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(71) Applicant: **EASTMAN KODAK COMPANY**
Rochester, New York 14650 (US)

(72) Inventors:
- **Wen, Xin**
  Eastman Kodak Co., Patent Legal Staff
  Rochester, New York 14650-2201 (US)
- **Honsinger, Chris W.**
  Eastman Kodak Co.,
  Rochester, New York 14650-2201 (US)

(74) Representative:
Lewandowsky, Klaus, Dipl.-Ing. et al
Kodak Aktiengesellschaft,
Patentabteilung
70323 Stuttgart (DE)

(54) Printing postage stamps with embedded information

(57) A digital printing apparatus is disclosed for printing on a receiver a postal image having invisible embedded information in response to a digital image having a plurality of pixels each having at least one pixel value and input information to embedded. The digital printing apparatus receives the digital image and the input information. The receiver includes a plurality of perforated peelable portions or a mailing envelope. The apparatus responds to the input information and the digital image for modifying a predetermined number of pixel values of pixels in the digital image with the input information so that the input information is embedded in the digital image and prints a postal stamp image on the receiver in accordance with the modified digital image having the embedded information wherein the embedded information is invisible to unaided human eyes that can subsequently be extracted.

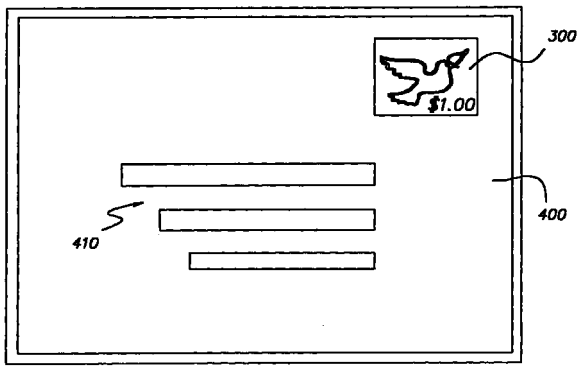

FIG. 4

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Description

[0001] The present invention relates to printing postage stamps with embedded information.

[0002] Postal stamps can be printed by gravure, intaglio, offset, and flexo techniques. The official postage stamps are commonly printed using a Gravure process. The Gravure process is capable of creating images of very high resolution, beyond the capabilities of most common printers. The Gravure process is an intaglio process. It uses a depressed or sunken surface etched into a copper cylinder to create the image and the unetched surface of the cylinder represent non-printing areas. The cylinder rotates in a bath of ink and the etched area picks up the ink and transfers it to the media creating the image. Gravure printing is considered excellent for printing highly detailed marks or pictures.

[0003] The high set-up cost (including making the cylinders and so forth) of the Gravure printing process makes it not economic for printing small quantities of stamps, for example, batches from about of 10 to 1000. This prohibits a consumer from choosing an image and having a postage stamp created using that image. It also does not permit a consumer to choose an image from a gallery of images that have been previously approved and having a postage stamp created using that previously approved image.

[0004] Several companies including Pitney Bowes Corporation, Stamps.com, Neopost, and E-stamp Corporation have started offering postage printing by printers at offices or homes. This has been previously conducted with a mechanical postage meter. In 1999, the United States Postal Service (USPS) has mandating replacement of these mechanical postage meters with more secure digital electronic meters, wherein credit and payment can be better monitored through the Internet.

[0005] One issue with the postal stamps is the authentication of the stamps. The security, mailing or postage information can be printed in a bar code. The bar code can be in one dimensional or two dimensional forms. US-A-4,835,713 discloses security information encoded in binary code in printed indicia. The security information is printed in an array of dots and can be retrieved by a special reader. US-A-5,413,037 discloses an apparatus and method for enhancing the security of mechanical postage meters through use of an encapsulated fluorescence quenching substance. An encapsulated quenching substance is blended with red fluorescent inks that are used to print postage indicia.

[0006] An object of this invention is to provide postage stamps having embedded information in a postal image.

[0007] A further object of the present invention is to provide invisible embedded information that can be used to carry security, payment or credit, and address information in the images on the postal stamps.

