** is an illustration of a personal electronic device constructed in accordance with the principles of the present invention;

DETAILED DESCRIPTION OF THE INVENTION

[0036] FIG. **1** shows card **100** that includes printed information **111** and **120**, displays **112** and **113**, and buttons **130-134**. Card **100** may be, for example, a payment card such as a credit card, debit card, and/or gift card. Payment information, such as a credit/debit card number may be provided as static information **111**, dynamic information **112** and/or **113**, or any combination thereof.

[0037] For example, a particular number of digits of a credit card number (e.g., the last 3 digits) may be provided as dynamic information. Such dynamic information may be changed periodically (e.g., once every hour). Information may be changed via, for example, encryption. Software may be provided at, for example, the payment verification server that verifies the dynamic information for each period of time such that a payment can be validated and processed for a particular user. A user may be identifies using, for example, static information that is used to form a credit card number or other static information (e.g., information **120**). Additionally, identification information may be derived (e.g., embedded) in dynamic information. Persons skilled in the art will appreciate that a credit card number may have, for example, a length of 15 or 16 digits. A credit card number may also have a length of up to 19 digits. A verification code may be used with some payment systems and such a verification code may be provided statically on the card or may be provided as dynamic information. Such a verification code may be provided on a second display located on, for example, the front or rear surface of card **100**. Alternatively, a verification code may be displayed on the same display as other dynamic information (e.g., dynamic information **112**). A display may be, for example, a flexible electronic ink display. Such a flexible electronic ink display may, for example, utilize power to change displayed information, but may not utilize power to display information after the information is changed.

[0038] Card **150** may be provided. Card **150** may include static magnetic stripe tracks **153** and **152**. A magnetic emulator may be provided as device **151**. Device **151** may be operable to electrically couple with a read-head of a magnetic stripe reader. Persons skilled in the art will appreciate that a read-head housing of a magnetic stripe reader may be provided with one, two, or three active read-heads that are operable to each couple with a separate magnetic track of information. A reader may also have more than one read-head housing and each read-head housing may be provided with one, two, or three active read-heads that are operable to each couple with a separate magnetic track of information. Such read-head housings may be provided different surfaces of a magnetic stripe reader. For example, the read-head housings may be provided on opposite walls of a trough sized to accept payment cards. Accordingly, the devices on the opposite sides of the trough may be able to read a credit card regardless of the direction that the credit card was swiped.

[0039] A magnetic emulator may be provided and may be positioned on card **150** such that when card **150** is swiped through a credit card reader, the magnetic emulator passes

underneath, or in the proximity of, a read-head for a particular magnetic track. An emulator may be large enough to simultaneously pass beneath, or in the proximity of, multiple read-heads. Information may be transmitted, for example, serially to one or more read-heads. Information from different tracks of data may also be transmitted serially and the magnetic stripe reader may determine the different data received by utilize the starting and/or ending sentinels that define the information for each track. A magnetic emulator may also transmit a string of leading and/or ending zeros such that a magnetic reader may utilize such a string of zeros to provide self-clocking. In doing so, for example, information may be transmitted serially at high speeds to a magnetic stripe reader. For example, credit card information may be transmitted to a magnetic stripe reader at speeds up to, and greater than, 30 Khz).

[0040] Different emulators may be provided, and positioned, on card **150** to each couple with a different read-head and each emulator may provide different track information to those different read-heads. Read-head detectors may be utilized to detect when a read-head is over an emulator such that an emulator is controlled by a processor to operate when a read-head detector detects the appropriate presence of a read-head. In doing so, power may be saved. Additionally, the read-head detector may detect how many read-heads are reading the card and, accordingly, only communicate with the associated emulators. In doing so, additional power may be conserved. Accordingly, an emulator may be utilized to communicate dynamic information to a magnetic stripe reader. Such dynamic information may include, for example, dynamic payment card information that changes based on time.

[0041] A static magnetic stripe may be provided to transmit data for one or more tracks to a magnetic strip reader where dynamic information is not desired. Card **150**, for example, may include static magnetic track **153** and static magnetic track **152**. Information on static magnetic tracks **152** and **153** may be encoded via a magnetic stripe encoder. Device **151** may include an emulator such that dynamic information may be communicated through emulator **151**. Any combination of emulators and static magnetic tracks may be utilized for a card or device.

[0042] One or more batteries, such as flexible lithium polymer batteries, may be utilized to form card **100**. Such batteries may be electrically coupled in a serial combination to provide a source of power to the various components of card **100**. Alternatively, separate batteries may provide power to different components of card **100**. For example, a battery may provide power to a processor and/or display of card **100**, while another battery provides a source of energy to one or more magnetic emulators of card **100**. In doing so, for example, a processor may operate even after the battery that supplies power to an emulator completely discharges. Accordingly, the processor may provide information to another component of card **100**. For example, the processor may display information on a display to indicate to a user that the magnetic emulator is not longer operational due to power exhaustion. Batteries may be, for example, rechargeable and contacts, or other devices, may be provided on card **100** such that the battery may be recharged.

[0043] Buttons (e.g., buttons **130-134**) may be provided on a card. Such buttons may allow a user to manually provide information to a card. For example, a user may be provided with a personal identification code (e.g., a PIN) and such a personal identification code may be required to be manually inputted into a card using the buttons in order for the card to operate in a particular manner. For example, the use of a magnetic emulator or the use of a display may require a personal identification code.

[0044] By dynamically changing a portion of a user's credit card number, for example, credit card fraud is minimized. By allowing the dynamic information to displayed visually to a user, and changed magnetically on a card, user behavior change is minimized (with respect to a credit card with completely static information). By requiring the use of a personal identification code, the fraud associated with lost or stolen credit cards is minimized. Fraud associated with theft/loss is minimized as third party users do not know the personal identification code needed to operate particular aspects of a credit card with dynamic information.

