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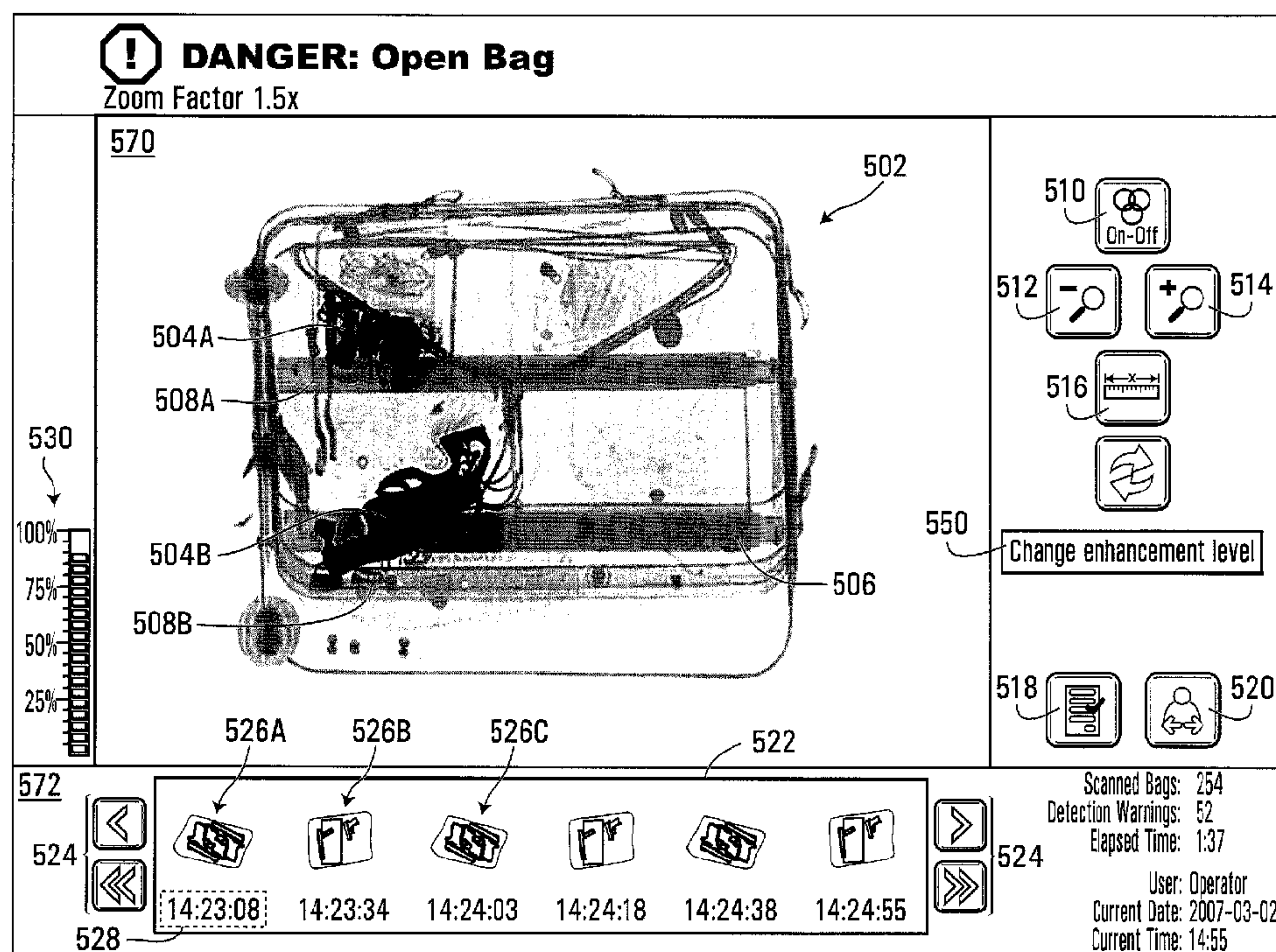
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(71) Demandeur/Applicant:
OPTOSECURITY INC., CA

(72) Inventeurs/Inventors:
GUDMUNDSON, DAN, CA;
PERRON, LUC, CA

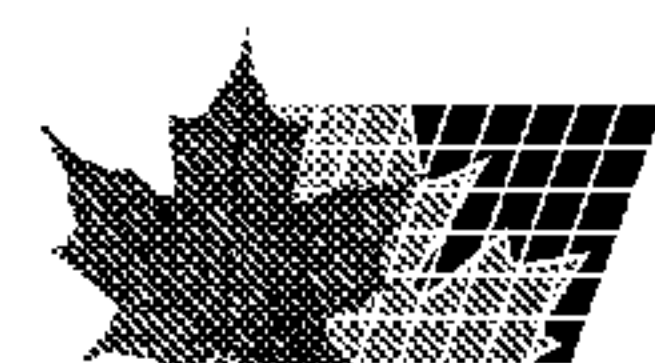
(74) Agent: SMART & BIGGAR

(54) Titre : INTERFACE UTILISATEUR DESTINEE AU CONTROLE DE SECURITE FOURNISSANT DES CAPACITES
D'AMELIORATION D'IMAGE ET APPAREIL ASSOCIE
(54) Title: USER INTERFACE FOR USE IN SECURITY SCREENING PROVIDING IMAGE ENHANCEMENT
CAPABILITIES AND APPARATUS FOR IMPLEMENTING SAME



(57) Abrégé/Abstract:

An apparatus, method and system for facilitating visual identification of a prohibited object in an image during security screening are provided. Data derived from an apparatus that scans the receptacle with penetrating radiation conveying an image of the



(57) Abrégé(suite)/Abstract(continued):

contents of a receptacle is received. Information from an automated threat detection processor is also received and indicates an area of interest in the image potentially containing a prohibited object. The image is then processed to generate an enhanced image. In a first example, portions of the enhanced image outside the area of interest are visually de-emphasized. In a second example, features appearing inside the area of interest are visually emphasized. The enhanced image is then displayed on a display device. Optionally, thumbnail images associated with previously screened receptacles may be displayed and a user is enabled to select one or more thumbnail images. An enhanced image corresponding to the selected thumbnail image is then displayed. In alternative implementations, an apparatus, method and system for use in screening a person for facilitating visual identification of a prohibited object thereon is provided.

ABSTRACT

An apparatus, method and system for facilitating visual identification of a prohibited object in an image during security screening are provided. Data derived from an apparatus that scans the receptacle with penetrating radiation conveying an image of the contents of a receptacle is received. Information from an automated threat detection processor is also received and indicates an area of interest in the image potentially containing a prohibited object. The image is then processed to generate an enhanced image. In a first example, portions of the enhanced image outside the area of interest are visually de-emphasized. In a second example, features appearing inside the area of interest are visually emphasized. The enhanced image is then displayed on a display device. Optionally, thumbnail images associated with previously screened receptacles may be displayed and a user is enabled to select one or more thumbnail images. An enhanced image corresponding to the selected thumbnail image is then displayed. In alternative implementations, an apparatus, method and system for use in screening a person for facilitating visual identification of a prohibited object thereon is provided.

**USER INTERFACE FOR USE IN SECURITY SCREENING PROVIDING IMAGE
ENHANCEMENT CAPABILITIES AND APPARATUS FOR IMPLEMENTING SAME**

5 **FIELD OF THE INVENTION**

The present invention relates generally to security systems and, more particularly, to a user interface providing image enhancement capabilities for use in screening luggage, mail parcels or cargo containers to identify certain objects located therein or for screening persons to identify
10 certain objects located thereon and to a method and system for implementing such a user interface.

BACKGROUND

Security in airports, train stations, ports, mail sorting facilities, office buildings and other public or
15 private venues is becoming increasingly important in particular in light of recent violent events.

Typically, security-screening systems at airports make use of devices generating penetrating radiation, such as x-ray devices, to scan individual pieces of luggage to generate an image conveying the contents of the luggage. The image is displayed on a screen and is examined by a
20 human operator whose task it is to identify, on the basis of the image, potentially threatening objects located in the luggage.

A deficiency with current systems is that they are entirely reliant on the human operator to identify potentially threatening objects. However, the performance of the human operator greatly varies
25 according to such factors as poor training and fatigue. As such, the process of detection and identification of threatening objects is highly susceptible to human error.

Another deficiency with current systems is that the labour costs associated with such systems are significant since human operators must view the images.

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Yet another deficiency is that the images displayed on the x-ray machines provide little, if any, guidance as to what is being observed. It will be appreciated that failure to identify a threatening object, such as a weapon for example, may have serious consequences, such as property damage, injuries and human deaths.

Consequently, there is a need in the industry for providing a device for facilitating visual identification of a prohibited object in an image during security screening that alleviates at least in part the deficiencies of the prior art.

SUMMARY OF THE INVENTION

In accordance with a broad aspect, a method for facilitating visual identification of a prohibited object in an image during security screening is provided. The method comprises receiving data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation. The method also comprises receiving information from an automated threat detection processor indicating an area of interest in the image potentially containing a prohibited object. The method also comprises processing the image to generate an enhanced image in which portions outside the area of interest are visually de-emphasized. The method also comprises displaying the enhanced image on a display device.

Advantageously, by de-emphasizing portions of the image outside the area of interest, visual information located in portions of the image outside the area of interest is filtered out. As a result, the enhanced image displayed to the user conveys the area of interest in a visually contrasting manner relative to portions of the image outside the area of interest. As such, during security screening, the attention of screening operators is led to an area of the enhanced image identified as an area of interest and that likely represents a higher risk of hiding a potential threat there by facilitating visual identification of a prohibited object in an image.

In accordance with a specific implementation, the method comprises receiving information from an automated threat detection processor indicating a plurality of areas of interest in the image potentially containing respective prohibited objects. The method also comprises processing the image to generate the enhanced image in which portions outside the areas of interest are visually de-emphasized.

In accordance with a specific example of implementation, portions of the enhanced image inside the area of interest are visually emphasized.

Advantageously, generating an enhanced image by concurrently de-emphasizing portions of the image outside the area of interest and emphasizing portions of the image inside the area of interest, provides an improved visual cue for directing the visual attention of a screener to an area of the image most likely to contain a prohibited object.

In accordance with a specific example of implementation, the method comprises providing a user control allowing a user to select either one of the image conveyed by the data received and the enhanced image to be displayed on the display device.

In accordance with a specific example of implementation, the method comprises providing a user control allowing a user to select a level of enhancement from a set of possible levels of enhancement. In a first example, the method comprises processing the image to generate the enhanced image such that portions outside the area of interest in the enhanced image are visually de-emphasized at least in part based on the selected level of enhancement. In a second example, the method comprises processing the image to generate the enhanced image such that portions inside the area of interest in the enhanced image are visually emphasized at least in part based on the selected level of enhancement. Optionally, the method comprises providing a first user control and a second user control for allowing a user to select a first level of enhancement and a second level of enhancement from a set of possible levels of enhancement. The method comprises processing the image to generate the enhanced image such that portions inside the area of interest in the enhanced image are visually emphasized at least in part based on the selected second level of enhancement

and portions outside the area of interest are visually de-emphasized at least in part based on the selected first level of enhancement.

In accordance with a specific example of implementation, the method comprises providing a user control allowing a user to select a level of enlargement from a set of possible levels of enlargement. The method also comprises processing the image to generate the enhanced image such that portions inside the area of interest are enlarged at least in part based on the selected level of enlargement such that features of the portion of the enhanced image inside the area of interest appear on a larger scale than features in portions of the enhanced image outside the area of interest.

In accordance with another broad aspect, apparatus is provided suitable for implementing a user interface for facilitating visual identification of a prohibited object in an image during security screening in accordance with the above described method.

In accordance with another broad aspect, a computer readable storage medium including a program element suitable for execution by a CPU for implementing a graphical user interface module is provided for facilitating visual identification of a prohibited object in the image during security screening in accordance with the above described method.

In accordance with yet another broad aspect, a system for detecting the presence of one or more prohibited objects in a receptacle is provided. The system includes an image generation apparatus, an automated threat detection processor, a display module and an apparatus for implementing a user interface module. The image generation apparatus is suitable for scanning a receptacle with penetrating radiation to generate data conveying an image of contents of the receptacle. The automated threat detection processor is in communication with the image generation apparatus and is adapted for processing the image to identify an area of interest in the image potentially containing a prohibited object. The apparatus is in communication with the image generation apparatus, the automated threat detection processor and the display module and implements a user interface module for facilitating visual identification of a prohibited object in an image during

security screening. The apparatus comprises a first input for receiving the data conveying the image of the contents of the receptacle and a second input for receiving information indicating the area of interest in the image. The apparatus also comprises a processing unit in communication with the first input and the second input. The processing unit is operative for implementing the user interface module. The user interface module is adapted for processing the image to generate an enhanced image in which portions outside the area of interest are visually de-emphasized and for displaying the enhanced image on the display module.

In accordance with yet another broad aspect, a client-server system is provided for implementing a graphical user interface module for facilitating visual identification of a prohibited object in an image during security screening. The client-server system comprising a client system and a server system operative to exchange messages over a data network. The server system stores a program element for execution by a CPU. The program element comprises a first program element component executed on the server system for receiving data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation and for receiving information from an automated threat detection processor indicating an area of interest in the image potentially containing a prohibited object. The program element also comprises a second program element component executed on the server system for processing the image to generate an enhanced image in which portions outside the area of interest are visually de-emphasized. The program element comprises a third program element component executed on the server system for sending messages to the client system for causing the client system to display the enhanced image on a display device.

In accordance with another broad aspect, an apparatus is provided for implementing a user interface module for facilitating visual identification of a prohibited object in an image during security screening. The apparatus comprises means for receiving data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation. The apparatus also comprises means for receiving information from an automated threat detection processor indicating an area of interest in the image potentially containing a prohibited

object. The apparatus also comprises means for processing the image to generate an enhanced image in which portions outside the area of interest are visually de-emphasized. The apparatus also comprises means for releasing a display signal, the display signal being suitable for causing a display device to display the enhanced image.

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In accordance with another broad aspect, a method is provided for facilitating visual identification of a prohibited object in an image during security screening. The method comprises receiving data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation. The method also comprises receiving information from an automated threat detection processor indicating an area of interest in the image potentially containing a prohibited object. The method also comprises processing the image to generate an enhanced image in which features appearing inside the area of interest are visually emphasized. The method also comprises displaying the enhanced image on a display device.

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In accordance with a specific example of implementation, the method comprises providing a user control allowing a user to select either one of the received image and the enhanced image for display on the display device.

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In accordance with another broad aspect, an apparatus is provided suitable for implementing a user interface for facilitating visual identification of a prohibited object in an image during security screening in accordance with the above described method.

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In accordance with another broad aspect, a computer readable storage medium is provided including a program element suitable for execution by a CPU for implementing a graphical user interface module for facilitating visual identification of a prohibited object in the image during security screening in accordance with the above described method.

In accordance with yet another broad aspect, a system is provided for detecting the presence of one or more prohibited objects in a receptacle. The system includes an image generation apparatus, an automated threat detection processor, a display module and an apparatus for implementing a user

interface module. The image generation apparatus is suitable for scanning a receptacle with penetrating radiation to generate data conveying an image of contents of the receptacle. The automated threat detection processor is in communication with the image generation apparatus and is adapted for processing the image to identify an area of interest in the image potentially containing a prohibited object. The apparatus is in communication with the image generation apparatus, the automated threat detection processor and the display module and implements a user interface module for facilitating visual identification of a prohibited object in an image during security screening. The apparatus comprises a first input for receiving the data conveying the image of the contents of the receptacle and a second input for receiving information indicating the area of interest in the image. The apparatus also comprises a processing unit in communication with the first input and the second input. The processing unit is operative for implementing the user interface module. The user interface module is adapted for processing the image to generate an enhanced image in which features appearing inside the area of interest are visually emphasized and for displaying the enhanced image on the display module.

In accordance with yet another broad aspect, a client-server system is provided for implementing a graphical user interface module for facilitating visual identification of a prohibited object in an image during security screening. The client-server system comprising a client system and a server system operative to exchange messages over a data network. The server system stores a program element for execution by a CPU. The program element comprises a first program element component executed on the server system for receiving data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation and information from an automated threat detection processor indicating an area of interest in the image potentially containing a prohibited object. The program element also comprises a second program element component executed on the server system for processing the image to generate an enhanced image in which features appearing inside the area of interest are visually emphasized. The program element also comprises a third program element component executed on the server system for sending messages to the client system for causing the client system to display the enhanced image on a display device.

In accordance with another broad aspect, an apparatus is provided for implementing a user interface module for facilitating visual identification of a prohibited object in an image during security screening. The apparatus comprises means for receiving data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation. The apparatus also comprises means for receiving information from an automated threat detection processor indicating an area of interest in the image potentially containing a prohibited object. The apparatus also comprises means for processing the image to generate an enhanced image in which features appearing inside the area of interest are visually emphasized. The apparatus also comprises means for displaying the enhanced image on a display module.

In accordance with another broad aspect, a method is provided for facilitating visual identification of prohibited objects in images associated with previously screened receptacles. The method comprises providing a plurality of records associated to respective previously screened receptacles. Each record includes an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation and information derived from an automated threat detection processor and indicating an area of interest in the image potentially containing a prohibited object. The method also comprises displaying on a displaying device a first viewing space conveying a set of thumbnail images, each thumbnail image in the set of thumbnail images being derived from a record in the plurality of records. The method also comprises enabling a user to select at least one thumbnail image in the set of thumbnail images. The method also comprises displaying on the display device a second viewing space conveying an enhanced image derived from a certain record in the plurality of records corresponding to the selected at least one thumbnail image.

In accordance with a specific example of implementation, the enhanced image is an enhanced previous image. The method further comprises receiving data conveying a current image of the contents of a currently screened receptacle derived from an apparatus that scans the currently screened receptacle with penetrating radiation. The method also includes receiving information

from an automated threat detection processor indicating an area of interest in the current image potentially containing a prohibited object. The method also includes processing the current image to generate an enhanced current image in which portions outside the area of interest are visually de-emphasized. The method also includes enabling the user to select between the enhanced previous
5 image and the enhanced current image. The method also includes displaying the selected on of the enhanced current image and the enhanced previous image on a display module.

In accordance with another broad aspect, a computer readable storage medium is provided including a program element suitable for execution by a CPU for implementing a graphical user
10 interface module for facilitating visual identification of a prohibited object in the image during security screening in accordance with the above described method.

In accordance with another broad aspect, an apparatus suitable for implementing a user interface for facilitating visual identification of a prohibited object in an image during security screening is
15 provided. The apparatus comprises a memory and a processing unit. The memory is suitable for storing a plurality of records associated to respective previously screened receptacles, each record including: an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation; and information derived from an automated threat detection processor and indicating an area of interest in the image potentially containing a prohibited object.
20 The processing unit is in communication with the memory unit and implements the user interface module. The user interface module is adapted for displaying on a displaying device a first viewing space conveying a set of thumbnail images, each thumbnail image in the set of thumbnail images being derived from a record in the plurality of records. The user interface module is also adapted for enabling a user to select at least one thumbnail image in the set of thumbnail images. The user
25 interface module is also adapted for displaying on the display device a second viewing space conveying an enhanced image derived from a certain record in the plurality of records corresponding to the selected at least one thumbnail image.

In accordance with another broad aspect, a method is provided for displaying information associated to a receptacle for use in detecting the presence of a threat in the receptacle during security screening. The method comprises receiving data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation. The method also comprises receiving data conveying a level confidence that a threat has been detected in the receptacle. The method also comprises deriving a perceived level of threat associated with the receptacle at least in part based on the level confidence. The method also comprises displaying a screening image derived at least in part based on the data conveying the image of the contents of a receptacle. The method also comprises displaying concurrently with the screening image a threat probability scale, the threat probability scale conveying the perceived level of threat associated with the receptacle in graphical format.

In accordance with another broad aspect, an apparatus is provided suitable for implementing a user interface for displaying information associated to a receptacle for use in detecting the presence of a threat in the receptacle during security screening in accordance with the above described method.

In accordance with another broad aspect, a computer readable storage medium is provided including a program element suitable for execution by a CPU for implementing a graphical user interface module for displaying information associated to a receptacle for use in detecting the presence of a threat in the receptacle during security screening in accordance with the above described method.

Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying Figures.

