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(54) SECURE SMART CARD SYSTEM

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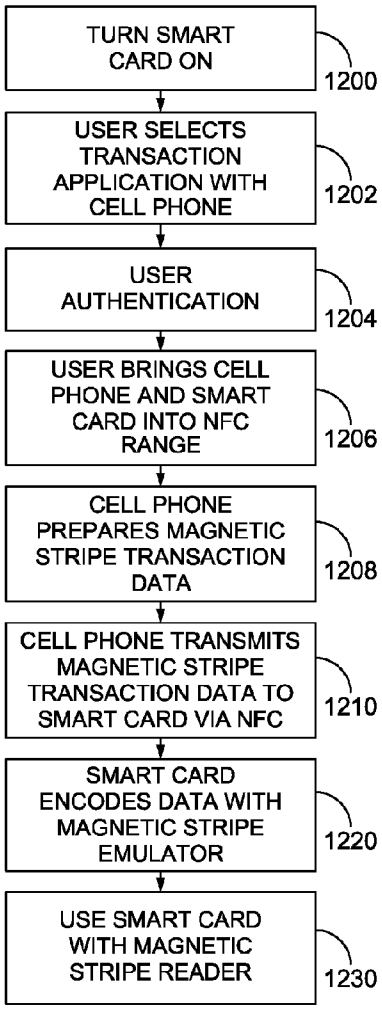
(57) **ABSTRACT**

A smart card usable in magnetic stripe swipe transactions with a transaction terminal configured to read transaction information encoded on a magnetic stripe of a standard transaction card includes a card body, which includes a magnetic stripe emulator for use with the transaction terminal, a smart card chip programmed with at least one transaction application for providing secured data for use in a transaction and dynamic card verification data, a power supply, and a card controller in communication with the magnetic stripe emulator. The card controller is configured to receive the dynamic card verification data and control the magnetic stripe emulator to emit a magnetic field encoded with at least a portion of the secured data and the dynamic card verification data.



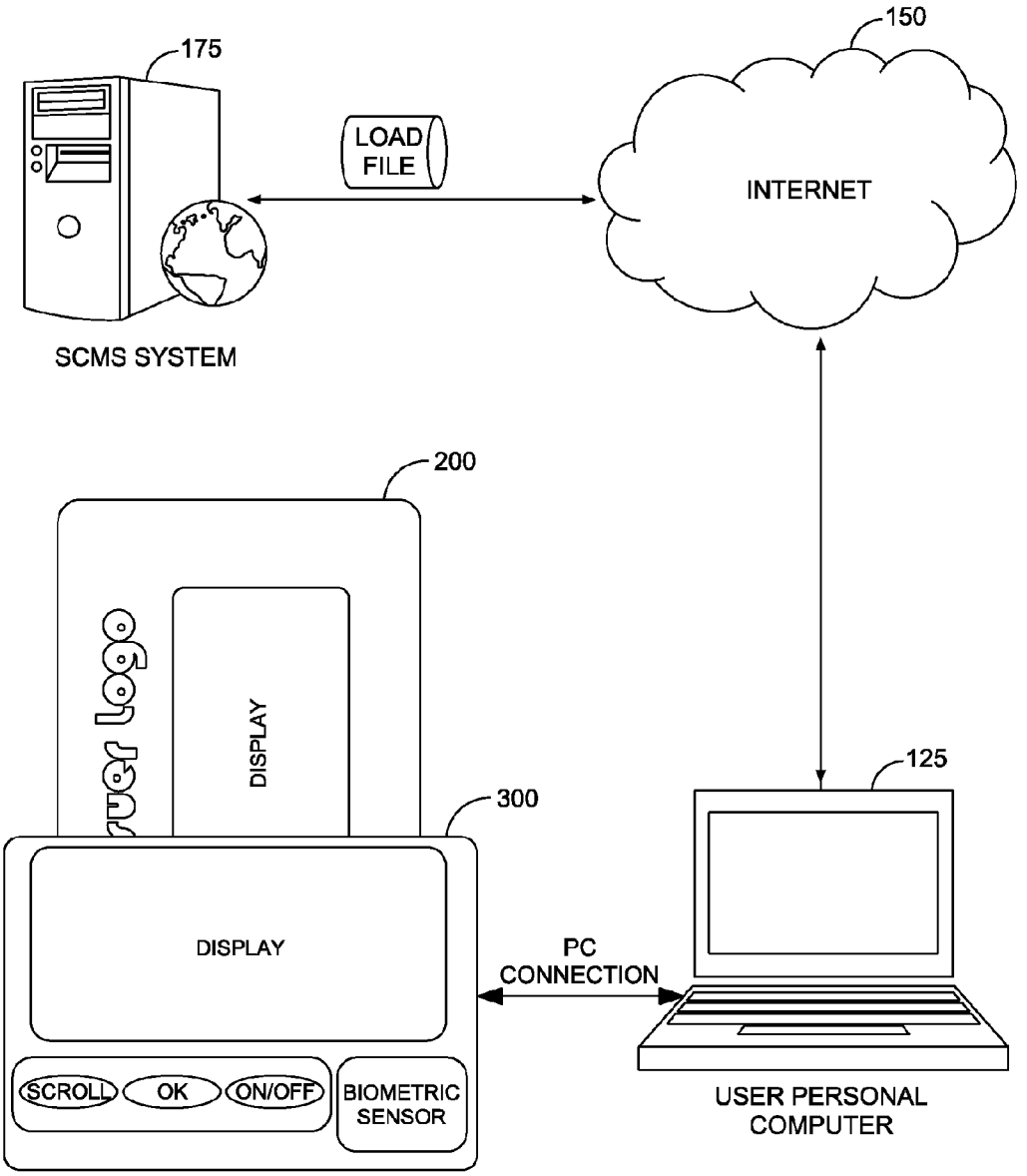

175
150
LOAD FILE
INTERNET
SCMS SYSTEM
200
User Logo
DISPLAY
300
125
DISPLAY
PC CONNECTION
SCROLL
OK
ON/OFF
BIOMETRIC SENSOR
USER PERSONAL COMPUTER

FIG. 1

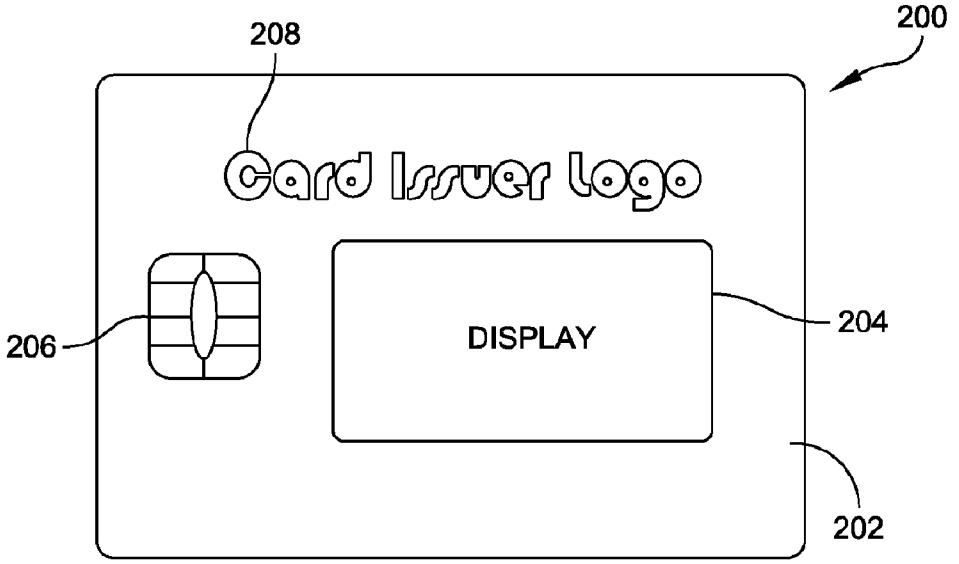

208
200
Card Issuer Logo
206
DISPLAY
204
202

FIG. 2A

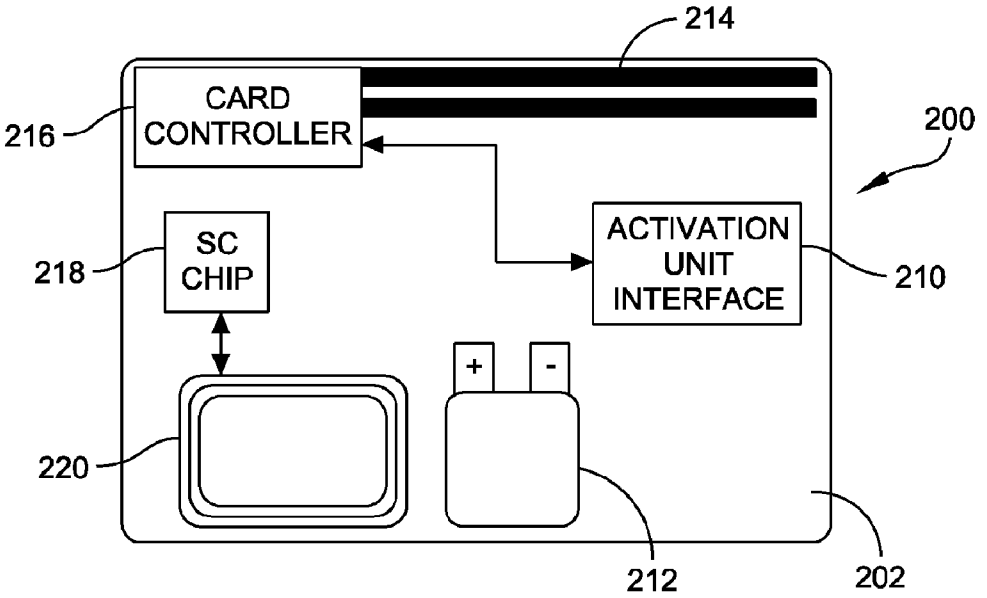

214
CARD
CONTROLLER
216
200
SC
CHIP
218
ACTIVATION
UNIT
INTERFACE
210
+
-
220
212
202

FIG. 2B

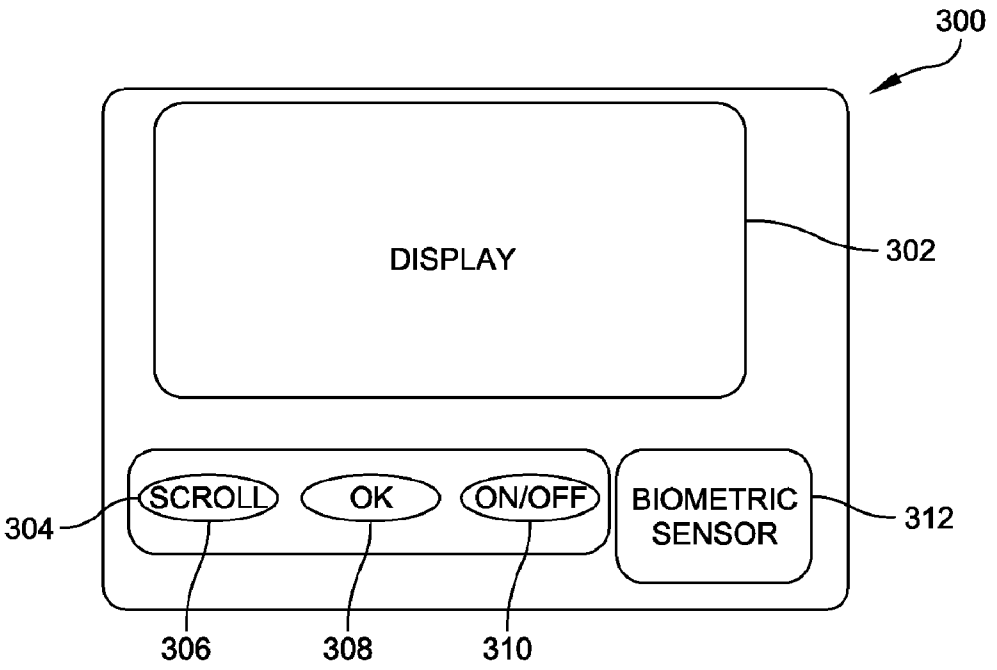

300
DISPLAY
302
SCROLL
OK
ON/OFF
BIOMETRIC SENSOR
304
312
306
308
310

FIG. 3A

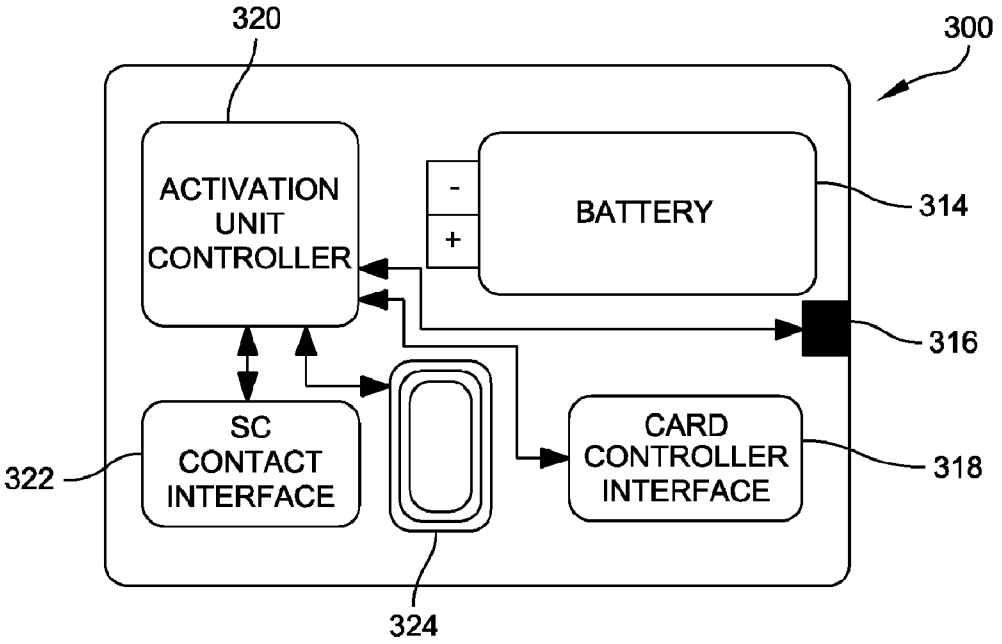

320
300
ACTIVATION UNIT CONTROLLER
-
+
BATTERY
314
316
SC CONTACT INTERFACE
CARD CONTROLLER INTERFACE
322
318
324

FIG. 3B

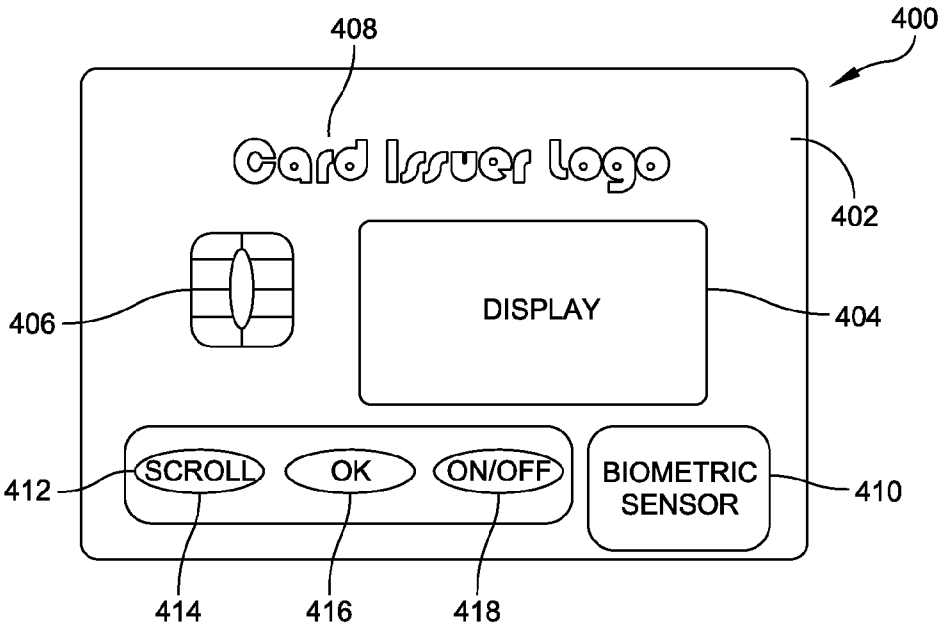

408
400
Card Issuer Logo
402
406
DISPLAY
404
412
SCROLL
OK
ON/OFF
BIOMETRIC SENSOR
410
414
416
418

