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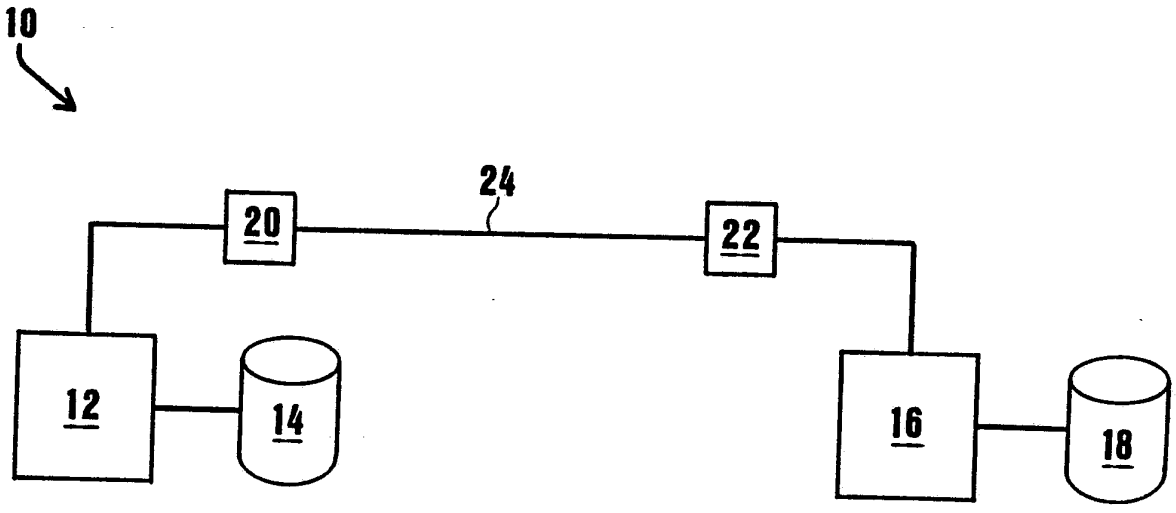

(57) Abstract

An improved remote file access system (10) having a base computer (12) and an associated base computer mass storage device (14) containing a primary directory (28) which is a listing of file names (32) associated with files (34) which are stored thereon, and at least one branch computer (16), in communication with the base computer (12) via a data link (24), with an associated branch computer mass storage device (18) containing a secondary directory (30) which is a listing of file names (32) associated with files (34). When a file (34) is required for use at the branch computer (16), it is selected from the secondary directory (30), and retrieved from the branch computer mass storage device (18) if it is stored thereon or, if the desired file is not stored in the branch computer mass storage device (18) the file (34) is retrieved, via the data link (24), from the base computer mass storage device (14).

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REMOTE FILE ACCESS SYSTEM

TECHNICAL FIELD

The present invention relates generally to the field of electronic data storage and retrieval means and more particularly to an improved system for providing access to data from a base computer or network to a remote computer.

BACKGROUND ART

The advent of technology for making small and portable computers with sufficient capacity for a wide variety of applications has been a great boon to persons who must, or choose, to work away from their offices or places of business. Such computers frequently have sufficient mass storage capacity to accomplish many tasks. However, many tasks require access to files which are on a distant office computer. A frequent problem which arises for those who wish to use their computers away from the office is that a data file with which they wish to work may be on their office computer, but not on their portable or home computer, to which they have immediate access. Alternatively, even if they have a version of the needed files on their portable computer, that version may not be the most recently updated iteration of the file.

There are a variety of data communications means by which computers can be caused to exchange data from remote locations. For example, modulator/demodulator ("modem") devices are available to allow data to be sent between computers via telephone line interfaces. Using such a data communications means, all that is required to cause the desired transfer of data is to cause the receiving computer to be instructed to receive data via the modem, and to cause the sending computer to be instructed to send data via the modem. Such instruction is generally accomplished by means of software.

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A difficulty with existing data exchange means is that, even if both a user's office computer and home computer are equipped to communicate together, there is no provision for ascertaining whether the information contained in a home computer is current as compared to that contained in the office computer. Unless the user can be certain that the information contained in the home or portable computer is current, there is no alternative except to "upload" the entire data files in question. Further, even when the user knows that the immediately available file differs from a more current version in a remote computer only in a few details, the only method available for obtaining those few changes is to upload the entire revised file. This can be both time consuming and costly, particularly if cellular phone transmission or long distance telephone transmission is utilized. In addition, this method places the burden of "knowing" what is the most recent version of a file on the user and, of course, the user can sometimes be wrong, which could potentially result in a serious problem. Furthermore, the very fact that the user is required to perform separate and distinct operations in order to access and retrieve files from the remote computer is undesirable, both because of the excess work required of the user and because the user is required to learn the necessary commands required to accomplish these tasks.

A number of programs are commercially available for causing computers to send and/or receive data to and from other computers. Varieties include straight forward file transfer programs which require the user to have immediate access to both the sending and receiving computers, and "communications" programs wherein a receiving computer is placed in a "ready" status to receive any incoming data that may be sent to it from a sending computer. More complex programs allow files to be "uploaded" from a base computer to remote computers, as requested by the remote computer. Several methods for allowing the sharing of files and/or program and processing resources among computers connected to local area networks ("LANs"), and the like, have been found

worthy of patent protection, including U.S. Patent No. 4,558,413 issued to Schmidt et al., U.S. Patent No. 4,851,988 issued to Trottier et al., U.S. Patent No. 4, 897,781 issued to Chang et al., and U.S. Patent No. 4,780, 821 issued to Crossley. However, none of these inventions have addressed the unique requirements of computers which are connected only by telephone links, or the like, wherein there is a specific expense associated with each access of one computer to another. Because the costs of such communications means is so high, computers which are so linked must communicate only intermittently, and not continuously, with each other.

All of the prior art means for communicating files between remote computers within the inventor's knowledge have required that the user decide what files are needed to be retrieved from a distant computer system and, further, that such files be transmitted in their entirety from that distant computer system when they are required.

No prior art means for communicating files between remote computers, to the inventor's knowledge, has successfully provided a means by which computers can automatically be furnished with the most recent iteration of required files. All successful applications to date have required that the user decide which files are required to be retrieved from a remote location, and then perform a complex, time consuming, and potentially costly process for retrieving the required files.

DISCLOSURE OF INVENTION

Accordingly, it is an object of the present invention to provide a means for greatly increasing the efficiency and ease of use of computers with files which may be stored and/or altered at a remote location.

It is another object of the present invention to provide a means for allowing a computer to automatically ascertain whether a version of a required file which is stored in its mass storage devices is the most recent iteration available.

It is still another object of the present invention to provide a means for greatly reducing the time and cost required to obtain an updated file from a distant computer.

