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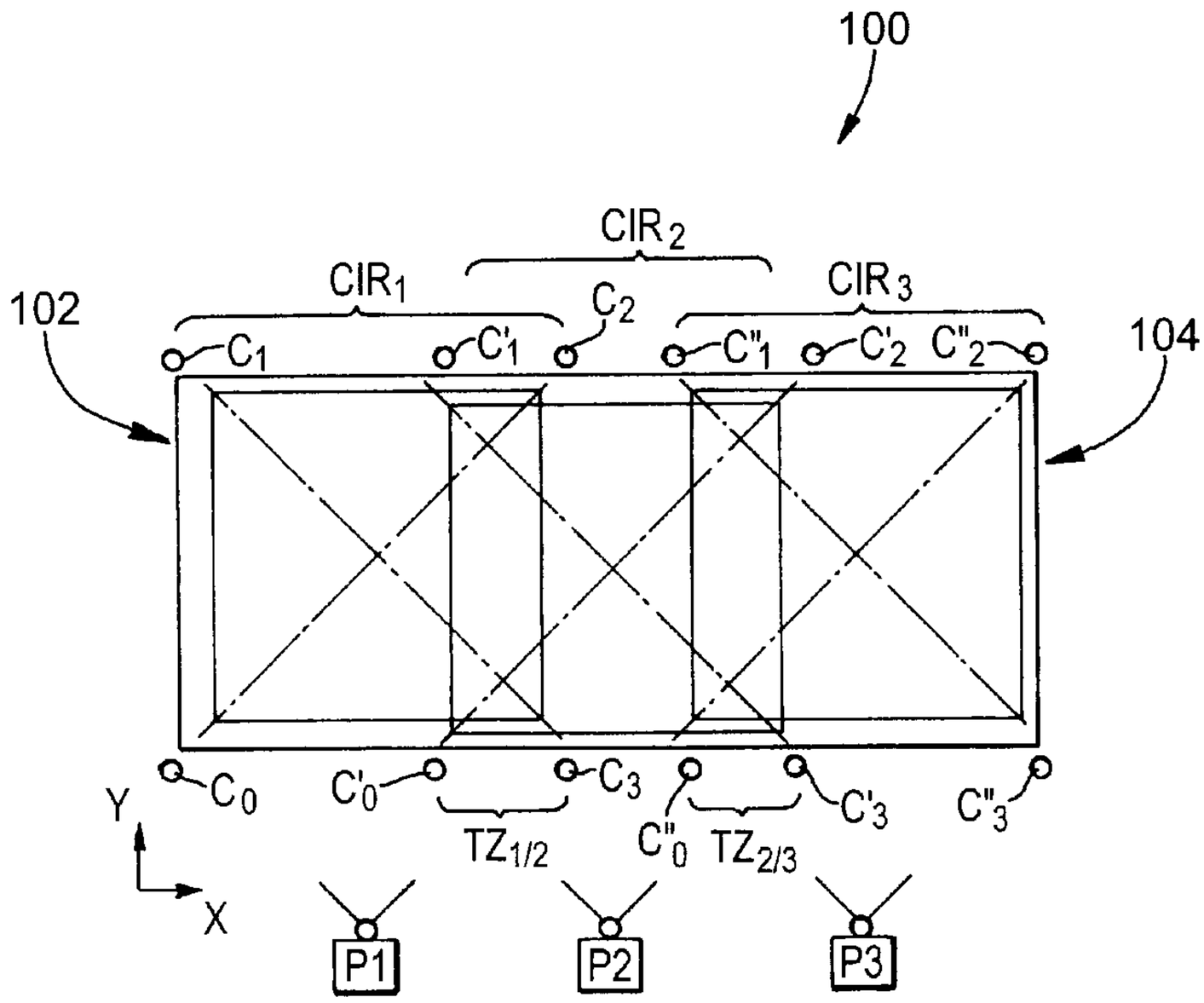

(57) Abrégé/Abstract:
A touch system (100) comprises a large scale touch surface (102) on which an image is presented and at least two imaging devices (C_0 to C''_3) looking across the touch surface and having overlapping fields of view. Processing structure (108, 110) communicates with the imaging devices and processes image data acquired by the imaging devices to determine pointer contacts on the touch surface using triangulation. The processing structure further executes at least one application to facilitate user interaction with the touch surface. Methods of interacting with the touch surface are also disclosed.

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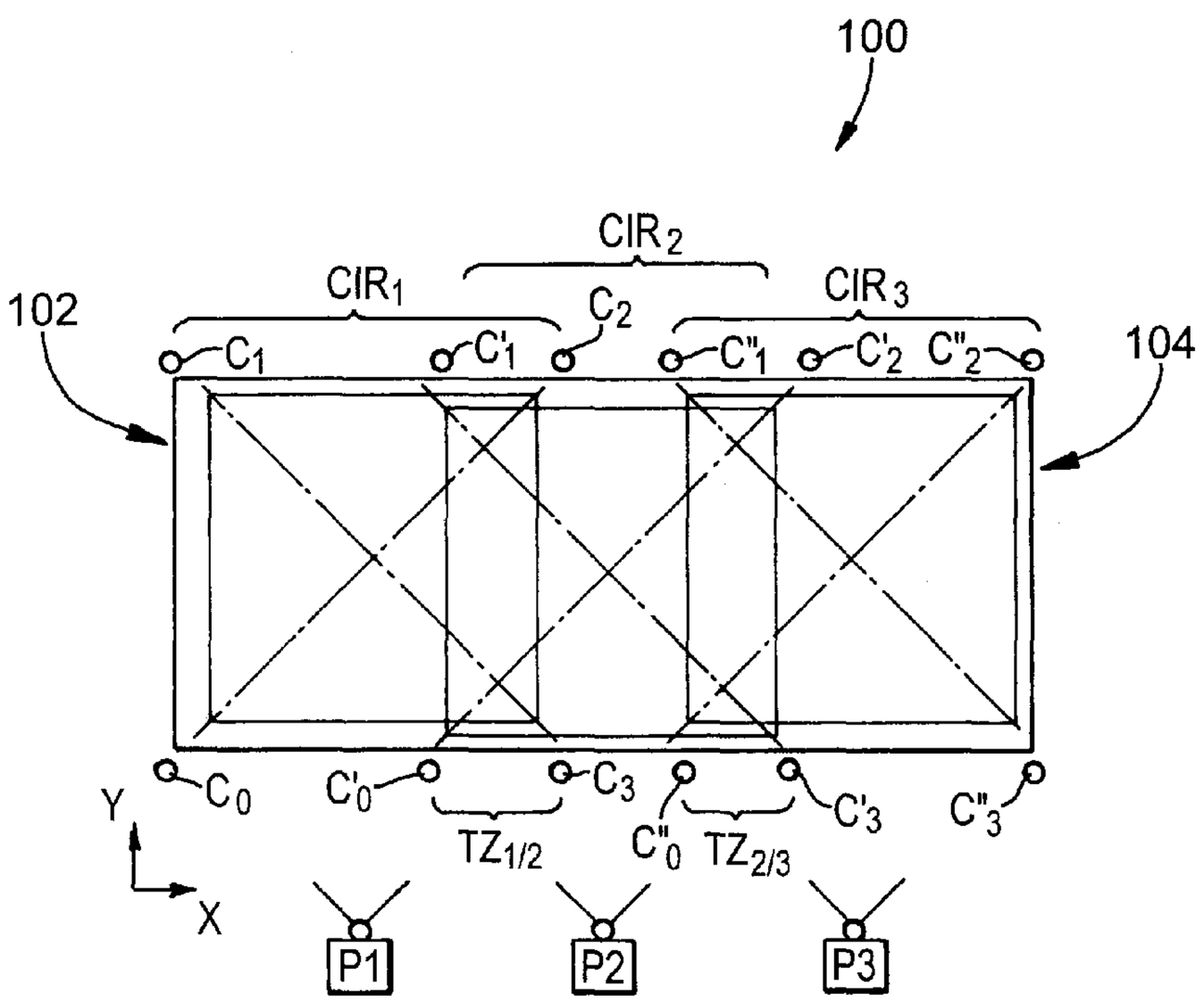

(57) Abstract: A touch system (100) comprises a large scale touch surface (102) on which an image is presented and at least two imaging devices (C_0 to C''_3) looking across the touch surface and having overlapping fields of view. Processing structure (108, 110) communicates with the imaging devices and processes image data acquired by the imaging devices to determine pointer contacts on the touch surface using triangulation. The processing structure further executes at least one application to facilitate user interaction with the touch surface. Methods of interacting with the touch surface are also disclosed.

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LARGE SCALE TOUCH SYSTEM AND METHODS FOR INTERACTING WITH THE SAME

Field of the Invention

[0001] The present invention relates generally to interactive input systems and in particular, to a large scale touch system and methods of interacting with the same.

Background of the Invention

[0002] Touch systems are well known in the art and typically include a touch screen having a touch surface on which contacts are made using a pointer in order to generate user input. Pointer contacts with the touch surface are detected and are used to generate corresponding output depending on areas of the touch surface where the contacts are made. Common touch systems utilize analog resistive, electromagnetic, capacitive, acoustic or machine vision to identify pointer interactions with the touch surface.

[0003] For example, International PCT Application No. PCT/CA01/00980 filed on July 5, 2001 and published under No. WO 02/03316 on January 10, 2002, assigned to SMART Technologies Inc., assignee of the present invention, discloses a camera-based touch system comprising a touch screen that includes a passive touch surface on which a computer-generated image is presented. A rectangular bezel or frame surrounds the touch surface and supports digital cameras at its corners. The digital cameras have overlapping fields of view that encompass and look across the touch surface. The digital cameras acquire images from different locations and generate image data. Image data acquired by the digital cameras is processed by digital signal processors to determine if a pointer exists in the captured image data. When it is determined that a pointer exists in the captured image data, the digital signal processors convey pointer characteristic data to a master controller, which in turn processes the pointer characteristic data to determine the location of the pointer in (x,y)-coordinates relative to the touch surface using triangulation. The pointer coordinate data is conveyed to a computer executing one or more applications programs. The computer uses the pointer coordinate data to update the computer-generated image that is presented on the touch surface.

Pointer contacts on the touch surface can therefore be recorded as writing or drawing or used to control execution of applications programs executed by the computer.

[0004] Although the above touch system works extremely well, since the field of view of each camera is arranged to encompass the entire touch surface, camera resolution has placed a limit on the size of the touch system that can be made.

[0005] In many environments such as in teaching institutions, large scale touch systems are desired so that visible presentations can be made to large groups. A large scale touch system created from a series of side-by-side mounted touch panels has been considered. Although this touch system provides a larger touch surface, the touch surface is not continuous due to the individual frames surrounding the touch surfaces. Also, tracking pointer movements from one touch surface to another is cumbersome and user unfriendly.

[0006] A large scale touch system that overcomes the above-noted problems is disclosed in U.S. Patent Application Serial No. 10/750,219 to Hill et al. and assigned to SMART Technologies Inc., assignee of the present invention. This large scale touch system includes a touch surface divided into a plurality of coordinate input sub-regions. The input sub-regions overlap to define a generally contiguous input surface. Each coordinate input sub-region generates pointer coordinate data in response to pointer contacts thereon. The pointer coordinate data is processed to update image data presented on the input surface. When a pointer contact is made on a coordinate input sub-region that does not overlap with an adjacent coordinate input sub-region, the coordinate input sub-region processes acquired images to derive pointer data and triangulates the position of the pointer using the derived pointer data thereby to determine the position of the pointer contact relative to the touch surface. When a pointer contact is made on a coordinate input sub-region that overlaps with an adjacent coordinate input sub-region, each overlapping coordinate input sub-regions processes acquired images to derive pointer data and triangulates the position of the pointer using the derived pointer data.

Thereafter, the triangulated positions generated by the overlapping coordinate input sub-regions are processed in accordance with defined logic thereby to determine the position of the pointer contact relative to the touch surface.

[0007] The above-noted Hill et al. large scale touch system provides a contiguous touch surface making it extremely useful in environments where the touch surface is to be viewed by larger groups. Increasing the size of the touch surface however presents challenges. Various situations can arise where a user cannot readily physically interact with the touch surface. For example, depending on the size of the touch surface and the physical size and/or condition of the user, the user may not be able to reach upper regions of the touch surface. Also, situations may arise where the user is standing to one side of the touch surface but needs to interact with image content displayed adjacent the opposite side of the touch surface. Having to walk to the opposite side of the touch surface to interact with the touch surface is inconvenient and may result in the image presented on the touch surface being disrupted or obscured. Furthermore, the size of the touch surface can make it difficult for a user to identify visually displayed objects such as modal boxes. As will be appreciated, methods of interacting with such large scale touch systems to facilitate user interaction are desired.

