An expansion unit may be removably coupled to a primary computer unit, thus expanding the functionality of the primary unit without requiring external electrical connections. When the primary unit and expansion unit are coupled, all of the electrical connections are contained within at least one of a primary unit housing and/or an expansion unit housing, thereby eliminating the need for external connections. To that end, the expansion unit includes the expansion unit housing, which at least partially contains an expansion unit interface and an expansion unit bus. The expansion unit interface is mechanically and electrically coupled to a primary unit interface when the two units are coupled. When coupled, the primary unit interface and expansion unit interface are both substantially completely contained within at least one of the primary unit housing and the expansion unit housing.
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COMPUTER EXPANSION SYSTEM

FIELD OF THE INVENTION

The invention generally relates to computer systems and, more particularly, the invention relates to expanding and upgrading computer systems.

BACKGROUND OF THE INVENTION

Computer systems commonly are obsolete within several months of purchase. For example, within a given time period after initial purchase, the amount of random access memory ("RAM") within a computer system may not be adequate for such computer system to efficiently process a relatively complicated, but widely used, software program.

Consequently, most current computer systems include expansion slots that electrically connect preconfigured printed circuit boards ("computer cards") to the other internal computer components, thus expanding computer system functionality. For example, a RAM card may be added to an unused expansion slot in a computer system to enlarge the available RAM within such computer system.

Undesirably, the total number of expansion slots in a computer system is limited. Consequently, when all of the expansion slots of a computer system are in use, such computer system cannot effectively be expanded and/or upgraded. Accordingly, a new computer system must be purchased if improved functionality is necessary. The art has responded to this problem by enabling computer systems to couple with other computer systems via cables and other external connectors. Use of external connections, however, creates additional problems. Primarily, the external connections create electromagnetic interference that may interfere with peripherals and other computer systems located near the computer system. Moreover, external connectors create signal timing problems that also can degrade system performance. Still other exemplary problems with such solution is that external connecting cables are not aesthetically pleasing, can become cumbersome, and can become inadvertently disconnected.
SUMMARY OF THE INVENTION

In accordance with one aspect of the invention, an expansion unit having expansion slots and/or additional expanding hardware may be removably coupled to a primary computer unit (e.g., a unit operating substantially similar to a conventional computer) without requiring external electrical connections. When the primary computer unit and expansion unit are coupled, all of the electrical connections are contained within at least one of a primary computer unit housing and/or an expansion unit housing, thereby eliminating the need for external connections. To that end, the expansion unit includes the expansion unit housing that at least partially contains an expansion unit interface and an expansion unit bus. The expansion unit interface is mechanically and electrically coupled to a primary computer unit interface when the two units are coupled. As suggested above, when coupled, the primary computer unit interface and expansion unit interface are both substantially completely contained within at least one of the primary computer unit housing and the expansion unit housing.

In preferred embodiments, the computer system includes state detector that determines if the primary unit and expansion unit are coupled, and a system initializer that initializes the primary unit and expansion unit if the state detector determines that the primary unit and expansion unit are coupled. Basic power on self-test (a/k/a "POST" procedures) start-up procedures may be executed by the initializer at start-up. The primary unit and expansion unit operate as a single computer system after being initialized. In other embodiments, the primary unit interface includes an interface slot, and the expansion unit interface includes an interface card that is mechanically couplable with the interface slot. The primary unit housing and expansion unit housing may be manufactured from metal.

The primary unit interface and expansion unit interface preferably are electrically coupled when the primary unit is coupled to the expansion unit. The expansion unit may have a pin that couples with a securing hole in the primary unit housing. The pin thus couples through the securing hole when the primary unit is coupled to the expansion unit to removably couple the primary unit to the expansion unit. In other embodiments, the expansion unit includes an expansion card, which may be coupled to a backplane.
In accordance with other aspects of the invention, the expansion unit interface includes an interface card, while the primary computer unit interface includes an interface slot. When the primary computer unit and expansion unit are coupled, the interface card mates with the interface slot to electrically connect the two units. In further embodiments, the primary computer unit housing and the expansion unit housing are manufactured from metal to contain any electromagnetic interference from the primary and expansion interfaces within the combination of the two housings.

In accordance with yet another aspect of the invention, the primary computer unit housing defines a securing hole and the expansion unit housing includes a securing pin. When the two units are coupled, the pin couples through the securing hole to removably couple the two units. In additional embodiments, the expansion unit includes a backplane coupled between the expansion unit bus and the expansion unit interface. The expansion unit also may include an expansion slot for receiving additional computer cards.

