(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 March 2008 (27.03.2008)

PCT

(10) International Publication Number
WO 2008/036907 A2

(51) International Patent Classification:
G06K 17/00 (2006.01)

(21) International Application Number:
PCT/US2007/079172

(22) International Filing Date:
21 September 2007 (21.09.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/826,489 21 September 2006 (21.09.2006) US
11/850,489 5 September 2007 (05.09.2007) US

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(81) **Designated States** (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

(54) Title: A PRINTER AND ENCODER SYSTEM AND ASSOCIATED ANTENNA-COUPLER

(57) Abstract: A RFID system and an associated antenna-coupler are provided. The system may be for selectively communicating with a targeted transponder from among a group of multiple adjacent transponders is provided. The system may include a transponder conveyance, a transceiver, and an antenna-coupler. The transponder conveyance is adapted to transport at least one targeted transponder from a group of multiple adjacent transponders through a transponder operating region. The transceiver is configured to generate one or more electrical signals. The antenna-coupler has first and second microstrips in a cross-like arrangement relative to each other. Each of the first and second microstrips is configured to transmit one or more electro-magnetic fields concentrated in a near-field region of the antenna-coupler based on the one or more electrical signals for communicating with the targeted transponder.

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A PRINTER AND ENCODER SYSTEM AND ASSOCIATED ANTENNA-COUPLER

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention generally relates to systems configured to print indicia on a surface of a smart media and communicate data to and from an associated transponder of the smart media and, in particularly, to spatially selective antenna-couplers of such systems capable of selectively communicating with a targeted transponder from among a group of adjacent transponders.

Description of Related Art

Printers are used to print text, graphics, and other indicia on a variety of media, including media having data storage devices such as magnetic strips, memory components, radio frequency identification (RFID) tags, barcodes, optical devices, and the like. For purposes of the present invention and appended claims the term "information card" shall refer to a printable media that is adapted to convey and/or contain information. A credit card is an exemplary information card that conveys information in the form of printed indicia and contains information that is stored as data on a magnetic strip. This data is retrieved simply by swiping the card's magnetic strip in front of a reader as will be apparent to one of ordinary skill in the art.

Smart cards are information cards having a memory for storing data and a device for accessing the memory. Contactless smart cards use an antenna or other similar devices to communicate wirelessly with a reader. Other types of smart cards communicate with a reader based on direct electrical contact between conductors or "contacts" defined on the card (e.g., copper or gold plated contacts) and similar conductors disposed on the reader.

The printed information conveyed by an information card is typically created during printing operations that are distinct from the encoding operations used to write data to the information card's memory. For example, a blank information card may be fed through a printer to print text, graphics, barcodes, etc., to either side or both sides of the information card. Data is conventionally written to the card memory before or after such printing operations. In this regard, the same p inter can be used for printing various cards, regardless of the type of encoding to be performed. Similarly, a single electronic communication device or reader can be used to encode various cards, regardless of the type of printing to be performed. However, separate operations for printing and encoding can increase the time and expense necessary to manufacture information cards. Further, care must be taken to ensure that the printed and electronically encoded information for each card correspond to one another. Said differently, if the cards are taken out of order between the printing and encoding operations, such cards may inadvertently receive printed information that was intended for a first card type and electronic data that was intended for a different card type. In addition, different printing and encoding devices typically require separate electrical connections to one or more host computers that generally control such devices through multiple communication ports.

Separate printing and encoding operations are typically controlled by a host computer using separate software for controlling each of the different operations. For example, if a change in the printing operation is to be effected, an operator typically accesses a first software program on the host computer. To make a change to the encoding operation, the operator instead accesses a second software program on the computer. This can complicate the operator's role, possibly increasing the time required for making changes or verifying an operation and also increasing the risk of operator error.

Thus, there exists a need for a printer/encoder that addresses the deficiencies noted above and achieves multiple other benefits as will be described in greater detail below.

SUMMARY

The present invention may address some of the deficiencies discussed above by providing a system that may be configured to print and encode media, such as cards with associated transponders. More specifically, the system may include a transceiver and a near field antenna-coupler for communicating with the associated transponders.

For example, according to an embodiment of the present invention, a system for selectively communicating with a targeted transponder from among a group of multiple adjacent transponders is provided. The system may include a transponder conveyance, a transceiver, and an antenna-coupler. The transponder conveyance is adapted to transport at least one targeted transponder from a group of multiple adjacent transponders through a transponder operating region. The transceiver is configured to generate one or more electrical signals. The antenna-coupler has first and second microstrips in a cross-like arrangement relative to each other. Each of the first and second microstrips is configured to transmit one or more electro-magnetic waves concentrated in a near-field region of the antenna-coupler based on the one or more electrical signals for communicating with the targeted transponder.

The antenna-coupler may further include a first port in communication with both of the first and second microstrips such that both of the first and second microstrips receive the one or more electrical signals concurrently. Or the system may further include a switch for sending the one or more electrical signals from the transceiver to either one of the first and second microstrips. In other words, the switch may be used to activate only one of the microstrips such that only one is transmitting the electro-magnetic fields or both microstrips may be activated such that both are transmitting electro-magnetic fields.

According to an embodiment, the first and second microstrips are spaced apart and separated by the at least one substrate. In another embodiment, the first and second microstrips are substantially co-planar and the first microstrip further

includes a first section, a second section, and a bridge. The first section extends from a first end of the first microstrip to approximately the second microstrip. The second section extends from approximately the second microstrip to a second end of the first microstrip. And the first and second sections are linked through the bridge that extends around the second microstrip such that the first and second microstrips do not intersect.

The antenna-coupler may further include a first resistive load for terminating the first microstrip and a second resistive load for terminating the second microstrip. The first microstrip defines a characteristic impedance which may be less than the first resistive load. Similarly, the second microstrip defines a characteristic impedance which may be less than the second resistive load.

Each of the first and second microstrips has a tapered profile. For example, the tapered profile may be a modified bow-tie. Each of the first and second microstrips defines a length. According to an embodiment, the length is substantially equal to a multiple of one half a wavelength of an operational frequency of the antenna-coupler. The operational frequency of the antenna-coupler may be selected from a range of frequencies from 300 MHz to 3 GHz or from a range of frequencies from 860 MHz to 960 GHz. According to yet another embodiment a system for printing and communicating with one or more media units, each media unit defines a length and includes a transponder configured to operate within a range of frequencies from 300 MHz to 3 GHz. The system may include a printhead for printing indicia on the one or more media cards and a communication device for communicating with the one or more media cards; wherein the communication device is positioned proximate to the printhead such that the printing and the communicating of the printhead and the communication device occur substantially simultaneously.

The communication device may be configured to communicate with a targeted media unit within a communication field generated by the communication device and wherein the communication field extends a distance equal to approximately twice the length of the targeted media card along a feed path of the one or more media cards. For example, the communication field may be substantially centered about the printhead such that the communication field extends from a point about the length of the targeted media unit before the printhead to a point about the length of the targeted media unit after the printhead.

The system may include an RFID transceiver and an antenna-coupler. The antenna-coupler may include first and second microstrips in a cross-like arrangement as described above.

In another embodiment a method is provided for printing and encoding a media unit. The method may include providing a printhead proximate a print position; advancing a media unit toward the print position; providing a communication device proximate the print position; communicating with the media unit via the communication device; initiating printing operations including printing one or more colors onto the media unit; validating communication with the media unit via the communication device; and if the validating is successful, finishing printing operations including printing one or more colors onto the media card.

If the validation is not successful, ceasing printing operations such that no additional colors are printed onto the media card and sending the media card toward an exit. Or, as another example, if the validation is not successful, finishing printing operations including printing a reject indicia onto the media card.

Another embodiment may provide a method of manufacturing an antenna-coupler. The method may include providing a first microstrip extending from a first end to a second end; terminating the second end of the first microstrip with a first resistive load; providing a second microstrip extending from a first end to a second end; terminating the second end of the second microstrip with a second resistive load; crossing the first microstrip and the second microstrip such that the first microstrip and the second microstrip are generally orthogonal to each other; providing a ground plane spaced apart from the first and second microstrip; and providing at least one substrate extending at least partially between the ground plane and the first and second microstrips.

The crossing the first microstrip and the second microstrip may include spacing the first microstrip and the second microstrip apart and separating the first microstrip and the second microstrip by the at least one substrate. As another example, the providing the first microstrip may include a first section, a second section, and a bridge; and the crossing of the first and second microstrips may include extending the first section along a plane common to the second microstrip toward the second microstrip, extending the second section along the plane common to the second microstrip away from the second microstrip and extending the bridge around the second microstrip and linking the first and second sections such that the first and second microstrips do not intersect.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

Figure 1 is a section view schematically illustrating a printer according to one embodiment of the present invention;

Figure 2 is a perspective view illustrating an exemplary media card that can be processed with a printing and reading/writing operation of the printer of Figure 1 according to one embodiment of the present invention;

Figure 3 is a perspective view illustrating a printer having a reject tray according to one embodiment of the present invention;

Figure 4 is a block diagram schematically illustrating a printer according to another embodiment of the present invention;

Figure 5 is a schematic diagram illustrating a graphical user interface for use in conjunction with controlling a printer according to one embodiment of the present invention;

Figure 6 is a section view schematically illustrating a printer according to another embodiment of the present invention;

Figure 7 is a block diagram illustrating a process of simultaneously communicating with and printing to a card or other media and validating the printed or communicated information according to one embodiment of the invention;

Figure 8 is a block diagram illustrating a different process of communicating with and printing to a card and validating the printed or communicated information according to one embodiment of the present invention;

Figure 9 is a block diagram illustrating yet another process of communicating with and printing to a card and validating the printed or communicated information according to one embodiment of the present invention;

Figure 10 is a block diagram schematically illustrating the printer having a an integrated interface and configured to print a card and communicate with a card in parallel according to one embodiment of the present invention;

Figure 11a is a perspective view of an antenna-coupler according to an embodiment of the present invention;

Figure 11b is a side section view of the antenna-coupler of Figure 11a;

Figures 12a-e illustrate various types of RFID transponders in landscape and portrait orientations relative to the feed direction according to an embodiment of the present invention;

Figure 13a illustrates crosswise transponder movement over the antenna-coupler of Figure 11a;

Figure 13b illustrates lateral transponder movement over the antenna-coupler of Figure 11a;

Figure 14 is a high-level system block diagram of a XML system according to one embodiment of the present invention;

Figure 15 is a section view schematically illustrating a printer according to another particular embodiment of the present invention;

Figure 16a is a perspective view of an antenna-coupler according to another embodiment of the present invention;

Figure 16b is a side section view of the antenna-coupler of Figure 16a;

Figure 17a illustrates crosswise transponder movement over the antenna-coupler of Figure 16a; and

Figure 17b illustrates lateral transponder movement over the antenna-coupler of Figure 16a.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

Smart Media Printer and Encoder

Various embodiments of the present invention are directed to a printer that is configured to communicate with a host device for receiving a signal and, in response to the signal, printing indicia on a media and/or electronically storing data on an electronic storage device associated with the media. According to one embodiment of the present invention, the printer includes a print device for printing human or machine-readable indicia, such as graphics, text, barcodes, or the like on one or more surfaces of the media. A controller can be configured to control the print device. The printer also includes at least one communication device for communicating with the media according to a select protocol. For purposes of this application, "communicating" with the media may include writing information to or reading information from the media. In other words, a communication device communicating with the media may include such reading and writing operations as encoding an electronic storage device or magnetic strip on the media, writing information on the media in the form of a barcode or hologram, reading information from an electronic storage device, barcode, hologram, or magnetic strip, etc.

Each electronic communication device (also referred to herein simply as "a communication device") can be configured to store data on the media and/or read data therefrom using different communication protocols. For example, each of the electronic communication devices can be adapted for various types of communication with various types of electronic storage devices that may be provided on the media. In particular, the media can include a magnetic strip, a contactless (i.e., non-contact) device such as an RFID tag or other contactless memory circuitry, a contact device such as an integrated circuit with contact terminals, and the like. Alternatively, one or more of the electronic communication devices can be configured to store or read data by disposing or detecting material on the media, e.g., fluorescent text, a hologram, encoded pixilated images, or the like. In any case, the printer can include multiple types of electronic communication devices, each of which can communicate using a different communication protocol, so that the printer can read and/or write to various types of media.

Each electronic communication device of the printer can be integral to the printer so that the printer can perform each of the printing and electronic communication operations. Further, the printer can perform both operations as part of a combined process, i.e., while the media is being fed through the printer in one or more pass along a feed or conveyance path thereof. The printing and electronic communication can be controlled by a single controller, such as a microprocessor or the like that communicates with each of the electronic communication devices. In addition, the electronic communication devices can communicate with an external controller, such as a host computer, which can be the same host computer that controls the operation of the printer functions of the printer. In fact, the printer can communicate with the host computer or other controller via a single, integrated communication port, for example single wireless communication port, and/or a single communication cable. For example, the cable can include conductive elements configured for communication using one or more protocols such as parallel, serial, universal serial bus (USB), Ethernet, and the like for controlling each of the different printing and reading/writing operations.

According to one aspect of the invention, the host computer, the cable, and the communication port of the printer are configured for communicating signals for printing as well as communicating with the media via the different electronic communication devices so that different types of communication can be performed. That is, the host device can communicate a signal to the printer via the integrated communication port, and the signal can be representative of the indicia and data to be encoded on the media. The electronic communication devices can also be configured to read data from the media according to the respective protocols, and any data read from the media or related to the printing or encoding of the media can be communicated to the host via the same integrated communication port.

In addition, the host computer can be programmed to control each of the operations of the printer using an integral software program. For example, the host computer can be configured to perform a plurality of operations of an integral software program, which is configured to control the printing of the indicia by the print device and the communication of the data by the communication device(s). The integral software program can provide a single user interface for controlling the printing of the indicia by the print device and the communication of the data by the first and second electronic communication devices. Thus, an operator can control the printing and reading/writing communication operations of the printer using one software program, and the software program can have a single user interface therefor.

According to one embodiment, the present invention provides a method of printing on a media in a printer and selectively electronically storing data on the media according to one of multiple communication protocols in response to a signal received from a host device. A signal that is representative of an indicia and data is received from the host device via an integrated communication port. The indicia is printed on a surface of the media according to the signal. One of multiple communication protocols is selected for storing the data, and, in some cases, one of multiple electronic communication devices is selected according to the select communication protocol. Each electronic communication device can be configured to store the data on the media using a different communication protocol. The communication devices and/or communication protocols can also be used for reading data from the media. Thus, the data can be stored on the media according to the signal using the select communication protocol and/or the select communication device. The printing, selecting, and storing operations can be controlled and/or performed by a controller, and these operations can be performed during a combined operation, e.g., while the media is fed in one or more passes through the printer. The printing and storing operations can be controlled by a single, i.e., integral, software program that includes a plurality of operations. Further, a single user interface can be provided for controlling the printing of the indicia and the storing of the data.

According to another embodiment, the present invention also provides a computer program product for communicating between a host device and a printer. The computer program product includes a computer-readable storage medium having computer-readable program code portions stored therein. The computer-readable program code portions can include a first executable portion for communicating a signal representative of an indicia and data to the printer so that the signal controls the printer to print the indicia on a surface of a media and store the data on the media according to a select one of multiple communication protocols. The first executable portion can be configured to select one of multiple electronic communication devices of the printer according to the select communication protocol and thereby control the select communication device to store the data on the media. For example, the data can be stored on a magnetic strip, an RFID tag, or an integrated circuit, or the data can be stored using fluorescent text, a barcode, a hologram, or encoded pixilated images. The first executable portion can be configured to communicate with the printer via the integrated communication port using a parallel port, a serial port, a universal serial bus (USB) port, or an Ethernet port, and communication by each type of port can be performed using a communication protocol that corresponds to the particular type of port that is used, e.g., a USB protocol can be used when communicating via a USB port. For example, the first executable portion can communicate the signal to a controller of the printer via an integrated communication port so that the controller is configured to receive the signal and print the indicia and store the data according to the signal. A second executable portion of the computer program product can provide an integral user interface for controlling the printing of the indicia and the storing of the data. A third executable portion can also be provided to read data from the media according to the select communication protocol.

Referring now to the figures and, in particular, to Figure 1, there is shown a printer **10** according to one embodiment of the present invention. The printer **10** is electrically connected to a host computer **12** via an input/output (I/O) port **14** and a data communication cable **16**. The printer **10** illustrated in Figure 1 is adapted for printing cards **18**, such as information cards. As shown in Figure 2, the card **18** can include one or more magnetic strips **18a**, contactless devices such as RFID tags **18b**, contact devices such as an integrated circuit **18c** with a memory and contact terminals **18d**, fluorescent text **18e**, holograms **18f**, a barcode **18g** or otherwise encoded pixilated image, or the like.

The printer **10** can include features of the P310i, P330i, P430i, and P530i Printers available from Zebra Technologies Corp., which are generally configured for printing cards. However, it is appreciated that the printer **10** can alternatively be adapted to receive other types of media such as labels, paper or cardboard sheets or strips, envelopes, tickets, and the like. As illustrated in Figure 1, the printer **10** defines a feed or conveyance path **20** that extends through a housing **22** of the printer **10** from an entrance **24** to an exit **26**. The conveyance path **20** generally defines the path of travel of the media, such as the cards **18**, through the printer **10**. Rotatable rollers **28** or other media support and transport devices, such as one or more belts, may be provided along the conveyance path **20** to feed or convey the media therethrough. The rollers **28** are typically rotated by one or more electric motors **30**, which are controlled by a motor driver **32**, to feed the cards **18** or other media along the conveyance path **20** through the printer **10** during operation. Thus, during a typical printing operation of the printer **10**, a stack of the cards **18** can be provided in a hopper **34** proximate to the entrance **24** of the conveyance path **20**, and the cards **18** can be individually fed from one side of the stack and then fed along the conveyance path **20** to the exit **26**. The printer **10** can include an output hopper **35** proximate the exit **26** of the conveyance path **20** for collecting the cards **18** after they are fed along the conveyance path **20**.