BRIEF DESCRIPTION OF THE DRAWINGS

A detailed description of the embodiments of the present invention is provided herein below, by way of example only, with reference to the accompanying drawings, in which:

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Figure 1 is a high-level block diagram of a system for screening a receptacle to detect therein the presence of one or more prohibited objects in accordance with a specific example of implementation of the present invention;

10 Figure 2 is a block diagram of an output module suitable for use in connection with the system depicted in Figure 1 in accordance with a specific example of implementation of the present invention;

15 Fig. 3 is a block diagram of an apparatus suitable for implementing a user interface module for facilitating visual identification of a prohibited object in an image during security screening in accordance with a specific example of implementation of the present invention;

Fig. 4 shows a flow diagram depicting a process for facilitating visual identification of a prohibited object in an image during security screening;

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Fig. 5 depicts a viewing window of a user interface displayed by the output module of figure 2 in accordance with a specific example of implementation of the present invention;

25 Fig. 6 depicts a control window of a user interface module displayed by the apparatus of figure 3 allowing a user to configure screening options in accordance with a specific example of implementation of the present invention;

Figure 7 is a flow diagram depicting a process for facilitating visual identification of prohibited objects in images associated with previously screened receptacles in accordance with a specific example of implementation of the present invention;

5 Figure 8 is a block diagram of an automated threat detection processor suitable for use in connection with the system depicted in Figure 1 in accordance with a specific example of implementation of the present invention;

10 Figure 9 is a flow diagram of a process suitable to be implemented by the automated threat detection processor depicted in figure 8 in accordance with specific examples of implementation of the present invention;

Figure 10 is a block diagram of an apparatus suitable for implementing a user interface for facilitating visual identification of prohibited objects the images during security screening in accordance with a specific example of implementation of the present invention;

15 Figure 11 is a block diagram of an apparatus suitable for implementing the automated threat detection processor depicted in figure 8 and for implementing a user interface for facilitating visual identification of prohibited objects the images during security screening in accordance with a specific example of implementation of the present invention;

20 Fig. 12 shows a functional block diagram of a client-server system suitable for implementing a user interface for facilitating visual identification of prohibited objects in an image during security screening in accordance with an alternative specific example of implementation of the present invention;

25 Fig. 13a and 13b depict a first example of an original image conveying contents of a receptacle and a corresponding enhanced image in accordance with a specific example of implementation of the present invention;

Fig. 13c and 13d depict a second example of an original image conveying contents of a receptacle and a corresponding enhanced image in accordance with a specific example of implementation of the present invention.

- 5 Fig. 13e, 13f and 13g depict a third example of an original image conveying contents of a receptacle and two (2) corresponding enhanced images in accordance with a specific example of implementation of the present invention.

10 In the drawings, the embodiments of the invention are illustrated by way of examples. It is to be expressly understood that the description and drawings are only for the purpose of illustration and are an aid for understanding. They are not intended to be a definition of the limits of the invention.

DETAILED DESCRIPTION

Shown in Figure 1 is a system 100 for screening a receptacle in accordance with a specific example of implementation of the present invention. It is to be understood that the expression “receptacle”, as used for the purposes of the present description, is used to broadly describe an entity adapted for receiving objects therein such as, for example, a luggage item, a cargo container or a mail parcel. In addition, the expression “luggage item” is used to broadly describe luggage, suitcases, handbags, backpacks, briefcases, boxes, parcels or any other similar type of item suitable for containing objects therein.

As depicted, the system 100 includes an image generation apparatus 102, an automated threat detection processor 106 in communication with the image generation apparatus 102 and an output module 108.

The image generation apparatus 102 is adapted for scanning a receptacle 104 to generate data conveying an image of contents of the receptacle 104. The automated threat detection processor 106 receives the data conveying the image of contents of the receptacle 104 and processes that image to identify an area of interest in the image potentially containing a prohibited object. Optionally, as shown in the embodiment depicted in figure 1, the automated threat detection processor 106 receives and processes the image from the image generation apparatus 102 in combination with a plurality of images associated with prohibited objects to detect a presence of at least one prohibited object in the receptacle 104. In a specific implementation, the plurality of images is stored in a database of prohibited objects 110. The automated threat detection processor 106 releases information indicating an area of interest in the image and, optionally, information conveying the identity of a prohibited object potentially detected in the receptacle 104. Examples of the manner in which the information indicating an area of interest in the image can be derived will be described later on in the specification. The output module 108 receives the data conveying the image of the contents of the receptacle from the image generation apparatus 102 and the information indicating the area of interest in the image from the automated threat detection

processor 106. The output module 108 processes the image to generate an enhanced image based at least in part on the area of interest in the image conveyed by the information released by the automated threat detection processor 106. More specifically, the output module 108 generates an enhanced image so that an operator's attention can be focused on areas of the image most likely to contain prohibited objects. The enhanced image displayed to the user conveys the area of interest in a visually contrasting manner relative to portions of the image outside the area of interest. The output module 108 may process the image to generate an enhanced image in which portions outside the area of interest are visually de-emphasized or in which features appearing inside the area of interest are visually emphasized. Alternatively, the output module 108 may process the image to generate an enhanced image in which portions outside the area of interest are visually de-emphasized and in which features appearing inside the area of interest are visually emphasized. The output module 108 then displays the enhanced image on a display module.

Advantageously, the system 100 provides assistance to the human security personnel using the system by facilitating visual identification of a prohibited object in an image during security screening. More specifically, displaying the enhanced image allows focussing an operator's attention to areas most likely to contain a prohibited object thereby improving the security personnel's efficiency and productivity.

Image Generation Apparatus 102

In a specific example of implementation, the image generation apparatus 102 uses penetrating radiation or emitted radiation to generate data conveying an image of the contents of the receptacle 104. Specific examples of such devices include, without being limited to, x-ray, gamma ray, computed tomography (CT scans), thermal imaging, TeraHertz and millimeter wave devices. Such devices are known in the art and as such will not be described further here. In a non-limiting example of implementation, the image generation apparatus 102 is a conventional x-ray machine suitable for generating data conveying an x-ray image of the receptacle 104. The x-ray image conveys, amongst others, material density information in relation to objects within the receptacle.

The data generated by the image generation apparatus 102 and conveying an image of the contents of the receptacle 104 may convey as a two-dimensional (2-D) image or a three-dimensional (3-D) image and may be in any suitable format. Possible formats include, without being limited to, JPEG, GIF, TIFF and bitmap amongst others.

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Database of Prohibited Objects 110

In a specific example of implementation, the database of prohibited objects 110 includes a plurality of entries associated to respective prohibited objects that the system 100 is designed to detect.

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In a non-limiting implementation, for each entry associated to a prohibited object at least one image (hereinafter referred to as a “target image”) is provided in the database of prohibited objects 110. The format of the target images will depend upon the image processing algorithm implemented by the automated threat detection processor 106. More specifically, the format of the target images is such that a comparison operation can be performed by the automated threat detection processor 106 between the target images and data conveying an image of contents of the receptacle 104.

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Optionally, for each entry associated to a prohibited object, a set of images is provided in the database of prohibited objects 110. For example, images depicting the prohibited object in various orientations may be provided.

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Optionally still, for each entry associated to a target object, characteristics of the prohibited object are provided. Such characteristics may include, without being limited to, the name of the prohibited object, its associated threat level, the recommended handling procedure when such a prohibited object is detected and any other suitable information. In a specific implementation, the threat level information associated to the target object convey the relative threat level of a prohibited object compared to other prohibited objects in the database of prohibited objects 110. For example, a gun would be given a relatively high threat level while a metallic nail file would be given a relatively

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low level threat level and a pocket knife would be given a threat level between that of the nail file and the gun. Optionally still, each entry in the database of prohibited objects 110 is also associated to a respective prohibited object identifier data element.

- 5 In the case of luggage screening (in an airport facility for example) the prohibited object typically constitutes a potential threat to the safety of the passenger or aircraft.

In the case of mail parcel screening, the prohibited object is typically an object that is normally not permitted to be sent through the mail, such as guns (in Canada) for example, due to registration
10 requirements/permits and so on.

In a non-limiting example of implementation, the database of prohibited objects 110 includes one or more entries associated to objects which are not prohibited but which may represent potential threats. For example, the presence of a metal plate or a metal canister in a piece of luggage going
15 through luggage security screening is not prohibited in itself. However such objects may conceal one or more dangerous objects. As such, it is desirable to be able to detect the presence of such objects in receptacle such as to bring them to the attention of the security screeners.

The specific design and content of the database of prohibited objects 110 may vary from one
20 implementation to the next. The design of the database is not critical to the present invention and as such will not be described further here.

Although the database of prohibited objects 110 has been shown in Figure 1 to be a component separate from the automated threat detection processor 106, it will be appreciated that in certain
25 embodiments the database of prohibited objects 110 may be part of automated threat detection processor 106. In addition, it will also be appreciated that in certain implementations, a same database of prohibited objects 110 may be shared between multiple threat detection processors 106. It will also be appreciated that in alternative examples of implementation of the present invention database of prohibited objects 110 may be omitted.

Output Module 108

In a specific example of implementation, the output module 108 displays to a user of the system 100 a user interface conveying an enhanced image of contents of the receptacle 104 for facilitating visual identification of a prohibited object.

A specific example of implementation of the output module 108 is shown in Figure 2 of the drawings. As depicted, the output module includes an output device 202 and an apparatus implementing a user interface module 200.

The output device 202 may be any device suitable for conveying an enhanced image of contents of the receptacle to a user of the system 100. In a specific example of implementation, the output device 202 is in communication with the apparatus implementing a user interface module 200 and includes a display unit adapted for displaying in visual format information related to the presence of a prohibited object in the receptacle 104. The display unit may be part of a computing station or may be integrated into a hand-held portable device for example. In another specific example of implementation, the output device 202 includes a printer adapted for displaying in printed format information related to the presence of a prohibited object in the receptacle 104. The person skilled in the art will readily appreciate, in light of the present specification, that other suitable types of output devices may be used here in alternative implementations.

The apparatus implementing a user interface module 200 receives data conveying an image of the contents of a receptacle derived from the image generation apparatus 102. The apparatus 200 also receives information from the automated threat detection processor 106 indicating an area of interest in the image potentially containing a prohibited object. Optionally, the information received from the automated threat detection processor 106 also conveys a level of confidence associated to the area of interest that the area of interest contains a prohibited object. Optionally still, the information received from the automated threat detection processor 106 also conveys an identification of the prohibited object potentially detected in the image.

In a specific example of implementation, the information received from the automated threat detection processor 106 conveying the area of interest includes location information conveying a location in the image of the contents of a receptacle derived from the image generation apparatus 102.

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In a first non-limiting example of implementation, the location information is an (X,Y) pixel location conveying the center of an area in the image. The area of interest is established based on the center location (X,Y) provided by the automated threat detection processor 106 in combination with a shape for the area. The shape of the area may be pre-determined in which case it may be of any suitable geometric shape and will have any suitable size. Alternatively, the shape and/or size of the area of interest may be determined by the user on the basis of a user configuration command.

In a second non-limiting example of implementation, the shape and/or size of the area of interest is determined on the basis of information provided by the automated threat detection processor 106. For example, the information may convey a plurality of (X,Y) pixel locations defining an area in the image of the contents of a receptacle. In such a case, the information received will convey both the shape of the area of interest in the image and the position of the area of interest in that image.

In yet another non-limiting example of implementation, the automated threat detection processor 106 may provide an indication of a type of prohibited object potentially identified in the receptacle being screened in addition to a location of that potentially prohibited object in the image. Based on this potentially identified prohibited object, an area of interest having a shape and size conditioned on the basis of the potentially identified prohibited object may be determined.

A functional block diagram of apparatus 200 is depicted in figure 3 of the drawings. In the implementation depicted, the apparatus 200 is adapted for communicating with output device 202 including a display screen for causing the latter to display the user interface module generated by the apparatus 200. The apparatus 200 for implementing a user interface releases a signal at output 310 for causing the output device 202 to convey the user interface to a user of the system.

The apparatus 200 implements a user interface module for facilitating visual identification of a prohibited object in an image during security screening. A specific example of a method implemented by the apparatus 200 will now be described with reference to figure 4. At step 400, data is received conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation such as the image generation apparatus 102 depicted in figure 1. At step 402, information is received from an automated threat detection processor (such as automated threat detection processor 106 depicted in figure 1) indicating an area of interest in the image potentially containing a prohibited object. At step 404, the image received at step 400 is processed the image to generate an enhanced image. In a first example of implementation, at step 404 portions of the image outside the area of interest, conveyed by the information received at step 402, are visually de-emphasized. In a second example of implementation, at step 404 features appearing inside the area of interest, conveyed by the information received at step 402 are visually emphasized. In yet another example, at step 404, the portions of the image outside the area of interest are visually de-emphasized and features appearing inside the area of interest are visually emphasized. At step 406 the enhanced image is caused to be displayed on a display module.

As depicted in figure 3, the apparatus 200 suitable for implementing the above described process includes a first input 304, a second input 306, a processing unit 300 and an output 310. Optionally, as depicted in figure 3, the apparatus 200 further includes a user input 308.

The first input 304 is for receiving data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation. In a specific implementation, the image signal is derived from a signal generated by the image generation apparatus 102 (shown in figure 1).

The second input 306 is for receiving information from an automated threat detection processor indicating an area of interest in the image potentially containing a prohibited object. In a specific implementation, the information is provided by the automated threat detection processor 106. The type of information received at the second input 306 depends on the specific implementation of the

automated threat detection processor 106 and may vary in alternative implementations. Examples of the type of information that may be received include information on the position of the prohibited object detected within the image, information about the level of confidence of the detection and data allowing identifying the prohibited object detected.

5

The user input 308, which is an optional feature, is for receiving signals from a user input device, the signals conveying commands for controlling the type information displayed by the user interface module or for annotating the information displayed. Any suitable user input device for providing user commands may be used such as, for example, a mouse, keyboard, pointing device,
10 speech recognition unit or touch sensitive screen.

The processing unit 300 is in communication with the first input 304, the second input 306 and the user input 308 and implements a user interface module for facilitating visual identification of a prohibited object in an image of contents of a receptacle.

15

More specifically, the processing unit 300 is adapted for processing the image received at the first input 304 to generate an enhanced image based at least in part on the information received at the second input 306 and optionally on commands received at the user input 308.

20

In a specific non-limiting example of implementation, the processing unit 300 is adapted for generating an image mask on the basis of the information received indicating an area of interest in the image. The image mask includes a first enhancement area corresponding to the area of interest and a second enhancement area corresponding to portions of the image outside the area of interest. The image mask allows applying a different type of image enhancement processing to portions of
25 the image corresponding to the first enhancement area and the second enhancement area to generate an enhanced image.

Figures 13a to 13g depict various illustrative examples of images and corresponding enhanced images generated by the processing unit 300 in accordance with specific examples of implementation of the invention.

5 Figure 13a depicts a first exemplary image 400 conveying contents of a receptacle that was generated by an x-ray machine. The processing unit 300 processes the first exemplary image 400 to derive information conveying an area of interest, denoted as area of interest 402 in the figure. Figure 13b depicts an enhanced version of the image of figure 13a, herein referred to as enhanced
10 image 450 resulting from the application of an image mask include an enhancement area corresponding to the area of interest 402. In the example shown, the enhanced image 450 is such that portions 404 of the image which lie outside the area of interest 402 have been visually de-emphasized and features appearing inside the area of interest 402 have been visually emphasized.

Figure 13c depicts a second exemplary image 410 conveying contents of another receptacle that
15 was generated by an x-ray machine. The processing unit 300 processes the second exemplary image 410 to derive information conveying a plurality of areas of interest, denoted as areas of interest 462a 462b and 462c in the figure. Figure 13d depicts an enhanced version of the image of figure 13c, herein referred to as enhanced image 460. In the example shown, the enhanced image 460 is such that portions 464 of the image which lie outside the areas of interest 462a 462b and
20 462c have been visually de-emphasized and features appearing inside the areas of interest 462a 462b and 462c have been visually emphasized.

Figure 13e depicts a third example of an illustrative image 1300 conveying contents of a receptacle. The processing unit 300 processes the image 1300 to derive information conveying an
25 area of interest, denoted as area of interest 1302 in the figure. Figure 13f depicts a first enhanced version of the image of figure 13e, herein referred to as enhanced image 1304. In the example shown, the enhanced image 1304 is such that portions of the image which lie outside the area of interest 1302 have been visually de-emphasized. The de-emphasis is illustrated in the figure by the features appearing in portions of the image that lie outside the area of interest being presented in

dotted lines. Figure 13g depicts a second enhanced version of the image of figure 13e, herein referred to as enhanced image 1306. In the example shown, the enhanced image 1306 is such that features appearing inside the area of interest 1302 have been visually emphasized. The emphasis is illustrated in the figure by the features appearing in the area of interest being enlarged such that features of the enhanced image 1306 located inside the area of interest 1302 appear on a larger scale than features in portions of the enhanced image located outside the area of interest.

De-emphasizing portions outside the area of interest

In a first example of implementation, the processing unit 300 processes the image received at input 304 to generate an enhanced image wherein portions outside the area of interest, conveyed by the information received at second input 306, are visually de-emphasized. Any suitable image manipulation technique for de-emphasizing the visual appearance of portions of the image outside the area of interest may be used by the processing unit 300. Such image manipulation techniques are well-known in the art and as such will not be described in detail here.

In a specific example, the processing unit 300 processes the image to attenuate portions of the image outside the area of interest. In a non-limiting example, the processing unit 300 processes the image to reduce contrasts between feature information appearing in portions of the image outside the area of interest and background information appearing in portions of the image outside the area of interest. Alternatively, the processing unit 300 processes the image to remove features from portions of the image outside the area of interest. In yet another alternative embodiment, the processing unit 300 processes the image to remove all features appearing in portions of the image outside the area of interest such that only features in the areas of interest remain in the enhanced image.

In another example, the processing unit 300 processes the image to overlay or replace portions of the image outside the area of interest with a pre-determined visual pattern. The pre-determined

visual pattern may be a suitable textured pattern or may be a uniform pattern. The uniform pattern may be a uniform color or other uniform pattern.

In yet another example, where the image includes color information, the processing unit 300 processes the image to modify color information associated to features of the image appearing outside the area of interest. In a non-limiting example of implementation, portions of the image outside the area of interest are converted into grayscale or other monochromatic color palette.

In yet another example of implementation, the processing unit 300 processes the image to reduce the resolution associated to portions of the image outside the area of interest. This type of image manipulation results in portions of the enhanced image outside the area of interest appearing blurred compare to portions of the image inside the area of interest.

In yet another example of implementation, the processing unit 300 processes the image to shrink portions of the image outside the area of interest such that at least some features of the enhanced image located inside the area of interest appear on a larger scale than features in portions of the enhanced image located outside the area of interest.

It will be appreciated that the above-described techniques for de-emphasizing the visual appearance of portions of the image outside the area of interest may be used individually or in combination with one another. It will also be appreciated that the above described exemplary techniques for de-emphasizing the visual appearance of portions of the image outside the area of interest are not meant as an exhaustive list of such techniques and that other suitable techniques may be used in specific implementations.

Emphasizing features appearing inside the area of interest

In a second example of implementation, the processing unit 300 processes the image received at input 304 to generate an enhanced image wherein features appearing inside the area of interest,

conveyed by the information received at step 402 are visually emphasized. Any image manipulation suitable technique for emphasizing the visual appearance of features of the image inside the area of interest may be used. Such image manipulation techniques are well-known in the art and as such will not be described in detail here.

5

In a specific example, the processing unit 300 processes the image to increase contrasts between feature information appearing in portions of the image inside the area of interest and background information appearing in portions of the image inside the area of interest. For example, contour lines defining objects inside the area of interest are made to appear darker and/or thicker compared to the background. In a non-limiting example, contrast-stretching tools with settings highlighting the metallic content of portions of the image inside the area of interest are used to enhance the appearance of such features.

In another specific example, the processing unit 300 processes the image to overlay portions of the image inside the area of interest with a pre-determined visual pattern. The pre-determined visual pattern may be a suitable textured pattern or may be a uniform pattern. The uniform pattern may be a uniform color or other uniform pattern. In a non-limiting example, portions of the image inside the area of interest are highlighted by overlaying the area of interest with a brightly colored pattern. Preferably the visual pattern has transparent properties in that a user can see features of the image in portions of the image inside the area through the visual pattern once the pattern is overlaid in the image.