It is yet another object of the present invention to provide a means for increasing the efficiency of file management between remotely located computers and/or computer networks.

It is still another object of the present invention to provide an improved means for sharing files among computers.

It is yet another object of the present invention to provide an improved means for efficiently allowing a computer user to have access to data files stored on distant computer.

It is still another object of the present invention to provide a file access system which does not require that the user learn new skills.

It is yet another object of the present invention to provide a file access system which will work in conjunction with existing software.

Briefly, the preferred embodiment of the present invention is a remote file access systems embodied within a computer system, said computer system having at least two computers which are located at remote locations relative to each other. The remote file access system is adapted for allowing one of the computers to have access to the mass storage devices of the other, such that the first (local) computer can obtain files and/or file updates from the second (remote) computer, as required, in a manner which is relatively transparent to the user in that the user is required only to "call up" the file as though that file was residing, in its entirety, within his or her local computer. The local computer provides the user with a complete listing of available files, as though all of those files were stored within the immediate mass storage devices of the local computer. When the user selects a file for use, the local computer first determines whether or not that file is stored within its own mass storage devices. If that file is not within the mass storage devices of the local computer, the remote computer is "called up" via modem, in the best

presently known embodiment of the invention, and the remote computer is instructed to send the file to the local computer. If the local computer does have the required file in its mass storage, then the remote computer is contacted and requested to advise as to the most recent version of that file. If the most recent version is that which is stored within the local computer, no further action is required and the user can proceed to use that file. If the most recent version is other than that which is stored within the local computer, then a "delta file" having information pertaining to the differences between the most recent version and the locally available version is transmitted, and the local version is updated to conform to the most recent version.

An advantage of the present invention is that the use of computers having files which are stored and/or altered at a remote location is made more efficient.

A further advantage of the present invention is that a computer can automatically ascertain whether a version of a required file which is stored in its mass storage devices is the most recent iteration available.

Yet another advantage of the present invention is that the time and cost required to obtain an updated file from a distant computer are greatly reduced.

Still another advantage of the present invention is that efficiency of file management between remotely located computers and/or computer networks is greatly increased.

Yet another advantage of the present invention is that the files may be shared between computers with a minimum of user effort and cost.

Still another advantage of the present invention is that a computer user can have access to data files stored on a distant computer, without having to unnecessarily upload the entire data file.

Yet another advantage of the present invention is that the user does not have to learn new skills in order to operate the system.

Still another advantage of the present invention is that it will work in conjunction with existing software.

These and other objects and advantages of the present invention will become clear to those skilled in the art in view of the description of the best presently known mode of carrying out the invention and the industrial applicability of the preferred embodiment as described herein.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is a block schematic diagram of a computer system configured to embody the inventive remote file access system;

Fig. 2 is a memory map depicting an example of the content of mass storage devices used in conjunction with the present invention;

Fig. 3 is an updated version of the memory map of Fig. 2; and

Fig. 4 is an updated version of the memory map of Fig. 3.

BEST MODE FOR CARRYING OUT INVENTION

The best presently known mode for carrying out the invention is a remote file access system for coordination of files among a plurality of computers. The predominant expected usage of the inventive remote file access system is for providing access to the files of a "base" computer from a secondary computer, particularly wherein the secondary computer is a home or portable computer which is adjunct to the base computer such that an efficient means for accessing the files of the base computer from the secondary computer is desirable.

A computer system configured to embody the remote file access system of the presently preferred embodiment of the present invention is illustrated in a block schematic diagram in Fig. 1 and is designated therein by the general reference character **10**. The remote file access system **10** has a base computer **12** with a base computer mass storage device **14** and a branch computer **16** with a branch computer mass storage device

18. The base computer 12 is equipped with a base computer modem 20 and the branch computer is equipped with a branch computer modem 22. A data link 24 connects the base computer modem 20 to the branch computer modem 22.

In the best presently known embodiment 10 of the invention, the base computer 12 is an office desktop computer, and the branch computer 16 is a laptop type portable computer which the user may employ, as required, at home or at some other location remote from the base computer 12. The branch computer 16 may, alternatively, be a notebook type computer, a "full sized" home computer system, or the like. The base computer mass storage device 14 and the branch computer mass storage device 18 are fixed rigid disk drive devices in the best presently known embodiment 10 of the present invention, since such devices are the predominant type of mass storage devices currently in use. However, the present invention is not restricted to use with this, or any other, particular type of mass storage media, and other devices such as optical or magneto-optical mass storage devices could be employed for the purpose.

Further, in the best presently known embodiment 10 of the present invention, the base computer modem 20 and the branch computer modem 22 are conventional telephone modem devices, and the data link 24 is conventional telephonic communications means. However, the present invention is not restricted to use with such conventional means for exchanging data between the base computer 12 and the branch computer 16. For example, the data link 24 could be a conventional cellular telephone interconnection, and the base computer modem 20 and the branch computer modem 22 adapted for connection to that form of data link 24, or the data link 24 could be a local area network ("LAN").

It should be noted that the present invention is not restricted to use with a single branch computer 16, and that additional branch computers (not shown) could be employed, each functioning as does the branch computer 16 described herein. Furthermore, the base computer 12 could be an isolated conventional desk top computer, or the like.

Alternatively, the base computer **12** could be a part of a larger computer network (not shown) wherein the base computer **12**, itself, has access to files from a network server (not shown) and or other computers within the network (not shown). It should be noted that such alternative configurations of the base computer **12** and/or other elements of the remote file access system **10** are not expected to effect the operation of the best presently known embodiment **10** of the present invention.

Figs. 2 through 4 are a series of memory maps **26** which are diagrammatic representations of the varying content of the mass storage devices **14** and **18**, according to the best presently known embodiment **10** of the present invention. The memory maps **26** of Figs. 2 through 4 are intended to illustrate the content, only, of the mass storage devices **14** and **18**. The memory maps **26** of Figs. 2 through 4 do not purport to represent a particular location in memory, or an amount of memory assigned to each of the elements shown therein. One skilled in the art will recognize that the various divisions of the memory maps **26**, which will be discussed hereinafter, are fictions for presenting the various types of data portions contained therein and, in actual practice, such data portions are scattered throughout available mass storage memory according to a scheme dictated by the operating system and hardware interface (not shown) of the particular computing device being utilized.

