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(54) **HANDWRITING RECOGNITION METHOD AND APPARATUS HAVING MULTIPLE SELECTABLE DICTIONARIES**

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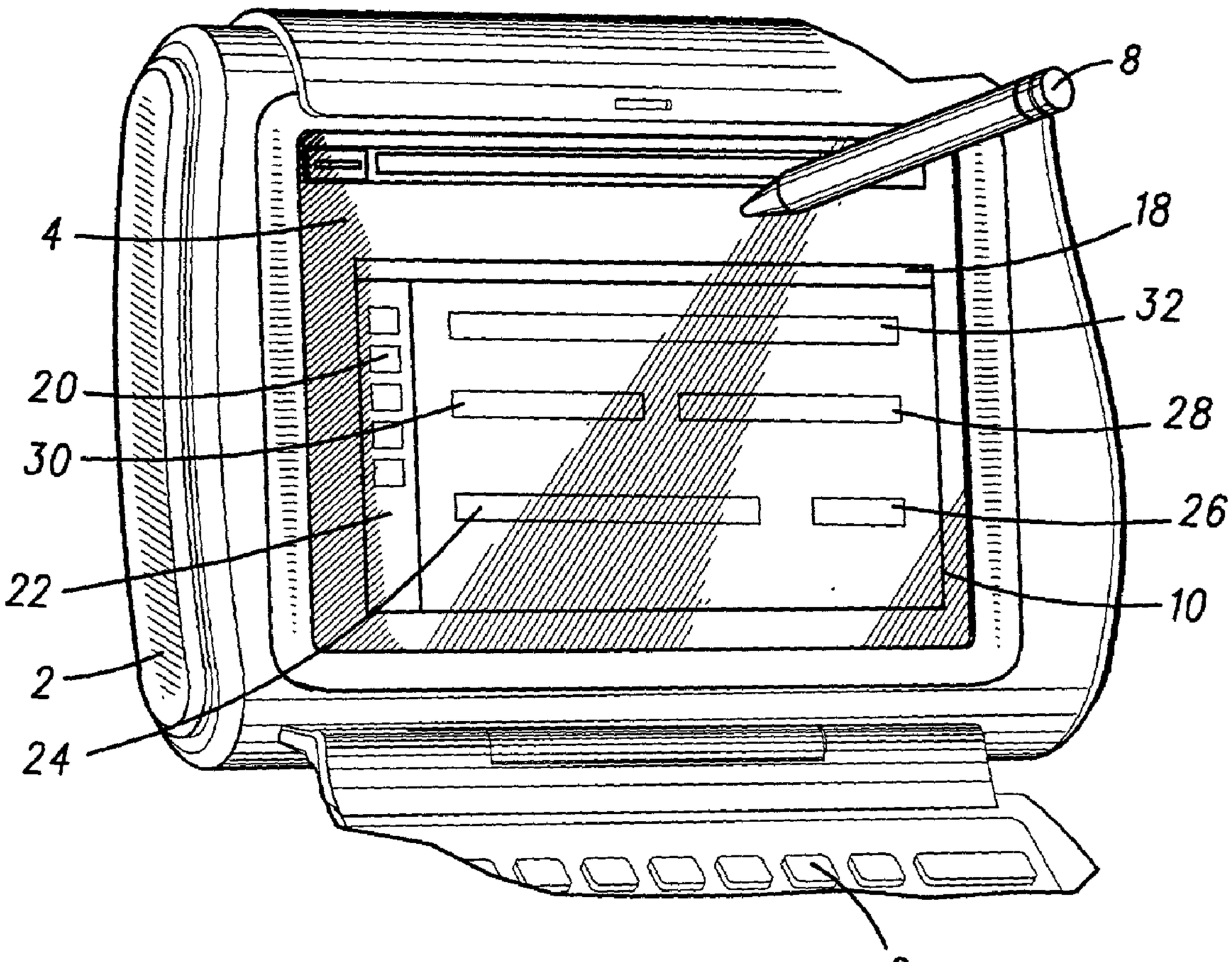
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(57) **ABSTRACT**

Multiple selectable dictionaries are used by a handwriting recognition system to provide accurate and prompt recognition processing. Sets of the multiple dictionaries are selectable by the user or automatically by the recognition program in response to the user handwriting in predetermined fields on a user interface.



