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FILED
CLERK, U.S. DISTRICT COURT
JUL 19 2012
CENTRAL DISTRICT OF CALIFORNIA
BY ______ DEPUTY

UNITED STATES DISTRICT COURT

FOR THE CENTRAL DISTRICT OF CALIFORNIA

NEOLOGY, INC., Plaintiff, v. FEDERAL SIGNAL CORPORATION, FEDERAL SIGNAL TECHNOLOGIES, LLC, and SIRIT CORP., Defendant.	Case No.: CV12- 4422 JAK-JPR **FIRST AMENDED COMPLAINT** **DEMAND FOR JURY TRIAL** FILED BY FAX

FIRST AMENDED COMPLAINT FOR PATENT INFRINGEMENT

Plaintiff Neology, Inc., ("Neology") a Delaware corporation, by and through its undersigned attorneys alleges as follows:

The Parties

1. Neology is a corporation duly organized under the laws of the State of Delaware, with its principal place of business at 12760 Danielson Ct., Suite A, Poway California, 92064.

2. Neology is informed and believes and thereon alleges that defendant Federal Signal Corporation ("FSC") is a corporation duly organized under the laws of the state of Delaware, with its principal place of business at 1415 West 22nd Street, Suite 1100, Oak Brook, Illinois 60523.

3. Neology is informed and believes and thereon alleges that defendant Federal Signal Technologies, LLC ("FSTech"), is a limited liability corporation duly organized under the laws of the State of Delaware doing business as Federal Signal Technologies Group, with its principal place of business at 2 Technology Drive, Suite 100, Irvine, California 92618.

4. Neology is informed and believes and thereon alleges that defendant Sirit Corporation ("Sirit") is a corporation duly organized under the laws of the State of Texas, with its principal place of business at 2 Technology Drive, Suite 100, Irvine, California 92618.

5. Neology is informed and believes that Sirit and FSTech are wholly owned subsidiaries or affiliated companies of FSC.

6. Defendants FSC, FSTech, and Sirit are collectively referred to herein as "Defendants."

Nature of Claims, Jurisdiction, and Venue

7. This action arises under the Patent Laws of the United States under 35 U.S.C. §§ 271 *et seq.*, and seeks damages, injunctive relief and attorneys' fees under 35 U.S.C. §§ 283, 284, and 285. This Court has subject matter jurisdiction pursuant to 28 U.S.C. §§ 1331 and 1338.

8. This Court has personal jurisdiction over Defendants because Defendants do business in this judicial district, have purposely availed themselves of the privileges and benefits of the laws of the State of California, have directed continuous and systematic activities at this judicial district, and have, on information and belief, committed acts of patent infringement during the course of their business within this judicial district.

9. Venue is proper in this district pursuant to 28 U.S.C. §§ 1391 and 1400(b).

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/ / /

Count I

(Patent Infringement, Contributory Infringement & Inducement To Infringe ‘688 Patent)

10. Plaintiff Neology incorporates and alleges paragraphs 1-9 above as if fully set forth herein.

11. On April 26, 2006, United States Letters Patent No. 7,034,688 (the "‘688 Patent") was duly and properly issued for an invention entitled "Selective Metal Removal Process for Metallized Retro-Reflective and Holographic Films and Radio Frequency Devices Made Therewith." The ‘688 Patent was duly and legally issued to Neology, assignee of inventors Francisco Martinez de Velasco Cortina and Manfred Rietzler. A copy of the ‘688 Patent is attached hereto as Exhibit "A."

12. Neology is the owner of the ‘688 Patent and has all legal and equitable rights to enforce the ‘688 Patent, to bring and maintain this action, and to make, have made, use, import, offer or sell products or services covered by the ‘688 Patent.

13. The ‘688 Patent is now, and at all relevant times since its date of issuance has been, valid and enforceable.

14. Despite the fact that Neology has exclusive rights in the inventions of the ‘688 Patent, Defendants have infringed, contributed to the infringement of, and/or have induced infringement of, literally or under the doctrine of equivalents, the ‘688 Patent by making, using, offering to sell, and/or selling Radio Frequency Identification ("RFID") transponders ("RFID tags") that infringe, or contribute to, or induce others to infringe at least claim 1 of the ‘688 Patent. These infringing products comprise at least the following: ID*entity* Headlamp Mount Tag with Hologram and/or ID*entity* Windshield Tag with Hologram. It is believed that Defendants will continue to infringe, contributorily infringe, and/or induce infringement of, the ‘688 Patent unless enjoined by this Court. Defendants' infringement and other actions have caused substantial injury to Neology.

15. On information and belief, Defendants' acts were committed knowingly and intentionally.

16. Prior to the filing of the lawsuit Defendants knew of the existence of the '688 Patent. On at least one occasion, on or about 2008, Neology made an investor presentation to Defendants' executives that included a disclosure of the technology covered in the '688 Patent and the '688 Patent.

17. The amount of money damages that plaintiff Neology has suffered due to Defendants' acts of infringement has not been calculated but is subject to proof at trial.

18. Photographic examples of the accused infringing products incorporating holograms are enclosed herein as Exhibit "B."

Count II

(Patent Infringement, Contributory Infringement & Inducement To Infringe '154 Patent)

19. Plaintiff Neology incorporates and alleges paragraphs 1-18 above as if fully set forth herein.

20. On December 8, 2008, United States Letters Patent No. 7,463,154 (the "'154 Patent") was duly and properly issued for an invention entitled "Selective Metal Removal Process for Metallized Retro-Reflective and Holographic Films and Radio Frequency Devices Made Therewith." The '154 Patent was duly and legally issued to Neology, assignee of inventors Francisco Martinez de Velasco Cortina and Manfred Rietzler. A copy of the '154 Patent is attached hereto as Exhibit "C."

21. Neology is the owner of the '154 Patent and has all legal and equitable rights to enforce the '154 Patent, to bring and maintain this action, and to make, have made, use, import, offer or sell products or services covered by the '154 Patent.

22. The '154 Patent is now, and at all relevant times since its date of issuance has been, valid and enforceable.

23. Despite the fact that Neology has exclusive rights in the inventions of the '154 Patent, Defendants have infringed, have contributed to the infringement of, and/or have induced infringement of, literally or under the doctrine of equivalents, the '154 Patent by making, using, offering to sell, and/or selling RFID tags that infringe or contribute to, or induce others to infringe at least claim 31 of the '154 Patent. These infringing products comprise at least the following: the ID*entity* Headlamp Mount Tag with Hologram and/or ID*entity* Windshield Tag with Hologram. It is believed that Defendants will continue to infringe, contributorily infringe, and/or induce infringement of, the '154 Patent unless enjoined by this Court. Defendants' infringement and other actions have caused substantial injury to Neology.

24. On information and belief, Defendants' acts were committed knowingly and intentionally.

25. Prior to the filing of the lawsuit Defendants knew of the existence of the '154 Patent. On at least one occasion, on or about 2008, Neology made an investor presentation to Defendants' executives that included a disclosure of the technology covered by the '154 Patent, which is a continuation of the '688 Patent disclosed to Defendants in said presentation.

26. The amount of money damages that plaintiff Neology has suffered due to Defendants' acts of infringement has not been calculated but is subject to proof at trial.

<u>Count III</u>

(Patent Infringement, Contributory Infringement & Inducement To Infringe '488 Patent)

27. Plaintiff Neology incorporates and alleges paragraphs 1-26 above as if fully set forth herein.

28. On June 26, 2012, United States Reissue Patent No. RE43,488 (the "'488 Patent") was duly and properly issued for an invention entitled "System and

Method for Providing Secure Identification Solutions Utilizing a Radio Frequency Device in a Non-Metallized Region Connected to a Metallized Region." The '488 Patent was duly and legally issued to Neology, assignee of inventor Francisco Martinez de Velasco Cortina. A copy of the '488 Patent is attached hereto as Exhibit "D."

29.The '488 Patent is a reissue of United States Patent No. 7,091,862 (the "'862 Patent) which was issued on August 15, 2006.

30. Neology is the owner of the '488 Patent and has all legal and equitable rights to enforce the '488 Patent, to bring and maintain this action, and to make, have made, use, import, offer or sell products or services covered by the '488 Patent.

31. The '488 Patent is now, and at all relevant times since its date of issuance has been, valid and enforceable.

32. Despite the fact that Neology has exclusive rights in the inventions of the '488 Patent, Defendants have infringed, contributed to the infringement of, and/or have induced infringement of, literally or under the doctrine of equivalents, the '488 Patent by making, using, offering to sell, and/or selling RFID inlays and/or transponders that infringe, or contribute to, or induce others to infringe at least claim 1 of the '488 Patent. These infringing products comprise at least the following: RFID inlays including product numbers IN-43, IN-49, IN-50, IN-54, IN-58, IN-69, IN-74, and IN-75; and RFID tags that incorporate such inlays, such as the ID*entity* Headlamp Mount Tag (transferable and non-transferable). It is believed that Defendants will continue to infringe, contributorily infringe, and/or induce infringement of, the '488 Patent unless enjoined by this Court.

33. Defendants' infringement and other actions have caused substantial injury to Neology.

34. On information and belief, Defendants' acts were committed knowingly and intentionally.

35. Prior to the filing of the lawsuit Defendants knew of the existence of the ‘862 Patent from which the ‘488 Reissue Patent reissued. On at least one occasion, on or about 2008, Neology made an investor presentation to Defendants’ executives that included a disclosure of the technology covered in the ‘862 Patent and the ‘862 Patent.

36. The amount of money damages that plaintiff Neology has suffered due to Defendants’ acts of infringement has not been calculated but is subject to proof at trial.

Count IV

(Patent Infringement, Contributory Infringement & Inducement To Infringe ‘664 Patent)

37. Plaintiff Neology incorporates and alleges paragraphs 1-36 above as if fully set forth herein.

38. On October 10, 2006, United States Patent No. 7,119,664 (the "‘664 Patent") was duly and properly issued for an invention entitled "Deep Sleep in an RFID Tag." The ‘664 Patent was duly and legally issued to ID Solutions, Inc. ("IDSI"), assignee of inventor Bruce B. Roesner. A copy of the ‘664 Patent is attached hereto as Exhibit "E."

39. IDSI in turn assigned all rights, title, and interest in the ‘664 Patent to Neology.

40. Neology is the current owner of the ‘664 Patent and has all legal and equitable rights to enforce the ‘664 Patent, to bring and maintain this action, and to make, have made, use, import, offer or sell products or services covered by the ‘664 Patent.

41. The ‘664 Patent is now, and at all relevant times since its date of issuance has been, valid and enforceable.

42. Despite the fact that Neology has exclusive rights in the inventions of the ‘664 Patent, Defendants have infringed, contributed to the infringement of,

and/or have induced infringement of, literally or under the doctrine of equivalents, the ‘664 Patent by making, using, offering to sell, and/or selling RFID Readers, RFID inlays and/or RFID transponders that infringe, or contribute to, or induce others to infringe at least claim 16 of the ‘664 Patent. These infringing products comprise at least the following: ID*entity* Windshield Mount Tag (transferable and non-transferable); ID*entity* Headlamp Mount Tag; ID*entity* External License Plate Tag; ID*entity* Self Declaration Tag; ID*entity* Card Tag; ID*entity* 5100 multi-protocol reader; ID*entity* 5100 ETSI multi-protocol reader; ID*entity* 5200/5204 multi-protocol reader; ID*entity* 5200/5204 ETSI multi-protocol reader; the IN*finity* 610 multi-protocol reader; and the ID*entity* 6204 multi-protocol reader. It is believed that Defendants will continue to infringe, contributorily infringe, and/or induce infringement of, the ‘664 Patent unless enjoined by this Court.

43. Defendants’ infringement and other actions have caused substantial injury to Neology.

44. On information and belief, Defendants’ acts were committed knowingly and intentionally.

45. Prior to the filing of the lawsuit Defendants knew of the existence of the ‘664 Patent. The named inventor of the ‘664 Patent, Bruce B. Roesner, has been the Chief Technology Officer and Vice President of Engineering for Defendant Sirit since January 2007. Bruce B. Roesner is also the Chief Technology Officer for Defendant FSTech.

46. The amount of money damages that plaintiff Neology has suffered due to Defendants’ acts of infringement has not been calculated but is subject to proof at trial.

REQUESTED RELIEF

WHEREFORE, plaintiff Neology respectfully requests the following relief:

a. judgment that Defendants infringe the ‘688 Patent;

b. judgment that Defendants infringe the ‘154 Patent;

c. judgment that Defendants infringe the '488 Patent;

d. judgment that Defendants infringe the '664 Patent;

e. the entry of a permanent injunction, requiring Defendants and their officers, directors, agents, servants, employees, attorneys, licensees, successors, assigns, and customers, and those in active concert or participation with any of them, to stop making, using, offering to sell, or selling in the United States or importing into the United States any devices that infringe any claim of the '688, '154, '488, and '664 Patents, or contributing to or inducing the same by others;

f. judgment against each of the defendants for money damages to Neology for Defendants' infringement, contributory infringement, and/or inducement of infringement of the '688, '154, '488, and '664 Patents including but not limited to reasonable royalties and/or lost profits;

g. that any such money judgment against Defendants be trebled in view of the willful and deliberate nature of the Defendants' infringement;

h. an award to Neology of prejudgment and post-judgment interest;

i. an accounting by Defendants sufficient to determine damages;

j. judgment that this is an exceptional case under 35 U.S.C. § 285, and an award to Neology of its costs and expenses of suit, including reasonable attorneys' fees for bringing and prosecuting this action; and

k. such other and further relief as the Court may deem just and proper.

JURY DEMAND

Neology respectfully requests a jury trial on all issues triable to a jury.

DATED: July 18, 2012

PROCOPIO, CORY, HARGREAVES & SAVITCH LLP

By: ______________________
Anthony J. Dain
Victor M. Felix
Robin L. Phillips
Brian J. Kennedy
Attorneys for Plaintiff Neology, Inc.

EXHIBIT "A"

US007034688B2

(12) **United States Patent**
Rietzler et al.

(10) **Patent No.: US 7,034,688 B2**
(45) **Date of Patent: Apr. 25, 2006**

(54) **SELECTIVE METAL REMOVAL PROCESS FOR METALLIZED RETRO-REFLECTIVE AND HOLOGRAPHIC FILMS AND RADIO FREQUENCY DEVICES MADE THEREWITH**

(75) Inventors: **Manfred Rietzler**, Marktoberdorf (DE); **Francisco Martinez de Velasco Cortina**, Mexico City (MX)

(73) Assignee: **Neology, Inc.**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 438 days.

(21) Appl. No.: **10/118,092**

(22) Filed: **Apr. 9, 2002**

(65) **Prior Publication Data**

US 2002/0160786 A1 Oct. 31, 2002

(51) **Int. Cl.**
G08B 13/14 (2006.01)

(52) **U.S. Cl.** **340/572.7**; 340/572.8; 340/5.86; 359/529; 359/2; 205/125; 29/600; 216/102

(58) **Field of Classification Search** 340/572.7, 340/572.8; 235/492; 359/1, 529; 29/825; 156/60; 343/720, 749, 845, 846, 895
See application file for complete search history.

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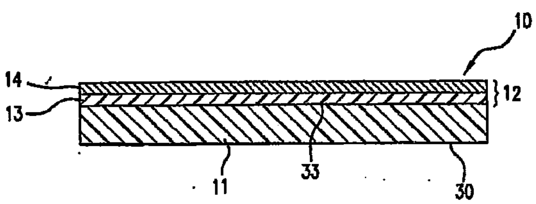
(Continued)

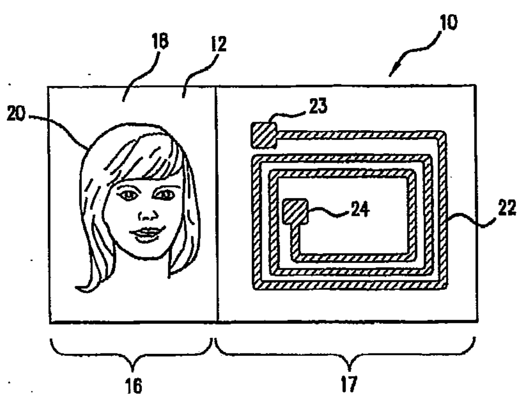
Primary Examiner—Benjamin C. Lee
(74) *Attorney, Agent, or Firm*—Baker & McKenzie LLP

(57) **ABSTRACT**

A method for selectively removing metal from a metallized substrate (e.g., a metallized polymer film) and the formation fo devices thereby are provided. The method involves selectively exposing the metallized surface to a demetallizing (i.e., an oxidizing) chemical solution. The metallized layer can be selectively exposed to the demetallizing solution using a flexographic printing process wherein printing rollers are used to transfer the demetallizing solution to the metallized surface. An identification device including, for example, a holographic, retro-reflective, or other metallized material and a radio-frequency transponder are also provided. The radio-frequency transponder includes an RF chip and an antenna in electrical communication with the chip. The identification device including the holographic image allows both electronic identification through the reading of identification data stored in the chip and optical identification via the holographic image.

21 Claims, 7 Drawing Sheets





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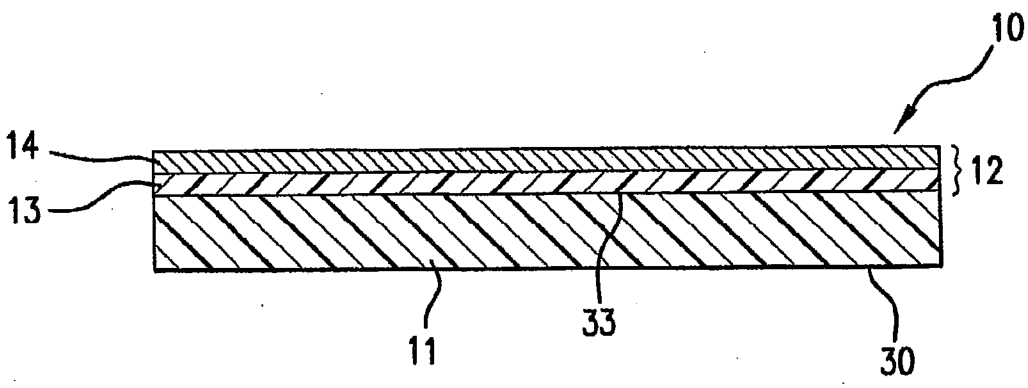

FIG.1

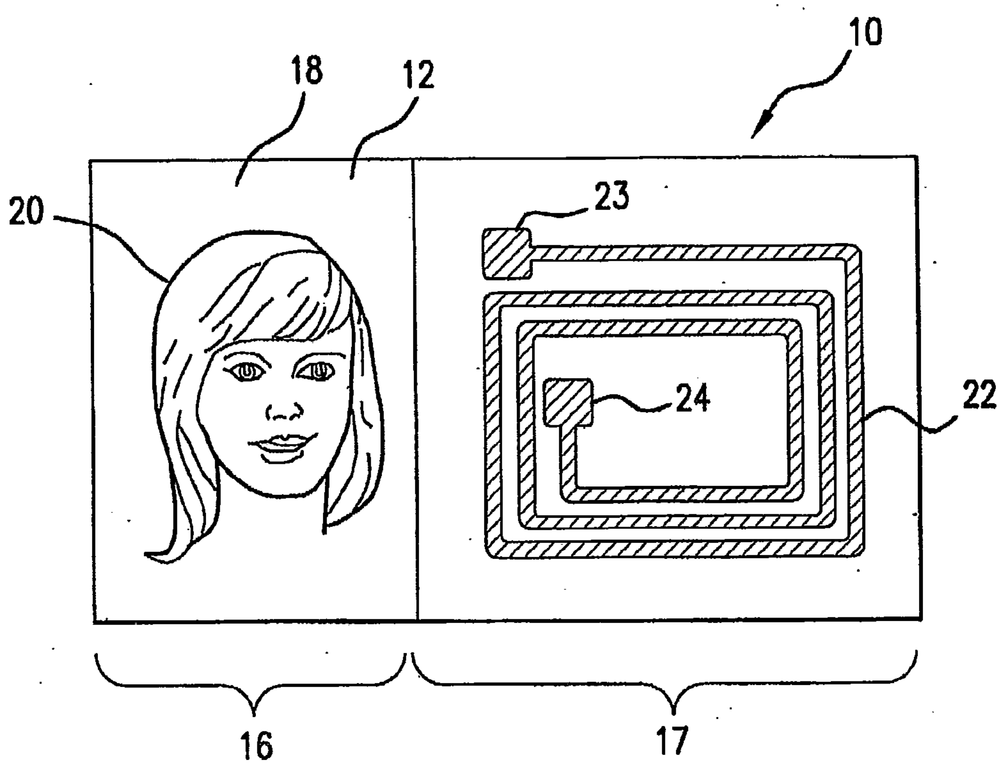

FIG.2

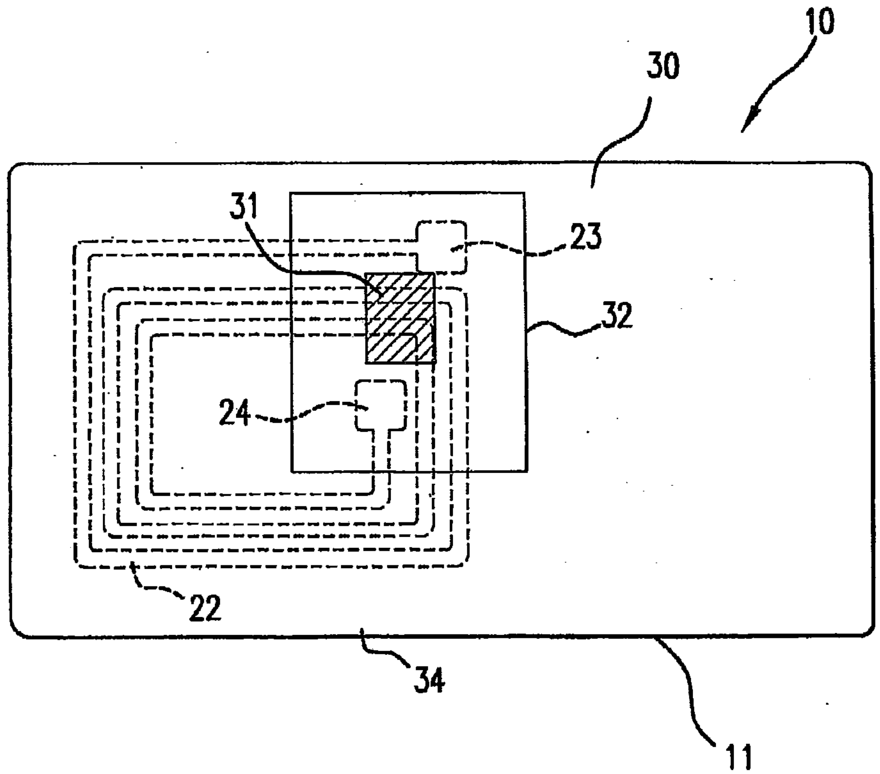
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FIG.3

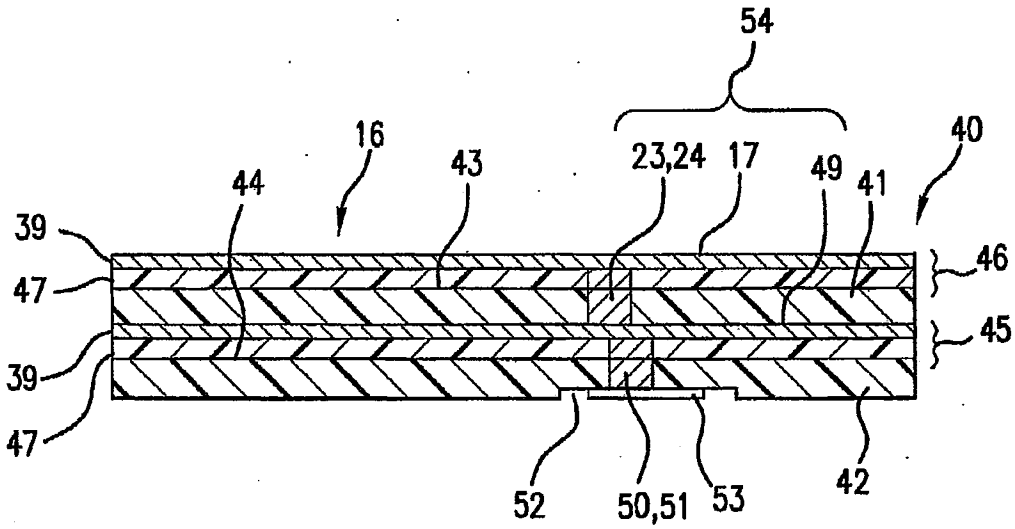
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FIG.4