FIG. 4A

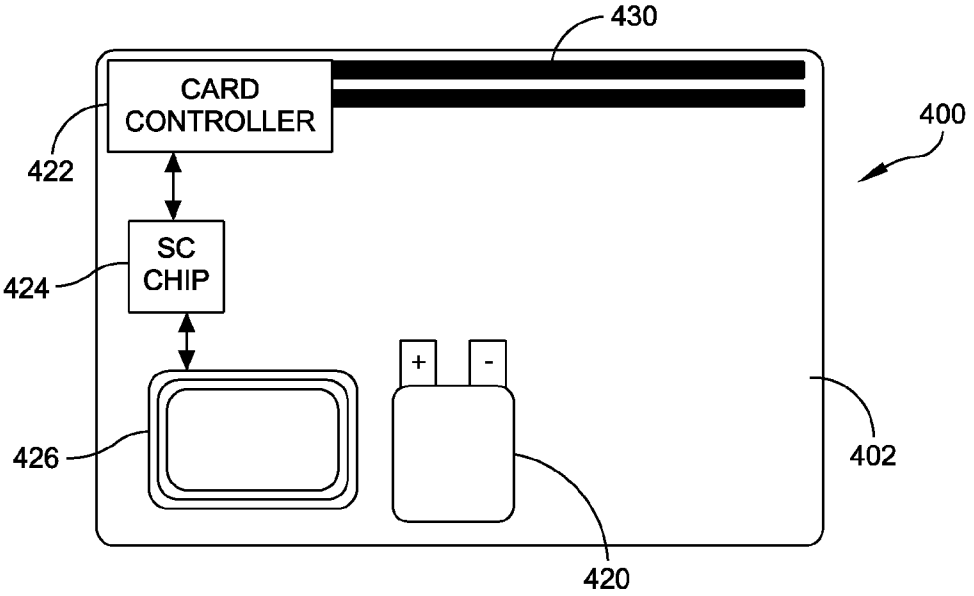

430
CARD CONTROLLER
400
422
SC CHIP
424
+
-
426
402
420

FIG. 4B

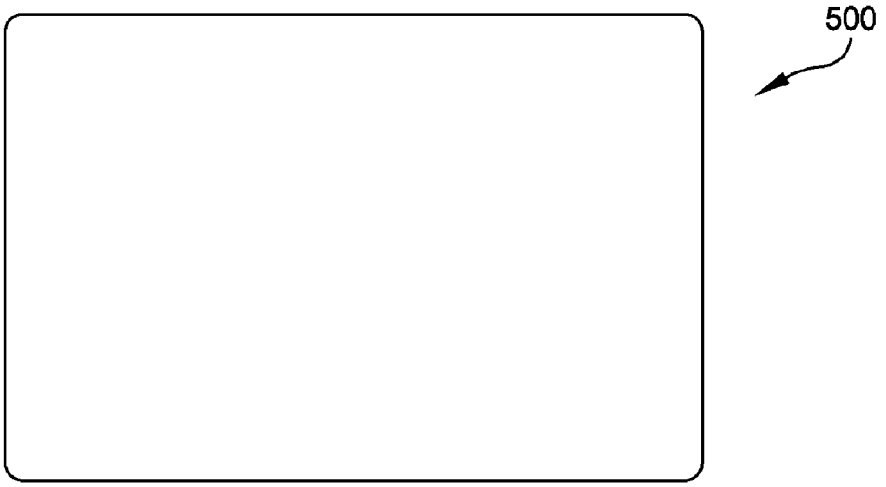

500

FIG. 5A

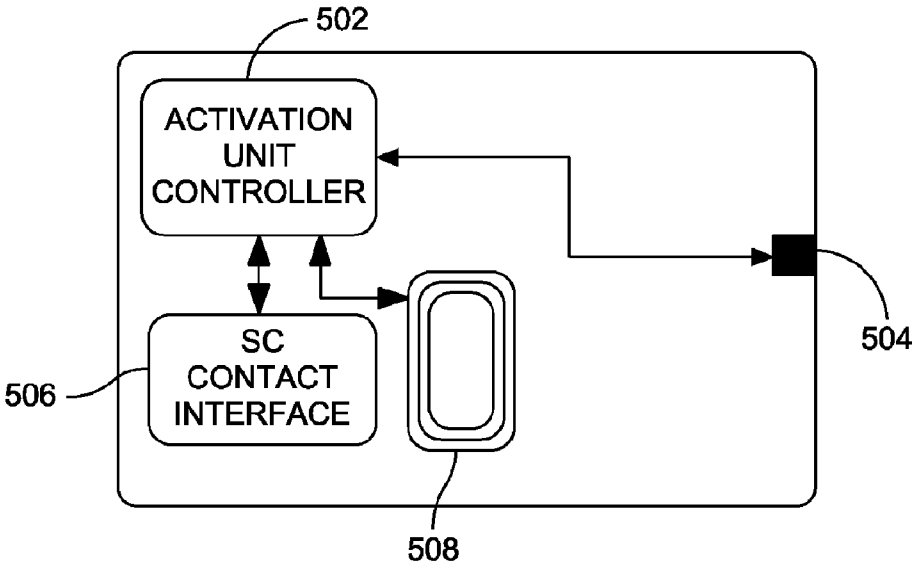

502
ACTIVATION UNIT CONTROLLER
SC CONTACT INTERFACE
506
504
508

FIG. 5B

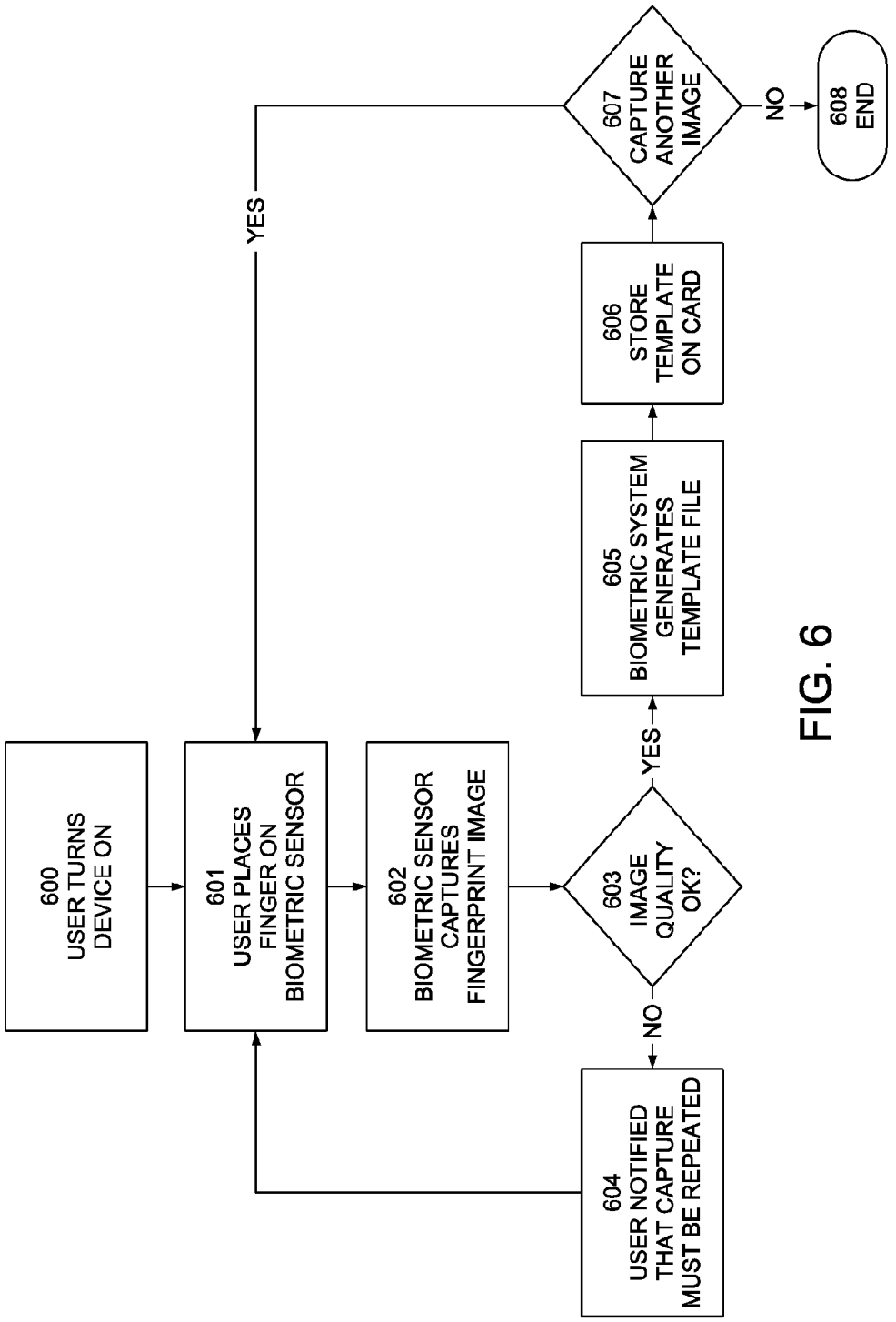

600
USER TURNS DEVICE ON
601
USER PLACES FINGER ON BIOMETRIC SENSOR
602
BIOMETRIC SENSOR CAPTURES FINGERPRINT IMAGE
603
IMAGE QUALITY OK?
NO
YES
604
USER NOTIFIED THAT CAPTURE MUST BE REPEATED
605
BIOMETRIC SYSTEM GENERATES TEMPLATE FILE
606
STORE TEMPLATE ON CARD
607
CAPTURE ANOTHER IMAGE
YES
NO
608
END

FIG. 6

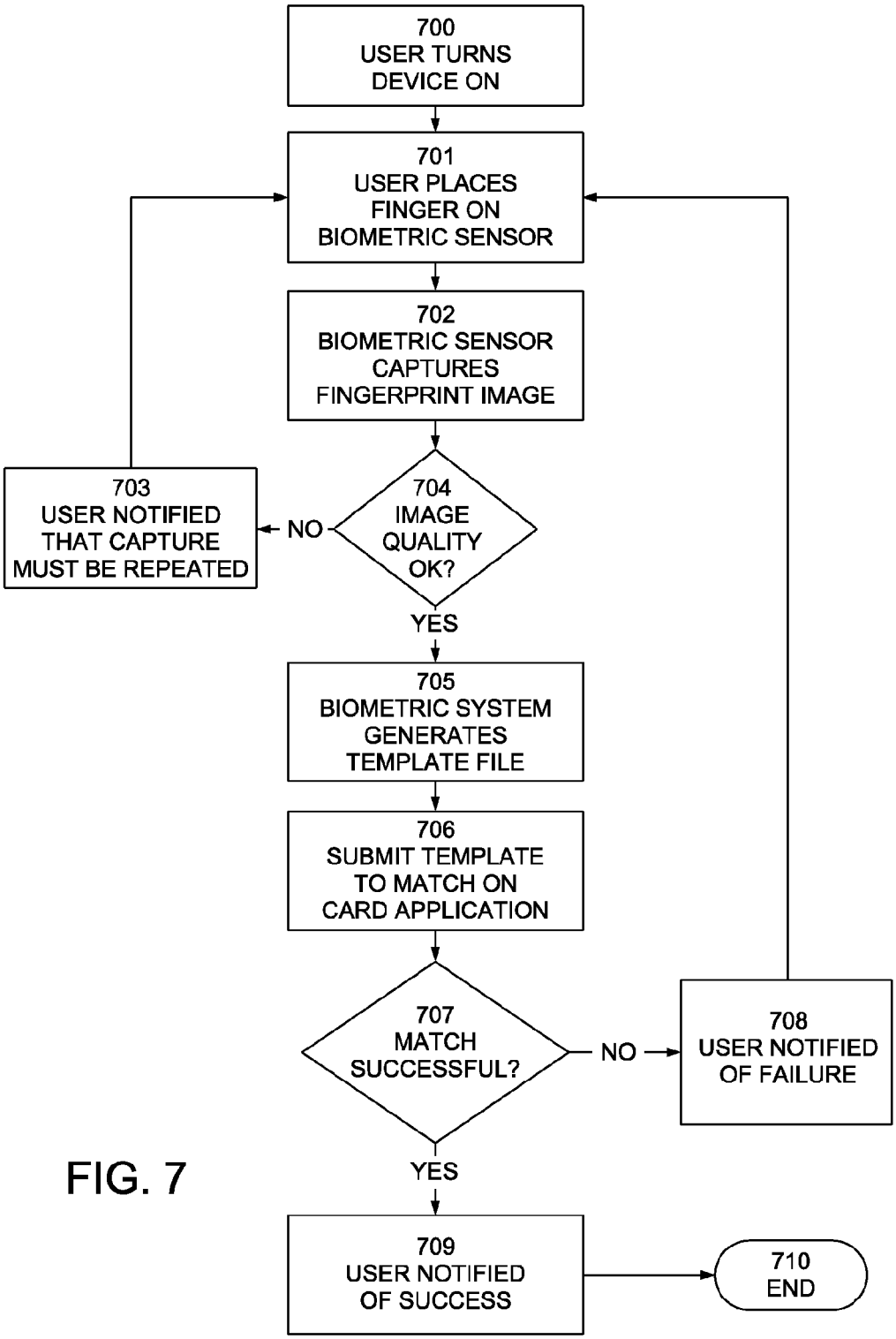

700
USER TURNS DEVICE ON
701
USER PLACES FINGER ON BIOMETRIC SENSOR
702
BIOMETRIC SENSOR CAPTURES FINGERPRINT IMAGE
704
IMAGE QUALITY OK?
NO
703
USER NOTIFIED THAT CAPTURE MUST BE REPEATED
YES
705
BIOMETRIC SYSTEM GENERATES TEMPLATE FILE
706
SUBMIT TEMPLATE TO MATCH ON CARD APPLICATION
707
MATCH SUCCESSFUL?
NO
708
USER NOTIFIED OF FAILURE
YES
709
USER NOTIFIED OF SUCCESS
710
END

FIG. 7

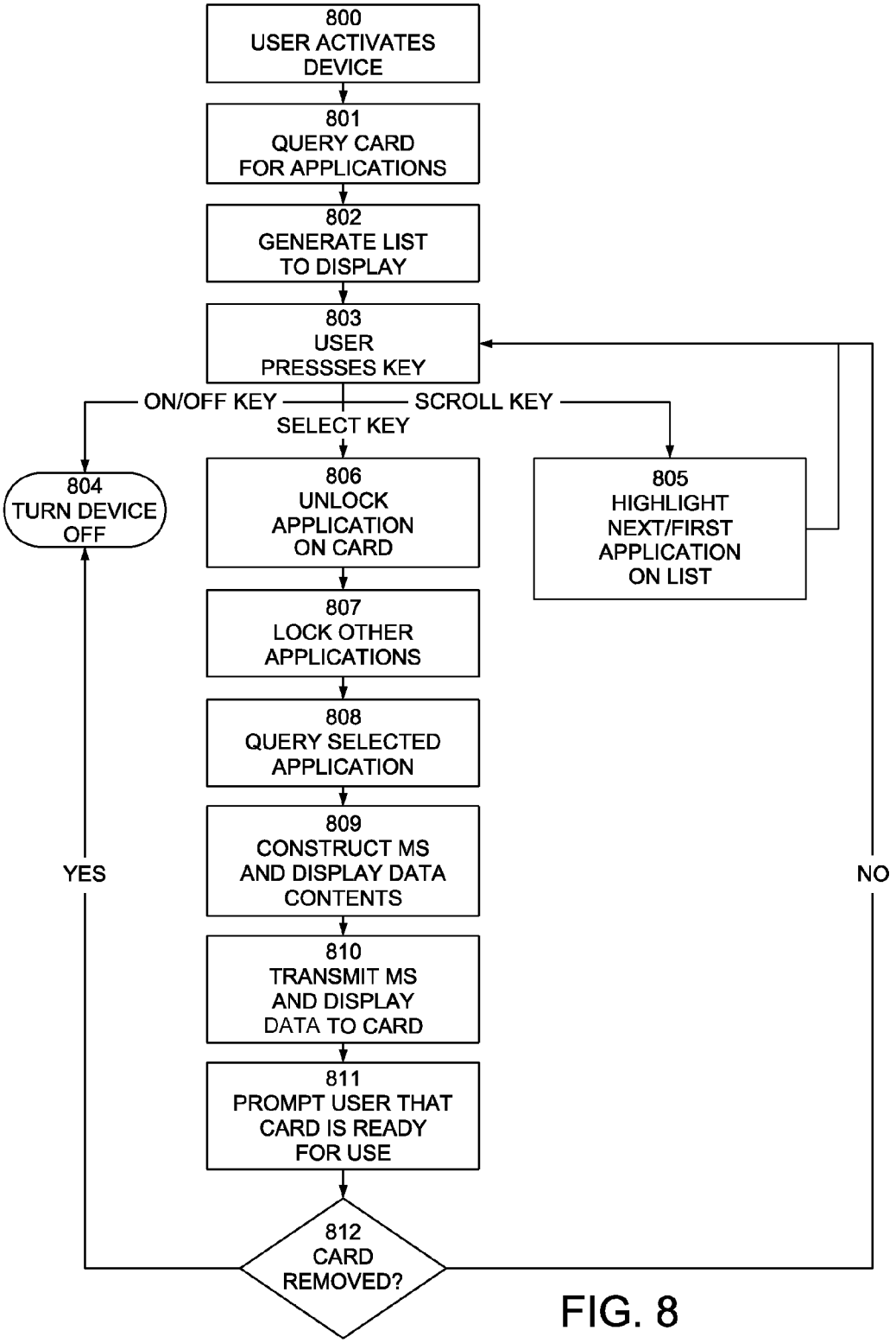

800
USER ACTIVATES DEVICE
801
QUERY CARD FOR APPLICATIONS
802
GENERATE LIST TO DISPLAY
803
USER PRESSSES KEY
ON/OFF KEY
SCROLL KEY
SELECT KEY
804
TURN DEVICE OFF
806
UNLOCK APPLICATION ON CARD
805
HIGHLIGHT NEXT/FIRST APPLICATION ON LIST
807
LOCK OTHER APPLICATIONS
808
QUERY SELECTED APPLICATION
809
CONSTRUCT MS AND DISPLAY DATA CONTENTS
YES
NO
810
TRANSMIT MS AND DISPLAY DATA TO CARD
811
PROMPT USER THAT CARD IS READY FOR USE
812
CARD REMOVED?