In another non-limiting example, the processing unit 300 processes the image to modify color information associated to features of the image appearing inside the area of interest. For example, colors for features of the image appearing inside the area of interest may be made to appear brighter or may be replaced by other more visually contrasting colors. In particular, color associated to metallic objects in an x-ray image may be made to appear more prominently by either replacing it with a different color or changing an intensity of the color. For example, the processing

unit 300 may transform features appearing in blue inside the area of interest such that these same features appear in red in the enhanced image.

5 In another non-limiting example, processing unit 300 processes the image to enlarge a portion of the image inside the area of interest such that at least some features of the enhanced image located inside the area of interest appear on a larger scale than features in portions of the enhanced image located outside the area of interest. Figure 13g of the drawings, previously described, depicts an enhanced image derived from the image depicted in figure 13e wherein the area of interest 1302 has been enlarged relative to the portions of the image outside the area of interest. The resulting
10 enhanced image 1306 is such that the features inside the area of interest 1302 appear on a different scale that the features appearing in the portions of the image outside the area of interest 1302.

It will be appreciated that the above described techniques for emphasizing the visual appearance of portions of the image inside the area of interest may be used individually or in combination with
15 one another or with other suitable techniques. For example, processing the image may include modifying color information associated to features of the image appearing inside the area of interest and enlarging a portion of the image inside the area of interest. It will also be appreciated that the above described exemplary techniques for emphasizing portions of the image inside the area of interest are not meant as an exhaustive list of such techniques and that other suitable
20 techniques may be used.

Concurrently de-emphasizing portions outside the area of interest emphasizing features inside the area of interest

25 In addition, it will be appreciated that embodiments may also concurrently de-emphasize portions of the image outside the area of interest and emphasize features of the image inside the area of interest.

Portions surrounding the area of interest

Optionally, the processing unit 300 processes the image received at input 304 to modify portions of areas surrounding the area of interest to generate the enhanced image. In a specific example, the processing unit 300 modifies portions of areas surrounding the area of interest includes applying a blurring function to the edges surrounding the area of interest. In a specific example of implementation, the edges of the area of interest are blurred. Advantageously, blurring the edges of the area of interest accentuates the contrast between the area of interest and the portions of the image outside the area of interest.

Multiple areas of interest

It will be appreciated that, although the above described examples describe situations in which a single area of interest is conveyed by the information received from the automated threat detection processor 106, implementations of the invention adapted from processing information indicating a plurality of areas of interest in the image are within the scope of the invention. As such, the processing unit 300 is adapted for receiving at input 306 information from an automated threat detection processor, such as automated threat detection processor 106, indicating a plurality of areas of interest in the image potentially containing respective prohibited objects. The processing unit 300 then processes the image received at input 304 to generate the enhanced image. The processing of the image is performed using the same principles as those described above with reference to information conveying a single area of interest. The person skilled in the art will readily appreciate, in light of the present description, the manner in which the processing unit 300 may be adapted for processing information conveying a plurality of areas of interest without required further guidance.

Returning to figure 3, the output 310 is for releasing a signal for causing the output device 202 (shown in figure 2) to display the graphical user interface module implemented by processing unit 300. A graphical user interface module implemented by apparatus 200 in accordance with a

specific example of implementation is described in greater detail herein below with reference to figure 5.

Graphical User Interface Module Example

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With reference to figure 5, there is shown a display generated by a graphical user interface module implemented in accordance with a non-limiting implementation on the invention.

As depicted, the user interface module provides a viewing window 500 including a viewing space 570 for displaying an enhanced image 502 wherein areas of interest 504a and 504b are displayed to the user in a visually contrasting manner relative to portions of the image outside the areas of interest 506. In this fashion, an operator's attention can be focused on the areas interest 504a and 504b of the image which are the areas most likely to contain prohibited objects.

15 In the example depicted, portions of the image outside the areas of interest 504a and 504b have been de-emphasized. Amongst possible other processing, portions of the image outside the areas of interest 504a and 504b, generally designated with reference numeral 506, have been attenuated by reducing contrasts between the features and the background. These portions appear paler relative to the areas of interest 504a and 504b. In the example depicted, features depicted in the areas of interest 504a and 504b have also been emphasized by using contrast-stretching tools to increase the level of contrast between the features depicted in the areas of interest 504a and 504b and the background. Finally, as depicted in the figure, the edges 508a and 508b surrounding the area of interest 504a and 504b have been blurred to accentuates the contrast between the areas of interest 504a and 504b and the portions of the image outside the areas of interest 504a and 504b. The location of the areas of interest 504a and 504b was derived on the basis of the information received at input 306 (shown in figure 3) from the automated threat detection processor 106.

Optionally, the user interface module also provides a set of controls 510 512 514 516 550 518 and 520 for allowing a user to providing commands for modifying features of the graphical user

interface module to change the appearance of the enhanced image 502 displayed in the viewing window 500.

In a specific implementation, the controls in the set of controls 510 512 514 516 550 518 allow the user to change the appearance of the enhanced image displayed in the viewing window 500 by using an input device in communication with the apparatus 200 (shown in figure 3) through user input 308. In the example depicted, the controls in the set of controls 510 512 514 516 550 518 are in the form of a buttons that can be selectively actuated by a user. Examples of user input devices include, without being limited to, a mouse, a keyboard, a pointing device, a speech recognition unit and a touch sensitive screen. In an alternative embodiment, the controls may be provided as a physical button (or key) on a keyboard or other input device that can be selectively actuated by a user. In such an implementation, the physical button (or key) is in communication with the apparatus 200 (shown in figure 3) through user input 308. Suitable forms of user controls other than buttons may also be used in alternative specific implementations.

It will be apparent that certain controls in the set of controls 510 512 514 516 550 518 may be omitted from certain implementations and that additional controls may be included in alternative implementations of a user interface.

In the specific example of implementation depicted, functionality is provided to the user for allowing the latter to select for display in viewing window 500 the “original” image received at input 304 of apparatus 200 (shown in figure 3) or the enhanced image generated by apparatus 200. In a specific example, such functionality is enabled by displaying a control on the user interface allowing a user to effect the selection. In figure 5 this control is embodied as control button 510 which may be actuated by the user via a user input device to toggle between the enhanced image and the “original” image for display in viewing window 500. Other manners for providing such functionality will become readily apparent to the person skilled in the art in light of the present description and as such will not be described further here.

In the specific example of implementation depicted, functionality is also provided to the user for allowing the latter to select a level of enlargement from a set of possible levels of enlargement to be applied to the image in order to derive the enhanced image for display in the viewing window 500. The functionality allows the user to independently control the scale of features appearing in areas of interest 504a and 504b relative to the scale of features in portions of the image outside the areas of interest 504a and 504b. In a specific example, such functionality may be enabled by displaying a control on the user interface allowing a user to effect the selection of the level of enlargement. In figure 5 this control is embodied as control buttons 512 and 514 which may be actuated by the user via a user input device. In the example depicted, by actuating button 514, the enlargement factor (“zoom-in”) to be applied to the areas of interest 504a and 504b by the processing unit 300 (shown in figure 3) is increased and by actuating button 512 the enlargement factor (“zoom-out”) to be applied to the areas of interest 504a and 504b is decreased. It will be readily apparent to the person skilled in the art that other type of controls for allowing a user to select a level of enlargement from a set of levels of enlargement may be envisaged in alternative specific implementations. In a specific example of implementation, the set of possible levels of enlargement includes at least two levels of enlargement. In a non-limiting example, one of the levels of enlargement is a “NIL” level wherein features of the portion of the enhanced image inside the area of interest appear on a same scale as features in portions of the enhanced image outside the area of interest. In other examples of implementation, the set of possible levels of enlargement includes two or more distinct levels of enlargement other than the “NIL” level. The enhanced image is such that portions inside the areas of interest are enlarged at least in part based on the selected level of enlargement. It will also be appreciated that although the above refers to a level of “enlargement” to be applied to the areas of interest 504a and 504b, a corresponding level of “shrinkage” may instead be applied to portions of the image outside the areas of interest 504a and 504b so that in the resulting enhanced image features in the areas of interest appear on a larger scale than portions of the image outside the area of interest. Other manners for providing such functionality will become readily apparent to the person skilled in the art in light of the present description and as such will not be described further here.

In another specific example of implementation, not depicted in the figure, functionality is also provided to the user for allowing the latter to select a zoom level to be applied to derive the enhanced image 502 for display in the viewing window 500. The functionality allows the user to change the zoom amount to be applied to the image depicted in the viewing space of viewing window 500. This zoom level functionality differs from the level of enlargement functionality described above, and enabled by buttons 512 and 514, in that the zoom level functionality affects the entire image with a selected zoom level. In other words, modifying the zoom level does not affect the relative scale between the areas of interest and portions of the image outside the area of interest remains. In a specific example, such functionality may be enabled by displaying a control on the user interface allowing a user to effect the selection of the zoom level. Any suitable type of control for allowing a user to select a zoom level may be envisaged in specific implementations of the user interface module.

In the specific example of implementation depicted, functionality is also provided to the user for allowing the latter to select a level of enhancement from a set of possible levels of enhancement. The functionality allows the user to independently control the type of enhancement to be applied to the original image to generate the enhanced image for display in the viewing window 500. In a specific example of implementation, the set of possible levels of enhancement includes at least two levels of enhancement. In a non-limiting example, one of the levels of enhancement is a “NIL” level wherein the areas of interest are not emphasized and the portions of the images outside the areas of interest are not de-emphasized. In other examples of implementation, the set of possible levels of enlargement includes two or more distinct levels of enhancement other than the “NIL” level. In a specific example of implementation, each level of enhancement in the set of levels of enhancement is adapted for causing an enhanced image to be derived wherein:

- portions inside the areas of interest are visually emphasized at least in part based on the selected level of enhancement; or
- portions outside the areas of interest are visually de-emphasized at least in part based on the selected level of enhancement; or

- portions inside the areas of interest are visually emphasized and portions outside the areas of interest are visually de-emphasized at least in part based on the selected level of enhancement.

For example, the different levels of enhancement may cause the processing unit 300 to apply
5 different types of image processing functions or different degrees of image processing such as to
modify the appearance of the enhanced image depicted in the viewing window 500.
Advantageously, this allows the user to adapt the appearance of the enhanced image 502 based on
either user preferences or in order to view an image in a different manner to facilitate visual
identification of a prohibited object. In a specific example, the above-described functionality may
10 be enabled by providing a control on the user interface allowing a user to effect the selection of the
level of enhancement. In figure 5 this control is embodied as control button 550 which may be
actuated by the user via a user input device. In the example depicted, by actuating button 550 the
type of enhancement to be applied by the processing unit 300 (shown in figure 3) is modified based
on a set of predetermined levels of enhancement. In an alternative implementation, not shown in
15 the figures, a control in the form of a drop-down menu providing a set of possible levels of
enhancement is provided. The user is able to select a level of enhancement from the set of levels of
enhancement to modify the type of enhancement to be applied by the processing unit 300 (shown
in figure 3) to generate the enhanced image. It will be readily apparent to the person skilled in the
art that other type of controls for allowing a user to select a level of enhancement from a set of
20 levels of enhancement may be envisaged in alternative specific implementations.

In a specific example of implementation, not shown in the figures, functionality is also provided to
the user for allowing the latter to independently control the amount of enhancement to be applied to
the area(s) of interest of the images and the amount of enhancement to be applied to portions of the
25 image outside of the area(s) of interest. In a specific example, the above-described functionality
may be enabled by providing on a user interface a first user control for enabling the user to select a
first selected level of enhancement, and a second user control is provided for allowing a user to
select a second level of enhancement. The processing unit generates the enhanced image such that:

- portions inside the area of interest are visually emphasized at least in part based on the selected second level of enhancement; and
- portions outside the area of interest are visually de-emphasized at least in part based on the selected first level of enhancement.

5

Optionally still, the user interface module is adapted for displaying a control 518 for allowing a user to modify other configuration elements of the user interface. In accordance with a non-limiting specific implementation, actuating control 518 causes the user interface module to displays a control window 600 of the type depicted in figure 6 allowing a user to select screening options. In

10 the specific example depicted, the user is enabled to select between the following screening options:

- Generate a report data 602: this option allows a report to be generated detailing information associated to the screening of the receptacle. In the example depicted, this is done by providing a control in the form of a button that can be
15 toggled between an “ON” state and an “OFF” state. It will be readily apparent that other suitable forms of controls may also be used in alternative practical embodiments. The information generated in the report may include, without being limited to, time of the screening, identification of the security personnel operating the screening system, identification of the receptacle and/or receptacle
20 owner (e.g. passport number in the case of a customs screening), locations information, area of interest information, confidence level information, identification of the prohibited object detected and description of the handling that took place and the results of the handling amongst others. Advantageously, this report allows a tracking of the screening operation.
- Display warning window 606: this option allows a user to cause a visual
25 indicator in the form of a warning window to be removed from or displayed on the user interface module when a prohibited object is detected in a receptacle.
- Set threshold sensitivity/confidence level 608: this option allows a user to modify the detection sensitivity level of the screening system. In specific

implementations, this may be done by providing a control in the form of a text box, sliding ruler (as shown in the figure), selection menu or other suitable type of control allowing the user to select between a range of detection sensitivity levels. It will be readily apparent that other suitable forms of controls may also be used in alternative practical embodiments.

The person skilled in the art in light of the present description will readily appreciate that other options may be provided to the user and that certain options described above may be omitted from certain implementations. As a variant, certain options may be selectively provided to certain users or, alternatively, may require a password to be modified. For example, the setting threshold sensitivity/confidence level 608 may only be made available to user having certain privileges (examples screening supervisors or security directors). As such, the user interface module may include some type of user identification functionality, such as a login process, to identify the user of the screening system. Alternatively, the user interface module, upon selection by the user of the setting threshold sensitivity/confidence level 608 option, may prompt the user to enter a password for allowing the user to modify the detection sensitivity level of the screening system.

Optionally still, the user interface module is adapted for displaying a control 520 for allowing a user to login/log-out of the system in order to provide user identification functionality. Manners in which user identification functionality can be provided are well-known in the art and are not critical to the present invention and as such will not be described further here.

Optionally still, not shown in the figures, the user interface module is adapted to allow the user to add complementary information to the information being displayed on the user interface. In a specific example of implementation, the user is enabled to insert markings in the form of text and/or visual indicators in the image displayed on the user interface. The marked-up image may then be transmitted to a third party location, such as a checking station, so that the checking station is alerted to verify the marked portion of the receptacle to locate a prohibited object. In such an implementation, the user input 308 (depicted in figure 3) receives signals from a user input device,

the signals conveying commands for marking the image displayed in the user interface. Any suitable user input device for providing user commands may be used such as, for example, a mouse, keyboard, pointing device, speech recognition unit or touch sensitive screen. The specific manner in which the functionality for marking the image is provided is not critical to the present invention and as such will not be described further here.

Previously Screened Receptacles

In accordance with a specific example of implementation, apparatus 200 shown in figure 3 is adapted for storing information associated with receptacles so that this information may be accessed at a later time. More specifically, for a given receptacle, the apparatus 200 is adapted for receiving at first input 304 data conveying an image of the contents of the receptacle derived from an apparatus that scans the receptacle with penetrating radiation and at second input 306 information from an automated threat detection processor indicating an area of interest in the image potentially containing a prohibited object. The processing unit 300 of apparatus 200 is adapted for generating a record associated to the screened receptacle. The record includes the image of the contents of the receptacle received at the first input 304 and the information received at second input 306. Optionally, the record may also include additional information such as for example a time stamp, identification data conveying the type of prohibited object potentially detected, the level of confidence of the detection, a level of risk data element, an identification of the screener, the location of the screening station, identification information associated to the owner of the receptacle and/or any other suitable type of information that may be of interest to a user of the system for later retrieval. The record is then stored in memory 350 for later access.

The generation of a record may be effected for all receptacles being screened or for selected receptacles only. In practical implementations of the inventions, in particular in areas where traffic levels are high and a large number of receptacles are screened, it may be preferred to selectively store the images of the receptacles rather than storing images for all the receptacles. The selection of which images to store may be effected by the user of the user interface by providing a suitable

control on the user interface for receiving user command to that effect. Alternatively, the selection of which images may be effected in the basis of information received from the automated threat detection processor 106. For example, a record may be generated for a given object when a prohibited object was potentially detected in the receptacle as could be conveyed by a signal
5 received from the automated threat detection processor 106.

A process for facilitating visual identification of prohibited objects in images associated with previously screened receptacles is depicted in figure 7 of the drawings.

10 As shown, at step 700, a plurality of records associated to previously screened receptacles are provided. In a non-limiting example of implementation, apparatus 200 enables step 700 by providing the memory 350 for storing a plurality of records associated to respective previously screened receptacles. As described above, each record includes an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation and
15 information derived from an automated threat detection processor and indicating an area of interest in the image potentially containing a prohibited object.

At step 702, a set of thumbnail images derived from the plurality of records is displayed in viewing space 572. In a specific example of implementation, processing unit 300 is adapted for displaying a
20 set of thumbnail images 522 in viewing space 572, each thumbnail image 526a 526b 526c in the set of thumbnail images 522 being derived from a record in the plurality of records stored in memory unit 350 (shown in figure 3).

At step 704 a user is enabled to select at least one thumbnail image from the set of thumbnail
25 images 522. The selection may be effected on the basis of the images themselves or by allowing the user to specify either a time or time period associated to the records. In the specific example depicted, the user can select thumbnail image from the set of thumbnail images 522 using a user-input device to actuate the desired thumbnail image. Any suitable user input device for providing

user commands may be used such as, for example, a mouse, keyboard, pointing device, speech recognition unit or touch sensitive screen.

At step 706, an enhanced image derived from a record corresponding to the selected thumbnail
5 image is displayed in a second viewing space 570. More specifically, in response to a selection of a thumbnail image from the set of thumbnail images, an enhanced image derived from the certain record corresponding to the selected thumbnail image is displayed in viewing space 570. When multiple thumbnail images are selected, the corresponding enhanced images may be displayed concurrently with another or may be displayed separately in viewing space 570.

10 The enhanced image derived from the certain record corresponding to the selected thumbnail image may be derived in a similar manner as that described previously in the present specification. For example, for a given record in the database of records including a certain image and information conveying a certain area of interest in the image, portions of the certain image outside
15 the certain area of interest may be visually de-emphasized to generate the enhanced image. In a second example of implementation, features appearing inside the certain area of interest are visually emphasized to generate the enhanced image. In yet another example, the portions of the image outside the certain area of interest are visually de-emphasized and features appearing inside the certain area of interest are visually emphasized to generate the enhanced image. The manner in
20 which the portions of the certain image outside the certain area of interest may be visually de-emphasized and features appearing inside the certain area of interest may visually emphasized have been previously described in the present application and as such will not be described further here.

In the specific example of implementation depicted, functionality is also provided to the user for
25 allowing the latter to scroll through a plurality of thumbnail images so the different sets of the thumbnail images may be displayed in viewing space 572. In a specific example, such functionality may be enabled by displaying a control on the user interface allowing a user to scroll through plurality of thumbnail images. In figure 5 this control is embodied as scrolling controls 524 which may be actuated by the user via a suitable user input device.

Optionally, each thumbnail image in the set of thumbnail images conveys information derived from an associated time stamp data element. In the example depicted in figure 5, this is done by displaying timing information 528. Optionally, not shown in the figures, each thumbnail image in the set of thumbnail images conveys information derived from an associated level of risk data element. It will be readily apparent to the person skilled in the art that any suitable additional type of information may be displayed or conveyed in connection with the thumbnail images.

Optionally, the user interface module implemented by apparatus 200 (shown in figure 2) includes functionality for enabling a user to select between an enhanced image associated to a previously screened receptacle, herein referred to as enhanced previous image, and an enhanced image associated with a receptacle currently being screened. The selected image is then displayed in viewing space 570. More specifically, data conveying a current image of the contents of a currently screened receptacle derived from an apparatus that scans the currently screened receptacle with penetrating radiation is received at first input 304 of apparatus 200 (shown in figure 2). In addition, information from an automated threat detection processor indicating an area of interest in the current image potentially containing a prohibited object is received at second input 306 of apparatus 200 (also shown in figure 2). The processing unit 300 is adapted for processing the current image to generate an enhanced current image in which portions outside the area of interest are visually de-emphasized. The user interface module enables the user to select between an enhanced previous image and the enhanced current image by providing a user operable control (not shown in the figures) to effect the selection.

