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Hullot

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[54] SYSTEM AND METHOD FOR CONFIGURING A GRAPHIC INTERFACE

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[73] Assignee: NeXT Computer, Inc., Redwood City, Calif.

[21] Appl. No.: 879,126

[22] Filed: May 5, 1992

Related U.S. Application Data

[63] Continuation of Ser. No. 419,764, Oct. 11, 1989, abandoned.

[51] Int. Cl.^{5} G06F 15/20
[52] U.S. Cl. 395/148
[58] Field of Search 395/144-149, 395/155, 157, 159, 161

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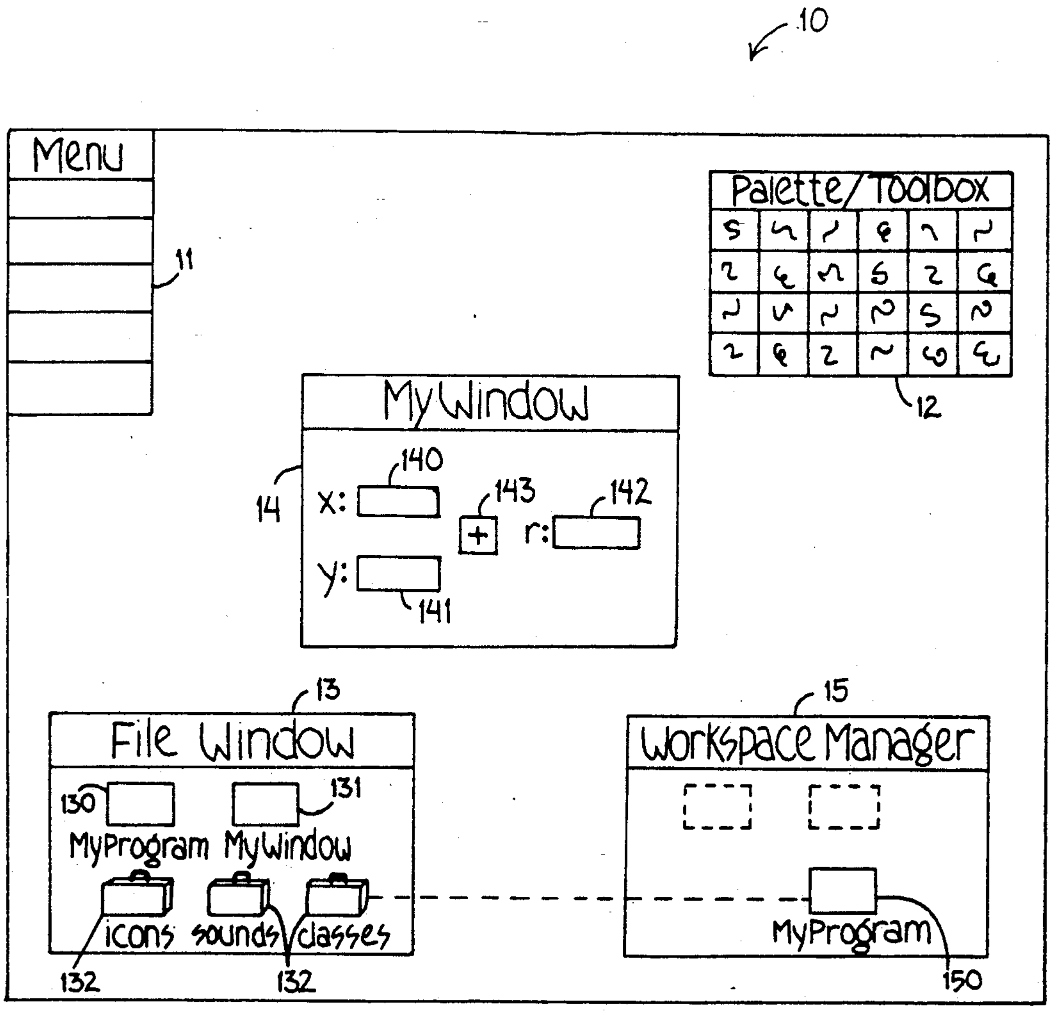
Attorney, Agent, or Firm—Laurence S. Rogers; Jeffrey H. Ingerman

[57] **ABSTRACT**

A graphic interface configuration system is allows a user to create a graphic interface for a computer program in which graphic elements in the interface are linked to variables or functions in any one of a number of programming elements.

21 Claims, 11 Drawing Sheets



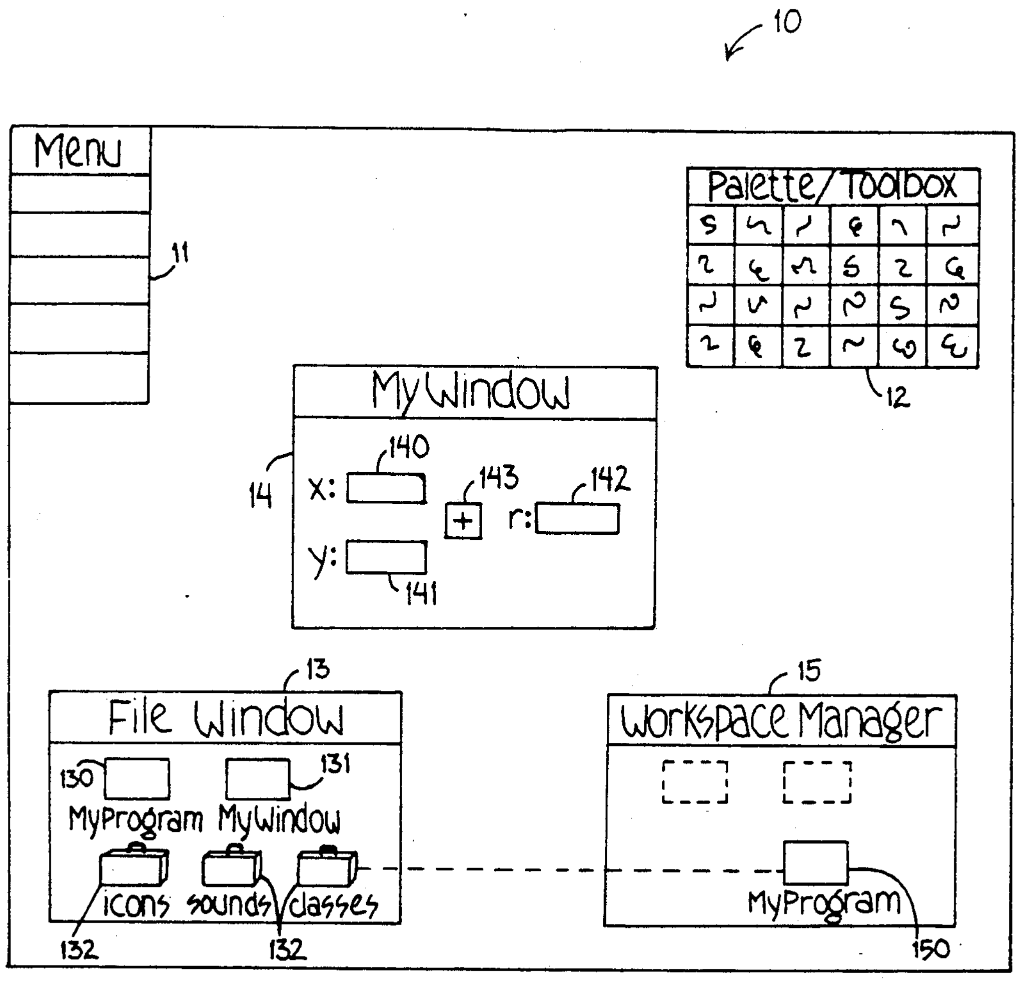

10
Menu
11
Palette/Toolbox
12
MyWindow
14
x:
140
143
142
r:
y:
141
13
File Window
130
131
MyProgram
MyWindow
icons
sounds
classes
132
132
15
Workspace Manager
MyProgram
150

FIG. 1

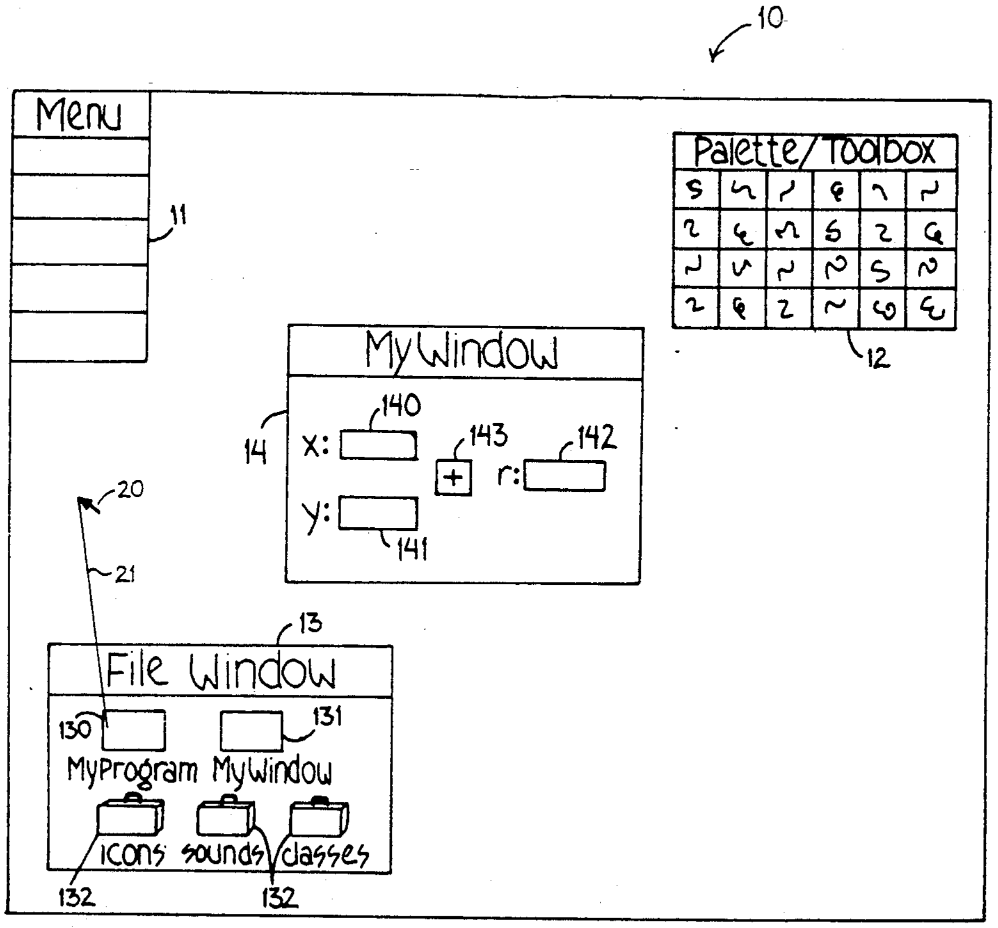

10
Menu
11
Palette/Toolbox
12
MyWindow
14
x:
140
143
+
r:
142
y:
141
20
21
13
File Window
130
131
MyProgram
MyWindow
icons
sounds
classes
132
132