[0045] FIG. **2** shows card **200**. Card **200** may include, for example, static magnetic stripe track **203**, static magnetic stripe track **201**, and magnetic emulator **202** sandwiched between read-head detectors **204** and **205**. A read-head detector may, for example, be provided as a circuit that detects, for example, changes in capacitance or mechanical coupling to a conductive material. Processor **220** may be provided to, for example, receive information from read-head detectors **204** and **205** and control emulator **202**. Persons skilled in the art will appreciate that processor **220** may cause a current to flow through a coil of emulator **202** in a different direction to produce different electromagnetic fields. The transitions between the different electromagnetic fields may be sensed by a magnetic stripe reader as information. Accordingly, a magnetic emulator may transmit data serially while a read-head is electrically coupled with a magnetic reader.

[0046] RFID antenna **210** may be provided on card **200**. Such an RFID antenna may be operable to transmit information provided by processor **220**. In doing so, for example, processor **220** may communicate with an RFID device using RFID antenna **210** and may communicate with a magnetic stripe reader using magnetic emulator **202**. Both RFID antenna **210** and magnetic emulator **202** may be utilized to communicate payment card information (e.g., credit card information) to a reader. Processor **240** may also be coupled to display **240** such that dynamic information can be displayed on display **240**. Button array **230** may also be coupled to processor **220** such that the operation of card **200** may be controlled, at least in part, by manual input received by button array **230**.

[0047] Persons skilled in the art will appreciate that a static magnetic track may be a read-write track such that information may be written to a magnetic track from a magnetic stripe reader that includes a head operable to magnetically encode data onto a magnetic track. Information may be written to a magnetic track as part of a payment process (e.g., a credit card or debit card transaction). Persons skilled in the art will appreciate that a static magnetic track may include a magnetic material that includes ferromagnetic materials that provide for flux-reversals such that a magnetic stripe reader can read the flux-reversals from the static magnetic track.

[0048] Persons skilled in the art will also appreciate that a magnetic emulator may communicate information that remains the same from payment card transaction to payment card transaction (e.g., static information) as well as information that changes between transactions (e.g., dynamic information).

[0049] A card may include magnetic emulators without, for example, including a static magnetic track. Read-head detectors may also be provided. Persons skilled in the art will appreciate that a magnetic reader may include the ability to read two tracks of information (e.g., may include at least two read-heads). All of the information needed to perform a financial transaction (e.g., a credit/debit card transaction) may be included on two magnetic tracks. Alternatively, all of the information needed to perform a financial transaction (e.g., a gift card transaction) may be included on one magnetic track. Accordingly, particular cards, or other devices, may include the ability, for example, to only transmit data associated with the tracks that are needed to complete a particular financial transaction. Persons skilled in the art will appreciate that for systems with three tracks of information, the bottom two tracks may be utilized for credit card information. Persons skilled in the art will also appreciate that a secure credit card transaction may be provided by only changing, for example, one of two magnetic tracks utilized in a credit card transaction (for those transactions that utilize two tracks). Accordingly, one track may be a static magnetic track constructed from a magnetic material and the other track may be provided as a magnetic emulator. Persons skilled in the art will also appreciate that numerous additional fields of data may be provided on a magnetic track in addition to a credit card number (or a security code). Dynamic information may be provided in such additional fields in order to complete a particular financial transaction. For example, such additional dynamic information may be numbers (or characters), encrypted with time and synced to software, at a validating server, operable to validate the encrypted number for a particular period of time.

[0050] Card **250** includes emulator **251** that includes active region **254** operable to communicate data serially to a magnetic stripe reader. Similarly, for example, emulator **251** may receive information for a magnetic stripe encoder. Persons skilled in the art will appreciate that emulator **251** includes a tail that is spread-out. Such a tail may include the return lines of emulator **251** and may be spaced such that a magnetic reader is not able to pick up the electromagnetic fields generated by such a tail. Accordingly, active region **254** may be spaced close together such that a magnetic stripe reader is able to pick up the cumulative electromagnetic field generated by such an active region. Processor **253** may drive emulator **251** via switching circuitry **252**. Switching circuitry **252** may include, for example, one or more transistors that may be utilized to control the direction of current via emulator **251** (e.g., the polarity of voltage(s) across a drive resistor).

[0051] Magnetic shielding may be provided to limit an electromagnetic field of an emulator. For example, layer **310** of FIG. **3** may include magnetic shielding **311** (which may be a magnetic material). Magnetic shielding may block magnetic fields from emulator **351** on layer **320**. Accordingly, for example, a card may not interact with read-heads blocked from emulator **351** from magnetic shielding **311**. In doing so, for example, a magnetic stripe reader may receive information from a single read-head of a read-head housing at any given time. Layer **330** may be provided, for example, with magnetic shielding **331** that includes an active-region space **332**. Accordingly, layer **330** may block magnetic fields from emulator **351** except for those fields generated by active portion **354** (e.g., if space **332** is aligned with active potion **354**).

[0052] FIG. **4** shows environment **400** that may include magnetic stripe reader **410**, read-head housing **440**, card **420**, and magnetic emulator **430**. Read-head housing **440** may include any number of read-head's such as, for example, one, two, or three read-heads. Each read-head may independently receive magnetic fields from magnetic emulator **430** (or a magnetic stripe, such as a magnetic stripe encoded on-card by card **420**). Emulator **430** may be positioned to be adjacent to any one or more read-heads of read-head housing **440** or may be positioned to communicate information to any one or more read-heads of read-head housing **440**. Persons skilled in the art will appreciate that emulators with longer lengths may be located within the proximity of one or more read-heads for a longer duration of time when a card is swiped. In doing so, for example, more information may be transmitted from an emulator to a read-head when a card is being swiped.