Optionally, as depicted in figure 5, functionality is provided for conveying a perceived level of threat associated to a receptacle. In a specific example of implementation, this perceived level of threat is derived based on a confidence level data element received from an automated threat detection processor such as automated threat detection processor 106 depicted in figure 1. The confidence level conveys a likelihood that a threat was positively detected in the receptacle. The perceived level of threat may be the confidence level or may be conditioned on the basis of external actors such as a national emergency status for example. In the embodiment depicted, the

perceived level of threat is conveyed through the use of a graphical threat probability scale 530 including various graduated levels of threats. In addition, in the embodiment depicted, the perceived level of threat is also conveyed through the use of a message at the top of the screen. The message to be displayed is conditioned on the basis of the confidence level and on the basis of a threshold sensitivity/confidence level. As described above, the threshold/sensitivity level may be a parameter of the user interface configurable by the user or may be a predetermined value. In a specific example, if the confidence level exceeds the threshold sensitivity/confidence level, a warning message of the type: "DANGER: OPEN BAG" or "SEARCH REQUIRED" may be displayed. If the confidence level is below the threshold sensitivity/confidence level, either no message may be displayed or an alternative message of the type "NO THREAT DETECTED - SEARCH AT YOUR DISCRETION" may be displayed.

Automated Threat Detection Processor 106

The automated threat detection processor 106 shown in figure 1 will now be described in greater detail with reference to Figure 8. As depicted, the automated threat detection processor 106 includes a first input 810, a second input 314, an output 812 and a processing unit, generally comprising a pre-processing module 800, an image comparison module 802, an area of interest locator module 804 and an output signal generator module 806.

In a specific example of implementation of the invention, either one or both of the region of the interest locator module 804 and the image comparison module 802 may generate information conveying an area of interest. In a non-limiting example of implementation, the area of interest locator module 804 is adapted for generating information conveying one or more regions of interest based on characteristics inherent to the image conveying contents of a receptacle. In a non-limiting example of implementation where the image is an x-ray image, the characteristics inherent to the image include, without being limited to, density information conveyed by an x-ray type image example. Conversely, in this non-limiting example of implementation, the image comparison module 802 is adapted for generating information conveying one or more regions of interest based

on a comparison between the image conveying contents of a receptacle and images in a database of target objects. It will readily appreciated that specific examples of implementation may omit either one of the image comparison module 802 and the area of interest locator module 804 for implementing the functionality for generating information conveying an area of interest.

5

The first input 810 is for receiving data conveying an image of the contents of a receptacle from the image generation apparatus 102 (shown in Figure 1).

10 The second input 314 is for receiving target images from the database of prohibited objects 110. It will be appreciated that in embodiments where the database of prohibited objects 110 is part of automated threat detection processor 106, the second input 314 may be omitted.

15 The output 812 is for releasing information for transmittal to output module 108 indicating an area of interest in the image potentially containing a prohibited object. Optionally, the information released also conveys a level of confidence that the area of interest contains a prohibited object as well as the identity of the prohibited object potentially detected.

20 The processing unit of the automated threat detection processor 106 receives the data conveying an image of the contents of the receptacle 104 from the first input 810 and processes that image to derive an area of interest in the image and, optionally, to identify a prohibited object in the receptacle 104. The processing unit of the automated threat detection processor 106 generates and releases at output 812 information conveying an area of interest in the image an optionally information conveying the identity of a detected prohibited object.

25 The process implemented by the various functional elements of the processing unit of the automated threat detection processor 106 is depicted in Figure 9 of the drawings. At step 900, the pre-processing module 800 receives the data conveying an image of the contents of the receptacle 104 via the first input 810. At step 901, the pre-processing module 800 processes the data in order to enhance the image, remove extraneous information therefrom and remove noise artefacts in

order to obtain more accurate comparison results. The complexity of the requisite level of pre-processing and the related trade-offs between speed and accuracy depend on the application. Examples of pre-processing may include, without being limited to, brightness and contrast manipulation, histogram modification, noise removal and filtering amongst others. It will be appreciated that all or part of the functionality of the pre-processing module 800 may actually be external to the automated threat detection processor 106, e.g., it may be integrated as part of the image generation apparatus 102 or as an external component. It will also be appreciated that the pre-processing module 800 (and hence step 901) may be omitted in certain embodiments. As part of step 901, the pre-processing module 800 releases data conveying a modified image of the contents of the receptacle 104 for processing by the image comparison module 802 and by the area of interest locator module 804.

At step 950, the area of interest locator module 804 processes the data conveying the modified image received from the pre-processing module 800 (or the data conveying an image of the contents of the receptacle received via the first input 810) to generate information conveying an area of interest in the image. The area of interest in the image is an area that potentially contains a prohibited object. Any suitable method to determine an area of the image of (or modified image of) contents of a receptacle that potentially contains a prohibited object may be used. In a specific example, the area of interest locator module 804 is adapted for generating information conveying area of interest based on characteristics inherent to the input image. In a first specific example of implementation, the image is an x-ray image conveying information related to the material density associated to contents of the receptacle. The area of interest locator module 804 is adapted to process the image and identify areas including a certain concentration of elements characterized by a certain material density, say for example metallic-type elements, and label these areas as areas of interest. Characteristics such as the size of the area exhibited the certain density may also be taken into account to identify an area of interest. It will be apparent to the person skilled in the art that other suitable methods for identifying regions of interest in an image may be used. Many such methods are known in the art and as such will not be described further here.

At step 902, the image comparison module 802 verifies whether there remain any unprocessed target images in the database of prohibited objects 110. In the affirmative, the image comparison module 802 proceeds to step 903 where the next target image is accessed and the image comparison module 802 then proceeds to step 904. If at step 902 all target images in the database of prohibited objects 110 have been processed, the image comparison module 802 proceeds to step 910 and the process is completed.

At step 904, the image comparison module 802 compares the image (or modified image) of the contents of the receptacle 104 against the target image accessed at step 903 to determine whether a match exists. The comparison may be effected using any image processing algorithm suitable for comparing two images. Optionally, the comparison may make use of the area of interest information generated by the area of interest locator module to limit the comparison operation to the area of interest. Examples of algorithms that can be used to perform image processing and comparison include without being limited to:

A - Image enhancement

- Brightness and contrast manipulation
- Histogram modification
- Noise removal
- Filtering

B - Image segmentation

- Thresholding
 - Binary or multilevel
 - Hysteresis based
 - Statistics/histogram analysis
- Clustering
- Region growing
- Splitting and merging

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- Texture analysis
- Watershed
- Blob labeling

5 **C - General detection**

- Template matching
- Matched filtering
- Image registration
- Image correlation
- 10 - Hough transform

D - Edge detection

- Gradient
- Laplacian

15

E - Morphological image processing

- Binary
- Grayscale

20 **F - Frequency analysis**

- Fourier Transform
- Wavelets

G - Shape analysis and representations

- 25 - Geometric attributes (e.g. perimeter, area, euler number, compactness)
- Spatial moments (invariance)
- Fourier descriptors
- B-splines
- Chain codes

- Polygons
- Quad tree decomposition

H - Feature representation and classification

- 5 - Bayesian classifier
- Principal component analysis
- Binary tree
- Graphs
- Neural networks
- 10 - Genetic algorithms
- Markov random fields

The above algorithms are well known in the field of image processing and as such will not be described further here.

15 In a specific example of implementation, the image comparison module 802 includes an edge detector to perform part of the comparison at step 904. In another specific example of implementation, the comparison performed at step 904 includes effecting a correlation operation between the image (or modified image) of contents of the receptacle and the target images in the
20 database 110. In a specific example of implementation, the correlation operation is performed by an optical correlator. In an alternative example of implementation, the correlation operation is performed by a digital correlator. In yet another implementation, a combination of methods is used to effect the comparison of step 904. The results of the comparisons are then combined to obtain a joint comparison result.

25 The image comparison module 802 then proceeds to step 906 where the result of the comparison effected at step 904 is processed to determine whether a match exists between the image (or modified image) of the contents of receptacle 104 and the target image. In a specific example of implementation, the comparison at step 904 generates a score conveying a likelihood that there is a

match between a portion of the image (or modified image) of the contents of receptacle 104 and the target image. A match is detected if the score obtained by the comparison at step 904 is above a certain threshold score. This score can also be considered as the confidence level associated to detection of a match. In the absence of a match, the image comparison module 802 returns to step 5 902. In response to detection of a match, the image comparison module 802 triggers the output signal generator module 806 to execute step 910. Then, the image comparison module 802 returns to step 902 to continue processing with respect to the next target image.

At step 910, the output signal generator module 806 generates information conveying the presence 10 of a prohibited object in the receptacle 104, and the information is released at output 812. The information conveys positioning information associated to the prohibited object within the image received at input 810. The positioning information conveys an area of interest in the image where the prohibited object is potentially located which was derived either from the area of interest locator module 804 or the image comparison module 802. The information may be conveyed in 15 any suitable format. In a non-limiting example, the information may convey a plurality of (X,Y) pixel locations defining an area in the image of the contents of a receptacle. In another non-limiting example of implementation, the information conveys an (X,Y) pixel location conveying the center of an area in the image. Optionally, the information released also conveys a level of confidence that the area of interest contains a prohibited object. Optionally still an identification of the prohibited 20 object potentially detected in the image is also provided.

Alternative embodiment –Screening of Persons

Although the above-described screening system was described in connection with screening of 25 receptacles, the concepts described above can also be applied to the screening of people.

For example, in an alternative embodiment, a system for screening people is provided. The system includes components similar to those described in connection with the system depicted in Figure 1. In a specific example of implementation, the image generation apparatus 102 is configured to scan 30 a person and possibly to scan the person along various axes and/or views to generate multiple

images associated to the person. The image or images associated with the person convey information related to the objects carried by the person. Each image is then processed in accordance with the method described in the present specification to facilitate visual identification of a prohibited object on the person.

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Optionally, in the case of a system for screening people, database of prohibited objects 110 may further include entries associated to non-prohibited objects and/or objects that do not represent a potential threat. Such entries may be used to detect objects commonly carried by people such as cell-phones, watches and rings, for example, which are not prohibited and not threatening.

10 Advantageously, by identifying such objects unnecessary manual verifications can be avoided.

Specific Physical Implementation

Certain portions of the apparatus 200 for implementing a user interface (shown in figure 3) can be
15 implemented on a general purpose digital computer 1300, of the type depicted in Figure 10, including a processing unit 1302 and a memory 1304 connected by a communication bus. The memory includes data 1308 and program instructions 1306. The processing unit 1302 is adapted to process the data 1308 and the program instructions 1306 in order to implement the functional blocks described in the specification and depicted in the drawings. The digital computer 1300 may
20 also comprise an I/O interface 1310 for receiving or sending data elements to external devices.

Similarly, certain portions of the automated threat detection processor 106 can also be implemented on a general purpose digital computer having a similar structure as that described in connection with figure 10. Certain portions of the automated threat detection processor 106 and of the
25 apparatus 200 for implementing a user interface may be implemented on a same general purpose digital computer in specific practical implementations.

Alternatively, the above-described automated threat detection processor 106 can be implemented on a dedicated hardware platform where electrical/optical components implement the functional

blocks described in the specification and depicted in the drawings. Specific implementations may be realized using ICs, ASICs, DSPs, FPGA, an optical correlator, digital correlator or other suitable hardware platform.

5 Other alternative implementations of the automated threat detection processor 106 and the apparatus 200 for implementing a user interface can be implemented as a combination of dedicated hardware and software such as apparatus 1000 of the type depicted in Figure 11. As shown, such an implementation comprises dedicated image processing hardware module 1008 and a general purpose computing unit 1006 including a CPU 1012 and a memory 1014 connected by a communication bus. The memory includes data 1018 and program instructions 1016. The CPU 1012 is adapted to process the data 1018 and the program instructions 1016 in order to implement the functional blocks described in the specification and depicted in the drawings. The CPU 1012 is also adapted to exchange data with the dedicated image processing hardware module 1008 over communication link 1010 to make use of the image processing capabilities of the dedicated image processing hardware module 1008. The apparatus 1000 may also comprise I/O interfaces 1002 1004 for receiving or sending data elements to external devices.

It will be appreciated that the screening system 100 (depicted in figure 1) may also be of a distributed nature where the images of contents of receptacles are obtained at one location or more locations and transmitted over a network to a server unit implementing the method described above. The server unit may then transmit a signal for causing an output unit to display information to the user. The output unit may be located in the same location where the images of contents of receptacles were obtained or in the same location as the server unit or in yet another location. In a non-limiting implementation, the output unit is part of a centralized screening facility. Figure 12 illustrates a network-based client-server system 1100 for system for screening receptacles. The client-server system 1100 includes a plurality of client systems 1102, 1104, 1106 and 1108 connected to a server system 1110 through network 1112. The communication links 1114 between the client systems 1102, 1104, 1106 and 1108 and the server system 1110 can be metallic conductors, optical fibres or wireless in specific practical embodiments. The network 1112 may be

any suitable network including but not limited to a global public network such as the Internet, a private network and a wireless network. The server 1110 may be adapted to process and issue signals concurrently using suitable methods known in the computer related arts.

5 The server system 1110 includes a program element 1116 for execution by a CPU. Program element 1116 includes functionality to implement the methods described above, including a method for displaying information associated to a receptacle and for facilitating visual identification of a prohibited object in an image during security screening, and includes the necessary networking functionality to allow the server system 1110 to communicate with the client
10 systems 1102, 1104, 1106 and 1108 over network 1112. In a specific implementation, the client systems 1102, 1104, 1106 and 1108 include display units responsive to signals received from the server system 1110 for displaying a user interface module implementation by the server system 1110.

15 Although the present invention has been described in considerable detail with reference to certain preferred embodiments thereof, variations and refinements are possible. Therefore, the scope of the invention should be limited only by the appended claims and their equivalents.

CLAIMS:

1. A method for facilitating visual identification of a prohibited object in an image during
5 security screening, said method comprising:
 - receiving data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation;
 - receiving information from an automated threat detection processor indicating an area of interest in the image potentially containing a prohibited object;
 - 10 - processing the image to generate an enhanced image in which portions outside the area of interest are visually de-emphasized;
 - displaying the enhanced image on a display device.
2. A method as defined in claim 1, wherein processing the image includes modifying portions
15 of the image outside the area of interest.
3. A method as defined in claim 1, wherein processing the image includes reducing contrasts between feature information appearing in portions of the image outside the area of interest and background information appearing in portions of the image outside the area of interest.
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4. A method as defined in claim 1, wherein processing the image includes attenuating portions of the image outside the area of interest.
5. A method as defined in claim 1, wherein processing the image includes replacing portions of
25 the image outside the area of interest with a pre-determined visual pattern.
6. A method as defined in claim 1, wherein processing the image includes overlaying portions of the image outside the area of interest with a pre-determined visual pattern.

7. A method as defined in claim 1, wherein the image includes color information, wherein processing the image includes modifying color information associated to features of the image appearing outside the area of interest.
- 5 8. A method as defined in claim 7, wherein processing the image includes converting portions of the image outside the area of interest into grayscale.
9. A method as defined in claim 1, wherein processing the image includes reducing a resolution associated to portions of the image outside the area of interest.
- 10 10. A method as defined in claim 1, said method further comprising modifying portions of areas surrounding the area of interest to generate the enhanced image.
11. A method as defined in claim 10, wherein modifying portions of areas surrounding the area of interest includes applying a blurring function to portions of areas surrounding the area of interest.
- 15 12. A method as defined in claim 1, wherein said method comprises:
- receiving information from an automated threat detection processor indicating a plurality of areas of interest in the image potentially containing respective prohibited objects;
 - processing the image to generate the enhanced image in which portions outside the areas of interest are visually de-emphasized.
- 20 13. A method as defined in claim 1, wherein said method comprises shrinking portions of the image outside the area of interest such that at least some features of the enhanced image located inside the area of interest appear on a larger scale than features in portions of the enhanced image located outside the area of interest.
- 25

14. A method as defined in claim 2, wherein portions of the enhanced image inside the area of interest are visually emphasized.

15. A method as defined in claim 14, wherein processing the image includes modifying portions of the image inside the area of interest to derive the enhanced image.

16. A method as defined in claim 14, wherein processing the image includes increasing contrasts between feature information appearing in portions of the image inside the area of interest and background information appearing in portions of the image inside the area of interest.

17. A method as defined in claim 14, wherein processing the image includes overlaying portions of the image inside the area of interest with a pre-determined visual pattern.

18. A method as defined in claim 14, wherein processing the image includes modifying color information associated to features of the image appearing inside the area of interest.

19. A method as defined in claim 15, wherein said method comprises enlarging a portion of the image inside the area of interest such that at least some features of the enhanced image located inside the area of interest appear on a larger scale than features in portions of the enhanced image located outside the area of interest.

20. A method as defined in claim 1, said method comprising providing a user control allowing a user to select either one of the image conveyed by the data received and the enhanced image to be displayed on the display device.

21. A method as defined in claim 1, said method comprising:

- providing a user control allowing a user to select a level of enhancement from a set of possible levels of enhancement;

- processing the image to generate the enhanced image such that portions outside the area of interest in the enhanced image are visually de-emphasized at least in part based on the selected level of enhancement.

5 22. A method as defined in claim 14, said method comprising:

- providing a user control allowing a user to select a level of enhancement from a set of possible levels of enhancement;
- processing the image to generate the enhanced image such that portions inside the area of interest in the enhanced image are visually emphasized at least in part based on the selected level of enhancement.

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23. A method as defined in claim 22, wherein said user control is a first user control and the selected level of enhancement is a first selected level of enhancement, said method comprising:

- providing a second user control allowing a user to select a second level of enhancement from a set of possible levels of enhancement;
- processing the image to generate the enhanced image such that portions inside the area of interest in the enhanced image are visually emphasized at least in part based on the selected second level of enhancement.

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24. A method as defined in claim 1, said method comprising:

- providing a user control allowing a user to select a level of enlargement from a set of possible levels of enlargement;
- processing the image to generate the enhanced image such that portions inside the area of interest are enlarged at least in part based on the selected level of enlargement such that features of the portion of the enhanced image inside the area of interest appear on a larger scale than features in portions of the enhanced image outside the area of interest.

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25. An apparatus for implementing a user interface module for facilitating visual identification of a prohibited object in an image during security screening, said apparatus comprising:

- a first input for receiving data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation;
- a second input for receiving information from an automated threat detection processor indicating an area of interest in the image potentially containing a prohibited object;
- a processing unit in communication with the first input and the second input, said processing unit being operative for implementing the user interface module, said user interface module being adapted for:
 - i. processing the image to generate an enhanced image in which portions outside the area of interest are visually de-emphasized;
 - ii. displaying the enhanced image on a display module.

26. An apparatus as defined in claim 25, wherein said user interface module is operative for modifying portions of the image outside the area of interest during processing of the image to generate the enhanced image.

27. An apparatus as defined in claim 25, wherein processing the image includes reducing contrasts between feature information appearing in portions of the image outside the area of interest and background information appearing in portions of the image outside the area of interest.

28. An apparatus as defined in claim 25, wherein processing the image includes attenuating portions of the image outside the area of interest.

29. An apparatus as defined in claim 25, wherein processing the image includes replacing portions of the image outside the area of interest with a pre-determined visual pattern.

30. An apparatus as defined in claim 25, wherein processing the image includes overlaying portions of the image outside the area of interest with a pre-determined visual pattern.

31. An apparatus as defined in claim 25, wherein the image includes color information, wherein processing the image includes modifying color information associated to features of the image appearing outside the area of interest.

32. An apparatus as defined in claim 31, wherein processing the image includes converting portions of the image outside the area of interest into grayscale.

33. An apparatus as defined in claim 25, wherein processing the image includes reducing a resolution associated to portions of the image outside the area of interest.

34. An apparatus as defined in claim 25, wherein said user interface module is adapted for modifying portions of areas surrounding the area of interest to generate the enhanced image.

35. An apparatus as defined in claim 34, wherein modifying portions of areas surrounding the area of interest includes applying a blurring function to portions of areas surrounding the area of interest.

36. An apparatus as defined in claim 25, wherein processing the image includes shrinking portions of the image outside the area of interest such that at least some features of the enhanced image located inside the area of interest appear on a larger scale than features in portions of the enhanced image located outside the area of interest.

37. An apparatus as defined in claim 26, wherein portions of the enhanced image inside the area of interest are visually emphasized.

38. An apparatus as defined in claim 37, wherein processing the image includes modifying portions of the image inside the area of interest to derive the enhanced image.