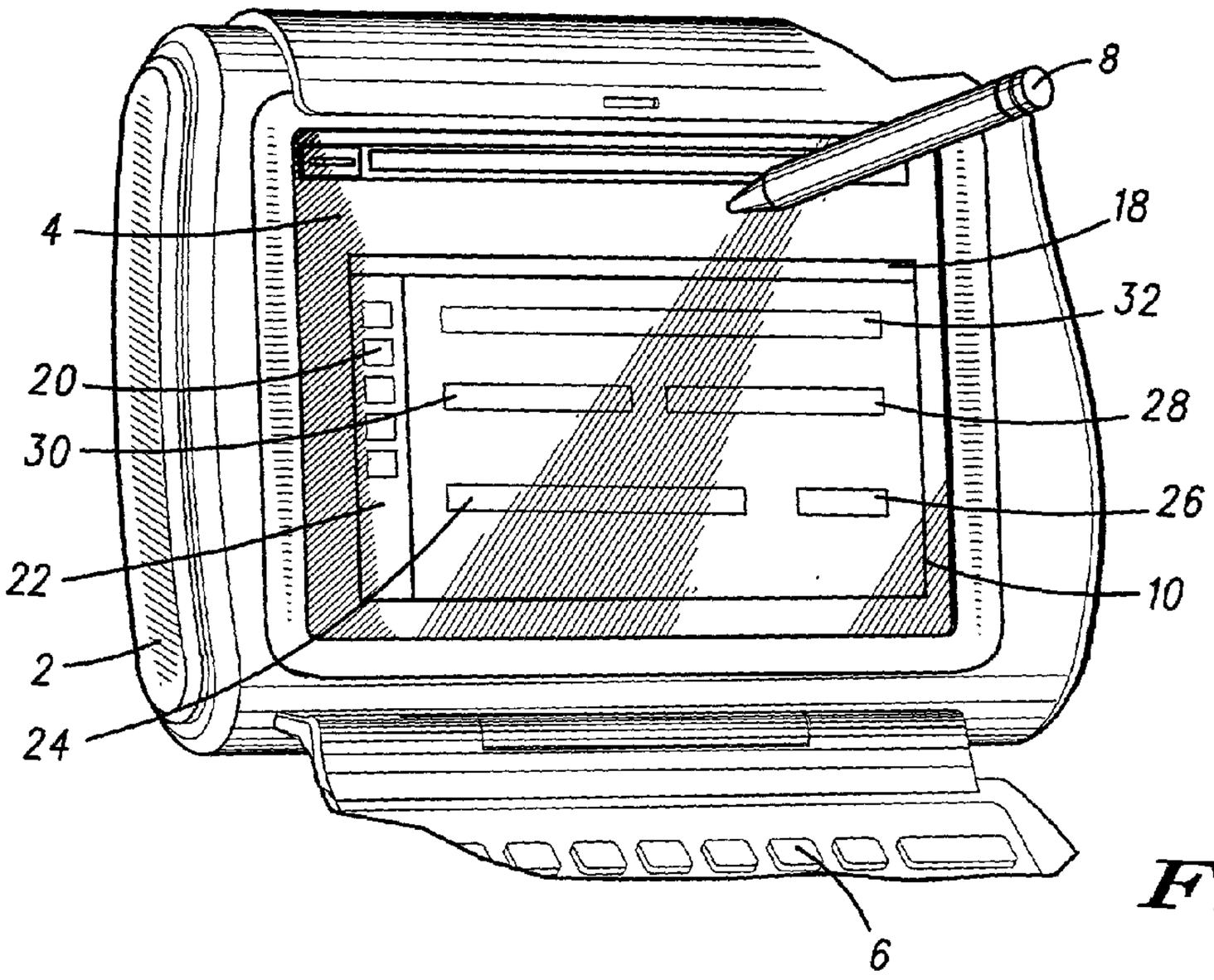


FIG. 1

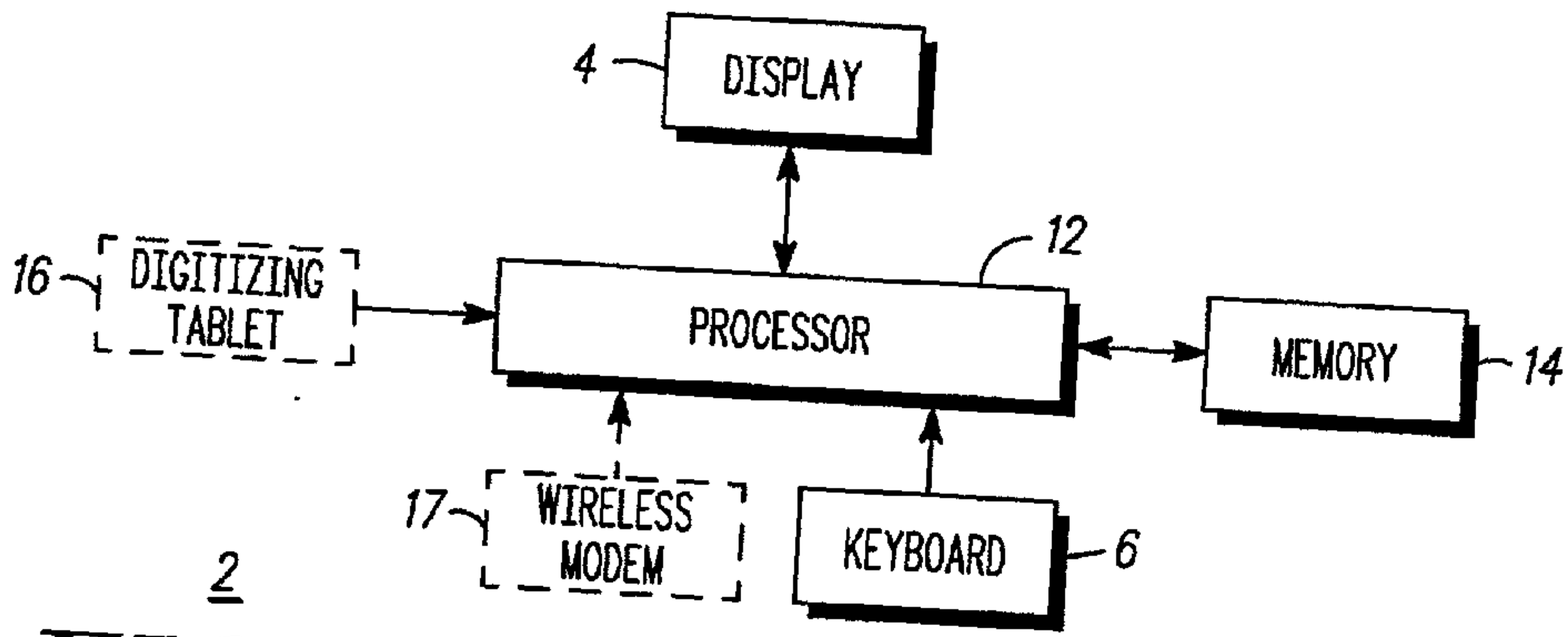


FIG. 2

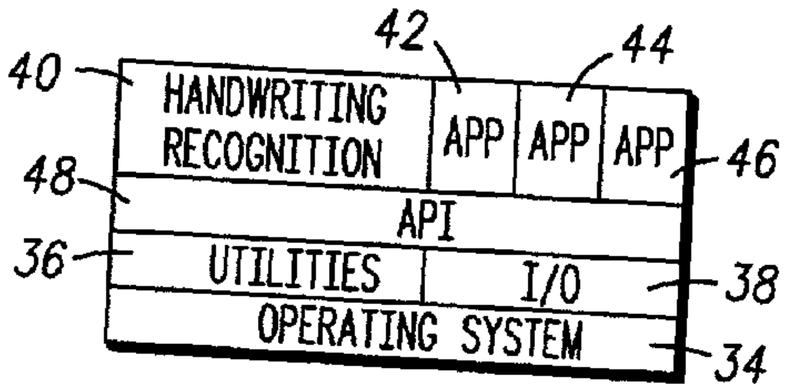


FIG. 3

FIG. 4

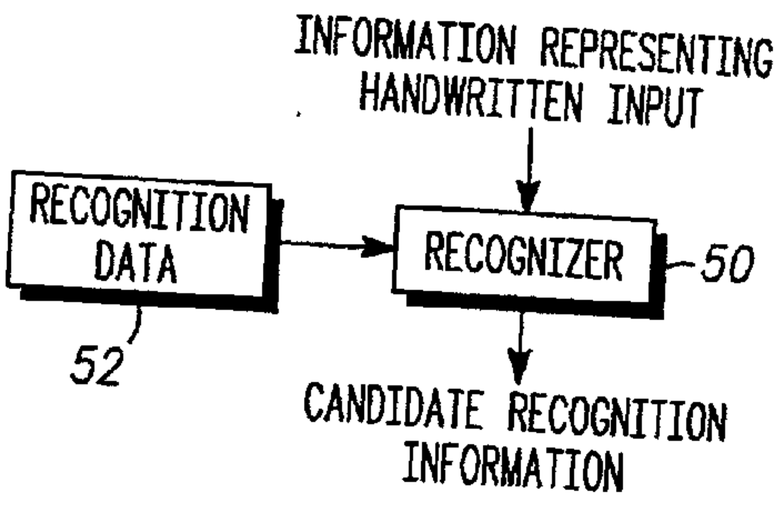


FIG. 5

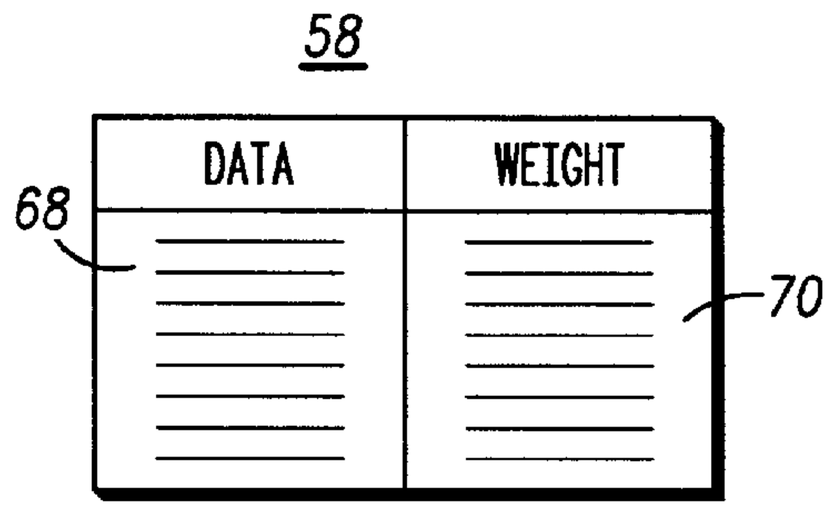


FIG. 6

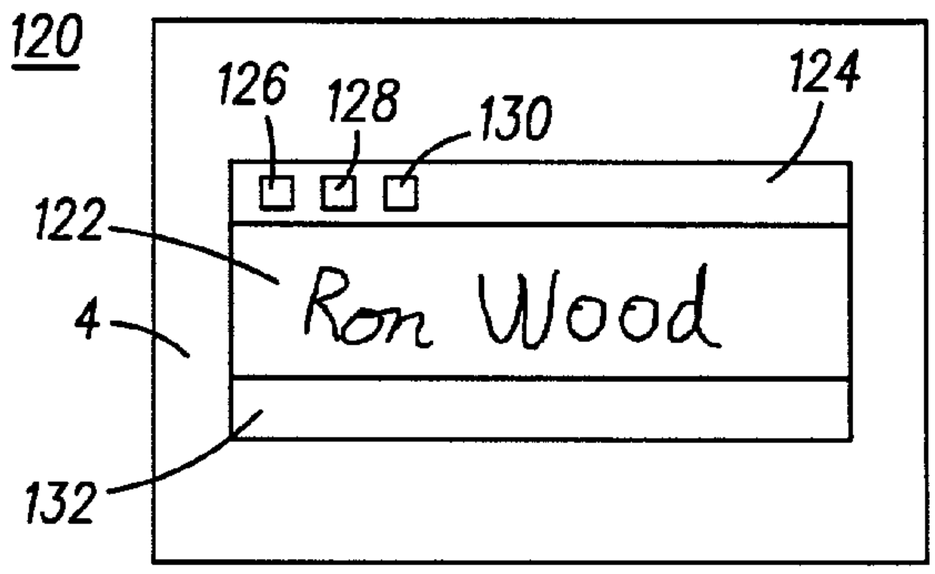


FIG. 10

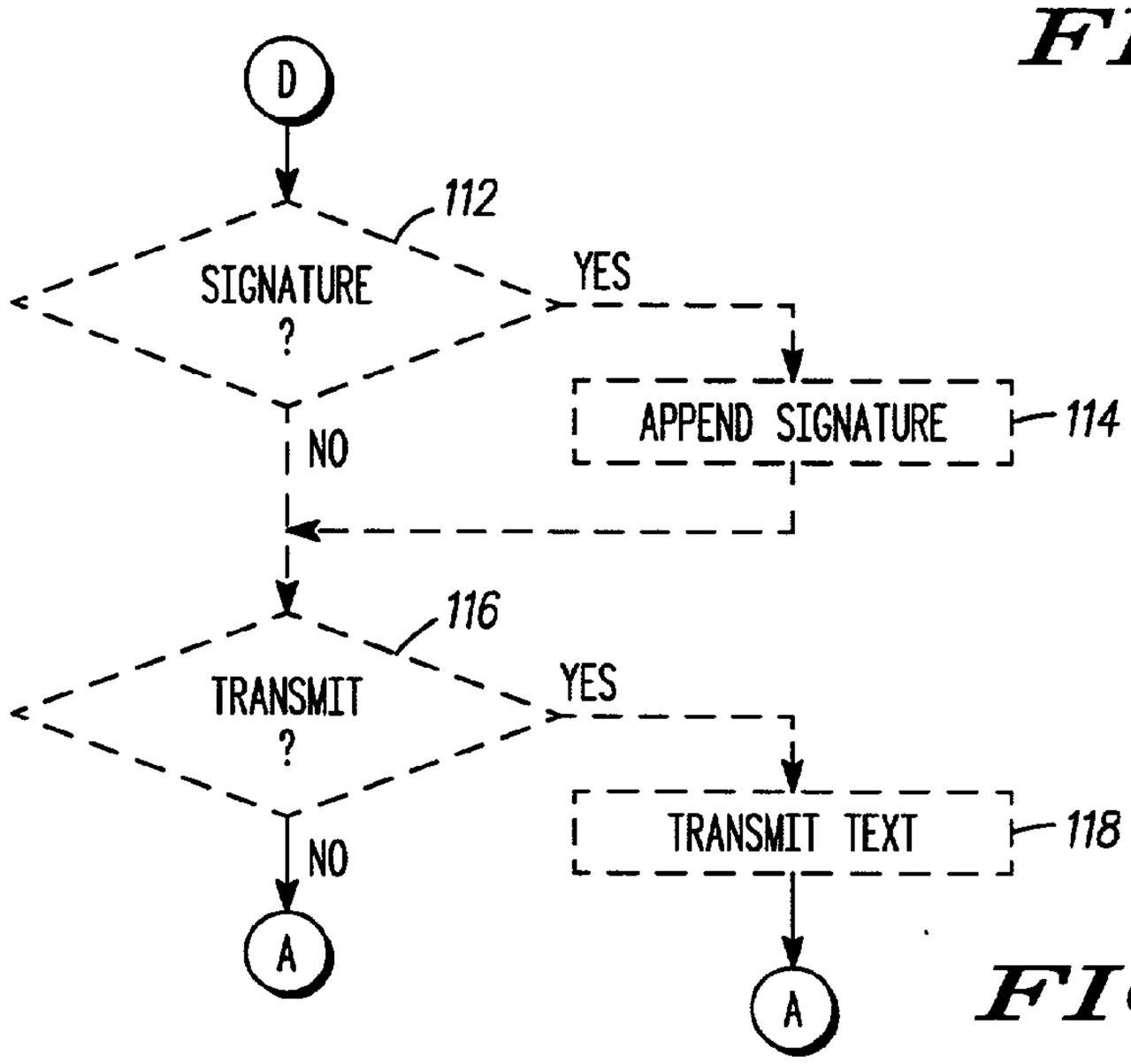


FIG. 9

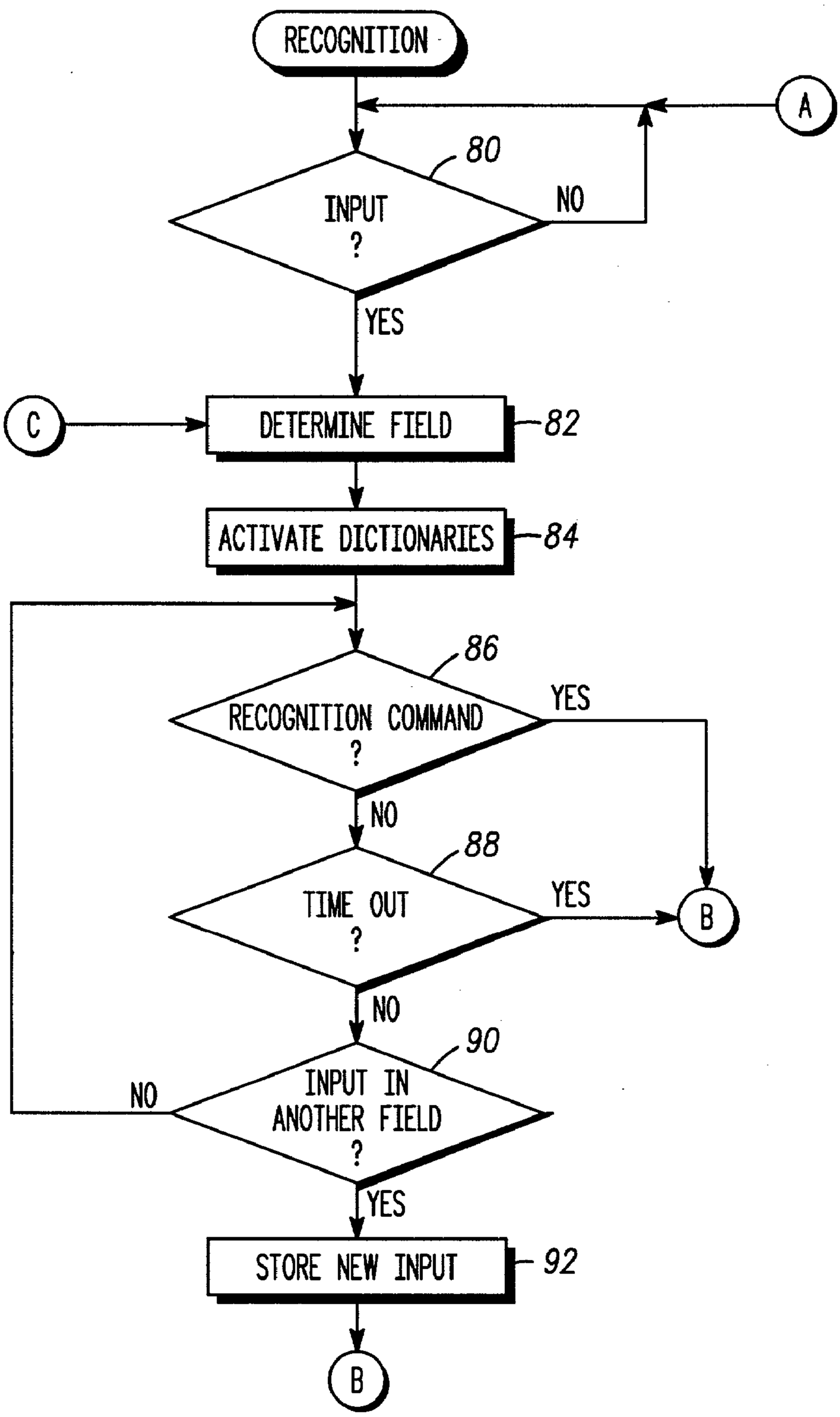

RECOGNITION
A
80
INPUT ?
NO
YES
C
DETERMINE FIELD