[0008] These objects are achieved by a digital printing apparatus for printing on a receiver a postal image having invisible embedded information in response to a digital image having a plurality of pixels each having at least one pixel value and input information to embedded, comprising

a) means for receiving the digital image and the input information;

b) the receiver including a plurality of perforated peelable portions or is a mailing envelope;

c) means responsive to the input information and the digital image for modifying a predetermined number of pixel values of pixels in the digital image with the input information so that the input information is embedded in the digital image; and

d) means for printing a postal stamp image on the receiver in accordance with the modified digital image having the embedded information wherein the embedded information is invisible to unaided human eyes that can subsequently be extracted.

[0009] An advantage of the present invention is that the information such as security information can be embedded on the postal images of postal stamps. The embedded information does not alter the image content of the postal image and is invisible to eyes. The security is therefore enhanced. The embedded information can be extracted by a scanner and a software.

[0010] A further advantage of the present invention is that the postal information such as the security, mailing or postage information can be printed as embedded information inside the area of the postal image which eliminates the need for additional area on a postal stamp or a mail piece for printing bar code or any other dedicated postal security marks, as in the prior art.

[0011] A further advantage of the present invention is that the embedded information is printed with the same printer as the postal image thus saving the need for using fluorescent or IR dyes as in the prior art.

[0012] Yet another advantage of the present invention is that it is compatible with many different types of digital printers such as thermal resistive printers, ink jet printers, or laser printers.

[0013] Again another advantage of the present invention is that the embedded information can readily be extract by a system which can selectively display the embedded information or the postal image, or a combination of both.

FIG. 1 is a partial schematic showing a thermal resistive printer in accordance with the present invention;

FIG. 2 shows the layout of a donor web of FIG. 1, including different colored dye and lamination patches;

FIG. 3 shows a receiver sheet carrying peelable postal images printed by the thermal resistive

printer in FIG. 1 and such postal images having embedded information;

FIG. 4 shows the layout of a mail envelope including a mailing address and a postal stamp that is peeled off from the receiver sheet in FIG. 3 and such postal stamp having embedded information;

FIG. 5 is a system block diagram illustrating the information embedding and the printing of the postal image having the embedded information in accordance with the present invention; and

FIG. 6 illustrates the extract system for extracting embedded information from a image printed on a receiver having the embedded information.

[0014] The present invention is described in relation to a digital printing apparatus for printing postal stamps carrying postal image, wherein the postal image is printed with embedded information. In the present invention, the terminology "stamp" refers to a receiver sheet to be attached to a mailing envelope, or the postal mark printed on the mail envelope. The stamp carries authenticated postal image including images and postage amount. The term mailing envelope will be understood to include any article which can be delivered by the post office, which includes other articles such as letters or gifts, for example.

[0015] Referring to FIG. 1, a digital printer 10 is exemplified as a thermal resistive printer in accordance with the present invention includes a print head assembly 12, a supply spool 14 and take-up spool 16 for supply and transporting a donor web 17. The print head assembly 12 includes a plurality of resistive heating elements, each of which can print image pixels on a receiver sheet 28. The donor web 17 is coated with colorant materials that can be transferred by the print head assembly 12 to the receiver sheet 28. For the best image quality and best appeal to the users, the colorant materials are preferably dye molecules in the present invention. It is understood that many other forms of digital printers are also compatible with the present invention and can be used in the place of the digital printer 10. For example, the digital printer 10 can also be an ink jet printer, an electrophotographic printer (or laser printer), a laser thermal printer, or a digital silver halide printer.

[0016] The digital printer 10 also includes a roller platen 18 for providing the pressure and compliance to the receiver sheet 28 and donor web 17 during printing, a pair of pinch rollers 20 and 22 for driving the receiver sheet 28, a receiver tray 24 for storing and supplying the receiver sheets 28, and a receiver guide 30 for guiding the receiver sheet 28 during transport. The receiver sheet 28 includes a colorant (dye) receiving layer that can receive colorant from the donor web 17 under heat and pressure. The receiver sheet 28 also preferably includes a substrate and peelable receiver portions 300 comprising the colorant receiving layer (FIG. 3). The peelable receiver portions 300 can be peeled off from the substrate after stamp images are formed on them. Preferably, the digital printer 10 is a dye-diffusion (also referred to as dye-sublimation) printer that is cable of continuous tone printing of photo quality images. It is well known in the art that thermal resistive dye-diffusion printer can provide photographic quality images that the other common thermal transfer printers cannot provide.