39. An apparatus as defined in claim 37, wherein processing the image includes increasing contrasts between feature information appearing in portions of the image inside the area of interest and background information appearing in portions of the image inside the area of interest.

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40. An apparatus as defined in claim 37, wherein processing the image includes overlaying portions of the image inside the area of interest with a pre-determined visual pattern.

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41. An apparatus as defined in claim 37, wherein processing the image includes modifying color information associated to features of the image appearing inside the area of interest.

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42. An apparatus as defined in claim 38, wherein said user interface module is adapted for enlarging a portion of the image inside the area of interest such that features located in the portion of the enhanced image inside the area of interest appear on a larger scale than features located in portions of the enhanced image outside the area of interest.

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43. An apparatus as defined in claim 25, wherein said user interface module is adapted for displaying a user control allowing a user to select either one of the image conveyed by the data received and the enhanced image to be displayed on the display device.

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44. An apparatus as defined in claim 25, wherein said user interface module is adapted for :

- displaying a user control allowing a user to select a level of enhancement from a set of possible levels of enhancement;
- processing the image to generate the enhanced image such that portions outside the area of interest in the enhanced image are visually de-emphasized at least in part based on the selected level of enhancement.

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45. An apparatus as defined in claim 25, wherein said user interface module is adapted for :

- displaying a user control allowing a user to select a level of enhancement from a set of possible levels of enhancement;

- processing the image to generate the enhanced image such that portions inside the area of interest in the enhanced image are visually emphasized at least in part based on the selected level of enhancement.

5 46. An apparatus as defined in claim 44, wherein said user control is a first user control and the selected level of enhancement is a first selected level of enhancement, said user interface module being further adapted for :

- displaying a second user control allowing a user to select a second level of enhancement from a set of possible levels of enhancement;
- 10 - processing the image to generate the enhanced image such that portions inside the area of interest in the enhanced image are visually emphasized at least in part based on the selected second level of enhancement.

47. An apparatus as defined in claim 25, wherein said user interface module is adapted for :

- 15 - displaying a user control allowing a user to select a level of enlargement from a set of possible levels of enlargement;
- processing the image to generate the enhanced image such that portions inside the area of interest are enlarged at least in part based on the selected level of enlargement such that features of the portion of the enhanced image inside the area of interest appear on a larger scale than features in portions of the enhanced image outside the area of interest.
- 20

48. A computer readable storage medium storing a program element suitable for execution by a CPU, said program element implementing a graphical user interface module for facilitating visual identification of a prohibited object in the image during security screening, said graphical user interface module being adapted for:

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- receiving data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation;

- receiving information from an automated threat detection processor indicating an area of interest in the image potentially containing a prohibited object;
- processing the image to generate an enhanced image in which portions outside the area of interest are visually de-emphasized;
- 5 - displaying the enhanced image on a display device.

49. A system for detecting the presence of one or more prohibited objects in a receptacle, comprising:

- an image generation apparatus suitable for scanning a receptacle with penetrating radiation to generate data conveying an image of contents of the receptacle;
- 10 - an automated threat detection processor in communication with said image generation apparatus, said automated threat detection processor being adapted for processing the image to identify an area of interest in the image potentially containing a prohibited object;
- 15 - a display module;
- an apparatus in communication with said image generation apparatus, said automated threat detection processor and said display module, said apparatus implementing a user interface module for facilitating visual identification of a prohibited object in an image during security screening, said apparatus comprising:
- 20 i. a first input for receiving the data conveying the image of the contents of the receptacle;
- ii. a second input for receiving information indicating the area of interest in the image;
- iii. a processing unit in communication with the first input and the second input, said processing unit being operative for implementing the user interface module, said user interface module being adapted for:
- 25 1. processing the image to generate an enhanced image in which portions outside the area of interest are visually de-emphasized;
- 2. displaying the enhanced image on said display module.

50. A client-server system for implementing a graphical user interface module for facilitating visual identification of a prohibited object in an image during security screening, said client-server system comprising a client system and a server system, said client system and said server system operative to exchange messages over a data network, said server system storing a program element for execution by a CPU, said program element comprising:

- first program element component executed on said server system for receiving:
 - i. data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation; and
 - ii. information from an automated threat detection processor indicating an area of interest in the image potentially containing a prohibited object;
- a second program element component executed on said server system for processing the image to generate an enhanced image in which portions outside the area of interest are visually de-emphasized;
- a third program element component executed on said server system for sending messages to said client system for causing said client system to display the enhanced image on a display device.

51. A client-server system as defined in claim 50, wherein the data network is the Internet.

52. An apparatus for implementing a user interface module for facilitating visual identification of a prohibited object in an image during security screening, said apparatus comprising:

- means for receiving data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation;
- means for receiving information from an automated threat detection processor indicating an area of interest in the image potentially containing a prohibited object;
- means for processing the image to generate an enhanced image in which portions outside the area of interest are visually de-emphasized;
- means for releasing a display signal, the display signal being suitable for causing a display device to display the enhanced image.

53. A method for facilitating visual identification of a prohibited object in an image during security screening, said method comprising:

- receiving data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation;
- receiving information from an automated threat detection processor indicating an area of interest in the image potentially containing a prohibited object;
- processing the image to generate an enhanced image in which features appearing inside the area of interest are visually emphasized;
- displaying the enhanced image on a display device.

54. A method as defined in claim 53, wherein processing the image includes increasing contrasts between features appearing in portions of the image inside the area of interest and background information appearing in portions of the image inside the area of interest.

55. A method as defined in claim 53, wherein processing the image includes modifying color information associated to features of the image appearing inside the area of interest.

56. A method as defined in claim 53, wherein said method comprises enlarging a portion of the image inside the area of interest such that at least some features of the enhanced image located inside the area of interest appear on a larger scale than features in portions of the enhanced image located outside the area of interest.

57. A method as defined in claim 53, said method comprising providing a user control allowing a user to select either one of the image conveyed by the data received and the enhanced image to be displayed on the display device.

58. A method as defined in claim 53, said method comprising:

- providing a user control allowing a user to select a level of enhancement from a set of possible levels of enhancement;

- processing the image to generate the enhanced image such that portions inside the area of interest in the enhanced image are visually emphasized at least in part based on the selected level of enhancement.

5 59. A method as defined in claim 53, said method comprising:

- providing a user control allowing a user to select a level of enlargement from a set of possible levels of enlargement;
 - processing the image to generate the enhanced image such that portions inside the area of interest are enlarged at least in part based on the selected level of enlargement such that features of the portion of the enhanced image inside the area of interest appear on a larger scale than features in portions of the enhanced image outside the area of interest.
- 10

15 60. A method as defined in claim 59, wherein said user control allows the user to select the level of enlargement from the set of possible levels of enlargement by using an input device selected from the set consisting of a mouse, keyboard, pointing device, speech recognition unit and touch sensitive screen.

20 61. A method as defined in claim 53, wherein processing the image includes modifying portions of the image outside the area of interest.

62. A method as defined in claim 61, wherein processing the image includes attenuating portions of the image outside the area of interest.

25 63. An apparatus for implementing a user interface module for facilitating visual identification of a prohibited object in an image during security screening, said apparatus comprising:

- a first input for receiving data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation;

- a second input for receiving information from an automated threat detection processor indicating an area of interest in the image potentially containing a prohibited object;
- a processing unit in communication with the first input and the second input, said processing unit being operative for implementing the user interface module, said user interface module being adapted for:
 - i. processing the image to generate an enhanced image in which features appearing inside the area of interest are visually emphasized;
 - ii. displaying the enhanced image on a display module.

64. An apparatus as defined in claim 63, wherein processing the image includes increasing contrasts between features appearing in portions of the image inside the area of interest and background information appearing in portions of the image inside the area of interest.

65. An apparatus as defined in claim 63, wherein processing the image includes modifying color information associated to features of the image appearing inside the area of interest.

66. An apparatus as defined in claim 63, wherein processing the image includes enlarging a portion of the image inside the area of interest such that at least some features of the enhanced image located inside the area of interest appear on a larger scale than features in portions of the enhanced image located outside the area of interest.

67. An apparatus as defined in claim 63, said user interface module being adapted for displaying a user control allowing a user to select either one of the image conveyed by the data received and the enhanced image to be displayed on the display device.

68. An apparatus as defined in claim 63, said user interface module being adapted for :

- displaying a user control allowing a user to select a level of enhancement from a set of possible levels of enhancement;

- processing the image to generate the enhanced image such that portions inside the area of interest in the enhanced image are visually emphasized at least in part based on the selected level of enhancement.

- 5 69. An apparatus as defined in claim 63, wherein said user interface module being adapted for:
- displaying a user control allowing a user to select a level of enlargement from a set of possible levels of enlargement;
 - processing the image to generate the enhanced image such that portions inside the area of interest are enlarged at least in part based on the selected level of enlargement such that features of the portion of the enhanced image inside the area of interest appear on a larger scale than features in portions of the enhanced image outside the area of interest.
- 10
70. An apparatus as defined in claim 69, wherein said user control allows the user to select the level of enlargement from the set of possible levels of enlargement by using an input device selected from the set consisting of a mouse, keyboard, pointing device, speech recognition unit and touch sensitive screen.
- 15
71. An apparatus as defined in claim 63, wherein processing the image includes modifying portions of the image outside the area of interest.
- 20
72. An apparatus as defined in claim 63, wherein processing the image includes attenuating portions of the image outside the area of interest.
- 25
73. A computer readable storage medium storing a program element suitable for execution by a CPU, said program element implementing a graphical user interface module for facilitating visual identification of a prohibited object in the image during security screening, said graphical user interface module being adapted for:
- receiving data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation;
- 30

- receiving information from an automated threat detection processor indicating an area of interest in the image potentially containing a prohibited object;
- processing the image to generate an enhanced image in which features appearing inside the area of interest are visually emphasized;
- 5 - displaying the enhanced image on a display device.

74. A method for facilitating visual identification of prohibited objects in images associated with previously screened receptacles, said method comprising:

- providing a plurality of records associated to respective previously screened
10 receptacles, each record including:
 - i. an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation;
 - ii. information derived from an automated threat detection processor and indicating an area of interest in the image potentially containing a prohibited
15 object;
- displaying on a displaying device a first viewing space conveying a set of thumbnail images, each thumbnail image in said set of thumbnail images being derived from a record in the plurality of records;
- enabling a user to select at least one thumbnail image in the set of thumbnail
20 images;
- displaying on the display device a second viewing space conveying an enhanced image derived from a certain record in the plurality of records corresponding to the selected at least one thumbnail image.

25 75. A method as defined in claim 74, wherein said the user is enabled to select the at least one thumbnail image by using an input device selected from the set consisting of a mouse, keyboard, pointing device, speech recognition unit and touch sensitive screen.

76. A method as defined in claim 74, said method including displaying a user control for enabling the user to display different sets of thumbnail images in the first viewing space.

77. A method as defined in claim 74, wherein said user control is a scrolling control.

5

78. A method as defined in claim 74, wherein at least some records in said plurality of record include a level of risk data element conveying a perceived threat level associated to a respective previously screened receptacle.

10 79. A method as defined in claim 74, wherein at least some records in said plurality of record include a time stamp data element, wherein each thumbnail image in said set of thumbnail images conveys information derived from an associated time stamp data element.

15 80. A method as defined in claim 74, wherein said method comprises processing an image in the certain record at least in part based on information in the certain record indicating a certain area of interest to derive the enhanced image.

81. A method as defined in claim 80, wherein portions of the enhanced image inside the certain area of interest are visually emphasized.

20

82. A method as defined in claim 80, wherein portions of the enhanced image outside the certain area of interest are visually de-emphasized.

25 83. A method as defined in claim 74, wherein the enhanced image is an enhanced previous image, said method further comprising:

- receiving data conveying a current image of the contents of a currently screened receptacle derived from an apparatus that scans the currently screened receptacle with penetrating radiation;

- receiving information from an automated threat detection processor indicating an area of interest in the current image potentially containing a prohibited object;
 - processing the current image to generate an enhanced current image in which portions outside the area of interest are visually de-emphasized;
 - 5 - enabling the user to select between the enhanced previous image and the enhanced current image;
 - displaying the selected one of the enhanced current image and the enhanced previous image on a display module.
- 10 84. An apparatus for implementing a user interface module for facilitating visual identification of a prohibited object in an image during security screening, said apparatus comprising:
- a memory suitable for storing a plurality of records associated to respective previously screened receptacles, each record including:
 - 15 i. an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation;
 - ii. information derived from an automated threat detection processor and indicating an area of interest in the image potentially containing a prohibited object;
 - a processing unit in communication with said memory unit, said processing unit implementing the user interface module, said user interface module being adapted for:
 - 20 i. displaying on a displaying device a first viewing space conveying a set of thumbnail images, each thumbnail image in said set of thumbnail images being derived from a record in the plurality of records;
 - 25 ii. enabling a user to select at least one thumbnail image in the set of thumbnail images;
 - iii. displaying on the display device a second viewing space conveying an enhanced image derived from a certain record in the plurality of records corresponding to the selected at least one thumbnail image.

85. An apparatus as defined in claim 84, wherein said user interface module enables the user to select the at least one thumbnail image by using an input device selected from the set consisting of a mouse, keyboard, pointing device, speech recognition unit and touch sensitive screen.

5

86. An apparatus as defined in claim 84, said user interface module is operative for displaying a user control for enabling the user to display different sets of thumbnail images in the first viewing space.

10 87. An apparatus as defined in claim 84, wherein said user control is a scrolling control.

88. An apparatus as defined in claim 84, wherein at least some records in said plurality of record include a level of risk data element conveying a perceived threat level associated to a respective previously screened receptacle, wherein each thumbnail image in said set of
15 thumbnail images conveys information derived from an associated level of risk data element.

89. An apparatus as defined in claim 84, wherein at least some records in said plurality of record include a time stamp data element, wherein each thumbnail image in said set of thumbnail images conveys information derived from an associated time stamp data element.

20

90. An apparatus as defined in claim 84, wherein said user interface module is operative for processing an image in the certain record at least in part based on information in the certain record indicating a certain area of interest to derive the enhanced image.

25 91. An apparatus as defined in claim 90, wherein portions of the enhanced image inside the certain area of interest are visually emphasized.

92. An apparatus as defined in claim 90, wherein portions of the enhanced image outside the certain area of interest are visually de-emphasized.

93. An apparatus as defined in claim 84, wherein the enhanced image is an enhanced previous image, said user interface module being further operative for:

- receiving data conveying a current image of the contents of a currently screened receptacle derived from an apparatus that scans the currently screened receptacle with penetrating radiation;
- receiving information from an automated threat detection processor indicating an area of interest in the current image potentially containing a prohibited object;
- processing the current image to generate an enhanced current image in which portions outside the area of interest are visually de-emphasized;
- enabling the user to select between the enhanced previous image and the enhanced current image;
- displaying the selected one of the enhanced current image and the enhanced previous image on a display module.

94. A computer readable storage medium storing a program element suitable for execution by a CPU, said program element implementing a graphical user interface module for facilitating visual identification of a prohibited object in the image during security screening, said graphical user interface module being adapted for:

- providing a plurality of records associated to respective previously screened receptacles, each record including:
 - i. an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation;
 - ii. information derived from an automated threat detection processor and indicating an area of interest in the image potentially containing a prohibited object;
- displaying on a displaying device a first viewing space conveying a set of thumbnail images, each thumbnail image in said set of thumbnail images being derived from a record in the plurality of records;

- enabling a user to select at least one thumbnail image in the set of thumbnail images;
- displaying on the display device a second viewing space conveying an enhanced image derived from a certain record in the plurality of records corresponding to the selected at least one thumbnail image.

95. A method for displaying information associated to a receptacle for use in detecting the presence of a threat in the receptacle during security screening, said method comprising:

- receiving data conveying an image of the contents of a receptacle derived from an apparatus that scans the receptacle with penetrating radiation;
- receiving data conveying a level confidence that a threat has been detected in the receptacle;
- deriving a perceived level of threat associated with the receptacle at least in part based on the level confidence;
- displaying a screening image derived at least in part based on the data conveying the image of the contents of a receptacle;
- displaying concurrently with the screening image a threat probability scale, the threat probability scale conveying a perceived level of threat associated with the receptacle in graphical format.

