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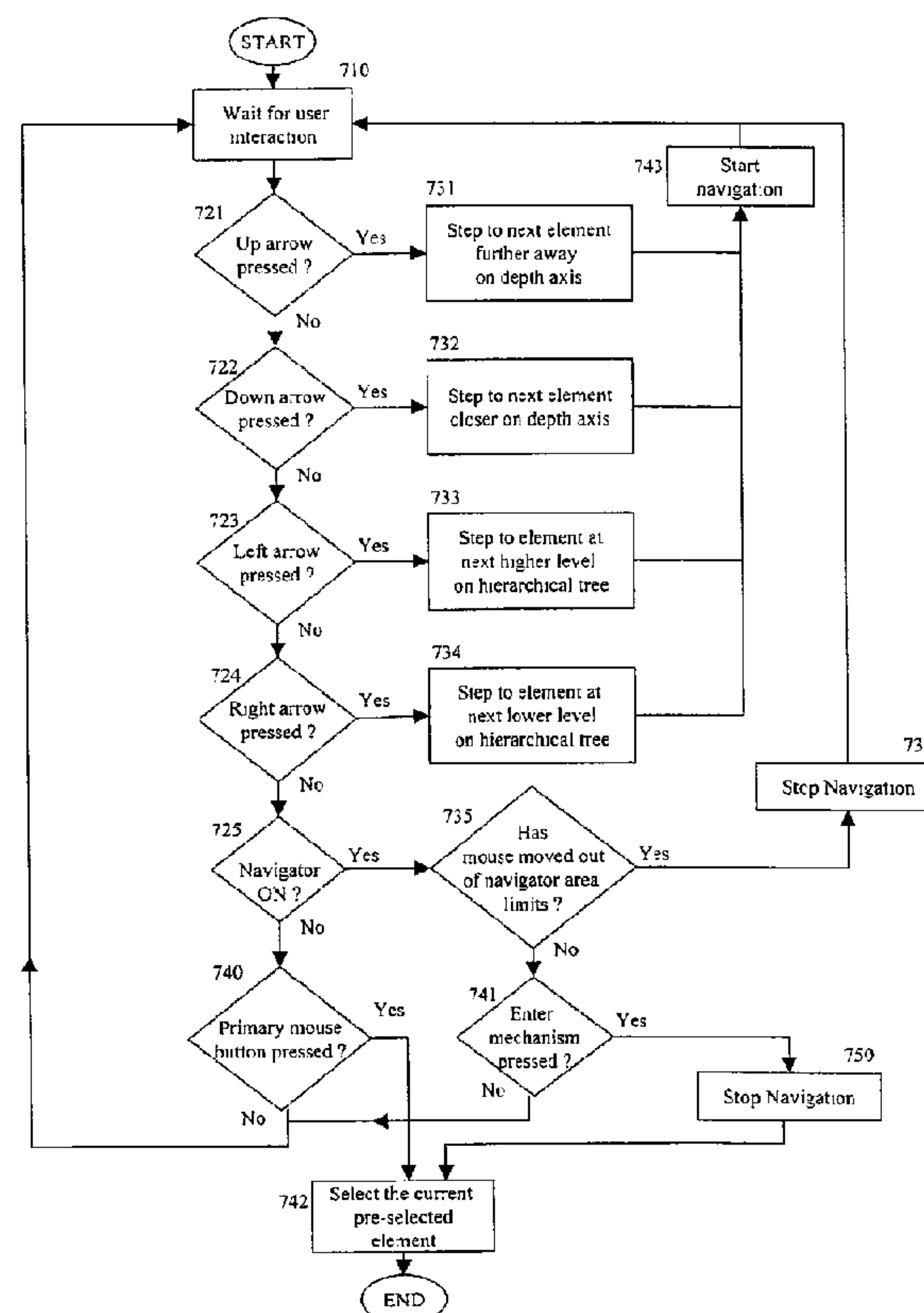
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(54) Titre : NAVIGATEUR DE SELECTION

(54) Title: SELECTION NAVIGATOR



(57) Abrégé/Abstract:

The invention provides generally a method and system for selecting an element of a computer generated drawing model graphically represented on a computer screen wherein each selectable element of the model occupies a position in a hierarchical tree describing the model. A pointer can be used to specify a position on the screen and pre-selecting an element on an axis extending from the position of the pointer along a predetermined direction such that the direction is not in the plane of the screen. Pre-selection can be moved from a first position on the hierarchical tree to a second position on the hierarchical tree in response to activation of an arrow mechanism. Full selection can be accomplished by activating a selection mechanism.



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ABSTRACT

The invention provides generally a method and system for selecting an element of a computer generated drawing model graphically represented on a computer screen wherein each selectable element of the model occupies a position in a hierarchical tree describing the model. A pointer can be used to specify a position on the screen and pre-selecting an element on an axis extending from the position of the pointer along a predetermined direction such that the direction is not in the plane of the screen. Pre-selection can be moved from a first position on the hierarchical tree to a second position on the hierarchical tree in response to activation of an arrow mechanism. Full selection can be accomplished by activating a selection mechanism.

SELECTION NAVIGATOR

BACKGROUND

5 Computer systems can be used to model objects and fluids. Computer application software can be used to display a model including an image of an object or a fluid flow. Images often include one or more elements or parts. Selection of an element is usually accomplished with a pointing device associated with the computer displaying the model. A cursor on a computer screen is typically directed by a pointing device, such as a mouse,
10 to make a selection. A pointing device can position a cursor at different points, each point correlating to an X and Y coordinate. Different elements of a model are commonly selectable by using a pointing device to position the cursor at a point intersecting the element and clicking a button on the pointing device.

 Modeling with three or more dimensions can also be accomplished on a computer
15 system and displayed on a computer screen. In the context of computer graphics, the X and Y axes are usually placed in the plane defined by the computer screen while the depth or Z axis at any given point on the screen is defined either by the theoretical line going from that point on the screen to a human eye placed at some distance from the screen (conical representation) or by the normal to the screen in that point (cylindrical
20 representation). A three-dimensional representation may include features of an object depicted with horizontal (X) and vertical (Y) axis and also depth (Z axis). However, selection of an element included in a model with more than two dimensions may require the identification of an intersection with an element, or some other method of specifying which elements are selectable.

25 Pointing devices utilized by point and click systems can travel in two dimensions across a computer screen allowing for horizontal or vertical movement. As it relates to graphical designations, a pointing device such as a mouse provides for movement along X and Y axis. However, as a two axis pointing device cannot simultaneously make a depth designation such as in the Z direction, ambiguity can result as to the exact element
30 being pointed to when more than one element is intersected by the Z axis corresponding to the point (or pixel) on the screen designated by the X,Y coordinates.

5 A user of a CAD/CAM/CAE (computer aided design/ manufacture/engineering)
or PDM II (product data management, second version) system, may need to select a
particular element in a complex structure that is graphically represented on a screen in a
computer system. One known way to select an element is for a user to reference a
hierarchical tree representing the components or specifications of the structure. The tree
10 can show successive degrees of details allowing a user to select a detail in the tree. In
many CAD/CAM/CAE applications, however, the hierarchical tree is very large and
extremely complex. Many users find it confusing to try and locate one element of an
overall product as a position in a complex hierarchical tree representing a structure in
terms of product components or design specifications. Generally, human operators prefer
15 to reference a graphical representation directly.

It would be useful to have a convenient mechanism to allow the selection of an
element directly on the graphical representation of the computer model.

SUMMARY OF THE INVENTION

20 The invention provides generally a method and system for selecting an element of
a computer generated three-dimensional model graphically represented on a computer
screen wherein each selectable element of the model occupies a position in a hierarchical
tree describing the model.

 The invention further provides a method and system for allowing a user to
25 navigate through a computer generated model including various selectable elements until
an element to be selected is reached.

 In one aspect the invention includes detecting a position of a pointer on the
computer screen and pre-selecting an element of the model on an axis extending from the
position of the pointer along a predetermined direction wherein the direction is not in the
30 plane of the screen. In one embodiment of the invention the predetermined direction is
the direction normal to the plane of the computer screen and the axis is the normal to the
plane of the screen at the position of the pointer. In another embodiment, the axis can be
defined as the straight line drawn from the eye of a user sitting in front of the screen and
intersecting the plane of the screen at the position of the pointer. It will be readily
35 understood, however, that the direction of the axis can be any direction, provided it is not

5 in the plane of the screen itself. In all cases the axis is called the depth axis. Depending
on the position of the pointer, the depth axis may intersect one or more selectable
elements of the model or none at all. If no selectable element is intersected by the depth
axis, no element is pre-selected. If one selectable element only is intersected by the depth
axis, this selectable element is pre-selected. If more than one selectable element is
10 intersected by the depth axis, as will usually be the case, one of these selectable elements
is pre-selected. In a preferred embodiment the pre-selected element is the selectable
element of the model which is closest to the eye of the user in the three-dimensional
representation of the model. Pre-selection of a selectable element is preferably
represented by highlighting the element.

15 Pre-selection can be moved from one selectable element located at a first position
on the hierarchical tree to a selectable element located at a second position on the
hierarchical tree in response to activation of a navigation control mechanism. In a
preferred embodiment the hierarchical tree describes the model in terms of its design
specifications but the invention applies as well to the case where the tree would describe
20 the model in terms of its product components or in any other way. When, as a result of
the navigation, the element to be selected has been reached, full selection can be
accomplished by activating a selection mechanism. In one embodiment of the invention,
the navigation command mechanism is a set of directional arrow keys on a keyboard
associated with the computer and the selection mechanism is a primary button on the
25 mouse or the keyboard Enter key.

In another aspect of the invention, a user interface can include a first display
region to display a computer generated model and a second display region to display the
hierarchical tree describing the model. Any pre-selection of a selectable element of the
graphical representation of the model, e.g. by highlighting it, results in the same element
30 being pre-selected or highlighted in the hierarchical tree.

In still another aspect of the invention, an image of a user activatable navigation
control mechanism, or navigator, is displayed on the computer screen in the vicinity of a
point indicated by a pointing mechanism. In a preferred embodiment, the pointing
mechanism is a pointer associated with a computer mouse and the image of the navigator
35 is a representation of four directional arrow keys together with a central button

corresponding to the Enter key of a keyboard. An area on the screen surrounding the point indicated by the pointing mechanism and encompassing the image of the navigator can be defined as a navigator area. Subsequent movements of the mouse pointer within the limits of the navigator area do not change the location of the point originally indicated by the mouse pointer. This makes it possible for the mouse pointer to be used for activating the various elements of the navigation control mechanism.

In a preferred embodiment, activation of the up and down arrow keys control the navigation along the depth axis, so that the various selectable elements found along that axis can be pre-selected. Activation of the left and right arrow keys control the navigation along branches of the hierarchical tree, so that the various selectable elements in a branch of the tree can be pre-selected. When the navigation control mechanism is displayed on the screen, activation of the central button or of the Enter key on the keyboard accomplishes the full selection of the element then pre-selected. When the navigation control mechanism is not displayed on the screen, clicking on the primary button of the mouse accomplishes the full selection of the element then pre-selected.

Embodiments can include, for example, a computer program stored on a computer readable medium and a user interface invocable by an application program.

