US009355090B2

(12) **United States Patent**
Goldsmith et al.

(10) **Patent No.: US 9,355,090 B2**
(45) **Date of Patent: May 31, 2016**

(54) **IDENTIFICATION OF CANDIDATE CHARACTERS FOR TEXT INPUT**

(75) Inventors: **Deborah Eileen Goldsmith**, Los Gatos, CA (US); **Leland Douglas Collins, Jr.**, Palo Alto, CA (US); **Chia-Chi Chou**, Saratoga, CA (US); **Maria Celia Vigil**, Los Altos, CA (US)

(73) Assignee: **APPLE INC.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1081 days.

(21) Appl. No.: **12/167,044**

(22) Filed: **Jul. 2, 2008**

(65) **Prior Publication Data**

US 2009/0295737 A1 Dec. 3, 2009

Related U.S. Application Data

(60) Provisional application No. 61/057,757, filed on May 30, 2008.

(51) **Int. Cl.**

G06F 17/27	(2006.01)
G06F 3/0488	(2013.01)
G06F 3/01	(2006.01)

(52) **U.S. Cl.**

CPC ***G06F 17/276*** (2013.01); ***G06F 3/018*** (2013.01); ***G06F 3/04883*** (2013.01)

(58) **Field of Classification Search**

CPC G06K 9/18; G06F 3/023; G06F 17/28; G06F 17/21; G09G 5/00

USPC 345/156, 168, 171, 173; 715/264–265, 715/703

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,379,057	A	1/1995	Clough et al.	
5,535,119	A	7/1996	Ito et al.	
5,675,362	A	10/1997	Clough et al.	
5,959,629	A	9/1999	Masui	
6,115,053	A	9/2000	Perlin	
6,278,968	B1 *	8/2001	Franz et al.	704/3
6,323,846	B1	11/2001	Westerman et al.	
6,570,557	B1	5/2003	Westerman et al.	
6,661,409	B2	12/2003	Demartines et al.	
6,677,932	B1	1/2004	Westerman	

(Continued)

FOREIGN PATENT DOCUMENTS

CN	1292517	4/2001
CN	1606753 A	4/2005

(Continued)

OTHER PUBLICATIONS

Authorized officer Philippe Becamel, International Preliminary Report on Patentability in PCT/US2009/033696 mailed Sep. 16, 2010, 7 pages.

(Continued)

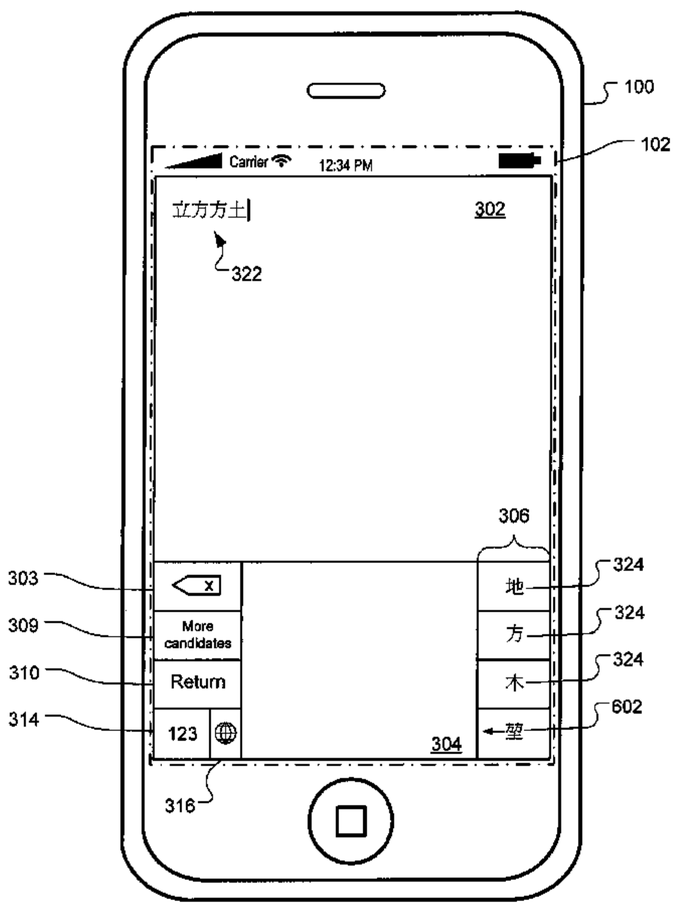
Primary Examiner — Kenneth Bukowski

(74) *Attorney, Agent, or Firm* — Morrison & Foerster LLP

(57) **ABSTRACT**

Methods, systems, devices, and apparatus, including computer program products, for identifying candidates for text entry. One or more inputs entering one or more characters are received. One or more first candidate characters are identified and presented for the inputs using a first dictionary. One or more second candidate characters related to a respective first candidate character are identified and presented.

12 Claims, 11 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

6,766,179	B1 *	7/2004	Shiau et al.	455/566
6,888,536	B2	5/2005	Westerman et al.	
7,030,863	B2	4/2006	Longe et al.	
7,096,432	B2	8/2006	Huapaya et al.	
7,137,076	B2	11/2006	Iwema et al.	
7,147,562	B2	12/2006	Ohara et al.	
7,619,677	B2	11/2009	Matsuda et al.	
2002/0167545	A1	11/2002	Kang et al.	
2002/0168107	A1 *	11/2002	Tang et al.	382/187
2003/0024375	A1	2/2003	Sitrick	
2003/0100965	A1	5/2003	Sitrick	
2003/0160817	A1	8/2003	Ishida et al.	
2003/0216913	A1	11/2003	Keely	
2004/0140956	A1	7/2004	Kushler et al.	
2004/0230912	A1	11/2004	Clow et al.	
2005/0024341	A1 *	2/2005	Gillespie et al.	345/173
2005/0099408	A1	5/2005	Seto et al.	
2005/0152600	A1	7/2005	Chen et al.	
2005/0174333	A1	8/2005	Robinson et al.	
2006/0053387	A1	3/2006	Ording	
2006/0062461	A1 *	3/2006	Longe et al.	382/185
2006/0085757	A1	4/2006	Andre et al.	
2006/0117067	A1	6/2006	Wright et al.	
2006/0144211	A1	7/2006	Yoshimoto	
2006/0265648	A1 *	11/2006	Rainisto et al.	715/534
2006/0274051	A1	12/2006	Longe et al.	
2007/0024736	A1	2/2007	Matsuda et al.	
2007/0120822	A1	5/2007	Iso	
2008/0025613	A1 *	1/2008	Kumar et al.	382/189
2008/0030481	A1 *	2/2008	Gunn et al.	345/173
2008/0072156	A1	3/2008	Sitrick	
2008/0094356	A1	4/2008	Ording et al.	
2009/0037837	A1	2/2009	Raghunath et al.	
2009/0051661	A1	2/2009	Kraft et al.	
2009/0058823	A1	3/2009	Kocienda	
2009/0077464	A1	3/2009	Goldsmith et al.	
2009/0193361	A1	7/2009	Lee et al.	
2009/0225041	A1	9/2009	Kida et al.	
2009/0226091	A1	9/2009	Goldsmith et al.	
2009/0265669	A1	10/2009	Kida et al.	

FOREIGN PATENT DOCUMENTS

CN	1949158	4/2007
CN	101013344	8/2007
EP	1 698 982	9/2006
JP	08-272787	10/1996
JP	10-049272	2/1998
JP	2000-112636	4/2000
JP	2000-222401	8/2000
JP	2002-108543	4/2002
JP	03-314276	8/2002
JP	2002-0325965	11/2002
JP	2005-092441	4/2005
WO	WO 00/74240	12/2000
WO	WO 2005/064587	7/2005
WO	WO 2007/037809	4/2007
WO	WO 2007/047188	4/2007
WO	WO 2007/67858	6/2007
WO	WO 2007/070223	6/2007
WO	WO 2009/032483	3/2009
WO	WO 2009/111138	9/2009

OTHER PUBLICATIONS

International Preliminary Report on Patentability in International Application No. PCT/US2009/072803 mailed Mar. 18, 2010.
Translated First Office Action dated Jul. 29, 2010 issued in Chinese Application No. 200910118235.X, 9 pages.
T. Masui, "An Efficient Text Input Method for Pen-based Computers," Proceedings of the ACM Conference on Human Factors in Computing System (CHI '98), Apr. 1998, ACM press, pp. 328-335.
T. Masui, "POBox: An Efficient Text Input Method for Handheld and Ubiquitous Computers," Proceedings of the Internation Symposium on Handheld and Ubiquitous Computer (HUC '99), Sep. 1999, pp. 289-300.
C. Liu et al., "Online Recognition of Chinese Characters: The State-of-the-Art," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 26, No. 2, Feb. 2004, pp. 198-213.
H. Sacher, "Interactions in Chinese: Designing Interfaces for Asian Languages," Interactions Magazine, vol. 5, Issue 5, Sep.-Oct. 1998, pp. 28-38.
International Search Report and Written Opinion, dated Apr. 29, 2009, issued in International Application No. PCT/US2009/033696.
International Search Report and Written Opinion, dated Feb. 18, 2009, issued in International Application No. PCT/US2009/072803.
Invitation to Pay Fees and Partial International Search Report, dated Nov. 11, 2008, issued in International Application No. PCT/US2009/072803.
Kida et al., "Language Input Interface on a Device", U.S. Appl. No. 12/107,711, filed Apr. 22, 2008.
Chou, "Zhuyin Input Interface on a Device", U.S. Appl. No. 12/476,121, filed Jun. 1, 2009.
Yoshikawa, "i-Phone First Impression," [online], Jul. 10, 2007, [Search on Nov. 22, 2011], Internet (English translation).
Office Action dated Nov. 22, 2012, received in Chinese Patent Application No. 200910145649.1, which corresponds to U.S Appl. No. 12/167,044, 13 pages (Goldsmith).
Office Action dated Jul. 2, 2013, received in Chinese Patent Application No. 200910145649.1, which corresponds to U.S Appl. No. 12/167,044, 10 pages (Goldsmith).
Notice of Allowance received for Chinese Patent Application No. 200910145649.1, mailed on Apr. 29, 2014, 1 page.