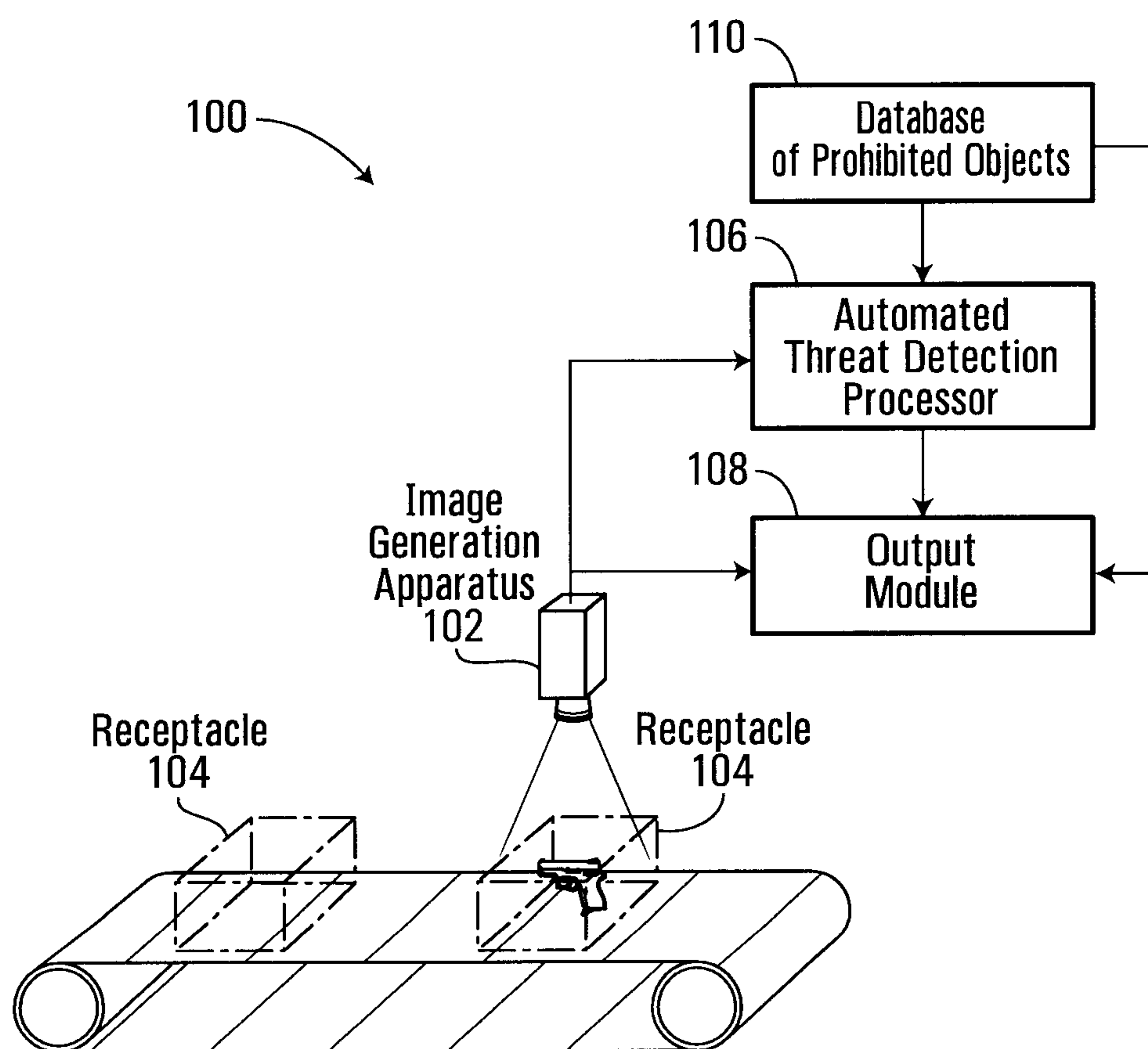


FIG. 1

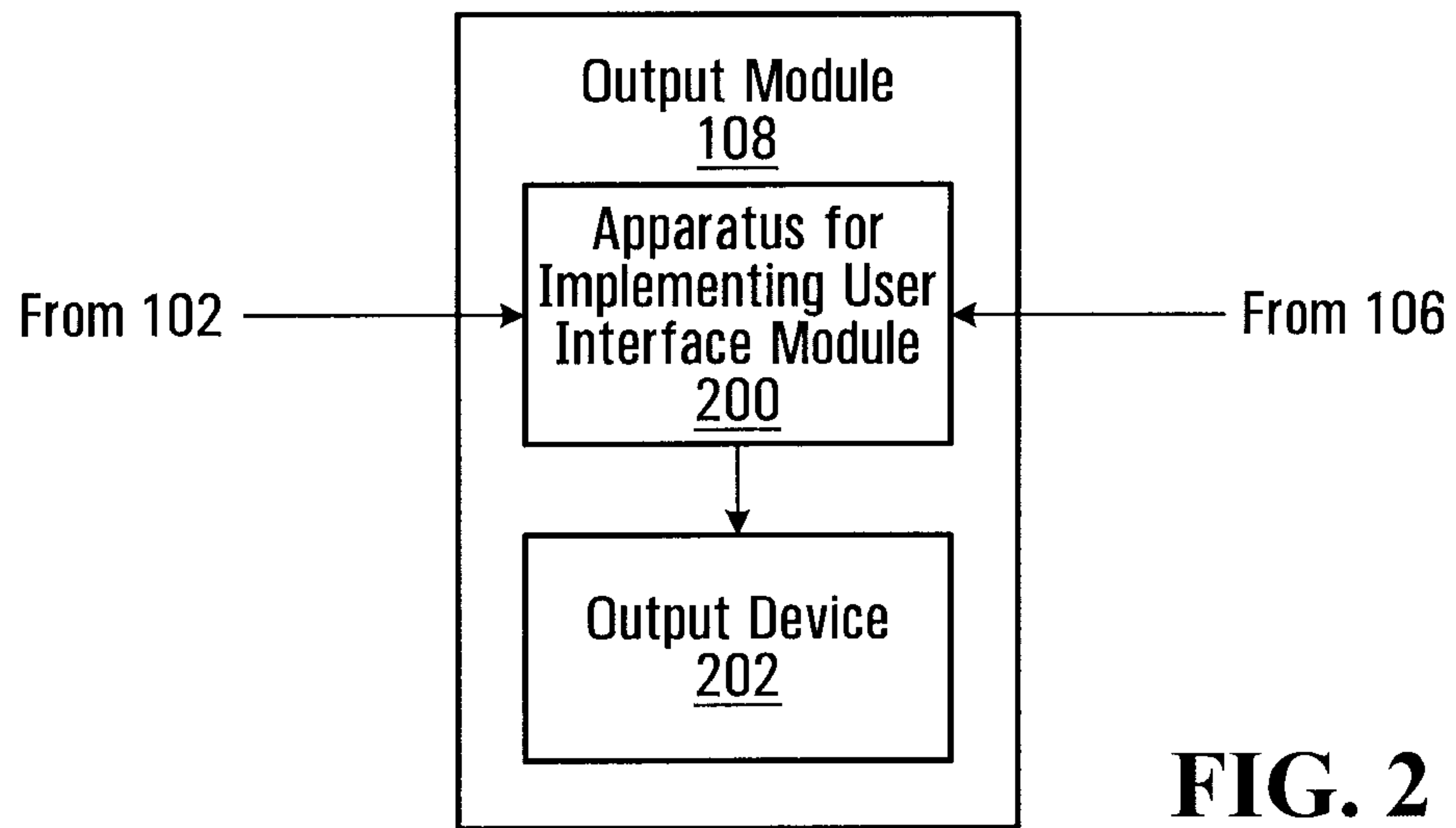


FIG. 2

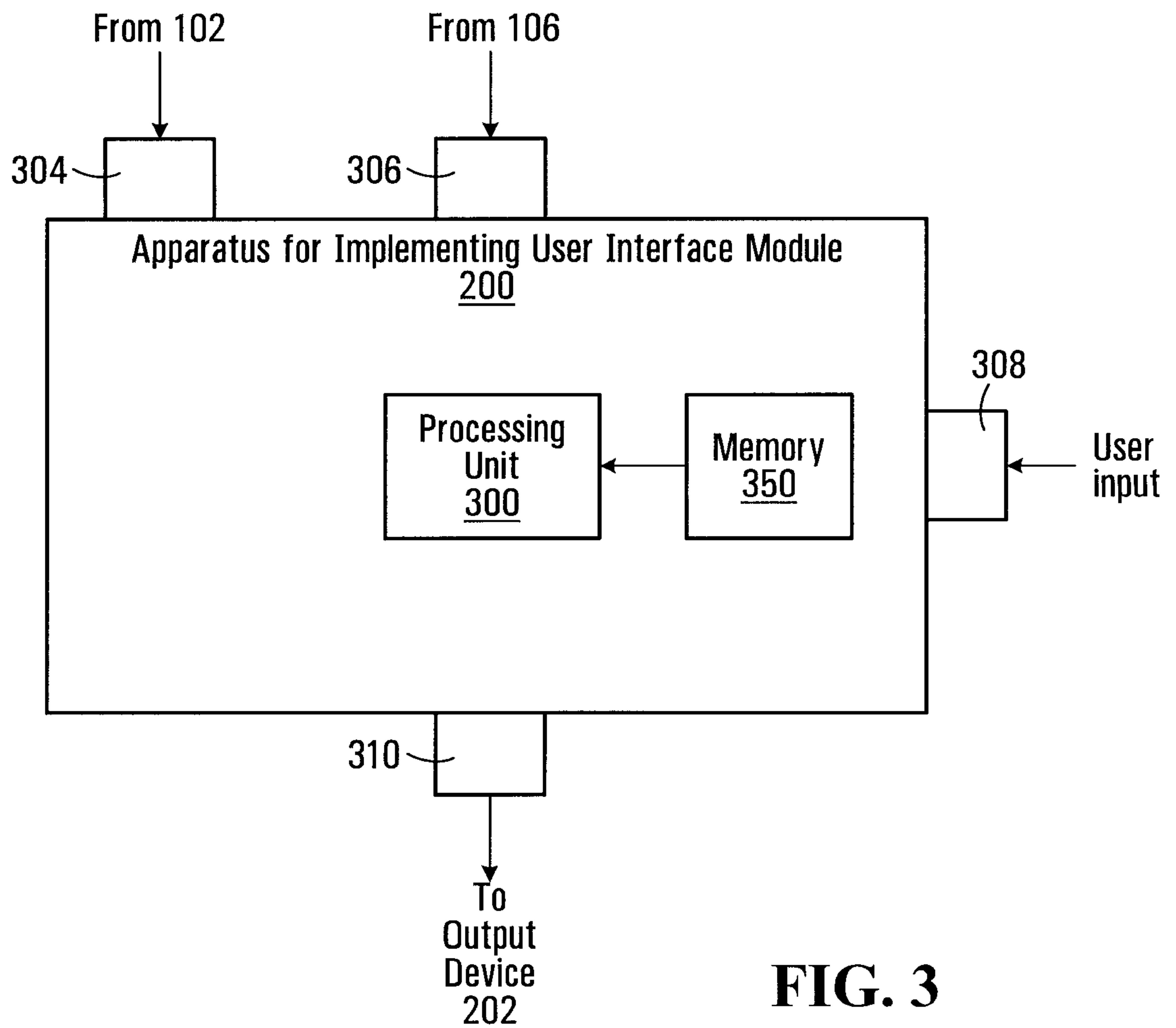


FIG. 3

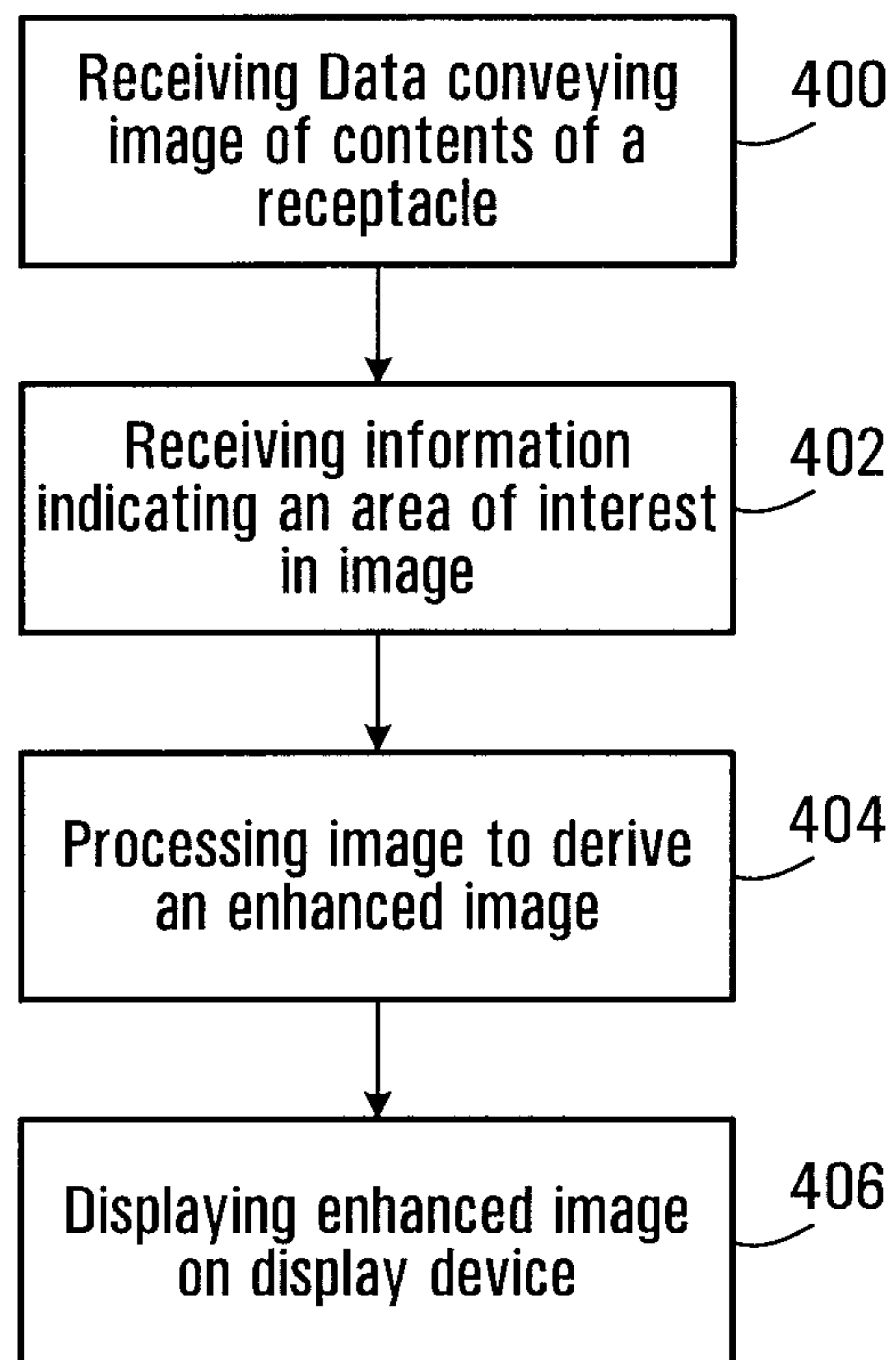
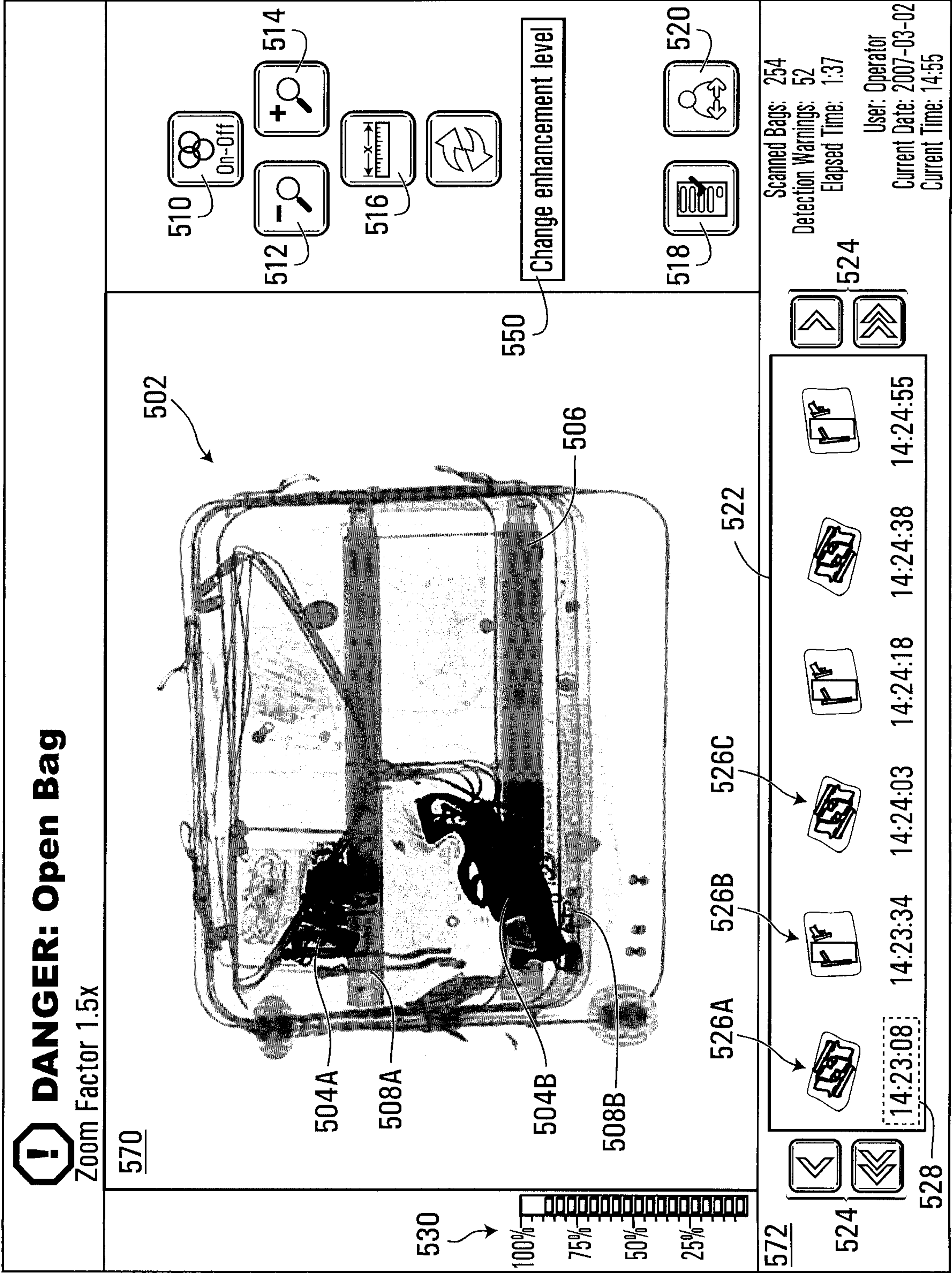


