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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : G05B 19/418	A1	(11) International Publication Number: WO 97/49018
		(43) International Publication Date: 24 December 1997 (24.12.97)

(21) International Application Number: PCT/US97/10311

(22) International Filing Date: 13 June 1997 (13.06.97)

(30) Priority Data:
08/667,223 19 June 1996 (19.06.96) US

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(81) Designated States: CN, JP, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: MULTI-TASKING PROCESS CONTROL SYSTEM AND METHOD

(57) Abstract

An integrated workstation is disclosed to monitor and control a manufacturing process as well as permit an operator to execute a more general application on the same workstation. Data acquired from a process control system is stored into a form that is usable by the general application for future display and manipulation.

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MULTI-TASKING PROCESS CONTROL SYSTEM AND METHOD

FIELD OF INVENTION

The present invention relates generally to the field of process control operator interfaces, and, more particularly, to a process control workstation that provides a dual display showing a process control interface on one display and a user selectable application on the other display.

Background of the Invention

Control of various manufacturing processes has seen significant advances in the recent past. In particular, a portion of a manufacturing process, or even an entire process, may now be controlled from a remote location by an operator situated at an operator workstation. One or more operators man remote workstations to monitor and control various parameters throughout the process.

The entire control function may be included in a central processing system or the various control functions may be distributed at the various control points within the process. In either event, each operator is provided with an interface or display, and the means for effecting changes within the process. For example, chemical processes may call for a specific recipe of temperatures, pressures, flow rates, and other parameters to properly make the end product. A flow rate of a chemical reactant may be affected by, for example, a valve position. An operator, remote from the process, monitors the flow rate, which must be maintained within specified limits. If the operator notes a flow rate approaching an out of specification condition, he or she may adjust the flow rate by opening or closing a throttle control valve. This is often accomplished by interacting directly with the interface, such as by clicking a cursor on an icon of the interface, and then adjusting the position of the valve by inputting the appropriate command.

In other situations, one parameter, such as pressure, may be affected by another parameter, such as temperature, in a saturated system. To correct a low pressure condition, a set of heaters may be energized to raise the temperature (and thus the pressure) in a pressurizer.

In general, processing systems monitor the parameters of temperature, pressure, flow rate, and others, in an analog form. The analog value may be digitized and then transmitted to a computer for monitoring and control or the analog signal itself may be transmitted to the central computer and there digitized. In either case, the process control software generally uses the digitized analog signal in a digital form useful for control and monitoring of the parameters, and

this digital form is usually hexadecimal. This digital form is unrecognizable by more general purpose applications, which are in a binary, decimal, or binary coded decimal (BCD) form. Thus, known systems are not adapted for using process control data in other applications, such as spreadsheet applications and statistical analysis.

In known processing systems, periods of time may pass between operator activities in making adjustments to a process control. Thus, while the operator is absolutely vital to the safe and proper operation of the process, there may be idle time between any actions on the part of the operator.

The operator may often have a need to use other, more general purpose applications on some other computer system. An operator may wish to communicate with a supervisor or another operator through, for example, an electronic-mail system. This requires the operator to shift attention to another operating system, or, if such an operating system is not readily available at his workstation location, he must leave his post to use such a system. Or, the operator, in the course of his duties, may be required to use a word processing or spreadsheet program, which may also require that his attention be diverted away from his responsibilities at the process control workstation.

In the course of their duties, operators are also required to review standard operating procedures (SOP's), material safety data sheets (MSDS's), and other instructions. Such documents are commonly provided to the operator in printed or hard copy form.

Highly skilled process control operators are usually required by their employers to maintain skills and stay up to date on recent innovations by continuing education provided by the employer. It is desirable for operators to undergo a prescribed training regimen. The operator under continuing training often sits in front of a monitor and executes a training program conducted by computer, referred to as multi-media training.

Thus, there is a need for a multi-tasking, process control system that permits an operator to monitor and control a manufacturing process, such as a chemical process, while simultaneously having access to more general purpose applications on the same system, *e.g.*, multi-media training, spreadsheet applications, SOP's and MSDS's, and historical data from the operation of the process and the like. Such a system would permit the operator to maintain vigilance to the process control duties while having the freedom to study other process variables, such as prior data.

SUMMARY OF THE INVENTION

The present invention solves these and other drawbacks of the prior art by providing an operator workstation with multiple functionality in the process control environment. The workstation user interface preferably provides at least two screens, side by side, with one screen displaying process control functions for real-time, interactive control and monitoring of a process. A second screen houses general process data and background information relating to a selected process, as well as more general computer applications, and is used for interactive use of user selectable applications, such as word processing, training, spreadsheets, electronic-mail, computer telephone, and other applications. The second screen is also used for viewing historical process parameters and data.

The monitor for displaying the two or more screens is preferably at least 21" diagonal to provide adequate real estate to display at least two applications simultaneously.

A plurality of controllers are coupled to a local area network (LAN). A process control program on a server that is also coupled to the LAN periodically receives and stores data from the controllers. An operator workstation, and preferably a plurality of operator workstations, are also coupled to the LAN. These workstations are capable of displaying the real-time process control data and enable the operator to control the process while simultaneously executing general purpose applications. The real-time process control data, with time stamps appended, are made available to the workstations for display and manipulation as historical data.

Thus, an embodiment of the present invention relates to an interactive, integrated process control workstation comprising a) a process control system for controlling a process; b) a server coupled to a local area network to store data collected from the process; c) a display unit to display data collected or generated from the process; d) a central processing unit to manage workstation applications; e) means for displaying processing data; and, f) means for manipulating data to storage for general purpose applications on the workstation.

These and other features of the present invention will be apparent to those of skill in the art from a review of the following detailed description along with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1A and 1B together depict an embodiment of the dual-screen, multi-tasking user interface of the present invention.

Figure 2 is a general block diagram of a computer system to support a dual display.

Figure 3 depicts an overall block diagram of a multi-tasking system, including preferred components, to carry out the present invention.

Figures 4a and 4b together depict a logic flow diagram of a program that establishes a communication link between a server supporting the present invention and each of a plurality of controllers.

Figure 5a - 5c together depict a logic flow diagram of a subroutine to convert hexadecimal bytes into their decimal equivalents.

Figures 6a and 6b together depict a logic flow diagram of a database interface.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Process Control Workstation Background

Referring first to Figure 1, there is depicted a preferred user interface **10** of the multi-tasking workstation of the present invention. The interface includes a process control display **12**, shown in Figure 1A as Screen One. The interface further includes a display **14**, referred to as Screen Two, showing a user selectable application, depicted in Figure 1B as Hoechst Celanese Corporation homepage on the Web server. As shown in Figure 1A, the process control display **12** has been selected by the workstation operator to run in the Group-Trend mode, included as a part of Honeywell Scan 3000® system. Scan 3000® is a trademark of Honeywell Corporation, Houston, Texas.

The display **14** may include a depiction of historical data in a window **16**. An important feature of the present invention includes acquisition, display, and manipulation of the data in the window **16** that has been acquired from the process control system.

In a preferred embodiment, the workstation shown in Figure 1 is an Intergraph TD-40® operator workstation, available from Intergraph Corp., Huntsville, AL. This workstation provides the operator with personal computer (PC) workstation power and productivity on a single desktop. This workstation includes two Intel® 133-megahertz Pentium® (INTEL and PENTIUM are trademarks of Intel Corporation, Mountain View, CA) processors. The dual screens give the operator the flexibility to monitor process control on one screen and view standard operating procedures, historical data such as past process parameters, MSDS's, documents, or view electronic mail on the second screen, as shown in Figure 1.

The feature of the Intergraph TD-40® that supports the present invention in this application is the dedication of the hardware, *e.g.*, the backplane with more than one video card,

to multiple screens, and the dual processors operate in parallel to enhance the multi-tasking computing power of the workstation. Each video card may be configured to display on a defined region of the monitor on the workstation.

As the operator views other applications, the process control software continues to update the display **12** with current data. An integrated keyboard which includes among other items, a microphone, dual speakers and a volume slide control are employed and described below with regard to Figure 2. The preferred microphone utilizes the capability of Internet phone or voice recognition. The dual speakers preferably provide voice alarming and process alarming with volume control.

Figure 2 depicts a structural block diagram of a workstation **17**. The workstation comprises a processor **18**, including a pair of central processing units **CPU 1** and **CPU 2** which operate in parallel, as well as a memory **20**, such as volatile and non-volatile memory. The workstation **17** further includes peripheral devices, such as a hard disk storage **22**, CD ROM **24**, and a floppy disk device **26**. Coupled to the processor is a pointing device such as a mouse **28**. As previously described, the processor **18** provides the information to be displayed on a display **12** and a display **14**. Although the present invention is described as preferably having two displays, one display having a split window is acceptable. Also coupled to the processor **18** is an integrated keyboard **30**, with features as described above. Finally, the processor **18** communicates with other processors in a complete system through a communication port **32**.

