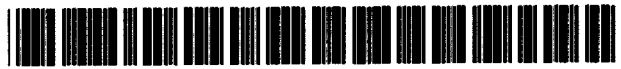


EXHIBIT G



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Reynolds et al.

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[45] **Date of Patent:** **May 26, 1998**

[54] **COMMON NAME SPACE FOR LONG AND SHORT FILENAMES**

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2148341 7/1990 Japan G06F 12/00
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[73] Assignee: **Microsoft Corporation**, Redmond, Wash.

[21] Appl. No.: **711,692**

[22] Filed: **Sep. 5, 1996**

Related U.S. Application Data

[63] Continuation of Ser. No. 427,004, Apr. 24, 1995, Pat. No. 5,579,517, which is a continuation of Ser. No. 41,497, Apr. 1, 1993, abandoned.

[51] **Int. Cl.**⁶ **G06F 17/30**

[52] **U.S. Cl.** **707/200; 707/1; 707/6**

[58] **Field of Search** **395/600; 364/200**

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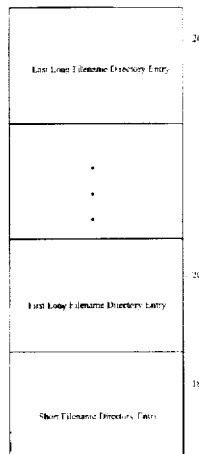
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[57] **ABSTRACT**

An operating system provides a common name space for both long filenames and short filenames. In this common namespace, a long filename and a short filename are provided for each file. Each file has a short filename directory entry and may have at least one long filename directory entry associated with it. The number of long filename directory entries that are associated with a file depends on the number of characters in the long filename of the file. The long filename directory entries are configured to minimize compatibility problems with existing installed program bases.

28 Claims, 8 Drawing Sheets



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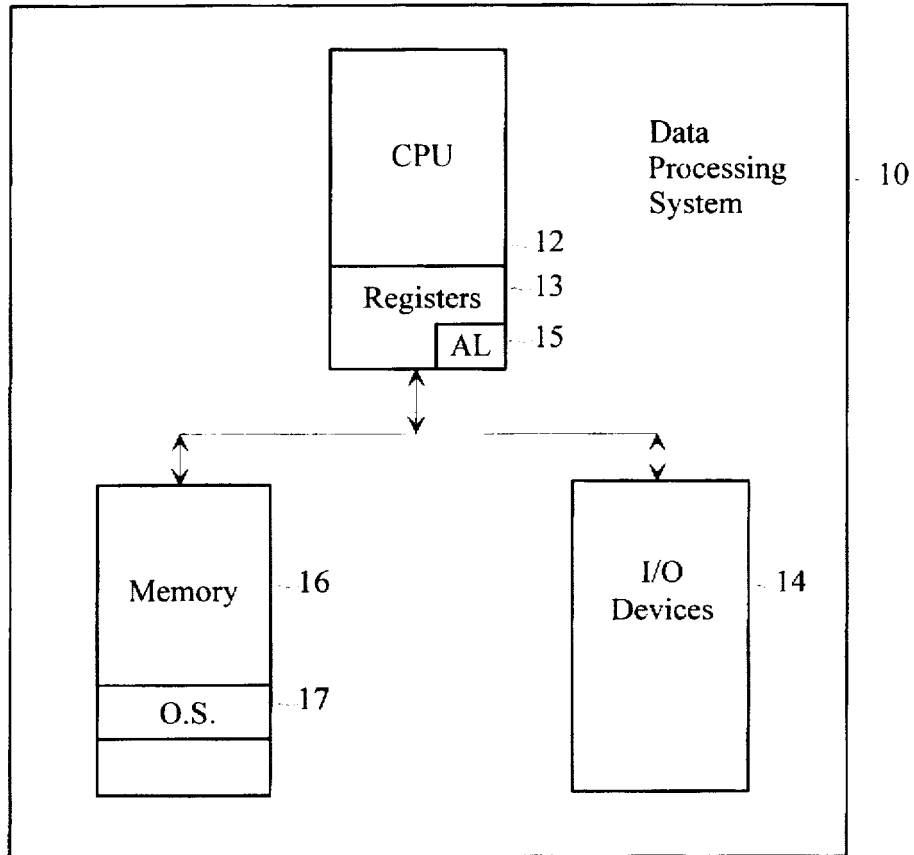