In one embodiment, such as in the embodiment depicted by Figure 3, the printer **10** can include a reject tray **37** into which rejected cards are deposited. For example, the printer **10** may include a method and/or a device for checking whether the cards **18** or other media have been printed, encoded, or otherwise communicated with effectively. If the printer **10** determines that the cards **18** have not been effectively communicated with, the printer **10** may be configured to send the cards **18** into the reject tray **37** instead of sending the cards to the output hopper **35**. The printer may have a second conveyance path **21** configured to feed a rejected card from the conveyance path **20** to the reject tray **37**.

Referring again to Figure 1, a head **36** of the printer **10** can be a device for disposing a dye onto stock media. For example, a thermal dye ribbon **38** can extend from a supply spool **40** to a take-up spool **42** with the ribbon **38** disposed between the head **36** and one of the cards **18** in the conveyance path **20**. Dyes of one or more colors may be carried on the ribbon **38**, and the head(s) **36** is configured to press the ribbon **38** against the card **18** and/or heat the ribbon **38** at particular locations so that the dye in the particular locations of the ribbon **38** is transferred to the card **18**. Such a thermal printing operation is described, e.g., in U.S. Patent No. 6,151,037 to Kaufman, et al.; U.S. Patent No. 5,978,004 to Ehrhardt; and U.S. Patent No. 5,657,066 to Adams, et al., each of which is assigned to the assignee of the present application, and the contents of each of which are incorporated herein in their entirety by reference. In other embodiments of the present invention, the printer can be alternatively configured to print, e.g., using a retransfer printing mechanism, direct thermal printing mechanism, or other printing mechanisms.

As each card **18** is fed along the conveyance path **20** of the printer **10**, the head **36** can dispose one or more colors onto the card **18** in a predetermined pattern. In some cases, the ribbon **38** can define repeating frames of panels, each panel having a dye of a different color than the other panels of the same frame. For example, each frame can include panels that are yellow, magenta, and cyan, respectively. The cards **18** can be alternately advanced and retracted in opposite directions along the conveyance path **20** so that each card **18** is fed under the head **36** multiple times, during which the head **36** can print different colors from the different panels of a frame.

The printer **10** is also configured to communicate data to and/or from the media using one or more electronic communication devices **44**. The devices **44** can generally be used to read data from the media and/or write data to the media. For example, one or more of the devices **44** can be adapted to communicate with a particular type of electronic storage device provided on the media, i.e., on a surface of the media, embedded within the media, or otherwise associated with the media. Thus, the printer **10** can be used to selectively communicate with the media according to the type of media and the desired form of data storage. In fact, the printer **10** can be used to process various types of media and can communicate accordingly using one or more protocols for each media. The electronic communication devices **44** can be disposed on either or both sides of the conveyance path **20**, and, as illustrated in Figure 1, the devices **44** can be located at various positions throughout the printer **10**. In one embodiment, the printer **10** includes two or more electronic communication devices **44** that are disposed internal to the housing **22** of the printer **10** and configured to communicate using at least two different protocols. Any number of the electronic communication devices **44** can be activated during processing of the media.

In one embodiment, one or more of the electronic communication devices **44** may be a modular component that is easily replaced without significant interruption of printing operations. For example, each of the electronic communication devices **44** disposed within the housing **22** of the printer **10** can be configured to be interchangeable with each other and/or with other communication devices. That is, the electronic communication devices **44** can be similar in size, shape, structure, or other physical configuration. In some cases, the electronic communication devices **44** can also be configured to connect to the printer **10** using similar electrical connections. Thus, the communication devices **44** can be quickly and easily replaced, e.g., if it is desired to communicate with the media using an electronic communication device that is not presently provided in the printer **10**, to adjust one of the electronic communication devices **44** in a particular position or orientation to correspond to a particular type of media being processed, or if any of the electronic communication devices **44** require maintenance or repair.

The printer **10** includes a controller **46** for communicating with the host **12** and controlling the operations of the printer **10**. As shown in Figure 1, the controller **46** can be a single integral device that controls the feeding, printing, reading, writing, and other operations of the printer **10**. However, it is also appreciated that the functions of the controller **46** can be shared by multiple devices, such as a separate print controller, communication controller, motor driver controller, and the like.

Figure 4 illustrates a controller **46** according to one embodiment of the present invention. The controller **46** is configured to communicate with the host computer **12** via the cable **16** and I/O port **14**. The controller **46** is also configured to communicate via an internal electrical connection **48** with the print mechanism **50**, i.e., the roller motor(s) **30** and/or motor driver **32**, one or more print heads **36**, a printer display, and other equipment of the printer **10**. The controller **46** includes a microprocessor **52** or other electrical control device capable of receiving a signal from the host computer **12** and responding by controlling the print and communication operations accordingly. A memory **54** can also be provided, e.g., for buffering signals from the host computer **12**, for storing operating instructions, and the like. Thus, the host computer **12** can perform a print operation by sending a signal to the controller **46** instructing the controller **46** to control the print mechanism **50** accordingly to feed, i.e., convey, the media and print text, graphics, or other indicia on one or both sides of the media.

The microprocessor **52**, or alternatively another device of the controller **46**, is also configured to communicate with the electronic communication devices **44**, designated by reference numerals **44a-44g** and referred to collectively by numeral **44**. As shown in Figure 4, the controller **46** is electrically connected to a Wi-Fi receiver/transmitter **44a**, a magnetic card reader/writer **44b**, a Bluetooth receiver/transmitter **44c**, a contact smart card encoder/de-coder **44d**, a contactless smart card encoder/de-coder **44e**, a barcode printer/scanner **44f**, and a holographic printer/reader **44g**.

The electronic communication devices **44** are generally configured to communicate using different protocols. For example, the Wi-Fi receiver/transmitter **44a** is configured to detect and/or generate Wi-Fi signals for communicating with another Wi-Fi device, such as a Wi-Fi receiver disposed on the card **18** or other media. Similarly, the Bluetooth receiver/transmitter **44c** is configured to detect and/or generate a Bluetooth wireless signal.

The first smart card encoder/de-coder **44d** is a "contact" device configured to transmit and/or receive a signal for writing to and/or reading from a smart card via electrical contacts that touch corresponding contacts of the smart card. For example, the encoder/decoder **44d** can communicate data to and/or from an integrated circuit with a memory that is disposed on the card **18** via contacts **18d**.

The second smart card encoder/de-coder **44e** is a contactless, i.e., non-contact, device that is configured to transmit and/or receive a radio frequency (RF) signal to communicate data to and/or from an electronic data storage device on the media, such as an RFID tag or an electronic article surveillance (EAS) RF resonant security element. In one embodiment, the smart card encoder/de-coder **44d** is configured to communicate in the ultra-high-frequency (UHF) electromagnetic energy band. In another embodiment, the encoder is configured to communicate in the high-frequency (HF) band. UHF encoders generally transmit and receive signals in the 300 MHz – 3GHz range, and preferably in the 860-960 MHz range, while HF encoders generally transmit and receive signals in the 13.56 MHz range.

The magnetic card reader/writer **44b** includes a magnetic head that is configured to read and/or write to a magnetic strip on a media. The barcode printer/scanner **44f** is configured to print and/or scan a barcode or other printed indicia on the media. For example, the barcode can be scanned by directing a laser or other optical radiation at the barcode and detecting reflectance therefrom. In some cases, the printing mechanism **50** can be used to print the barcode on the media, and the barcode communication device **44f** can be a scanner that is configured to read but not write the bar code. Similarly, the holographic printer/reader **44g** can be configured to dispose material for forming a holographic image and/or to detect such material for decoding the image, e.g., a hologram formed as an overlay on the media. However, in some embodiments, the hologram communication device **44g** can be configured to detect the hologram, which can be printed by the printing mechanism **50** or otherwise. Further, each of the barcode and hologram communication devices **44f, 44g** can alternatively be configured for printing or detecting other indicia such as alphanumeric symbols, text, graphics, colored markings, or the like. It is appreciated that the printer **10** can include any of these or other communication devices.

The electronic communication devices **44** can be provided at various locations throughout the printer **10** and can be positioned adjacent the conveyance path **20** or remotely from the conveyance path **20**. For example, in one embodiment, one or more communication devices **44** are provided at a position that is spaced from the conveyance path **20** and configured to communicate wirelessly with a contactless device, such as an RFID tag **18b**, supported on the card **18**. Exemplary positions for the electronic communications devices **44** that are remote from the conveyance path **20** are illustrated in Figure 1 and indicated by reference numerals **44'**, **44''**, **44'''**. The remotely positioned communication devices **44'**, **44''**, **44'''** are also referred to collectively with the other communication devices by reference numeral **44**.

In addition, the electronic communication devices **44** can be configured to communicate with the card **18** at various times throughout the processing of the card **18** in the printer **10**. For example, as illustrated in Figure 1, one of the electronic communication devices **44'** is provided generally below the print head **36** such that the electronic communication device **44'** is in sufficient proximity with (though not adjacent to) the card **18** for communicating with the card **18** when the card is substantially positioned below the head **36** and available to the head **36** for printing. In particular, the electronic communication device **44'** can be a contactless device, such as a contactless smart card encoder/de-coder, and the communication device **44'** can be configured to read from and/or write to the card **18**, such as to an RFID tag **18b** on the card **18**, while the head **36** is printing on the card **18** or while the card is otherwise positioned and ready for printing by the head **36**. Thus, in some cases, the printer **10** can print on the card **18** while simultaneously or substantially simultaneously communicating with one or more data storage devices on the card **18**, such as a magnetic strip **18a**, RFID tag **18b**, integrated circuit **18c**, fluorescent text **18e**, hologram **18f**, barcode **18g**, or the like. As the term is used herein, "substantially simultaneously" means that the printing and communication operations have at least a partial overlap between their respective start and finish times.

Single Integrated Interface with the Host Device

As noted above, the host computer **12** and the controller **46** can communicate via the I/O port **14** and the cable **16**. In particular, the host computer **12** can transmit signals to the controller **46** via the cable **16** and I/O port **14** for controlling the operation of the printer **10**. Typically, the signal transmitted by the host computer **12** includes information for controlling an operation for printing the media by the printer **10**, as well as information for controlling the communication with the media using the communication devices **44**.

According to one embodiment of the present invention, the host computer **12** issues a signal having communication data corresponding, at least in part, to the particular communication device **44** that is to be used in a reading/writing operation of data storage devices supported by the media. For example, if it is desired for the controller **46** to encode data to data storage devices on the media using a select one of the electronic communication devices **44**, information identifying or otherwise describing the particular communication device (or the type of communication or media) can be communicated to the host computer **12** by the controller **46**, the operator, or otherwise. Thereafter, the host computer **12** can issue a signal using an appropriate protocol. That is, the data transmitted to the controller **46** can be in a format for use by the select communication device **44**. For example, if a magnetic strip on the media is to be encoded with binary data, the data can be communicated to the controller **46** in a binary format. Alternatively, if graphical information is to be stored on the media, the data can be communicated to the controller **46** in any of various graphical formats. In other embodiments of the present invention, the controller **46** can be configured to format or otherwise process the data before the data is delivered to the appropriate communication device **44**. Thus, in some cases, the host computer **12** can provide a signal that is received by the controller **46** and thereafter used by the controller **46** for communicating with any of various types of media.

In some cases, the controller **46** can also transmit information to the host computer **12** via the cable **16** and I/O port **14**. For example, if any of the communication devices **44** are used for reading data from the media, that data can be communicated by the controller **46** to the host computer **12**. In addition, the controller **46** can communicate other information to the host computer **12**, such as the operational status of the printer **10**, the progress or success of the printer **10** in a printing and/or reading/writing operation, the type of media in the printer **10**, and the like.

Thus, the cable **16** and I/O port **14** can provide an integrated connection by which the printer **10** can receive data for printing to the media and can receive and/or transmit data that is being written to and/or read from the media, even if the data is provided in different protocols. In some cases, the controller **46** can include a multiplexer that transmits portions of the signal from the host computer **12** to a respective one of the devices **44, 50**. Thus, a serial type communication between the host computer **12** and the controller **46** can be used to communicate data for simultaneous or generally contemporaneous printing and reading/writing operations.

In addition, the printer **10** can be controlled by a single driver software program that is capable of controlling each of the printing and reading/writing operations of the printer **10**. In this regard, Figure 5 schematically illustrates a display **60**, such as a cathode ray tube or liquid crystal display in communication with the host computer **12**. The display **60** can be used to graphically output information to the operator (and request input from the operator) regarding the host computer **12**, the printer **10**, and operations thereof. In particular, as illustrated in Figure 5, the driver software program for controlling the printer **10** can provide a graphical user interface on the display **60**. The graphical user interface can be used to communicate information relating to both the printing and reading/writing operations of the printer **10**. For example, the graphical user interface can provide a first submenu **62** for controlling the printing operation and a second submenu **64** for controlling the reading/writing operations. Each submenu **62, 64** can provide features for accessing information relating to the status of the respective operation and for entering information for changing the operation, e.g., for changing the text, graphics, colors, or the like that are to be printed on the media, or for indicating to the host computer **12** a change to the media type being used, the data to be communicated to/from the media, and the like. In this regard, the software can include instructions for inputting information from the operation, e.g., using typical input devices such as a keyboard, mouse, touchpad, trackball, microphone, or the like. A third submenu **64** can also be provided for accessing options relating to both of the printing and reading/writing operations, e.g., for verifying or changing the status or configuration of the printer **10** with the host computer **12**, such as by adjusting aspects of the connection therebetween.

Other embodiments of the printer having an integrated interface are further disclosed in U.S. Patent Publication No. 2006/0049253, which is assigned to the assignee of the present application and which is hereby incorporated by reference in its entirety.

Location of Communication Device(s) and Timing of Communication Operations

In one embodiment illustrated by Figure 6, one or more electronic communication devices **44** are positioned proximate to the print head's printline **39**. The printline **39** is the area where the print head **36** prints indicia onto the card **18** or other media. In the illustrated embodiment, an electronic communication device **44** is positioned close enough to the printline **39** so that the electronic communication device **44** is capable of communicating with the media before or at the same time that the print head **36** is printing on the media. By performing the communication operation before or simultaneously with the printing operation, the throughput of the printer may be increased.

In one embodiment of the present invention, the communication device **44** is placed directly opposite the print head **36**. However, in some embodiments it is not necessary for the communication device **44** to be placed directly opposite the print head **36** in order for the printer **10** to allow for before or simultaneous printing and reading/writing operations. For example, as illustrated in Figure 6, where the communication device **44** is a contactless device, such as an RF coupler, the communication device **44** may create a communication field **45** that extends beyond the immediate proximity of the communication device **44**. Preferably, the communication device **44** is configured so that it can communicate with a card **18** disposed within a communication field **45** that has an approximate diameter of two times the card length (i.e., one card length on each side of the print line **39**).

As described above, the printer **10** may move the card **18** back and forth under the print head **36** and along the conveyance path **20** in order to print different colors on various areas of the card **18**. Furthermore, different cards may have the contactless device, such as an RFID tag, located at different places on the card **18**.

A communication field **45** that covers an area of the conveyance path **20** approximating two card lengths (i.e., an area from about one card length before the printline **39** to about one card length beyond the printline **39**) would generally allow the communication device **44** to communicate with an RFID tag (or other contactless data storage device) supported by the card **18** regardless of where the tag was placed on the card **18** and regardless of where the printer **10** moves the card **18** beneath the printline **39** during printing operations.

In another embodiment, it may also be preferred that the communication field **45** does not extend much beyond a card length on either side of the print line as a communication field **45** that is too large risks mistaken communication with upstream and downstream cards (e.g., the cards located in the input hopper **34** or the output hopper **35**). In one exemplary embodiment, the card **18** has dimensions of two inches by four inches and the communication field **45** has dimensions of approximately four inches by six inches. In another embodiment, card(s) that are awaiting subsequent printing/reading/writing may be staged or held approximately four inches upstream of the communication field **45**. Similarly, card(s) that have recently been printed/read/written may be staged or held approximately four inches downstream of the communication field **45**.

Figure 7 is a flow chart **100** illustrating various steps that a printer **10** structured according to various embodiments of the present invention may perform when simultaneously communicating with and printing to a card **18** or other media. As represented by block **110**, the printer **10** moves the card **18** from the input hopper **34** along the conveyance path and toward a print position. As soon as the contactless device on the card **18** enters the communication field **45**, the at least one of the contactless communication devices **44** may begin wirelessly communicating with (e.g., encoding, writing to, or reading from, etc.) the card **18**, as represented by block **130**. This communication may continue as the card **18** is printed, as represented by block **120**. Once the card communication **130** and printing **120** steps are completed, the card **18** can be sent along the conveyance path **20** to exit **26** and deposited into the output hopper **35**.

In one embodiment, the printer is configured to confirm whether the card communication step **130** (e.g., whether the card was properly encoded, etc.) and printing steps **120** were effective, as represented by block **140**. If the printer determines that such steps were effective, the card **18** can then be sent to the output hopper **35**. If the printer determines that these steps were not effective, then the card **18** may be sent to the reject tray **37**, assuming that the selected printer model is equipped with a reject tray, as represented by block **150**. In other embodiments, the printer may use other methods or devices (e.g., error messages, etc.) to notify a user that the printing and/or communication steps were ineffective for a given card **18**. The printer may also employ other methods or devices to distinguish between cards in which the printing and communication steps properly occurred and cards in which such steps did not properly occur.