In accordance with another aspect of the invention, a computer system includes a primary unit with primary unit computing logic and a primary unit interface that couples with an expansion unit. The expansion unit includes expansion unit computing logic and an expansion unit interface that couples with the primary unit interface. The system also includes a state detector that determines if the primary unit and expansion unit are coupled, and a system initializer that initializes the primary unit and expansion unit when coupled (i.e., if determined to be coupled by the state detector). Once initialized by the system initializer, the primary unit and expansion unit operate as a single computer system.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The foregoing and other objects and advantages of the invention will be appreciated more fully from the following further description thereof with reference to the accompanying drawings wherein:

Figure 1 schematically shows a preferred embodiment of a computer expansion system that includes a primary computer unit and an expansion unit.

Figure 2 schematically shows many of the internal elements within the primary computer unit.
Figure 3 schematically shows the primary unit and expansion unit prior to coupling.

Figure 4 schematically shows the primary unit and expansion unit coupled together.

Figure 5 schematically shows many of the internal elements within the primary unit and the expansion unit.

Figure 6 shows a preferred method of initializing the combination system of the primary unit and expansion unit.

DESCRIPTION OF PREFERRED EMBODIMENTS

In accordance with preferred embodiments of the invention, a computer system may be expanded by electrically and mechanically connecting with an expansion unit having expansion hardware. Such hardware may include, for example, expansion slots, busses, I/O (input/output) subsystems, video cards, RAM (random access memory) cards, and other computer cards. When coupled, the computer system and expansion unit seamlessly operate in a manner similar to a single integrated computer system. The computer system and expansion unit each include respective interfaces that, when coupled, are substantially completely contained within the housing of either or both of the computer system and the expansion unit.

Figure 1 schematically shows a computer expansion system configured in accordance with preferred embodiments of the invention. The system includes a primary computer unit ("primary unit 100") that may be removably coupled to an expansion unit 102. It should be noted that the terms "coupled to" and "connected to" as used herein do not necessarily require a direct physical connection. Accordingly, two elements may be coupled or connected even though an additional element is positioned between the two elements.

As shown in figure 2, the primary unit 100 includes many of the elements that are commonly included in a currently known computer system. For example, the primary unit 100 preferably includes a central processing unit (CPU) 205 (mounted on a motherboard, discussed below) having a conventional microprocessor, random access memory (RAM) 210 for temporary storage of information, and read only memory (ROM) 215 for permanent storage of read only information. A memory controller 220 is provided for controlling system RAM 210. A bus controller 225 controls a primary unit bus 230 (e.g., a PCI bus), and an
interrupt controller 235 receives and processes various interrupt signals from the other system components.

Mass storage may be provided by known non-volatile storage media, such as a diskette 242, a digital versatile disk (not shown), a CD-ROM 247, or a hard disk 252. Data and software may be exchanged with the primary unit 100 via removable media, such as the diskette 242 and the CD-ROM 247. The diskette 242 is insertable into a diskette drive 241, which utilizes a diskette drive controller 240 to interface with the bus 230. Similarly, the CD-ROM 247 is insertable into a CD-ROM drive 246, which utilizes a CD-ROM drive controller 245 to interface with the bus 230. Finally, the hard disk 252 is part of a fixed disk drive 251, which utilizes a hard drive controller 250 to interface with the bus 230.

User input to the primary unit 100 may be provided by a number of devices. For example, a keyboard 256 and a mouse 257 may be connected to the bus 230 by a keyboard and mouse controller 255. An audio transducer 296, which may act as both a microphone and a speaker, is connected to the bus 230 by audio controller 297. It should be obvious to those reasonably skilled in the art that other input devices, such as a pen and/or tablet and a microphone for voice input, may be connected to primary unit 100 through bus 230 and an appropriate controller. A direct memory access (DMA) controller 260 is provided for performing direct memory access to system RAM 210. A visual display may be generated by a video controller 265, which controls a display device 270.

A network adapter 290 also may be included to enable the primary unit 100 to be interconnected to a network 295 via a network bus 291. The network 295, which may be a local area network (LAN), a wide area network (WAN), or the Internet, may utilize general purpose communication lines that interconnect a plurality of network devices.