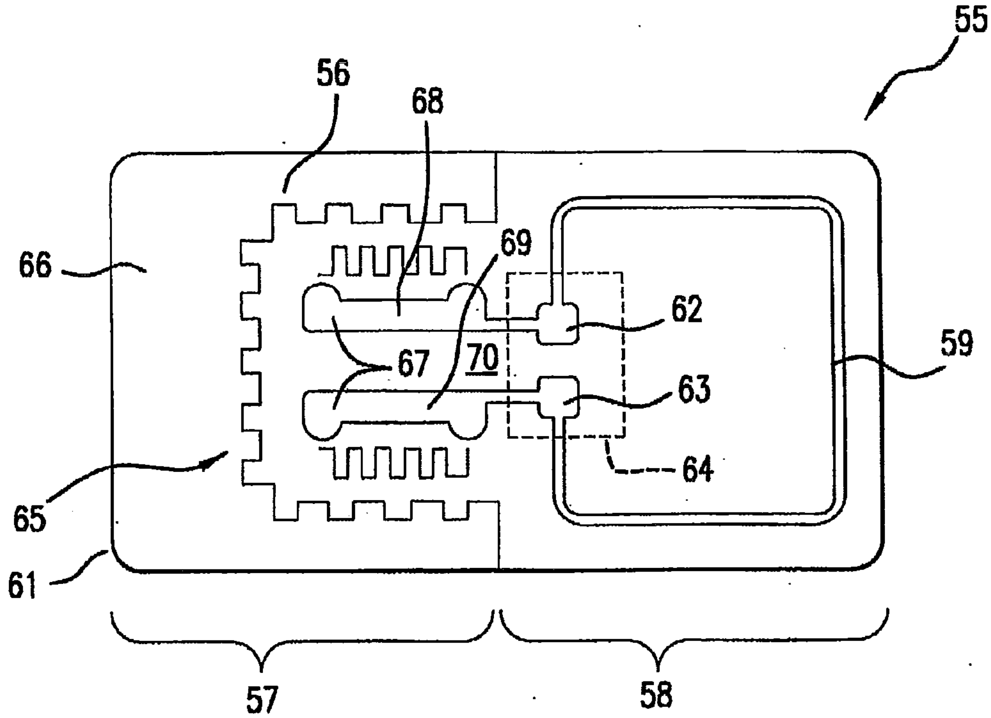

FIG.5

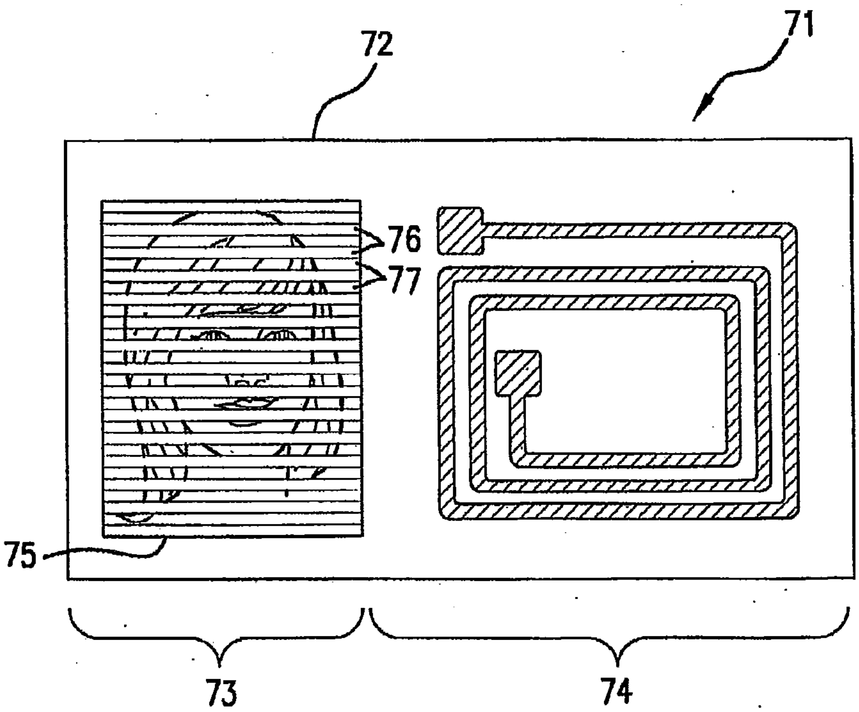

FIG.6

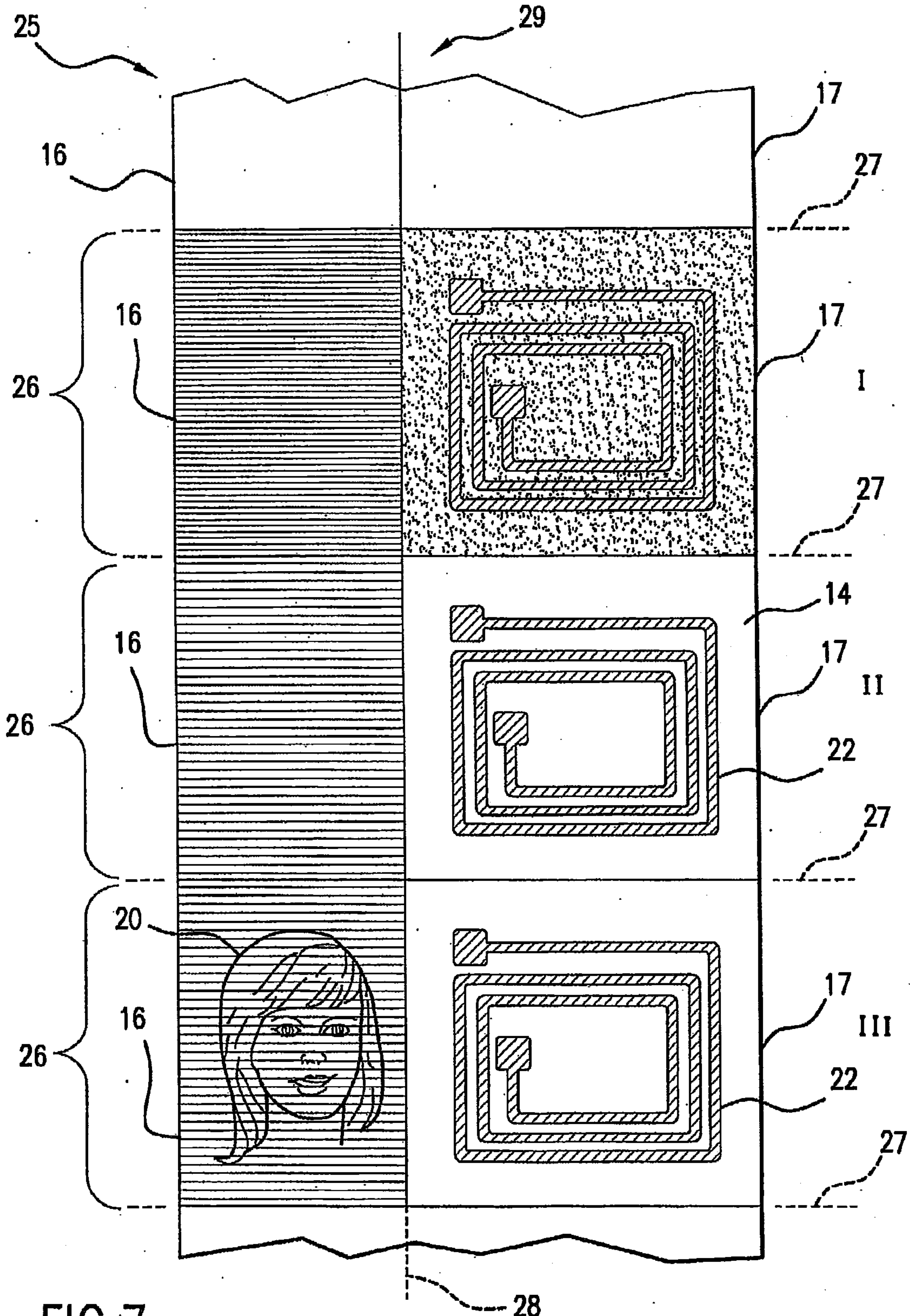
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FIG.7

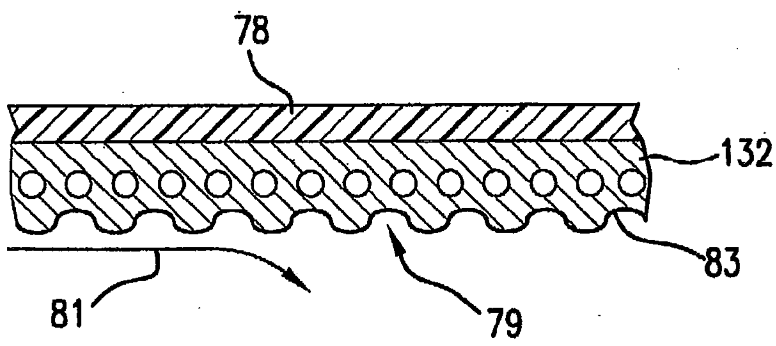

FIG.8

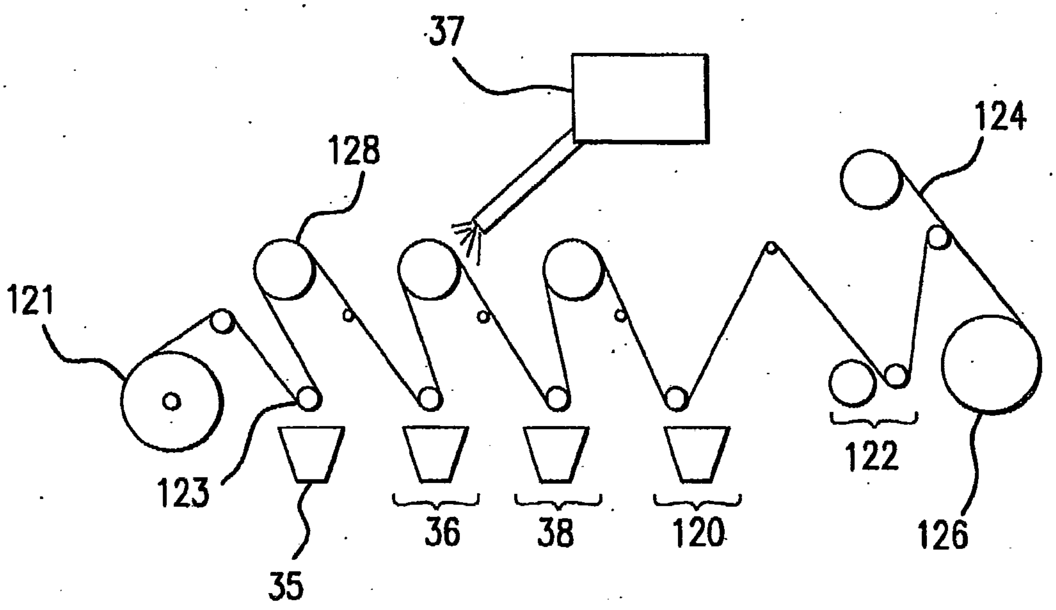

FIG.9

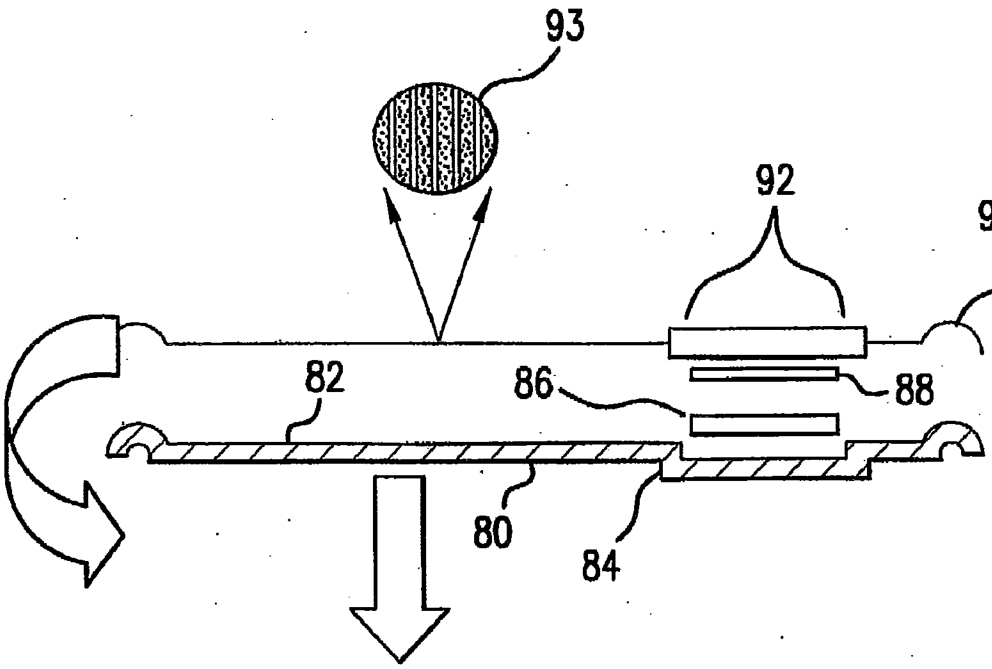

FIG.10

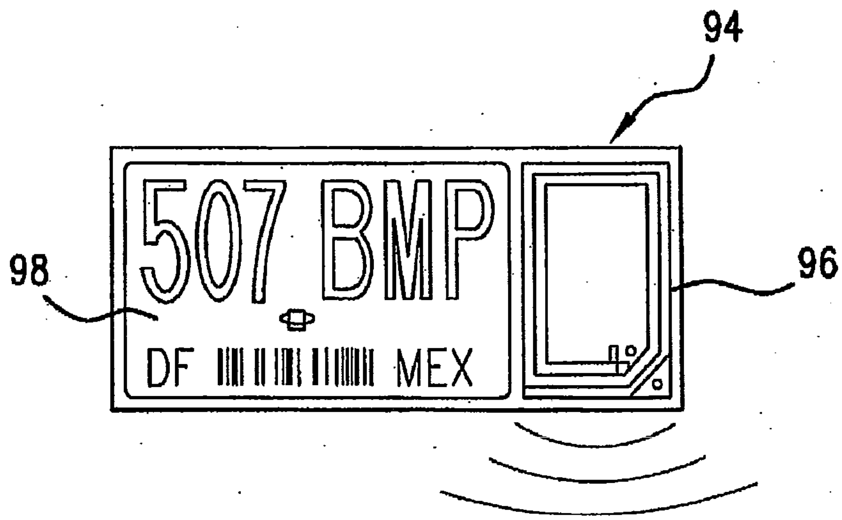

FIG.11

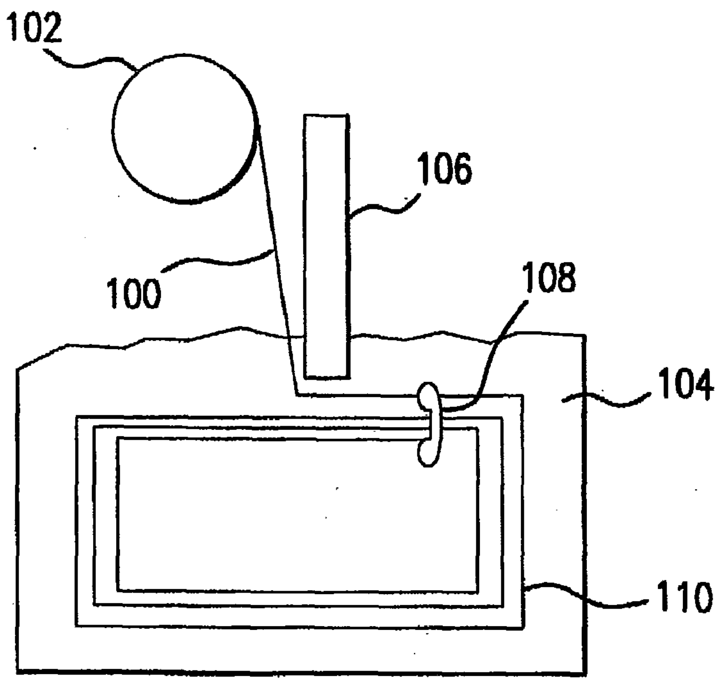

FIG.12

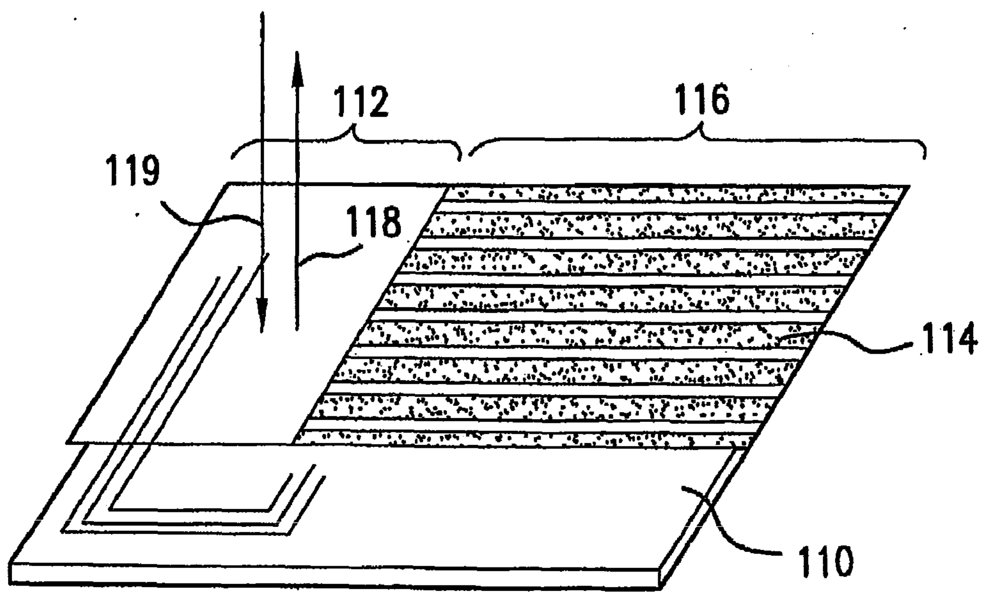

FIG.13

SELECTIVE METAL REMOVAL PROCESS FOR METALLIZED RETRO-REFLECTIVE AND HOLOGRAPHIC FILMS AND RADIO FREQUENCY DEVICES MADE THEREWITH

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to a process for selectively removing metallic material from a metallized film and, in particular, to the removal of metallic material from a metallized polymeric film using a printing method such as flexographic printing. The film can be a reflective film (e.g., a retro-reflective film) or a holographic film that can be used, for example, in an identification device comprising a radio frequency (RF) transponder.

2. Background of the Technology

Retro-reflective materials can reflect and re-emit incident light in a direction that is parallel to that of the source of the incident light. In other words, retro-reflective materials reflect light directly back toward the source of the light. Such materials and devices are widely used in the areas of nighttime transportation and safety. For example, retro-reflective materials are used to identify highway lanes and road signs using the light emitted from vehicle headlights. Retro-reflective materials are also used for the production of car plates, decals and distinctives for all kinds of vehicles and for truck containers, tractors and other applications. Retro-reflective materials have a bright effect under direct light without disturbing human sight.

Holographic materials have also been used for identification purposes. Since holograms are all but impossible to counterfeit, they are being increasingly used on all types of identification, including driver's licenses, credit cards, bus passes, etc., to increase security.

Both retro-reflective and holographic materials typically contain a very high level of metal such as aluminum. Holograms, for example, are typically stamped from metal foils. It is known that metal blocks the transmission and reception of radio frequency (RF) signals because the RF signal is absorbed or distorted by the metal content in the material. As a result, the signal cannot be received by an antenna blocked by metal. Such a blocked signal cannot be used, for example, to activate a connected device. This same blocking effect can occur whether the device is positioned on top of or underneath the metallic material because the distortion and absorption of the RF signal will be affected in either case. Thus, there is a problem in the prior art with regard to using retro-reflective and holographic materials, as well as other materials containing metals, on the surface of devices for receiving RF signals.

It would be desirable to incorporate an RF transponder into an identification device comprising a retro-reflective material, a holographic image, or other material containing a metal. The RF transponder could be used for electronic identification.

SUMMARY OF THE INVENTION

According to a first aspect of the invention, an identification device is provided that includes retro-reflective or holographic materials, or other materials containing metal, and a usable antenna for receiving radio frequency (RF) signals. The identification device comprises: a base layer; an RF transponder comprising a mounted RF chip and an antenna disposed on the base layer; and a metallized region. The metallized region can comprise a holographic image or

a retro-reflective layer. The antenna is in electrical communication with the chip. According to this aspect of the invention, the metallized region has been selectively demetallized such that the RF transponder can transmit and receive information.

According to a second aspect of the invention, a method of forming a pattern in a metallized layer is provided. The method comprises: transferring a metal etching solution to portions of an exposed surface of the metallized layer using a printing process; allowing the etching solution to react with the metallized layer to selectively demetallize the surface; and washing the selectively demetallized surface.

According to a third aspect of the invention, a method of making an identification device comprising a base layer and at least one metal region disposed thereon is provided. The method comprises: selectively demetallizing a first metal region of the device; forming a holographic image in the first metal region; forming an antenna on the base layer; and mounting an RF chip on the base layer in electrical communication with the antenna to form an RF transponder. According to this aspect of the invention, the selective demetallization of the first metal region allows the RF transponder to transmit and receive information.

According to a fourth aspect of the invention, a method of making an identification device comprising a base layer and a metallized retro-reflective layer is provided. The method comprises: forming a selectively demetallized retro-reflective layer on the base layer; forming an antenna on the base layer; and mounting an RF chip on the base layer in electrical communication with the antenna to form an RF transponder. According to this aspect of the invention, the selective demetallization of the retro-reflective layer retains the retro-reflective properties of the retro-reflective layer while allowing the RF transponder to transmit and receive information.

Additional advantages and novel features of the invention will be set forth in part in the description that follows, and in part will become more apparent to those skilled in the art upon examination of the following or upon learning by practice of the invention.

BRIEF DESCRIPTION OF THE FIGURES

The invention will be described with reference to the accompanying figures, wherein:

FIG. 1 is a lateral cross-sectional view of a metallized substrate suitable for making an identification device according to the invention;

FIG. 2 is a top view of an identification device according to the invention comprising a holographic image and an antenna;

FIG. 3 is a bottom view of the identification unit shown in FIG. 2, showing a chip module mounted on the bottom surface of the identification device;

FIG. 4 is a lateral cross-sectional view of a further embodiment of a device according to the invention, comprising two metallized layers arranged one above the other;

FIG. 5 is a top view of a device according to the invention, wherein the antenna is in electrical communication with the holographic image;

FIG. 6 is a top view of a further embodiment of an identification device according to the invention, wherein the device has a selectively demetallized holographic image;

FIG. 7 illustrates a method of making identification devices from a continuous strip of metallized material having multiple segments that may be separated from the strip to make individual identification devices, in accordance with embodiments of the invention;

FIG. **8** illustrates a method of selectively removing metal from a metallized substrate according to the invention;

FIG. **9** shows an apparatus that can be used for the continuous selective demetallization of a metallized film according to the invention;

FIG. **10** shows a method of making a license plate having a retroreflective layer and an RF transponder according to the invention;

FIG. **11** shows a license plate according to the invention, comprising a retro-reflective layer and an RF transponder made by the method illustrated in FIG. **10**;

FIG. **12** shows a method of forming an inlaid antenna according to the invention; and

FIG. **13** shows a method of forming an identification device according to the invention comprising inlaying an antenna in the base layer and overlying a selectively demetallized retro-reflective layer.

DETAILED DESCRIPTION OF THE INVENTION

The present inventors have discovered a method by which a radio frequency (RF) device can be integrated into an identification device comprising a metallized reflective (e.g., a retro-reflective) or holographic material. In particular, the present inventors have discovered that, by selectively removing metal from the metallized layer, the conductivity of the metallized layer can be broken and the effect of absorption and distortion of the radio waves that an RF device uses as a power source can be reduced. In this manner, a radio frequency device can be incorporated into a retro-reflective or holographic material, such as a license plate, a decal (e.g., for a car license plate) or an identification card.

According to the invention, a demetallizing solution, such as a solution of sodium hydroxide (NaOH), can be used in place of ink in a printing process to selectively demetallize a metal layer. In particular, the demetallizing solution can be poured into the stainless steel trays of a printing apparatus. The demetallizing solution can then be applied to the metallized surface using a printing process. For example, the solution can be applied to a printing plate having a raised pattern. The plate can then be contacted with the metallized surface such that the solution on the raised areas is transferred to the metallized surface. The application of the demetallizing solution to the metallized surface can be controlled by the inking rollers of a printing apparatus (e.g., by the pressure applied to the inking rollers).

According to a preferred embodiment of the invention, the demetallizing solution is applied to the metallized layer using a flexographic printing process. The flexographic printing process is a rotary in-line printing method that uses flexible resilient plates with raised images to apply inks to a substrate. According to a preferred embodiment of the invention, the flexographic printing process can be performed using laser-engraved anilox rolls to allow for high resolutions.

By using a printing process, such as a flexographic printing process, the sodium hydroxide solution can be transferred to selective portions of the metallized film. In this manner, metal can be selectively removed from those areas. According to the invention, the exposure time of the metallized layer to the sodium hydroxide solution can be controlled to ensure that the resulting chemical reaction sufficiently removes metal from the desired areas.

According to the invention, after the demetallization process is complete, the selectively demetallized film can be transferred to a washing unit where any excess or remaining chemical solution can be removed. According to a preferred embodiment of the invention, washing of the demetallized surface can be accomplished using fine sprinklers.

The metallized film, which has been moistened by the previous wash, can then be subjected to a residue evaporation process. Residue evaporation can be accomplished using a set of two rolls (e.g., one made of rubber, one made of steel), as well as by such processes as use of air-cleaning filters, sponges and/or blown air. The residue evaporation process can be used as a preparation step preliminary to a heat-driven drying stage. During the heat-driven drying stage, the heat can be generated, for example, by electrical resistance.

The metal removal process according to the invention can be used to produce a metallized material that is non-blocking to radio frequency transmissions. Therefore, a radio frequency device can be incorporated into an identification device (e.g. a card or plate) having a metallized (i.e., a retro-reflective or holographic) layer. As a result of the demetallization process, the radio-frequency device can transmit or receive information while in close proximity to the metallized layer. Additionally, by using a selective demetallization process according to the invention, the metallized film can be made translucent. Therefore, a visible seal can be incorporated beneath the metallized layer according to the invention.

Features of the present invention directed to a metal-removal process for a metallized material (e.g., a metallized polymer film) will now be described in greater detail. According to a preferred embodiment of the invention, the method comprises subjecting the metallized material to a flexographic printing process, wherein the inks are replaced by a metal etching solution. According to a preferred embodiment of the invention, the metal etching solution is an oxidizing solution. For example, an oxidizing solution can be poured into the stainless steel ink trays of a standard flexographic printing station. The oxidizing solution according to the invention preferably comprises sodium hydroxide (NaOH), water (H_2O), and, optionally, ethylene-glycol. The ethylene glycol can be used as a density-reduction agent.

According to a preferred embodiment of the invention, the oxidizing solution can be transferred to the inking rollers through a second roller (i.e., an "anilox" roller). The oxidizing solution can then be transferred to a third roller, which conveys the solution to the metallized surface.

The exposure time of the metallized surface to the demetallizing solution can be controlled to ensure that the resulting chemical reaction removes the metal properly from the desired areas.

As set forth above, the demetallizing solution according to the invention can be an aqueous solution of sodium hydroxide (NaOH). When NaOH contacts the metallic surface, the metal is converted into a metallic oxide via an oxidative chemical reaction. To stop this oxidative process, the metallized surface can be washed with water. For example, the metallized surface can be washed using fine sprinklers to cover the entire metallized surface to ensure the removal of any residue and/or excess of the demetallizing solution.

The present invention also relates to the manufacture of an identification device created with a metallized material (e.g., a retro-reflective or holographic material), which device includes a chip and an antenna (i.e., a radio frequency device). According to a preferred embodiment of the invention, the antenna can be formed from the same metallized layer used to manufacture the reflective or holographic material. When the device is made with a holographic image, an identification device can be provided having a capability of both electronic identification (i.e., via the reading of data stored in the chip) and optical identification (i.e., using the holographic image). For example, the device can be configured as an identification card that allows an electronic identification through the reading of data stored in the chip and the optical identification via a check of the hologram on the device.

For the holographic image on the identification device, metallic films such as aluminum films can be used. The metallic films can be grouped on the device to form the hologram using known techniques. For example, the hologram can be made using conventional techniques, such as forming the hologram by stamping a metal foil with a hologram plate made using an engraving process.

In the case of identification cards or identification stickers, which can allow the transmission of identification data stored in a chip to a reading device, a grouping technique can be used involving coupling a transporting unit with a chip and an antenna. The antenna can be made by placing a wire conductor on the device or by etching the antenna in the metallic film.

A purpose of the invention is therefore to provide an identification device that allows both optical identification via a holographic image on the device and electronic identification via an RF chip mounted on the device. The metallized layer can be used to prepare both the antenna for the RF device as well as to prepare the optical image on the device. The fact that the antenna and the image can be made from the same metallized layer represents an advantage since only a single metallized layer is required. As a result, the manufacturing process can be simplified and the cost of manufacturing the device can be reduced.

Additionally, the antenna and the image device can be formed on opposite sides of a substrate material. It may also be advantageous to build the antenna on the device in several parts (i.e., by making one part of the antenna on the same side as the image device and the other part of the antenna on the side opposite the optical image). In this case, a high power antenna can be made on a relatively small identification device.

Depending specifically of the desired frequency of the oscillating circuit made by the chip and the antenna, the antenna may be produced as a coil or as a dipole. To influence the oscillating chip frequency behavior, it may be advantageous to use the image material at least partially to make an electronic commutation element. For example, the image material may be used for making a part of the antenna. This is particularly advantageous when the antenna is made as an antenna coil. It is also possible to use the image material to make a capacitor element. To prevent the creation of metallic layers that may negatively affect the antenna's electromagnetic field, it may be useful to superimpose the image structure with a superficial structure to separate the metallic surface from the hologram support, thereby creating electrically isolated partial metallic layers.

Turning to the figures, FIG. 1 shows the side view of an identification unit **10** according to the invention having a substrate or base layer **11** which has a metallized film or foil **12** mounted on its upper surface **33**. The lower surface **30** of the substrate **11** is also shown. As shown, the metallized film or foil **12** comprises a film **13** coated with a metallic layer **14**. The film **13** is preferably a dielectric film, such as a polymer film. Polyethylene terephthalate (PET) is a preferred material for the film. Other materials, however, can also be used for the film **13**. The substrate is also preferably a dielectric material. However, the substrate **11** can be made of material with either electrically conductive or dielectric properties depending on the type of film **13** used. For example, if the film **13** is a dielectric material, such as a polymer film, the substrate **11** does not have to be a dielectric material.

The identification device **10** shown in FIG. 1 can be in the form of a card or an identification label. A label is typically more flexible than an identification card. The rigidity of the identification device can be varied by the choice of the material used for substrate **11** and by the thickness of substrate **11**.

In addition, it should be noted that the identification device **10** shown in FIG. 1 does not necessarily represent the actual end product but can, in addition to the layers shown in FIG. 1, be provided with further layers, particularly layers covering the top and the bottom. Further, if the identification unit is to be constructed as an identification label, the device can be provided with an adhesive surface such as a pressure sensitive adhesive surface.

