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(71) Applicant: GENERAL ELECTRIC COMPANY [US/US]; 1 River Road, Schenectady, NY 12345 (US).

(72) Inventors: KAUFMAN, Ellen; 82 Crescent Drive, Albany, NY 12208 (US). CHATI, Mandar; 1187 Hillside Avenue, Apartment #1B8, Niskkayuna, NY 12309 (US).

(74) Agents: SNYDER, Bernard et al.; General Electric Company, 3135 Easton Turnpike W3C, Fairfield, CT 06431 (US).

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(54) Title: METHOD AND SYSTEM FOR PROVIDING DESIGN TOOLS TO MULTIPLE USERS

(57) Abstract: An exemplary embodiment of the invention is a system for providing design tools to users at remote locations. The system includes a host system (14) for executing the design tools. The design tools relate plastics and manufacturing of plastic components. A user system (18) is connected to a network (12) which is connected to the host system (14). The user system (18) accesses the design tools via the network (12). A database (70) is coupled to the host system (14) for storing data relating to properties of plastics and manufacturing of plastic components.

METHOD AND SYSTEM FOR PROVIDING DESIGN TOOLS TO MULTIPLE USERS

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. provisional patent application 60/182,621 filed February 15, 2000, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

The invention relates to a method and system for providing design tools to multiple users at remote locations. Currently, designers use a variety of tools to develop a product. For example, in the design of a plastic component, a design engineer may rely on material datasheets and engineering calculation tools to develop a plastic component. Existing design tools are available to a designer, but not in a convenient fashion. For example, with respect to data sheets, a designer would typically contact a manufacturer and describe the application. The designer would rely on the manufacturer's expertise to select one or more products that would meet the designers needs and forward the relevant datasheets (via facsimile or mail) to the designer. This process would be repeated with multiple manufacturers. If 'he datasheets provided to the designer were not acceptable, the process continues while extracting a toll on design resources.

Similarly, engineering design software is available to product designers which aids the designer in performing calculations for verifying aspects of the design. Such engineering design software is often installed on the designer's personal computer. Such engineering design software often utilizes data and/or transfer functions developed by the software provider. If the provider of the engineering design software develops additional data (which can improve accuracy of interpolation, extrapolation, etc.) or develops enhanced transfer functions, the engineering design software must be updated. This is typically done by mailing the new software to the designer or having the designer download the new software (e.g., via the Internet) to

the designer's personal computer for installation. Both these processes have disadvantages. Mailing new software requires maintaining accurate records of customer addresses. Providing updated software by download requires that the designer to contact the provider, perform the download and install the updated software. This process is time consuming and can lead to errors in the installation process given the variability in the designer's personal computer hardware and/or software.

BRIEF SUMMARY OF THE INVENTION

An exemplary embodiment of the invention is a system for providing design tools to users at remote locations. The system includes a host system for executing the design tools. The design tools relate to plastics and manufacturing of plastic components. A user system is connected to a network which is connected to the host system. The user system accesses the design tools via the network. A database is coupled to the host system for storing data relating to properties of plastics and manufacturing of plastic components.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the drawings, wherein like elements are numbered alike in the several FIGURES:

FIG. 1 is a block diagram of a system for providing design tools to multiple users in one embodiment of the invention;

FIG. 2 depicts an exemplary main user interface;

FIG. 3 depicts an exemplary user interface for the datasheet module shown in FIG. 1;

FIG. 4 depicts an exemplary user interface for the material selection module shown in FIG. 1;

FIG. 5 depicts an exemplary user interface for the material selection module shown in FIG. 1;

FIG. 6 depicts an exemplary user interface for the visualization module shown in FIG. 1;

FIG. 7 depicts an exemplary user interface for the visualization module shown in FIG. 1;

FIG. 8 depicts an exemplary user interface for the visualization module shown in FIG. 1;

FIG. 9 depicts an exemplary user interface for the color selection module shown in FIG. 1;

FIG. 10 depicts an exemplary user interface for the engineering calculation module shown in FIG. 1;

FIG. 11 depicts an exemplary user interface for the engineering calculation module shown in FIG. 1;

FIG. 12 depicts an exemplary user interface for the engineering calculation module shown in FIG. 1;

FIG. 13 depicts an exemplary user interface for the engineering calculation module shown in FIG. 1;

FIG. 14 depicts an exemplary user interface for the troubleshooting module shown in FIG. 1;

FIG. 15 depicts an exemplary user interface for the troubleshooting module shown in FIG. 1; and

FIG. 16 depicts an exemplary process implemented by the design for six sigma module shown in FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 is a block diagram of a system for providing design tools to multiple users in one embodiment of the invention. The system includes one or more user systems 18 coupled to a host system 14 via a network 12. Each user system 18 may be implemented using a general-purpose computer executing a computer program for carrying out the process described herein. The network 12 may be any type of known network including a local area network (LAN), wide area network (WAN), global network (e.g., Internet), intranet, etc. One or both of the user systems 18 and the host system 14 may be connected to the network 12 in a wireless fashion and network 12 may be a wireless network. In a preferred embodiment, the network 12 is the Internet and each user system 18 executes a user interface application (e.g., web browser) to contact the host system 14 through the Internet 12. Alternatively, the user system 18 may be implemented using a device programmed primarily for accessing network 12 such as WebTV.

The host computer system 14 includes a network server 20 (often referred to as a web server) to communicate with the user systems 18. The network server may be implemented using commercially available servers as are known in the art. The network server 20 handles sending and receiving information to and from user systems 18 and can perform associated tasks. The host system 14 also includes a firewall 41 to: (1) prevent unauthorized access to the host system 14; and (2) with respect to individuals/companies that are authorized access to the host system 14, enforce any limitations on the authorized access. For instance, a system administrator typically may have access to the entire system and have authority to update portions of the system. By contrast, a designer contacting the host system 14 from a user system 18 would have access to use applications provided by applications server 39 but not alter the applications or data stored in database 70. The firewall 41 may be implemented using conventional hardware and/or software as is known in the art.

The host system 14 also includes an applications server 39. Applications server 39 executes a plurality of software applications or modules as shown in FIG. 1.

The applications include a datasheet module 50, a material selection module 52, a visualization module 54, a color selection module 56, an engineering calculation module 58, a troubleshooting module 60 and a design for six sigma (DFSS) module 62. Each module serves as a tool that aids users at user systems 18 in the design of products as described herein. Each module may be implemented though a computer program. The computer programs that implement the modules may be stored on server 39 or may be stored in a location remote from server 39. Alternatively, more than one application server may be used to execute the software modules.

The applications server 39 is coupled to a database 70. Database 70 contains a variety of information used by the software modules. In an exemplary embodiment, the system is directed to aiding designers in the manufacture of plastic components. In this embodiment, the database 70 includes data related to plastic material that the designer may use to create a plastic part. Such data includes single point data (e.g., a single value for a property such as compressive strength of the material), multipoint data (e.g., a plot of stress versus elongation for a material) and transfer functions which are used to relate variables.

Exemplary sources of data for database 70 are shown in FIG. 1. The sources include process data 80, part test data 82, material test data 84 and product line data 86. In an exemplary embodiment, the system is used to aid designers in manufacture of plastic parts. The operator of the host system 14 may be a supplier of the plastic. The process data 80 relates to manufacture of plastic parts and contains information such as melt temperature, mold pressure, mold time, etc. The data may be obtained from experimental and/or actual manufacturing processes. Such data may be used to update single point and multipoint data in database 70 and update and/or modify transfer functions in database 70.

Part test data 82 is data relating to physical properties of a part made from plastic. Such data includes information such as stiffness, impact, creep, fatigue, etc. for a variety of geometries (e.g., flat plates, ribbed plates, etc.). The data may be obtained from experimental parts or commercially available parts. Such data may be

used to update single point and multipoint data in database 70 and update and/or modify transfer functions in database 70.

Material test data 84 is related to properties of the plastic in its raw form prior to manufacturing a part. Such data includes properties such a melt temperature, drying time, moisture content, and various thermal, physical, optical, electrical and flammability properties. Such data may be used to update single point and multipoint data in database 70 and update and/or modify transfer functions in database 70.

Product line data 86 defines the various materials and grades of products in the database 70. In an exemplary embodiment, the system is directed to facilitating the design of plastic parts. As described herein, when a user system 18 contacts the host system, the user is often prompted to select a material (e.g., Lexan brand resin) and grade (e.g., 141). The product line data 86 defines the materials and grades that are available to a designer.

One or more of the process data 80, part test data 82 and material test data 84 can be filtered to prevent erroneous data from being incorporated in database 70. Such filtering may include eliminating data that deviates from current data by more than a statistically acceptable margin. Data eliminated by filtering can then be re-evaluated to confirm accuracy. This prevents corruption of database 70.

Operation of the system will now be described. In an exemplary embodiment, the user system 18 includes a user interface application (e.g., a web browser) which allows the user system 18 to contact the host system 14 via network 12 (e.g., the Internet). Once the user system 18 contacts the host system 14, the host system 14 may require the user to log in by providing a user ID and password. This confirms that the user is permitted to access the host system 14 and provides control on the level of access (e.g., administrator versus user). In creating a user ID and password, the user may be prompted to specify a user application (e.g., automotive, medical, aerospace, etc.). The host system 14 may provide the user system 18 with a predefined list of user applications to facilitate the selection process. The software modules may provide varying output depending upon the user application specified

by the user. For example, only certain materials may be approved for use in medical instruments. Accordingly, the software modules will present a user in the medical field with information limited to these approved materials. The user is also given the option to have the host system 14 ignore the user application to prevent limitation of information.

Once the user has entered a valid user ID and password, the user system 18 is presented with a main screen such as that shown in FIG. 2. The user can request execution of the software modules 50-62 by selecting buttons 90 using an input peripheral such as a mouse, trackball, keyboard, etc. at the user system 18. Each button 90 corresponds to one of the software modules shown in FIG. 1. Upon the user selecting a button 90, application server 39 executes the selected software module.

If the user selects the datasheet button 90, the datasheet module 50 is launched and the user is presented with a datasheet main screen as shown in FIG. 3. The user selects a material from a predefined list of materials 92. Once the user has selected a material, the user is presented with a list of grades 94 for that material. The user may specify a geographic limitation by selecting a predefined geographic region from a region list 91. The predefined region list, material list and grade list may be implemented using drop down menus as known in the art. Not all materials may be available from all regions and thus the user may wish to limit the information to locally available materials. The identity of available materials and grades is provided through product line data 86 stored in database 70. Upon selecting a grade, the user is presented with a datasheet corresponding to the material and grade selected by the user. The datasheet can then be printed or saved on a memory device (e.g., hard drive) accessible by the user system 18. The materials and/or grades presented to the user system 18 may be limited by the user application specified by the user in creating the user's account. For example, if the user application is automotive, then materials and grades suitable for automotive applications will appear in the predefined lists presented to the user system 18 and shown in FIG. 3.

Referring to FIG. 2, if the user selects the material selector button 90, the material selection module 52 is launched and the user is presented with a material selection main screen as shown in FIG. 4. Through the material selection main screen, the user enters one or more search criteria relating to properties of the product. In a preferred embodiment, the product is plastic and thus, FIG. 4 depicts selection of properties related to plastic materials. The properties are arranged in categories including mechanical, thermal, electrical, other, processing and additives. FIG. 4 only depicts exemplary mechanical and thermal properties. The user selects a property by selecting property indicator 100 and entering a minimum and/or maximum for the property in text boxes 102. The range and units of the property are also presented to the user as show in FIG. 4. The range values indicate the minimum and maximum values for the property for all materials and grades in the database 70. The search may be limited to a geographic region as described above with reference to FIG. 1 by selecting a geographic limitation from a predefined list 104. The search may also be limited by the user application provided by the user. For example, if the user has specified an automotive application, the search will be limited to materials approved for automotive applications.

Once the user has entered the search criteria, the user initiates the search by selecting a search icon (not shown). The material selection module 52 searches database 70 based on the search criteria and any geographic limitation entered by the user. The results are presented to the user as shown in FIG. 5. As shown in FIG. 5, the material name, material grade, generic name and properties are presented to the user system 18. The user can view a datasheet for each material by selecting a datasheet hyperlink. An online datasheet hyperlink 106 presents the datasheet in an HTML format and the pdf datasheet hyperlink 107 presents the datasheet in a pdf format. The properties presented to the user in FIG. 5 correspond to the properties searched as identified by the user.

Referring to FIG. 2, if the user selects the visualizer button 90, the visualization module 54 is launched and the user is presented with a visualization main screen as shown in FIG. 6. The visualization module 54 allows a user to view

graphs of a number of material properties. As shown in FIG. 6, the user initially selects a property from a predefined property list 110. When a property is highlighted, a description of the property appears in a description window 112. Once the user has selected a desired property, the user selects the GO button 114 and the user is presented with a material/grade selection screen as show in FIG. 7.

As shown in FIG. 7, the user selects a material and grade from a predefined list of materials 116. Once the user has selected a material, the user is presented with a list of grades 118 for that material. The list of materials and grades may be limited by a geographic limitation as described above. In addition, the list of materials may be limited by the user application as described above. Once the user has selected a material and grade, the user selects the GO button 120 and the user is presented with a graph as shown in FIG. 8 of the property selected in FIG. 6. The user can add another material to the graph by selecting the add material button 122. A new material can be graphed by itself by selecting the new material button 124 or a new property may be graphed by selecting the new test button 126.