Fig. 2 illustrates an exemplary memory map **26a** representing contents of the mass storage devices **14** and **18** as might be encountered during the operation of the best presently known embodiment **10** of the present invention. As is depicted in the example of Fig. 2, the base computer mass storage device **14** has a primary directory **28**, and the branch computer mass storage device **18** has a secondary directory **30**. The primary directory **28** is a listing of file names **32** of a plurality (7 in the example of Fig. 2) of files **34** located in the base computer mass storage device **14**, and the primary directory **28** is, itself, stored in the base computer mass storage device **14**. The file names **32** are represented in the

example of Fig. 2 by the nomenclature Nn, where n is 1 through 7, in the example of Fig. 2, corresponding to the seven files **34** (F1 through F7) presently written into the base computer mass storage device **14**. One skilled in the art will recognize that, in practice, the denominations N1 through N7 will actually be brief textual names and the files **34** will be comparatively lengthy data files, such as word processor files or spreadsheet files. One skilled in the art will further recognize that the correspondence of file names **32** to files **34** within the base computer mass storage device **14** is conventional in that there is a file name **32** in the primary directory **28** corresponding to each file **34** in the base computer mass storage device **14**. It should further be noted that executable files (programs), and the like, are omitted from the discussion of the best presently known embodiment **10** of the invention, herein, as the best presently known embodiment **10** of the invention is concerned with access to data files. However, should it be desired, the present inventive method could be extended to provide access to executable files. It will be evident in light of the discussion, hereinafter, that the content of two different iterations of any particular file **34** may, or may not, be identical. Indeed, the detection of any such variations and the correction thereof is a primary purpose of the present inventive method.

In the best presently known embodiment **10** of the present invention, the secondary directory is placed in a "virtual disk" (not shown) within the branch computer mass storage device **18**. The "virtual disk" is a conceptual device well known to those skilled in the use of the DOS operating system. The "virtual disk" is a portion of the branch computer mass storage device **18** which is treated by DOS as though it were a physical drive distinct from the branch computer mass storage device, even though it is not. Through the use of this conceptual mechanism, the best presently known embodiment **10** of the present invention redirects a directory inquiry to this "virtual disk" through the means conventionally available in DOS. When a file name **32** is

selected from the secondary directory **30**, the best presently known embodiment **10** of the present invention then causes the appropriate action to be taken, as will be described hereinafter. By using the "virtual disk" concept, the inventive remote file access system **10** can more easily be used in conjunction with existing software which is written such that it recognizes that files may be stored within various disks or "virtual disks".

It should be noted that, in the example of Fig. 2, all of the files **32** are shown within the unitary primary directory **28** while, in practice, subdirectories (not shown) may be contained within the base computer mass storage device **14**. The example of Fig. 2 does not include subdirectories, as the invention is more clearly illustrated using the relatively simplistic memory map **26a** of the example of Fig. 2. One skilled in the art will easily be able to apply the inventive methods described herein to more lengthy and/or complex directory structures, should that be required.

The secondary directory **30**, as depicted in the example of Fig. 2 is also a listing of file names **32**, the content of which will be discussed hereinafter. The branch computer mass storage device **18** also contains a plurality (3 in the example of Fig. 2) of files **34**.

In addition to the files **34** and the primary directory **28** listing the file names **32**, the base computer mass storage device also contains a primary version list **36**, a remote file catalog **38** and a plurality (2 in the example of Fig. 2) of delta files **40**. The primary version list **36** has a plurality (3 in the example of Fig. 2) of primary version indicators **42** corresponding to the files **34** located in the base computer mass storage device **14**, the primary version indicators **42** being shown in the example of Fig. 2 having the form "VFx,y", wherein x is the number of the file **34** which is being referenced and y represents a particular iteration or "version" of that file **34**. For example, a certain "VF2.y" primary version indicator **42.2** in the example of Fig. 2 indicates that a corresponding "F2" file **34.2** having a corresponding "N2" file name **32.2** is in a second iteration

(y=2), as presently stored on the base computer mass storage device. Each time that the "F2" file **34.2** is "saved" to the base computer mass storage device **14**, the corresponding "VF2.y" primary version indicator **42.2** would be updated, such that if the "F2" file **34.2** were to be again saved, as compared to the status illustrated in Fig. 2, the corresponding "VF2.y" primary version indicator **42.2** would then become "VF2.3", using the terminology of the example of Fig. 2.

The remote file catalog **38** allows the base computer **14** (Fig. 1) to know which files **34** are presently being held within the branch computer mass storage device **18** and, further, which iteration of such files **34** is being held within the branch computer mass storage device **18**. In the example of Fig. 2, the remote file catalog **38** contains three remote file listings **44**, indicating that version 1 of a certain "F1" file **34.1**, version 1 of a certain "F5" file **34.5** and version 1 of a certain "F6" file **34.6** are presently within the branch computer mass storage device **18**. It should be noted that the content of the remote file catalog **38** is based upon a last previous communication between the base computer **12** and the branch computer **16**. If any modification of the content of the branch computer mass storage device **18** has occurred since such last previous communication, then the content of the remote file catalog **38** will not reflect the actual current status of the branch computer mass storage device **18**.

It should be noted that the method of the present invention is not limited to use with a single branch computer **16** (Fig. 1), and that if more than one branch computer **16** is employed, then the remote file catalog **38** will have a remote file listing **44** corresponding to each file **34** contained in each of such branch computers **16**, such that the base computer **12** (Fig. 1) can know which version of each file **34** is presently contained in each of the branch computers **16**.

It should further be noted that the inventors of the present invention acknowledge that "state" files, such as the remote file listings **44** within the remote file catalog **38**,

can be a potential source of problems. In general, when the base computer **12** is required to keep track of the content of the branch computer mass storage device **18**, then potential for error is introduced which may, or perhaps may not, outweigh the advantages of that feature. Therefore, the inventors contemplate that variations of the present invention may be developed which minimize the use of such "state" files as the remote file listings **44**, even though such modification might mean that some additional delta files **40** might have to be retained, as compared to those described as being retained in conjunction with the best presently known embodiment **10** of the present invention, particularly if there is more than a single branch computer **16** being used. Such a modification, as well as other such modifications to the best presently known embodiment **10** of the present invention, are considered to be changes only in details of the best presently known embodiment **10** of the present invention, and they do not vary in scope or purpose from the inventive aspects of the inventive remote file access system **10**.

In the best presently known embodiment **10** of the present invention, in addition to the files **34** and the secondary directory **30** listing of file names **32**, the branch computer mass storage device **18** also contains a secondary version list **46** having therein a plurality (3 in the example of Fig. 2) of secondary version indicators **48** corresponding to the files **34** which are contained within the branch computer mass storage device **18**. Therefore, if the content of the remote file catalog **38** within the base computer mass storage device **14** is current, the secondary version indicators **48** will be equal in number to, and will agree in substance as compared to, the remote file listings **44** in the base computer mass storage device **14**.

Turning now to a discussion of the steps of the present inventive method for updating and accessing the files **34** within the best presently known embodiment **10** of the present invention, it can be seen in the example of Fig. 2 that a certain "F7" file **34.7** is present in the base computer mass

storage device **14**, as is a corresponding "N7" file name **32.7** and a corresponding "VF7.y" primary version indicator **42.7**. In the example of Fig. 2, it should be noted that the "F7" file **34.7** is not, however, located within the branch computer mass storage device **18**. This condition depicted in the example of the memory map **26a** would exist when the "F7" file **34.7** has been created and entered into the base computer mass storage device **14** since a last previous communication between the branch computer **16** and the base computer **12**.