The primary unit 100 preferably is controlled and coordinated by operating system software, such as the WINDOWS NT® operating system (distributed by Microsoft Corp. of Redmond, WA). Among other computer system control functions, the operating system controls allocation of system resources and performs tasks such as process scheduling, memory management, networking, and I/O services.

Figure 1 also shows additional elements that are included in preferred embodiments of the primary unit 100. In particular, the primary unit 100 preferably includes a primary unit
housing 600 for containing the primary computer elements (e.g., those elements shown in figure 2), an industry standard architecture slot ("ISA slot 106", also referred to as "interface 106") for receiving a computer card configured in accord with the ISA standard, and four securing holes 108 for mechanically coupling to the expansion unit 102. Each of the securing holes 108 preferably includes a wider inner dimension portion 110, and a smaller inner dimension portion 112. In alternative embodiments, the interface 106 may accept other computer cards configured in accord with other known standards (e.g., the PCI standard).

As also shown in figure 1, the expansion unit 102 preferably includes an expansion unit housing 114, a plurality of expansion slots 116 for connecting various types of computer cards, an ISA card 118 (also referred to as "interface 118") extending from a top surface of the expansion unit housing 114 for coupling with the ISA slot 106 in the primary unit 100, and four pins 120 for mechanically coupling with the four securing holes 108 in the primary unit 100. Each of the pins 120 preferably includes a shaft 122 having a securing flange 124 circumscribing the shaft 122. It should be noted that the pins 120 and securing holes 108 are included solely as examples of mechanical coupling mechanisms. Accordingly, any known mechanical coupling mechanism may be utilized. In alternative embodiments, there is no other mechanical coupling mechanism other than the ISA card 118 and ISA slot 106.

The ISA card 118 preferably is a printed circuit board having edges that contact the ISA slot 106 for electrically coupling the expansion unit 102 with the primary unit 100. In alternative embodiments, the interface 118 may be another type of computer card configured in accord with other known standards. Alternatively, in lieu of the primary unit ISA slot 106 and the expansion unit ISA card 118, the primary unit 100 and expansion unit 102 each may have conventional interfaces for electrically coupling together the two units 100 and 102.

Figures 3 and 4 respectively show the two units 100 and 102 just before and after coupling. Prior to coupling (figure 3), the primary unit 100 is positioned on the expansion unit 102 so that the four pins 120 and their respective flanges 124 align and pass through the wider dimension portion 110 of the securing holes 108. The two units 100 and 102 may be mechanically coupled (figure 4) by moving the primary unit 100, relative to the expansion unit 102, so that the pins 20 are slid into the smaller inner dimension portion 112 of the securing holes 108. This mechanically removably secures the units 100 and 102 together.
because the flanges 124 each have a larger outer dimension than the smaller inner dimension portion 112 of each of the securing holes 108. This also causes the ISA card 118 (in the expansion unit 102) to slide into (i.e., to mate with) the ISA slot 106 (in the primary unit 100) to electrically couple the two units. When the two units are coupled (referred to herein as a "combination system"), the housing 104 of the primary unit 100 and the housing 114 of the expansion unit 102 substantially completely contain the ISA card 118 and ISA slot 106. Accordingly, the electrical interfaces for each unit are internal to the combination system. Since the housings 104 and 114 preferably are manufactured substantially from sheet metal, substantially all electromagnetic emissions from the interfaces 106 and 118 should be contained within the combination system.

In alternative embodiments (not shown), the primary unit 100 includes the interface card 118 while the expansion unit includes the interface slot 106. In a manner similar to that described above, the slot 106 and card 118 couple to electrically couple the primary unit 100 with the expansion unit 102.

Figure 5 schematically shows a number of the interior elements of the primary unit 100 and the expansion unit 102. In particular, among other things, the primary unit 100 includes a motherboard 500 (noted above) that has each of the central processing unit 205, an interface signal monitor ("monitor 501") that determines when the expansion unit 102 is coupled to the primary unit 100 (see figure 6 below), and the ISA slot 106 (shown schematically as an interface slot) for coupling with the expansion unit ISA card 118. The primary unit 100 also includes a primary unit controller 502 for managing (discussed below) the combination system, a basic input/output system ("BIOS 503") that initializes the entire combination system when the expansion unit 102 is coupled with the primary unit 100, a primary unit power supply 505, and the primary unit bus 230 to facilitate communication between each element within the primary unit 100. In addition to the functions noted above, the BIOS 503 also initializes the primary unit 100 when not coupled with the expansion unit 102.