[0017] In the printing process, the receiver sheet 28 is loaded from the receiver tray 24. The receiver sheet 28 is transported by the pinch rollers 20 and 22 through the receiver guide 30 while the print head assembly 12 is in a "up position" leaving a gap for the receiver sheet 28 to be transported underneath. After the receiver sheet 28 is transported to the correct position, the print head assembly 12 is lowered to a "down position" which forms a pressure interface (nip) between the print head assembly 12, the donor web 17, the receiver sheet 28, and the roller platen 18. The print head assembly 12 subsequently prints a dye postal image on the receiver sheet 28 by thermally activating the diffusion of dye molecules from the donor web 17 to the receiver sheet 28. The dye postal image 320 (FIG. 3) is transferred from each color patch (see FIG. 2) in an image-wise pattern corresponding to the image content in the specific color plane. The lamination material is then uniformly transferred from the lamination patch 210 (FIG. 2) over the dye postal image 320 (FIG. 3) printed on the receiver sheet 28. The lamination layer on the receiver sheet 28 protects the printed dye postal image 320 from physical abrasion, finger print and light fade. The receiver sheet 28 carrying the dye postal images 320 is finally ejected from the print head assembly 12.

[0018] Details of the thermal resistive printing are also disclosed in the commonly assigned US-A-5,176,458 and US-A-5,841,459, the disclosures of which are incorporated herein by reference.

[0019] The image printed on the peelable receiver portion 300 (FIG. 3) in the receiver sheet 28 can include visible information such as the country of issue, denomination (postage), other postal indicia such as images stored in the database of the postal authority. The image printed on the peelable receiver portion 300 can also include user-selected or user-produced images and annotations that are approved by the postal authority. The personally selected or personally created images are appealing to many users.

[0020] Referring to FIG. 2, the donor web 17 includes a sequence of yellow (Y), magenta (M), cyan (C), and black (K) color dye patches 200. A lamination patch 210 (L) is often included for provide a protection sheet over the printed dye postal image 310 (FIG. 3) on the receiver sheet 28. Each group of the Y, M, C, K and L patches (200,210) are used for producing one set of color dye postal images 320 on the receiver sheet 28.

[0021] The receiver sheet 28 of FIG. 1 and 2 is shown in more detail in FIG. 3. The receiver sheet 28 includes one or a multiple of perforated peelable receiver portions 300. In the process as described

above, a dye postal image 310 is printed on each peelable receiver portion 300 to form a peelable stamp 320 by the digital printer 10.

[0022] In accordance to the present invention, the postal image 310 also includes invisible embedded information such as security information, postage information, the credit information of the user, the printer serial number that can be stored in the computer memory or the printer memory, the mailing date, and the mailing address information. One advantage of the present invention is that these information can be printed with the same digital printer on the same location as the postal image. No additional information channels or materials such as IR dyes, UV dyes, magnetic materials, or extra colorants (inks or dye donor) are needed to print such embedded information. The embedded information also does not take additional space to the postal image as the postal barcode in the prior art.

[0023] After the dye postal images 310 are formed, a peelable stamp 320 can be peeled off from the receiver sheet 28 and be adhered to a mail envelope 400 as shown in FIG. 4. The mail envelope 400 includes a mailing address 410 and the attached peelable stamp 320. Preferably, the peelable stamp 320 contains self-adhesive on the back surface so that no adhesive is required to attach it to the mail envelope 400.

[0024] In the present invention, the postal image having the embedded information can be directly printed on a mail piece. A mail piece can be an envelope or container in which the mail is contained.

[0025] The process of printing postal image 310 having embedded information is now described. In FIG. 5, the computer 500 will be understood to include a Central Processing Unit (CPU), memory storage device. The computer 500 performs at least two operations the image processing 510 and embedding information 520. At least one CPU and at least one memory although more than one can be used are necessary to provide the image processing in block 510 and embedding information in block 520. After an image is processed in block 510, the processed image is stored in a memory. The digital image includes the basic image content to be printed in the postal image 310. The input information can include one or more of the following: security information, postage information, the credit information of the user, the printer serial number that can be stored in the computer memory or the printer memory, the mailing date, and the mailing address information.