In one embodiment of the invention, the graphs generated by the visualization module 54 presents data in a graph, as shown in FIG. 8, based on existing empirical data. Test data acquired through one or more test conditions, is stored in database 70 and presented to the user. In this embodiment, the user selects test conditions (e.g., temperature, pressure, time, etc.) from a predefined list (not shown). In an alternative embodiment of the invention, the user is permitted to alter the test conditions to user-defined values. In this embodiment, the visualization module 54 may utilize a transfer function stored in database 70 to generate a graph such as that shown in FIG. 8. Alternatively, the visualization module 54 can perform interpolation and/or extrapolation to generate data based on user-defined test conditions. Accordingly, the visualization module 54 is not limited to displaying empirical data.

Referring to FIG. 2, if the user selects the color selector button 90, the color selection module 56 is launched and the user is presented with a color selection screen as shown in FIG. 9. As shown in FIG. 9, the user can submit a target color to the host

system 14 to determine the existence of available colors matching the target color. Through the user system 18, the user selects a material name from a predefined product name list 130 which may be implemented using a drop down menu. The user then selects a color space from a predefined list of color spaces 132 which may be implemented using a drop down menu. In the example shown in FIG. 9, the color space is the L*, a*, b* color space. The user enters a target color in target color fields 134 and initiates a search by selecting the search icon 136. The host system 14 searches available colors in database 70 for values close to the target color entered by the user. As described above, the search may be limited to predefined colors based on the user application. The closeness between the target color and the available colors may be based on distance in the three-dimensional color space. The N (e.g., nine) closest available colors are displayed as foreground regions 138 positioned over a background 140 displayed in the target color. This display allows the user to make a comparison between the target color and the N closest available colors. The user can select a foreground region 138 using an input device and the differences between the target color and the available color are presented in color difference window 142. The color difference window includes a difference value for each coordinate of the color space (dL*, da*, db*) and a total difference dE*. In this way, the user can determine which of the available colors is closest to the target color.

Referring to FIG. 2, if the user selects the engineering calculations button 90, the engineering calculation module 58 is launched and the user is presented with an engineering calculation screen as shown in FIG. 10. The engineering calculation module 58 allows the user to perform engineering calculations for a variety of properties for plastic materials. The user application may dictate the types of engineering calculations presented to the user. For example, if the user has specified an automotive application, the engineering calculations may include computation of crash worthiness of bumpers or panels made from plastic. An exemplary engineering calculation module includes applications for determining a number of properties including part properties (such as stiffness, creep, impact, fatigue, snap fit) molding properties (such as flow, cost, cooling) and cost properties. A user familiar with these concepts can perform calculations by entering data though the material performance

window or the minimize system cost window. For example, if the user selects fatigue data in the material performance window, the user is presented with a user interface such as that shown in FIG. 11. The user can enter values for certain test conditions and then graph the data as shown in FIG. 12. The test conditions and data shown in the graph may be empirical data stored in database 70. Thus, the test conditions are selected from predefined data for which empirical data has been obtained. Alternatively, the data plotted in the graph may be derived from transfer functions, interpolation and/or extrapolation. In this embodiment, the user is not limited to viewing graphs of already existing empirical data but may generate graphs based on any condition.

The engineering calculation module 58 also includes a number of wizards including a stiffness wizard, a creep wizard, impact wizard, fatigue wizard, snap fit wizard, shrinkage wizard. The wizards are routines that educate the user about the property selected and guide the user through the various graphs that may be used to represent the property. FIG. 13 depicts a user interface to a fatigue wizard which describes the fatigue condition and guides the user through the process of calculating fatigue.

Referring to FIG. 2, if the user selects the troubleshooting button 90, the troubleshooting module 60 is launched and the user is presented with a troubleshooting main screen as shown in FIG. 14. The troubleshooting module 60 may be an injection molding troubleshooting module that guides the user through possible causes and related solutions for injection molding fault symptoms. It provides the user with insight into what the probable causes and the ultimate solutions are regarding their molding problems. FIG. 14 depicts an exemplary user interface to the troubleshooting module 60 in which the user is prompted to select a fault symptom from a predefined list of fault symptoms. The user at user system 18 selects molding fault symptoms from a predefined fault symptom list 150. Upon selecting one of the predefined fault symptoms, the user is presented with one or more diagnostic question screens, one of which is shown in FIG. 15. The diagnostic question screen includes a question field 160, a test field 162 and an explanation field

164. The question field 160 is to be answered by the user so that the cause of the fault symptom can be determined. The test field 162 presents the user with a test which can be performed to help determine the answer to the question. The explanation field 164 provides the user with a description of why the question is relevant. The user answers the question 160 by selecting a yes or no icon and the user may navigate through the decision process with other icons.

The troubleshooting module 60 may be implemented using a plastics engineering and testing system commercially available from General Electric Company. The user can browse categories of troubleshooting information as shown in FIG. 14 or the user may search troubleshooting information. The search may be a keyword search or may be a natural language search. The molding fault symptoms and possible solutions viewable by the user may be limited based on the user application. For example, in certain applications (e.g., compact discs) fault symptoms may occur that do not occur in other applications (e.g., automotive parts). The fault symptoms can be limited based on user application to prevent unnecessary information from being provided to the user.

Referring to FIG. 2, if the user selects the DFSS button 90, the DFSS module 62 is launched. The DFSS module allows the user to apply six sigma techniques in the design process. FIG. 16 is a flowchart of a process implemented by the DFSS module 62. In an initial step 230, the user can access a quality function deployment (QFD) routine in which process variables or product design parameters (often referred to as key control parameters or KCPs) are analyzed to determine effects on critical to quality parameters (CTQs). The user can define CTQs and determine the effect that KCPs have on CTQs. Conventional QFD applications software may be used to allow the user to define CTQs and analyze the interaction between KCPs and the CTQs. Once the QFD process is performed, flow proceeds to step 248 where the user enters application factors concerning the product to be manufactured. The application factors define the product to be manufactured and generally will not vary with materials or processing parameters.

Once the application factors have been entered, flow proceeds to step 250 where the user selects a material to be used in forming the product. The user can identify a material through a predefined list of materials. The material characteristics (cost, hardness, melt temperature, etc.) are contained in the database 70. Instead of selecting a predefined material, the user may define characteristics of a material that is not commercially available. For example, the user may define a custom material by entering material characteristics (cost, hardness, etc.) that are not realized by any commercially available material. This allows the user to design a product based on non-existing materials and evaluate whether the expense in generating the custom material is warranted.

Once the user has selected a material, either predefined or user-defined, at step 250, flow proceeds to step 252 where the user enters responses. The responses represent parameters that the user may want to control or optimize and may correspond to the critical to quality parameters (CTQ's) identified in a QFD process. The responses are typically effected by the factors and, as described herein, the DFSS module 62 determines the relationship between the factors and responses. Once the user has defined responses at step 252, flow proceeds to step 254 where the user

enters manufacturing factors. The manufacturing factors represent factors in the manufacturing process that may be controlled or modified. Once the manufacturing factors have been entered at step 254, flow proceeds to step 256 where the user is presented with a factor/response summary. The factor/response summary includes application factors and manufacturing factors. The term factors, as used herein, is intended to have a broad meaning and is not limited to the particular examples or categories described above. The factor/response summary also includes responses. This provides the user with a general indication of how factor values effect response values. If the user wants to determine how changes in a factor effect a response, the user must alter the value of a factor and recalculate the responses. The user may view the factor/response summary and determine that certain responses (e.g., total cost) are too far from desired values and return to prior steps, such as material selection to effect the response. To optimize responses, more sophisticated tools are used as described herein.

Once the user is satisfied with the factor/response summary provided in step 256, flow proceeds to step 258 where the design of experiments (DOE) routine is initiated. The DOE routine may be implemented using commercially available design of experiments software applications. The user can specify the type of DOE to be performed. Once the design of experiments has been set up, flow proceeds to step 260 where the design of experiments data is generated. For each material specified by the user, the design of experiments routine perturbs the factors and obtains values for responses. Design of experiments data is generated for each material specified by the user. For each material, a design space is generated corresponding to the relationship between factors and responses.

Once the design of experiments process is completed, flow proceeds to step 262 where one or more transfer functions are generated which mathematically relate the factors to responses for each material. A regression routine performs regression on the design of experiments data to generate transfer functions which mathematically relate the factors to the responses for each material. The transfer functions may be stored in database 70 for use by other modules as described herein.

Once the transfer functions are generated, flow proceeds to step 264 where optimization is performed. For a given material, the user can optimize one or more responses in multiple ways. The optimization routine uses the transfer functions generated by the regression step and determines the appropriate values for the factors to optimize the responses as identified by the user.

Once the factors have been optimized based on the optimization criteria identified by the user, flow proceeds to step 266 where the user can set up visualization of the factors and responses for each material. The user can select the materials, factors and responses which are to be displayed and select the type of display. The visualization step 268 presents the information to the user system 18 in the requested format.

The system of FIG. 1 allows designers to access multiple design tools without requiring that the software for implementing the design tools be installed on the user systems 18. This has the advantage of facilitating updates to the modules 50-62 and facilitating updates to database 70. In addition, conventional processes such as obtaining material datasheets or matching product colors are simplified for the user.

The invention has been described in the context of providing designs tools to designers of plastic components. The design tools are selected to facilitate tasks performed by designers of plastic components. It is understood that the design tools may be utilized in other applications and the invention is not limited to design tools for designers of plastic components.

As described above, the present invention can be embodied in the form of computer-implemented processes and apparatuses for practicing those processes. The present invention can also be embodied in the form of computer program code containing instructions embodied in tangible media, such as floppy diskettes, CD-ROMs, hard drives, or any other computer-readable storage medium, wherein, when the computer program code is loaded into and executed by a computer, the computer becomes an apparatus for practicing the invention. The present invention can also be embodied in the form of computer program code, for example, whether stored in a

storage medium, loaded into and/or executed by a computer, or transmitted over some transmission medium, such as over electrical wiring or cabling, through fiber optics, or via electromagnetic radiation, wherein, when the computer program code is loaded into and executed by a computer, the computer becomes an apparatus for practicing the invention. When implemented on a general-purpose microprocessor, the computer program code segments configure the microprocessor to create specific logic circuits.

While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A system for providing design tools to users at remote locations, the system comprising:

a host system (14) executing said design tools, said design tools relating to one of plastics and manufacturing of plastic components;

a network (12) connected to said host system (14);

a user system (18) coupled to said network (12), said user system (18) accessing said design tools via said network (12); and

a database (70) coupled to said host system (14) for storing data relating to one of properties of plastics and manufacturing of plastic components.

2. The system of claim 1 wherein:

wherein said design tools include a datasheet module (50) for providing a representation of a material datasheet to said user system (18), said material datasheet including properties of a plastic.

3. The system of claim 2 wherein:

said user system (18) submits a user application to said host system (14), said datasheet module (50) restricts available material datasheets based on said user application.

4. The system of claim 1 wherein:

said design tools include a material selection module (52) for receiving search criteria from said user system (18), searching said database (70) for plastics based on said search criteria, and providing search results to said user system (18).

5. The system of claim 4 wherein:

said user system (18) submits a user application to said host system (14), said material selection module (52) restricts said searching based on said user application.

6. The system of claim 1 wherein:

said design tools include a visualization module (54) for receiving requests to view a property of a plastic from said user system (18), said visualization module (54) providing a graphical representation of said plastic property to said user system (18).

7. The system of claim 6 wherein:

said user system (18) submits a user application to said host system (14), said visualization module (54) restricts said graphical representation of said plastic property based on said user application.

8. The system of claim 1 wherein:

said design tools include a color selection module (56) for receiving a target color for a plastic from said user system (18), said color selection module (56) searching said database (70) for available colors close to said target color and providing search results to said user system (18).

9. The system of claim 8 wherein:

said user system (18) submits a user application to said host system (14), said color selection module (56) restricts said searching of said database (70) to predefined colors based on said user application.

10. The system of claim 1 wherein:

said design tools include a engineering calculation module (58) for allowing said user system (18) to perform engineering calculations relating to properties of plastic components.

11. The system of claim 10 wherein:

said user system (18) submits a user application to said host system (14), said engineering calculation module (58) restricts types of engineering calculations based on said user application.

12. The system of claim 1 wherein:

said design tools include a troubleshooting module (60) for allowing the user system (18) to identify a fault symptom and presenting to said user system (18) a series of questions designed to determine the cause of the fault symptom.

13. The system of claim 12 wherein:

said user system (18) submits a user application to said trouble host system (14), said troubleshooting module (60) restricts fault symptoms presented to the user system (18) based on said user application.

14. The system of claim 1 wherein:

said design tools include a design for six sigma module (62) for allowing the user to:

define factors corresponding to characteristics of a plastic component and manufacturing conditions for manufacturing the plastic component,

define responses corresponding to characteristics of the plastic and the plastic component effected by the factors;

determine a relationship between the factors and the responses; and

determine values for factors to optimize one or more responses.