* cited by examiner

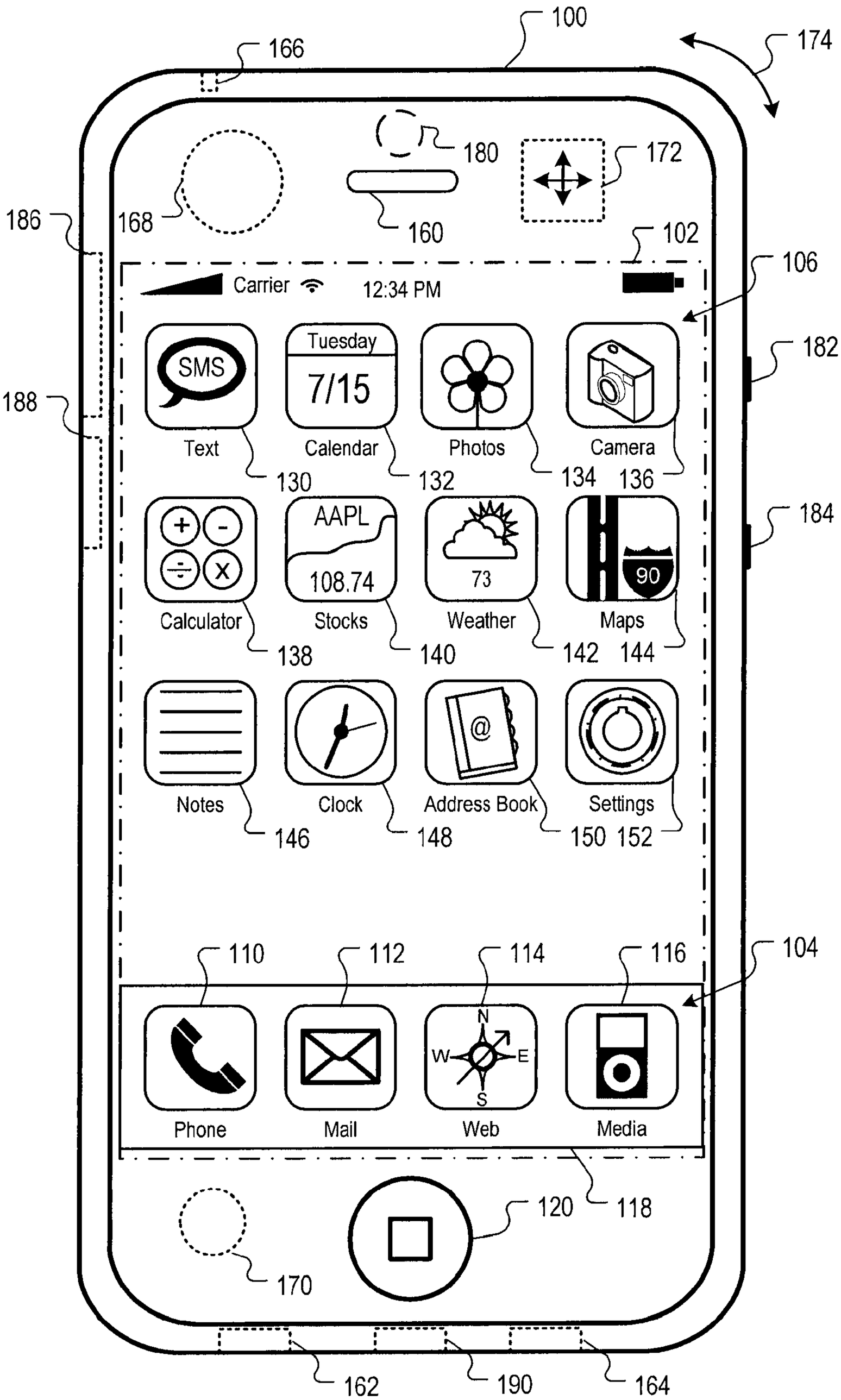

100
166
174
180
172
168
160
186
102
106
Carrier
12:34 PM
182
188
SMS
Tuesday
7/15
Text
Calendar
Photos
Camera
130
132
134
136
184
AAPL
108.74
73
90
Calculator
Stocks
Weather
Maps
138
140
142
144
Notes
Clock
Address Book
Settings
146
148
150
152
110
112
114
116
104
N
W
E
S
Phone
Mail
Web
Media
118
120
170
162
190
164

FIG. 1

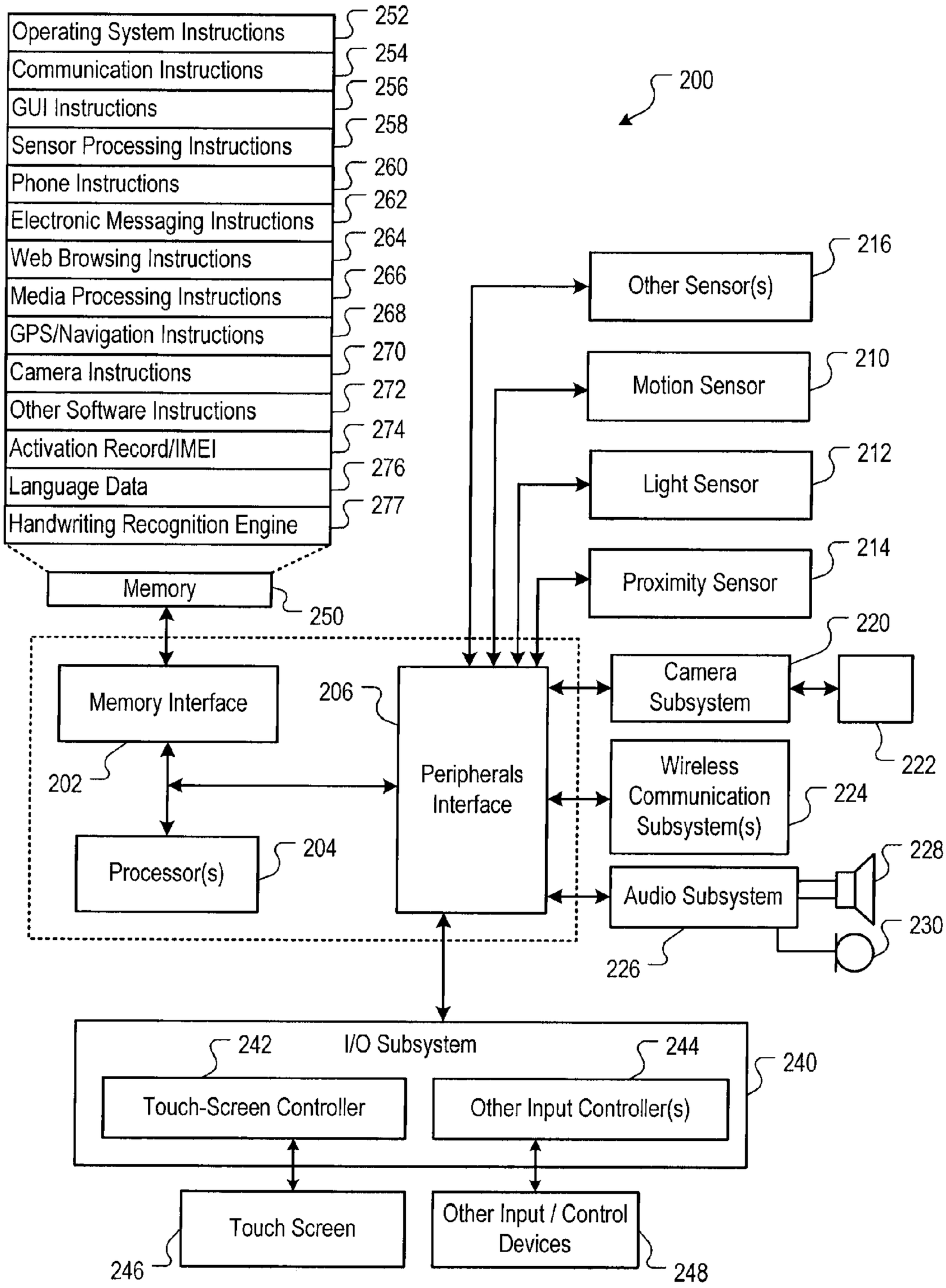

Operating System Instructions
252
Communication Instructions
254
GUI Instructions
256
Sensor Processing Instructions
258
Phone Instructions
260
Electronic Messaging Instructions
262
Web Browsing Instructions
264
Media Processing Instructions
266
GPS/Navigation Instructions
268
Camera Instructions
270
Other Software Instructions
272
Activation Record/IMEI
274
Language Data
276
Handwriting Recognition Engine
277
Memory
250
200
Other Sensor(s)
216
Motion Sensor
210
Light Sensor
212
Proximity Sensor
214
Memory Interface
202
206
Peripherals Interface
Camera Subsystem
220
222
Wireless Communication Subsystem(s)
224
Processor(s)
204
Audio Subsystem
228
230
226
I/O Subsystem
242
244
240
Touch-Screen Controller
Other Input Controller(s)
Touch Screen
246
Other Input / Control Devices
248

