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Wyatt

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(54) **MULTI-FUNCTION ELECTRONIC PAYMENT DEVICE**

(71) Applicant: **Virtual Electric Inc.**, San Jose, CA (US)

(72) Inventor: **David Wyatt**, San Jose, CA (US)

(73) Assignee: **Virtual Electric Inc.**, San Jose, CA (US)

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This patent is subject to a terminal disclaimer.

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(51) **Int. Cl.**
G06Q 20/34 (2012.01)
G07F 19/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
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(Continued)

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CPC G06K 17/0022; G06K 19/0719; G06K 19/07703; G06K 19/12; G06K 19/14; G06K 7/0008
See application file for complete search history.

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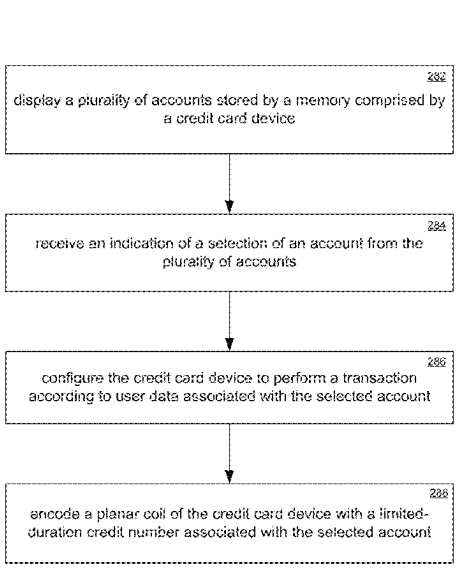
Primary Examiner — Seung H Lee

(57) **ABSTRACT**

An embodiment includes a multi-function electronic device capable of generating a programmed magnetic field of alternating polarity based on a speed of a card swipe, and methods for constructing the device for the purpose of emulating a standard credit card. An apparatus is described to allow the device to emulate behavior of a credit card when used in electronic credit card readers. Additionally methods are described to allow user control of the device for the purpose of authorizing or controlling use of the device in the application of credit, debit and cash transactions, including cryptocurrency and card-to-card transactions. Methods are also described for generating a limited-duration credit card number when performing a transaction for the purpose of creating a limited-use credit card number, which is limited in scope of use to a predetermined number of authorized transactions. Furthermore the device may interact with other similar devices in proximity for the purpose of funds or credit/debit transfers.

20 Claims, 13 Drawing Sheets



Related U.S. Application Data

continuation of application No. 14/680,946, filed on Apr. 7, 2015, now Pat. No. 9,430,765, which is a continuation of application No. 14/217,261, filed on Mar. 17, 2014, now Pat. No. 9,022,286.

(60) Provisional application No. 61/794,891, filed on Mar. 15, 2013.

(51) **Int. Cl.**

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G06Q 20/22	(2012.01)
G06Q 20/38	(2012.01)
G07F 7/08	(2006.01)
G06K 19/06	(2006.01)
G06K 19/07	(2006.01)
G06K 19/077	(2006.01)
G06Q 20/24	(2012.01)
G06Q 20/40	(2012.01)

(52) **U.S. Cl.**

CPC ***G06Q 20/3827*** (2013.01); ***G06Q 20/409*** (2013.01); ***G06Q 20/4012*** (2013.01); ***G07F 7/0873*** (2013.01); ***G07F 19/00*** (2013.01)

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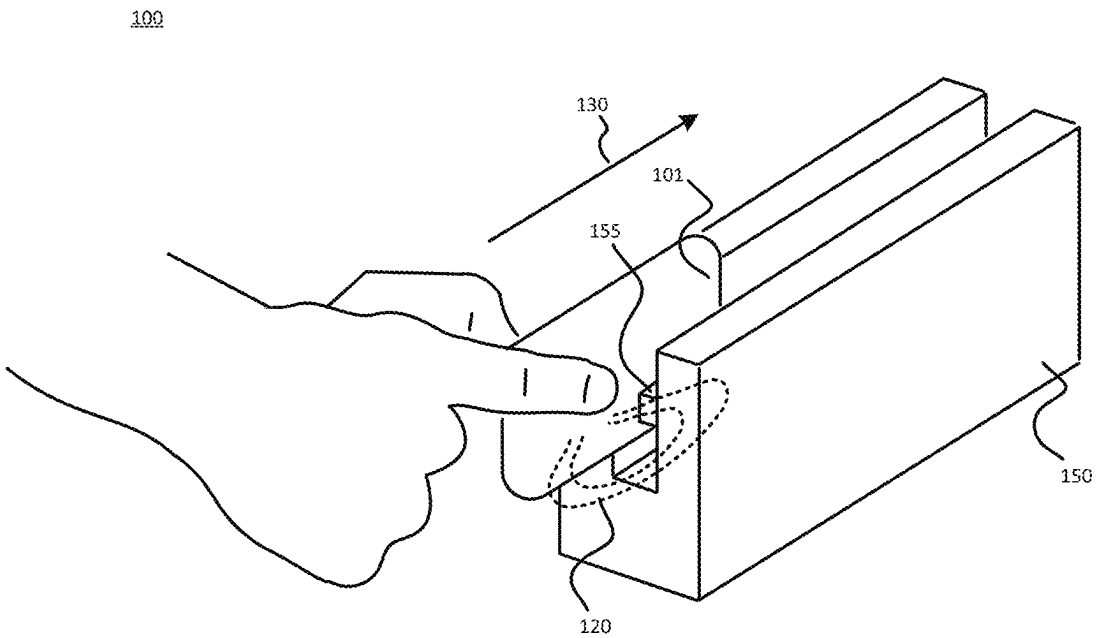

FIG. 1

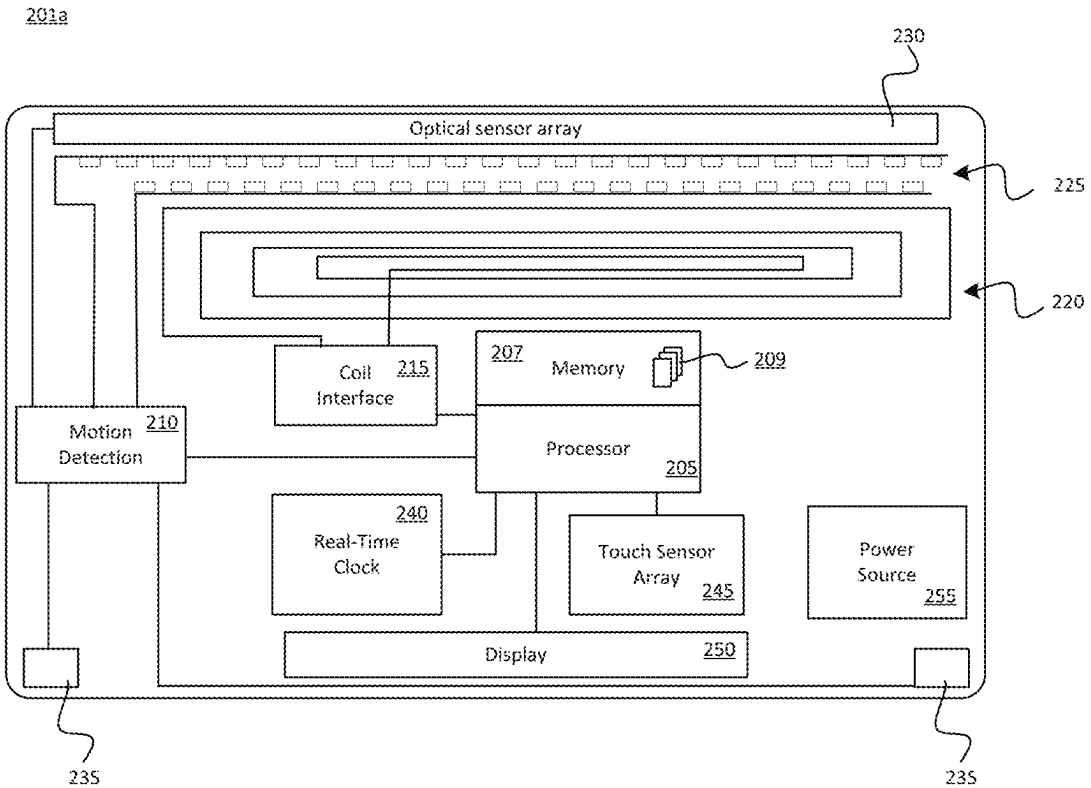
201a
230
Optical sensor array
225
220
Coil Interface 215
207 Memory
209
Motion Detection 210
Processor 205
240 Real-Time Clock
Touch Sensor Array 245
Power Source 255
Display 250
235
235

FIG. 2A

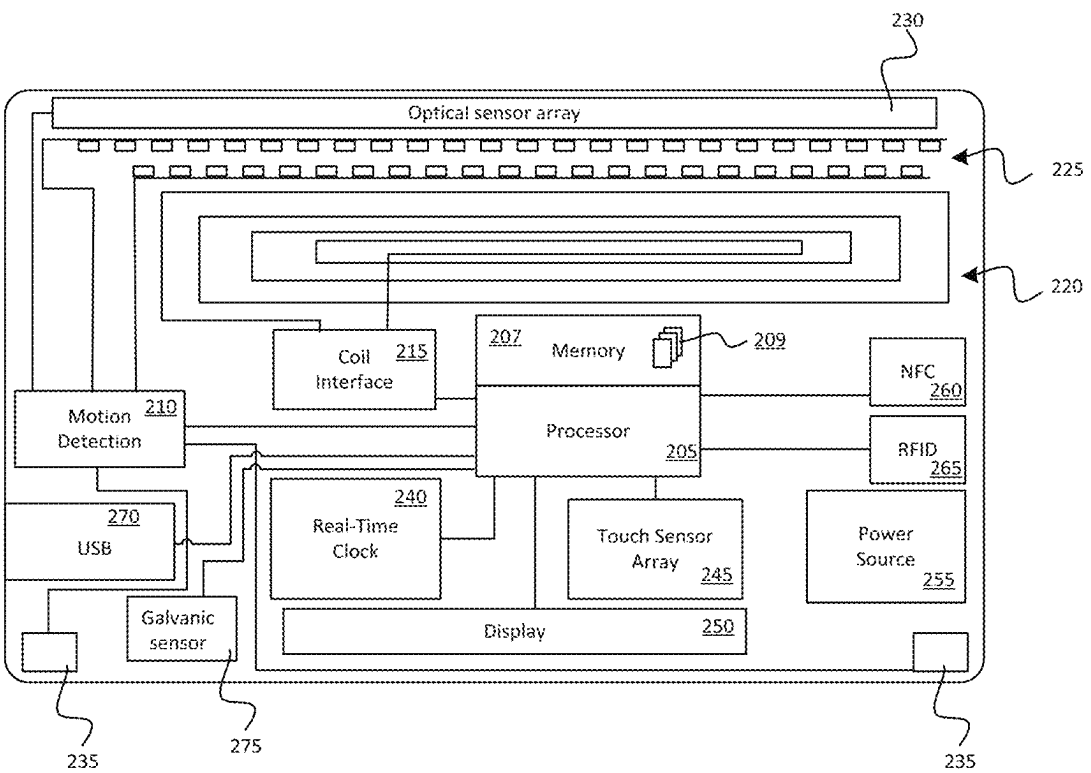
201b
230
Optical sensor array
225
220
Coil Interface 215
207 Memory
209
NFC 260
Motion Detection 210
Processor 205
RFID 265
270 USB
240 Real-Time Clock
Touch Sensor Array 245
Power Source 255
Galvanic sensor
Display 250
235
275
235

FIG. 2B

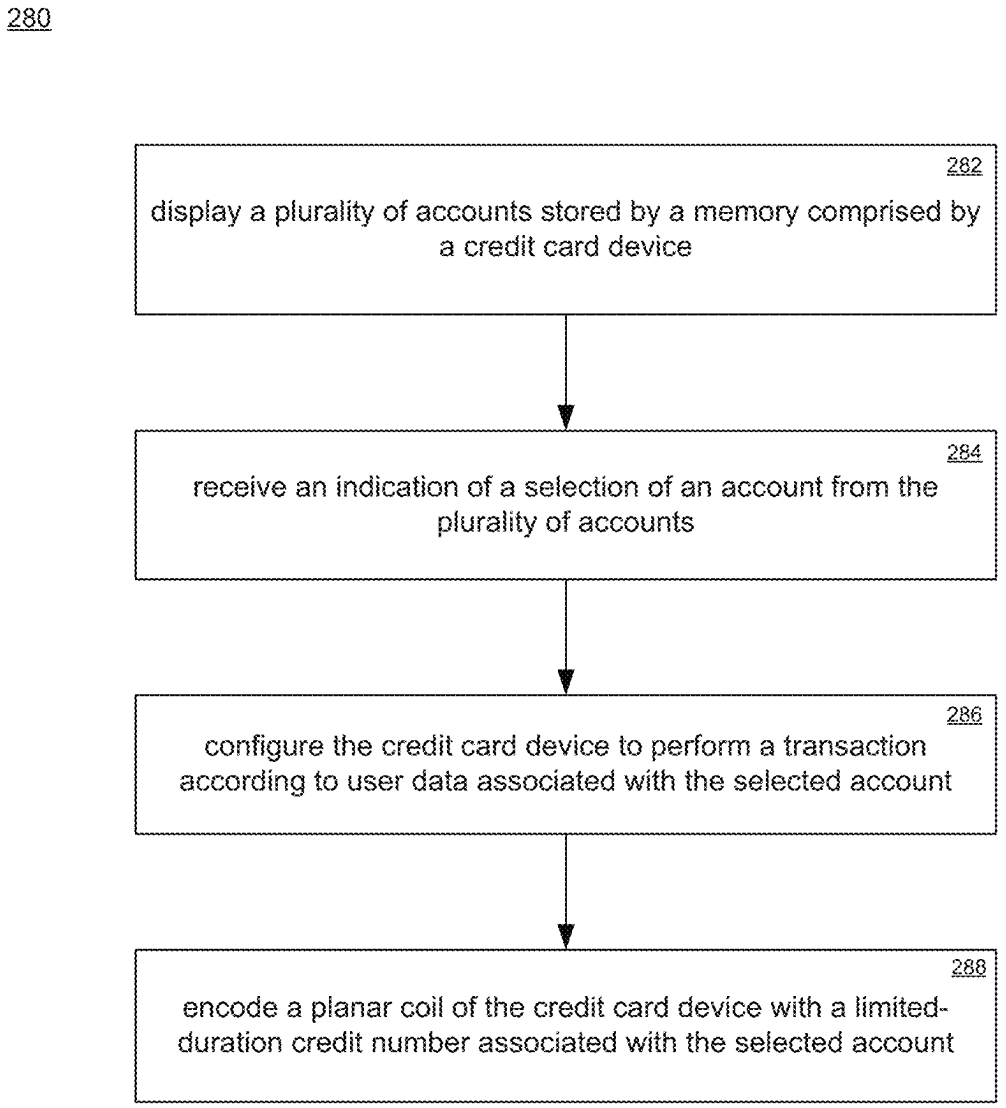
280
282
display a plurality of accounts stored by a memory comprised by a credit card device
284
receive an indication of a selection of an account from the plurality of accounts
286
configure the credit card device to perform a transaction according to user data associated with the selected account
288
encode a planar coil of the credit card device with a limited-duration credit number associated with the selected account