Figure 1

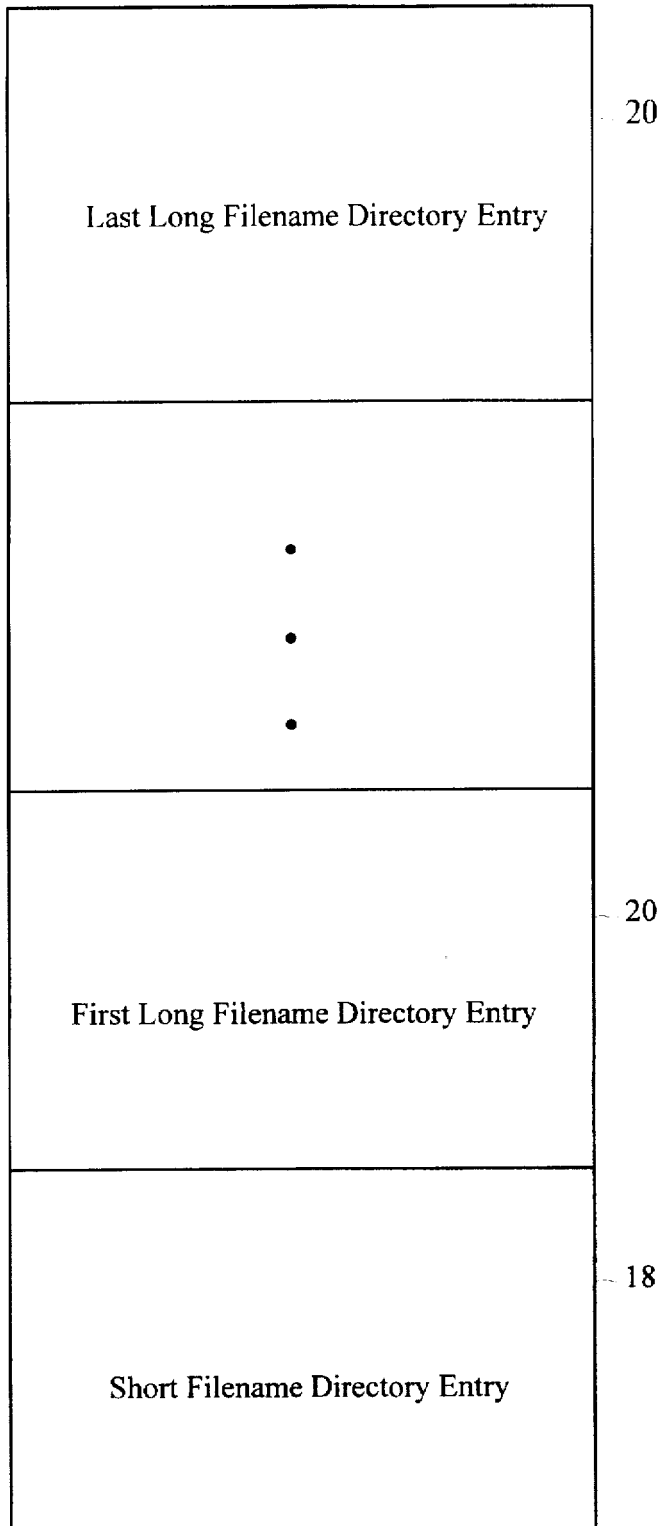


Figure 2

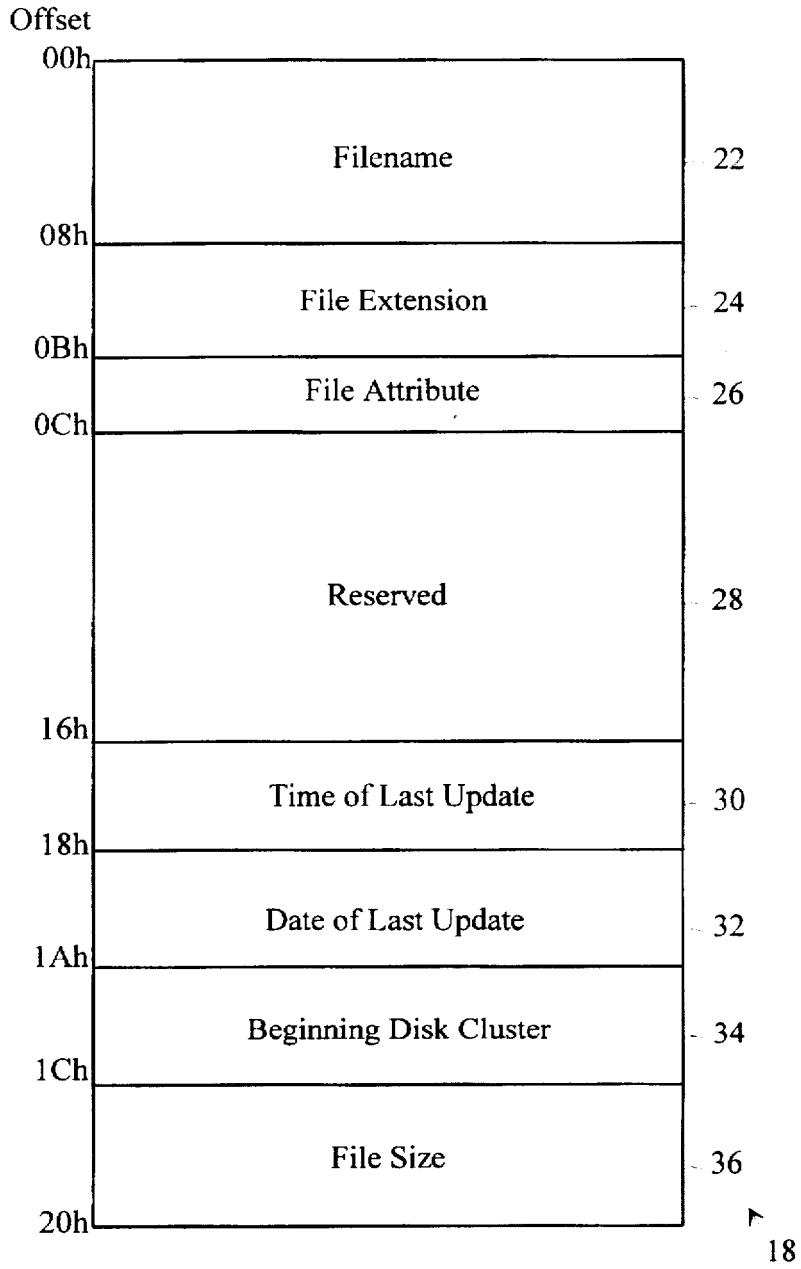


Figure 3a

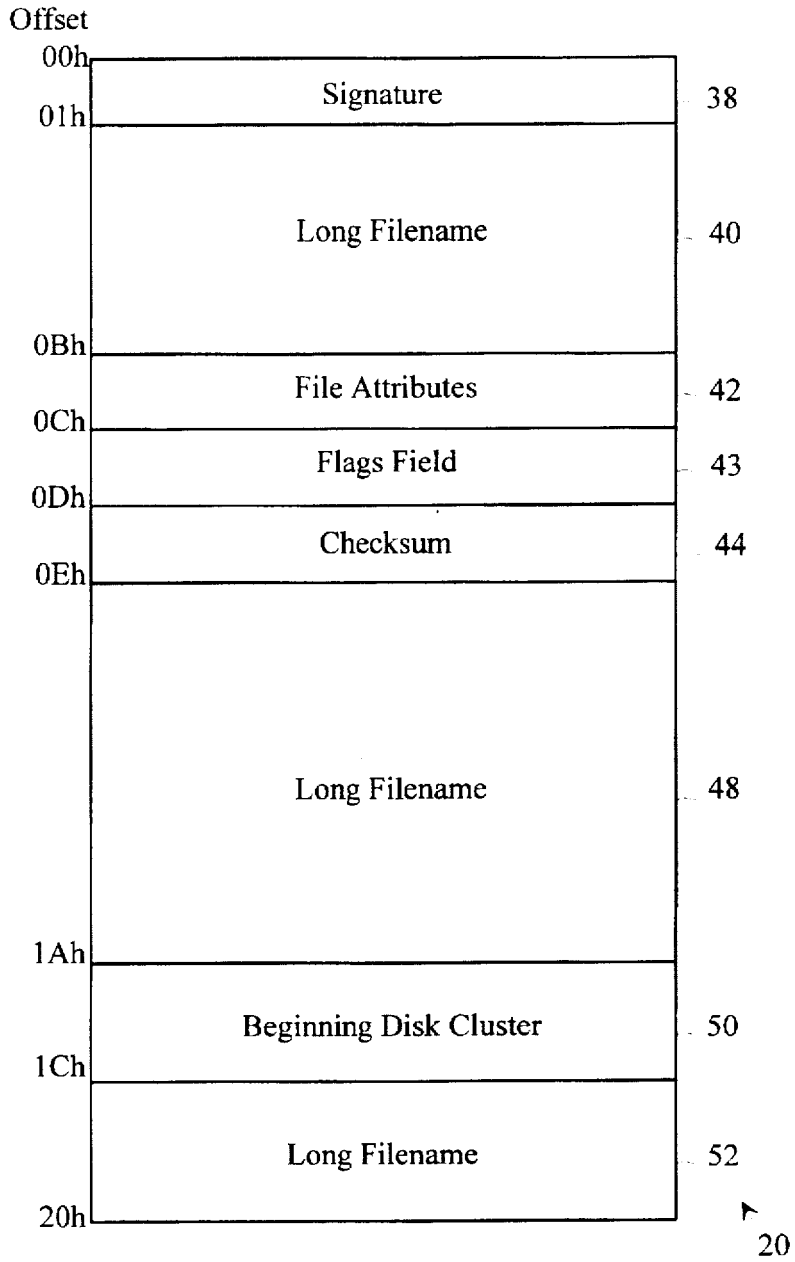


Figure 3b

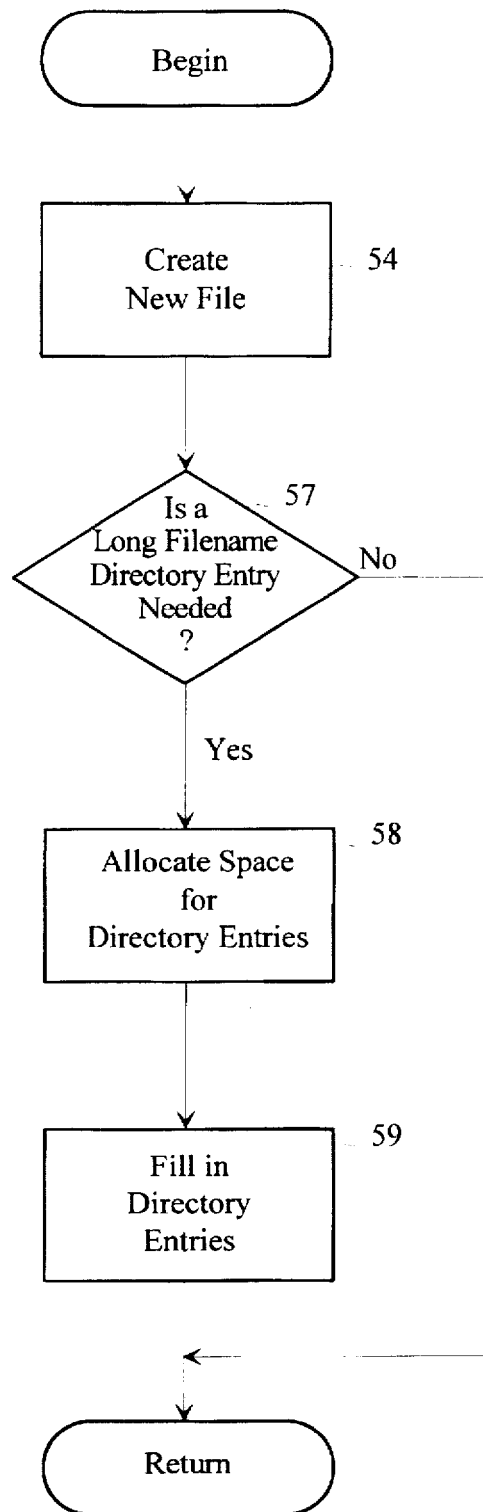


Figure 4

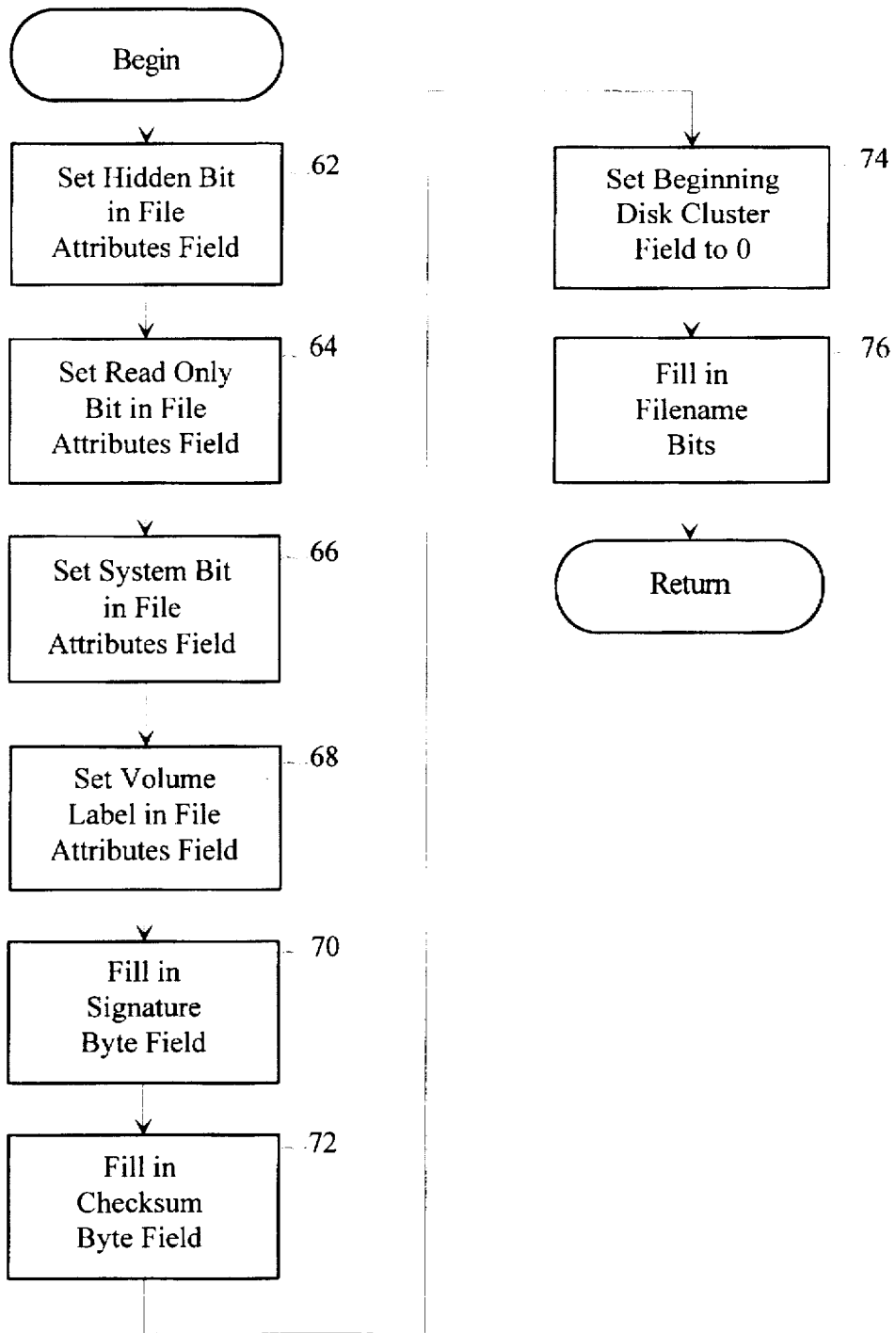


Figure 5a

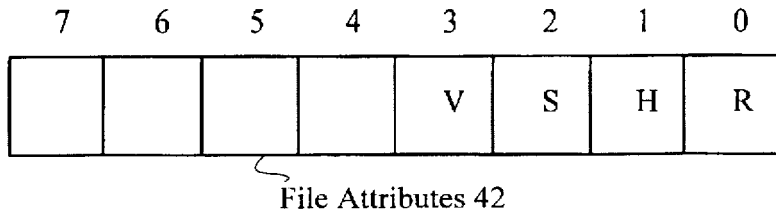


Figure 5b

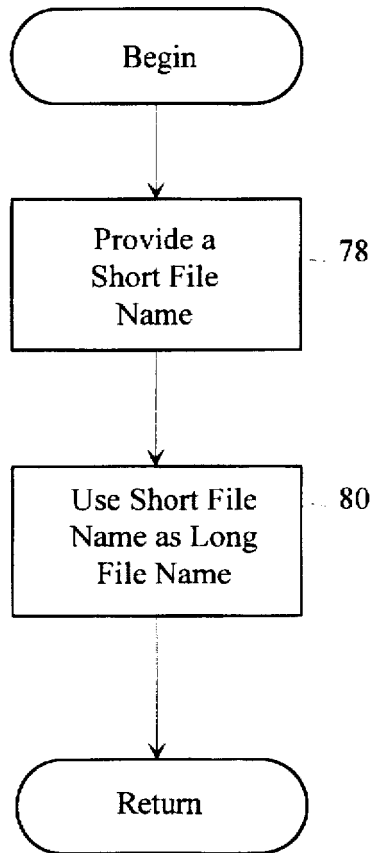


