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Virtual Font Cartridge

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to the field of printers and more specifically to printers capable of printing in more than one font.

5 2. Description of Related Art

Early printers were originally based upon the technology of typewriters. As typewriter technology developed, so too did printer technology. However, these early printers and typewriters were typically limited to a single typeface having fixed attributes including spacing, height, pitch, style, stroke weight, symbol set, and orientation. Special capabilities, such as underlining or bolding, often could only be performed by the printer by backing up and restriking. In more advanced typewriters, the typeface could be changed by physically removing a component, usually a ball or a wheel, that bore every printable character.

Later printers, e.g. laser printers, diverged from typewriter technology. These printers did not have a set typeface, but could print a variety of typefaces having a range of attributes. The computer attached to a printer must be able to communicate to the printer as to how the printer should print. These printer instructions typically identify a "font" which is a set of characters that have similar attributes. A font has an assigned name, typeface, and is described by its format (bitmap or scalable), spacing (fixed or proportional), height, pitch, style (e.g. italic), stroke weight (e.g. bold), symbol set (e.g. English, mathematical), and orientation (e.g. portrait, landscape).

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Typically, when a computer instructs an attached printer to print a document, the computer communicates to the printer which font to use and the information to be printed. In a popular application, the computer communicates, not a font's name, but the desired font's attributes. Next, the printer selects the appropriate font having the desired attributes from those it has available. To make the selection, the printer has a data processor (e.g. microprocessor) that utilizes a set of instructions called printer logic. The data processor also performs other functions, including printer initialization, output synthesis, and error handling.

Fonts are typically available to the data processor from a Font List which is usually a predetermined memory address space in which the fonts are located. The font that will be used by the printer is selected from the Font List by the data processor by finding the best fit based upon the attributes that are sent from the computer. Of course, printing of the document as requested by the computer requires that the printer have the desired font available. Also, more than one font in the Font List may have the desired attributes. However, only one font may be selected at a time. It is the data processor that makes the selection.

Printers generally have fonts available from three sources - resident, downloaded or cartridges. Resident fonts, also known as internal fonts, are fonts which are manufactured into the printer. Typically, resident fonts are stored in read-only memory (ROM). ROMs are well known to those skilled in the art. Downloaded fonts are fonts which are transferred into the printer's user random access memory (RAM) from the host computer. RAM is well known to those skilled in the art. A font cartridge is a removable media containing multiple fonts that, like resident fonts, are typically stored in ROM. When a cartridge is plugged into a slot in a printer, the printer has access to the fonts contained in the cartridge. A

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printer may have more than one slot for cartridges.

5 As discussed, resident fonts typically are stored in
ROM. However, resident fonts may also be stored in the
printer on a hard disk or other non-volatile rewritable
storage device. Generally, when the printer is first
powered on the data processor performs an initialization
routine that includes transferring the resident fonts from
the hard disk to the Font List in memory. In this case,
the resident fonts are transferred to printer RAM at
10 predefined memory addresses.

Previously, printers have often resolved font
selection conflicts by assigning priority to the source
of the fonts. Font selection conflicts arise when more
than one font in the Font List matches the attributes sent
15 by the host computer. Downloaded fonts generally have the
highest priority, next cartridge fonts, last resident
fonts. If there is more than one slot in the printer for
cartridges, the slots are given separate priorities. The
user controls the font selection by providing downloadable
20 fonts and/or installing cartridges into the slots.

Printers typically have initialization procedures.
The printer initializes whenever the power is cycled, or
may initialize in response to a front panel control or
external command. Initialization procedures typically
25 include procedures for recognizing resident and cartridge
fonts. Typically, after power has been cycled or during
printer initialization, downloaded fonts are removed. It
is also possible to selectively delete downloaded fonts
from printer memory through special initialization
30 commands. When resident fonts are stored on a hard disk
in the printer, initialization generally includes loading
of the resident fonts into memory.

Cartridges have many drawbacks. They are generally
expensive. Repeated insertion and removal can deteriorate
35 the electrical connections between a cartridge and its
socket in the printer. Typically, a printer will have
only one or two cartridge slots. This means that there

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is little versatility in the sizes and varieties of fonts that can be used.