15. The system of claim 1 wherein:

said network (12) is the Internet.

16. The system of claim 15 wherein:

said user system (18) includes a web browser for accessing said host system (14) via said network (12).

17. A method for providing design tools to users at remote locations in a system including a host system (14) executing the design tools relating to one of plastics and manufacturing of plastic components, a database (70) coupled to the host system (14) and a user system (18) coupled to the host system (14) by a network (12), the method comprising:

receiving at the host system (14) a request from the user system (18) to execute one of the design tools;

executing the design tool at the host system (14);

receiving input at the host system (14) from the user system (18) in response to the design tool; and

providing the user system (18) with output generated by the design tool.

18. The method of claim 17 wherein:

wherein said design tools include a datasheet module (50) for providing a representation of a material datasheet to said user system (18), said material datasheet including properties of a plastic.

19. The method of claim 18 further comprising:

receiving at the host system (14) a user application from the user system (18), said datasheet module (50) restricting available material datasheets based on said user application.

20. The method of claim 17 wherein:

said design tools include a material selection module (52) for receiving search criteria from said user system (18), searching said database (70) for plastics based on said search criteria, and providing search results to said user system (18).

21. The method of claim 20 further comprising:

receiving at the host system (14) a user application from the user system (18), said material selection module (52) restricts said searching based on said user application.

22. The method of claim 17 wherein:

said design tools include a visualization module (54) for receiving requests to view a property of a plastic from said user system (18), said visualization module (54) providing a graphical representation of said plastic property to said user system (18).

23. The method of claim 22 further comprising:

receiving at the host system (14) a user application from the user system (18), said visualization module (54) restricts said graphical representation of said plastic property based on said user application.

24. The method of claim 17 wherein:

said design tools include a color selection module (56) for receiving a target color for a plastic from said user system (18), said color selection module (56) searching said database (70) for available colors close to said target color and providing search results to said user system (18).

25. The method of claim 24 further comprising:

receiving at the host system (14) a user application from the user system (18), said color selection module (56) restricts said searching of said database (70) to predefined colors based on said user application.

26. The method of claim 17 wherein:

said design tools include a engineering calculation module (58) for allowing said user system (18) to perform engineering calculations relating to properties of plastic components.

27. The method of claim 26 further comprising:

receiving at the host system (14) a user application from the user system (18), said engineering calculation module (58) restricts types of engineering calculations based on said user application.

28. The method of claim 17 wherein:

said design tools include a troubleshooting module (60) for allowing the user system (18) to identify a fault symptom and presenting to said user system (18) a series of questions designed to determine the cause of the fault symptom.

29. The method of claim 28 further comprising:

receiving at the host system (14) a user application from the user system (18), said troubleshooting module (60) restricts fault symptoms presented to the user system (18) based on said user application.

30. The method of claim 17 wherein:

said design tools include a design for six sigma module (62) for allowing the user to:

define factors corresponding to characteristics of a plastic component and manufacturing conditions for manufacturing the plastic component,

define responses corresponding to characteristics of the plastic and the plastic component effected by the factors;

determine a relationship between the factors and the responses; and determine

values for factors to optimize one or more responses.

31. A storage medium encoded with machine-readable computer program code for providing design tools to users at remote locations in a system including a host system (14) executing the design tools relating to one of plastics and manufacturing of plastic components, a database (70) coupled to the host system (14) and a user system (18) coupled to the host system (14) by a network (12), the storage medium including instructions for causing the host system (14) to implement a method comprising:

receiving at the host system (14) a request from the user system (18) to execute one of the design tools;

executing the design tool at the host system (14);

receiving input at the host system (14) from the user system (18) in response to the design tool; and

providing the user system (18) with output generated by the design tool.

32. The storage medium of claim 31 wherein:

wherein said design tools include a datasheet module (50) for providing a representation of a material datasheet to said user system (18), said material datasheet including properties of a plastic.

33. The storage medium of claim 32 further comprising instructions for causing the host system (14) to implement:

receiving at the host system (14) a user application from the user system (18), said datasheet module (50) restricting available material datasheets based on said user application.

34. The storage medium of claim 31 wherein:

said design tools include a material selection module (52) for receiving search

criteria from said user system (18), searching said database (70) for plastics based on said search criteria, and providing search results to said user system (18).

35. The storage medium of claim 34 further comprising instructions for causing the host system (14) to implement:

receiving at the host system (14) a user application from the user system (18), said material selection module (52) restricts said searching based on said user application.

36. The storage medium of claim 31 wherein:

said design tools include a visualization module (54) for receiving requests to view a property of a plastic from said user system (18), said visualization module (54) providing a graphical representation of said plastic property to said user system (18).

37. The storage medium of claim 36 further comprising instructions for causing the host system (14) to implement:

receiving at the host system (14) a user application from the user system (18), said visualization module (54) restricts said graphical representation of said plastic property based on said user application.

38. The storage medium of claim 31 wherein:

said design tools include a color selection module (56) for receiving a target color for a plastic from said user system (18), said color selection module (56) searching said database (70) for available colors close to said target color and providing search results to said user system (18).

39. The storage medium of claim 38 further comprising instructions for causing the host system (14) to implement:

receiving at the host system (14) a user application from the user system (18), said color selection module (56) restricts said searching of said database (70) to predefined colors based on said user application.

40. The storage medium of claim 31 wherein:

said design tools include a engineering calculation module (58) for allowing said user system (18) to perform engineering calculations relating to properties of plastic components.

41. The storage medium of claim 40 further comprising instructions for causing the host system (14) to implement:

receiving at the host system (14) a user application from the user system (18), said engineering calculation module (58) restricts types of engineering calculations based on said user application.

42. The storage medium of claim 31 wherein:

said design tools include a troubleshooting module (60) for allowing the user system (18) to identify a fault symptom and presenting to said user system (18) a series of questions designed to determine the cause of the fault symptom.

43. The storage medium of claim 42 further comprising instructions for causing the host system (14) to implement:

receiving at the host system (14) a user application from the user system (18), said troubleshooting module (60) restricts fault symptoms presented to the user system (18) based on said user application.

44. The storage medium of claim 31 wherein:

said design tools include a design for six sigma module (62) for allowing the user to:

define factors corresponding to characteristics of a plastic component and

manufacturing conditions for the manufacturing the plastic component,

define responses corresponding to characteristics of the plastic and the plastic component effected by the factors;

determine a relationship between the factors and the responses; and determine values for factors to optimize one or more responses.

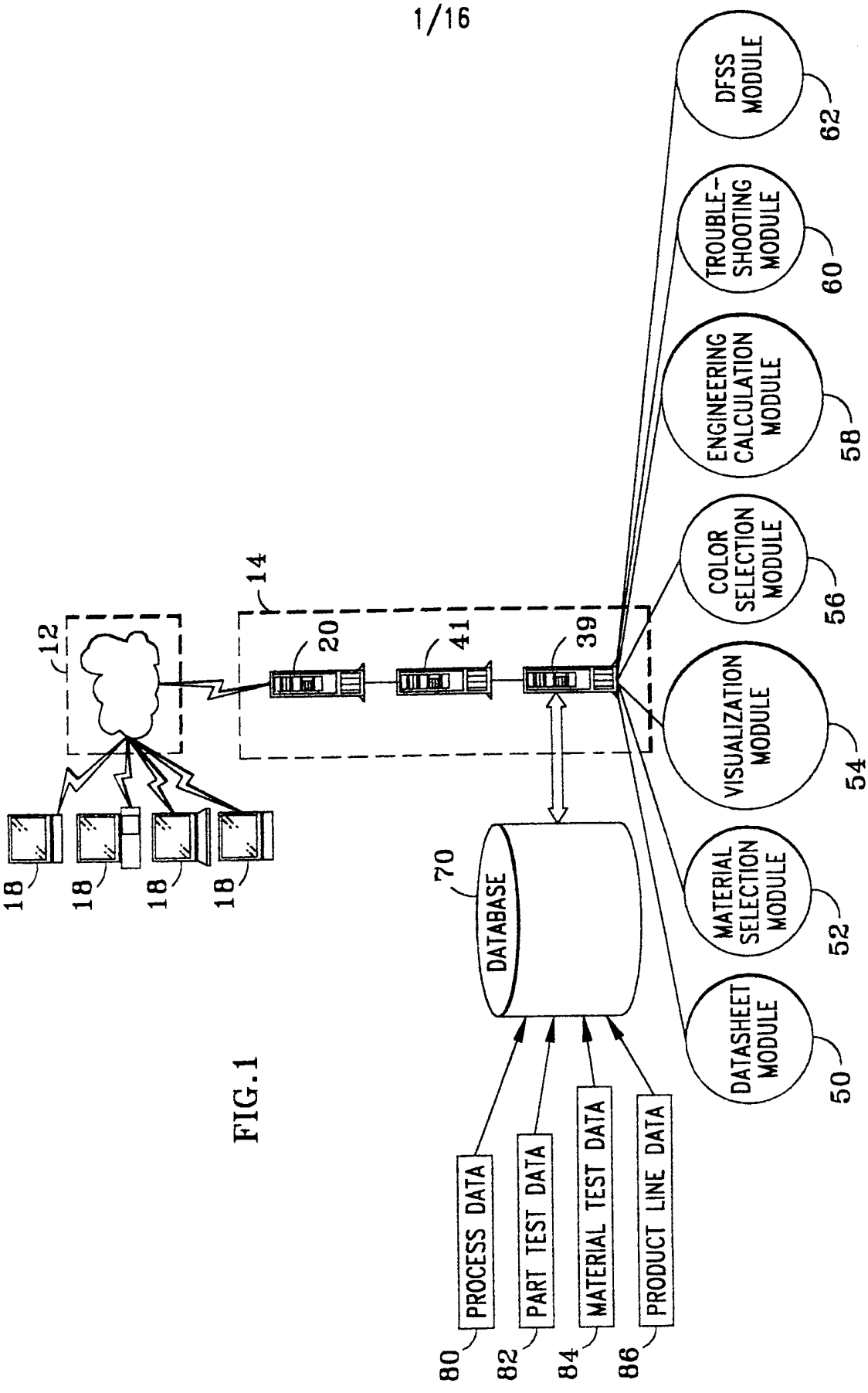
DFSS MODULE
62
TROUBLE-SHOOTING MODULE
60
ENGINEERING CALCULATION MODULE
58
COLOR SELECTION MODULE
56
VISUALIZATION MODULE
54
MATERIAL SELECTION MODULE
52
DATASHEET MODULE
50
DATABASE
70
PROCESS DATA
80
PART TEST DATA
82
MATERIAL TEST DATA
84
PRODUCT LINE DATA
86
12
14
20
41
39
18
18
18
18

FIG.1

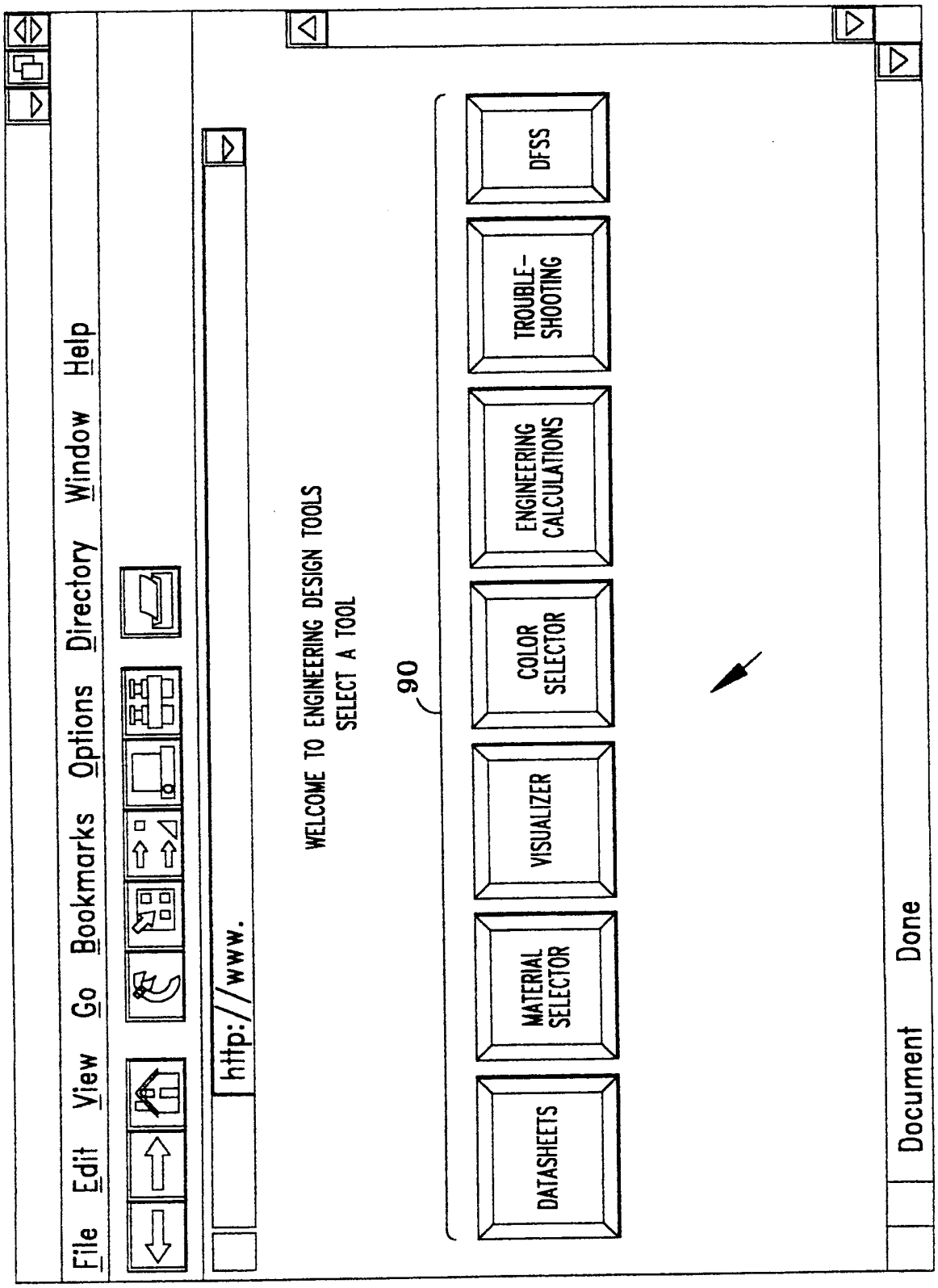
File Edit View Go Bookmarks Options Directory Window Help
http://www.
WELCOME TO ENGINEERING DESIGN TOOLS
SELECT A TOOL
90
DATASHEETS
MATERIAL SELECTOR
VISUALIZER
COLOR SELECTOR
ENGINEERING CALCULATIONS
TROUBLE-SHOOTING
DFSS
Document Done