FIG. 2

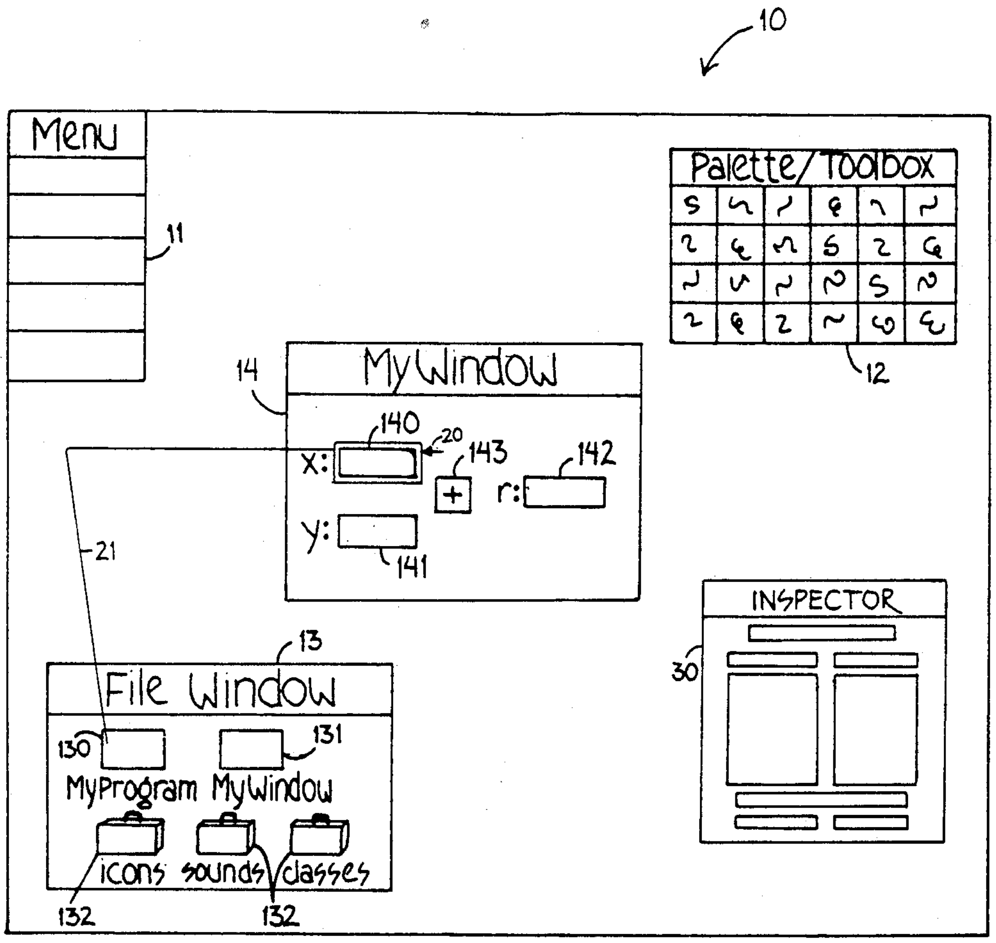

10
Menu
11
Palette/Toolbox
12
14
MyWindow
140
20
143
142
x:
+
r:
y:
141
21
13
File Window
130
131
MyProgram
MyWindow
icons
sounds
classes
132
132
INSPECTOR
30

FIG. 3

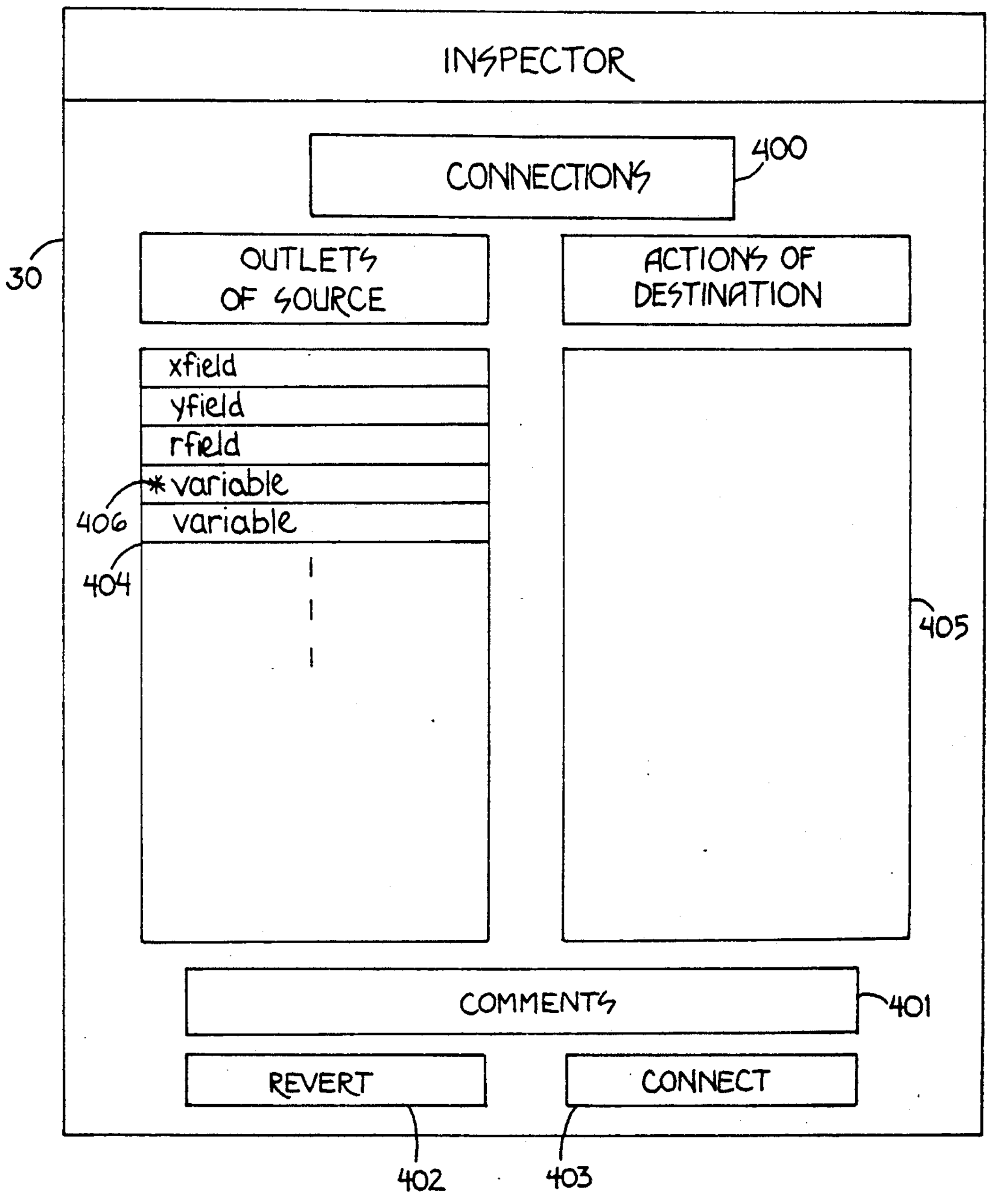

INSPECTOR
CONNECTIONS
400
30
OUTLETS OF SOURCE
ACTIONS OF DESTINATION
xfield
yfield
rfield
*variable
variable
406
404
405
COMMENTS
401
REVERT
CONNECT
402
403