In other embodiments, the printer **10** may use a communication device **44** to check whether a card has undergone effective printing and communication processes. For example, a communication device **44** may be configured to read data from an encoded RFID tag or a printed barcode on the card **18** and compare such data to data that was expected to be associated with the card **18**. Such verification steps may occur at any position along the conveyance path. In one embodiment, the printer **10** is configured to use the same communication device **44** referenced above for communicating with the card at block **130** to check the effectiveness of such communication at block **140**. Although Figure 7 depicts the verification steps **140**, **145** as occurring after the printing step **120**, in another embodiment, the printer may be structured to perform such verification during printing operations.

Figure 8 illustrates a second process **200** whereby the printer **10** simultaneously prints and communicates with a card **18** or other media, according to another embodiment of the invention. As represented by block **210**, the printer **10** moves a card **18** from the input hopper **34** along the conveyance path and toward a print position or region. Once the contactless device on the card **18** enters the communication field **45**, the contactless communication device **44** may begin communicating with the card **18**, as represented by block **230**. Such communication may continue as the printer **10** prints the card **18**, as represented by block **220**.

As described above, card printers generally print in multiple passes for each of at least three colors (e.g., yellow, cyan, and magenta). However, in the process illustrated by Figure 8, before the print assembly begins the last color pass (which is usually a dark color) the printer checks whether the communication step **230** (e.g., encoding, reading, etc.) was effective, as represented by blocks **240** and **245**. As described above with respect to Figure 7, such a validation operation may be performed as the printer is printing the first color passes or after the printer has completed the first color passes. If the printer finishes printing before the communication and validation steps are complete, the printer will pause before printing the last color and wait for the validation step to indicate that the communication step was effective. If the printer determines that the communication step was effective, the printer finishes printing the card, as illustrated by block **260**, and then transmits the card **18** along the conveyance path **20** to the exit **26** where the card **18** is deposited into an output hopper **35**. However, if the printer determines through the validation step that the communication step was ineffective, the printer will use the last (usually dark) color pass to print "void" or some other reject indicia, on the card **18**, as represented by block **250**. The printer **10** will then transmit the "voided" card to an exit of the printer, which may be an output hopper **35** or, in some embodiments, a reject tray **37**.

Figure 9 illustrates a third process **300** whereby the printer **10** communicates with the card **18** prior to printing in accordance with another embodiment of the invention. As represented by block **310**, the printer **10** moves a card **18** from the input hopper **34** along the conveyance path into the communication field **45**. As soon as the contactless storage device on the card **18** enters the communication field **45**, the contactless communication device **44** may begin communicating with the card **18**, as represented by block **320**. After this communication step, the printer confirms whether the communication step was effective, as represented by blocks **330** and **335**. As described above with respect to Figure 7, such a validation process may be performed by the communication device **44** that was responsible for the communication step or by another communication device.

If the printer determines that the communication step was effective, the printer prints the card, as illustrated by block **350**, and then sends the card **18** to the exit **26** of the printer, which may include an output hopper **35**, as illustrated by block **360**. However, if the printer determines that the communication step was ineffective, the printer **10** may not print the card **18** and could instead send the card **18** directly to an exit of the printer, which in some embodiments could include a reject tray **37**. If the printer does not have a reject tray **37**, the printer could send the rejected card **18** to the output hopper **35** leaving a user to interpret that card's lack of printed indicia as an indication that the communication step was ineffective. In another embodiment, as noted above, the printer may print "void" or other appropriate indicia to the card indicating that the card was rejected.

A printer configured to operate as illustrated in Figure 9 can save ink (and relatively expensive print ribbon) as compared to printers configured to simultaneously print and communicate with cards. For example, when the printing and communication steps are performed simultaneously, cards that are rejected for failure of the communication step are still printed and any ink or ribbon used is wasted. Alternatively, the process illustrated by Figure 9 allows the communication and validation steps to occur before printing. Therefore, rejected cards may be diverted before printing, while cards undergoing an effective communication step may proceed normally to the printing step.

In embodiments whereby the printer is configured to perform communication and validation steps before printing, the communication device **44** may be physically located upstream from the printline **39** so that a card **18** moving along the conveyance path **20** from the entrance **24** to the exit **26** encounters the communication device **44** prior to the printline **39**. In another embodiment, the communication device **44** may be located proximate the printline **39**, as described above with respect to Figure 6. In such embodiments, the printer controller may be logically configured to perform the communication and validation steps prior to beginning print operations. Alternatively, the printer controller may be logically configured, perhaps through the host, to prompt a user to select whether the printer **10** should operate in (1) a high-throughput mode, where the printing and communication/validation steps are conducted simultaneously (e.g., Figure 7), or

(2) an ink-saving mode, where the communication and validation steps are conducted prior to printing operations (e.g., Figure 9). The host **12** may provide the printer controller with the user's selection or in other embodiments this selection may be provided through a user input device associated with the printer. In other embodiments, the printer may be configured to perform the communication step (*e.g.*, encoding and/or validating the card) without stopping the movement of the card through the printer, which increasing the output of the printer regardless on whether the printing operation occurs simultaneously or after such operations.

Although the above Figures and the descriptions describe printer configurations whereby the printing and the contactless communication steps can be conducted simultaneously, other types of communication may also be conducted simultaneously according to embodiments of the present invention. For example, if a card **18** has a contact electronic storage device and a contactless electronic storage device, the printer **10** may be configured such that the contact communication device is located within the communication field **45** of a contactless communication device. In this way, the printer can simultaneously communicate with any contact and contactless storage devices supported by the card **18**.

Therefore, as described above, in one embodiment the printer **10** can be configured so that at least one communication step is conducted by the printer **10** in parallel with at least one other communication or printing step. As also described above, according to one embodiment, the printer **10** may be configured to have a single interface with a host device **12**. Figure 10 illustrates a particular embodiment of the present invention whereby a printer **420** is configured to include a single interface **430** with a host device **12** and is also configured to perform a communication step in parallel with at least one printing or second communication step. In particular, the embodiment illustrated by Figure 10 shows an RFID encoding operation conducted in parallel with a printing operation as described in greater detail below.

Referring to Figure 10, host **12** communicates with the printer **420** through communication interface **410** and printer interface **430**. As described above, the printer interface **430** is a single integrated I/O interface for allowing communication between the host **12** and the various print devices and communication devices that may be present in the printer **420**. The communication interface **410** may comprise a single wire or data communication cable. In one embodiment, the communication interface **410** is wireless and permits wireless communication between the host **12** and the printer interface **430** using wireless transmitter/receiver devices that will be apparent to one of ordinary skill in the art in view of this disclosure.

In one embodiment, the host **12** communicates to the printer **420** through the printer interface **430** to instruct the printer **420** to move the card **18** into proper position for a contact programmer **440** to program or otherwise communicate with a contact electronic storage device supported by the card or other media. The host **12** communicates with the contact programmer **440** via the printer interface **430** and instructs the contact programmer **440** to program the card with the data provided by the host **400** (the data also being provided via the printer interface **430**).

The printer **420** may then move the card **18** into position for simultaneous printing by the print assembly **450** and communication by the RFID programmer **460**. The information that is printed to the card **18** and the information that is written to or read from the RFID tag (or other data storage device) on the card **18** may be derived from data received from the host **12** via the integrated printer interface **430**.

The printer may then move the card **18** into position for magnetic communication by the magnetic encoder **470**. The information written to a magnetic strip on the card **18** may be derived from data provided to the magnetic encoder **470** from the host **12** via the integrated printer interface **430**. Finally, the completed card **18** or other media may be ejected by the printer **420**.

Throughout the process, the printer **420** and/or the individual components of the printer **420** may communicate back to the host **400** via the printer interface **430** and the communication interface **410** in order to provide feedback related to the printing or communication processes.

Post-Encoding Validation of Smart Card Data

As described in some detail above in relation to Figures 7-9, various embodiments of the present invention provide a process whereby data written to or otherwise included on a card or in a data storage device supported by a smart card or other media is validated. For example, after the print head prints data to a card or after a communication device **44** communicates data to or from a card or other media (e.g., after a communication device **44** encodes a card **18** with data) the printer may check the data in order to determine whether the data was effectively printed and/or communicated. The communication device **44** may be configured to validate the printed or communicated data immediately after the printer or the communication device **44** prints to or communicates with the card **18**. For example, where the communication device **44** is an RFID transceiver, the RFID communication device **44** may be configured to encode data to the card **18** when the card **18** is in the communication field **45**. In one embodiment, after the RFID communication device **44** encodes data to the RFID tag on the card **18** and before the card **18** leaves the communication field **45**, the same RFID communication device **44** reads the encoded data from the card's RFID tag and compares it to stored data that was intended for encoding. If the read data matches the data that was supposed to be encoded, the printer **10** permits the card **18** to proceed to the next station in the printer **10** (e.g., send the card to the output hopper **35** if there are no other stations). The printer **10** may also communicate a signal to the host **12** indicating that the print/communication step was effective or that a card **18** was effectively printed or communicated with. If the read data does not match the data that was supposed to be encoded, the printer may reject the card. In one embodiment, if the data has not been communicated effectively, the printer instructs the communication device to try to communicate with the card again, if such is possible. In some embodiments, the printer sends the rejected card to a reject tray **37** and/or prints "void" or some other rejection indication on the card **18**, as described above. If a card **18** is rejected, the printer **10** may send a signal to the host device **12** indicating that a card **18** was rejected and/or may send data pertaining to why the card was rejected. Alternatively, in one embodiment, the printer may simply not communicate anything to the host device and may try to print on and communicate with the next card in place of the rejected card. If the next card also is not printed or communicated with effectively, the printer may then send an error signal to the host **12**.

Authentication of Media and Automatic Printer Configuration

In one embodiment, the printer **10** may include a system for authenticating a consumable and/or a system for automatically configuring the printer **10**. The authentication system may be used to determine whether a printer consumable, such as a resin thermal transfer ribbon or a roll of smart media, is an "allowed" consumable that is supported by the printer **10**. Similar descriptions of such authentication systems are further disclosed in U.S. Patent Application No. 2006/0191022, which is assigned to the assignee of the present application and is hereby incorporated by reference in its entirety.

In one embodiment, a RFID transponder (also referred to as a RFID "tag") is provided on or otherwise associated with a printer consumable. Although an RFID transponder is described, the transponder need not be limited to radio frequency signals, and may utilize any form of suitable electromagnetic radiation, such as visible, ultraviolet and infra-red light, as is known in the art. In one embodiment, the RFID transponder contains a unique, factory-programmed serial number. Certain commercially available RFID transponders each contain a unique 32 to 64-bit transponder serial identification number used in the "anti-collision" protocol. This protocol enables separation and unique identification of several transponders simultaneously appearing in the field of the RFID reader, which may be caused by multiple host devices being located in relatively close proximity.

In one embodiment, an authentication number is calculated from the unique serial number using an encryption function selected by and confidential to the manufacturer of the printer consumable. The authentication number is permanently stored on the RFID transponder. The encryption function is made available to the printer **10** and/or host **12** during operation thereof. For example, in one embodiment, the confidential encryption function can be programmed into the printer **10** during manufacture. In another embodiment, the confidential encryption function is made available to the host **12** over a network. When the printer consumable is loaded into the printer **10**, an RF transceiver in the printer reads the values of the serial number and the authentication number from the RFID transponder attached to or on the consumable. It then determines whether the authentication number matches the serial number as transformed by the confidential encryption function. If the values agree, then the ribbon cartridge consumable article is deemed to be an authentic media product that is useable on that printer.

Similarly, an RFID transponder on the media can be used to automatically configure some aspect of the printer **10** or to send data pertaining to the media to the host **12**. For example, if a web of smart labels intended for printing and encoding is loaded into the printer, a transponder on the roll of smart labels may indicate to the printer **10** and/or to the host **12** information related to the media, such as the type of label, the type of electronic media attached to the label, the size of the labels, the number of labels on the roll, the distance between the labels on the web, etc. The printer **10** may use such information to automatically configure itself to print and/or communicate with the media. Such information may be stored as data on the RFID transponder or may be communicated indirectly through a serial number unique to the type of media roll. The printer **10** and/or the host **12** may be configured to recognize this serial number and, thus, access files related to the media that are stored within or otherwise available to the printer **10** or host **12**.

In one embodiment, the transponder for authenticating the consumable and/or configuring the printer is located on a portion of the consumable packaging. In other embodiments, the transponder is located on the consumable itself. For example, in one embodiment, where the consumable is, for example, a roll of ink ribbon or a roll of labels, the transponder may be attached to the core of the roll. In such an embodiment, the transceiver for reading the transponder may be located in the spindle that holds the core of the roll in the printer.

In another embodiment, where the consumable is, for example, a roll of smart labels or a stack of smart cards, the information for authenticating the media and/or configuring the printer may be stored in the transponder memory of one of more of the smart labels or cards. This transponder memory may be that which is intended to receive additional information (e.g., through encoding) from the printer or the smart media may comprise two or more transponders, with one transponder memory dedicated to carrying authentication data and/or printer set-up or configuration information.

In another embodiment, only the first label on a roll of labels or the first card in a stack of cards **18** may contain a transponder (or other data storage device) having authentication data and/or printer set-up or configuration information stored therein. In such an embodiment, the communication device **44** used to encode or otherwise communicate with a transponder (or other storage device) associated with the media may also be used to read the authentication, printer set-up, or configuration data stored in one or more of the transponders. Such embodiments may require only one communication device **44** for reading authentication, set-up, or configuration data from a transponder and for writing data to such a device. As described above, a printer may also be structured so that the same communication device is also used for verifying effective communication between the printer and the transponder or other data storage device.

In another embodiment, the printer **10** may include a separate communication device **44** that is dedicated exclusively to reading authentication, set-up or configuration information from the transponder or other data storage device. Such a communication device **44** may be located along the conveyance path **20** generally before a print position.

Contactless communication devices (whether for authentication, printer set-up retrieval or otherwise) structured in accordance with various embodiments of the present invention may use UHF RFID transceivers and transponders or HF RFID transceivers and transponders. Other wireless communication devices may also be used as noted above.

Antenna-Coupler for UHF RFID Communication Devices

As described above, in some embodiments one or more of the communication devices **44** may comprise an RFID transceiver for communicating with RFID transponders supported by smart cards **18** or other media. In various embodiments, the RFID transceiver may be configured to generate and transmit RF communication signals via an antenna-coupler, for example a UHF antenna-coupler **1000**, (shown in Figure 11) that is located proximate the conveyance path **20**, for example as illustrated in Figure 6. For purposes of the present specification, the transceiver and the antenna-coupler **1000** may be referred to collectively as forming at least part of an RFID communication device **44**. As will be explained in more detail below, the RFID communication device **44** transmits an electromagnetic signal for establishing, at predetermined transceiver power levels, a mutual coupling between the transceiver and a targeted transponder of a media unit (e.g., a card **18**) located in the communication field, such that data may be read from and written to the transponder.

In general, the transceiver is a device configured to generate, transmit, process, and receive electrical communication signals and generally share the same hardware for transmitting and receiving purposes. It is understood that similar devices such as readers, transmitters, receivers, or transmitter-receivers may be used within this invention. "Transceiver" as used in the present application refers to the devices noted above and to any device capable of generating, processing, or receiving electrical signals.

In general, the antenna-coupler receives and transmits electro-magnetic fields based on the electrical signals generated by the transceiver or the transponder. To transmit signals, the antenna-coupler converts the electrical signals generated by the transceiver or the transponder to electromagnetic waves and, to receive signals, the antenna-coupler converts electromagnetic waves to electrical signals. The electromagnetic fields serve to couple the transceiver and the transponder. Moreover in the case of a passive transponder, the electromagnetic fields of the antenna-coupler energizes the transponder and thereby prompts the transponder to respond to the transceiver by re-radiating the received signal back and modulating the fields in a well-known technique called backscattering. In the case of an active transponder, the transponder may respond to the electro-magnetic fields by transmitting an independently powered reply signal to the transceiver through the coupler.

Problems can occur when communicating with multiple adjacent transponders regardless on whether the transponders are passively or actively powered. For example, the electro-magnetic fields propagating from the coupler, also referred to as an interrogating electro-magnetic signal, may activate more than one transponder at a given time. This simultaneous activation of multiple transponders may lead to collision or communication (i.e. read and write) errors because each of the multiple transponders may transmit reply signals to the transceiver at the same time.

The printer **10** may employ an RF-shielded housing or anechoic chamber for shielding the adjacent and non-targeted transponders from the electromagnetic field. In various embodiments, transponders individually pass though a shielded housing that defines a transponder encoding region for individualized exposure to an interrogating electro-magnetic field.

However, in other embodiments the antenna-coupler may be adapted to have a controlled transmission range that can be limited to minimize the inadvertent activation of transponders outside a transponder encoding region. As such, the antenna-coupler may operate with little to no anti-collision management techniques or shielding components. The structure and shape of the antenna-coupler may vary and, in one embodiment, the antenna-coupler is generally configured to propagate an electromagnetic wave that is weak in far field and is strong in near field, wherein the far field component is too weak to activate or communicate with any of the transponders and the near field component is concentrated mostly in the transponder encoding region such that it only activates or communicates with the transponders in the transponder encoding region. The boundaries between the field regions (e.g., near and far fields) are dependent on antenna-coupler dimensions/wavelength ratio. For example, for a 915 MHz frequency, the wavelength is approximately 0.33 m and "D" is approximately 0.1 m (where "D" denotes the largest dimension of the antenna-coupler) and the near field surrounds the antenna-coupler up to approximately 50-55 mm.