FIG. 4



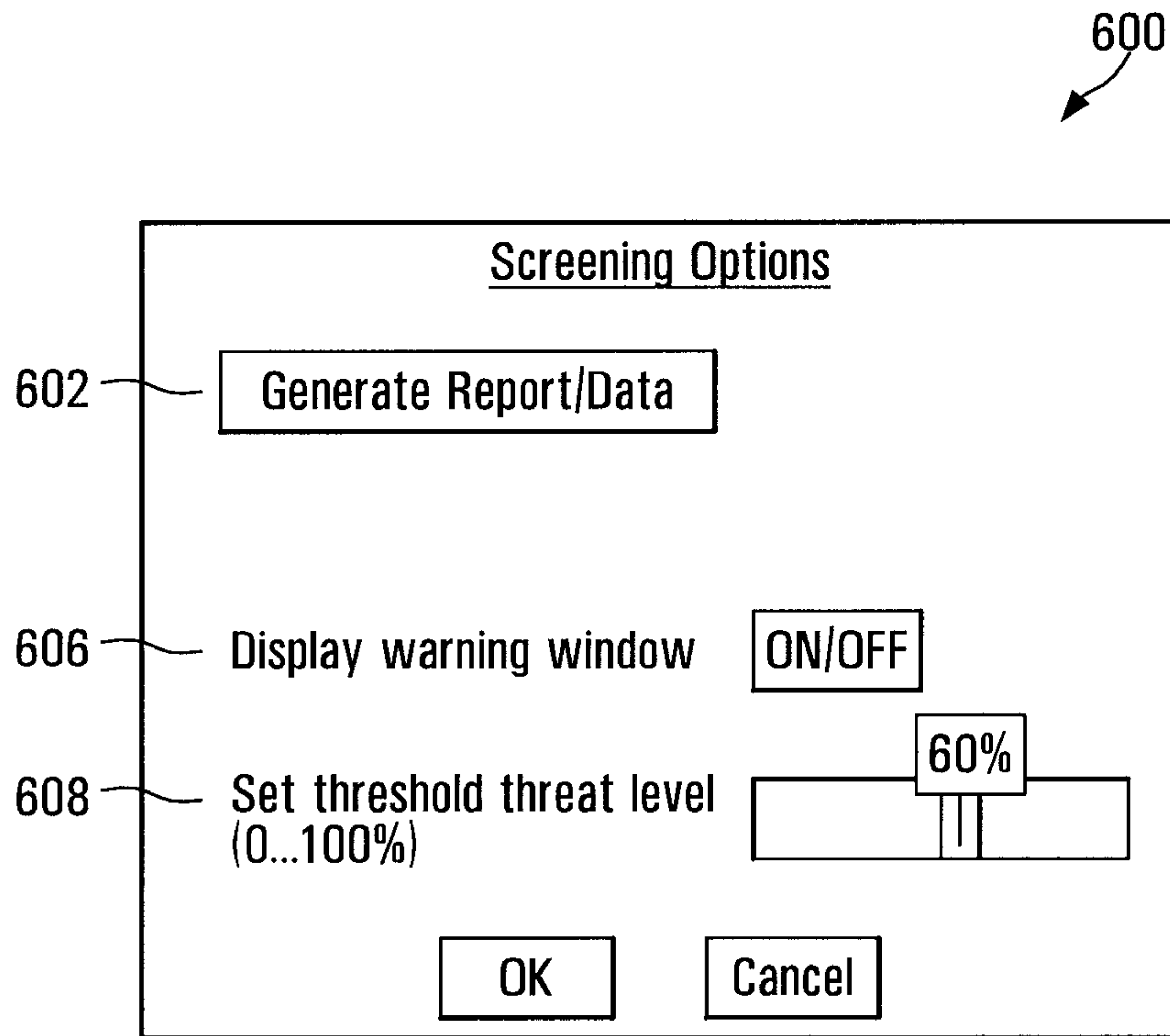
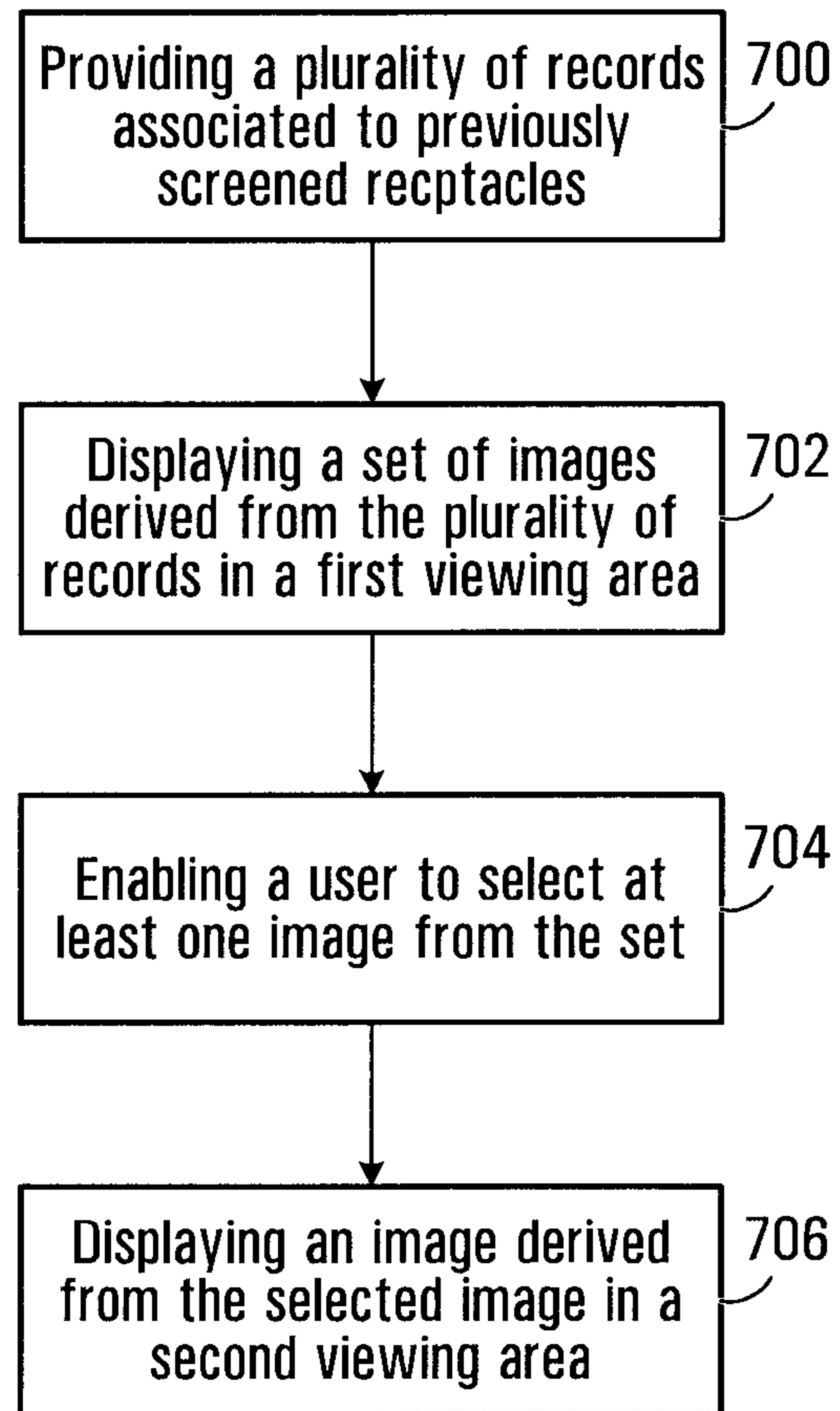
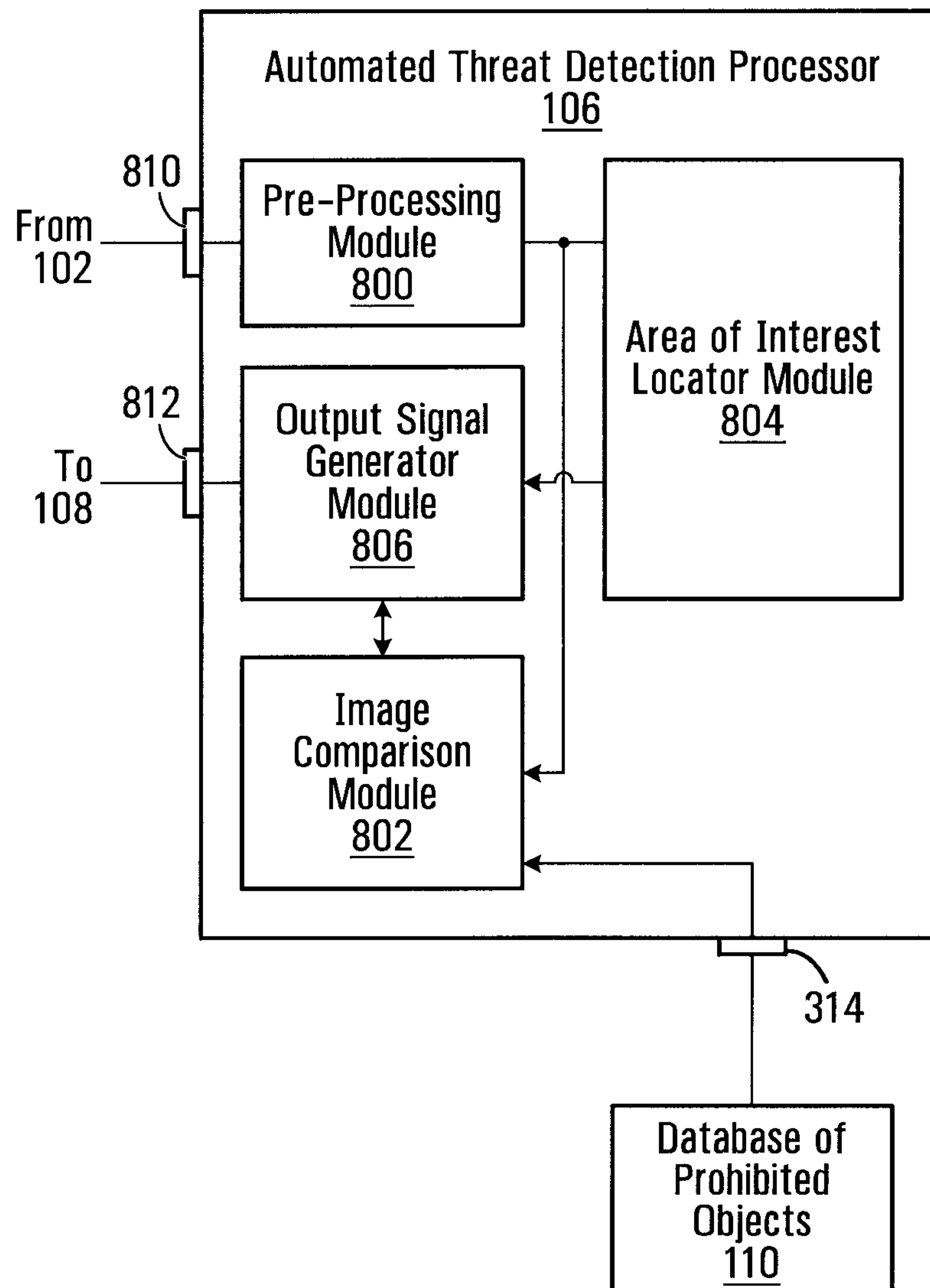