[0008] It is therefore an object of the present invention to provide a novel large scale touch system and methods of interacting with the same.

Summary of the Invention

[0009] Accordingly, in one aspect there is provided in a large scale touch system having a touch surface on which a displayed image is presented, a method of facilitating user interaction with said displayed image comprising:

displaying a scaled version of at least a portion of said displayed image on said touch surface at a user accessible location; and

mapping the scaled version to the corresponding portion of said displayed image so that user interactions with the scaled version are translated to interactions with said displayed image.

[0010] In one embodiment, during the displaying a scaled version of the entire displayed image is presented within a window. The window is positioned adjacent a lower portion of the touch surface. The position of the window is user adjustable.

[0011] According to another aspect there is provided in a large scale touch system having a touch surface on which a displayed image is presented, a method of facilitating user interaction with said displayed image comprising:

defining a text input region on said touch surface adjacent a user accessible location;

detecting text input into said text input region; and

displaying the detected input text in a text display region spaced from said text input region.

[0012] In one embodiment, the text display region is positioned adjacent the upper portion of the touch surface and the text input region is positioned adjacent a lower portion of the touch surface. The position of both the text input region and text display region are user adjustable.

[0013] According to yet another aspect there is provided in a large scale touch system having a touch surface, a method of positioning displayed objects presented on said touch surface comprising:

tracking movement of a user relative to said touch surface; and

positioning one or more displayed objects proximate said user.

[0014] In one embodiment, the position of the user is tracked by monitoring the position of the last touch input. Displayed objects are presented proximate to the position of the last touch input.

[0015] In an alternative embodiment, the tracking comprises capturing images of a region surrounding the touch surface and processing the captured images to determine the position of the user relative to the touch surface. Shadows cast on the touch surface can also be detected so that displayed objects are presented on the touch surface adjacent the user and outside of detected shadows.

[0016] According to still yet another aspect there is provided in a large scale touch system having a touch surface on which a displayed image is presented, a method of facilitating user interaction with said displayed image comprising:

highlighting at least one displayed object which requires user interaction to provide strong visual feedback concerning the existence of said at least one displayed object.

[0017] In one embodiment, the at least one displayed object is a modal box and the highlighting comprises applying an overlay to the displayed image. The overlay has an opening therein sized to correspond generally with the modal box and being colored to contrast sharply with the modal box thereby to highlight the modal box. In an alternative embodiment, the highlighting comprises displaying concentric rings about the modal box.

[0018] According to still yet another aspect there is provided in a large scale touch system having a touch surface on which a displayed image is presented, a method of facilitating user interaction with said displayed image comprising:

reproducing at least one region of said displayed image on said touch surface at a user accessible location; and

mapping the reproduced region to the corresponding portion of said displayed image so that user interactions with the reproduced region are translated to interactions with the corresponding portion of said displayed image.

[0019] In one embodiment, the at least one region is the upper region of the displayed image. The upper region of the displayed image is reproduced adjacent the bottom portion of the displayed image. The opposite side portions of the displayed image are also reproduced adjacent each side of the touch surface.

[0020] According to still yet another aspect there is provided in a large scale touch system having a touch surface on which a displayed image is presented, a method of facilitating user interaction with said displayed image comprising:

displaying a mouse object on said touch surface;

detecting pointer interactions on said touch surface within said mouse object; and

processing mouse events corresponding to said pointer interactions in a manner to avoid input focus being shifted to said mouse object.

[0021] During processing, mouse events are injected into the mouse event queue of the touch system operating system. The mouse object may include one or more buttons. In one embodiment, the mouse object is stationary and resembles a mouse pad. In another embodiment, the mouse object is movable across the touch surface in response to pointer interactions with the touch surface.

[0022] According to still yet another aspect there is provided in a touch system comprising:

a large scale touch surface on which an image is presented;

at least two imaging devices looking across said touch surface and having overlapping fields of view; and

processing structure communicating with said imaging devices and processing image data acquired by said imaging devices to determine pointer contacts on said touch surface using triangulation, said processing structure further executing at least one application to facilitate user interaction with said touch surface.

[0023] The interaction methods provide advantages in that a user is able to interact with the entire display area of the touch surface notwithstanding the fact that much of the touch surface may be beyond the physical reach of the user. The interaction methods also facilitate user interaction by avoiding the need for the user to move to inconvenient locations to interact with the touch surface and ensure that displayed objects requiring immediate attention by the user are clearly visible on the touch surface.

Brief Description of the Drawings

[0024] Embodiments will now be described more fully with reference to the accompanying drawings in which:

Figure 1 is a front plan view of a large scale touch system including an elongate rectangular, generally contiguous touch surface divided into a series of coordinate input sub-regions;

Figure 2 is a schematic block diagram of the touch system of Figure 1;

Figure 3 is another front plan view of the large scale touch system of Figure 1;

Figure 4 is a front plan view of the large scale touch system of Figure 1 showing a scaled desktop window displayed during execution of a scaled desktop application;

Figures 5a to 5e are front plan views of a portion of the touch surface showing a text input window and an upper text display region displayed during execution of a text input application;

Figure 6 is a front plan view of the touch surface showing a highlighted displayed modal box;

Figure 7 is a front plan view of the touch surface showing a mouse object displayed during execution of an on-screen mouse application;

Figures 8a to 8c are additional front plan views of the touch surface showing the mouse object;

Figures 9a and 9b are flowcharts showing the steps performed during handling of mouse events during execution of the on-screen mouse application;

Figure 10 is a front plan view of the touch surface showing a relative mouse pad object displayed during execution of a relative mouse pad application; and

Figures 11a and 11b are additional front plan views of the relative mouse pad.

Detailed Description of the Embodiments

[0025] Turning now to Figures 1 and 2, a large scale interactive touch system of the type described in U.S. Patent Application No. 10/750,219 to Hill et al. filed on January 2, 2004, assigned to SMART Technologies, Inc., assignee of the present invention, the content of which is incorporated herein by reference, is shown and is generally identified by reference numeral 100. Touch system 100 includes an elongate generally rectangular and contiguous touch surface 102 surrounded by an illuminated bezel 104. Illuminated bezel 104 provides infrared backlighting across the touch surface 102.

[0026] A plurality of sets 106 of cameras, in this example three sets 106 of cameras, is associated with the touch surface 102. The sets 106 of cameras are positioned along the length of the touch surface 102. Each set 106 of cameras includes four cameras arranged to define the corners of a rectangle. The cameras of each set 106 have overlapping fields of view oriented to look across a portion of the touch surface 102 thereby to define a touch or coordinate input sub-region. Thus, in the present embodiment, the sets 106 of cameras define a series of three side-by-side coordinate input sub-regions CIR_1, CIR_2 and CIR_3 respectively. The fields of view of the cameras are also oriented so that the coordinate input sub-regions defined by adjacent sets of cameras overlap to define two transition zones $TZ_{1/2}$ and $TZ_{2/3}$ respectively.

[0027] Each set 106 of cameras communicates with a master controller 108. Each master controller 108 processes pointer characteristic data received from its associated set 106 of cameras to determine the positions of pointers appearing in images captured by the cameras in (x,y)-coordinates using triangulation. The master controllers 108 transmit the pointer coordinate data to a computer 110 allowing the computer 110 either to record the pointer coordinate data as writing or drawing or use the pointer coordinate data as a mouse event to control execution of an applications program executed by the computer 110. The computer 110 provides image data to a series of projectors P_1 to P_3, which in turn project images onto the touch surface 102. The image data is updated by the computer 110 in response to

received pointer coordinate data so that the images projected onto the touch surface 102 reflect the pointer activity.

[0028] Each projector is associated with a different coordinate input sub-region and projects an image thereon. As can be seen, projector P_1 projects an image I_1 onto coordinate input sub-region CIR_1, projector P_2 projects an image I_2 onto coordinate input sub-region CIR_2 and projector P_3 projects an image I_3 onto coordinate input sub-region CIR_3. The projected images I_1, I_2 and I_3 are aligned and joined seamlessly along vertical lines generally at the mid-points of the transition zones $TZ_{1/2}$ and $TZ_{2/3}$ to provide a smooth and continuous image spanning the touch surface 102. In the present embodiment, the computer 110 executes a desktop application. Each coordinate input sub-region is associated with and tied to a specific section of the desktop. As a result, the computer 110 provides image data to the projectors P_1 to P_3 so that the appropriate desktop sections are displayed on the coordinate input sub-regions.

[0029] A tool tray 112 is also associated with each coordinate input sub-region. Each tool tray 112 holds a number of pointers or tools (not shown) having different assigned attributes. In this case, each tool tray holds a number of colored pens as well as an eraser. When a tool is lifted from the tool tray, the tool tray 112 provides a signal to the associated master controller 108 which in turn conveys the signal to the computer 110 to identify the selected tool. In this manner, when a colored pen is used to contact the touch surface 102, writing in the appropriate color tracking the pen movement is projected onto the touch surface. When an eraser is used to contact the touch surface 102 writing projected onto the touch surface over which the eraser is moved is erased. As is known, the desktop application can be conditioned to assign properties to pointers used to contact each coordinate input sub-region.

[0030] Each coordinate input sub-region is divided into four quadrants using diagonal lines extending between the cameras at opposite corners of the coordinate input sub-region. Image capture to permit pointer tracking within each quadrant is the responsibility of a different pair of cameras in the

set. The top quadrant Q_T is the responsibility of the bottom left and bottom right cameras in the set, the bottom quadrant Q_B is the responsibility of the top left and top right cameras in the set, the left quadrant Q_L is the responsibility of the top left and bottom left cameras in the set and the right quadrant Q_R is the responsibility of the top right and bottom right cameras in the set.

[0031] When a pointer contacts a quadrant within one of the coordinate input sub-regions outside of a transition zone, the images captured by the pair of cameras assigned to that quadrant are processed by the cameras and the associated master controller 108 in the manner described in U.S. Patent No. 6,954,197 to Morrison et al., assigned to SMART Technologies Inc., assignee of the present invention, the content of which is incorporated by reference. In this manner, a bounding box surrounding the pointer contact is determined allowing the location of the pointer in (x,y)-coordinates with respect to the coordinate input sub-region to be calculated. Thus, in this case only one master controller 108 reports pointer coordinate data to the computer 110. The computer 110 in turn records the pointer coordinate data as writing or drawing if the pointer contact is a write event or injects the pointer coordinate data into the active applications program being run by the computer 110 if the pointer contact is a mouse event.

[0032] In general to determine if a pointer contact is a write or mouse event, the tool type and point of first contact is examined. If a drawing tool is used to make the contact and the contact is within a designated writing area within the projected desktop section, the pointer contact is treated as a write event; otherwise the pointer contact is treated as a mouse event.

[0033] When a pointer contacts the touch surface 102 within a transition zone, the master controllers 108 associated with the two sets of cameras that observe the transition zone generate pointer coordinates in the same manner referenced above and convey the generated pointer coordinates to the computer 110. Upon receipt of the two reported pointer coordinates, the computer 110 uses defined logic, in this case a weighted averaging technique, to yield a single (x,y)-coordinate pair representing the position of the pointer contact. The computer 110 in turn records the pointer

coordinate data as writing or drawing if the pointer contact is a write event or injects the pointer coordinate data into the active applications program being run by the computer 110 if the pointer contact is a mouse event.

[0034] When a user interacts with the touch surface, due to the size of the touch surface, displayed objects with which the user needs to interact may be beyond the reach of the user requiring the user to move across the front of the touch surface to a location near the displayed objects. This of course can be problematic as the projected images can be interrupted and/or the view of the touch surface obscured. Displayed objects may also be difficult to see due to the size of the touch surface 102.

[0035] To overcome this problem, a number of different interaction methods can be invoked to facilitate user interaction with the large scale touch surface 102. The interaction methods supported by the large scale touch system 102 will now be described.

Scaled Desktop

[0036] As mentioned above, in many instances portions of the displayed image with which the user must interact are beyond the reach of the user. To deal with this problem, a scaled desktop application stored on the computer 110 can be invoked in response to an associated input gesture. For example, the input gesture may require the user to touch the touch surface 102 with two fingers close together and then move the fingers apart generally horizontally in opposite directions. Alternatively, the input gesture may require the user to touch the touch surface 102 with a finger and then move the finger back and forth generally horizontally within a short time frame.