FIG. 2C

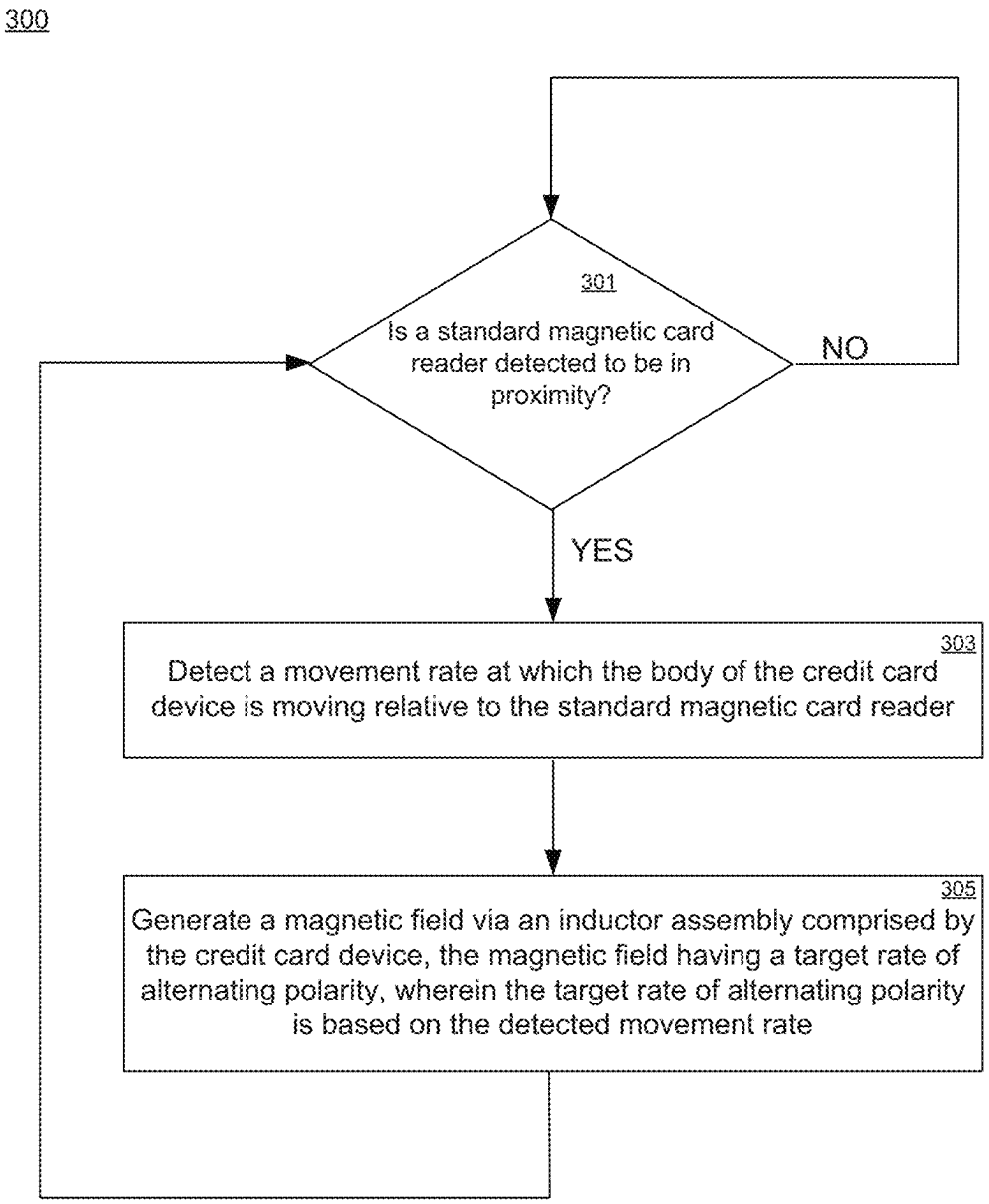
300
301
Is a standard magnetic card reader detected to be in proximity?
NO
YES
303
Detect a movement rate at which the body of the credit card device is moving relative to the standard magnetic card reader
305
Generate a magnetic field via an inductor assembly comprised by the credit card device, the magnetic field having a target rate of alternating polarity, wherein the target rate of alternating polarity is based on the detected movement rate

FIG. 3

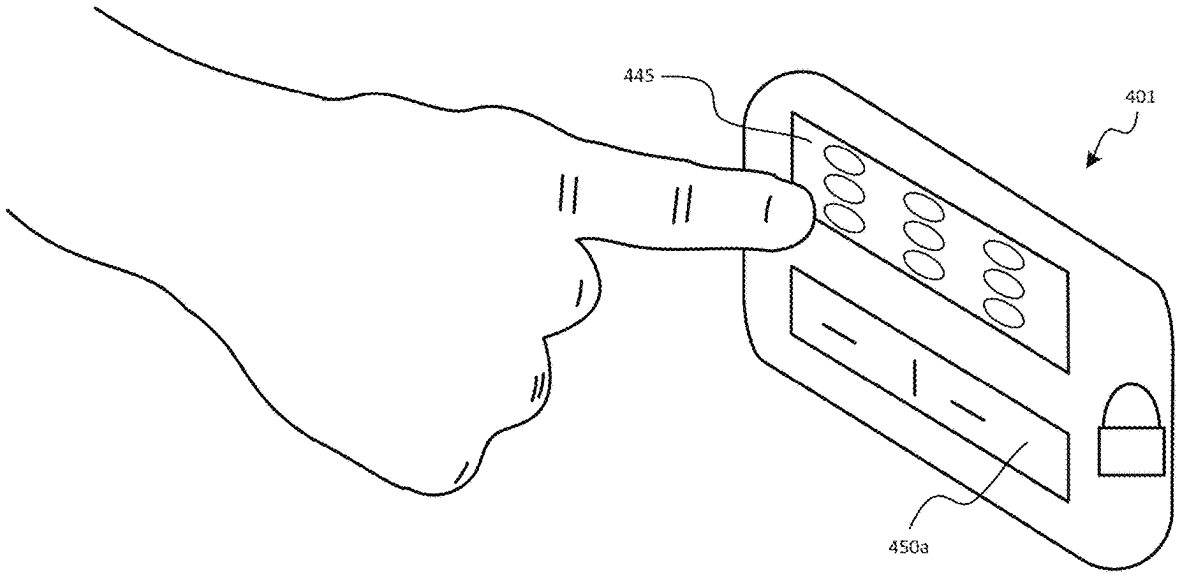

FIG. 4A

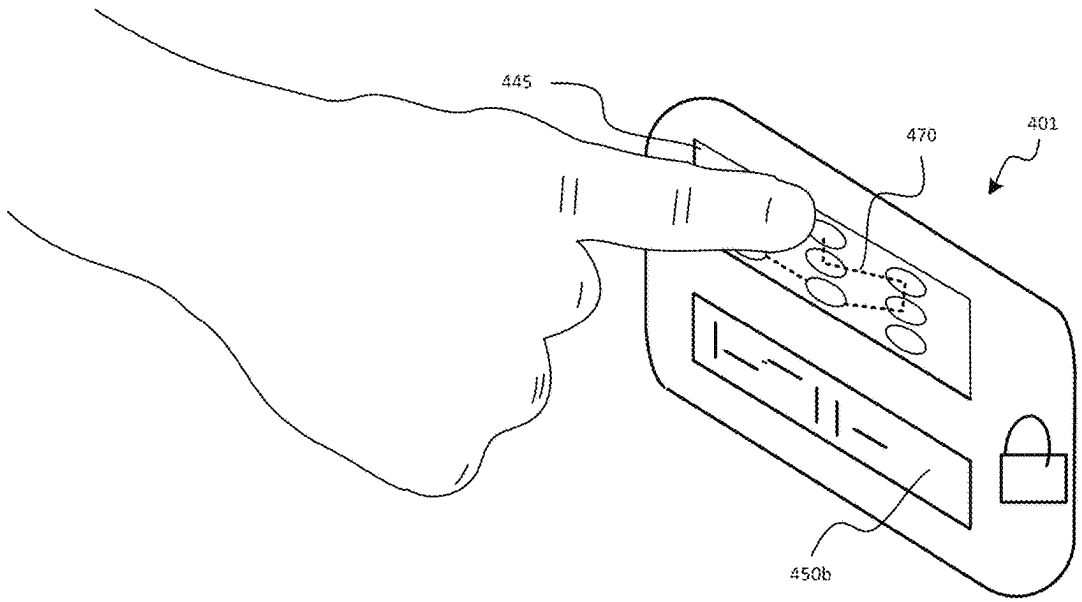

FIG. 4B

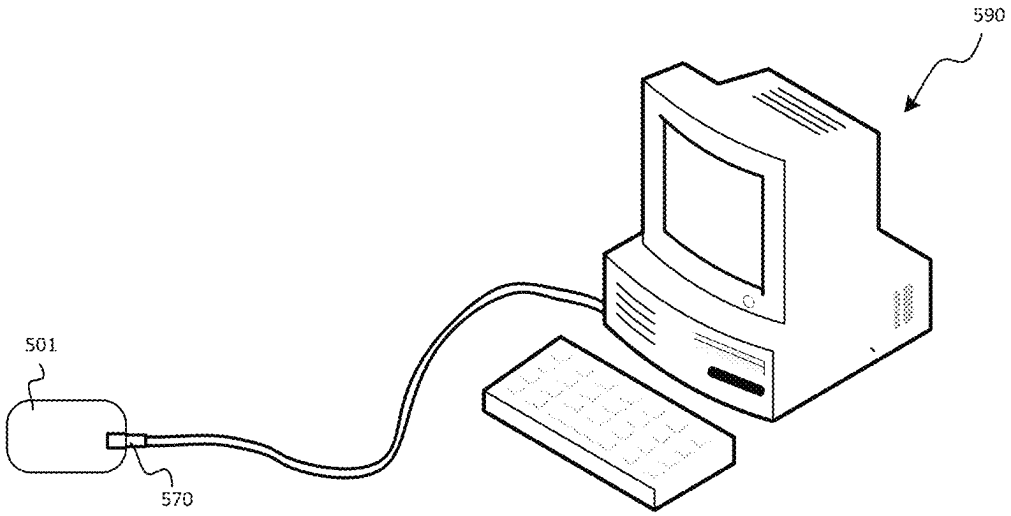

FIG. 5

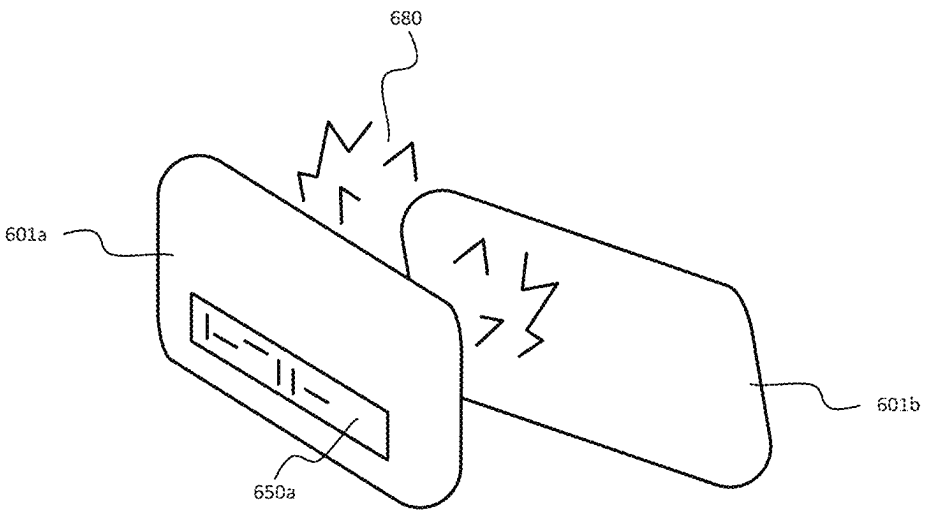

FIG. 6

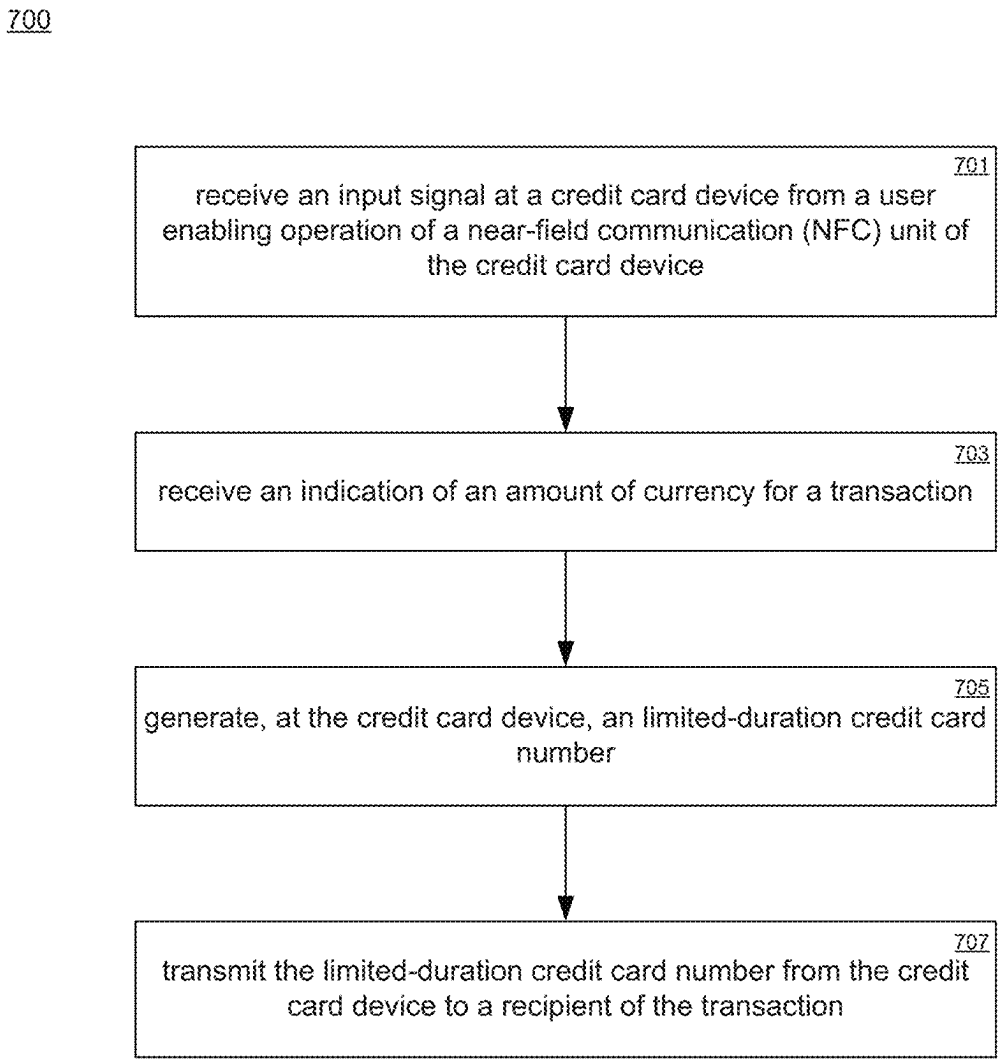
700
701
receive an input signal at a credit card device from a user enabling operation of a near-field communication (NFC) unit of the credit card device
703
receive an indication of an amount of currency for a transaction
705
generate, at the credit card device, an limited-duration credit card number
707
transmit the limited-duration credit card number from the credit card device to a recipient of the transaction