Examples of such antenna-couplers are further disclosed in U.S. Patent Application Publication Nos. 2005/0045723 and 2005/0045724, and U.S. Application Nos. 11/263,093 and 11/371,785, each of which is assigned to the assignee of the present application, and the contents of each of which is hereby incorporated by reference in its entirety.

Figures 11a and 11b illustrate yet another antenna-coupler **1000** employable within embodiments of the present invention. According to the embodiment illustrated in Figures 11a and 11b, the antenna-coupler **1000** includes a first microstrip **1002** and a second microstrip **1004**. The microstrip **1002, 1004** are generally orthogonal to each other and generally centered relative to one another forming a cross-like shape. More specifically, as used herein "cross-like shape" defines a spatial relationship between the two microstrips **1002, 1004** in which the first microstrip **1002** traverses the second microstrip **1004**. The angle and point at which the first microstrip **1002** traverses the second microstrip **1004** may vary. In the illustrated embodiments, the first microstrip **1002** traverses the second microstrip **1004** at approximately ninety degrees and at approximately the center of the second microstrip **1004**. Moreover, in the illustrated embodiments, approximately the center of the first microstrip **1002** traverses the second microstrip **1004**. In other embodiments, the angle of traverse may vary between forty-five degrees and one hundred and thirty five degrees. And any point of the first microstrip **1002** between a first end and a second end of the first microstrip **1002** may traverse the second microstrip **1004** at any point between the first and second ends of the second microstrip **1004**. Also, according to the embodiment of Figures 11a and 11b, the microstrips **1002, 1004** are disposed on separate but parallel planes and separated from one another by a substrate material **1006**.

The first microstrip **1002** extends from a first end to a second end and defines a length. The first end is connected to a first port **1008** (also referred to herein as port-1) of the antenna-coupler and the second end is terminated by a first resistive load **1010**. Similarly, the second microstrip **1004** extends from a first end to a second end and defines a length. The first end is connected to a second port **1012** (also referred to herein as port-2) of the antenna-coupler and the second end is terminated by a second resistive load **1014**. Each of the resistive loads **1010, 1014** is connected to a ground layer **1016** that is generally parallel to the microstrips **1002, 1004** and spaced apart from the microstrip **1002, 1004** by the substrate material **1006**.

In order to increase the energy transfer efficiency between the antenna-coupler **1000** and a transponder, the resistive load **1010, 1014** for each microstrip may be higher than the characteristic impedance defined by each of the microstrips **1002**, **1004**. This may in turn generate a standing wave and increase the electrical field strength along each of the microstrips **1002**, **1004**. Also, in order to avoid an impedance mismatch between the microstrips **1002**, **1004** and the transceiver, the length of each of the microstrips **1002**, **1004** may be substantially equal to a multiple of one half the wavelength of the operational frequency (*i.e.*, the length may substantially equal $N*\lambda/2$, wherein N may equal 1, 2, 3, 4, 5, ...). In other words, by setting the length of a microstrip to a multiple of one half the wavelength of the operational frequency, the load impedance of the antenna-coupler is substantially matched to the port impedance regardless of the characteristic impedance of the microstrip.

In general, the lower the characteristic impedance of the microstrips **1002**, **1004**, the wider the microstrips **1002**, **1004** and the narrower the bandwidth of the antenna-coupler **1000**. To enlarge the bandwidth and decrease the length (*i.e.*, the distance from the first end to the second end) of the microstrips **1002**, **1004**, a non-uniform or a varying width profile for the microstrips may be used, as further described in U.S. Patent Application Serial No. 11/371,785, which is owned by the present assignee and is incorporated herein in its entirety. For example, according to the embodiment illustrated in Figures 11a and 11b, each of the microstrips **1002**, **1004** may have a bow-tie profile. Other examples include exponential, Klopfenstein, triangular, Hecken, or other tapered profiles. Among other things, the tapered profiles allow for the miniaturization of the antenna-coupler. In addition to or instead of tapered profiles, the antenna-coupler may be further miniaturized by using a substrate material with a relatively high permittivity, for example, Rogers R3006: $\varepsilon=6$, or R3010: $\varepsilon=10$, or other material substrates with $\varepsilon>20$.

The transponder in the smart card may have various orientations relative to the feed direction such as landscape, as shown in Figures 12a, c, e, and g, and portrait, as shown in Figures 12b, d, f, and h. A landscape orientation is generally when the length of the transponder is parallel to the media or card feed direction. A portrait is generally when the length of the transponder is perpendicular to the feed direction.

In addition to the orientation between the transponder and the feed direction, the orientation of the transponder to the antenna-coupler may vary as the transponder moves across the antenna-coupler. For example, the transponder may move across the antenna-coupler such that the length of the transponder travels along the length of a conductive strip of the coupler in a parallel manner, referred to as "lateral movement." As another example, the transponder may move across the antenna-coupler such that the length of the transponder travels across the length of the conductive strip at a generally perpendicular angle in a parallel manner, referred to as a "cross-wise movement."

Many transponders include a dipole antenna structure, referred to as a dipole type transponder. In some embodiments, for optimum coupling with a dipole type transponder, the antenna-coupler should be arranged for a mutual lateral movement, *i.e.* the opposite ends of the dipole should be exposed to a phase differential as the dipole passes through the electro-magnetic fields.

The two microstrips conductors **1002, 1004** forming a general cross-shape allows for the antenna-coupler **1000** to accommodate various transponder orientations to the feed direction and transponder orientations to the antenna-coupler as illustrate in Figures 13a and 13b. For example, both microstrips can be fed by the transceiver's signal in phase simultaneously and one port at a time can be activated by a switch depending on the transponder orientation to the antenna-coupler such as lateral movement or cross-wise movement. As another example, for transponder orientations to the antenna-coupler between the lateral and cross-wise movements, port-1 and port-2 can be fed using a phase shifter depending on the orientation of the transponder such that the two microstrips create a phase differential between the two microstrips for coupling with the transponder. As yet another example and as illustrated in Figure 16a, 16b, 17a, and 17b, both of the microstrips **2002, 2004** may be activated simultaneously through one port **2008**. In other words, both microstrips may be receiving or directing an electrical signal from or to the transceiver.

Referring again to the embodiment in Figures 16a, 16b, 17a, and 17b, rather than the two microstrips being in separate and parallel planes as discussed above, the two microstrips **2002, 2004** may be substantially co-planar. As illustrated, one of the microstrips **2002** may include a bridge **2020** to avoid the two microstrips **2002, 2004** from physically intersecting at the center. For example, the first microstrip **2002** may have two sections **2012, 2014**. The first section **2012** may extend from the first end of the first microstrip **2002** to approximately the second microstrip **2004**. The second section **2014** may extend from approximately the second microstrip **2004** to the second end of the first microstrip **2008**. The two sections **2012, 2014** may be linked through a bridge **2020** that extends around the second microstrip **2004** such that the first and second microstrips **2002, 2004** do not intersect (*i.e.*, the first and second microstrips **2002, 2004** do not have a common point) even though the two microstrips **2002, 2004** are in a cross-like configuration. The bridge **2020** may include a jumper wire and/or one or more traces. Also, as mentioned above, in this embodiment, the antenna-coupler **2000** may have one port that leads to both the first and second microstrip such that both the first and second microstrips may be activated simultaneously or concurrently. Each of the microstrips **2002, 2004** may be terminated by a resistive load **2010, 2014** and be spaced apart from a ground plane **2016** separated by a substrate **2006**.

The antenna-coupler herein is described in context with a printer-encoder configured to process UHF RFID smart cards. However, the application of the antenna-coupler described herein is not limited to printer-encoder for UHF RFID smart cards and may be applied to other RFID enabled encoders or systems that may benefit from the ability to selectively communicate with a randomly oriented targeted transponder disposed among multiple adjacent transponders.

XML Communication between the Host and the Printer

In one embodiment of the present invention, the printer **10** is configured to print and/or encode the media based on an extensible markup language (XML) input data stream. In one embodiment, the printer **10** is configured to communicate with the host **12** using XML. Examples of printer systems configured with XML systems are further disclosed in U.S. Patent Application Publication Nos. 2006/0138227, 2005/0150953, 2004/0149826, 2004/0094632 and 2003/0136841, each of which is assigned to the assignee of the present application, and the contents of each of which is hereby incorporated by reference in its entirety.

Figure 14 illustrates a specific embodiment of a high-level system block diagram. The system illustrated in the figure and described below may be executed by the processor of the host **12**. Again, the processor of the host **12** may perform functions common to both the host computer **12** and the printer **10**. There may be one or more processors, which may function in concert or which may function separately. It is not material to the scope of this invention whether the processing or processing functions are performed by or in the host **12** or by or in the printer **10**.

The XML system includes an XML processor **1170** (also referred to as the "XML parser"), an XSLT **1174** (extensible stylesheet language transformation) processor, an XSLFO **1178** (extensible stylesheet language formatting object) processor, a bit map/barcode/RFID rendering engine **1180**, an RFID transceiver **1161**, and the printer driver **1154**. Note that although the figure and the following description describe the XML system with relation to printing a barcode or encoding an RFID transponder, the same system can be used for encoding other types of storage devices and for printing other human-readable or machine-readable indicia.

Also note that the printer driver **1154** is an example of a component whose function may be performed by either the processing device in the computer system **12** or the processing device in the printer system **10**, depending upon the physical location of the associated processing device. A single processing device, if sufficiently powerful, may handle all functions for the XML system.

An XML schema repository **1182** (schema repository) may provide input to the XML processor **1170** while an XSLT stylesheet repository **1184** (stylesheet repository) may provide input to the XSLT processor **1174**. The system may also include an enterprise resource planning (ERP) system **1188**, which may be, for example, a warehouse management system that transmits an XML input data stream **1144** to the XML processor **1170**. The ERP system **1188** may initiate the request to print the barcode label or encode the RFID data into the RFID transponder **1162**, and may provide the XML data that forms the bar code, RFID encoded data, and other variable label or element fields to be printed or encoded. Such variable label fields may include, for example, any or all of the human-readable text and/or characters printed on the label.

When referring to the XML data, two basic types shall be referred to herein, namely, the XML value data and the XML element name. The XML value data is the changeable data or the data that is desired to be printed on the barcode label or encoded into the RFID transponder, such as the data "1122 Green Street," which may be part of the XML value data corresponding to, for example, a shipping address. The XML element names are part of the XML language semantics where an arbitrary label or element name may be selected to represent the XML value data, the use of which is defined by the XML language. Typically, the element names appear between angled bracket ("<element name>").

Known barcode label and other automatic identification systems often use proprietary software encoding schemes. Additionally, such schemes are often prone to errors, and the underlying value data is usually unreadable by a non-technical individual. In known systems, if an error exists in the underlying value data sent from the enterprise system, or if the data is missing or otherwise incorrect, the barcode system will print or encode what it is instructed to do, which of course, produces an error in the barcode label or RFID transponder, rendering it inaccurate or useless.

Moreover, when dealing with compliance labeling, known systems require non-trivial changes in the data encoding when the form or content of the label changes in accordance with the compliance label demands. Such changes in the form or content of the barcode or RFID transponder, again, are susceptible to errors. Business relationships may also be damaged by continued problems in the barcode labeling system or the RFID encoding system.

Embodiments of the present XML system utilize an open format. In particular, the formatting requirements and the form of the barcode label or RFID transceiver are all defined in the XML language. Moreover, not only is XML well defined and available for all to use, but non-programmers can understand the data and commands in an XML data stream or file (or hard copy) with minimal training.

Various XML system components are commercially available. Several different commercially available XML processors **1170** may be used interchangeably or with little modification. For example, the following commercially available XML processors may be used: "XML for C++" available from IBM Corporation, "MSXML3" available from Microsoft Corporation, "Oracle XML Developers Kit for C" available from Oracle Corporation, "Expat" available from Thai Open Source Software Center, Ltd., or "Xerces-C++" available from the Apache Software Foundation. However, any suitable XML processor may be used.

Similarly, several different commercially available XSLT processors **1174** may be used interchangeably or with little modification. For example, the following XSLT processors may be used: "iXSLT" available from Infoteria Corporation, "MSXML3" available from Microsoft Corporation, and "Libxslt" available from Gnome. However, any suitable XSLT processor may be used.

Again, several different commercially available XSLFO processors **1178** may be used interchangeably or with little modification. For example, the following XSLFO processors may be used: "XEP" available from RenderX Corporation, "XSL Formatter" available from Antenna House Corporation, and "FOP" available from the Apache Software Foundation. However, any suitable XSLFO processor may be used.

The XML processor **1170** receives the XML input data stream **1144** from an external source. For example, as described above, the external source may be the ERP system **1188**, such as the warehouse management system. The XML processor **1170** essentially parses and processes the XML input data stream **1144** and generates a set of nodes, which may be in a "tree" structure, as is known in the art. Each of the system processors acts on the nodes of the "tree" to perform their required function. The underlying value data contained in the XML input data stream from the ERP system is processed and entered into a "label values node tree," which holds the data.

The following is a brief overview of the operation of the various system components. First, note that the XML input data stream **1144** includes text that identifies the name and location of other required XML documents or files. One such document is referred to as "XML schema" or "schema" **1182**. The schema **1182** is used to validate the XML input data stream **1144**, including the underlying value data. If validation is successful, a stylesheet **1184** is applied, as will be described below. The name and location of the stylesheet **1184** is also specified in the XML input data stream **1144**. Application of the stylesheet is handled by the XSLT processor **1174**, which under the direction of the stylesheet **1184**, may transform the underlying XML element names and/or underlying value data. Next, the data is processed by the XSLFO processor **1178**, which handles formatting and "layout" of the underlying value data, which may include, for example, formatting the underlying value data in accordance with, for example, font type, font size, color, and the like. Next, the underlying value data is processed by the bitmap/barcode/RFID rendering engine **1180**, which creates a bitmap of the barcode label or the programming code sequence for the RFID transponder corresponding to the transformed and formatted data. The rendering engine **1180** may utilize an "instream foreign object" residing in the stylesheet to direct creation of the bitmap. The bitmap is then sent to the printer driver **1154** for subsequent printing of the barcode label by the barcode printer or to the RFID transceiver **1161** for encoding into the RFID transponder **1162**.

As described above, the schema **1182** functions to validate the entire input data stream, in particular, the underlying value data, where errors may be typically found. In practice, errors are often inadvertently introduced when changes are made to the form or content of the bar code label.

The name and location of the schema document **1182** is contained in the XML input data stream **1144**, which XML input data stream corresponds to the request to print and/or encode a barcode label. The XML processor **1170** in conjunction with a schema validation module **1179** validates the underlying value data. The use of schema **1182** is cost effective because it prevents errors and omissions with respect to the final output, namely, the bar code label, or "shipping label," or RFID tag or transponder.

If the XML input data stream **1144** is rejected or flagged as having an error, an error message may be transmitted back to the source. This may flag or trigger human intervention to correct the error. For example, in one specific example, the source is an ERP system **1188**. In this way, the data is initially checked prior to processing to insure that it complies with all required label and barcode rules.

This may be particularly beneficial when dealing with compliance labeling. In known systems, the compliance demander would merely notify the supplier as to the changes in the compliance labeling requirements. If the supplier then makes an error in interpreting or implementing these changes or instructions, the labels produced or RFID transponders encoded and applied to products shipped to the compliance demander may have errors, which could jeopardize future business or cause monetary fines to be applied.

In the present invention, the compliance demander preferably makes the changes directly to the schema **1182** and/or the XSLT stylesheet **1184**. For example, if the physical layout of the label has been changed or if element names have been changed, the compliance demander will modify the XSLT stylesheet **1184**. Similarly, if the underlying value data has been added or deleted or otherwise qualified (i.e., a new acceptable numerical range for a zip code), the compliance demander may modify the schema **1182**. In this way, the supplier need only modify the output of its ERP system **1188** to ensure that it matches the modified XML input data stream **1144**. If only the physical layout of the label has changed, the supplier does not need to make any modifications at all.

For example, the compliance demander may now require that a nine digit zip code be used rather than the original five digit zip code. Accordingly, the compliance demander may modify the schema **1182** to require both a first and second zip code field, and the second field will also be limited to numerical digits within a certain range, perhaps 0000-9999. The compliance demander may also modify the stylesheet **1184** to accommodate that change. In response thereto, the supplier must insert the added zip code field in its ERP system **1188** so that it appears in the XML input data stream **1144** sent to the XML system. If such modification of the XML input data stream **1144** is not performed correctly, the schema **1182** will cause an error to be reported back to the ERP system **1188**, and the label will not be printed or the RFID transponder **1162** will not be encoded.

Thus, the supplier need only access the modified schema **1182** and/or stylesheet **1184** from the repository, which is automatically applied to the underlying value data when received. Essentially, minor changes, and significantly, major changes, to the form and content of the barcode label or RFID transponder are transparent to the supplier, and such changes to the content of the barcode label or RFID transponder are validated in accordance with the schema **1182**. Accordingly, the supplier need not incur costs to change the form or content of the barcode label or RFID transponder dictated by the compliance demander, and cannot make any errors in implementing such changes.

The schema documents **1182** are preferably obtained from a XML schema repository. In one specific embodiment, the schema repository may be external to the XML system and the host **12**, and may be accessed via the network, the Internet, or via any suitable network to which the host computer **12** is coupled. The schema repository may contain a plurality of schema documents. Thus, the XML input data streams **1144** representing the various requests to create a barcode label or RFID transponder may each specify the name and location of the corresponding schema **1182** in the repository. When the request is received by the XML processor **1170**, the corresponding schema **1182** may be retrieved from the schema repository.