[0037] When the scaled desktop application is invoked, a scaled version of the entire image projected on the touch surface 102 is displayed within a small window 200 either adjacent the location of the input gesture or a suitable lower portion of the touch surface as shown in Figure 4. In this example, the window 200 is approximately one square foot and is displayed adjacent the bottom edge of the touch surface 102 at a location that is easily accessed by the user. When a user wishes to interact with displayed image

presented on the touch surface 102, the user simply needs to interact with the scaled version of the displayed image within the window 200. Touches and interactions with the scaled image in the window 200 are mapped to the larger image projected on the touch surface 102. In this manner, the user is only required to interact with the small area within the window 200 in order to interact with the entire area of the touch surface. The mapping of the window 200 to the touch surface is achieved via a rectangular coordinate transformation. Assuming the touch surface 102 has dimensions SW and SH and the window 200 is at TX and TY has dimensions TW and TH, coordinates X, Y within the window 200 can be mapped to touch surface coordinates as follows:

$$SX = (TX - X) / TW \times SW$$

$$SY = (TY - Y) / TH \times SH$$

[0038] As will be appreciated, the scaled desktop application facilitates user interaction with the entire touch surface 102 including regions of the touch surface 102 that typically are beyond the reach of the user.

Text Input

[0039] When the user is interacting with a designated writing area within the projected image, the user can invoke a text input application stored on the computer 110 to enable the user to place text in the designated writing area at hard to reach locations. In response to a user input command to invoke the text input application, a text box window 250 is opened and presented adjacent a lower bottom corner of the touch surface 102. The text box window 250 is linked to an upper text display region 252 adjacent the top edge of the touch surface 102. When a character is written into the text box window 250 and entered via a mouse command, the written character is recognized by the computer 110, injected into the text display region 252 and presented in the image displayed on the touch surface 102. Figures 5a to 5e show the text box window 250 with the characters “h”, “e”, “l”, “l” and “o” injected into the upper text display region 252. The position of the text box window 250 can be manipulated by the user allowing the text box window 250

to be positioned at basically any desired location on the touch surface 102. Likewise, the text display region 252 linked to the text box window 250 can be manipulated by the user to allow it to be positioned at basically any desired location on the touch surface 102.

Intelligent Displayed Object Determination

[0040] The position of displayed objects such as toolbars, pop-up windows etc. on the touch surface 102 is important as not all areas of the touch surface are immediately accessible to the user. To help ensure displayed objects are displayed at convenient locations, a variety of methods for intelligently displaying objects can be employed by the touch system 100.

[0041] The various methods for intelligently displaying objects are based on user position relative to the touch surface 102. In this manner, as the user moves relative to the touch surface, so do the locations of displayed objects helping to ensure that displayed objects remain at conveniently accessible locations on the touch surface 102.

[0042] In one embodiment, when a displayed object is to be presented on the touch surface 102, the displayed object is presented at a location proximate to the last mouse event input via the touch surface 102 taking into account the position of the touch surface edges and other presented objects such as windows and toolbars. In this case, it is assumed that a user typically will not move great distances in between mouse interactions with the touch surface 102.

[0043] In another embodiment, the extended fields of view of the cameras C are utilized. Images captured by the cameras that are processed to detect pointer interactions with the touch surface 102 are also processed to locate the position of the user relative to the touch surface 102. The user's position as seen by the cameras is then used to position displayed objects so that the displayed objects are presented at a location proximate to the user. Using the extended fields of view of the cameras is however limited since it requires the user to remain within the fields of view of the cameras.

[0044] In yet another embodiment, an auxiliary stand-alone camera (not shown) or a projector with a built-in auxiliary camera that is positioned in front of or behind the touch surface 102 is used to capture images that are processed by the computer 110 to detect the position of the user relative to the touch surface 102. The auxiliary camera may be one used for purposes of video conferencing or security. The user's position as seen by the auxiliary camera is used to position displayed objects so that the displayed objects are presented at a location proximate to the user. This allows displayed objects to track movement of the user. If desired, images captured by the auxiliary camera can be further processed to detect shadows cast on the touch surface 102 and to present displayed objects on the touch surface 102 at locations proximate the user and outside of cast shadows.

Modal Box Display

[0045] As the touch surface 102 is large, some displayed objects presented on the touch surface 102 may be difficult to detect visually. Depending on the nature of the displayed object, not being able to see the displayed object may create user frustration. For example, when a modal box is displayed, the user is inhibited from interacting with the application running on computer 110 until the modal box is answered. If the user is unaware of the existence of the modal box, frustration can arise as the user struggles with the application that has become unexpectedly disabled. To assist a user to visually identify modal boxes or the like, when a modal box 300 is presented on the touch surface 102, a dark overlay 302 is also presented on the touch surface 102 that has a hole cut in it corresponding in size and shape to the modal box as shown in Figure 6. The overlay 302 may also include holes for sub-dialog boxes, tool-tips and other graphical information that may need to be visible to the user to enable the user to answer the modal box 300. The overlay 302 provides strong visual feedback to the user to ensure that the modal box 300 is easily identified on the touch surface 102.

[0046] Presentation of the modal box 300 on the touch surface 102 is detected by a listener application running on the computer 110. When the

user answers with the modal box, the overlay 302 is immediately removed. If desired, when a modal box is to be presented on the touch surface 102, the modal box can be presented on the touch surface at a location adjacent the position of the user using one of the intelligent displayed object methods described above.

[0047] Alternatively, different visual feedback to highlight the modal box may be used. For example, the existence of a displayed modal box may be highlighted by presenting concentric circles of narrowing diameter around the modal box similar to a radar "ping".

Voice Recognition

[0048] If desired, the touch system 100 may make use of voice recognition to allow the user to use voice commands to interact with the touch surface 102. In this case, the computer 110 executes XP voice recognition software. A microphone (not shown) coupled to the computer 110 is also provided to pick-up user input voice commands. To simplify menu selection, voice command menus are provided that can be pulled down allowing the user to read the appropriate voice command to be entered. In this manner, files can be opened, closed and manipulated via voice input avoiding the need for the user to interact physically with the entire touch surface 102. Input voice commands can also be entered to control the projectors P_1 to P_3 or to change the nature of the tool (i.e. pen or eraser) being used to input touch commands.

[0049] In this embodiment, the voice recognition feature is enabled and disabled dynamically through a specified touch command to allow discussions in the vicinity of the touch system 100 to be carried out without inadvertently activating a voice command.

Intelligent Mouse

[0050] When using a mouse on a personal computer or the like, the mouse has a hover mode which allows the user to determine when the mouse is positioned over a target displayed object. This facilitates user interaction

with displayed objects. Unfortunately in touch systems generally and especially in the large scale touch system 100, mouse position feedback is lost making it difficult for a user to determine when the mouse is positioned over a target displayed object.

[0051] To deal with this loss of feedback, the computer 110 can be conditioned to execute an intelligent mouse application. When a mouse down event is received, the location of the mouse down event is examined to determine if the mouse down event is proximate a viable target displayed object. In this example, a proximate viable target displayed object is one that is positioned within five (5) pixels of the mouse down event. If the mouse down event is proximate a viable target displayed object, the mouse down event is automatically moved to the position of the viable target displayed object and the displayed cursor is moved to the position of the target displayed object. Depending on the nature of the displayed object, the cursor may or may not be locked to the displayed object. For example, if the mouse event is adjacent a window border, the cursor is not locked to the window border as it is assumed that the mouse down event is to resize the window. When the position of the mouse moves beyond a threshold distance from the target displayed object, the mouse down event and cursor are released.

On Screen Control

[0052] The large scale touch system 100 can also be conditioned to invoke one or more of a number of on-screen control applications to facilitate user interaction with hard to reach areas of the touch surface 102. These on-screen control applications include an absolute mirror mode application, a relative mouse pad application, an on-screen mouse application and a relative mouse application.

[0053] When the on-screen mouse application is invoked, a mouse object 350 is presented adjacent the bottom of the touch surface 102 as shown in Figure 7. The mouse object 350 is similar to a standard mouse and has right, left and center buttons 352 to 356 respectively. When a pointer contact on the body 358 of the mouse object 350 is made, the mouse object

can be moved by dragging the pointer across the touch surface 102 resulting in corresponding movement of the cursor across the touch surface. This allows the user to position the cursor at any desired location on the touch surface 102. When a pointer contact is made with on the right, left or center button, right click, left click or center click mouse events based on the cursor position relative to the touch surface 102 are generated.

[0054] If the user drags the mouse object 350 to a border of the displayed image and contact between the pointer and the mouse object is lost, the mouse object 350 is automatically re-centered mimicking the re-centering behaviour of a conventional mouse pad. If a drag operation is being performed as a result of a left click operation and the automatic re-centering takes place, the left click operation remains locked when the mouse object 350 is re-centered allowing the drag operation to be continued. If the user performs a click operation and drags the mouse object using the pointer, the mouse object 350 remains stationary and the cursor moves within the boundary of the mouse object tracking the pointer movement.

[0055] To avoid contact with the displayed mouse object 350 affecting the mouse of the computer operating system and interfering with operating system window input focus, mouse events resulting from pointer interactions with the mouse object are injected into the operating system mouse queue thereby to inhibit input focus from shifting to the mouse object. This is achieved in a manner similar to that described in U.S. Patent No. 6,741,267 to van Ieperen, assigned to SMART Technologies Inc., assignee of the present invention, the content of which is incorporated herein by reference.

[0056] For example, Figure 8a shows the mouse object 350 where a pointer contact has been made on the body 358 of the mouse object and the pointer has been dragged to the left resulting in the mouse object 350 moving across the touch surface 102 to the left. Figure 8b shows the mouse object 350 where a pointer contact has been made on the body 358 of the mouse object and the pointer has been dragged to the right and up resulting in the mouse object 350 moving across the touch surface 102 to the right and up. Figure 8c shows the mouse object 350 where a pointer contact has been

made on the left button 352 and the pointer has been dragged up and to the left resulting in a drag operation to the left and up.

[0057] Figures 9a and 9b are flowcharts showing the manner by which mouse object events are handled. When a pointer contact is made on the touch surface 102, a check is made to determine whether the pointer contact occurs within the mouse object (step 500). If so, the mouse object is examined to determine if it is in a mouse down condition (step 502). If so, a mouse flag is set (step 504) and the contact event is sent to the on-screen mouse application to enable the mouse contact to be processed (step 506) as will be described. If the mouse object is not in a mouse down condition, the mouse flag is cleared (step 508) and the mouse event is sent to the operating system mouse queue (step 510).

[0058] At step 500, if the contact event occurs outside of the mouse object, a check is made to determine if the mouse flag is set (step 512). If not, the mouse event is sent to the operating system mouse queue (step 510). If the mouse flag is set, the contact event is sent to the on-screen mouse application for processing (step 514).

[0059] When a contact event is sent to the on-screen mouse application, the contact event is examined to determine its type (step 520). If the contact event is a contact up event, the x,y coordinates of the contact up event location are scaled (step 522) and the contact up event is sent to the operating system mouse queue (step 524).

[0060] If the contact event is a mouse move event, the x,y coordinates of the mouse move are scaled (step 526) and the mouse move event is sent to the operating system mouse queue (step 528).

[0061] If the contact event is a mouse down event, the location of the pointer contact is saved (step 530) and the area of the mouse object on which the pointer contact is made is examined (step 532). If the left button is contacted, left button down and left button up events are generated (steps 534 and 536). The x,y coordinates of the pointer contact are then scaled (step 538) and the left click mouse events are sent to the operating system mouse queue (step 540). If the right button is contacted, right button down

and right button up events are generated (steps 542 and 544). The x,y coordinates of the pointer contact are then scaled (step 538) and the right click mouse events are sent to the operating system mouse queue (step 540). If the middle mouse button is contacted, middle button down and middle button up events are generated (steps 550 and 552). The x,y coordinates of the pointer contact are then scaled (step 538) and the middle click mouse events are sent to the operating system mouse queue (step 540). If the mouse body is contacted, mouse move events are generated (steps 560 and 562). The x,y coordinates of the pointer contact are then scaled (step 538) and the mouse move event is sent to the operating system mouse queue (step 540).

[0062] When the relative mouse pad application in invoked, a mouse pad object 600 is presented adjacent the bottom of the touch surface 102 as shown in Figure 10. The mouse pad object 600 is similar to the mouse pad on a laptop computer and includes a left button 602, a right button 604 and, a center button 606 a stroke input area 608. When a user strokes the input area 608 with a pointer, the pointer movement is used to move the cursor across the touch surface 102. When a pointer contact is made on either the right, left or center button, right click, left click and center click mouse events based on the cursor position relative to the touch surface are generated. The mouse events are handled in a manner similar to that described above with reference to the on-screen mouse application. For example, Figure 11a shows the mouse pad object 600 where a pointer contact is made on the input area 608 and the pointer is dragged across the input area. This results in the cursor moving across the touch surface 102 in the direction of pointer movement. The further the pointer is dragged, the faster the cursor is moved. Figure 11b shows the mouse pad object 600 where a pointer contact has been made on the right button 604.