FIG. 4

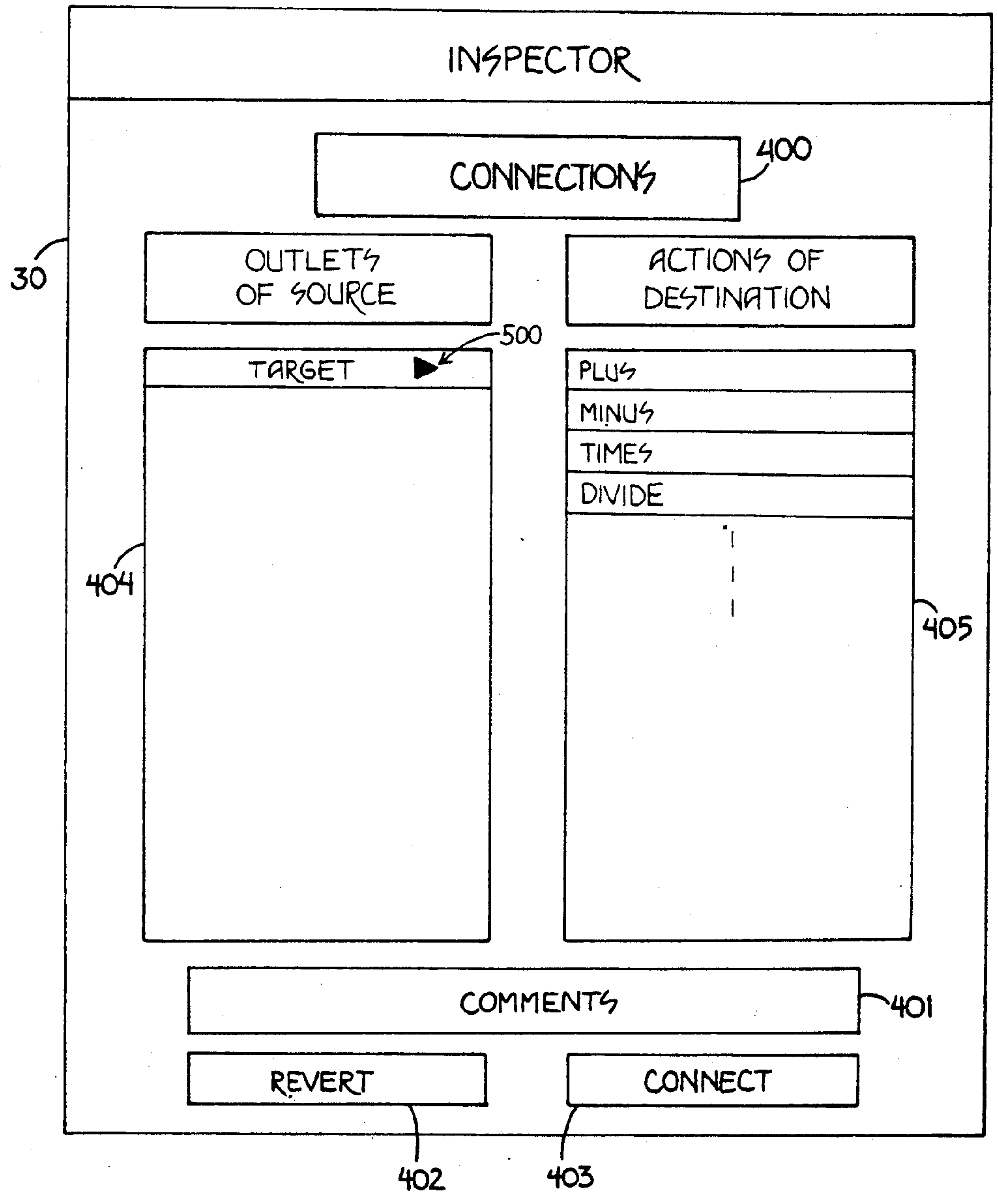
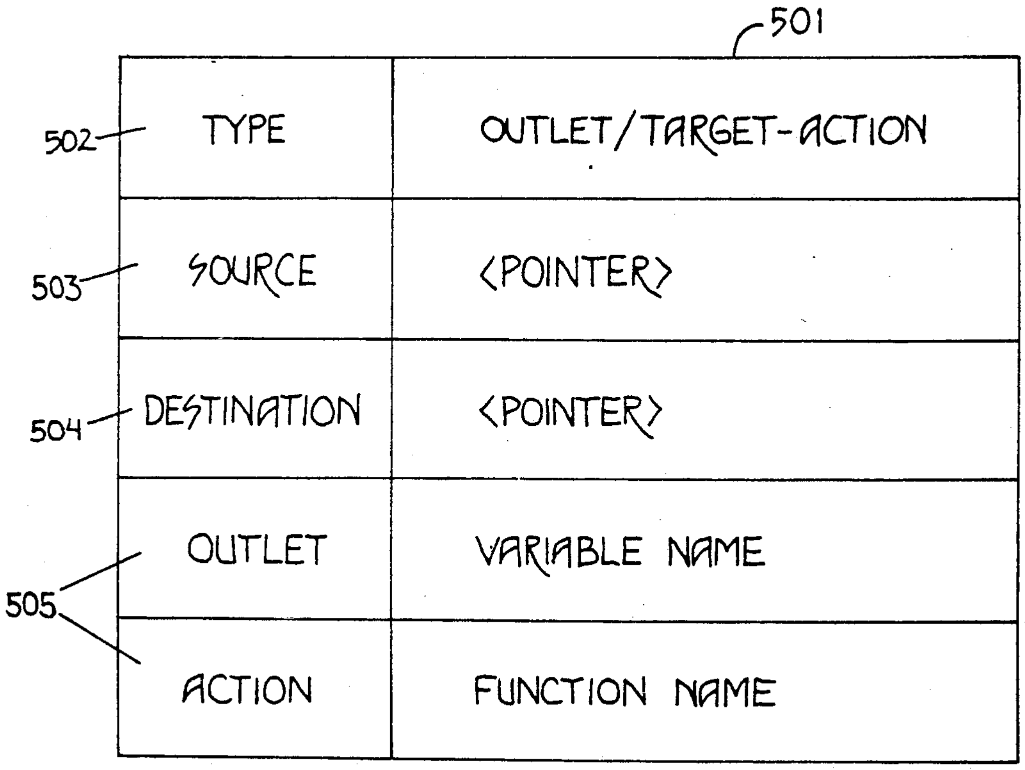
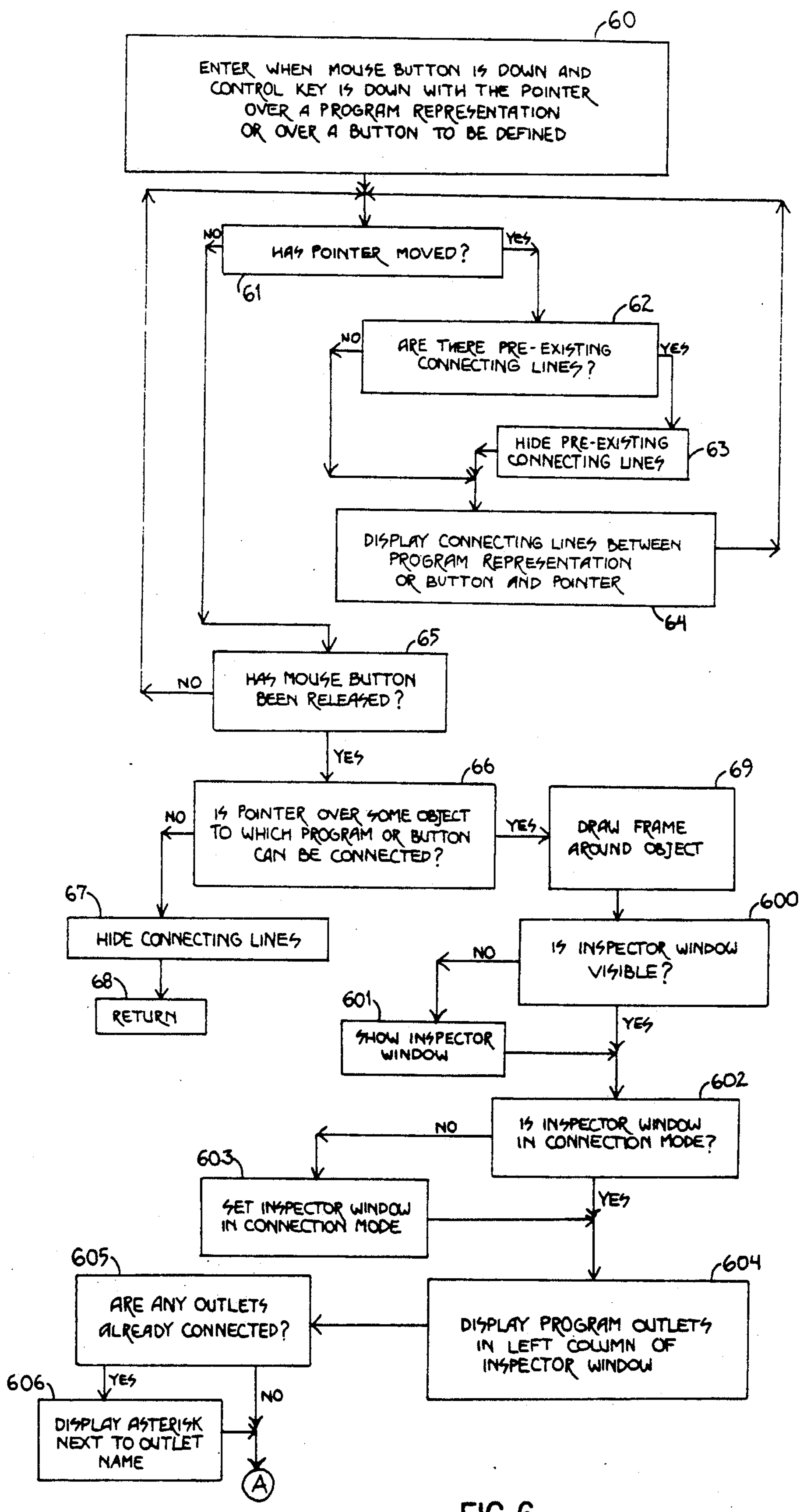

INSPECTOR
CONNECTIONS
400
30
OUTLETS OF SOURCE
ACTIONS OF DESTINATION
500
TARGET
PLUS
MINUS
TIMES
DIVIDE
404
405
COMMENTS
401
REVERT
CONNECT
402
403