Given an instantaneous condition as depicted in the example of the memory map **26a**, when a user wishes to use the branch computer **16**, the branch computer modem **20** must be connected to the data link **24** such that the branch computer **16** can access the base computer **12** therethrough. As has been discussed previously, herein, the data link **24** may be conventional telephone lines, cellular telephone circuits, or the like. If the data link **24** to be used is a conventional telephone circuit, the user must physically connect the branch computer modem **22** to the data link **24** prior to the following described operations.

In order to use the branch computer **16** the user, according to the present inventive method, is not required to perform operations differently than would be the case if the branch computer **16** were a stand alone computer having therein all data files required by the user. Instead, the inventive method is performed by means of the hardware/software combination of the best presently known embodiment **10** of the invention, as described herein. After being connected to the data link **24**, the branch computer **16** is turned on according to the normal activation procedure for that device.

One familiar with the operation of computers will recognize that the user can cause the secondary directory **30** (Fig. 2), or a portion thereof, to be displayed on the branch computer **16** by any of several actions. For example, when operating in a DOS environment, the user can enter a directory ("DIR") command. Alternatively, if operating in a Windows™ environment, the file names **32** can be displayed as icons on the branch computer **16**. In either case, when

running within an operations program, such as a word processor or a spreadsheet, the display may be regulated by that program such that only entries bearing a specified suffix are displayed and/or such that entries within a certain specified "path" are displayed, and the like. In any event, according to the present invention, the secondary directory **30** (or a portion thereof, as discussed above) will be displayed instead of the actual contents of the branch computer mass storage device **18**.

Now continuing a discussion of the operation of the inventive remote file access system **10** beginning at the condition depicted in the example of the memory map **26a**, the following example will show the updating of the secondary directory **30** and retrieval of the "F1" file **34.1**, according to the present inventive method, resulting in a condition as will be depicted in Fig. 3. When the user first requires that the branch computer **16** (Fig. 1) display the secondary directory **30**, the branch computer **16** will access the base computer **14** via the data link **24** to update the secondary directory **30** such that the secondary directory **30** will agree with the primary directory **28**. Following this, a first updated memory map **26b** will, as shown in Fig. 3, include the "N7" file name **32.7** in the secondary directory **30**, as well as in the primary directory **28**. Therefore, the user is alerted to the fact that the "F7" file **34.7** has been added to the base computer mass storage device **14**, and is available for use.

While the inventive remote file access system **10**, as described herein, provides for the updating of files **34** at the branch computer **16** with delta files **40** which are created at the base computer **12**, it is within the scope of the present invention that this process could be made bidirectional, with delta files **40** being created at the branch computer **16** and transmitted to the base computer **12** for updating the files **34** of the base computer **12** according to changes which may have been made at the branch computer **16**. Indeed, in such a configuration, the base computer **12** and the branch computer **16** could, if desired, be assigned an

equal status, such that the base computer **12** and the branch computer **16** were not a "master" and "slave", as described herein.

Continuing the discussion from the condition depicted by the first updated memory map **26b** of Fig. 3, should the user then wish to use the "F1" file **24.1**, upon the user's calling for that file the branch computer **16** (Fig. 1) accesses the base computer **12** via the data link **24** for the purpose of assuring that the "F1" file **34.1**, as stored within the branch computer mass storage device **18** is current with the "F1" file **34.1** as stored within the base computer mass storage device **14**. Upon comparing the "VF1.y" primary version indicator **42.1** to a "VF1.y" secondary version indicator **48.1** it can be seen that the "F1" file **34.1**, as stored within the branch computer mass storage device **18** is, in fact, current with the "F1" file **34.1** as stored within the base computer mass storage device **14**, and no updating procedures are required. Therefore, the "F1" file is retrieved from the branch computer mass storage device **18**.

Alternatively, again beginning at the condition depicted by the first updated memory map **26b** of Fig. 3, should the user call for the "F5" file **34.5**, the branch computer **16** would access the base computer **12** via the data link **24**, this time for the purpose of assuring that the "F5" file **34.5**, as stored within the branch computer mass storage device **18** is current with the "F5" file **34.5** as stored within the base computer mass storage device **14**. As can be seen in the first updated memory map **26b** of Fig. 2, a "VF5.y" primary version indicator **42.5** indicates that a "version" (y=2) number 2 of the "F5" file **34.5** exists in the base computer mass storage device **14**, while the "VF5.y" secondary version indicator **48.5** indicates that a "version" (y=1) number 1 of the "F5" file **34.5** exists in the branch computer mass storage device **18**. Therefore, the "F5" file **34.5**, as stored within the branch computer mass storage device **18**, must be updated. It is within the scope of the present inventive method that the entire "F5" file **34.5** might be transmitted from the base computer **12** to the branch computer **16** and the "F5" file **34.5**

(version number 1) previously stored in the branch computer mass storage device **18** replaced therewith. However, according to the best presently known embodiment **10** of the present invention, a "DF5" delta file **40.5** containing any differences between the versions of the "F5" file, as found in the base computer mass storage device **14**, is transmitted via the data link **24** to the branch computer **16**, and the branch computer mass storage device **18**, and the "DF5" file **40.5** is integrated into the "F5" file **34.5** within the branch computer **16** such that the "F5" file **34.5** within the branch computer mass storage device **18** is updated to conform to that same "F5" file **34.5** within the base computer mass storage device **14**. In essentially all cases, the "DF" files **40** will be much smaller and easily transferred than the entire corresponding files **34**. A second updated memory map **26c**, Fig. 4, depicts the content of the mass storage devices **14** and **18** following these operations.

In the second updated memory map **26c** it can be seen that the former "VF5.y" secondary version indicator **48.5** (Fig. 3) has been updated to read "VF5.2" to indicate that a "version" (y=2) number 2 of the "F5" file **34.5** is now stored in the branch computer mass storage device **18**. Furthermore, an "RF5.y" remote file listing has been updated from reading "RF5.1" (Fig. 3) to reading "RF5.2" in Fig. 4. This allows the base computer **12** to know that the "F5" file **34.5** has been updated in the branch computer mass storage device **18** to version number 2 thereof. The reason that a separate listing of versions of files **34** stored within the branch computer mass storage device **18** is kept within the remote file catalog **38** of the base computer mass storage device **14** is illustrated by the absence of a "DF5" file **40.5** (Fig. 3) within the second updated memory map **26c** (Fig. 4). It should be noted that, when the "version" indications (y of "VFx,y" and of "RFx,y") of corresponding primary version indicators **42** and remote file listings **44** agree, there is no reason to keep a delta file (DFx) **40** for the corresponding (Fx) file **34**, and that delta file **40** is deleted. Similarly, if a file **34** is deleted from the branch computer mass storage device **18**,

there is no longer a need to keep a corresponding delta file **40** within the base computer mass storage device **14** because, should that file **34** be required at the branch computer **16**, it will have to be transmitted in its entirety via the data link **24** (Fig. 1), anyway. Alternatively, it is within the scope of the present inventive remote file access system **10** that the files **34** might not be erased as soon as they appear not to be needed, such that an older version of the file **34** could be restored, as required. The inventors contemplate that this could be accomplished by means of a "reverse delta file" (not shown), which would be a version of a delta file **40** which carries changes required to restore a new version of a file **34** back to an older version.