[0063] The absolute mirror mode application is invoked in response to actuation of a toggle button displayed at the bottom corner of the touch surface 102. When the toggle button is actuated and the absolute mirror mode is invoked, the portion of the displayed image adjacent the top edge of

the touch surface 102 is reproduced and mirrored adjacent the bottom edge of the touch surface 102. The reproduced portion of the displayed image is mapped to its corresponding portion of the displayed image using a rectangular coordinate transformation. When the user contacts the touch surface in the reproduced portion of the displayed image, the contact is mapped to its corresponding portion of the touch surface 102 allowing the user to interact easily with the top portion of the touch surface. If the displayed image is updated in response to the user contact, updates occurring in the top portion of the displayed image are redrawn in the reproduced portion of the displayed image appearing adjacent the bottom of the touch surface. If opposite sides of the touch surface 102 display different user interactable objects, the sides of the touch surface can be mirrored.

[0064] When the relative mouse application is invoked, when a contact is made on the touch surface, the initial contact is treated as a reference point for the cursor. Each subsequent contact with the touch surface results in the cursor being moved a set distance from the previous cursor position in the direction of the contact. Mouse clicks are generated by making consecutive stationary contacts.

[0065] A number of tools are described above to facilitate user interaction with a large scale touch system. Those of skill in the art will appreciate that the large scale interactive touch system may include any one or various combinations of the above described interactive tools.

[0066] Although embodiments have been described with reference to the figures, those of skill in the art will also appreciate that variations and modifications may be made without departing from the spirit and scope thereof as defined by the appended claims.

What is claimed is:

1. In a large scale touch system having a touch surface on which a displayed image is presented, a method of facilitating user interaction with said displayed image comprising:

displaying a scaled version of at least a portion of said displayed image on said touch surface at a user accessible location; and

mapping the scaled version to the corresponding portion of said displayed image so that user interactions with the scaled version are translated to interactions with said displayed image.

2. The method of claim 1 wherein during displaying, a scaled version of the entire displayed image is presented within a window.

3. The method of claim 2 wherein said window is positioned adjacent a lower portion of said touch surface.

4. The method of claim 3 wherein the position of said window is user adjustable.

5. In a large scale touch system having a touch surface on which a displayed image is presented, a method of facilitating user interaction with said displayed image comprising:

defining a text input region on said touch surface adjacent a user accessible location;

detecting text input into said text input region; and

displaying the detected input text in a text display region spaced from said text input region.

6. The method of claim 5 wherein said text display region is positioned adjacent an upper portion of said touch surface.

7. The method of claim 6 wherein said text input region is positioned adjacent a lower portion of said touch surface.

8. The method of claim 7 wherein the position of at least one of said text input region and text display region is user adjustable.

9. The method of claim 8 wherein the position of each of said text input region and text display region is user adjustable.

10. In a large scale touch system having a touch surface, a method of positioning displayed objects presented on said touch surface comprising:

tracking movement of a user relative to said touch surface; and

positioning one or more displayed objects proximate said user.

11. The method of claim 10 wherein the position of the user is tracked by monitoring the position of the last touch input, displayed objects being presented proximate to the position of the last touch input.

12. The method of claim 10 wherein said tracking comprises capturing images of a region surrounding said touch surface and processing the captured images to determine the position of said user relative to said touch surface.

13. The method of claim 12 wherein said processing further comprising detecting shadows cast on said touch surface, displayed objects being presented on said touch surface adjacent said user and outside of detected shadows.

14. In a large scale touch system having a touch surface on which a displayed image is presented, a method of facilitating user interaction with said displayed image comprising:

highlighting at least one displayed object which requires user interaction to provide strong visual feedback concerning the existence of said at least one displayed object.

15. The method of claim 14 wherein said at least one displayed object is a modal box.

16. The method of claim 15 wherein said highlighting comprises applying an overlay to said displayed image, said overlay having an opening therein sized to correspond generally with said modal box and being colored to contrast sharply with said modal box thereby to hightlight said modal box.

17. The method of claim 15 wherein said highlighting comprises displaying concentric rings about said modal box.

18. In a large scale touch system having a touch surface on which a displayed image is presented, a method of facilitating user interaction with said displayed image comprising:

reproducing at least one region of said displayed image on said touch surface at a user accessible location; and

mapping the reproduced region to the corresponding portion of said displayed image so that user interactions with the reproduced region are translated to interactions with the corresponding portion of said displayed image.

19. The method of claim 18 wherein said at least one region is the upper region of said displayed image.

20. The method of claim 19 wherein said upper region of said displayed image is reproduced adjacent the bottom portion of said displayed image.

21. The method of claim 20 wherein the opposite side portion of said displayed image is reproduced adjacent each side of said touch surface.

22. In a large scale touch system having a touch surface on which a displayed image is presented, a method of facilitating user interaction with said displayed image comprising:

displaying a mouse object on said touch surface;

detecting pointer interactions on said touch surface within said mouse object; and

processing mouse events corresponding to said pointer interactions in a manner to avoid input focus being shifted to said mouse object.

23. The method of claim 22 wherein said processing comprises injecting mouse events into the mouse event queue of the touch system operating system.

24. The method of claim 23 wherein said mouse object includes at least one button.

25. The method of claim 24 wherein said mouse object is stationary and resembles a mouse pad.

26. The method of claim 24 wherein said mouse object is moveable across said touch surface in response to pointer interactions with said touch surface.

27. A touch system comprising:

a large scale touch surface on which an image is presented;

at least two imaging devices looking across said touch surface and having overlapping fields of view; and

processing structure communicating with said imaging devices and processing image data acquired by said imaging devices to determine pointer contacts on said touch surface using triangulation, said processing structure further executing at least one application to facilitate user interaction with said touch surface.

28. A touch system according to claim 27 wherein said at least one application is a scaled desktop application, during execution of said desktop application, said processing structure causing a scaled version of said image to be presented in a smaller window, said smaller window being mapped to said touch surface to enable a user to interact with said touch surface via pointer contact within said smaller window.

29. A touch system according to claim 27 wherein said at least one application is a text input application, during execution of said text input application, said processing structure causing a text input region to be presented on said touch surface that is linked to a text display region of said touch surface spaced from said text input region, text entered into said text input region through pointer contacts therein being injected and displayed in said text display region.

30. A touch system according to claim 27 wherein said at least one application is a user tracking application, during execution of said user tracking application, said processing structure tracking movement of said user and causing objects in said image to be displayed proximate to said user location.

31. A touch system according to claim 27 wherein said at least one application is an object highlighting application, during execution of said highlighting application, said processing structure visually highlighting selected displayed objects to make said selected displayed objects visually distinct.

32. A touch system according to claim 27 wherein said at least one application is a displayed image mirror application, during execution of said displayed image mirror application, said processing structure reproducing at least one portion of said displayed image at a user accessible location, said reproduced portion being mapped to a corresponding portion of said displayed image.

33. A touch system according to claim 27 wherein said at least one application is a mouse object application, during execution of said mouse object application, said processing structure displaying a mouse object on said touch surface and detecting pointer interactions on said mouse object and processing resulting mouse events while avoiding input focus shifting to said mouse object.