In another aspect of the present invention, there is provided a method of selecting an element of a computer generated model graphically represented on a computer screen. Each selectable element of the model occupies a position in a hierarchical tree describing the model. The method comprises:

- detecting a position of a pointer on the screen;
- pre-selecting a first selectable element of the model on an axis extending from the position of the pointer along a predetermined direction wherein the direction is not in the plane of the screen;
- moving pre-selection from the first selectable element to a second selectable element responsive to activation of a navigation control mechanism, wherein the second selectable element occupies a position in the hierarchical tree which is different from a position occupied by the first element; the activation of the navigation control mechanism allowing for movements to higher and lower levels in the hierarchical tree; and
- activating a selection mechanism to select the second element.

In another aspect of the present invention, there is provided a computer readable medium having computer readable code embodied therein for causing a computer to select an element comprising a computer generated model. The computer readable code has instructions executable by a computer for:

- detecting a position of a pointer on a computer screen;
- pre-selecting a first selectable element of the model on an axis extending from the position of the pointer along a predetermined direction, wherein the direction is not in the plane of the computer screen;
- moving pre-selection from the first selectable element to a second selectable element responsive to activation of a navigation control mechanism, wherein the second selectable element occupies a position in the hierarchical -tree which is different from a position occupied by the first element; the activation of the navigation control mechanism allowing for movements to higher and lower levels in the hierarchical tree; and
- activating a selection mechanism to select the second element.

In another aspect of the present invention, there is provided a method for selecting at least one of a plurality of graphical elements for display on a computer screen depicting an x-y plane. The plurality of graphical elements are representative of features of a physical object and are aligned in a direction not in the x-y plane. At least one of the plurality of graphical elements are obscured by another of the plurality of graphical elements. The method comprises the steps of:

- initially selecting the another of the plurality of graphical elements;
- indicating that the another of the plurality of graphical elements has been selected;
- receiving an input for selecting the at least one of the plurality of graphical elements;
- selecting the at least one of the plurality of graphical elements; and
- indicating that the at least one of the plurality of graphical elements has been selected.

In another aspect of the present invention, there is provided a computer system comprising a processor operatively interconnected to a memory, an input device and a display device depicting a plane. A plurality of graphical elements are depicted by way of the display device so as to be aligned in a direction not in the plane and so that at least one of the plurality of graphical elements is obscured by another of the plurality of graphical elements. The plurality of graphical elements are representative of features of a physical object. The computer system includes electronic circuitry and software for selecting one of the plurality of graphical elements for display on the display device according to the steps of:

initially selecting the another of the plurality of graphical elements;
indicating that the another of the plurality of graphical elements has been selected;
receiving an input for selecting the at least one of the plurality of graphical elements;
selecting the at least one of the plurality of graphical elements; and
indicating that the at least one of the plurality of graphical elements has been selected.

DESCRIPTION OF DRAWINGS

FIG. 1 is a computer hardware diagram.

FIG. 2 is an isometric view of a three-dimensional computer model used as an example to explain the operation of the invention.

FIG. 3 is a profile view of the model in FIG. 2 as it can appear on a computer screen in the example.

FIG. 4 is an illustration of a user activatable navigation control mechanism according to the invention.

FIG. 5a is an isometric view of the model with a front edge pre-selected.

FIG. 5b is an isometric view of the model with the pre-selection having moved to a circle.

FIG. 5c is an isometric view of the model with the pre-selection having moved to a cylinder.

5 FIG. 5d is an isometric view of the model with the pre-selection having moved to a rear edge.

FIG. 6 is a profile view of the model corresponding to the isometric view of FIG. 5b.

10 FIG. 7 illustrates a flow diagram of a program for controlling element selection.

DETAILED DESCRIPTION

Fig. 1 depicts physical resources of a computer system 100. The computer 100 has a central processor 101 connected to a processor host bus 102 over which it provides data, address and control signals. The processor 101 may be a conventional general
 15 purpose single- or multi-chip microprocessor such as a Pentium® processor, a Pentium® Pro processor, a Pentium II® processor, a MIPS® processor, a Power PC® processor or an ALPHA® processor. In addition, the processor 101 may be any conventional special purpose microprocessor such as a digital signal processor or a graphics processor. The microprocessor 101 has conventional address, data, and control lines coupling it to a
 20 processor host bus 102.

The computer 100 includes a system controller 103 having an integrated RAM memory controller 104. The system controller 103 is connected to the host bus 102 and provides an interface to random access memory 105. The system controller 103 also provides host bus to peripheral bus bridging functions. The controller 103 thereby
 25 permits signals on the processor host bus 102 to be compatibly exchanged with signals on a primary peripheral bus 110. The peripheral bus 110 may be, for example, a Peripheral Component Interconnect (PCI) bus, an Industry Standard Architecture (ISA) bus, or a Micro-Channel bus. Additionally, the controller 103 can provide data buffering and data transfer rate matching between the host bus 102 and peripheral bus 110. Accessory
 30 devices including, for example, a video display controller 112 and network adapter 114 can be coupled to the peripheral bus 110.

Input devices such as a keyboard 128 and a pointing device 127 also can connect to the controller 121. A pointing device 127, such as a mouse, can have an activation mechanism such as a button to "click". Typically, a mouse will have a primary button
 35 129 designated as the left button for right handed users. The primary button 129 can be

5 clicked to select an item on screen with a cursor. A secondary button 130 can be used for various programmed functions.

The computer 100 also includes non-volatile ROM memory 122 to store basic computer software routines. ROM 122 may include alterable memory, such as EEPROM (Electronically Erasable Programmable Read Only Memory), to store configuration data.
 10 For example, EEPROM memory may be used to store hard disk 113 geometry and configuration data. BIOS routines 123 are included in ROM 122 and provide basic computer initialization, systems testing, and input/output (I/O) services.

An operating system may be fully loaded in the RAM memory 105 or may include portions in RAM memory 105, disk drive storage 113, or storage at a network
 15 location. An operating system, such as Windows 95™ or Windows NT™ provides functionality to control computer peripherals such as devices 112-114, 121, and 124, and to execute user applications. Application software programs stored on a disk 113 or accessed at a remote server. Application software can include commercially available software programs such as computer aided drawing and manufacturing software,
 20 scientific software, internet access software, word processing software, and many other types of software. User applications may access computer system peripherals 112-114, 121, and 124 through an application programming interface provided by the operating system and/or may directly interact with underlying computer system 100 hardware.

Fig. 2 shows an isometric view of a three-dimensional computer generated model
 25 of an object, in the present example a notched block 210, that can be produced by a CAD/CAM/CAE/PDM II application software program accessing operating system functionality to send control commands to the video controller 112. In the chosen example, the view shown on Fig. 2 is for explanation purposes only. What the user actually sees on the screen is the profile view of the same model shown on Fig. 3. It is
 30 also shown on Fig. 2, alongside model 210 on the same screen 200 a hierarchical tree 230 representing the various design specifications of the model. The whole model appears as PartBody 240, while the block itself appears as Pad 1, reference 231, on Fig. 2 and the pocket in the block appears as Pocket 1. References 232 and 233 point to other, more detailed, specifications for a point, Point 2, and a contour, Contour 1, respectively, which
 35 are part of the design specifications of Pad 1. It will be apparent that some of the design

5 specifications do not correspond to selectable elements of the graphical model. This is
the case, for example, for elements such as Parallelism or AbsoluteAxis. The tree is
shown on Fig. 2 for illustrative purposes but it does not need to be displayed for
practicing the invention. Displaying the tree alongside the graphical view of the model is
a design option, which may be selected by the user. This applies to the other computer
10 screens on Figs 3-6 as well.

Referring now to Fig. 3, a profile view of the notched block 210 is shown and will
be assumed to be what the user actually sees on the screen when working with the model
in the example given here.

Referring now to Fig. 4, a programmable menu 400 can provide navigation and
15 selection functions. In one embodiment, a programmable menu 400 can be shown on the
screen with user interactive controls 410, 415, 420, 425 and 450 to operate as a user-
interactive navigation control mechanism. The operation of this navigation control
mechanism will be explained in more detail later. In a preferred embodiment, the
navigation control mechanism, or navigator, comprises four arrows 410, 415, 420 and
20 425 corresponding to the four directional arrows on a keyboard and a central button 450
corresponding to the Enter key on the keyboard. When the navigator is in use, as will be
described later, activation of one of the arrows on the navigator has the same effect as
depressing the corresponding arrow key on a keyboard associated with the computer.
Similarly, activating the central button has the same effect as depressing the Enter key on
25 the keyboard. In a preferred embodiment, activation of any arrow or the central button is
done by clicking on them with the primary button of the computer mouse.

Referring now to Fig. 5a through 5d, a specific example of one embodiment of the
invention is illustrated. As already mentioned above, Fig. 5a through 5d do not show the
model as it actually appears on the screen to the user but show the model in isometric
30 view to better explain the operation of the invention. On Fig. 5a model 510 is shown
with pointer 221 of the mouse shown in the position shown as a cross hair, as a result of a
user moving the pointer across the screen to that position. In one embodiment, the
system is programmed for testing if the pointer stays at the same position for a short
period of time, which may be .5 second or less. If so, the system pre-selects, for example
35 by way of some form of highlighting, the selectable element of the model that is closest

5 to the eye of the user on the depth axis at the location of the pointer, in this case front edge 511. It will be understood that the pre-selection of the selectable element that is closest to the eye of the user is only one of many possible design options and that the system could be programmed to pre-select instead the selectable element which is farthest from the eye of the user or any other selectable element on the depth axis. In another
 10 embodiment, there is no testing whether the pointer remains at the same position for any period of time. As soon as the pointer moves to a point on the screen corresponding to a pixel in the image of the model, the system pre-selects a selectable element according to one of the design options mentioned above and continues the pre-selection process until the pointer stops at a location on the screen decided by the user. For the rest of the
 15 description of Fig. 5a through 5d, the cross hair will indicate the final position reached by pointer 221, as selected by the user. In a preferred embodiment, the system is programmed to display in the vicinity of the cross hair, after a time delay which may be up to a few seconds, the navigator 400 shown in more detail on Fig. 4. An area of the screen (not shown on Fig. 5a) around the cross hair and encompassing navigator 400 is
 20 defined as the navigator area. When the navigator is displayed, movement of mouse pointer 221 within the limits of the navigator area does not change the position of the cross hair. Should, however, pointer 221 be moved by the user outside the navigator area, the position of the cross hair would then start again to follow the movement of the pointer. Fig. 5a also shows on the left hierarchical tree 230 as already shown on Fig. 2. As already mentioned, displaying hierarchical tree is an optional feature of the invention.
 25 When it is displayed, as on Fig. 5a, the reference of the element pre-selected on the graphical representation of the model is also pre-selected on tree 230. In the example shown on Fig. 5a, highlighted front edge 511 corresponds to highlighted Line 2 on the design specification tree, bearing the reference 520.