Downloadable fonts also have disadvantages. A downloadable font is typically downloaded each time the printer needs it. Downloading a font from a computer to the printer is time consuming. Downloadable fonts occupy substantial computer storage space, and more importantly, substantial printer storage and memory space. If the printer is connected to a computer network, it is desirable that every computer on the network be able to download the desired fonts. Downloadable fonts also can be difficult to update, since every computer must be updated, and each computer may have downloadable fonts in different directories.

Resident fonts also have disadvantages. Resident fonts stored in ROM may only be changed by removing the ROM chips and replacing them. Generally, ROMs are fragile, and removal and replacement may damage the ROMs or the printer. Furthermore, such removal and replacement can be inconvenient, and may require a skilled technician. Even when resident fonts are stored on a hard disk in the printer, updates are difficult to perform.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an improved font loading, storage and selection system for printers, obviating for practical purposes the above-mentioned limitations, particularly in a manner requiring uncomplicated electronic arrangement.

These and other objects and advantages are achieved in a printer which, in accordance with a preferred embodiment of the present invention, has fonts stored internally in a manner similar to that of resident fonts and yet assigned a selection priority as if the fonts were stored in cartridges. As explained in greater detail below, these fonts are stored in "virtual cartridges" which are actually on the hard disk or other memory of the

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printer or computer system.

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BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic block diagram of one embodiment of a printer employing virtual cartridges.

5 Figure 2 is a diagrammatic example of a floppy disk for use with a printer employing virtual cartridges.

Figure 3 is an example of a memory map of a printer.

Figure 4 is an example of a Virtual Cartridge Table in a printer employing virtual cartridges.

10 Figure 5 is an example of a Slot Table in a printer employing virtual cartridges.

Figure 6 is a schematic block diagram of another embodiment of a printer employing virtual cartridges.

DESCRIPTION OF THE PREFERRED EMBODIMENT

15 In accordance with one aspect of the present invention, physical font cartridges are replaced with "virtual font cartridges." As used herein, the term "virtual cartridge" refers to a collection of fonts as normally found on a cartridge, except that herein the
20 fonts are stored in the printer's nonvolatile memory. As explained in greater detail below, once a virtual cartridge is mounted, the virtual cartridge emulates a cartridge.

First Preferred Embodiment

25 Referring now to Figure 1, there is shown a printer 5 which includes a data processor 10 connected to a floppy drive 30, a hard disk 40, a memory 50, a front panel 60, and a print engine 20. The mechanisms of the first
30 illustrated embodiment that permit virtual cartridges to emulate cartridges include the hard disk 40 and floppy drive 30 for storage of the virtual cartridges; a data processor 10 to control the other components, including

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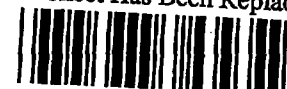
Virtual Cartridge Management Logic for managing the virtual cartridges on the hard disk 40, floppy drive 30, and in memory 50, and Print Management Logic for performing the print operations; the memory 50 to store in a Font List 51 all fonts selected by the user, a Print Buffer for assembling the print data 90 to be delivered to the Print Engine 20, a Virtual Cartridge Table 53 to store a list of the virtual cartridges on the hard disk 40, and a Slot Table 54 to store a list of the mounted virtual cartridges; and a front panel 60 including controls 61 for accepting user input and display 62 for displaying status information and virtual cartridge names.

In the first illustrated embodiment, virtual cartridges are initially loaded from a removable non-volatile data storage device, such as a floppy disk 35 in the appropriate operating system file format, such as MS-DOS format. Of course, other file formats may be used, such as Macintosh, Unix, VMS, etc. The virtual cartridges are then transferred and stored in a non-volatile read-write data storage device such as a hard drive 40. In the first preferred embodiment, virtual cartridges are segregated on the hard disk 40 in a predetermined directory (e.g. "\vfonts" in MS-DOS format as shown in Figure 4).