FIG. **2** is a top view of an identification device **10** according to the invention. As shown in FIG. **2**, metallized layer **12** has been divided into two fields placed in adjacent position: a holographic image field **16** and an antenna field **17**. In the holographic field **16**, the metallic film **12** forms a holographic image **18** that can be transferred to the identification device in a known manner (e.g., by using a stamping process) to form a hologram **20**.

As shown in FIG. **2**, the antenna field **17** comprises an antenna coil **22** created, for example, by using a chemical etching technique according to the invention. The coil as shown is provided on each end with contact fields **23** and **24**. Contact fields **23** and **24** are provided as through contacts that provide an electric connection with the bottom surface **30** of the base layer **11**, as shown in FIG. **3**.

For the construction of the antenna coil **22** shown in FIG. **2**, a corrosive material (i.e., an aqueous NaOH solution) can be printed onto the metallic layer **14** to selectively remove portions of the metallic layer **18** from the metal foil **12**, thereby leaving behind only the area defined as the antenna coil **22**.

FIG. **3** shows the bottom view of the device of FIG. **2**. As shown in FIG. **3**, the contact points **23**, **24** of the antenna coil **22** are connected as through-contacts to a chip **31** on the bottom side **30** of the substrate **11** which, as shown, is mounted in a chip module **32** to make electrical contact between the antenna **22** and chip **31** easier.

The antenna coil **22** and the chip **31** of the identification device **10** shown in FIGS. **1** to **3** forms a transponder unit **34** which enables, by means of a reader unit, contact-free access to the data on the chip **31** for purposes of electronic identification. At the same time, the hologram **20** mounted on the upper side of the identification unit **10** enables optical identification to be made.

FIG. **4** illustrates an identification device **40** having two substrates **41**, **42** lying on top of each other, each of which has a metallized foil **45**, **46** mounted on its upper surface **43**, **44**. The components are arranged in such a way that metallized foil **45** is positioned between substrates **41** and **42** and metallized foil **46** is situated on the upper surface **43** of the metallized layer **41** and forms at the same time the top layer of the identification device **40**. As shown in FIG. **4**, each of the metal foils **45**, **46** comprises a film or foil layer **47** having a metallized surface **39**. According to a preferred embodiment of the invention, the metal foils 45, 46 comprise a polymer film having a metallized surface comprising aluminum.

In the identification unit 40 shown in FIG. 4, the upper metal foil 46 is structured or divided up in the same way as metal foil 12 of FIG. 2. That is to say, the identification device 40 is provided with both a hologram 20, for example, in a hologram area 16 as well as an antenna coil 22 in an antenna area 17. As shown, the metal foil 45 mounted on the upper side 44 of substrate 42 and arranged between substrate 42 and substrate 41 is provided with a second antenna coil 49 which is in electrical contact with a first antenna coil located on antenna area 17 via through-contacts with contact points 23, 24. The second antenna coil 49 is itself connected by through-contacts with contact points 50, 51 which themselves are connected to a chip module 53, which is mounted in a recess 52 in the bottom of substrate 42. In this way, the antenna coils 22 and 49 each form a component of the complete antenna unit 54 of identification device 40.

FIG. 5 illustrates a top view of an identification device 55 comprising a metal foil 56 on the upper side of a substrate, not shown. In a similar manner to metal foils 12 and 46 of FIGS. 2 and 4, respectively, identification device 55 comprises, for example, a hologram or retro-reflective area 57, or other metallized substance, and an antenna area 58. The antenna area 58 as shown in FIG. 5 comprises a single antenna coil 59, which can be created in the manner previously described by selectively etching a metal foil made up of a metallic layer 61 deposited on a film or foil layer (not shown). As shown, the antenna coil 59 is provided with contact points 62, 63. Contact points 62, 63 can be designed as through-contacts connected to contact areas of a chip module 64 mounted on the bottom side of the substrate.

In the hologram or other metallized area 57 of metal foil 56, a hologram or other image 65 is formed in the metallic layer in the manner previously described. As shown in FIG. 5, however, the hologram or other metal material 65 comprises two image sections 66, 67 which are electrically isolated from each other and which form, when viewed, a complex connected optical structure. The smaller image section 67, is electrically isolated from the larger image section 66. As shown, the smaller image section 67 comprises two metal surfaces which appear generally as two U-shaped islands. As shown in FIG. 5, each of these metal surfaces are connected with a contact area 62 or 63 and form the panels 68, 69 of a capacitor unit 70.

FIG. 6 shows an identification device 71 comprising a metal film 72, similar to the metal films 12, 46, 56 shown in FIGS. 2, 4, and 5, respectively. As shown, the identification device 71 also comprises a holographic field 73, which could also or alternatively include other types of images, or for example, retro-reflective material, and an antenna field 74. In contrast to the metal film 12 shown in FIG. 2, however, the metal film 72 is a reticulated metallic coating having lines or stripes of metallic material 75. As a result, the image is formed from non-metallic fields 76 alternating with metallic fields 77. Such a structure can be created using the same process as the antenna coil 22 using the previously described printing/chemical etching procedure. In particular, the continuous metal coating in the holographic field 73 can be reticulated by printing lines of a chemical etchant on the continuous metal coating. As a result, a reticulated holographic material (i.e., with alternating lines or stripes of metallic material removed) can be formed.

When FIGS. 2 and 6 are compared, it can be seen that the image contents of the holographic material 78 of FIG. 6 and the holographic material 20 of FIG. 2 are similar. However, the images have different resolutions. In particular, the image in FIG. 6 has a lower resolution due to the reticulated structure of holographic material 78. However, the reticulated structure of holographic material 78 reduces interference with RF energy such that an RF transponder can be mounted on the identification device 71.

FIG. 7 illustrates a method of manufacturing a metal foil having a holographic or other metallized field and an antenna field, such as the metal foil 12 shown in FIG. 2. In particular, a metal foil strip 25 with a large number of foil segments 26 connected to each other in continuous order is shown in FIG. 7. When the metal foil strip 25 is separated lengthwise along the dotted severance lines 27, individual metal foil sections, such as metal foil 12 in FIG. 2, can be provided.

As shown in FIG. 7, the metal foil strip 25 comprises, in the running direction 28, a sequence of hologram or other metallized areas 16 and antenna areas 17, continuously following on from each other, which, as shown, are situated on the left and right sides of a central running line 29. The arrangement of the hologram or other metallized areas 16 and the antenna areas 17 in one long line following each other in the running direction 28 enables the continuous production of holograms or other metallized materials 20 in the hologram or other metallized area 16 and of antenna coils 22 in the antenna area 17 when the metal foil strip 25 moves forward in the running direction 28. In addition, the forward movement of the metal foil strip 25 can be phased in such a way that, at various stages (indicated in FIG. 7 as stages I, II and III), various operations can be performed on the foil. In particular, the antenna area 17 on the metal foil strip 25 can undergo printing with a metal etchant in stage 1. The remains of the corrosive material can be washed away, while, at the same time, the oxidized areas of the metallic layer 14 can be removed in stage II. Finally, the antenna area 17 of the metal foil strip 25 can be dried (stage III).

In conjunction with the production of the antenna coil 22 in the antenna area 17 of the metal foil strip 25, the metallized layer in the holographic or other metallized field 16 can be selectively demetallized as shown in FIG. 7. Further, the holographic or other metallized material 20 can be formed in the hologram or other area 16 of the metal foil strip 25 (e.g., by means of a revolving press) after the demetallization process.

In order to construct the identification device 10 shown in FIG. 2, the metal foil strip 25 having holograms or other metallized materials 20 formed in the hologram or other metallized areas 16 and antenna coils 22 formed in the antenna areas 17 can be positioned on a substrate, not shown, laminated (e.g., with an adhesive) and separated along the severance lines 27 to provide individual identification devices, such as the identification device 10 shown in FIG. 2.

A demetallizing process according to the invention will now be described in more detail.

Once the areas to be demetallized have been determined (e.g., using graphical design) a rubber engraving (e.g., flexographic plate) can be made to cover the printing roller that is going to be used to deposit the demetallizing solution (e.g., an aqueous solution of sodium hydroxide) on the metallized surface of the film. The sodium hydroxide solution can, for example, be placed in one of the printing stations of a conventional flexographic printing apparatus. For example, the demetallizing solution can be placed in a stainless steel tray typically used for holding ink. The demetallizing solution can then be applied to the metallized surface by means of the printing roller such that the demetallizing solution is selectively transferred to areas of the metallized surface which are going to be demetallized. The volume of sodium hydroxide that is "printed" on the metallized film can be controlled, as with printing using ink, by, for example, the structure (i.e., the resolution) of the printing roller (i.e., the anilox roller) and the inking rollers and by the pressure that is exerted on the printing roller.

Although the demetallizing effect is practically immediate once the demetallizing solution is applied to the metallized surface, it may be desirable to allow the demetallizing solution to remain a certain amount of time in contact with the metallized surface so that the chemical reaction is completed in those areas in contact with the solution.

To stop the oxidizing effect of the solution, the metallized surface can be washed with water (preferably non-recycled). For example, the metallized surface (previously printed) can be passed through a washing area where the residual sodium hydroxide and the oxidized metal (i.e., aluminum oxide) can be removed. In a preferred embodiment, the water will wet the entire printed area of the metallized surface. For example, fine sprinklers can be used to cover the entire printed area. In order to make the washing process more efficient and to completely remove the residuals of the chemical process, washing may be repeated one or more times using fresh water each time.

Before the film enters the drying station, it may be desirable to remove excess water from the metallized surface in order to facilitate the evaporation of and remaining residual water. In order to remove the water, it is recommendable to use a pair of rollers (e.g., one of rubber and another metallic), air cleaners, sponges and/or air sprinklers. Finally the film is passed through the drying unit through for a heat dry (e.g., using electrical resistance heating) to completely remove the water from the material.

As a complement to the method of selective demetallizing, it is possible to include in the same line of production an overprinting process with ink. In this manner, the effects of demetallizing and printing can be obtained on the same material.

Compared with solvent based inks, water based inks are very manageable, clean and highly resistant to ultraviolet (UV) light. For these reasons, water based inks are desirable. Nevertheless, because one of the sub-processes of the demetallizing process is washing, it is preferable to print with water based inks after the demetallizing and washing steps have been completed.

In addition, if certain metallized areas are desired not to be printed, it is possible to use a transparent solvent based varnish for print protecting the metallized film. After print protection, the metallized layer can be demetallized. In this manner, higher resolutions can be achieved. This technique can be used in high security applications to produce micro-text and/or very fine lines.

A demetallizing process for use with a metallized, such as a retro-reflective material, according to the invention is described below in reference to FIG. 8. First, any liner or protective layer 81 present on the metal layer 83 is removed to expose the metal. In FIG. 8, the metal layer 132 is shown disposed on a carrier or base layer 78. The carrier or base layer 78 can be polyvinyl chloride or polyethylene terephthalate. The metal layer 132 is then selectively exposed 79 to the corrosive action of a corrosive material, such as a sodium hydroxide solution, using a flexographic, screen, offset or any other printing process to remove metal from the desired areas. This process is described in detail in Mexican Patent Application Nos. 2001/010968 and 2001/010969 as well as in German Patent Application No. 101 21 126. These applications are herein incorporated in their entirety by reference. Selective metal removal can be used to form an antenna for the RF transponder.

As a second step, a fine line demetallizing process can be performed over the remaining metal surface using the same demetallizing process to break the conductivity of the metal layer and the absorption or distortion of radio waves. This allows the RF energy to be captured by the antenna of the radio frequency device. This process is preferably done at a high resolution to maintain the retro-reflective (or, for example, holographic) properties of the remaining metal layer while, at the same time, interrupting the conductivity of the metal to allow RF reception and transmission.

According to a preferred embodiment of the invention, the metallized layer is demetallized in a square grid pattern comprising a first set of parallel lines of demetallized material oriented at right angels to a second set of parallel lines or demetallized material. According to a further embodiment of the invention, the squares of metallized material in the square grid pattern will have dimensions of 5 mm×5 mm or less, more preferably 3 mm×3 mm or less. It has been found that, when the squares of metallized material have dimensions of about 5 mm or less, shielding (i.e., distorion and/or absorption) is reduced to about 5% or less and when the squares of metallized material have dimensions of about 3 mm or less, shielding (i.e., distorion and/or absorption) is reduced to about 1% or less.

Although a square grid demetallized pattern is preferred, other patterns can be employed according to the invention. When other patterns are employed, it is preferred that the longest straight line that can be drawn on any metallized area is about 5 mm or less, more preferably about 3 mm or less.

A schematic of an apparatus for selective demetallization of a roll of metallized material is shown in FIG. 9. As shown in FIG. 9, metallized material (e.g., retro-reflective material) from a roll 121 is unrolled and passed over a printing roller 123 where a chemical etchant (e.g., NaOH) from reservoir 35 is applied in a desired pattern. The printed metallized layer is then passed over a temperature application roller 128 to a washing station 36. After washing, hot air from dryer 37 is directed over the surface of the washed material. Afterward, the selectively demetallized material is optionally transferred to various printing stations 38, 120 so that designs can be overprinted thereon. After over-printing, the metallized material can be transferred to an adhesive application roller 122 and adhesively bonded to a carrier material or base layer material 124. The base layer material 124 can have perforations (not shown) to allow for separation of individual identification devices from the continuous length. After bonding to the base layer, the material is shown wound onto a take-off roller 126.

After exposing the material to the demetallizing agent, the demetallizing process can be terminated by washing the surface with water and immediately drying. Afterward, a design can be over-printed on the identification device using a fixed or variable printing process.

Once the metal is removed from an area of the device, it is possible to mount a radio frequency device in the demetallized area. The radio-frequency device can be used as a label or as an identification tag, such as a car license plate.

In one example application, labels according to the invention can, for example, be used for all types of vehicle control. The labels can be provided in auto-adhesive form for use with a car license plate, a tractor platform or for container information, vehicle control applications, etc. The labels can be provided with read and write capabilities and can include biometric data, such as fingerprints, iris recognition data, facial recognition data, voice recognition data, picture data and traffic violation data for drivers.

Car license plates are typically made from metal, acrylic or polycarbonate. Regardless of the material, the process of applying an RF device will usually be similar. This process is described below with reference to FIG. 10 for a metal license plate. First, an upper surface 82 of a metal plate 80 is embossed to form a depressed region 84. An isolation layer 86 (e.g., a ferrite composite layer) is then deposited in depressed region 84. A radio frequency device 88 is then mounted on the isolation layer. In this manner, RF device 88 is able to transmit and receive information without interference from the metal plate 80. Afterward, the license plate can be laminated with, for example, a selectively demetallized retro-reflective material 90. According to a preferred embodiment of the invention, the region of the retro-reflective material 90 above the area 92 where the radio frequency device 88 is mounted will be free of metallized material. Further, the rest of the retro-reflective material 90 is preferably selectively demetallized with a fine line demetallizing pattern 94 using a demetallizing process as described above to reduce interference.

The resulting license plate is shown in FIG. 11. As can be seen from FIG. 11, the license plate 94 comprises an antenna region 96 and a retro-reflective region 98. The retro-reflective region is shown over-printed with a license plate number. As can be seen from FIG. 11, the retro-reflective material has been removed from the antenna region 96. The antenna can be formed by selectively demetallizing a continuous metal layer using a printing procedure as described above.

An alternative process of forming the antenna comprises producing a thin polymer layer (e.g., polyvinyl chloride (PVC) or polyethylene terephthalate) having an antenna (preferably a copper antenna) embedded therein. Structures of this type are commonly referred to as inlays. A method of manufacturing an inlaid antenna according to the invention is shown in FIG. 12. As shown in FIG. 12, a conductive wire 100 (preferably a copper wire) is unrolled from a spool 102 and embedded in the surface of a polymer sheet 104. As shown in FIG. 12, the conductive wire 100 passes over a thermal ultrasound head 106 and under a bridge 108 before being embedded in the polymer sheet 104 to form the antenna 110. The inlaid antenna can be applied with an auto-adhesive or pressure sensitive adhesive to the base layer or substrate of the identification device. The antenna should be applied in an area of the device that has been demetallized to avoid contact with any metal in the identification device.

An alternative way of obtaining a retro-reflective or other metallized material on a metal plate or sticker can be employed wherein the carrier or base layer is a polymer such as PVC or PET. In this embodiment, the antenna can be embedded directly in the carrier using ultrasonic energy as set forth above. The retro-reflective or other metallized layer can then be applied onto the carrier. Portions of the retro-reflective or other metallized layer overlying the antenna should be demetallized to avoid any contact of the antenna with the metal content of the retro-reflective or other metallized material. A fine line demetallization process can be used as describe above over the remainder of the retro-reflective or other metallized material to minimize RF distortion or absorption that can interfere with the radio frequency device. Afterward, an acrylic or epoxy resin can be applied to transform the identification device into a label

FIG. 13 shows an identification device according to this embodiment of the invention wherein an inlaid antenna 110 is positioned on a carrier layer (not shown) beneath a demetallized portion 112 of a retro-reflective or other metallized layer 114. Also as shown in FIG. 13, a fine line demetallizing process has been used on the continuous metal portion 116 of the retro-reflective layer 114 to reduce interference and thereby ensure adequate performance of the radio frequency transmitting 118 and receiving 119 functions. In this manner, the retro-reflective or other metallized material properties can be retained while allowing for the adequate transmission and reception of RF energy.

These and other modifications and variations to the present invention may be practiced by those of ordinary skill in the art, without departing from the spirit and scope of the present invention. Furthermore, those of ordinary skill in the art will appreciate that the foregoing description is by way of example only, and is not intended to limit the invention.

What is claimed is:

1. An identification device, comprising:

a base layer;

a radio-frequency (RF) transponder comprising an RF chip and an antenna disposed on the base layer, wherein the antenna is in electrical communication with the chip; and

a metallized region;

wherein the metalized region includes a holographic image;

wherein the holographic image and the antenna form a single layer;

wherein the metallized region has been selectively demetallized, such that the RF transponder is able to transmit and receive information.

2. The device of claim 1, wherein the metallized region includes a retro-reflective layer.

3. The device of claim 1, wherein the base layer has at least one side, and wherein the antenna and the metallized region are located on the same side of the base layer.

4. The device of claim 1, wherein the base layer has at least a first side and a second side, the first side being opposite the second side, and wherein the antenna and the metallized region are located on opposite sides of the base layer.

5. The device of claim 1, wherein the base layer has at least a first side and a second side, the first side being opposite the second side, and wherein a first part of the antenna and the metallized region are located on the first side, and a second part of the antenna is located on the second side of the base layer, and wherein the first part of the antenna is electrically connected to the second part of the antenna.

6. The device of claim 1, wherein the device comprises an upper metal layer positioned above the base layer and a lower metal layer positioned below the base layer, wherein a first part of the antenna is formed on the upper metal layer and a second part of the antenna is formed on the lower metal layer, the device further comprising a through contact connecting the first part of the antenna to the second part of the antenna.

7. The device of claim 1, wherein the metallized region comprises a plurality of electrically isolated holographic regions.

8. The device of claim 1, wherein the base layer is an electrically conductive layer.

9. The device of claim 8, wherein an isolation layer is formed on the base layer.

10. The device of claim 9, wherein the radio frequency (RF) chip is mounted on the isolation layer.

11. The device of claim 9, wherein the base layer includes a depressed region, and wherein the isolation layer is formed in the depressed region.

12. The device of claim 1, wherein the base layer has at least one side, and wherein the antenna and the metallized region are formed on the same side of the base layer in discrete, non-overlapping areas.

13. The device of claim 1, wherein the antenna comprises a conductive wire inlaid in a polymer layer.

14. The device of claim 1, wherein the device is selected from the group consisting of a decal, a license plate, and an identification card.

15. The device of claim 1, wherein the metallized region has been selectively demetallized in a square grid pattern.

16. The device of claim 15, wherein the squares in the square grid pattern have a length of about 5 mm or less.

17. The device of claim 15, wherein the squares in the square grid pattern have a length of about 3 mm or less.

18. An identification device, comprising:

a base layer;

a radio-frequency (RF) transponder comprising an RF chip and an antenna disposed on the base layer, wherein the antenna is in electrical communication with the chip; and

a metallized region;

wherein the metalized region includes a holographic image;

wherein the metallized region has been selectively demetallized, such that the RF transponder is able to transmit and receive information and

wherein the metallized region is in electrical communication with the antenna.

19. The device of claim 18, wherein the metallized region comprises an electronic commutation element.

20. The device of claim 18, wherein the metallized region comprises a capacitor.

21. A method of making an identification device comprising a base layer and a plurality of metallized regions disposed thereon, the method comprising:

forming an antenna in a first metallized region; and

forming a holographic image in a second metallized region;

wherein the antenna is formed by a method comprising:

transferring a metal etching solution to portions of an exposed surface of the metallized layer using a printing process;

allowing the etching solution to react with the metal to selectively demetallize the surface; and

washing the selectively demetallized surface and

wherein the first and second metallized regions form a single metal layer.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,034,688 B2
APPLICATION NO. : 10/118,092
DATED : April 25, 2006
INVENTOR(S) : Reitzler, et al

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page, col. 1 section (65) Prior Publication Data– include the folowing:

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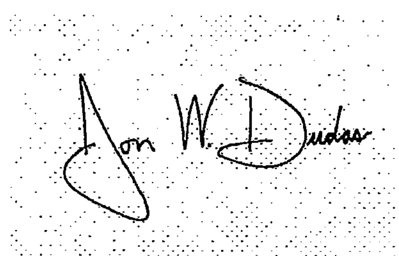
10121126.0	04/30/01	Germany
010967	10/26/01	Mexico
010968	10/26/01	Mexico
010969	10/26/01	Mexico
010671	10/26/01	Mexico
003141	03/25/02	Mexico
003202	03/26/02	Mexico

Signed and Sealed this

Fifteenth Day of August, 2006



JON W. DUDAS
Director of the United States Patent and Trademark Office

EXHIBIT "B"


sirit
Tamper evident windshield tag


Track vehicle registration, insurance
& compliance
2554
TOYOTA
sirit

EXHIBIT "C"

US007463154B2

(12) **United States Patent**
Cortina et al.

(10) **Patent No.: US 7,463,154 B2**
(45) **Date of Patent: *Dec. 9, 2008**

(54) **SELECTIVE METAL REMOVAL PROCESS FOR METALLIZED RETRO-REFLECTIVE AND HOLOGRAPHIC FILMS AND RADIO FREQUENCY DEVICES MADE THEREWITH**

(75) Inventors: **Francisco Martinez De Velasco Cortina**, Col. Hipodromo Condesa (MX); **Manfred Rietzler**, Marktoberdorf (DE)

(73) Assignee: **Neology, Inc.**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 3 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **10/485,863**

(22) PCT Filed: **Apr. 30, 2002**

(86) PCT No.: **PCT/IB02/01439**

§ 371 (c)(1),
(2), (4) Date: **Oct. 7, 2004**

(87) PCT Pub. No.: **WO02/089338**

PCT Pub. Date: **Nov. 7, 2002**

(65) **Prior Publication Data**

US 2005/0046573 A1 Mar. 3, 2005

Related U.S. Application Data

(63) Continuation-in-part of application No. 10/118,092, filed on Apr. 9, 2002, now Pat. No. 7,034,688.

(30) **Foreign Application Priority Data**

Apr. 30, 2001	(DE)	101 21 126
Oct. 26, 2001	(MX)	010967
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Oct. 26, 2001	(MX)	010969
Oct. 26, 2001	(MX)	010971
Mar. 25, 2002	(MX)	003141
Mar. 26, 2002	(MX)	003202

(51) **Int. Cl.**

G08B 13/14	(2006.01)
G06K 19/06	(2006.01)
H01L 23/02	(2006.01)
H01Q 7/04	(2006.01)

(52) **U.S. Cl.** 340/572.7; 340/572.8; 235/492; 257/679; 343/842

(58) **Field of Classification Search** ... 340/572.1–572.9; 235/492; 257/679, 787; 343/841–842, 851, 343/749–752

See application file for complete search history.

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Primary Examiner—Benjamin C Lee
(74) *Attorney, Agent, or Firm*—Baker & McKenzie LLP

(57) **ABSTRACT**

A method for selectively removing metal from a metallized substrate (e.g., a metallized polymer film) and the formation of devices thereby are provided. Th method involves selectively exposing the metallized surface to a demetallizing (i.e., an oxidizing) chemical solution. The metallized layer can be selectively exposed to the demetallizing solution using a flexographic printing process wherein printing rollers are used to transfer the demetallizing solution to the metallized surface. An identification device including, for example, a holographic, retro-reflective, or other metallized material and a radio-frequency transponder are also provided. The radio-frequency transponder includes an RF chip and an antenna in electrical communication with the chip. The identification device including the holographic image allows both electronic identification through the reading or identification data stored in the chip and optical identification via the holographic image.