Figure 6a

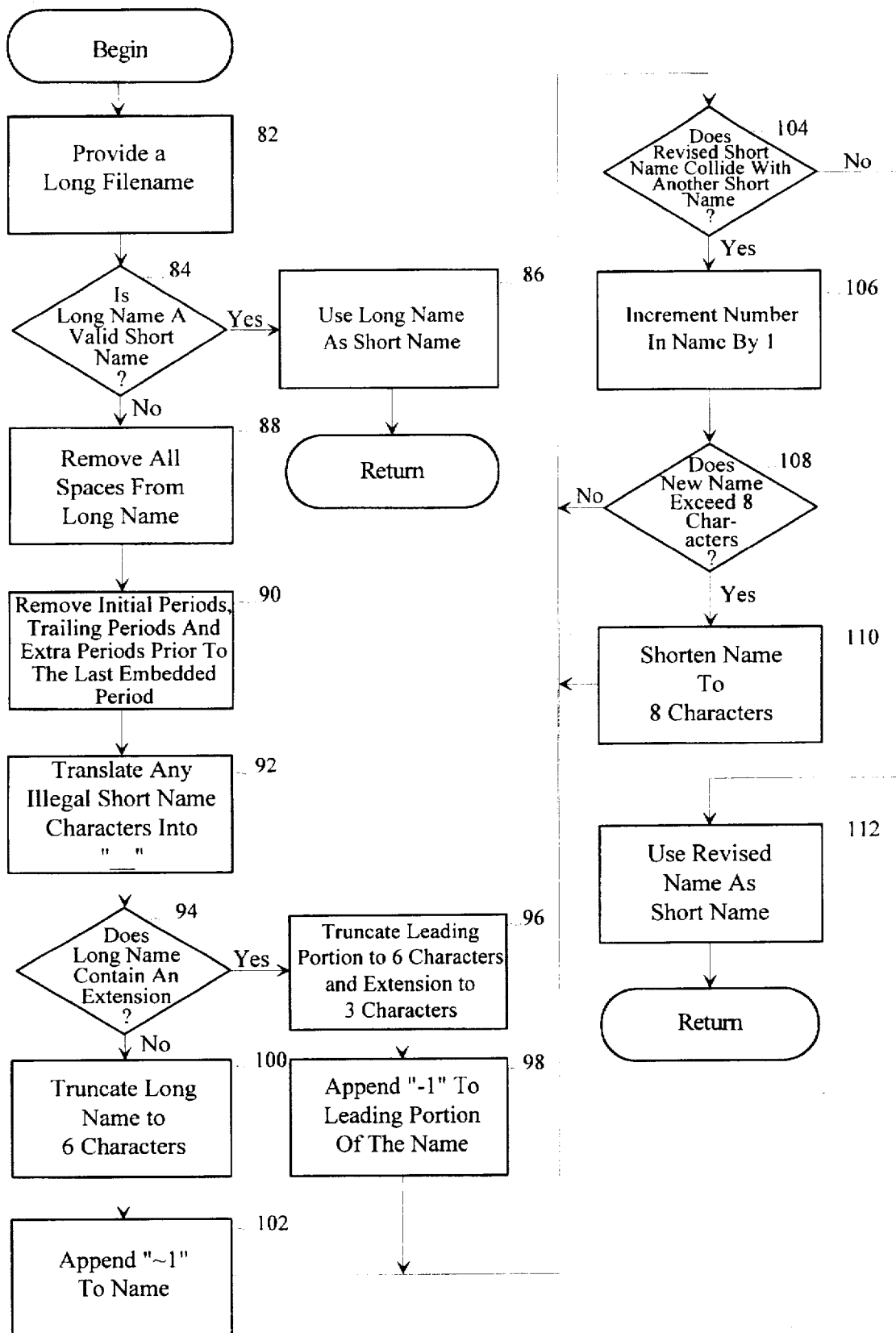


Figure 6b

COMMON NAME SPACE FOR LONG AND SHORT FILENAMES

This application is a continuation of U.S. patent application Ser. No. 081427,004, filed Apr. 24, 1995, now U.S. Pat. Ser. No. 5,579,517 which is a file wrapper continuation of U.S. patent application Ser. No. 08/041,497, filed Apr. 1, 1993, now abandoned.