Referring now to Figure 3, each workstation is connected to the LAN **34** using a conventional network protocol link. In a preferred embodiment Transmission Control Protocol/Internet Protocol ("TCP/IP") link is employed and establishes a client/server relationship between each workstation and a number of servers, as shown in Figure 3. The software that resides on the workstation is the operating system plus the client-based software to access the appropriate server. Real-time process data and historical data is stored remotely to the appropriate server.

Coupled to the LAN **34** is a process control server **36**. In a preferred embodiment an ALPHA Server 2000™, from Digital Equipment Corporation, Maynard, MA is employed. The process control server **36** includes the process control software, preferably Honeywell Scan 3000® software and CM50S® software, both available from Honeywell Corp., Houston, TX. CM50S® is an interface program provided by Honeywell to interface TDC 3000 with Scan 3000®. TDC 3000 is a distributed control system (DCS) which provides viewing of the process

control data. The process control server also preferably includes PINET®, which is remote node software provided by Oil Systems, San Leandro, CA, to remotely communicate with the historical database. DEC TCP/IP establishes the client/server relationship between server and workstation.

The LAN also includes a server **38** providing user access to historical data. In a preferred embodiment, this data is provided through a PI Database from Oil Systems. The data is imported from several sources, including at least one programmable logic controller (PLC) **48**, the PLC including a remote station identified in Figure 3 as a remote I/O rack. If desired for analytical purposes, an on-line gas chromatograph (GC) may be included with the PLC. An on-line GC is identified in Figure 3 and communicates with the PLC through the MODBUS RTU protocol. This server **38** is shown in Figure 3 as a VAX® server and VAX® is a trademark of Digital Equipment Corporation, Maynard, MA. The server **38** also provides a time service to assign a time stamp for all acquired data, for historical and display purposes.

In accordance with this invention, the preferred PLC is a Series 9200E® from Honeywell Corp., Houston, TX. The controller, in addition to the PLC 48, includes an Ethernet loop processor module (ELPM), a loop processor module (LPM), a remote I/O rack, a MODBUS remote terminal unit (RTU), and a serial link module (SLM).

A feature of the present invention is the coupling of the server **36**, housing the process control program, and the server **38**, housing the program interface program and the historical database, to the local area network **34**, to which is coupled one or more controllers **48**. In this way, the process parameters from the controller is made available for monitoring and control of the process at the workstation **17**. The process values from the controller are also stored to a historical database for retrieval at the workstation for manipulation and display by the operator.

The LAN **34** further includes a server **40** which in the illustrated embodiment provides the system with electronic mail capability. The present invention preferably utilizes Microsoft Mail®, a trademark of Microsoft Corp., Eugene, OR, although other mail services may be employed. A server **42** provides operator access to work orders and purchase order requisitions. A server **44** serves as a connection to additional process parameters, and company information, such as standard operating procedures as previously described. Information which the operator needs or desires may be loaded onto server **44**. A server **46** provides graphics capability and flow sheets of the process. It is to be understood that the servers discussed herein are merely illustrations. The operator may utilize the servers for whatever information and capabilities are

desired.

As previously described, the LAN **34** includes one or more operator workstations **17**. Since the present invention establishes a client/server relationship, the applications on the workstation are the client-based software to allow communication with each of the servers **36**, **38**, **40**, **42**, **44**, and **46**. These applications include Windows NT® operating system, a trademark of Microsoft Corporation. The workstation further includes a desktop program launcher and a time synchronization program. Other client software preferably residing on the workstation is Honeywell Scan 3000® process control software, a world wide web browser, MS Office Products®, Oil System PI® products, Reflections®, and Tardis®. Reflections®, from Walker Richer & Quinn, Inc., Seattle, WA is a terminal emulator that links the user to work orders and purchase requisitions.

Time synchronization is an important element in process control. This feature is accomplished through Tardis®. Tardis® synchronizes each workstation to a time service located on the server **38**.

Windows NT® is the operating system that provides the multi-tasking environment that allow numerous applications to run simultaneously. It provides an environment with security features for both the user and the desired applications. It also provides better network access for client/server relationships. A user friendly environment is provided using a program launcher called Dezktop®, from Rattus Hacking Software, Chester, England. Dezktop® enables application icon shells to appear on the screen for the end user to select the appropriate application needed, and provides the capability of sizing an application to the appropriate screen. In a preferred embodiment of this invention, the application icons are located on screen two in a stationary position and appear on top of an application.

In an embodiment of the present invention, the user will see on screen one Honeywell's Scan 3000® displayed through server **36**. Scan 3000® is a robust process control software that provides real-time supervisory control, monitoring, trending, tuning, batch records, recipes, operator log, alarming, and graphics. Utilizing Scan 3000®, points of the process being monitored are displayed on screen one and are updated at a frequency interval between 2 and 60 seconds, preferably every 5 seconds. A user studies the points or data generated and alters the process being monitored accordingly. If a setpoint change is made by the user, the information is sent immediately to the appropriate control system, and the information is verified.

As previously described, the LAN may also include at least one remote sensor, such as an

on-line gas chromatograph **50**, which provides data to a universal station **52**, for example a TDC 3000. The station **52** is coupled to the LAN **34** through a computer module **58** to communicate with servers such as the PLC **48**.

In an embodiment of this invention, a user can utilize screen two to view the various applications described herein. For example, a web browser gives the user the ability to view operating procedures, chemical inventory, and the like. The user can create, edit, and view documents, and access and manipulate historical data. On-line historical trending with periodic updates is available.

Software Programs

In accordance with this invention, a communication link between the server **36** (containing the process control program) and each PLC **48** is established. This process control program or interface may be referred to herein as UnitVal, shown in the logic flow diagram of Figures 4a and 4b. Although it may be written in any appropriate programming language, the UnitVal program is preferably written in C programming language.

Alternate languages include FORTRAN®, PASCAL®, and the like. The interface consists essentially of two parts, (1) establishes the communication link and (2) converting data to a decimal floating point number.

The interface program resides on the server **38**. In order to communicate with the PLC it uses the TGV Incorp. Multinet TCP/IP out of Santa Cruz, California. After initializing variables in step **60** and checking the identity of the particular controller against a host table on the server **38** in steps **62**, **64**, and **66**, the interface opens a socket to begin communication between the server **38** and the desired PLC **48** in step **68**. Step **70** binds the socket created in step **68** to ensure a dedicated communication channel.

Once proper connection is verified in steps **74** and **76**, a read request for data is transmitted to the PLC in step **78** for each analog point defined thereon. In step **80**, a reply message returns representing the value in hexadecimal format. Each byte value is placed in a two dimensional array, four byte array in step **82**. Each value is represented by a floating point number of four hexadecimal bytes. Step **84** checks to see if all data points have been received, and when they have, step **86** closes the socket. Step **88** then calls up the Binext subroutine, depicted in Figures 5a through 5c.

Although one PLC is illustrated in Figure 3 and described herein, it is expected that more

than one PLC would be employed in a commercial process of this invention. The interface or process control program would be scheduled to run in sequence per PLC unit.

The process control program enables a user to establish communication between the desired PLC to receive or collect process variables or process values. The program allows the values to be collected and stored in a historical database, and the user is able to view this data with the appropriate applications, such as PI® products as previously described. Generally, the data is viewed through screen two.

To summarize Figures 4a and 4b, the UnitVal program begins by creating, binding, and verifying a socket to each desired PLC. It initializes client information and variables to be used throughout the program. Once the connection is made to the desired PLC, and send-read-request in hexadecimal format is sent to the desired PLC. If successful, a reply message, also in hexadecimal format, is returned from the desired PLC, thus confirming connection. Four hexadecimal bytes are then stored in a two dimensional array.

Once the data is in a two dimensional array, the bytes are converted to a 32 bit binary number in the Binext subroutine, as shown in Figures 5a - 5c. Binext begins by reading the hexadecimal values in step **90**. Each byte is evaluated to determine whether it is a positive byte, and if not, the negative byte is converted to a positive byte with the following calculation:

positive byte = negative byte - 0xffffff00

The "0x" prefix is a convention recognizable by the computer as indicating a hexadecimal number.

Each binary number from step **92** is then stored in a array in step **94**. The binary number is then examined to determine whether it is less than eight bits. Each byte is eight bits, to allow for the IEEE 32 byte standard floating point number format required. If the number is less than eight bits, it is padded with zeroes to make it eight bits or one byte. The numbers are then placed in a high-order first form, meaning that the number order is sign bit, exponent, and then fractions last. The first bit is the sign bit, positive or negative, bits 1-8 consist of the exponent, and bits 9-31 consist of the fractions. Each bit is then examined to determine the final decimal value in step 98.