FIG. 5


501
502
503
504
505

TYPE	OUTLET/TARGET-ACTION
SOURCE	<POINTER>
DESTINATION	<POINTER>
OUTLET	VARIABLE NAME
ACTION	FUNCTION NAME

FIG. 5A



60
ENTER WHEN MOUSE BUTTON IS DOWN AND CONTROL KEY IS DOWN WITH THE POINTER OVER A PROGRAM REPRESENTATION OR OVER A BUTTON TO BE DEFINED
NO
HAS POINTER MOVED?
YES
61
62
NO
ARE THERE PRE-EXISTING CONNECTING LINES?
YES
HIDE PRE-EXISTING CONNECTING LINES
63
DISPLAY CONNECTING LINES BETWEEN PROGRAM REPRESENTATION OR BUTTON AND POINTER
64
65
NO
HAS MOUSE BUTTON BEEN RELEASED?
YES
66
NO
IS POINTER OVER SOME OBJECT TO WHICH PROGRAM OR BUTTON CAN BE CONNECTED?
YES
69
DRAW FRAME AROUND OBJECT
67
HIDE CONNECTING LINES
68
RETURN
600
NO
IS INSPECTOR WINDOW VISIBLE?
601
SHOW INSPECTOR WINDOW
YES
602
NO
IS INSPECTOR WINDOW IN CONNECTION MODE?
603
SET INSPECTOR WINDOW IN CONNECTION MODE
YES
605
ARE ANY OUTLETS ALREADY CONNECTED?
604
DISPLAY PROGRAM OUTLETS IN LEFT COLUMN OF INSPECTOR WINDOW
606
YES
NO
DISPLAY ASTERISK NEXT TO OUTLET NAME
A

FIG. 6

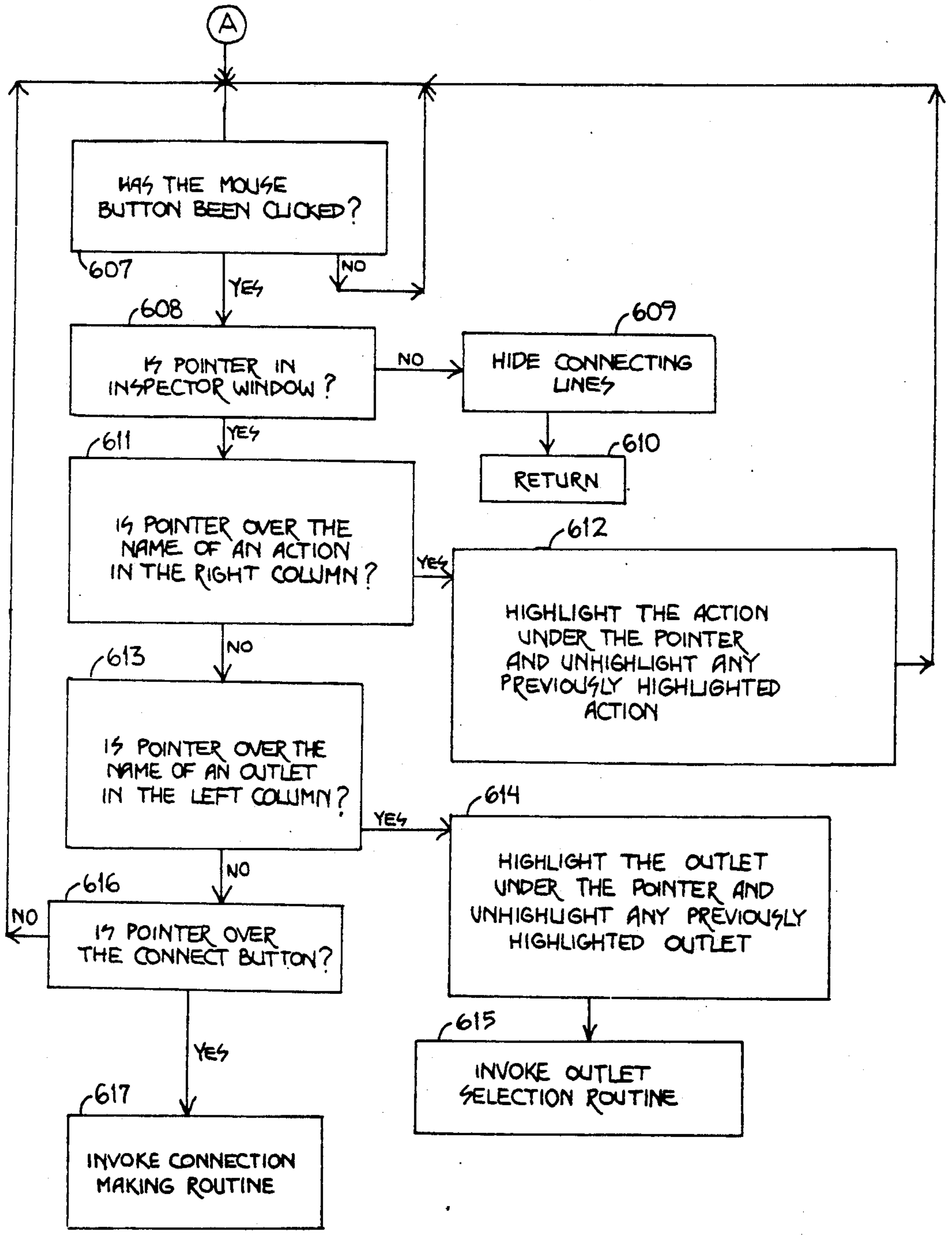

A
HAS THE MOUSE BUTTON BEEN CLICKED?
607
NO
YES
608
IS POINTER IN INSPECTOR WINDOW?
NO
609
HIDE CONNECTING LINES
610
RETURN
YES
611
IS POINTER OVER THE NAME OF AN ACTION IN THE RIGHT COLUMN?
YES
612
HIGHLIGHT THE ACTION UNDER THE POINTER AND UNHIGHLIGHT ANY PREVIOUSLY HIGHLIGHTED ACTION
NO
613
IS POINTER OVER THE NAME OF AN OUTLET IN THE LEFT COLUMN?
YES
614
HIGHLIGHT THE OUTLET UNDER THE POINTER AND UNHIGHLIGHT ANY PREVIOUSLY HIGHLIGHTED OUTLET
NO
616
NO
IS POINTER OVER THE CONNECT BUTTON?
615
INVOKE OUTLET SELECTION ROUTINE
YES
617
INVOKE CONNECTION MAKING ROUTINE

FIG. 6A

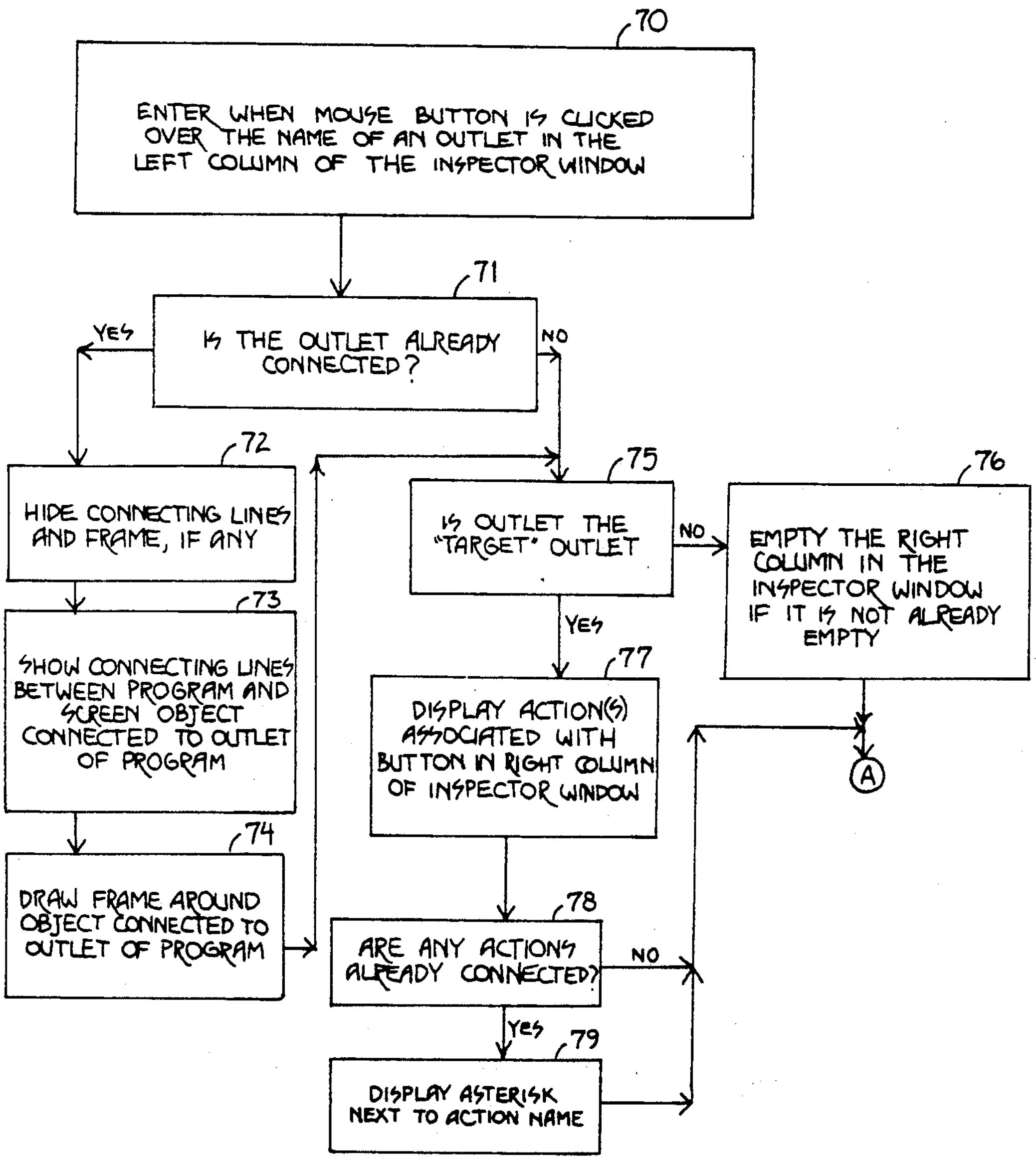

70
ENTER WHEN MOUSE BUTTON IS CLICKED OVER THE NAME OF AN OUTLET IN THE LEFT COLUMN OF THE INSPECTOR WINDOW
71
IS THE OUTLET ALREADY CONNECTED?
YES
NO
72
HIDE CONNECTING LINES AND FRAME, IF ANY
73
SHOW CONNECTING LINES BETWEEN PROGRAM AND SCREEN OBJECT CONNECTED TO OUTLET OF PROGRAM
74
DRAW FRAME AROUND OBJECT CONNECTED TO OUTLET OF PROGRAM
75
IS OUTLET THE "TARGET" OUTLET
NO
76
EMPTY THE RIGHT COLUMN IN THE INSPECTOR WINDOW IF IT IS NOT ALREADY EMPTY
YES
77
DISPLAY ACTION(S) ASSOCIATED WITH BUTTON IN RIGHT COLUMN OF INSPECTOR WINDOW
A
78
ARE ANY ACTIONS ALREADY CONNECTED?
NO
YES
79
DISPLAY ASTERISK NEXT TO ACTION NAME