30 Referring now to Fig. 5b, an up arrow mechanism has been activated by the user to indicate that pre-selected element 511 of Fig. 5a is not the element wanted for final selection. The wanted element is assumed here to be a selectable element which is located behind (that is further away from the eye of the user) element 511. If navigator 400 is displayed and used by the user, as shown on Fig. 5b, up arrow 410 has been
 35 activated (it is shown as highlighted on Fig. 5b) by bringing the mouse pointer on arrow

5 410 and clicking on it with the primary button of the mouse. As a result of the activation of up arrow 410, pre-selection has shifted to the next selectable element on the depth axis, namely circle 545 forming the top of the cylindrical pocket 555. The same effect could have been obtained by depressing the up arrow key on the keyboard associated with the computer. Up and down arrows, whether on navigator 400 or on the keyboard,
 10 have been programmed to shift pre-selection to a next selectable element of the model further away from or closer to the eye of the user on the depth axis, respectively. If the hierarchical tree is displayed, the reference of circle 545 in the tree, namely Circle 1, referenced 540 on Fig. 5B, is highlighted too.

Fig. 6 illustrates the same situation as Fig. 5b but on the profile view, which is the
 15 one actually presented to the user on the screen, as previously explained in reference to Fig. 3. Highlighted circle 545 appears as a highlighted portion of the top edge of model 210. In hierarchical tree 230 the same element 540 as in Fig. 5B is highlighted since the hierarchical tree is not dependent on the view presented to the user on the screen.

Referring now to Figs. 5c and 5d, they illustrate two different scenarios evolving
 20 from the situation shown on Fig. 5b. In Fig. 5c a left arrow mechanism, which can be the left arrow 420 of navigator 400 or the left arrow key on the keyboard associated with the computer, has been activated. As a result, the pre-selection has shifted from circle 545 of Fig. 5b to the whole pocket 555, which is shown highlighted on Fig. 5c. At the same time, highlighting on the hierarchical tree has shifted from Circle 1, reference 540 on Fig.
 25 5b, to Pocket 1, reference 575 on Fig. 5c. In the embodiment described, the left and right arrow mechanisms have been programmed to shift the pre-selection to a higher or lower level of specifications in the design specification tree, respectively. The tree shown on the drawings comprises three levels of specifications : the top level with the selectable element PartBody, the intermediate level with selectable elements Pad 1 and Pocket 1,
 30 and the lowest level with all the elements at the end of the tree branches. It will be understood that in most real life applications the tree will contain many more levels and elements. It will also be understood that, although the pre-selection shift caused by activation of the left and right arrow mechanisms has been defined in terms of movements to higher or lower levels in the specification tree, the actual display of the
 35 tree on the screen is not required for the practice of the invention. The graphical

5 representation of the model contains as much pre-selection information as the tree. Although Fig. 5c shows the navigator on and the pre-selection shift being caused by activation of left arrow 420 of the navigator, the same result could have been obtained without the navigator, by using the left arrow key on a keyboard associated with the computer.

10 Referring now to Fig. 5d, it is shown what would have happened if, in the situation of Fig. 5b, the up arrow mechanism had been activated instead of the left arrow mechanism. Pre-selection has shifted from circle 540 on Fig. 5b to rear edge 550 of the model, as shown on Fig. 5d, that is to the next selectable element further away from the user's eye along the depth axis. The navigator is shown as being on and up arrow 410 of
 15 the navigator is highlighted to show that it has been activated. Here again, the same pre-selection shift could be obtained without the navigator, by depressing the up arrow key on the keyboard. On the optional display of the tree, pre-selection has shifted to Line 6, reference 551, which corresponds to rear edge 550 on the graphical representation of the model.

20 Figs. 5a through 5d have been used to illustrate some of the possible steps in the navigation through the model. It will be readily understood that, starting from the pre-selection reached on Fig. 5d, activation of the down arrow would bring the pre-selection to that shown on Fig. 5b, while activation of the left arrow would result in the pre-selection of the whole block (Pad 1 on the specification tree). Similarly, starting from the
 25 situation shown on Fig. 5c, activation of the right arrow would bring the pre-selection to that shown on Fig. 5b.

At any step in the navigation, activation of the central button of the navigator when the latter is on will result in the full selection of the element then highlighted. Depressing the Enter key on an associated keyboard would have the same effect. When
 30 the navigator is not on, full selection of the then pre-selected element can be achieved by clicking with the primary button of the mouse. As can be seen from Fig. 6, the invention makes it possible for the user to select elements of the model, even though they are not visible on the screen, directly from the graphical representation of the model, without having to display the hierarchical tree and to find the element to be selected in the tree.
 35 From a general standpoint, the invention allows for freely navigating in three-

5 dimensional computer generated models by using combinations of depth movements and hierarchical shifts. Although the invention has been described with reference to a navigation control mechanism using arrow keys on a keyboard or a graphical user interface navigator, other forms of navigation control mechanisms, such as a voice control mechanism, a joystick, a joypad, a space mouse or a space ball, could be used.

10 Referring now to Fig. 7, a software program can start when the system detects movement of the mouse pointer over a pixel of the image of a model on the computer screen and pre-selects a selectable element corresponding to the location of the pointer. As mentioned above in relation to Fig. 5a, the pre-selected element may be any selectable element on the depth axis at the pixel reached by the pointer. When the movement stops,
 15 the program waits for a user interaction 710 to determine if the then pre-selected element is the one the user wants to select. Activating an arrow key on the keyboard or activating an arrow on the navigator can both function to « press an arrow ». If the user interaction consists in pressing the up arrow 721, the program shifts the pre-selection to the next further away selectable element along the depth axis. If the user interaction consists in
 20 pressing the down arrow 722, the program shifts the pre-selection to the next closer selectable element on the depth axis. If the user interaction consists in pressing the left arrow 723, the program shifts the pre-selection to the selectable element of the next higher level in the design specification tree. If the user interaction consists in pressing the right arrow 724, the program shifts the pre-selection to the element of the next lower
 25 level in the design specification tree. It will be readily understood that, although these various types of user interactions are shown on the flow diagram to be tested in a particular sequence, any particular sequence can be programmed or the program can just wait for a particular interaction to take place without testing the arrows in sequence. After any one of steps 731-734, the program enters the navigation mode at step 743 and
 30 waits for the next user interaction. Depending on the particular design option retained, the navigator can be set on at this step 743. In another option, it could be set on directly at step 710.

The program then tests at step 725 if the navigator is on. If so, the program tests at step 735 if the mouse pointer has moved out of the limits of the navigator area. If not,
 35 the program tests at step 741 if the central button of the navigator or the Enter key of the

5 keyboard has been activated. If so, navigation stops at step 750 and the currently pre-selected element is fully selected at step 742 and the process ends.

If the program detects at step 725 that the navigator is not on, it then goes on to test if the primary button of the mouse is activated. If so, the currently pre-selected element is fully selected at step 742 and the process ends.

10 If the program detects at step 735 that the mouse has moved out of the navigation limits, navigation is stopped at step 736 and the program returns to a wait state. If the Enter mechanism at step 741 has not been activated, the program returns to a wait state. The same occurs if, at step 740, the primary button of the mouse has not been activated.

The invention may be implemented in digital electronic circuitry, or in computer
15 hardware, firmware, software, or in combinations of them. Apparatus of the invention may be implemented in a computer program product tangibly embodied in a machine-readable storage device for execution by a programmable processor; and method steps of the invention may be performed by a programmable processor executing a program of instructions to perform functions of the invention by operating on input data and
20 generating output. The invention may advantageously be implemented in one or more computer programs that are executable on a programmable system including at least one programmable processor coupled to receive data and instructions from, and to transmit data and instructions to, a data storage system, at least one input device, and at least one output device. Each computer program may be implemented in a high-level procedural
25 or object-oriented programming language, or in assembly or machine language if desired; and in any case, the language may be a compiled or interpreted language. Suitable processors include, by way of example, both general and special purpose microprocessors. Generally, a processor will receive instructions and data from a read-only memory and/or a random access memory. Storage devices suitable for tangibly
30 embodying computer program instructions and data include all forms of non-volatile memory, including by way of example semiconductor memory devices, such as EPROM, EEPROM, and flash memory devices; magnetic disks such as internal hard disks and removable disks; magneto-optical disks; and CD-ROM disks. Any of the foregoing may be supplemented by, or incorporated in, specially designed ASICs (application-specific
35 integrated circuits).

5 Other embodiments are within the scope of the following claims.

WHAT IS CLAIMED IS:

1. A method of selecting an element of a computer generated model graphically represented on a computer screen, wherein each selectable element of the model occupies a position in a hierarchical tree describing the model, the method comprising:

detecting a position of a pointer on the screen;

pre-selecting a first selectable element of the model on an axis extending from the position of the pointer along a predetermined direction wherein the direction is not in the plane of the screen;

moving pre-selection from said first selectable element to a second selectable element responsive to activation of a navigation control mechanism, wherein said second selectable element occupies a position in the hierarchical tree which is different from a position occupied by said first element; said activation of the navigation control mechanism allowing for movements to higher and lower levels in the hierarchical tree; and

activating a selection mechanism to select said second element.

2. The method of claim 1 wherein activation of the navigation control mechanism further allows for movements along the spatial depth of the model.

3. The method of any one of claims 1 and 2, additionally comprising the step of defining a navigation limit inclusive of a specified position of the pointer, wherein movement of the pointer within the navigation limit does not change the specified position of the pointer.

4. The method of claim 3 wherein a programmable menu is located within the navigation limit.

5. The method of any one of claims 1 to 4 wherein the navigation control mechanism is a set of directional arrow keys on a keyboard associated with the computer, a first group of directional arrow keys in the set corresponding to a movement along the spatial depth of the model and a second group of directional arrow keys corresponding to a movement to higher and lower levels in the hierarchical tree, and wherein the step of

moving pre-selection from the first selectable element to the second selectable element comprises:

detecting activation of the directional arrow keys; and

moving pre-selection according to the movement determined by the activated directional arrow keys.

6. The method of any one of claims 1 to 5 wherein the second position occupies a different level on the hierarchical tree than the first position.

7. The method of claim 1 wherein the step of moving pre-selection from the first selectable element to the second selectable element comprises:

displaying on the screen a user activatable navigation control mechanism as a set of directional indicators, a first group of directional indicators in the set corresponding to a movement along the spatial depth of the model and a second group of directional indicators in the set corresponding to a movement to higher and lower levels in the hierarchical tree;

detecting activation of the directional indicators; and

moving pre-selection according to the movement determined by the activated directional indicators.

8. The method of any one of claims 1 to 7 wherein the selection mechanism is an enter key on a keyboard associated with the computer.

9. The method of any one of claims 1 to 7 wherein the selection mechanism is a primary button on a pointing device.

10. The method of any one of claims 1 to 7 wherein the selection mechanism is a user activatable control displayed on a screen by a software program.

11. A computer readable medium having computer readable code embodied therein for causing a computer to select an element comprising a computer generated model, the computer readable code having instructions executable by a computer for:

detecting a position of a pointer on a computer screen;

pre-selecting a first selectable element of the model on an axis extending from the position of the pointer along a predetermined direction wherein the direction is not in the plane of the computer screen;

moving pre-selection from said first selectable element to a second selectable element responsive to activation of a navigation control mechanism, wherein said second selectable element occupies a position in the hierarchical -tree which is different from a position occupied by said first element; said activation of the navigation control mechanism allowing for movements to higher and lower levels in the hierarchical tree; and

activating a selection mechanism to select said second element.

12. The computer readable medium of claim 11, wherein the computer readable code further has instructions executable by a computer for:

testing for a selectable element on the axis extending from the position of the pointer and repositioning the pointer if a selectable element is not located along the axis extending from the position of the pointer.