FIG. 7

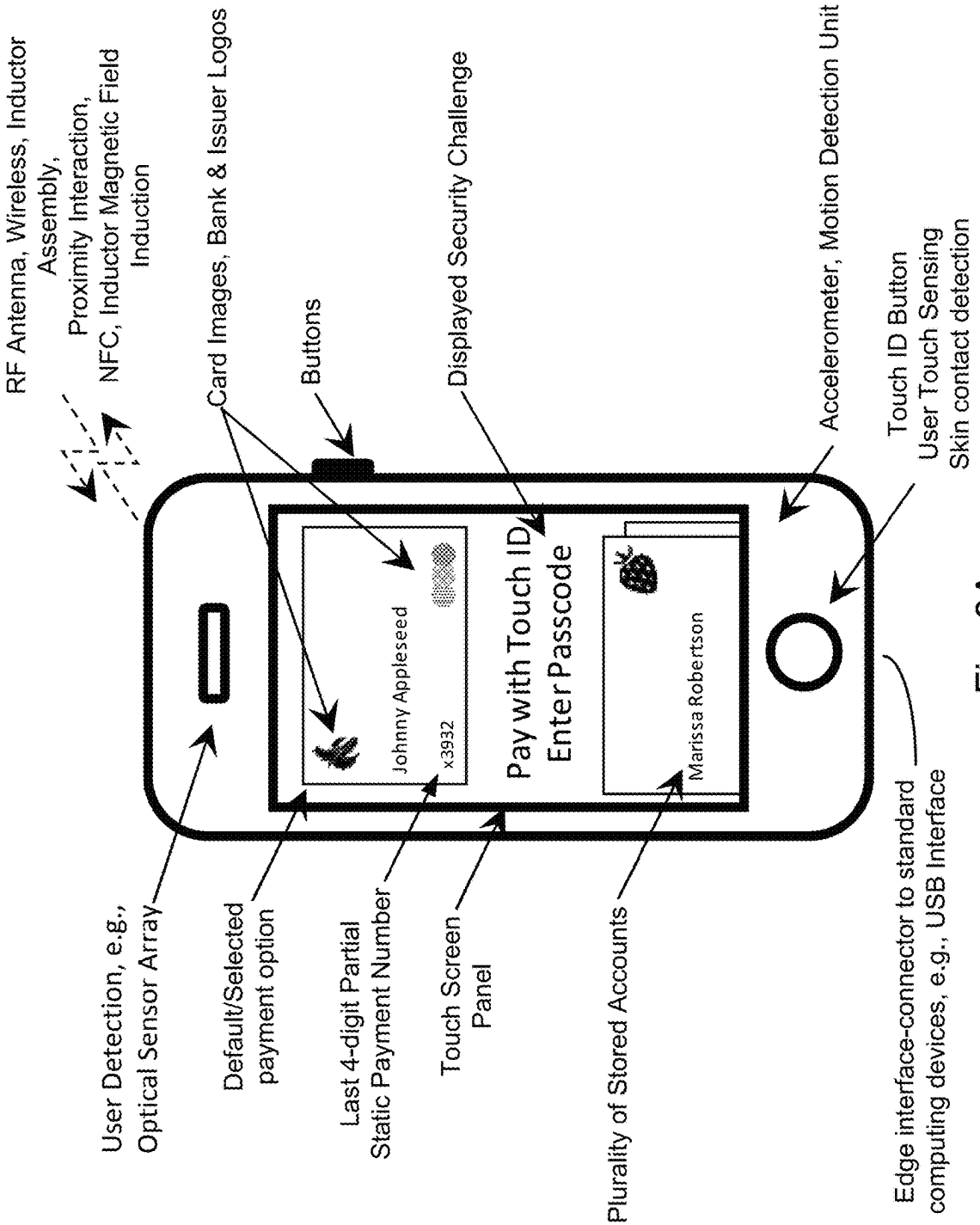
RF Antenna, Wireless, Inductor Assembly, Proximity Interaction, NFC, Inductor Magnetic Field Induction
Card Images, Bank & Issuer Logos
Buttons
Displayed Security Challenge
Accelerometer, Motion Detection Unit
Touch ID Button User Touch Sensing Skin contact detection
Johnny Appleseed
x3932
Pay with Touch ID
Enter Passcode
Marissa Robertson
User Detection, e.g., Optical Sensor Array
Default/Selected payment option
Last 4-digit Partial Static Payment Number
Touch Screen Panel
Plurality of Stored Accounts
Edge interface-connector to standard computing devices, e.g., USB Interface

Fig. 8A

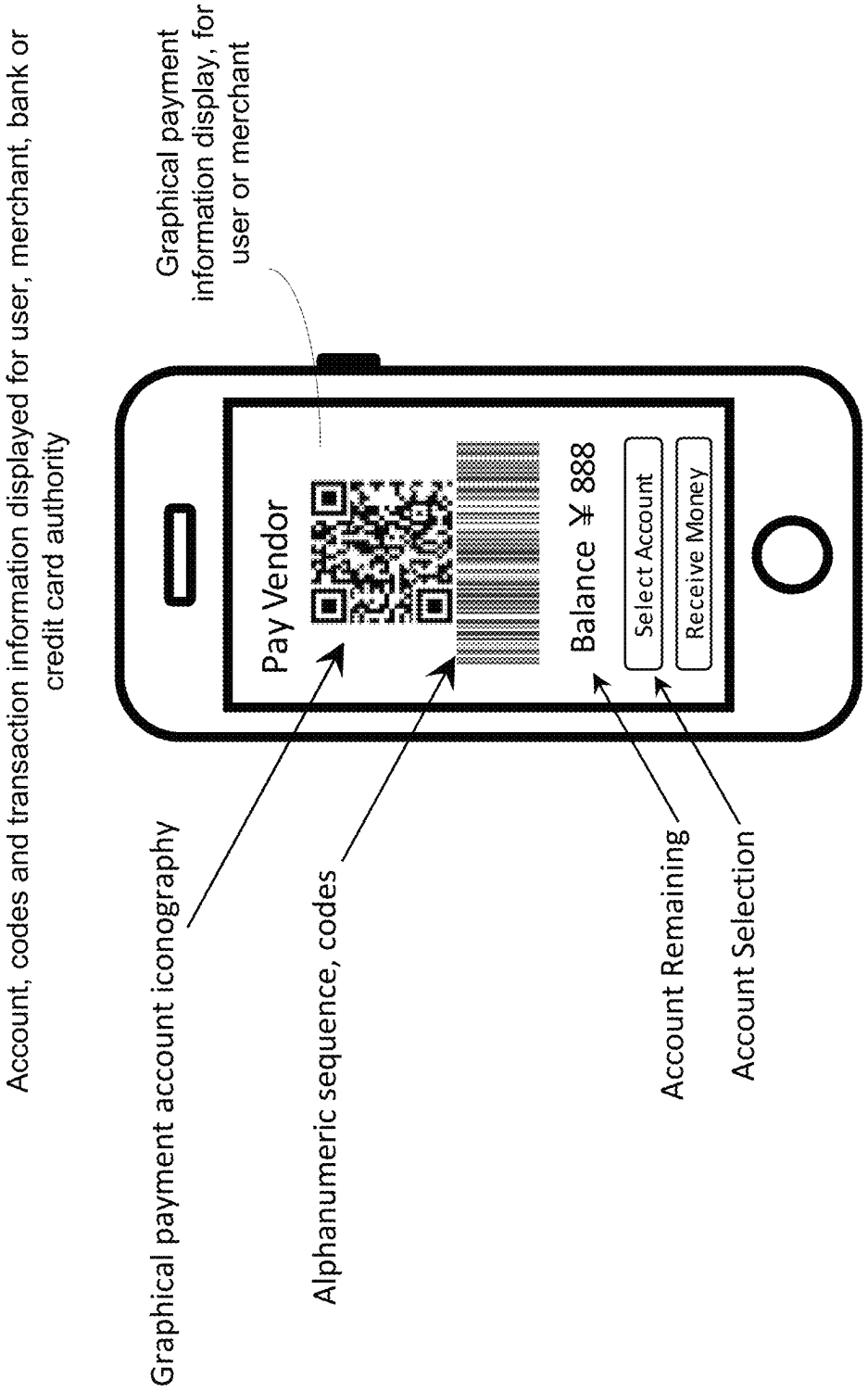
Account, codes and transaction information displayed for user, merchant, bank or credit card authority
Graphical payment information display, for user or merchant
Pay Vendor
Balance ¥ 888
Select Account
Receive Money
Graphical payment account iconography
Alphanumeric sequence, codes
Account Remaining
Account Selection

Fig. 8B

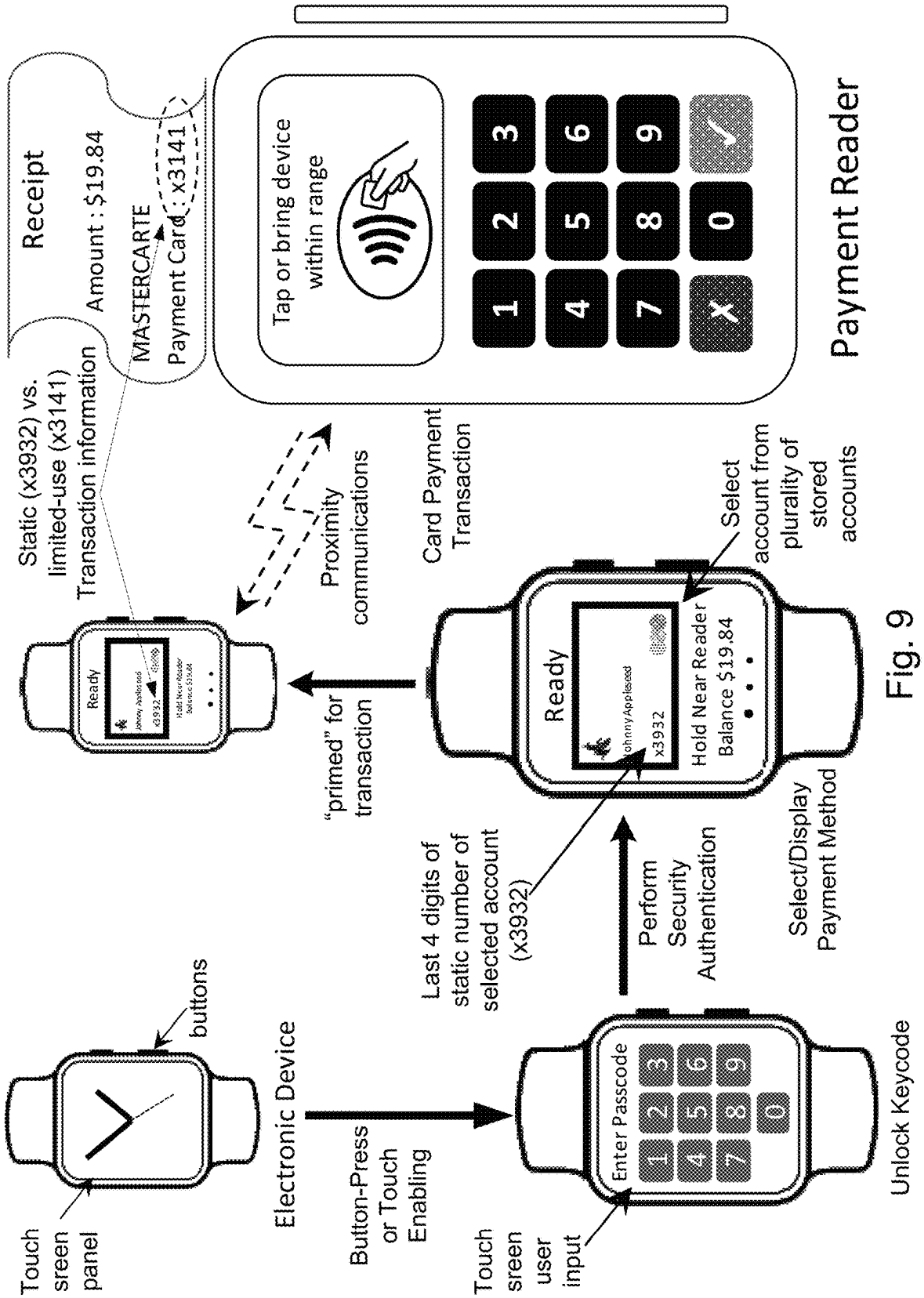
Payment Reader
Tap or bring device within range
1 2 3
4 5 6
7 8 9
X 0
Receipt
Amount : $19.84
MASTERCARTE
Payment Card : x3141
Static (x3932) vs. limited-use (x3141) Transaction information
Proximity communications
Card Payment Transaction
Select account from plurality of stored accounts
Ready
Johnny Appleseed
x3932
Hold Near Reader
Balance $19.84
"primed" for transaction
Last 4 digits of static number of selected account (x3932)
Perform Security Authentication
Select/Display Payment Method
Electronic Device
buttons
Touch sreen panel
Button-Press or Touch Enabling
Touch sreen user input
Enter Passcode
Unlock Keycode