In another embodiment, the schema **1182** obtained from the schema repository via the network may be kept locally, and thus may temporarily reside in a memory subsystem of the host **12** or printer **10**, such as a hard disk or a database. In this way, if the same schema **1182** is used for multiple XML input data streams **1144** or for subsequent barcode label or RFID tag requests, the XML processor **1170** need not retrieve the same schema **1182** externally via the network, but rather, may retrieve that schema **1182** from the memory subsystem, which may be more efficient. According to this embodiment, the compliance demander may change or modify the schema **1182** in an external repository at only certain times. For example, the compliance demander may change the schema **1182** only at 1:00 AM each day. Thus, the supplier need only update the schema **1182** from the repository into the memory subsystem only once per day, for example, after the compliance demander has performed the schema update. The supplier would then know that the schema saved temporarily in the memory subsystem is the most recent schema document, at least up until the time that the updating is scheduled to occur. Regardless of the location from where the schema **1182** is obtained, the schema validation module performs the checking and validation of the underlying data.

Of course, the stylesheet **1184** is also an XML document, and thus it is also processed by the XML processor **1174**. Accordingly, the result of the processing of the stylesheet is an XSLT stylesheet node tree, which is the "memory representation" or working model of the stylesheet that was processed. The XSLT stylesheet node tree may be in the form of a "document object model" (DOM), as is known in the art. Further, the XSLT stylesheet node tree may reside in cache memory for efficiency. The XSLT processor operates on the data in the XSLT stylesheet node tree to perform its function of transforming the underlying value data or underlying element names in accordance with the stylesheet.

The XSLT processor **1174** may modify, reposition, and rearrange the underlying value data or may add to the underlying value data or delete some of the underlying value data. For example, under direction of the stylesheet **1184**, the underlying value data may be rearranged into table format or into columns. In particular, the stylesheet **1184** may add XSLFO formatting elements and attributes.

After the underlying value data in the label value node tree has been processed in accordance with the corresponding stylesheet **1184**, an XSLFO instance node tree is produced. Again, the XSLFO instance node tree may be in the form of a document object module, as is known in the art. The XSLFO instance node tree contains XSLFO commands (layout instructions) that directs the XSLFO processor **1178** with respect to formatting and layout. The XSLFO processor **1178** then interprets the XSLFO commands and applies such commands to the underlying value data so as to properly format and layout the underlying value data. The XSLFO processor **1178** produces the XSLFO area node tree, which represents the final output of formatting before rendering.

The XSFLO area node tree is then passed to the bitmap/barcode/RFID rendering block **1180** where it is interpreted to direct creation of the bitmap **1192** of the barcode label or the programming code sequence for the RFID transponder corresponding to the transformed and formatted data from the XML input data stream **1144**. This bitmap or programming code sequence is then sent to either the printer driver **1154** or the RFID transceiver **1161** as the case may be.

Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which the invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

THAT WHICH IS CLAIMED:

1. A system for selectively communicating with a randomly oriented targeted transponder from among a group of multiple adjacent transponders, the system comprising:

a transponder conveyance adapted to transport at least one targeted transponder from a group of multiple adjacent transponders through a transponder operating region;

a transceiver configured to generate one or more electrical signals;

an antenna-coupler having first and second microstrips in a cross-like arrangement relative to each other and wherein, each of the first and second microstrips is configured to transmit one or more electro-magnetic fields concentrated in a near-field region of the antenna-coupler based on the one or more electrical signals for communicating with the randomly oriented targeted transponder.

2. The system of Claim 1, wherein the antenna-coupler includes a first port in communication with both of the first and second microstrips such that both of the first and second microstrips receive the one or more electrical signals concurrently.

3. The system of Claim 1 further comprising a switch for sending the one or more electrical signals from the transceiver to either one of the first and second microstrips or both.

4. The system of Claim 1, wherein the first and second microstrips are spaced apart and separated by at least one substrate.

5. The system of Claim 1, wherein the first and second microstrips are substantially co-planer and the first microstrip further includes a first section, a second section, and a bridge; wherein the first section extends from a first end of the first microstrip to approximately the second microstrip, the second section extends from approximately the second microstrip to a second end of the first

microstrip, and the first and second sections are linked through the bridge that extends around the second microstrip such that the first and second microstrips do not intersect.

6. The system of Claim 1, wherein the antenna-coupler further includes a first resistive load for terminating the first microstrip and a second resistive load for terminating the second microstrip, and wherein the first microstrip defines a characteristic impedance less than the first resistive load and the second microstrip defines a characteristic impedance less than the second resistive load.

7. The system of Claim 1, wherein each of the first and second microstrips has a tapered profile.

8. The system of Claim 1, wherein each of the first and second microstrips defines a length substantially equal to a multiple of one half a wavelength of an operational frequency of the antenna-coupler.

9. The system of Claim 1, wherein the operational frequency of the antenna-coupler is selected from a range of frequencies from 300 MHz to 3 GHz.

10. The system of Claim 1, wherein the operational frequency of the antenna-coupler is selected from a range of frequencies from 860 MHz to 960 GHz.

11. An antenna-coupler for a system having a transceiver and being configured to process one or more smart media and associated transponders of the smart media, the antenna-coupler comprising:

a first microstrip extending from a first end to a second end, wherein the second end is terminated by a first resistive load and the first end is in communication with the transceiver for receiving and sending one or more electrical signals;

a second microstrip extending from a first end to a second end, wherein the second end is terminated by a second resistive load and the first end is in communication with the transceiver for receiving and sending one or more electrical signal; wherein the first microstrip and the second microstrip are generally orthogonal to each other forming a cross-like arrangement;

a ground plane spaced apart from the first and second microstrip; and

at least one substrate extending at least partially between the ground plane and the first and second microstrips.

12. The antenna-coupler according to Claim 11, wherein the first and second microstrips are spaced apart and separated by the at least one substrate.

13. The antenna-coupler according to Claim 12, wherein the first and second microstrips are substantially co-planer and the first microstrip further includes a first section, a second section, and a bridge; wherein the first section extends from the first end of the first microstrip to approximately the second microstrip, the second section extends from approximately the second microstrip to the second end of the first microstrip, and the first and second sections are linked through the bridge that extends around the second microstrip such that the first and second microstrips do not intersect.

14. The antenna-coupler according to Claim13, wherein the jumper includes at least a jumper wire.

15. The antenna-coupler according to Claim 13, further comprising an input port for connecting both the first end of the first microstrip and the first end of the second microstrip to the transceiver.

16. The antenna-coupler according to Claim 11, further comprising a first input port for connecting the first end of the first microstrip to the transceiver and a second input port for connecting the first end of the second microstrip to the transceiver.

17. The antenna-coupler according to Claim 11, wherein each of the first and second microstrips define a characteristic impedance and wherein the first resistive load is greater than the characteristic impedance of the first microstrip and the second resistive load is greater than the characteristic impedance of the second microstrip.

18. The antenna-coupler according to Claim 17, wherein each of the first and second microstrips define a length and the length of the each of the first and second microstrips is substantially equal to a multiple of one half a wavelength of an operational frequency of the antenna-coupler.

19. The antenna-coupler according to Claim 18, wherein each of the first and second microstrips has a tapered profile.

20. An antenna-coupler for communicating with a media unit having a transponder, the antenna-coupler comprising:

a first microstrip and a second microstrip in a cross-like arrangement relative to each other and, wherein each of the first and second microstrips is configured to transmit one or more electro-magnetic fields concentrated in a near-field region of the antenna-coupler based on the one or more received electrical signals for communicating with the transponder, and wherein each of the first and second microstrips defines a length substantially equal to one half a wavelength of an operational frequency of the antenna-coupler selected from a range of frequencies from 300 MHz to 3 GHz.

21. A system for printing and communicating with one or more media units, each media unit defines a length and includes a transponder configured to operate within a range of frequencies from 300 MHz to 3 GHz, the apparatus comprising:

a printhead for printing indicia on the one or more media cards; and

a communication device for communicating with the one or more media cards; wherein the communication device is positioned proximate to the printhead such that the printing and the communicating of the printhead and the communication device occur substantially simultaneously.

22. The system according to Claim 21, wherein the communication device is configured to communicate with a targeted media unit within a communication field generated by the communication device and wherein the communication field extends a distance equal to approximately twice the length of the targeted media card along a feed path of the one or more media cards.

23. The system according to Claim 22, wherein the communication field is substantially centered about the printhead such that the communication field extends from a point about the length of the targeted media unit before the printhead to a point about the length of the targeted media unit after the printhead.

24. The system according to Claim 22, wherein the communication device includes an RFID transceiver and an antenna-coupler.

25. The system according to Claim 24, wherein the antenna-coupler includes first and second microstrips in a cross-like arrangement relative to each other and wherein, each of the first and second microstrips is configured to transmit one or more electro-magnetic fields concentrated in a near-field region of the antenna-coupler based on the one or more electrical signals for communicating with a transponder of the targeted media card.

26. A method comprising:

providing a printhead proximate a print position;

advancing a media unit toward the print position;

providing a communication device proximate the print position;

communicating with the media unit via the communication device;

initiating printing operations including printing one or more colors onto the media unit;

validating communication with the media unit via the communication device;

if the validating is successful, finishing printing operations including printing one or more colors onto the media card.

27. The method of Claim 26 further comprising, if the validation is not successful, ceasing printing operations such that no additional colors are printed onto the media card and sending the media card toward an exit.

28. The method of Claim 26 further comprising, if the validation is not successful, finishing printing operations including printing a reject indicia onto the media card.

29. A method of manufacturing an antenna-coupler comprising:

providing a first microstrip extending from a first end to a second end;

terminating the second end of the first microstrip with a first resistive load;

providing a second microstrip extending from a first end to a second end;

terminating the second end of the second microstrip with a second resistive load;

crossing the first microstrip and the second microstrip such that the first microstrip and the second microstrip are generally orthogonal to each other;

providing a ground plane spaced apart from the first and second microstrip; and

providing at least one substrate extending at least partially between the ground plane and the first and second microstrips.

30. The method of Claim 29, wherein crossing the first microstrip and the second microstrip includes spacing the first microstrip and the second microstrip apart and separating the first microstrip and the second microstrip by the at least one substrate.

31. The method of Claim 28 wherein providing the first microstrip includes a first section, a second section, and a bridge; and wherein the crossing of the first and second microstrips includes extending the first section along a plane common to the second microstrip toward the second microstrip, extending the second section along the plane common to the second microstrip away from the second microstrip and extending the bridge around the second microstrip and linking the first and second sections such that the first and second microstrips do not intersect.