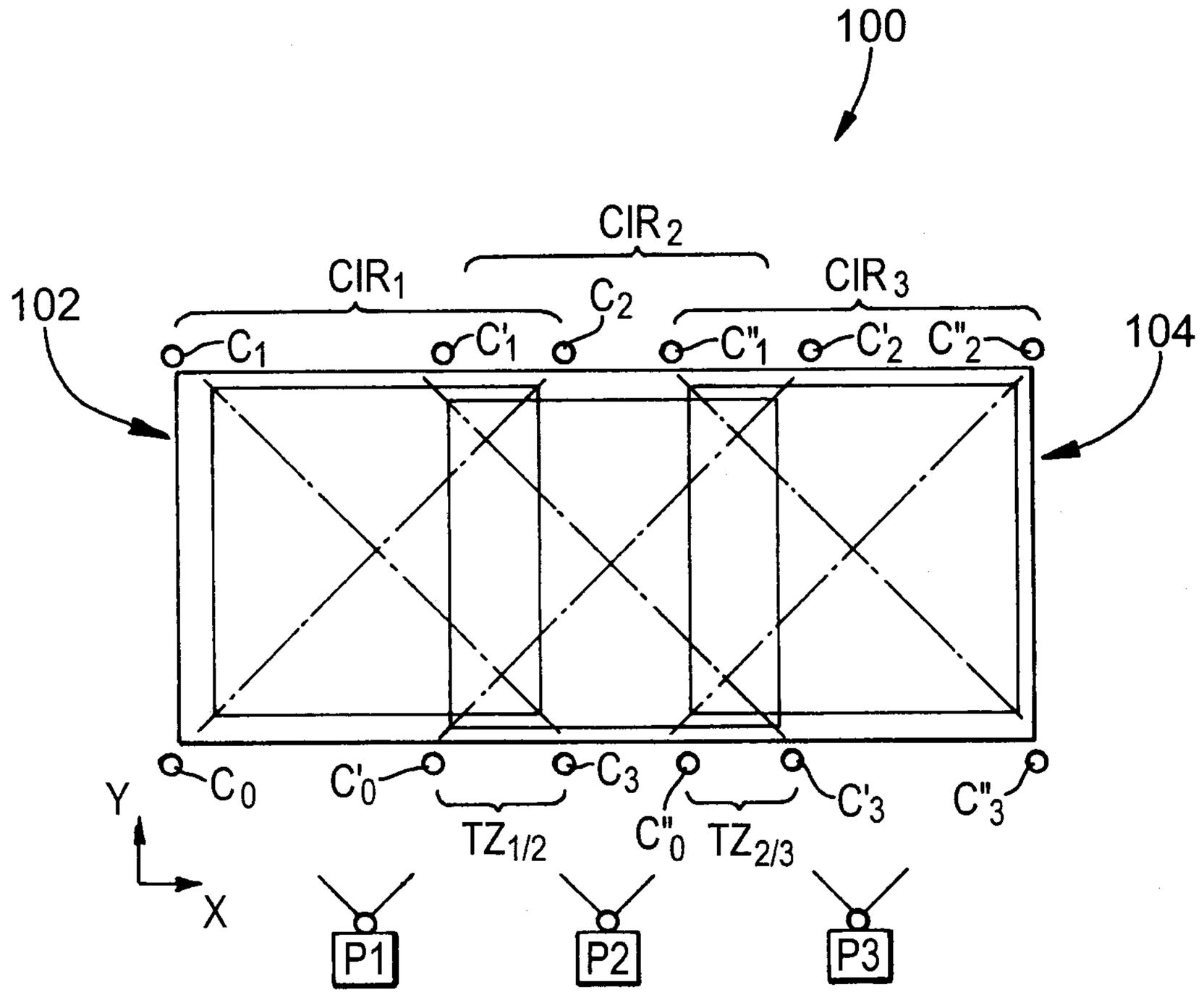

100
CIR2
CIR1
CIR3
102
104
C1
C'1
C2
C"1
C'2
C"2
C0
C'0
C3
C"0
C'3
C"3
TZ1/2
TZ2/3
Y
X
P1
P2
P3

FIG. 1

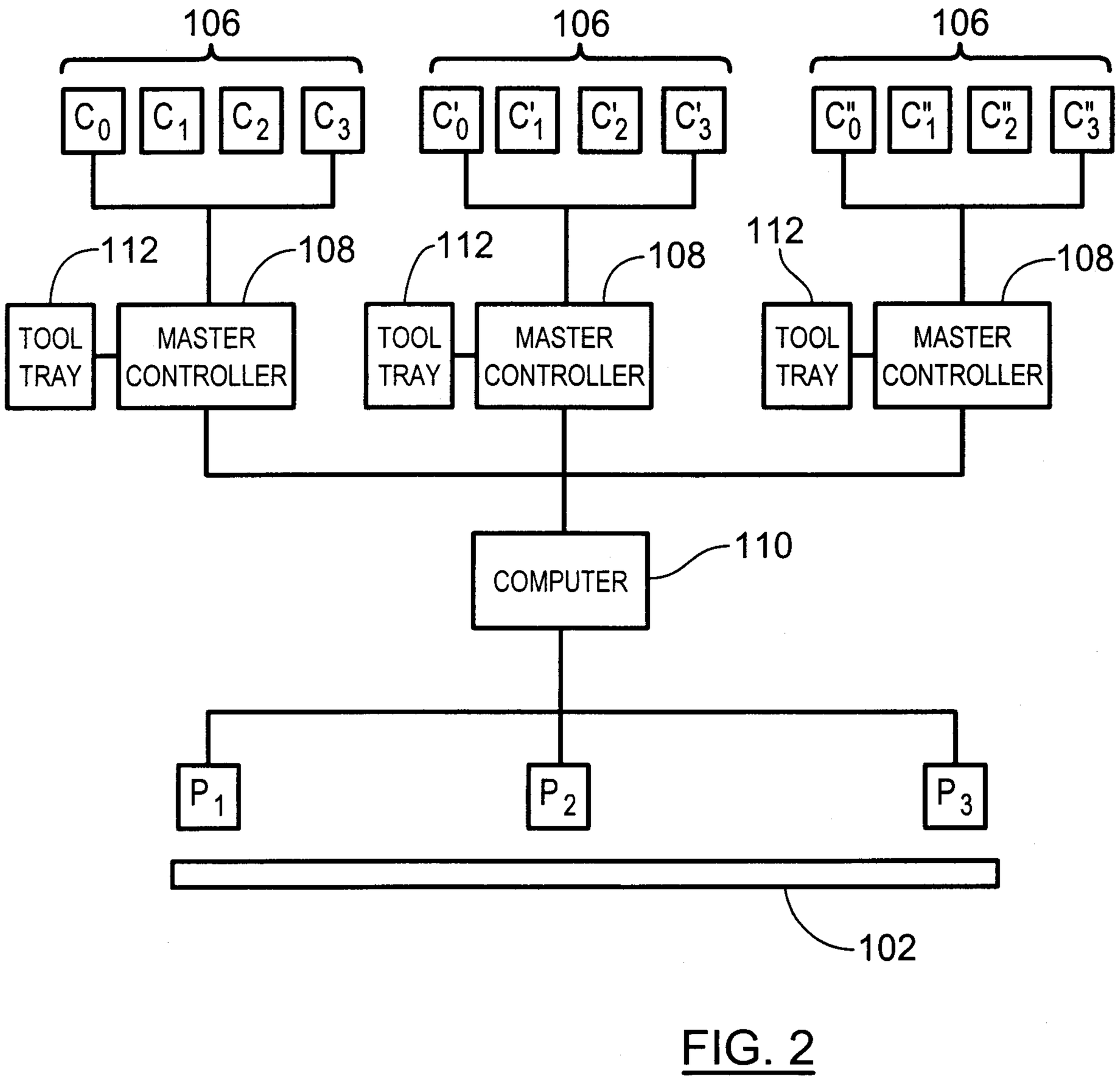

106
106
106
C_0
C_1
C_2
C_3
C'_0
C'_1
C'_2
C'_3
C''_0
C''_1
C''_2
C''_3
112
108
112
108
112
108
TOOL TRAY
MASTER CONTROLLER
TOOL TRAY
MASTER CONTROLLER
TOOL TRAY
MASTER CONTROLLER
COMPUTER
110
P_1
P_2
P_3
102