Fig. 9

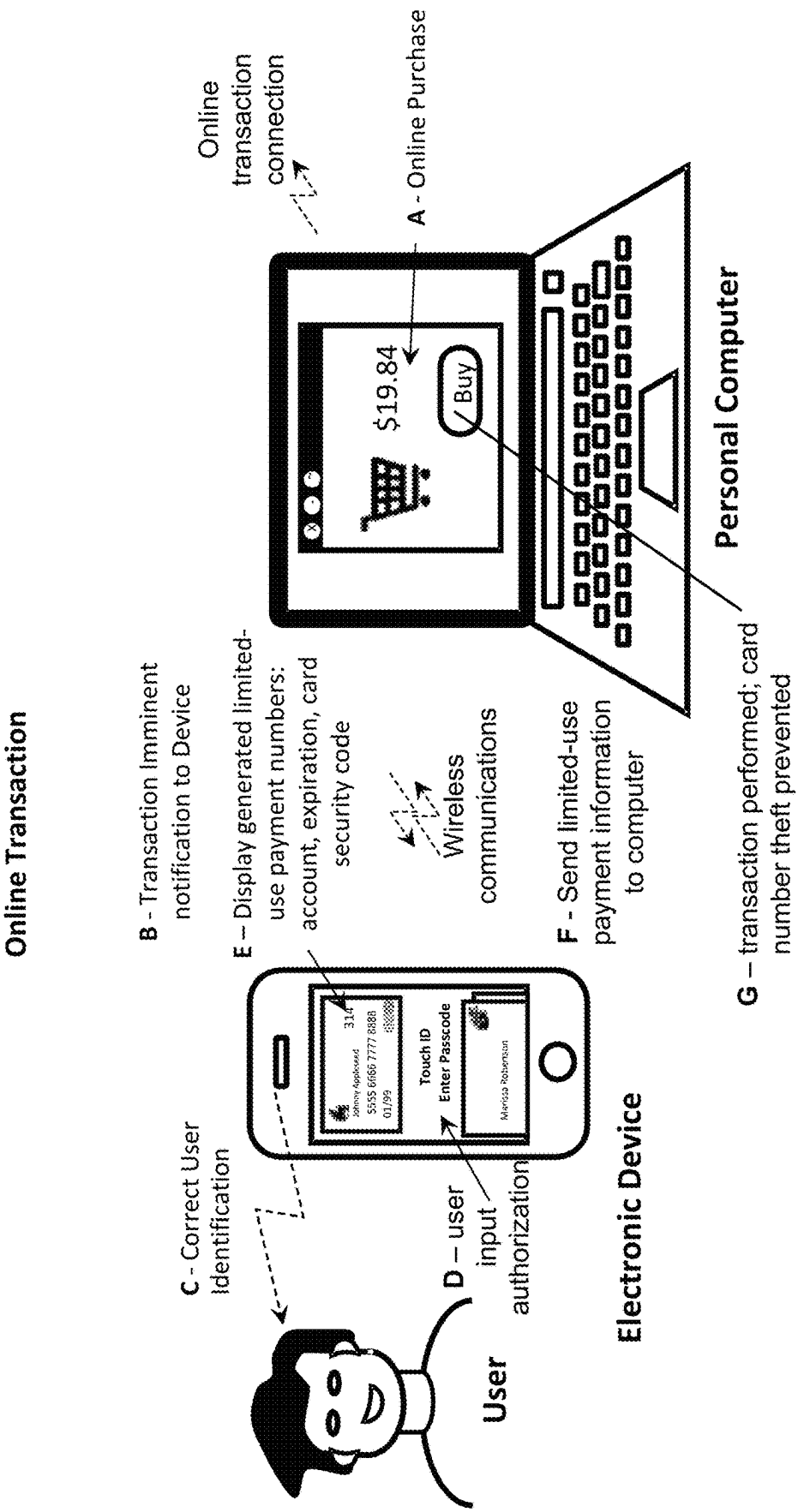
Online Transaction
Online transaction connection
A - Online Purchase
$19.84
Buy
Personal Computer
B - Transaction Imminent notification to Device
E – Display generated limited-use payment numbers: account, expiration, card security code
Wireless communications
F - Send limited-use payment information to computer
G – transaction performed; card number theft prevented
C - Correct User Identification
D – user input authorization
Touch ID
Enter Passcode
User
Electronic Device

Fig 10

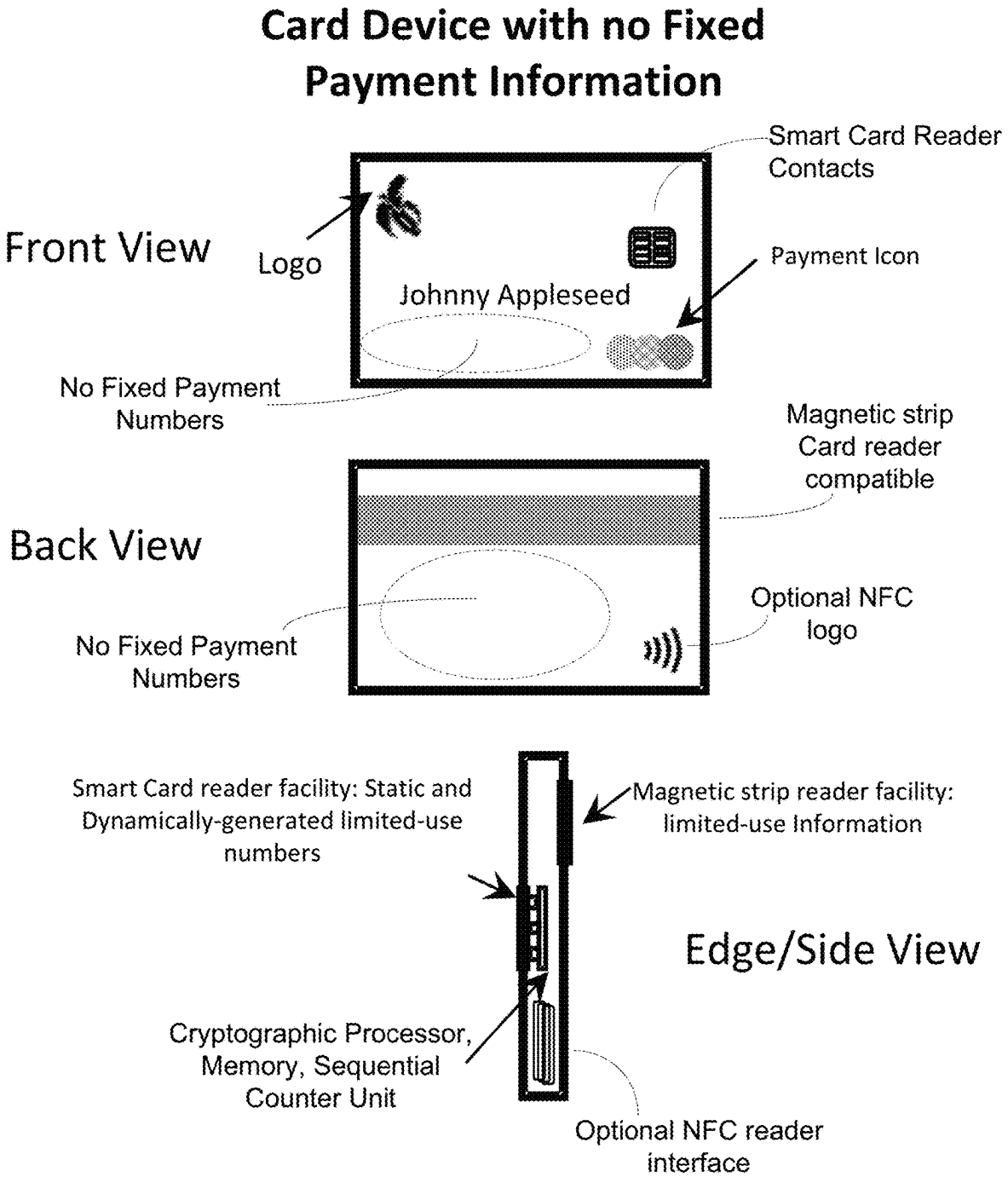
Card Device with no Fixed Payment Information
Front View
Logo
Smart Card Reader Contacts
Payment Icon
Johnny Appleseed
No Fixed Payment Numbers
Back View
Magnetic strip Card reader compatible
Optional NFC logo
No Fixed Payment Numbers
Smart Card reader facility: Static and Dynamically-generated limited-use numbers
Magnetic strip reader facility: limited-use Information
Edge/Side View
Cryptographic Processor, Memory, Sequential Counter Unit
Optional NFC reader interface

Fig 11

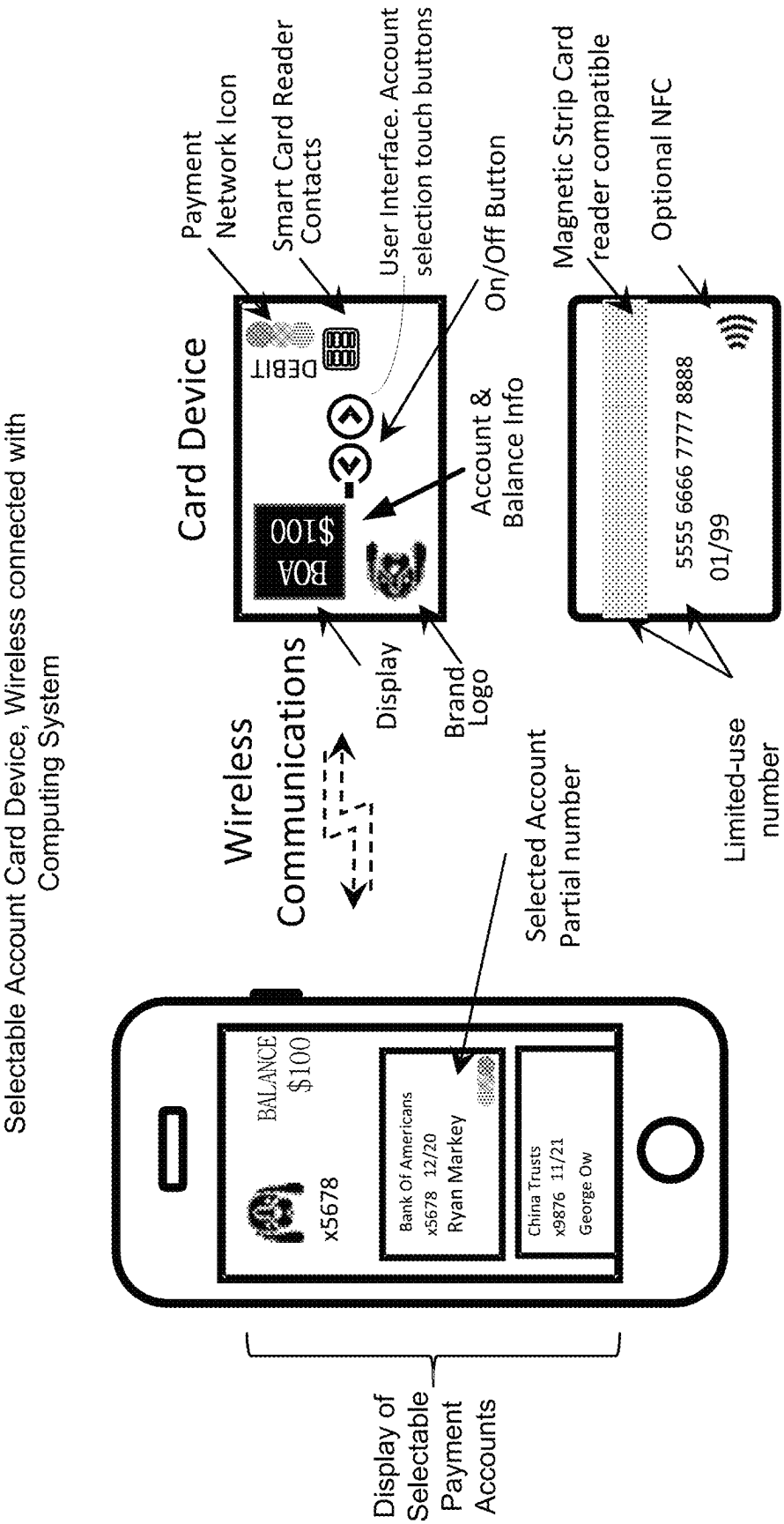
Selectable Account Card Device, Wireless connected with Computing System
Card Device
Payment Network Icon
Smart Card Reader Contacts
User Interface. Account selection touch buttons
On/Off Button
Magnetic Strip Card reader compatible
Optional NFC
DEBIT
BOA
$100
Account & Balance Info
5555 6666 7777 8888
01/99
Wireless Communications
Display
Brand Logo
Selected Account Partial number
Limited-use number
BALANCE
$100
x5678
Bank Of Americans
x5678 12/20
Ryan Markey
China Trusts
x9876 11/21
George Ow
Display of Selectable Payment Accounts

Fig. 12

MULTI-FUNCTION ELECTRONIC PAYMENT DEVICE

RELATED APPLICATIONS

This is a Continuation application of, commonly-owned U.S. patent application Ser. No. 15/250,698, now U.S. Pat. No. 10,013,693, filed Aug. 29, 2016, which in turn was a continuation of U.S. patent application Ser. No. 14/680,946, now U.S. Pat. No. 9,430,765 entitled "MULTI-FUNCTIONAL CREDIT CARD TYPE PORTABLE ELECTRONIC DEVICE," filed Apr. 7, 2016 to inventor David Wyatt, which is itself a continuation of U.S. patent application Ser. No. 14/217,261, now U.S. Pat. No. 9,022,286, similarly entitled "MULTI-FUNCTIONAL CREDIT CARD TYPE PORTABLE ELECTRONIC DEVICE," filed Mar. 17, 2014 by the same inventor David Wyatt, and claims the benefit of U.S. Provisional Patent No. 61/794,891 entitled "Multi-Functional Credit Card Device," filed Mar. 15, 2013 to inventor David Wyatt. The benefit of the earlier filing dates is hereby claimed and the contents of the earlier filed related applications are further incorporated by reference in their entirety.

FIELD OF THE INVENTION

Embodiments according to the present disclosure generally relate to electronic or smartmulti-function electronic devices and, more specifically, to more secure, smart multi-function electronic payment devices and transaction processing thereof.

BACKGROUND OF THE INVENTION

There are several different types of credit cards available in the marketplace at present. A first type of credit card is a conventional, standard piece of plastic with a magnetic strip, which is readily available and in wide commercial use. The advantage of this first type of credit card is that a large portion of the infrastructure for credit card transactions is built around this type of card, and consequently such a card works in a wide array of vendors' credit card machines, automated teller machines (ATMs), and other devices that support the present credit card and banking infrastructure.