FIG. 2

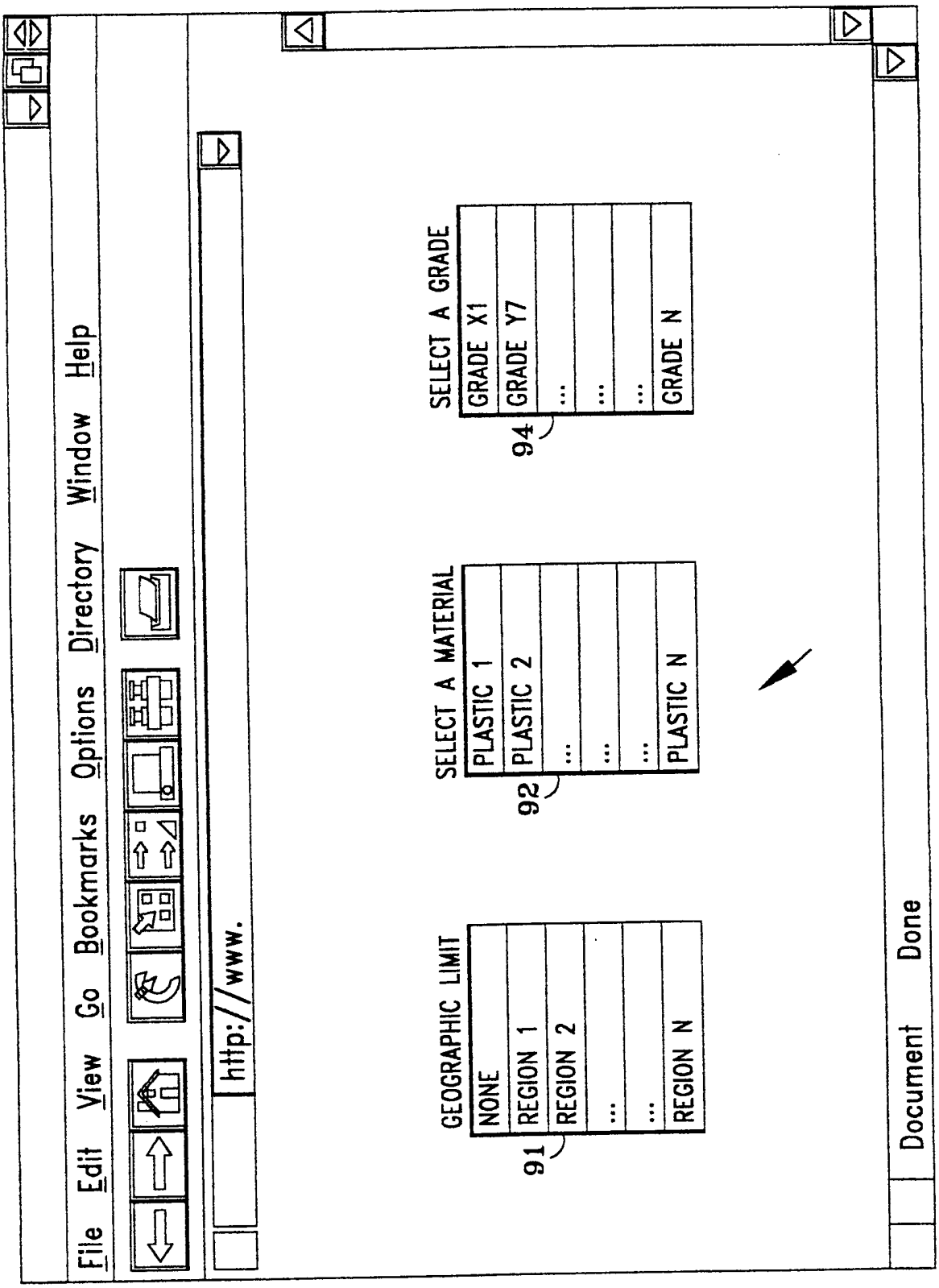
File Edit View Go Bookmarks Options Directory Window Help
http://www.
GEOGRAPHIC LIMIT
NONE
REGION 1
REGION 2
...
...
REGION N
91
SELECT A MATERIAL
PLASTIC 1
PLASTIC 2
...
...
...
PLASTIC N
92
SELECT A GRADE
GRADE X1
GRADE Y7
...
...
...
GRADE N
94
Document Done

FIG. 3

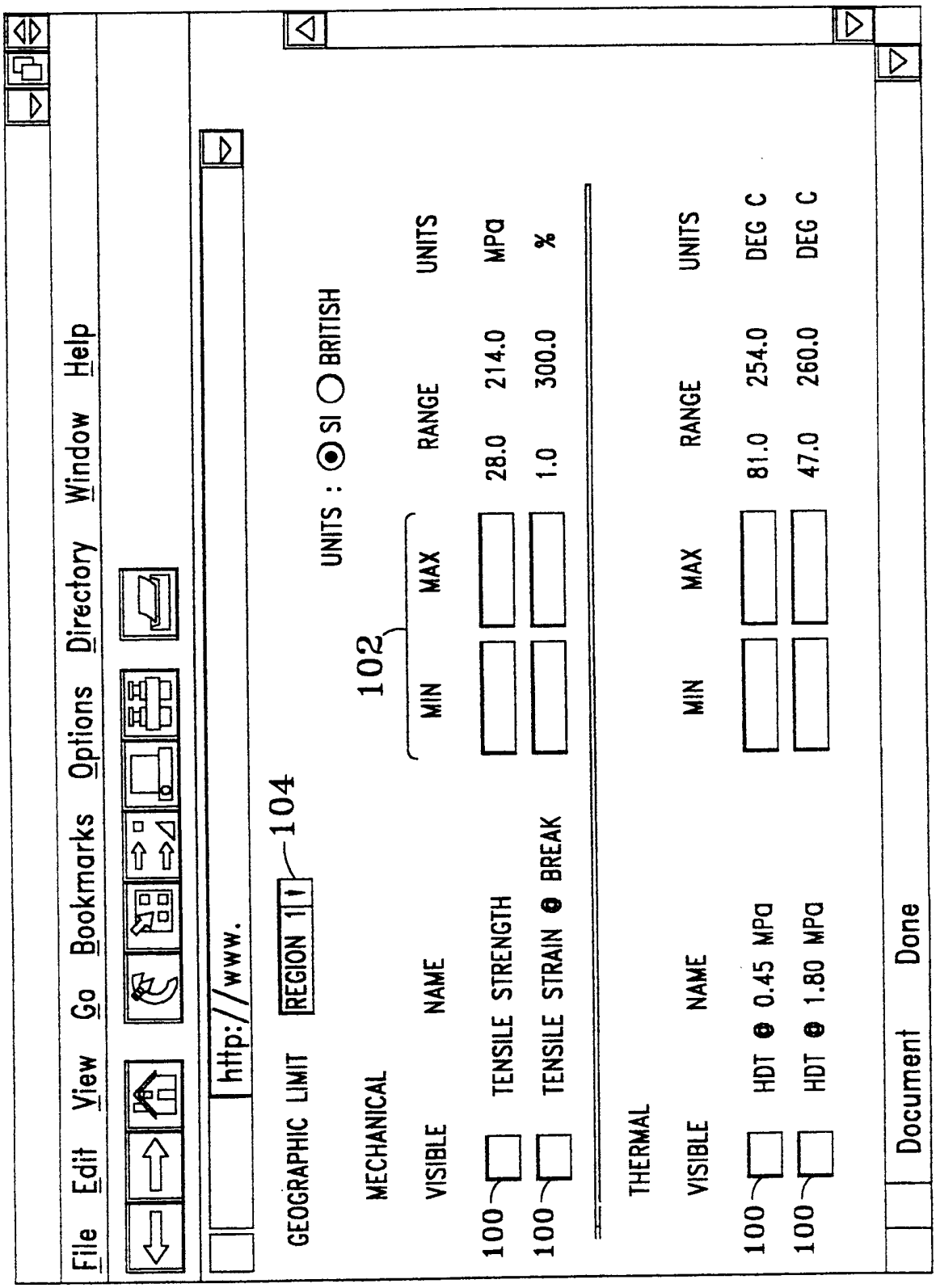
File Edit View Go Bookmarks Options Directory Window Help
http://www.
GEOGRAPHIC LIMIT
REGION 1
104
UNITS : SI BRITISH
102
MECHANICAL
VISIBLE
NAME
MIN
MAX
RANGE
UNITS
100
TENSILE STRENGTH
28.0
214.0
MPa
100
TENSILE STRAIN @ BREAK
1.0
300.0
%
THERMAL
VISIBLE
NAME
MIN
MAX
RANGE
UNITS
100
HDT @ 0.45 MPa
81.0
254.0
DEG C
100
HDT @ 1.80 MPa
47.0
260.0
DEG C
Document Done

FIG. 4

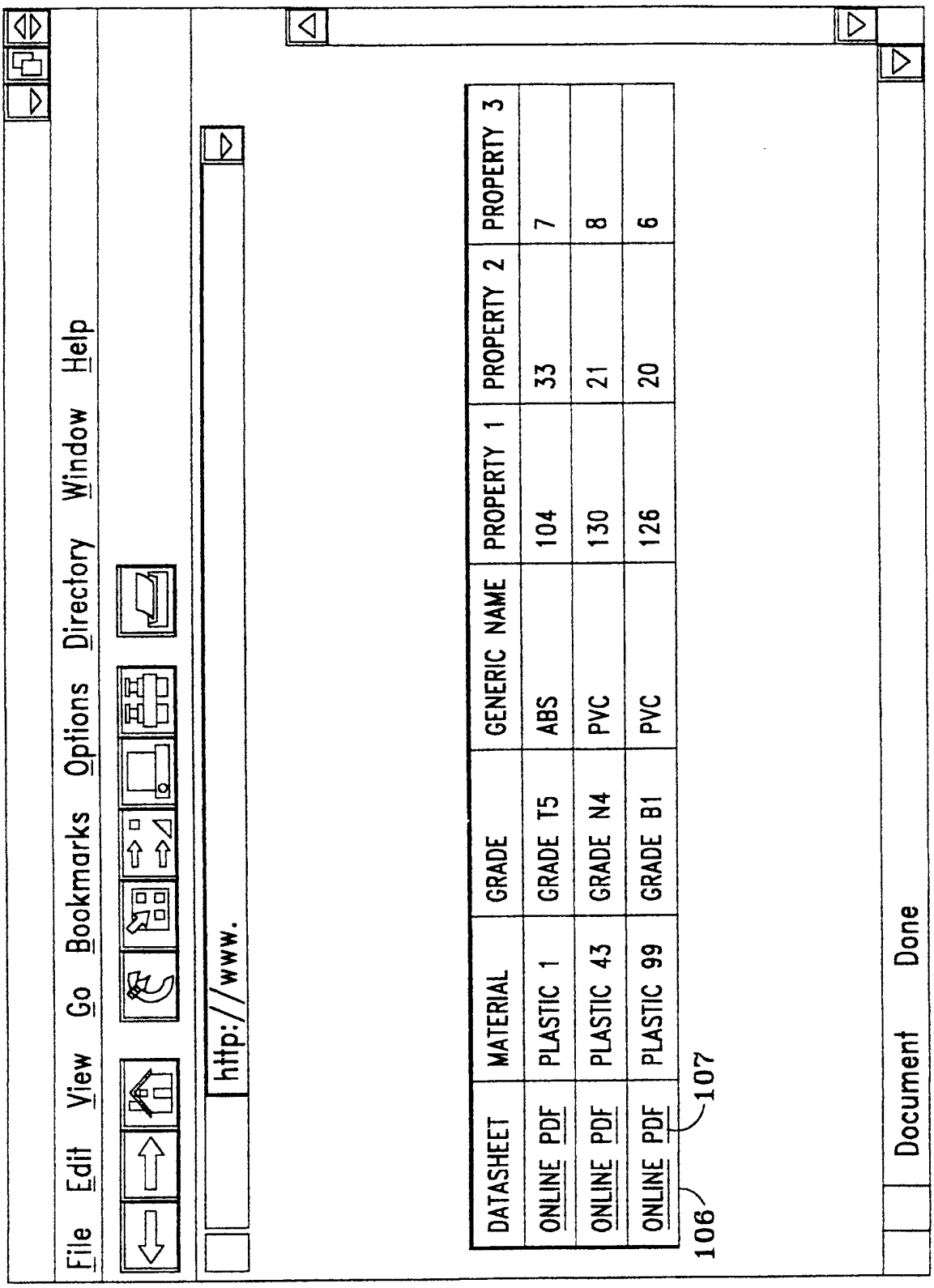
File Edit View Go Bookmarks Options Directory Window Help
http://www.
Document Done
DATASHEET | MATERIAL | GRADE | GENERIC NAME | PROPERTY 1 | PROPERTY 2 | PROPERTY 3
ONLINE PDF | PLASTIC 1 | GRADE T5 | ABS | 104 | 33 | 7
ONLINE PDF | PLASTIC 43 | GRADE N4 | PVC | 130 | 21 | 8
ONLINE PDF | PLASTIC 99 | GRADE B1 | PVC | 126 | 20 | 6
106
107