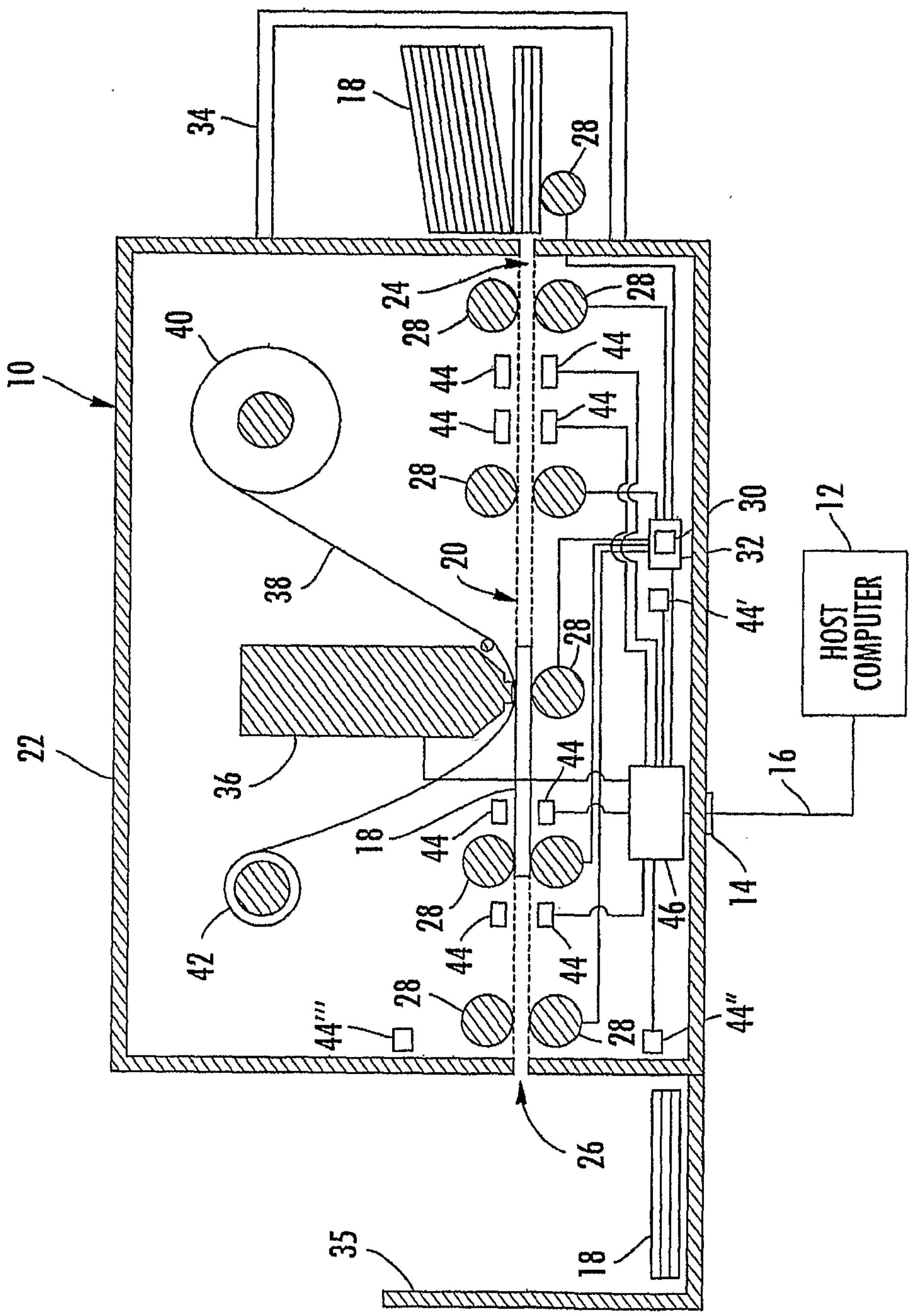

HOST COMPUTER
10
12
14
16
18
20
22
24
26
28
30
32
34
35
36
38
40
42
44
44'
44''
44'''
46

FIG. 1

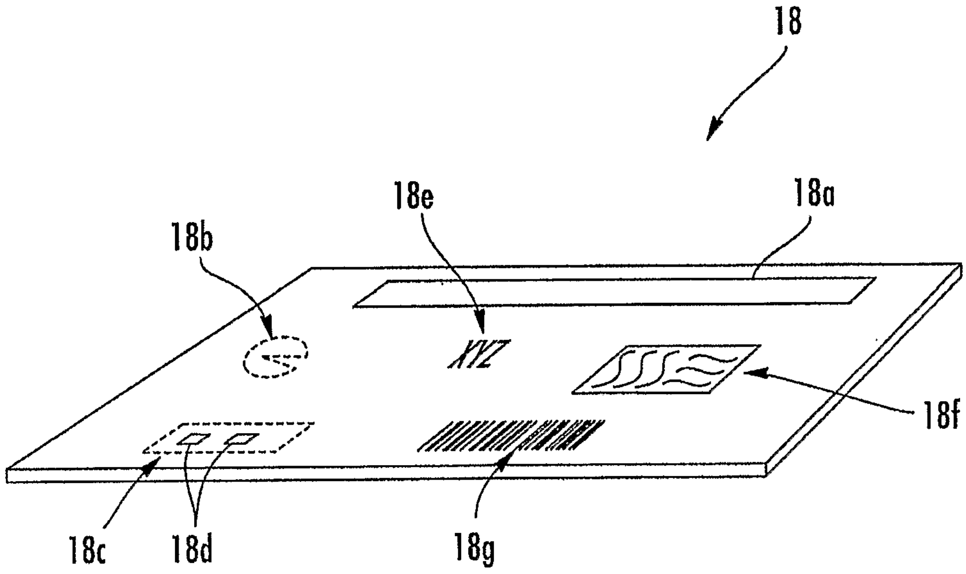


FIG. 2

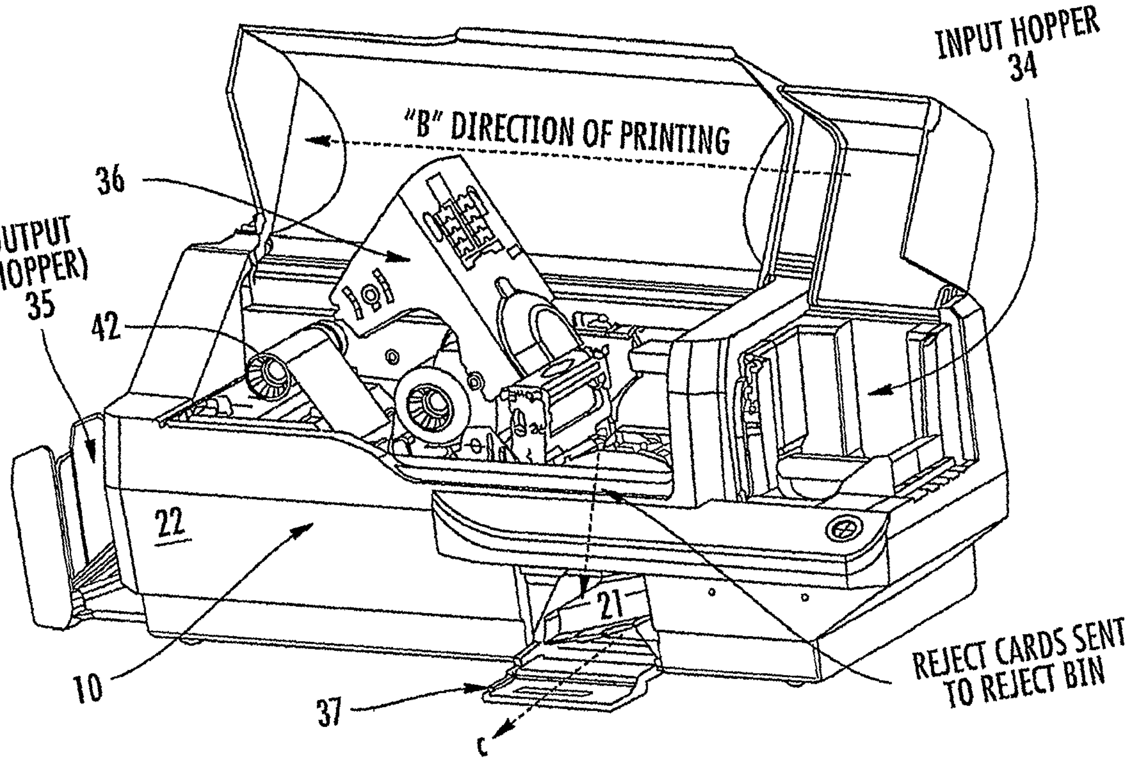

INPUT HOPPER
34
"B" DIRECTION OF PRINTING
36
OUTPUT
(HOPPER)
35
42
22
10
21
37
C
REJECT CARDS SENT
TO REJECT BIN

FIG. 3

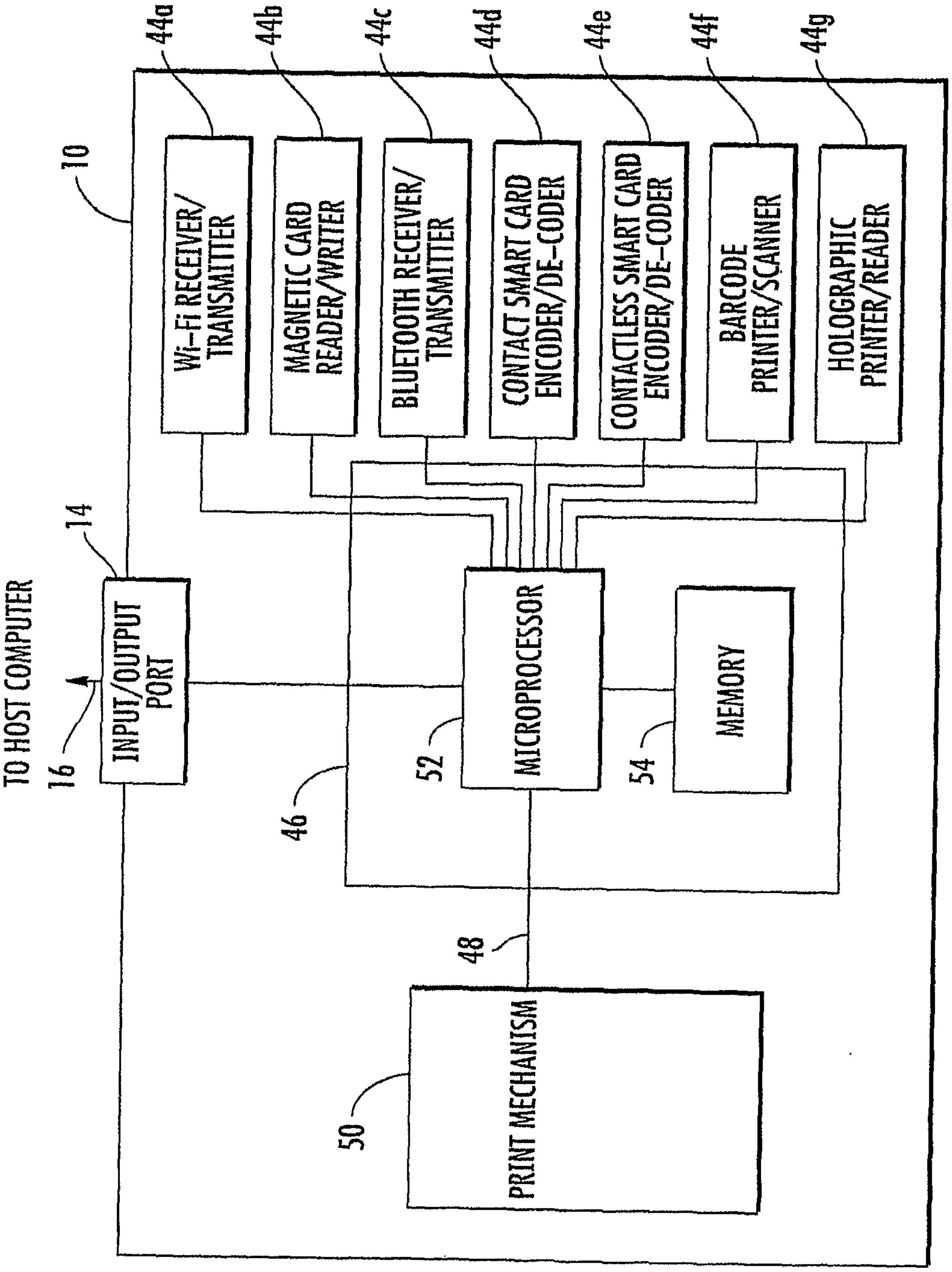

10
44a
44b
44c
44d
44e
44f
44g
Wi-Fi RECEIVER/ TRANSMITTER
MAGNETIC CARD READER/WRITER
BLUETOOTH RECEIVER/ TRANSMITTER
CONTACT SMART CARD ENCODER/DE-CODER
CONTACTLESS SMART CARD ENCODER/DE-CODER
BARCODE PRINTER/SCANNER
HOLOGRAPHIC PRINTER/READER
TO HOST COMPUTER
16
14
INPUT/OUTPUT PORT
MICROPROCESSOR
52
MEMORY
54
46
48
PRINT MECHANISM
50

FIG. 4

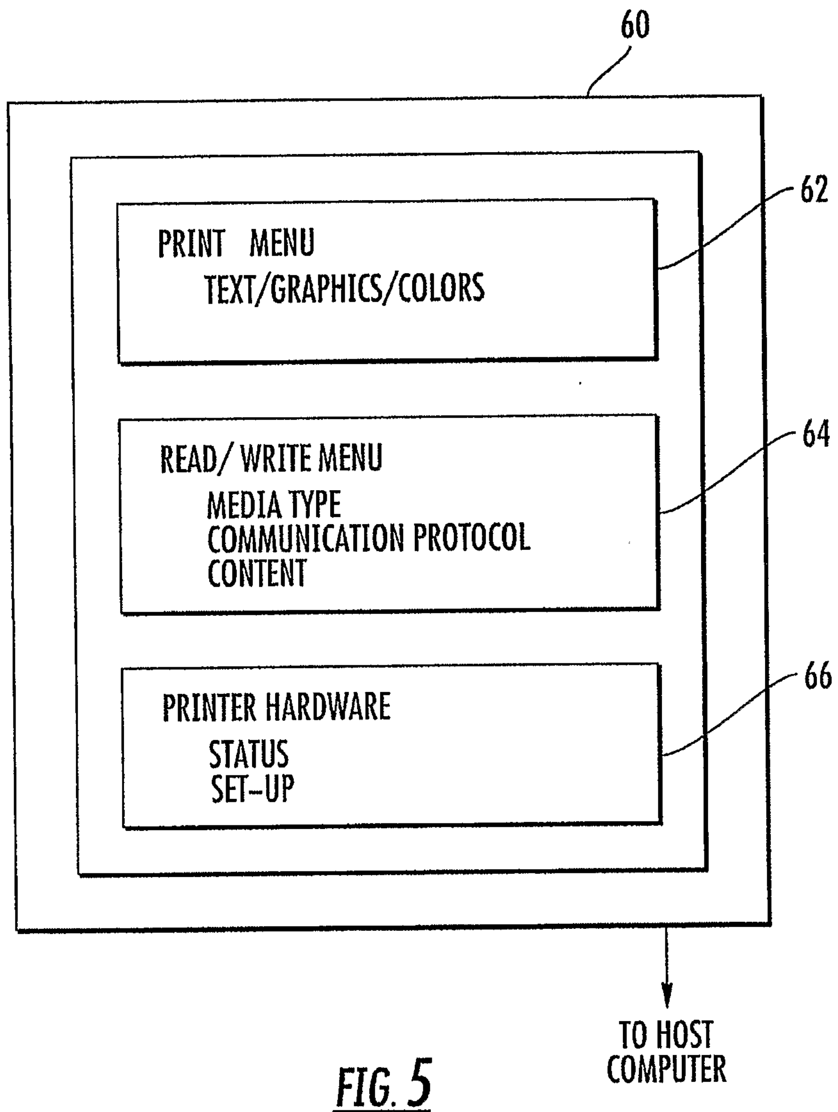

60
62
64
66
PRINT MENU
TEXT/GRAPHICS/COLORS
READ/ WRITE MENU
MEDIA TYPE
COMMUNICATION PROTOCOL
CONTENT
PRINTER HARDWARE
STATUS
SET-UP
TO HOST
COMPUTER

FIG. 5

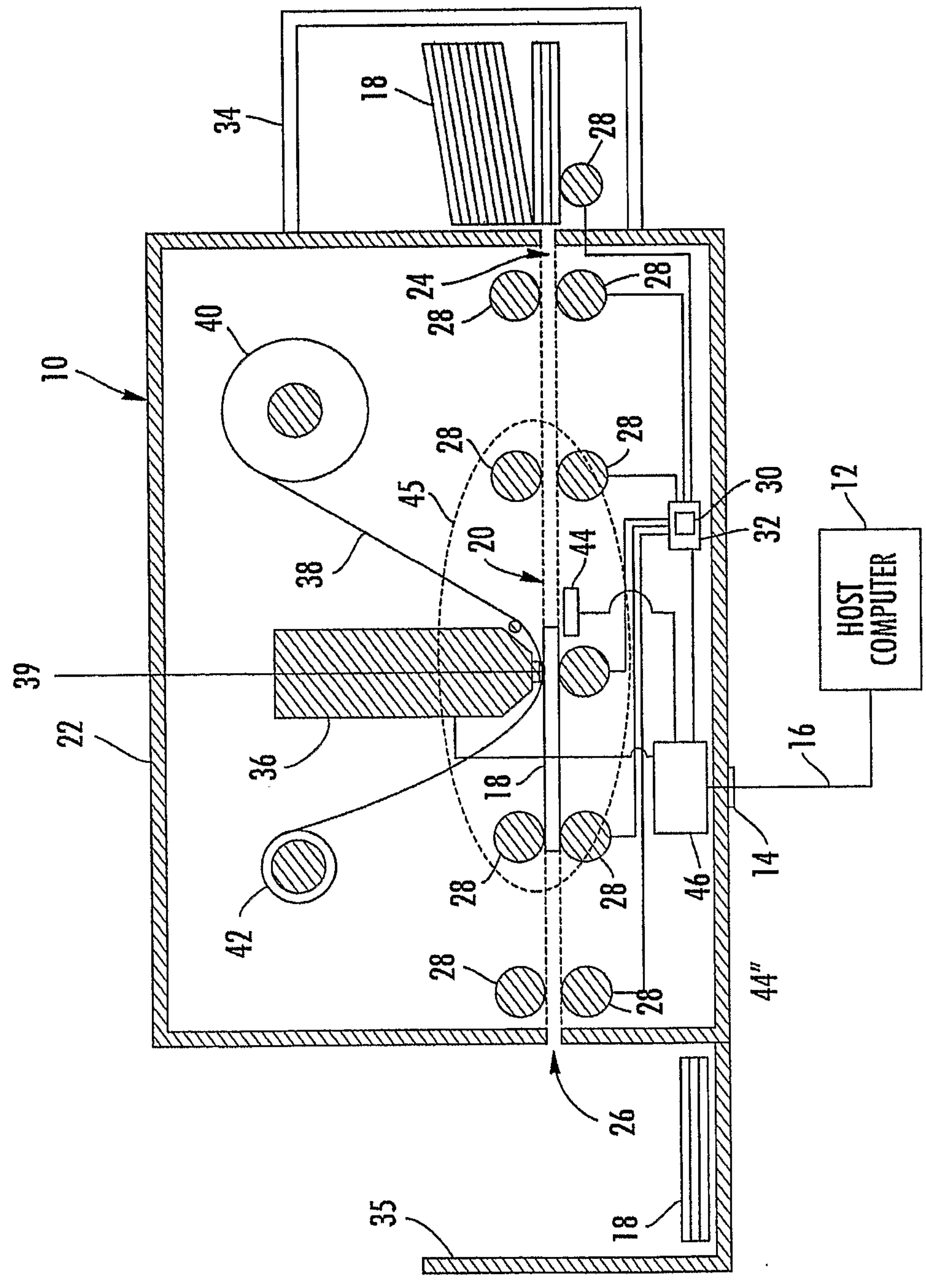

HOST
COMPUTER
10
12
14
16
18
20
22
24
26
28
30
32
34
35
36
38
39
40
42
44
44"
45
46

FIG. 6

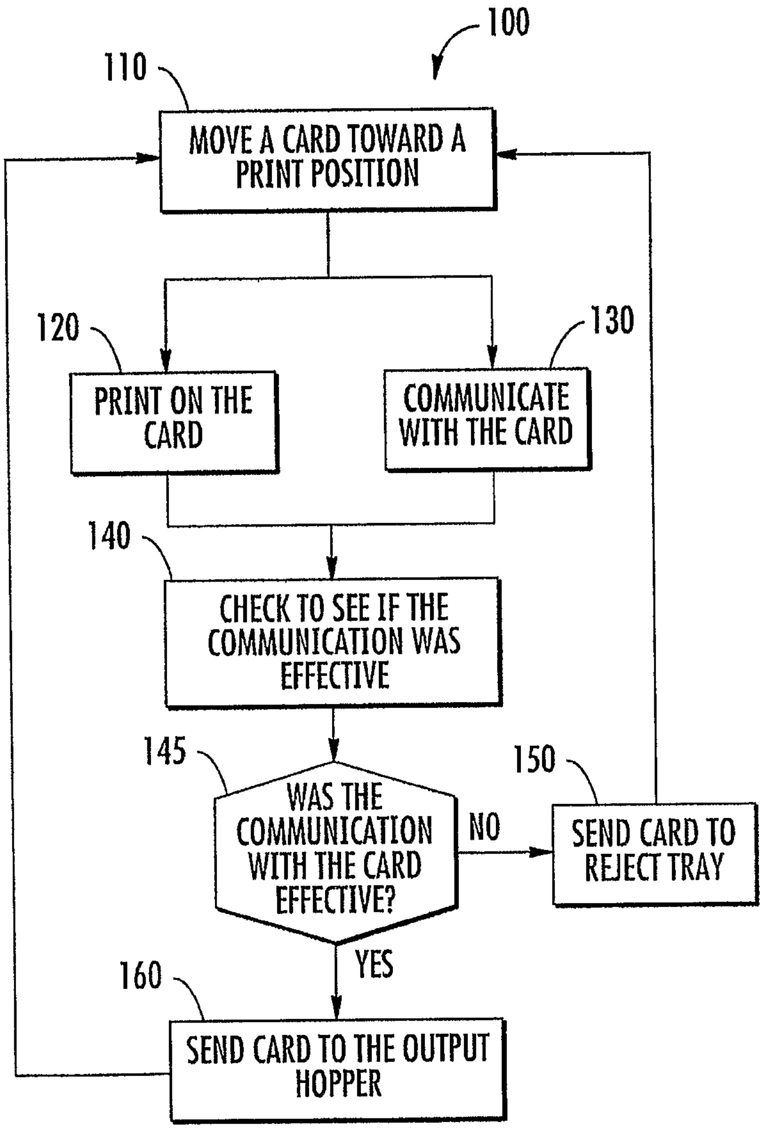

100
110
MOVE A CARD TOWARD A PRINT POSITION
120
PRINT ON THE CARD
130
COMMUNICATE WITH THE CARD
140
CHECK TO SEE IF THE COMMUNICATION WAS EFFECTIVE
145
WAS THE COMMUNICATION WITH THE CARD EFFECTIVE?
NO
150
SEND CARD TO REJECT TRAY
YES
160
SEND CARD TO THE OUTPUT HOPPER