Another type of credit card device employs the use of a smart integrated circuit chip. These types of credit cards have a built in microprocessor with cryptographic capabilities. These microprocessors operate in a similar manner to a cell phone having a chip comprising a cryptographic processor. Such a smart card device requires contact with a reader in order to be read and to perform a transaction. The reader provides the manner in which a facility interacts with the built-in processor on the card, e.g., for purposes of performing verification on the authenticity of the card or for making a direct deposit on the card. These credit card devices also comprise a magnetic strip such that they are compatible with standard plastic credit card readers in wide use.

A different type of credit card device in circulation employs radio frequency identification ("RFID"). These cards essentially have a low-power RF antenna built into the card, and when the cardholder passes the antenna in front of a reader comprising an RF field, enough power is generated to enable the processor to interact wirelessly with the receiving device.

A concern with each of these types of credit cards presently available in the marketplace is that they can all be, in various ways, susceptible to theft and/or compromise. Therefore, these types of credit cards have security limitations. Further, cards employing smart integrated circuit chips and RF technology are not in wide use at present because they are incompatible with existing credit card infrastructure, which still predominantly supports conventional plastic credit cards.

SUMMARY OF THE INVENTION

This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

An embodiment includes a multi-function electronic device capable of generating a programmed magnetic field of alternating polarity based on a speed of a card swipe, and methods for constructing the device for the purpose of emulating a standard credit card. An apparatus is described to allow said device to emulate behavior of a credit card when used in electronic credit card readers. Additionally methods are described to allow user control of said device for the purpose of authorizing or controlling use of said device in the application of credit, debit and cash transactions, including cryptocurrency and card-to-card transactions. Methods are also described for generating a limited-duration credit card number when performing a transaction for the purpose of creating a limited-use credit card number, which is limited in scope of use to a predetermined number of authorized transactions. Furthermore said device may interact with other similar devices in proximity for the purpose of funds or credit/debit transfers.

More specifically, an aspect of the present disclosure provides an apparatus comprising: a thin card shaped sized body; a memory operative to store a plurality of identification data; a processor coupled to the memory; a user interface for selecting a select identification data of said plurality of identification data; a magnetic card reader detection unit for determining if the body is adjacent to a standard magnetic card reader; and an inductor assembly coupled to the processor and integrated into the body, the inductor assembly under processor control for generating a magnetic field of alternating polarity responsive to the body being detected as adjacent to a standard magnetic card reader, the magnetic field generated in a region substantially encompassing the standard magnetic card reader, wherein the magnetic field encodes said select identification data, and wherein the magnetic field is operable to be read by a magnetic read head of the standard magnetic card reader.

According to another aspect of the present disclosure, a multi-function electronic device comprises: a near-field communication (NFC) unit; a touch sensor array; a display; a motion rate detection array; a memory, storing a user data and a currency amount; and a processor operatively coupled to the NFC unit, the touch sensor array, the display, the motion rate detection array, and the memory; and wherein the processor initiates a card-to-card transaction between two multi-function electronic devices by a detected proximity of a first multi-function electronic device and a second multi-function electronic device and an input of information by a first user via said touch sensor array, and wherein the card-to-card transaction comprises an exchange of stored currency and said user data between the first multi-function electronic device and the second multi-function electronic device via the NFC unit.

According to yet another aspect of the present disclosure, a method of performing a transaction comprises: receiving an input signal at a multi-function electronic device from a user enabling operation of a near-field communication (NFC) unit of the multi-function electronic device; receiving an indication of an amount of currency for a transaction; generating at said multi-function electronic device a limited-duration credit card number; and transmitting said limited-duration credit card number from said multi-function electronic device to a recipient of the transaction.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present disclosure are illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings and in which like reference numerals refer to similar elements.

FIG. **1** is an illustration depicting an exemplary interaction between a multi-function electronic device and a standard magnetic card reader, according to an embodiment of the present disclosure.

FIGS. **2**A-**2**B are block diagrams illustrating data flow between the magnetic coils on the multi-function electronic device and the microprocessor on the multi-function electronic device according to an embodiment of the present disclosure.

FIG. **2**C depicts an exemplary process of selecting an account from a plurality of stored accounts according to an embodiment of the present disclosure.

FIG. **3** is a flowchart illustrating an exemplary process of generating a magnetic field with an alternating polarity according to an embodiment of the present disclosure.

FIGS. **4**A-**4**B illustrate a user interacting with a touch sensor of the multi-function electronic device, according to an embodiment of the present disclosure.

FIG. **5** is an illustration of a multi-function electronic device connected with a computing system and operating according to an embodiment of the present disclosure.

FIG. **6** is an illustration of two multi-function electronic devices performing a transaction according to an embodiment of the present disclosure.

FIG. **7** depicts an exemplary process according to an embodiment of the present disclosure.

FIG. **8**A illustrates an exemplary multifunction electronic device, in accordance with embodiments of the present invention.

FIG. **8**B illustrates exemplary displayed characteristics of multifunction electronic device, in accordance with embodiments of the present invention.

FIG. **9** illustrates an exemplary process of performing a financial transaction with a portable electronic device in conjunction with a payment reader, in accordance with embodiments of the present invention.

FIG. **10** illustrates an exemplary process for performing a financial transaction with a portable electronic device in conjunction with a personal computer, in accordance with embodiments of the present invention.

FIG. **11** illustrate an exemplary electronic credit-card-like multi-function electronic device that has no fixed payment information, in accordance with embodiments of the present invention.

FIG. **12** illustrates an exemplary process for user selection of a preferred payment account for an electronic credit card-like device, in accordance with embodiments of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to the various embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. While described in conjunction with these embodiments, it will be understood that they are not intended to limit the disclosure to these embodiments. On the contrary, the disclosure is intended to cover alternatives, modifications and equivalents, which may be included within the spirit and scope of the disclosure as defined by the appended claims. Furthermore, in the following detailed description of the present disclosure, numerous specific details are set forth in order to provide a thorough understanding of the present disclosure. However, it will be understood that the present disclosure may be practiced without these specific details. In other instances, well-known methods, procedures, components, and circuits have not been described in detail so as not to unnecessarily obscure aspects of the present disclosure.

Some portions of the detailed descriptions which follow are presented in terms of procedures, steps, logic blocks, processing, and other symbolic representations of operations on data bits that can be performed on computer memory. These descriptions and representations are the means used by those skilled in the data processing arts to most effectively convey the substance of their work to others skilled in the art. A procedure, computer generated step, logic block, process, etc., is here, and generally, conceived to be a self-consistent sequence of steps or instructions leading to a desired result. The steps are those requiring physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated in a computer system. It has proven convenient at times, principally for reasons of common usage, to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, or the like.

It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the following discussions, it is appreciated that throughout the present claimed subject matter, discussions utilizing terms such as "storing," "creating," "protecting," "receiving," "encrypting," "decrypting," "destroying," or the like, refer to the action and processes of a computer system or integrated circuit, or similar electronic computing device, including an embedded system, that manipulates and transforms data represented as physical (electronic) quantities within the computer system's registers and memories into other data similarly represented as physical quantities within the computer system memories or registers or other such information storage, transmission or display devices.

Encoding Via an Alternating Polarity of a Magnetic Field

In one embodiment of the present disclosure, a smart multi-function electronic device comprises a dynamic magnetic region (strip) incorporating a main inductor assembly from which programmed magnetic field data symbols are dynamically generated. In one embodiment the inductor assembly may be a planar coil formed within the material that embodies the multi-function electronic device. An advantage of using a planar coil is that it can dynamically produce a magnetic field in such a manner as to emulate the interaction between a traditional magnetic strip and a conventional credit card reader. As the magnetic strip of a

conventional credit card is passed through a magnetic reader head, stripes of alternating magnetic polarity embedded in the strip induce a magnetic field of alternating polarity at the reader head. The pattern formed by the alternating polarity of the magnetic field encodes information, which when transformed by a transducer to a current signal in the magnetic reader head, provides user information for a transaction.

Embodiments of the present disclosure provide a multi-function electronic device able to generate a programmed magnetic field, wherein data is encoded and represented by an alternating polarity of the generated magnetic field. In a similar manner to a conventional plastic credit card, the magnetic field produced by the planar coil is able to be read by a pickup (or "transducer") and to thereby transmit information to the magnetic card reader. FIG. **1** illustrates a credit card transaction **100** performed between a multi-function electronic device **101** and a conventional magnetic reader **150**. The multi-function electronic device **101** generates a magnetic field of alternating polarity **120** to be read by the conventional magnetic card reader **150**, according to an embodiment of the present disclosure. The multi-function electronic device **101** is moved at a rate **130** relative to a magnetic reader head **155** of conventional magnetic card reader **150**. The magnetic field **120** extends with sufficient distance and intensity from **101** so as to be read by magnetic head reader **155**. The magnetic head reader **155** responds to the magnetic field **120** by producing a current in the conventional fashion, which is then interpreted as encoded information by the magnetic reader **150**. Therefore the magnetic field of alternating polarity **120** produced by the multi-function electronic device **101** has a substantially identical encoding effect as a traditional magnetic strip.

A characteristic of encoding information in a conventional magnetic card strip is that binary information is encoded by the pattern of alternating magnetic polarity formed by ferromagnetic stripes embedded on the magnetic strip. As the conventional magnetic card strip has a standardized format, the encoding of information is provided at a specified data density (bits per inch), according to which conventional magnetic readers are designed for interpretation of encoded data. In order to most ably emulate a conventional credit card interaction with a conventional magnetic reader the multi-function electronic device **101** of the present disclosure is provided with a means of determining a substantially optimal rate for alternating the polarity of the generated magnetic field **120** in order to produce data at a rate which is able to be readily received and correctly interpreted by the conventional magnetic reader **150**. Embodiments of the present disclosure provide several means of determining the relative movement rate **130** between the multi-function electronic device **101** and the magnetic reader head **155**. These features, as well as other characteristics of the multi-function electronic device of the present disclosure, can be better appreciated by a description of the internal components and functions of multi-function electronic device **101**.

FIGS. **2**A and **2**B depict exemplary embodiments of a smart multi-function electronic device, in a block diagram view. The components of the block diagram are illustrated according to functional connections, and their locations should not be construed as being limited to the respective locations as depicted in FIGS. **2**A-**2**B. In FIG. **2**A, multi-function electronic device **201***a* is shown in a block diagram view. Multi-function electronic device **201***a* comprises a processor **205** and a memory unit **207**, the processor **205** operatively coupled to the components of multi-function electronic device **201***a*. The memory **207** comprises a plurality of accounts **209**, which may be credit card accounts, banking accounts, merchant accounts, online accounts, cryptocurrency accounts, and combinations thereof. A motion detection module **210** is coupled to the processor unit **205** and to a set of motion detection units, which comprise a rate detection assembly **225**, an optical sensor array **230**, and a set of accelerometers **235**. The magnetic field is generated via a planar coil **220**, which is controlled by the processor unit **205** via a coil interface **215**. The rate at which the magnetic field changes polarity to encode the user data depends on the rate of relative movement detected by the rate detector. The multi-function electronic device **201***a* further comprises a real-time clock **240**, a touch-sensor array **245**, and a display **250**, each operatively coupled to the processor unit **205**. A user input may be made via the touch sensor array **245**, which may comprise a touch screen panel, a keypad, or a combination thereof. The display **250** is able to display an alphanumeric sequence, as well as graphical icons (such as a logo for a bank, or other images). See, for example, FIGS. **8**A and **11**. Further, an optional backup power source **255** is depicted.

In one embodiment, the processor unit **205** is connected to the planar coil **220** and the motion detection units, via the motion detection module **210**. The processor unit **205** is responsible for determining the appropriate rate with which to output data from the planar coil **220**, wherein output data is encoded using alternating polarity of a generated magnetic field. The rate of the alternating polarity of the magnetic field is generated in accordance with the detected movement speed with which the card is swiped through the reader, in order for the reader to receive the encoded data at the appropriate rate. Magnetic card readers, which are designed to read conventional credit cards, are constructed to read data at specified input rates that correspond with the data density present in conventional magnetic card strips. The magnetic data symbols generated by the planar coil **220** are produced to align with the rate at which data is being read by the magnetic card reader. Accordingly, it is irrelevant if the multi-function electronic device **201***a* of the present disclosure is being swiped quickly or slowly, the planar coil **220** is controlled by the processor unit **205** to produce data at a substantially optimized rate, where the rate of data production is dependent on the rate at which the multi-function electronic device **201***a* is detected to be passing across the magnetic reader head.

FIG. **2**B depicts a multi-function electronic device **201***b* according to an embodiment of the present disclosure. Device **201***b* comprises a processor **205** and a memory unit **207**, the processor **205** operatively coupled to the components of multi-function electronic device **201***b*. The memory **207** comprises a plurality of accounts **209**, which may be credit card accounts, banking accounts, merchant accounts, online accounts, cryptocurrency accounts, and combinations thereof. A motion detection module **210** is coupled to the processor unit **205** and to a set of motion detection units, which comprise a rate detection assembly **225**, an optical sensor array **230**, and a set of accelerometers **235**. Additionally, a galvanic sensor **275** is coupled to processor unit **205**. The magnetic field is generated via a planar coil **220**, which is controlled by the processor unit **205** via a coil interface **215**. The rate at which the magnetic field changes polarity to encode the user data depends on the rate of relative movement detected by the rate detector. The multi-function electronic device **201***b* further comprises a real-time clock **240**, a touch-sensor array **245**, and a display **250**, each operatively coupled to the processor unit **205**. A user input may be made via the touch sensor array **245**, which may comprise

a touch screen panel, a keypad, or a combination thereof. See also, for example, FIGS. **8** and **9**. The display **250** is able to display an alphanumeric sequence, as well as graphical icons (such as a logo for a bank, or other images). Further, an optional backup power source **255** is depicted. Multi-function electronic device **201***b* further comprises a near-field communication (NFC) unit **260**, as well as a radio frequency identification (RFID) unit **265**, both of which are operatively coupled to the processor unit **205**. In one embodiment the NFC and RFID may share the planar coil for use as a RF antennae, through the coil interface **215**. In one embodiment one or both the NFC and the RFID may have antennae dedicated to that individual sub-system. A universal serial bus (USB) connector **270** is coupled to the processor unit **205**. The functionality of the components with regard to exemplary uses of multi-function electronic devices **201***a* and **201***b* is described in greater detail in the following description.