FIG. 2

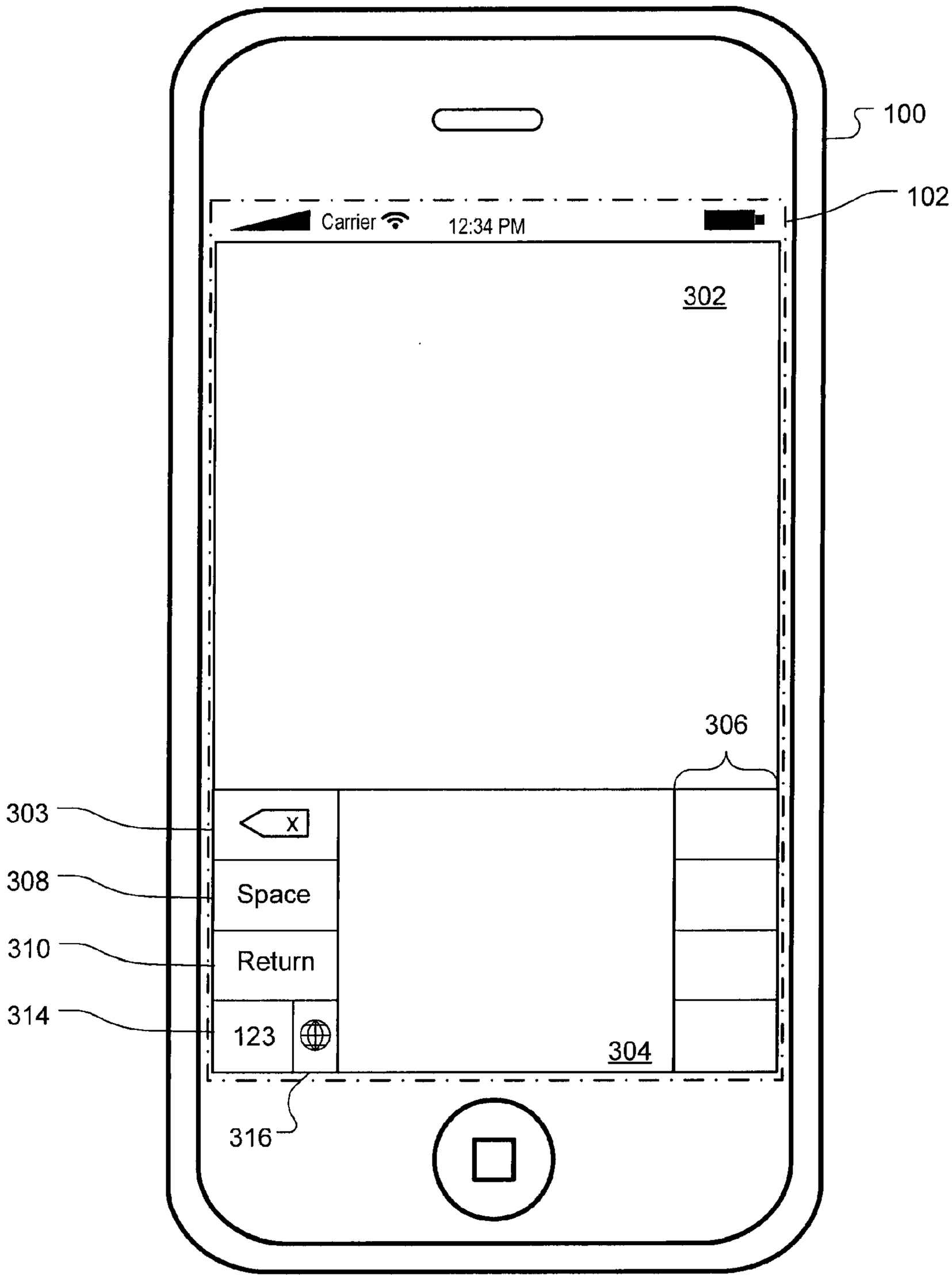

100
102
Carrier
12:34 PM
302
306
303
308
310
314
316
X
Space
Return
123
304

FIG. 3A

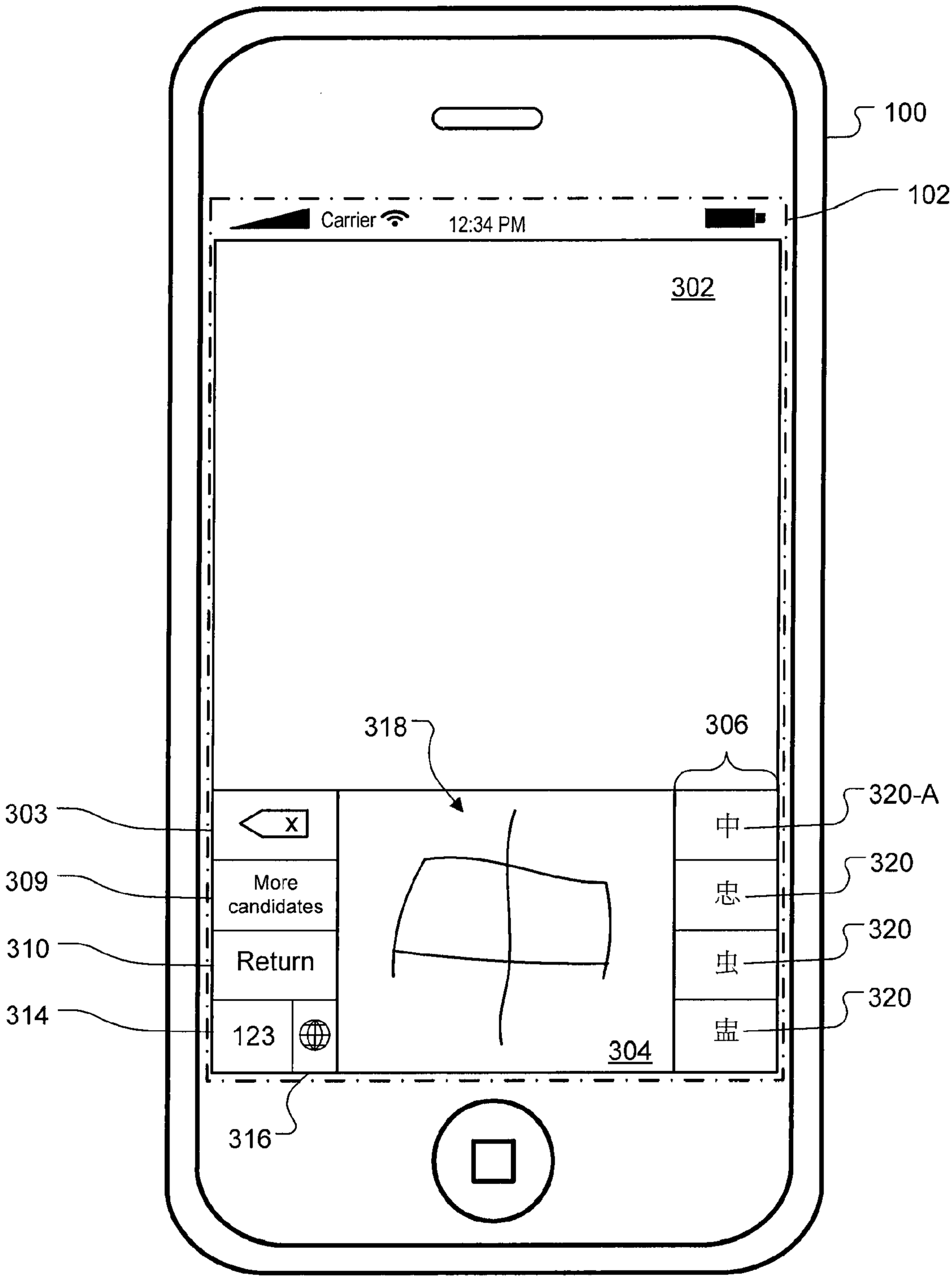

100
102
Carrier
12:34 PM
302
318
306
303
309
310
314
316
320-A
320
320
320
X
More candidates
Return
123
中
忠
虫
蛊
304