82
ACTIVATE DICTIONARIES
84
86
RECOGNITION COMMAND ?
YES
NO
88
TIME OUT ?
YES
B
NO
90
INPUT IN ANOTHER FIELD ?
NO
YES
STORE NEW INPUT
92
B

FIG. 7

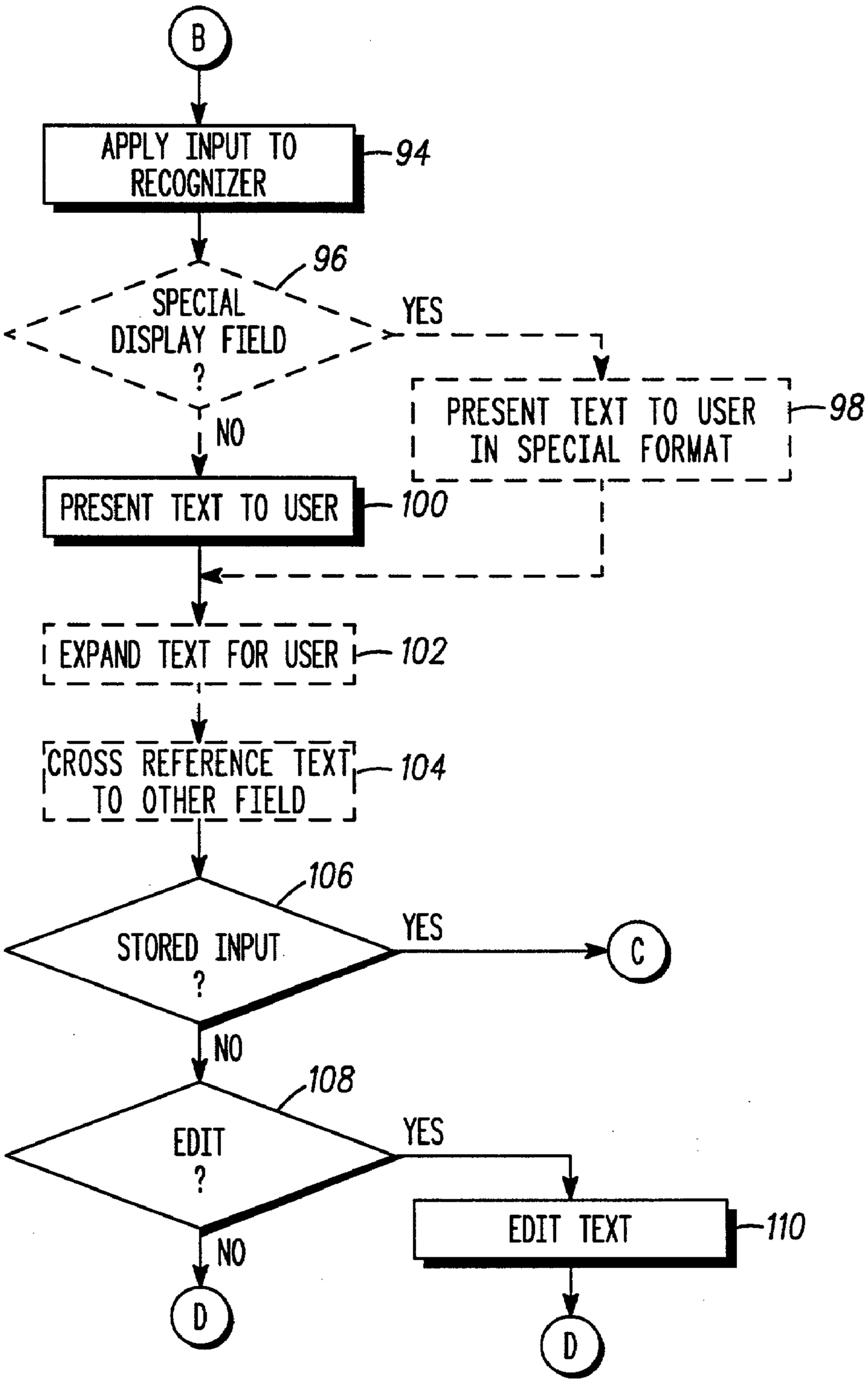

B
APPLY INPUT TO RECOGNIZER
94
96
SPECIAL DISPLAY FIELD ?
YES
PRESENT TEXT TO USER IN SPECIAL FORMAT
98
NO
PRESENT TEXT TO USER
100
EXPAND TEXT FOR USER
102
CROSS REFERENCE TEXT TO OTHER FIELD
104
106
STORED INPUT ?
YES
C
NO
108
EDIT ?
YES
EDIT TEXT
110
NO
D
D

FIG. 8

HANDWRITING RECOGNITION METHOD AND APPARATUS HAVING MULTIPLE SELECTABLE DICTIONARIES

FIELD OF THE INVENTION

[0001] This invention relates generally to the field of handwriting recognition, and more particularly to handwriting recognition data templates used in handwriting recognition systems.

BACKGROUND OF THE INVENTION

[0002] Handwriting recognition programs generally operate by comparing data generated from handwritten words or characters to stored recognition data (referred to as a dictionary by those skilled in the art) in an attempt to correctly replicate the handwritten words or characters as typewritten text. As commercial applications for handwriting recognition become more prominent in the marketplace, the trend has been to increase the size of the dictionary to make the recognition program more general in nature so as to be universally useful in various applications.