13. The computer readable medium of claim 11, wherein the computer readable code further has instructions executable by a computer for:

defining a navigation limit inclusive of a specified position of the pointer, wherein movement of the pointer within the navigation limit does not change the specified position of the pointer.

14. A method for selecting at least one of a plurality of graphical elements for display on a computer screen depicting an x-y plane, said plurality of graphical elements being representative of features of a physical object and being aligned in a direction not in said x-y plane, at least one of said plurality of graphical elements being obscured by another of said plurality of graphical elements, the method comprising the steps of:

initially selecting said another of said plurality of graphical elements;

indicating that said another of said plurality of graphical elements has been selected;

receiving an input for selecting said at least one of said plurality of graphical elements;

selecting said at least one of said plurality of graphical elements; and

indicating that said at least one of said plurality of graphical elements has been selected.

15. The method of claim 14, wherein the step of indicating that said another of said plurality of graphical elements has been selected includes the step of highlighting said another of said plurality of graphical elements on said computer screen;

and wherein the step of indicating that said at least one of said plurality of graphical elements has been selected includes the step of highlighting said at least one of said plurality of graphical elements on said computer screen.

16. The method of claim 14, further comprising a hierarchical tree listing of said plurality of graphical elements, wherein the step of indicating that said another of said plurality of graphical elements has been selected includes the step of:

highlighting said another of said plurality of graphical elements in said hierarchical tree;

and wherein the step of indicating that said at least one of said plurality of graphical elements has been selected includes the step of:

highlighting said at least one of said plurality of graphical elements in said hierarchical tree.

17. The method of claim 14, further comprising a hierarchical tree having a plurality of levels, at least some of said levels including at least a single graphical element selected from said plurality of graphical elements, with at least some of said levels including at least two graphical elements selected from said plurality of graphical elements, the method further comprising the steps of:

receiving an input for selecting one of said levels;

selecting all of said graphical elements included in said one of said levels; and

indicating that said all of said graphical elements included in said one of said levels have been selected.

18. The method of claim 17, wherein the step of indicating that said all of said graphical elements included in said one of said levels have been selected includes the steps of:

highlighting said all of said graphical elements included in said one of said levels on said computer screen; and

highlighting said one of said levels in said hierarchical tree.

19. The method of claim 14, wherein the steps of initially selecting said another of said plurality of graphical elements and of selecting said at least one of said plurality of graphical elements include the step of:

activating a navigation control mechanism.

20. The method of claim 19, wherein the navigation control mechanism includes keys on a keyboard associated with said computer screen and the step of activating a navigation control mechanism includes the step of:

activating said keys.

21. The method of claim 19, wherein said navigation control mechanism includes selection indicators displayed on said computer screen and the step of activating a navigation control mechanism includes the step of:

activating said selection indicators.

22. A computer system comprising a processor operatively interconnected to a memory, an input device and a display device depicting a plane, wherein a plurality of graphical elements are depicted by way of said display device so as to be aligned in a direction not in said plane and so that at least one of said plurality of graphical elements is obscured by another of said plurality of graphical elements, the plurality of graphical elements being representative of features of a physical object, the computer system including electronic circuitry and software for selecting one of said plurality of graphical elements for display on the display device according to the steps of:

initially selecting said another of said plurality of graphical elements;

indicating that said another of said plurality of graphical elements has been selected;

receiving an input for selecting said at least one of said plurality of graphical elements;

selecting said at least one of said plurality of graphical elements; and

indicating that said at least one of said plurality of graphical elements has been selected.

23. The computer system of claim 22, wherein the step of indicating that said another of said plurality of graphical elements has been selected includes the step of:

highlighting said another of said plurality of graphical elements on said display device;

and the step of indicating that said at least one of said plurality of graphical elements has been selected includes the step of:

highlighting said at least one of said plurality of graphical elements on said display device.

24. The computer system of claim 22, further comprising a hierarchical tree listing of said plurality of elements, wherein the steps of indicating that said another of said plurality of graphical elements has been selected includes the step of:

highlighting said another of said plurality of graphical elements in said hierarchical tree;

and wherein the step of indicating that said at least one of said plurality of graphical elements has been selected includes the step of:

highlighting said at least one of said plurality of graphical elements in said hierarchical tree.

25. The computer system of claim 22, further comprising a hierarchical tree having a plurality of levels, at least some of said levels including a single graphical element selected from said plurality of graphical elements, with at least some of said levels including at least two graphical elements selected from said plurality of graphical elements, said electronic circuitry and software further being operative to perform the steps of:

receiving an input for selecting one of said levels;

selecting all of said graphical elements included in said one of said levels; and
indicating that said all of said graphical elements included in said one of said
levels have been selected.

26. The computer system of claim 25, wherein the step indicating that said all of said graphical elements included in said one of said levels have been selected includes:

highlighting said all of said graphical elements included in said one of said levels
on said display device; and

highlighting said one of said levels in said hierarchical tree.

27. The computer system of claim 22, the computer system further comprising a navigation control mechanism which is operable to perform said steps of initially selecting said another of said plurality of graphical elements and of selecting said at least one of said plurality of graphical elements.

28. The computer system of claim 27, wherein the navigation control mechanism includes keys on a keyboard associated with said computer screen and the navigation control mechanism is activated using said keys.

29. The computer system of claim 27, wherein said navigation control mechanism includes selection indicators displayed on said display device and the navigation control mechanism activates said selection indicators.

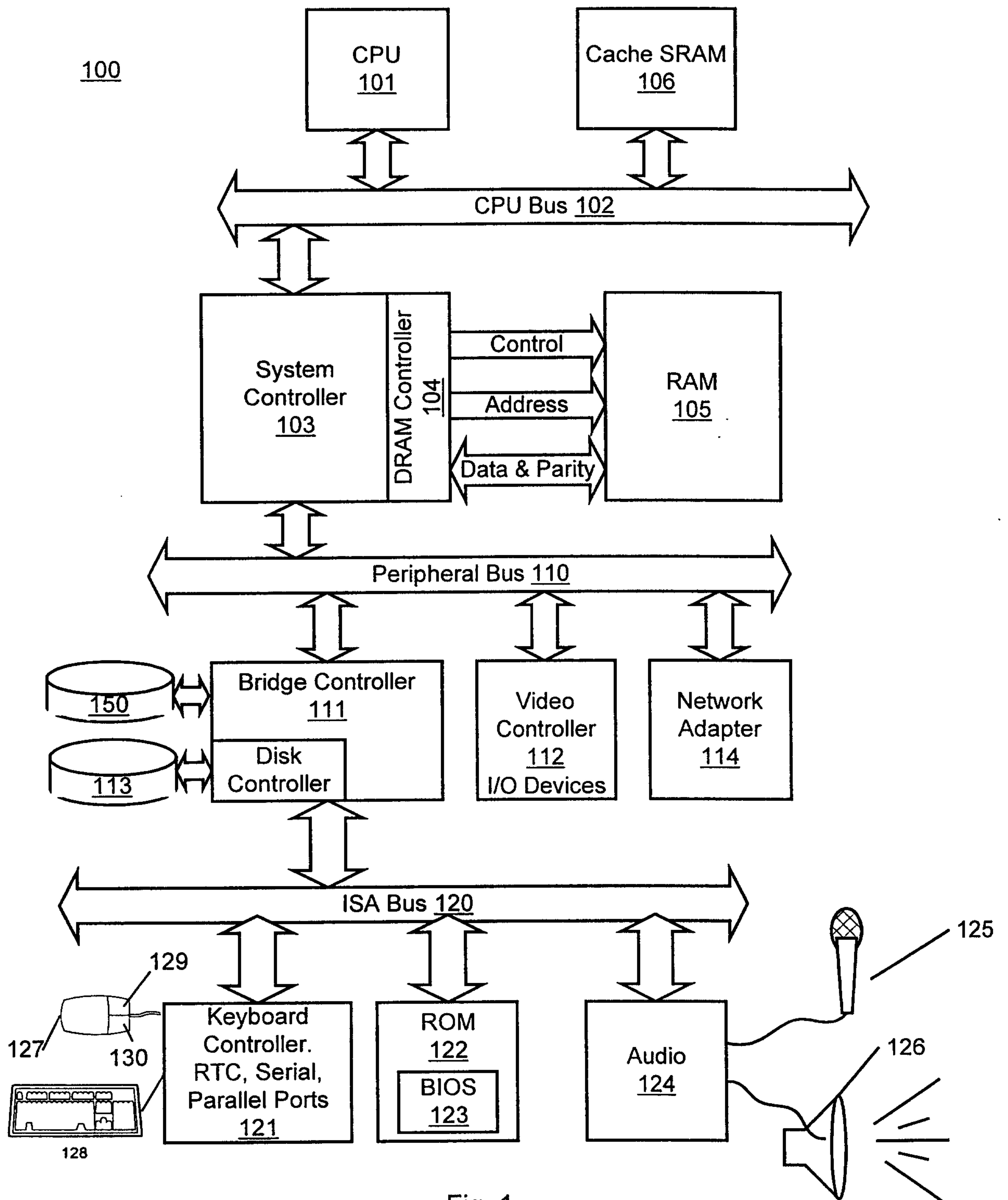


Fig. 1
(Prior Art)