34 Claims, 7 Drawing Sheets

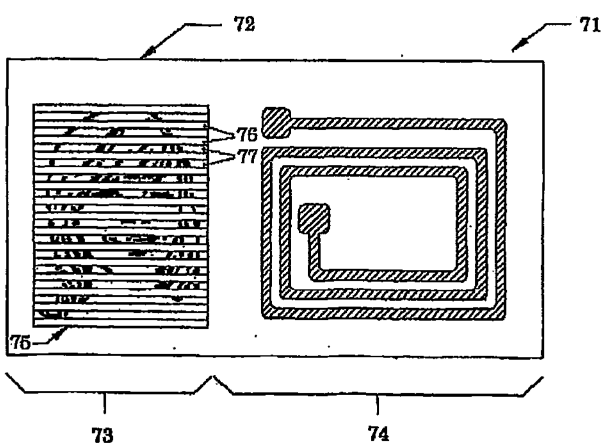

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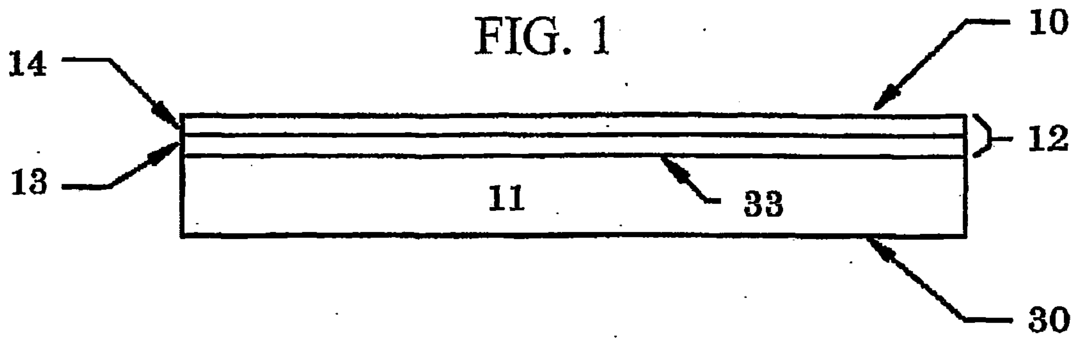
FIG. 1



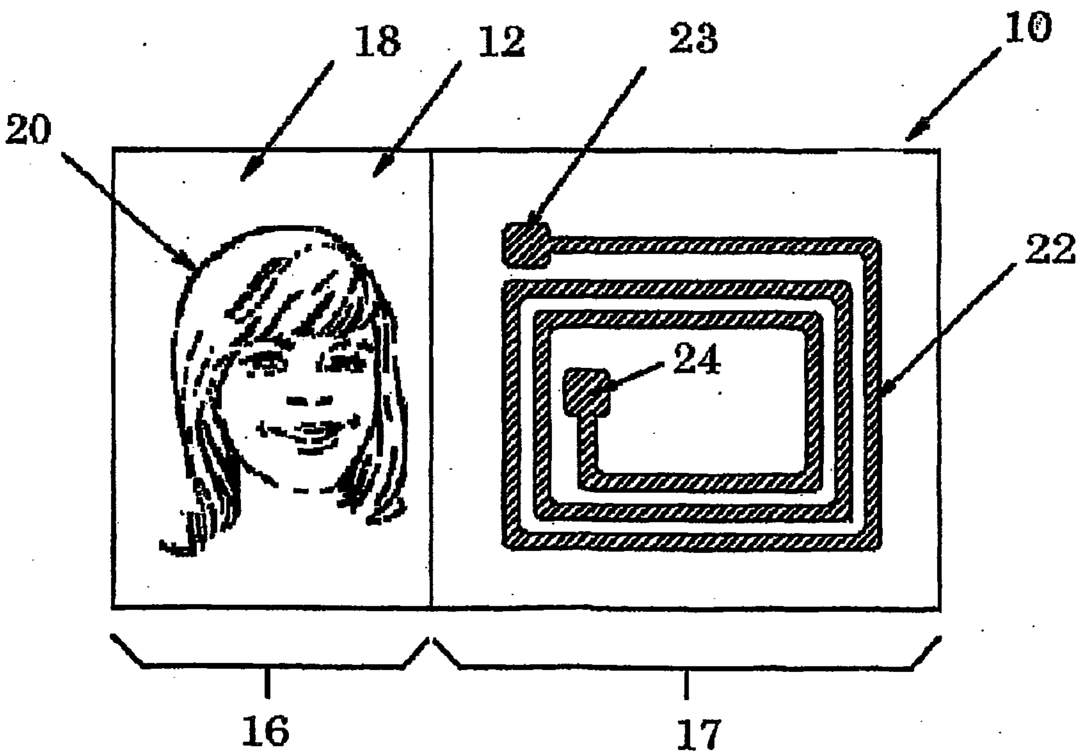
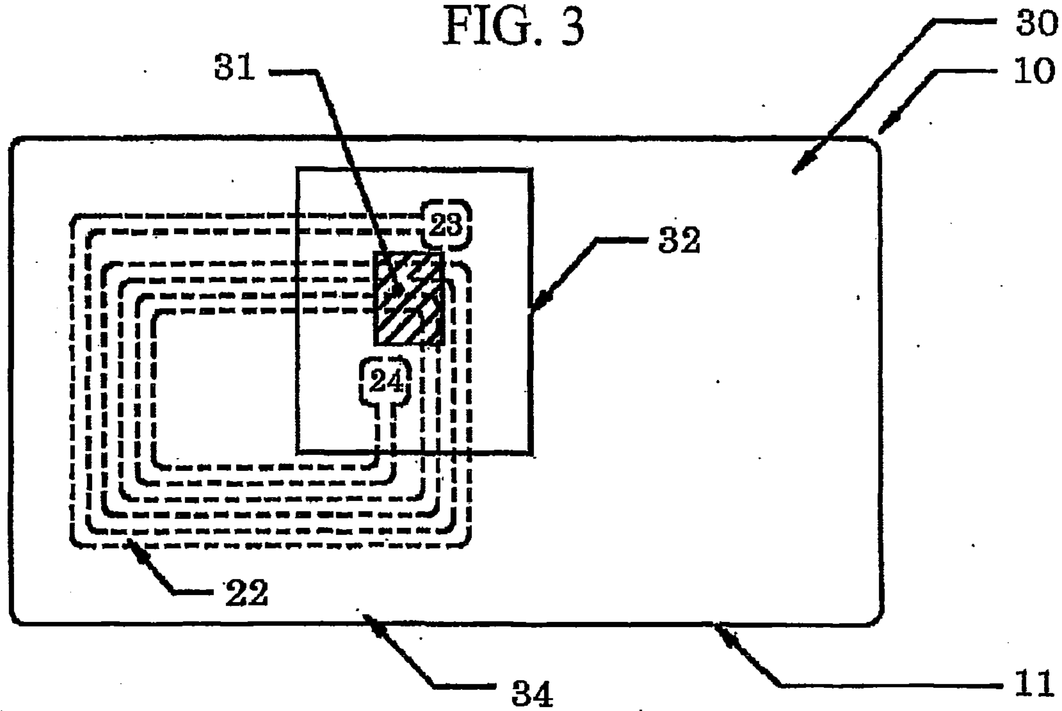


FIG. 2

FIG. 3



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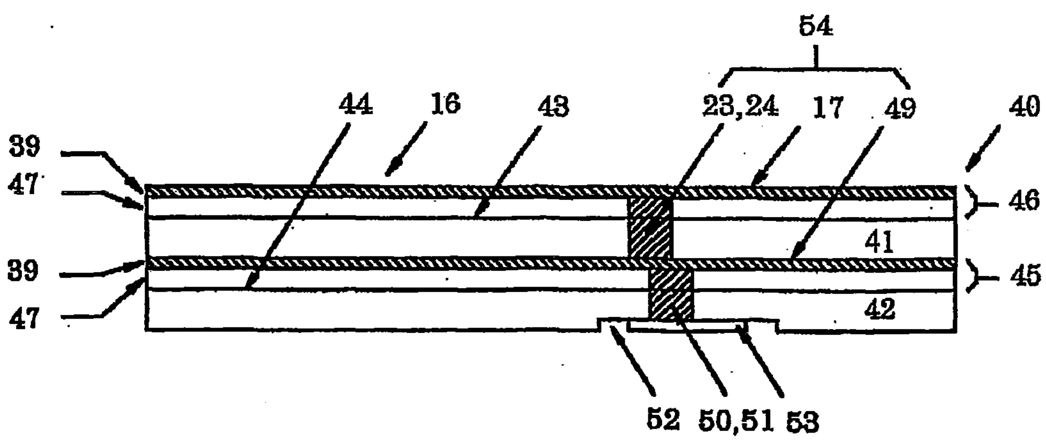

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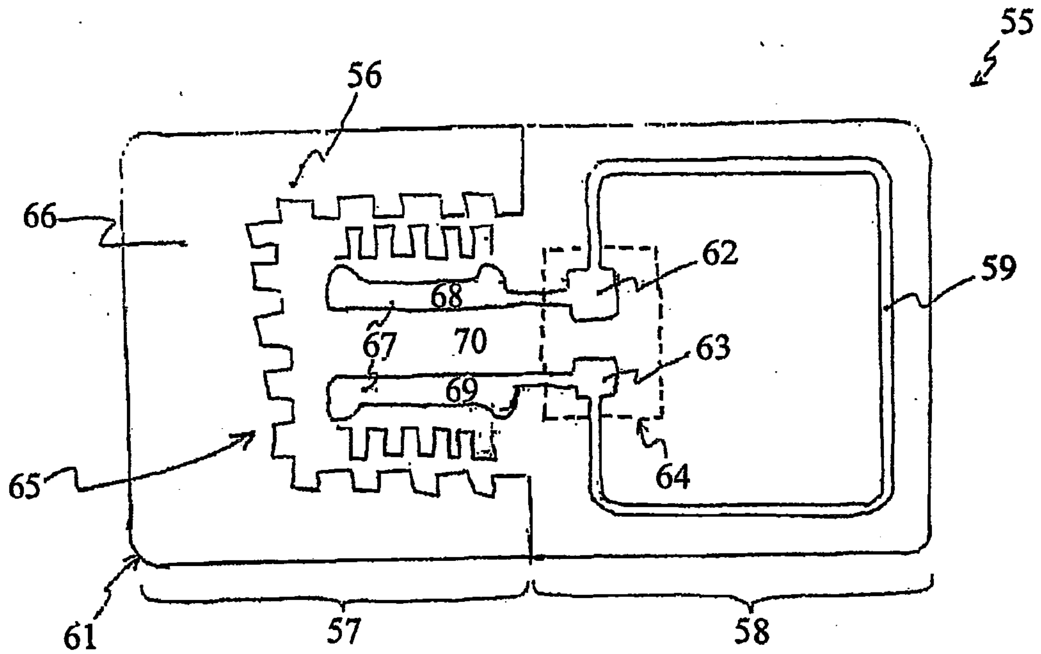
FIG. 4

FIG. 5



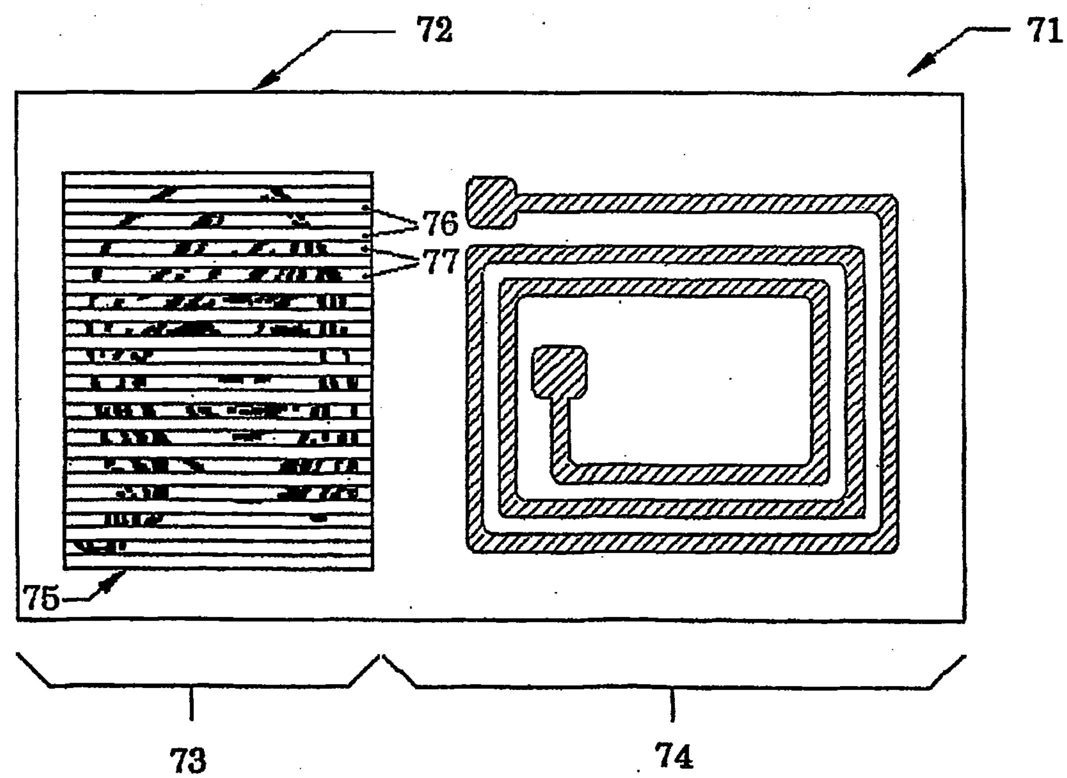


FIG. 6

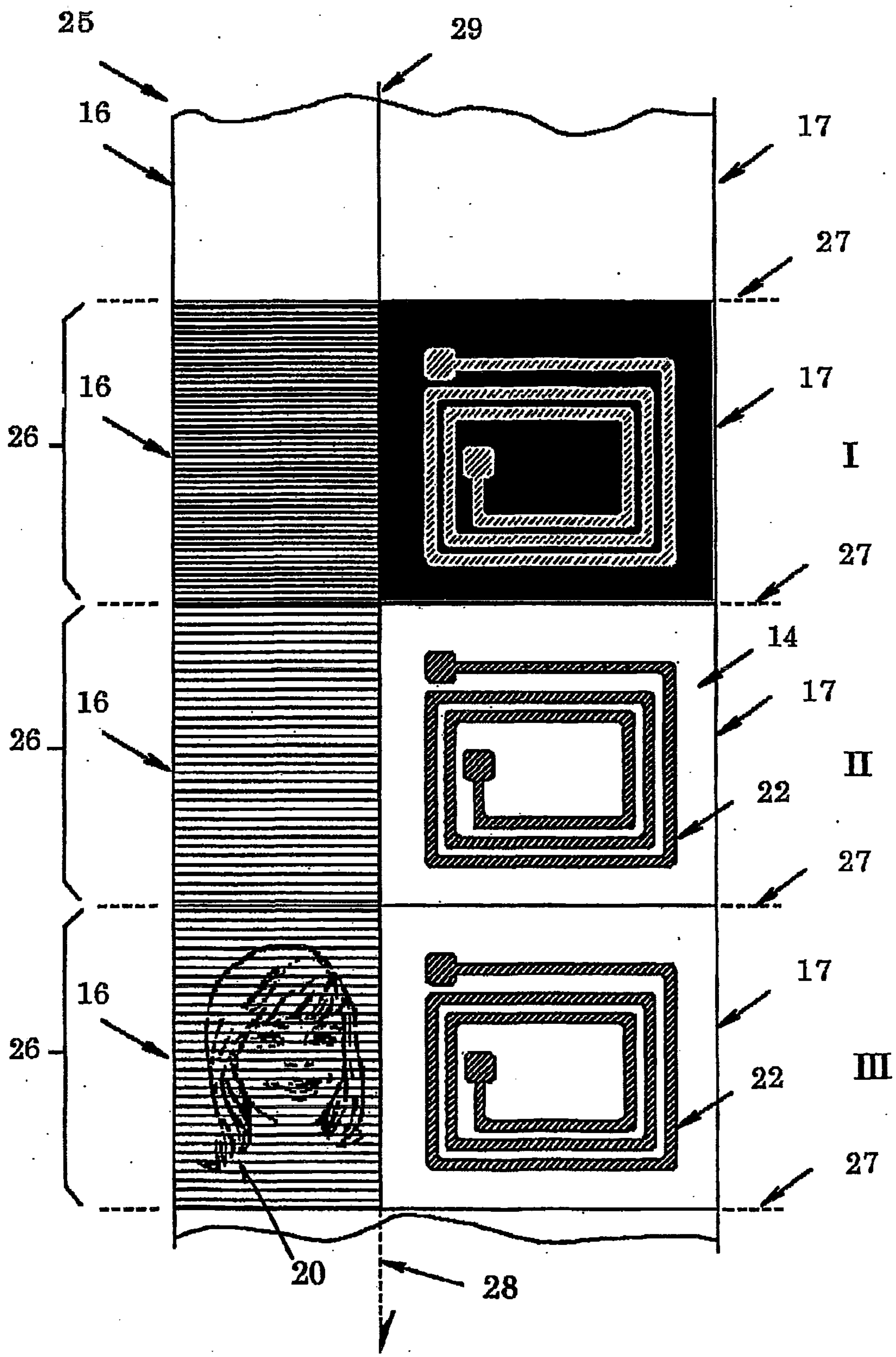

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FIG. 7

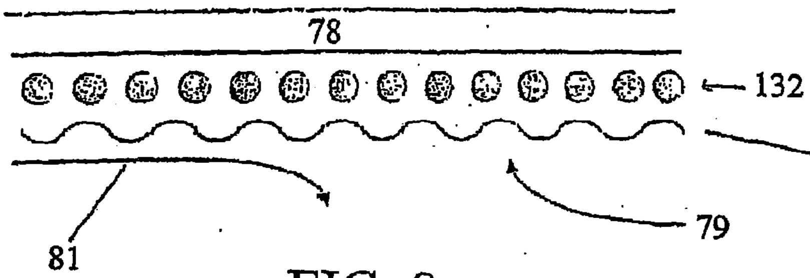

FIG. 8

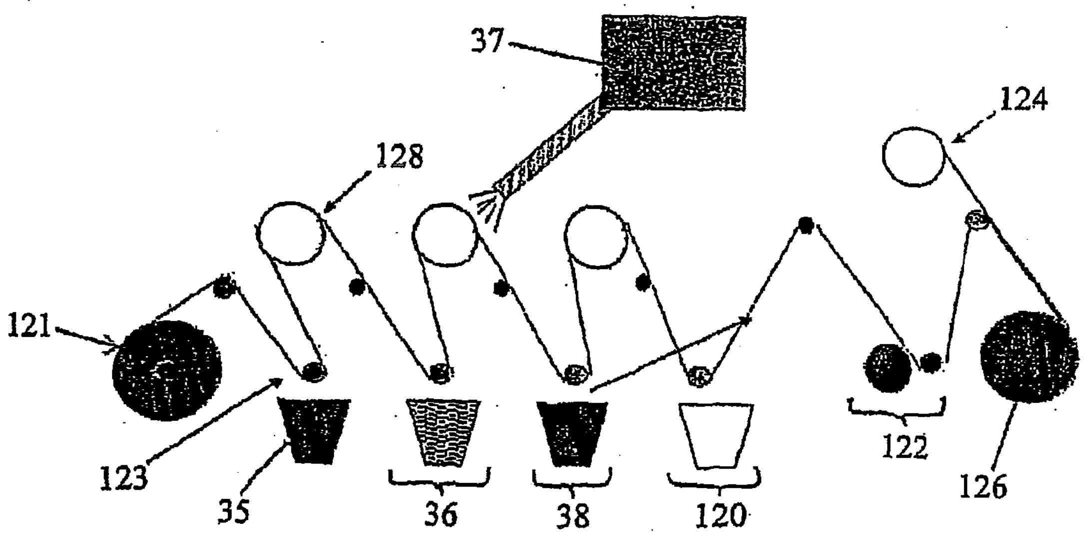

FIG. 9

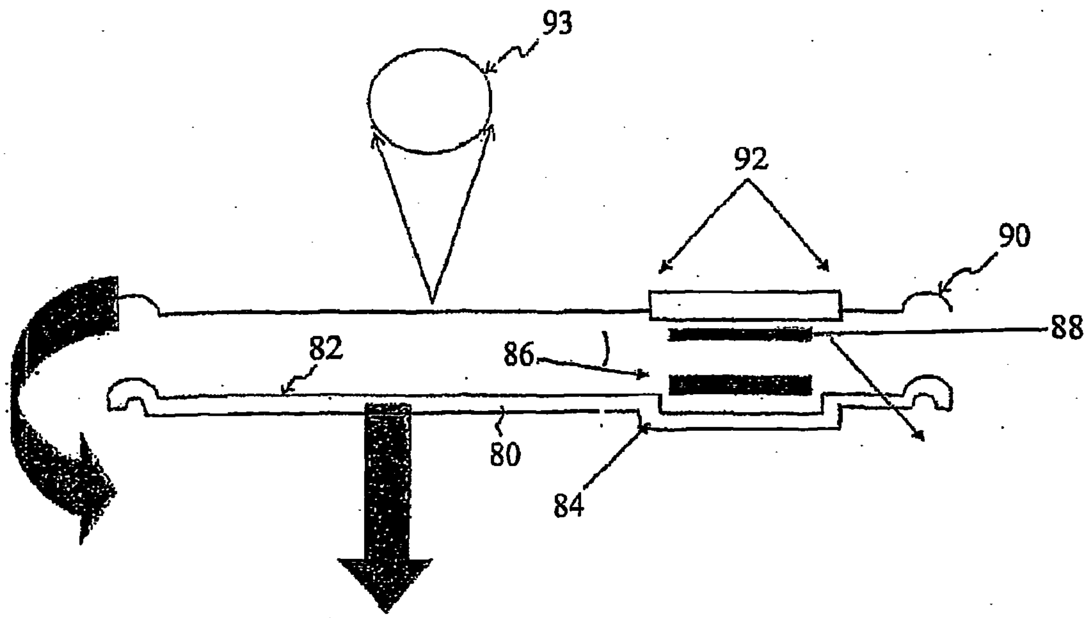

FIG. 10

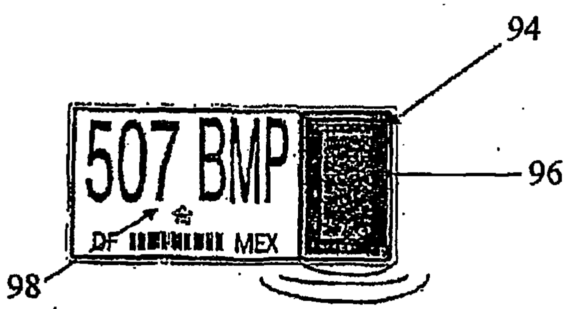

FIG. 11

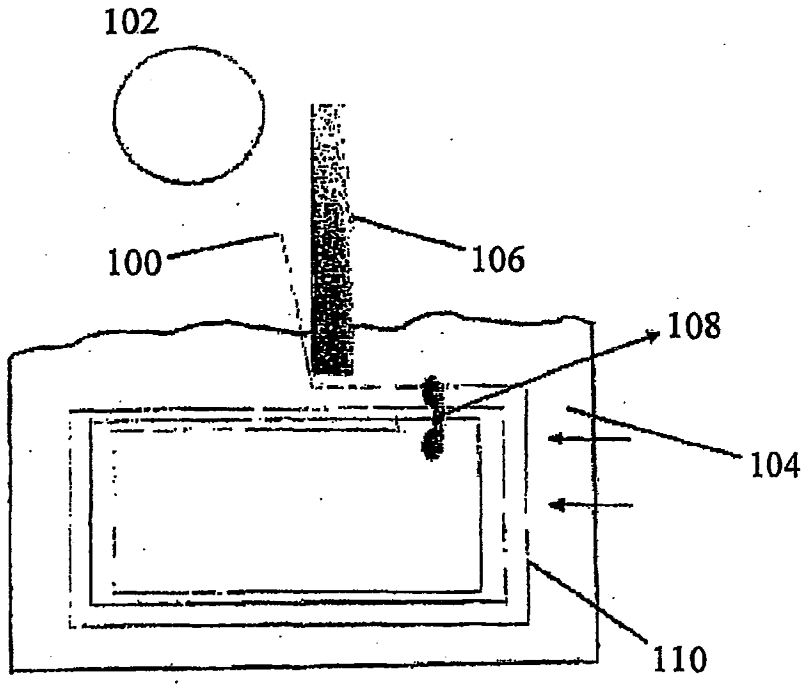

FIG. 12

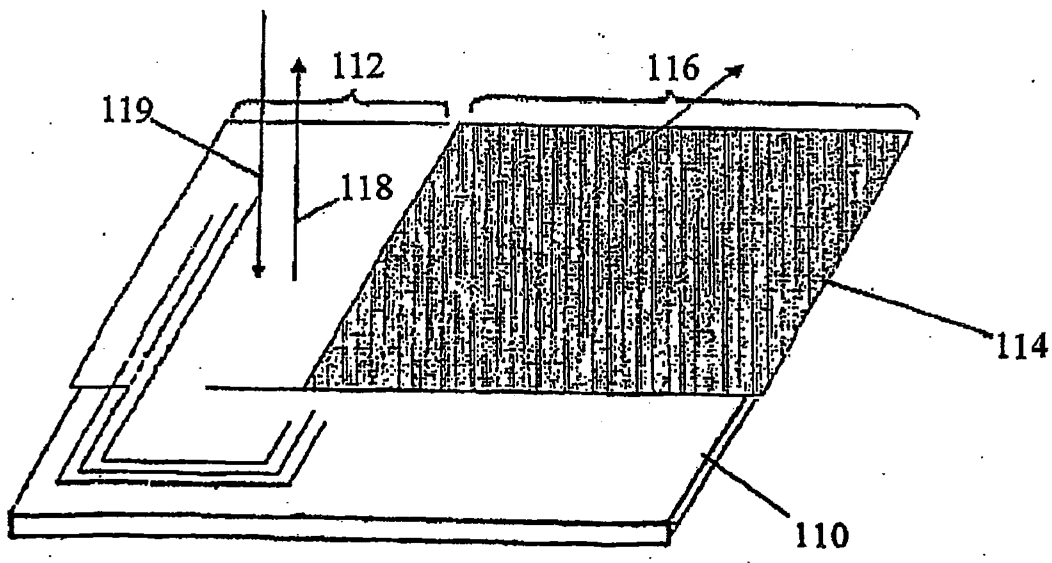

FIG. 13

SELECTIVE METAL REMOVAL PROCESS FOR METALLIZED RETRO-REFLECTIVE AND HOLOGRAPHIC FILMS AND RADIO FREQUENCY DEVICES MADE THEREWITH

This application claims priority from German Patent Application No. 10121126.0 filed 30 Apr. 2001 and from Mexican Patent Applications No. 010967 filed 26 Oct. 2001, No. 010968 filed 26 Oct. 2001, No. 010969 filed 26 Oct. 2001, No. 010971 filed 26 Oct. 2001, No. 003141 filed 25 Mar. 2002, and No. 003202 filed 26 Mar. 2002, the disclosures of all of which are hereby incorporated by reference. This application is a continuation-in-part of U.S. patent application Ser. No. 10/118,092 filed 9 Apr. 2002, now U.S. Pat. No. 7,034,688 the disclosure of which is also hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to a process for selectively removing metallic material from a metallized film and, in particular, to the removal of metallic material from a metallized polymeric film using a printing method such as flexographic printing. The film can be a reflective film (e.g., a retro-reflective film) or a holographic film that can be used, for example, in an identification device comprising a radio frequency (RF) transponder.

2. Background of the Technology

Retro-reflective materials can reflect and re-emit incident light in a direction that is parallel to that of the source of the incident light. In other words, retro-reflective materials reflect light directly back toward the source of the light Such materials and devices are widely used in the areas of nighttime transportation and safety. For example, retro-reflective materials are used to identify highway lanes and road signs using the light emitted from vehicle headlights. Retro-reflective materials are also used for the production of car plates, decals and distinctives for all kinds of vehicles and for truck containers, tractors and other applications. Retro-reflective materials have a bright effect under direct light without disturbing human sight

Holographic materials have also been used for identification purposes. Since holograms are all but impossible to counterfeit, they are being increasingly used on all types of identification, including driver's licenses, credit cards, bus passes, etc., to increase security.

Both retro-reflective and holographic materials typically contain a very high level of metal such as aluminum. Holograms, for example, are typically stamped from metal foils. It is known that metal blocks the transmission and reception of radio frequency (RF) signals because the RF signal is absorbed or distorted by the metal content in the material. As a result, the signal cannot be received by an antenna blocked by metal. Such a blocked signal cannot be used, for example, to activate a connected device. This same blocking effect can occur whether the device is positioned on top of or underneath the metallic material because the distortion and absorption of the RF signal will be affected in either case. Thus, there is a problem in the prior art with regard to using retro-reflective and holographic materials, as well as other materials containing metals, on the surface of devices for receiving RF signals.

It would be desirable to incorporate an RF transponder into an identification device comprising a retro-reflective material, a holographic image, or other material containing a metal. The RF transponder could be used for electronic identification.

SUMMARY OF THE INVENTION

According to a first aspect of the invention, an identification device is provided that includes retro-reflective or holographic materials, or other materials containing metal, and a usable antenna for receiving radio frequency (RF) signals. The identification device comprises: a base layer, an RF transponder comprising a mounted RF chip and an antenna disposed on the base layer, and a metallized region. The metallized region can comprise a holographic image or a ret reflective layer. The antenna is in electrical communication with the chip.

According to this aspect of the invention, the metallized region is discontinuous, such that the RF transponder can transmit and receive information at radio frequencies.

According to a second aspect of the invention, a method of forming a pattern in a metallized layer is provided. The method comprises: transferring a metal etching solution to portions of an exposed surface of the metallized layer using a printing process; allowing the etching solution to react with the metallized layer to selectively demetallize the surface; and washing the selectively demetallized surface.

According to a third aspect of the invention, a method of making an identification device comprising a base layer and at least one metal region disposed thereon is provided. The method comprises: selectively demetallizing a first metal region of the device; forming a holographic image in the first metal region; forming an antenna on the base layer; and mounting an RF chip on the base layer in electrical communication with the antenna to form an RF transponder. According to this aspect of the invention, the selective demetallization of the first metal region allows the RF transponder to transmit and receive information.

According to a fourth aspect of the invention, a method of making an identification device comprising a base layer and a metallized retro-reflective layer is provided. The method comprises: forming an antenna on a base layer; and mounting a radio frequency (RF) chip on the base layer in electrical communication with the antenna to form an RF transponder. According to this aspect of the invention, the antenna is formed by selective de-metallization of a continuous metallized layer or by partial deposition of a discontinuous metallized layer.

According to a fifth aspect of the invention, an identification device is provided. The device includes a base layer and a radio-frequency (RF) transponder comprising an RF chip and an antenna disposed on the base layer wherein the antenna is in electrical communication with the chip. According to this aspect of the invention, the antenna is formed by selective de-metallization of a continuous metallized layer or by partial deposition of a discontinuous metallized layer.

Additional advantages and novel features of the invention will be set forth in part in the description that follows, and in part will become more apparent to those skilled in the art upon examination of the following or upon learning by practice of the invention.