FIG. 3B

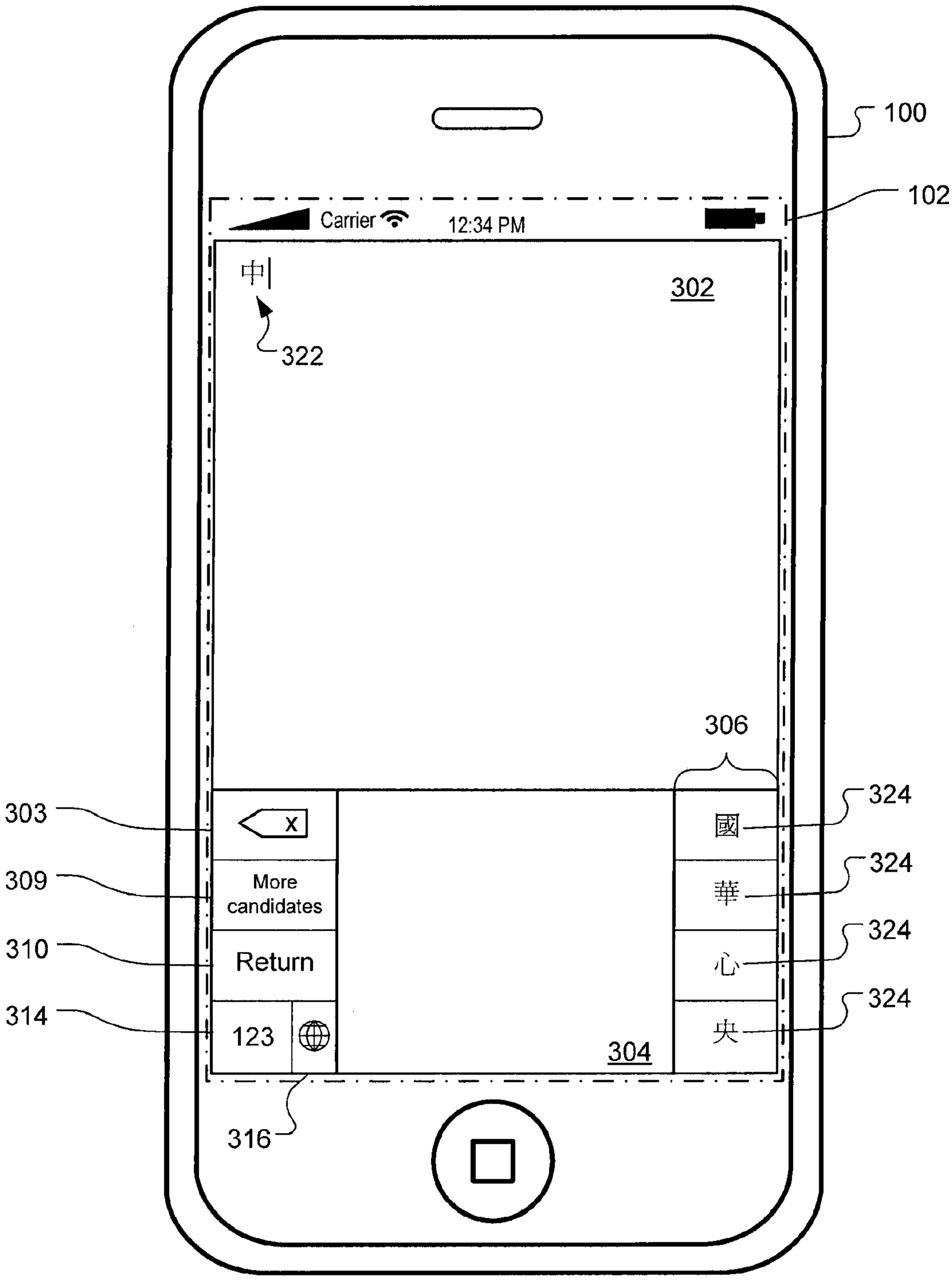

100
102
Carrier
12:34 PM
中
322
302
306
303
309
310
314
316
304
X
More candidates
Return
123
國
華
心
央
324
324
324
324

FIG. 3C

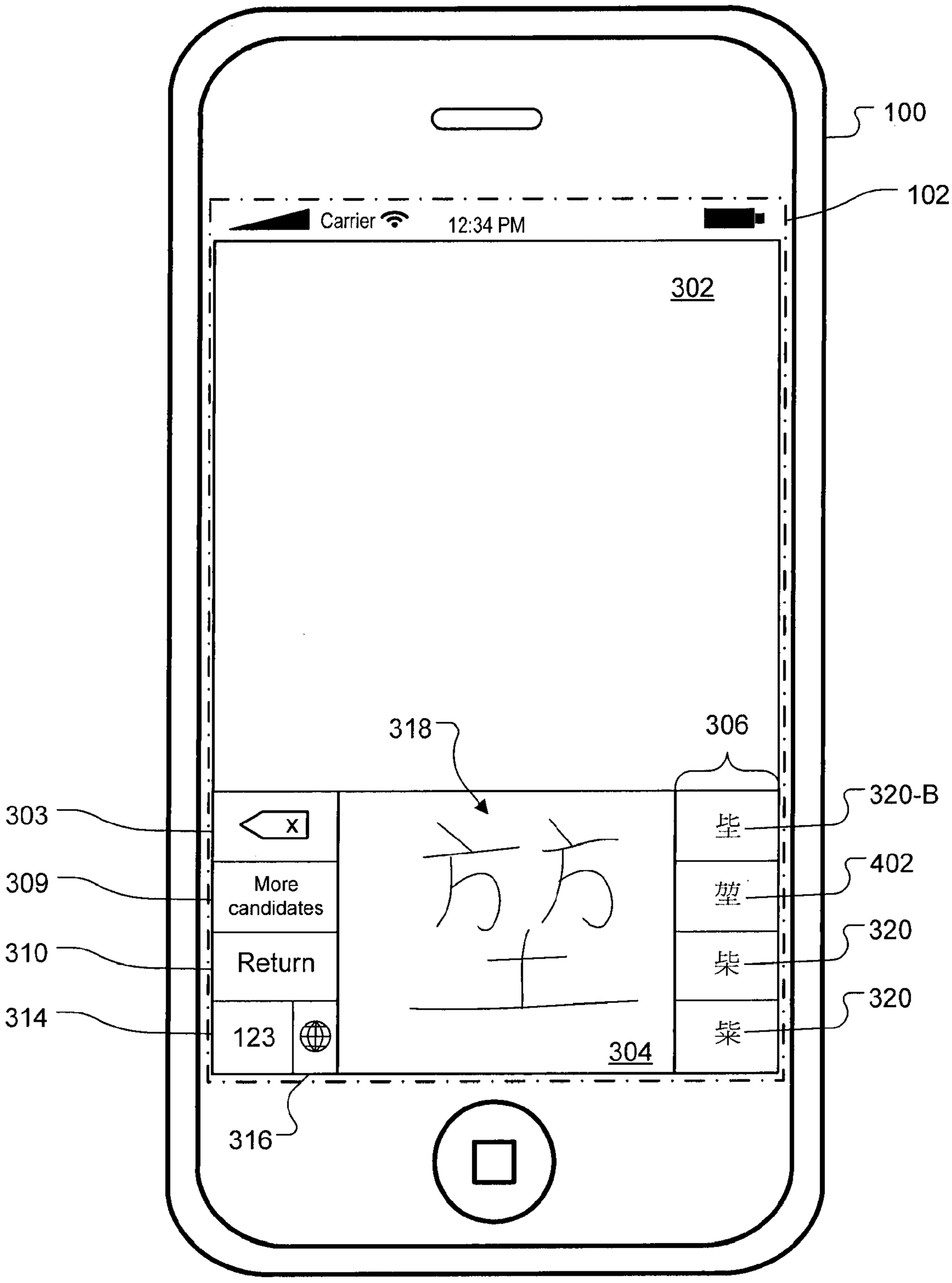

100
102
Carrier
12:34 PM
302
318
306
303
309
310
314
316
320-B
402
320
320
X
More candidates
Return
123
304
垒
塑
柴
柴