The data storage device need only support a file system. Therefore, devices such as floppy drives, RAMs, tape drives, CD-ROMs, magneto-optical disks, etc. may also be used. Preferably, the particular embodiment, to identify particular cartridges, relies upon the cartridge's name wherever possible rather than, for example, its location. This permits even greater data storage device independence.

In another embodiment, virtual cartridges are communicated to the printer from an external connection, similarly to downloaded fonts. However, the virtual cartridges would be given priorities as if they were cartridges, as is discussed below. In fact, nearly any

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method for delivering the virtual cartridges may be used, such as magnetic tapes, CD-ROMs, or physical font cartridges.

5 Referring to Figure 2, there is shown a diagrammatic example of a floppy disk 35 for use with a printer employing virtual cartridges. In this example, the floppy disk 35 contains identification (ID) files 36a and 37a, subdirectories 36b and 37b, and fonts files 36c and 37c. The floppy disk 35 can contain more than one virtual
10 cartridge. In this example, the floppy disk 35 contains two virtual cartridges. Each virtual cartridge comprises an ID file (e.g. "COURIER.ID" 36a), and a subdirectory (e.g. "COURIER" 36b), with the fonts being stored in a single file in the subdirectory (e.g. "COURIER.HPF" 36c).

15 In the first preferred embodiment, there is an ID file 36a, 37a on the floppy disk 35 for each virtual cartridge stored thereon. In this example, the eight character MS-DOS file name of the ID file 36a, 37a is the same name as that of the subdirectory 36b, 37b but with the extension
20 "ID". The ID file 36a, 37a contains identification information for the associated virtual cartridge stored in fields. In the first illustrated embodiment, the ID file 36a, 37a contains identification information in the following fields:

25 **FONTS**
 <cartridge name>
 <copyright information>
 <any other useful information, for example, a
 list of the fonts contained in the font file>

30 These fields are syntactically separated.

 In the first preferred embodiment, only the ID field "FONTS" and the <cartridge name> field are used by the printer. The other fields are informational only. The name associated with a virtual cartridge and stored in the
35 <cartridge name> field is used in the first preferred embodiment to select the virtual cartridge from the front panel display 62 for loading to the hard disk 40 or

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transfer to memory 50. This is discussed more fully below.

5 With regards the fonts file 36c, 37c, the name of the fonts file 36c, 37c stored in the subdirectory 36b, 37b is preferably the same as that of the ID file 36a, 37a but with a different extension. The extension indicates the format of the fonts that the fonts file 36c, 37c contains. In the first preferred embodiment, the fonts file 36c, 37c contains all of the fonts of a corresponding cartridge.

10 The virtual cartridge could be embodied as a single file. In such an embodiment, the ID file and fonts file would be combined, and there would be no subdirectory. Such an embodiment would be preferred where a communications line is used instead of a floppy drive for
15 loading virtual cartridges.

Alternatively, the ID file could include a list of the locations or descriptions of font files on the data storage device. In this alternative embodiment, each font file would include a single font. Preferably, all font
20 files for all virtual cartridges would be stored in a single subdirectory. As can be seen, this alternative would allow the virtual cartridges to share font files. This embodiment could provide space savings on the data storage devices - the floppy disk 35 and hard disk 40.

25 The hard disk 40 can store more virtual cartridges than can be accommodated by the Font List 51 and the Print Management Logic in the data processor 10. In the first preferred embodiment, up to three virtual cartridges may be made available to the Print Management Logic at a time.
30 The number of slots for virtual cartridges is based upon the available memory space 50 in the printer 5. The names and locations of the virtual cartridges are stored in the Virtual Cartridge Table 53.

35 The Virtual Cartridge Table 53 is maintained by the Virtual Cartridge Management Logic in the data processor 10. The Virtual Cartridge Table 53 is created in memory 50 when the printer 5 is initialized. As shown in Figure

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4, the Virtual Cartridge Table 53 maintains a list of the virtual cartridges on the hard disk 40. The Virtual Cartridge Table 53 preferably includes two fields for each virtual cartridge on the hard disk 40: "<cartridge name>" 53a and "<path>" 53b. The <cartridge name> field 53a is the same name as that in the ID file. The <path> field 53b is the directory path where the virtual cartridge is located on the hard disk 40.