The expansion unit 102 includes, among other things, the ISA card 118 (shown schematically as an interface card) for coupling with the primary unit ISA slot 106, a backplane 506 with a plurality of slots 116 for connecting the elements within the expansion
unit 102, an expansion unit bus 508 (e.g., a PCI bus) to facilitate communication within the expansion unit 102, an expansion unit controller 510 for managing the expansion unit 102 when coupled to the primary unit 100, and an expansion unit power supply 514 that draws power from a power source (not shown) via a power cord 516. Accordingly, the expansion unit 102 is self-powered and thus, does not require power from the primary unit 100.

In preferred embodiments, the expansion unit 102 does not include external connecting ports for connecting external peripherals (e.g., printers or external disk drives) to the expansion unit 102. In alternative embodiments, a parallel port and/or a serial port may be included to connect external peripherals.

Figure 6 shows a preferred method of initializing the combination system. The process begins at step 600 in which the monitor 501 monitors the voltage level of an interface signal. More particularly, upon start-up, an interface signal (mentioned above) preferably is produced by logic coupled with the interface slot 106, and then transmitted to the monitor 501. This signal preferably is transmitted via a direct connection within the motherboard 500 between the monitor 501 and interface slot 106. In preferred embodiments, the interface signal is a preselected DC value when the expansion unit 102 is not coupled to the primary unit 100. Due to loading considerations, however, the amplitude of the DC signal becomes attenuated when the interface card 118 is coupled with the interface slot 106. This attenuation is sensed by the monitor 501, thus causing it to detect that the expansion unit 102 is coupled with the primary unit 100 (see step 602). Accordingly, the monitor 501 may be considered to be a state detector that detects the state of the primary unit 100 (i.e., whether it is coupled to the expansion unit 102).

If (at step 602) the monitor 501 detects that the amplitude of the interface signal is attenuated from its full DC value, then the process continues to step 604 in which the primary unit 100 executes conventional start-up procedures. For example, the BIOS 503 may begin boot-up processes by executing well known power on self test ("POST") processes and loading the operating system into random access memory. As a further example, system power control and sequencing logic of the primary unit 100 may be configured to receive power from one power supply only (i.e., the primary unit power supply 505).

Returning to step 602, if the monitor 501 does in fact detect that the amplitude of the
interface signal is attenuated, then the process continues to step 606 in which the BIOS 503 determines the overall architecture of the combination system, executes POST procedures, and loads the operating system into random access memory. As an example of POST procedures, the BIOS 503 may check each of the slots 116 in the backplane 506 to determine which slots 116 include computer expansion cards. The BIOS 503 also may confirm the identity of those expansion cards.

The process then continues to step 608 in which the operating system begins executing, thus controlling the combination system (if continuing from step 606), or the primary unit 100 only (if continuing from step 604). Accordingly, when coupled, the combination system operates in a manner similar to a single integrated computer system. While coupled, the primary unit controller 502 and the expansion unit controller 510 cooperate to manage the operation of the combination system. In particular, the primary unit controller 502 periodically transmits messages that each request a status report of selected expansion unit elements and functions. For example, the primary unit controller 502 may transmit a message to the expansion unit controller 510 requesting the value of a given input voltage applied to the expansion unit 102. In response, the expansion unit 102 first determines such voltage, and then transmits a message, to the primary unit controller 502, with the value of such voltage. The primary unit controller 502 then may utilize application program system management software (e.g., INTERSITE™ management software, available from Intergraph Corp. of Huntsville, Alabama) that determines if such voltage is appropriate. If not appropriate, the software may cause the system to display a message on a display device noting a problem with the input voltage. A user then may take appropriate action in response to the message. Alternatively, the system management software may be preconfigured to automatically correct such problems either via a background process, or by interrupting the normal processing of the combination system. In addition to input voltages, the controllers 502 and 510 control and/or monitor the operation of various other combination unit subsystems. For example, the controllers 502 and 510 may monitor cooling fan operation, input power levels, and expansion card operation.

In preferred embodiments, the primary unit controller 502 is a combination of conventionally known programmable and logic integrated circuits that are preconfigured and
arranged to provide the desired controlling function. For example, the programmable integrated circuits may be model number LM78 circuits, available from National Semiconductor Corporation, of Arlington, Texas, and the logic integrated circuits may be model number F244 buffers, also available from National Semiconductor Corporation. In a similar manner, the expansion unit controller 510 also may be a combination of conventional programmable and logic integrated circuits that are preconfigured and arranged to provide the desired controlling function. Alternatively, the controllers 502 and 510 may utilize processors and software, in addition to the system management software, to manage the combination system.