It should be noted that the examples of this paragraph are influenced by the fact that a single branch computer **16** is utilized in the best presently known embodiment **10** of the present invention. As discussed previously, herein, one skilled in the art will recognize that, should multiple branch computers **16** be utilized, then a more complicated memory map **26** including multiple remote file catalogs **38** (one for each such branch computer **16**) and, when required, multiple delta files **40** (where different versions of a file are held at each of such branch computers **16** and at the base computer **12**), might be required.

It should be noted that since, as previously discussed herein, it is presumed that in essentially all applications of the present inventive method, the capacity of the branch computer mass storage device **18** will be substantially less than that of the base computer mass storage device **14**, it might well occur that any of the operations described herein as being part of the inventive method will cause the import of files **34** (or other data portions) from the base computer mass storage device **14** to the branch computer mass storage device **18** which operation might exceed the available (unused) capacity of the branch computer mass storage device **18**. For this reason, the inventive method causes whichever file **34** within the branch computer mass storage device **18** which has been least recently used to be deleted, as required, from the

branch computer mass storage device **18** to make available room within the branch computer mass storage device **18** for the operations described herein. Stated in other terms, the branch computer mass storage device **18** is acting as a "cache" for the content of the base computer mass storage device **14**. This method is known as a "least recently used" caching algorithm. The present invention is certainly not limited to this particular algorithm, and any caching algorithm, presently known or yet to be invented, could be used in conjunction with the best presently known embodiment **10** of the present invention to perform the function of selecting files **34** to be deleted, as necessary, to create space in branch computer mass storage device **18**.

It should further be noted that, within the best presently known embodiment **10** of the present invention, conventional data compression is utilized for transmission of files **34** and delta files **44** via the data link **24** (Fig. 1). It is anticipated by the inventors that data compression will be generally equally efficacious in the transmission of delta files **44** as compared to the transmission of the more conventional files **34**.

Returning now to an example beginning at the condition described by the memory map **26a**, it may be noted that a "VF6.y" primary version indicator **42.6** indicates that a "version" number 3 (y=3) of the "F6" file **34.6** is resident within the base computer mass storage device **14**, while a "version" number 1 (y=1) of the "F6" file **34.6** is stored within the branch computer mass storage device **18**, as indicated by a "VF6.y" secondary version indicator **48.6**. This condition is as might result from the "F6" file **34.6** having been revised twice since it was transmitted to the branch computer mass storage device **18**. According to the present inventive method, then, a "DF6" file **40.6** within the base computer mass storage device **16** will contain all differences between version 1 of the "F6" file **34.6** and version 3 of that same file. It should be noted that at some intermediate stage there has been a version 2 of that same "F6" file **34.6** in existence and, at that time, the "DF6" file

40.6 would have contained differences between version 1 of the "F6" file **34.6** and version 2 of that same file. One skilled in the art will recognize that it is a relatively simple matter to "merge" successive iterations of the delta files **40** such that cumulative differences between successive iterations of the files **34** may be contained therein, as required.

It should be noted that, as described herein, a new delta file **40** (or an updated version of an existing delta file **40**, as required) is made each time a updated iteration of a file **34** is stored to the base computer mass storage device **16**. It is recognized by the inventors that, depending upon the complexity of the files **34** and the processing speed of the base computer **12**, this may be unduly time consuming in some applications, and it is within the scope of the present inventive method that alternative times and/or means for creation of the delta files **40** may be incorporated into the best presently known embodiment **10** of the present invention, as required by such peculiar circumstances.

All of the above are only some of the examples of available embodiments of the present invention. Those skilled in the art will readily observe that numerous other modifications and alterations may be made without departing from the spirit and scope of the invention. Accordingly, the above disclosure is not intended as limiting and the appended claims are to be interpreted as encompassing the entire scope of the invention.

INDUSTRIAL APPLICABILITY

The remote file access system **10** is adapted to be widely used in conjunction with personal computers. The predominant current usages are for applications wherein a user has both an office computer and a secondary computer, the secondary computer usually being either a stationary home computer system, or a portable computer. In such instances, it is customary for the user to want or need to use files which are primarily stored in the office computer when the

user is away from the office. For example, the user may maintain a data base file of inventory in a portable computer when he or she is out taking orders. By means of the present invention, that file is automatically updated to the most recent iteration of the data base such that the user does not inadvertently sell something which has already been shown to have been removed from inventory in the office computer.

Another example is that the user may wish to refine a document stored in a word processor file while at home over the weekend. Prior to the present invention, even if the user had previously gone to the trouble of storing that word processor file in his or her home computer, if that file had been modified at the office, then the version on the home computer had become outdated and the user was faced with the choice of either trying to rewrite the recent revisions or working with the outdated version. However, by means of the present invention, the user is assured not only that all files which are stored in his or her office computer are available at the home computer, but also that the most recent version of each file is being used when working at home.

The inventive remote file access system **10** may be utilized in conjunction with either a single branch computer **12** or with a plurality of branch computers **12**, as described herein. Therefore, the present invention is applicable to situations wherein a single user needs access to the files **34** or, alternatively, to situations wherein multiple users require access to the same set of files **34** from the base computer mass storage device **14**. The present inventive remote file access system **10** may be adapted for use with any operating system, known or yet to be invented. Furthermore, the present inventive remote file access system **10** might even be incorporated into future revisions of operating systems.

Since the remote file access system **10** of the present invention may be readily constructed to operate using conventional prior art hardware components, it is expected that it will be acceptable in the industry as a substitute for conventional remote data retrieval means. Further, since the inventive remote file access system **10** does not require

that a user learn new operating procedures, it is expected that the present invention will be welcomed as a substantial aid to productivity by computer users. For these and other reasons, it is expected that the utility and industrial applicability of the invention will be both significant in scope and long-lasting in duration.