FIG. 7

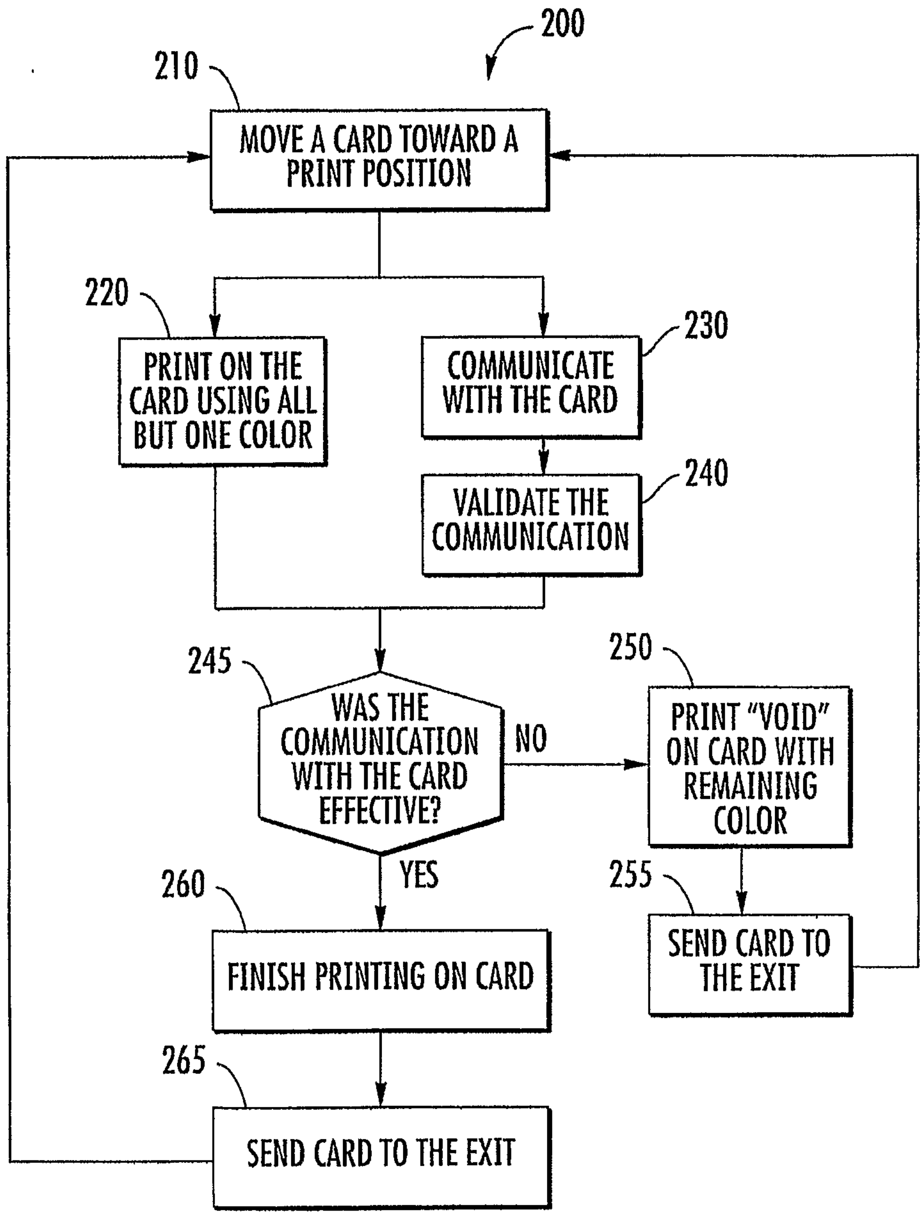

200
210
MOVE A CARD TOWARD A PRINT POSITION
220
PRINT ON THE CARD USING ALL BUT ONE COLOR
230
COMMUNICATE WITH THE CARD
240
VALIDATE THE COMMUNICATION
245
WAS THE COMMUNICATION WITH THE CARD EFFECTIVE?
NO
250
PRINT "VOID" ON CARD WITH REMAINING COLOR
255
SEND CARD TO THE EXIT
YES
260
FINISH PRINTING ON CARD
265
SEND CARD TO THE EXIT

FIG. 8

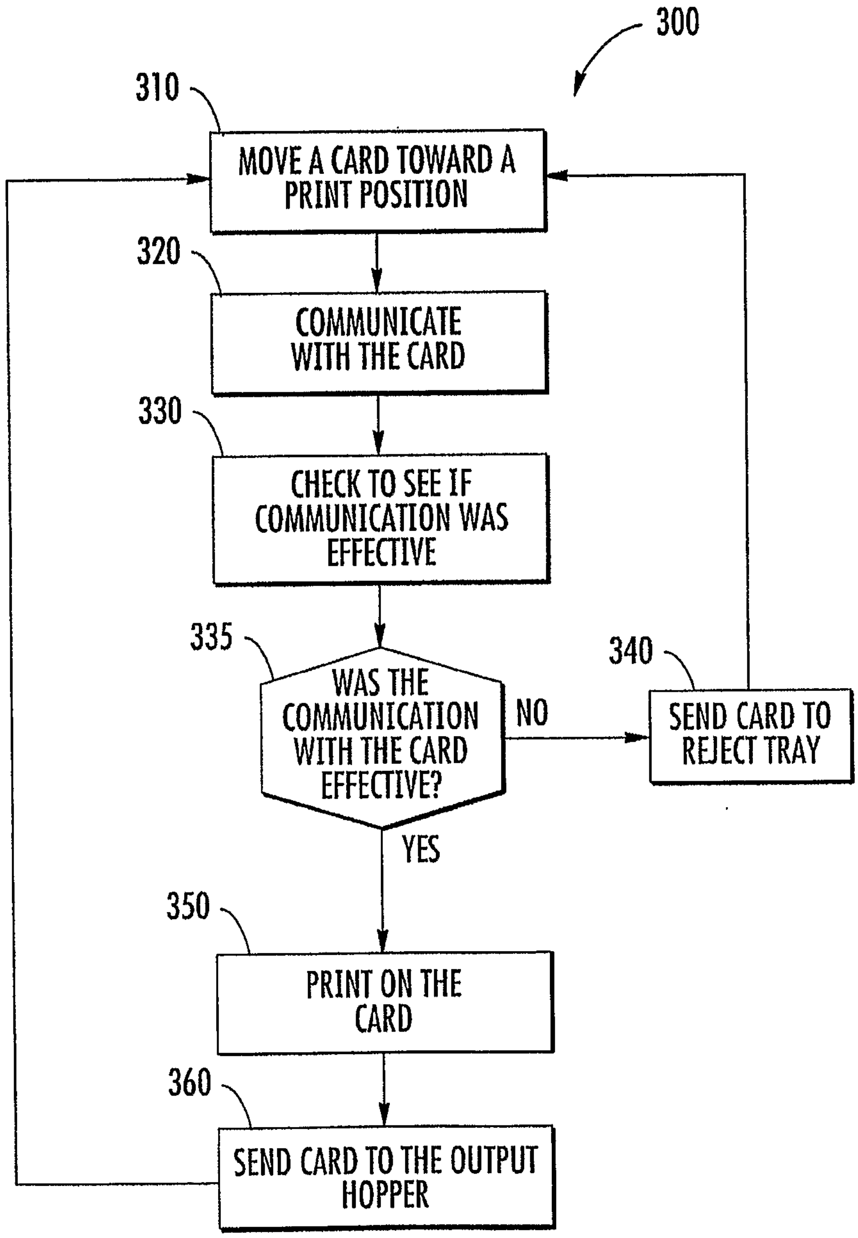
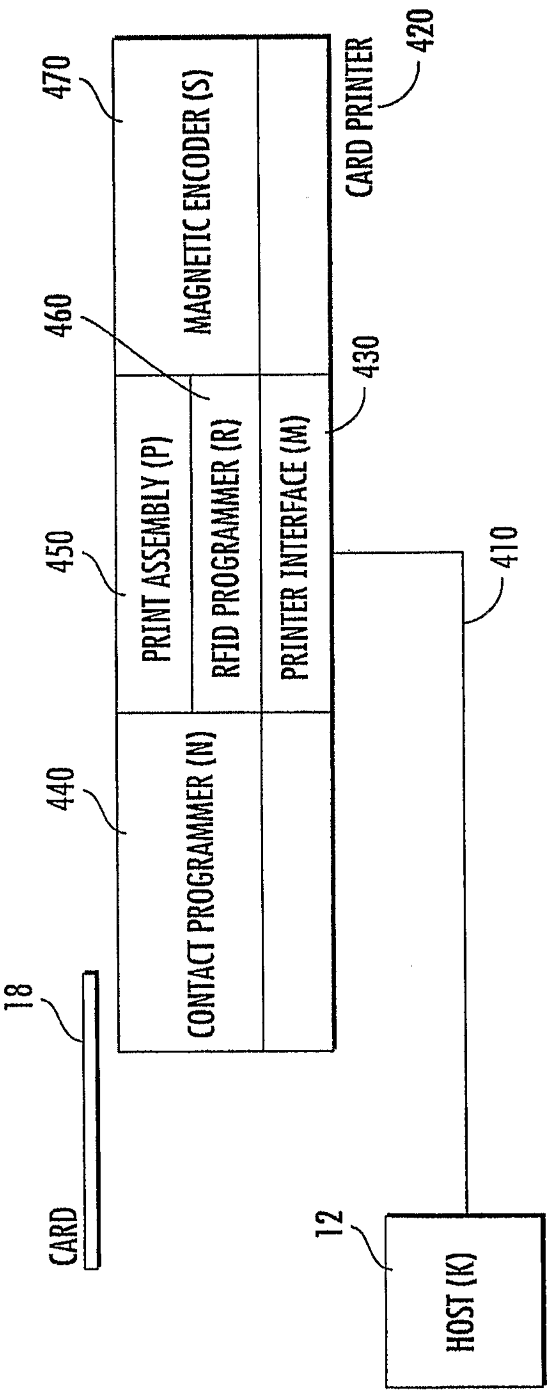

300
310
MOVE A CARD TOWARD A PRINT POSITION
320
COMMUNICATE WITH THE CARD
330
CHECK TO SEE IF COMMUNICATION WAS EFFECTIVE
335
WAS THE COMMUNICATION WITH THE CARD EFFECTIVE?
NO
340
SEND CARD TO REJECT TRAY
YES
350
PRINT ON THE CARD
360
SEND CARD TO THE OUTPUT HOPPER

FIG. 9



PARALLEL OPERATION (RFID/PRINT), SINGLE INTERFACE

FIG. 10

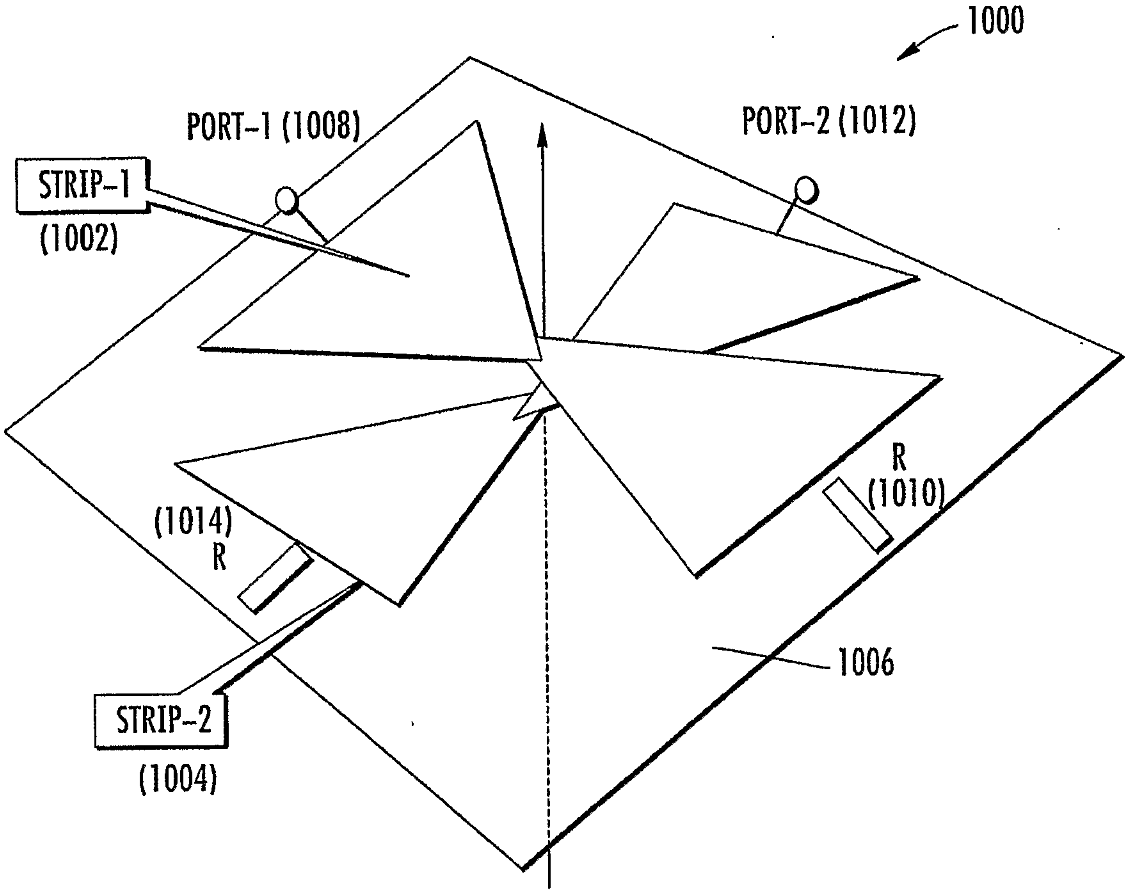


FIG. 11a

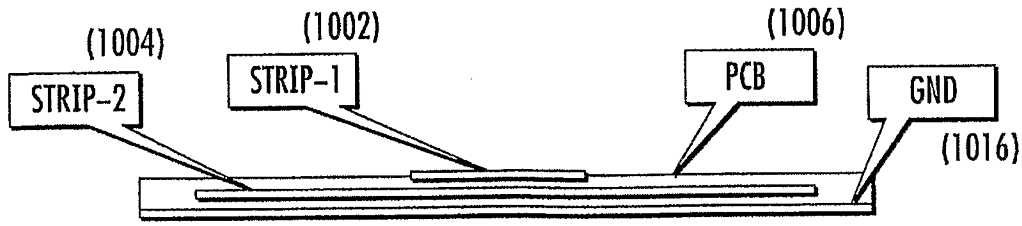
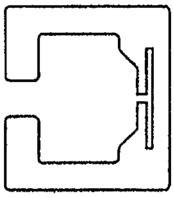
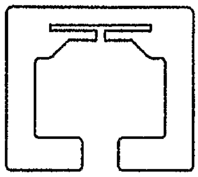