Although various exemplary embodiments of the invention have been disclosed, it should be apparent to those skilled in the art that various changes and modifications can be made which will achieve some of the advantages of the invention without departing from the true scope of the invention. These and other obvious modifications are intended to be covered by the appended claims.
We claim:

1. A computer system comprising:
   a primary unit having a primary unit housing at least partially containing a primary
   unit interface, the primary unit interface being coupled to a primary unit bus that couples
   primary unit computing logic; and
   
   an expansion unit having an expansion unit housing at least partially containing an
   expansion unit interface, the expansion unit interface being coupled to an expansion unit bus
   that couples expansion unit computing logic, the expansion unit being removably coupled to
   the primary unit;
   
   the primary unit interface electrically and mechanically coupling with the expansion
   unit interface when the primary unit is coupled to the expansion unit,
   
   at least one of the primary unit housing and the expansion unit housing substantially
   completely containing both the primary unit interface and the expansion unit interface when
   the primary unit is coupled to the expansion unit.

2. The computer system as defined by claim 1 wherein the primary unit interface
   includes an interface slot for coupling with the expansion unit interface.

3. The computer system as defined by claim 1 wherein the expansion unit interface
   includes an interface card for coupling with the primary unit interface.

4. The computer system as defined by claim 1 wherein the primary unit housing is
   comprised of metal.

5. The computer system as defined by claim 1 wherein the expansion unit housing is
   comprised of metal.

6. The computer system as defined by claim 1 wherein the primary unit interface and the
   expansion unit interface are electrically coupled when the primary unit is coupled to the
expansion unit.

7. The computer system as defined by claim 1 wherein the expansion unit housing includes a pin and the primary unit housing defines a securing hole, the pin coupling through the securing hole when the primary unit is coupled to the expansion unit to removably couple the primary unit to the expansion unit.

8. The computer system as defined by claim 1 wherein the expansion unit includes an expansion card contained within an expansion slot.

9. The computer system as defined by claim 1 wherein the expansion unit includes a backplane coupled between the expansion unit bus and the expansion unit interface.

10. The computer system as defined by claim 1 further comprising:
    a state detector that determines if the primary unit and expansion unit are coupled.

11. The computer system as defined by claim 10 further comprising:
    a system initializer that initializes the primary unit and expansion unit if the state detector determines that the primary unit and expansion unit are coupled, the primary unit and expansion unit operating as a single computer system after being initialized.

12. In a computer system, an expansion unit for expanding a primary unit, the primary unit having a primary unit housing and a primary unit interface, the primary unit interface being electrically coupled to a primary unit bus, the expansion unit comprising:
    an expansion unit housing, an expansion unit interface and an expansion unit bus, the expansion unit interface being electrically coupled to the expansion unit bus, the expansion unit being removably coupleable with the primary unit;
    the primary unit interface being mechanically coupled with the expansion unit interface when the primary unit is coupled to the expansion unit,
    at least one of the primary unit housing and the expansion unit housing substantially
completely containing both the primary unit interface and the expansion unit interface when the primary unit is coupled to the expansion unit.

13. The expansion unit as defined by claim 12 wherein the expansion unit interface includes an interface card for coupling with the primary unit interface.

14. The expansion unit as defined by claim 12 wherein the expansion unit housing is comprised of metal.

15. The expansion unit as defined by claim 12 wherein the primary unit interface and the expansion unit interface are electrically coupled when the primary unit is coupled to the expansion unit.

16. The expansion unit as defined by claim 12 wherein the expansion unit housing includes a pin and the primary unit housing defines a securing hole, the pin coupling through the securing hole when the primary unit is coupled to the expansion unit to removably couple the primary unit to the expansion unit.

17. The computer system as defined by claim 12 wherein the expansion unit further includes an expansion card contained within an expansion slot.

18. The computer system as defined by claim 12 wherein the expansion unit includes a backplane coupled between the expansion unit bus and the expansion unit interface.

19. A computer system comprising:
   a primary unit having a primary unit housing;
   an expansion unit having an expansion unit housing;
   the primary unit and expansion unit being removably mechanically coupled,
   an electrical coupler that couples the primary unit and the expansion unit when the primary unit and expansion unit are coupled, the means for electrically coupling being
substantially completely contained by at least one of the primary unit housing and the expansion unit housing when the primary unit and expansion unit are removably mechanically coupled.