A calculation is performed to determine the decimal value of each number, by calculating the sign, exponent, and fraction of the decimal equivalent, in a manner well known in the art, in step **102**. This value is then written to a flat or ASCII text file in step **104**. Step **106** then loops back to read the next hexadecimal value until all have been read. At this point, all of the desired

hexadecimal values stored in the array have been converted to decimal values and stored in a flat file, now available for display and manipulation by the operator.

In accordance with the present invention, the database interface program is written in FORTRAN programming language, although other programming languages may be used. This FORTRAN program takes the decimal values obtained from the interface and places them in the PI database for future use. As shown in Figures 6a and 6b this program initializes variables in step **108** and opens the flat file in step **110**. It then reads each value from the file in step **112** and places each data value in a one-dimensional array in step **114**. If the end of the file is not yet reached, step **116** loops back to read another value. When the end of the file is reached, step **118** closes the file.

A tag name, and its location, is verified with the PI database in step **120**. The values are then given a time stamp from the server **38** in step **128**, indicating the time the values are entered into the system. If the verification is successful, the value is written to the appropriate location in step **130**. If the verification is unsuccessful, an error message will appear in a log file. The user will then go back and determine where the error occurred and proceed accordingly.

This completes the interface. The interface is important to the invention because this enables the user to view historical along with real-time data. In the past, only real time has been available for viewing from the monitored process. The user was forced to go to another system, not connected to the process being monitored, to view historical data. This interface, and this invention, allow an operator to selectively and simultaneously view historical and real-time data, as well as perform additional computer related applications as desired.

Hardware/Software Structure and Interactions

A more detailed embodiment of the invention provides means to configure the workstation to other components coupled to the system. A user shell provides the means for various graphical user interface features, such as configuring icons, positioning applications, windowing, and so on, in the conventional manner. A time sync block cooperates with the time service on the server **38** for proper time synchronization between server and workstation.

The workstation **17** also communicates with process control software, such as the previously described Honeywell Scan 3000℠. The communication through the control software enables establishing communications with the server **36** and permits the user or the operator to control and monitor the process control system.

The workstation 17 may also include Internet® connections through a world wide web block or a means for terminal emulation. Historical data and trending provides a means for linking to the desired server. General office applications and means for screen capture for hard copy display are available features of the present invention.

System Operation

An overview of the operation of the system and method of the present invention follows. Description is based on a two screen system; however, it is understood by those of skill in the art that a single screen with split windows or more than two screens may be employed. The present invention is not limited to a dual screen operation.

Broadly speaking, an operator starts the workstation and elects to view Screen One (process control display) or Screen Two (general application display). A standard diagnostic test is performed upon startup of the workstation. Utilizing the icons present on the display screen, a user selects the desired applications. Generally, an operator chooses screen one, and accordingly activates the Scan 3000® software which will automatically begin the monitoring in real time of the manufacturing process.

The next step is to activate screen two, herein utilized for the more general applications. This is done by choosing the appropriate application from the menu listing icons. Once the desired application is activated, the operator proceeds accordingly. At this point, an operator may for example, call up on screen two an MSDS, chemical inventory, electronic mail, historical data, or the like.

This ends the operation of the system. The workstation is operated by conventional methods and appropriate care is taken in startup and shutdown operations of the workstation.

The principles, preferred embodiment, and mode of operation of the present invention have been described in the foregoing specification. This invention is not to be construed as limited to the particular forms disclosed, since these are regarded as illustrative rather than restrictive. Moreover, variations and changes may be made by those skilled in the art without departing from the spirit of the invention.

CLAIMS

What is claimed is:

1. An interactive, integrated process control workstation comprising

a) a process control system for controlling a process;

b) a server coupled to a local area network to store data collected from the process;

c) a display unit to display data collected or generated from the process;

d) a central processing unit to manage workstation applications;

e) means for displaying processing data; and,

f) means to collect and convert data to storage for general purpose applications on the workstation.

2. The workstation of claim 1, wherein the display receives processing data from a programmable logic controller.

3. The workstation of claim 2 further comprising a communication link to send a programmed request and receive response messages from the programmable logic controller.

4. The workstation of claim 1 wherein the process control system is a distributed control system.

5. The workstation of claim 4 further comprising a interface program communicating with the distributed control system.

6. The workstation of claim 1 wherein the display unit receives data from the programmable logic controller.

7. The workstation of claim 1 wherein the display unit receives data from the distributed control system.

8. The workstation of claim 1 wherein the display unit displays non-process control applications.

9. The workstation of claim 1 wherein the means for displaying process data comprises Scan 3000®.

10. The workstation of claim 1 wherein the means to collect and convert data to storage for general purpose applications comprises establishing a communication link to the process control system and converting data to a decimal floating point number.

11. An interactive and integrated workstation monitoring and control system in a process control system, the workstation monitoring and control system comprising:

a. a programmable logic controller;

b. a first server for continuously receiving and storing process control data from the process control system; and

c. a second server housing general process data information, and running at least one general computer application;

d. a process control program to receive and store data from the programmable logic controller; and

e. a workstation to receive and display process control data from the first server and general process data from the second server.

12. A method of process control from an interactive and integrated workstation comprising the steps of

a. activating a process control program from the workstation;

b. receiving and displaying real-time data from a process control system at the workstation;

c. activating a general purpose computer application from the workstation;

d. providing the stored real-time data to the general purpose computer application for display and manipulation as historical data.

13. The method of claim 12 further comprising the step of enabling the simultaneous control of a process based upon the real-time data and the display and manipulation of the historical data.

14. The method of claim 12 further comprising the step of enabling the simultaneous control of a process based upon the real-time data at the workstation and the execution of a general purpose computer application at the workstation.

15. The method of claim 12, wherein the general purpose computer application comprises a training program.

16. The method of claim 12 wherein the general purpose computer application comprises word processing, spreadsheet applications, statistical analysis, electronic mail, or inventory lists.

17. A method of process control from an interactive and integrated workstation comprising the steps of

a. providing process control data to the workstation for display and control on a first display; and

b. providing a general purpose computer application to the workstation for display and manipulation on a second display.

18. The method of claim 17 further comprising the step of coupling the workstation to a local area network.

19. The method of claim 18 further comprising the step of receiving and storing process control data in a server coupled to the local area network.

20. The method of claim 19 further comprising the step of providing the stored process control data to the workstation for display and manipulation on the second display.

21. The method of claim 20, wherein the step of providing the stored process control data to the workstation is carried out by the method of:

a. storing the process control data in an array in the memory of the server;

b. converting the process control data to decimal equivalent values of the data;

c. applying time stamps to the converted process control data;

and

d. storing the converted process control data in the desired storage media.

22. The method of claim 21 wherein the storage media is a server.

23. The method of claim 21 wherein the storage media is a hard disk.

24. An interactive, integrated process control workstation comprising a single workstation having at least first and second displays, said first display providing real-time display of process data and an interface to a process control system and said second display providing an interface to a general purpose computer application.

25. A method of process control from an interactive and integrated workstation comprising the steps of :

a) activating a process control program at the workstation to provide an interface to a process control system;

b) receiving, through said process control program, real-time data from a process control system and displaying said real-time data on a first display at the workstation; and,

c) providing an interface to a general purpose computer application on a second display at the workstation.