TECHNICAL FIELD

The present invention relates generally to data processing systems and, more particularly, to a common name space for long and short filenames.

BACKGROUND OF THE INVENTION

Many operating systems, such as the MS-DOS, version 5, operating system, sold by Microsoft Corporation of Redmond, Wash., support only short filenames. In the MS-DOS, version 5, operating system, filenames may be a maximum length of eleven characters. Each filename may have a main portion of eight characters followed by an extension of three characters. An example filename in the MS-DOS, version 5, operating system is "EXAMPLE.EXE", wherein "EXAMPLE1" constitutes the main portion and "EXE" constitutes the extension.

Each filename is limited to eleven characters due to constraints in the file system of the MS-DOS, version 5, operating system. This file system employs a directory structure in which each file has a directory entry associated with it. Unfortunately, the directory entry for a file only supports filenames with a maximum length of eleven characters. Such a limit in the length of the filenames is often frustrating to a user. The length limit of eleven characters prevents a user from employing adequately descriptive filenames and, in many instances, forces a user to insert awkward abbreviations of descriptive terms into the filename.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a system that supports long filenames.

It is another object of the present invention to provide a system that supports long filenames while minimizing the compatibility impact of supporting long filenames.

It is a further object of the present invention to provide a system that supports a common name space for both long filenames and short filenames.

In accordance with the first aspect of the present invention, a method is practiced in a data processing system having a memory means and a processing means. In accordance with this method, a first directory entry is created and stored in the memory means for a file. The first directory entry holds a first filename for the file and information about the file. A second directory entry is also created and stored in the memory means. The second directory entry holds at least one portion of a second filename having a fixed number of characters and information about the file. One of the first or second directory entries is accessed in the memory means to gain access to the information contained therein.

In accordance with another aspect of the present invention, a data processing system includes a memory that holds a first directory entry for a file, a second directory entry for the file, and an operating system. The first directory entry includes a first filename for the file and the second directory entry includes the second filename for the file. The

second filename includes more characters than the short filename. The data processing system also includes a processor for running the operating system and accessing either the first directory entry or the second directory entry to locate the file.

In accordance with yet another aspect of the present invention, a method is practiced in a data processing system having memory. In accordance with this method, a file is created and the file is assigned a user-specified long filename. The long filename is manipulated with the data processing system to create a short filename of fewer characters. The long filename and the short filename are stored in memory so that the file can be accessed by either the long filename or the short filename.

In accordance with a further aspect of the present invention, a method is practiced in which a first directory entry for a file is stored in a memory means. The first directory entry holds the short filename for the file. The short filename includes at most a maximum number of characters that is permissible by an application program. A second directory entry is also stored in the memory means for the file. A second directory entry holds at least the first portion of a long filename for the file. The long filename includes a greater number of characters than the maximum number of characters that is permissible by the application program. The application program is run on a processor of the data processing system. The application program identifies the file by the short filename.

In accordance with a still further aspect of the present invention, a method is practiced in which a first directory entry is stored in the memory means for a file. The first directory entry holds a short filename for the file that includes at most the maximum number of characters that is permissible by the operating system. A second directory entry is stored in the memory means for the file. The second directory entry holds a long filename for the file that includes more than the maximum number of characters that is permissible by the operating system. In this instance, the operating system does not use long filenames; rather, it uses solely short filenames. The first directory entry is accessed by the operating system to locate the file.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the present invention will now be described herein with reference to the Drawings. The Drawings include the following Figures.

FIG. 1 is a block diagram of a data processing system used for implementing the preferred embodiment of the present invention.

FIG. 2 is a block diagram illustrating the storage of short filename directories in locations adjacent to long filename directory entries.

FIG. 3a shows the format of a short filename directory entry in the preferred embodiment of the present invention.

FIG. 3b shows the format of a long filename directory entry in the preferred embodiment of the present invention.

FIG. 4 is a flow chart illustrating the steps performed by the preferred embodiment of the present invention when a new file is created.

FIG. 5a is a flow chart illustrating the steps performed in creating a long filename directory entry in the preferred embodiment of the present invention.

FIG. 5b is a block diagram illustrating bits in the file attributes fields of the long filename directory entry of FIG. 3b.

FIG. 6a is a flow chart illustrating the steps performed when a short filename is provided by the user in the preferred embodiment of the present invention.

FIG. 6b is a flow chart illustrating the steps performed when a long filename is provided by user in the preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

A preferred embodiment of the present invention described herein provides support for the use of long filenames (i.e., filenames that may have substantially more characters than current operating systems, such as the MS-DOS, version 5, operating system permit). "Short filenames" will be used hereinafter to refer to filenames that have a small limit (such as 11 characters) as to the maximum number of characters permitted. In the preferred embodiment, the long filenames are provided in a common name space with the short filenames. A long filename and a short filename are provided for each file in the system. The sharing of a common name space is realized through providing separate directory entries for long filenames and short filenames. Each file has a short filename directory entry associated with it and may also have at least one long filename directory entry. The short filenames are like those provided previously in the MS-DOS, version 5, operating system. The long filenames, as will be described in more detail below, may have a maximum length of up to 255 characters. The preferred embodiment will be described with reference to an implementation with the MS-DOS, version 5, operating system.

The potential compatibility problems of supporting long filenames are apparent by considering one solution to the problem of short filenames. This solution is not part of the present invention and is described herein merely to illustrate how a preferred embodiment avoids the compatibility problems suffered by this proposed solution. This solution supports long filenames by merely increasing the number of characters the operating system permits for a filename.

There are two major difficulties with this solution. First, the existing application bases of many systems use only short filenames (e.g., 11 characters or less) and are not prepared to utilize only long filenames (e.g., up to 255 characters). As an example, an application may allocate a buffer large enough to hold the short filename and if the operating system tries to place long filename data into this buffer, the buffer may overflow so as to cause the application data to be unexpectedly overwritten. Second, certain disk utility programs access the file system volume directly and, thus, do not rely on the operating system to access the files. If the file system is changed to support long filenames, compatibility problems with the disk utility programs arise.

The preferred embodiment of the present invention described herein, in contrast, seeks to minimize the compatibility impact of supporting long filenames by providing both a long filename and a short filename for each file. As a result, applications and utilities that require short filenames still have short filenames available, and applications that use long filenames have long filenames available.

The preferred embodiment of the present invention may be implemented as code realized as software or firmware. In order to support long filenames, the preferred embodiment of the present invention provides several long filename application program interfaces (APIs). These APIs are provided along with the conventional short filename interfaces that are standard with the operating system. The long

filename APIs support file operations and directory entries for long filenames. The APIs include a file attributes function, a file delete function, a file directory function, a file find function, a file open/create function and a file rename function.

The preferred embodiment of the present invention may be implemented in a data processing system 10 like that shown in FIG. 1. This data processing system 10 includes a central processing unit (CPU) 12 with a standard set of registers 13 that includes an accumulator (AL) register 15, a memory 16 and input/output (I/O) devices 14. The CPU 12 oversees the operations of the data processing system 10 and has access to the memory 16 and the I/O devices 14. The memory 16 may include both RAM and disc storage. The memory 16 holds an operating system 17 (denoted as "O.S." in FIG. 1) which includes the long and short filename APIs. Those skilled in the art will appreciate that the present invention may be implemented on other suitable data processing systems.

All of the functions for the long filename APIs and short filename APIs are incorporated into the operating system 17. Those functions are supported through an Int 21h interrupt call (where 21h denotes 21 in hexadecimal notation). In other words, all the functions are called by executing an Int 21h interrupt, wherein the function that is called through the Int 21h interrupt is specified by a value placed in a register, as will be described in more detail below. The Int 21h interface is like that provided in the MS-DOS, version 5, operating system except that the interface also supports calls to functions for long filenames. In calls to the long filename APIs, the function number to be called is placed in the AL register 15 of a processor, such as the CPU 12 in FIG. 1 before the interrupt is initiated.