20. The computer system as defined by claim 19 further comprising means for removably mechanically coupling the primary unit to the expansion unit.

21. The computer system as defined by claim 19 wherein the means for electrically coupling includes mating male and female connectors.

22. The computer system as defined by claim 19 wherein the expansion unit is comprised of metal.

23. The computer system as defined by claim 19 wherein the expansion unit includes means for connecting computer cards.

24. The computer system as defined by claim 19 further comprising:
   a state detector that determines if the primary unit and expansion unit are coupled.

25. The computer system as defined by claim 24 further comprising:
   a system initializer that initializes the primary unit and expansion unit if the state
detector determines that the primary unit and expansion unit are coupled, the primary unit and expansion unit operating as a single computer system after being initialized.

26. A computer system comprising:
   a primary unit having primary unit computing logic and a primary unit interface;
an expansion unit having expansion unit computing logic and an expansion unit interface, the primary unit interface electrically coupling the primary unit and expansion unit;
a state detector that determines if the primary unit and expansion unit are coupled; and
a system initializer that initializes the primary unit and expansion unit if the state
detector determines that the primary unit and expansion unit are coupled, the primary unit and expansion unit operating as a single computer system after being initialized.

27. The computer system as defined by claim 26 wherein the state detector determines if the primary unit and expansion unit are coupled upon start-up of the computer system.

28. The computer system as defined by claim 26 wherein the primary unit includes a central processing unit.

29. The computer system as defined by claim 26 wherein the expansion unit interface comprises an interface card.

30. The computer system as defined by claim 29 wherein the primary unit interface comprises a slot for mechanically receiving the interface card.

31. The computer system as defined by claim 26 wherein the primary unit includes a primary unit housing, the expansion unit having an expansion unit housing, the primary unit interface mechanically coupling with the expansion unit, at least one of the primary unit housing and expansion unit housing substantially completely containing both the primary unit interface and expansion unit interface when the primary unit is coupled to the expansion unit.

32. The computer system as defined by claim 26 wherein the expansion unit includes a backplane comprising a plurality of slots for receiving expansion cards.

33. A computer system comprising:

   a primary unit having a primary unit interface and primary unit computing logic within a primary unit housing, the primary unit interface being in electrical communication with the primary unit logic; and

   an expansion unit having an expansion unit interface and expansion unit logic within an expansion unit housing, the expansion unit logic being in electrical communication with
the expansion unit interface;
    the primary unit interface electrically and mechanically coupling with the expansion unit interface when the primary unit is coupled to the expansion unit,
    at least one of the primary unit housing and the expansion unit housing substantially completely containing both the primary unit interface and the expansion unit interface when the primary unit is coupled to the expansion unit.

34. The computer system as defined by claim 33 further comprising:
    a state detector that determines if the primary unit and expansion unit are coupled.

35. The computer system as defined by claim 34 further comprising:
    a system initializer that initializes the primary unit and expansion unit if the state detector determines that the primary unit and expansion unit are coupled, the primary unit and expansion unit operating as a single computer system after being initialized.
FIG. 1

SUBSTITUTE SHEET (RULE 26)
FIG. 5

SUBSTITUTE SHEET (RULE 26)
Begin

Monitor Monitors Interface Signal

Signal Attenuated?

No

BIOS Initializes System Without Expansion Unit

Yes

BIOS Initializes Combination System

Operating System Controls System Operation

End

FIG. 6
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6  G06F1/18  G06F1/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched: (classification system followed by classification symbols)

IPC 6  G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of database and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
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<td>US 5 311 397 A (HARSHBERGER MARTIN J ET AL) 10 May 1994</td>
<td>1-7, 9, 12-16, 18-23,33</td>
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  - "E" earlier document but published on or after the international filing date
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Date of the actual completion of the international search: 23 June 1999

Date of mailing of the international search report: 30/06/1999

Name and mailing address of the ISA:
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel: (+31-70) 340-2040, Tx: 31 651 epos nl, Fax: (+31-70) 340-3016

Authorized officer: Bailas, A

Form PCT/ISA/210 (second sheet) (July 1992)
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| X        | EP 0 459 427 A (SHARP KK)  
4 December 1991  
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| Y        |                                                                                  | 10, 11, 24, 25, 29-32, 34, 35 |
### INTERNATIONAL SEARCH REPORT

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