10

SCREEN ONE

12

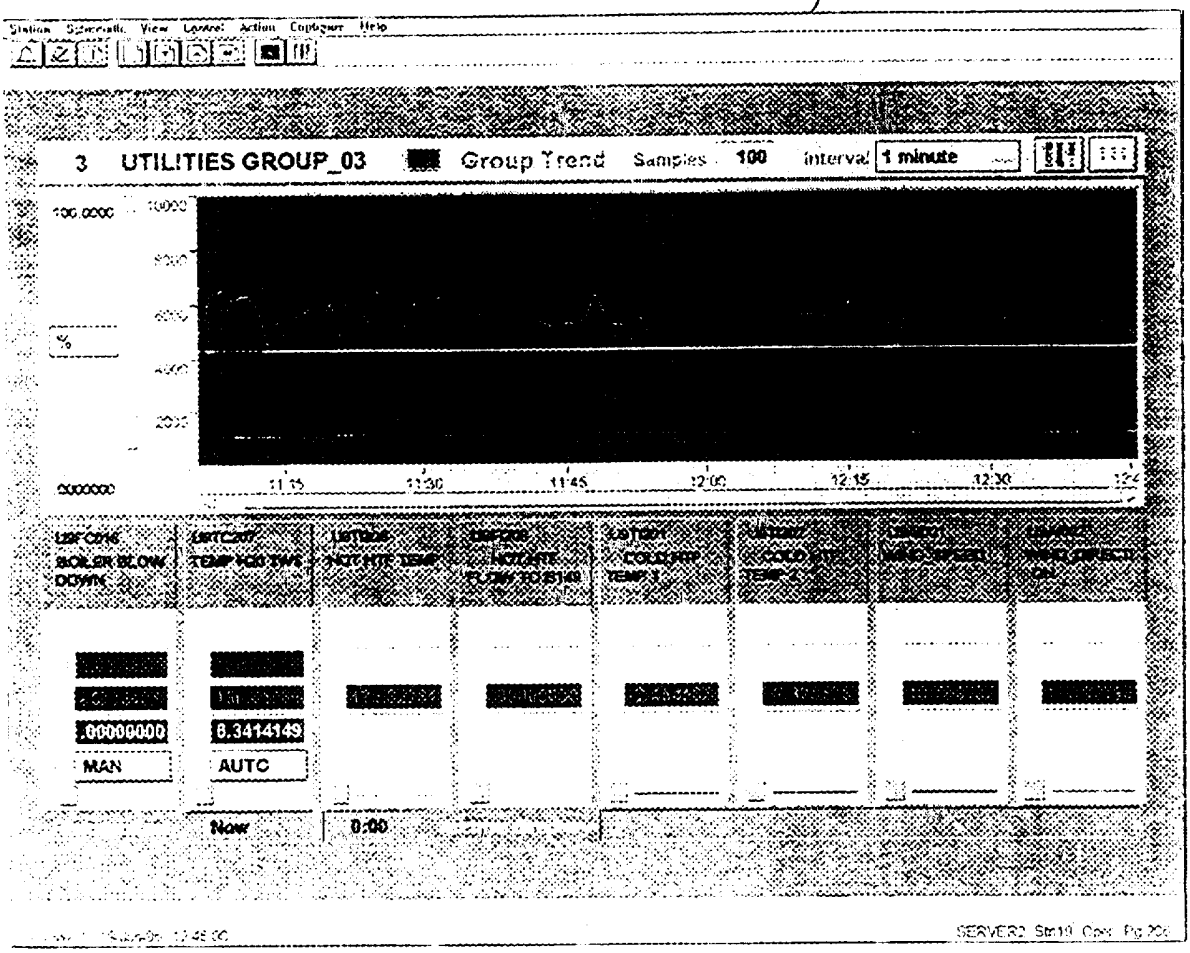


FIG. 1A

10

SCREEN TWO

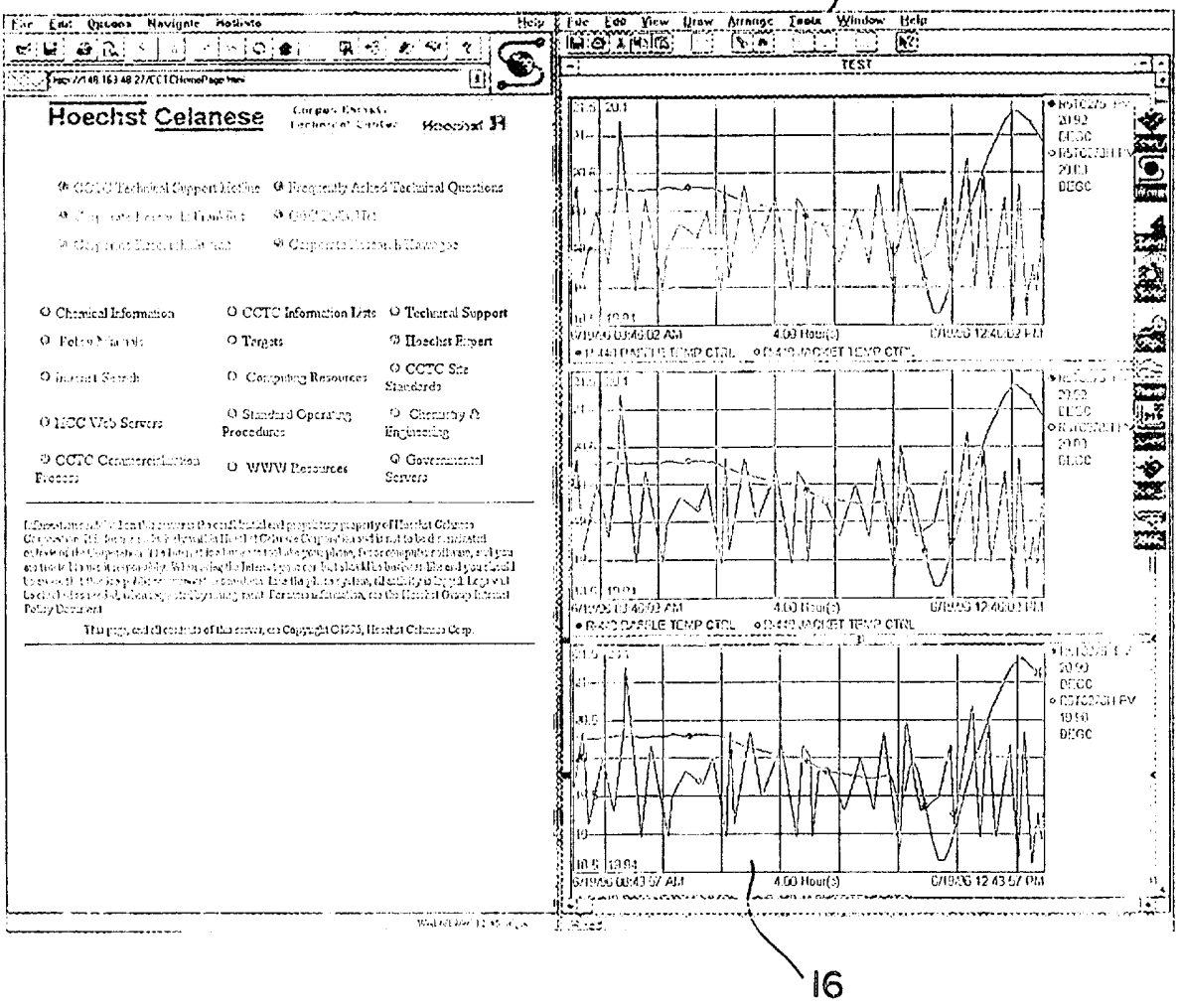


FIG. 1B

FIG.2

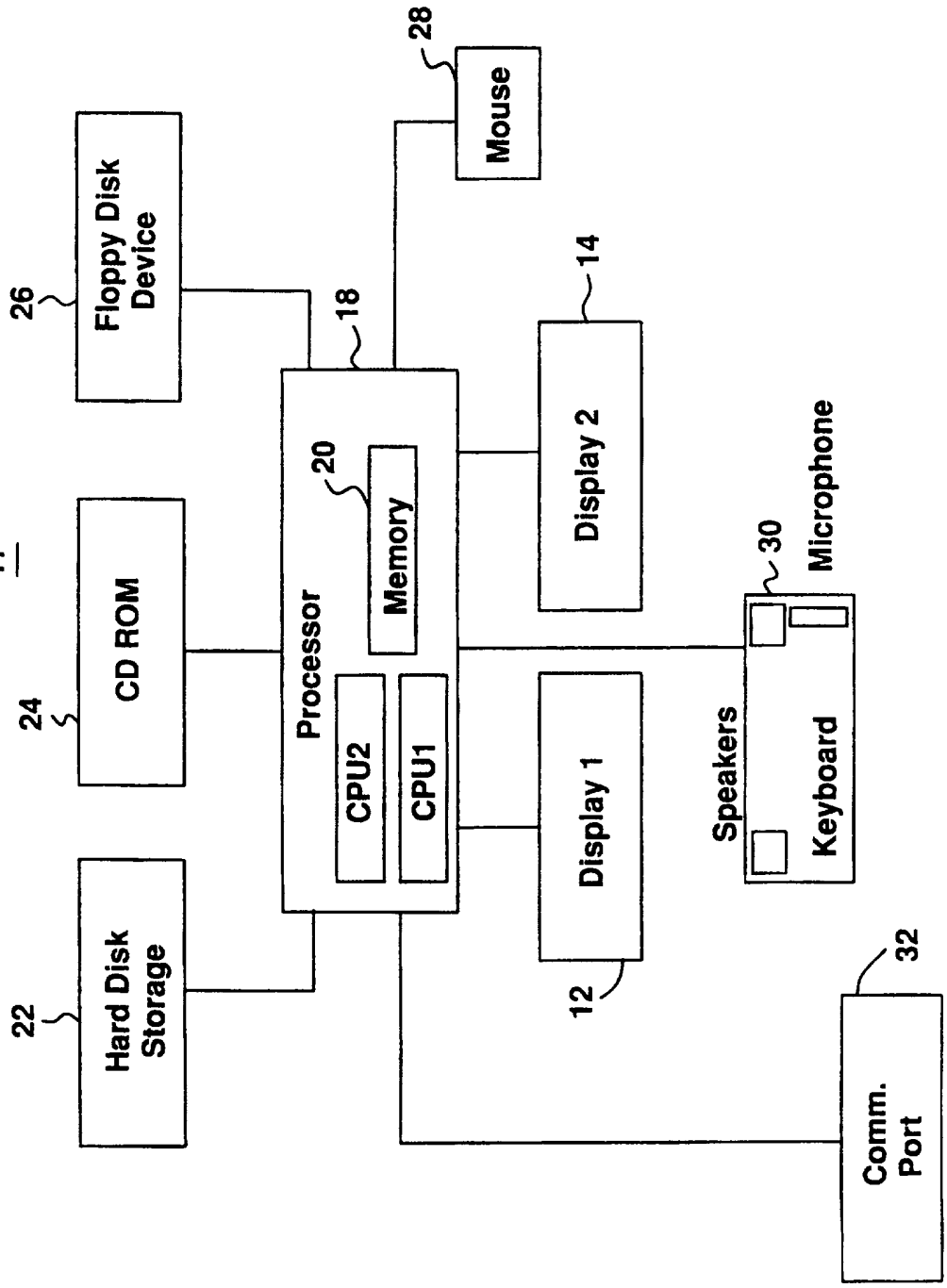

17
Floppy Disk Device
26
Mouse
28
Processor
18
Memory
20
CPU2
CPU1
Display 2
14
Display 1
12
CD ROM
24
Hard Disk Storage
22
Speakers
Keyboard
Microphone
30
Comm. Port
32

FIG.3

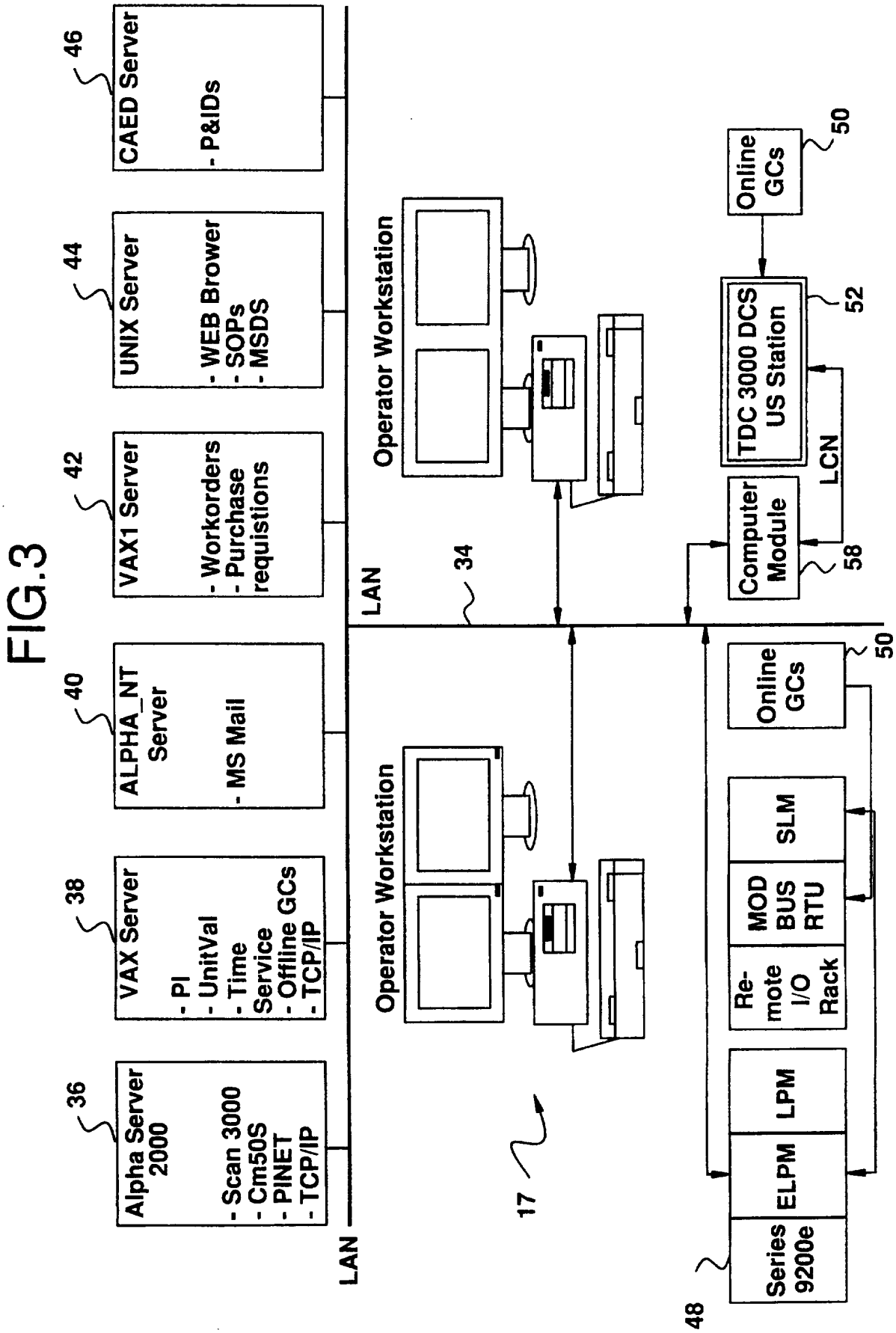

46
CAED Server
- P&IDs
44
UNIX Server
- WEB Brower
- SOPs
- MSDS
42
VAX1 Server
- Workorders
- Purchase requisitions
40
ALPHA_NT Server
- MS Mail
38
VAX Server
- PI
- UnitVal
- Time Service
- Offline GCs
- TCP/IP
36
Alpha Server 2000
- Scan 3000
- Cm50S
- PINET
- TCP/IP
LAN
34
Operator Workstation
Operator Workstation
17
Online GCs
50
Online GCs
50
TDC 3000 DCS US Station
52
LCN
Computer Module
58
SLM
MOD BUS RTU
Re-mote I/O Rack
LPM
ELPM
Series 9200e
48