[0026] The image is processed in block 510 to provide a processed digital image I(x,y). Image processing block 510 includes the scaling of the digital image to the proper image sizes for forming the postal image 310 and also includes tone scale calibration, color mapping, halftoning, and other image processing for printing a digital image well known in the printing art.

[0027] In block 520, the input information is embedded into the processed digital images I(x,y) by modifying a predetermined number of pixel values in the processed digital image I(x,y), thus producing a modified digital image I'(x,y).

[0028] The input information is first used to produce a message image M(x,y). The message image M(x,y), for example, can include alphanumeric or graphic information associated with the digital image. A carrier image C(x,y) is also generated with a uniform or flat Fourier amplitude spectrum and a phase spectrum generated using a random number generator for each phase component. The random phase is required to distribute the message image to make the message invisible and unreadable to human eyes.

[0029] The message image M(x,y) and the carrier image C(x,y) are then convolved to form a scrambled signal S(x,y).

$$S(x,y)=M(x,y)*C(x,y) \quad (1)$$

In eqn. (1), the symbol "*" denotes the mathematical operation of convolution. In particular, a circular convolution can be efficiently performed in either space domain (image domain) or Fourier frequency domain representations for the present invention (see "Digital Signal Processing" by Alan V. Oppenheim and Ronald W. Schafer, Prentice-Hall, Inc., 1975, pp-101-115). The scrambled signal S(x,y) is next added to the digital image I(x,y) to produce a modified digital image I'(x,y) carrying the embedded information:

$$I'(x, y) = I(x, y) + \alpha S(x, y) \quad (2)$$

The scrambled signal S(x,y) is scaled by a scale factor α a to maximize the signal of the embedded information while ensuring the invisibility of the scrambled message in the modified digital image I'(x,y). That is, the value of α is chosen in such a way that the maximum amplitude of the embedded signal does not exceed a pre-specified visibility threshold. Specifically, the value of α is determined by the printing parameters such as the bit-depth and the grain noise in the printed postal image 310 without the embedded information. To improve the reliability of the extraction of the embedded information, a plurality of blocks of scrambled signals S(x,y) can be superimposed to each processed digital image I(x,y) in one color plane.

[0030] The computer 500 sends electric signals to the digital printer 10 in accordance to the modified digital image I'(x,y) having the embedded information. A postal image 310 is subsequently printed in block 310 wherein the postal image 310 has the embedded information. The embedded information on the postal image 310 is invisible to unaided eyes and can subsequently be extracted, as described below.

[0031] As shown in FIG. 6, the information embedded in the postal image 310 can be extracted from the postal image 310 printed on a receiver by a extraction

system 600. The extraction system 600 includes a scanner 610, a processor 620, and a display device 630. The optical density values of the printed postal image 310 is digitized by the scanner 610 that scans the printed postal image 310 at discrete pixel locations to produce a scanned postal image I"(x,y).

[0032] The embedded information can be extracted from I"(x,y) in a processor 620. The scanned postal image $I''(x,y)$ is cross correlated with a replica of the carrier image $C(x,y)$ to produce an extracted message image M'(x,y) that includes the embedded information, as described by the following:

$$M'(x,y) = I''(x,y) \otimes C(x,y) \approx M(x,y) \qquad (3)$$

where ⊗ denotes the operation of a circular cross correlation.

[0033] The display device 630 can selectively display human readable information corresponding to the extracted embedded information and the scanned postal image I"(x,y) so that the user can determine the authenticity and all the security information associated with the postal image 310. The extracted information as described above can be displayed or printed for verifying the authenticity, the postage, the user credit, the printer identity, the mailing date and the mailing address associated with the printed postal image 310.