BRIEF DESCRIPTION OF THE FIGURES

The invention will be described with reference to the accompanying figures, wherein:

FIG. 1 is a lateral cross-sectional view of a metallized substrate suitable for making an identification device according to the invention;

FIG. 2 is a top view of an identification device according to the invention comprising a holographic image and an antenna;

FIG. 3 is a bottom view of the identification unit shown in FIG. 2, showing a chip module mounted on the bottom surface of the identification device;

FIG. 4 is a lateral cross-sectional view of a further embodiment of a device according to the invention, comprising two metallized layers arranged one above the other;

FIG. 5 is a top view of a device according to the invention, wherein the antenna is in electrical communication with the holographic image;

FIG. 6 is a top view of a further embodiment of an identification device according to the invention, wherein the device has a selectively demetallized holographic image;

FIG. 7 illustrates a method of making identification devices from a continuous strip of metallized material having multiple segments that may be separated from the strip to make individual identification devices, in accordance with embodiments of the invention;

FIG. 8 illustrates a method of selectively removing metal from a metallized substrate according to the invention;

FIG. 9 shows an apparatus that can be used for the continuous selective demetallization of a metallized film according to the invention;

FIG. 10 shows a method of making a license plate having a retro-reflctive layer and an RF transponder according to the invention;

FIG. 11 shows a license plate according to the invention, comprising a retro-reflective layer and an RF transponder made by the method illustrated in FIG. 10;

FIG. 12 shows a method of forming an inlaid antenna according to the invention; and

FIG. 13 shows a method of forming an identification device according to the invention comprising inlaying an antenna in the base layer and overlying a selectively demetallized retro-reflective layer.

DETAILED DESCRIPTION OF THE INVENTION

The present inventors have discovered a method by which a radio frequency (RF) device can be integrated into an identification device comprising a metallized reflective (e.g., a retro-reflective) or holographic material. In particular, the present inventors have discovered that, by selectively removing or depositing metal to form a discontinuous metal layer, the conductivity of the metallized layer can be broken and the effect of absorption and distortion of the radio waves that an RF device uses as a power source can be reduced. In this manner, a radio frequency device can be incorporated into a retro-reflective or holographic material, such as a license plate, a decal (e.g., for a car license plate) or an identification card.

According to the invention, a demetallizing solution, such as a solution of sodium hydroxide (NaOH), can be used in place of ink in a printing process to selectively demetallize a metal layer. In particular, the demetallizing solution can be poured into the stainless steel trays of a printing apparatus. The demetallizing solution can then be applied to the metallized surface using a printing process. For example, the solution can be applied to a printing plate having a raised pattern. The plate can then be contacted with the metallized surface such that the solution on the raised areas is transferred to the metallized surface. The application of the demetallizing solution to the metallized surface can be controlled by the inking rollers of a printing apparatus (e.g., by the pressure applied to the inking rollers).

According to a preferred embodiment of the invention, the demetallizing solution is applied to the metallized layer using a flexographic printing process. The flexographic printing process is a rotary in-line printing method that uses flexible resilient plates with raised images to apply inks to a substrate. According to a preferred embodiment of the invention, the flexographic printing process can be performed using laser-engraved anilox rolls to allow for high resolutions.

By using a printing process, such as a flexographic printing process, the sodium hydroxide solution can be transferred to selective portions of the metallized film. In this manner, metal can be selectively removed from those areas. According to the invention, the exposure time of the metallized layer to the sodium hydroxide solution can be controlled to ensure that the resulting chemical reaction sufficiently removes metal from the desired areas.

According to the invention, after the demetallization process is complete, the selectively demetallized film can be transferred to a washing unit where any excess or remaining chemical solution can be removed. According to a preferred embodiment of the invention, washing of the demetallized surface can be accomplished using fine sprinklers.

The metallized film, which has been moistened by the previous wash, can then be subjected to a residue evaporation process. Residue evaporation can be accomplished using a set of two rolls (e.g., one made of rubber, one made of steel), as well as by such processes as use of air-cleaning filters, sponges and/or blown air. The residue evaporation process can be used as a preparation step preliminary to a heat-driven drying stage. During the heat-driven drying stage, the heat can be generated, for example, by electrical resistance.

The metal removal process according to the invention can be used to produce a metallized material that is non-blocking to radio frequency transmissions. Therefore, a radio frequency device can be incorporated into an identification device (e.g. a card or plate) having a metallized (i.e., a retro-reflective or holographic) layer. As a result of the demetallization process, the radio-frequency device can transmit or receive information while in close proximity to the metallized layer. Additionally, by using a selective demetallization process according to the invention, the metallized film can be made translucent. Therefore, a visible seal can be incorporated beneath the metallized layer according to the invention.

Features of the present invention directed to a metal-removal process for a metallized material (e.g., a metallized polymer film) will now be described in greater detail. According to a preferred embodiment of the invention, the method comprises subjecting the metallized material to a flexographic printing process, wherein the inks are replaced by a metal etching solution. According to a preferred embodiment of the invention, the metal etching solution is an oxidizing solution. For example, an oxidizing solution can be poured into the stainless steel ink trays of a standard flexographic printing station. The oxidizing solution according to the invention preferably comprises sodium hydroxide (NaOH), water (H_2O), and, optionally, ethylene-glycol. The ethylene glycol can be used as a density-reduction agent.

According to a preferred embodiment of the invention, the oxidizing solution can be transferred to the inking rollers through a second roller (i.e., an "anilox" roller). The oxidizing solution can then be transferred to a third roller, which conveys the solution to the metallized surface.

The exposure time of the metallized surface to the demetallizing solution can be controlled to ensure that the resulting chemical reaction removes the metal properly from the desired areas.

As set forth above, the demetallizing solution according to the invention can be an aqueous solution of sodium hydroxide (NaOH). When NaOH contacts the metallic surface, the metal is converted into a metallic oxide via an oxidative chemical reaction. To stop this oxidative process, the metallized surface can be washed with water. For example, the metallized surface can be washed using fine sprinklers to cover the entire metallized surface to ensure the removal of any residue and/or excess of the demetallizing solution.

The present invention also relates to the manufacture of an identification device created with a metallized material (e.g., a retro-reflective or holographic material), which device includes a chip and an antenna (i.e., a radio frequency device). According to a preferred embodiment of the invention, the antenna can be formed from the same metallized layer used to manufacture the reflective or holographic material. When the device is made with a holographic image, an identification device can be provided having a capability of both electronic identification (i.e., via the reading of data stored in the chip) and optical identification (i.e., using the holographic image). For example, the device can be configured as an identification card that allows an electronic identification through the reading of data stored in the chip and the optical identification via a check of the hologram on the device.

For the holographic image on the identification device, metallic films such as aluminum films can be used. The metallic films can be grouped on the device to form the hologram using known techniques. For example, the hologram can be made using conventional techniques, such as forming the hologram by stamping a metal foil with a hologram plate made using an engraving process.

In the case of identification cards or identification stickers, which can allow the transmission of identification data stored in a chip to a reading device, a grouping technique can be used involving coupling a transporting unit with a chip and an antenna The antenna can be made by placing a wire conductor on the device or by etching the antenna in the metallic film.

One purpose of the invention is therefore to provide an identification device that allows both optical identification via a holographic image on the device and electronic identification via an RF chip mounted on the device. The metallized layer can be used to prepare both the antenna for the RF device as well as to prepare the optical image on the device. The fact that the antenna and the image can be made from the same metallized layer represents an advantage since only a single metallized layer is required. As a result, the manufacturing process can be simplified and the cost of manufacturing the device can be reduced.

Although the aforementioned method of selective de-metallization is preferred, other methods of selective de-metallization can be employed according to the invention. For example, a photo-mask layer can be formed on the metallized layer and a pattern formed on the mask layer using a photolithographic technique. Afterward, exposed portions of the metallized layer can be removed using either a wet (e.g., chemical) or dry (e.g., plasma) etching technique.

Additionally, the antenna and/or the discontinuous metallized region forming the hologram or retro-reflective layer according to the invention can be made by selectively de-metallizing a continuous metallized layer or, alternatively, by partial or selective deposition of a metallized layer. Partial deposition of the metallized layer can be performed, for example, using a masking technique. The antenna and/or the discontinuous metallized region can be formed, for example, by partial or selective deposition of a metallized layer using a deposition method selected from the group consisting of chemical deposition, electrical deposition, sputtering and vapor coating.

The metallized layer of the antenna and/or the discontinuous metallized region preferably comprises at least one metal selected from the group consisting of aluminum, aluminum alloys, nickel, silver and copper. The metal layer from which the antenna and/or the discontinuous metallized region is formed preferably comprises an amorphous metal. An amorphous metal layer can be formed using conventional deposition techniques. By using an amorphous metal, higher conductivities can be achieved. As a result, a thinner layer can be used for the antenna, thus providing an identification device having increased flexibility. The thickness of the metallized layer used to form the antenna is preferably from 0.5 to 3 microns. The use of an amorphous metal layer can also facilitate demetallization using a chemical etching solution, according to the invention.

The thickness of the base layer according to the invention is preferably between about 5 and 3,000 microns. Thinner base layers can be used to provide more flexible identification devices.

By forming the antenna from a metallized layer, tamper proof characteristics can be imparted to the device. For example, according to the invention, an antenna formed from a metallized layer (e.g., either a selectively demetallized or a partially deposited metallized layer) can be manufactured such that attempts to tamper with the device (e.g., by delaminating one or more layers of the device) are likely to result in damage to the antenna In this manner, an attempt to tamper with an identification device according to the invention can render the RF transponder inoperative.

Additionally, the antenna and the image device can be formed on opposite sides of a substrate material. It may also be advantageous to build the antenna on the device in several parts (i.e., by making one part of the antenna on the same side as the image device and the other part of the antenna on the side opposite the optical image). In this case, a high power antenna can be made on a relatively small identification device.

Depending specifically of the desired frequency of the oscillating circuit made by the chip and the antenna, the antenna may be produced as a coil or as a dipole. To influence the oscillating chip frequency behavior, it may be advantageous to use the image material at least partially to make an electronic commutation element For example, the image material may be used for making a part of the antenna. This is particularly advantageous when the antenna is made as an antenna coil. It is also possible to use the image material to make a capacitor element To prevent the creation of metallic layers that may negatively affect the antenna's electromagnetic field, it may be useful to superimpose the image structure with a superficial structure to separate the metallic surface from the hologram support, thereby creating electrically isolated partial metallic layers.

Turning to the figures, FIG. 1 shows the side view of an identification unit **10** according to the invention having a substrate or base layer **11** which has a metallized film or foil **12** mounted on its upper surface **33**. The lower surface **30** of the substrate **11** is also shown. As shown, the metallized film or foil **12** comprises a film **13** coated with a metallic layer **14**. The film **13** is preferably a dielectric film, such as a polymer film. Polyethylene terephthalate (PET) is a preferred material for the film. Other materials, however, can also be used for the film **13**. The substrate is also preferably a dielectric material. However, the substrate **11** can be made of material with either electrically conductive or dielectric properties depending on the type of film **13** used. For example, if the film **13** is a dielectric material, such as a polymer film, the substrate **11** does not have to be a dielectric material.

The identification device **10** shown in FIG. 1 can be in the form of a card or an identification label. A label is typically more flexible than an identification card. The rigidity of the identification device can be varied by the choice of the material used for substrate 11 and by the thickness of substrate 11.

In addition, it should be noted that the identification device 10 shown in FIG. 1 does not necessarily represent the actual end product but can, in addition to the layers shown in FIG. 1, be provided with further layers, particularly layers covering the top and the bottom. Further, if the identification unit is to be constructed as an identification label, the device can be provided with an adhesive surface such as a pressure sensitive adhesive surface.

FIG. 2 is a top view of an identification device 10 according to the invention. As shown in FIG. 2, metallized layer 12 has been divided into two fields placed in adjacent position: a holographic image field 16 and an antenna field 17. In the holographic field 16, the metallic film 12 forms a holographic image 18 that can be transferred to the identification device in a known manner (e.g., by using a stamping process) to form a hologram 20.

As shown in FIG. 2, the antenna field 17 comprises an antenna coil 22 created, for example, by using a chemical etching technique according to the invention. The coil as shown is provided on each end with contact fields 23 and 24. Contact fields 23 and 24 are provided as through contacts that provide an electric connection with the bottom surface 30 of the base layer 11, as shown in FIG. 3.

For the construction of the antenna coil 22 shown in FIG. 2, a corrosive material (i.e., an aqueous NaOH solution) can be printed onto the metallic layer 14 to selectively remove portions of the metallic layer 18 from the metal foil 12, thereby leaving behind only the area defined as the antenna coil 22.

FIG. 3 shows the bottom view of the device of FIG. 2. As shown in FIG. 3, the contact points 23, 24 of the antenna coil 22 are connected as through-contacts to a chip 31 on the bottom side 30 of the substrate 11 which, as shown, is mounted in a chip module 32 to make electrical contact between the antenna 22 and chip 31 easier.

The antenna coil 22 and the chip 31 of the identification device 10 shown in FIGS. 1 to 3 forms a transponder unit 34 which enables, by means of a reader unit, contact-free access to the data on the chip 31 for purposes of electronic identification. At the same time, the hologram 20 mounted on the upper side of the identification unit 10 enables optical identification to be made.

FIG. 4 illustrates an identification device 40 having two substrates 41, 42 lying on top of each other, each of which has a metallized foil 45, 46 mounted on its upper surface 43, 44. The components are arranged in such a way that metallized foil 45 is positioned between substrates 41 and 42 and metallized foil 46 is situated on the upper surface 43 of the metallized layer 41 and forms at the same time the top layer of the identification device 40. As shown in FIG. 4, each of the metal foils 45, 46 comprises a film or foil layer 47 having a metallized surface 39. According to a preferred embodiment of the invention, the metal foils 45, 46 comprise a polymer film having a metallized surface comprising aluminum.

In the identification unit 40 shown in FIG. 4, the upper metal foil 46 is structured or divided up in the same way as metal foil 12 of FIG. 2. That is to say, the identification device 40 is provided with both a hologram 20, for example, in a hologram area 16 as well as an antenna coil 22 in an antenna area 17. As shown, the metal foil 45 mounted on the upper side 44 of substrate 42 and arranged between substrate 42 and substrate 41 is provided with a second antenna coil 49 which is in electrical contact with a first antenna coil located on antenna area 17 via through-contacts with contact points 23, 24. The second antenna coil 49 is itself connected by through-contacts with contact points 50, 51 which themselves are

connected to a chip module 53, which is mounted in a recess 52 in the bottom of substrate 42. In this way, the antenna coils 22 and 49 each form a component of the complete antenna unit 54 of identification device 40.

FIG. 5 illustrates a top view of an identification device 55 comprising a metal foil 56 on the upper side of a substrate, not shown. In a similar manner to metal foils 12 and 46 of FIGS. 2 and 4, respectively, identification device 55 comprises, for example, a hologram or retro-reflective area 57, or other metallized substance, and an antenna area 58. The antenna area 58 as shown in FIG. 5 comprises a single antenna coil 59, which can be created in the manner previously described by selectively etching a metal foil made up of a metallic layer 61 deposited on a film or foil layer (not shown). As shown, the antenna coil 59 is provided with contact points 62, 63. Contact points 62, 63 can be designed as through-contacts connected to contact areas of a chip module 64 mounted on the bottom side of the substrate.

In the hologram or other metallized area 57 of metal foil 56, a hologram or other image 65 is formed in the metallic layer in the manner previously described. As shown in FIG. 5, however, the hologram or other metal material 65 comprises two image sections 66, 67 which are electrically isolated from each other and which form, when viewed, a complex connected optical structure. The smaller image section 67, is electrically isolated from the larger image section 66. As shown, the smaller image section 67 comprises two metal surfaces which appear generally as two U-shaped islands. As shown in FIG. 5, each of these metal surfaces are connected with a contact area 62 or 63 and form the panels 68, 69 of a capacitor unit 70.

FIG. 6 shows an identification device 71 comprising a metal film 72, similar to the metal films 12, 46, 56 shown in FIGS. 2, 4, and 5, respectively. As shown, the identification device 71 also comprises a holographic field 73, which could also or alternatively include other types of images, or for example, retro-reflective material, and an antenna field 74. In contrast to the metal film 12 shown in FIG. 2, however, the metal film 72 is a reticulated metallic coating having lines or stripes of metallic material 75. As a result, the image is formed from non-metallic fields 76 alternating with metallic fields 77. Such a structure can be created using the same process as the antenna coil 22 using the previously described printing/chemical etching procedure. In particular, the continuous metal coating in the holographic field 73 can be reticulated by printing lines of a chemical etchant on the continuous metal coating. As a result, a reticulated holographic material (i.e., with alternating lines or stripes of metallic material removed) can be formed.

When FIGS. 2 and 6 are compared, it can be seen that the image contents of the holographic material 78 of FIG. 6 and the holographic material 20 of FIG. 2 are similar. However, the images have different resolutions. In particular, the image in FIG. 6 has a lower resolution due to the reticulated structure of holographic material 78. However, the reticulated structure of holographic material 78 reduces interference with RF energy such that an RF transponder can be mounted on the identification device 71.

FIG. 7 illustrates a method of manufacturing a metal foil having a holographic or other metallized field and an antenna field, such as the metal foil 12 shown in FIG. 2. In particular, a metal foil strip 25 with a large number of foil segments 26 connected to each other in continuous order is shown in FIG. 7. When the metal foil strip 25 is separated lengthwise along the dotted severance lines 27, individual metal foil sections, such as metal foil 12 in FIG. 2, can be provided.

As shown in FIG. 7, the metal foil strip 25 comprises, in the running direction 28, a sequence of hologram or other metallized areas 16 and antenna areas 17, continuously following on from each other, which, as shown, are situated on the left and right sides of a central running line 29. The arrangement of the hologram or other metallized areas 16 and the antenna areas 17 in one long line following each other in the running direction 28 enables the continuous production of holograms or other metallized materials 20 in the hologram or other metallized area 16 and of antenna coils 22 in the antenna area 17 when the metal foil strip 25 moves forward in the running direction 28. In addition, the forward movement of the metal foil strip 25 can be phased in such a way that, at various stages (indicated in FIG. 7 as stages I, II and III), various operations can be performed on the foil. In particular, the antenna area 17 on the metal foil strip 25 can undergo printing with a metal etchant in stage 1. The remains of the corrosive material can be washed away, while, at the same time, the oxidized areas of the metallic layer 14 can be removed in stage II. Finally, the antenna area 17 of the metal foil strip 25 can be dried (stage III).

In conjunction with the production of the antenna coil 22 in the antenna area 17 of the metal foil strip 25, the metallized layer in the holographic or other metallized field 16 can be selectively demetalized as shown in FIG. 7. Further, the holographic or other metallized material 20 can be formed in the hologram or other area 16 of the metal foil strip 25 (e.g., by means of a revolving press) after the demetalzation process.

In order to construct the identification device 10 shown in FIG. 2, the metal foil strip 25 having holograms or other metallized materials 20 formed in the hologram or other metallized areas 16 and antenna coils 22 formed in the antenna areas 17 can be positioned on a substrate, not shown, laminated (e.g., with an adhesive) and separated along the severance lines 27 to provide individual identification devices, such as the identification device 10 shown in FIG. 2.

A demetallizing process according to the invention will now be described in more detail.

Once the areas to be demetallized have been determined (e.g., using graphical design) a rubber engraving (e.g., flexographic plate) can be made to cover the printing roller that is going to be used to deposit the demetallizing solution (e.g., an aqueous solution of sodium hydroxide) on the metallized surface of the film. The sodium hydroxide solution can, for example, be placed in one of the printing stations of a conventional flexographic printing apparatus. For example, the demetallizing solution can be placed in a stainless steel tray typically used for holding ink. The demetallizing solution can then be applied to the metallized surface by means of the printing roller such that the demetallizing solution is selectively transferred to areas of the metallized surface which are going to be demetallized. The volume of sodium hydroxide that is "printed" on the metallized film can be controlled, as with printing using ink, by, for example, the structure (i.e., the resolution) of the printing roller (i.e., the anilox roller) and the inking rollers and by the pressure that is exerted on the printing roller.

Although the demetallizing effect is practically immediate once the demetallizing solution is applied to the metallized surface, it may be desirable to allow the demetallizing solution to remain a certain amount of time in contact with the metallized surface so that the chemical reaction is completed in those areas in contact with the solution.

To stop the oxidizing effect of the solution, the metallized surface can be washed with water (preferably non-recycled). For example, the metallized surface (previously printed) can be passed through a washing area where the residual sodium hydroxide and the oxidized metal (i.e., aluminum oxide) can be removed. In a preferred embodiment, the water will wet the entire printed area of the metallized surface. For example, fine sprinklers can be used to cover the entire printed area. In order to make the washing process more efficient and to completely remove the residuals of the chemical process, washing may be repeated one or more times using fresh water each time.

Before the film enters the drying station, it may be desirable to remove excess water from the metallized surface in order to facilitate the evaporation of and remaining residual water. In order to remove the water, it is recommendable to use a pair of rollers (e.g., one of rubber and another metallic), air cleaners, sponges and/or air sprinklers. Finally the film is passed through the drying unit through for a heat dry (e.g., using electrical resistance heating) to completely remove the water from the material.

As a complement to the method of selective demetallizing, it is possible to include in the same line of production an overprinting process with ink. In this manner, the effects of demetallizing and printing can be obtained on the same material.

Compared with solvent based inks, water based inks are very manageable, clean and highly resistant to ultraviolet (UV) light. For these reasons, water based inks are desirable. Nevertheless, because one of the sub-processes of the demetallizing process is washing, it is preferable to print with water based inks after the demetallizing and washing steps have been completed.

In addition, if certain metallized areas are desired not to be printed, it is possible to use a transparent solvent based varnish for print protecting the metallized film. After print protection, the metallized layer can be demetallized. In this manner, higher resolutions can be achieved. This technique can be used in high security applications to produce microtext and/or very fine lines.

A demetallizing process for use with a metallized, such as a retro-reflective material, according to the invention is described below in reference to FIG. 8. First, any liner or protective layer 81 present on the metal layer 83 is removed to expose the metal. In FIG. 8, the metal layer 132 is shown disposed on a carrier or base layer 78. The carrier or base layer 78 can be polyvinyl chloride or polyethylene terephthalate. The metal layer 132 is then selectively exposed 79 to the corrosive action of a corrosive material, such as a sodium hydroxide solution, using a flexographic, screen, offset or any other printing process to remove metal from the desired areas. This process is described in detail in Mexican Patent Application Nos. 2001/010968 and 2001/010969 as well as in German Patent Application No. 101 21 126. These applications are herein incorporated in their entirety by reference. Selective metal removal can be used to form an antenna for the RF transponder.

As a second step, a fine line demetallizing process can be performed over the remaining metal surface using the same demetallizing process to break the conductivity of the metal layer and the absorption or distortion of radio waves. This allows the RF energy to be captured by the antenna of the radio frequency device. This process is preferably done at a high resolution to maintain the retro-reflective (or, for example, holographic) properties of the remaining metal layer while, at the same time, interrupting the conductivity of the metal to allow RF reception and transmission.

According to a preferred embodiment of the invention, the metallized layer is demetallized in a square grid pattern comprising a first set of parallel lines of demetallized material oriented at right angles to a second set of parallel lines or demetallized material. According to a further embodiment of the invention, the squares of metallized material in the square grid pattern will have dimensions of 5 mm×5 mm or less, more preferably 3 mm×3 mm or less. It has been found that, when the squares of metallized material have dimensions of about 5 mm or less, shielding (i.e., distorion and/or absorption) is reduced to about 5% or less and when the squares of metallized material have dimensions of about 3 mm or less, shielding (i.e., distorion and/or absorption) is reduced to about 1% or less.

Although a square grid demetallized pattern is preferred, other patterns can be employed according to the invention. When other patterns are employed, it is preferred that the longest straight line that can be drawn on any metallized area is about 5 mm or less, more preferably about 3 mm or less.

A schematic of an apparatus for selective demetallization of a roll of metallized material is shown in FIG. 9. As shown in FIG. 9, metallized material (e.g., retro-reflective material) from a roll 121 is unrolled and passed over a printing roller 123 where a chemical etchant (e.g., NaOH) from reservoir 35 is applied in a desired pattern. The printed metallized layer is then passed over a temperature application roller 128 to a washing station 36. After washing, hot air from dryer 37 is directed over the surface of the washed material. Afterward, the selectively demetallized material is optionally transferred to various printing stations 38, 120 so that designs can be overprinted thereon. After over-printing, the metallized material can be transferred to an adhesive application roller 122 and adhesively bonded to a carrier material or base layer material 124. The base layer material 124 can have perforations (not shown) to allow for separation of individual identification devices from the continuous length. After bonding to the base layer, the material is shown wound onto a take-off roller 126.

After exposing the material to the demetallizing agent, the demetallizing process can be terminated by washing the surface with water and immediately drying. Afterward, a design can be over-printed on the identification device using a fixed or variable printing process.

Once the metal is removed from an area of the device, it is possible to mount a radio frequency device in the demetallized area. The radio-frequency device can be used as a label or as an identification tag, such as a car license plate.

In one example application, labels according to the invention can, for example, be used for all types of vehicle control. The labels can be provided in auto-adhesive form for use with a car license plate, a tractor platform or for container information, vehicle control applications, etc. The labels can be provided with read and write capabilities and can include biometric data, such as fingerprints, iris recognition data, facial recognition data, voice recognition data, picture data and traffic violation data for drivers.

Car license plates are typically made from metal, acrylic or polycarbonate. Regardless of the material, the process of applying an RF device will usually be similar. This process is described below with reference to FIG. 10 for a metal license plate. First, an upper surface 82 of a metal plate 80 is embossed to form a depressed region 84. An isolation layer 86 (e.g., a ferrite composite layer) is then deposited in depressed region 84. A radio frequency device 88 is then mounted on the isolation layer. In this manner, RF device 88 is able to transmit and receive information without interference from the metal plate 80. Afterward, the license plate can be laminated with, for example, a selectively demetallized retro-reflective material 90. According to a preferred embodiment of the invention, the region of the reflective material 90 above the area 92 where the radio frequency device 88 is mounted will be free of metallized material. Further, the rest of the retro-reflective material 90 is preferably selectively demetallized with a fine line demetallizing pattern 93 using a demetallizing process as described above to reduce interference.

The resulting license plate is shown in FIG. 11. As can be seen from FIG. 11, the license plate 94 comprises an antenna region 96 and a retro-reflective region 98. The retro-reflective region is shown over-printed with a license plate number. As can be seen from FIG. 11, the retro-reflective material has been removed from the antenna region 96. The antenna can be formed by selectively demetallizing a continuous metal layer using a printing procedure as described above.

An alternative process of forming the antenna comprises producing a thin polymer layer (e.g., polyvinyl chloride (PVC) or polyethylene terephthalate) having an antenna (preferably a copper antenna) embedded therein. Structures of this type are commonly referred to as inlays. A method of manufacturing an inlaid antenna according to the invention is shown in FIG. 12. As shown in FIG. 12, a conductive wire 100 (preferably a copper wire) is unrolled from a spool 102 and embedded in the surface of a polymer sheet 104. As shown in FIG. 12, the conductive wire 100 passes over a thermal ultrasound head 106 and under a bridge 108 before being embedded in the polymer sheet 104 to form the antenna 110. The inlaid antenna can be applied with an auto-adhesive or pressure sensitive adhesive to the base layer or substrate of the identification device. The antenna should be applied in an area of the device that has been demetallized to avoid contact with any metal in the identification device.

An alternative way of obtaining a retro-reflective or other metalized material on a metal plate or sticker can be employed wherein the carrier or base layer is a polymer such as PVC or PET. In this embodiment, the antenna can be embedded directly in the carrier using ultrasonic energy as set forth above. The retro-reflective or other metallized layer can then be applied onto the carrier. Portions of the retro-reflective or other metallized layer overlying the antenna should be demetallized to avoid any contact of the antenna with the metal content of the retro-reflective or other metallized material. A fine line demetallization process can be used as describe above over the remainder of the retro-reflective or other metallized material to minimize RF distortion or absorption that can interfere with the radio frequency device. Afterward, an acrylic or epoxy resin can be applied to transform the identification device into a label

FIG. 13 shows an identification device according to this embodiment of the invention wherein an inlaid antenna 110 is positioned on a carrier layer (not shown) beneath a demetallized portion 112 of a retro-reflective or other metallized layer 114. Also as shown in FIG. 13, a fine line demetallizing process has been used on the continuous metal portion 116 of the retro-reflective layer 114 to reduce interference and thereby ensure adequate performance of the radio frequency transmitting 118 and receiving 119 functions. In this manner, the retro-reflective or other metallized material properties can be retained while allowing for the adequate transmission and reception of RF energy.