FIG.4A

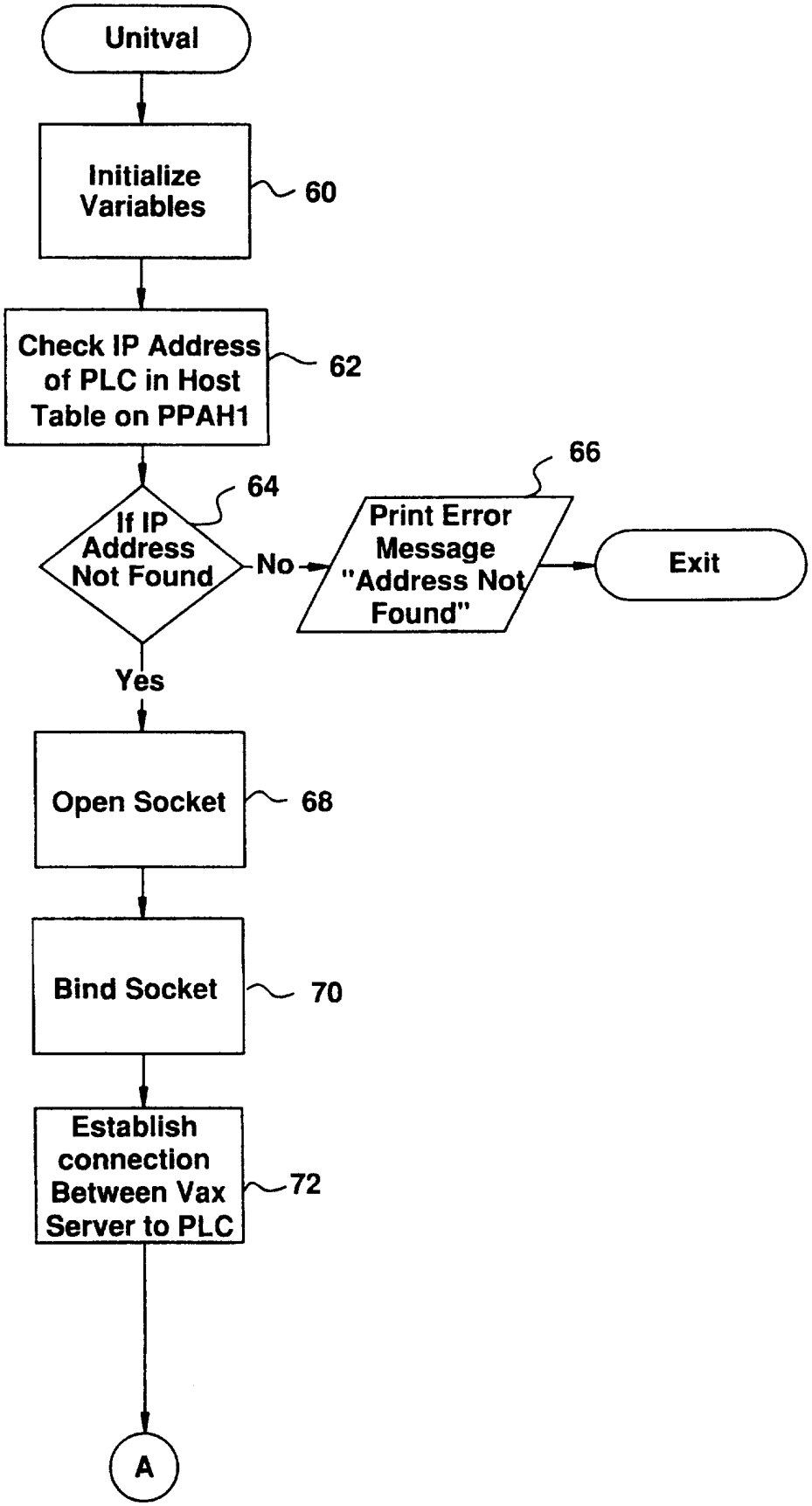

Unitval
Initialize Variables
60
Check IP Address of PLC in Host Table on PPAH1
62
If IP Address Not Found
64
No
Print Error Message "Address Not Found"
66
Exit
Yes
Open Socket
68
Bind Socket
70
Establish connection Between Vax Server to PLC
72
A

FIG.4B

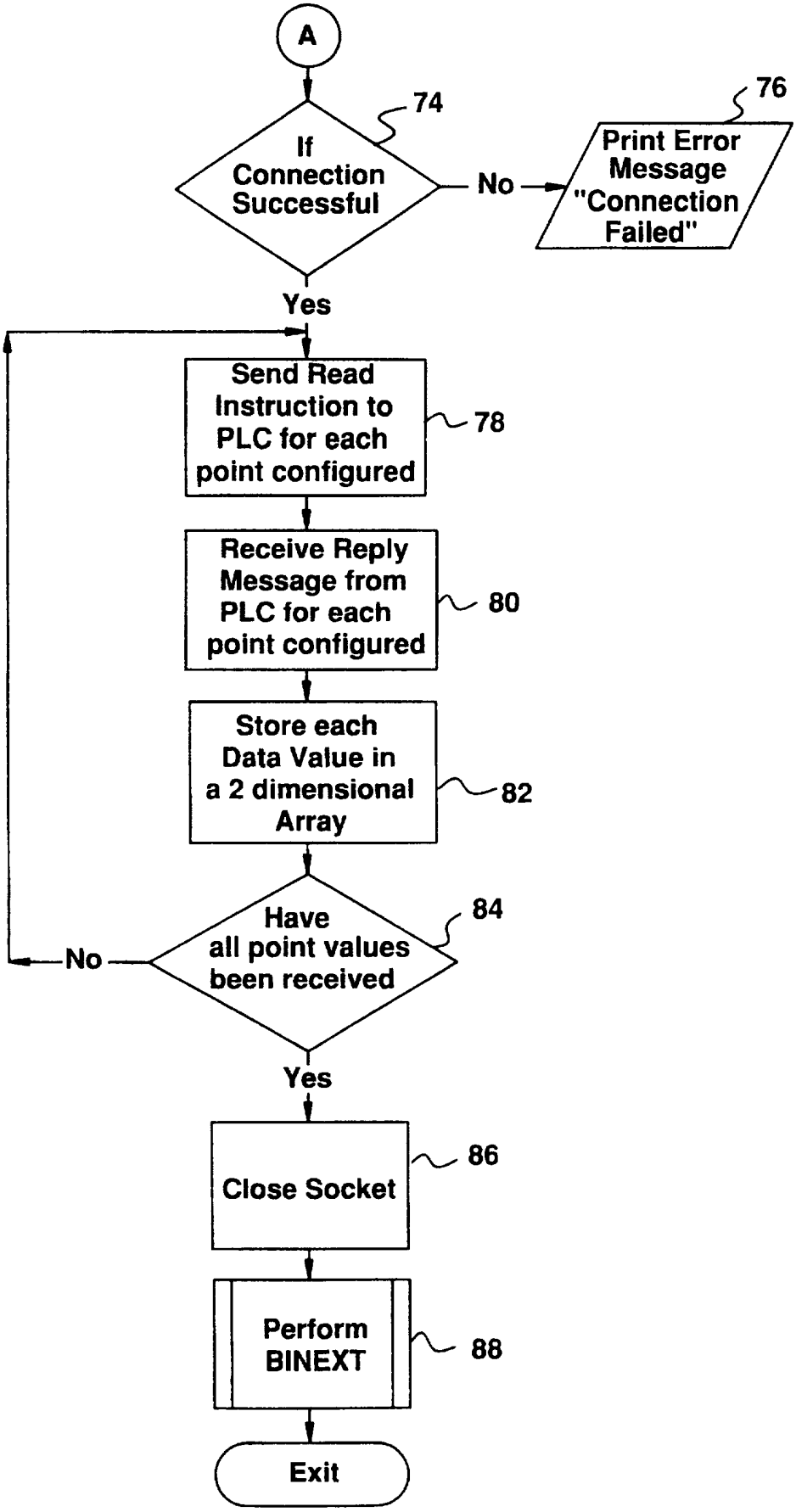

A
74
If Connection Successful
No
76
Print Error Message "Connection Failed"
Yes
Send Read Instruction to PLC for each point configured
78
Receive Reply Message from PLC for each point configured
80
Store each Data Value in a 2 dimensional Array
82
Have all point values been received
84
No
Yes
Close Socket
86
Perform BINEXT
88
Exit