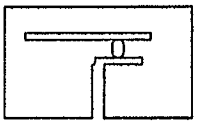
FIG. 11b



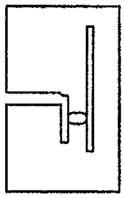
12a



12b

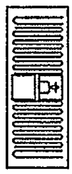


12c



12d

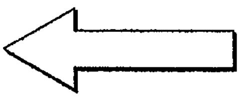
12e



12f

12g

12h



SMART CARD FEEDING DIRECTION

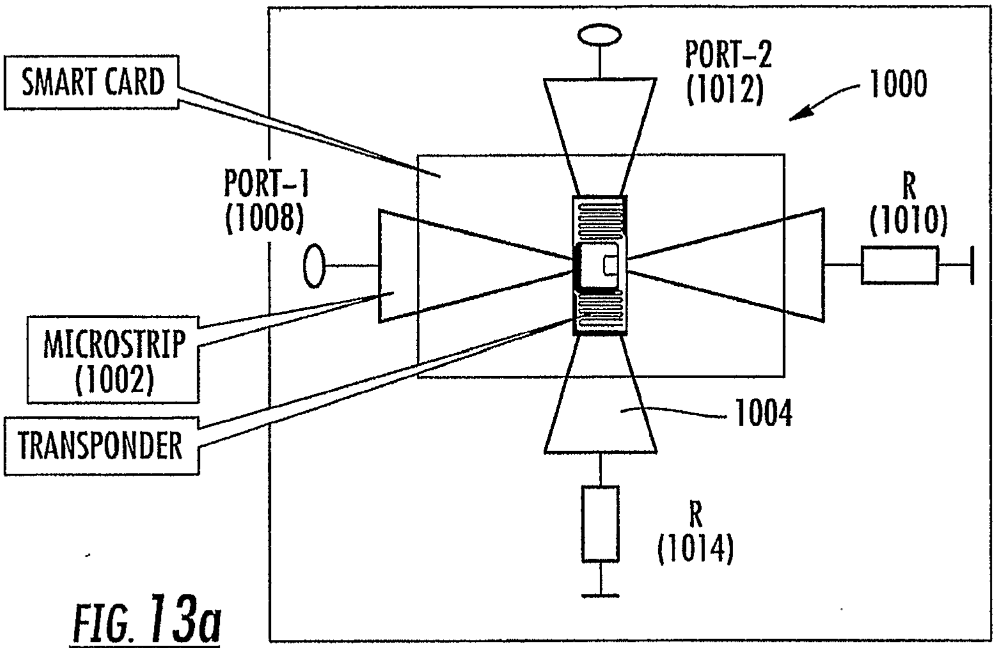


FIG. 13a

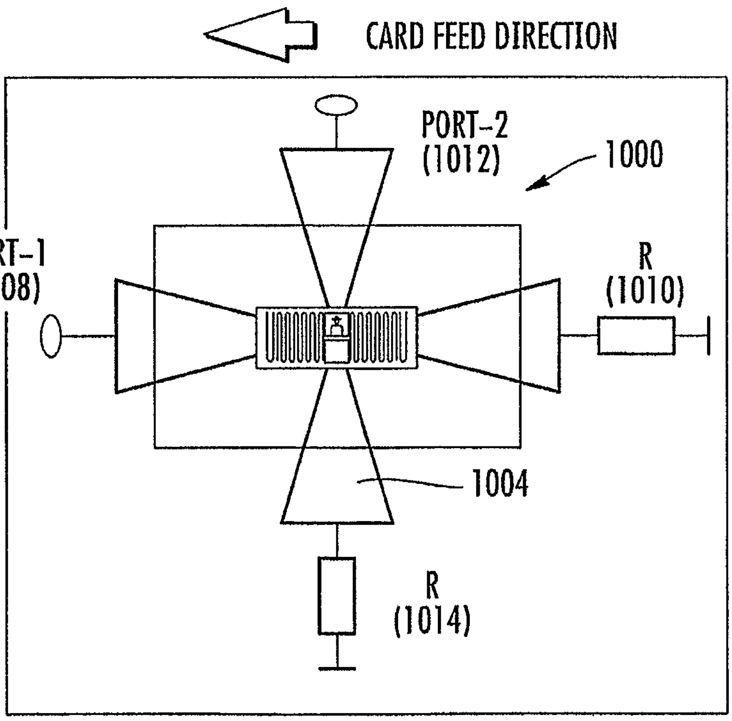


FIG. 13b

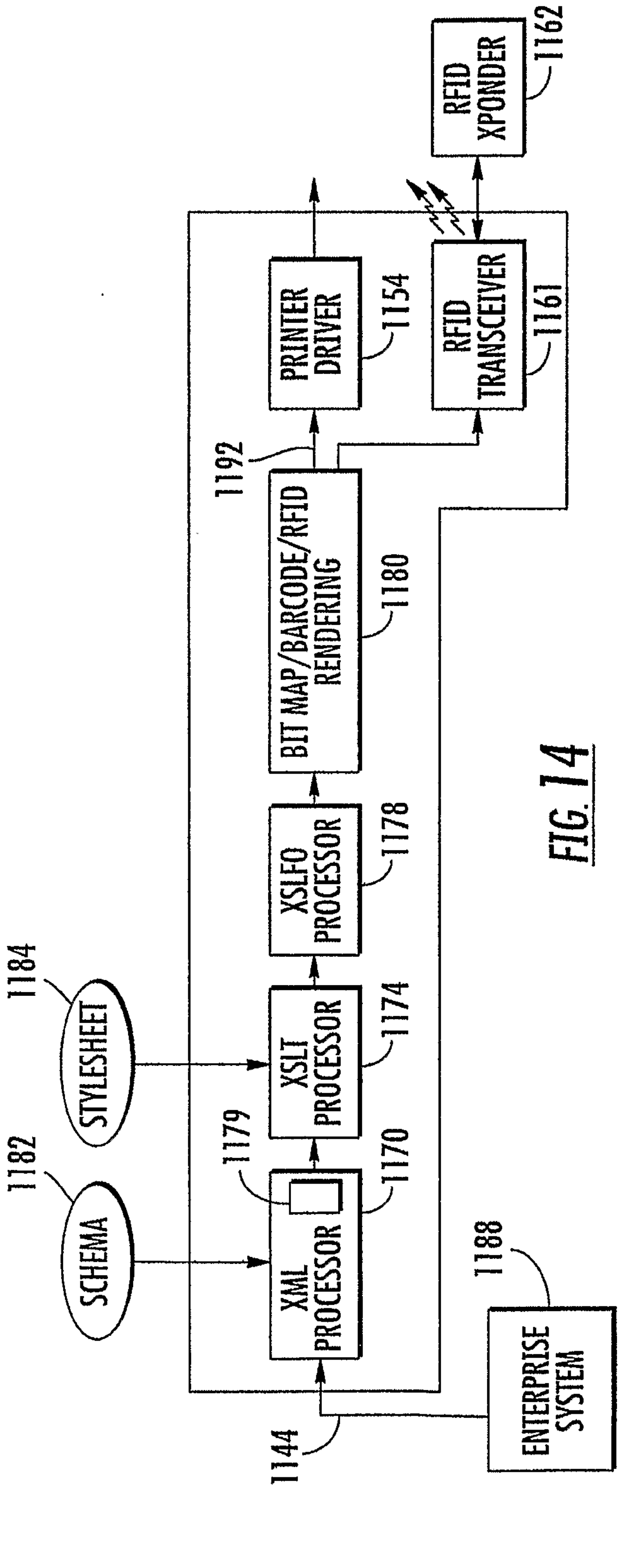

SCHEMA
1182
STYLESHEET
1184
XML PROCESSOR
1179
1170
XSLT PROCESSOR
1174
XSLFO PROCESSOR
1178
BIT MAP/BARCODE/RFID RENDERING
1180
1192
PRINTER DRIVER
1154
RFID TRANSCEIVER
1161
RFID XPONDER
1162
ENTERPRISE SYSTEM
1188
1144

FIG. 14

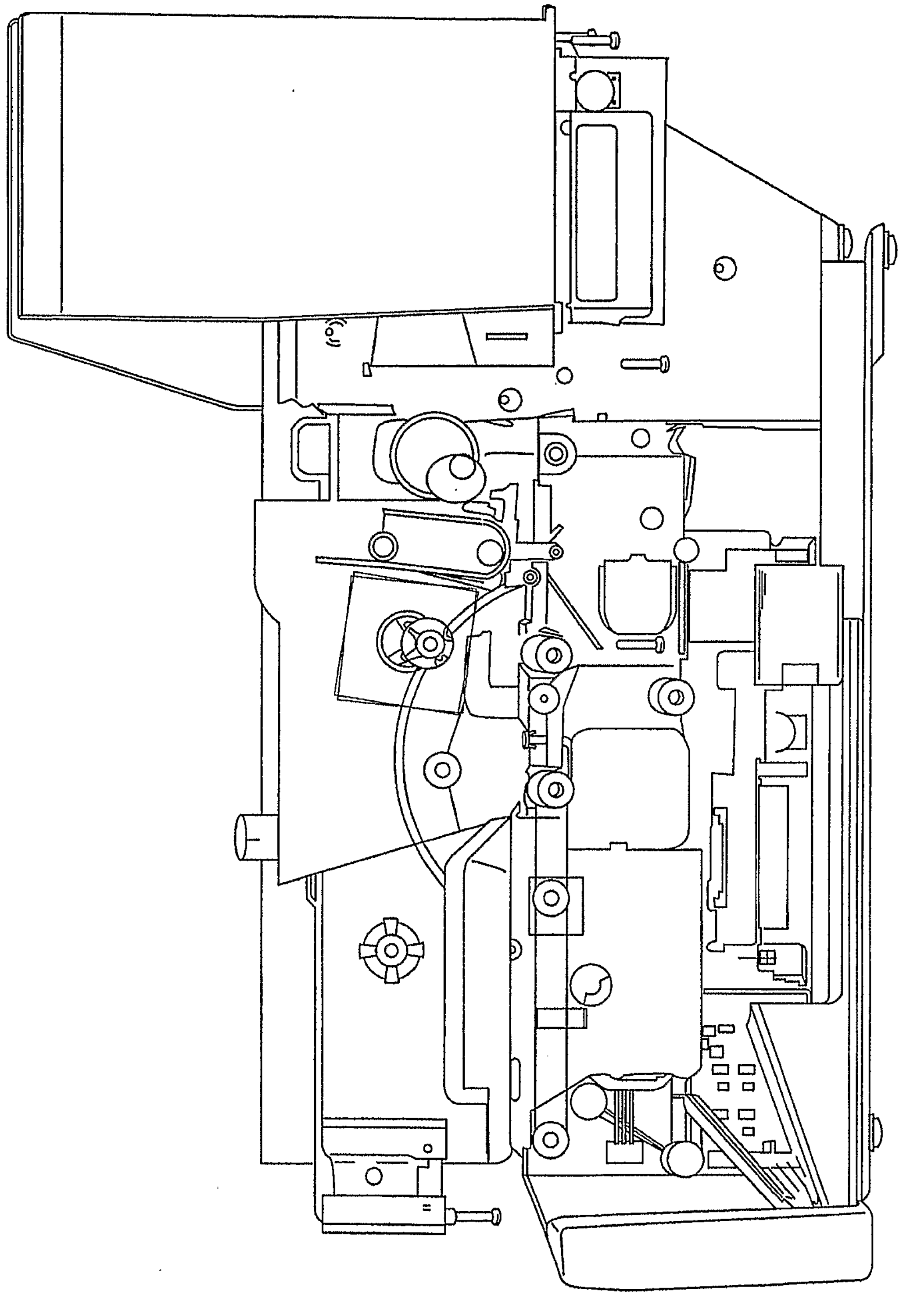


FIG. 15

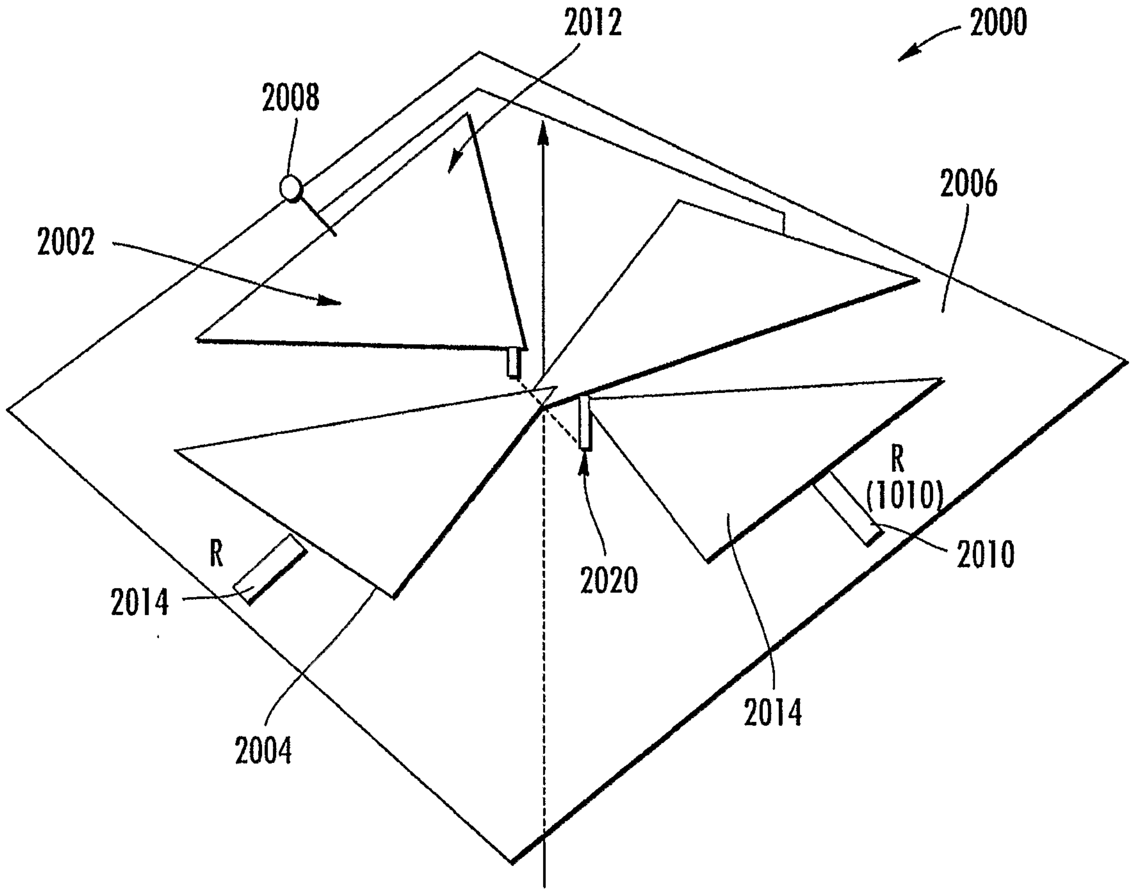


FIG. 16a

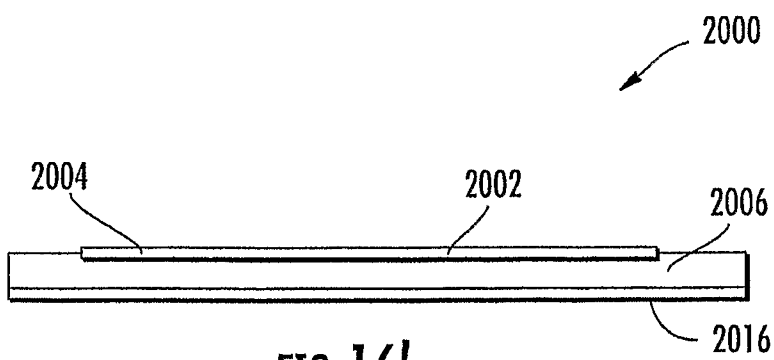


FIG. 16b

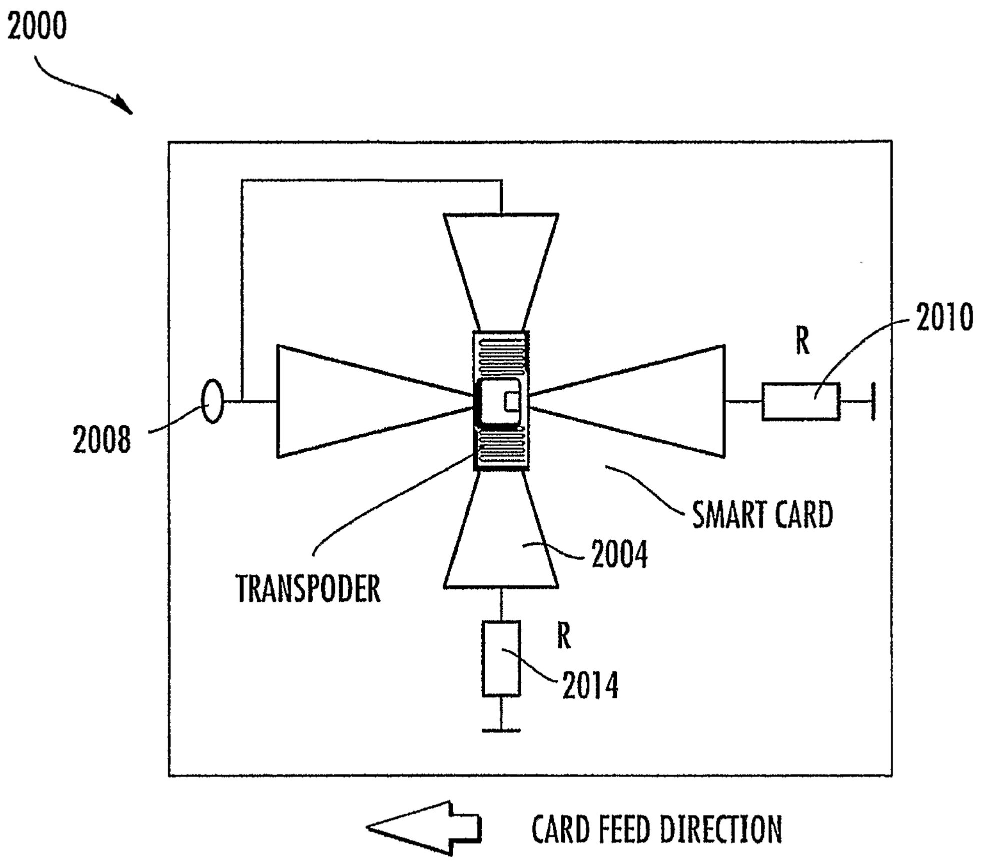

2000
2008
R
2010
SMART CARD
TRANSPODER
2004
R
2014
CARD FEED DIRECTION

FIG. 17a

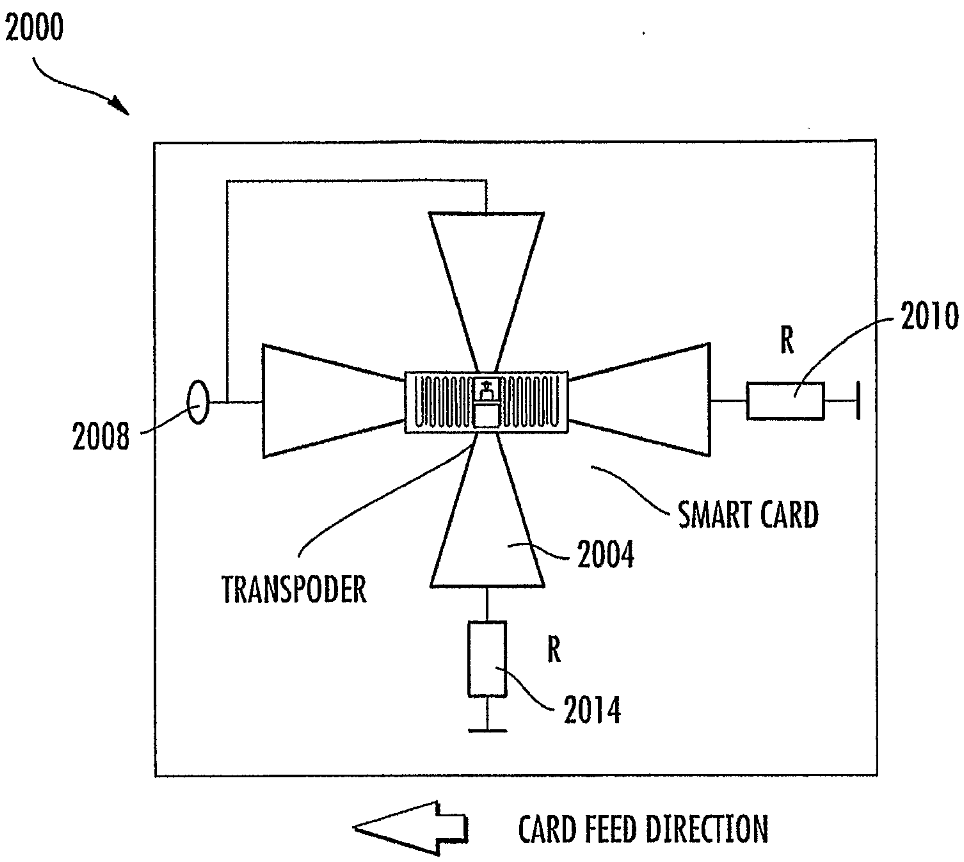

2000
2010
R
2008
SMART CARD
2004
TRANSPODER
R
2014
CARD FEED DIRECTION

FIG. 17b