FIG. 5

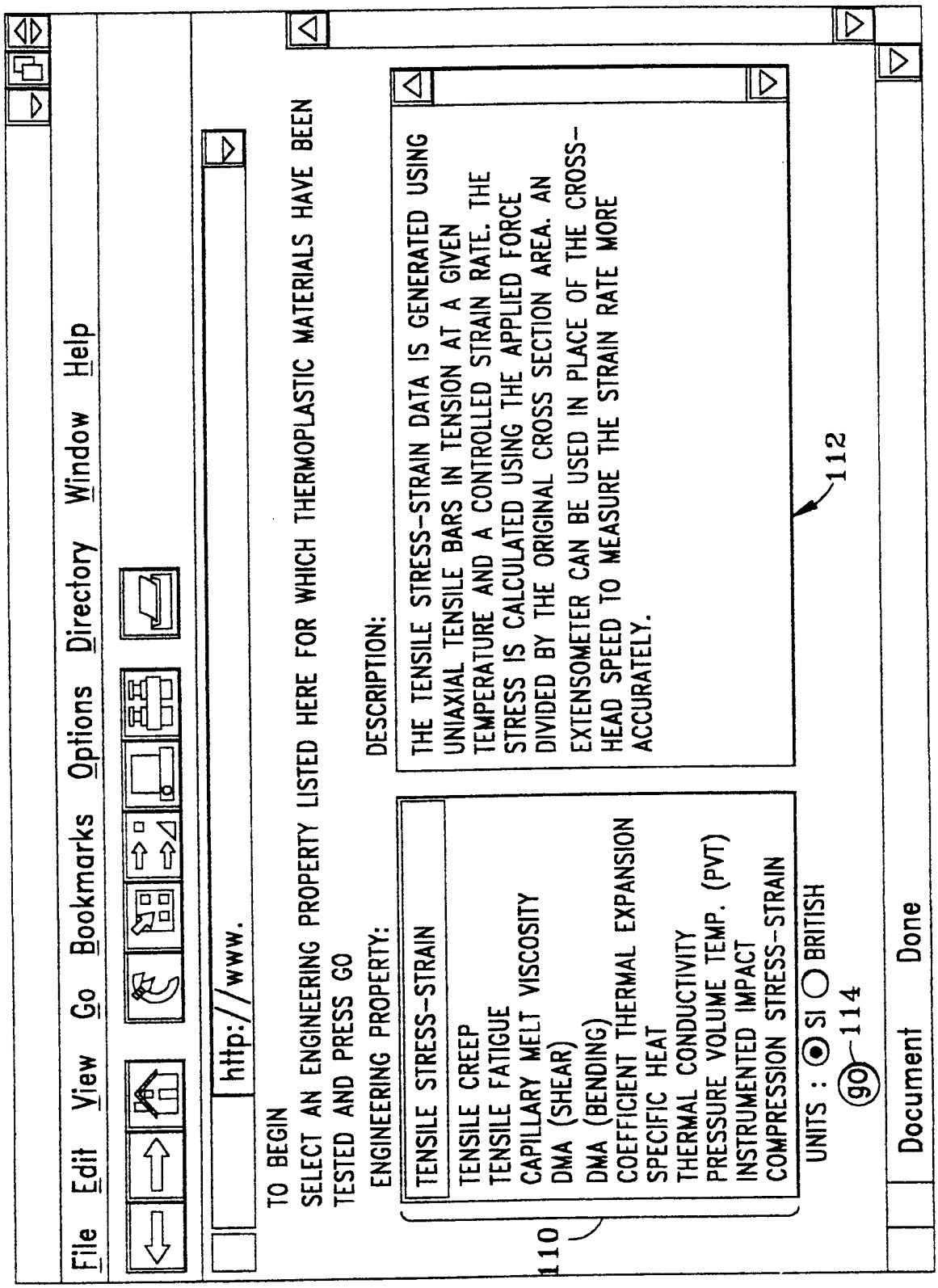
File Edit View Go Bookmarks Options Directory Window Help
http://www.
TO BEGIN
SELECT AN ENGINEERING PROPERTY LISTED HERE FOR WHICH THERMOPLASTIC MATERIALS HAVE BEEN TESTED AND PRESS GO
ENGINEERING PROPERTY:
TENSILE STRESS-STRAIN
TENSILE CREEP
TENSILE FATIGUE
CAPILLARY MELT VISCOSITY
DMA (SHEAR)
DMA (BENDING)
COEFFICIENT THERMAL EXPANSION
SPECIFIC HEAT
THERMAL CONDUCTIVITY
PRESSURE VOLUME TEMP. (PVT)
INSTRUMENTED IMPACT
COMPRESSION STRESS-STRAIN
110
UNITS : SI BRITISH
go
114
DESCRIPTION:
THE TENSILE STRESS-STRAIN DATA IS GENERATED USING UNIAXIAL TENSILE BARS IN TENSION AT A GIVEN TEMPERATURE AND A CONTROLLED STRAIN RATE. THE STRESS IS CALCULATED USING THE APPLIED FORCE DIVIDED BY THE ORIGINAL CROSS SECTION AREA. AN EXTENSOMETER CAN BE USED IN PLACE OF THE CROSS-HEAD SPEED TO MEASURE THE STRAIN RATE MORE ACCURATELY.
112
Document Done

FIG. 6

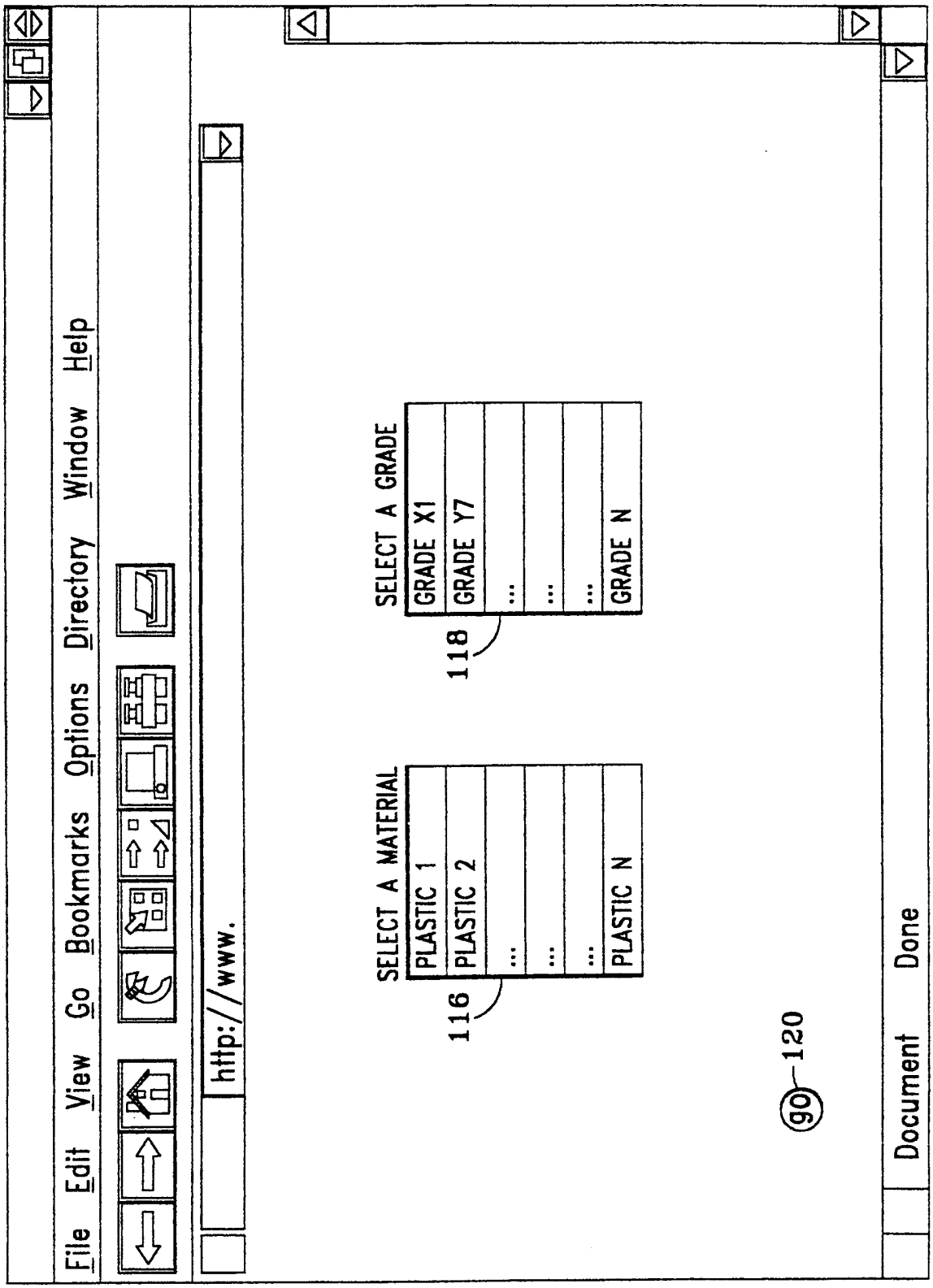
File Edit View Go Bookmarks Options Directory Window Help
http://www.
SELECT A MATERIAL
PLASTIC 1
PLASTIC 2
...
...
...
PLASTIC N
116
SELECT A GRADE
GRADE X1
GRADE Y7
...
...
...
GRADE N
118
120
Document Done

FIG. 7

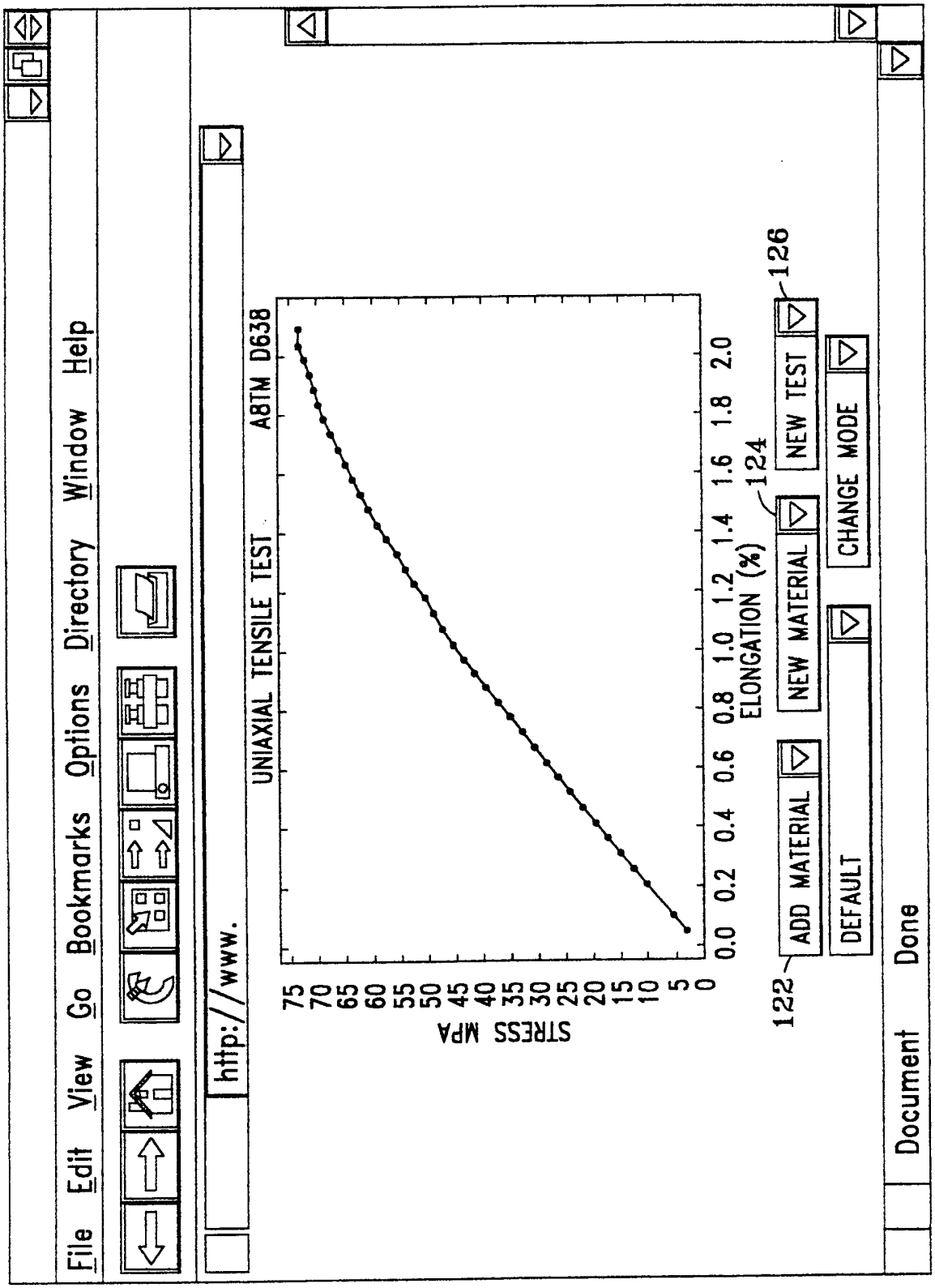
File Edit View Go Bookmarks Options Directory Window Help
http://www.
UNIAXIAL TENSILE TEST A8TM D638
STRESS MPA
75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0
0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0
ELONGATION (%)
124
126
122
ADD MATERIAL
NEW MATERIAL
NEW TEST
DEFAULT
CHANGE MODE
Document Done