FIG. 4

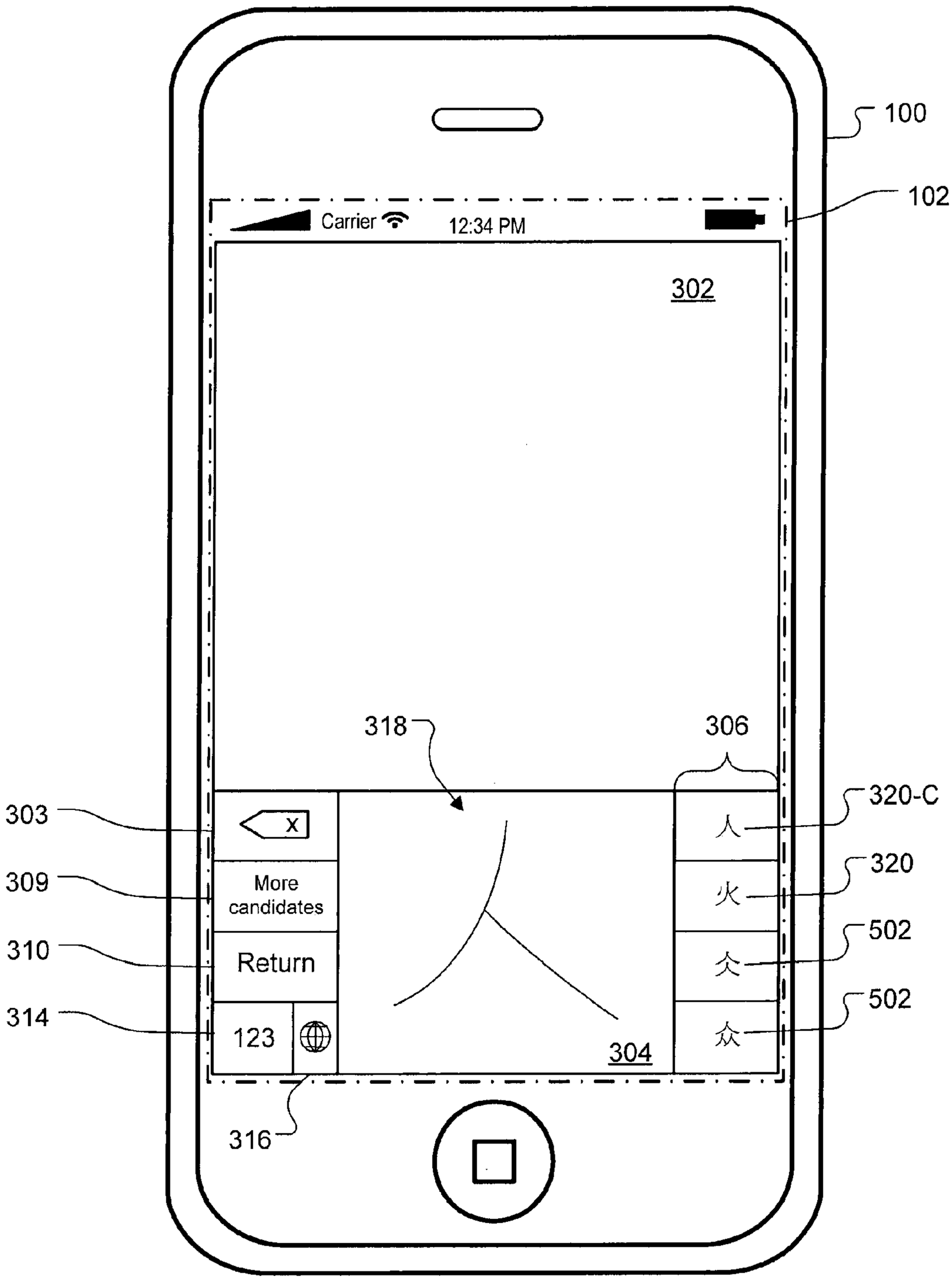

100
102
Carrier
12:34 PM
302
318
306
303
320-C
309
320
310
502
314
502
More candidates
Return
123
304
316
X
人
火
众
众

FIG. 5

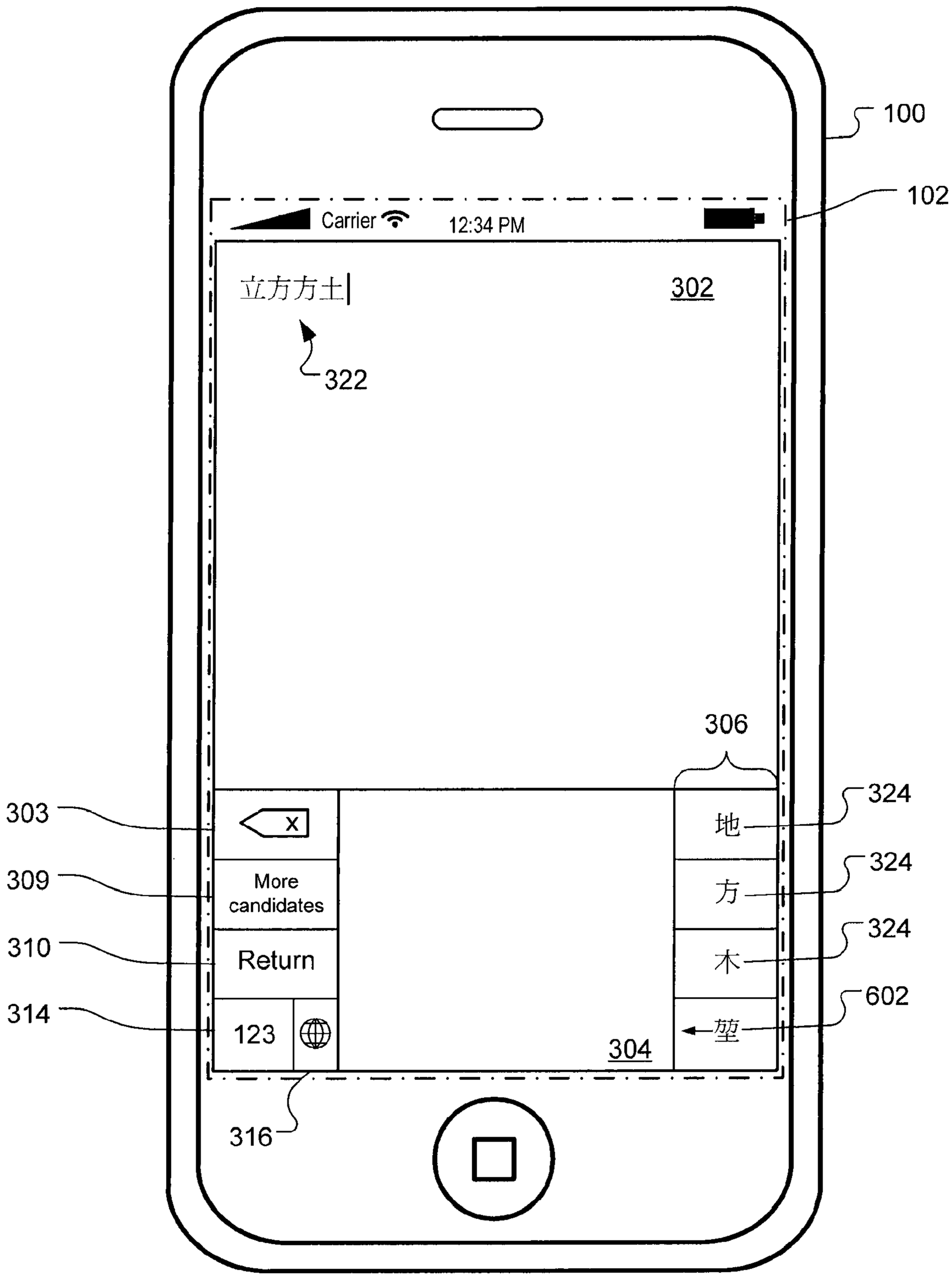

100
102
Carrier
12:34 PM
立方方土
302
322
306
303
309
310
314
316
304
X
More candidates
Return
123
地
方
木
堃
324
324
324
602

FIG. 6A

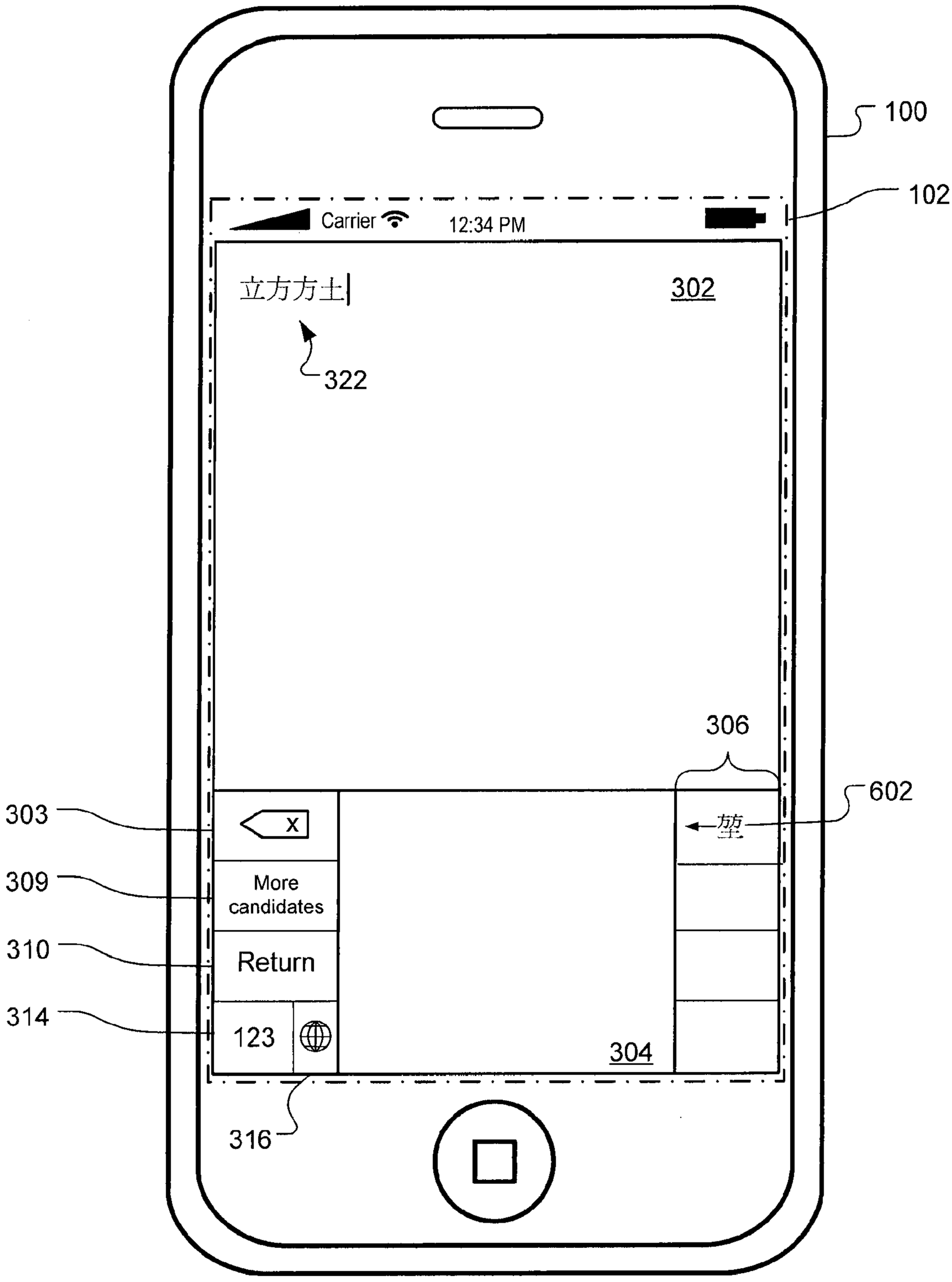

100
102
Carrier
12:34 PM
立方方土
302
322
306
303
309
310
314
316
602
X
More candidates
Return
123
304
堃