FIG. 8

Track 1 and Track 2 Format Specifications

Track 1: Up to 79 Alpha 7-bit characters (210bpi)

SS:	Start Sentinel	1 Character	"%"
FC:	Format Code	1 Character	"B"
PAN:	Primary Account Number	Up to 18 Characters	
CD:	Check Digit	1 Character	
FS:	Field Separator	1 Character	"^"
CC:	Country Code	3 Characters	
NM:	Name	2-26 Characters	
FS:	Field Separator	1 Character	"^"
ED:	Expiry Date	4 Characters	YYMM
SC:	Service Code	3 Characters	
DD:	Discretionary Data	Rest of characters excluding ES and LRC	
	PVKI: Pin Value Key Indicator	1 Character	
	PVV or Offset: Pin Verification Value	4 Characters	
	CVV → dCVV or CVC → CVC3	3 Characters	
	dCVV or CVC3 Indicator	1 Character	
	ATC: Application Transaction Counter	4 Characters	
ES:	End Sentinel	1 Character	"?"
LRC:	Longitude Redundancy Check	1 Character	

Track 2: Up to 40 BCD 5-bit (including parity) characters (numeric) (75bpi)

SS:	Start Sentinel	1 Character	";"
PAN:	Primary Account Number	Up to 18 Characters (using only 16 for now)	
CD:	Check Digit	1 Character	
FS:	Field Separator	1 Character	"="
CC:	Country Code	3 Characters	
ED:	Expiry Date	4 Characters	YYMM
SC:	Service Code	3 Characters	
DD:	Discretionary Data	Rest of characters excluding ES and LRC	
	PVKI: Pin Value Key Indicator	1 Character	
	PVV or Offset: Pin Verification Value	4 Characters	
	CVV → dCVV or CVC → CVC3	3 Characters	
	dCVV or CVC3 Indicator	1 Character	
ES:	End Sentinel	1 Character	"?"
LRC:	Longitude Redundancy Check	1 Character	

FIG. 9

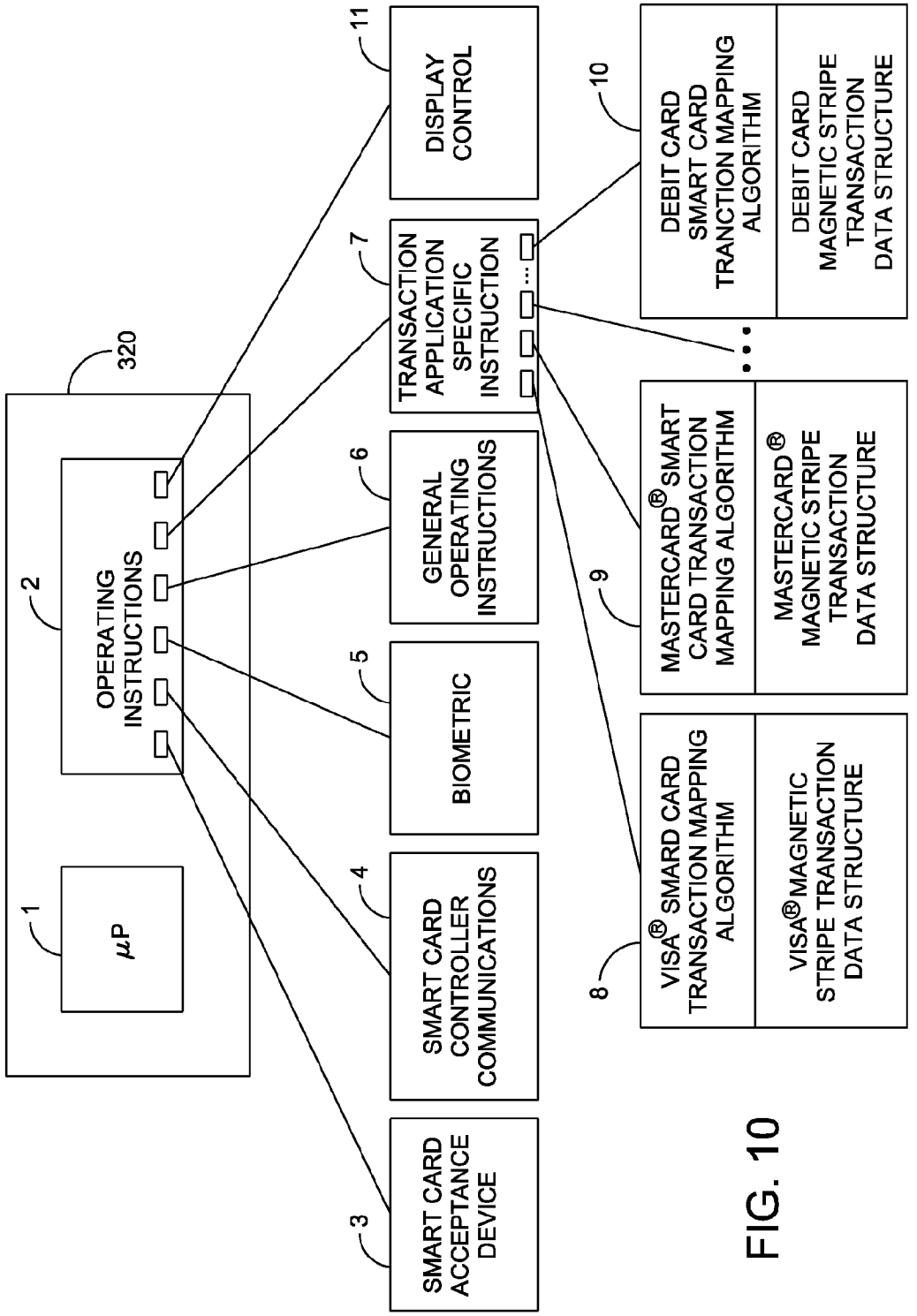

320
1
μP
2
OPERATING INSTRUCTIONS
3
SMART CARD ACCEPTANCE DEVICE
4
SMART CARD CONTROLLER COMMUNICATIONS
5
BIOMETRIC
6
GENERAL OPERATING INSTRUCTIONS
7
TRANSACTION APPLICATION SPECIFIC INSTRUCTION
11
DISPLAY CONTROL
8
VISA® SMARD CARD TRANSACTION MAPPING ALGORITHM
VISA® MAGNETIC STRIPE TRANSACTION DATA STRUCTURE
9
MASTERCARD® SMART CARD TRANSACTION MAPPING ALGORITHM
MASTERCARD® MAGNETIC STRIPE TRANSACTION DATA STRUCTURE
10
DEBIT CARD SMART CARD TRANCTION MAPPING ALGORITHM
DEBIT CARD MAGNETIC STRIPE TRANSACTION DATA STRUCTURE

FIG. 10

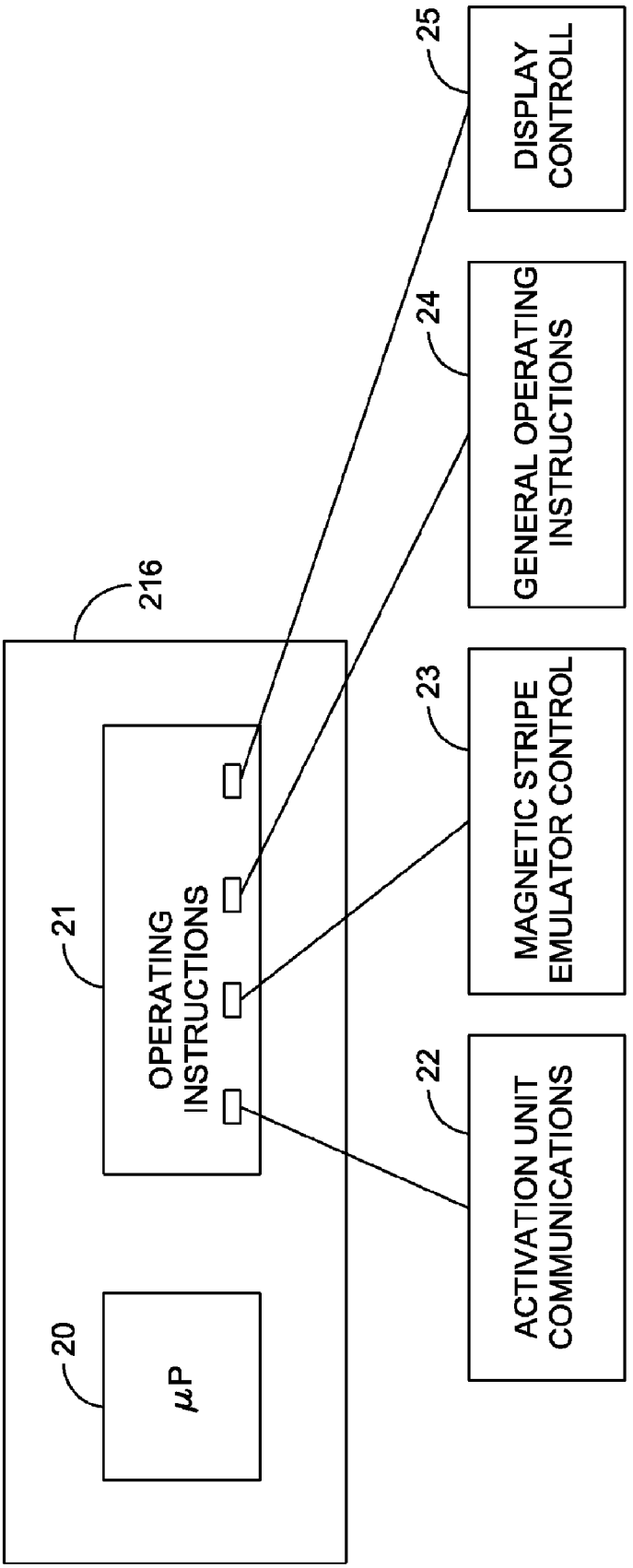

216
21
OPERATING INSTRUCTIONS
20
μP
25
DISPLAY CONTROLL
24
GENERAL OPERATING INSTRUCTIONS
23
MAGNETIC STRIPE EMULATOR CONTROL
22
ACTIVATION UNIT COMMUNICATIONS

FIG. 11

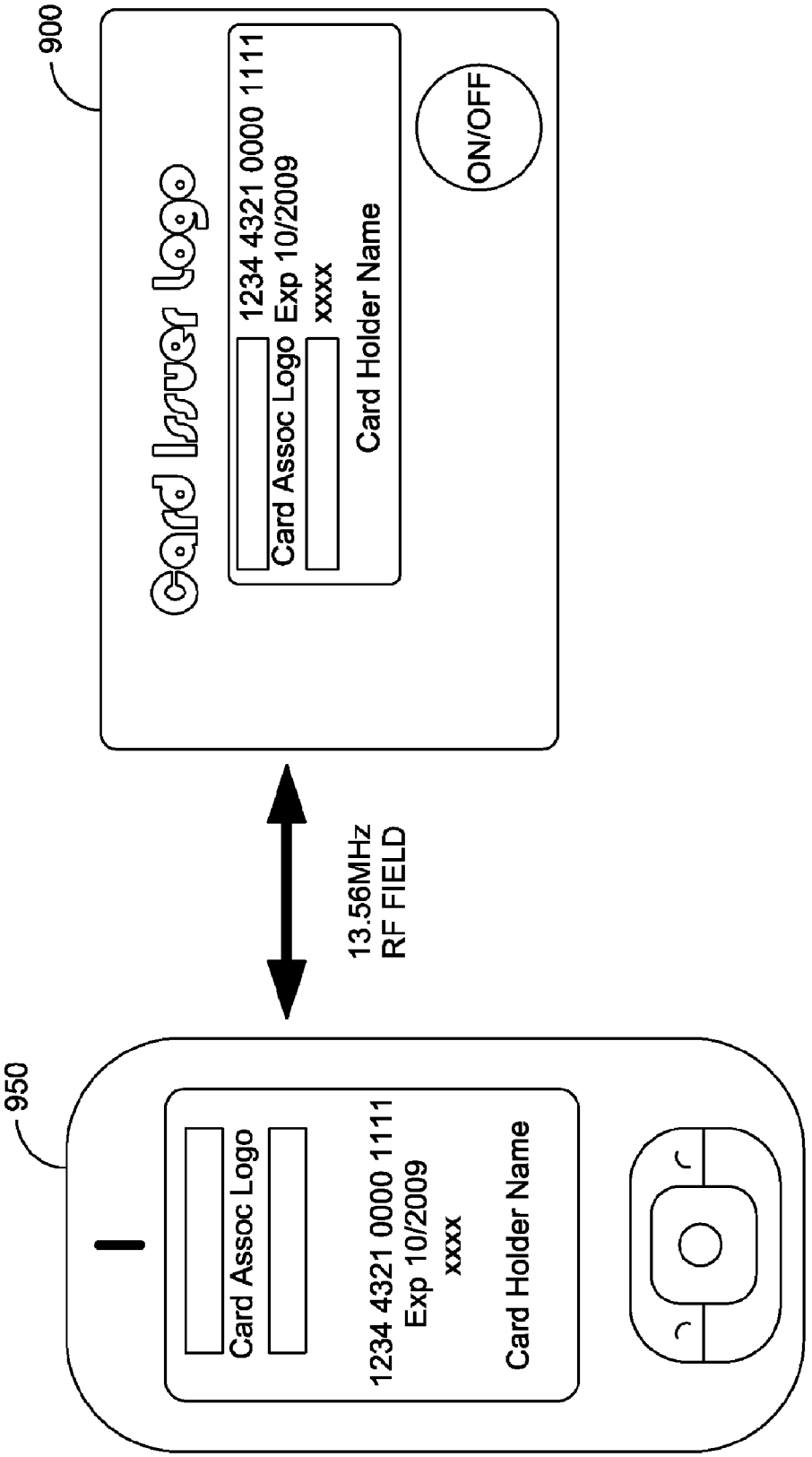

900
Card Issuer Logo
Card Assoc Logo
1234 4321 0000 1111
Exp 10/2009
xxxx
Card Holder Name
ON/OFF
13.56MHz
RF FIELD
950
Card Assoc Logo
1234 4321 0000 1111
Exp 10/2009
xxxx
Card Holder Name