PARTS LIST

[0034]

10	digital printer
12	print head assembly
14	supply spool
16	take-up spool
17	donor web
18	roller platen
20	pinch roller
22	pinch roller
24	receiver tray
28	receiver sheet
30	receiver guide
200	dye patch
210	lamination patch
300	peelable receiver portion
310	postal image
320	peelable stamp
400	mail envelope
410	mailing address
500	computer
510	image processing
520	embedding information
600	extraction system
610	scanner
620	processor
630	display device

Claims

1. A digital printing apparatus for printing on a receiver a postal image having invisible embedded information in response to a digital image having a plurality of pixels each having at least one pixel value and input information to embedded, comprising

a) means for receiving the digital image and the input information;
b) the receiver including a plurality of perforated peelable portions;
c) means responsive to the input information and the digital image for modifying a predetermined number of pixel values of pixels in the digital image with the input information so that the input information is embedded in the digital image; and
d) means for printing a postal stamp image on the receiver in accordance with the modified digital image having the embedded information wherein the embedded information is invisible to unaided human eyes that can subsequently be extracted.

2. The apparatus of the claim 1 wherein the printing means is a thermal resistive printer.

3. The apparatus of the claim 1 wherein the printing means is an ink jet printer.

4. The apparatus of the claim 1 further including an extraction system for digitizing the postal image printed on the receiver, and extracting the embedded information from the digitized image, and for displaying human readable information corresponding to the extracted embedded information.

5. The apparatus of claim 4 wherein the extracting system includes a scanner for digitizing the postal image on the receiver, a processor for extracting the embedded information from the digitized image, and a display device, the processor selectively applying the extracted information, or the digitized image, or a combination thereof, to the display device for viewing.

6. A digital printing apparatus for printing on a receiver a postal image having invisible embedded information in response to a digital image having a plurality of pixels each having at least one pixel value and input information to embedded, comprising

a) means for receiving the digital image and the input information;
b) the receiver is a mailing envelope;
c) means responsive to the input information and the digital image for modifying a predeter-

mined number of pixel values of pixels in the digital image with the input information so that the input information is embedded in the digital image; and

d) means for printing a postal stamp image on the receiver in accordance with the modified digital image having the embedded information wherein the embedded information is invisible to unaided human eyes that can subsequently be extracted.

7. The apparatus of the claim 5 wherein the printing means is a thermal resistive printer.

8. The apparatus of the claim 5 wherein the printing means is an ink jet printer.

9. The apparatus of the claim 1 further including an extraction system for digitizing the postal image printed on the receiver, and extracting the embedded information from the digitized image, and for displaying human readable information corresponding to the extracted embedded information.

10. The apparatus of claim 4 wherein the extracting system includes a scanner for digitizing the postal image on the receiver, a processor for extracting the embedded information from the digitized image, and a display device, the processor selectively applying the extracted information, or the digitized image, or a combination thereof, to the display device for viewing.