FIG. 2

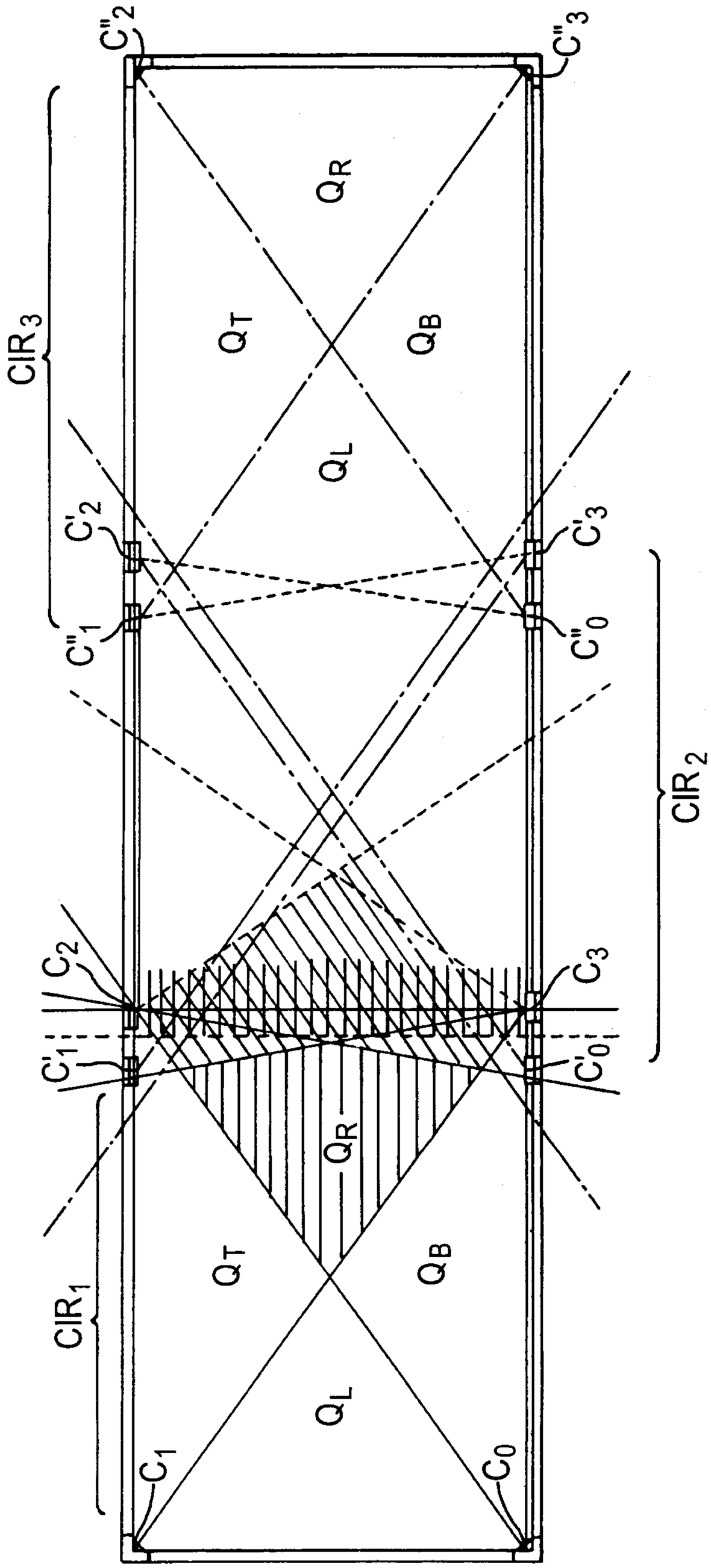

C"2
C"3
QR
QT
QB
QL
CIR3
C'2
C'3
C"1
C"0
C2
C3
C'1
C'0
CIR2
QR
QT
QB
QL
CIR1
C1
C0

FIG. 3

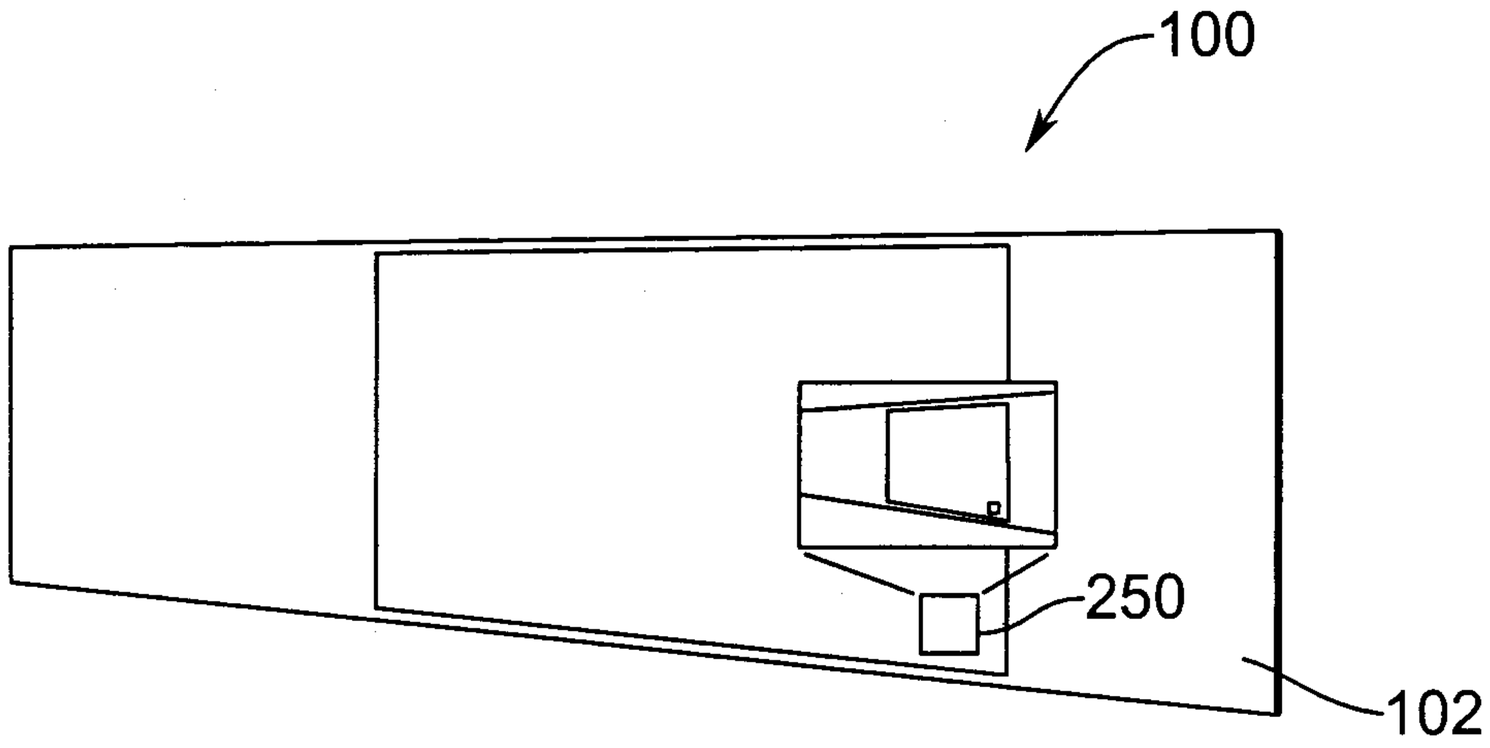


FIG. 4

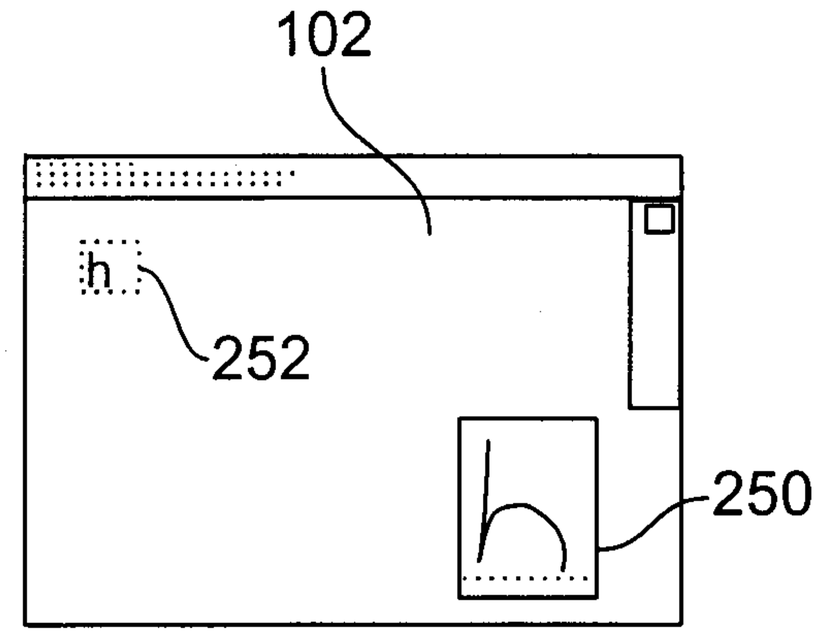


FIG. 5a

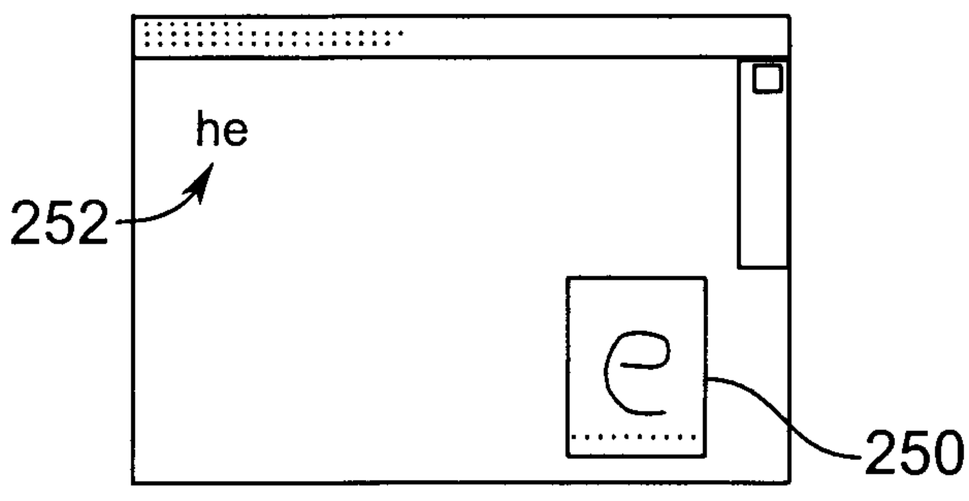


FIG. 5b

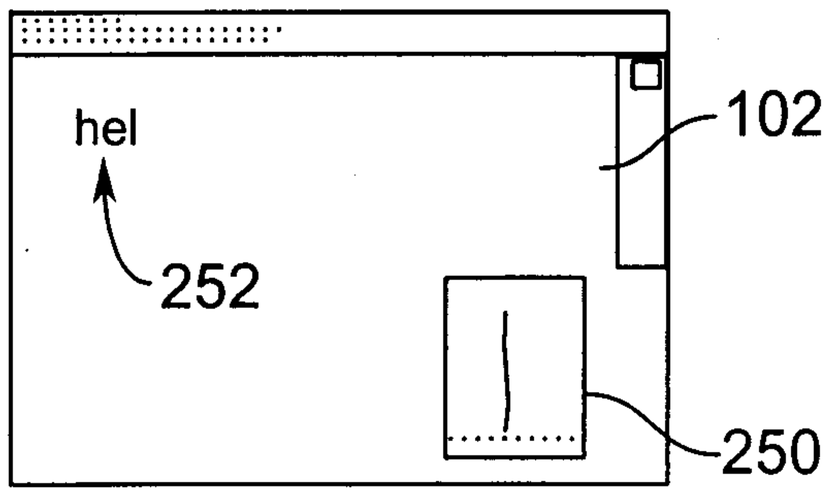


FIG. 5c

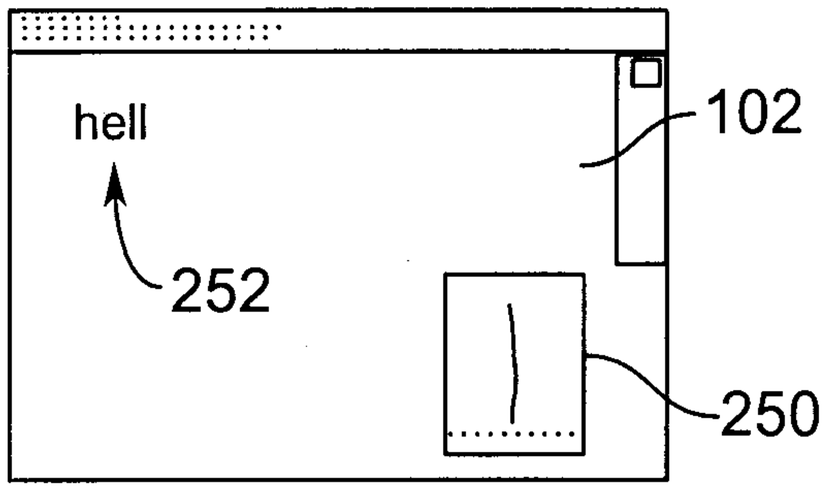


FIG. 5d

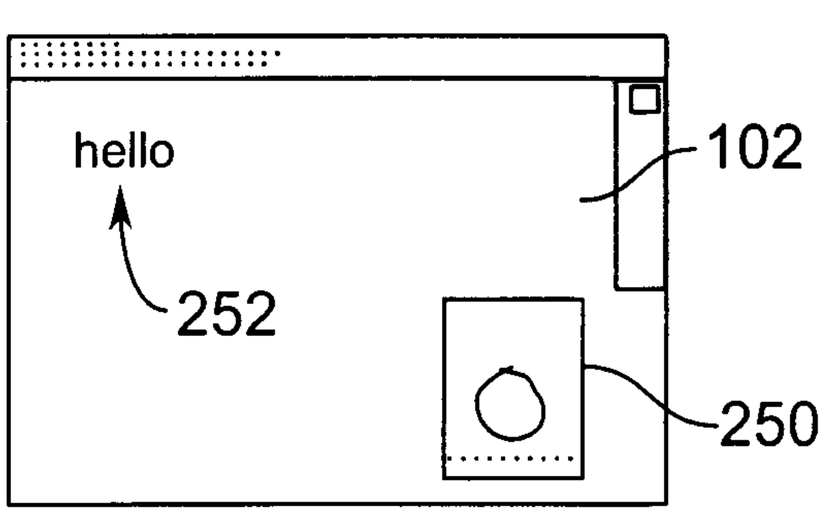


FIG. 5e

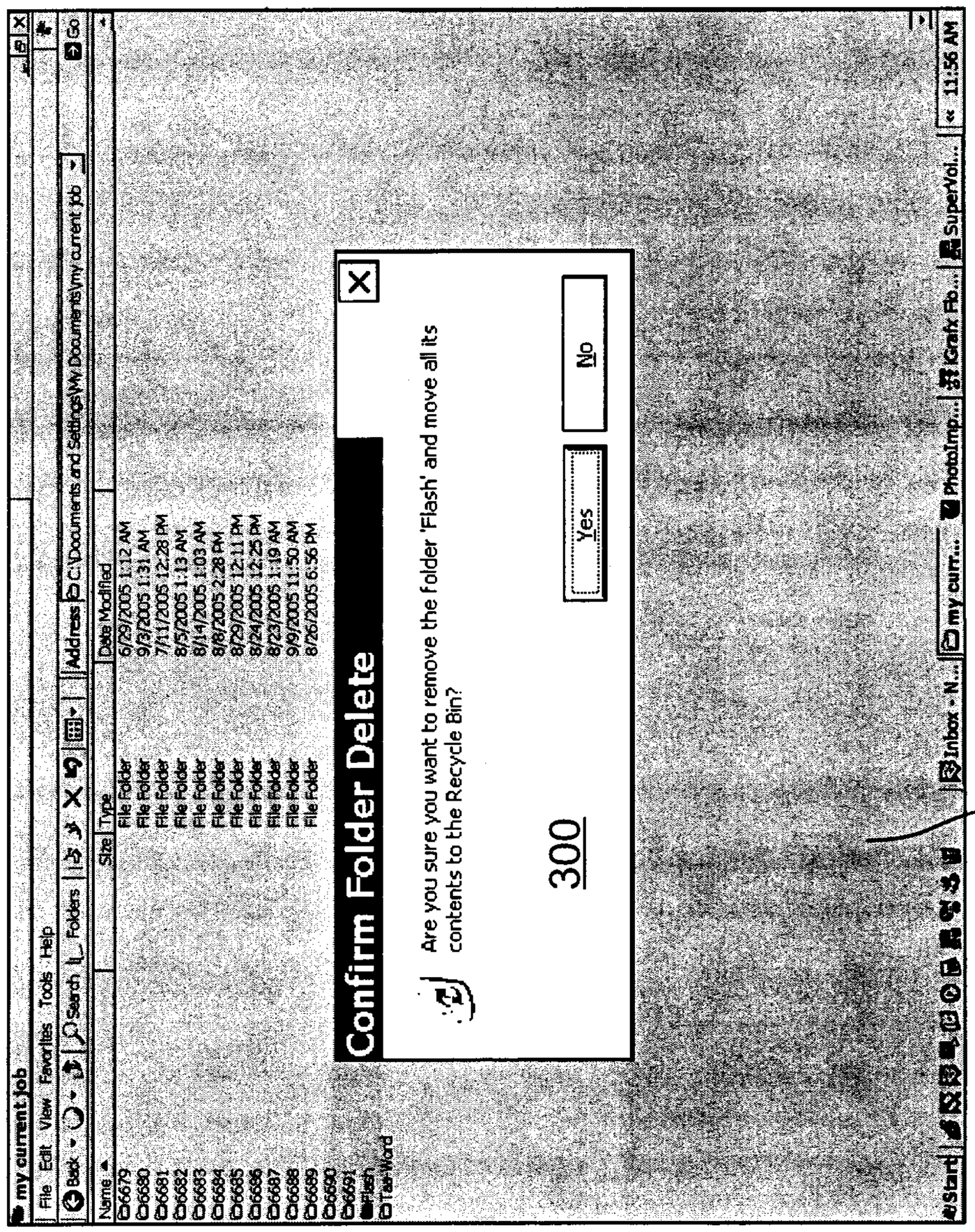

my current Job
File Edit View Favorites Tools Help
Back Search Folders
Address C:\Documents and Settings\My Documents\my current Job
Go
Name
Size
Type
Date Modified
6679 File Folder 6/29/2005 1:12 AM
6680 File Folder 9/3/2005 1:31 AM
6681 File Folder 7/11/2005 12:28 PM
6682 File Folder 8/5/2005 1:13 AM
6683 File Folder 8/14/2005 1:03 AM
6684 File Folder 8/8/2005 2:28 PM
6685 File Folder 8/29/2005 12:11 PM
6686 File Folder 8/24/2005 12:25 PM
6687 File Folder 8/23/2005 1:19 AM
6688 File Folder 9/9/2005 11:50 AM
6689 File Folder 8/26/2005 6:56 PM
6690
6691
Flash
Tax-Word
Confirm Folder Delete
Are you sure you want to remove the folder 'Flash' and move all its contents to the Recycle Bin?
Yes
No
300
302
Start
Inbox - N...
my curr...
PhotoImp...
iGrafx Flo...
SuperVol...
11:56 AM