FIG. 6B

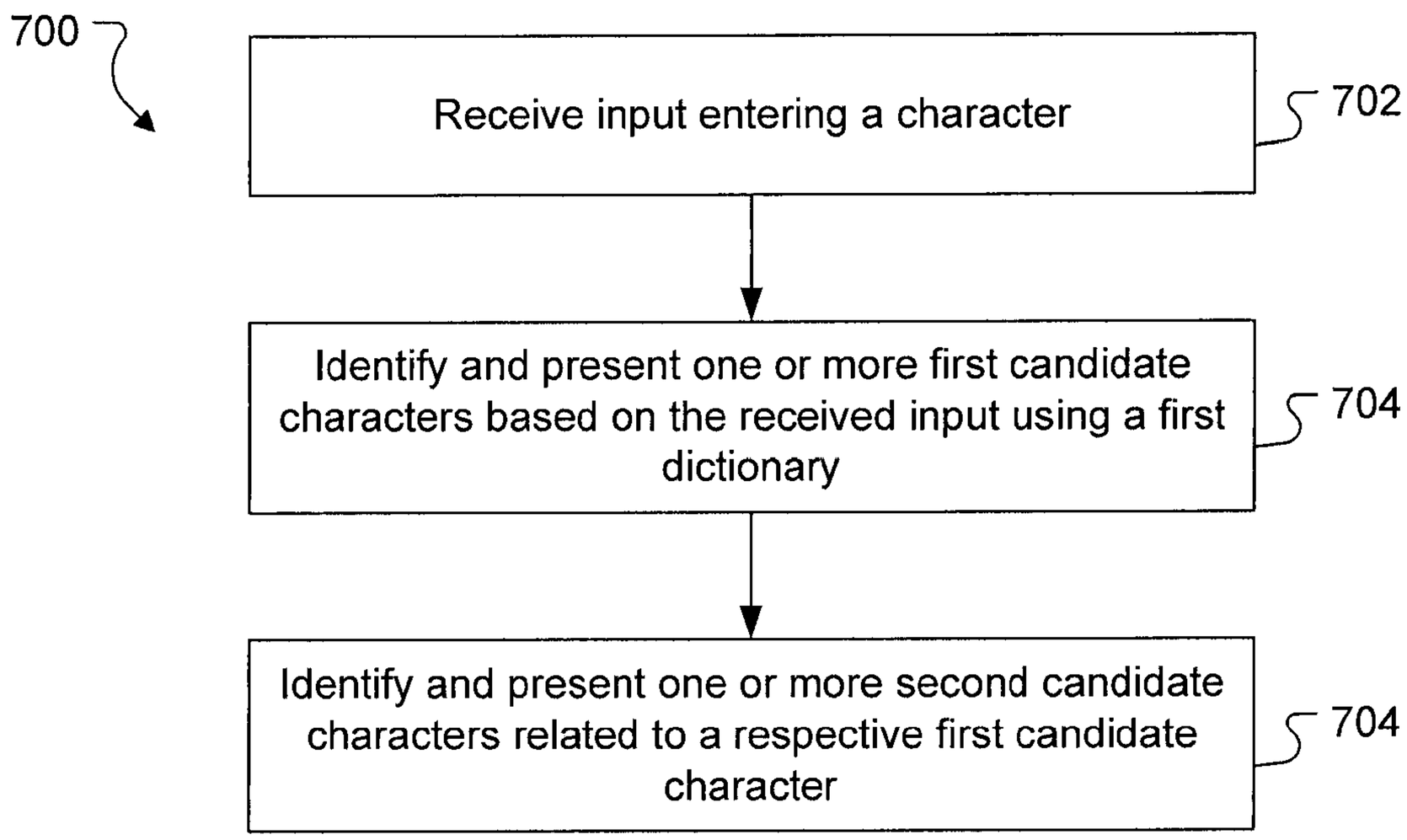

700
Receive input entering a character
702
Identify and present one or more first candidate characters based on the received input using a first dictionary
704
Identify and present one or more second candidate characters related to a respective first candidate character
704

FIG. 7

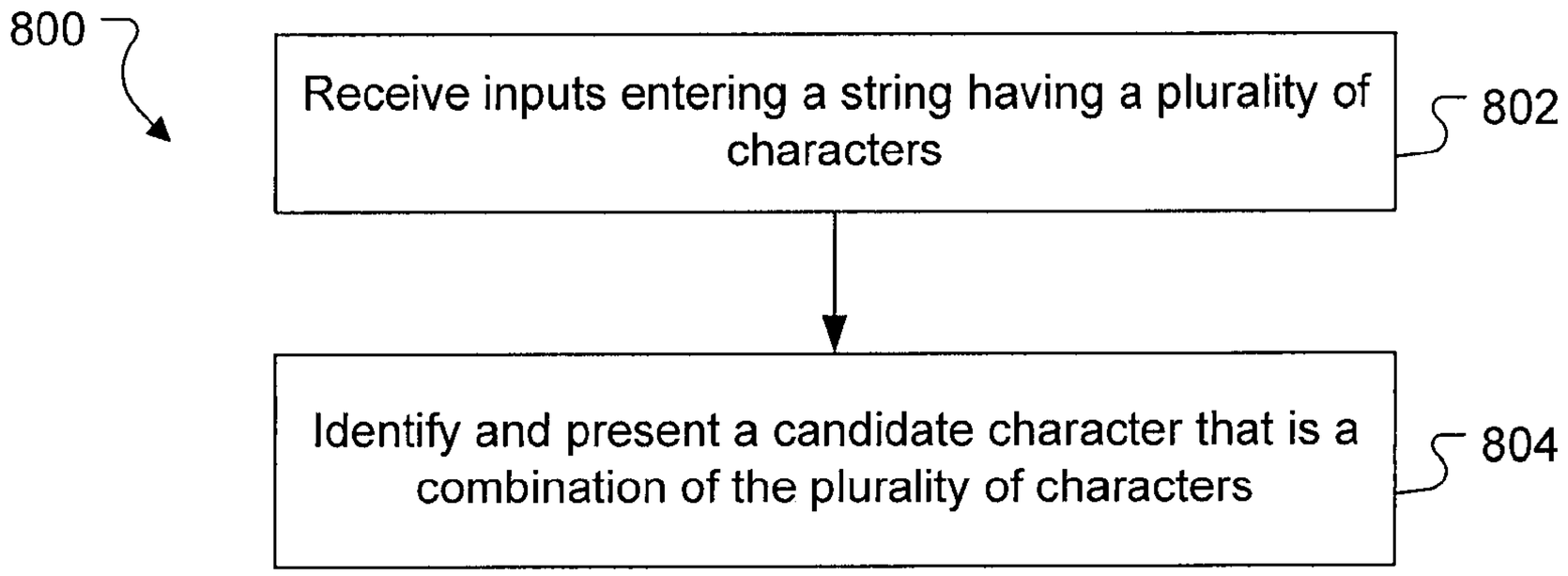

800
Receive inputs entering a string having a plurality of characters
802
Identify and present a candidate character that is a combination of the plurality of characters
804