FIG. 7

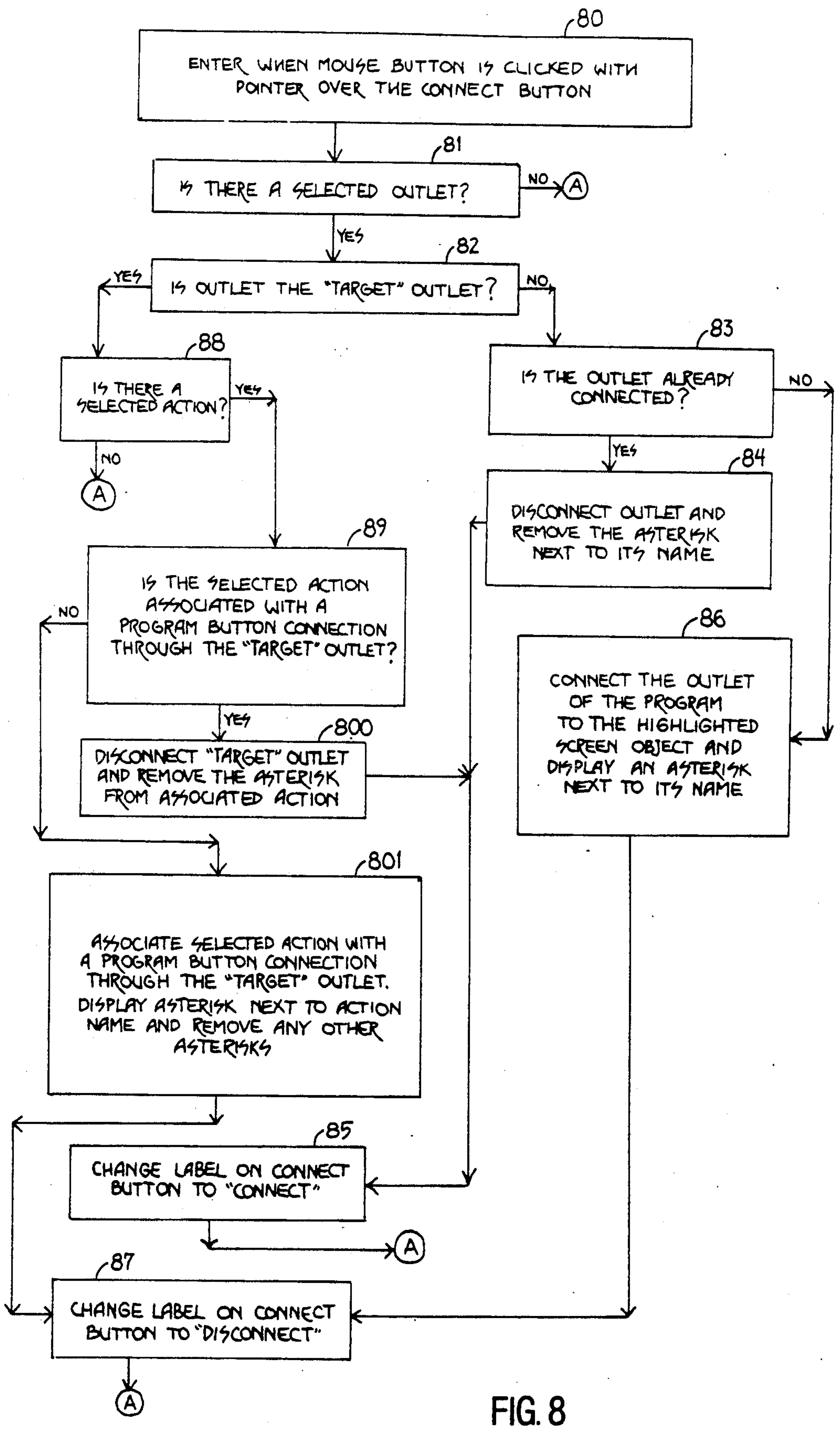
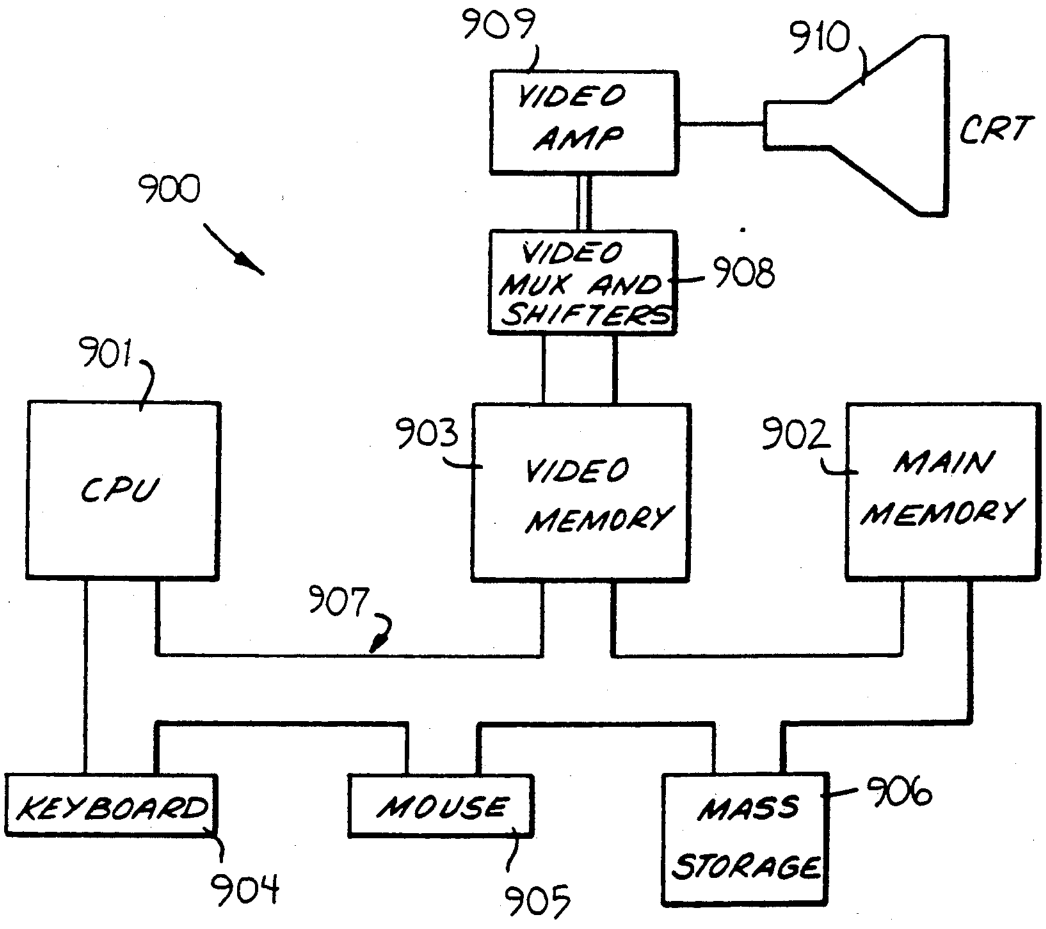

80
ENTER WHEN MOUSE BUTTON IS CLICKED WITH POINTER OVER THE CONNECT BUTTON
81
IS THERE A SELECTED OUTLET?
NO
A
YES
82
IS OUTLET THE "TARGET" OUTLET?
YES
NO
88
IS THERE A SELECTED ACTION?
YES
NO
A
83
IS THE OUTLET ALREADY CONNECTED?
NO
YES
84
DISCONNECT OUTLET AND REMOVE THE ASTERISK NEXT TO ITS NAME
89
IS THE SELECTED ACTION ASSOCIATED WITH A PROGRAM BUTTON CONNECTION THROUGH THE "TARGET" OUTLET?
NO
YES
800
DISCONNECT "TARGET" OUTLET AND REMOVE THE ASTERISK FROM ASSOCIATED ACTION
86
CONNECT THE OUTLET OF THE PROGRAM TO THE HIGHLIGHTED SCREEN OBJECT AND DISPLAY AN ASTERISK NEXT TO ITS NAME
801
ASSOCIATE SELECTED ACTION WITH A PROGRAM BUTTON CONNECTION THROUGH THE "TARGET" OUTLET. DISPLAY ASTERISK NEXT TO ACTION NAME AND REMOVE ANY OTHER ASTERISKS
85
CHANGE LABEL ON CONNECT BUTTON TO "CONNECT"
A
87
CHANGE LABEL ON CONNECT BUTTON TO "DISCONNECT"
A

FIG. 8

FIG. 9


909
VIDEO AMP
910
CRT
900
VIDEO MUX AND SHIFTERS
908
901
CPU
903
VIDEO MEMORY
902
MAIN MEMORY
907
KEYBOARD
904
MOUSE
905
MASS STORAGE
906

SYSTEM AND METHOD FOR CONFIGURING A GRAPHIC INTERFACE

This is a continuation of application Ser. No. 07/419,764, filed Oct. 11, 1989, abandoned entitled SYSTEM AND METHOD FOR CONFIGURING A GRAPHIC INTERFACE.