IN THE CLAIMS

1. An improved file access system, comprising:

a base computer including a base mass storage device;

a remote computer including a remote mass storage device; and

communications means for bidirectional transfer of data between said base computer and said remote computer, wherein;

the remote mass storage device and the base mass storage device each contain a directory of file names, the directory of file names being a listing of files available in said base mass storage device;

the base mass storage device further contains each of the files which is listed in the directory of file names;

the remote mass storage device contains a portion of the files which are listed in the directory of file names, such that;

when a user selects a specific file for use in said remote computer, said remote computer determines if that specific file is held in the remote mass storage device and, if that specific file is not held in the remote mass storage device, then that specific file is retrieved, via the communications means, from the base mass storage device and stored within the remote mass storage device for use at said remote computer.

2. The improved file access system of claim 1, wherein:

if the required specific file is held in the remote mass storage device then said remote computer communicates with said base computer to determine if that specific file has been updated according to any modifications which may have been made to that specific

file as that specific file is stored within the base mass storage device and, if that specific file has not been updated according to any modifications which may have been made to that specific file as that specific file is stored within the base mass storage device, then that specific file is updated to include any such modifications.

3. The improved file access system of claim 2, wherein:

said base computer creates and stores in the base mass storage device a delta file, the delta file being a file having therein all differences between an earlier version of a specific file and a current version of that same file, such that updating of files is accomplished by modifying the files with the corresponding delta file.

4. The improved file access system of claim 1, wherein:

said remote computer produces the directory displayed thereon such that the user may select from file names listed on that directory without regard for whether or not a corresponding file is located within the remote mass storage device.

5. The improved file access system of claim 1, wherein:

said communications means includes;

a plurality of modems, with a modem being associated with each of said base computer and said remote computer; and

telephonic communcations means for interconnecting the modems.

6. In a computer system having a base computer, a remote computer, and communications means for allowing data trasfer between the base computer and the remote computer, the improvement comprising:

a directory stored on a remote mass storage device of the remote computer, said directory having therein a

list of file names, including;

file names corresponding to files which are stored on the remote mass storage device; and

file names corresponding to files which are stored on a base mass storage device of the base computer, and which are not stored on the remote mass storage device;

said directory having the characteristic that it is a listing of all files available to the remote computer, whether such files are stored at the remote computer or at the base computer.

7. The improvement of claim 6, wherein:

a file may be selected for use at the remote computer by selecting from the directory, whether such file is stored at the romte computer or at the base computer.

8. The improvement of claim 6, wherein:

a file which is stored at the remote computer is updated to include any changes which have been made to that same file at the base computer, when that file is selected for use at the remote computer.

9. The improvement of claim 6, wherein:

when a file is to be updated, a delta file is sent from the base computer to the remote computer, the delta file being a file containing information relating to any differences between a most recent version of that file and an earlier version of that file.

10. The improvement of claim 6, wherein:

the directory of the remote computer is updated each time that communication is established between the remote computer and the base computer such that the directory of the remote computer contains all of the files which are stored at the base computer.

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11. A method for accessing the files of a base computer from a remote computer, comprising:

creating a directory listing of file names for the remote computer which includes files that are stored at the base computer but which are not stored at the remote computer;

causing the remote computer to decide if a required file is stored at the remote computer and, if it is not, causing the remote computer to establish communication with the base computer and to retrieve that required file from the base computer.

12. The method of claim 11, and further including:

when a required file is stored at the remote computer, causing the remote computer to establish communication with the base computer and to verify that a first version of that required file which is stored at the remote computer is identical to a second version of that required file which is stored at the base computer.

13. The method of claim 12, and further including:

when the first version of the required file stored at the remote computer is not identical to the second version of the required file stored at the base computer, causing the base computer to send to the remote computer information sufficient to update the first version of the required file to conform to the second version of the required file.

14. The method of claim 13, wherein:

the information sufficient to update the first version of the required file to conform to the second version of the required file includes a delta file, the delta file being a file stored at the base computer which is the differences between the first version of the required file and the second version of the required file.

15. The method of claim 14, wherein:

the delta file is erased after it is transmitted to the remote computer.