FIG.5A

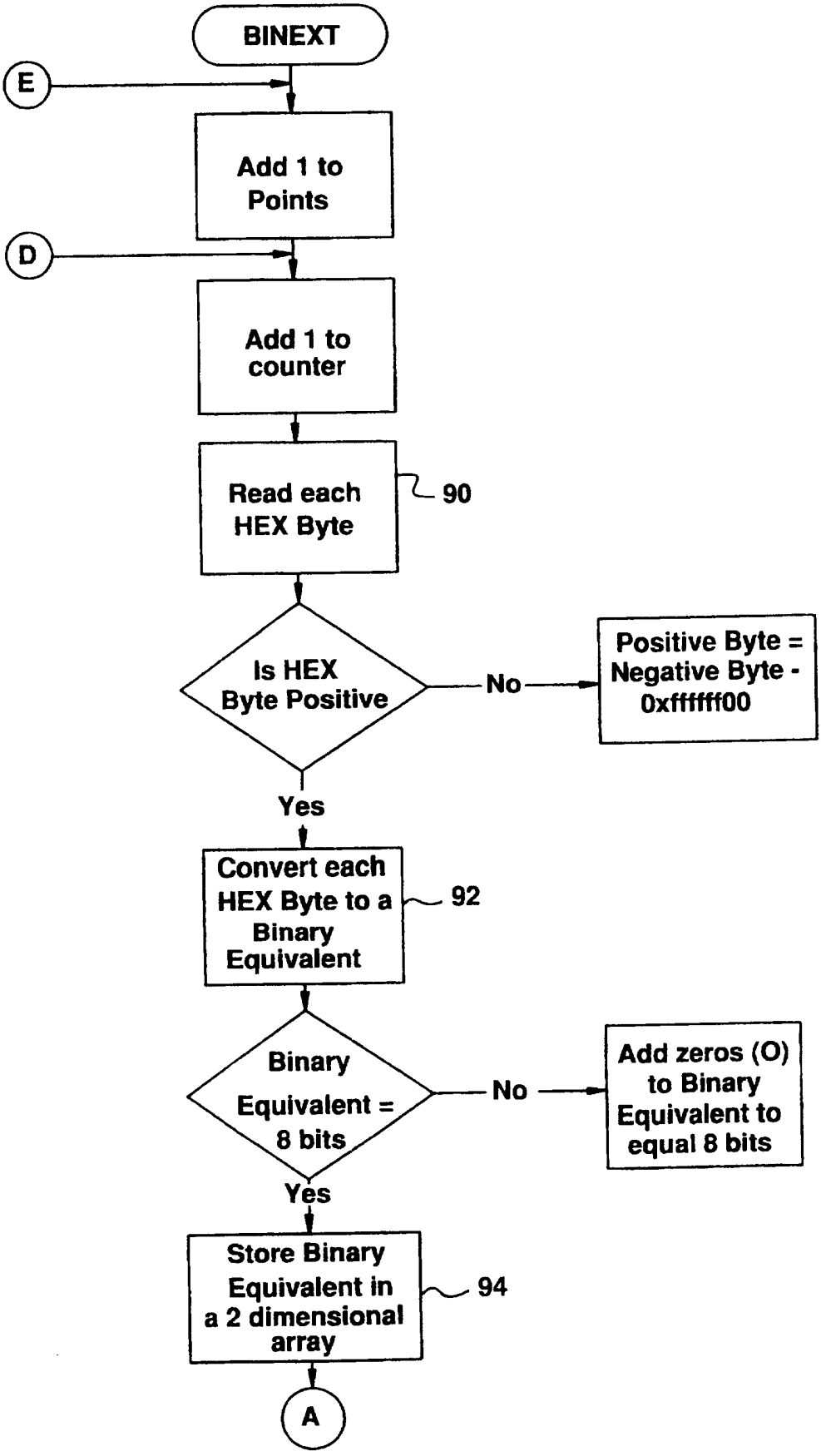

BINEXT
E
Add 1 to Points
D
Add 1 to counter
Read each HEX Byte
90
Is HEX Byte Positive
No
Positive Byte = Negative Byte - 0xffffff00
Yes
Convert each HEX Byte to a Binary Equivalent
92
Binary Equivalent = 8 bits
No
Add zeros (O) to Binary Equivalent to equal 8 bits
Yes
Store Binary Equivalent in a 2 dimensional array
94
A

FIG.5B

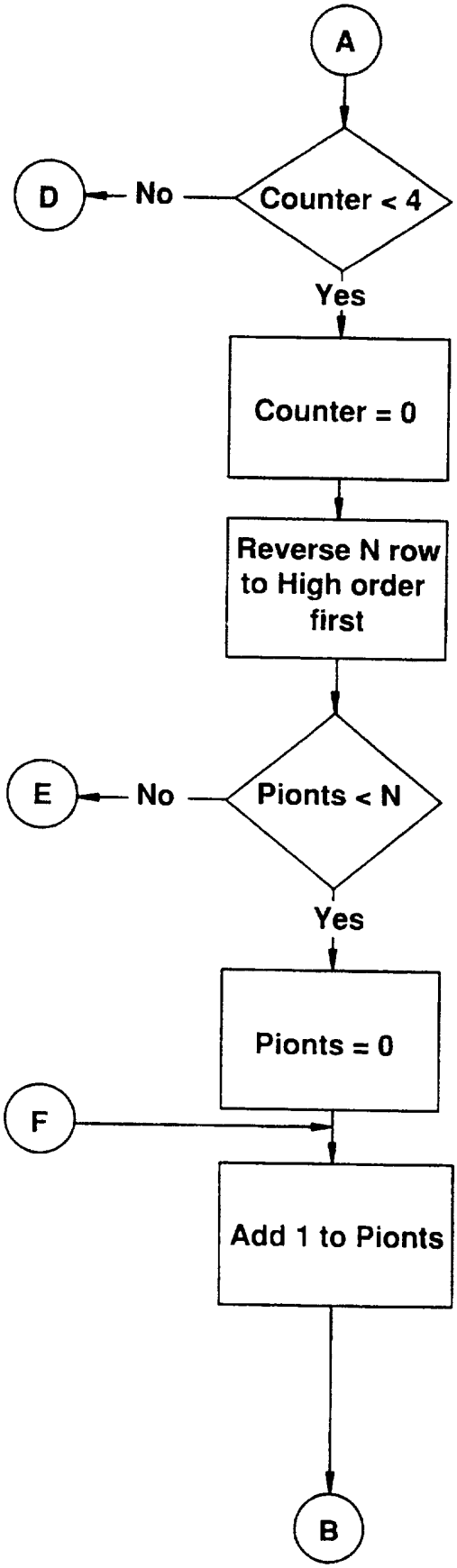

A
Counter < 4
No
D
Yes
Counter = 0
Reverse N row to High order first
Pionts < N
No
E
Yes
Pionts = 0
F
Add 1 to Pionts
B

FIG.5C

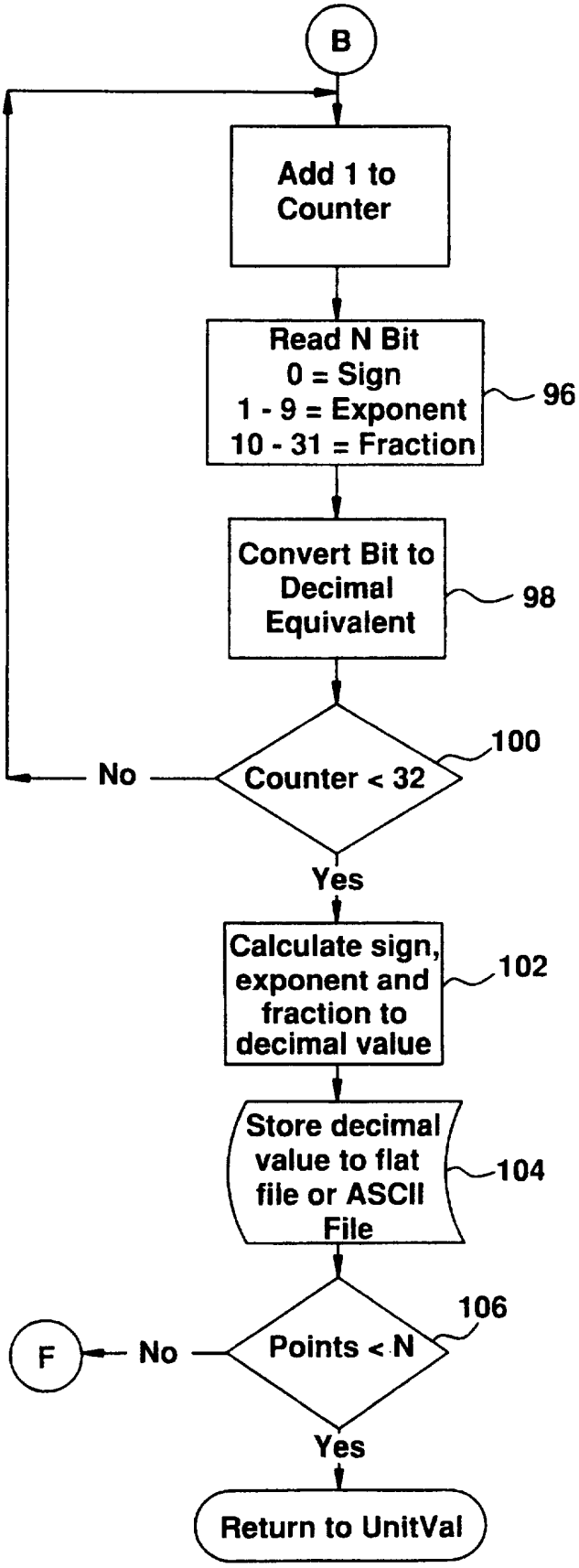

B
Add 1 to Counter
Read N Bit
0 = Sign
1 - 9 = Exponent
10 - 31 = Fraction
96
Convert Bit to Decimal Equivalent
98
Counter < 32
100
No
Yes
Calculate sign, exponent and fraction to decimal value
102
Store decimal value to flat file or ASCII File
104
Points < N
106
F
No
Yes
Return to UnitVal