[0053] FIG. **5** includes environment **500** that may include cards **520** and **530** as well as magnetic stripe reader **510**. Read-head housing **511** may be included on a wall of a trough of magnetic stripe reader **510**. The trough may be sized to accept cards (e.g., credit cards).

[0054] Card **520** may include emulator **521**. Emulator **521** may provide electromagnetic field **591** that may transmit through a portion of the housing of magnetic stripe reader **510** (e.g., through a wall of a trough to get to read-head housing **511**). Accordingly, card **520** may be located outside of a reader—yet still be operable to communicate information to a magnetic stripe reader. A reader may be provided with an outer wall, for example, with a thickness of a quarter of an inch or more. Emulator **521** can provide electromagnetic field **591** over a distance of, for example, a quarter of an inch or more.

[0055] Persons skilled in the art will appreciate that card **520** may be coupled to a device via a permanent or removable cable. Such a device may provide power to card **520** as well as control information—such as control information for emulator **530**. An external source of power may be utilized, for example, to provide a larger amount of electrical energy to emulator **521** than from a source of power located within card **520**. Persons skilled in the art will appreciate that a car having an internal battery may still be able to receive a cable from a device having its own source of electrical energy.

[0056] Card **530** may be provided with emulator **531** and may electrically couple with a read-head of magnetic stripe reader **510**. Any number of emulators may be provided in card **530** in any number of orientations such that the appropriate electromagnetic field may couple with a read head of read-head housing **511** regardless of the orientation of card **720** with respect to read-head **511**. More particularly, for example, additional read-head housings may be provided in magnetic stripe reader **510** at different locations about the reader to electrically couple with a emulators in a number of different configurations. A sticker and/or guide-structures may be provided on a magnetic stripe reader to, for example, direct a user on how to position his/her card (or other device) for contactless transmission of data (e.g., credit card data) to a read-head housing without using the trough that includes that read-head housing.

[0057] Persons skilled in the art will appreciate that a magnetic stripe reader may include a trough that includes two (or more) read-head housings **511** located in approximately the same vertical position on a card-swiping trough, but at different horizontal locations on opposite walls of the trough. In doing so, for example, a magnetic stripe may be read regardless of the direction that a card having the magnetic stripe is facing when the card is swiped. Magnetic emulator **521** may, for example, communicate magnetic fields outside both the

front and read surfaces of a card. Accordingly, a single emulator **521** may, for example, couple with a single read-head regardless of the direction the card was facing when swiped. In doing so, for example, the costs of readers may be reduced as only a single read-head may be need to receive information regardless of the direction a card is facing when swiped. Accordingly, magnetic readers do not need stickers and/or indicia to show a user the correct orientation to swipe a card through a magnetic stripe reader. An adapter may be provided that coupled directly to a read-head that allows a device not operable to fit in a trough to electrically couple with a read-head.

[0058] An emulator may be positioned about a surface of a card (or other device), beneath a surface of a device, or centered within a card. The orientation of a magnetic emulator in a card may provide different magnetic fields (e.g., different strength's of magnetic fields) outside different surfaces of a card. Persons skilled in the art will appreciate that a magnetic emulator may be printed via PCB printing. A card may include multiple flexible PCB layers and may be laminated to form a card. Portions of an electronic ink display may also be fabricated on a layer during a PCB printing process.

[0059] Persons skilled in the art will appreciate that a number does not need to, for example, change with time. Information can change, for example, based on manual input (e.g., a button press or combination of button presses). Additionally, a credit card number may be a static display number and may be wholly or partially displayed by a display. Such a static credit card number may result in the reduction of fraud if, for example, a personal identification code is required to be entered on a manual input entry system to activate the display. Additionally, fraud associated with card cloning may be minimized with the use of a magnetic emulator activated by the correct entry on a manual input entry system.

[0060] Person skilled in the art will also appreciate that a card may be cloned by a thief, for example, when the thief puts a illegitimate credit card reader before a legitimate credit card reader and disguising the illegitimate credit card reader. Thus, a read-head detector may detect a read-head housing and then, if a second read-head housing is detected on the same side of the credit card, the reader may transmit information to the second read-head that signifies that two read-head housings were detected. In doing so, for example, a bank, or the police, may be notified of the possibility of the presence of a disguised cloning device. The information representative of multiple read-heads may be included with information that would allow a credit card number to be validated. As such, a server may keep track of the number of read-head housings at each reader and, if more read-head housings are detected than expected, the server may contact an administrator (or the police). The server may also cause the credit card transaction to process or may reject the credit card transaction. If the number of read-head housings (or read-heads) is the number expected by the server, the server can validate the payment transaction.

[0061] A payment system using dynamic numbers may, for example, be operable with numbers that are stored outside of the period in which those numbers would otherwise be valid. A server may be included, for example, that accepts a dynamic credit card number, information representative of a past credit card number, and the merchant that is requesting payment. The server may register that merchant for that saved number. The number may be decrypted (or otherwise validated) for that past period of time. Accordingly, the credit card transaction may be validated. Additionally, the merchant identification information may be linked to the stored dynamic credit card number for that past period of time. If the server receives a transaction from a different merchant with that same dynamic credit card number for that same period of time, the server may reject the transaction. In doing so, a merchant may be protected from having credit card numbers stolen from its various storage devices. If a thief steals a number from a merchant's server that is associated with a past period of time, that number cannot be used, for example, anywhere else. Furthermore, such a topology may, for example, allow merchants to provide a one-click shopping, periodic billing, or any other type of feature that may utilize dynamic numbers that are stored and used outside of the period in which the dynamic numbers were generated.