FIG. 8

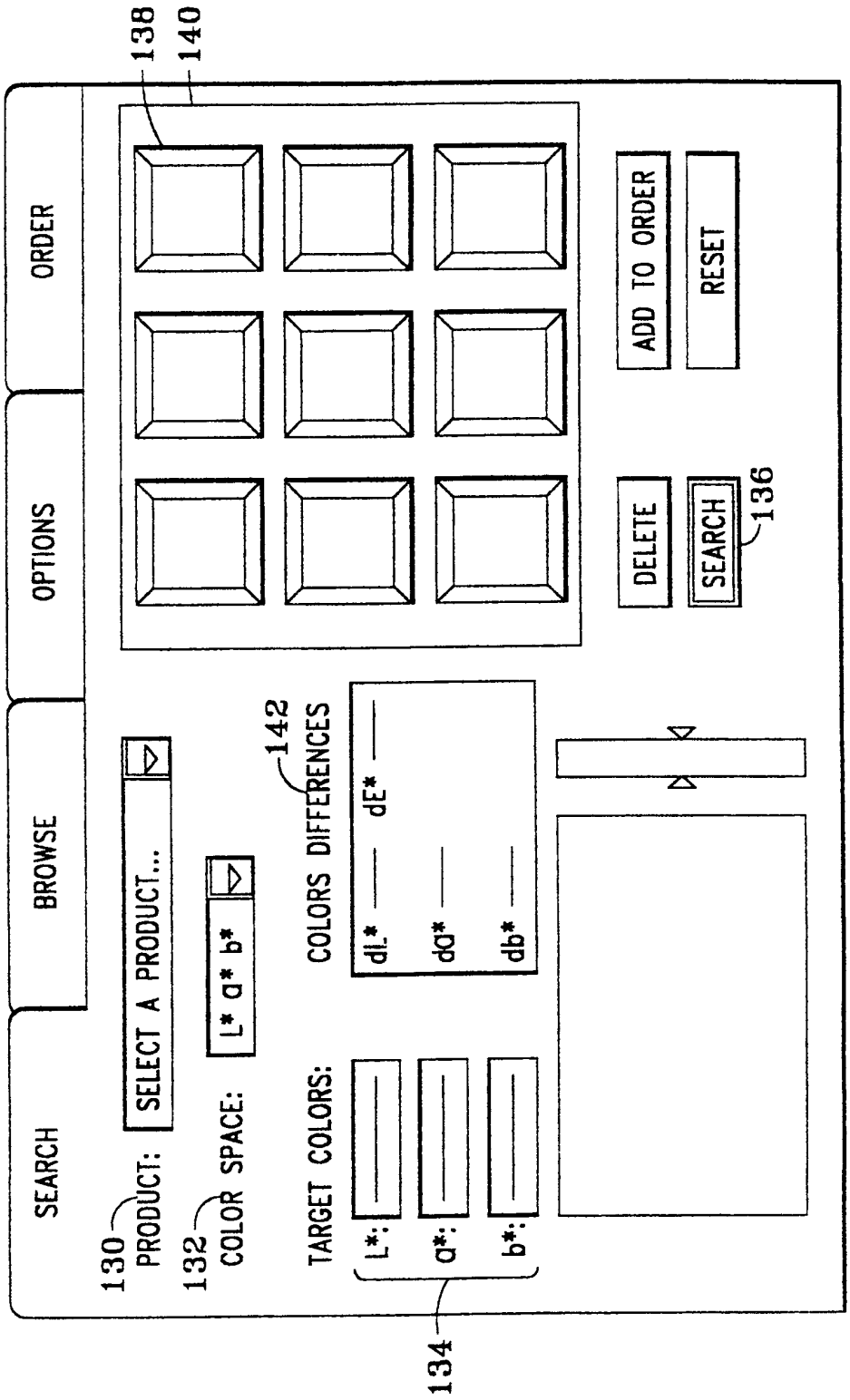
SEARCH
BROWSE
OPTIONS
ORDER
138
140
ADD TO ORDER
RESET
DELETE
SEARCH
136
142
COLORS DIFFERENCES
dE*
dL*
da*
db*
SELECT A PRODUCT...
L* a* b*
PRODUCT:
COLOR SPACE:
TARGET COLORS:
L*:
a*:
b*:
130
132
134

FIG.9

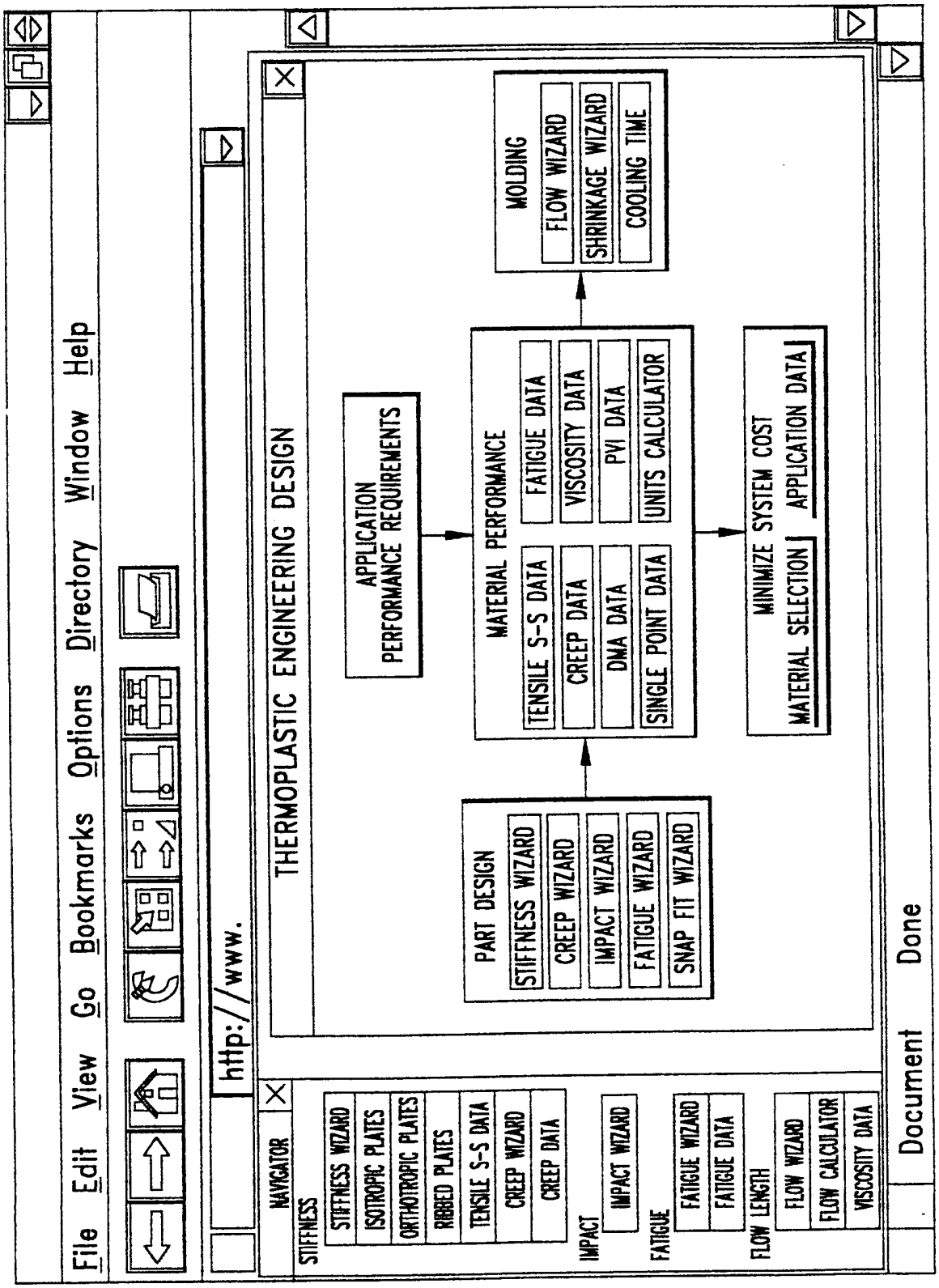
File Edit View Go Bookmarks Options Directory Window Help
http://www.
NAVIGATOR
STIFFNESS
STIFFNESS WIZARD
ISOTROPIC PLATES
ORTHOTROPIC PLATES
RIBBED PLATES
TENSILE S-S DATA
CREEP WIZARD
CREEP DATA
IMPACT
IMPACT WIZARD
FATIGUE
FATIGUE WIZARD
FATIGUE DATA
FLOW LENGTH
FLOW WIZARD
FLOW CALCULATOR
VISCOSITY DATA
THERMOPLASTIC ENGINEERING DESIGN
APPLICATION PERFORMANCE REQUIREMENTS
PART DESIGN
STIFFNESS WIZARD
CREEP WIZARD
IMPACT WIZARD
FATIGUE WIZARD
SNAP FIT WIZARD
MATERIAL PERFORMANCE
TENSILE S-S DATA
CREEP DATA
DMA DATA
SINGLE POINT DATA
FATIGUE DATA
VISCOSITY DATA
PVI DATA
UNITS CALCULATOR
MOLDING
FLOW WIZARD
SHRINKAGE WIZARD
COOLING TIME
MINIMIZE SYSTEM COST
MATERIAL SELECTION
APPLICATION DATA
Document Done