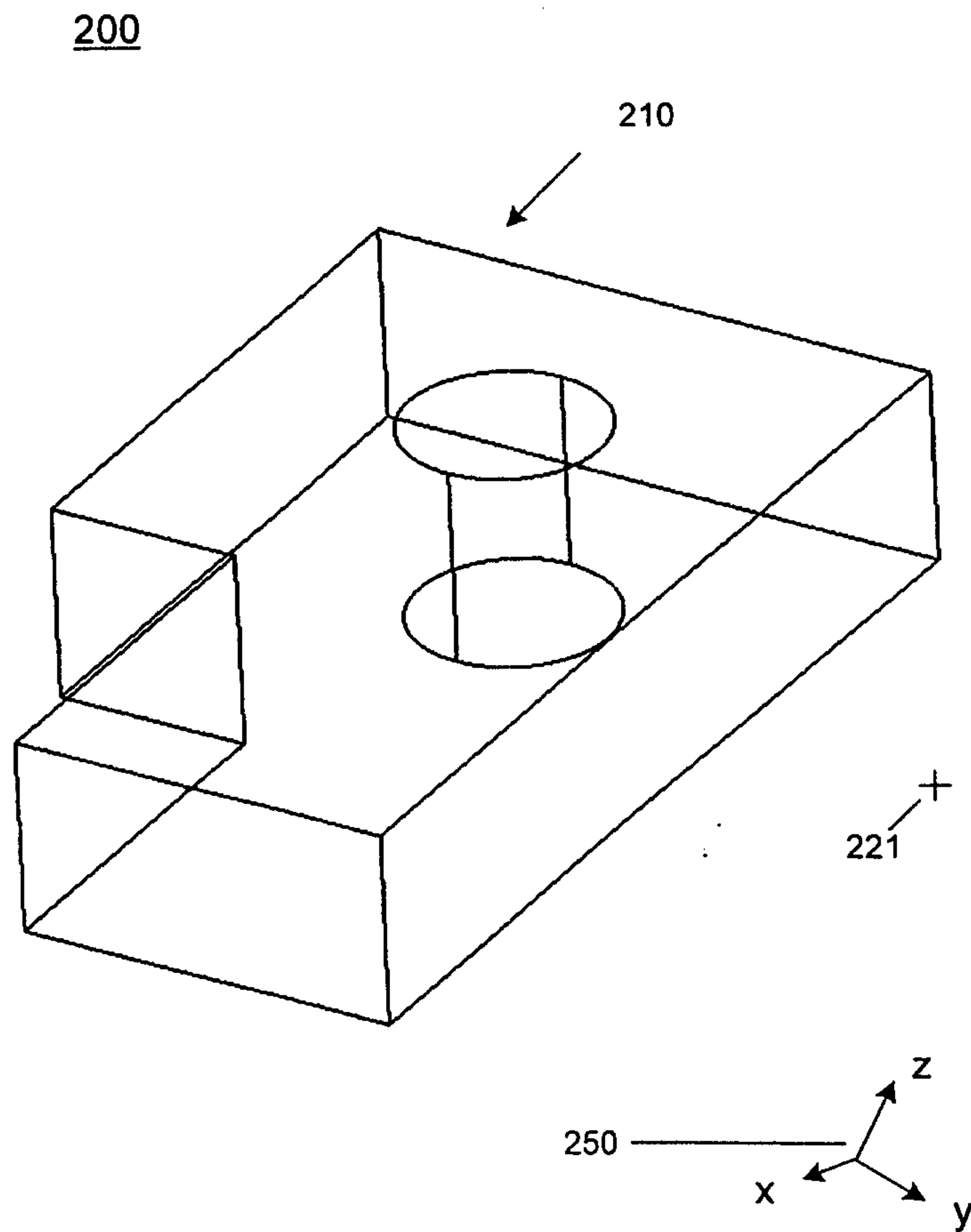
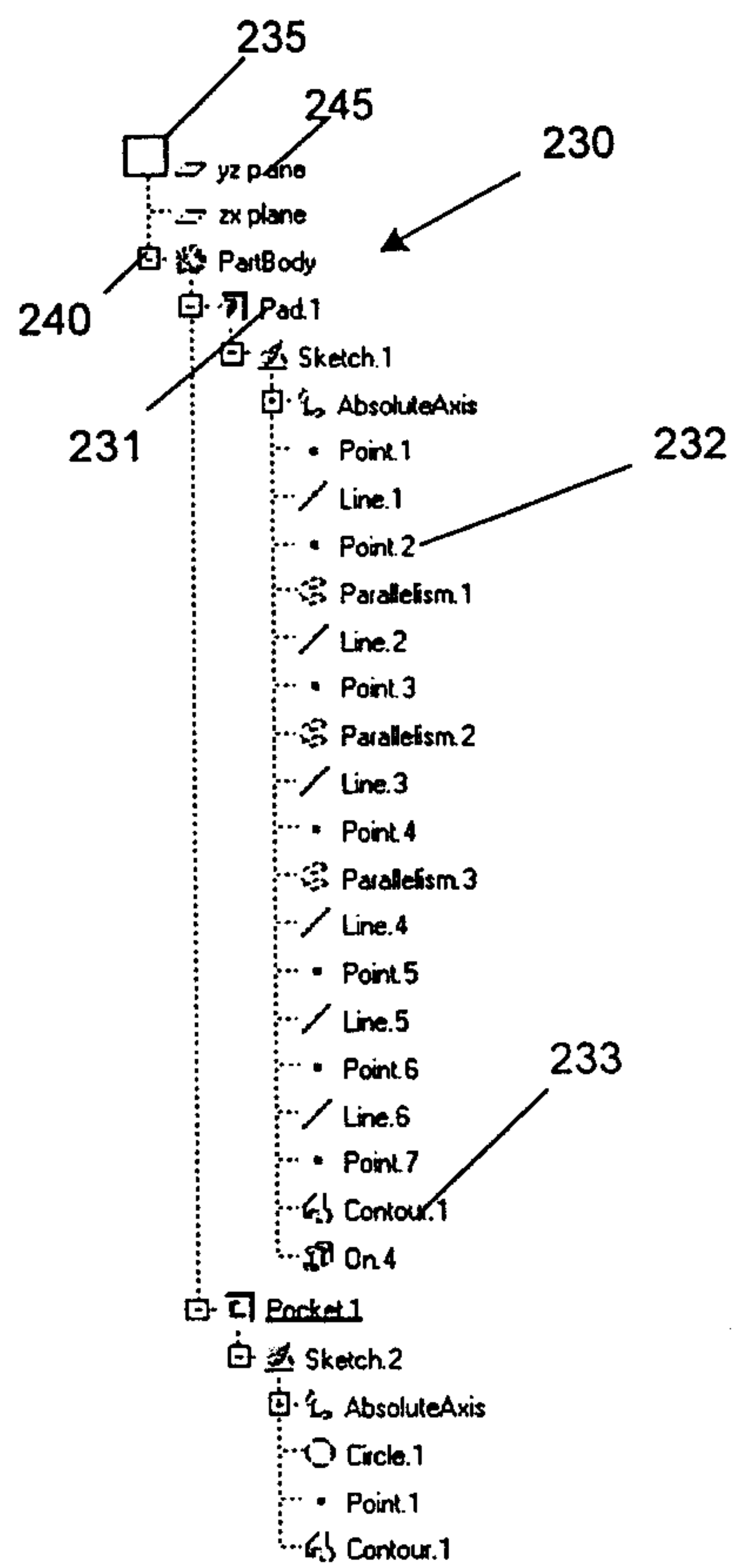


FIG. 2

PartV5R1
xy plane
yz plane
zx plane
PartBody
Pad.1
Sketch.1
AbsoluteAxis
Point.1
Line.1
Point.2
Parallelism.1
Line.2
Point.3
Parallelism.2
Line.3
Point.4
Parallelism.3
Line.4
Point.5
Line.5
Point.6
Line.6
Point.7
Contour.1
On.4
Pocket.1
Sketch.2
AbsoluteAxis
Circle.1