FIG. 12

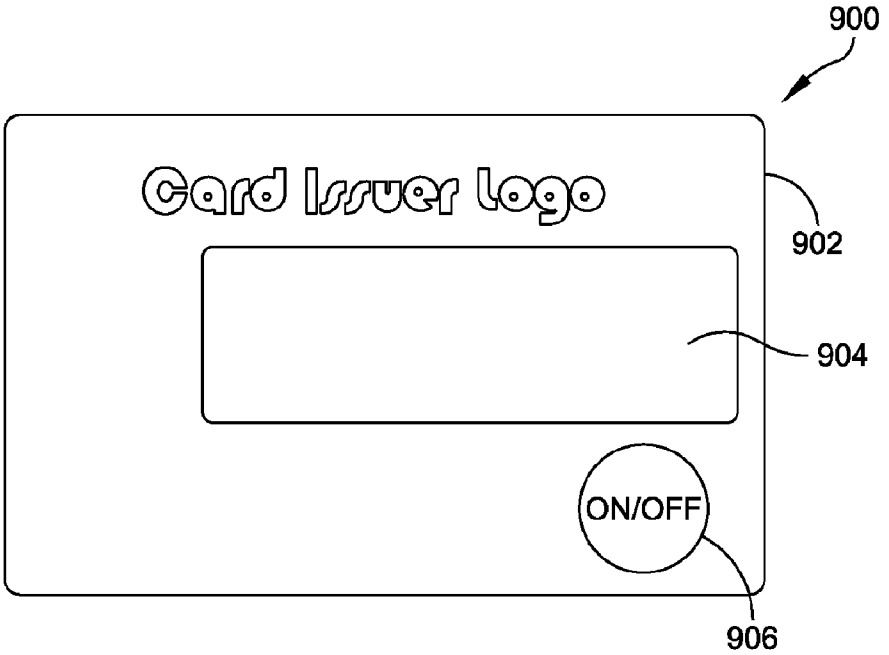


FIG. 13A

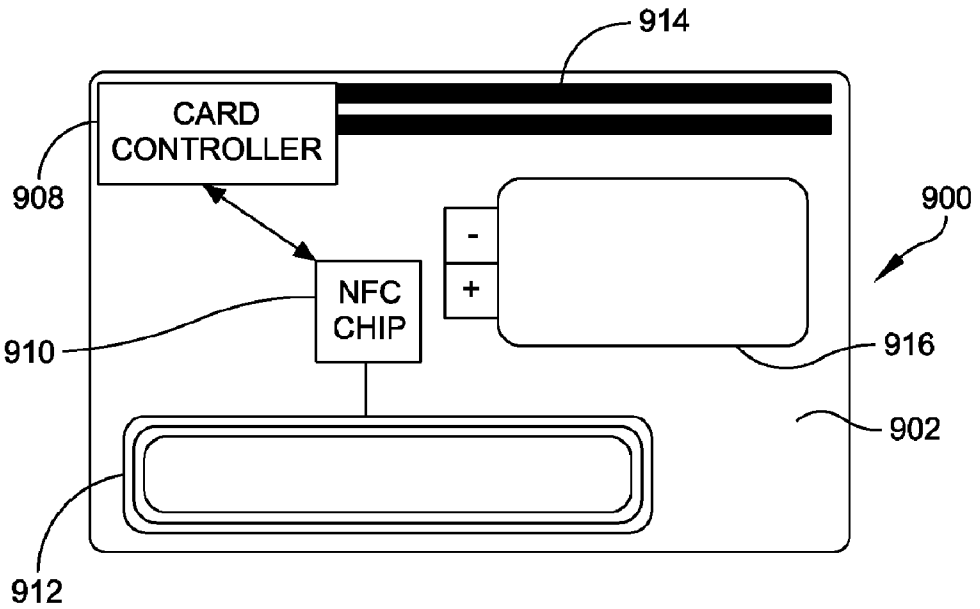


FIG. 13B

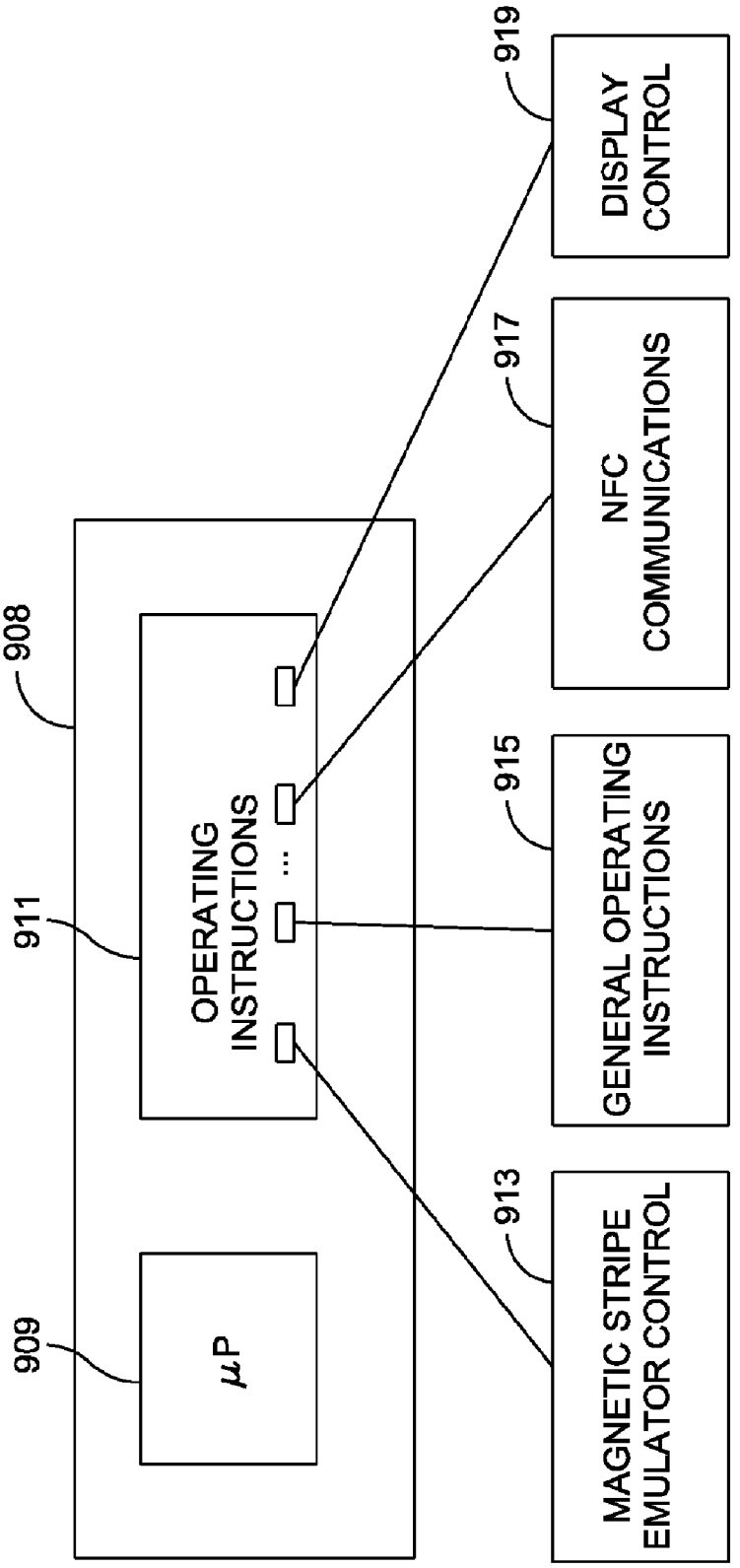

908
911
909
OPERATING INSTRUCTIONS
...
μP
919
917
915
913
DISPLAY CONTROL
NFC COMMUNICATIONS
GENERAL OPERATING INSTRUCTIONS
MAGNETIC STRIPE EMULATOR CONTROL

FIG. 14

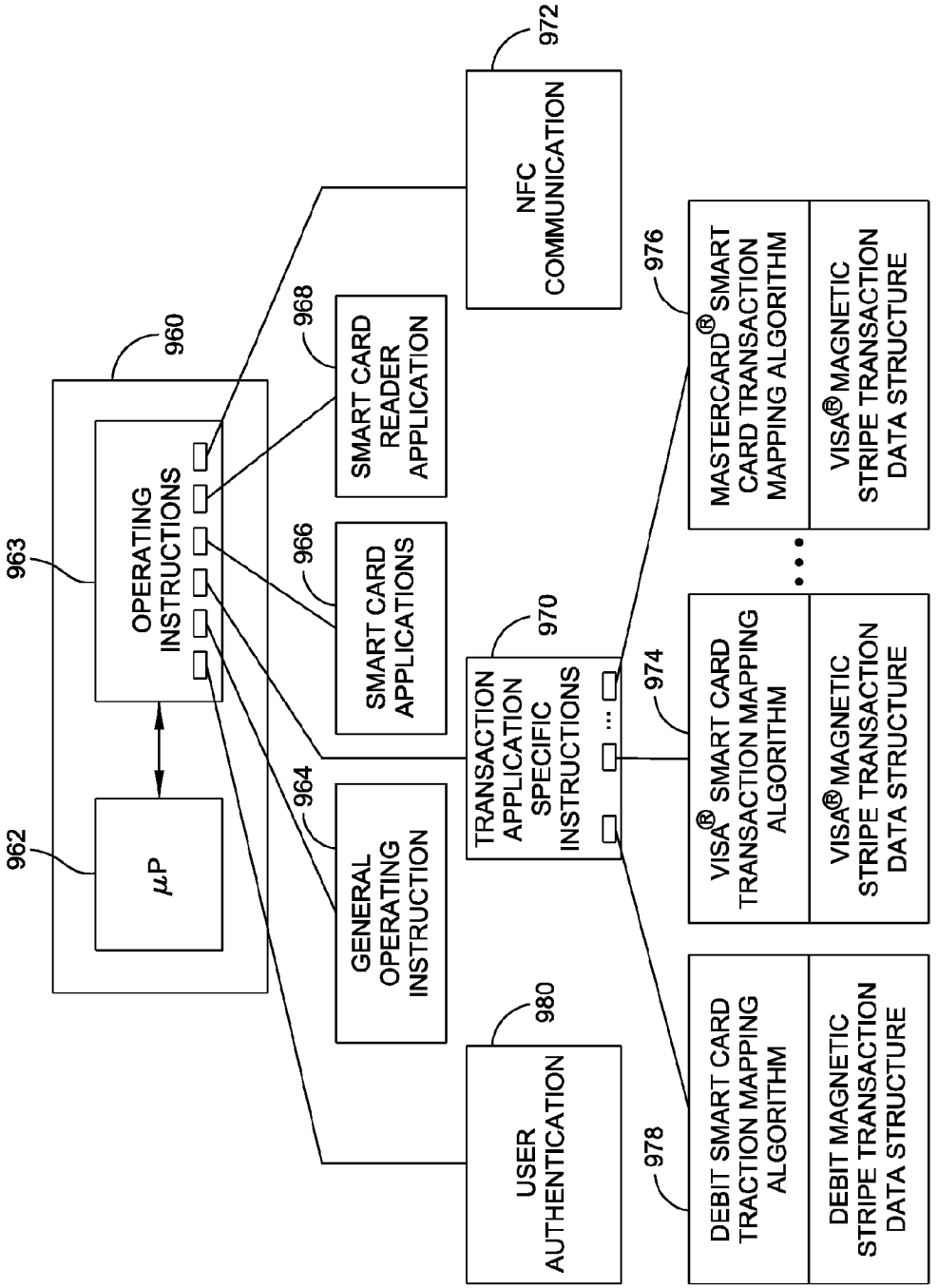

960
963
OPERATING INSTRUCTIONS
962
μP
968
SMART CARD READER APPLICATION
966
SMART CARD APPLICATIONS
964
GENERAL OPERATING INSTRUCTION
972
NFC COMMUNICATION
970
TRANSACTION APPLICATION SPECIFIC INSTRUCTIONS
980
USER AUTHENTICATION
976
MASTERCARD® SMART CARD TRANSACTION MAPPING ALGORITHM
VISA® MAGNETIC STRIPE TRANSACTION DATA STRUCTURE
974
VISA® SMART CARD TRANSACTION MAPPING ALGORITHM
VISA® MAGNETIC STRIPE TRANSACTION DATA STRUCTURE
978
DEBIT SMART CARD TRACTION MAPPING ALGORITHM
DEBIT MAGNETIC STRIPE TRANSACTION DATA STRUCTURE

FIG. 15

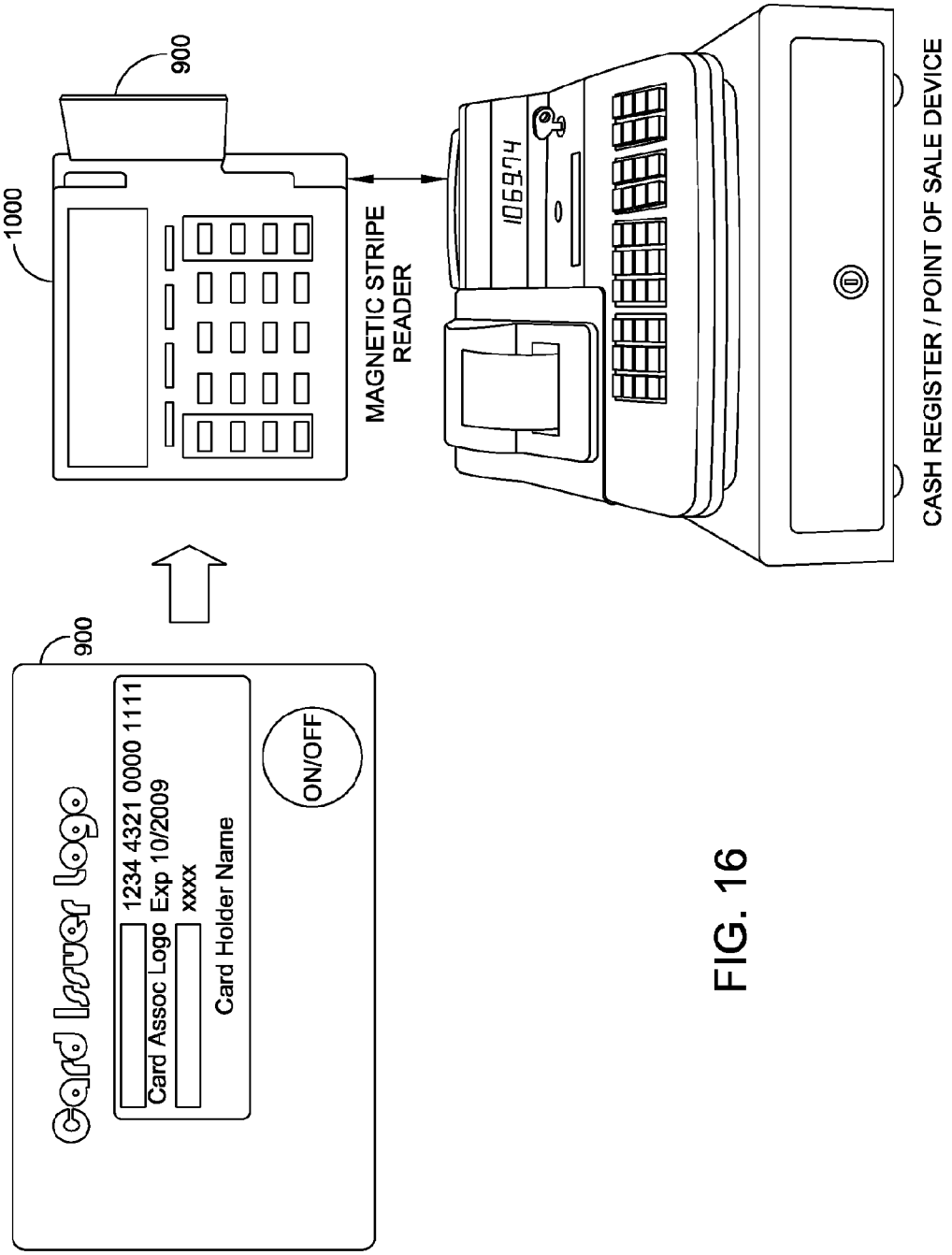

900
1000
MAGNETIC STRIPE READER
CASH REGISTER / POINT OF SALE DEVICE
900
Card Issuer Logo
1234 4321 0000 1111
Card Assoc Logo Exp 10/2009
xxxx
Card Holder Name
ON/OFF

FIG. 16

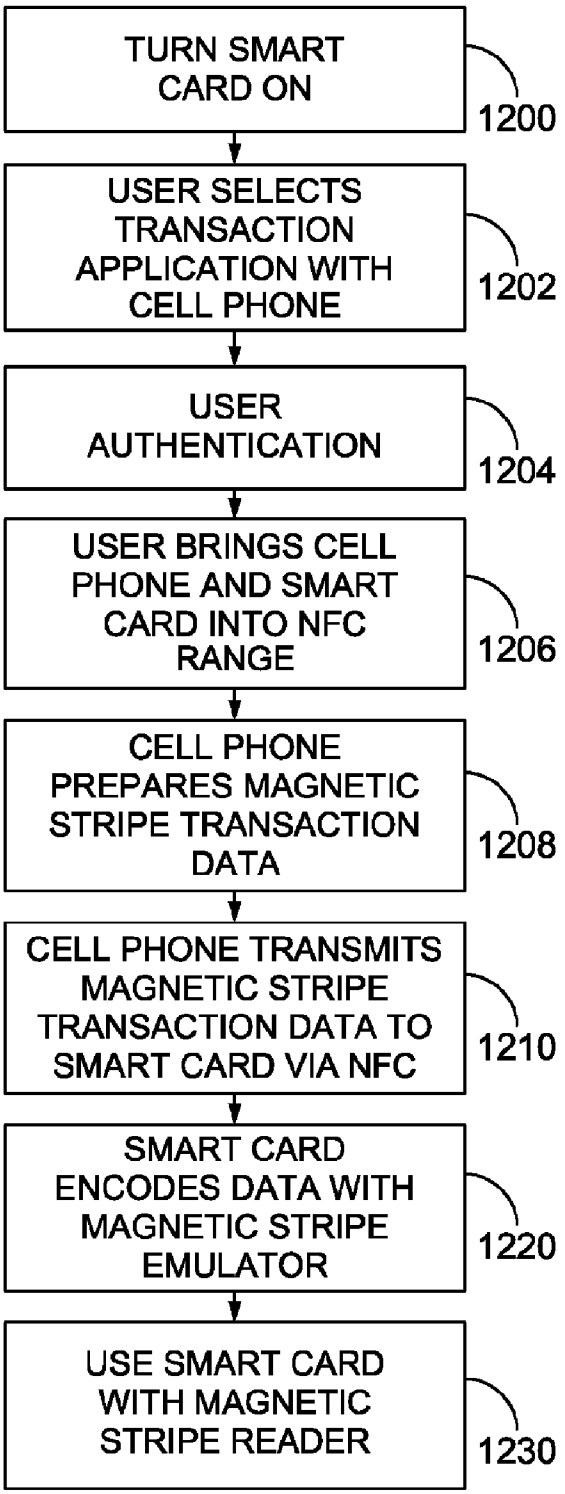

TURN SMART CARD ON
1200
USER SELECTS TRANSACTION APPLICATION WITH CELL PHONE
1202
USER AUTHENTICATION
1204
USER BRINGS CELL PHONE AND SMART CARD INTO NFC RANGE
1206
CELL PHONE PREPARES MAGNETIC STRIPE TRANSACTION DATA
1208
CELL PHONE TRANSMITS MAGNETIC STRIPE TRANSACTION DATA TO SMART CARD VIA NFC
1210
SMART CARD ENCODES DATA WITH MAGNETIC STRIPE EMULATOR
1220
USE SMART CARD WITH MAGNETIC STRIPE READER
1230