[0062] Persons skilled in the art will appreciate that different emulators may be controlled by different switching circuitry (e.g., different transistors).

[0063] Persons skilled in the art will appreciate that multiple buttons may be coupled together to form a single-bit bus. If any button is pressed, the bus may change states and signal to the processor to utilize different ports to determine what button was pressed. In this manner, buttons may be coupled to non-triggerable ports of a processor. Each button (or a subset of buttons) may be coupled to one or more triggerable ports of a processor. A port on a microprocessor may be utilized to drive an emulator in addition to, for example, receiving information from a button. For example, once an appropriate personal identification code is received by a processor, the processor may utilize one or more ports that receive information from one or more buttons to drive an emulator (e.g., for a period of time). Alternatively, for example, a magnetic emulator may be coupled to its own triggerable or non-triggerable processor port. A card may also include a voltage regulator to, for example, regulate power received from an internal or external source of power.

[0064] Persons skilled in the art will appreciate that any type of device may be utilized to provide dynamic magnetic information on a card to a magnetic stripe reader. As discussed above, a magnetic encoder may be provided that can change information on a magnetic medium where the changed information can be detected by a magnetic stripe reader.

[0065] FIG. **6** includes circuits **600** that may include magnetic emulator **650** that includes active region **651**. Magnetic emulator **650** may be, for example, a coil. Current may be provided through magnetic emulator **650** such that the magnetic emulator generates an electromagnetic signal. Active region **651** may include a dense section of coil segments where current runs through those coil segments in the same direction. Accordingly, the electromagnetic field is intensified in active region **651** compared to the area of the coil with coil segments that are widely spaced. Accordingly, a current may be placed through the coil such that a magnetic stripe reader is operable to receive information from active region **651** but not the region outside active region **651**. Persons skilled in the art will appreciate that the direction of current through magnetic circuit **650** may be reversed in a pattern that is representative of magnetic stripe data. Particularly, a processor may, for example, transmit information through a coil by changing the direction of the electromagnetic field generated from emulator circuit **650** at particular times. A change in the frequency of field reversals may be representative of, for example, a particular bit of information (e.g., "1" or "0").

Magnetic emulation circuit **650** may include a dense active region and a less dense tail region.

[0066] Magnetic emulation circuit **670** may be included that includes active region **671** and non-active regions **672** and **673**. Active region **671** may include coil segments in which current flows through the segments in the same direction. Non-active regions **672** and **673** may include, for example, coil segment spacing that is wider than the coil segment spacing of active regions **671**. Persons skilled in the art will appreciate, for example, that non-active regions **672** and **673** may be utilized to communicate information to a magnetic stripe reader. However, active region **671** may include a stronger electromagnetic signal then non-active regions **672** and **673**. Persons skilled in the art will also appreciate that a read-head may travel through non-active region **672**, through active region **671**, and through non-active region **673** when reading information communicated from emulator circuit **670**. Persons skilled in the art will appreciate that the level of current provided to emulator circuit **670** may be configured such that a magnetic read-head received information from active region **671** but does not receive information from non-active regions **672** and **673**. Emulator **670** may, for example, be tall enough such that more than one read-head passes over emulator **670** at any one time. For example, one read-head from a magnetic stripe reader may pass over active region **671** and another read-head from a magnetic stripe reader may pass under active region **671**. Person skilled in the art will appreciate that coil segments may be configured in an orientation such that they produce electromagnetic fields that are invisible to such read-heads. For example, active region **671** may include coil segments that are parallel to one another. Coil segments above and below active region **671** may be configured to be perpendicular to the coil segments of active region **671** or approximately oriented at a 45 degree angle from the coil segments of active region **671**.

[0067] Magnetic emulation circuit **680** may be provided that includes active region **681**. Persons skilled in the art will appreciate, for example, that the height of magnetic emulation circuit **680** may be approximately equal to the height of a read-head of a magnetic stripe reader such that, for example, only one track read-head, of a multiple track read-head housing, passes over magnetic emulation circuit **680**.

[0068] Multiple magnetic emulation circuits may be provided on a multiple layer PCB. For example, a magnetic emulation circuit may be provided with active region **691** (e.g., active region **698**) and non-active region **692** (e.g., non-active region **699**). Emulators may be provided on different layers such that active layers align with non-active layers. Accordingly, for example, a read-head may pick up a continuous stream of active regions. Accordingly, the active regions may be controlled through a common switching circuit such that current flows in the same direction through the active regions of the multiple layer PCB at a given time. Accordingly, the active regions may, for example, provide electromagnetic fields in the same direction. Persons skilled in the art will appreciate that the widths of coil segments of non-active regions may be widened to decrease the effect of those non-active regions when multiple non-active regions are stacked. Additionally, for example, the coil segments of vertically stacked non-active regions may be aligned with one another or may be staggered from one another. Furthermore, for example, current may flow through vertically stacked non-active regions in the same or different directions.

[0069] FIG. **7** shows card **700** that may include layers **710**, **720**, and **730** fabricated as, for example, flexible PCB layers. Layer **710** may include, for example, magnetic emulation circuit **712** that includes active region **711**. Layer **720** may include, for example, magnetic emulation circuit **722** that may include active region **721**. Layer **730** may include magnetic emulation circuit **732** that may include active region **731**.

[0070] FIG. **8** includes circuit **800** that may include, for example, active-region **811** and non-active regions **812** and **813**.