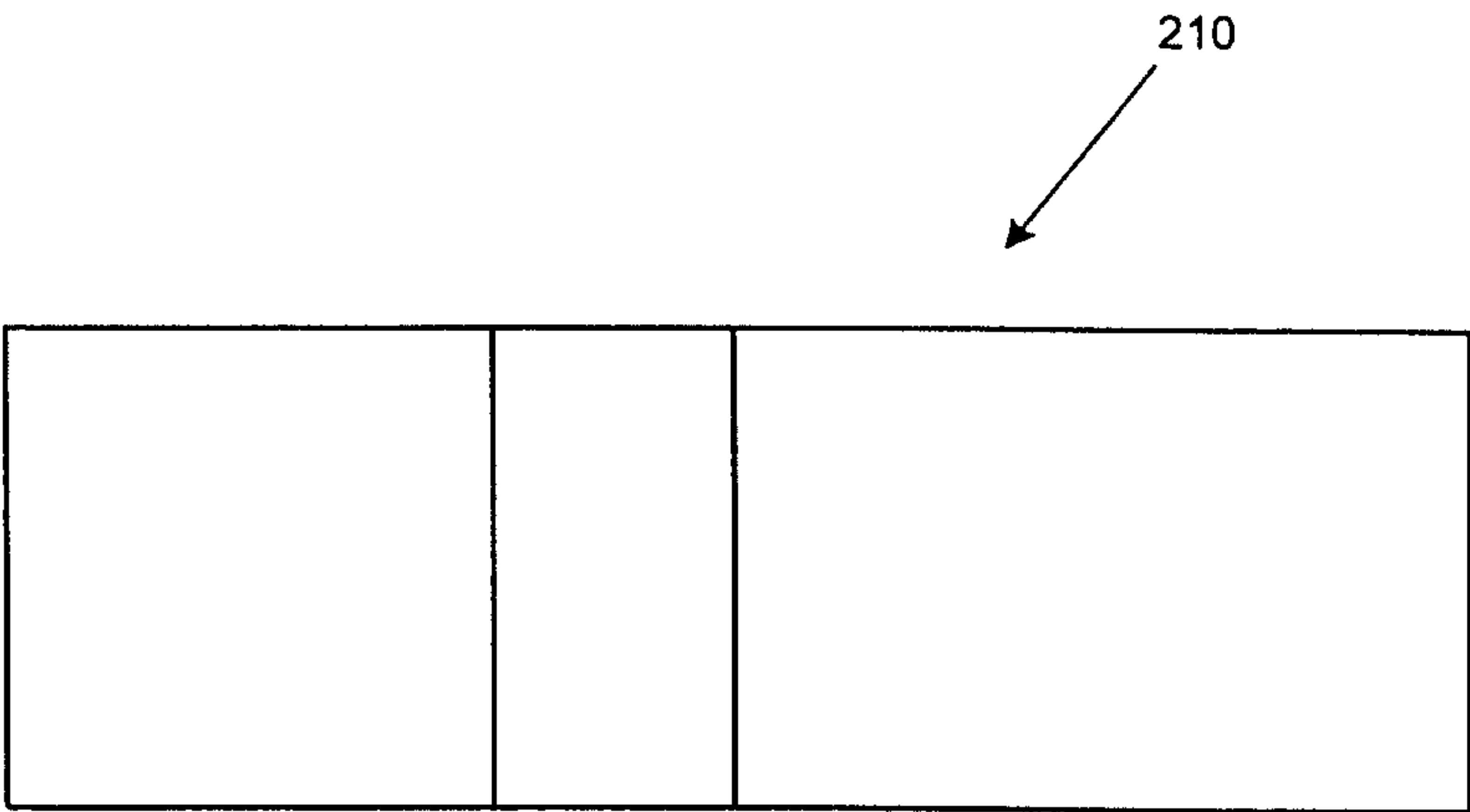


FIG. 3

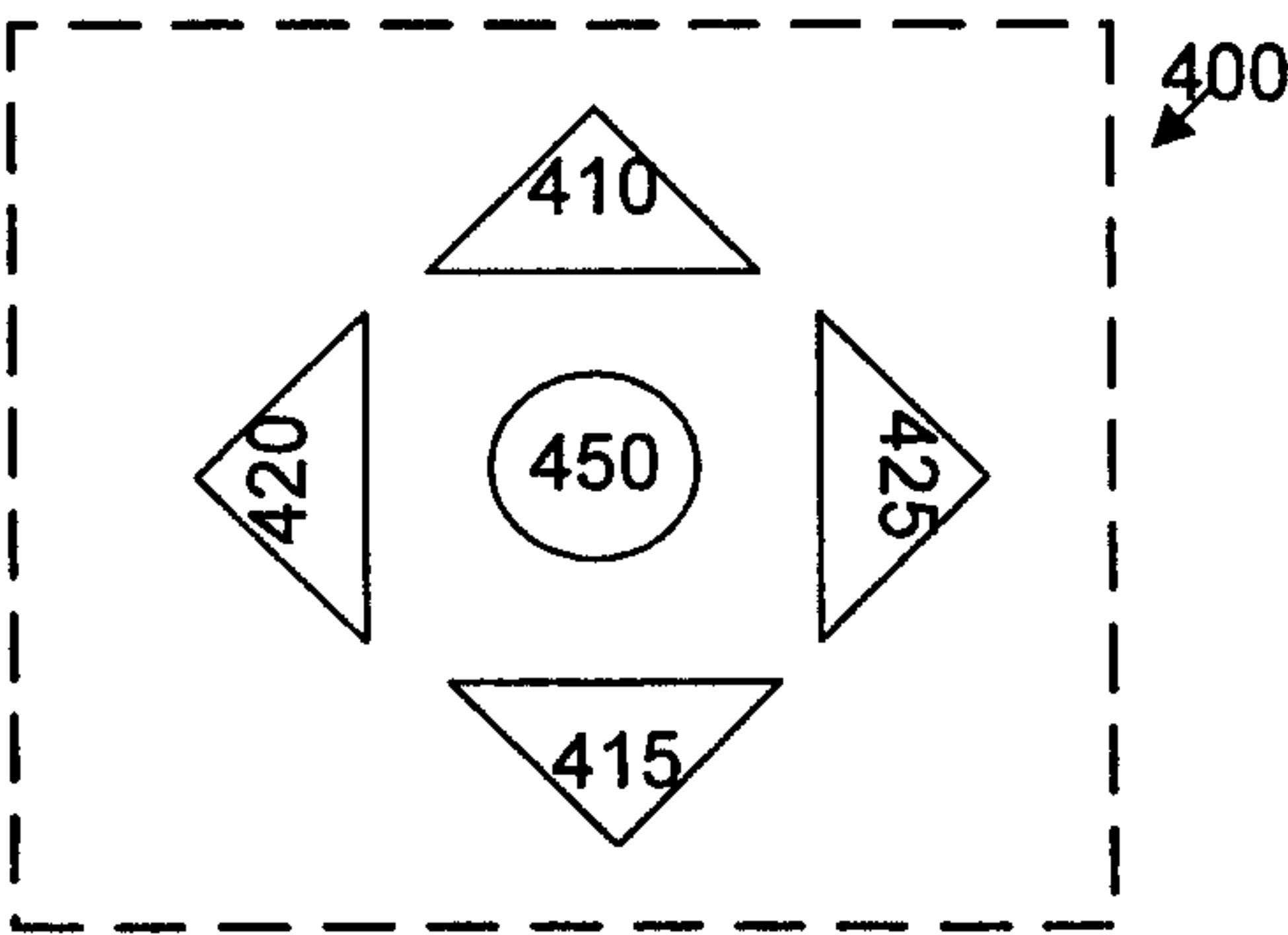


FIG. 4

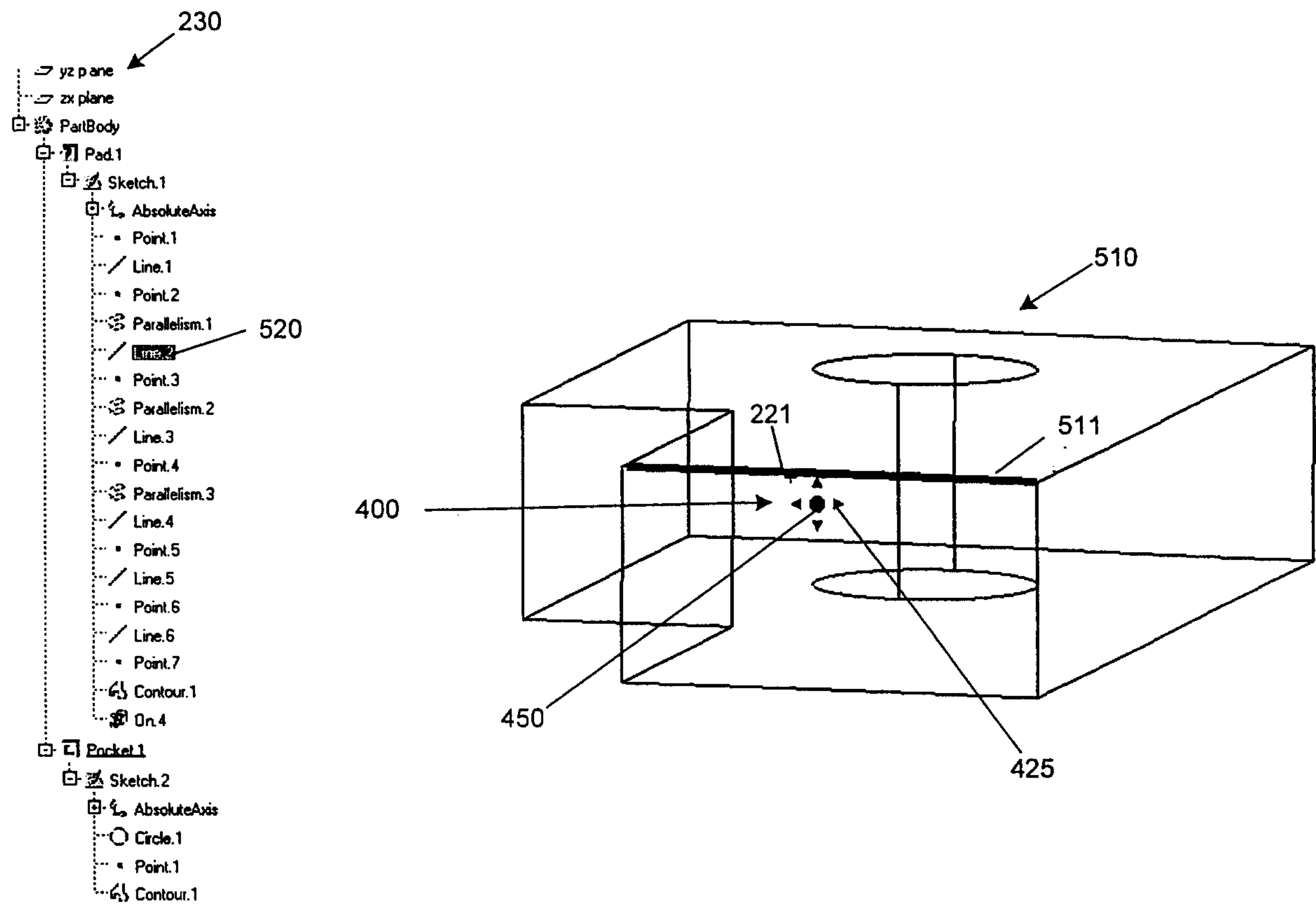


FIG. 5a

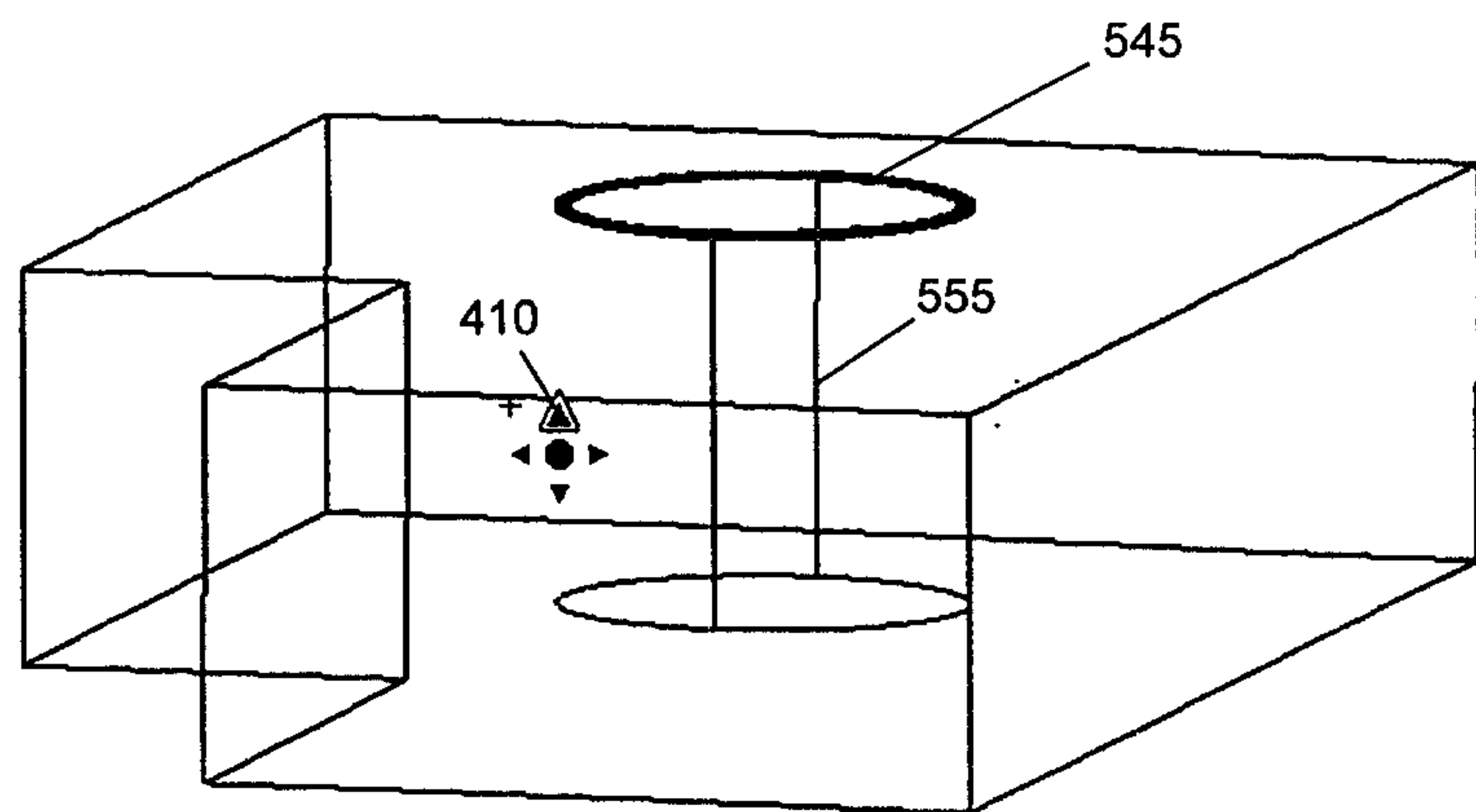
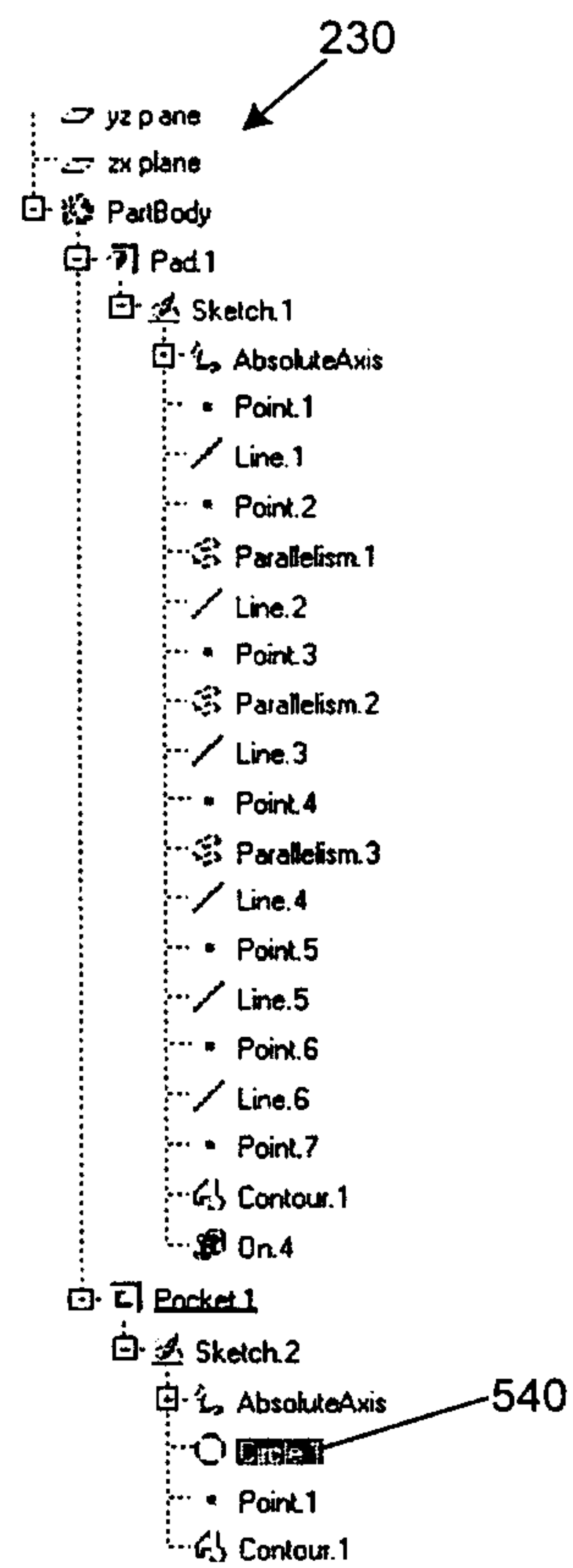