FIG. 17

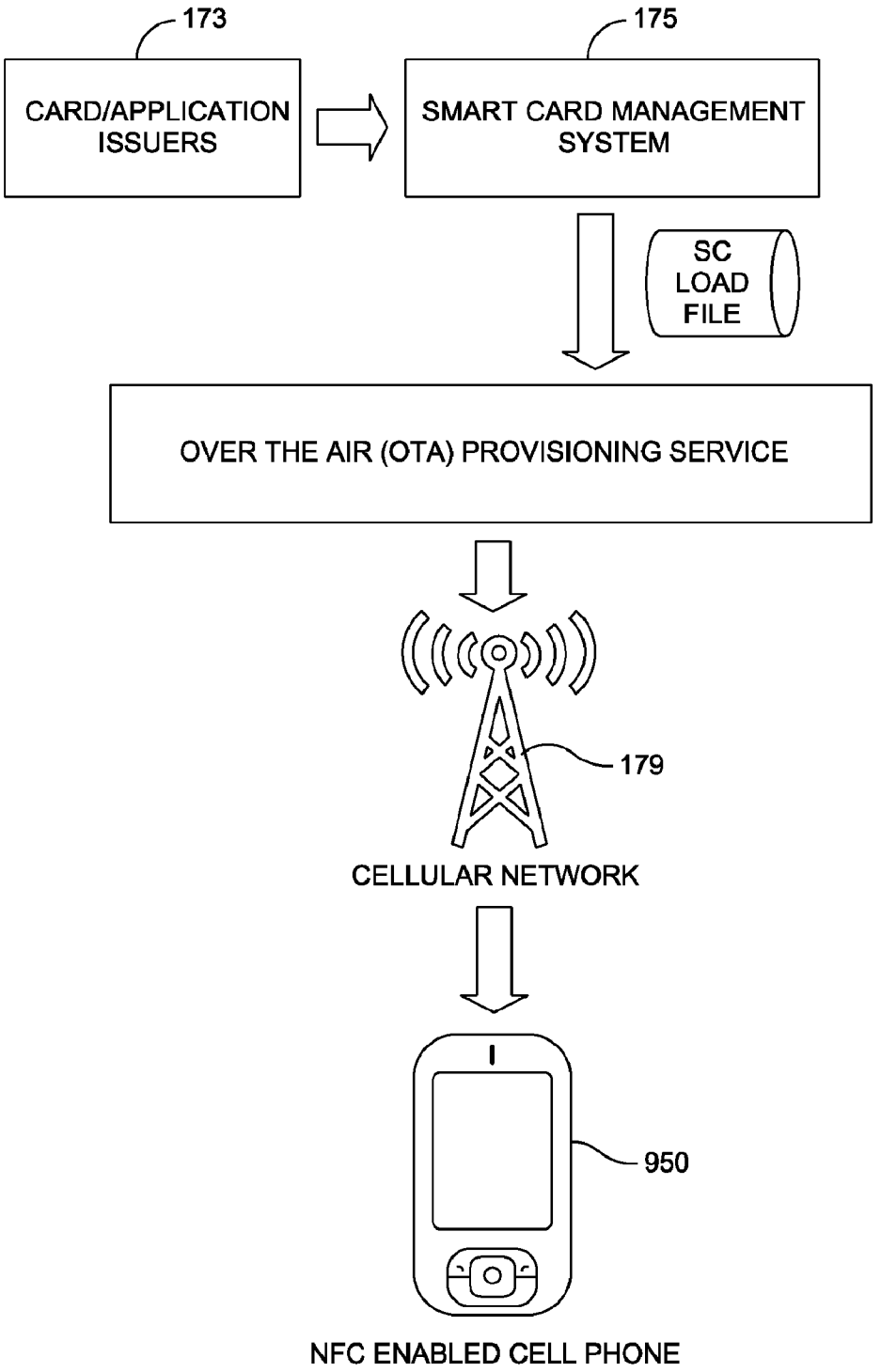

173
CARD/APPLICATION ISSUERS
175
SMART CARD MANAGEMENT SYSTEM
SC LOAD FILE
OVER THE AIR (OTA) PROVISIONING SERVICE
179
CELLULAR NETWORK
950
NFC ENABLED CELL PHONE

FIG. 18

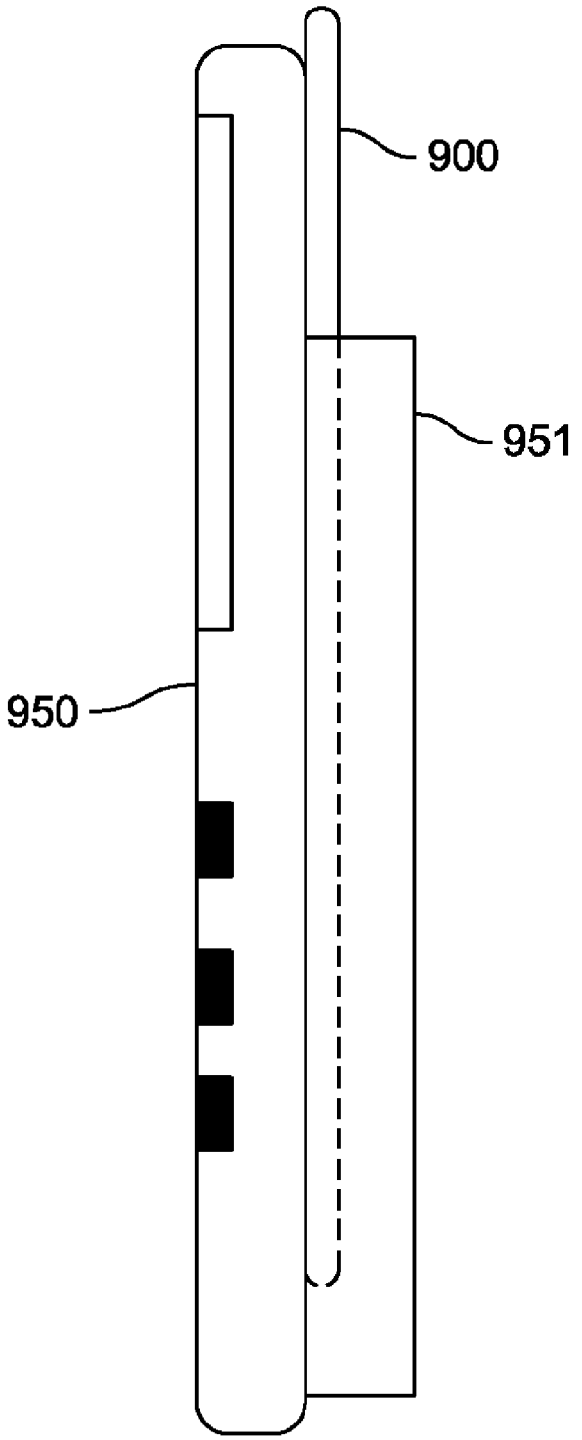


FIG. 19

SECURE SMART CARD SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 61/090,358, entitled "Biometrically Secured Powered Smart Card," filed Aug. 20, 2008, the entirety of which is hereby incorporated by reference herein.

[0002] This application also claims priority to U.S. Provisional Patent Application No. 61/090,362, entitled "NFC Cellphone Companion Card," filed Aug. 20, 2008, the entirety of which is hereby incorporated by reference herein.

FIELD OF THE INVENTION

[0003] The present invention relates to transaction cards, and more particularly to smart cards and to transaction cards having magnetic stripe emulators.

BACKGROUND OF THE INVENTION

[0004] Plastic card fraud has become a significant issue not only in the United States but also worldwide. Fraud levels can be measured in the tens of billions of dollars each year or higher when the various stakeholders that are involved in the losses associated with fraudulent transactions measure their total costs. A merchant loses not only the revenue and profit related to a sale, but the product itself, and possibly higher transaction fees when fraud occurs frequently in its business. A merchant must also incur the costs associated with investigating certain types of fraudulent transactions. Credit card associations like the VISA® and MASTERCARD® associations cover some costs associated with fraud but the credit card issuers incur significantly more costs, including costs associated with refunding the amounts charged to a card holder account, investigating possible fraudulent transactions and issuing new plastic cards if a significant breach of security has been identified. When the total costs of fraud are measured among all the parties involved in financial transactions, the losses are staggering.

[0005] Plastic card fraud has also opened up a market for all sorts of fraud detection and educational services. Neural network software to detect and hopefully prevent a fraudulent transaction from occurring costs card issuers and their processors millions of dollars to operate. Educational seminars to teach card issuers, merchants, and card holders on how to better safeguard the information that can be used to commit identity theft and plastic card fraud also cost card issuers millions of dollars. Existing security standards, like the Payment Card Industry (PCI) Data Security Standard, while being excellent network and system security practices also require merchants to take extra measures to safeguard the information they possess and these measures cost merchants millions of dollars to implement. An entire industry has been created to protect the static data used in today's plastic card transactions. All told, billions are spent and still fraud levels continue to increase. These increases are due not only to defective security; rather, plastic card programs continue to utilize static data that, if obtained, can be used to commit plastic card fraud.

[0006] Over the years, the industry has continued to layer additional static data on credit, debit, and ATM transaction cards. Pin numbers and card security codes have been implemented to help address specific issues of security but criminals continue to adapt their schemes to steal this information. Social engineering attacks like "phishing" are successful because they can target large numbers of people to obtain this static data. The use of holograms and new logos to help prevent counterfeit cards from being used has added to the costs of plastic cards. The plastic card industry has focused on preventing the use of static data rather than adopting a means of implementing some level of dynamic information into these transactions.

[0007] Some in the industry have viewed smart cards as one possible solution to this static data problem. The contact and contactless smart card standards and the hardware integrated into the smart card, the point of sale (POS) device, and the authorization process have adopted methods to include some dynamic data in the transaction authorization process. When implemented on a massive scale, for example the Chip and Pin systems common in Europe, these standards have been effective in the local prevention of fraud. For example, the Chip and PIN system in the United Kingdom is a government-backed initiative to implement the EMV standard for secure payments. In this initiative, banks and retailers replace traditional magnetic stripe equipment with smart card technology, where credit/debit cards contain an embedded microchip and are authenticated automatically using a PIN. When a customer wishes to pay for goods using this system, the card is placed into a "PIN pad" terminal (often by the customer themselves) or a modified swipe-card reader, which accesses the chip on the card. Once the card has been verified as authentic, the customer enters a 4-digit PIN, which is checked against the PIN stored on the card; if the two match, the transaction completes.

[0008] This kind of smart card technology has been shown to decrease certain types of fraud, an example being fraud associated with counterfeit cards, but fraud in total has continued to rise. This is due to the fact that smart cards are only implemented on a scale necessary to affect fraud regionally. Criminals can target other regions that still rely on the static information common to the vast majority of plastic cards in circulation or they can perform more "card not present" transactions, as in internet purchases or mail order transactions. Smart cards also suffer from having to continue to support the predominate point of sale reader technology deployed worldwide, i.e., magnetic stripe.

[0009] Implementing smart cards on a scale necessary to significantly affect fraud levels requires billions of dollars to be spent by merchants or governments to add the new point of sale readers, update the point of sale software, and add the processing functionality for all stakeholders that deal with financial transactions. There are an estimated 20,000,000 magnetic stripe readers in the field today. Replacing these readers with smart card readers would be a huge investment.

[0010] An improved and more cost-effective solution for preventing plastic card fraud is desired.

SUMMARY OF THE INVENTION

[0011] A smart card usable in magnetic stripe swipe transactions with a transaction terminal configured to read transaction information encoded on a magnetic stripe of a standard transaction card includes a card body, which includes a magnetic stripe emulator for use with the transaction terminal, a smart card chip programmed with at least one transaction application for providing secured data for use in a transaction and dynamic card verification data, a power supply, and a card controller in communication with the magnetic stripe emulator. The card controller is configured to receive the dynamic

card verification data and control the magnetic stripe emulator to emit a magnetic field encoded with at least a portion of the secured data and the dynamic card verification data.

[0012] The above and other features of the present invention will be better understood from the following detailed description of the preferred embodiments of the invention that is provided in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The accompanying drawings illustrate preferred embodiments of the invention, as well as other information pertinent to the disclosure, in which:

[0014] FIG. **1** is a block diagram of a smart card application management system;

[0015] FIGS. **2**A and **2**B illustrate a smart card according to one embodiment of the present invention;

[0016] FIGS. **3**A and **3**B illustrate a smart card activation unit for use with the smart card of FIGS. **2**A and **2**B according to an embodiment of the present invention;

[0017] FIGS. **4**A and **4**B illustrate an alternative embodiment of the smart card of FIGS. **2**A and **2**B;

[0018] FIGS. **5**A and **5**B illustrate an alternative embodiment of a smart card activation unit for use with the smart card of FIGS. **4**A and **4**B;

[0019] FIG. **6** is a flow diagram illustrating a method of enrolling biometric information on a smart card;

[0020] FIG. **7** is a flow diagram illustrating a method of authenticating a user using biometrics;

[0021] FIG. **8** is a flow diagram illustrating a method of selecting and activating a transaction application on a smart card;

[0022] FIG. **9** illustrates a data format for Track 1 and Track 2 for a credit transaction;

[0023] FIG. **10** is a block diagram of controller of the activation unit of FIGS. **3**A and **3**B;

[0024] FIG. **11** is a block diagram of the controller of smart card of FIGS. **2**A and **2**B;

[0025] FIG. **12** illustrates an embodiment of the present invention utilizing a cell phone/companion card combination for performing magnetic stripe transactions;

[0026] FIGS. **13**A and **13**B illustrate an embodiment of a NFC enabled companion card for use in the combination of FIG. **12**;

[0027] FIG. **14** is a block diagram of the controller of the NFC enabled companion card of FIGS. **13**A and **13**B;

[0028] FIG. **15** is a block diagram of the processing components of the cell phone illustrated in FIG. **12**;

[0029] FIG. **16** illustrates a transaction system using the companion card of FIGS. **13**A and **13**B;

[0030] FIG. **17** is a flow diagram illustrating the use of the companion card and cell phone of FIG. **12** in a transaction;

[0031] FIG. **18** illustrates a system for programming the cell phone of FIG. **12**; and

[0032] FIG. **19** illustrates an embodiment of the cell phone illustrated in FIG. **12**.

DETAILED DESCRIPTION

[0033] This description of the exemplary embodiments is intended to be read in connection with the accompanying drawings, which are to be considered part of the entire written description. In the description, relative terms such as "lower," "upper," "horizontal," "vertical," "above," "below," "up," "down," "top" and "bottom" as well as derivative thereof (e.g., "horizontally," "downwardly," "upwardly," etc.) should be construed to refer to the orientation as then described or as shown in the drawing under discussion. These relative terms are for convenience of description and do not require that the apparatus be constructed or operated in a particular orientation. Terms concerning attachments, coupling and the like, such as "connected" and "interconnected," refer to a relationship wherein structures are secured or attached to one another either directly or indirectly through intervening structures, as well as both movable or rigid attachments or relationships, unless expressly described otherwise.

[0034] In the following description, it is to be understood that aspects of the present invention may be implemented in various forms of hardware, software, firmware, or a combination thereof. In particular, the device modules described herein are preferably implemented in software as an application program that is executable by any suitable microprocessor architecture. The microprocessor architecture includes hardware such as one or more central processing units (CPU), a random access memory (RAM), and input/output (I/O) interface(s), as well as an operating system and microinstruction code. The various processes and functions described herein may be either part of the microinstruction code or application programs which are executed via the operating system.

[0035] It is to be further understood that, because some of the constituent system components described herein are preferably implemented as software modules, the actual system connections shown in the Figures may differ depending upon the manner in which the systems are programmed It is to be appreciated that special purpose microprocessors may be employed to implement the present invention. Given the teachings herein, one of ordinary skill in the related art will be able to contemplate these and similar implementations or configurations of the present invention.

[0036] As described in the Background section, massive investments have been made in the estimated 20,000,000 magnetic stripe readers in the field today. Replacing these readers with smart card readers would be a huge investment. Presented herein is are devices, systems and methods that perform secure transactions while making use of the existing magnetic stripe readers and all, or as much as possible, of the existing infrastructure for, for example, financial transactions. More specifically, the embodiments described herein make it possible to implement some dynamic data in transactions utilizing magnetic stripe readers while making it economical for card issuers to distribute this technology to their customers. This approach can serve as an effective safeguard for secured static credit card (or other) information and thus act as a significant tool against fraudulent transactions. The existing standards for magnetic stripe based financial transactions contain regions that can be requisitioned for use with dynamic data. In certain preferred embodiments, a smart card is provided that can support all point of sale (POS) readers, i.e., contact smart card readers, contactless smart card readers and magnetic stripe readers, and deliver dynamic data content through not only the smart card readers but also the magnetic stripe point of sale devices.

[0037] Existing smart card specifications for contactless and contact transactions call for the smart card chip to generate some dynamic data for inclusion in the transaction. By way of example only, Visa Inc.'s MSD contactless smart card specifications includes a code designated Dynamic Card Veri-

fication Value (dCVV) for each transaction. MasterCard Inc.'s PAYPASS® Magstripes smart card specification has a similar code designated the CVC3. These one-time (i.e., dynamic) codes are generated by the smart card chip and are unique to each transaction. Traditional magnetic stripe specifications for Track 1 and Track 2 contents require a specific static value called a CVV to be present. Replacing the static CVV value with the dynamic dCVV or CVC3 codes (in the embodiments where the data is formatted for VISA® and MASTERCARD® transactions, respectively) and including any other necessary data used to verify the dCVV or CVC3 codes (e.g., Application Transaction Counter (ATC) value and dynamic data presence flag) would provide sufficient information in the payment authorization process to eliminate both "card present" and "card not present" fraud. Dynamic data generated by a smart card chip for use in authorization of transactions (whether financial, information access or other) are generically referred to herein sometimes as "dynamic card verification data."

[0038] As described herein, necessary information for performing secure card not present transactions can be displayed on the smart card display. This information can include the dCVV or CVC3 codes discussed above that are generated by the smart card for use in card present transactions, or other dynamic information, such as a one-time-password (OTP). Companies and organizations such as QSecure of Los Altos, Calif., InCard Technologies of Los Angeles, Calif., RSA Division of EMC Corporation of Bedford, Mass., and OATH (Open AuTHentication) initiative and others have proposed various OTP schemes for inserting a dynamic code into the payment process. The device described below allows for existing smart card standards to be used in the generation and verification of OTP values rather than require card issues to support multiple OTP algorithms.