[0071] Persons skilled in the art will appreciate that magnetic emulation circuits with one non-active region may be vertically stacked with magnetic emulation circuits with two non-active regions. Magnetic emulation circuits with one non-active region may have non-active regions that are wider than the non-active regions of a magnetic emulation circuit with two non-active regions. FIG. **9** shows topology **900** that may include active region **912** (e.g., active region **951**), active region **922** (e.g., active region **952**), and active region **931** (e.g., active region **953**). Non-active regions **911**, **921**, **923**, and **932** may also be included.

[0072] FIG. **10** shows magnetic emulation circuit **1000** that may include region **1010**, **1020**, and **1030**. Regions **1010**, **1020**, and **1030** may include approximately the same spacing between coil segments or may provide different spacing between coil segments.

[0073] FIG. **11** shows circuit **1100** that may include region **1110**, **1120**, and **1130**. Circuit **1100** may also include read-head detectors **1141**, **1142**, **1143**, and **1144**. Read-head detectors **1141**, **1142**, **1143**, and **1144** may detect a read-head and/or a read-head housing of a magnetic stripe reader. A read-head detector may determine the presence of a read-head and/or read-head housing by detecting, for example, physical contact with a read-head and/or housing. Capacitive coupling, sonar, optical, or any other technique may be utilized to determine the presence of a read-head or read-head detector. Accordingly, for example, region **1020** may be utilized to communicate information to a magnetic stripe reader upon the detection of a read-head by a read-head detector. Accordingly, for example, no current may be provided through regions **1010** and **1030** when a read-head passes over regions **1010** and **1030**. Multiple read-heads may be utilized, for example, to determine the direction that a read-head is moving as well as the read-heads velocity and/or acceleration. Such information may be utilized, for example, to provide information in different ways. For example, a processor may transmit information at a first rate when a user swipes a card including circuit **1100** at a first velocity and the processor may transmit the same (or different) information at a second rate when that user swipes the card at a second velocity.

[0074] FIG. **12** shows topology **1200** that may include a magnetic emulation circuit having regions **1210**, **1220**, and **1230**. Persons skilled in the art will appreciate that a magnetic emulation circuit may act as a read-head detector as well as a magnetic information transmitter. For example, a magnetic emulator may be driven according to a process that includes step **1241**, in which a correct Personal Identification Code (e.g., a PIN) is determined to have been entered on a card. Accordingly, step **1242** may activate, in which a coil is driven such that its return paths act as a read-head detector. This may be done in numerous ways. For example, the current providing an electromagnetic field may undergo a phase-shift when a magnetic and/or conductive material is placed in the elec-

tromagnetic field. Accordingly, a phase-shift may be determined in step **1243**. When such a phase-shift is determined, step **1244** may initiate and a magnetic emulation circuit may be driven to communicate data serially. Accordingly, regions **1210** and **1230** may be utilized to detect a read-head and region **1220** may be utilized to communicate information to that read-head. Persons skilled in the art will appreciate that a magnetic emulation circuit may not be supplied current until an appropriate Personal Identification Code (PIC) is entered into manual interfaces located on the card. Such a scheme, for example, provides for power savings as well as prevents card cloning. Accordingly, a magnetic emulator may be driven into a read-head detector mode upon receiving an appropriate manual input and then into a data transmission mode after determining the presence of a read-head.

[0075] Persons skilled in the art will appreciate that timing zeros may be provided before and after data such that a magnetic stripe reader can utilize such timing zeros to perform synchronization activities. Accordingly, a magnetic stripe emulator may transmit zeros while in a read-head detector mode in step **1251** and upon the detection of a current phase-shift in step **1252** the magnetic emulation circuit may transmit information in step **1253**. After the data is transmitted, timing zeros may be transmitted again in step **1254**. Step **1253** may also detect the presence of a read-head to determine, for example, whether all of the information was received. If a read-head was not detected after data transmission, the processor may increase the rate of data transmission for future transmissions until, for example, read-heads are detected at the beginning and the end of the transmission of data.

[0076] Persons skilled in the art will appreciate that a card may include multiple magnetic emulation and read-head detectors circuits. In this manner, a card may include multiple circuits that can operate as both a data transmitter and a read-head detector.

[0077] FIG. **13** includes topology **1300** that may include, for example, a magnetic emulation circuit that includes regions **1310** and **1320**. Read-head detectors **1331**, **1332**, and **1332** may also be included.

[0078] A region (e.g., region **1310**) may be utilized to determine the velocity of a read-head. For example, step **1341** may be included in which a region is driven such that the region acts as a read-head detector. A read-head may be detected in **1342**, but the region may continue to drive the region to act as a read-head detector in step **1344**. A second read-head position may then be determined in step **1345**. The number of times that a read-head is sensed by a detector may correlate to a velocity. Information may then be transmitted (e.g., via another region) depending on the determined velocity. For example, the velocity of a swipe may be detected in step **1351** and information may be transmitted according to this velocity in step **1352**. Read-head detectors **1331**, **1332**, and **1333** may also be utilized, for example, to determine the velocity of a read-head as well as the direction of movement of the read-head. Persons skilled in the art will appreciate that a magnetic stripe reader may be motorized and may read a card at a pre-determined speed. Such a card may determine that the card is being read by a motorized reader and may utilize this information to transmit different information and/or transmit information in a different manner.

[0079] FIG. **14** shows card **1400** that may include magnetic emulation circuit **1420**. Magnetic emulation circuit **1420** may be included on a short side of a rectangle-shaped card—yet may transmit serially all of the information on a track of financial payment data (e.g., credit and/or debit data). Such transmitted financial payment data may be utilized to validate a financial payment (e.g., a credit card purchase). Any number of magnetic emulation circuits may be included on any side of card **1400**. For example, a magnetic emulation circuit may be provided on a long side of a rectangle-shaped card and another magnetic emulation circuit may be provided on the other long side of a rectangle-shaped card. Each magnetic emulation circuit may be utilized to transmit different data or the same data.