A further aspect of the present disclosure provides a single multi-function electronic device that can be used for multiple banks or financial institutions. For example, instead of carrying a separate credit card for each account of a variety of credit card companies, a customer need only to carry a single card according to embodiments of the present disclosure. The capability of the multi-function electronic device to generate a multitude of credit card numbers provides the ability of the multi-function electronic device to be associated with multiple accounts. Furthermore, inputs at the touch sensor array on the multi-function electronic device can be used to select the appropriate bank or credit provider account stored in the memory unit of the multi-function electronic device.

FIG. **2**C depicts a process of selecting an account from a plurality of stored accounts in order to perform a transaction with the selected account, according to an embodiment of the present disclosure. The process **280** begins at step **282**, where a plurality of accounts stored by the multi-function electronic device memory is displayed. The plurality of accounts **209** are stored by memory **207**, and are displayed using display **250**. A user indicates an account selected from the plurality of accounts at step **284**. The selection is able to be made by keypad or touch sensor array **245**, and an indication of the selected account can be displayed via display **250**. At step **286** the multi-function electronic device is configured according to account information associated with the selected account, which may include an account number, an expiration date, and other user information associated with the account (e.g. a username, PIN, password, email address, etc.). At step **288** the planar coil of the multi-function electronic device is encoded with a limited-duration credit card number that is associated with the selected account. The limited-duration credit card number is able to be generated according to the selected account, a timestamp, a transaction amount, an indicated merchant, user key or secrets, on-card unique hardware secrets, credit card authority key or secrets, user input from the card interface, and other information associated with the transaction.

Movement Rate Feedback

The relative movement rate of multi-function electronic device **201***a* is detected by one or more of the set of motion detection units, comprising the rate detection assembly **225**, the optical sensor array **230**, and the set of accelerometers **235**. Each of the motion detection units detects the motion of the credit card **201***a* in a distinct manner. The rate detection assembly **225**, which is positioned alongside (but independent of) the planar coil **220**, is able to detect the location of a magnetic head reader as the rate detection assembly **220** is being passed through the credit card reader. The reader module of a conventional credit card reader comprises a metal head having a small gap at the tip of the head. A pickup armature resides in this gap, such that as the metal head passes over a credit card strip, an electric field is induced in the head reader pickup circuit. In one embodiment the rate detection assembly **225** is constructed of an array of auxiliary inductor coils and magnetic pickup coils. As the metal head of the card reader assembly passes over the arrangement of auxiliary inductor coils and magnetic pickup coils of the rate detection assembly **225**, a disturbance in the magnetic field flowing between the two is induced, generating a change in current and producing a detected movement signal. The change in current is detected by the motion detection module **210**, and is used to determine the rate of motion of the card reader head passing across the surface of the multi-function electronic device **201***a* (and therefore along the planar coil **220**).

The optical sensor array **230** is also operable to detect a movement rate of the multi-function electronic device **201***a* with respect to a conventional magnetic card reader. The optical sensor array **230** is disposed nearby the planar coil **220**, in order to accurately detect a movement rate in the region of the planar coil **220**. In an embodiment, the optical sensor array **230** is a thin strip parallel to, and extending along, the length of the planar coil **220**. The optical sensor array **230** determines a location of a minimum of received light, which corresponds to the region of a surface in nearest proximity to the optical sensor array **230**. The magnetic reader head of a conventional magnetic card reader extends furthest from the surface of the card reader, and therefore the detected minimum in received light at the optical sensor array **230** corresponds with the location of the reader head. By tracking over time the position of this minimum received light along the optical sensor array, a detected movement rate may be found.

The set of accelerometers **235** are also operable to detect a movement rate of the multi-function electronic device **201***a*. The set of accelerometers **235** are positioned in the multi-function electronic device **201***a* in order to effectively measure the position and acceleration of the multi-function electronic device **201***a*. In an embodiment, the set of accelerometers comprises groups of accelerometers, each group having one or more accelerometers disposed at orthogonal planes to each other, and each group capable of generating signals that allow for determination of the orientation, motion and acceleration of the multi-function electronic device **201***a*.

The detected movement signal is received by the motion detection module **210**. The detected movement signal is generated by any one of the set of motion detection units, or any combination of motion detection units of the set. For example, the movement detection signal is able to be generated by the combination of the rate detection assembly **225** and the optical sensor array **230**. In an embodiment, the movement detection module **210** is able to determine the movement rate of the multi-function electronic device **201***a* from the detected movement signals, and transmits the determined movement rate, and orientation to the processor unit **205**. In an embodiment, the motion detection module **210** sends the detected movement signal to the processor unit **205**, and the processor unit **205** determines the relative movement rate.

In one embodiment, the generation of the magnetic field by the planar coil **220** at a specified rate of alternating polarity is accomplished according to the following descrip-

tion. One or more of the motion detection units in the set of motion detection units (rate detection assembly **225**, optical sensor array **230**, and set of accelerometers **235**) detect a movement rate of the multi-function electronic device **201***a* with respect to a magnetic card reader, and signal the motion detection module **210**. The movement rate is provided to the processor unit **205**, which determines the appropriate rate for alternating the polarity of the magnetic field generated by the planar coil **220**. The processor unit **205** outputs instructions or data to the coil interface **215** at the determined rate, which in an embodiment is a digital-to-analog converter (a DAC) and acts to translate the signal from digital to analog in order to drive the planar coil **220** and produce the magnetic field. The instructions from the processor unit **205** are comprise binary code, which are output through a shift register to the coil interface **215**. The shift register outputs data at a rate proportional to the determined movement rate of the multi-function electronic device **201***a*—thus, a higher determined multi-function electronic device **201***a* movement rate has a corresponding higher output rate at the shift register, leading to a higher rate of alternating polarity at the generated magnetic field (i.e., encoded data symbols output more quickly). Conversely, a lower movement rate of multi-function electronic device **201***a* leads the processor unit **205** to control the shift register to output data at a lower rate, and consequently the rate of alternating polarity in the generated magnetic field is lower.

FIG. **3** illustrates an exemplary process **300** for determining the rate to alternate the polarity of the generated magnetic field of the multi-function electronic device, according to an embodiment of the present disclosure. At step **301** the process determines if a standard magnetic card reader is detected to be in proximity with the multi-function electronic device. If NO, the step repeats. If YES, the process moves to step **303**. At step **303** a detection of a movement rate at which the body of the multi-function electronic device is moving relative to the standard magnetic card reader is made. The process continues at step **305**, wherein a magnetic field is generated by an inductor assembly comprised by the multi-function electronic device, the magnetic field having a target rate of alternating polarity that is based on the detected movement rate from step **303**. The process then repeats at step **301**, determining if a standard magnetic card reader is (or remains) in proximity to the multi-function electronic device. In this manner, while a standard magnetic card reader is detected to be in proximity to the multi-function electronic device, the movement rate of the multi-function electronic device is determined and the polarity and orientation of the generated magnetic field is alternated at the appropriate rate, to recreate the data as described above, at the correct rate, in order to clock out the data to be conveyed to the magnetic strip reader, at a rate matching the action of an ordinary magnetic strip card through same the magnetic card reader.

Security

Security is an area of concern for credit card holders, as the small form factor makes theft quite easy, and additionally there are many ways for a malicious third-p arty to record the account number of a credit card in order to later make fraudulent transactions on the account. Embodiments of the present disclosure address security concerns of a credit card owner on several fronts.

In one aspect, security of the multi-function electronic device is enhanced by providing a means of locking the multi-function electronic device in order to prevent use, until such time that a valid user input is entered. Embodiments of the present disclosure provide a multi-function electronic device having a region for receiving human input, e.g., touch sensors which are able to be formed by contacts that a user can press (e.g., the touch sensor array **245** of FIGS. **2**A-**2**B). FIGS. **4**A-**4**B illustrate a user interacting with a multi-function electronic device **401** via a keypad or touch sensor array **445**. In FIG. **4**A, the multi-function electronic device **401** is in a locked state. A display **450** is able to display a message to the user, for instance, the message "device locked" or "enter password," or question prompts which guide the user to respond with answers through the key-pad or the touch sensor, to certain preset questions, that confirm personal knowledge known only to the associated user. The touch sensor array **445** enables user interaction with the multi-function electronic device **401**. An exemplary use of the touch sensor array **445** is an input of a currency amount to be used in a transaction. The touch sensor array **445** is able to include buttons, or a touch-sensitive pad, or a combination of the two. Other embodiments of the touch sensor array **445** allowing a user to input data to the multi-function electronic device **401** are consistent with the spirit and scope of the present disclosure.

In order to unlock the multi-function electronic device **401** and enable a transaction or other usage, the user inputs data via the touch sensor array **445**. FIG. **4**B illustrates the user inputting a password via a gesture **470**, which operates to unlock the multi-function electronic device **401**. The display **450***b* is able to display a message indicating the multi-function electronic device **401** is unlocked and ready for use, for instance, display **450***b* may display the message "unlocked," or it may display an account number associated with the multi-function electronic device **401**.

Embodiments of the present disclosure provide additional functionality for the touch sensor array **445**. For example, there may be touch contact terminals that a user can press to wake up the multi-function electronic device **401**, to cause the battery to supply power, or to place the multi-function electronic device **401** in a power reduction mode when it is not being used. In an embodiment, if any number other than the correct password is entered multiple times, or if there is an attempted usage of the multi-function electronic device **401** without entering in a password, an automatic phone call may be triggered to the appropriate fraud protection authorities.

In one embodiment of the present disclosure, the display **450** is a thin-film liquid crystal display ("LCD"). The display **450** is able to have multiple uses. In one embodiment, the display **450** can be used to cue the user for a security question upon input of an improper password. Or if fraud protection services need to contact a customer, they can verify the customer's identity by transmitting a security question to the display **450** of user's multi-function electronic device **401**, to which the user would need to respond correctly using the input buttons of touch sensor **445** on the card. See also, for example, FIGS. **8** and **9**.

Limited-Duration Credit Card Number

A further security feature of the multi-function electronic device provided in the present disclosure is the capability of producing a limited-duration credit card number for performing transactions using accounts of the card. The multi-function electronic device comprises a real-time clock that is able to produce a cryptographically protected timestamp for each interaction. The power source is able to activate the processor unit such that a unique number may be generated by the multi-function electronic device and verified by the credit authority according to the timestamp and the transmitted user information. The limited-duration credit card number is able to be produced at the time the multi-function

electronic device is performing a transaction, and is able to be generated according to the user's private information, a bank information, information regarding the facility performing the transaction, and the time of day. The limited-duration credit card number is able to be limited to only one transaction, a finite number of transactions, or may be limited to a specified period of time—e.g., 2 minutes, 10 minutes, 3 hours—after which time that particular limited-duration number would become invalid. As detailed above, if an expired limited-duration credit card is attempted to be used for a transaction, the transaction is denied and an automatic notification is able to be made to a credit authority in order to notify the user and to prevent transactions on the account. The transaction count is able to be determined through the action of passing the card through magnetic reader, and the process of transmitting the card number to the card reader.

In one embodiment, the number on the front of the card is able to be a full or partial number. In an embodiment, the number displayed on the multi-function electronic device is a static number, but the number transmitted during a transaction is a limited-duration credit card number as described above. The number displayed on the multi-function electronic device may not necessarily be a static number. For example, the first four and last four digits of the credit card number are able to be fixed, while the remaining eight digits can be dynamically generated. As the credit card is read by the machine, part or all of the number may be dynamically produced at the time the card is read. As described above, the dynamic part of the limited-duration credit card number generated may be based on the user's private information, the user's bank information, the time of day or the facility that is reading the card. Further, the expiration date of the multi-function electronic device can also be dynamically generated. See also, for example, FIGS. **8**, **9** and **11**.

Effectively, embodiments of the present disclosure provide a multi-function electronic device that has no fixed number, as illustrated in FIG. **11**, and therefore the account cannot be compromised. Only the number generated at the instant of the credit card transaction matters. Accordingly, unauthorized use of the multi-function electronic device is highly unlikely, because a transaction cannot be conducted with an expired limited-duration credit card number, or only the static portion of the credit card number. In one embodiment of the present disclosure, sufficient dynamically generated numbers are provided for on the credit card such that a unique credit card number can be generated for each transaction. In this embodiment, the credit card of the present disclosure effectively acts as a unique per-transaction credit card.

With reference to FIG. **2**A, **2**B, in one embodiment, the process steps enabling a card transaction are as follows. A multi-function electronic device (e.g., multi-function electronic device **201***b*) is connected to a computer system (e.g. computer system **590**, FIG. **5**), via any of the connection means available to the multi-function electronic device (USB **270**, NFC **260**, and RFID **265**). User data and other essential information, such as account information, are downloaded to the multi-function electronic device. For example, for an account designed for online transactions, user account information will likely include an account email and an account password. The account may be for example a bank account, a credit account, a merchant account, an online transaction account, or a cryptocurrency. In one embodiment a currency amount is also downloaded, which is made accessible to the multi-function electronic device **201***b* for transactions. In an alternative embodiment, rather than a currency amount being downloaded to the multi-function electronic device **201***b*, the user account information (e.g., username and password) is stored such that a subsequent authorized multi-function electronic device **201***b* transaction is automatically pre-authorized to deduct (or credit) the entered transaction amount at a stored account. In an embodiment, a user uses the touch sensor array **245** of the multi-function electronic device **201***b* in order to input the user information, including the amount of currency to be stored. The information entered by the user is able to include an account source of a transaction (e.g., bank account, credit account, merchant account, ATM, online payment service, or a cryptocurrency), as well as a type of transaction to be made (e.g., as a debit card, as a credit card, or as a user account). In another embodiment, the information is entered using the computing system to which the multi-function electronic device **201***b* is connected.

Transactions may be authenticated on the specified account by entry of the username and password for the account during the transaction, using the touch sensor array **245**. In an embodiment, a password for an account is represented by a user input (such as a gesture, a swipe, and/or an unlock keycode) which is entered on multi-function electronic device **201***b* during a transaction for account authentication. See also, for example, FIG. **9**. According to an embodiment of the present disclosure, a user that has "primed" the multi-function electronic device **201***b* for a transaction has already performed a security authentication on the card, and therefore a subsequent card transaction is able to be pre-authorized to perform the transaction without further user authentication steps. The priming action can be a tap of the multi-function electronic device **201***b* detected by accelerometers **235**, or a gesture, swipe, or a key input received by touch sensor array **245**. See also, for example, FIG. **9**.

A transaction is able to be communicated using the planar coil **220**. In one embodiment, when the transaction is a credit card transaction, a limited-duration credit card number is generated. A user inputs an amount for the transaction using the touch sensor array **245**, and the limited-duration credit card number is generated to correspond with the entered amount. The binary data corresponding to this limited-duration credit card number is sent from the processor unit **205** to the coil interface **215**, where it is converted to an analog signal in order to drive the planar coil **220** to generate a magnetic field having an alternating polarity corresponding to the encoded data of the limited-duration credit card number.