[0003] However, continually increasing the size of the dictionary can lead to diminishing returns in the context of reduced recognition accuracy. Also, a large dictionary can lead to increased recognition processing, which manifests itself to the user as a slower recognition response time. Some more advanced handwriting recognition programs have attempted (with mixed results) to compensate for a large recognition dictionary by including weighting values associated with some or all of the stored recognition data that are used in the recognition process to improve the likelihood of correctly recognizing the handwritten input.

[0004] Nevertheless, there exists a need for a handwriting recognition system that may find wide application without compromising recognition accuracy and speed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] **FIG. 1** is a perspective view of a computing device in accordance with the present invention;

[0006] **FIG. 2** is an exemplary block diagram of the computing device of **FIG. 1**;

[0007] **FIG. 3** is a graphic diagram illustrating an exemplary software program configuration of the device of **FIG. 1** in accordance with the present invention;

[0008] **FIG. 4** is a block diagram of the exemplary recognition program of **FIG. 3** that may be used in accordance with the present invention;

[0009] **FIG. 5** is an illustration of the organization of the recognition data in accordance with the present invention;

[0010] **FIG. 6** is an exemplary illustration depicting an optional embodiment included weighted recognition data in accordance with the present invention;

[0011] **FIG. 7**, **FIG. 8**, and **FIG. 9** are flow diagrams illustrating a preferred method in accordance with the present invention;

[0012] **FIG. 10** is an illustration of an optional signature embodiment in accordance with the present invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

[0013] **FIG. 1** and **FIG. 2** illustrate a computing device **2** suitable for use with the present invention. The computer device **2** may be, for example, a Thinkpad lap-top type computer made by IBM. Alternately, a personal digital assistant, such as the Newton manufactured by Apple Computer, or the Envoy wireless communicator, made by Motorola, or similar computing devices could be employed with the present invention. As shown in **FIG. 1**, the computing device **2** includes a digitizing display **4** that may be used as an alternate to the keyboard **6** to input information by using a stylus **8** to select functions, enter instructions, or handwritten text, graphics, or other information onto the display **4**.

[0014] As is known, contemporary computing devices typically include a processing component **12** such as a microprocessor or digital signal processor that, together with other general circuitry, execute the instructions of one or more software programs residing in a memory **14** that may include an operating system to control the finctionality and operation of the computing device **2**. Optionally, a conventional digitizing tablet **16** may be used to enter printed or handwritten words or text allowing a conventional (non-digitizing or non-touch sensitive) display to be employed for the display **4**. Another option comprises a wireless modem (radio) **17** for transmitting, receiving, or transceiving information such as the Envoy wireless communicator is capable of doing.

[0015] Referring to **FIG. 1**, the display **4** may be seen to present a graphic user interface commonly referred to by those skilled in the art as a window **10**. The window **10** is associated with a computer application program or other computer program, and it is know for the particular association between a window and computer program to be displayed to the user via providing the name or identification of the computer program in an area of the window referred to as a title bar **18**. Generally, certain user commands or instructions are given to the computer program via user selection of one or more icons **20** that ordinarily reside in a area of the graphic user interface know as a toolbar **22** by those skilled in the art.

[0016] As can be seen in **FIG. 1**, the window **10** includes several fields **24-32** for receiving user handwriting via the stylus **8**. In the present invention, one field may be used or any number of fields may be used according to the application. According to the present invention, the recognition system comprises several dictionaries containing recognition data (with or without weighting). The present invention contains the size of any particular dictionary to a point that does not compromise recognition accuracy, but offers more universal application via selectively activating sets of dictionaries as appropriate for the application. In one embodiment, the user may select which dictionaries are active for use by the recognition system. In another embodiment, appropriate sets of dictionaries are automatically activated by the user handwriting in a particular field **24-32** of the window **10**.

[0017] **FIG. 3** illustrates a software program arrangement in accordance with the present invention to enable the computing device **2** of **FIG. 1** to utilize the present invention. Overall control of the computing device is governed by

an operating system **34**. Typical operating systems includes utility programs **36** and input/output (I/O) **38** control, and generally interfaces with other software programs (**40-46**) via an application programming interface (API) **38**. In the preferred embodiment of the present invention a software program **40** for recognizing handwritten user input resides above the API layer and includes instructions and data to implement printing and/or cursive handwriting recognition.

[**0018**] The present invention can be understood generally with reference to **FIG. 1** through **FIG. 4** in that a user could handwrite text (for example) onto the display **4** via the stylus **8**. Typically, the user's handwritten input is electronically displayed (which is referred to by those skilled in the art as "ink") in the window **10** (which in this example is associated with a handwriting recognition program). The I/O control portion **38** of the operating system **34** digitizes the handwriting (ink) via known techniques and sends information representing the handwritten input to the handwriting recognition program **40** via the API **48**. Executing the instructions of the user input recognition program **38** (for example, the Lexicus Longhand cursive handwriting recognition program or the QuickPrint print recognition program, both by the Lexicus Division of Motorola), the computing device **2** performs the functionality of any known handwriting recognition engine **50** and operates to compare the information representing the handwritten input with all or a selected set of a plurality dictionaries that contain stored recognition data **52**. Depending upon which dictionaries are active, the recognition data (commonly referred to by those skilled in the art as templates) is processed with the information representing the user handwritten input. The output of the recognition engine **46** is a list of candidate recognition information that, if correctly recognized, replicates the handwritten input as typewritten text on the display **4** and may be transferred, passed, or sent from the recognition program **40** to one of the other application programs (such as a word processing program).

[**0019**] **FIG. 5** illustrates a preferred multiple dictionary arrangement for the recognition data **52** arrangement in accordance with the present invention. As can be seen, the recognition data **52** comprises a plurality of dictionaries **54-60** that are selectively activated by the user or automatically by the recognition program **40**. For example, upon detection of a user writing in field **24** of window **10** in **FIG. 1, a** set **62** of the dictionaries **54-58** might be activated. Also, when the user writes in field **32**, the set of dictionaries **64** could be activated, while writing in the field **28** might automatically activate set **66** of dictionaries **56** and **58**.