BACKGROUND OF THE INVENTION

This invention relates to computers having graphically-oriented user interfaces. More particularly, this invention relates to such computers which provide the facility for users to create their own graphic interfaces for application programs that they write. Most particularly, this invention relates to a system and method for allowing users to link graphic elements of interfaces that they create to specific variables and functions in their application programs.

Computer systems are known in which the operating system provides a graphic interface with the computer user. The user can run application programs, manipulate files, and perform substantially all other functions needed by the average user by manipulating graphic images on the computer's display, either by using cursor control keys and other keyboard keys or by using a cursor controlling peripheral device such as a joystick, "mouse" or track ball.

In such a system, programs are frequently represented by small graphic images that identify the programs to the user. For example, a word processing program might be represented by a graphic image of a piece of paper having lines of text on it and a writing instrument such as a pencil or a quill pen writing on the page. A program is invoked by moving the cursor or a pointer to the graphic image representing the program (e.g., by using a mouse), and then pressing the appropriate button (e.g., the mouse button or the "Enter" key on the keyboard).

Similar facility is provided within programs that run on such systems. Thus, within the word processing program referred to above, various graphic elements are arranged within various windows which can be opened with the mouse, and the various graphic elements invoke various functions of the program (e.g., create a new document, retrieve an existing document, delete a document, print a document). These graphic interface features within applications programs are created by the writer of the program, based on knowledge of the operating system of the computer for which the software is written.

More recently, it has been known to provide as part of the operating system of some computers a graphic interface configuration utility that allows users to create graphic interfaces for their own application programs by using a set of "tools" provided in a "palette/toolbox" that appears on the screen when the utility is in use. The tools include line drawing functions, the ability to apply certain colors or shading to certain elements placed on the screen, and the ability to place boxes and other items (e.g., "buttons") at desired locations on the screen. The ability to create fields into which text or variables (e.g., for mathematical formulae) can be entered is also available. For example, a user may have written a simple program to give as a result the sum of two numbers, x and y, entered by the end user. Therefore, the user would use the graphic interface configuration utility to create three fields on the screen—one for x, one for y,

and one for the result, as well as a button to invoke the part of the program that performs the calculation. In order for such an interface to function, the fields must be linked to the appropriate variables in the underlying program, and the button must be linked to the appropriate code for performing the desired function (here, addition). The known graphic interface configuration utility provided a way for those links to be made in the case of the functional button, but not in the case of the variable fields. The program itself had to link the variables to the variable fields.

Furthermore, graphic-interface-oriented computers frequently use object-oriented programming languages, such as object-oriented C or objective FORTRAN. In such programming languages, programs are divided into a plurality of programming elements known as objects. In the known graphic interface configuration utility, when a particular window and its contents are defined, any button-type graphic elements in the window could be linked to portions of a single programming element or object, but not to different objects, which frequently limits the ability of the user to configure an interface to achieve a desired result. This is also a limitation when standard programming languages are used and more than one program is involved.

It would be desirable to be able to provide a graphic interface configuration utility that would allow fields in the interface to be linked to variables in an underlying program.

It would also be desirable to be able to provide a graphic interface configuration utility that would allow graphic elements in the interface to be linked to variables or functions in any one of a number of programming elements.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a graphic interface configuration utility that allows fields in the interface to be linked to variables in an underlying program.

It is also an object of this invention to provide a graphic interface configuration utility that allows graphic elements in the interface to be linked to variables or functions in any one of a number of programming elements.

In accordance with this invention, a graphic interface configuration utility is provided for use in a computer system having a visual display on which an application program is represented by a graphic image, the application program having at least one program element having variables and action portions, and the application program being executed through a graphical program interface that provides windows on the display, which windows contain graphic elements representing user inputs. The graphic image and graphic elements are capable of being moved on said display by a user. The graphical program interface configuration system includes graphical definition means for creating the window, graphical placement means for placing at least one of the graphic elements in the window, and graphical connection means for logically connecting each graphic element to any one of a number of program elements.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects and advantages of the invention will be apparent upon consideration of the following detailed description, taken in conjunction with the accompanying drawings, in which like reference characters refer to like parts throughout, and in which:

FIG. **1** shows a screen display presented to a user of the graphic interface configuration system and method of the present invention;

FIG. **2** shows another screen display presented to a user of the graphic, interface configuration system and method of the present invention;

FIG. **3** shows another screen display presented to a user of the graphic interface configuration system and method of the present invention;

FIG. **4** shows a portion of the screen display of FIG. **3**;

FIG. **5** shows another form of the display of FIG. **4**;

FIG. **5**A shows a table of information stored in accordance with the present invention;

FIGS. **6** and **6**A (hereinafter collectively referred to as FIG. **6**) are a flow diagram of a portion of the process implemented by the system and method of the present invention when a user begins the connection process;

FIG. **7** is a flow diagram of a portion of the process implemented by another portion of the connection process of the system and method of the present invention;

FIG. **8** is a flow diagram of a portion of the process implemented by another portion of the connection process of the system and method of the present invention; and

FIG. **9** is a block diagram of an exemplary hardware configuration for a computer on which the system and method of the present invention are implemented.

DETAILED DESCRIPTION OF THE INVENTION

Although the graphic interface configuration system of the present invention can be used on computers using any number of programming languages, it is best suited to computers running object-oriented programming languages such as those described above, and the preferred embodiment of the invention is designed for a computer whose graphic interface is written in the object-oriented C programming language. Therefore, the discussion that follows will be tailored at least in part to object-oriented programming, and to object-oriented C programming in particular. It is to be understood, however, that the present invention is not limited to systems that run object-oriented programming languages.

The graphic interface configuration system of the present invention is a self-contained utility that is separate from the underlying programs for which it is used to create interfaces. The underlying programs can be written before or after the interface is created, and are generally capable of being executed without an interface created by the present invention, or even without any graphic interface at all.

A user of the present invention may invoke the graphic interface configuration system either before or after the underlying program, an interface for which is to be created, has been written. If the program has not been written, the present invention allows the user to define the existence of certain variables and functions sufficiently to allow the user to construct the necessary graphic interface. At the same time it creates a skeletal program in which the variables and data structures are defined, so that the user can go back afterwards and define the remainder of the program. The remainder of the discussion will assume that the program has been written, and that the interface configuration system of the invention has available to it knowledge of the pro-

gram structure. How that knowledge is acquired will be discussed below.

FIG. **1** is a diagrammatic representation of a computer display that is seen when a user has entered the graphic interface configuration system of the invention, has identified to the system the program file for which the interface is to be created, and has created the interface display screen. In this case, the user program, named myProgram, is a simple program, as described above, for taking two numbers, x and y, as inputs and displaying their sum as the result, r.

As shown in FIG. **1**, display **10** shows the interface configuration system menu **11** from which the user has already selected the new application function, a palette/toolbox **12** from which the user has selected a window, three boxes and a button, and a file window **13** displaying information regarding files being worked on. Specifically, file window **13** contains a graphic element **130** representing myProgram, which has no visual counterpart, a graphic element **131** representing myWindow, which is the window **14** being defined by the user, and three graphic elements **132** in the shape of suitcases which represent various file characteristics. The user can open and close myWindow **14** by clicking on its representation **131**.

The user has defined myWindow **14** to contain a field **140** preceded by a text label "x: ", a field **141** preceded by a text label "y: ", a field **142** preceded by a text label "r: ", and a button **143** labelled "+". The program is used by moving the pointer to field **140** and clicking the mouse button, thus allowing entry of the value x, then doing the same with field **141** to enter the value y, then moving the pointer to button **143** and clicking, which invokes the functional portion of myProgram, causing the sum of x and y to be displayed in field **142**.

In order to have the program work in this way, it is necessary to link fields **140–142** to the variables in myProgram representing x, y and r, and to link button **143** to the functional portion of myProgram. In accordance with the preferred embodiment of the present invention, such linkage, or connection, is established as follows:

To link a field to a variable in a program, the user selects the program by moving the pointer **20** to the representation of that program in file window **13** (although not the case in FIG. **1**, there maybe more than one program from which to choose), and clicking the mouse button while holding down the control (CTRL) key on the computer keyboard. While continuing to hold the mouse button down (the control key can be released), the user moves the mouse toward the field of interest, drawing a line **21**, as shown in FIG. **2**, from the program representation. When the line reaches the field of interest (e.g., field **140**) and the user releases the mouse button, the field is highlighted, as shown in FIG. **3**. At that point, a new window **30** appears on display **10**, unless it was already present from a previous activity. Window **30** is called the inspector window, and it is shown in more detail in FIG. **4**. In this mode of operation—i.e., the linking or "connection" mode—the function of inspector window **30** is to display the variables and function routines of the program to which graphic elements are to be connected, and to facilitate the making of such connections.

Inspector window **30** has a mode subwindow **400** which displays the mode of operation of inspector window **30**, which has several different modes of operation. As shown in FIG. **4**, inspector window **30** is in the connection mode. Inspector window **30** also has a comment subwindow **401** which displays different comments depending on the mode of operation and on what portion of inspector window **30** is highlighted. Inspector window **30** also has two "buttons" **402**, **403** which initiate functions when clicked on with the mouse. Button **402**, labelled "Revert", has no function, and in fact is disabled, in connection mode. Button **403**, labelled "Connect", serves a connect/disconnect function, as described in more detail below, in connection mode. Finally, inspector window **30** has two subwindows **404**, **405**, respectively labelled "Outlets of Source" and "Actions of Destination", which respectively list the variables and program function routines available for connection.