FIG. 8

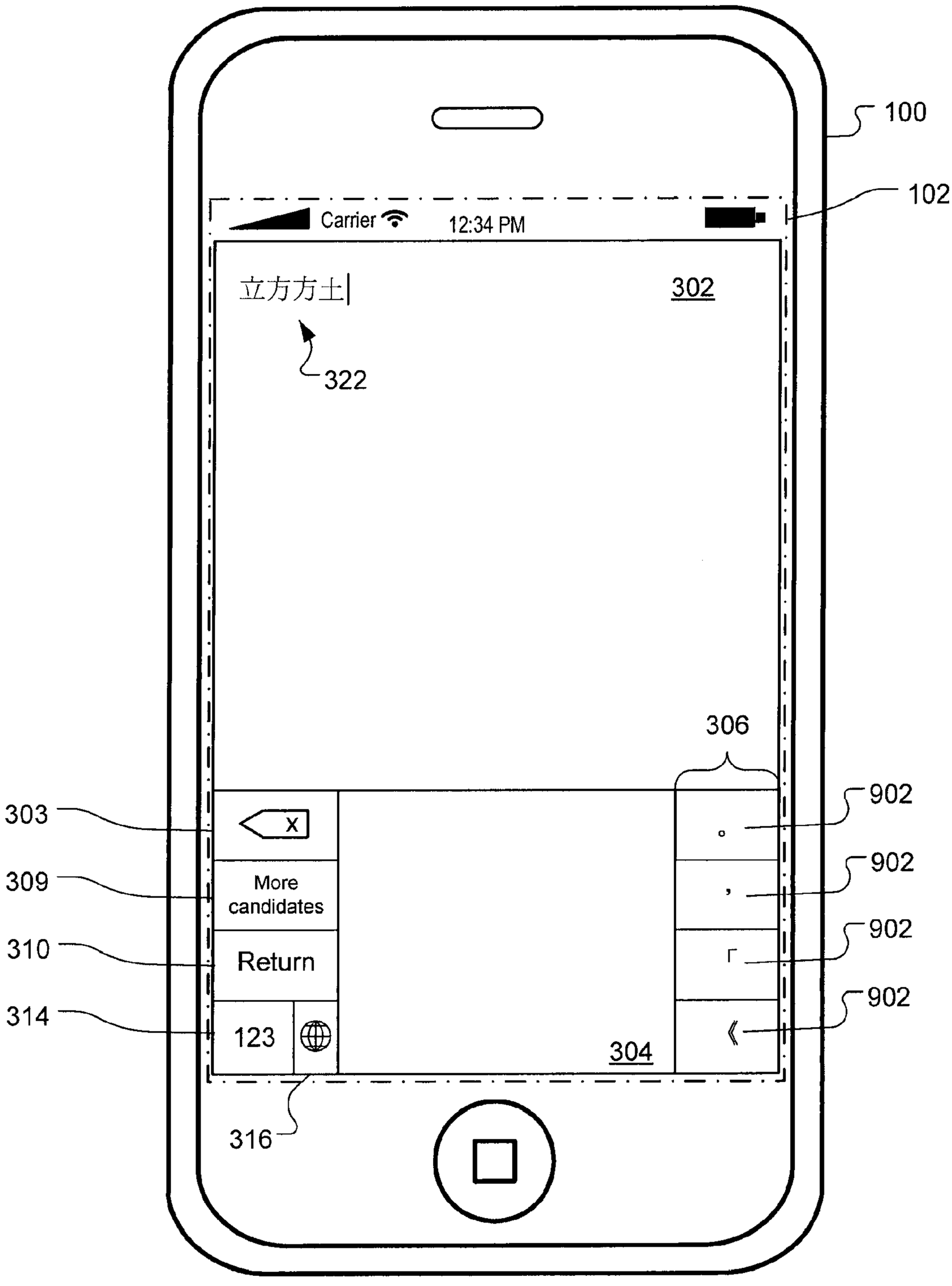

100
102
Carrier
12:34 PM
立方方土
302
322
306
303
309
310
314
316
X
More candidates
Return
123
304
902
902
902
902
。
，
「
《

FIG. 9

IDENTIFICATION OF CANDIDATE CHARACTERS FOR TEXT INPUT

RELATED APPLICATION

This application claims the benefit under 35 U.S.C. §119 of U.S. Provisional Application No. 61/057,757, titled "Identification of Candidate Characters for Text Input," filed May 30, 2008, which is incorporated by reference herein in its entirety.

BACKGROUND

The subject matter of this specification is related generally to text input interfaces.

A computer device can be configured to receive input of text and characters from a computer keyboard. Modern computer keyboards are composed of rectangular or near rectangular keys, and characters, such as the letters A-Z in the English alphabet, are usually engraved or printed on the keys. Generally, each press of a key corresponds to typing of a single character.

Traditional computer keyboards may be too large for portable devices, such as mobile phones, multimedia players, or personal digital assistants (PDAs). Some portable devices include a smaller version of the traditional computer keyboard or use a virtual keyboard to receive user input. A virtual keyboard can be of the form of a software application or a feature of a software application to simulate a computer keyboard. For example, in a portable device with a touch-sensitive display, a virtual keyboard can be used by a user to input text by selecting or tabbing areas of the touch-sensitive display corresponding to keys of the virtual keyboard.

These smaller keyboards and virtual keyboards may have keys that correspond to more than one character. For example, some of the keys can, by default, correspond to a character in the English language, for example, the letter "a," and may also correspond to other additional characters, such as another letter or the letter with an accent option, e.g., the character "ä," or other characters with accent options. Because of the physical limitations (e.g., size) of the virtual keyboard, a user may find it difficult to type characters not readily available on the virtual keyboard.

Input methods for devices having multi-language environments can present unique challenges with respect to input and spelling correction which may need to be tailored to the selected language to ensure accuracy and an efficient workflow.

SUMMARY

In general, one aspect of the subject matter described in this specification can be embodied in methods that include the actions of receiving an input entering a character, identifying and presenting one or more first candidate characters based on the received input using a first dictionary, and identifying and presenting one or more second candidate characters related to a respective first candidate character. Other embodiments of this aspect include corresponding systems, apparatus, devices, computer program products, and computer readable media.

In general, another aspect of the subject matter described in this specification can be embodied in methods that include the actions of receiving inputs entering a string having a plurality of characters, and identifying and presenting a candidate character that is a combination of the plurality of characters.

Other embodiments of this aspect include corresponding systems, apparatus, devices, computer program products, and computer readable media.

In general, another aspect of the subject matter described in this specification can be embodied in methods that include the actions of receiving one or more inputs entering a string one or more characters, and identifying and presenting one or more candidate character, where each of the candidate characters forms a respective word with one or more characters at the tail end of the string. Other embodiments of this aspect include corresponding systems, apparatus, devices, computer program products, and computer readable media.

Particular embodiments of the subject matter described in this specification can be implemented to realize one or more of the following advantages. Candidate characters that may not be identified by a handwriting recognition engine can be made available to a user. Characters can be made available to users in different ways. Performance of the handwriting recognition interface is enhanced. Certain complicated characters can be entered by a user more easily.

The details of one or more embodiments of the subject matter described in this specification are set forth in the accompanying drawings and the description below. Other features, aspects, and advantages of the subject matter will become apparent from the description, the drawings, and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of an example mobile device.

FIG. **2** is a block diagram of an example implementation of the mobile device of FIG. **1**.

FIGS. **3**A-**3**B illustrate an example user interface for entering characters using handwriting recognition.

FIG. **3**C illustrates an example of completion candidates.

FIG. **4** illustrates an example of synthetic candidates.

FIG. **5** illustrates an example of extension candidates.

FIGS. **6**A-**6**B illustrate an example of composition candidates.

FIG. **7** is a flow diagram illustrating an example process for identifying and presenting candidate characters related to another candidate character.

FIG. **8** is a flow diagram illustrating an example process for identifying and presenting a candidate character that includes multiple characters as components.

FIG. **9** illustrates an example of punctuation symbol candidates.

Like reference numbers and designations in the various drawings indicate like elements.

DETAILED DESCRIPTION

Example Mobile Device

FIG. **1** is a block diagram of an example mobile device **100**. The mobile device **100** can be, for example, a handheld computer, a personal digital assistant, a cellular telephone, a network appliance, a camera, a smart phone, an enhanced general packet radio service (EGPRS) mobile phone, a network base station, a media player, a navigation device, an email device, a game console, or a combination of any two or more of these data processing devices or other data processing devices.

Mobile Device Overview

In some implementations, the mobile device **100** includes a touch-sensitive display **102**. The touch-sensitive display

102 can implement liquid crystal display (LCD) technology, light emitting polymer display (LPD) technology, or some other display technology. The touch sensitive display **102** can be sensitive to haptic and/or tactile contact with a user.

In some implementations, the touch-sensitive display **102** can comprise a multi-touch-sensitive display **102**. A multi-touch-sensitive display **102** can, for example, process multiple simultaneous touch points, including processing data related to the pressure, degree, and/or position of each touch point. Such processing facilitates gestures and interactions with multiple fingers, chording, and other interactions. Other touch-sensitive display technologies can also be used, e.g., a display in which contact is made using a stylus or other pointing device. Some examples of multi-touch-sensitive display technology are described in U.S. Pat. Nos. 6,323,846, 6,570,557, 6,677,932, and 6,888,536, each of which is incorporated by reference herein in its entirety.

In some implementations, the mobile device **100** can display one or more graphical user interfaces on the touch-sensitive display **102** for providing the user access to various system objects and for conveying information to the user. In some implementations, the graphical user interface can include one or more display objects **104**, **106**. In the example shown, the display objects **104**, **106**, are graphic representations of system objects. Some examples of system objects include device functions, applications, windows, files, alerts, events, or other identifiable system objects.

Example Mobile Device Functionality

In some implementations, the mobile device **100** can implement multiple device functionalities, such as a telephony device, as indicated by a phone object **110**; an e-mail device, as indicated by the e-mail object **112**; a network data communication device, as indicated by the Web object **114**; a Wi-Fi base station device (not shown); and a media processing device, as indicated by the media player object **116**. In some implementations, particular display objects **104**, e.g., the phone object **110**, the e-mail object **112**, the Web object **114**, and the media player object **116**, can be displayed in a menu bar **118**. In some implementations, device functionalities can be accessed from a top-level graphical user interface, such as the graphical user interface illustrated in FIG. **1**. Touching one of the objects **110**, **112**, **114**, or **116** can, for example, invoke corresponding functionality.

In some implementations, the mobile device **100** can implement network distribution functionality. For example, the functionality can enable the user to take the mobile device **100** and provide access to its associated network while traveling. In particular, the mobile device **100** can extend Internet access (e.g., Wi-Fi) to other wireless devices in the vicinity. For example, mobile device **100** can be configured as a base station for one or more devices. As such, mobile device **100** can grant or deny network access to other wireless devices.