These and other modifications and variations to the present invention may be practiced by those of ordinary skill in the art, without departing from the spirit and scope of the present invention. Furthermore, those of ordinary skill in the art will appreciate that the foregoing description is by way of example only, and is not intended to limit the invention.

What is claimed is:

1. An identification device, comprising:

a base layer;

a metalized layer;

a radio-frequency (RF) transponder comprising an RF chip and an antenna disposed on the base layer and formed in an area of the metalized layer, wherein the antenna is in electrical communication with the chip; and

a discontinuous metallized region in electrical communication with the antenna and formed in a different area of the metalized layer relative to the antenna, wherein the discontinuous metallized region enables the RF transponder to transmit and receive information at radio frequencies,

wherein the antenna is formed by a method comprising:

transferring a metal etching solution to portions of an exposed surface of the metallized layer using a printing process;

allowing the etching solution to react with the metal to selectively demetallize the surface; and

washing the selectively demetallized surface.

2. The device of claim **1**, wherein the base layer has at least one side, and wherein the antenna and the discontinuous metallized region are located on the same side of the base layer.

3. The device of claim **1**, wherein the base layer has at least a first side and a second side, the first side being opposite the second side, and wherein the antenna and the discontinuous metallized region are located on opposite sides of the base layer.

4. The device of claim **1**, wherein the base layer has at least a first side and a second side, the first side being opposite the second side, and wherein a first part of the antenna and the discontinuous metallized region are located on the first side, and a second part of the antenna is located on the second side of the base layer, and wherein the first part of the antenna is electrically connected to the second part of the antenna.

5. The device of claim **1**, wherein the device comprises an upper metal layer positioned above the base layer and a lower metal layer positioned below the base layer, wherein a first part of the antenna is formed on the upper metal layer and a second part of the antenna is formed on the lower metal layer, the device further comprising a through contact connecting the first part of the antenna to the second part of the antenna.

6. The device of claim **1**, wherein the discontinuous metallized region comprises an electronic commutation element.

7. The device of claim **1**, wherein the discontinuous metallized region comprises a capacitor.

8. The device of claim **1**, wherein the discontinuous metallized region comprises a plurality of electrically isolated holographic regions.

9. The device of claim **1**, wherein the base layer is an electrically conductive layer.

10. The device of claim **9**, wherein an isolation layer is formed on the base layer.

11. The device of claim **10**, wherein the radio frequency (RF) chip is mounted on the isolation layer.

12. The device of claim **10**, wherein the base layer includes a depressed region, and wherein the isolation layer is formed in the depressed region.

13. The device of claim **1**, wherein the base layer has at least one side, and wherein the antenna and the discontinuous metallized region are formed on the same side of the base layer in discrete, non-overlapping areas.

14. The device of claim **1**, wherein the device is selected from the group consisting of a decal, a license plate, and an identification card.

15. The device of claim **1**, wherein the discontinuous metallized region comprises a square grid pattern.

16. The device of claim **15**, wherein the squares in the square grid pattern have a length of about 5 mm or less.

17. The device of claim **15**, wherein the squares in the square grid pattern have a length of about 3 mm or less.

18. The identification device of claim **1**, wherein the base layer has at least one side, and wherein the antenna and the holographic image are formed on the same side of the base layer in discrete, non-overlapping regions.

19. The identification device of claim **18**, wherein the radio frequency (RF) chip is mounted on the same side of the base layer as the antenna.

20. The identification device of claim **1**, further including: forming a depressed region in the base layer; and forming an isolation layer in the depressed region, wherein the radio frequency (RF) chip is mounted on the isolation layer.

21. The identification device of claim **20**, wherein the antenna is formed on the top of the depressed region.

22. The identification device of claim **20**, wherein the isolation layer comprises a ferrite composite.

23. The identification device of claim **1**, wherein the antenna is formed using a printing process in which the etching solution is substituted for ink normally used in such a process, and wherein the method for forming the antenna further comprises:

removing a liner or protector from the metallized layer;

creating the rollers or plates for use in the printing process with patterns and areas defining the antenna; and

applying the etching solution to an area of the device in which the antenna is to be formed suing the rollers or plates.

24. The identification device of claim **1**, wherein the discontinuous metallized region is formed by a method comprising:

transferring a metal etching solution to portions of an exposed surface of the metallized layer using a printing process;

allowing the etching solution to react with the metallized layer to selectively demetallize the surface; and

washing the selectively demetallized surface.

25. The identification device of claim **24**, wherein the discontinuous metallized region is formed using a printing process in which the etching solution is substituted for ink normally used in such a process, and wherein the method for forming the discontinuous metallized region further comprises:

removing a liner or protector from the metallized layer;

creating the rollers or plates for use in the printing process with patterns and areas defining the discontinuous metallized region; and

applying the etching solution to an area of the device in which the antenna is to be formed suing the rollers or plates.

26. The identification device of claim **24**, wherein forming the discontinuous metalized region further comprises allowing the etching solution to react with the metal layer to selectively demetallize the surface of the metallized layer in the area defining the discontinuous metallized region in a fine mesh pattern.

27. The identification device of claim **1**, wherein the metallized layer comprises reflective material.

28. The identification device of claim **1**, wherein the etching solution includes sodium hydroxide;

29. The identification device of claim **1**, wherein the method for forming the antenna is a flexographic printing process.

30. The identification device of claim **1**, wherein the metallized layer comprises retroreflective material.

31. An identification device, comprising:

a base layer;

a radio-frequency (RF) transponder comprising an RF chip and an antenna disposed on the base layer, wherein the antenna is in electrical communication with the chip; and

a discontinuous metallized region,

wherein the discontinuous metallized region enables the RF transponder to transmit and receive information at radio frequencies, wherein the discontinuous metallized region comprises a holographic image and wherein the holographic image and the antenna form a single metal layer.

32. An identification device, comprising:

a base layer;

a metallized layer disposed on the base layer and having a demetallized region and a discontinuous metallized region;

a radio-frequency (RF) transponder comprising an RF chip and an antenna disposed on the base layer and coinciding with the demetallized region, wherein the antenna is in electrical communication with the chip; and

wherein the discontinuous metallized region forms an image while enables the RF transponder to transmit and receive information at radio frequencies,

wherein forming the antenna comprises:

forming an inlaid antenna be embedding a conductive wire in a polymer layer; and

affixing the inlaid antenna to the base layer.

33. The identification device of claim 32, wherein the inlaid antenna is provided with an adhesive layer and wherein affixing an antenna further comprises adhesively bonding the antenna to the device through the adhesive layer.

34. The identification device of claim 32, wherein an adhesive, selected from a group consisting of an auto-adhesive and a pressure sensitive adhesive is used to affix the inlaid antenna to the base layer.

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EXHIBIT "D"

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(54) **SYSTEM AND METHOD FOR PROVIDING SECURE IDENTIFICATION SOLUTIONS UTILIZING A RADIO FREQUENCY DEVICE IN A NON-METALLIZED REGION CONNECTED TO A METALLIZED REGION**

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G08B 13/14	(2006.01)
G03H 1/00	(2006.01)
C25D 5/02	(2006.01)
H01S 4/00	(2006.01)
H01Q 13/00	(2006.01)

(52) **U.S. Cl.** **340/572.1**; 340/572.7; 340/933; 340/5.86; 340/572.8; 359/2; 205/125; 29/600; 216/102

(58) **Field of Classification Search** .... None
See application file for complete search history.

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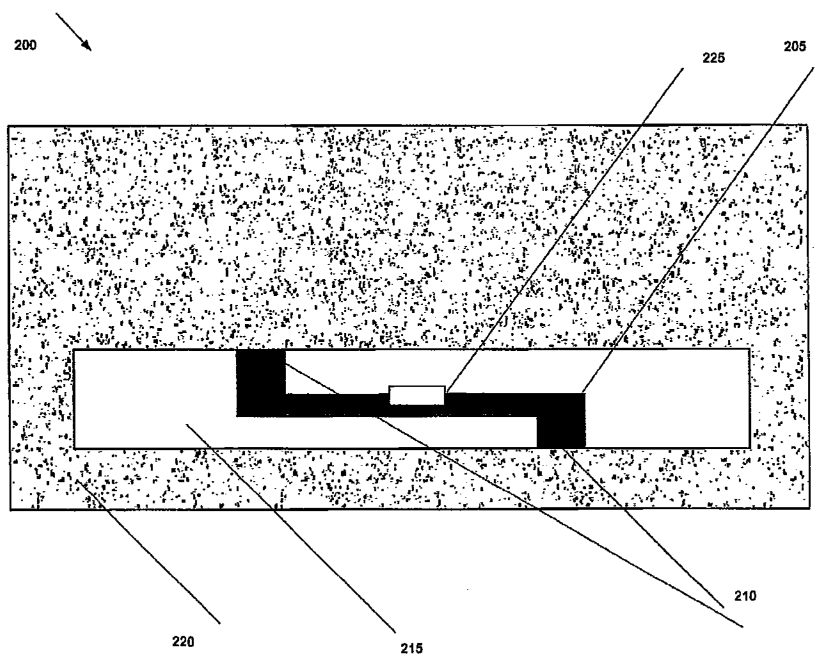
Primary Examiner — Julie Lieu
(74) *Attorney, Agent, or Firm* — Procopio, Cory, Hargreaves & Savitch LLP; Noel C. Gillespie

(57) **ABSTRACT**

The present invention provides systems and methods for transmitting and receiving information from a radio frequency (RF) transponder. A conductive adhesive connects an antenna in a non-metallized region to a metallized region. This feature transforms the entire metallized region of the radio frequency device (i.e., the remainder of the metallized material outside the non-metallized region) into an antenna.

16 Claims, 4 Drawing Sheets



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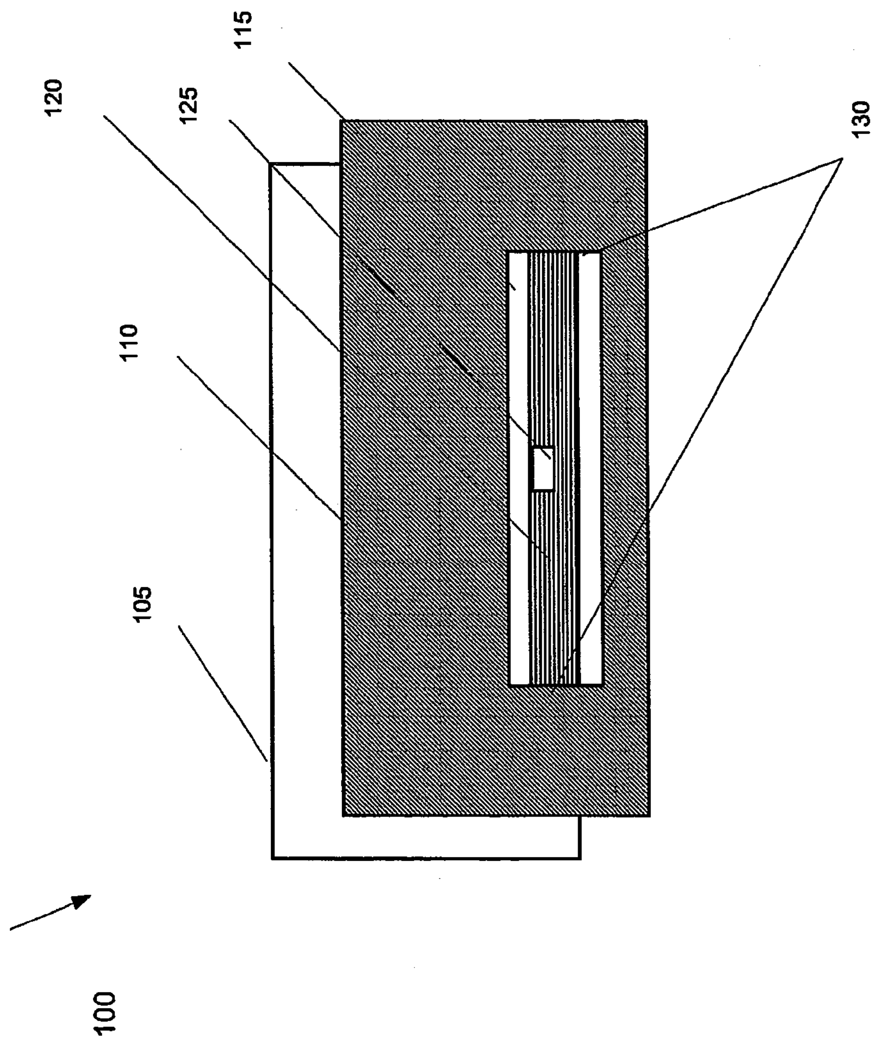


FIGURE 1

FIGURE 2

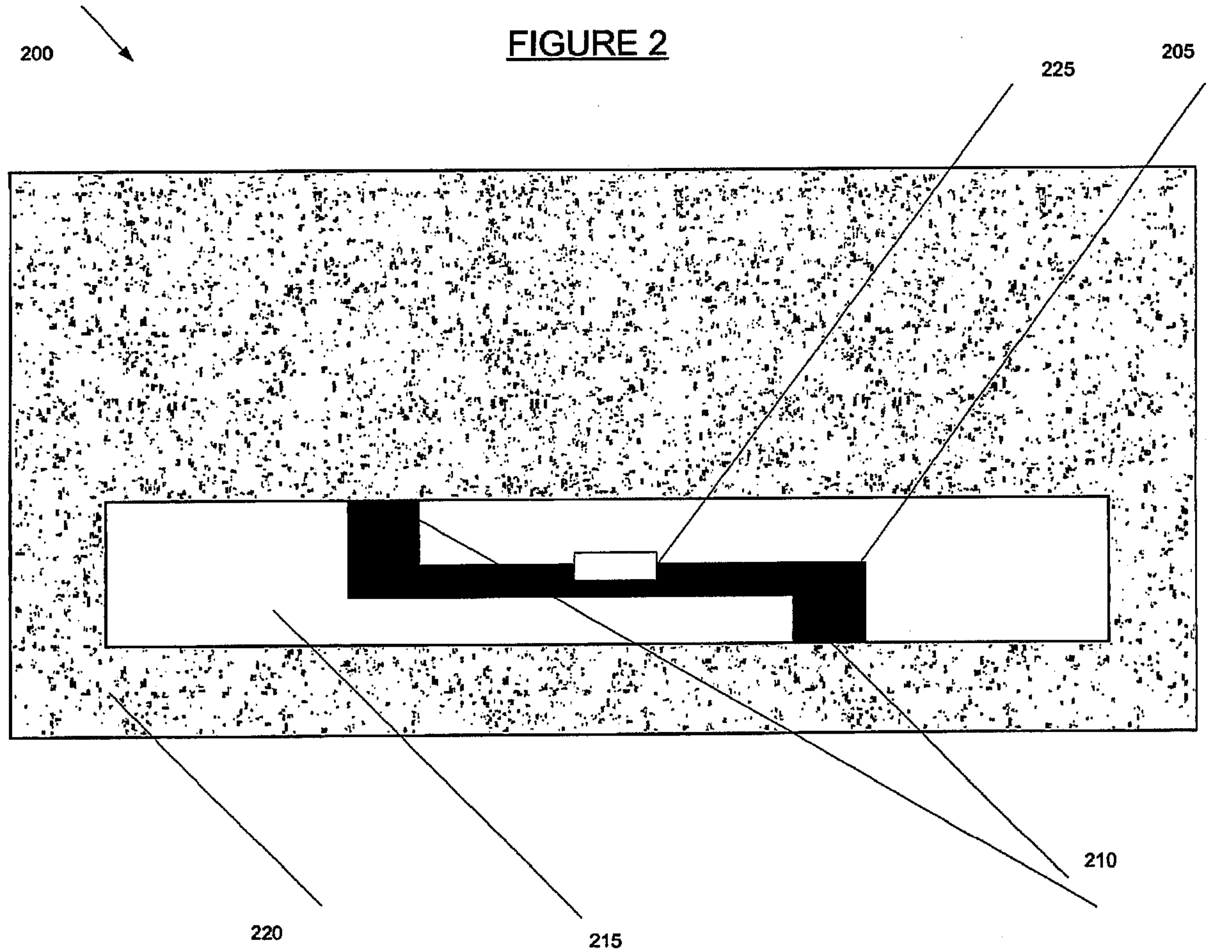
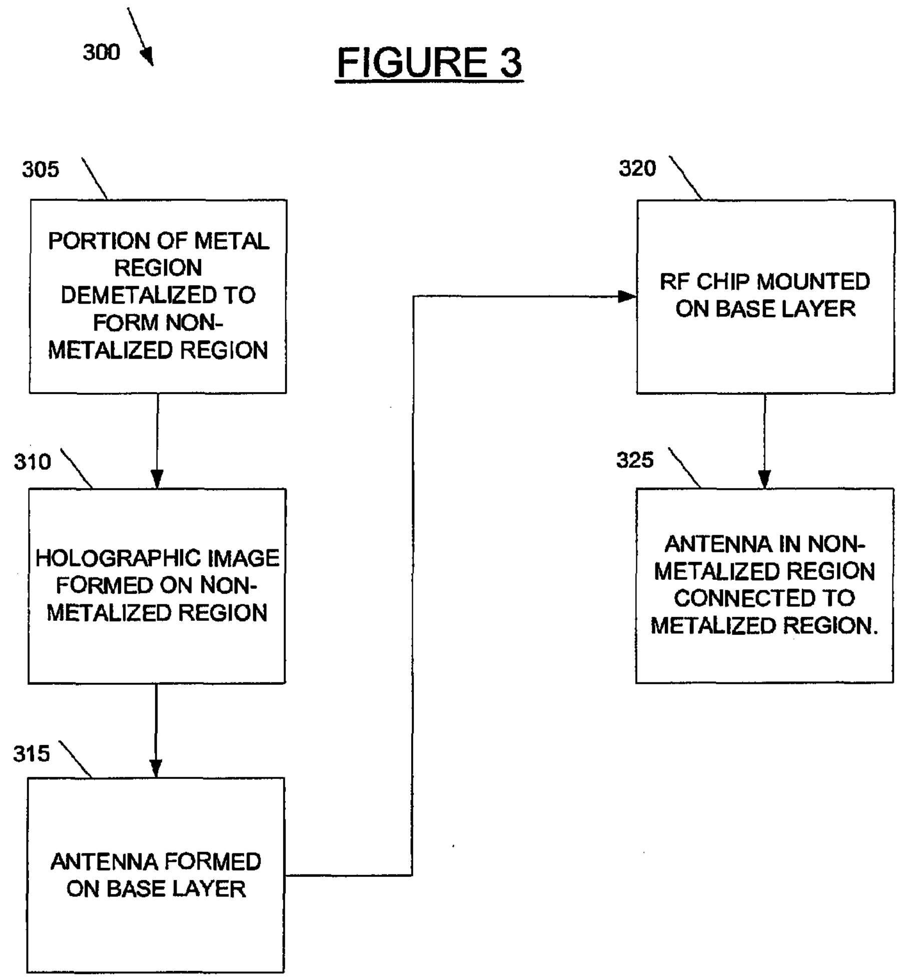


FIGURE 3


300
305
PORTION OF METAL REGION DEMETALIZED TO FORM NON-METALIZED REGION
310
HOLOGRAPHIC IMAGE FORMED ON NON-METALIZED REGION
315
ANTENNA FORMED ON BASE LAYER
320
RF CHIP MOUNTED ON BASE LAYER
325
ANTENNA IN NON-METALIZED REGION CONNECTED TO METALIZED REGION.

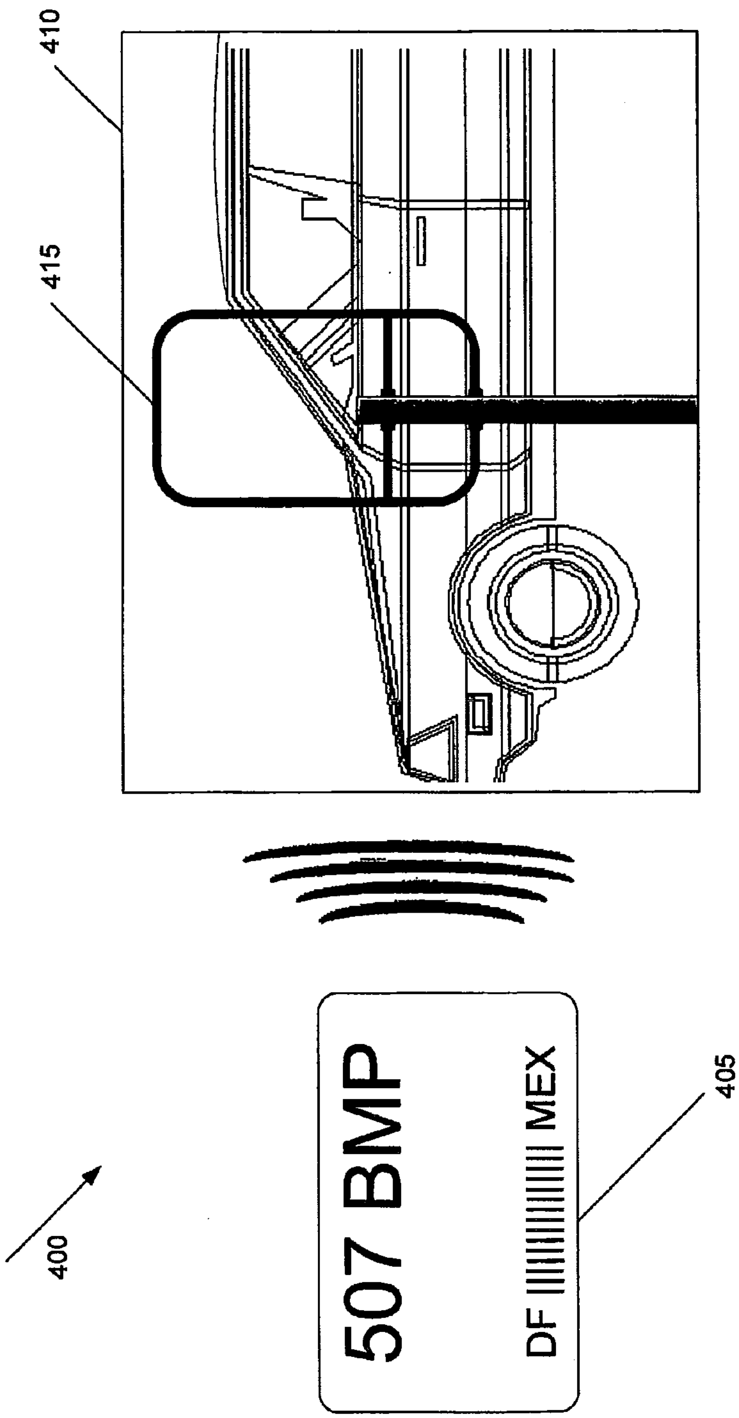


FIG. 4

SYSTEM AND METHOD FOR PROVIDING SECURE IDENTIFICATION SOLUTIONS UTILIZING A RADIO FREQUENCY DEVICE IN A NON-METALLIZED REGION CONNECTED TO A METALLIZED REGION

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

This application claims priority to U.S. Provisional Patent Application Ser. No. 60/428,257 filed Nov. 22, 2002. The entirety of that provisional application is incorporated herein by reference.

The application incorporates by reference: U.S. patent application Ser. No. 10/636,732, filed Aug. 8, 2003; U.S. patent application Ser. No. 10/615,026, filed Jul. 9, 2003; U.S. patent application Ser. No. 10/118,092, filed Apr. 9, 2002 now U.S. Pat. No. 7,034,688; PCT Patent Application PCT/IB02/01439, filed Apr. 30, 2002; German Patent Application No. 10121126.0, filed Apr. 30, 2001; Mexican Patent Applications No. 010967, filed Oct. 26, 2001, No. 010968, filed Oct. 26, 2001, No. 010969, filed Oct. 26, 2001, No. 010971, filed Oct. 26, 2001, No. 003141, filed Mar. 25, 2002, and No. 003202, filed Mar. 26, 2002.

FIELD OF THE INVENTION

The present invention relates generally to a system and method for providing secure identification solutions, and specifically to a system and method for providing secure identification solutions utilizing devices with radio frequency (RF) transponders.

BRIEF DESCRIPTION OF THE FIGURES

FIGS. **1** and **2** illustrate RF devices **100** and **200**, according to two embodiments of the present invention.

FIG. **3** illustrates a method of making **300**, according to one embodiment of the present invention.

FIG. **4** illustrates a method of use **400** of use of the RF device described above, according to one embodiment of the present invention.

DESCRIPTION OF THE INVENTION

The present invention provides systems and methods for transmitting and receiving information from a radio frequency (RF) device (e.g., an RF transponder). A conductive adhesive connects an antenna in a non-metallized region to a metallized region. This feature transforms the entire metallized region of the RF device (i.e., the remainder of the metallized material outside the non-metallized region) into an antenna. This enables greater reading distance and greater data capacity.

In one embodiment, the non-metallized region is a formerly metallized region that has been demetallized. A metal foil substrate which remains following the demetallization process is converted into an antennal surface. This antennal surface captures power as a parabolic or increased area, rather than allowing the metal foil substrate to interfere.

Connection of the antenna to the metallized region can take place in a variety of areas. The following description sets forth two possible attachment configurations (e.g., connections on the sides, connections on the top and bottom), but those experienced in the art will see that multiple other attachment configurations are possible.

The present invention utilizes the following features: passive transponder systems; and retro-reflective, holographic, and other metallic materials.

Passive Transponder Systems. Passive transponder systems are used worldwide for many identification purposes. A passive transponder system is powered by an electromagnetic field of a reader. (No power supply is within the transponder.) A transponder is a transceiver (e.g., a transmitter/receiver that both transmits and receives signals) in a communication satellite that receives a signal from an earth station and retransmits it on a different frequency to one or more other earth stations. An internal antenna of the transponder is used for both data transmission and energy transmission between the reader and the transponder, using, for example, the same frequency for the data and energy transmissions.

Retro-Reflective, Holographic, and Other Metallic Materials. Retro-reflective materials can reflect and re-emit incident light in a direction that is parallel to that of the source of the incident light. In other words, retro-reflective materials reflect light directly back toward the source of the light. Such materials and devices are widely used in the areas of nighttime transportation and safety. For example, retro-reflective materials are used to illuminate highway lanes and road signs using the light emitted from vehicle headlights. Retro-reflective materials are also used for the production of plates and decals for vehicles and for truck containers, tractors and other applications. Retro-reflective materials have a bright effect under direct light without disturbing human sight.

Holographic materials have also been used for identification purposes. Since holograms are difficult to counterfeit, they are increasingly used for identification purposes (e.g., driver's licenses, credit cards, bus passes, etc.) to increase security.

Both retro-reflective and holographic materials typically contain a very high level of metal such as aluminum. Holograms, for example, are typically stamped from metal foils. It is known that metal blocks the transmission and reception of RF signals because the RF signal is absorbed or distorted by the metal content in the material. As a result, the signal cannot be received by an antenna blocked by metal. Such a blocked signal cannot be used, for example, to activate a connected device. This same blocking effect can occur whether the device is positioned on top of or underneath the metallic material because the distortion and absorption of the RF signal will be affected in either case.

The RF Device

In one embodiment of the invention, as described further, for example, in U.S. Provisional Patent Application Ser. No. 60/394,241, filed Jul. 9, 2002, and the corresponding utility U.S. patent application Ser. No. 10/615,026, filed Jul. 9, 2003, a system for delivering security solutions is provided that includes one or more of the following: a radio frequency (RF) device; and an identification mechanism (e.g., a card, sticker, device). According to another embodiment of the present invention, as described further in these applications, the RF device includes retro-reflective, holographic, or other material containing metal, and an antenna for receiving radio frequency (RF) signals.