[0039] FIG. **1** is a block diagram of a system **100** for managing applications on a smart card. The system **100** includes a smart card **200**, a smart card activation unit **300**, which communicates with smart card **200**, and a personal computer (or other processor) **125**, which is communicatively coupled through a network (such as Internet **150**) to Smart Card Management System (SCMS) **175** and locally communicatively coupled to the smart card activation unit **300**. Through system **100**, a user can manage transaction applications stored on a smart card chip or processor within smart card **200**. More specifically, standards exist for managing applications on smart cards. By way of example only, one set of standards is defined by the GlobalPlatform Card, Device and Systems standards promulgated by GlobalPlatform, which is an independent, not-for-profit organization concerned with a standardized infrastructure for development, deployment and management of smart cards. GlobalStandards was founded in 1999 to take responsibility for Visa Inc.'s Open Platform specification, which is one of a number of competing smart card standards including GSM, EMV and OCF.

[0040] The GlobalPlatform Card Specification is a secure, dynamic card and application management specification that defines card components, command sets, transaction sequences and interfaces that are hardware-neutral, operating system neutral, vendor-neutral and application independent. The specifications are applicable to any type of application and industry, allowing any combination of applications from any industry on a single card—from mono-application to multi-application. The GlobalPlatform Card Security Requirements Specification provides guidance for selecting card configurations most appropriate to the security policies set up by the card issuer and application providers. Card vendors are also provided with guidance to implement security functions in a consistent manner. Most of the secure elements used in the Near Field Communication (NFC) context rely on GlobalPlatform card specification.

[0041] GlobalPlatform also provides a number of specifications for device programming, with different profiles for different industries. The profiles are organized around a common core framework technology and share most of their detailed API's. There are a number of GlobalPlatform specifications relating to the system's infrastructure, developed to standardize back-end systems from personalization to security, key management and application loading. The GlobalPlatform Profile Specification standardizes the interface between the data preparation system and the personalization device utilizing a simple, cost effective, interoperable machine-independent mechanism. Key Management Systems Functional Requirements Specification standardizes the description, or key profile, and procedures around key management, providing an opportunity to deliver centralized key management across separate systems. Communication between various components of the system's infrastructure is standardized via the GlobalPlatform Messaging Specification, which defines all the roles and responsibilities of the actors, or systems, for a multi application smart card infrastructure.

[0042] Referring again to FIG. **1**, the smart card **200** is shown docked (or otherwise interfaced) with the smart card activation unit **300**, which, as described in more detail below, preferably takes the form of a sleeve with a slot for receiving the smart card **200**. The SCMS system **175** is a server based application that manages all information necessary to create a Load File. This Load File is the program code and data that are used to install applications on a GlobalPlatform compliant smart card like the Card **200**. The user establishes a session to the SCMS System **175** over the Internet **150** and downloads the Load File to the smart card through the connection between the PC **125** and smart card activation unit **300**. The smart card activation unit **300** acts as a PC/SC (Personal Computer/Smart Card) compliant device and delivers the Load File to the GlobalPlatform compliant Card Manager running in the Smart Card Chip operating system (e.g. Java Card, Multos, etc.). The Card Manager handles the steps involved in installing the application. All the steps involved in this process are defined by the GlobalPlatform System, Device, and Card standards. The PC/SC specification was developed to facilitate the interoperability necessary to allow Integrated Circuit Card (ICC) technology, also known as smart cards, to be effectively utilized in the PC environment. The PC/SC specification is based on the ISO 7816 standard, and its formal name is "Interoperability Specification for ICCs and Personal Computer Systems."

[0043] The use of SCMS system in managing smart card applications is familiar to artisans in the relevant art. Briefly, the user gains access to the SCMS system **175** either through their web banking software or directly by using username/password credentials. The SCMS system presents the user with a list of applications already installed on the user's smart card and a list of applications available for downloading to the smart card. This process is called Post Issuance Provisioning and provides the ability to add or change applications on a smart card after it has been issued to the card holder. The user can select to download a VISA® Credit Card application

issued by their financial institution and the SCMS would use other related information to generate the load file, manage a secure communications channel with the smart card and download the load file to the smart card. The SCMS tracks all information about the smart card, e.g., chip identifier, OS, keys, issuer, card holder information and what changes have occurred to the applications on the card. The Global Platform System standard dictates the necessary functionality that is supported by a SCMS system.

[0044] Further details regarding use of the smart card activation unit **300**, besides its use in managing applications on the smart card **200**, such as its use in authenticating that a valid user is performing a transaction and its use in selecting an application (credit, debit, loyalty, access control, etc.) for use in a transaction, are described below, along with additional details regarding the smart card **200**.

[0045] FIG. **2**A is a front view of the smart card **200**, more specifically the smart card body **202**, and FIG. **2**B is a schematic illustration of the internal and rear side components of the smart card **200** and smart card body **202**. The smart card body **202** takes the shape of a standard plastic magnetic stripe card, as governed by applicable standards. The card **200** may include the logo **208** of the card issuer or other source indicia. In embodiments, the card **200** includes a display **204**, such as a LCD display. In embodiments, the display **204** can take the form of electronic paper, also called e-paper or electronic ink display. This display technology is designed to mimic the appearance of ordinary ink on paper. Unlike a conventional flat panel display, which uses a backlight to illuminate its pixels, electronic paper reflects light like ordinary paper and is capable of holding text and images indefinitely without drawing electricity, while allowing the image to be changed later. Examples of e-paper displays include electrophoretic displays, bistable LCD and cholesteric LCD. Smart card contact pad **206** is provided on a surface of the card for contact-based communications between an embedded smart card chip and a smart card reader. Smart card contact pad **206** is used to perform transactions on devices supporting the ISO/IEC 7816 standards. In Europe and in Canada this would include the Chip & Pin devices used to perform payment transactions. Contact smart cards are also common in physical access control systems.

[0046] Turning to FIG. **2**B, the card **200** includes an internal power source **212**, such as a battery, for providing power to the various operable components of the smart card **200**. Suitable long life batteries for the low power requirements are available. In particular embodiments, the internal power source **212** is a thin film battery, such as the FLEXION™ ultra-thin, flexible lithium polymer battery available from Solicore, Inc. or a lithium thin-film battery available from Varta Microbattery GmbH. In embodiments, a solar panel (not shown) may be provided. Solar cells are connected to a charger and can be used to extend the life of the card beyond that of a conventional battery and/or to recharge the battery. The card **200** includes a conventional smart card chip/processor **218** which communicates with an appropriately configured external smart card reader by way of the smart card contact pad **206** or wirelessly by way of integrated antenna **220** (i.e., contactless communication).

[0047] The smart card **200** also includes a smart card controller **216** (i.e., ASIC processor) in communication with an I/O port **210**, for communicating with an external source such as the card activation unit **300** (as described in more detail below) and a magnetic stripe emulator **214**. Various designs for magnetic stripe emulators are known in the art, some of which are described in, for example, U.S. Pat. No. 4,701,601 to Francini et al., entitled "Transaction Card with Magnetic Stripe Emulator", and U.S. Published Application Nos. 2007/0189581 and 2005/0194452 to Nordentoft et al., both entitled "Credit Card and Secured Data Activation System," the entirety of each of which is hereby incorporated by reference herein. A typical magnetic stripe emulator will include a transducer coil for each magnetic strip track and including a number of coil windings wound around a strip of electromagnetically inducible core material. Each transducer coil is individually inducible by a driver circuit. Instead of an electromagnetic coil, the transducer can be formed from an integrated thin film head. The number of transducer coils may be chosen to three in order to induce secured data signals corresponding to conventional magnetic strip information, which lies in magnetic strips in three tracks, but may as an alternative be provided in numbers ranging from one to more than three. For most applications, data is only to be generated in two transducer coils as shown for emulator **214**, corresponding to the first and second tracks of a conventional magnetic strip.

[0048] In conventional magnetic strips, the data is permanently magnetically presented to a credit card reader using a so-called F2F-format, or two frequency format, in which a "0" bit is formed by a magnet part of a predetermined length in the magnetic strip, and a "1" bit is two longitudinally, magnetically oppositely directed magnet parts, having a combined length equal to the length of the "0" bit magnet part. Thus, the transducer coils of the emulator **214** preferably emit and present data signals in the F2F-format to a reader, such as a credit card reader, which is to read information from the card **200** with a reader head.

[0049] The transducers generate varying magnetic fields that extend beyond the carrier. The transducer coil preferably produce a homogenous and relatively strong magnetic field encoded with the desired data in order for it to be readable by a credit card reader. The nature of this magnetic field is heavily influenced by the transducer coil construction, such as choice of core material and core construction of the cores strips, number and position of the core windings upon the core strips. The design of the emulator **214** based on these factors is within the skill of the artisan in this field. Variations in the signals to a transducer coil generates a variable magnetic field along the strip that is identical to the magnetic field that a reader head is influenced by when a conventional magnetic strip credit card holding the same secured data is passed through the same reader.

[0050] The material of the core strip is an electromagnetically inducible material, such as metal, preferably electromagnetic lamination, sheet iron or other sheet metal, either provided as a single or double foil on one or each side of the card body, advantageously having a width and a position corresponding to a conventional magnetic track in order to have a similar magnetic and physical appearance. The choice of core material of the core strips strongly influences the strength and distribution of the magnetic field produced and allows for an enhancement of the magnetic field being produced, resulting in the need for lower current in the core windings, which reduces the power consumption of the card.

[0051] The transducer strips of the magnetic stripe emulator **214** are positioned on card **200** in a manner such that alignment with the read sensor of existing reader terminals is facilitated. Current specifications call for the magnetic stripe

to be located 0.223 inches (5.66 mm) from the edge of the card, and to be 0.375 inches (9.52 mm) wide. Each track is 0.110 inches (2.79 mm) wide.

[0052] The card controller **216** controls all aspects of the functionality of the card **200** that are not provided by the conventional smart card chip **218**. The card controller is preferably a separate processor from the smart card chip, thereby enabling the use of the already standardized smart card chip **218**. While it is contemplated that in alternative embodiments the functions of the card controller **216** and smart card chip **218** could be merged, such a merged approach not preferred as it is more difficult to implement and would likely face difficulties in meeting EMV certification standards for the device. Further, it should be understood that although card controller **216** is shown as a single processor, its functions or operations could be distributed amongst two or more processors, controllers, drivers, chips or other devices (collectively referred to herein as "controller"). For example, the card controller **216** serves as a driver for managing the display **204**. This functionality can be built into a central processor or provided in the form of a separate driver chip. Likewise, the card controller **216** can have built in wireless capabilities for interfacing with antenna **220** to communicate with card activation unit **300**, or include a separate wireless communications chip (shown as activation unit interface **210**) for exchanging information with the unit **300**. In embodiments, activation unit interface **210** is a wireless RS485 chip for implementing wireless communications with the activation unit **300**. Alternatively, the interface **210** could be a wired communications interface, such as a RS232 chip. While it is possible to use the contact pad **206**, antenna **220**, and the smart card chip **218** as the means for communicating with the activation unit **300**, this approach would also require that the smart card operating system (OS) be modified to identify these non-standard communications and intercept and redirect the communications to the card controller **216**. This approach would likely be in violation of the EMV standards and thus prevent the device from being certified for use. Using a separate interface **210** for performing communications between the activation unit **300** and the smart card controller **216** leaves the smart card chip **218**, smart card contact pad **206** and antenna **220** as a stand-alone system, allowing the smart card **200** to pass EMV certification testing. Although not shown, the card **200** can includes a peripheral communications controller (e.g., SPI bus) for passing information between various components.

[0053] The card controller **216** controls the magnetic stripe emulator **214** for transmitting secure transaction data during a transaction, e.g., a credit card swipe transaction. Importantly, this data includes not only standard secured data, such as the static transaction data called for by governing specifications (e.g., account holder name, account number, etc.) but also dynamic information. Using this dynamic information in authorizing transactions prevents fraudulent transactions since the static information alone cannot be used to perform a transaction.

[0054] As explained above, the smart card chip **218** is a dual interface smart card (contact and contactless) found in many of the multi-application smart cards available in the market today. There are established standards and standard bodies (e.g., ISO/IEC 7816, ISO/IEC 14443, GlobalPlatform (described above) to name a few) that define this component's functions. These standards provide for secure communications and access to installed applications and data stored in secure memory. As described below, the smart card activation unit **300** communicates with the smart card chip **218** to allow a user to select an active application, queries the application for any necessary information for performing a transaction, and pass some of this information back to the card, specifically the card controller **216** for use in the magnetic stripe emulator **214** and/or display on the card display **204**.

[0055] In addition to its use in managing applications on the smart card **200**, the smart card activation unit **300** is also used during transactions to authenticate that a valid user is performing the transaction and to select what type of card application (e.g., credit, debit, loyalty, access control, etc.) is going to be used in the transaction. These uses are described below but first various features of the smart card activation unit **300** are described in connection with FIGS. **3**A and **3**B.

[0056] FIG. **3**A is a front external view of the smart card activation unit **300**. The activation unit **300** includes a biometric sensor **312**, which is preferably a fingerprint reader, and a user interface. In the illustrated embodiment, the user interface includes an input means **304** (e.g., keypad), including various input buttons or toggles, such as "scroll" button **306**, "ok" button **308** and "on/off" button **310**, and a display **302**, such as a LCD display. The on/off button **310** is used to turn the activation unit **300** on and off. The scroll button **306** is used to scroll through a list of applications stored on the smart card chip **218** of the smart card **200** and displayed on display **302**. A list of names (e.g., "VISA", "MASTERCARD", etc.) or other identifiers corresponding to these applications is displayed on the display **302**. The user uses the button **308** to select an active application from the displayed list of applications.

[0057] FIG. **3**B illustrates the internal components of the activation unit **300**. The activation unit includes an activation unit controller **320** that controls and interfaces with the other active components of the activation unit **300**. The activation unit includes a smart card interface **322** for contact interfacing with the smart card chip **218** of the smart card **200**. In the illustrated embodiment, the smart card interface is a contact based solution (ISO/IEC 7816) and communicates with the smart card chip **218** through smart card contact **206** on the face of the smart card **200**. As will be understood by those familiar with smart card communications, the smart card contact pad **206** has eight contact areas to support the communications: **c1** is assigned to the supply voltage; **c2** is assigned to a reset signal; **c3** is assigned to a clock signal; **c4** is not used; **c5** is assigned to ground; **c6** is not used; **c7** is for I/O; and **c8** is not used. The interface **322** corresponds to these electrical contacts, i.e., provides a physical connection to the pad **206** when the smart card and activation unit **300** are connected. The sleeve controller **320** can also use the contactless standard to communicate with the dual interface smart card chip **218** through the antenna **324**. Contactless communication with the smart card chip **218** can be accomplished with either NFC or Standard ISO/IEC 14443 components.

[0058] The activation unit also includes smart card controller interface **318** for wired (e.g., RS232) or wireless (RS485) wireless communications with the interface **210** of the smart card **200**.

[0059] In embodiments, the activation unit **300** includes an internal power source represented as battery power source **314**. The battery power source **314** can be a standard rechargeable lithium polymer battery commonly used in cell phones, PDA devices, hand held games and the like. An alternate or additional power source for the activation unit

300 is USB PC connection **316**. This PC Connection **316** serves as the means by which PC and Internet based software download content and applications to the card **200** as described above in connection with FIG. **1**. PC/SC is the standard for connection and interaction with a smart card acceptance device like activation unit **300**. The activation unit **300** can both read and write content to the smart card **200** using established standards like PC/SC and GlobalPlatform Card and Device standards.

[0060] When the activation unit **300** is turned on and the smart card is docked with the activation unit **300** (as shown in FIG. **1**, for example), the biometric sensor **312** is used to authenticate the user to the smart card **100**. In one preferred embodiment, this authentication process is accomplished by a smart card application resident at smart card chip **218** referred to as "Match on Card." Various companies, such as Precise Biometrics of Sweden, Sagem Orga of Germany and others supply this type of application for smart cards for use in access control solutions. The biometric sensor **312** captures a live image of a presented user's fingerprint. The live image is processed by software running on the controller **320** or by a separate processor (not shown) to generate a template from this image data. The sleeve controller communicates with the biometric sensor and transmits the template file through either smart card interface **322** or antenna **324** to the smart card chip **218**, specifically to the Match on Card application running on the smart card chip **218**. The Match on Card application compares this received live template file with one or more templates that have been previously stored in the smart card chip **218** (or associated memory). The result of the comparison is either a success or failure result. A Success results will allow the user to proceed, and a Failure result will stop any future use of the activation unit until a Success result is achieved. If the user cannot complete this authentication step, the user cannot use the smart card **100** for any transactions. That is, the smart card **200** is not unlocked.

[0061] The smart card application that is selected by the user for use is unlocked until the card is placed back into the sleeve. When the sleeve senses the presence of the card it will perform the necessary functions to lock all resident applications. The magnetic stripe **214** of the smart card is in active (transmit) mode until either the completion of a swipe or a timeout has occurred, or when the card is placed back into the sleeve. The timeout length is preferably user definable.

[0062] Although the authentication means is shown as a biometric system, other authentication systems may be used. For example, a secure PIN or password can be stored on the smart card chip **218**. In this embodiment, the user inputs the PIN or password rather than present a finger to be authenticated.