FIG.6A

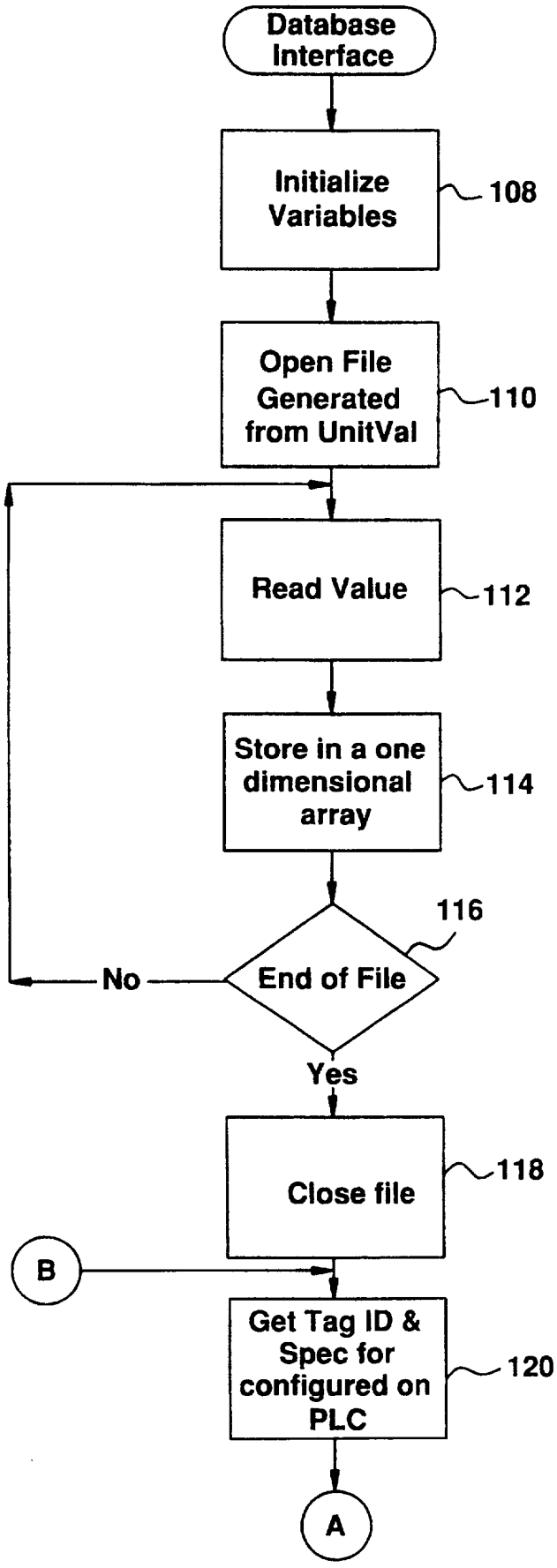
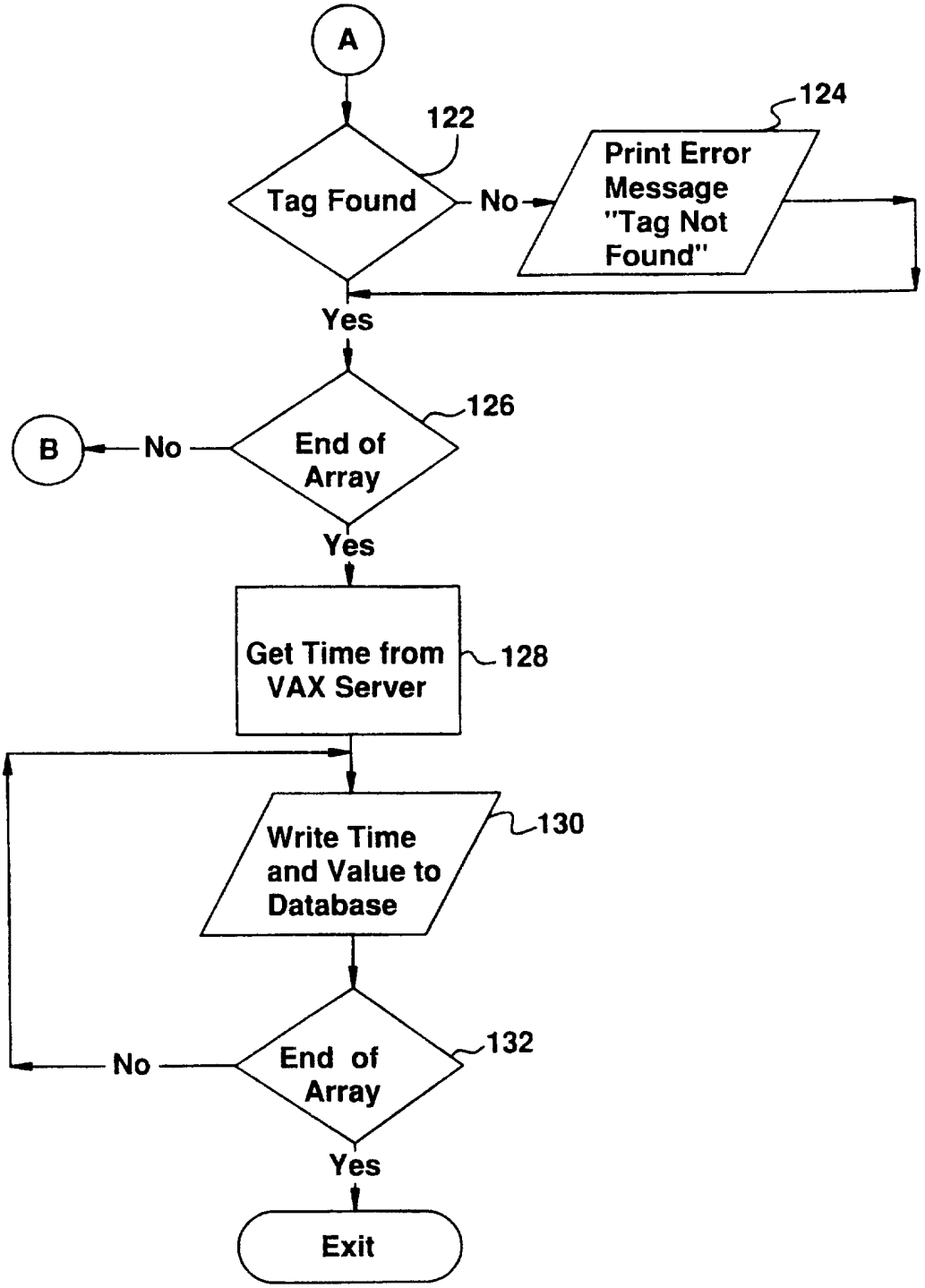

Database Interface
Initialize Variables
108
Open File Generated from UnitVal
110
Read Value
112
Store in a one dimensional array
114
116
End of File
No
Yes
Close file
118
B
Get Tag ID & Spec for configured on PLC
120
A

FIG.6B


A
122
Tag Found
No
124
Print Error Message "Tag Not Found"
Yes
126
End of Array
B
No
Yes
Get Time from VAX Server
128
Write Time and Value to Database
130
End of Array
132
No
Yes
Exit

INTERNATIONAL SEARCH REPORT

Intern ial Application No
PCT/US 97/10311

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G05B19/418

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 G05B

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 592 921 A (FISHER CONTROLS INT) 20 April 1994 see the whole document ---	1-25
Y	WO 95 09387 A (DOW BENELUX) 6 April 1995 see page 21, line 25 - page 24, line 32; figures 1-4 ---	1-25
A	PETER CLEVELAND: "Honeywell introduces SCAN 3000 and PC Network Manager on Windows NT" I & CS - INDUSTRIAL AND PROCESS CONTROL MAGAZINE., vol. 68, no. 11, November 1995, RADNOR, PENNSYLVANIA US, page 84 XP002043703 see the whole document --- -/--	1-25

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

1

Date of the actual completion of the international search	Date of mailing of the international search report
15 October 1997	31. 10. 97

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

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Intern ıal Application No
PCT/US 97/10311

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WAYNE LABS: "Integrated automation software family runs on Microsoft Windows 95 and Windows NT" I & CS - INDUSTRIAL AND PROCESS CONTROL MAGAZINE., vol. 68, no. 11, November 1995, RADNOR, PENNSYLVANIA US, page 82 XP002043704 see the whole document ---	1-25
A	KEITH HOGAN: "Advanced networks, I/os, OIs, software distribute the power of programmable controllers" I & CS - INDUSTRIAL AND PROCESS CONTROL MAGAZINE., vol. 68, no. 6, June 1995, RADNOR, PENNSYLVANIA US, pages 51-55, XP000522563 see the whole document ---	1-25
A	KWOK T: "ADVANCED WORKSTATION AS DCS OPERATOR CONSOLES" ADVANCES IN INSTRUMENTATION AND CONTROL, vol. 47, no. PART 01, 1 January 1992, pages 281-298, XP000330062 see page 282, line 1 - page 285, line 2; figure 9 ---	1-25
A	WOGSBERG E: "USE OF THE X WINDOW SYSTEM TO MEET SPECIAL OPERATOR CONSOLE REQUIREMENTS" ADVANCES IN INSTRUMENTATION AND CONTROL, vol. 49, no. PART 03, 23 October 1994, pages 899-910, XP000509000 see page 901, last paragraph - page 903, paragraph 1 -----	1-25

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern. al Application No
PCT/US 97/10311

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0592921 A	20-04-94	NONE	
WO 9509387 A	06-04-95	US 5631825 A	20-05-97
		AU 7657194 A	18-04-95
		EP 0721611 A	17-07-96
		JP 9503086 T	25-03-97