As explained above, in one embodiment of the present invention, an entire metallized region of an RF device is transformed into an antenna by connecting an antenna in a non-metallized region to a metallized region, allowing for greater reading distance and greater data accuracy. Connecting the antenna in the non-metallized region to the metallized region also aids in overcoming transmission problems created by metallic materials.

FIG. **1** illustrates an RF device **100**, according to one embodiment of the present invention. The RF device **100** comprises: a metallized region **110** (e.g., a retro-reflective, holographic, or other metal material), a non-metallized region **115** (e.g., a demetallized region), an antenna **120**, a chip **125**, and a connection **130** (e.g., a conductive adhesive). An optional holographic image is included in the non-metallized region. An optional liner **105** is used as a base layer to carry the adhesive into the label.

The metallized region **110** comprises, for example, the following materials: Retro-Reflective, Holographic, and metallized covers. The non-metallized region **115** comprises, for example, the following materials: PET, PVC, Polypropylene, vinyl. The antenna **120** comprises, for example, the following materials: conductive inks, aluminum, etc. The chip **125** (e.g., Picorypt made by Inside Technologies, Sahara made by BNC US Holding, San Diego, Calif., or any RF chip) comprises control logic for controlling the RF signal and for Analog to Digital or Digital to Analog conversion. The connection **130** comprises, for example, the following materials: gold and/or silver bumps. The holographic image comprises, for example, the following materials: Aluminum. The base layer comprises, for example, the following materials: PET, PVC, Polypropylene, vinyl. The connection **130** connects the sides of the antenna **120** in the non-metallized region **115** to the metallized region **110**. The antenna **120** is thus in electrical communication (i.e., electronically coupled) with the chip **125**. In one embodiment of the present invention, the non-metallized region **115** has been selectively demetallized such that the chip **125** can transmit and receive information.

FIG. **2** illustrates an RF device **200**, according to one embodiment of the present invention. The RF device **200** comprises: a metallized region **220** (e.g., a retro-reflective, holographic, or other metallic material), a non-metallized region **215**, an antenna **205**, a chip **225**, and a connection **210** (e.g., a conductive adhesive). The components of device **200**, in one embodiment, are made of material similar to that described above with reference to FIG. **1**. The connection **210** connects a portion of the top and bottom of the antenna **205** in the non-metallized region **215** to the metallized region **210**. The antenna **220** is in electrical communication with the chip **225**.

Method of Making the RF Device

FIG. **3** illustrates an overview of a method of making **300**, according to one embodiment of the present invention. A method of making an RF device comprising a base layer and at least one metal region disposed thereon is illustrated. In step **305**, a first metal region of the device is selectively demetallized to create a non-metallized region. The process of demetalization comprises covering the parts that are not wanted for demetalization with a protective layer of indelible inks, afterwards, the material is placed in a solution of ferric chloride and hydrochloric acid, which will remove the whole metallic material that has not been protected. Then, the material is washed to eliminate the residual acid and the protective inks. The conductivity of the material is measured for quality control, and to assure that the metallized material will be suitable for use as an antenna for the Radio Frequency device. In step **310**, a holographic image is formed on the non-metallized region. To make a holographic image, a beam of laser light is optically separated into two beams. One, the reference beam, is directed toward a piece of holographic film and expanded (its diameter increased) so that the light covers the film evenly and completely. The second (object) beam is directed at the subject of the composition and similarly expanded to illuminate it.

When the object beam reflects off the subject, it carries with it information about the location, size, shape and texture of the subject. Some of this reflected object beam then meets the reference beam at the holographic film, producing an interference pattern which is recorded in the light sensitive emulsion.

Embossed holograms are holograms with a mirror backing. Embossing is the most frequently used method of mass-production in holography. The holographic information is transferred from light sensitive glass plates to nickel embossing shims. The holographic images are "printed" by stamping the interference pattern onto plastic and then backing the images with a light reflecting foil. The resulting hologram can be duplicated millions of times. In step **315**, an antenna is formed on the base layer. In step **320**, an RF chip is mounted on the base layer in electrical communication with the antenna to form an RF transponder. In step **325**, the antenna in the non-metallized region is connected to the metallized region with a connector (e.g., a conductive adhesive).

Example use of the RF Device

FIG. **4** illustrates a method of use **400** of RF device **100** and/or **200**, according to one embodiment of the present invention. In this case, the RF device is a window sticker **405** displayed on a vehicle **410**. As the vehicle passes an RF reader **415** (e.g., a U519 reader manufactured by BNC US holding, San Diego, Calif.) the information from the RF device is read. In one embodiment, an RF reader/writer is used, and information is read and written to and from the RF device. As will be apparent to those skilled in the relevant art(s) after reading the description herein, the window sticker is merely one illustration of the multiple uses of an RF device, and that the present invention is not limited to this embodiment. Other example uses of the RF device are: a passport, a driver's license, a license plate or other vehicle identification mechanism, a sticker, and a cell phone.

CONCLUSION

The present invention is described in terms of the above embodiments. This is for convenience only and is not intended to limit the application of the present invention. In fact, after reading the description of the present invention or upon learning by practice of the invention, additional advantages, features, and embodiments of the invention will be apparent to one skilled in the relevant arts.

In addition, it should be understood that the Figures described above, which highlight the functionality and advantages of the present invention, are presented for example purposes only. The architecture of the present invention is sufficiently flexible and configurable, such that it may be utilized in ways other than that shown in the Figures.

What is claimed is:

1. A radio frequency device comprising:

at least one metallized region;

at least one non-metallized region;

at least one antenna on the at least one non-metallized region;

at least one radio frequency chip in *electrical* communication with the at least one antenna; and

at least one electrical connection connecting the at least one antenna to the at least one metallized region, *wherein the at least one antenna is electrically interspersed between the radio frequency chip and the at least one metallized region,* such that the at least one metallized region acts as a second antenna *or as a part of the at least one antenna; and,*

wherein the at least one metallized region is not in direct electrical communication with the at least one radio frequency chip.

2. The radio frequency device of claim **1**, further comprising:

at least one base layer.

3. The radio frequency device of claim **2**, wherein the at least one metallized region is disposed on the at least one base layer.

4. The radio frequency device of claim **1**, wherein the at least one non-metallized region is created by demetallizing a portion of the at least one metallized region.

5. The radio frequency device of claim **1**, further comprising at least one holographic image.

6. The radio frequency device of claim **5**, wherein the at least one holographic image is in the at least one non-metallized region.

7. A radio frequency device comprising:

at least one base layer;

at least one metallized region disposed on the at least one base layer;

at least one non-metallized region;

at least one antenna on the at least one non-metallized region;

at least one radio frequency chip on the at least one base layer in *electrical* communication with the at least one antenna; and

at least one electrical connection connecting the at least one antenna to the at least one metallized region, *wherein the at least one antenna is electrically interspersed between the radio frequency chip and the at least one metallized region,* such that the at least one metallized region acts as a second antenna *or as a part of the at least one antenna; and,*

wherein the at least one metallized region is not in direct electrical communication with the at least one radio frequency chip.

8. The radio frequency device of claim **7**, further comprising at least one holographic image.

9. The radio frequency device of claim **7**, wherein the at least one holographic image is in the at least one non-metallized region.

10. The radio frequency device of claim **7**, wherein the at least one non-metallized region is created by demetallizing a portion of the at least one metallized region.

11. A radio frequency device comprising:

at least one base layer;

at least one metallized region disposed on the at least one base layer;

at least one non-metallized region;

at least one holographic image;

at least one antenna on the at least one non-metallized region;

at least one radio frequency chip in the at least one base layer in communication with the at least one antenna; and

at least one electrical connection connecting the at least one antenna to the at least one metallized region, *wherein the at least one antenna is electrically interspersed between the radio frequency chip and the at least one metallized region,* such that the at least one metallized region acts as a second antenna *or as a part of the at least one antenna; and,*

wherein the at least one metallized region is not in direct electrical communication with the at least one radio frequency chip.

12. The radio frequency device of claim **11**, wherein the at least one holographic image is in the at least one non-metallized region.

13. The radio frequency device of claim **11**, wherein the at least one non-metallized region is created by demetallizing a portion of the at least one metallized region.

14. A radio frequency device comprising:

at least one base layer;

at least one metallized region disposed on the at least one base layer;

at least one non-metallized region;

at least one holographic image on the at least one non-metallized region;

at least one antenna on the at least one non-metallized region;

at least one radio frequency chip in the at least one base layer in communication with the at least one antenna; and

at least one electrical connection connecting the at least one antenna to the at least one metallized region such that the at least one metallized region acts as a second antenna *or as a part of the one antenna*.

15. The radio frequency device of claim **14**, wherein the at least one non-metallized region is created by demetallizing a portion of the at least one metallized region.

16. A radio frequency device comprising:

at least one base layer;

at least one metallized region disposed on the at least one base layer;

at least one non-metallized region;

at least one holographic image in the at least one non-metallized region;

at least one antenna on the at least one non-metallized region;

at least one radio frequency chip on the at least one base layer in communication with the at least one antenna; and

at least one electrical connection connecting the at least one antenna to the at least one metallized region such that the at least one metallized region acts as a second antenna *or as a part of the at least one antenna*; and

whereby the at least one non-metallized region is created by demetallizing a portion of the at least one metallized region.

* * * * *

EXHIBIT "E"

US007119664B2

(12) **United States Patent**
Roesner

(10) **Patent No.: US 7,119,664 B2**
(45) **Date of Patent: Oct. 10, 2006**

(54) **DEEP SLEEP IN AN RFID TAG**

(75) Inventor: **Bruce B. Roesner**, San Diego, CA (US)

(73) Assignee: **ID Solutions, Inc.**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 118 days.

(21) Appl. No.: **10/666,226**

(22) Filed: **Sep. 17, 2003**

(65) **Prior Publication Data**

US 2005/0057341 A1 Mar. 17, 2005

(51) **Int. Cl.**
H04Q 5/22 (2006.01)
G08B 13/14 (2006.01)

(52) **U.S. Cl.** **340/10.33**; 340/10.2; 340/10.3; 340/10.4; 340/10.1; 340/572.3

(58) **Field of Classification Search** 340/10.33, 340/10.2, 10.3, 10.4, 10.1, 572.3
See application file for complete search history.

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2002/0097143 A1		7/2002	Dalglish	

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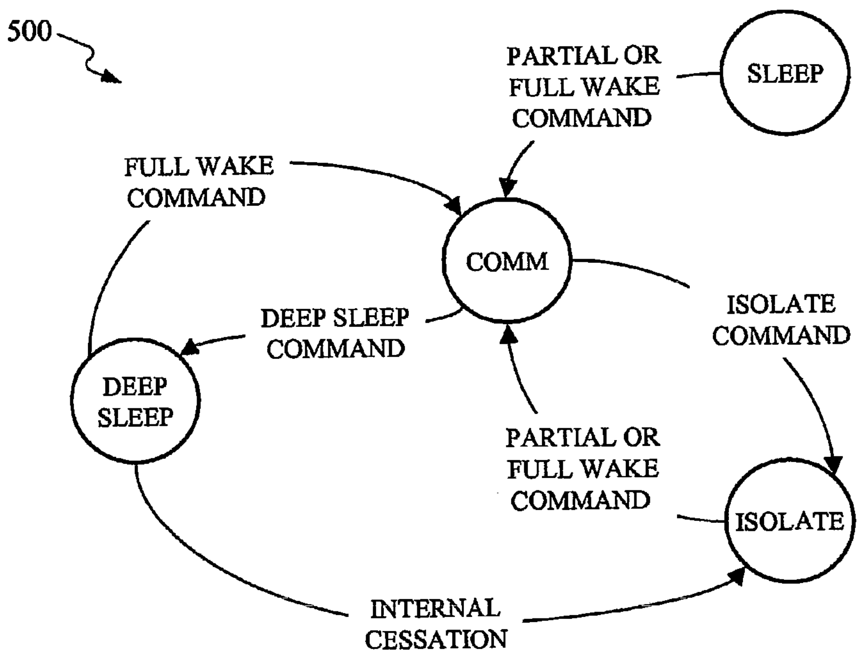
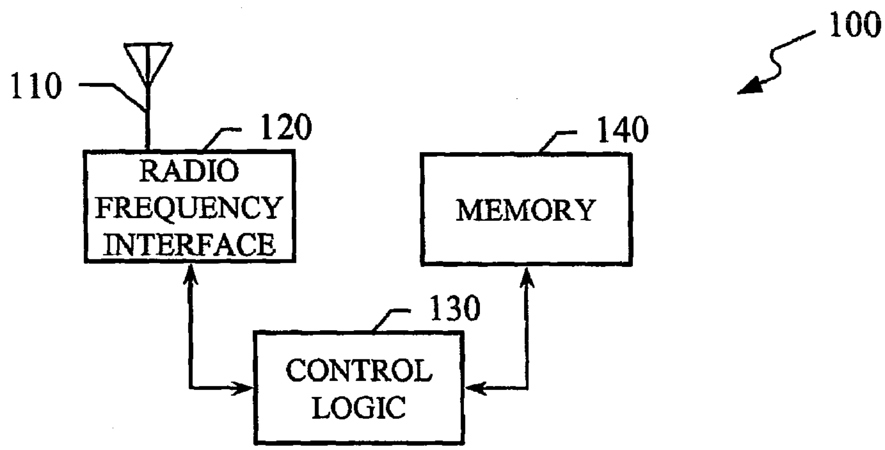
Assistant Examiner—Scott Au
(74) *Attorney, Agent, or Firm*—Fish & Richardson P.C.

(57) **ABSTRACT**

Systems and techniques to provide radio frequency identification tags including a non-responsive state, which is independent of supplied power, initiated in conjunction with a tag communications reset. In general, in one implementation, a passive radio frequency identification tag includes an antenna, a radio frequency interface coupled with the antenna, and control logic that initiates a deep sleep state in response an event, the deep sleep state including a non-responsive state that is independent of supplied power, and the control logic providing a following state entered upon conclusion of the non-responsive state, where communications initiate from the following state.

30 Claims, 4 Drawing Sheets

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110
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RADIO
FREQUENCY
INTERFACE
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MEMORY
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CONTROL
LOGIC

FIG. 1

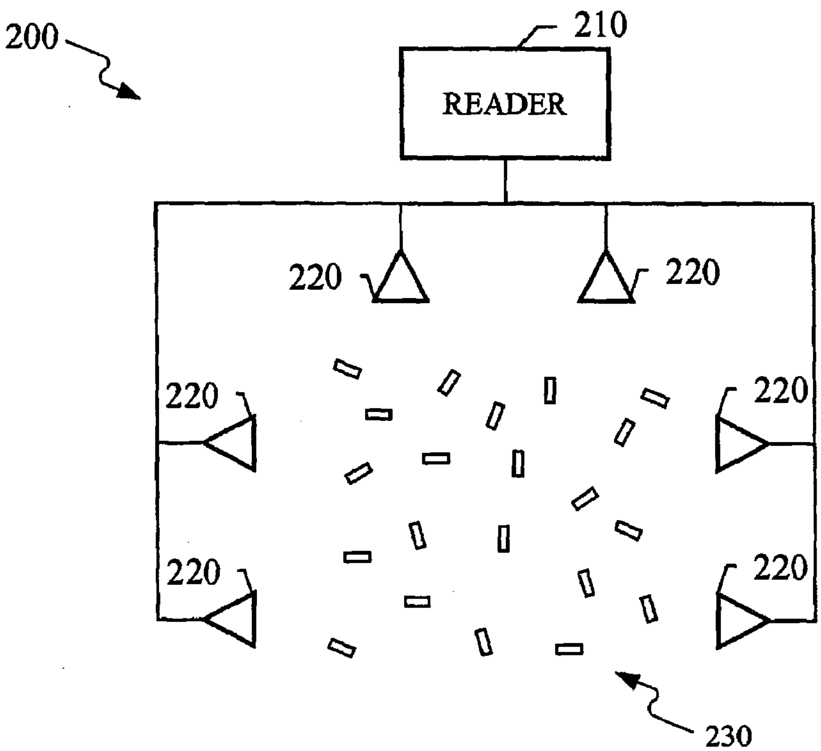
200
210
READER
220
220
220
220
220
220
230

FIG. 2

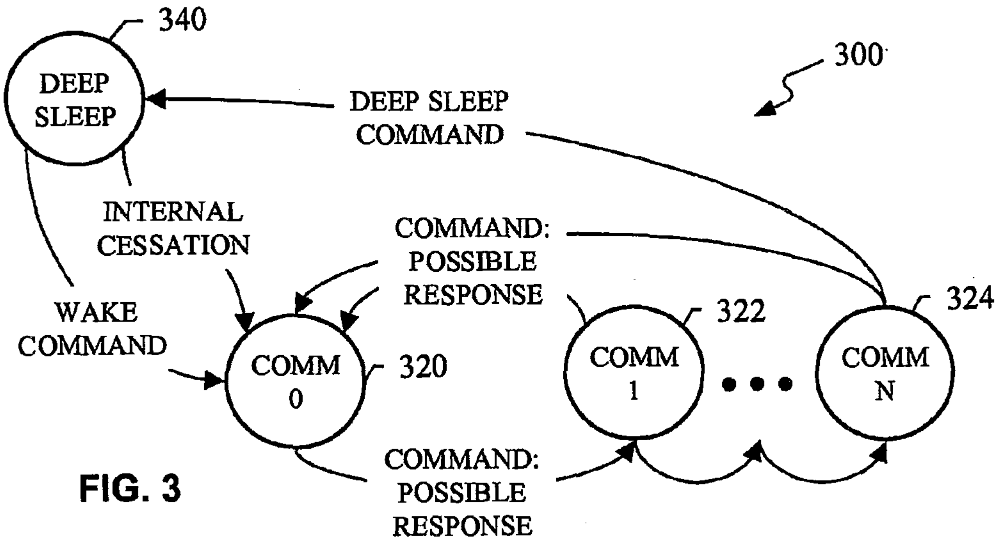
340
300
DEEP SLEEP
DEEP SLEEP COMMAND
INTERNAL CESSATION
COMMAND: POSSIBLE RESPONSE
WAKE COMMAND
322
324
COMM 0
320
COMM 1
COMM N
COMMAND: POSSIBLE RESPONSE

FIG. 3

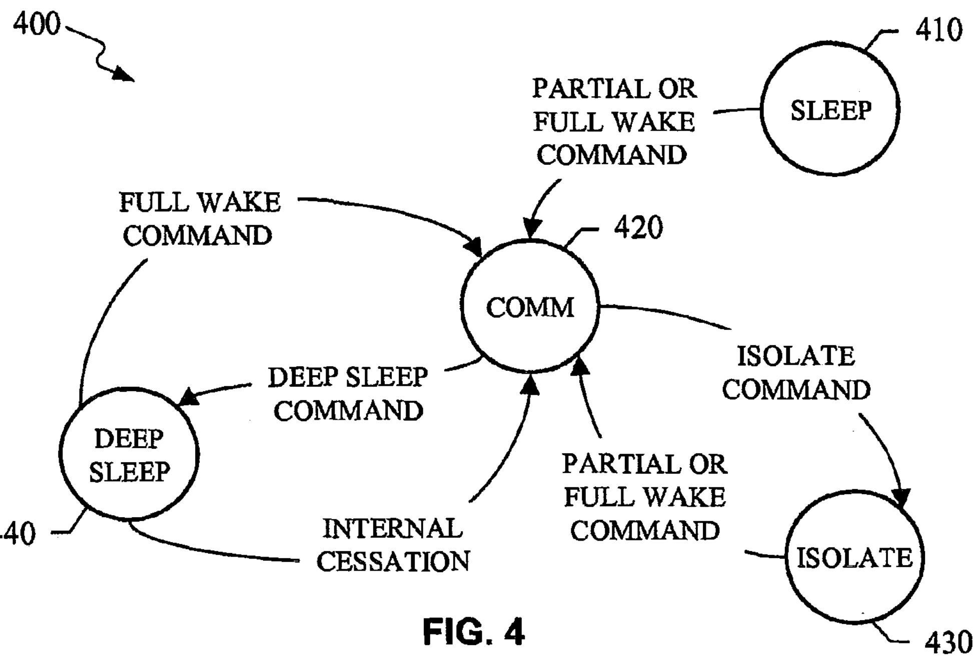
400
410
PARTIAL OR FULL WAKE COMMAND
SLEEP
FULL WAKE COMMAND
420
COMM
ISOLATE COMMAND
DEEP SLEEP COMMAND
DEEP SLEEP
PARTIAL OR FULL WAKE COMMAND
440
INTERNAL CESSATION
ISOLATE
430

FIG. 4

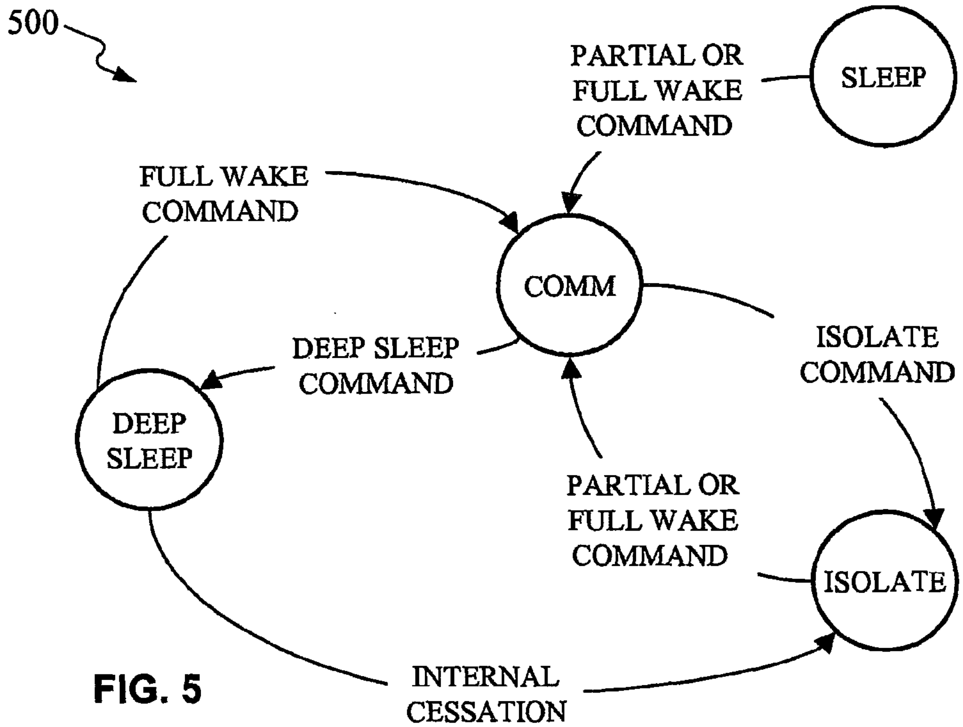
500
PARTIAL OR FULL WAKE COMMAND
SLEEP
FULL WAKE COMMAND
COMM
DEEP SLEEP COMMAND
ISOLATE COMMAND
DEEP SLEEP
PARTIAL OR FULL WAKE COMMAND
ISOLATE
INTERNAL CESSATION

FIG. 5

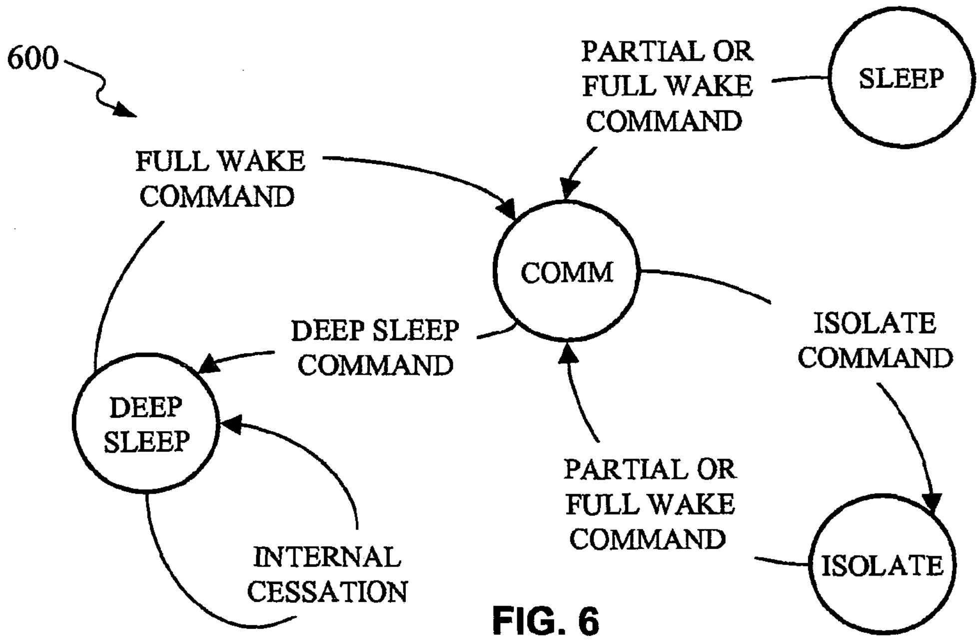
600
PARTIAL OR FULL WAKE COMMAND
SLEEP
FULL WAKE COMMAND
COMM
DEEP SLEEP COMMAND
ISOLATE COMMAND
DEEP SLEEP
PARTIAL OR FULL WAKE COMMAND
INTERNAL CESSATION
ISOLATE

FIG. 6

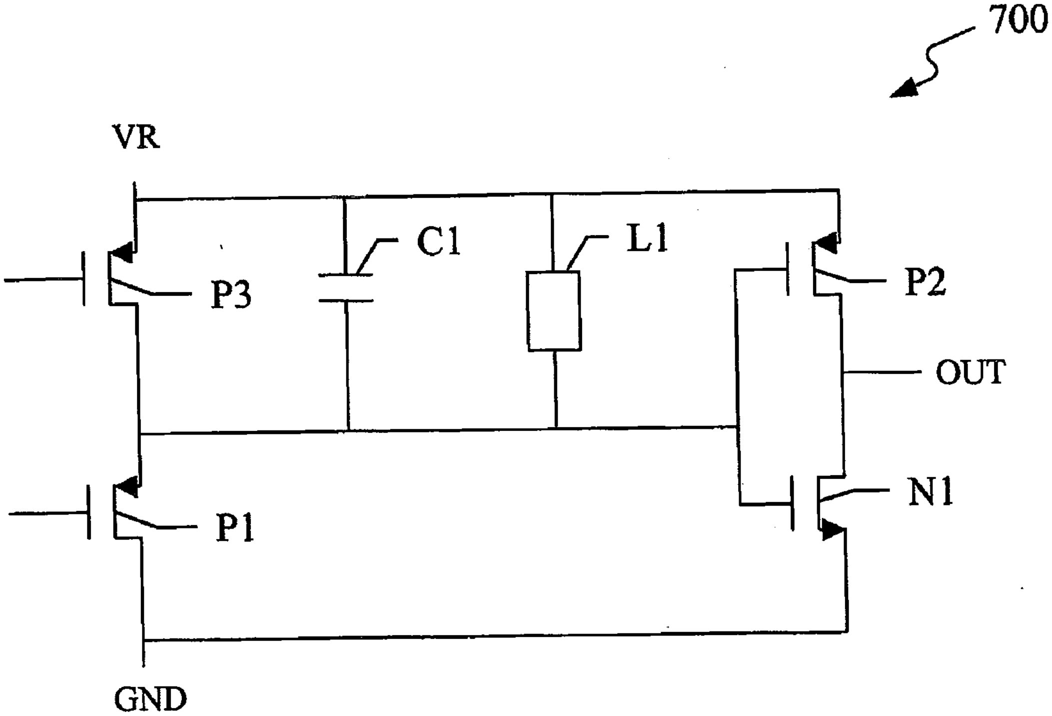

FIG. 7

DEEP SLEEP IN AN RFID TAG

BACKGROUND

The present application describes systems and techniques relating to radio frequency identification (RFID) tag design and use, for example, an RFID chip design for use in tag communication and management.