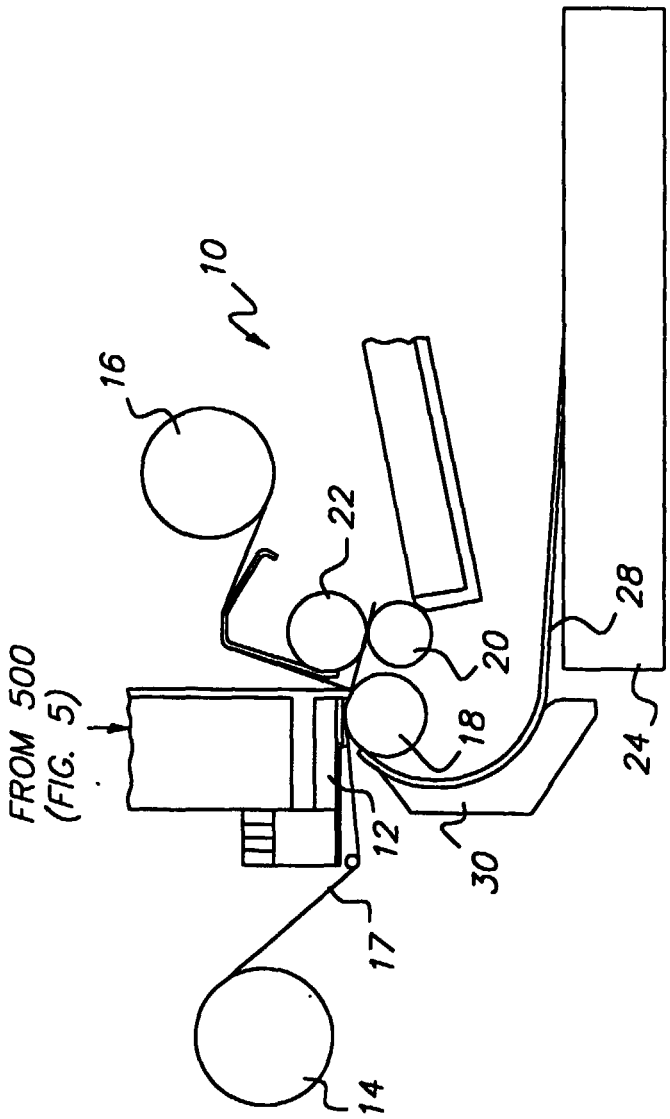

FIG. 1

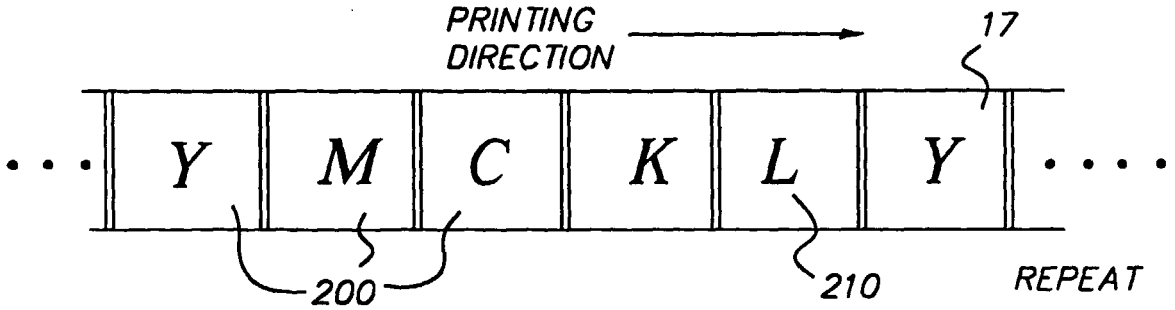
PRINTING
DIRECTION
17
Y
M
C
K
L
Y
200
210
REPEAT