The mounted virtual cartridges, i.e. the virtual cartridges that have been selected to be made available to the Print Management Logic, are listed in the Slot Table 54. In the example shown in Figure 5, the Slot Table 54 stores the <cartridge name> field 54b from the Virtual Cartridge Table 53 (53a in Figure 4). However, any other reference to virtual cartridges may be used, such as the <path> field 53b of the Virtual Cartridge Table 53. The Slot Table 54 is also maintained by the Virtual Cartridge Management Logic in the data processor 10 and created when the printer 5 is initialized. As shown in Figure 5, the Slot Table 54 maintains a list of which, if any, virtual cartridges have been mounted in each slot. For each virtual cartridge listed in the Slot Table 54, that virtual cartridge's fonts are in the Font List 51. If a slot 54a is empty, that is, if no virtual cartridge has been mounted to that slot, the value in the <cartridge name> field 54b is "NULL" (or some value desired to have that meaning).

The slots 54a in the Slot Table 54 have priority amongst themselves. For example, the fonts in the virtual cartridge mounted in Slot-1 may have the highest priority of the virtual cartridges, and the fonts in a virtual cartridge mounted in Slot-3 the lowest priority.

The Font List 51, Virtual Cartridge Table 53, Slot Table 54 and Print Management Logic are discussed more fully below. The methods of implementing and using tables and lists in memories are well known to those skilled in the art.

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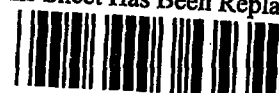
As set forth above and shown in Figure 3, the Font List 51 is a list of the fonts that may be readily accessed by the Print Management Logic of the data processor 10. In the first illustrated embodiment, fonts are accessed using indirect methods well known in the art. That is, the fonts are accessed through address pointers to the memory storage location of the fonts stored in memory 50. However, the Font List 51 may also be implemented using direct memory accessing. Use of pointers is well-known in the art.

As discussed, the Print Management Logic of the data processor 10 accesses fonts from the Font List 51. The Font List 51 holds resident fonts and downloaded fonts as well as virtual cartridge fonts. Resolution of font selection conflicts is performed as is known in the art through the priorities associated with the sources of the fonts, including the slot if applicable. Once a font is loaded from a virtual cartridge on the hard disk 40 to the Font List 51, the emulation of a physical cartridge is complete. In other words, the Print Management Logic of the data processor 10 accesses the virtual cartridge fonts as if they were cartridge fonts. The portion of the Font List 51 that would have comprised ROMs in a cartridge instead comprises RAM in memory 50.

Referring again to Figure 1, the data processor 10 includes Virtual Cartridge Management Logic and Print Management Logic. The Virtual Cartridge Management Logic includes commands for:

1. Loading a virtual cartridge from a floppy disk 35 in the floppy drive 30 to the hard disk 40.
2. Deleting virtual cartridges from the hard disk 40.
3. Initializing and resetting the Font List 51, the Virtual Cartridge Table 53 and the Slot Table 54 in the memory 50.
4. Mounting virtual cartridges.
5. Unmounting virtual cartridges.

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The Print Management Logic includes command for:

1. Selecting a font from the Font List 51 based upon the attributes in the print data 90 sent by the host computer.
- 5 2. Combining print data 90 with the selected font to produce print output.
3. Outputting via the print engine 20.

10 The Front Panel 60 has two parts - controls 61 and display 62. The controls 61 may be any commonly used input controls, such as switches and buttons. Other forms of input controls are well known in the art. The display 62 may be any device for communicating information to the user or external control mechanism. Such displays are also well known in the art. Information to be displayed 15 by the present invention include virtual cartridge names and status information of the components of the printer. The display 62 may display easily identifiable English words, codes, or the like.

20 Embodiments of the present invention may replace or complement the front panel 60 with connections to external input and output mechanisms. For example, user control input and printer display output could be accomplished via the host computer. In that case, the user or a control program running in the host computer would send 25 instructions to the printer, and receive information back to be displayed on the host computer's monitor or utilized by a control program. Control of the printer through the host computer would be communicated via escape sequences, as is known in the art.