In order to support both a long filename and a short filename for each file, the preferred embodiment provides a short filename directory entry 18 (FIG. 2) and may provide at least one long filename directory entry 20 for each file in a common name space. Each file has a long filename and a short filename associated with it. A long filename directory entry 20 is only created when the long filename cannot be correctly stored in the short filename directory entry. The long filename directory entries 20 are stored adjacent to the corresponding short filename directory entry 18 as part of the common name space used in memory 16. Moreover, the long filename directory entries 20 are configured to minimize compatibility problems with operating systems that support only short filenames.

FIG. 2 shows an example of the directory entries 18 and 20 for a file in the preferred embodiment described herein. The short filename directory entry 18 is provided along with several long filename directory entries 20. The number of long filename directory entries 20 provided (including zero long filename directory entries) for a file depends upon the number and type of characters in the long filename. As will be described in more detail below, each long filename directory entry 20 may hold up to 26 characters of a long filename. The long filename directory entries 20 are dynamically allocated based upon the number of characters in the long filename. For example, a file with a long filename of 50 characters has two long filename directory entries 20 allocated for it, whereas a file with a long filename of 70 characters has three long filename directory entries 20 allocated for it. As was mentioned above, a long filename may have a maximum of 255 characters and thus, a maximum of 10 long filename directory entries 20 may be allocated for any file. The maximum of 255 characters per filename is a product of maximum path length (260 characters) limitations of the operating system 17.

There may be many instances in which the long filename does not completely fill all of the space available in the allocated long filename directory entries **20**. In such an instance, a null terminator is placed after the last character of the long filename so that additional spaces or nonsensical data will not be returned. The extra spaces are filled with **0FFh** (where "h" indicates the use of hexadecimal notation).

FIG. 3a illustrates the format of the short filename directory entry **18**. Each of the fields in the directory entry begins at a different offset relative to the starting address of the directory entry. A filename field **22** holds the main portion (i.e., the leading 8 characters) of the short filename. As the main portion of the short filename may hold up to eight characters of the short filename, the filename field **22** is eight bytes in length and begins at offset **00h**. The filename field **22** is followed by a file extension field **24** at offset **08h**. The file extension field holds the characters of the extension of the short filename. The extension field **24** is three bytes in length (encoding three characters).

Following the extension field **24** at offset **0Bh** is a file attributes field **26**. The file attributes field **26** includes a number of bits that, based upon whether the bits are set or not, specify information about the associated file.

The short filename directory entry **18** also includes a reserved field **28**. The reserved field **28** begins at offset **0Ch** and is ten bytes in length. The short filename directory entry **18** additionally includes a time of last update field **30** and a date of last update field **32**. The time of last update field **30** is two bytes in length and begins at offset **16h**. The date of last update field **32** is two bytes in length and begins at offset **18h**.

The short filename directory entry **18** includes a beginning disk cluster field **34**. The beginning disk cluster field **34** holds a pointer to the section of the memory **16** (FIG. 1) where the file's first disk cluster is held (i.e. to the beginning of the allocation chain for the file). This beginning disk cluster field **34** (FIG. 3a) is stored at offset **1Ah** and is two bytes in length. A file size field **36** follows the beginning disk cluster field **34**. The file size field **36** holds a value that specifies the amount of memory occupied by the file associated with the short filename directory entry **18**. The file size field **36** is four bytes in length and begins at offset **1Ch**.

FIG. 3b illustrates the format used for each of the long filename directory entries **20**. The long filename directory entry **20** additionally includes a signature field **38** that holds a digital signature. The signature field **38** is useful in specifying the order of a long filename directory entry **20** in a sequence of associated long filename directory entries. For example, a first long filename directory entry includes a signature field **38** that specifies that it is the first entry, and each successive long filename directory entry includes a signature field **38** that specifies where the long filename directory entry fits in the sequence of long filename directory entries for a file. The signature field **38** is provided primarily for use with utility programs that directly access the file system volume. The signature field **38** is one byte in length and begins at offset **00h**, which is the beginning of the filename field **22** (FIG. 3a) of the short filename directory entry **18**. The signature field **38**, given its location in the long filename directory entry, might easily be mistaken for a portion of a short filename by certain utility programs. Hence, the signature field **38** includes only illegal short filename characters so that the characters may not be readily changed by systems or utilities that support only short filenames.

The long filename directory entry **20** includes three fields **40**, **48** and **52** that are provided for holding characters of the

long filename. The first long filename field **40** begins at offset **01h** and may hold up to ten characters of the long filename (i.e., it is 10 bytes in length). The second long filename field **48** begins at offset **0Eh** and may hold up to twelve characters (i.e., 12 bytes) of the long filename. Lastly, the third long filename field **52** begins at offset **1Ch** and may hold up to four characters (i.e., 4 bytes) of the long filename. Thus, cumulatively, these three fields **40**, **48** and **52** may hold up to twenty-six characters of the long filename. The long filename fields **40**, **48** and **52** are filled sequentially beginning with field **40** and then filling fields **48** and **52**, consecutively.

While the long filename directory entry **20** differs from the short filename directory entry **18**, the long filename directory entry **20**, nevertheless, includes certain similar fields at the same specified offsets as were discussed above for the short filename directory entry **18** (FIG. 3a). As such, operating systems that do not support long filenames are not disturbed by the long filename directory entries **20**. For instance, the long filename directory entry **20** includes a file attributes field **42** which is like the file attributes field **26** (see FIG. 3a) provided in the short filename directory entry.

The long filename directory entry **20** contains a checksum field **44**, which is one byte in length and at offset **0Dh**. The checksum field **44** holds a checksum of the short filename. The checksum byte, as will be described in more detail below, is used to ensure that the long name is valid for the associated short filename and to act as a pointer to the short filename directory entry **18** that is helpful to disk utility programs. A flags field **43** is held at offset **0Ch**. The flags field **43** holds a flag bit that may be set when unicode characters are used. In addition, the beginning disk cluster field **50** (FIG. 3b) of the long filename directory entry **20** is analogous to the beginning disk cluster field **34** (FIG. 3a) of the short filename directory entry **18**. However, it always has a constant value of zero in the long filename directory entry.

The above discussion has focused on how the directory entries **18** and **20** (FIG. 2) are used to support both long filenames and short filenames. The discussion below will focus on how such directory entries are supported by the preferred embodiment of the present invention.

When a new file is created, the preferred embodiment must take steps to support both a long filename and a short filename for the new file. In discussing how the preferred embodiment supports both long filenames and short filenames, it is helpful to first focus on the creation of the directory entries and then to focus on the creation of the filenames. FIG. 4 is a flowchart depicting the basic steps performed upon creation of the new file. Initially, the new file is created (step **54**) using either a long filename API or a short filename API. Both varieties of APIs support the creation of files. Depending on the type of API that is used to create the files, the file will initially have a long filename and/or a short filename. In other words, if a file is created with a long filename API, it will initially have a long filename and if a file is created with a short filename API, it will initially have a short filename, which may also be the long filename for the file.

At least one long filename directory entry **20** may be created for the file. First, a determination is made whether a long filename directory entry **20** is required (step **51**). If the long filename will not correctly fit in the short filename directory entry **18**, a long filename directory entry **20** is required. Long filename directory entries **20** are dynamically allocated based upon the number of characters in the long filename. At a minimum, a short filename directory entry **18**

will be created that has the format that is shown in FIG. 3a. Thus, the system checks to see how many long filename directory entries are needed and allocates space for the short filename directory entry and as many additional long filename directory entries as are required (step 58). It should be appreciated that when both a short filename directory entry 18 and at least one long filename directory entry 20 are created, space for both types of directory entries are allocated together at the same time. The long and short filename directory entries 18 and 20 are then filled in step 59. However, if no long filename directory entry is required, no space will be allocated (i.e., steps 58 and 59 are skipped).

FIG. 5a is a flowchart depicting the steps performed in filling in a long filename directory entry 20 (see step 59 in FIG. 4). The steps are shown in a given sequence, but those skilled in the art will appreciate that the steps need not be performed in this illustrated sequence. Rather, other sequences are equally acceptable.