[0080] FIG. **15** includes circuit **1500** that may include read-head detectors **1541**, **1542**, **1543**, **1544**, **1545**, and **1546**. Circuit **1500** may include a magnetic emulation circuit that includes regions **1511**, **1512**, **1513**, **1521**, **1531**, **1522**, **1532**, **1523**, **1524**, **1533**, **1525**, **1534**, and **1526**. Regions **1511-1513** may be operable to communicate with a read-head that passes through regions **1511-1513**. The magnetic emulation circuit may include a coil. Regions **1511-1513** may include, for example, coil segments that are parallel to one another. The coil segments may produce an electromagnetic field operable to communicate data to a read-head of a magnetic stripe reader. The coil segments of regions **1521-1526** may be oriented approximately at a **45** degree angle from the coil segments of regions **1511-1513**. Accordingly, for example, the orientation offset of regions **1521-1526** from regions **1511-1513** may allow regions **1521-1526** to produce an electromagnetic field that cannot communicate with a read-head of a magnetic stripe reader when regions **1511-1513** are communicating data to a read-head of a magnetic stripe reader. Similarly, the coil segments of regions **1531-1534** may be oriented perpendicular to the coil segments of regions **1511-1513**. Accordingly, for example, the orientation offset of regions **1531-1534** from regions **1511-1513** may allow regions **1531-1534** to produce an electromagnetic field that cannot communicate with a read-head of a magnetic stripe reader when regions **1511-1513** are communicating data to a read-head of a magnetic stripe reader.

[0081] FIG. **16** shows card layout **1600** that may include flexible PCB layers **1610**, **1620**, **1630**, and **1640** to form card **1650**. Layer **1610** may include magnetic emulation circuit **1511**. Layer **1620** may include magnetic shielding **1621** and **1622**. Layer **1630** may include magnetic emulation circuit **1631**. Layer **1640** may include read-head detectors (e.g., read-head detector **1642**) and magnetic shielding (e.g., shielding **1641**).

[0082] FIG. **17** includes circuit **1700** that may include, for example, read-head detectors **1741**, **1742**, **1751**, and **1752**. Circuit **1700** may also include, for example, magnetic emulation circuits **1710**, **1720**, and **1730**. Read-head detectors **1741**, **1742**, **1751**, and **1752** may be utilized as read-head detectors and may provide the capability for a read-head to be detected when the read-head is over a particular magnetic emulation circuit or portion of a magnetic emulation circuit. Read-head detectors **1741**, **1742**, **1751**, and **1752** may detect a read-head by sensing, for example, capacitive coupling of a read-head. Alternatively, for example, a read-head contact may be, for example, pressed against another contact when pressure is applied via a read-head.

[0083] Persons skilled in the art will appreciate that a display on the card may display a credit card number that does not change with time. Additionally, for example, a magnetic emulator (or multiple magnetic emulators) may magnetically

communicate financial data that does not change with time. Such a card may reduce, for example, the effects of physical card theft and card cloning.

[0084] One or more light generation devices, such as a Light Emitting Diode (LED), may be provided as part of a card (or other device). Such an LED may produce light, for example, upon a manual input such as a button press, the correct entry of a PIC such as a PIN, and/or the incorrect entry of a PIC. A light emitting device may be operable to produce different colors of light. For example, the incorrect entry of a PIC may produce a red light and the correct entry of a PIC may produce a green light. A PIC may take any form such as a numerical code or a code that include alphabet letters and/or symbols. For example, a PIC may be "A-B-B-B-A" and an "A" button may be provided on a card in addition to a "B" button (as well as other buttons such as a "C," "D," and/or "E" buttons).

[0085] Persons skilled in the art will appreciate that any numbers of a credit card number may remain static and/or change either with time or based off a transaction (e.g., by sensing a read-head "swipe"). Additionally, any static and/or dynamic numbers may be displayed via a display or printed on a card. For example, a middle 6 digits of a credit/debit card number may be static and may be displayed on a display. Such a middle 6 digits may be displayed, for example, upon the entry of a correct PIC. Similarly, a magnetic emulator may not communicate information until a correct PIC has been entered by a user. Doing so may, for example, reduce fraud associated with card cloning. Additionally, a receipts may be provided that includes masked credit card numbers except for the last few digits of credit card numbers. Accordingly, displaying a static middle **6** digits of credit card numbers may allow for such a receipt to be provided while still reducing credit card fraud from hiding numbers that are not displayed on such a receipt. Any amount of numbers and/or characters may be displayed through a display. For example, nineteen digits may be displayed as part of a credit/debit numbers and these numbers may also be communicated through one or more magnetic emulation circuits. The entry of particular PICs may provide different results. For example, a first PIC may only display a string of alphanumeric characters. A second PIC may only activate a magnetic emulation circuit to transmit information including that string of alphanumeric characters (or a different string). A third PIC may activate a magnetic emulation circuit and a display. A display and/or magnetic emulation circuit may be turned OFF, for example, upon entry of an incorrect PIC and/or after a period of time has passed since the entry of the PIC and/or after the detection of a particular number of swipes by a read-head detector (e.g., one or two).

[0086] Persons skilled in the art will appreciate that a credit/debit card number (or any other information) may remain static until an event occurs and then may become dynamic (e.g., change based on swipes and/or time). For example, a particular PIC may change from a static to a dynamic topology and/or a topology may be changed from static to dynamic after a pre-determined period of time. Additionally a card and/or device may include a wireless receiver and a topology may be changed from a static to a dynamic topology upon, for example, receiving an appropriate signal from the wireless receiver. Accordingly, a validation process may change at a validation server depending upon whether a card is utilizing a static and/or dynamic topology at any given time. Additionally, a static credit/debit card number may be printed on the face of a card and information (e.g., a security code) may be displayed via a display and remain static over time (or with use) or be provided dynamically.