30 The print engine 20 may be any of those print engines well known in the art. The memory 50 in the first preferred embodiment is of sufficient size to store the Font List 51, Virtual Cartridge Table 53 and Slot Table 54 while also having sufficient space for the print buffer 35 52.

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Loading a Virtual Cartridge from a Floppy.Disk to the Hard Disk

In the first preferred embodiment, the following process is exemplary of a process used to load a virtual cartridge stored on a floppy disk 35 to the hard disk 40.

5

(1) The floppy disk 35 is inserted into the floppy drive 30.

(2) The user indicates via the front panel controls 61 that a virtual cartridge is to be loaded.

10

(3) In response to (2), the data processor accesses the floppy disk 35 in the floppy drive 30, scanning for ID files.

15

(4) Upon locating an ID file, the data processor 10 causes the cartridge name stored in the ID file to be displayed on the front panel display 62. Depending upon the size of the front panel display 62, one or more virtual cartridge names may be displayed at once.

20

(5) The user selects the virtual cartridge displayed. Of course, the virtual cartridge names can be scrolled until the desired virtual cartridge is located.

25

(6) In response to (5), the data processor 10 accesses the floppy disk 35, and copies the virtual cartridge to the predetermined directory on the hard disk 40. That is, the ID file is copied to the predetermined directory on the hard disk, a subdirectory is also created there, and the fonts file is copied to the new subdirectory.

30

Mounting a Virtual Cartridge

35

In the first preferred embodiment, the following process is exemplary of a process used to mount a virtual cartridge stored on the hard drive 40. Once a virtual cartridge is mounted, the fonts from that virtual cartridge are added to the Font List 51.

(1) The user indicates via the front panel controls

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61 that a virtual cartridge is to be mounted.

(2) The user selects into which slot the virtual cartridge will be mounted. Upon selection of the slot, the name of the virtual cartridge then mounted in the slot, if any, is displayed.

(3) In response to (2), the data processor accesses the Virtual Cartridge Table 53 and displays the cartridge names on the front panel display 62. Depending upon the size of the front panel display 62, one or more virtual cartridge names may be displayed at once.

(4) The user selects a virtual cartridge. Of course, the virtual cartridge names can be scrolled until the desired virtual cartridge is located.

(5) In response to (4), the data processor 10 accesses the hard disk 40, and copies the virtual cartridge fonts into the Font List 51 in the memory 50.

(6) The data processor 10 updates the Slot Table 54 to reflect the mounting of the virtual cartridge in the selected slot.

In an alternative embodiment, the Virtual Cartridge Table 53 may be omitted. In this embodiment, mounting a virtual cartridge would involve accessing the hard disk 40 to scan for ID files. Upon locating an ID file, the data processor 10 would cause the virtual cartridge name stored in the ID file to be displayed. The remaining steps of the procedure would follow as explained.

Initializing the Printer

In the first preferred embodiment, printer initialization includes steps for remounting previously mounted virtual cartridges. As discussed, when a virtual cartridge is mounted, the Virtual Cartridge Management Logic updates the Slot Table 54 to reflect the selection. During initialization, the Virtual Cartridge Management Logic creates the Virtual Cartridge Table 53 and Slot Table 54 and loads the fonts of virtual cartridges

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5 selected as indicated in the Slot Table 54 from the hard disk 40 to the Font List 51. Since turning off or resetting the printer would normally eliminate the Virtual Cartridge Table 53 and Slot Table 54 in memory 50, the values stored in the tables should also be stored in non-volatile memory such as on the hard disk 40. It will be seen by those skilled in the art that the Virtual Cartridge Table 53 and Slot Table 54 may also be implemented in non-volatile memory.

10 Second Preferred Embodiment

15 The configuration of the second preferred embodiment is similar to that of the first preferred embodiment. The major difference is that in the second preferred embodiment, the data storage device is ROM. That is, virtual cartridges are stored in printer ROM, rather than on the hard disk or floppy disk of the first preferred embodiment. In this embodiment, the printer may have a very large number of built-in fonts. Some of these built-in fonts may have identical font selection characteristics and yet be visibly different when utilized. By utilizing virtual font cartridges, otherwise unresolvable ambiguities between two fonts may be resolved.