A hidden bit in the file attributes field 42 is set to have a value of one (step 62). FIG. 5b shows the bits included in the file attributes field 42. The hidden bit is designated by the letter "H" in FIG. 5b and is present at bit position 1 in the file attributes field 42. When the hidden bit is set to a value of one, the directory entry is hidden and is excluded from normal searches of the directory entries 18 and 20. By setting the hidden bit, the long filename directory entries 20 (FIG. 2) are not searched in conventional directory entry searches. The hidden bit is set so that down level systems (i.e., systems that support only short filenames) will not see the long filename directory entries 20.

A read-only bit is also set in the file attributes field (step 64 in FIG. 5a). The read-only bit is designated by the letter "R" in FIG. 5b and is present at bit position 0 in the file attributes field 42. Setting the read-only bit to a value of one indicates that the file is a read-only file and any attempts to write to the file will fail.

A system bit in the file attributes field 42 is set to a value of one (step 66 in FIG. 5a). The system bit is designated by the letter "S" in FIG. 5b and is present at bit position 2 in the file attributes field 42. Setting the system bit to a value of one designates the file as a system file and excludes the directory entry from normal searches of the directory entries 18 and 20. The setting of the system bit to a value of one hides the long filename directory entries 20 from down level operating systems that support only short filenames.

Next, a volume label bit is set in the file attributes field 42 (step 68 in FIG. 5a). The volume label bit is designated by the letter "V" in FIG. 5b and is present at bit position 3 in the file attributes field 42. Setting the volume label bit to a value of one hides the long filename directory entry from "Check Disk" operations of certain disk utility programs. For example, MS-DOS, version 5.0, includes a utility named CHKDSK. The setting of the volume label attribute hides the long filename directory entries from CHKDSK.

The discussion will now return again to the flowchart of FIG. 5a. The signature byte field 38 (FIG. 3b) is filled with a digital signature (step 70 in FIG. 5a). As was mentioned above, the signature distinguishes the order of the long filename directory entries 20 for the file. The checksum field 44 in FIG. 3b is filled with the appropriate checksum of the short filename (step 72 in FIG. 5a). The checksum byte field 44 (FIG. 3b) is used to associate the long filename directory entries 20 with their appropriate short filename by holding a checksum of the short filename. The beginning disk cluster field 50 (FIG. 3b) is set to zero (step 74 in FIG. 5a). The long filename directory entry 20, thus, has no data allocated to it.

This helps to make the long filename directory entry invisible in down level systems. Lastly, the bits for the characters of the long filename are stored in the appropriate long filename fields 40, 48 and 52 (FIG. 3b) of the long filename directory entry 20 (step 76 in FIG. 5a).

By setting the file attributes field 42 (FIG. 5b) bits as described above and by setting the beginning disk cluster field 50 to zero (FIG. 3b), the preferred embodiment of the present invention makes the long filename directory entries nearly invisible to operating systems that support only short filenames (i.e., down level systems). Nevertheless, files with long filenames are still permitted in down level operating systems. The long filename directory entries are not visible in the directory entry listing for down level systems. The combination of bit settings in the file attributes field and the zeroing of the beginning disk cluster field 50 make the long filename directory entries invisible to down level systems. Thus, compatibility problems arising from having long filenames in the down level operating system are minimized. Moreover, utility programs, that may skew the order of directory entries, are not a problem. The signature field 40 (FIG. 3b) and the checksum field 44 may be used in conjunction to rearrange entries that are out of order. In particular, the checksum fields 44 are used to associate long filename directory entries 20 with a short filename directory entry and the signature fields 40 of the long filename directory entries are used to assign related long filename directory entries into proper sequence.

The discussion above has noted that filenames are created using either short filename APIs or long filename APIs. As a result, when a file is created it has either a long filename or short filename assigned to it by the user, depending on whether a long filename API or short filename API is used. The preferred embodiment of the present invention described herein automatically creates the missing short filename or long filename. For instance, if a file is created using a short filename API, the preferred embodiment described herein establishes a corresponding long filename (which is the same as the short filename). Analogously, if a file is created using a long filename API, the preferred embodiment generates a corresponding short filename that is stored in a short filename directory entry 18. FIG. 6a shows the steps performed by the preferred embodiment when the short filename is provided by the user. In particular, the user provides a short filename (step 78 in FIG. 6a), and the short filename is used as the long filename (step 80). When the user provides a short filename, the system checks whether the name is a valid short filename and whether there are any existing files that pose a conflict (not shown). If there is no problem in terms of format or conflict, the file is assigned the provided short filename. The short filename is then used as the long filename, and there is no long filename directory entry 20 for the file.

When a file is created using a long filename API, the resulting creation of a corresponding short filename may be quite complex. FIG. 6b is a flowchart illustrating the steps performed to create the short filename in such an instance. Initially, the long filename is provided by the user (step 82 in FIG. 6b). The preferred embodiment then checks whether the long filename is a valid short filename (step 84). If the long filename is a valid short filename, the long filename is used as the short filename (step 86).

However, if the long filename does not qualify as a valid short filename, a short filename is created by removing the spaces from the long filename and using the resulting characters as a proposed short filename (step 88). Initial periods, trailing periods and extra periods that are prior to

the last embedded period are then removed from the proposed short filename (step 90). Furthermore, any illegal short filename character is translated into an underscore (step 92). A check of whether the proposed short filename contains an extension is then performed (step 94). If the proposed short filename contains an extension, the leading main portion of the filename is truncated to six characters in length, and the leading three characters of the extension are used (step 96). Subsequently, a "~1" is appended to the leading portion of the remaining characters (step 98) to serve as the short filename.

If the modified long filename does not contain an extension (step 94), the long filename is truncated to six characters (step 100), and "~1" is appended to the truncated filename (step 102) to serve as the short filename. In both of the above-described instances (i.e., the "yes" instance and "no" instance of step 94), the preferred embodiment next checks whether the proposed short filename collides with any other short filename (step 104). If the proposed short filename does not collide with another short filename (i.e., there is no other identical short filename), the proposed short filename is assigned as the short filename for the file (step 112). In the case where the proposed short filename collides with another short filename, the characters that are appended to the name are incremented by one (step 106). Thus, if the number value is initially "~1", the number value is incremented in step 106 by one to "~2". The preferred embodiment checks whether the new proposed short filename exceeds eight characters in length (step 108). If the new proposed short filename does not exceed eight characters in length, the checking of whether the proposed short filename collides with another short filename is repeated (step 104). When the number of characters in the filename exceeds eight characters in length, the new short filename is shortened to eight characters (step 110). In particular, if the length of the leading portion of the filename (ignoring the extension) plus the tilde and the number exceeds eight characters, the leading portion of the filename is shortened until the new proposed short filename (absent the extension) fits in eight characters. For example, the filename "MonKey~10.EXE" is shortened to "MonKe~10.EXE." The above-described steps 104, 106, 108 and 110 are repeated until a short filename is created for the file that is of proper length and that does not collide with another short filename.

The preferred embodiment of the present invention provides a solution to the problem of short filenames while minimizing the compatibility impact of the solution. The use of a common name space that provides a long filename and a short filename for each file allows the files to be used both with applications that support short filenames and applications that support long filenames.

While the present invention has been described with reference to a preferred embodiment thereof, those skilled in the art will appreciate that various changes in scope and form may be made without departing from the present invention as defined in the appended claims.

We claim:

1. In a computer system having a storage, a directory service for accessing directory entries and a file system that uses the directory entries to access files, a method, comprising the computer-implemented steps of:

- (a) creating a first directory entry for a file wherein the first directory holds a short filename for the file and the location of the file;
- (b) creating a second directory entry for the file wherein the second directory entry holds at least one portion of

a long filename having a fixed number of characters and a signature that identifies that the second directory entry holds a first portion of the long filename;

- (c) storing the first directory entry and the second directory entry on the storage among the directory entries used by the directory service; (d) accessing the second directory entry by the directory service to access the file; and (e) creating and storing in the storage a sequence of at least one additional directory entry for holding a next sequential portion of the long filename.

2. The method as recited in claim 1 wherein the long filename contains more characters than the short filename.

3. The method as recited in claim 1 wherein each additional directory entry may hold only a fixed number of characters of the long filename and how many additional directory entries are created is dictated by how many additional directory entries are required to store characters of the long filename which are not already stored in the second directory entry.

4. The method as recited in claim 1 wherein the step of creating at least one additional directory entry for the long filename further comprises the step of creating a plurality of additional directory entries.

5. The method as recited in claim 1 wherein the step of creating at least one additional directory entry for the long filename further comprises the step of providing a signature in each additional directory entry that identifies which portion of the long filename the additional directory entry holds.