FIG. 6

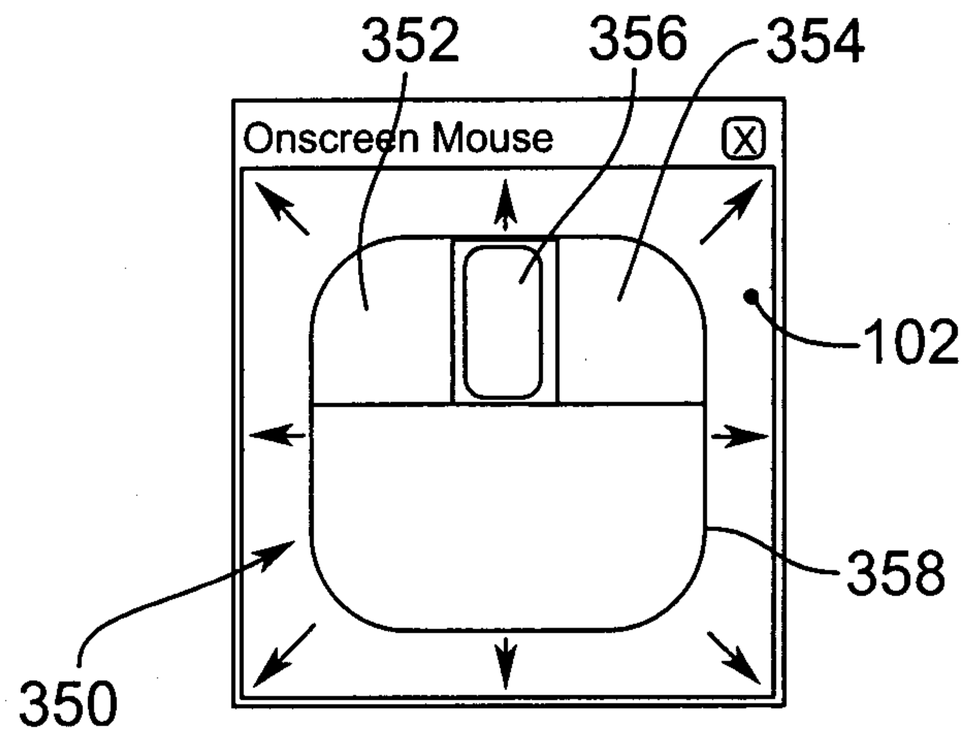


FIG. 7

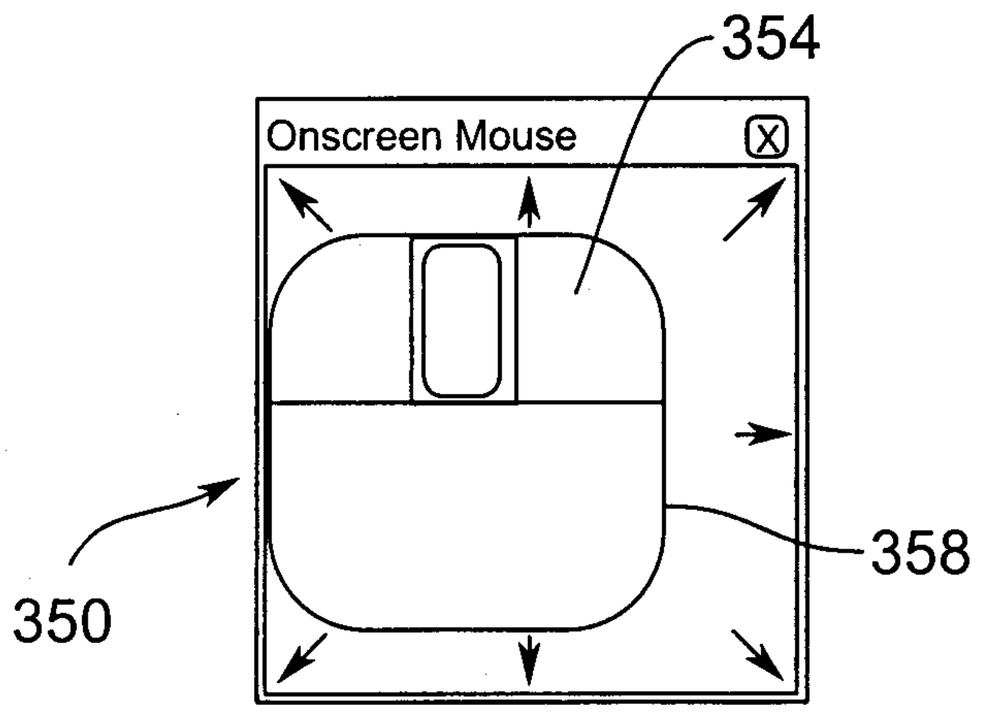


FIG. 8a

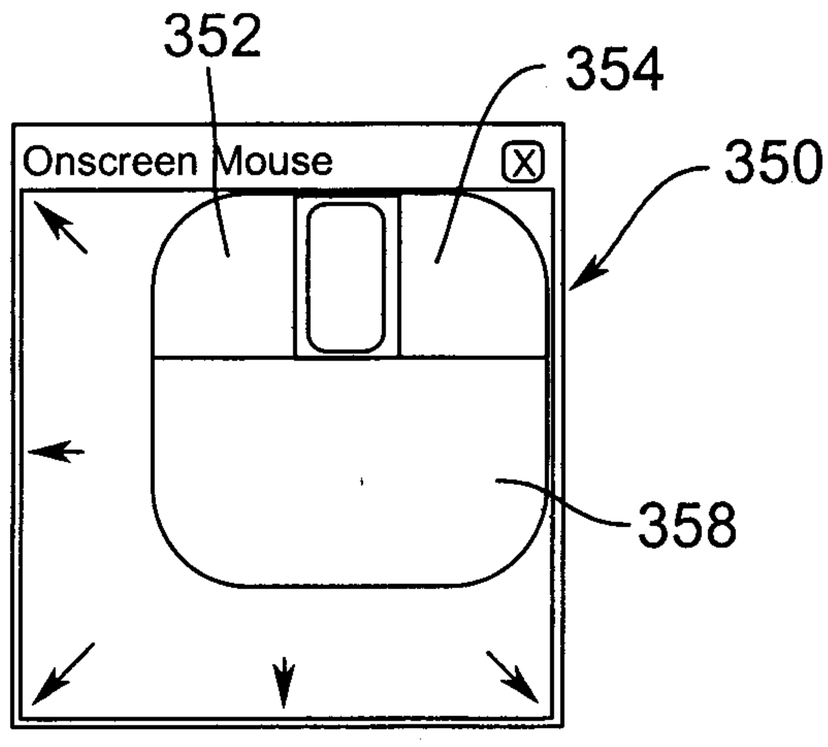


FIG. 8b

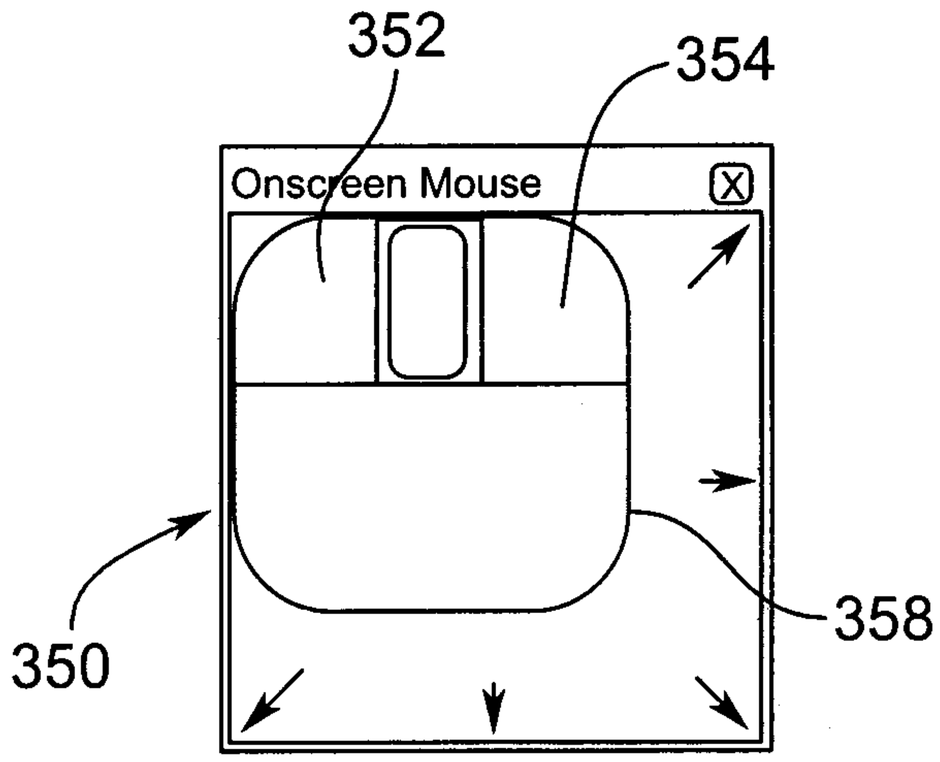


FIG. 8c

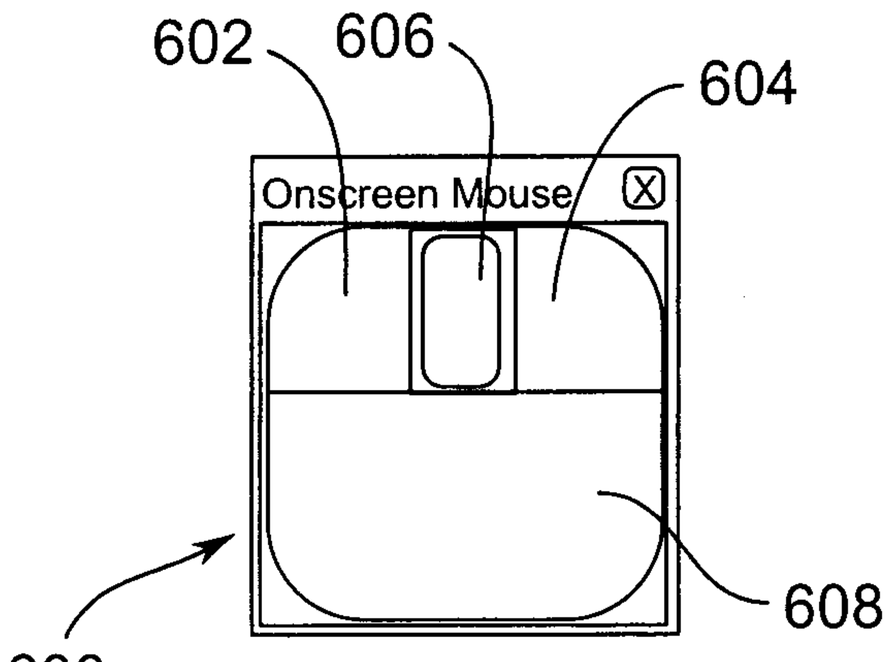


FIG. 10

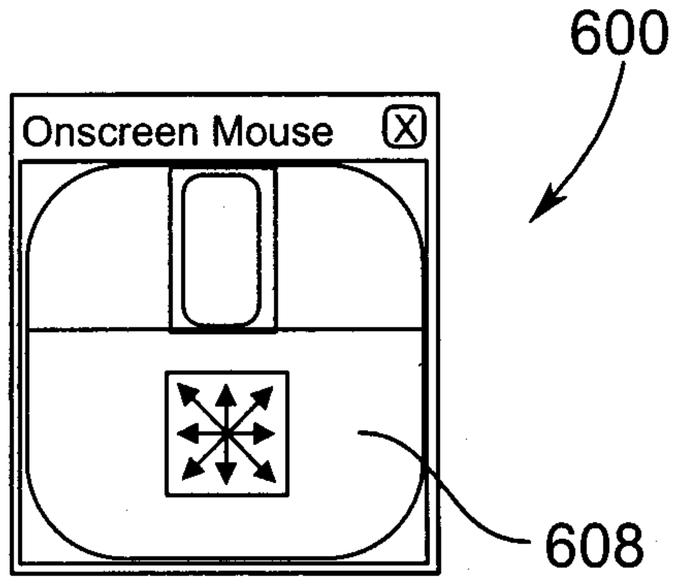


FIG. 11a

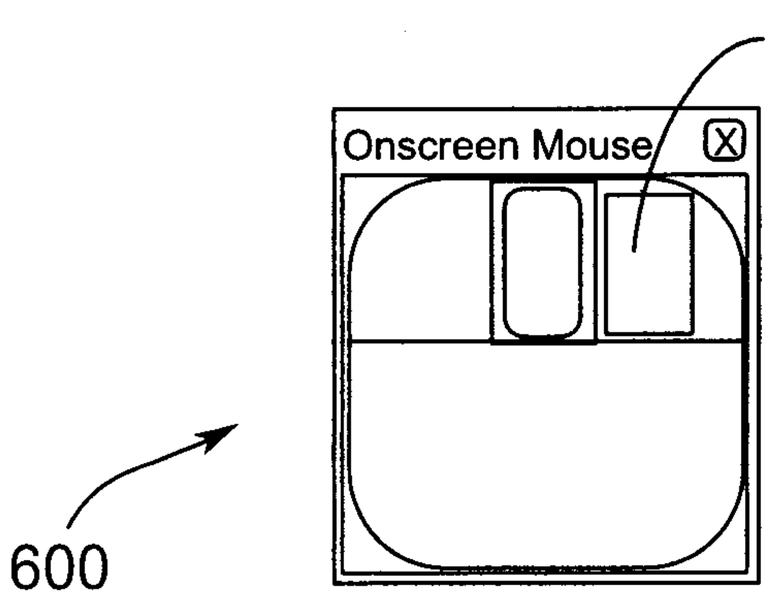


FIG. 11b

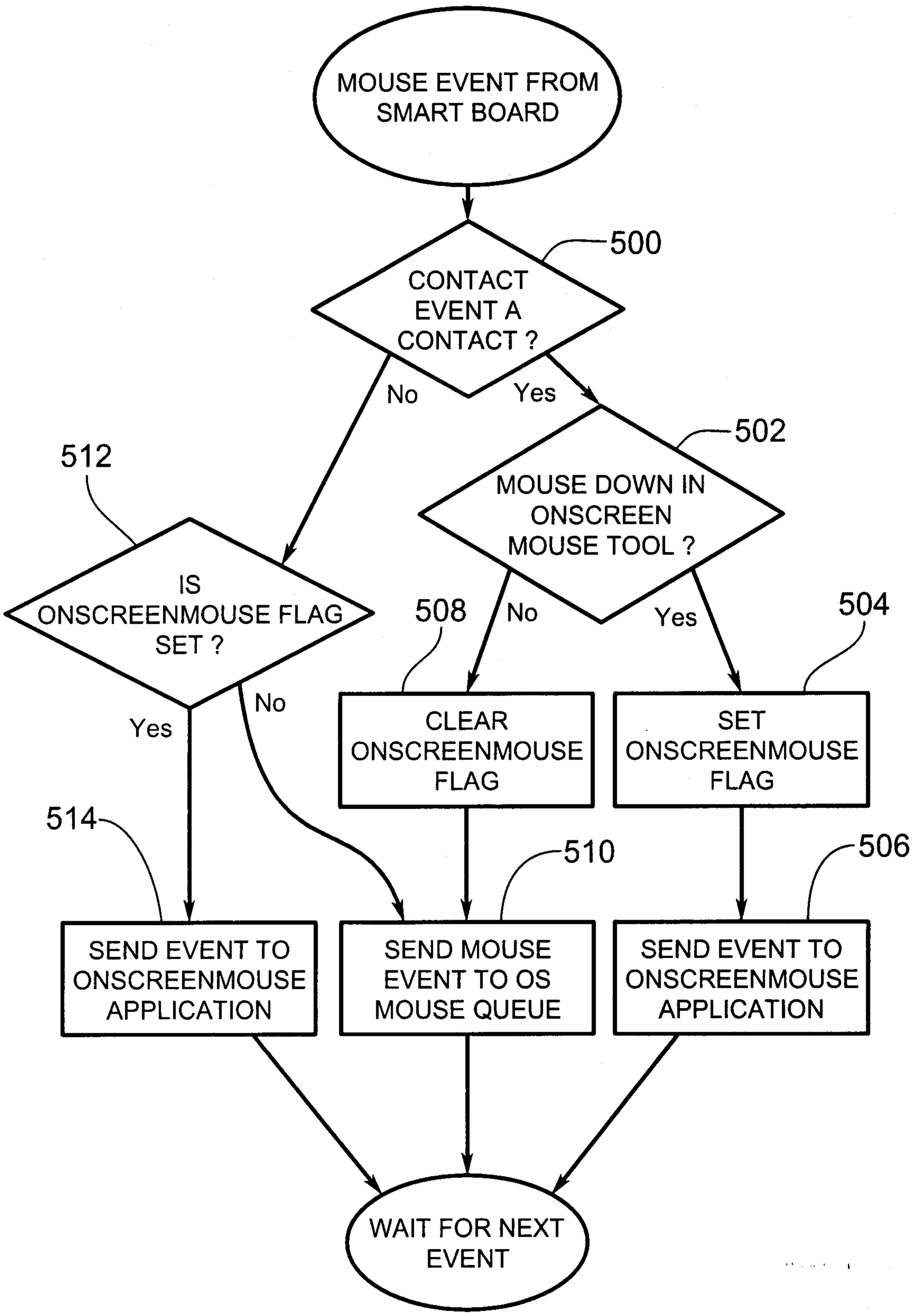

MOUSE EVENT FROM SMART BOARD
500
CONTACT EVENT A CONTACT ?
No
Yes
502
MOUSE DOWN IN ONSCREEN MOUSE TOOL ?
No
Yes
508
504
CLEAR ONSCREENMOUSE FLAG
SET ONSCREENMOUSE FLAG
512
IS ONSCREENMOUSE FLAG SET ?
Yes
No
514
510
506
SEND EVENT TO ONSCREENMOUSE APPLICATION
SEND MOUSE EVENT TO OS MOUSE QUEUE
SEND EVENT TO ONSCREENMOUSE APPLICATION
WAIT FOR NEXT EVENT

FIG. 9a

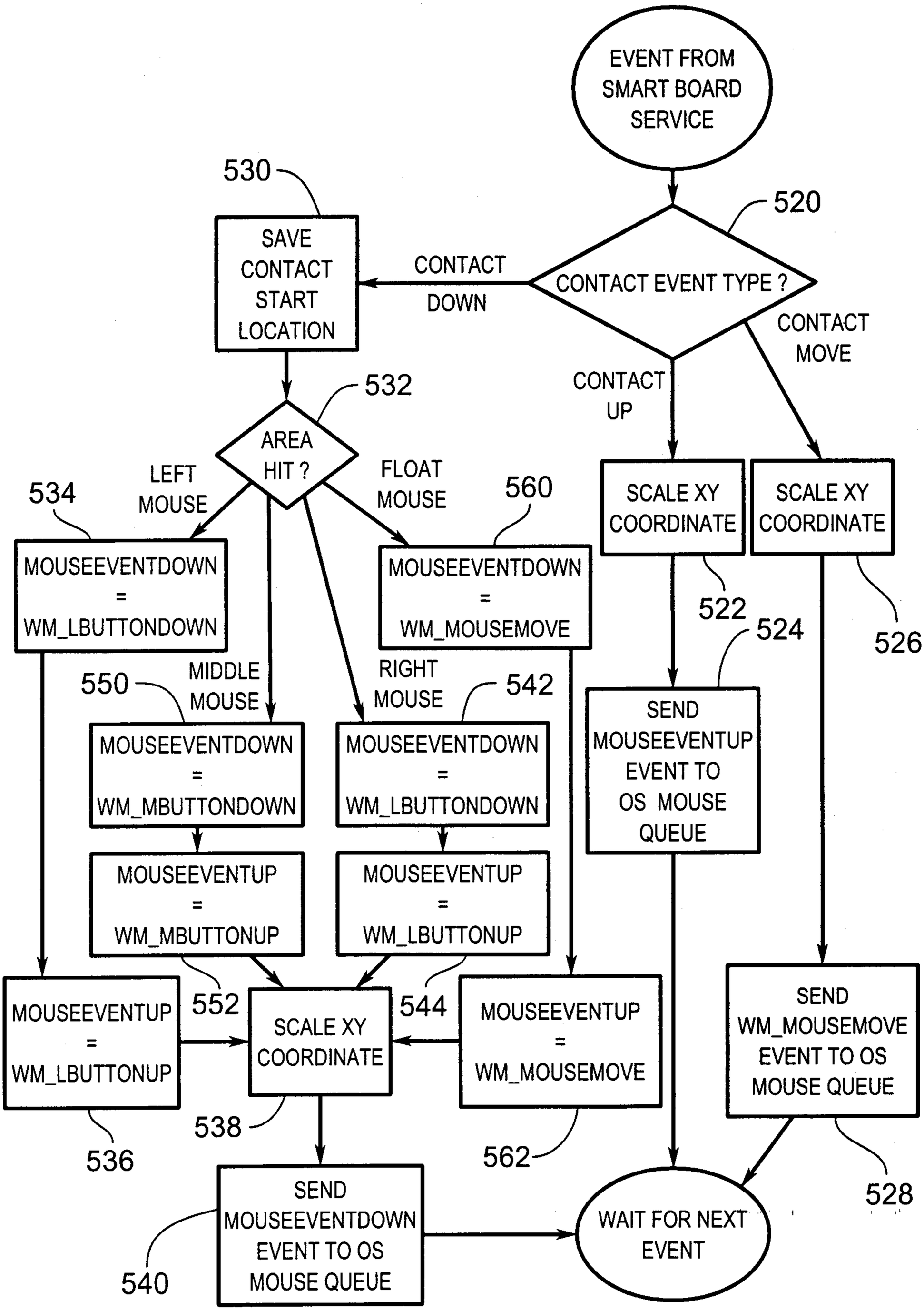