20 Referring now to Figure 6, there is shown a printer 15 which includes a data processor 10a connected to a ROM 70, a memory 50a, a front panel 60, and a print engine 20. As can be seen, the hard disk 40, floppy disk 35 and floppy drive 30 of Figure 1 are replaced by ROM 70 in Figure 6.

30 Other components are also simpler in the second preferred embodiment. The Virtual Cartridge Management Logic of the data processor 10a need only manage the slot assignments of the virtual cartridges. The memory 50a has a Font List 51 to store a list of the fonts available to the user, a Print Buffer for assembling the print data 90 to be delivered to the Print Engine 20, and a Slot Table 54 to store a list of the mounted virtual cartridges.

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5 In the second illustrated embodiment, virtual
cartridge fonts are stored in ROM. These ROM-based fonts
are used for both resident fonts and virtual cartridge
fonts. The virtual cartridges of the second preferred
embodiment include both fonts and identification
information (e.g. "<cartridge name>"). The Font List 51,
rather than storing actual fonts, instead stores font
addresses. For virtual cartridge fonts and resident
10 fonts, these addresses are to printer ROM 70. For
downloaded fonts, the addresses are to printer memory 50a.
Virtual cartridges available through the Font List 51 are
said to be "mounted."

15 In the second preferred embodiment, the ROM 70 is an
EEPROM. As is known in the art, an EEPROM may be erased
and rewritten. Therefore, virtual cartridges may be
added, deleted, or updated through the communication
channel to the host computer.

20 Much like in the first preferred embodiment, the
mounted virtual cartridges, i.e. the virtual cartridges
that have been selected to be made available to the Print
Management Logic, are listed in the Slot Table 54.
Referring again to Figure 5, the Slot Table 54 stores the
<cartridge name> field 54b. The Slot Table 54 is
maintained by the Virtual Cartridge Management Logic in
25 the data processor 10a and created when the printer 15 is
initialized. As shown in Figure 5, the Slot Table 54
maintains a list of which, if any, virtual cartridges have
been mounted in each slot. For each virtual cartridge
listed in the Slot Table 54, that virtual cartridge's
30 fonts are available through the Font List 51. If a slot
54a is empty, that is, if no virtual cartridge has been
mounted to that slot, the value in the <cartridge name>
field 54b is "NULL" (or some value desired to have that
meaning). As in the first preferred embodiment, the slots
35 54a in the Slot Table 54 have priority amongst themselves.

As set forth above and shown in Figure 3, the Font

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List 51 is a list of the fonts that may be readily accessed by the Print Management Logic of the data processor 10a. As mentioned, in the second illustrated embodiment, fonts are accessed using indirect methods. However, the Font List 51 may also be implemented using direct memory accessing. Furthermore, the virtual cartridges may be either a group of fonts in ROM or a list of pointers to fonts in ROM. The latter embodiment permits virtual cartridges to, in essence, share fonts.

As discussed, the Print Management Logic of the data processor 10a accesses fonts from the Font List 51. Resolution of font selection conflicts is performed as is known in the art through the priorities associated with the sources of the fonts, including the slot if applicable. Once a virtual cartridge is mounted, the emulation of a physical cartridge is complete. In other words, the Print Management Logic of the data processor 10 accesses the virtual cartridge fonts as if they were cartridge fonts. The portion of the Font List 51 that would have comprised ROMs in a cartridge instead comprises ROM 70 in the printer.

Referring again to Figure 6, the data processor 10 includes Virtual Cartridge Management Logic and Print Management Logic. The Virtual Cartridge Management Logic includes commands for:

1. Mounting a virtual cartridge.
2. Unmounting virtual cartridges.
3. Initializing and resetting the Font List 51 and the Slot Table 54 in the memory 50a.

The Print Management Logic includes command for:

1. Selecting a font from the Font List 51 based upon the attributes in the print data 90 sent by the host computer.
2. Combining print data 90 with the selected font to produce print output.
3. Outputting via the print engine 20.