[**0020**] According to the invention, one of the dictionaries (**60** for example) can be added to by the user so that certain proper names, acronyms, and other words not contained in the other dictionaries can be added for use by the recognition system. The other dictionaries are preferably divided into general and specialty areas such as: U.S. State Names; Prescription Drug Names; Over-the-counter Drugs; City or County Names; Historical Names, Events, or Places; Medical Terms (or medial specialties such as optometry) Legal Terms (or legal specialties such as patent law); U.S. President Names; a Main Dictionary (that may be generally active with selected other dictionaries); or only Numbers. Moreover, since in the preferred embodiment the dictionaries are data stored in a memory (**14** of **FIG. 2**), additional dictionaries may be added or replaced by the user.

[**0021**] **FIG. 6** is an exemplary illustration of dictionary **58** in the form of a table that is preferably stored in memory (**14** in **FIG. 2**) components of the computing device. In this embodiment, the dictionary **58** includes a plurality of data templates **68** each having a weighting value **70** associated therewith. Any known data association technique (e.g., vectors, pointers, tables, or appending data) is suitable for use with the present invention to associate a particular data template with its weighting value. Alternately, the present invention contemplates that only certain of the data templates, such as, for example, the data templates known to cause the most recognition errors, could have an associated weighting value. The weighting values **70** are used by the recognition engine (**50** in **FIG. 4**) via established practices to enhance the likelihood that the candidate recognition information correctly replicates the handwritten input.

[**0022**] In this alternate embodiment, templates for a handwritten word may reside in multiple of the dictionaries some having differing weighting values depending upon the dictionary. For example the city name "Chicago" may have a relative high weighting value in a City Name dictionary as compared to the Main dictionary, which left to itself my recognize that handwritten city name as "Chicago". According to the invention, when multiple active dictionaries contain templates for the same word, the recognizer returns only the word associated with the template having the highest weighting value from the various active dictionaries as the candidate recognition information for presentation to the user. This permits other candidate words to be presented to the user in an editing mode should a recognition error be made due to poor handwriting or other causes.

[**0023**] **FIG. 7**, **FIG. 8**, and **FIG. 9** are flow diagrams that, together with **FIG. 1**, illustrate the preferred method of the present invention. Upon detection of input (decision **80**), the field receiving the input (assuming more that one field is used) is determined (step **82**) and the set of dictionaries associated with that field are activated in step **84** (or the user selected set in the one field case). Decision **86** determines whether the user has instructed that the handwritten input be processed such as by the user selecting a particular icon **20** from the toolbar **22**. If recognition has not been user initiated, decision **88** determines whether a time interval has elapsed from the conclusion of input (referred to as pen-up by those skilled in the art). If the time interval has not elapsed, decision **90** determines whether the user has started handwriting input in another field, from which an inference is drawn that the input in the prior field is complete and can be applied to the recognition system. An affirmative determination from decision **90** stores the new input (step **92**) after which, and in the case of affirmative determinations from decisions **86** or **88**, the input is applied to the recognizer for processing with the active dictionaries in step **94**.

[**0024**] After recognition, decision **96** optionally determines whether the field receiving the input has special presentation or display parameters associated with it. For example, a field might be selected by a user to present recognized text in all capital letters. A field associated with telephone numbers could automatically group numbers for area code and prefix and insert dashes ("-") in between. If special presentation formats are not used, the recognized text is presented to the user (step **100**), however, the present invention contemplates an optional step **102** wherein the recognized text or character might be expanded to form

complete words for phrases preset by the user or contained in a dictionary. For example a check character (√) or a "Y" can be expanded to "Yes", while a "N" or dash character ("-") can be expanded to "No". In a medical application, recognized text such as "Tyl 350 2×" could be expanded to "Tylenol 350 mg Take Twice A Day".

[**0025**] Another option contemplated by the present invention for multiple field applications comprises step **104** which cross-references text recognized in one field to known associated text in other fields. For example, in a legal or medical application, a client or patient name can be cross-referenced to the associated client or patient number and/or case number or chart number. Address and phone numbers can be automatically completed in the appropriate fields. Further examples range from relative simple phone/address book applications where the fields can include: Name field; Address field; City field; State field; Zip Code field; and Phone Number field. A more complicated application includes medical applications where the fields can include: Name field; Patient Number field; Drug field; Drug strength field; Frequency (of taking medication) field; Refill field; and General Instruction field. Legal applications are also contemplated where the field can include: Client Name field; Client Number field; Matter Number field; Other Party field; Other Firm field; Other Counsel field; Contact Information field; and Issues field.

[**0026**] After the recognized text has been present using any of the various options contemplated by the present invention, decision **106** determines whether any user input was stored in **92** indicating that more input remains to be recognized. If so, the flow returns to step **82** to determine the field in which the stored text was entered and the flow proceeds for activating appropriate dictionaries and recognizing the text as described above. Conversely however, if no stored input remains to be recognized, decision **108** determines whether the user desires to edit any recognition errors in the recognized text such as by selecting a particular icon **20** in **FIG. 1**. If so, errors may be corrected using any known technique, the present invention contemplates the editing method used not offer as alternative words the same words from other dictionaries as described above in conjunction with **FIG. 6**.

[**0027**] Once the recognized text is correct, decision **112** determines whether the user desires to append an optional signature or other information to the recognized text as a measure of authentication. This alternate embodiment is particularly useful with the present invention in a medical application such as to authenticate a prescription from a medical doctor. If a signature is desired, it is appended in step **114** to the text or into a signature field.

[**0028**] Decision **116** determines whether the optional wireless modem (**17** in **FIG. 2**) is used in the application of the present invention such as to transmit a prescription to a pharmacy to be filled for a patient. If so, the information (with our without the signature) is transmitted in step **118** prior to returning to **FIG. 7** to await further input from the user.