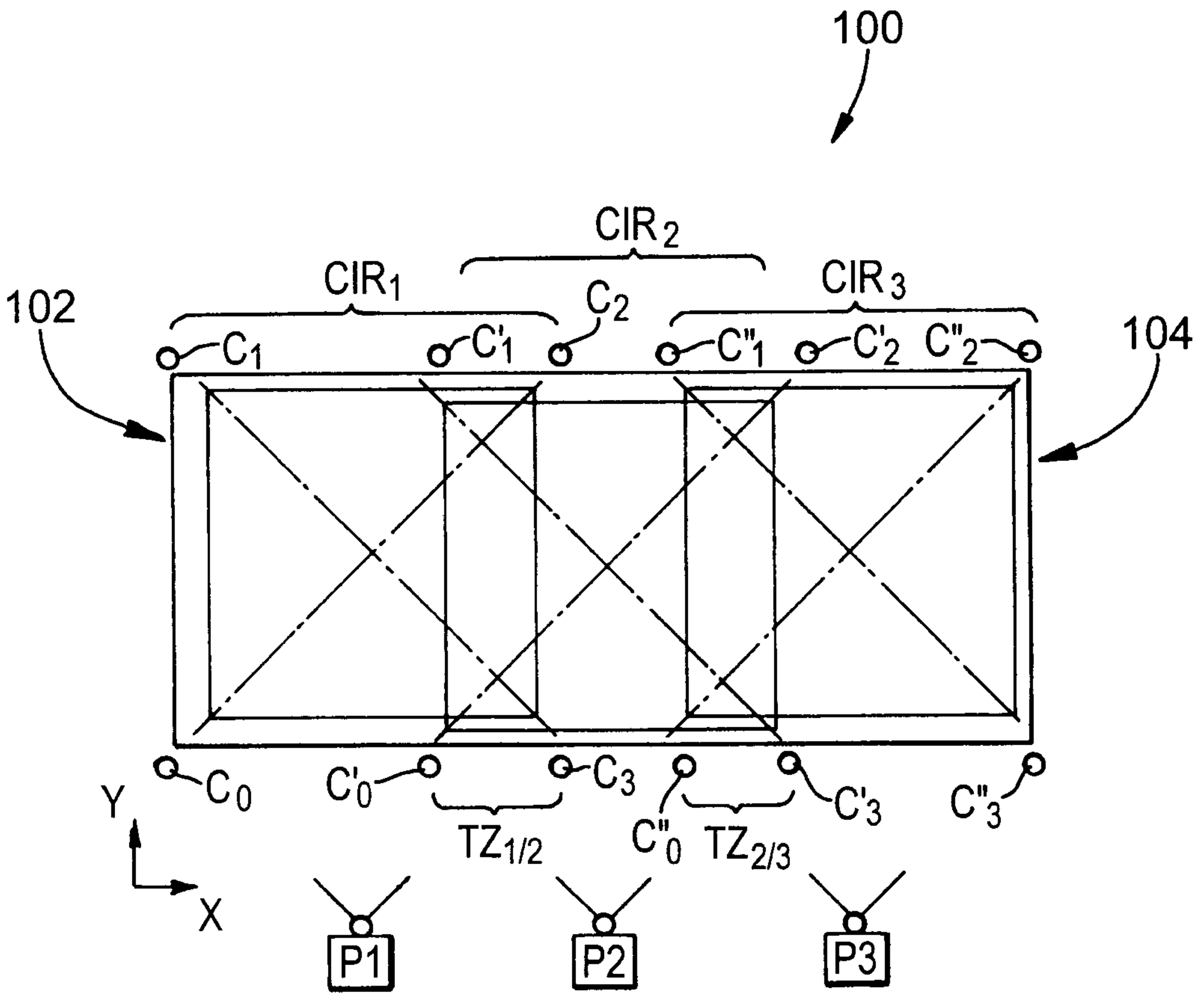

EVENT FROM SMART BOARD SERVICE
520
CONTACT EVENT TYPE ?
CONTACT DOWN
CONTACT MOVE
CONTACT UP
SAVE CONTACT START LOCATION
530
532
AREA HIT ?
LEFT MOUSE
MIDDLE MOUSE
FLOAT MOUSE
534
550
542
560
MOUSEEVENTDOWN = WM_LBUTTONDOWN
MOUSEEVENTDOWN = WM_MBUTTONDOWN
MOUSEEVENTDOWN = WM_LBUTTONDOWN
MOUSEEVENTDOWN = WM_MOUSEMOVE
MOUSEEVENTUP = WM_MBUTTONUP
MOUSEEVENTUP = WM_LBUTTONUP
MOUSEEVENTUP = WM_LBUTTONUP
MOUSEEVENTUP = WM_MOUSEMOVE
552
544
538
536
562
SCALE XY COORDINATE
SCALE XY COORDINATE
SCALE XY COORDINATE
522
524
526
SEND MOUSEEVENTUP EVENT TO OS MOUSE QUEUE
SEND WM_MOUSEMOVE EVENT TO OS MOUSE QUEUE
SEND MOUSEEVENTDOWN EVENT TO OS MOUSE QUEUE
540
528
WAIT FOR NEXT EVENT

FIG. 9b


100
CIR2
CIR1
CIR3
102
C2
C1
C'1
C"1
C'2
C"2
104
C0
C'0
C3
C"0
C'3
C"3
TZ1/2
TZ2/3
Y
X
P1
P2
P3