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5 The Front Panel 60 and print engine 20 have similar configurations and functionalities as in the first preferred embodiment. The memory 50a in the second preferred embodiment is of sufficient size to store the Font List 51 and Slot Table 54 while also having sufficient space for the print buffer 52.

Mounting a Virtual Cartridge

10 In the second preferred embodiment, the following process is exemplary of a process used to mount a virtual cartridge stored in ROM 70. Once a virtual cartridge is mounted, the fonts from that virtual cartridge are available through the Font List 51.

(1) The user indicates via the front panel controls 61 that a virtual cartridge is to be mounted.

15 (2) The user selects into which slot the virtual cartridge will be mounted. Upon selection of the slot, the name of the virtual cartridge then mounted in the slot, if any, is displayed.

20 (3) In response to (2), the data processor scans the ROM 70 for virtual cartridge identification information (virtual cartridge names).

25 (4) The data processor 10a causes the virtual cartridge names to be displayed on the front panel display 62. Depending upon the size of the front panel display 62, one or more virtual cartridge names may be displayed at once.

(5) The user selects a virtual cartridge. Of course, the virtual cartridge names can be scrolled until the desired virtual cartridge is located.

30 (6) In response to (5), the data processor 10a copies the virtual cartridge address into the Font List 51 in the memory 50a.

35 (7) The data processor 10a updates the Slot Table 54 to reflect the mounting of the virtual cartridge in the selected slot.

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Initializing the Printer

In the second preferred embodiment, printer initialization includes steps for remounting previously mounted virtual cartridges to memory. As discussed, when
5 a virtual cartridge is mounted, the Virtual Cartridge Management Logic updates the Slot Table 54 to reflect the selection. During initialization, the Virtual Cartridge Management Logic creates the Slot Table 54 and mounts the virtual cartridges selected as indicated in the Slot Table
10 54. Since turning off or resetting the printer would normally eliminate the Slot Table 54 in memory 50a, the values stored in the Slot Table 54 should also be stored in a non-volatile memory. It will be seen by those skilled in the art that the Slot Table 54 may also be
15 implemented in non-volatile memory.

Summary

In this way, address space that previously was occupied by fonts stored in ROMs in physical cartridges is occupied by virtual cartridge fonts stored on hard
20 disks, in RAM, or in printer ROMs. Thus the virtual cartridge fonts emulate physical cartridge fonts. Once virtual cartridge fonts are listed in the Slot Table 54 and so available in the Font List 51, they are treated exactly as if they were actual cartridge fonts. No change
25 need be made to the Print Management Logic.

It will thus be seen that the objects set forth above, and those made apparent from the preceding description, are efficiently attained. Since certain changes may be made without departing from the scope of the invention,
30 it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

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We claim:

1. In a printer having a read-write data storage device, the improvement comprising a virtual font cartridge comprising:

5 a fonts file containing at least one font and having a first filename and file format; and

an identification file containing information indicative of the fonts in the fonts files and having a second filename and file format;

10 wherein the fonts file and the identification file are stored on the read-write data storage device.

2. The printer of claim 1 wherein the data storage device has a plurality of directories and subdirectories,

5 the fonts file is stored in a subdirectory of the data storage device, the subdirectory having a third filename and format, and

the first filename, second filename, and third filename are substantially the same.

3. The printer of claim 1 wherein:

the first filename, second filename, and third filename each comprise a name and an extension, and

5 the name of the first, second and third filenames are the same.

4. The printer of claim 1 wherein the data storage device is a hard disk.

5. The printer of claim 1 wherein the data storage device is a floppy disk.

6. The printer of claim 2 wherein the first format, second format, and third format are MS-DOS compatible.

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7. In a printer having a data storage device, the improvement comprising a virtual font cartridge comprising:

5 a file containing at least one font and information indicative of the fonts, and having a filename and format; wherein

the file is stored on the data storage device.

8. In a printer comprising a data processor, a data storage device, a memory, and a control responsive to user command;

5 a method of operating the data processor comprising the steps of:

10 (a) accepting a first user command through the control indicative of a virtual cartridge to be loaded, the virtual cartridge comprising at least one font and information indicative of the fonts and stored on the data storage device;

(b) loading the fonts of the selected virtual cartridge from the data storage device to the memory.