FIG. 2

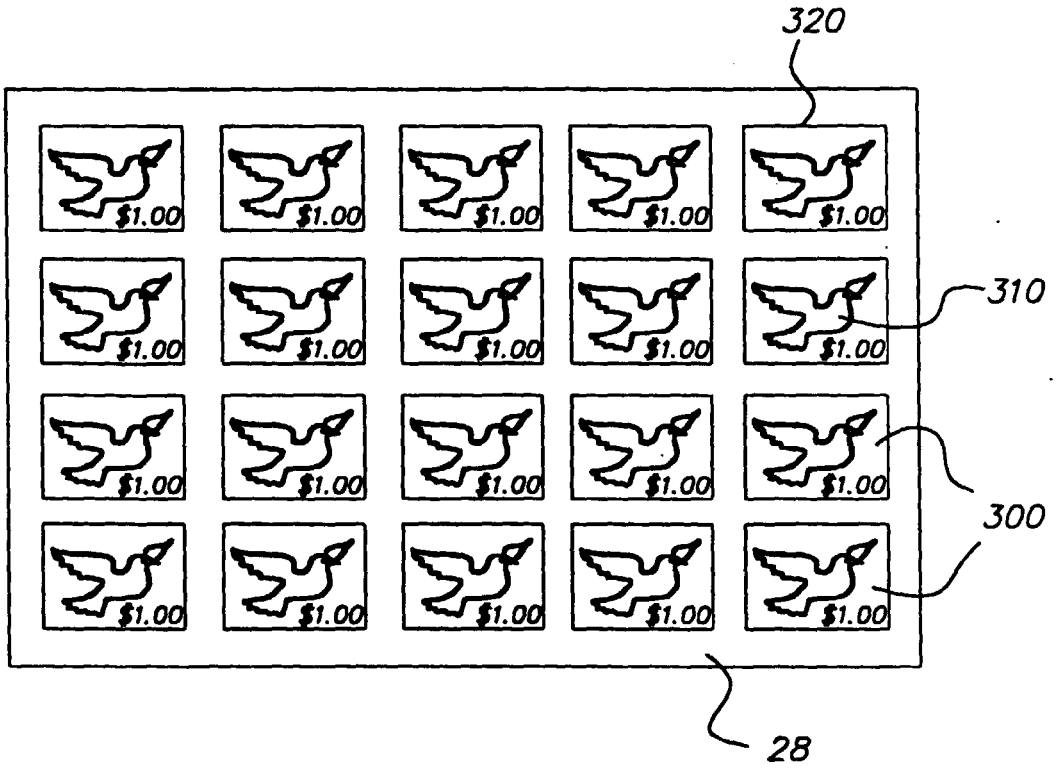
320
$1.00
310
300
28

FIG. 3

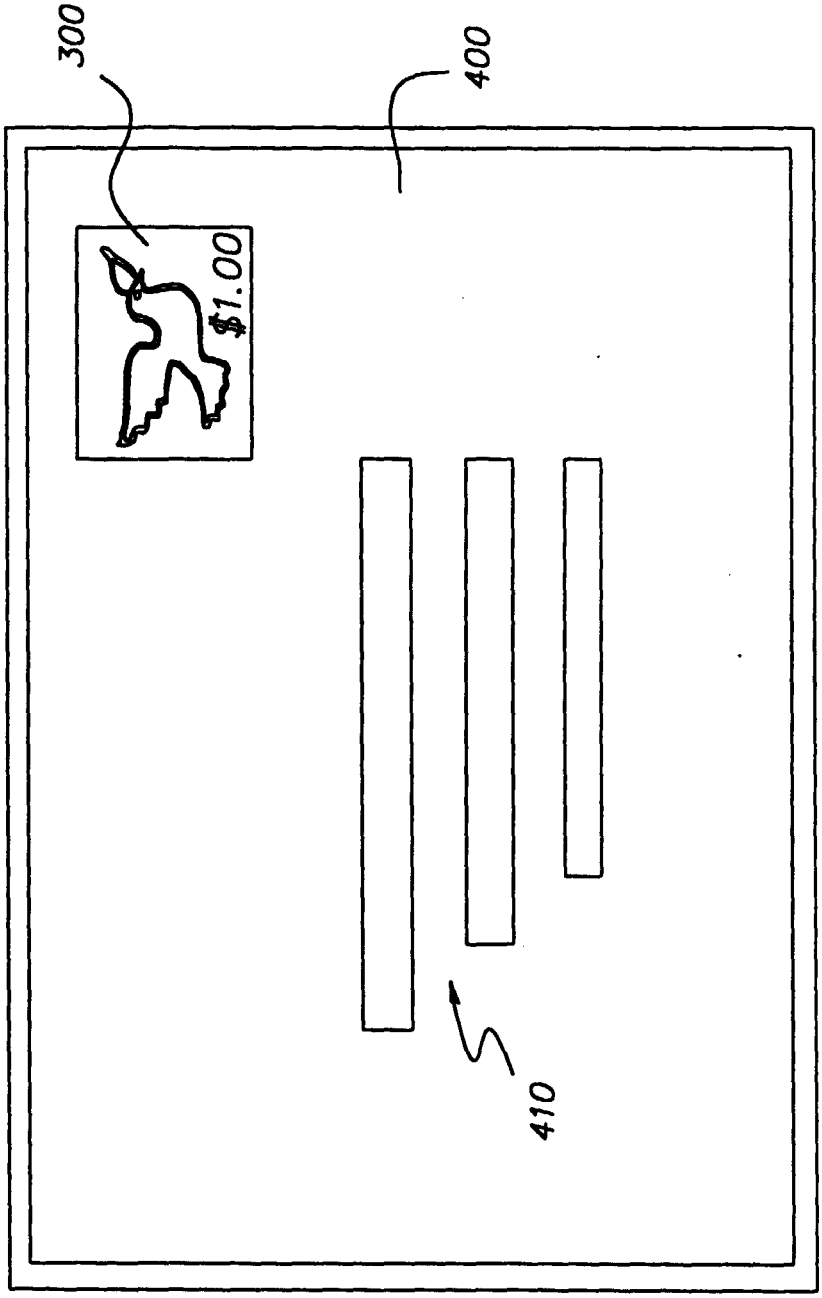

FIG. 4

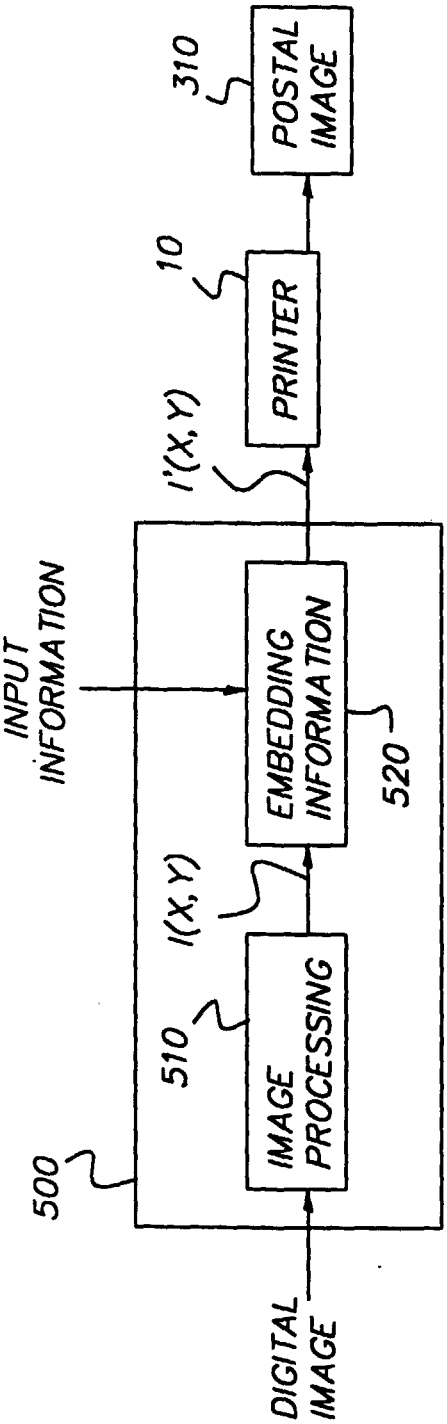
DIGITAL IMAGE
500
IMAGE PROCESSING
510
I(X,Y)
EMBEDDING INFORMATION