FIG. 5b

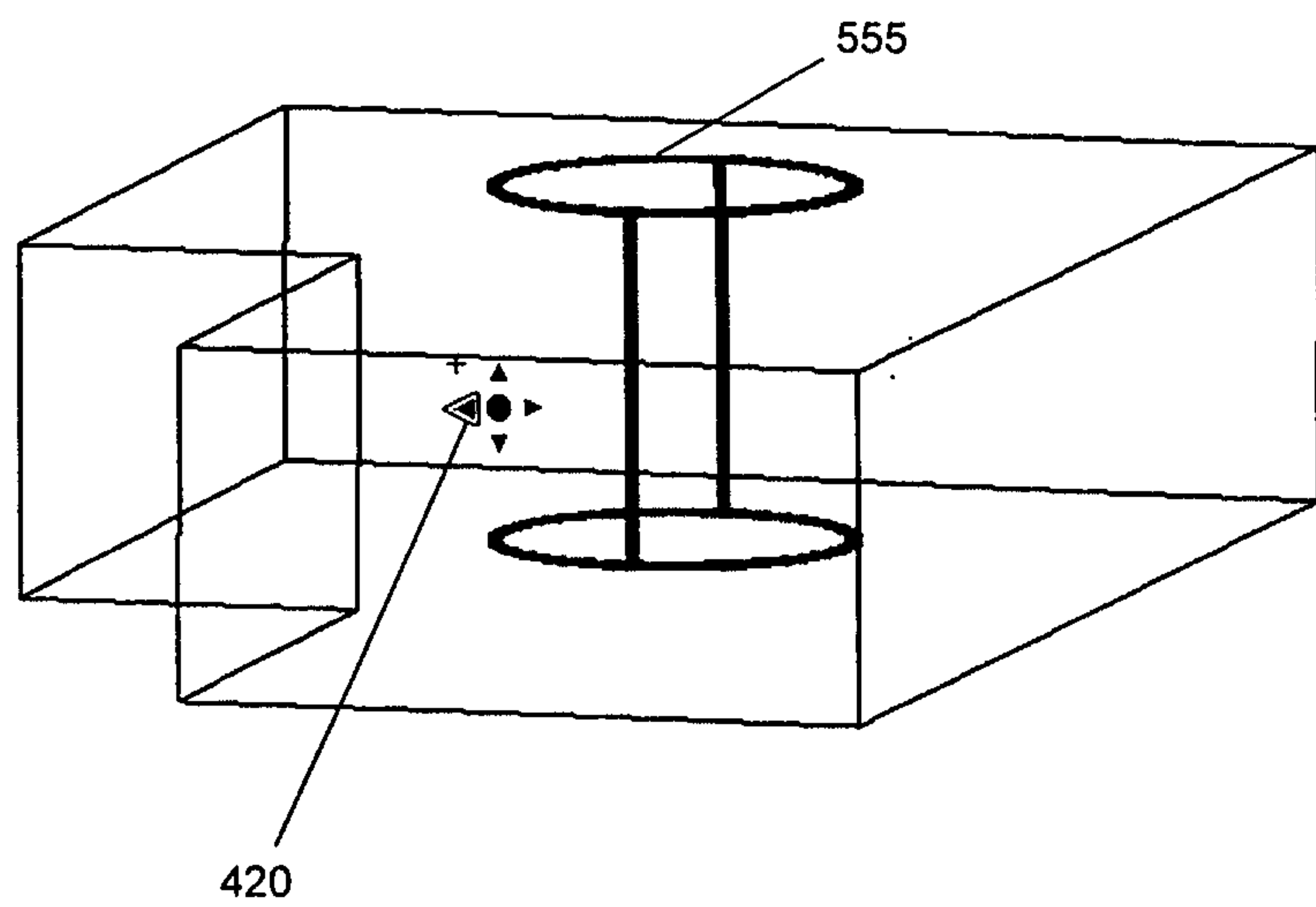
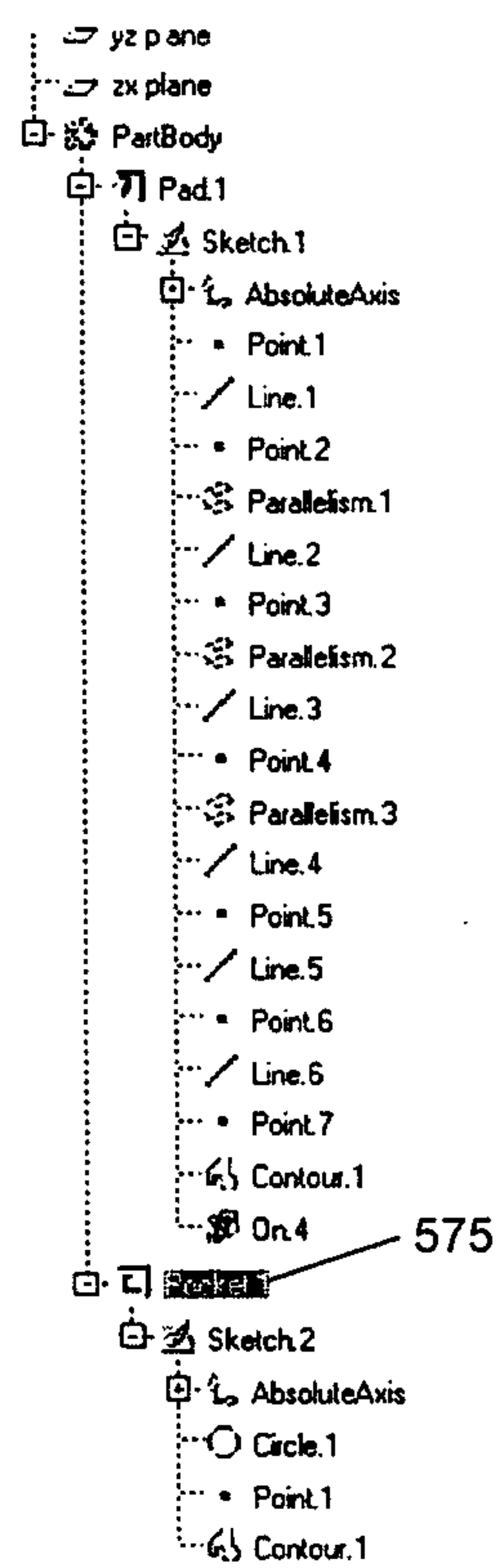