5 9. The method of claim 8, wherein the memory comprises a Slot Table indicative of whether the virtual cartridges have been loaded into the memory, and the loading step further includes changing the Slot Table to indicate that a particular virtual cartridge has been selected.

5 10. The method of claim 9, wherein the Slot Table further comprises slot numbers associated with the indications of whether the virtual cartridges have been loaded into the memory, and the method further includes accepting a third user command through the control indicative of the particular slot number with which to associate the selected virtual cartridge.

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21.

11. The method of claim 10, wherein the memory further comprises a Font List defining a memory space, and the fonts, when loaded into the memory, are loaded particularly to the Font List.

12. The method of claim 11, wherein the printer further comprises a a display, and the memory further comprises a Virtual Cartridge Table, the Virtual Cartridge Table comprising a list of the virtual cartridges on the data storage device, the method beginning by:

- 5 (a) accepting a second user command through the control, and
- (b) displaying on the display information indicative of the fonts of the virtual cartridges listed in the Virtual Cartridge Table.
- 10

13. The method of claim 12 wherein the Virtual Cartridge Table comprises a list of names and locations of the virtual cartridges on the data storage device, and the information displayed in the displaying step is the virtual cartridge names.

5

14. In a printer comprising a data processor, a first data storage device, a second data storage device, and a control responsive to user command;

5 a method of operating the data processor comprising the steps of:

- (a) accepting a first user command through the control indicative of a virtual cartridge to be loaded, the virtual cartridge comprising at least one font and information indicative of the fonts;
- 10 (b) loading the fonts of the selected virtual cartridge from the first data storage device to the second data storage device.

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22.

15. The method of claim 14, wherein the printer further comprises a display, the method beginning with the steps of:

- 5 (a) accepting a second user command through the control;
- (b) scanning the first data storage device for virtual cartridges;
- (c) displaying on the display information indicative of the fonts in the virtual cartridge.

16. The method of claim 15, wherein the printer further comprises a Virtual Cartridge Table comprising a list of entries, each entry comprising a virtual cartridge name, the method comprising the additional step of
5 updating the Virtual Cartridge Table to include an entry of the loaded virtual cartridge.

17. The method of claim 16, wherein the first data storage device is a floppy disk in a floppy disk drive, and the second data storage device is a hard disk.

18. The method of claim 16, wherein the Virtual Cartridge Table is stored in a memory.

19. In a printer, the improvement comprising a virtual cartridge table comprising a list of entries, each entry comprising a virtual cartridge name, and virtual cartridge path.

20. In a printer, the improvement comprising a slot table comprising a list of entries, each entry comprising a slot name, and a virtual cartridge identifier.

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23.

21. In a printer having a ROM, the improvement comprising a virtual font cartridge comprising at least one font and information indicative of the fonts, wherein the fonts and the indicative information are stored in the ROM.

22. In a printer comprising a data processor, a data storage device, a memory, and a control responsive to user command;

a method of operating the data processor comprising the steps of:

(a) accepting a first user command through the control indicative of a virtual cartridge to be mounted, the virtual cartridge comprising at least one font and information indicative of the fonts and defining a data storage device address;

(b) copying the data storage device address of the selected virtual cartridge into the memory.

23. The method of claim 22, wherein the memory comprises a Font List defining a memory space, and the virtual cartridge addresses, when copied into the memory, are copied particularly to the Font List.

24. The method of claim 23, wherein the printer further comprises a display, the method beginning by:

(a) accepting a second user command through the control, and

(b) displaying on the display information indicative of the virtual cartridges.

25. The method of claim 22, wherein the memory further comprises a Slot Table indicative of whether the virtual cartridge addresses have been copied into the memory, and the copying step further includes changing the Slot Table to indicate that a particular virtual cartridge has been selected.

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24.

26. The method of claim 25, wherein the Slot Table further comprises slot numbers associated with the indications of whether the virtual cartridge addresses have been copied into the memory, and the method further includes accepting a third user command through the control indicative of the particular slot number with which to associate the selected virtual cartridge.

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