6. The method as recited in claim 1 wherein the step of creating at least one additional directory entry for the long filename further comprises the step of providing a checksum of the first filename in each additional directory entry.

7. In a data processing system having a processor running an operating system and a memory means having memory locations wherein the operating system is stored in the memory means, a method, comprising the steps of:

- (a) storing in a first of the memory locations of the memory means a first directory entry for a file wherein the first directory entry holds a short filename for the file, said short filename including at most a maximum number of characters that is permissible by an application program;

- (b) storing in a second of the memory locations of the memory means that is adjacent to the first of the memory locations a second directory entry for the file wherein the second directory entry holds at least a first portion of a long filename for the file, said long filename including a greater number of characters than the maximum number of characters that is permissible by the application program, and

- (c) accessing one of the directory entries to locate the file.

8. The method as recited in claim 7 wherein the step of storing the second directory further comprises the step of storing a checksum of the short filename in the second directory entry.

9. The method as recited in claim 7, further comprising the step of storing at least one additional directory entry holding a next portion of the long filename in the memory means.

10. The method as recited in claim 9 wherein the step of storing at least one additional directory entry further comprises the step of storing a checksum of the short filename in the additional directory entry.

11. The method as recited in claim 9 wherein the step of storing at least one additional directory entry further comprises the step of storing a signature that uniquely identifies

which portion of the long filename is stored in the additional directory entry.

12. In a computer system having a storage, a directory service for accessing directory entries and a file system that uses the directory entries to access files, a computer-readable medium holding computer-executable instructions for performing a method comprising computer-implemented steps of:

- (a) creating a first directory entry for a file wherein the first directory holds a short filename for the file and the location of the file;
- (b) creating a second directory entry for the file wherein the second directory entry holds at least one portion of a long filename having a fixed number of characters;
- (c) storing the first directory entry and the second directory entry on the storage among the directory entries used by the directory service; and
- (d) accessing the second directory entry by the directory service to access the file.

13. The computer-readable medium of claim 12 wherein the long filename contains more characters than the short filename.

14. The computer-readable medium of claim 12 also holding computer-executable instructions for creating and storing in the storage a sequence of at least one additional directory entry for holding a next sequential portion of the long filename.

15. The computer-readable medium of claim 14 wherein each additional directory entry may hold only a fixed number of characters of the long filename and how many additional directory entries are created is dictated by how many additional directory entries are required to store characters of the long filename which are not already stored in the second directory entry.

16. The computer-readable medium of claim 14 wherein the step of creating at least one additional directory entry for the long filename further comprises the step of creating a plurality of additional directory entries.

17. The computer-readable medium of claim 14 wherein the step of creating the second directory entry further comprises the step of providing a signature in the second directory entry that identifies that the second directory entry holds the first portion of the long file name.

18. The computer-readable medium of claim 17 wherein the step of creating at least one additional directory entry for the long filename further comprises the step of providing a signature in each additional directory entry that identifies which portion of the long filename the additional directory entry holds.

19. The computer-readable medium of claim 14 wherein the step of creating at least one additional directory entry for the long filename further comprises the step of providing a checksum of the first filename in each additional directory entry.

20. In a data processing system having a processor running an operating system and a memory means with memory locations, wherein said memory means stores the operating system, a computer-readable medium holding computer-executable instructions for performing a method comprising the steps of:

- (a) storing in a first of the memory locations of the memory means a first directory entry for a file wherein the first directory entry holds a short filename for the file, said short filename including at most a maximum number of characters that is permissible by an application program;

- (b) storing in a second of the memory locations of the memory means that is adjacent to the first of the memory locations a second directory entry for the file wherein the second directory entry holds at least a first portion of a long filename for the file, said long filename including a greater number of characters than the maximum number of characters that is permissible by the application program; and

- (c) accessing one of the directory entries to locate the file.

21. The computer-readable medium of claim 20 wherein a checksum of the short filename is stored in the second directory entry.

22. The computer-readable medium of claim 20 wherein at least one additional directory entry is stored to hold a next portion of the long filename in the memory means.

23. The computer-readable medium of claim 22 wherein a signature is stored in the additional directory entry that uniquely identifies which portion of the long filename is stored in the additional directory entry.

24. In a computer system having a directory service for accessing directory entries and a file system that uses the directory entries to access files, a method comprising the computer-implemented steps of:

- (a) creating a first directory entry for a file wherein the first directory entry holds a short filename for the file and the location of the file.

- (b) creating a second directory entry for a file wherein the second directory entry is configured to appear as if it holds a short filename to a program that uses only short filenames and wherein the second directory entry holds at least one portion of a long filename for the file, said long filename having more characters than the short filename; and

- (c) accessing one of the first directory entries and the second directory entry by the directory service in order to access the file.

25. The method of claim 24 wherein the program that uses only short filenames is an operating system.

26. The method of claim 24 wherein the program that uses only short filenames is an application program.

27. The method of claim 24 wherein the storage includes storage locations and wherein the first directory entry and the second directory entry are stored in adjacent storage locations.

28. In a computer system having a directory device for accessing directory entries and a file system that uses the directory entries to access files, a computer-readable medium holding computer-executable instructions for executing a method comprising the computer-implemented steps of:

- (a) creating a first directory entry for a file wherein the first directory entry holds a short filename for the file and the location of the file;

- (b) creating a second directory entry for a file wherein the second directory entry is configured to appear as if it holds a short filename to a program that uses only short filenames and wherein the second directory entry holds at least one portion of a long filename for the file, said long filename having more characters than the short filename; and

- (c) accessing one of the first directory entries and the second directory entry by the directory service in order to access the file.

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 5,758,352
 DATED : May 26, 1998
 INVENTOR(S) : A.R. Reynolds et al.

Page 1 of 2

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

<u>TITLE PAGE, ITEM</u>	<u>LINE</u>	
[56]	Refs. Cited (Other Pubs., Item 4)	"sharing" should read --Sharing--
[56]	Refs. Cited (Other Pubs., Item 5)	"1988" should read --1989--
[56]	Refs. Cited (Other Pubs., Item 8)	after "Duncan" insert --,--
<u>COLUMN</u>		
10 (Claim 1, line 15)	6	after "service;" insert paragraph return
10 (Claim 1, line 17)	8	after "file; and" insert paragraph return
10 (Claim 7, line 18)	51	"program," should read --program;--
11 (Claim 12, line 6)	8	"implementented" should read --implemented--
11 (Claim 12, line 7)	9	"directry" should read --directory--
11 (Claim 12, line 14)	16	"storag" should read --storage--
11 (Claim 17, line 5)	43	"file name" should read --filename--

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Page 2 of 2

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<u>COLUMN</u>	<u>LINE</u>	
12 (Claim 23, line 1)	16	"claim" should read --claim--
12 (Claim 24, line 7)	27	"," should read --;--
12 (Claim 24, line 13)	33	"then" should read --than--
12 (Claim 27, line 1)	42	"claim" should read --claim--
12 (Claim 28, line 15)	60	"then" should read --than--

Signed and Sealed this

Twenty-ninth Day of September, 1998

Attest:



BRUCE LEHMAN

Attesting Officer

Commissioner of Patents and Trademarks



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(12) **EX PARTE REEXAMINATION CERTIFICATE (5551st)**

United States Patent
Reynolds et al.

(10) **Number:** **US 5,758,352 C1**
(45) **Certificate Issued:** ***Oct. 10, 2006**

(54) **COMMON NAME SPACE FOR LONG AND SHORT FILENAMES**

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(*) Notice: This patent is subject to a terminal disclaimer.

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Certificate of Correction issued Sep. 29, 1998.

Related U.S. Application Data

(Continued)

(63) Continuation of application No. 08/427,004, filed on Apr. 24, 1995, now Pat. No. 5,579,517, which is a continuation of application No. 08/041,497, filed on Apr. 1, 1993, now abandoned.

Primary Examiner—Luke S Wassum

(57) **ABSTRACT**

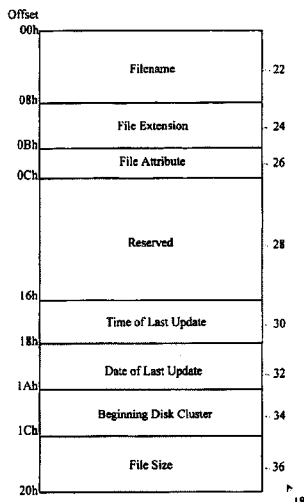
(51) **Int. Cl.**
G06F 12/00 (2006.01)
G06F 17/30 (2006.01)

An operating system provides a common name space for both long filenames and short filenames. In this common namespace, a long filename and a short filename are provided for each file. Each file has a short filename directory entry and may have at least one long filename directory entry associated with it. The number of long filename directory entries that are associated with a file depends on the number of characters in the long filename of the file. The long filename directory entries are configured to minimize compatibility problems with existing installed program bases.