[0087] A card or other device (e.g., a mobile telephone) may accept a pre-determined number of consecutive incorrect PICs before locking the card for a period of time or until an appropriate secondary PIC is entered. Accordingly, a user may enter in an incorrect PIC a number of times and then, after a card becomes locked, call a support center for a secondary one-time use PIC. A card may cycle through unlocking PICs based, for example, on time or the number of previous unlock attempts.

[0088] A website may be provided where a user enters in his/her credit card number, pays a fee, and a new card is programmed and sent to the user. The new card may include a display to display a portion of the users credit/debit card number in a static form upon entry of an appropriate PIC. Such a card may also include one or more magnetic emulation circuits to transmit the information to a reader. Such a card may or may not, for example, include a portion of a magnetic stripe. For example, three tracks of magnetic stripe data may be communicated via three different emulation circuits, more than three different emulation circuits, one emulation circuits (e.g., tracks communicated serially to all read-heads), or one or more tracks may be represented by magnetic stripe(s) while one or more other tracks may be represented by a magnetic emulation circuit. A track of data may also be partially represented by a magnetic emulation circuit and partially represented by a magnetic stripe.

[0089] FIG. **18** shows card **1800** that may include, for example, one or more IC chips **1830** (e.g., EMV chips), RFID antennas **1820**, processors **1840**, displays **1850**, dynamic magnetic communications devices **1810** (e.g., magnetic encoders and/or magnetic emulators), batteries **1860**, and buttons **1851** and **1852**. Additional circuitry **1898** may be provided which may be, for example, one or more oscillators or emulator driving circuits. Persons skilled in the art will appreciate that button **1851** may, for example, be utilized by a user to select one encryption algorithm for a number displayed on display **1850** while button **1852** may be utilized by a user to select a different encryption algorithm. Persons skilled in the art will appreciate that the components of card **1800** may be provided on either surface of a card (e.g., a front or rear surface of the card) or inside of a card. A logo (e.g., of a card issuer) and logo may be provided on either surface of a card.

[0090] A button, such as button **1051**, may be utilized, for example, to display a number. Such a number may be, for example, encrypted from a secure number based on time or use. For example, one-time use numbers (e.g., a payment number or code) may be retrieved from a list of numbers on memory each time button **1851** is pressed and displayed on display **1850**. A processor may only go through each number once on a list. A registration process may be provided in which a user may be requested to enter in a sequence of numbers such that a remote server may validate the card and learn where in a sequence of a list a card currently resides. Numbers may be repeated on a list or may only occur once on a list. All of the numbers available by the length of the number may be utilized by the list or only a portion of the numbers available by the length of the number may be provided by the list. A secret number may be encrypted on a card and a verification server may also have knowledge of this secret number. Accordingly, the remote server may perform the

same encryption function as the card on the secret number and verify that the resultant encrypted number is the same as the resultant encrypted number on a card. Alternatively, for example, the remote server may decrypt the received encrypted number to determine the authenticity of the encrypted number and validate an activity (e.g., validate a security access request or a purchase transaction).

[0091] Persons skilled in the art will appreciate, for example, that a card may include an IC chip (e.g., EMV chip), RFID, and a dynamic magnetic communications device (e.g., a magnetic emulator or encoder). The same information may be communicated through, for example, any number of such devices (e.g., a dynamic magnetic communications device, RFID, and an EMV chip). A central processor may cause each device to communicate the information (in the same format or a different format). Each component may have its own processor or driving circuitry. Such individual processors or driving circuitry may be coupled to a central processor. An EMV chip may be utilized, for example, to provide control signals to other devices (e.g., circuitry driving a display as well as a dynamic magnetic communications device). Such an EMV chip may receive signals provided by one or more buttons to determine, for example, that a particular button, or sequence of buttons, was pressed by a user.

[0092] Persons skilled in the art will appreciate that a read-head housing may include, for example, multiple read-heads. A read-head detector may, more generally, detect a read-head housing and, in doing so, detect a read-head.

[0093] FIG. **19** shows card **1900** that may include, for example, signature area **1940** that may include a material operable to receive marks from a pen (e.g., a signature). Card **1900** may also include, for example, displays **1920** and **1930**. Display **1920** may, for example, display a payment number while display **1930** displays a security code (e.g., for online purchase authentication). Display **1920** as well as display **1930** may be utilized on the same side as, for example, dynamic magnetic communications device **1910**.

[0094] FIG. **20** shows personal electronic device **2000** which may be, for example, a portable telephonic device, portable media player, or any type of electronic device. Persons skilled in the art will appreciate that the functionality of a card may be provided on a personal device and displayed through a graphical user interface. Personal electronic device **2000** may include, for example, user inputs **2040** and display **2010**. Virtual card **2020** may be displayed on display **2020**. Display **2020** may be a touch-sensitive display such that, for example, virtual button **2030** may be provided on virtual card **2020**. Persons skilled in the art will appreciate that cards may be provided as virtual cards and a user may interact with such virtual cards in order to provide a variety of functions. Personal electronic device **2000** may communicate to a card reader such as, for example, an RFID reader.