[0063] While the activation unit **300** is shown as a standalone device, the activation unit **300** and its functionality can be incorporated into other devices, such as a personal digital assistant or other portable devices such as a cell phone. To the extent this device has Internet capabilities, the device could provide both the activation unit and computer aspects of the system of FIG. **1**.

[0064] As described in more detail below in connection with the flow diagram of FIG. **8**, the sleeve controller **320** uses a card Interface **318** to communicate any necessary information to the smart card for display on the card display **204** and for transmission through the magnetic stripe emulator **214**. Application specific information can be displayed for visual verification or other typical plastic card risk management functions like comparing a displayed name against another form of identification. In preferred embodiments, the card interface **318** and card controller **216** communicate via wireless RS-485, but, as explained above, wired communications (e.g., RS-232) with interface I/O **210** can also be used.

[0065] FIGS. **4**A and **4**B illustrate an alternative embodiment of the smart card **400**. In this embodiment, many of the components of the activation unit **300** are incorporated into the smart card **400**. The smart card body **402** includes a smart card contact pad **406**, an optional logo **408**, a biometric sensor **410**, and a user interface including a display **404** and a user input keypad **412** including scroll button **414**, OK button **416** and on/off button **418**. With reference to FIG. **4**B, the card **400** includes smart card controller **422**, which is coupled to magnetic stripe emulator **430**, smart card chip **424** and antenna **426**. The card **400** includes an internal battery power source **420**.

[0066] The card **400** can be used with a simplified activation unit **500** illustrated in FIGS. **5**A and **5**B. In this embodiment, the activation unit **500** includes a sleeve controller **502** and a PC interface **504** and is operable only for managing applications on the smart card chip **424**. The sleeve controller **502** communicates with the smart card chip **424** of the card **400** through either contact communications via smart card contact interface **506** (described above) or contactless communications using antenna **508**. The activation unit is essentially a standard smart PC/SC card acceptance device for supporting smart cards, such as those devices sold by Advanced Card Systems Ltd. Of Hong Kong, Gemalto (formerly Gemplus) of the Netherlands, Fujitsu of Japan and others. In this embodiment of the smart card **400**, the card controller **422** communicates directly with the smart card chip **424** through an interconnect with the smart card chip **424** rather than through the activation unit. The smart card chip **424** must support some form of bus design, like SPI, to communicate with an outside controller chip like the card controller **422**.

[0067] In use, the user uses keypad **412** to turn on the card **400**. As described above in connection the embodiments of card **200** and activation unit **300**, the biometric sensor **410** captures a live image and it is converted to a template by appropriate software, which is provided to the Match on Card application resident on the smart card chip **424**. A successful match against a previously stored template authenticates the user and activates the card for use. The user then used keypad **412** to scroll through the available applications on the smart card chip **424** and to select one of the available applications for use. Once an application is selected, the controller **422** retrieves the secured static and dynamic data for the application and controls magnetic stripe emulator **430** to emulate this data, thus allowing the smart card **400** to be used with a conventional magnetic stripe reader but with the further advantages of enhanced security and fraud prevention provided by the use of the dynamic data. Of course, the card could also be used with conventional smart card readers. For card not present transactions, the controller **422** controls display **404** to display any necessary information for performing the transactions (e.g., dynamic card verification data such as a dynamic code or one time password or other data).

[0068] FIG. **6** is a flow diagram of the biometric enrollment process for initializing the smart card **200** with a user's fingerprint template for later use in authenticating the user during transactions. While the method is described in connection with smart card **200**, the method is equally applicable to

modified smart card **400**. This process determines what users can access applications stored on the smart card chip **218**.

[0069] At step **600**, the user docks the smart card **200** with the activation unit **300** and turns on the activation unit using on/off button **310** of the keypad **304**.

[0070] At step **601**, the user places a finger on the biometric sensor **312**. In embodiments, this sensor can be a silicon based area sensor or a swipe sensor commonly found on many laptops.

[0071] At step **602**, the biometric sensor **312** captures the fingerprint image, and at step **603** the image quality is checked to make sure enough relevant points are identified to enable accurate authentication using the fingerprint.

[0072] At step **604**, if the image quality is not sufficient the user is prompted to repeat the capture step (via display **302**) and the process returns to repeat steps **601** to **603**.

[0073] At step **605**, if the image is of sufficient quality (as determined at step **603**), the biometric sensor **312** processes the image into a template file of the representative data points.

[0074] At step **606**, the template is stored in the secure memory of the smart card chip **218**, which can be accessed in the future by the Match on Card application of the smart card chip **218**.

[0075] At step **607**, the user is asked if another image should be captured for future comparison. If another image is requested the process is repeated. If no additional images are to be captured the process terminates at step **508**.

[0076] FIG. **7** is a flow diagram of the user authentication process. Assuming biometrics are used for authentication, this process is only used after the user completes the biometric enrollment process described above in connection with FIG. **6**.

[0077] At step **700**, the user docks the smart card **200** with the activation unit **300** and turns on the activation unit using the on/off button **310** of keypad **304**.

[0078] At step **701**, the user places a finger on the biometric sensor **312**.

[0079] At step **702**, the biometric system captures the live biometric image.

[0080] At step **703**, the biometric system checks the image quality to determine if there are a sufficient number of data points for comparison.

[0081] At step **703**, if quality is determined to be insufficient, the user is notified at step **704** (through display **302**) that the image capture step must be repeated.

[0082] At step **705**, if the image is of sufficient quality (as determined at step **703**), the biometric system processes the image into a template file of the representative data points.

[0083] At step **706**, the template file is submitted from the activation unit **300** to the Match on Card application of the smart card chip **218** for comparison to the template(s) that were stored during the biometric enrollment process (FIG. **6**).

[0084] At step **707**, the Match on Card application returns a value of success or failure.

[0085] At step **708**, if a failure to match occurs the user is notified of the result (via display **302**), returned to step **701** and prompted to place a finger on the biometric sensor.

[0086] At step **709**, if a successful match is determined the user is notified (via display **302**) and the process ends (step **710**) by sending the user to the application selection process defined in FIG. **8**. At this point, the user has been authenticated and the card id active.

[0087] While the method of FIG. **7** is described in connection with smart card **200** and activation unit **300**, the method is equally applicable to modified smart card **400**. That is, the process is performed entirely within the smart card **400** rather than by using the activation unit **300**.

[0088] FIG. **8** is a flow diagram illustrating an application selection process where an application is selected for use in a transaction and the magnetic stripe emulator of the smart card **200** (or **400**) is primed for use in the transaction. The method FIG. **8** follows the user authentication process of FIG. **7**.

[0089] At step **800**, the user successfully activates the device using the method of FIG. **7**.

[0090] At step **801**, the activation unit **300**, specifically the activation unit controller **320** through, for example, the smart card interface **322**, performs a query of the smart card chip **218** to obtain a list of its installed applications.

[0091] At step **802**, the activation unit controller **320** generates a list of applications and displays the list on the display unit **302**.

[0092] At step **803**, the user presses a key on the keypad **304**.

[0093] If the user pressed the on/off key **310** at step **803**, the activation **300** unit is turned off at step **804**. The function to lock all applications on the smart card is called when the user turns off the card activation unit while card is in the activation unit or when a card is placed back into the card activation unit.

[0094] At step **805**, if the user pressed the scroll key **306** at step **803**, the next item on the list is highlighted. If the user had scrolled to the last application on the list the highlight is returned to the first application on the list and control is passed back to step **803** where the activation unit waits for the next key to be pressed.

[0095] At step **806**, if the user pressed the ok key **308**, the life cycle status of the application selected is changed to "unlocked" and the other applications have their life cycle statuses changed to "locked" (step **807**). Application life-cycles and the methods of changing them are defined in the GlobalPlatform Card and other standards discussed above.

[0096] Steps **808** to **810** represents steps that enable the use of smart card dynamic card verification data in magnetic stripe transactions. At step **808**, the activation unit **300**, through its controller **320** acting as a GlobalPlatform device (or other device if another standard is employed) queries the user-selected application from the smart card chip **218** and obtains the necessary data values to be used by the smart card **200** in constructing the magnetic stripe data and any data elements for display on the card display **302**. During step **708**, any necessary keys are passed from the activation unit **300** to the smart card application to authenticate activation unit **300** as a valid GlobalPlatform (or other) device, according to the applicable industry standard.

[0097] At step **709**, a mapping algorithm is used by the controller **320** to take the output from the query of the smart card application to format a data stream that is to be emulated by the magnetic stripe emulator **214**. This algorithm maps the output of the smart card, which is a given number of data bits representing various data elements of a smart card transaction, to various data elements called for in the applicable magnetic stripe transaction specification for the given transaction application. The activation unit can then create a new data stream in accordance with the transaction application rules for the magnetic stripe transaction, including all of the necessary data elements plucked from the smart card data stream (e.g., user name, account number, etc.) but also including dynamic card verification data. In embodiments, the dynamic card verification data includes: (a) dynamic data

code flag; (b) a dynamic data code (retrieved from the smart card data stream); and (c) an incremental transaction number (also retrieved from the smart card data stream). The controller also received any necessary data for display during card not present transactions.

[0098] At step **810**, the activation unit **300** sends the newly created magnetic stripe data and any display data to the smart card controller **216**. The card controller **216** then sends the display data to the display **204** and the magnetic stripe data to the magnetic stripe emulator **214**.

[0099] At step **811**, once all the information is obtained and properly communicated to the smart card from the activation unit **300**, the activation unit **300** notifies the user through display **302** that the card can be removed from the activation unit and is ready for use with any card reader (i.e., contact or contactless smart card reader or standard magnetic stripe reader).

[0100] At step **812**, if the smart card **200** is removed from the activation unit **300** the activation unit **300** is turned off. If the smart card **200** is not removed from the activation unit **300**, control is passed back to step **803** and the device waits for another key to be pressed. The removal of the smart card **200** at step **712** is a system level event meaning and at any time if this event occurs, the activation unit **300** is turned off.

[0101] The magnetic stripe emulator will stay active for a user definable period of time or until the sensors that form part of the emulator sense a successful swipe past a magnetic read head. The smart card will stay active until the card is placed back into the sleeve.

[0102] FIG. **9** is a table illustrating the generally applicable data format specifications for magnetic stripe credit card transactions defined in ISO/IEC 7813. FIG. **9** also illustrates how to change static magnetic stripe data to include some dynamic information for use in a transaction. Tracks **1** and **2** include many fields that are used to allow a card issuer or its agent to authorize a financial transaction. On each track there is a Discretionary Data (DD) segment that allows for the issuer to include some relevant information to use in the transaction authorization process. The typical DD segment includes the static CVV (VISA) or CVC (MASTERCARD) values, which are allotted three characters. Replacing the three character CVV or CVC data with a three digit dynamic code (dCVV in Visa, Inc. terms, or CVC3 in MasterCard, Inc. terms), including the dCVV of CVC3 indicator character (e.g., a status flag indicating that dynamic data is present), and including a four character Application Transaction Counter value allows the card issuer to use a set of data unique to each transaction to authorize a transaction. The smart card chip application in use increments the transaction counter after each transaction from that particular smart card application (i.e., each smart card application maintains its own transaction counter). This value is passed to the transaction server (which is part of the credit card transaction infrastructure in place) during authorization and eliminates the need on the server side to stay in sync as is required by many of today's security tokens.

[0103] This approach takes the dynamic code scheme already defined in the specifications for secure smart card transactions, but not for magnetic stripe transactions, and allows for it to be supported in traditional magnetic stripe transactions. Use of this dynamic information in a magnetic stripe transaction allows the same smart card verification algorithms already in place for use with smart card transactions to be reused for magnetic stripe transactions, thereby providing magnetic stripe transactions with the security of smart card transactions through existing magnetic stripe readers. This approach saves a tremendous amount of resources and money by implementing secure transactions through existing magnetic stripe readers already deployed in the field.

[0104] It should be understood that the specific scheme described above in connection with FIG. **9**, where a CVV or CVC value is replaced with a dCVV or CVC3 value, is specific to only one data specification. The scheme (i.e., particular data format, location of dynamic data, selected dynamic data, etc.) can change according to the card issuer and transaction application. Modifications on data formats clearly fall within the spirit and scope of the present invention. Those familiar with transaction cards will recognize that a number of international organization for standardization standards have been promulgate, e.g., ISO/IEC 7810, ISO/IEC 7811, ISO/IEC 7812, ISO/IEC 7813, ISO 8583, and ISO 4909, for defining the physical properties of the card, including size, flexibility, location of the magstripe, magnetic characteristics, and data formats. These standards also provide the standards for financial cards, including the allocation of card number ranges to different card issuing institutions. These standards will guide the artisan in formatting the secured data and dynamic card verification data for use in a magnetic stripe transaction.

[0105] Magnetic stripes following these specifications can typically be read by most point-of-sale hardware, which are simply general-purpose computers that can be programmed to perform specific tasks. Examples of cards adhering to these standards include ATM cards, bank cards (credit and debit cards including VISA and MasterCard), gift cards, loyalty cards, driver's licenses, telephone calling cards, membership cards, and electronic benefit transfer cards (e.g., food stamps). The approach described herein can be used in nearly any application in which value or secure information is stored on the card itself or even in remote storage. For example, health care information can be stored at a central provider. The user can be issued a smart card as described herein. The smart card would have some secured data, such as an identification of the user and an account number, as well as a smart card chip that can generate dynamic data (e.g., a code and/or transaction number). The user can use the smart card to authorize a doctor or other health care provider to access this secured data (i.e., a transaction) and the backend system would operate in the manner described above to use authorization algorithms with the dynamic data to authorize the transaction (i.e., release of the medical data). FIG. **10** is a more detailed block diagram view of the processing components of the card activation unit controller **320**. The controller **320** includes a microprocessor **1** programmed with memory **2** containing its various operating instructions. Memory **2** includes instruction set **3** for enabling the controller **320** to act as a smart card acceptance device. These instructions allow the device to interface with and manage applications on a smart card chip as described above. Instruction set **4** includes instructions for allowing the controller **320** to communicate with a smart card controller **216** of smart card **200**. Instruction set **5** is used by the controller **320** in performing the biometric scanning, template formation, etc. operations of the controller. Instruction set **6** includes the general operating instructions of the controller. These operating instructions form the operating framework for the device, including the use of the various other instruction sets in performing the operations and methods described herein, and the like. Operating

instructions **2** includes a set of instructions **11** for controlling the display information to the user on the activation unit display **302**. Finally, the operating instructions include sets of transaction application specific instructions **7**. These instructions are used by the controller **320** in mapping/parsing the smart card transaction data received from the smart card, as described above, and formatting some or all of the data for use in a magnetic stripe transaction. For example, the transaction specific instructions **7** can include a set of instructions **8** that are specific to Visa, Inc. transactions. Instructions **8** include a smart card transaction mapping algorithm that is used by the controller **320** to identify specific data elements in a VISA® smart card transaction data communication received from the smart card chip **218** as well as instructions for constructing a magnetic stripe transaction data structure in accordance the governing specification, including the necessary static data elements and the dynamic card verification data for the magnetic stripe transaction data structure. Other instruction sets, such as instruction set **9**, which is specific to Mastercard, Inc. transactions, and instruction set **10** specific to debit card transactions, etc. are also included.

[0106] FIG. **11** is a block diagram of the processing components of smart card controller **216**. Smart card controller **216** includes a microprocessor **20** programmed in accordance with operating instructions **21**. The operating instructions can include, for example, instruction set **22** for managing communications with the activation unit **300**. The operating instructions **21** also include an instructions set **23** relating to control of the magnetic stripe emulator **214**. The operating instructions include a general set of operating instructions **24** for controlling the overall operation of the device. These operating instructions form the operating framework for the device, including the use of the various other instruction sets in performing the operations and methods described herein, and the like. Finally, operating instructions **21** includes a set of instructions **25** for controlling the display of information to the user on the activation unit display **204**.

[0107] As described above, smart card controller **422** would incorporate many of the functions performed by activation unit controller **320**. That is, in addition to the operating instruction sets described above for smart card controller **216** in FIG. **11**, smart card controller **422** can include those instructions sets from FIG. **10** necessary for performing the operations described above in connection with smart card **400**.

[0108] FIGS. **12-20** illustrate an embodiment of a transaction system that utilizes a smart card transaction enabled cell phone or other portable wireless communication device. FIG. **12** shows a short-range communication enabled cell phone **950** in communication with a NFC enabled companion card **900**. In embodiments, the short-range communication scheme is Near Field Communication or NFC, which is a short-range high frequency wireless communication technology that enables the exchange of data between devices over about a 10-20 centimeters (about 4-8 inches) distance. As such, the cell phone is enabled for both long range (e.g., cell communications) and short-range communications. NFC is an extension of the ISO/IEC 14443 proximity-card standard (contactless card, RFID) that combines the interface of a smart card and a reader into a single device. An NFC device can communicate with both existing ISO/IEC 14443 smart cards and readers, as well as with other NFC devices, and is thereby compatible with the existing contactless RFID infrastructure already in use for, for example, public transportation and payment. While the transaction system is described herein in connection with NFC communications, it should be understood that NFC communication is only one possible embodiment and other protocol/approaches for short range communications can be used to communicate between devices. The phrase "near field communications" is used herein generically to refer to these short range communications while NFC as an acronym refers to the specific Near Field Communications standard.