Online Transactions

FIG. **5** displays the multi-function electronic device **501** in connection with a computing device **590**. In one embodiment, the multi-function electronic device **501** is able to be used to make online purchases. In one embodiment, the multi-function electronic device **501** is equipped with a means **570** for communicating with the USB port on a computer or other device in order to make online purchases. In one embodiment the multi-function electronic device **501** may have an area cut-out, such that contact terminals corresponding to a USB cable connector are contained within, enabling connection of a USB cable (e.g., a micro-USB connection). When performing online transactions, the multi-function electronic device **501** can uniquely generate a limited-duration credit card number (as described above) for online purchases. The multi-function electronic device **501** receives a user input indicating that a transaction is imminent, and an authorization. The user input is able to comprise a gesture, a swipe, a key input sequence, and

combinations thereof. The limited-duration credit card number is able to be displayed on the front display of the multi-function electronic device **501**. In one embodiment, the multi-function electronic device **501** is able to use RFID **265** or near field communication NFC **260** technology in order to connect to a personal computer **590**. This enables a per-transaction, limited-use credit card number, enhancing the security of the credit account by substantially negating the possibility of a theft of the credit card number used to perform the transaction leading to account compromise. See also, for example, FIG. **10**.

According to an embodiment, the transaction is able to include information regarding a user account, such as an email address of the user, and upon reconnection of multi-function electronic device **201***b* to a computer system (for instance, computer system **590**), the transaction information stored on multi-function electronic device **201***b* could be "replayed" by the computer system in order to finalize the transaction.

In one embodiment, a means of limiting an available credit amount are provided. According to the download process described above, the multi-function electronic device is able to have a total credit available. The multi-function electronic device is able to reference the total credit available in subsequent transactions, and will provide limited-duration credit card numbers corresponding to amounts up to, but not exceeding, the remaining credit available to the multi-function electronic device. An attempt to perform a transaction having an amount exceeding the remaining credit available will not result in a valid limited-duration credit card number, and therefore an authenticated transaction cannot proceed. In general, the multi-function electronic device will only successfully generate a limited-duration credit card number if the proper conditions for a transaction are determined to be present. The proper conditions for a transaction comprise a correct identification having been made by the user (via a gesture, swipe, and/or key input) and an amount for the transaction indicated to be less than the total credit available to the account indicated for the transaction.

Card-to-Device Transactions

In addition to transactions performed using conventional magnetic card readers (such as at point-of-sale locations, banks, and automated teller machines (ATMs)) and via cable connection with a computing device, transactions performed wirelessly between a card and a device (e.g., card-to-card, card-to-computer device having a reader dongle, card-to-ATM) are provided according to embodiments of the present disclosure. See, for example, FIGS. **8** and **10**. For simplicity, the following describes a card-to-card transaction, but it will be understood that card-to-device transactions are similarly provided.

FIG. **6** illustrates a card-to-card transaction according to one embodiment. A first multi-function electronic device **601***a* comprises a display **650***a*, and is in contact with a second multi-function electronic device **601***b*. A contact interaction between the cards is indicated by interaction **680**. In one embodiment, the contact interaction is a tapping of multi-function electronic device **601***a* against multi-function electronic device **601***b*. In another embodiment, an optical sensor array at one or both of the cards detects interaction **680**. In another embodiment, interaction **680** indicates a swipe of multi-function electronic device **601***a* across multi-function electronic device **601***b*. In one embodiment a user input through the key-pad initiates and enables a transaction from first card to second card. In one embodiment the presence of second card in preparation for card to card transaction is confirmed through "polling", the process of which involves transmission of data between cards, and confirmed receipt of transmitted data by response received from second card received at first card, including information confirming receipt of the information, by second card.

The planar coil comprised by each of multi-function electronic device **601***a* and multi-function electronic device **601***b* is able to be a means of transferring information for a transaction, e.g., such as an antenna. Once either, or both, of multi-function electronic device **601***a* and multi-function electronic device **601***b* detect interaction **680**, a transaction is able to be completed via generation of a magnetic field at one card and reception of the magnetic field (i.e., reading) at the other card. In this manner, the card (e.g., multi-function electronic device **601***a*) receiving the transaction information operates its planar coil in an antenna mode. This enables multi-function electronic device **601***a* and multi-function electronic device **601***b* to authentically perform a transaction, and to transfer a currency between multi-function electronic device **601***a* and multi-function electronic device **601***b*. As described above, in an embodiment the transaction is able to use a limited-duration card number to encode the transaction.

In an embodiment, a set of accelerometers is used to detect the beginning of the transaction, for instance, a transaction performed by a swipe of multi-function electronic device **601***a* across multi-function electronic device **601***b*. Further, the set of accelerometers can detect a "priming" action for a multi-function electronic device, i.e., an indication for a multi-function electronic device that a transaction is imminent. The priming action can be a tap of the multi-function electronic device **601***a*, or tapping the multi-function electronic device **601***a* against the multi-function electronic device **601***b*. In one embodiment, a touch sensor array is able to be used for the priming action.

In an embodiment of a card-to-card transaction, one card (e.g. **601***a*, the card of the user having a currency debit) generates the limited-duration credit card number, which is transmitted via the card's planar coil. The multi-function electronic device of the recipient (e.g., **601***b*, the card of the user receiving a currency credit) receives the encoded data via the planar coil, acting as an antenna, and the coil interface is able to convert the received signal into a digital signal understood by the processor to be the limited-duration credit card number, identifying both the correct account and the amount of the transaction.

In one embodiment, the multi-function electronic device **201***b* stores cryptocurrency information in processor unit **205**. The cryptocurrency information stored is able to include a plurality of cryptocurrency addresses, a plurality of private keys, and a plurality of public keys. The multi-function electronic device **201***b* is able to perform a transaction, as described above, using a cryptocurrency as the specified account. In one embodiment, the multi-function electronic device **201***b* is able to hash a portion of the transaction, using the processor unit **205** and the real-time clock **240** along with user information pertinent to the cryptocurrency account and the transaction. A subsequent connection of the credit card **201***b* to a computing device provides a means of connecting to the cryptocurrency servers and finalizing the transaction. Further, the multi-function electronic device **201***b* is able to sign a cryptocurrency transaction by, for instance, receiving a prompt at the display **250** to input a dynamic PIN specific to the transaction, which is able to be entered by touch sensor array **245**.

In a card-to-card cryptocurrency exchange, a record of the transaction can be made according to the following. A first

card (e.g. **601***a*) making a deduction with an amount indicated via touch sensor array **245** is able to generate a record of the transaction and store the record in the card memory, while a second card (e.g. **601***b*) receiving the cryptocurrency is able to generate a confirmation of the received transaction amount. In one embodiment, the amount indicated is provided by the receiving card **601***b*. The hashed record of the transaction contains the unique information of each user, along with the transaction amount. The success or failure of the transaction is able to be displayed on the respective displays of credit cards **601***a* and **601***b*.

Account Theft and Unintended Use Prevention

A security concern for conventional credit cards utilizing wireless communication means is the ability of a thief to access and/or copy user information through un-detected interaction with the wireless communication means. Sensitive and confidential information can be gleaned via, for example, "listening-in" on an RFID interaction between a credit card and a contactless reader, recording the characteristics of the interaction, and replicating certain characteristics to fake an authorized transaction. While to a great extent security concerns are addressed by the usage of limited-duration credit card numbers and other security features provided for by the credit card of the present disclosure and previously described, a further security feature regarding the wireless communication means of the multi-function electronic device is described herein.

In one embodiment, wireless communication means of the multi-function electronic device **201***b* are in a powered-down, or disabled, state prior to receiving an authenticated activation signal from a user. Upon receiving the activation signal, the communication means (e.g., NFC **260**, RFID **265**, and planar coil **220**) are activated, enabling the multi-function electronic device **201***b* to conduct a transaction. The activation signal can originate from one (or a combination) of the set of motion detection units (rate detection **225**, optical sensor array **230**, and accelerometers **235**), the touch sensor array **245**, and the galvanic sensor **275**. The galvanic sensor **275** is operable to detect a contact of human skin, via a current produced at the sensor **275** upon such contact. See also, for example, FIG. **8**. In an embodiment the galvanic sensor **275** is comprised of metallic contacts disposed on opposite sides of, and isolated by, the body of multi-function electronic device **201***b*. In one embodiment, the current produced by user contact with the galvanic sensor **275** contacts is sufficient to provide small amounts of energy in order to power components of the card. For example, energy produced is able to power the processor unit **205** and the RFID **265**. In one embodiment the galvanic sensor **275** further comprises two conducting surfaces separated by a junction, and the galvanic sensor **275** is configured as a thermoelectric generator (e.g., via the Peltier effect, the Seebeck effect, or a combination). For example, heat applied at one surface of the multi-function electronic device **201***b* may lead to differential heating between the opposing, separated conducting surfaces of the galvanic sensor **275**, generating an electric current and powering a subset of, or all of, the components of multi-function electronic device **201***b* (e.g., the processor unit **205**, the NFC **260**, and the RFID **265**).

In an embodiment, the communication means are activated only so long as the activation signal continues to be detected. In another embodiment, the communication means are activated for a specified amount of time following detection of the activation signal. For example, if using the multi-function electronic device **201***b* in an ATM (or other device) preventing continuous human contact, the activation signal is able to be a swipe, gesture, or key input sequence entered via the touch sensor array **245**, which activates the card for a specified duration (for instance, one minute). In an embodiment the detection of motion through accelerometer input indicates activation by a valid user. In one embodiment the specific motion detected through accelerometer input corresponding with a specific user action, such as a "flick", "swipe", "spin", "wave", "tap," may be used to initiate activation, wherein the motion is not normally generated at idle and during periods of inactivity. For example the motion not being generated accidentally while the card is stored in a user's wallet, carried while the user is actively moving, or is being handed from user to a clerk at a point of transaction. In one embodiment the specific motion, or sequence of motions, may be associated with a user, and stored on the card memory, such that performing the correct sequence when prompted can confirm the possession of the card by the known owner, thus initiating activation and enabling usage.

FIG. **7** depicts a process of selectively enabling the communication capability of the multi-function electronic device according to an embodiment of the present disclosure. The process **700** begins at step **701**, where an input signal is received at the multi-function electronic device from a user. The input signal is able to be generated by any one, or combination, of a plurality of input means, where the input means comprise: a swipe gesture received at a touch sensor array; a key press sequence; an accelerometer sensor indication of multi-function electronic device motion; and a galvanic sensor indication that the credit card is in a user grasp. The input received from the user enables operation of a near-field communication (NFC) unit of the multi-function electronic device. In one embodiment, the NFC unit is disabled prior to receiving the input signal. In one embodiment, an RFID communication unit is disabled prior to receiving the input signal, and is activated by the input signal. In one embodiment, the planar coil is disabled prior to receiving the input signal, and is activated by the input signal.

The multi-function electronic device, following enablement of the NFC unit, receives an indication of an amount of currency for a transaction at step **703**. At step **705**, the multi-function electronic device generates a limited-duration credit card number, which at step **707** is transmitted to a recipient of the transaction. In one embodiment, the limited-duration credit card number has a limited recurrence, and is limited in scope of use to a predetermined number of authorized transactions.

In the foregoing description of process **700**, the ordering of the process steps is exemplary and should not be construed as limiting. Alternative ordering of the process steps is consistent with the present disclosure, as conceived by one skilled in the relevant art.

In one embodiment of the present invention, a credit card comprises a dynamic magnetic strip incorporating a main inductor assembly from which magnetic field data symbols are dynamically generated. In one embodiment the inductor assembly may be a planar coil formed within the plastic that the credit card is composed with. The advantage of using a planar coil is that it can produce the same magnetic field interaction that a traditional magnetic strip on a conventional credit card can produce when it is passed through a reader. Similar to a traditional plastic credit card, the planar coil can also produce a magnetic field that can be read by a pickup (or "transducer"). The pickup produces electric current in the coil that, in turn, produces a magnetic field that is read by the pickup. Accordingly, the planar coil can be read in the same way as the magnetic strip on a traditional plastic credit

card. The magnetic field produced by the planar coil would behave identically to a traditional magnetic strip.

In one embodiment, alongside the main planar coil, auxiliary rate detection assembly independent of the main inductor assembly would be provided to assist with the alignment of the production of data from the loop as it is being passed over the head of the credit card reader. The reader module of a traditional credit card reader comprises a metal head with a small gap on the tip of the head. This gap is where the pickup armature resides, so that when the metal head passes over the credit card strip, an electric field is induced in the head reader pickup circuit. In one embodiment the auxiliary rate detection assembly is constructed of an array of auxiliary inductor coils and magnetic pickup coils, alongside the main coil. As the metal head of the card reader assembly passes over the arrangement of auxiliary coils and pickup circuits, a disturbance in the magnetic field flowing between the two generates a electrical current change that is detected by a rate detection circuit so as to detect the rate of motion of the card reader head passing across the surface of the card and therefore along the main induction assembly. The purpose of this is to allow the determination of the rate or production of magnetic data symbols in the main inductor assembly to align with the rate at which data is being read by the reader, according to the data density of standard card magnetic strips. Accordingly, it is irrelevant if the credit card of the present invention is being swiped fast or slow, the main inductor assembly produces data at just the right rate depending on the rate at which the card is detected it is being passed over the reader's head.

In one embodiment, a microprocessor is connected to the main coil and the alignment pickups. The microprocessor is responsible for producing the data from the coil at the appropriate rate in accordance with the speed with which the card is swiped through the reader. As shown in FIG. **1**, the auxiliary coil detects the rate at which the credit card is being swiped. The microprocessor then uses this information to produce the data from the main planar coil at the appropriate rate for the credit card reader.

In addition, the credit card of the present invention comprises a real time clock that can produce a cryptographically worthy timestamp for each interaction and a battery back up that can be used to power up the microprocessor. Further, the card can comprise additional human inputs, e.g., touch sensors which can be formed by contacts that a user can press. For example, there can be contacts that a user can press to wake up the card, to cause the battery to supply power, or to put the card to sleep when it is not being used. There can also be additional inputs to key in customer specific information. For example, there can be inputs to key in a password or any other kind of unique identifier. If any other number besides the password is entered multiple times, or if there is attempted usage of the card without entering in a password, an automatic phone call may be triggered to the appropriate fraud protection authorities.