[0095] A display may be bi-stable or non bi-stable. A bi-stable display may consume electrical energy to change the information displayed on the bi-stable display but may not consume electrical energy to maintain the display of that information. A non bi-stable display may consume electrical energy to both change and maintain information on the non bi-stable display. A display driving circuit may be provided, for example, for a bi-stable display (or a non bi-stable display). Such a display driving circuit may step-up a supply voltage (e.g., 1-5 volts) to a larger voltage (e.g., 6-15 volts) such that a bi-stable display may change displayed information. A controller (e.g., a processor) may be utilized to control such a display driving circuit. Persons skilled in the art will appreciate that a display may be configured to display numerical data or alphanumerical data. A display may also be configured to display other indicia (e.g., the image of a battery and its remaining life).

[0096] A magnetic stripe reader may, for example, determine information on a magnetic stripe by detecting the frequency of changes in magnetic fields (e.g., flux transversals). A particular frequency of flux transversals may correlate to, for example, a particular information state (e.g., a logic "1" or a logic "0"). Accordingly, for example, a magnetic emulator may change the direction of an electromagnetic field at particular frequencies in order to communicate a different state of information (e.g., a logic "1" or a logic "0").

[0097] Persons skilled in the art will appreciate that a magnetic emulator may electromagnetically communicate information serially by changing the magnitude of an electromagnetic field with respect to time. As such, for example, a current in a single direction may be provided through a magnetic emulator in order for that magnetic emulator to generate an electromagnetic field of a single direction and a particular magnitude. The current may then be removed from the magnetic emulator such that, for example, the electromagnetic field is removed. The creation of a presence of an electromagnetic field, and the removal of that electromagnetic field, may be utilized to communicate information to, for example, a magnetic stripe reader. A magnetic stripe reader may be configured to read, for example, the change in flux versus time and may associate an increase in an electromagnetic field (e.g., creation of a field) as one flux transversal and a decrease (e.g., removal of a field) as another transversal. In doing so, for example, driving circuitry (not shown) may be provided which, in turn, controls when current is provided to a magnetic emulator. The timing of magnetic flux transversals, as determined by a magnetic stripe reader, may be utilized by that reader to determine whether a logic one ("1") or logic zero ("0") was communicated. Accordingly, a driving circuit may change the frequency of when current is supplied and removed from a magnetic emulator in order to communicate a logic one ("1") or a logic zero ("0").

[0098] A driving circuit may, for example, change the direction of current supplied to a magnetic emulator to increase the amount of change in an electromagnetic field magnitude for a period of time. In doing so, for example, a magnetic stripe reader may more easily be able to discern overall changes in an electromagnetic field and, as such, may more easily be able to discern information. As such, for example, a driving circuit may increase the magnitude of an electromagnetic field by providing negative current, decrease the amount of negative current until no current is provided and provide an increasing positive current in order to provide a large swing in the magnitude of an electromagnetic field. Similarly, a driving circuit may switch from providing one amount of negative current (or positive current) to one amount of positive current (or negative current).

[0099] Persons skilled in the art will appreciate that a string of a particular bit of data (e.g., a string of logic zeros "0s") may be communicated before as well as after information is communicated through a magnetic emulator. A magnetic stripe reader may utilize such data, for example, to determine base timing information such that the magnetic stripe reader has a timing reference that the reader can utilize to assist in determining timing changes of perceived flux transverals. Accordingly, for example, a magnetic emulator may send

data at different overall frequencies and a magnetic stripe reader may be able to reconfigure itself to receive data at such overall frequencies. Information may be encoded using, for example, Frequency/Double Frequency (F2F) encoding such that magnetic stripe readers may perform, F2F decoding.

[0100] A processor may control one or more emulators by, for example, controlling the direction of the current supplied through one or more segments of an emulator. By changing the direction of current through a region, for example, the direction of an electromagnetic field may be changed. Similarly, a processor may control one or more emulators by, for example, controlling the change in magnitude of current supplied through one or more segments of an emulator. As such, for example, a processor may increase the magnitude of current as well as decrease the magnitude of current supplied through an emulator. A processor may control the timing of such increases and decreases in current such that a magnetic emulator may, for example, communicate F2F encoded information.

[0101] Persons skilled in the art will appreciate that a dynamic magnetic communications device (e.g., a magnetic emulator or magnetic encoder) may be fabricated, either completely or partially, in silicon and provided as a silicon-based chip. Other circuitry (e.g., driving circuitry) may also be fabricated on such a silicon-based chip. A processor, such as a processor for controlling a magnetic communications device, may be, for example, a programmable processor having on-board programmable non-volatile memory (e.g., FLASH memory), volatile memory (e.g., RAM), as well as a cache. Firmware as well as payment information (e.g., dynamic numbers) may be, for example, communicated from a programming device to a processor's on-board programmable non-volatile memory (e.g., a FLASH memory) such that a card may provide a variety of functionalities. Such a processor may also have one or more power-saving operating modes, in which each operating mode turns OFF a different set of circuitry to provide different levels of power consumption. One or more power-savings modes may turn OFF, for example, one or more clocking circuitry provided on a processor. An Application-Specific Integrated Circuit (ASIC) may also be included in a card or other device to provide, for example, processing, dynamic magnetic communications, as well as driving capabilities.

[0102] Persons skilled in the art will also appreciate that the present invention is not limited to only the embodiments described. Instead, the present invention more generally involves dynamic information. Persons skilled in the art will also appreciate that the apparatus of the present invention may be implemented in other ways then those described herein. All such modifications are within the scope of the present invention, which is limited only by the claims that follow.

1-5. (canceled)

6. A card comprising:

an electronic device operable to communicate information to a magnetic stripe reader, wherein said electronic device includes a first horizontal end point, a second horizontal end point, and first vertical end point, and a second vertical end point; and

a read-head detector located between said first end point and said second end point, wherein said read-head detector is located between said first vertical end point and said second vertical end point.

7. The card of claim **6**, further comprising a battery.

8. The card of claim **6**, further comprising a processor.

* * * * *