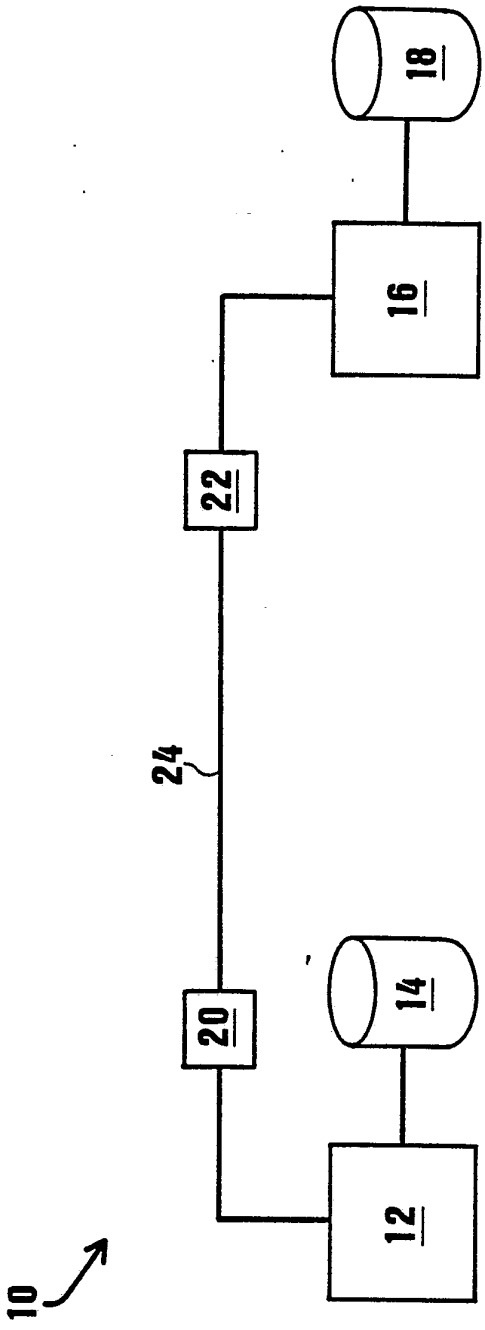


Fig. 1

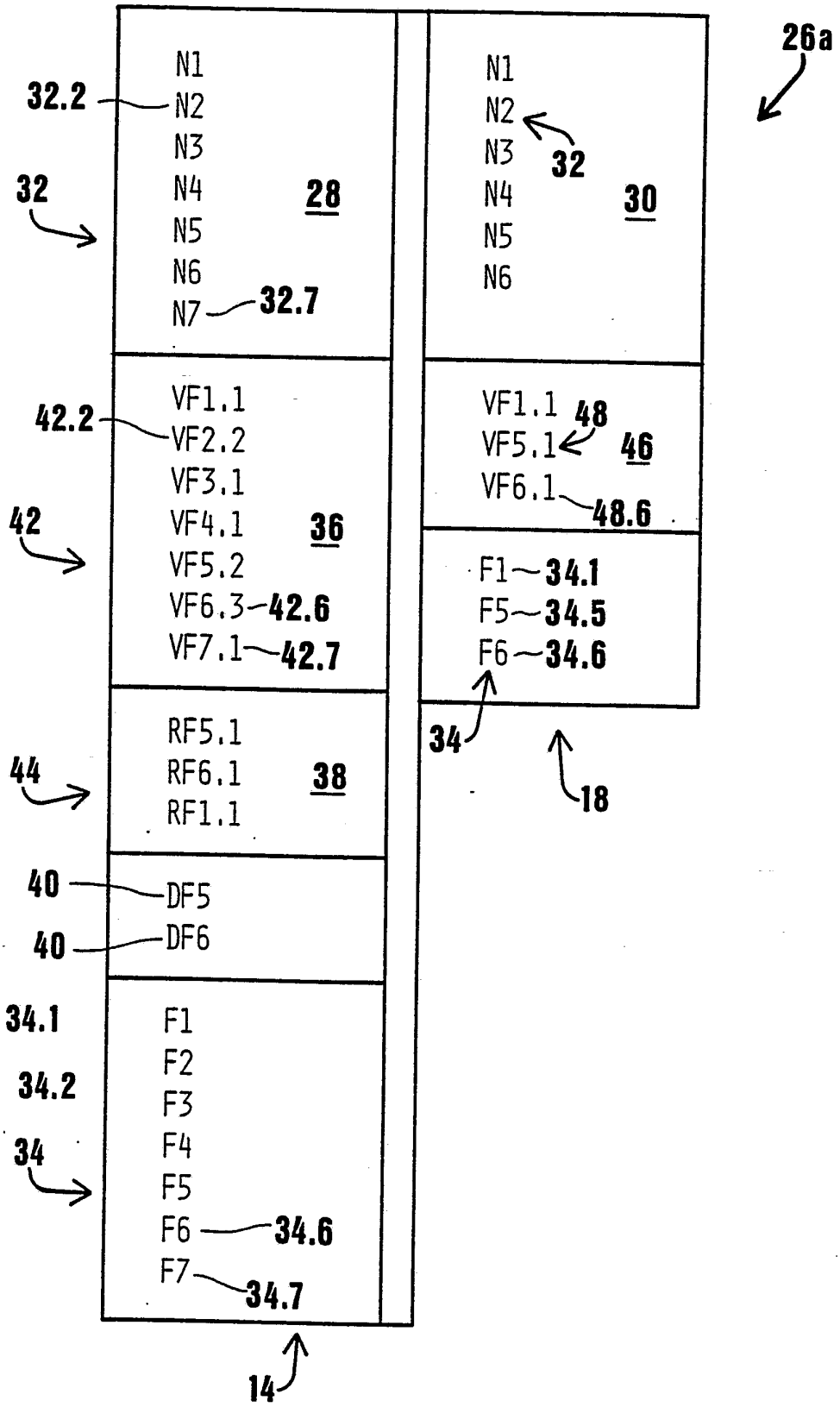
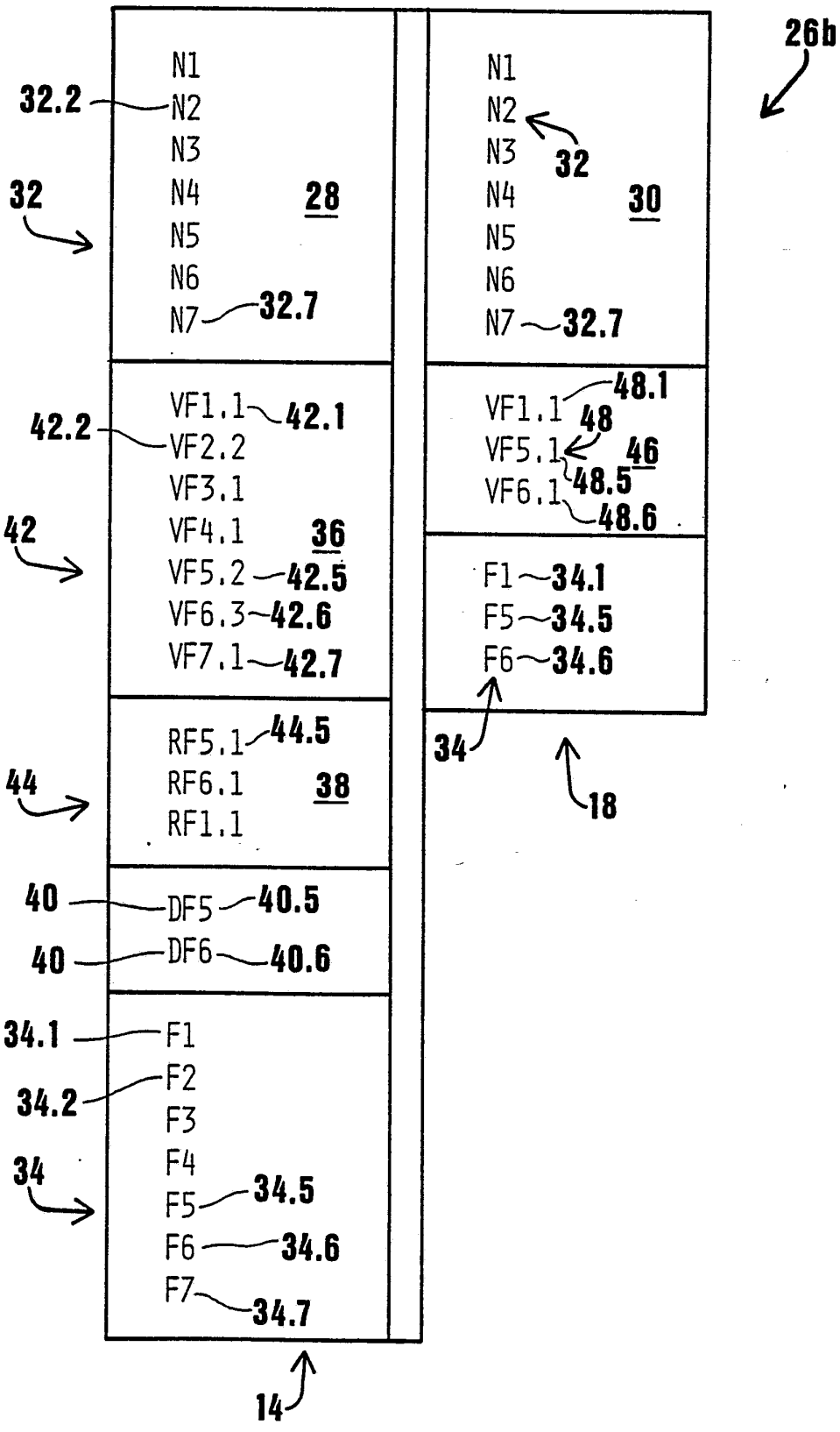