[**0029**] **FIG. 10** illustrates an alternate preferred embodiment for optionally entering a personal signature or other symbol to be used as authentication information according to the present invention. An authentication or signature mode can be selected for example by the user selecting a particular icon **20** in the tool bar **22** of **FIG. 1**. In this mode, a graphical image (window) **120** is presented to the user on the display **4** of the computing device **2** of **FIG. 1**. Preferably, the graphical image **120** includes a signature area **122** and may also include a command (tool bar) area **124** that includes several icons **126-130** used to affect editing or other functions and a status area **132** used to convey information to the user. In the illustrated example, the signature "William Smith" has been handwritten in the signature area **124** to be stored and later appended to other handwritten input or sent to other application programs (**34-38** in **FIG. 3**) for the convenience of the user. According to the invention, the signature "ink" is not applied to the recognizer, but rather, is stored as information representing the "ink" to be used, for example, by a doctor to authenticate a drug prescription.

[**0030**] Accordingly, it will be appreciated by those skilled in the art that the present invention provides significant flexibility to handwriting recognition programs by activating selective sets of multiple specialized or general recognition dictionaries as described above. Several optional features of the present invention offer significant advantages for use in a wide variety of applications. Further optional variants of the present invention include the user of multiple windows (pages) that each may have one or more fields and having the active sets of dictionaries change depending upon which page (window) is being displayed to the user. Also, the recognition engine used to process the handwritten input with the active dictionaries may change depending upon the input field or window. In this regard, some fields may utilized a printed character handwriting recognizer while other field may employ a cursive handwriting recognition engine.

What is claimed is:

1. A method, comprising the steps of:

displaying a graphical image having at least one handwriting entry area to receive handwritten input;

processing information representing the handwritten input with a selected set of a plurality of dictionaries having stored recognition data to identify candidate recognition information; and

displaying the candidate recognition information.

2. The method of claim 1 wherein the processing step further comprises processing the information representing the handwritten input with a user selected set of the plurality of dictionaries.

3. The method of claim 1 wherein the processing step further comprises automatically selecting the selected set of the plurality of dictionaries responsive to the handwritten input being received in a particular handwriting entry area.

4. The method of claim 1, which includes the step of expanding the candidate recognition information into expanded recognition information.

5. The method of claim 1, which includes the step of cross-referencing the candidate recognition information to other information and displaying the other information in a display area associated with the other information.

6. The method of claim 1, wherein the processing step further comprises processing information representing the handwritten input from a first handwriting entry area upon detection of handwritten input in another handwriting entry area.

7. The method of claim 1, which includes the step of transmitting the candidate recognition information.

8. The method of claim 1, which includes the step of receiving handwritten input from a handwriting entry area to provide authentication information.

9. The method of claim 8, which includes the step of combining the authentication information with the candidate recognition information to provide authenticated information.

10. A method, comprising the steps of:

displaying a graphical image having a plurality of handwriting entry areas to receive handwritten input;

selecting, responsive to receiving handwritten input in a handwriting entry area, a set of a plurality of dictionaries to provide selected recognition data at least some of which has a weighting value associated therewith;

processing information representing the handwritten input with the selected recognition data to identify candidate recognition information; and

displaying the candidate recognition information.

11. The method of claim 10 wherein the processing step further comprises processing the information representing the handwritten input with the selected recognition data having the highest weighting value when the recognition data reside in more than one dictionary with different weighting values to identify the candidate recognition information.

12. The method of claim 10, which includes the step of expanding the candidate recognition information into expanded recognition information.

13. The method of claim 10, which includes the step of cross-referencing the candidate recognition information to other information and displaying the other information in a display area associated with the other information.

14. The method of claim 1, wherein the processing step further comprises processing information representing the handwritten input from a first handwriting entry area upon detection of handwritten input in another handwriting entry area.

15. The method of claim 1, which includes the step of transmitting the candidate recognition information.

16. The method of claim 1, which includes the step of receiving handwritten input from a handwriting entry area to provide authentication information.

17. The method of claim 16, which includes the step of combining the authentication information with the candidate recognition information to provide authenticated information.

18. An apparatus, comprising:

a touch-sensitive display for displaying handwriting entry areas to receive handwritten input and for displaying recognized words or characters, and for providing information representing the handwritten input;

a memory having a plurality of dictionaries each having recognition data stored therein to provide stored recognition data; and

digital processing circuitry programmed to select a set of the plurality of dictionaries to provided selected recognition data and to compare the information representing the handwritten input with the selected recognition data to provide the recognized words or characters to the display.

19. The apparatus of claim 18, wherein the digital processing circuitry is programmed to accept user instructions or commands to select the set of dictionaries.

20. The apparatus of claim 18, wherein the digital processing circuitry is programmed to automatically select the set of dictionaries based upon which handwriting entry area received the handwritten input.

21. The apparatus of claim 18, wherein the digital processing circuitry is programmed to compare the information representing the handwritten input with the selected recognition data responsive to handwritten input being received in another handwriting entry area.

22. The apparatus of claim 18, which includes a timer and the digital processing circuitry is programmed to compare the information representing the handwritten input with the selected recognition data responsive to the timer.

23. The apparatus of claim 18, which includes a wireless transmitter for transmitting the recognized words or characters.

24. An apparatus, comprising:

a display for displaying a plurality of handwriting entry areas, to display information representing handwritten input, and for displaying recognized words or characters;

a digitizing input device for receiving the handwritten input and for providing the information representing the handwritten input;

a memory having a plurality of dictionaries each having recognition data stored therein to provide stored recognition data;

digital processing circuitry programmed to select a set of the plurality of dictionaries associated with the plurality of handwriting entry areas to provided selected recognition data and to compare the information representing the handwritten input with the selected recognition data upon receiving handwritten input in another of the plurality of handwriting entry areas to provide the recognized words or characters to the display.

25. The apparatus of claim 24, which includes a wireless transmitter for transmitting the recognized words or characters.

* * * * *