Traditional passive RFID tags frequently include some form of deactivation capability. Such capability can be of use when reading a large number of passive RFID tags in a field. After a particular tag has been read, that tag can be deactivated to prevent the tag from being read again, while the tag remains supplied with power.

Traditional tag deactivation capabilities provide a non-responsive state for the chip in the tag. The non-responsive state can be dependent on supplied power, such as from a reader or a charge storage device built into the tag (e.g., a large capacitor attached in parallel with the chip's voltage rail so that the chip does not lose power when temporarily removed from the RF field). The non-responsive state can be independent of supplied power, such as a state that blocks the input or the output of the chip using an internal clock that doesn't require maintaining normal power levels in the chip (e.g., a series switch activated in response to a "Cloak" logic command).

When the input is blocked using the Cloak technique, the front end of the chip is effectively disconnected such that incoming signals cannot be recognized in the chip, and the chip cannot respond to any commands from a reader. As described in U.S. Pat. No. 5,963,144, a series switch can be activated to disconnect an antenna of a passive RFID tag for a period determined by a charged resistor-capacitor (RC) circuit. When the output is blocked using the "Mute" technique, the chip continues listening and responding to commands from a reader, but cannot communicate the responses due to the blocked output. As described in U.S. Patent Application Publication No. 2002/0097143 A1, an AND gate can be used to couple a Cloak bar node and an Output node such that no signal can be backscattered from the passive RFID tag when the tag is Muted.

SUMMARY

The present disclosure includes systems and techniques relating to radio frequency identification tags including a non-responsive state, which is independent of supplied power, initiated in conjunction with a tag communications reset. According to an aspect, a passive radio frequency identification tag includes an antenna, a radio frequency interface coupled with the antenna, and control logic that initiates a deep sleep state in response an event, the deep sleep state including a non-responsive state that is independent of supplied power, and the control logic providing a following state entered upon conclusion of the non-responsive state, where communications initiate from the following state.

Using the systems and techniques described, passive RFID tags can be placed in a deactivated state of deep sleep, where the tag remains in deep sleep even if it falls out of, and then re-enters the RF field supplying the tag with power. The deep sleep state prevents the tag from timing out of its deactivated state and unexpectedly jumping into the middle of current tag-reader communications. This provides significant flexibility and control in designing RFID chip communication and management protocols.

Moreover, the tag may allow the deep sleep state to be concluded by a command received from a reader, providing additional flexibility. In reader systems designed to read many tags quickly, the deep sleep state may prevent a tag from being read multiple times unnecessarily. Reducing repetitive reading of tags may significantly increase a reader system's efficiency. Moreover, the present systems and techniques may result in reduced tag manufacturing costs.

Details of one or more implementations are set forth in the accompanying drawings and the description below. Other features and advantages may be apparent from the description and drawings, and from the claims.

DRAWING DESCRIPTIONS

FIG. **1** illustrates, in block diagram form, a passive RFID tag that employs a deep sleep state.

FIG. **2** illustrates, in block diagram form, a HF tag reader system and multiple HF passive RFID tags employing a deep sleep capability.

FIG. **3** is a state diagram illustrating modes of operation, including a deep sleep mode, as can be implemented in control logic of a passive RFID tag.

FIG. **4** is a state diagram illustrating additional modes of operation, including a deep sleep mode, as can be implemented in control logic of a passive RFID tag.

FIG. **5** is a state diagram illustrating a variation of the modes of operation illustrated in FIG. **4**.

FIG. **6** is a state diagram illustrating another variation of the modes of operation illustrated in FIG. **4**.

FIG. **7** is a circuit diagram illustrating an example circuit that can be used in implementing a deep sleep mode in a passive RFID tag.

Details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features and advantages may be apparent from the description and drawings, and from the claims.

DETAILED DESCRIPTION

FIG. **1** illustrates, in block diagram form, a passive RFID tag **100** that employs a deep sleep state. The tag **100** can include an antenna **110**, a radio frequency (RF) interface **120**, and control logic **130**. The tag **100** can also include a memory **140**.

The tag **100** can obtain its power from an inductive coupling of the tag to energy circulating around a reader coil when designed to operate in a low frequency (LF) band (e.g., 13.56 MHz). Alternatively, the tag **100** can use radiative coupling, such as in ultra-high frequency (UHF) and microwave RFID systems.

The RF interface **120**, the control logic **130** and the memory **140** can be combined in a single integrated circuit (IC), such as a low-power complementary metal oxide semiconductor (CMOS) IC. The RF interface **120** can be an analog portion of the IC, and the control logic **130** and the memory **140** can be a digital portion of the IC. The memory **140** can be a non-volatile read-write memory, such as an electrically erasable programmable read only memory (EEPROM).

The IC can also include an antenna tuning capacitor and an RF-to-DC rectifier system designed for the antenna **110**, which is the coupling element for the tag **100**. The antenna **110** can enable the passive RFID tag to obtain power to energize and active the tag's chip. The antenna **110** can have many different shapes and sizes, depending on the type of RFID coupling system being employed.

The control logic **130** can include both digital control and data modulation circuits. The control logic **130** can initiate a deep sleep state in response to an event, such as a received deep sleep command or a last command in a sequence of associated commands. The deep sleep state can include a non-responsive state that is independent of supplied power. The non-responsive state can be implemented using the control logic **130** and/or the RF interface **120**.

The control logic **130** provides a following state entered upon conclusion of the non-responsive state, where communications initiate from the following state. The following state can be an initial communication state, an isolate state, or the non-responsive state reinitiated, as described further below. Moreover, the non-responsive state can be implemented such that the non-responsive state can be concluded by cessation of an internal timer (e.g., the natural voltage decay of a charged RC circuit within the IC) or by receipt of a command, such as a full wake command received from a reader.

The control logic **130** can thus ensure that, once the tag is placed in deep sleep, the tag does not wake up in the middle of a sequence of commands and jump into communications currently occurring between other tags and a reader. The control logic **130** can require the tag **100** to go to the beginning of a command structure as part of entering the deep sleep state. Thus, while the tag **100** can continue to listen for a wake command, the tag **100** can ignore other commands that are not intended for the tag in deep sleep.

When the tag **100** is instructed to sleep, the tag can be placed in a deep sleep mode and held in that state until one of two conditions is met: (1) a specific command is received to awaken the tag, or (2) the internal timer runs out. When the tag **100** awakens from the deep sleep state, the tag can then respond to additional commands from a reader. Thus, the tag **100** can be deactivated using a non-responsive state that is independent of supplied power; this non-responsive state can be maintained even if the tag falls out of the RF field for a period of time, without requiring the tag **100** to maintain a capacitative power source in the tag.

While the tag **100** is in this non-responsive state, the control logic **130** can still recognize a command to activate the tag **100** and wake up from the deep sleep state. When the tag **100** wakes up, either due to a received command or due to internal cessation, the tag can be prevented from jumping into the middle of current tag-reader communications. By preventing the tag **100** from becoming active in the middle of communications between the reader and other tags, the deep sleep state can be used in passive RFID communication and management protocol(s) to reduce interference among tags being read and increase the efficiency of a tag reader system.

FIG. **2** illustrates, in block diagram form, a HF tag reader system **200** and multiple HF passive RFID tags **230** employing a deep sleep capability. The reader system **200** can include a reader **210** and multiple reader antennas **220**. The reader **210** can include an RF transceiver module, signal processor, and controller unit. Additionally, the system **200** can include a host system (not shown) to which the reader **210** can be communicatively coupled to relay data relating to the tags **230**.

The reader antennas **220** can produce partially overlapping fields and can be multiplexed by the reader **210** to read all the HF passive RFID tags **230**. In general, the reader system **200** can be designed to provide at least one reader antenna at about forty five to ninety degrees to each tag in a group of randomly oriented tags. Once a tag is read by the system **200**, such as by using a binary search protocol to

identify the tag, that tag can be turned off temporarily by placing the tag in the deep sleep state. The deep sleep state can reset the chip in the tag with the exception of the command structure looking for a full wake command.

Thus, a passive RFID tag placed in the deep sleep state can remain in its inactive state even if the tag temporarily falls out of a field providing the tag's power, the tag can be brought out of the deep sleep state by issuing an appropriate wake command, and the tag can ignore all other commands while it remains in the deep sleep state. This deep sleep state provides significant flexibility in how the reader **210** communicates and manages the tags **230**.

When a tag is placed in the deep sleep state, the reader **210** can proceed with communicating with the remaining tags without the risk that the tag in deep sleep will wake up in the middle of a sequence of commands and unexpectedly jump into the middle of current tag-reader communications. The tags **230** can be designed such that they communicate with the reader **210** only if they come in at the beginning of a command structure. Moreover, multiple sleep states can be employed, such as described below, to provide still further flexibility in tag communication and control.

FIG. **3** is a state diagram **300** illustrating modes of operation, including a deep sleep mode, as can be implemented in control logic of a passive RFID tag. Multiple communication states **320**, **322**, **324** can allow response to a sequence of associated commands when receipt of the command sequence begins in an initial communication state **320**. A command received in a communication state can result in a transition to a new communication state and/or in a possible response being generated. For example, the command sequence can be a portion of a binary search protocol, where tags in a field are iteratively queried as to whether they have an internal identifier with particular values in specific bit locations, and the tags respond accordingly.

A deep sleep state **340** can be initiated from any of these communication states in response to receipt of a deep sleep command and/or automatically, such as at the end of a command sequence. The deep sleep state **340** can be a non-responsive state that is independent of supplied power, and the control logic can provide a following state entered upon conclusion of the non-responsive state, where this following state is the initial communication state **320**. The non-responsive state, and thus the deep sleep state **340**, can be concluded in response to receipt of a wake command or internal cessation of the non-responsive state. The wake command can be specific to an identified tag or can be a universal wake command applicable to multiple tags.

When the deep sleep state **340** concludes, and the initial communication state **320** is entered, any received commands that are not a beginning command in a command sequence, and thus relate to tags that are currently in a higher communication state **322**–**324**, can be ignored by the tag. Because the tag has just left the deep sleep state **340**, the tag can remain in the initial communication state **320** until it receives the beginning command in a full command sequence.

FIG. **4** is a state diagram **400** illustrating additional modes of operation, including a deep sleep mode, as can be implemented in control logic of a passive RFID tag. A sleep state **410** can be entered by the tag when it is first powered up by a RF field. This sleep state **410** causes the tag to wait for a recognized command from a reader before entering a communication state **420**. Such recognized commands can be a partial wake command, a full wake command, and/or a beginning command in a full command sequence. Thus, the communication state **420** can have multiple separate communications states as described above in connection with FIG. **3**, and/or the sleep state **410** can be considered the initial communication state described above.

A tag can enter an isolate state **430**, where the tag is isolated in the field, in response to an isolate command received from a reader and/or automatically, such as at the end of a command sequence. The tag can be removed from the isolate state **430** and put back in the communication state **420** in response to a partial wake command, a full wake command, and/or a beginning command in a full command sequence. The sleep and isolate states **410**, **430** can be dependent upon supplied power, and the sleep and isolate states **410**, **430** can correspond to the same state in the control logic, or they can correspond to distinct control logic states, depending on the implementation.

A deep sleep state **440** can be implemented as described above, with the addition that the deep sleep state **440** can be concluded by receipt of a full wake command. The full wake command can be distinguished from the partial wake command by the tag, and the full wake command can be specific to an identified tag or can be a universal full wake command applicable to multiple tags. Thus, for example, the partial wake command can cause all tags in a field that are in either the sleep or isolate states **410**, **430** to become active again, and the full wake command can cause all tags in the field that are in either the sleep, isolate or deep sleep states **410**, **430**, **440** to become active again.

Other alternative functional combinations of the partial and full wake commands are also possible. The partial wake command can cause all tags in a field that are in the sleep state **410** to become active again, and the full wake command can cause all tags in the field that are in either the sleep, isolate or deep sleep states **410**, **430**, **440** to become active again. The partial wake command can cause all tags in a field that are in the sleep state **410** to become active again, and the full wake command can cause all tags in the field that are in either the sleep or deep sleep states **410**, **440** to become active again. The partial wake command can cause all tags in a field that are in either the sleep or isolate states **410**, **430** to become active again, and the full wake command can cause all tags in the field that are in either the sleep or deep sleep states **410**, **440** to become active again. In implementations where the isolate state is not affected by the full wake command and/or the partial wake command, another command can be used to conclude the isolate state, or no such command may be provided (e.g., when the isolate state only concludes upon the tag falling out of the field).

FIG. **5** is a state diagram **500** illustrating a variation of the modes of operation illustrated in FIG. **4**. In this variation, the following state can be the isolate state, and thus internal cessation of the non-responsive state can cause a transition from the deep sleep state to the isolate state. FIG. **6** is a state diagram illustrating another variation of the modes of operation illustrated in FIG. **4**. In this variation, the following state can be the non-responsive state reinitiated, and thus internal cessation of the non-responsive state can cause a transition from the deep sleep state back to itself. Other variations of the modes of operation described herein are also possible.

FIG. **7** is a circuit diagram illustrating an example circuit **700** that can be used in implementing a deep sleep mode in a passive RFID tag. The circuit **700** includes a voltage rail (VR) line, a ground (GND) line, an output (OUT) line, a capacitor C1, a load device L1, and four transistors N1, P1, P2, P3. During normal operation of the tag, the transistors P1, P3 are off and the common node between the transistors is pulled high so that the output is low. To activate deep sleep, P1 can be turned on causing the common node to be pulled low and the output to go high. Over time, the capacitor C1 discharges through the load device L1 and eventually, the output goes low again. To terminate deep sleep, P3 can be turned on, resetting the circuit **700** to its initial state.

The load device L1 can reduce the risk of premature triggering of the circuit **700**, such as may happen if the leakage of P1 is greater than the leakage of P3. In addition, C1 and L1 can be selected such that, once deep sleep has been activated, the chances of the circuit **700** not coming back out of the deep sleep state are reduced while power is being supplied.

P1 is attached to GND, in contrast with traditional CMOS logic in which the P channel device is typically attached to the positive voltage rail and the N channel device to ground. Once deep sleep is activated, a voltage is built up across the capacitor C1. If power to the chip is subsequently lost and VR drops to 0 volts, the bottom node of the capacitor should go below ground. The drain of an N channel device may then become a forward biased diode causing the capacitor C1 to discharge. Thus, when power is reapplied, the circuit may not be in the deep sleep state. Connecting the P1 transistor to ground as shown in the circuit **700** can prevent this from happening.

Other embodiments may be within the scope of the following claims.

What is claimed is:

1. A passive radio frequency identification tag comprising:

an antenna;

a radio frequency interface coupled with the antenna; and

control logic that initiates a deep sleep state in response to an event, the deep sleep state comprising non-responsive state that is independent of supplied power, and the control logic providing a following slate entered upon conclusion of the non-responsive state, wherein communications initiate from the following state, wherein the following state comprises an initial communication state from a plurality of communication states, wherein the plurality of communication states allow response to a sequence of associated commands when receipt of the command sequence begins in the initial communication state; wherein the deep sleep state initiates in response to an event comprising receipt of a deep sleep command; wherein the non-responsive state concludes in response to a first occurring event from events comprising receipt of a wake command and internal cessation of the non-responsive state; and where the control logic further provides a sleep state that is entered upon power up and an isolate state that is entered upon receipt of an isolate command, the sleep and isolate states being dependent upon supplied power, wherein the sleep, isolate and non-responsive states conclude upon receipt of a full wake command, and the sleep and isolate states, but not the non-responsive state, conclude upon receipt of a partial wake command.

2. The passive radio frequency identification tag of claim **1**, where the radio frequency interface comprises an analog portion of a complementary metal oxide semiconductor (CMOS) integrated circuit (IC), the control logic comprises a digital portion of the CMOS IC, and the internal cessation of the non-responsive state comprises a voltage decay of a charged RC circuit in the CMOS IC.

3. A passive radio frequency identification tag comprising:

an antenna;

a radio frequency interface coupled with the antenna; and

control logic that initiates a deep sleep state in response to an event, the deep sleep state comprising a non-responsive state that is independent of supplied power, and the control logic providing a following state entered upon conclusion of the non-responsive state, wherein communications initiate from the following state, wherein the following state comprises an initial communication state from a plurality of communication states, wherein the plurality of communication states allow response to a sequence of associated commands when receipt of the command sequence begins in the initial communication state; wherein the deep sleep state initiates in response to an event comprising receipt of a deep sleep command; wherein the non-responsive state concludes in response to a first occurring event from events comprising receipt of a wake command and internal cessation of the non-responsive state; and where the control logic further provides a sleep state that is entered upon power up and an isolate state that is entered upon receipt of an isolate command, the sleep and isolate states being dependent upon supplied power, wherein the sleep and non-responsive states, but not the isolate state, conclude upon receipt of a full wake command, and the sleep and isolate states, but not the non-responsive state, conclude upon receipt of a partial wake command.

4. The passive radio frequency identification tag of claim **3**, where the radio frequency interface comprises an analog portion of a complementary metal oxide semiconductor (CMOS) integrated circuit (IC), the control logic comprises a digital portion of the CMOS IC, and the internal cessation of the non responsive state comprises a voltage decay of a charged RC circuit in the CMOS IC.

5. A passive radio frequency identification tag comprising:

an antenna;

a radio frequency interface coupled with the antenna; and

control logic that initiates a deep sleep state in response to an event, the deep sleep state comprising a non-responsive state that is independent of supplied power, and the control logic providing a following state entered upon conclusion of the non-responsive state, wherein communications initiate from the state, wherein the following state comprises an initial communication state from a plurality of communication states, wherein the plurality of communication states allow response to a sequence of associated commands when receipt of the command sequence begins in the initial communication slate; wherein the deep sleep state initiates in response to an event comprising receipt of a deep sleep command; wherein the non-responsive state concludes in response to a first occurring event from events comprising receipt of a wake command and internal cessation of the non-responsive state; and where the control logic further provides a sleep state that is entered upon power up and an isolate state that is entered upon receipt of an isolate command, the sleep and isolate states being dependent upon supplied power; wherein the sleep and non-responsive states, but not the isolate state, conclude upon receipt of a full wake command, and the sleep state, but not the isolate and non-responsive states, conclude upon receipt of a partial wake command.

6. The passive radio frequency identification tag of claim **5**, where the radio frequency interface comprises an analog portion of a complementary metal oxide semiconductor

(CMOS) integrated circuit (IC), the control logic comprises a digital portion of the CMOS IC, and the internal cessation of the non responsive state comprises a voltage decay of a charged RC circuit in the CMOS IC.

7. A passive radio frequency identification tag comprising:

an antenna;

a radio frequency interface coupled with the antenna; and

control logic that initiates a deep sleep state in response to an event, the deep sleep state comprising a non-responsive state that is independent of supplied power, and the control logic providing a following state entered upon conclusion of the non-responsive state, wherein communications initiate from the following state, wherein the following state comprises an initial communication state from a plurality of communication states, wherein the plurality of communication states allow response to a sequence of associated commands when receipt of the command sequence begins in the initial communication state; wherein the deep sleep state initiates in response to an event comprising receipt of a deep sleep command; wherein the non-responsive state concludes in response to a first occurring event from events comprising receipt of a wake command and internal cessation of the non-responsive state; and where the control logic further provides a sleep state that is entered upon power up and an isolate state that is entered upon receipt of an isolate command, the sleep and isolate states being dependent upon supplied power, wherein the sleep, isolate and non-responsive states conclude upon receipt of a full wake command, and the sleep state, but not the isolate and non-responsive states, conclude upon receipt of a partial wake command.

8. The passive radio frequency identification tag of claim **7**, where the radio frequency interface comprises an analog portion of a complementary metal oxide semiconductor (CMOS) integrated circuit (IC), the control logic comprises a digital portion of the CMOS IC, and the internal cessation of the non responsive state comprises a voltage decay of a charged RC circuit in the CMOS IC.

9. A passive radio frequency identification tag comprising:

a radio frequency interface coupled with the antenna; and

control logic that initiates a deep sleep state in response to an event, the deep sleep state comprising a non-responsive state that is independent of supplied power, and the control logic providing a following state entered upon conclusion of the non-responsive state, wherein communications initiate from the following state, wherein the non-responsive state concludes upon internal cessation, the following state comprises an isolate state, and the deep sleep and isolate states conclude upon receipt of a full wake command.

10. The passive radio frequency identification tag of claim **9**, where the radio frequency interface comprises an analog portion of a complementary metal oxide semiconductor (CMOS) integrated circuit (IC), the control logic comprises a digital portion of the CMOS IC, and the internal cessation of the non responsive state comprises a voltage decay of a charged RC circuit in the CMOS IC.

11. A passive radio frequency identification tag comprising:

an antenna;

a radio frequency interface coupled with the antenna; and

control logic that initiates a deep sleep state in response to an event, the deep sleep state comprising a non-responsive state that is independent of supplied power, and the control logic providing a following state entered upon conclusion of the non-responsive state, wherein communications initiate the following state, wherein the non-responsive state concludes upon internal cessation, the following state comprises the non-responsive state reinitiated, and the deep sleep state concludes upon receipt of a full wake command.

12. The passive radio frequency identification tag or claim **11**, wherein the command sequence comprises at least a portion of a binary search protocol.

13. The passive radio frequency identification tag of claim **11**, wherein the antenna comprises a near-field coupling element configured to operate in a high frequency band.

14. The passive radio frequency identification tag of claim **11**, further comprising a non-volatile memory.

15. The passive radio frequency identification tag of claim **11**, where the radio frequency interface comprises an analog portion of a complementary metal oxide semiconductor (CMOS) integrated circuit (IC), the control logic comprises a digital portion of the CMOS IC, and the internal cessation of the non responsive state comprises a voltage decay of a charged RC circuit in the CMOS IC.

16. A system comprising:

a radio frequency identification (RFID) tag reader that sends commands including at least one sequence of associated commands used to identify an RFID tag on an article; and

multiple passive RFID tags, each tag being attached to an article and each tag comprising a radio frequency sub-system and control logic coupled with the radio frequency sub-system, wherein the control logic resets tag communications and initiates a non-responsive state in response to at least one event, the non-responsive state being independent of supplied power, and the control logic responds to a wake command but ignores other commands in the command sequence while the tag is in the non-responsive state, and the wake command response concludes the non-responsive state;

wherein the control logic further provides a sleep state that is entered upon power up and an isolate state that is entered upon receipt of an isolate command, the sleep and isolate states being dependent upon supplied power, wherein the sleep, isolate and non-responsive states conclude upon receipt of a full wake command, and the sleep and isolate states, but not the non-responsive state, conclude upon receipt of a partial wake command.

17. The system of claim **16**, wherein the non-responsive state also concludes upon internal cessation.

18. The system of claim **17**, wherein each tag comprises an antenna and an integrated circuit (IC) that comprise the radio frequency sub-system and the control logic, and the internal cessation of the non-responsive state comprises a voltage decay of a charged RC circuit in the IC.

19. The system of claim **18**, wherein the antenna comprises a near-field coupling element configured to operate in a high frequency band, and the IC further comprises a non-volatile memory.

20. A system comprising:

a radio frequency identification (RFID) tag reader that sends commands including at least one sequence of associated commands used to identify an RFID tag on an article; and

multiple passive RFID tags, each tag being attached to an article and each tag comprising a radio frequency sub-system and control logic coupled with the radio frequency sub-system, wherein the control logic resets

tag communications and initiates a non-responsive state in response to at least one event, the non-responsive state being independent of supplied power, and the control logic responds to a wake command but ignores other commands in the command sequence while the tag is in the non-responsive state, and the wake command response concludes the non-responsive state;

wherein the control logic further provides a sleep state that is entered upon power up and an isolate state that is entered upon receipt of an isolate command, the sleep and isolate states being dependent upon supplied power, wherein the sleep and non-responsive states, but not the isolate state, conclude upon receipt of a full wake command, and the sleep and isolate states, but not the non-responsive state, conclude upon receipt of a partial wake command.

21. The system of claim **20**, wherein the non-responsive state also concludes upon internal cessation.

22. A system comprising:

a radio frequency identification (RFID) tag reader that sends commands including at least one sequence of associated commands used to identify an RFID tag on an article; and

multiple passive RFID tags, each tag being attached to an article and each tag comprising a radio frequency sub-system and control logic coupled with the radio frequency sub-system, wherein the control logic resets tag communications and initiates a non-responsive state in response to at least one event, the non-responsive state being independent of supplied power, and the control logic responds to a wake command but ignores other commands in the command sequence while the tag is in the non-responsive state, and the wake command response concludes the non-responsive state;

wherein the control logic further provides a sleep state that is entered upon power up and an isolate state that is entered upon receipt of an isolate command, the sleep and isolate states being dependent upon supplied power, wherein the sleep and non-responsive states, but not the isolate state, conclude upon receipt of a full wake command, and the sleep state, but not the isolate and non-responsive states, conclude upon receipt of a partial wake command.

23. The system of claim **22**, wherein the non responsive state also concludes upon internal cessation.

24. A system comprising:

a radio frequency identification RFID tag reader that sends commands including at least one sequence of associated commands used to identify an RFID tag on an article; and

multiple passive RFID tags, each tag being attached to an article and each tag comprising a radio frequency sub-system and control logic coupled with the radio frequency sub-system, wherein the control logic resets tag communications and initiates a non-responsive state in response to at least one event, the non-responsive state being independent of supplied power, and the control logic responds to a wake command but ignores other commands in the command sequence while the tag is in the non-responsive state, and the wake command response concludes the non-responsive state;

wherein the control logic further provides a sleep state that is entered upon power up and an isolate state that is entered upon receipt of an isolate command, the sleep and isolate states being dependent upon supplied power, wherein the sleep, isolate and non-responsive states conclude upon receipt of a full wake command,

and the sleep state, but not the isolate and non-responsive states, conclude upon receipt of a partial wake command.

25. The system of claim **24**, wherein the non responsive state also concludes upon internal cessation.

26. A passive radio frequency identification tag comprising:

means for receiving power and commands in a command structure; and

means for entering a deep sleep state comprising a reset of the command structure and a non-responsive state that is independent of supplied power, wherein the non responsive state concludes in response to receipt of a wake command;

wherein the means for entering the deep sleep state comprise:

means for preventing premature triggering of the deep sleep state; and

means for maintaining the deep sleep state when power is reapplied after loss of the received power.

27. A system comprising:

a radio frequency identification (RFID) tag reader that sends commands including at least one sequence of associated commands used to identify an RFID tag on an article; and

multiple passive RFID tags, each tag being attached to an article and each tag comprising a radio frequency sub-system and control logic coupled with the radio frequency sub-system, wherein the control logic resets tag communications and initiates a non-responsive state in response to at least one event, the non-responsive state being independent of supplied power, and the control logic responds to a wake command but ignores other commands in the command sequence while the tag is in the non-responsive state, and the wake command response concludes the non-responsive state;

wherein the non-responsive state concludes upon internal cessation, the control logic provides an isolate state

entered upon conclusion of the non-responsive state, and the isolate state concludes upon receipt of the wake command.

28. The system of claim **27**, wherein each tag comprises an antenna and an integrated circuit (IC) that comprise the radio frequency sub-system and the control logic, and the internal cessation of the non-responsive state comprises a voltage decay of a charged RC circuit in the IC.

29. A system comprising:

a radio frequency identification (RFID) tag reader that sends commands including at least one sequence of associated commands used to identify an RFID tag on an article; and

multiple passive RFID tags, each tag being attached to an article and each tag comprising a radio frequency sub-system and control logic coupled with the radio frequency sub-system, wherein the control logic resets tag communications and initiates a non-responsive state in response to at least one event, the non-responsive state being independent of supplied power, and the control logic responds to a wake command but ignores other commands in the command sequence while the tag is in the non-responsive state, and the wake command response concludes the non-responsive state;

wherein the non-responsive state concludes upon internal cessation, and the non-responsive state is reinitiated upon conclusion of the non-responsive state by internal cessation.

30. The system of claim **29**, wherein each tag comprises an antenna and an integrated circuit (IC) that comprise the radio frequency sub-system and the control logic, and the internal cessation of the non-responsive state comprises a voltage decay of a charged RC circuit in the IC.

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