(52) **U.S. Cl.** **707/200; 707/1; 707/6**

(58) **Field of Classification Search** **707/1, 707/6, 200**

See application file for complete search history.



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**EX PARTE
REEXAMINATION CERTIFICATE
ISSUED UNDER 35 U.S.C. 307**

THE PATENT IS HEREBY AMENDED AS
INDICATED BELOW.

Matter enclosed in heavy brackets [] appeared in the patent, but has been deleted and is no longer a part of the patent; matter printed in italics indicates additions made to the patent.

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

The patentability of claims 24–28 is confirmed.

Claims 9, 14 and 22 are cancelled.

Claims 1, 7, 8, 10–12, 15–17, 19–21 and 23 are determined to be patentable as amended.

Claims 2–6, 13 and 18, dependent on an amended claim, are determined to be patentable.

New claims 29–44 are added and determined to be patentable.

1. In a computer system having a storage, a directory service for accessing directory entries and a file system that uses the directory entries to access files, a method, comprising the computer-implemented steps of:

- (a) creating a first directory entry for a file wherein the first directory *entry* holds a short filename for the file and the location of the file;
- (b) creating a second directory entry for the file wherein the second directory entry holds at least one portion of a long filename having a fixed number of characters and a signature that identifies that the second directory entry holds a first portion of the long filename;
- (c) storing the first directory entry and the second directory entry on the storage among the directory entries used by the directory service;
- (d) accessing the second directory entry by the directory service to access the file; and
- (e) creating and storing in the storage a sequence of at least one additional directory entry for holding a next sequential portion of the long filename.

7. In a data processing system having a processor running an operating system and a memory means having memory locations wherein the operating system is stored in the memory means, a method, comprising the steps of:

- (a) storing in a first of the memory locations of the memory means a first directory entry for a file wherein the first directory entry holds a short filename for the file, said short filename including at most a maximum number of characters that is permissible by an application program;
- (b) storing in a second of the memory locations of the memory means that is adjacent to the first of the memory locations a second directory entry for the file wherein the second directory entry holds at least a first portion of a long filename for the file, said long filename including a greater number of characters than the maximum number of characters that is permissible by the application program;

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(c) storing at least one additional directory entry holding a next portion of the long filename in the memory means; and

[(c)] (d) accessing one of the directory entries to locate the file.

8. The method as recited in claim 7 wherein the step of storing the second directory *entry* further comprises the step of storing a checksum of the short filename in the second directory entry.

10. The method as recited in claim [9] 7 wherein the step of storing at least one additional directory entry further comprises the step of storing a checksum of the short filename in the additional directory entry.

11. The method as recited in claim [9] wherein the step of storing at least one additional directory entry further comprises the step of] 7 further comprising storing a signature in each of the second directory entry and the at least one additional directory entry that uniquely identifies which portion of the long filename is stored in [the additional] that directory entry.

12. In a computer system having a storage, a directory service for accessing directory entries and a file system that uses the directory entries to access files, a computer-readable medium holding computer-executable instructions for performing a method comprising computer-implemented steps of:

(a) creating a first directory entry for a file wherein the first directory holds a short filename for the file and the location of the file;

(b) creating a second directory entry for the file wherein the second directory entry holds at least one portion of a long filename having a fixed number of characters;

(c) creating a sequence of at least one additional directory entry for holding a next sequential portion of the long filename;

[(c)] (d) storing the first directory entry [and] the second directory entry and the at least one additional directory entry on the storage among the directory entries used by the directory service; and

(e) accessing the second directory entry and the at least one additional directory entry by the directory service to access the file.

15. The computer-readable medium of claim [14] 12 wherein each additional directory entry may hold only a fixed number of characters of the long filename and how many additional directory entries are created is dictated by how many additional directory entries are required to store characters of the long filename which are not already stored in the second directory entry.

16. The computer-readable medium of claim [14] 12 wherein the step of creating at least one additional directory entry for the long filename further comprises the step of creating a plurality of additional directory entries.

17. The computer-readable medium of claim [14] 12 wherein the step of creating the second directory entry further comprises the step of providing a signature in the second directory entry that identifies that the second directory entry holds the first portion of the long filename.

19. The computer-readable medium of claim [14] 12 wherein the step of creating at least one additional directory entry for the long filename further comprises the step of providing a checksum of the first filename in each additional directory entry.

20. In a data processing system having a processor running an operating system and a memory means with memory locations, wherein said memory means stores the

operating system, a computer-readable medium holding computer-executable instructions for performing a method comprising the steps of:

- (a) storing in a first of the memory locations of the memory means a first directory entry for a file wherein the first directory entry holds a short filename for the file, said short filename including at most a maximum number of characters that is permissible by an application program;
- (b) storing in a second of the memory locations of the memory means that is adjacent to the first of the memory locations a second directory entry for the file wherein the second directory entry holds at least a first portion of a long filename for the file, said long filename including a greater number of characters than the maximum number of characters that is permissible by the application program;
- (c) storing at least one additional directory entry in at least one other of the memory locations that is adjacent to the second of the memory locations of the memory means wherein the at least one additional directory entry holds a next portion of the long filename; and

[(c)] (d) accessing one of the directory entries to locate the file.

21. The computer-readable medium of claim 20 wherein a checksum of the short filename is stored in the second directory entry and the at least one additional directory entry.

23. The computer-readable medium of claim [22] 20 wherein a signature is stored in each of the second directory entry and the at least one additional directory entry [that], each signature uniquely [identifies] identifying which portion of the long filename is stored in [the additional] its respective directory entry.

29. The method as recited in claim 1, wherein the signature is stored at a beginning of the second directory entry and comprises characters that are not permitted to be used as characters of a short filename of a file.

30. The method as recited in claim 5, wherein the signature provided in each additional directory entry is stored at a beginning of that additional directory entry and comprises characters that are not permitted to be used as characters of a short filename of a file.

31. The method as recited in claim 11, wherein the signatures are stored at the beginnings of the second directory entry and the at least one additional directory entry and each signature comprises characters that are not permitted to be used as characters of a short filename of a file.

32. The computer-readable medium as recited in claim 17, wherein the signature provided in the second directory entry is stored at a beginning of the second directory entry and comprises characters that are not permitted to be used as characters of a short filename of a file.

33. The computer-readable medium as recited in claim 18, wherein the signatures provided in each additional directory entry are stored at the beginnings of each addi-

tional directory entry and comprise characters that are not permitted to be used as characters of a short filename of a file.

34. The method as recited in claim 23, wherein the signatures stored in the second directory entry and the at least one additional directory entry are stored at a beginning of each respective directory entry and comprise characters that are not permitted to be used as characters of a short filename of a file.

35. The method as recited in claim 24, wherein the step of creating the second directory entry further comprises the step of storing a checksum of the short filename in the second directory entry.

36. The method as recited in claim 24, further comprising the step of creating at least one additional directory entry holding a next portion of the long filename.

37. The method as recited in claim 36 wherein the step of creating at least one additional directory entry further comprises the step of storing a checksum of the short filename in the at least one additional directory entry.

38. The method as recited in claim 36, further comprising storing a signature in each of the second directory entry and the at least one additional directory entry that uniquely identifies which portion of the long filename is stored in that directory entry.

39. The method as recited in claim 38, wherein the signatures stored in the second directory entry and the at least one additional directory entry are stored at a beginning of each respective directory entry and comprise characters that are not permitted to be used as characters of a short filename of a file.

40. The computer-readable medium as recited in claim 28 wherein the step of creating the second directory further comprises the step of storing a checksum of the short filename in the second directory entry.

41. The computer-readable medium as recited in claim 28, further comprising the step of creating at least one additional directory entry holding a next portion of the long filename.

42. The computer-readable medium as recited in claim 41, wherein the step of creating at least one additional directory entry further comprises the step of storing a checksum of the short filename in the at least one additional directory entry.

43. The computer-readable medium as recited in claim 41, further comprising storing a signature in each of the second directory entry and the at least one additional directory entry that uniquely identifies which portion of the long filename is stored that directory entry.

44. The computer-readable medium as recited in claim 43, wherein the signatures stored in the second directory entry and the at least one additional directory entry are stored at a beginning of each respective directory entry and comprise characters that are not permitted to be used as characters of a short filename of a file.