With the variables of myProgram displayed in subwindow **404**, the user moves the pointer to the desired variable and clicks to highlight it (not shown). The user then moves the pointer to the connect/disconnect button **403**, which is then labelled "Connect", and clicks. That establishes the connection between the variable and the field in myWindow that is highlighted. At that point, a flag, such as asterisk **406**, appears next to the variable name in subwindow **404**, indicating that that variable is connected and not available for other connections. At the same time, the label of the connect/disconnect button changes to "Disconnect" (not shown).

If, when inspector window **30** is first opened, there are already connected variables listed in subwindow **404** (from a previous connection operation), then asterisk **406** will already be displayed for each connected variable, and if the user highlights a variable that is already connected, a line like line **21** will be displayed, showing the connection to myProgram. This allows connections to be checked, either to make sure they are correct, or to find out what they are. If the user had drawn line **21**, intending to connect an unconnected variable, but highlights a connected variable by mistake, line **21** will disappear, and will be replaced by a line between the field to which that variable is connected and myProgram. In the preferred embodiment line **21** has to be redrawn by the user before field **140** can be connected to another variable, although it may be possible to provide an "Undo" function that will unhighlight the already connected variable and restore line **21** automatically. Again, whenever a connection is displayed, button **403** will be labelled "Disconnect" and the user has the option of clicking that button to disconnect the variable or ignoring the Disconnect button and choosing another variable.

The above process can be repeated until all fields are connected to the desired variables. It is then necessary to connect any action buttons, such as button **143**, to the program structures that perform the desired functions. Such connections are established by a process that is similar to that for linking fields to variables, except that instead of positioning the pointer over the program representation in file window **13** and drawing a line to the desired field, one starts with the pointer on the desired button. Again, the mouse button is held down while CTRL is being pressed and a line is drawn (not shown) from button **143** to representation **130** of myProgram in file window **13** which becomes highlighted as did field **140** in the process described above.

In this case, the display in inspector window **30** is slightly different, as shown in FIG. **5**. The user is really interested in connecting an action to myProgram. However, in the preferred embodiment of the invention, only variables (or "outlets") can be connected to a program. Therefore, when an action is to be connected, it must be connected through a special variable known as "Target", which is one of the variables that will be displayed in subwindow **404** during the action connection process, as shown in FIG. **5**. The listing for the variable "Target" will be marked by an arrow **500** pointing toward action subwindow **405**, where various possible actions, available through corresponding structures in myProgram, are listed. To connect the action "Plus" to button **143**, the user highlights the variable "Target", then the action "Plus" and clicks on "Connect" button **403**. As in the case of variables, an asterisk or other flag (not shown) is displayed next to the name of a connected action, and when it is highlighted, "Connect" button **403** becomes a "Disconnect" button. Similarly, existing connections to a program will be displayed if a connected action is highlighted.

In the case, referred to above, when a program already exists, its characteristics are made available to the graphic interface configuration system of the present invention through a facility in the preferred embodiment of the operating system known as the workspace manager. The workspace manager provides a window **15**, shown in FIG. **1**, in which representations of various available files are displayed. By highlighting representation **150** of myProgram, dragging it to File Window **13**, and dropping it into that one of suitcases **132** labelled "classes", the user makes the characteristics of myProgram known to the graphic interface configuration system.

When a graphic interface has been configured and the user signifies completion of the configuration process by selecting "Save" from menu **11**, the graphic interface configuration system stores the graphic interface configuration in a file containing a list of all programming objects related to the interface and a list of connections. For each connection in the connection list, the system stores as part of the graphic interface configuration file a table **501** (shown in FIG. **5A**) containing the type of connection **502** (outlet or target-action), its source **503** (for an outlet) or destination **504** (for a target-action) in the form of a pointer to the correct object in the object list, and the name **505** of the outlet variable or action object. When the configuration file, including one or more tables **501**, has been saved, the work of the graphic interface configuration system of the invention is complete.

When the user writes the program for which the interface is constructed, whether before or after the interface has been constructed, the first line must be an instruction to load and execute the graphic interface configuration file. Execution of the configuration file loads the correct files, makes the appropriate connections (based in part on the tables **501**), and displays the correct windows and other graphic elements, so that the end user of the program is faced only with the interface.

FIG. **6** is a flow diagram of a routine (hereinafter referred to as the main connection routine) which is invoked, at step **60**, when a user presses a mouse button while the CTRL key is down and pointer **20** is over a program representation such as graphic element **130**, or over a screen button object such as button **143**. At test **61**, the system checks to see if the pointer has moved. If the pointer has moved, then at test **62**, the system tests to see if there are pre-existing connecting lines. If there are pre-existing connecting lines, they are removed from the screen at step **63**. Whether or not there were preexisting connecting lines, new connecting lines between program representation **130**, or button **143**, and pointer **20** are displayed at step **64**, and the system returns to test **61** to check for further pointer movement.

If at test **61** the pointer has not been moved, then the system checks at test **65** to see if the mouse button has been released. If the mouse button has not been released, the system returns to test **61** to continue checking for pointer movement. If at test **65** the mouse button has been released, then at test **66** the system checks to see if the pointer is over a type of object to which the program represented by element **130** (if the connecting line starts there) or the button depicted at **143** (if the connecting line starts there) can be connected. If the pointer is not over an object to which a connection can be made, then at step **67** all connecting lines are removed from the screen and the main connection routine ends at step **68**.

If at test **66**, the pointer is over an object to which a connection can be made, then at step **69** a frame is displayed around the object and the system checks at test **600** to see if the inspector window is visible. If the inspector window is not visible, it is made visible at step **601**, and in any event the system checks at test **602** to see if the inspector window is in the connection mode. If the inspector window is not in the connection mode, then it is set to the connection mode at step **603**, and in any event the available program outlets are displayed at step **604** in the left-hand column of the inspector window. At test **605**, the system tests to see if any of the displayed outlets are already connected. If any of the displayed outlets are connected, then at step **606** an asterisk is displayed next to each one that is connected, and in any event the system checks at test **607** to see if the mouse button has been clicked. If the mouse button has not been clicked, the system continues to test for a click at test **607**. If the mouse button has been clicked, then the system checks at test **608** to see if the pointer is within the inspector window. If the pointer is not within the inspector window, then all connecting lines are removed from the screen at step **609** and the main connection routine ends at step **610**.

If at test **608** the pointer is within the inspector window, then the system checks at test **611** to see if the pointer is over the name of an action in the right-hand column of the inspector window. If the pointer is over the name of an action in the right-hand column of the inspector window, then at step **612** the action under the pointer is highlighted and any previously highlighted action is unhighlighted, and the system returns to test **607** to check for further clicking of the mouse button.

If at test **611** the pointer is not over the name of an action in the right-hand column of the inspector window, then at test **613** the system checks to see if the pointer is over the name of an outlet in the left-hand column of the inspector window. If the pointer is over the name of an outlet in the left-hand column of the inspector window, then at step **614** the outlet under the pointer is highlighted and any previously highlighted outlet is unhighlighted, and at step **615** the system invokes the outlet selection routine of FIG. **7**, below. If at test **613**, the pointer is not over the name of an outlet in the left-hand column of the inspector window, then at test **616** the system checks to see if the pointer is over the connect button. If the pointer is not over the connect button, then the system returns to test **607** to check for further clicking of the mouse button. If at test **616**

the pointer is over the connect button, then at step **617** the system invokes the connection making routine of FIG. **8**, below.

FIG. **7** is a flow diagram of the outlet selection routine referred to above, which is invoked at step **615** in FIG. **6**. The routine is entered at step **70** when the mouse button is clicked while the pointer is over the name of an outlet in the left-hand column of the inspector window. The system checks at test **71** to see if the outlet that the pointer is over is already connected to a screen object. If the outlet that the pointer is over is already connected to a screen object, then any connecting lines and frame that may be visible are removed from the screen at step **72**, new connecting lines between the program and the screen object connected to the outlet are displayed at step **73**, and a frame is drawn around the object connected to the outlet at step **74**.

From step **74**, or if at test **71** the outlet that the pointer is over is not already connected to a screen object, the system proceeds to test **75** to see if the outlet the pointer is over is the "target" outlet. If the outlet the pointer is over is not the "target" outlet, then no actions should be visible in the right-hand column of the inspector window, and at step **76** any actions that may have been visible in the right-hand column of the inspector window from a previously highlighted "target" outlet are removed from the screen. The system then returns to test **607** of the main connection routine to await further mouse clicks.

If at test **75** the outlet the pointer is over is the "target" outlet, then at step **77** any action or actions associated with the button highlighted on the screen are displayed in the right-hand column of the inspector window. At test **78**, the system tests to see if any of the displayed actions are already connected to other program segments. If none of the displayed actions are already connected to other program segments, then the system returns to test **607** of the main connection routine to await further mouse clicks. If any of the displayed actions are already connected to other program segments, then at step **79** an asterisk is displayed next to the name of each action so connected, and then the system returns to test **607** of the main connection routine to await further mouse clicks.

FIG. **8** is a flow diagram of the connection making routine referred to above, which is invoked at step **617** in FIG. **6**. The routine is entered at step **80** when the mouse button is clicked while the pointer is over the connect button. At test **81**, the system checks to see if there is a selected outlet. If there is no selected outlet, then the system returns to test **607** of the main connection routine to await further mouse clicks. If at test **81** there is a selected outlet, the system checks at test **82** to see if the selected outlet is the "target" outlet. If the selected outlet is not the "target" outlet, then at test **83** the system checks to see if the outlet is already connected. If the outlet is already connected, then at step **84** the outlet is disconnected from the highlighted screen object and the asterisk is removed from next to the name of the outlet in the left-hand column of the inspector window. The label of the connect button is then changed to "Connect" at step **85**, and then the system returns to test **607** of the main connection routine to await further mouse clicks. If at test **83** the outlet is not already connected, then at step **86** the outlet is connected to the highlighted screen object and an asterisk is displayed next to the name of the outlet in the left-hand column of the inspector window. The label of the connect button is then changed to "Disconnect" at step **87**, and then the system returns to test **607** of the main connection routine to await further mouse clicks.