FIG. 10

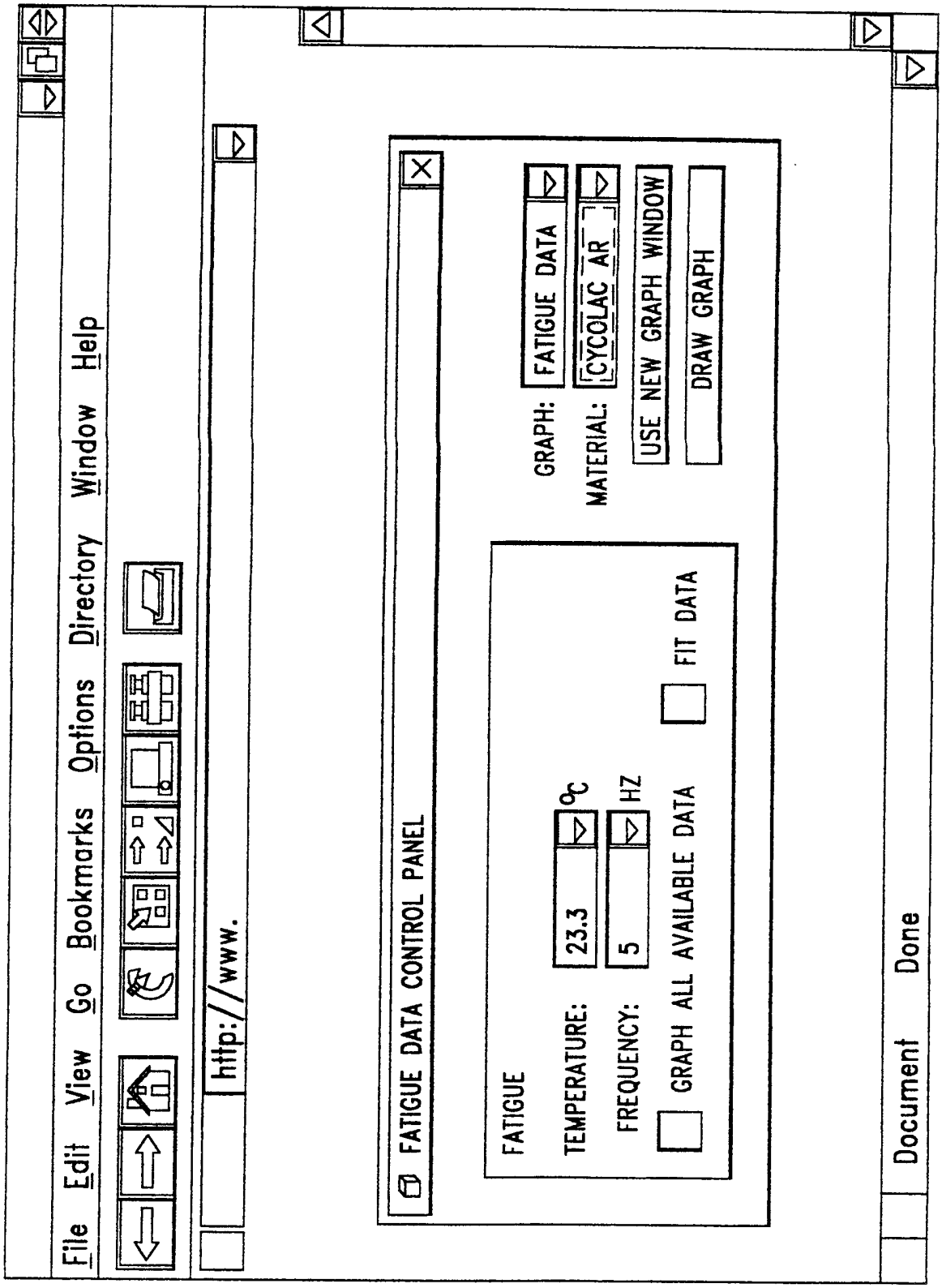
File Edit View Go Bookmarks Options Directory Window Help
http://www.
FATIGUE DATA CONTROL PANEL
FATIGUE
TEMPERATURE:
23.3
°C
FREQUENCY:
5
HZ
GRAPH ALL AVAILABLE DATA
FIT DATA
GRAPH:
FATIGUE DATA
MATERIAL:
CYCOLAC AR
USE NEW GRAPH WINDOW
DRAW GRAPH
Document Done

FIG. 11

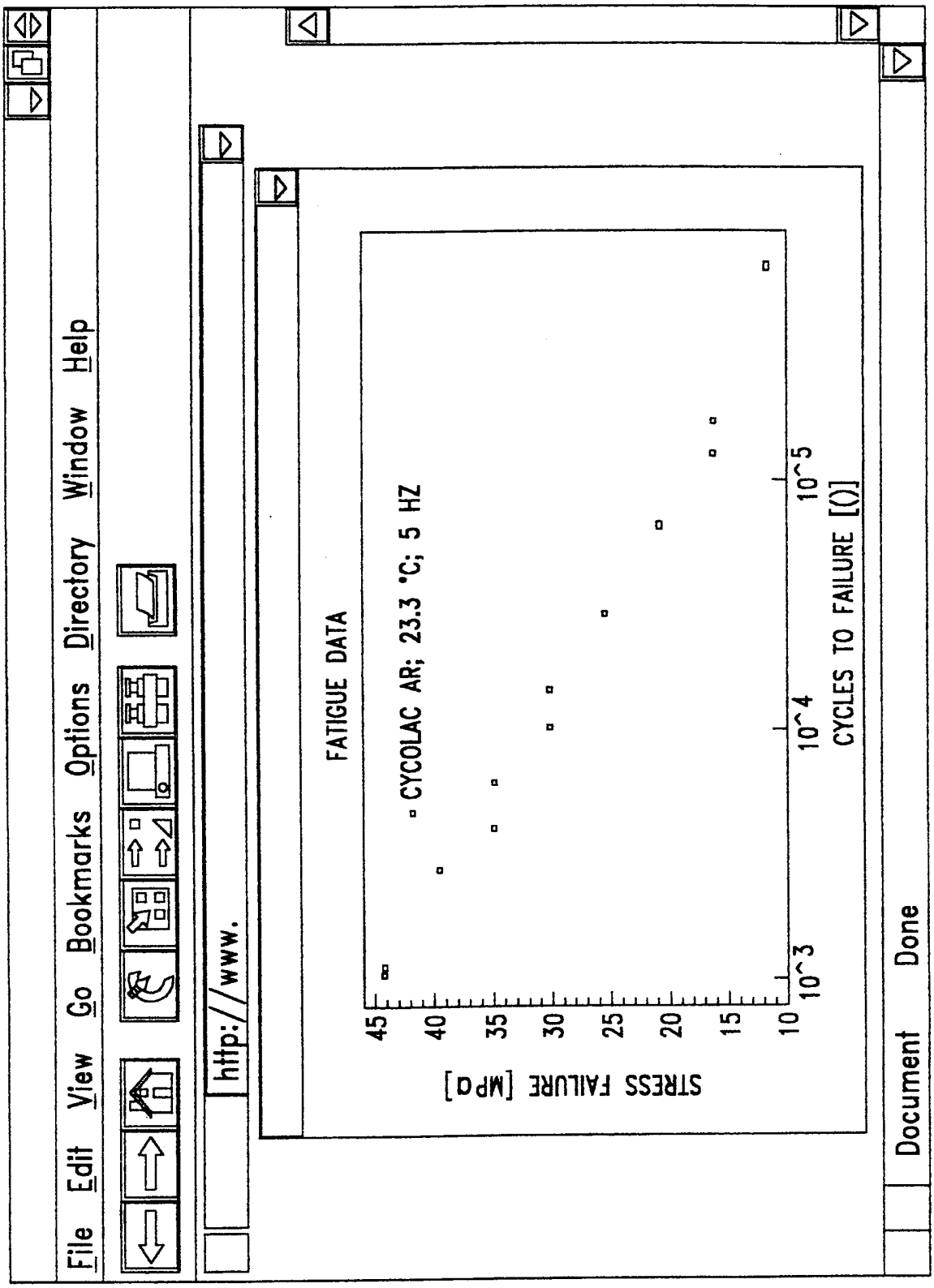
File Edit View Go Bookmarks Options Directory Window Help
http://www.
FATIGUE DATA
CYCOLAC AR; 23.3 °C; 5 HZ
STRESS FAILURE [MPa]
45
40
35
30
25
20
15
10
10^3
10^4
10^5
CYCLES TO FAILURE [()]
Document Done

FIG. 12

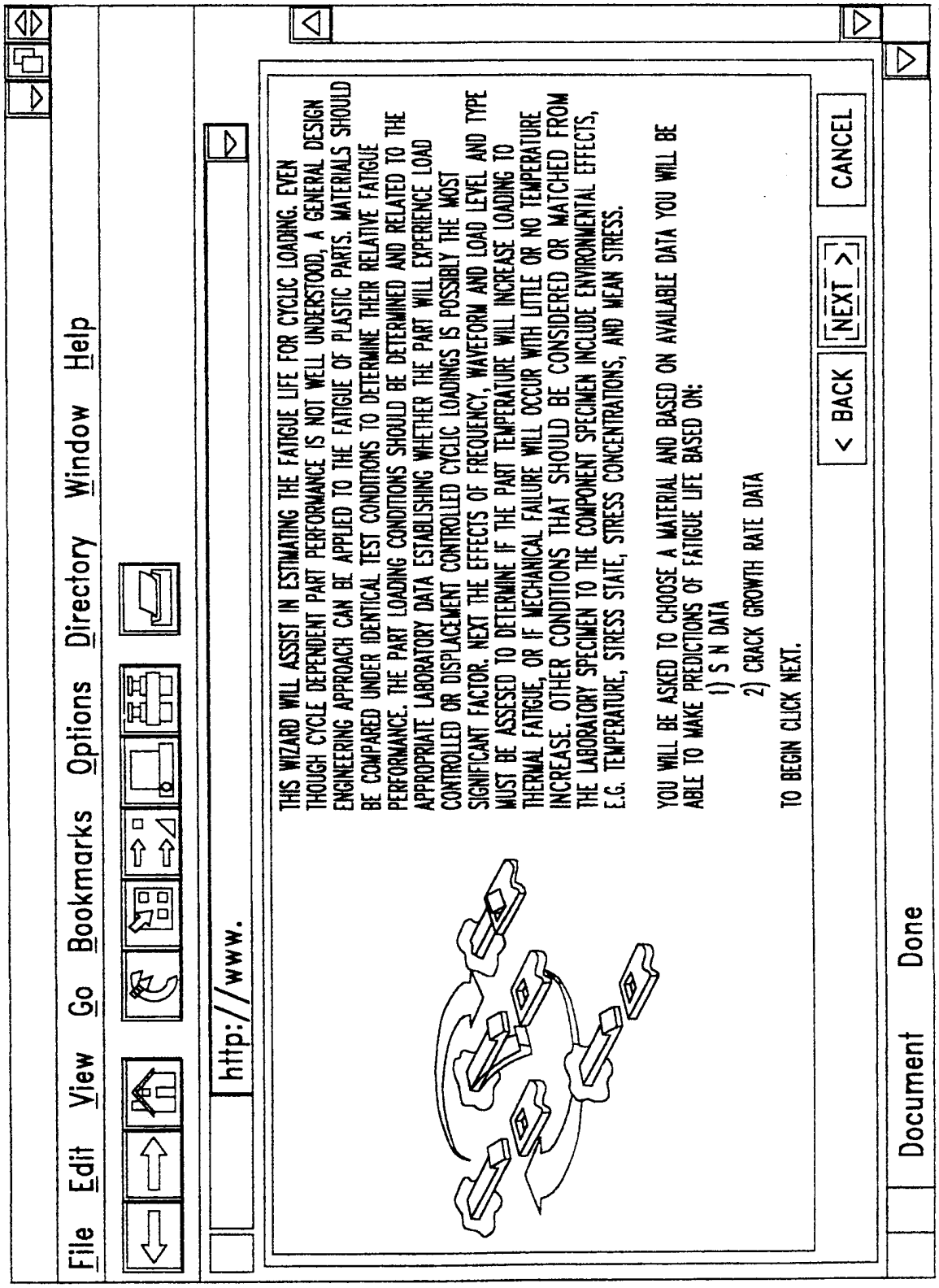
File Edit View Go Bookmarks Options Directory Window Help
http://www.
THIS WIZARD WILL ASSIST IN ESTIMATING THE FATIGUE LIFE FOR CYCLIC LOADING. EVEN THOUGH CYCLE DEPENDENT PART PERFORMANCE IS NOT WELL UNDERSTOOD, A GENERAL DESIGN ENGINEERING APPROACH CAN BE APPLIED TO THE FATIGUE OF PLASTIC PARTS. MATERIALS SHOULD BE COMPARED UNDER IDENTICAL TEST CONDITIONS TO DETERMINE THEIR RELATIVE FATIGUE PERFORMANCE. THE PART LOADING CONDITIONS SHOULD BE DETERMINED AND RELATED TO THE APPROPRIATE LABORATORY DATA ESTABLISHING WHETHER THE PART WILL EXPERIENCE LOAD CONTROLLED OR DISPLACEMENT CONTROLLED CYCLIC LOADINGS IS POSSIBLY THE MOST SIGNIFICANT FACTOR. NEXT THE EFFECTS OF FREQUENCY, WAVEFORM AND LOAD LEVEL AND TYPE MUST BE ASSESSED TO DETERMINE IF THE PART TEMPERATURE WILL INCREASE LOADING TO THERMAL FATIGUE, OR IF MECHANICAL FAILURE WILL OCCUR WITH LITTLE OR NO TEMPERATURE INCREASE. OTHER CONDITIONS THAT SHOULD BE CONSIDERED OR MATCHED FROM THE LABORATORY SPECIMEN TO THE COMPONENT SPECIMEN INCLUDE ENVIRONMENTAL EFFECTS, E.G. TEMPERATURE, STRESS STATE, STRESS CONCENTRATIONS, AND MEAN STRESS.
YOU WILL BE ASKED TO CHOOSE A MATERIAL AND BASED ON AVAILABLE DATA YOU WILL BE ABLE TO MAKE PREDICTIONS OF FATIGUE LIFE BASED ON:
1) S N DATA
2) CRACK GROWTH RATE DATA
TO BEGIN CLICK NEXT.
< BACK
NEXT >
CANCEL
Document Done