FIG. 5c

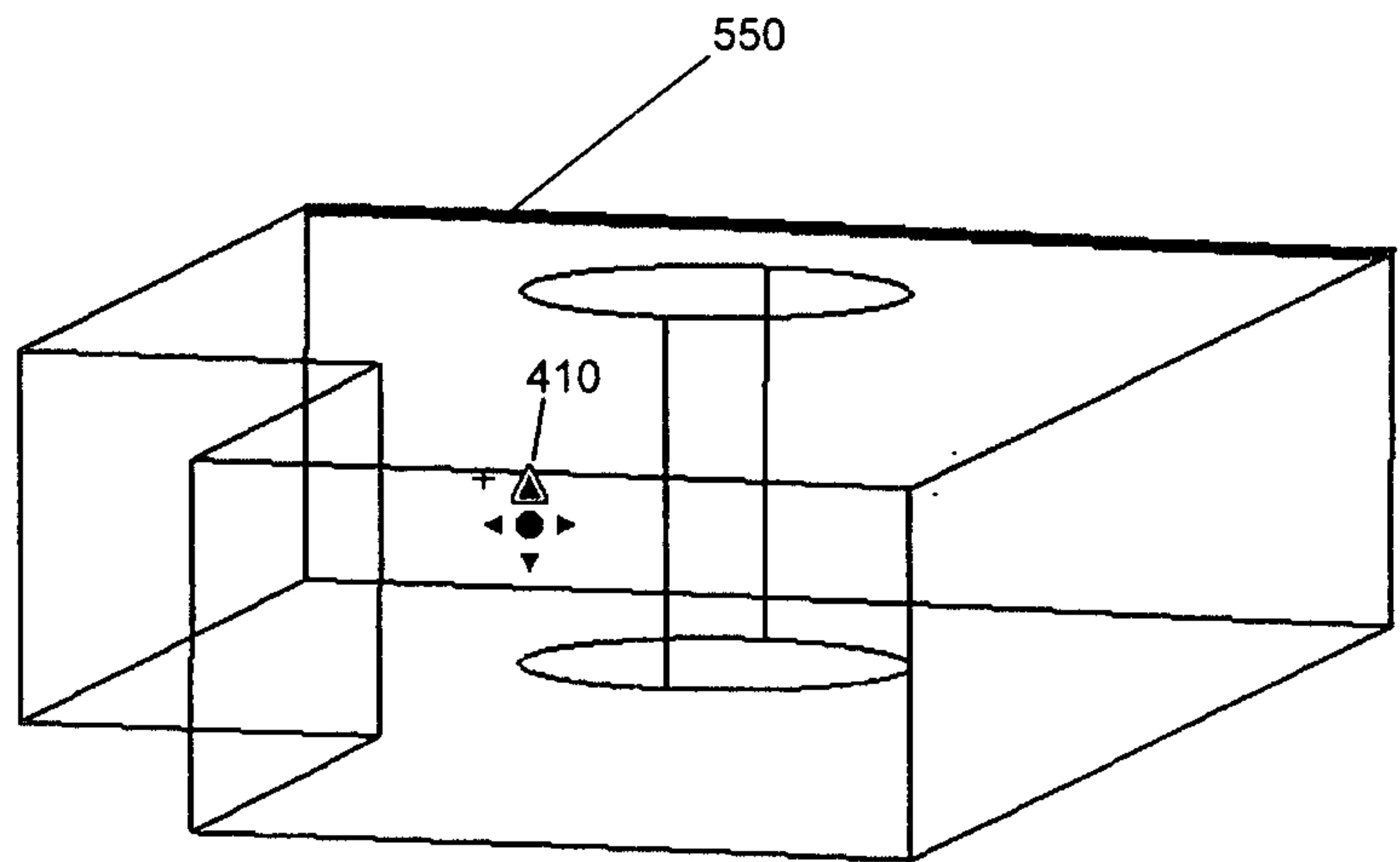
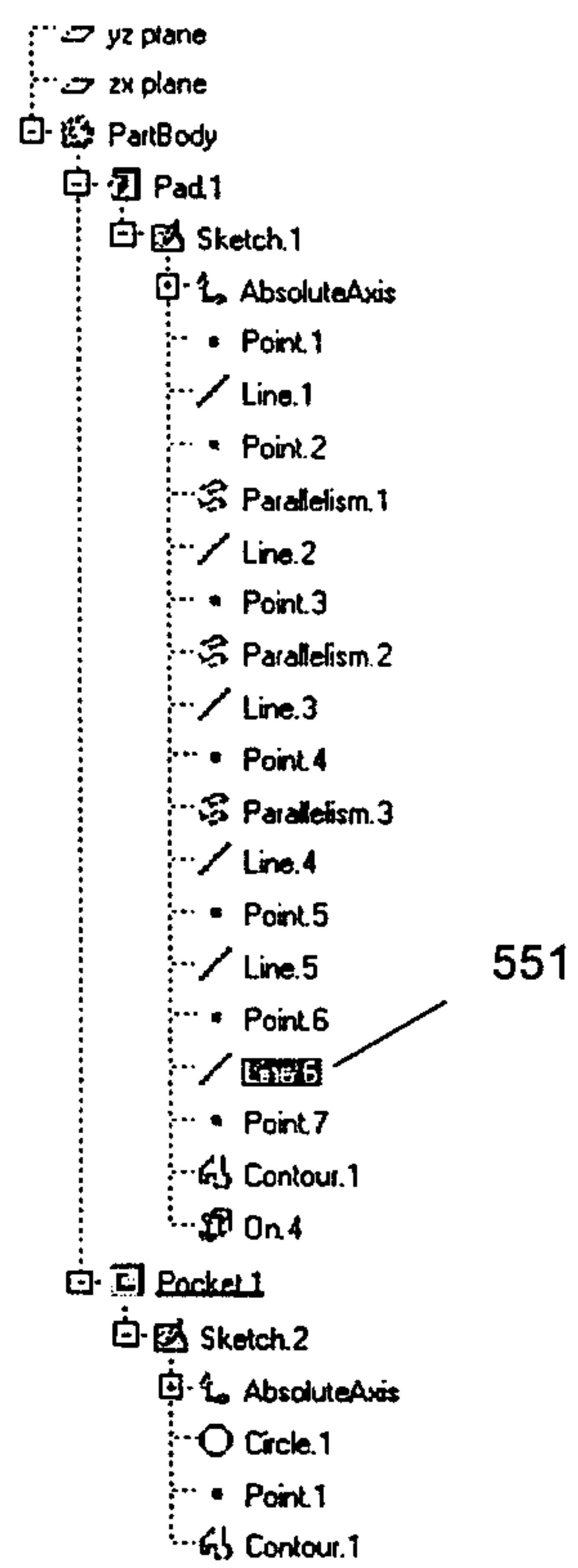


FIG. 5d

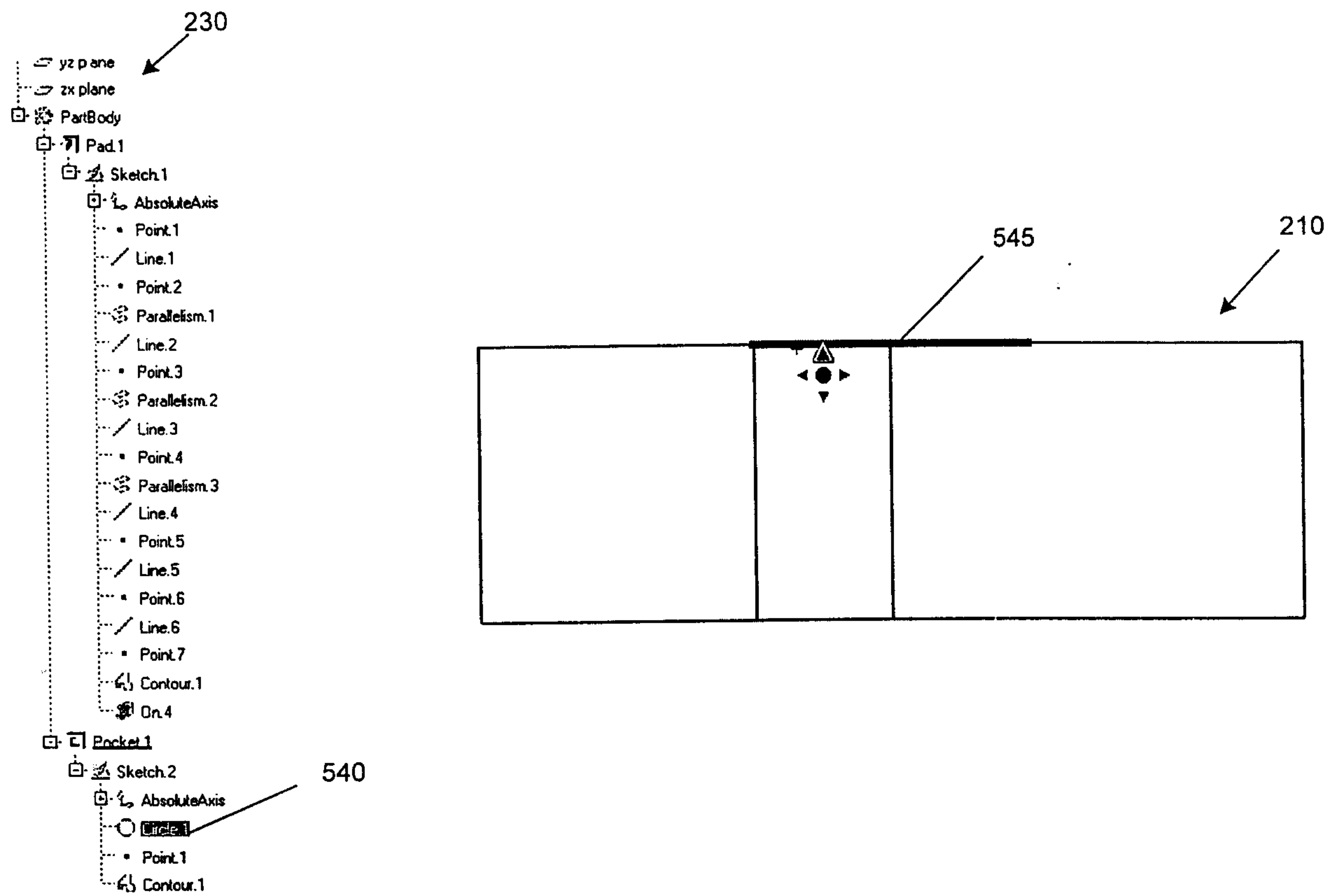


FIG. 6

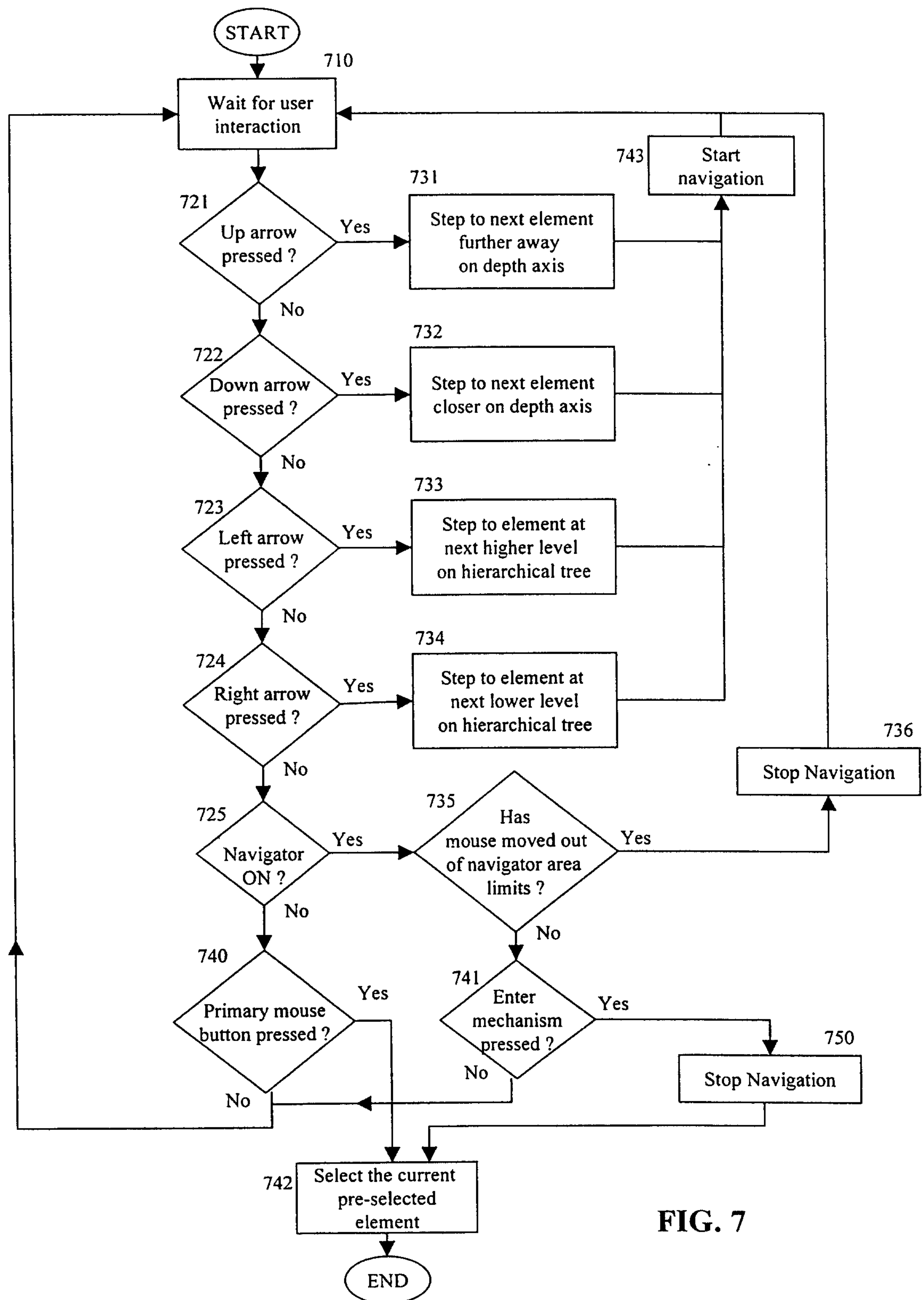


FIG. 7