FIG. 6

**FIG. 7**

**FIG. 8**

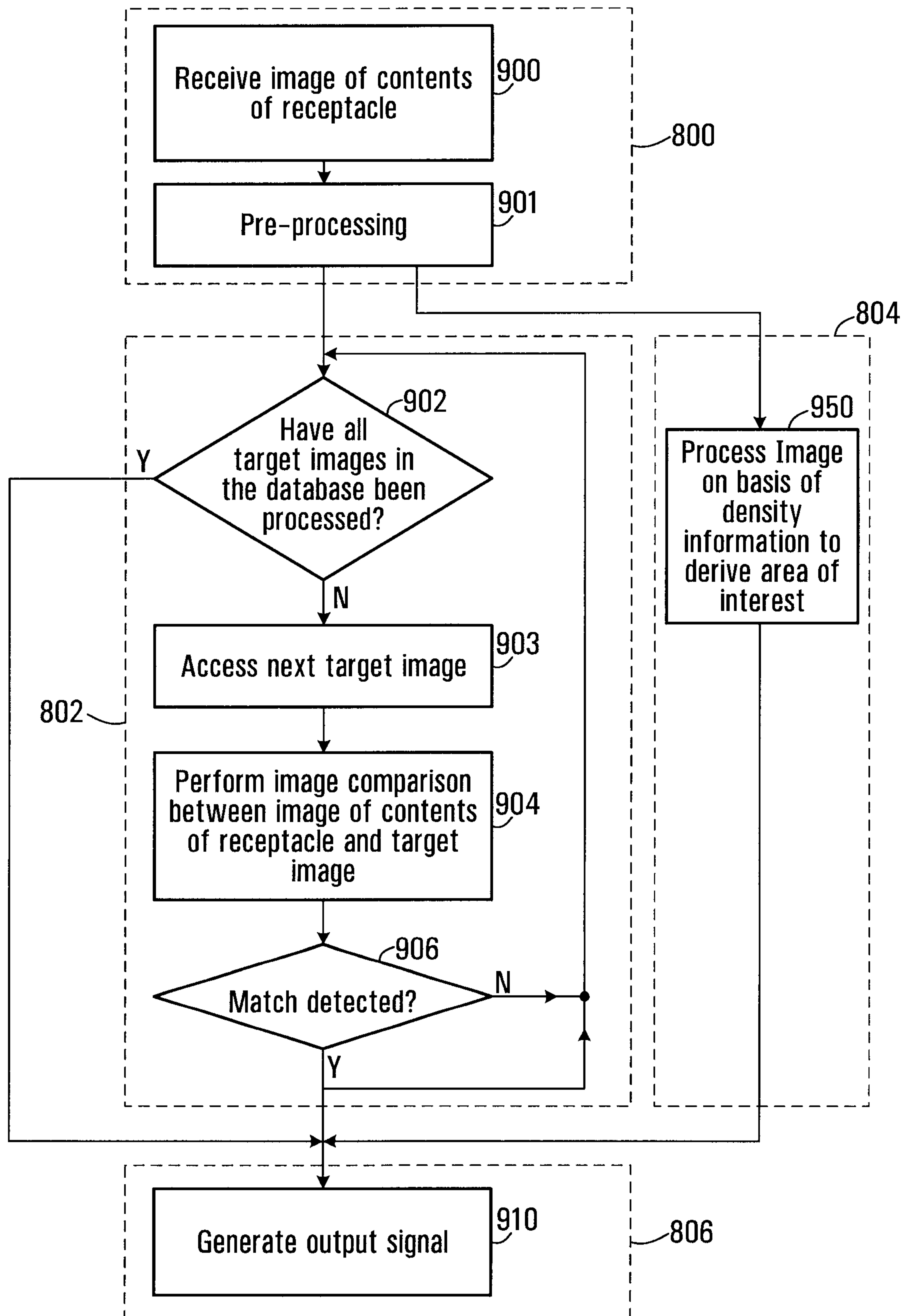


FIG. 9

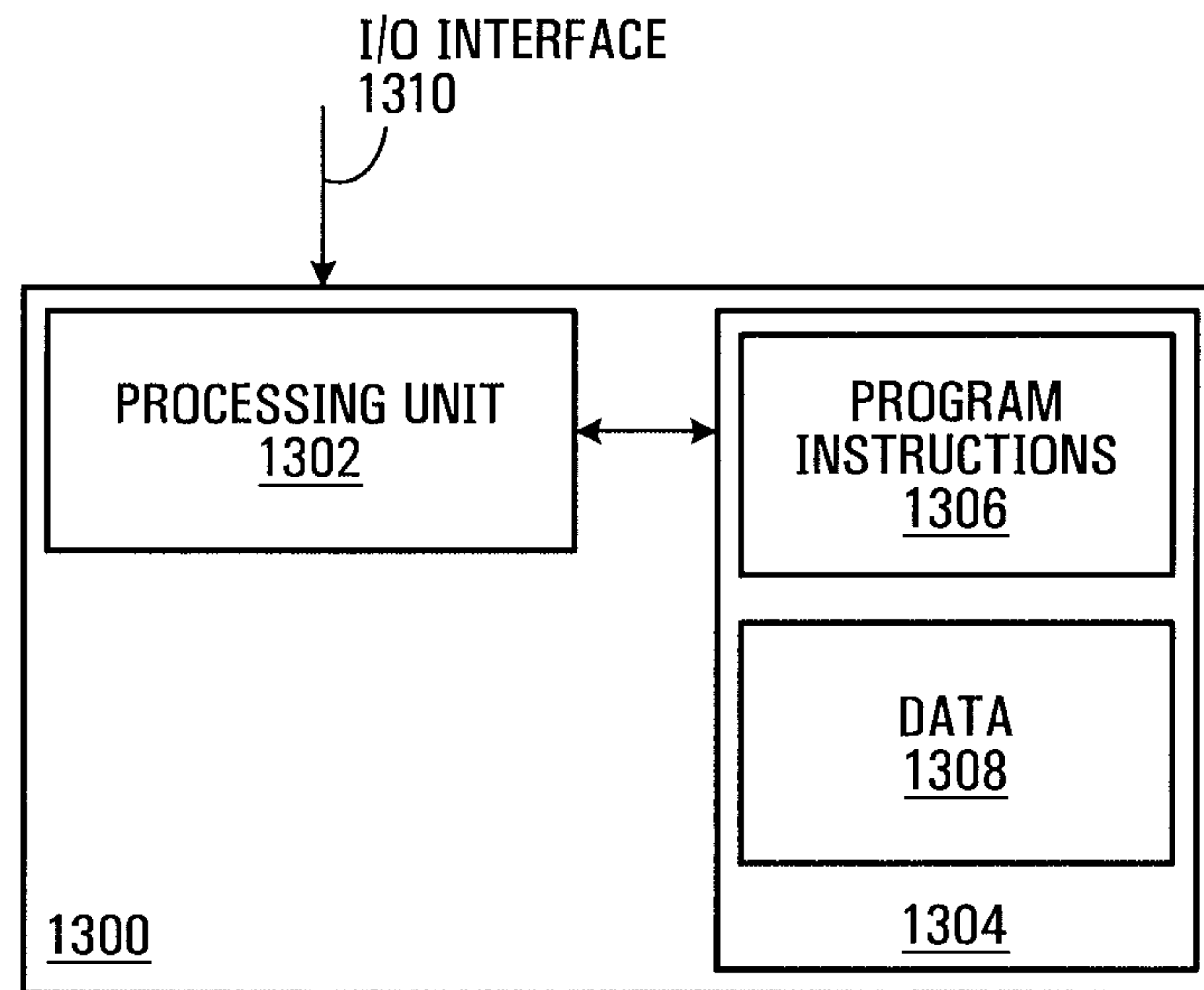


FIG. 10

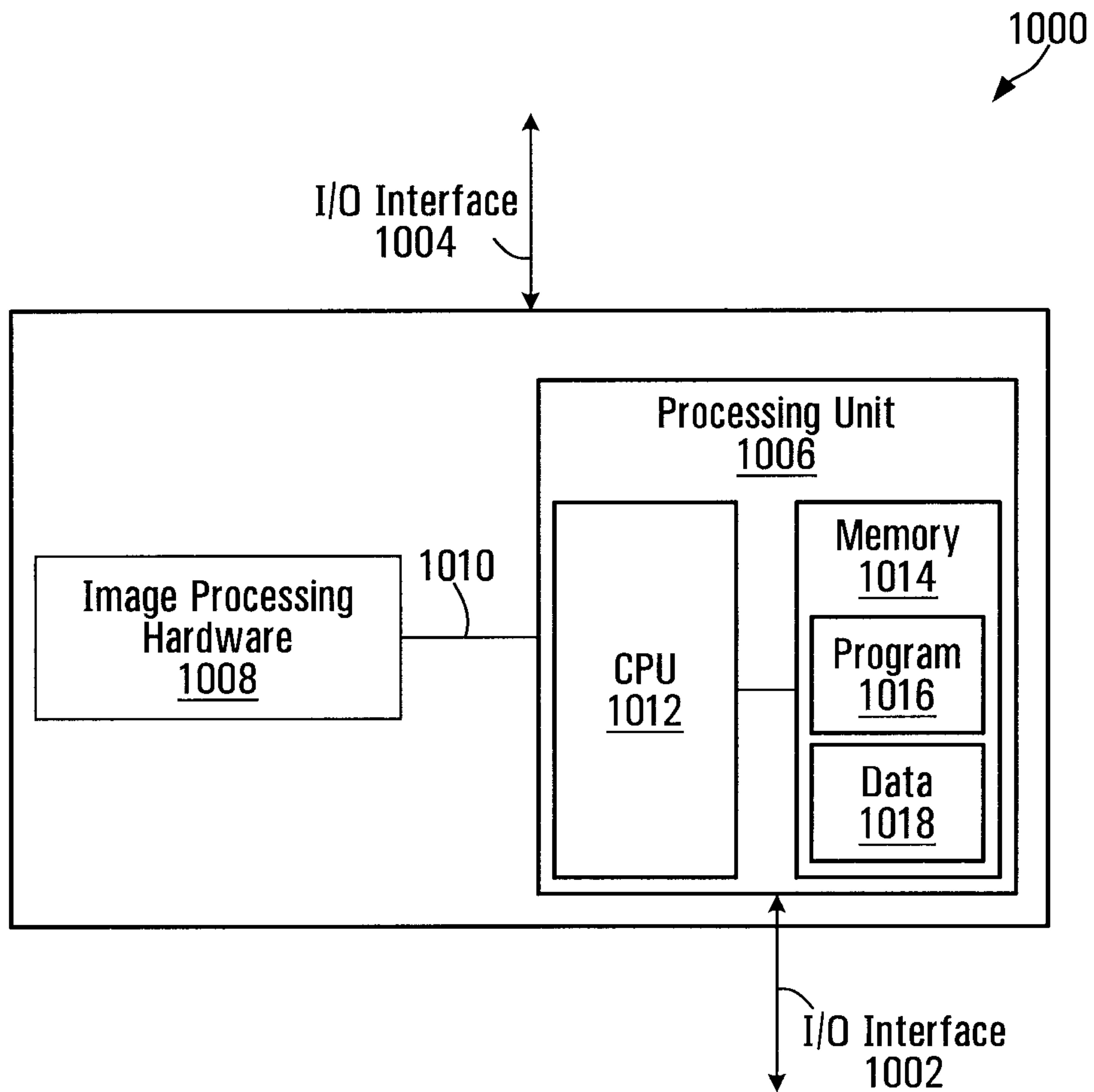


FIG. 11

+

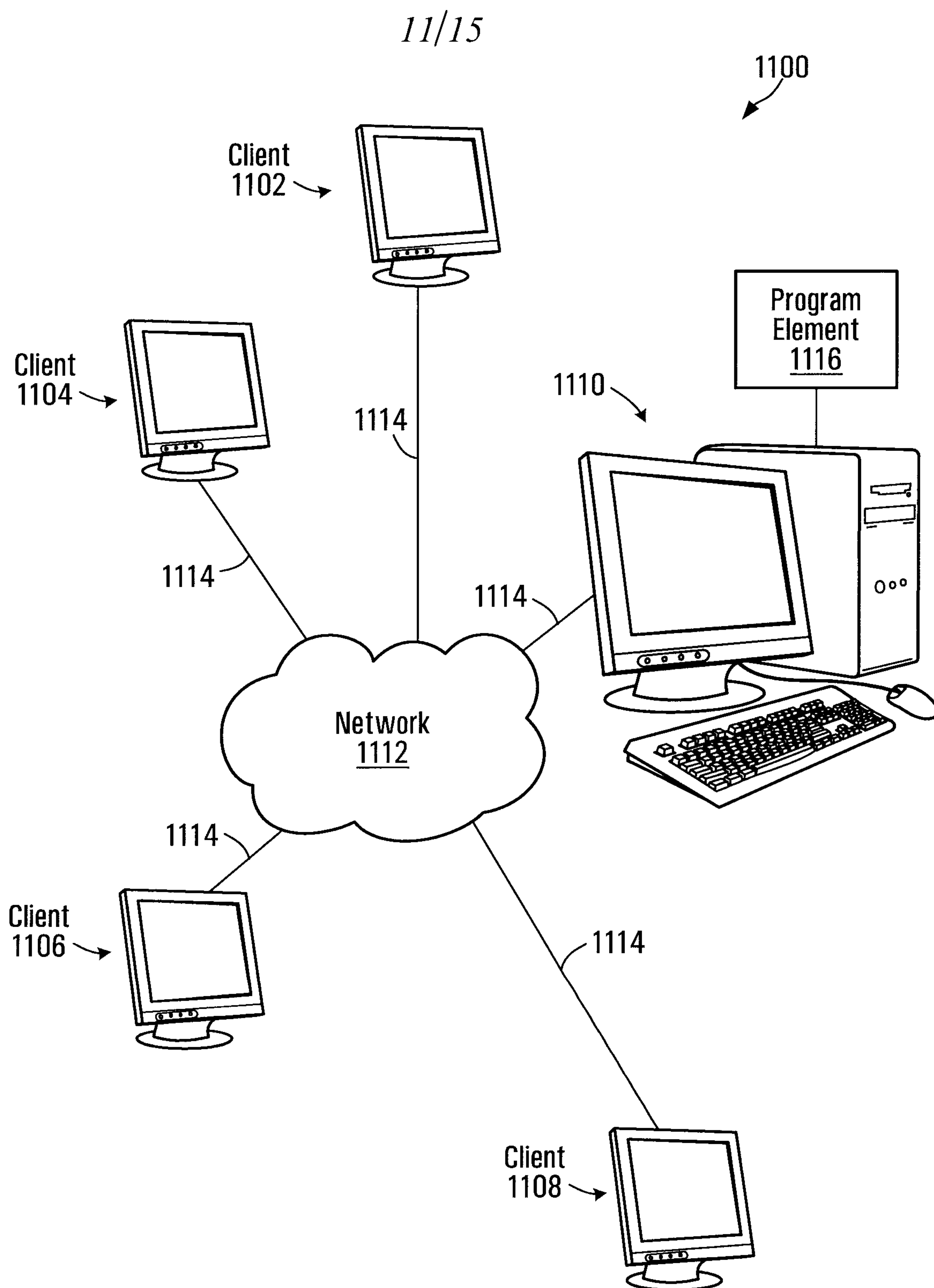


FIG. 12

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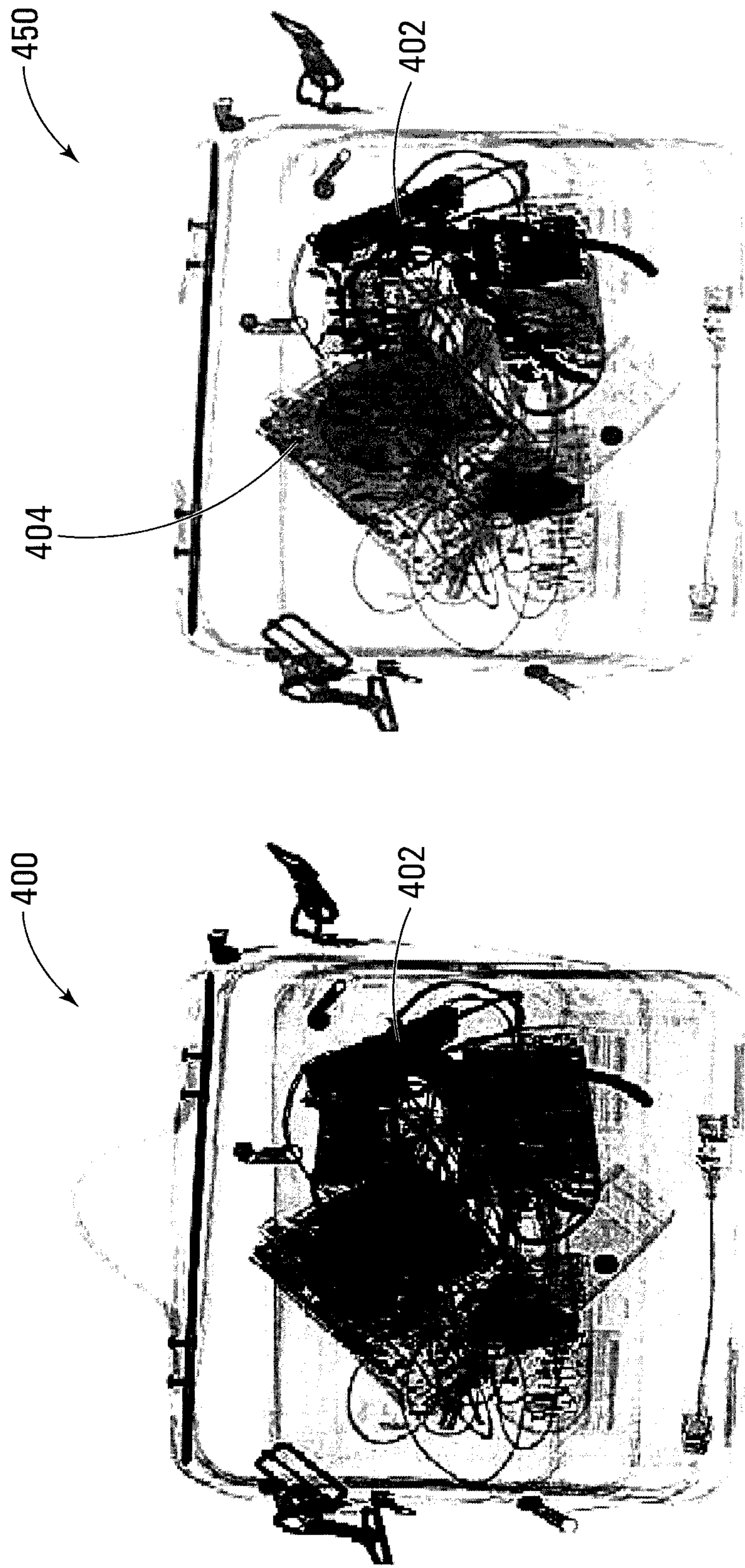


FIG. 13A

FIG. 13B



FIG. 13C

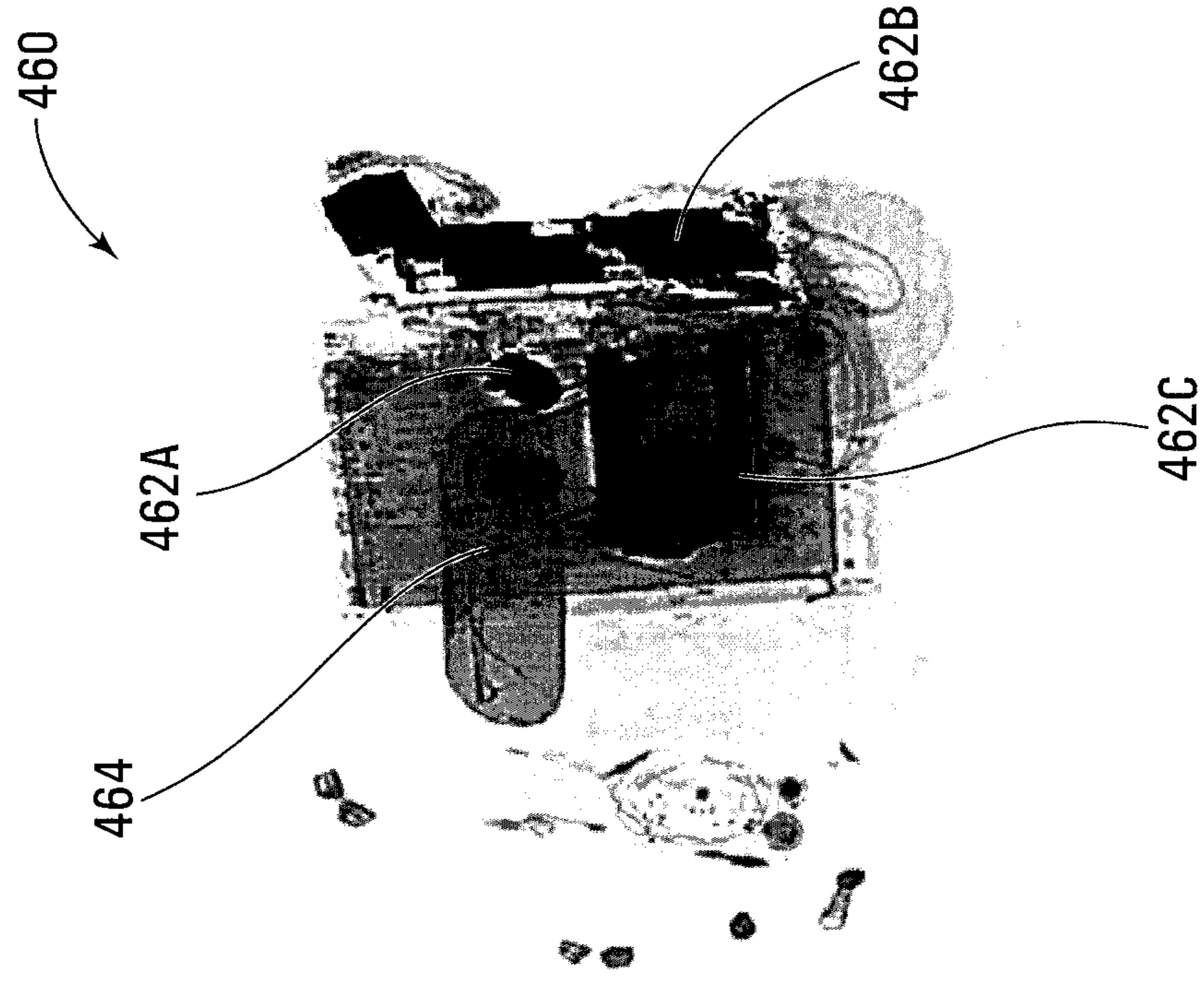


FIG. 13D

+

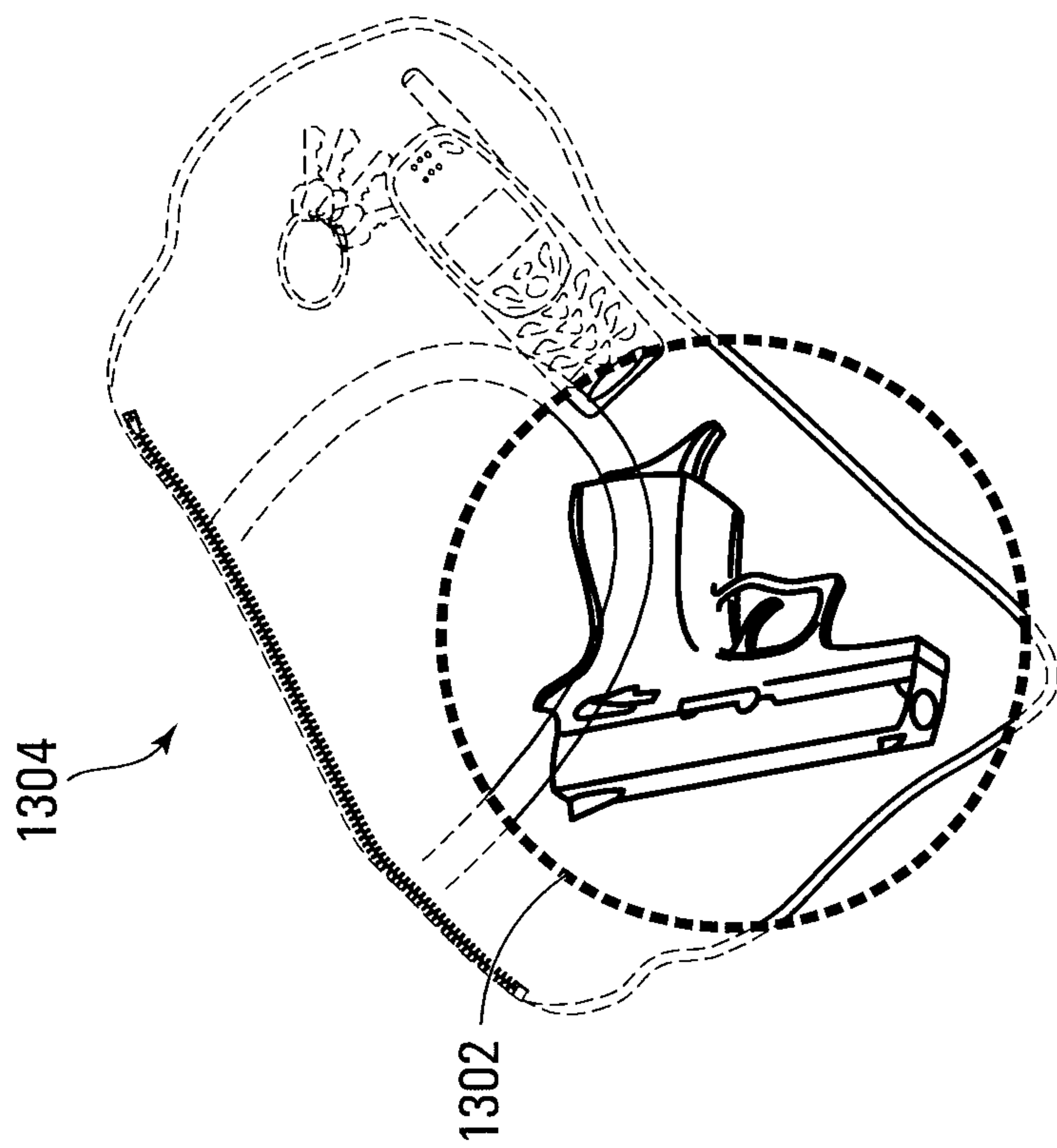


FIG. 13F

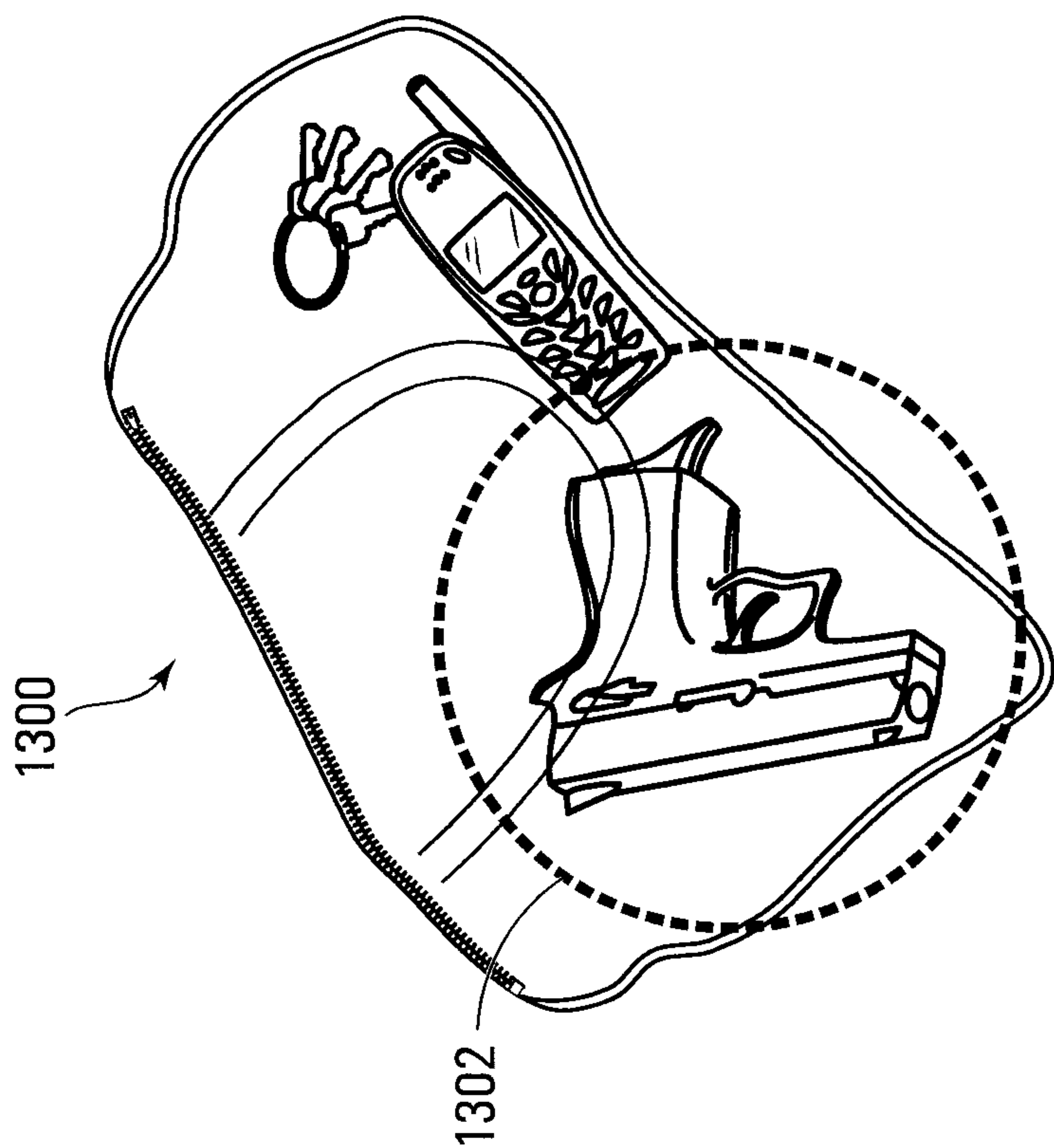
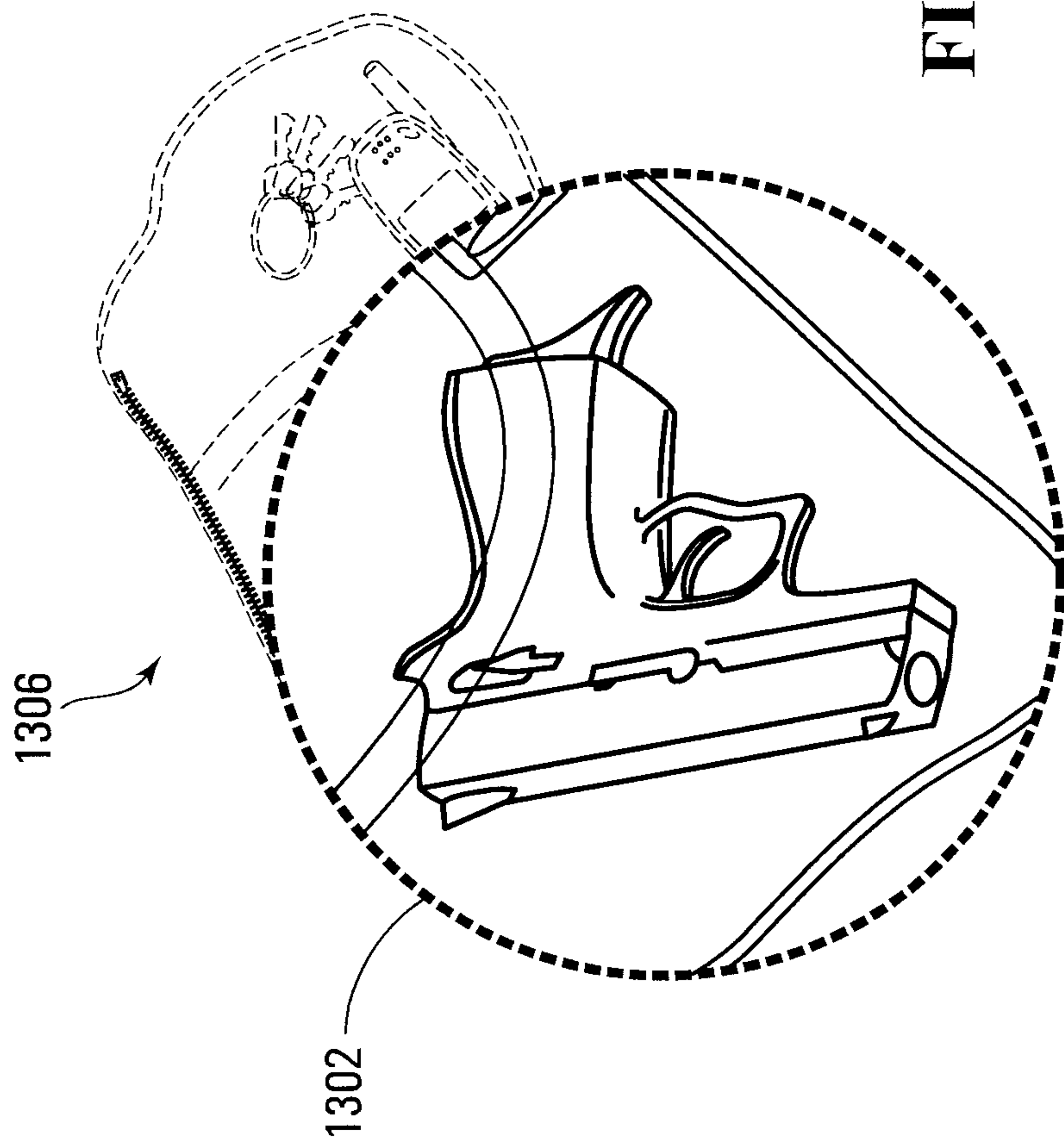


FIG. 13E

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FIG. 13G





DANGER: Open Bag

Zoom Factor 1.5x

500

570

502

504A

508A

504B

508B

506

526A

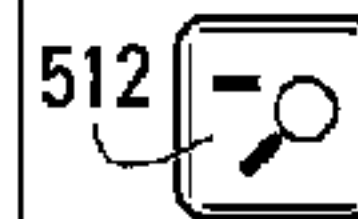
526B

526C

522



510



512



514



516



550

Change enhancement level



518



520

530

100%
75%
50%
25%

572

524



528

14:23:08

14:23:34

14:24:03

14:24:18

14:24:38

14:24:55

524



Scanned Bags: 254
Detection Warnings: 52
Elapsed Time: 1:37

User: Operator
Current Date: 2007-03-02
Current Time: 14:55