FIG. 13

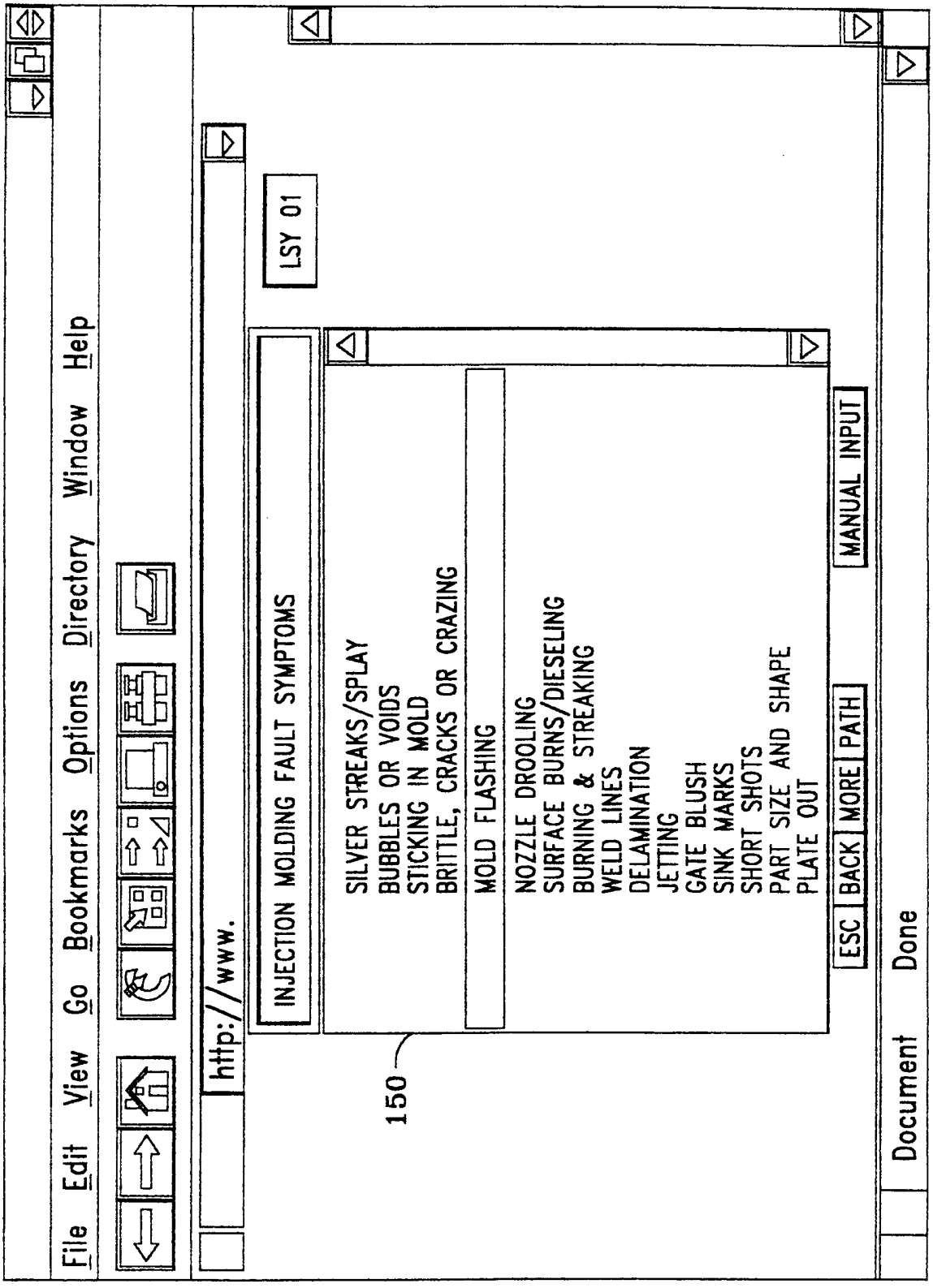
File Edit View Go Bookmarks Options Directory Window Help
http://www.
LSY 01
INJECTION MOLDING FAULT SYMPTOMS
SILVER STREAKS/SPLAY
BUBBLES OR VOIDS
STICKING IN MOLD
BRITTLE, CRACKS OR CRAZING
MOLD FLASHING
NOZZLE DROOLING
SURFACE BURNS/DIESELING
BURNING & STREAKING
WELD LINES
DELAMINATION
JETTING
GATE BLUSH
SINK MARKS
SHORT SHOTS
PART SIZE AND SHAPE
PLATE OUT
MANUAL INPUT
ESC BACK MORE PATH
150
Document Done

FIG. 14

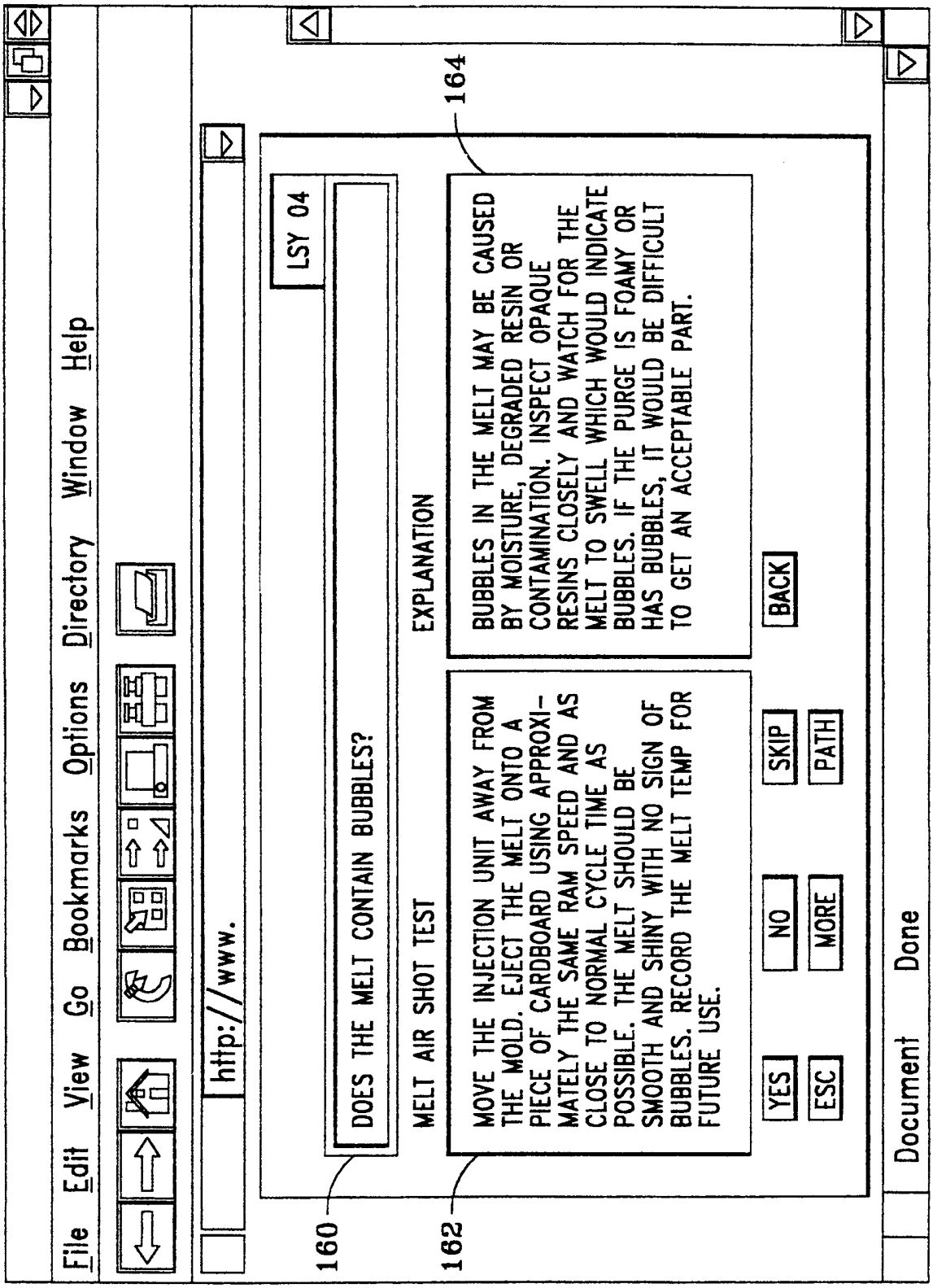
File Edit View Go Bookmarks Options Directory Window Help
http://www.
LSY 04
DOES THE MELT CONTAIN BUBBLES?
MELT AIR SHOT TEST
MOVE THE INJECTION UNIT AWAY FROM THE MOLD. EJECT THE MELT ONTO A PIECE OF CARDBOARD USING APPROXIMATELY THE SAME RAM SPEED AND AS CLOSE TO NORMAL CYCLE TIME AS POSSIBLE. THE MELT SHOULD BE SMOOTH AND SHINY WITH NO SIGN OF BUBBLES. RECORD THE MELT TEMP FOR FUTURE USE.
YES
NO
SKIP
ESC
MORE
PATH
EXPLANATION
BUBBLES IN THE MELT MAY BE CAUSED BY MOISTURE, DEGRADED RESIN OR CONTAMINATION. INSPECT OPAQUE RESINS CLOSELY AND WATCH FOR THE MELT TO SWELL WHICH WOULD INDICATE BUBBLES. IF THE PURGE IS FOAMY OR HAS BUBBLES, IT WOULD BE DIFFICULT TO GET AN ACCEPTABLE PART.
BACK
Document Done
160
162
164

FIG. 15

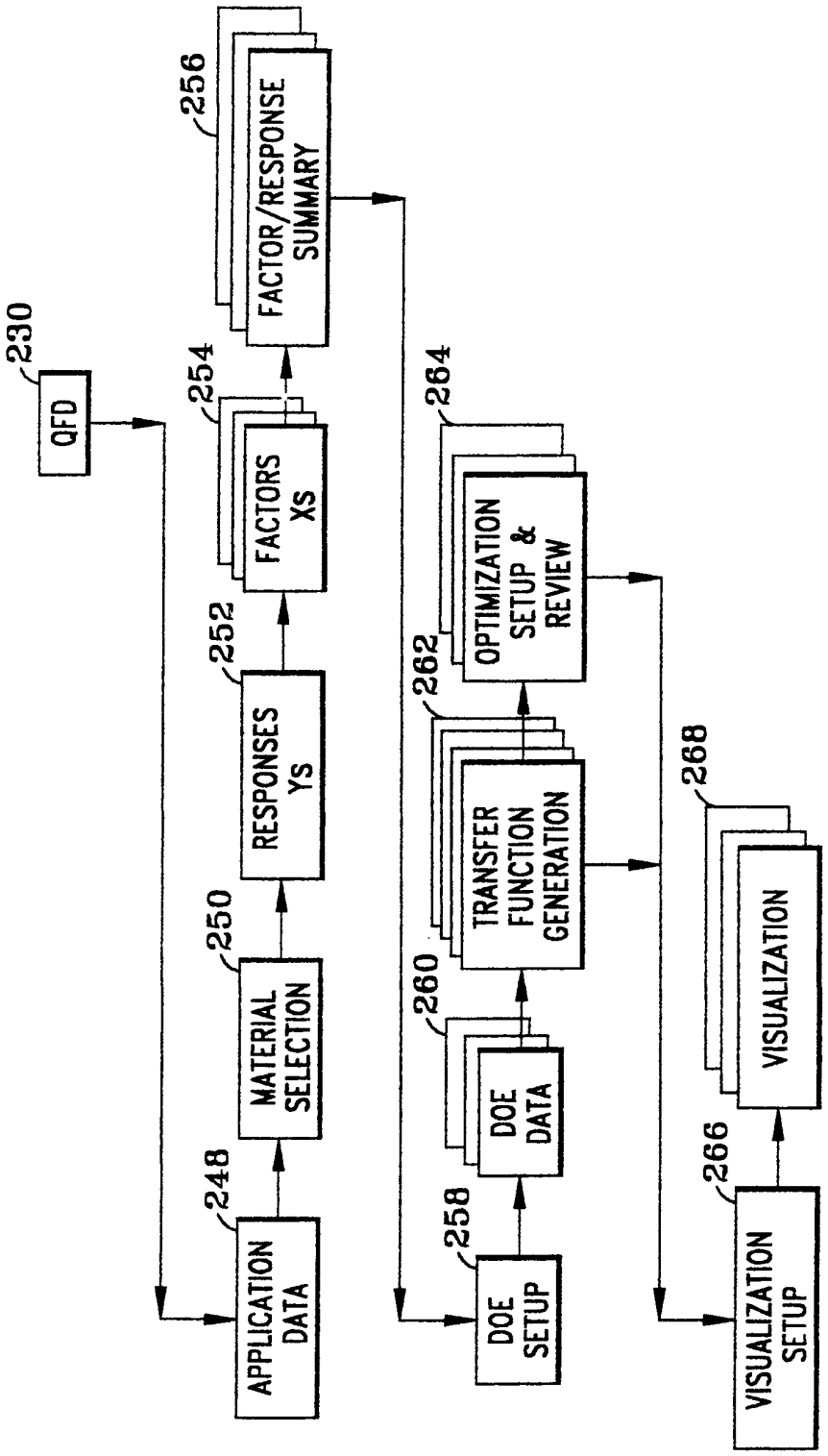
230
QFD
248
APPLICATION DATA
250
MATERIAL SELECTION
252
RESPONSES Ys
254
FACTORS Xs
256
FACTOR/RESPONSE SUMMARY
258
DOE SETUP
260
DOE DATA
262
TRANSFER FUNCTION GENERATION
264
OPTIMIZATION SETUP & REVIEW
266
VISUALIZATION SETUP
268
VISUALIZATION

FIG. 16