520
INPUT INFORMATION
I'(X,Y)
PRINTER
10
POSTAL IMAGE
310

FIG. 5

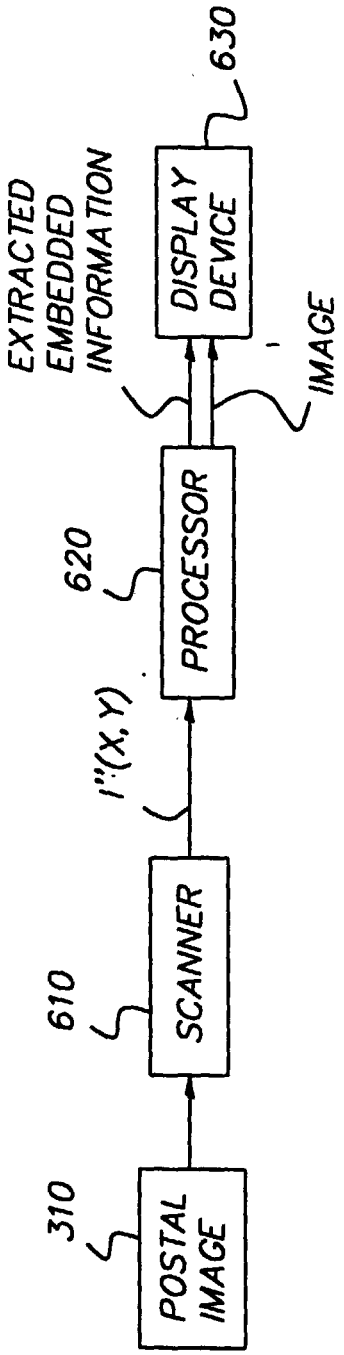
POSTAL IMAGE
310
SCANNER
610
I''(X,Y)
PROCESSOR
620
EXTRACTED EMBEDDED INFORMATION
IMAGE
DISPLAY DEVICE
630

FIG. 6