In one embodiment, the number on the front of the card can be a full or partial number. The number may not have to necessarily be a static number. For example, the first four and last four digits of the card number can be fixed while the remaining eight can be dynamically generated. As the credit card is read by the machine, part or all of the number may be dynamically produced at the time the card is read. The dynamic part of the number generated may be based on the user's private information, the user's bank information, the time of day or the facility that is reading the card. Further, the expiration date of the card can also be dynamically generated. Effectively, a credit card can be created that has no fixed number and therefore cannot be stolen. Only the number generated at the instant the card is being used matters. Accordingly, unauthorized use of the card is nearly impossible because no transaction can be conducted with only the partial static part of the credit card number. In one embodiment of the present invention, enough dynamically generated numbers are provided for on the credit card such that a unique credit card number can be generated for each transaction. In this embodiment, the credit card of the present invention effectively acts as a unique per transaction credit card.

In embodiments of the present invention comprising dynamically created credit card numbers, a single credit card can be used for multiple banks. For example, instead of carrying a separate credit card for all the different credit card companies, a customer would only need to carry a single card and one of the inputs on the front of the card can be used to select the appropriate bank or credit provider.

In one embodiment of the present invention, a thin film liquid crystal display ("LCD") can be fitted on the card so the credit card can have a display screen. The display can have multiple uses. In one embodiment, the display can be used to ask the user a security question if an improper password is entered. Or if the fraud protection services need to contact a customer, they can verify the customer's identity by transmitting a security question to the user's credit card screen to which the user would then need to respond correctly using the input buttons on the card.

In one embodiment, the credit card of the present invention could also be used to make online purchases. In this embodiment, the card could use RFID or near field technology so that it can connect to a personal computer and be used to uniquely generate a credit card number for online purchases. The number could also, in one embodiment, be displayed on the front LCD of the card. In one embodiment, the card may also be equipped with a means for communicating with the USB port on the computer in connection with making the online purchases.

Table 1

What is claimed is:

1. An apparatus for conducting credit transactions comprising:
   - a device with the similar dimensions and thickness to a standard credit card
   - an inductor assembly integrated into said device capable of generating a programmed magnetic field at a location on the device where it will come into proximity to a standard credit card magnetic-strip reader
   - the inductor assembly being operable to be read by a magnetic pickup of an electronic credit card reader;
   - at least one auxiliary rate detection units adjacent to said inductor assembly, wherein said at least one auxiliary detection unit is operable to detect a rate at which said device, including said inductor assembly, is passed through said electronic credit card reader; and
   - a microprocessor operatively coupled to said inductor assembly and said at least one detection unit, wherein said microprocessor is operable to simulate magnetic-strip data fields using the inductor assembly, at a rate determined from said auxiliary detection units.

2. A method of Claim **1**, wherein the inductor assembly is a planar coil which is a looped inductor with dimension roughly equal to, and along the axis of, the standard credit-card magnetic strip

3. A method of Claim **1**, wherein said detection assembly consists of a plurality of motion rate detection units, which

may comprise inductor coils and companion magnetic-field pickup coils, each of which is able to detect the proximity of metallic objects, such as magnetic-strip reader heads, passing through the magnetic field created by said inductor and detected by said pickup coil.

4. A method of Claim **1**, wherein said device may incorporate a plurality of touch sensors arranged along the surface of said device which may;

allow user input of information,

allow introducing a transaction specific identifier,

to confirm/deny transaction information,

to operate in sequence, or with a gesture across said sensor for the purpose lock/unlock or control access for transactions

5. A method of Claim **4**, wherein said device contains a real-time clock or counter unit which generates a sequential parameter when the card is read by said credit card reader, and which along with certain user information, transaction identifiers, user secrets, credit card authority secrets is combined to generate a limited-use credit card number, which has a limited recurrence, is limited in scope of use to a predetermined number of authorized transactions

6. A method of Claim **5**, wherein the time, sequence, user, credit card authority and other information is similarly combined by credit card processing facility to generate a credit card number for comparison to the number transmitted by the credit card reader, for the purposes of authenticating said number is from a recognized card used in a user-authorized transaction

7. A method of Claim **1**, wherein said device incorporates a display allowing credit card number, time, passcodes, sequence codes, amounts and other credit card transaction information to be displayed for user, merchant, bank or credit card authority

8. An Apparatus for conducting credit transactions comprising,

wherein the edge of said device contains a connector for connection to standard computing devices such as a USB interface.

The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, to thereby enable others skilled in the art to best utilize the invention and various embodiments with various modifications as may be suited to the particular use contemplated.

Embodiments according to the invention are thus described. While the present disclosure has been described in particular embodiments, it should be appreciated that the invention should not be construed as limited by such embodiments, but rather construed according to the below claims.

What is claimed is:

1. A payment device comprising:

a thin shaped body having no fixed payment numbers disposed thereon;

a memory;

a cryptographic processor coupled to the memory; and

a reader interface, including at least one interface selected from a set comprising: a magnetic-stripe, a smart card reader interface, a mag-stripe inductor interface, an RF interface, an NFC interface, and a wireless interface, and

wherein payment information for a transaction is operable to be conveyed via the reader interface and comprises limited-use payment information, and wherein further the limited-use payment information is to be used in place of card issuer payment information for payment transactions by said device at payment card reader facilities.

2. The device of claim **1**, wherein the body comprises fixed payment information disposed thereon and wherein the fixed payment information includes only: a card-holder name; a payment issuing logo; and a card payment network logo, and wherein further, the body is free of any account numbers, expiration dates, card security codes, or other fixed payment numbers, disposed thereon.

3. The device of claim **1**, wherein the limited-use payment information is conveyed via the magnetic-stripe and is unique to the payment device and to the magnetic stripe, and

wherein the limited-use payment information is limited to use by the payment device and is operable for conveying payment information to a magnetic-stripe payment card reader, and

wherein said limited-use payment information has a limited period of valid use, and

wherein said limited-use payment information is not valid when used other than through a magnetic stripe payment card reader.

4. The device of claim **1**, wherein said limited-use payment information is provided by a card issuing authority for use by the payment device and wherein the card processing authority rejects as invalid, any use of said limited-use payment information obtained via any means other than: a payment card reader reading said limited-use payment information from the reader interface.

5. The device of claim **1**, wherein a request for payment includes at least one of a set comprising: payment information, transaction information, merchant information, and payment card reader information, and

wherein a card-present transaction is one including the limited-use payment information, and valid payment card reader information, and wherein a card-not-present transaction is one including at least a portion of said limited-use card payment information, and not including valid payment card reader information; and,

wherein a processing authority is operable to approve as valid, a card-present payment transaction; and,

wherein said card processing authority is operable to reject, as not valid, a use of the limited-use card payment information in a card-not-present payment transaction; and

wherein a card issuing authority receiving said request for payment is operable to decline a transaction not involving a valid card-present use of a limited-use card payment information portion used in place of card issuer supplied payment information.

6. The device of claim **1**, wherein a card processing authority is operable to reject as invalid, a use of the limited-use payment information provided via the reader interface, in online payment transactions.

7. The device of claim **1**, wherein a card issuer providing the limited-use payment information, for use by the payment device, limits valid approval of said limited-use payment information to performing a card-present payment transaction by the card device, and wherein said card issuer declines as invalid a use of said limited-use payment information in transactions other than wherein the payment device is present, and

wherein a card issuer limits said card payment information to use for a finite amount of time, and declines as invalid use when said amount of time has expired, and

wherein a card issuer limits use to payment for transactions with the user approving, and declines as invalid use when the card user is denying an approval, and

wherein a card issuer limits to use in place of card issuer information for payments by the payment device.

8. The device of claim **1**, wherein the reader interface is operable to wirelessly receive cardholder transaction information and to identify a valid user through at least one user-validation action, selected from a set of comprising:

a device touch ID sensor identifying a touch of the valid user;

a device touch sensor-array receiving a user entered valid passcode;

a device key-pad receiving a use entered a valid passcode;

a device user interface receiving a user entered a valid PIN or Key-Code;

a device user interface receiving a user entered a valid password;

a device user interface reading a user swipe or gesture;

a user tapping a predetermined sequence on the device;

a user motioning the device in accordance with a sequence;

a skin-contact sensing identifying a valid user;

a device sensor array reading a touch of an identified user;

a device biometric recognition of a valid user; and

a biometric sensing of the device remaining continuously in the possession of a valid user,

wherein a display of the device is operable to display transaction information through a user interface, and wherein transaction information includes at least one of a set comprising: a transaction time; a transaction amount; transaction merchant information; a transaction location; a transaction facility; card information; a partial card number; graphical card images; and

wherein upon validating the user, the user-interface is operable to receive a valid user input, of at least one user action selected from a set comprising: a payment approval authorization; a payment denial; and an adjustment of a transaction payment.

9. The device of claim **1**, wherein a dynamically-generated one-time limited-use payment information portion is generated by said processor when coupled to a reader interface accessible to said processor, and

wherein the payment information conveyed to a payment card reader, at the time of transaction, includes at least one of a portion of: a static limited-use portion; and a dynamically-generated limited-use portion, and

wherein said static limited-use payment information is provided by a card issuing authority for use in place of a card issuer payment information.

10. The device of claim **1**, wherein the processor cryptographically dynamically generates a one-time limited-use number based on combination of a card device transaction sequence count, and at least one of a set of information including:

a user information;

a user card account number;

a device account number;

device secret keys;

card issuer keys;

a time;

a merchant;

a location;

an online address;

a payment information;

a card reader information;

an account information;

an amount;

a transaction information; and

a cryptographic combination of at least two of the above set of information, and wherein the processor increments the card device transaction sequence count on each transaction.

11. An online payment system, the system comprising:

a thin payment device comprising no fixed payment numbers visible thereon; and

a personal computing device, wherein the personal computing device comprises:

a processor;

a memory;

a wireless interface;

a display operable to provide a visual user-interface operable for performing online transactions; and

a user-interface coupled to the processor, and

wherein the wireless interface is operable to wirelessly obtain card device payment account information, and

wherein the processor is operable to generate limited-use payment information based on the card device payment account information, and

wherein the personal computing device is operable to generate complete payment information, including the limited-use payment information, and to convey said complete payment information via at least one interface of a set comprising: said display; and the wireless interface, and

wherein the limited-use payment information is configured to be used in place of a card issuer payment information.

12. The system of claim **11**, wherein the thin payment device bears no fixed payment numbers, and bears only: the cardholders name; a brand logo; and the card payment network logo.

13. The system of claim **11** wherein the personal computing device is configured for presenting on the display a limited-use card security code number for use in payments in place of card issuer payment information, and

wherein the personal computing device is further configured to generate said limited-use card security code responsive to an input request from a valid user, via said user-interface, and

wherein said limited-use number is generated on the personal computing device from at least one information from a set comprising:

a payment device user information;

a payment device account number;

a payment device sequence counter;

a payment device identifier;

payment device secrets;

a payment device key;

computing device secrets;

computing device keys;

payment device issuer secrets;

payment device issuer keys;

a time;

an expiration date;

an amount;

a merchant locality;

an online location;

a transaction information; and

a cryptographic combination of at least two of the above.

14. The system as described in claim 11 wherein the personal computing device is configured for presenting on the display, a limited-use card account number, and a limited-duration expiration date, for use in payments in place of a card issuer payment information, and

wherein said personal computing device is further configured to generate said limited-use card payment information responsive to an input request from a valid user, and

wherein the personal computing device is configured to identify a valid device-user through at least one user-validation input available to the personal computing device, of a set comprising:

a touch ID sensor operable to identify the touch a valid user;

a user entering of a valid passcode on a touch sensor-array;

a user entering of a valid passcode on a key-pad;

a user entering of a valid PIN or Key-Code on the user-interface;

a user entering of a valid password on the user-interface;

a valid user swiping or gesturing on a touch sensor-array;

a valid sequence of a user tapping of the device detectable by device accelerometer;

a valid user sequence of user motioning of the device detectable by device motion sensor unit;

a skin-contact sensing identifying a valid user on a device contact sensor;

a touching of an identified user's skin on a device touch sensor array;

a device biometric recognition of a valid user via a device biometric sensing; and

a biometric sensing of the device remaining continuously in the proximity possession of a valid user via device skin-proximity sensor; and, wherein the personal computing device conveys the limited-use payment information through the user interface.

15. An online payment system comprising:

a thin card-shaped payment card device that bears no fixed payment numbers on the card device; and

a computing device operable for completing an online payment transaction and comprising:

a display;

a user-interface;

a processor; and

a memory for storing a payment card information accessible to the processor,

wherein card issuer provided payment card information is wirelessly downloaded into the computing device, and

wherein at least one of the set comprising:

the computing device; and

the card-shaped payment device,

is configured to dynamically generate a limited-use payment information, upon the authorization of a valid computing device user, and

wherein the payment information provided by the computing device is used in online transactions in place of a card issuers payment card information.

16. The system of claim 15 wherein the card device bears no fixed payment numbers, and bears only: the cardholders name; the brand logo; and the card payment network logo.

17. The system of claim 15 wherein the dynamically generated limited-use payment information is displayable on a display of the computing device.

18. The system of claim 15 wherein the limited-use payment information includes a static limited-use card account number, a limited-duration card expiration date, and a limited-use card security code and,

wherein the dynamically generated limited-use payment information is conveyed by the computing device to complete an online transaction.

19. The system of claim 15 wherein the computing device is operable to generate a limited-use card security code number, for use in place of a card issuers card security code by generating said limited-use number via cryptographically combining information from at least one of a set comprising:

a user information;

an internet address;

an email address;

a device transaction sequence counter;

a device account number;

device identifiers;

device secrets;

device keys;

issuer secrets;

issuer keys;

a payment card account number;

a payment card security code;

a time;

an expiration date;

an amount;

a merchant locality;

a transaction information;

and a cryptographic combination of at least two of the above set, and wherein the computing device is operable to display the generated limited-use card security code on the display.

20. The system of claim 15 wherein the computing device is further operable to obtain a user payment approval through at least one user-interface element of the computing device, from a set comprising:

a display interface,

a touch-screen interface,

a touch ID button,

input buttons,

a touch key-pad,

a key-pad,

a key-board,

an optical sensor array,

a motion detection unit,

an accelerometer,

the swiping of a recognized user skin over a device sensor array, a biometric sensor,

a wireless interface,

an NFC interface,

an RF interface,

a device biometric sensing the device is continuously remaining in contact with a valid user; and,

wherein the computing device is operable to display at least one of a set comprising: the transaction information, the merchant information, the time, the location of the transaction, the payment bank logo, the card issuer icon, the payment card image, and the amount, on a display of the computing device, and,

a user input providing for at least one user action from a set comprising: an approving of a transaction, a denying of a transaction, and an adjusting of a transaction, via the user-interface.

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