If at test **82** the outlet is the "target" outlet, then at test **88** the system checks to see if there is a highlighted action in the right-hand column of the inspector window. If there is not a highlighted action in the right-hand column of the inspector window, then the system returns to test **607** of the main connection routine to await further mouse clicks. If there is a highlighted action in the right-hand column of the inspector window, then at test **89** the system checks to see if the highlighted action is associated with a program-button connection through the "target" outlet. If the highlighted action is associated with a program-button connection through the "target" outlet, then at step **800** the "target" outlet is disconnected and the asterisk next to the name of the associated action in the right-hand column of the inspector window is removed from the screen. The label of the connect button is then changed to "Connect" at step **85**, and then the system returns to test **607** of the main connection routine to await further mouse clicks. If at test **89** the highlighted action is not associated with a program-button connection through the "target" outlet, then at step **801** a "target" outlet-program connection is made, the highlighted action is associated with that connection, an asterisk is displayed next to the name of the action in the right-hand column of the inspector window, and any other asterisks in the right-hand column of the inspector window are removed from the screen. The label of the connect button is then changed to "Disconnect" at step **87**, and then the system returns to test **607** of the main connection routine to await further mouse clicks.

HARDWARE SYSTEM

While the present invention may advantageously be implemented on nearly any conventional computer system, an exemplary computer system **900** on which the present invention is implemented is shown in FIG. **9**.

FIG. **9** shows a preferred embodiment of a hardware system **900** implementing the present invention as part of a computer system. In FIG. **9**, system **900** includes CPU **901**, main memory **902**, video memory **903**, a keyboard **904** for user input, supplemented by a conventional mouse **905** for manipulating graphic images according to the present invention, and mass storage **906** which may include both fixed and removable media using any one or more of magnetic, optical or magnetooptical, storage technology or any other available mass storage technology. These components are interconnected via conventional bidirectional system bus **907**. Bus **907** contains 32 address lines for addressing any portion of memory **902** and **903**. System bus **907** also includes a 32 bit data bus for transferring data between and among CPU **901**, main memory **902**, video memory **903**, and mass storage **906**. In the preferred embodiment of system **900**, CPU **901** is a Motorola 68030 32-bit microprocessor, but any other suitable microprocessor or microcomputer may alternatively be used. Detailed information about the 68030 microprocessor, in particular concerning its instruction set, bus structure, and control lines, is available from MC68030 *User's Manual*, published by Motorola Inc., of Phoenix, Ariz.

Main memory **902** of system **900** comprises eight megabytes of conventional dynamic random access

memory, although more or less memory may suitably be used. Video memory **903** comprises 256K bytes of conventional dual-ported video random access memory. Again, depending on the resolution desired, more or less such memory may be used. Connected to a port of video memory **903** is video multiplex and shifter circuitry **908**, to which in turn is connected video amplifier **909**. Video amplifier **909** drives cathode-ray tube (CRT) raster monitor **910**. Video multiplex and shifter circuitry **908** and video amplifier **909**, which are conventional, convert pixel data stored in video memory **903** to raster signals suitable for use by monitor **910**. Monitor **910** is of a type suitable for displaying graphic images having a resolution of 1120 pixels wide by 832 pixels high.

Thus it is seen that a graphic interface configuration utility is provided that allows graphic elements in the interface to be linked to variables or functions in any one of a number of programming elements. One skilled in the art will appreciate that the present invention can be practiced by other than the described embodiments, which are presented for purposes of illustration and not of limitation, and the present invention is limited only by the claims which follow.

What is claimed is:

1. In a computer system having a visual display on which an application program is represented by a graphic image, said application program having at least one program routine having variables and action portions, said application program being executed through a graphical program interface that provides a program window on said display, said program window containing graphic elements representing user inputs and outputs, said graphic image and graphic elements being capable of being moved on said display by a suer, a graphical program interface configuration system for allowing a programmer to define said graphical program interface, said system comprising:

programmer-controllable graphical definition means for allowing a programmer to define said program window;

programmer-controllable graphical placement means for for allowing a programmer to place at least one of said graphic elements in said program window;

programmer-controllable graphical connection means for allowing a programmer to logically designate any of said at least one graphic element as an input/output element for any one of said at least one program routine.

2. The graphical program interface configuration system of claim **1** wherein said at least one graphic element represents an input field for a variable, and said programmer-controllable graphical connection means is for logically designating said graphic element as an input/output element for a variable in said program routine.

3. The graphical program interface configuration system of claim **1** wherein said at least one graphic element represents an action for selection by a user, and said programmer-controllable graphic connection means is for logically designating said graphic element as an input element for an action portion in said program routine.

4. The graphical program interface configuration system of claim **1** wherein said programmer-controllable graphical connection means comprises means for graphically displaying a logical designation established between said graphic element and said program routine.

5. The graphical program interface configuration system of claim 4, wherein said programmer-controllable graphical connection means further comprises means for graphically highlighting said graphic element and said program routine while said logical designation is displayed.

6. The graphical program interface configuration system of claim 4, wherein said graphical connection means further comprises means for graphically displaying said variables and said action portions for which said graphical element can be designated as an input/output element.

7. The graphical program interface configuration system of claim 6, wherein said graphical variable and action portion display means comprises means for indicting if any one of said variables and action portions has a graphic element logically designated as an input/output element therefor.

8. The graphical program interface configuration system of claim 6 wherein said graphical variable and action portion display means comprises means for selecting one of said displayed variables and action portions.

9. The graphical program interface configuration system of claim 8 wherein said graphical variable and action portion display means comprises actuation means for (a) if a selected one of said displayed variables and action portions does not have a graphic element logically designated as an input/output element therefor, logically designating said graphic element as an input/output element for said selected one of said displayed variables and action portions, and (b) if a selected one of said displayed variables and action portions has a graphic element logically designated as an input/output element therefor, cancelling logical designation of said graphic element as an input/output element for said selected one of said displayed variables and action portions.

10. The graphical program interface configuration system of claim 9 wherein said programmer-invocable actuation means changes its appearance according to whether or not said selected one of said displayed variables and action portions has a graphic element logically designated as an input/output element therefor.

11. The graphical program interface configuration system of claim 8 wherein said programmer-controllable graphical connection means comprises means for, if a selected one of said displayed variables and action portions is subject to a pre-existing logical designation of a second graphic element in said program window as an input/output element therefor, terminating the graphical display of an attempted logical designation established between said graphic element and said one of said variables and action portions and graphically displaying said pre-existing logical designation between said second graphic element and said one of said variables and action portions.

12. For use in a computer system having a visual display on which an application program is represented by a graphic image, said application program having at least one program routine having variables and action portions, said application program being executed through a graphical program interface that provides a program window on said display, said program window containing graphic elements representing user inputs and outputs, said graphic image and graphic elements being capable of being moved on said display by a user, a graphical program interface configuration method for

allowing a programmer to define said graphical program interface, said method comprising the steps of:
- allowing a programmer to graphically define said window;
- allowing a programmer to graphically place at least one of said graphic elements in said window;
- allowing a programmer to graphically logically designate any of said at least one graphic element as an input/output element for any one of said at least one program routine.

13. The graphical program interface configuration method of claim 12 wherein said at least one graphic element represents an input field for a variable, and said graphical logical designation step is for logically designating said graphic element as an input/output element for a variable in said program routine.

14. The graphical program interface configuration method of claim 12 wherein said at least one graphic element represents an action for selection by a user, and said graphical logical designation step is for logically designating said graphic element as an input element for an action portion in said program routine.

15. The graphical program interface configuration method of claim 12 wherein said graphical designation step comprises graphically displaying a logical designation established between said graphic element and said program routine.

16. The graphical program interface configuration method of claim 15, wherein said graphical designation step further comprises graphically highlighting said graphic element and said program routine while said logical designation is displayed.

17. The graphical program interface configuration method of claim 15, wherein said graphical designation step further comprises graphically displaying said variables and said action portions for which said graphical element could be designated as an input/output element.

18. The graphical program interface configuration method of claim 17, wherein said graphical variable and action portion displaying step comprises indicating if any one of said variables and action portions has a graphic element logically designated as an input/output element therefor.

19. The graphical program interface configuration method of claim 17 wherein said graphical variable and action portion displaying step comprises selecting one of said displayed variables and action portions.

20. The graphical program interface configuration method of claim 19 wherein said graphical variable and action portion displaying step comprises an actuation step of (a) if a selected one of said displayed variables and action portions does not have a graphic element logically designated as an input/output element therefor, logically designating said graphic element as an input/output element for said selected one of said displayed variables and action portions, and (b) if a selected one of said displayed variables and action portions has a graphic element logically designated as an input/output element therefor, cancelling logical designation of said graphic element as an input/output element for said selected one of said displayed variables and action portions.

21. The graphical program interface configuration method of claim 19 wherein said graphical designation step comprises, if a selected one of said displayed variables and action portions is subject to a pre-existing logical designation of a second graphic element in said

program window as an input/output element therefor, terminating the graphical display of an attempted logical designation established between said graphic element and said one of said variables and action portions

and graphically displaying said pre-existing logical designation between said second graphic element and said one of said variables and action portions.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO.	:	5,163,130
DATED	:	Nov. 10, 1992
INVENTOR(S)	:	Jean-Marie Hullot

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

Item [57] Abstract, line 1, "is" should be deleted.

Column 1, line 6, "abandoned" should be -- now abandoned, --.

Column 3, line 7, "graphic," should be -- graphic --.

Claim 1, column 10, line 35, "suer," should be -- user, --;

column 10, line 43, "for" (second occurrence) should be deleted.

Claim 3, column 10, line 60, "graphic" should be -- graphical --.

Signed and Sealed this

Twelfth Day of April, 1994

Attest:

[illegible]

BRUCE LEHMAN

Attesting Officer

Commissioner of Patents and Trademarks