[0109] In this embodiment, the cell phone **950** is configured for contactless transactions (e.g., contactless credit or debit transactions) using existing NFC techniques. However, existing contactless transaction enabled cell phones cannot be used for magnetic stripe transactions, which is the dominant technology presently in use. In the embodiment illustrated in FIG. **12**, the cell phone **950** communicates with the NFC enabled companion card **900** by way of NFC communications. Specifically, in much the same manner described above in connection with the activation unit **300**, the cell phone **950** communicates transaction data to the NFC enabled companion card **900** for use in a magnetic stripe transaction using a magnetic stripe emulator. In exemplary embodiments, this transaction data preferably include any necessary static secured data for performing the transaction as well as dynamic card verification data for use in authorizing the transaction. Any necessary data for display on the NFC enabled companion card **900** for use in the transaction can also be transmitted.

[0110] Turning to FIGS. **13**A and **13**B, FIG. **13**A is a frontal view of the NFC enabled companion card **900** and FIG. **13**B illustrates the internal and some rear components of the NFC enabled companion card **900**. The NFC enabled companion card **900** has a smart card body **902** that is shaped like a conventional credit or transaction card. The smart card includes an on/off button **906** for powering the smart card on/off and a display **904** for displaying information to the user. As with other embodiments of smart cards described herein, the NFC enabled companion card **900** includes a smart card controller (i.e., ASIC) **908** in communication with a magnetic stripe emulator. The NFC enabled companion card **900** also includes an internal battery power source **916** for powering at least the smart card controller **908** and the magnetic stripe emulator **914**. The NFC enabled companion card **900** includes a NFC chip (i.e., contactless RF module) that is configured for RF communications via the antenna **912** with another NFC enabled device. While the NFC chip is shown as a separate chip set **910**, the NFC functionality can be built into the ASIC that serves as the controller **908**. The NFC enabled companion card **900** does not need to include a smart card chip, as the smart card application(s) is/are resident on the cell phone **950**.

[0111] FIG. **14** is a block diagram of the processing components of smart card controller **908**. Smart card controller **908** includes a microprocessor **909** programmed in accordance with operating instructions **911**. The operating instructions **911** include, for example, instruction set **913** relating to control of the magnetic stripe emulator **914** and instruction set **917** for engaging in NFC communications with another NFC enabled device. Instruction set **917** interfaces with NFC chip set **910** if the NFC chip set is a separate component from controller **908** or includes the NFC chip set functionality if the NFC communication functionality is incorporated into the controller **908**. The operating instructions include a general set of operating instructions **915** for controlling the overall

operation of the device. These operating instructions **915** form the operating framework for the device, including the use of the various other instruction sets in performing the operations and methods described herein, and the like. Operating instructions **911** can also includes a set of instructions **919** for controlling the display of information to the user on the display **904**.

[0112] FIG. **15** is block diagram of the relevant processing components of cell phone **950**. It should be understood that only those portions of the processing capabilities pertinent to interacting with the NFC enabled companion card **900** for performing a transaction are described herein. The general processing capabilities of a cell phone, PDA or other wireless communication device for performing its standard operations (e.g., placing a telephone call, communicating via the Internet, email, etc.) are familiar to those in the art of wireless communication devices and are not described herein so as to avoid obscuring the description of the present invention. The cell phone **950** includes a controller **960** that includes a microprocessor **962** programmed in accordance with operating instructions **963**.

[0113] The operating instructions **963** include a set of general operating instructions **964**. These operating instructions **964** form the operating framework for the device, including the use of the various other instruction sets in performing the operations and methods described herein, the display of information to the user on display of the cell phone and the like. Instruction set **966** includes one or more smart card applications **966** for performing contactless smart card transactions, such as by way of NFC communications. These instructions correspond to the VISA® smart card transaction applications, MASTERCARD® smart card transaction applications, debit transaction application, information access transaction, etc. described above as being resident in secure memory of the smart card chips **218**, **424** discussed above. These applications **966** initiate transactions using secured data stored in the device, generate dynamic card verification data (e.g., the dCVV code for VISA® transactions and transaction counters) and provide information for display to a user during a transaction. These smart card applications **966** are familiar to those artisans in this field. The operating instructions **963** also include one or more smart card reader applications **968** for communicating with the smart card applications **966**. These instructions correspond to the smart card acceptance device instruction set **3** described above and allow the device to interface with and manage smart card applications **966**. This application **968** enables the controller **960** to mimic a smart card acceptance device (e.g., a reader) to receive secure communications with the contactless smart card transaction data from the smart card transaction applications **966**. By way of example and with specific reference to credit card applications, this "reader" application **966** queries the selected application to return the Track 2 equivalent data. In a Visa, Inc. application, this Track 2 data would include the dCVV and the transaction counter data. Once this data is obtained the "reader" application can provide the data to the transaction application specific instructions **970** (described below) to derive Track 1 data for use in a magnetic stripe transaction. The magnetic stripe transaction data is passed to the NFC communication program **972**, which establishes a peer-to-peer session with an in-range NFC enabled companion card **900**.

[0114] The operating instructions **963** include a set of transaction application specific instructions **970** similar to instruction set **7** discussed above in connection with FIG. **10**. These instructions are used by the controller **960** in mapping/parsing the smart card transaction data received from the smart card application(s) **966**, as described above, and formatting some or all of the data for use in a magnetic stripe transaction. For example, the transaction application specific instructions **970** can include a set of instructions **974** specific to Visa, Inc. transactions. Instructions **974** include a smart card transaction mapping algorithm that is used by the controller **960** to identify specific data elements in a VISA® smart card transaction contactless data communication from the smart card application **966** as well as instructions for constructing a magnetic stripe transaction data structure in accordance the governing specification, including the necessary static data elements and the dynamic card verification data for the magnetic stripe transaction data structure. Other instruction sets, such as instruction set **976**, which is specific to MasterCard, Inc. transactions, and instruction set **978** specific to debit card transactions, etc. are also included.

[0115] Finally, the operating instructions **963** can include an instruction set **980** for performing user authentication for transactions. These instructions can be specific to biometric authentication (e.g., biometric scanning, template formation, etc.) or other kinds of authentication, such as user PIN or password authentication.

[0116] FIG. **16** illustrates the use of the NFC enabled companion card **900** in a transactions, specifically a credit transaction, after the magnetic stripe emulator **914** has been encoded with transaction information. Once the magnetic stripe emulator **914** is encoded with the proper transaction data, the NFC enabled companion card **900** is swiped through a standard magnetic stripe reader **1000** connected to a POS device, such as a cash register **1100**. If dynamic card verification data is included in the encoded data, that data is used during the authorization process as discussed above.

[0117] FIG. **17** is a basic flow diagram illustrating a method of using the NFC enabled companion card **900** and cell phone **950** in a transaction. The details of many of the individual steps shown in FIG. **17** are described above in more detail in connection with the flow diagrams of FIGS. **6-8**.

[0118] At step **1200**, the user turns on the NFC enabled companion card **900**.

[0119] At step **1202**, the user uses the cell phone (or other wireless communication device) to bring up a list of transaction applications (e.g., debit, VISA, Inc., MasterCard Inc., etc.) and the user selects one of the transactions for use. During this step, the smart card reader application **968** can query the smart card applications for available applications and the processor **962** displays those applications on the display of the cell phone **950**. The user scrolls through the listing and selects an application for use. The cell phone **950** can be programmed with a mobile wallet application that allows the user to select from among the installed applications (credit, debit, others) and enable or activate one for use in the next transaction.

[0120] At step **1204**, the user is authenticated, such as using biometrics if the cell phone (or smart card) has biometric capabilities or a PIN or password authentication scheme.

[0121] At step **1206**, the user brings the NFC enabled companion card **900** within NFC range of the cell phone **950** so that they can communicate with one another. Once in range of one another the NFC enabled mobile phone and the smart

card establish a peer-to-peer session and pass data to each other. The NFC peer-to-peer session is governed by applicable standards.

[0122] At step **1208**, the cell phone **950**, using transaction application specific instructions **970**, prepares magnetic stripe transaction data for use by the NFC enabled companion card **900**. As will be understood from the foregoing description, the smart card reader application **968** obtains contactless smart card transaction data from the smart card application(s) **966** and provides that information to the transaction application specific instructions **970** to prepare the magnetic stripe transaction data.

[0123] At step **1210**, the cell phone **950** transmits the magnetic stripe transaction data to the smart card using NFC communication instructions **972**. The transmission of data between the phone and the card can be encrypted according to the established standards covering NFC and ISO 14443 contactless smart cards.

[0124] At step **1220**, the NFC enabled companion card **900** receives the magnetic stripe transaction data and the smart card controller **908** controls the magnetic stripe emulator to encode the received magnetic stripe transaction data in its magnetic field.

[0125] At step **1230**, the user is notified (through the display **904** of the NFC enabled companion card **900** and/or the display of the cell phone **950**) that the card is ready to use in a traditional magnetic stripe reader. The user uses the smart card with a standard magnetic stripe reader to perform a transaction.

[0126] After a successful transaction, at a predetermined time limit or when the user presses the on/off button **906**, the NFC enabled companion card **900** deletes any transaction data and is available for use in the next transaction. For security purposes, the NFC enabled companion card **900** retains no useful information related to the transaction.

[0127] The cell phone can also be used in conventional contactless smart card transactions. For the VISA® MSD and MASTERCARD® Magstripe smart card specifications this means that the cell phone returns Track 2 equivalent data. The contactless reader application takes Track 2 data and creates Track 1 data since a lot of the information is redundant on the Tracks. The only significant difference in the track data is that the card holder name is on Track 1 but including this information in payment information is sometimes not recommended. The contactless reader then sends this data to the POS system for use in authorizing the transaction.

[0128] FIG. **18** illustrates a system for programming the cell phone **950** with transaction applications and managing those applications. The system operates in much the same manner as the system shown in FIG. **1** and described above except that the programming occurs over-the-air via a cellular system. Of course, programming could also occur via wireless Internet communications. The system includes Smart Card Managements System **175**, which is described above. The issuer **173** (or its agent) takes standard account information and a SCMS system **175** and combines the account information with other data to create a load file that is downloaded to the cell phone **950** via the cellular data network **179** and Over the Air (OTA) Provisioning Service **177**, such as the Trusted Service Provider service provided by Venyon of Helsinki, Finland. This service is responsible for, among other things, managing the cellular communications during the download of the Load File. When the mobile phone **950** receives this load file it is routed to the card manager program resident on the phone **950** that controls the installation and activation of the smart card applications on the phone.

[0129] FIG. **19** illustrates an option for storing and charging the NFC enabled companion card **900**. More specifically, the NFC enabled companion card **900** is stored in a slot or pocket **951** behind the cell phone **950**. A connection is provided to couple the cell phone **950** to the NFC enabled companion card **900** so that the internal battery **916** of the NFC enabled companion card **900** can be recharged by the internal battery of cell phone **950**.

[0130] While the smart card system described herein provides particular advantages when used in connection with financial transactions, the system is not so limited. The smart card system can be used in connection with access to customer records, health records, financial records or other confidential information. As such, the term "transaction" as used herein is not limited to financial transactions but rather more generically refers to the provision of information by way of smart card or magnetic stripe for use in some form of authentication and/or authorization.

[0131] Although the invention has been described in terms of exemplary embodiments, it is not limited thereto. Rather, the appended claims should be construed broadly to include other variants and embodiments of the invention that may be made by those skilled in the art without departing from the scope and range of equivalents of the invention.

What is claimed is:

1. A smart card usable in magnetic stripe swipe transactions with a transaction terminal configured to read transaction information encoded on a magnetic stripe of a standard transaction card, the smart card comprising a card body, which comprises:

a magnetic stripe emulator for use with the transaction terminal;

a smart card chip programmed with at least one transaction application for providing secured data for use in a transaction and dynamic card verification data;

a card controller in communication with the magnetic stripe emulator, wherein the card controller is configured to receive the dynamic card verification data and control the magnetic stripe emulator to emit a magnetic field encoded with at least a portion of the secured data and the dynamic card verification data; and

a power supply.

2. The smart card of claim **1**, wherein the card body further comprises at least one of a smart card contact pad and a wireless interface for interfacing with a smart card reader.

3. The smart card of claim **1**, wherein the card body comprises stored biometric data corresponding to an authorized user of the smart card.

4. The smart card of claim **3**, wherein the smart card chip includes an authentication application for authenticating received biometric data against the stored biometric data.

5. The smart card of claim **4**, wherein the received and stored biometric data comprise fingerprint data.

6. The smart card of claim **4**, wherein the card body further comprises a biometric sensor on a face thereof.

7. The smart card of claim **1**, wherein the smart card chip includes a plurality of transaction applications, each transaction application providing respective secured data for use in a transaction.

8. The smart card of claim **7**, wherein the plurality of transaction applications correspond to two or more of a credit

transaction application, a debit transaction application and an information access control application.

9. The smart card of claim **7**, wherein the card body further comprises a user interface on a face thereof for enabling user selection among the plurality of transaction applications resident in the smart card chip for use.

10. The smart card of claim **1**, wherein the card body further comprises a display in communication with the card controller.

11. The smart card of claim **10**, wherein the card controller displays the dynamic card verification data on the display.

12. The smart card of claim **10**, wherein the card controller displays on the display information for use in authorizing a card-not-present transaction.

13. The smart card of claim **1**, wherein the magnetic stripe emulator includes two or more emulated magnetic stripe tracks.

14. The smart card of claim **1**, wherein an incremented transaction number is encoded with the secured data and the dynamic card verification data in the magnetic field.

15. The smart card of claim **1**, wherein the card controller is configured to receive data for encoding with the magnetic stripe emulator from a source external to the smart card, wherein the card body further comprises a smart card interface in communication with the smart card chip for providing data to the source external to the smart card.

16. The smart card of claim **1**, wherein the card controller communicates with the smart card chip to receive data, including the secured data and dynamic data code, wherein the smart card controller formats at least some of the data for use in a magnetic stripe transaction and provides the formatted data to the magnetic stripe emulator.

17. A smart card activation unit comprising:

one or both of a contact and contactless interfaces for communicating with a smart card chip;

an activation unit controller configured to receive from the smart chip through the interfaces smart card transaction data including secured data from the smart card chip for use in a transaction and a dynamic card verification data, and to format at least some of the secured data and the dynamic card verification data into magnetic stripe transaction data; and

a card interface through which the activation unit controller provides magnetic stripe transaction data to the smart card for used in a magnetic stripe transaction.

18. The smart card activation unit of claim **17**, further comprising:

a display; and

user input means operable with the display for selecting among transaction applications available on the smart card.

19. The smart card activation unit of claim **17**, further comprising a biometric sensor for capturing biometric information from a presented user, wherein the activation unit controller provides a signal corresponding to the captured biometric information to the smart card for on-card comparison of the captured biometric information with stored biometric information.

20. The smart card activation unit of claim **17**, wherein the activation unit controller controls the display to provide an indication to the presented user that the smart card is ready for use in a transaction.

21. The smart card activation unit of claim **17**, wherein the smart card activation unit has a slot in which the smart card is received.

22. The smart card activation unit of claim **17**, further comprising a battery power source.

23. A smart card usable in both magnetic stripe transactions and contact or contactless smart card transactions, comprising a smart card body, the smart card body comprising:

a smart card chip programmed with at least one transaction application for performing smart card transactions, the smart card transactions involving transmission to a smart card reader of smart card transaction data including secured data and dynamic card verification data dynamically developed by the smart card chip, wherein the smart card chip is also programmed with a biometric match on card application for authenticating a use against pre-stored user biometric information;

a smart card interface for interfacing the smart card chip with a smart card reader;

a magnetic stripe emulator for interfacing the smart card with a magnetic stripe reader configured to read transaction information encoded on a magnetic stripe of a transaction card;

an internal power supply;

a card controller in communication with the magnetic stripe emulator, wherein the card controller controls the magnetic stripe emulator to emit a magnetic field encoded with magnetic stripe transaction data, wherein the magnetic stripe transaction data includes the dynamic card verification data and at least some of the secured data from the smart card transaction data; and

a display under the control of the card controller.

24. The smart card of claim **23**, wherein the card controller is configured to receive the magnetic stripe transaction data from a source external to the smart card.

25. The smart card of claim **23**,

wherein the card body further comprises a biometric sensor on a face thereof for capturing biometric data, wherein the biometric data is provided to the match on card application for authentication of a presented user, and

wherein the card controller communicates with the smart card chip to receive the smart card transaction data, formats the dynamic card verification data and at least some of the secured data from the smart card transaction data into the magnetic stripe transaction data, and provides the magnetic stripe transaction data to the magnetic stripe emulator.

26. A transaction system, comprising:

a portable, personal wireless communication device enabled for near field communications with a similarly enabled device, the wireless communication device being programmed with at least one smart card application for use in contactless smart card transactions, wherein the wireless communication device is configured to format contactless smart card transaction data for magnetic stripe transactions and communicate magnetic stripe transaction data by near field communication; and

a companion card enabled for near field communications with a similarly enabled device, the companion card including a card body which includes:

a magnetic stripe emulator for use with a transaction terminal configured to read transaction information encoded on a magnetic stripe of a standard transaction card;

a card controller in communication with the magnetic stripe emulator, wherein the card controller is configured to receive the magnetic stripe transaction data communicated to the companion card by near field communication and control the magnetic stripe emulator to emit a magnetic field encoded with the magnetic stripe transaction data; and

a power supply.

27. The transaction system of claim **26**, wherein the contactless smart card transaction data includes dynamic card verification data, wherein dynamic card verification data is included in the magnetic stripe transaction data.

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