26a
32.2
32
42.2
42
44
40
40
34.1
34.2
34
N1
N2
N3
N4
N5
N6
N7
28
32.7
VF1.1
VF2.2
VF3.1
VF4.1
VF5.2
VF6.3
VF7.1
36
42.6
42.7
RF5.1
RF6.1
RF1.1
38
DF5
DF6
F1
F2
F3
F4
F5
F6
F7
34.6
34.7
14
N1
N2
N3
N4
N5
N6
32
30
VF1.1
VF5.1
VF6.1
48
46
48.6
F1
F5
F6
34.1
34.5
34.6
34
18

Fig. 2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N2
N3
N4
N5
N6
N7
28
32.7
VF1.1
42.1
VF2.2
VF3.1
VF4.1
36
VF5.2
42.5
VF6.3
42.6
VF7.1
42.7
RF5.1
44.5
RF6.1
38
RF1.1
DF5
40.5
DF6
40.6
F1
F2
F3
F4
F5
34.5
F6
34.6
F7
34.7
14
N1
N2
N3
32
N4
30
N5
N6
N7
32.7
VF1.1
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VF5.1
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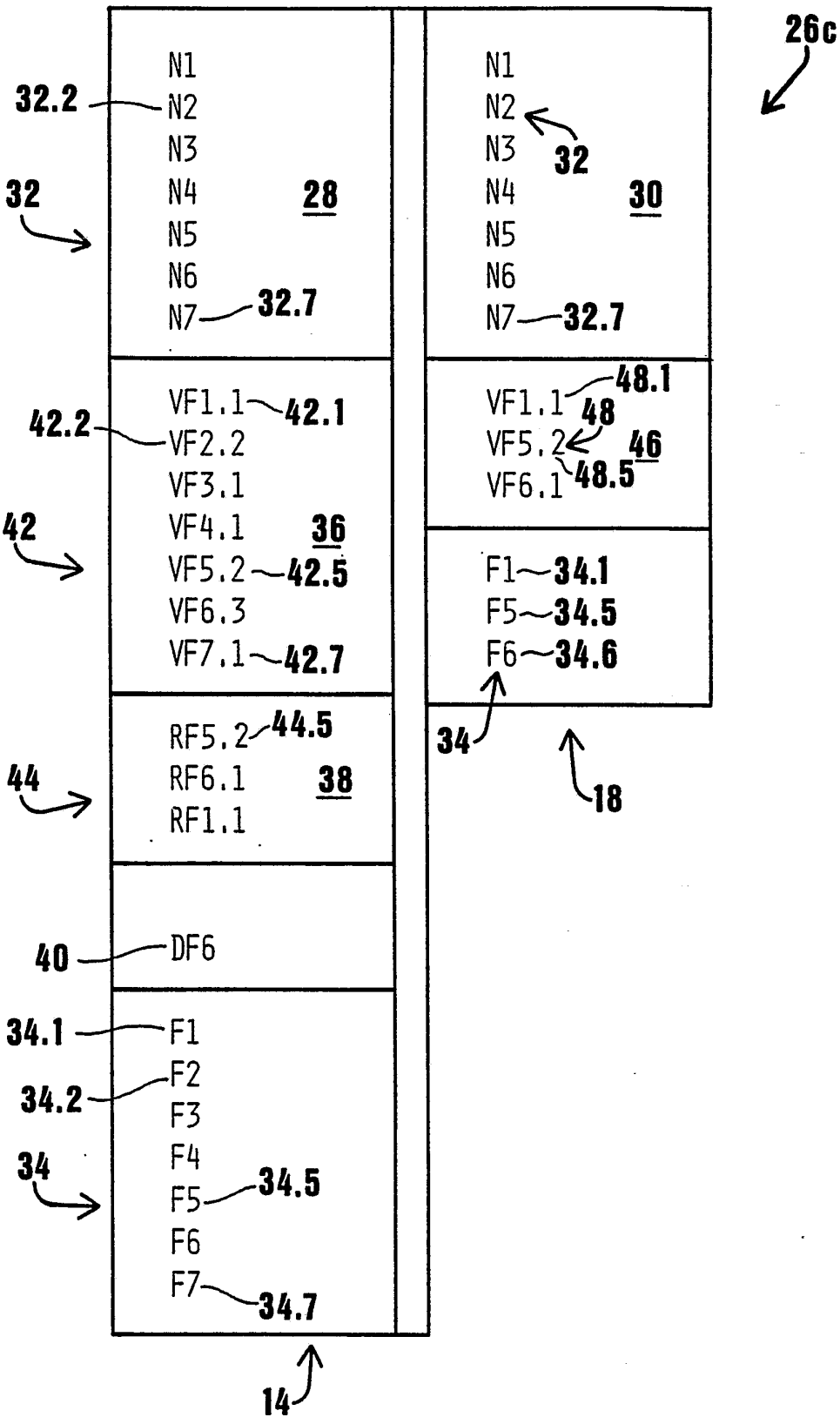
VF6.1
48.6
F1
34.1
F5
34.5
F6
34.6
34
18

Fig. 3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N6
N7
32.7
42.2
42
VF1.1
42.1
VF2.2
VF3.1
VF4.1
36
VF5.2
42.5
VF6.3
VF7.1
42.7
VF1.1
48.1
48
VF5.2
46
VF6.1
48.5
F1
34.1
F5
34.5
F6
34.6
34
18
44
RF5.2
44.5
RF6.1
38
RF1.1
40
DF6
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34.2
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F1
F2
F3
F4
F5
34.5
F6
F7
34.7
14

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/02652

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :G06F 13/00,15/40
US CL :395/600
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)

U.S. : 395/200,425,575,650,700

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 practicable, search terms used)

APS (Automated Patent Search) (Distributed File Access), Update, Deltas Changes

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US,A, 4,891,785 (Donohoo) 02 January 1990 See figures 5, col. 7, lines 14-48.	1,4,5,6, 7,10,11
Y,P	US,A, 5,155,847 (Kirouac et al.) 13 October 1992. See col. 3, line 27 through col. 4, line 61.	2,3,8,9, 12-15
Y	US,A, 4,914,583 (Weisshaar et al.) 03 April 1990. See Abstract.	1,4-7,10-11

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"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
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"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		

Date of the actual completion of the international search 21 JUNE 1993	Date of mailing of the international search report 19 JUL 1993
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. NOT APPLICABLE	Authorized officer JOHN C. LOOMIS Telephone No. (703) 305-3833

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