In some implementations, upon invocation of device functionality, the graphical user interface of the mobile device **100** changes, or is augmented or replaced with another user interface or user interface elements, to facilitate user access to particular functions associated with the corresponding device functionality. For example, in response to a user touching the phone object **110**, the graphical user interface of the touch-sensitive display **102** may present display objects related to various phone functions; likewise, touching of the email object **112** may cause the graphical user interface to present display objects related to various e-mail functions; touching the Web object **114** may cause the graphical user interface to present display objects related to various Web-surfing functions; and touching the media player object **116** may cause the graphical user interface to present display objects related to various media processing functions.

In some implementations, the top-level graphical user interface environment or state of FIG. **1** can be restored by pressing a button **120** located near the bottom of the mobile device **100**. In some implementations, each corresponding device functionality may have corresponding "home" display objects displayed on the touch-sensitive display **102**, and the graphical user interface environment of FIG. **1** can be restored by pressing the "home" display object.

In some implementations, the top-level graphical user interface can include additional display objects **106**, such as a short messaging service (SMS) object **130**, a calendar object **132**, a photos object **134**, a camera object **136**, a calculator object **138**, a stocks object **140**, a weather object **142**, a maps object **144**, a notes object **146**, a clock object **148**, an address book object **150**, and a settings object **152**. Touching the SMS display object **130** can, for example, invoke an SMS messaging environment and supporting functionality; likewise, each selection of a display object **132**, **134**, **136**, **138**, **140**, **142**, **144**, **146**, **148**, **150**, and **152** can invoke a corresponding object environment and functionality.

Additional and/or different display objects can also be displayed in the graphical user interface of FIG. **1**. For example, if the device **100** is functioning as a base station for other devices, one or more "connection" objects may appear in the graphical user interface to indicate the connection. In some implementations, the display objects **106** can be configured by a user, e.g., a user may specify which display objects **106** are displayed, and/or may download additional applications or other software that provides other functionalities and corresponding display objects.

In some implementations, the mobile device **100** can include one or more input/output (I/O) devices and/or sensor devices. For example, a speaker **160** and a microphone **162** can be included to facilitate voice-enabled functionalities, such as phone and voice mail functions. In some implementations, an up/down button **184** for volume control of the speaker **160** and the microphone **162** can be included. The mobile device **100** can also include an on/off button **182** for a ring indicator of incoming phone calls. In some implementations, a loud speaker **164** can be included to facilitate hands-free voice functionalities, such as speaker phone functions. An audio jack **166** can also be included for use of headphones and/or a microphone.

In some implementations, a proximity sensor **168** can be included to facilitate the detection of the user positioning the mobile device **100** proximate to the user's ear and, in response, to disengage the touch-sensitive display **102** to prevent accidental function invocations. In some implementations, the touch-sensitive display **102** can be turned off to conserve additional power when the mobile device **100** is proximate to the user's ear.

Other sensors can also be used. For example, in some implementations, an ambient light sensor **170** can be utilized to facilitate adjusting the brightness of the touch-sensitive display **102**. In some implementations, an accelerometer **172** can be utilized to detect movement of the mobile device **100**, as indicated by the directional arrow **174**. Accordingly, display objects and/or media can be presented according to a detected orientation, e.g., portrait or landscape. In some implementations, the mobile device **100** may include circuitry and sensors for supporting a location determining capability, such as that provided by the global positioning system (GPS) or other positioning systems (e.g., systems using Wi-Fi access points, television signals, cellular grids,

Uniform Resource Locators (URLs)). In some implementations, a positioning system (e.g., a GPS receiver) can be integrated into the mobile device **100** or provided as a separate device that can be coupled to the mobile device **100** through an interface (e.g., port device **190**) to provide access to location-based services.

In some implementations, a port device **190**, e.g., a Universal Serial Bus (USB) port, or a docking port, or some other wired port connection, can be included. The port device **190** can, for example, be utilized to establish a wired connection to other computing devices, such as other communication devices **100**, network access devices, a personal computer, a printer, a display screen, or other processing devices capable of receiving and/or transmitting data. In some implementations, the port device **190** allows the mobile device **100** to synchronize with a host device using one or more protocols, such as, for example, the TCP/IP, HTTP, UDP and any other known protocol.

The mobile device **100** can also include a camera lens and sensor **180**. In some implementations, the camera lens and sensor **180** can be located on the back surface of the mobile device **100**. The camera can capture still images and/or video.

The mobile device **100** can also include one or more wireless communication subsystems, such as an 802.11b/g communication device **186**, and/or a Bluetooth™ communication device **188**. Other communication protocols can also be supported, including other 802.x communication protocols (e.g., WiMax, Wi-Fi, 3G), code division multiple access (CDMA), global system for mobile communications (GSM), Enhanced Data GSM Environment (EDGE), etc.

Example Mobile Device Architecture

FIG. **2** is a block diagram **200** of an example implementation of the mobile device **100** of FIG. **1**. The mobile device **100** can include a memory interface **202**, one or more data processors, image processors and/or central processing units **204**, and a peripherals interface **206**. The memory interface **202**, the one or more processors **204** and/or the peripherals interface **206** can be separate components or can be integrated in one or more integrated circuits. The various components in the mobile device **100** can be coupled by one or more communication buses or signal lines.

Sensors, devices, and subsystems can be coupled to the peripherals interface **206** to facilitate multiple functionalities. For example, a motion sensor **210**, a light sensor **212**, and a proximity sensor **214** can be coupled to the peripherals interface **206** to facilitate the orientation, lighting, and proximity functions described with respect to FIG. **1**. Other sensors **216** can also be connected to the peripherals interface **206**, such as a positioning system (e.g., GPS receiver), a temperature sensor, a biometric sensor, or other sensing device, to facilitate related functionalities.

A camera subsystem **220** and an optical sensor **222**, e.g., a charged coupled device (CCD) or a complementary metal-oxide semiconductor (CMOS) optical sensor, can be utilized to facilitate camera functions, such as recording photographs and video clips.

Communication functions can be facilitated through one or more wireless communication subsystems **224**, which can include radio frequency receivers and transmitters and/or optical (e.g., infrared) receivers and transmitters. The specific design and implementation of the communication subsystem **224** can depend on the communication network(s) over which the mobile device **100** is intended to operate. For example, a mobile device **100** may include communication subsystems **224** designed to operate over a GSM network, a GPRS network, an EDGE network, a Wi-Fi or WiMax network, and a Bluetooth™ network. In particular, the wireless communication subsystems **224** may include hosting protocols such that the device **100** may be configured as a base station for other wireless devices.

An audio subsystem **226** can be coupled to a speaker **228** and a microphone **230** to facilitate voice-enabled functions, such as voice recognition, voice replication, digital recording, and telephony functions.

The I/O subsystem **240** can include a touch screen controller **242** and/or other input controller(s) **244**. The touch-screen controller **242** can be coupled to a touch screen **246**. The touch screen **246** and touch screen controller **242** can, for example, detect contact and movement or break thereof using any of a plurality of touch sensitivity technologies, including but not limited to capacitive, resistive, infrared, and surface acoustic wave technologies, as well as other proximity sensor arrays or other elements for determining one or more points of contact with the touch screen **246**.

The other input controller(s) **244** can be coupled to other input/control devices **248**, such as one or more buttons, rocker switches, thumb-wheel, infrared port, USB port, and/or a pointer device such as a stylus. The one or more buttons (not shown) can include an up/down button for volume control of the speaker **228** and/or the microphone **230**.

In one implementation, a pressing of the button for a first duration may disengage a lock of the touch screen **246**; and a pressing of the button for a second duration that is longer than the first duration may turn power to the mobile device **100** on or off. The user may be able to customize a functionality of one or more of the buttons. The touch screen **246** can, for example, also be used to implement virtual or soft buttons and/or a keyboard.

In some implementations, the mobile device **100** can present recorded audio and/or video files, such as MP3, AAC, and MPEG files. In some implementations, the mobile device **100** can include the functionality of an MP3 player, such as an iPod™. The mobile device **100** may, therefore, include a 36-pin connector that is compatible with the iPod. Other input/output and control devices can also be used.

The memory interface **202** can be coupled to memory **250**. The memory **250** can include high-speed random access memory and/or non-volatile memory, such as one or more magnetic disk storage devices, one or more optical storage devices, and/or flash memory (e.g., NAND, NOR). The memory **250** can store an operating system **252**, such as Darwin, RTXC, LINUX, UNIX, OS X, WINDOWS, or an embedded operating system such as VxWorks. The operating system **252** may include instructions for handling basic system services and for performing hardware dependent tasks. In some implementations, the operating system **252** can be a kernel (e.g., UNIX kernel).

The memory **250** may also store communication instructions **254** to facilitate communicating with one or more additional devices, one or more computers and/or one or more servers. The memory **250** may include graphical user interface instructions **256** to facilitate graphic user interface processing; sensor processing instructions **258** to facilitate sensor-related processing and functions; phone instructions **260** to facilitate phone-related processes and functions; electronic messaging instructions **262** to facilitate electronic-messaging related processes and functions; web browsing instructions **264** to facilitate web browsing-related processes and functions; media processing instructions **266** to facilitate media processing-related processes and functions; GPS/Navigation instructions **268** to facilitate GPS and navigation-related processes and instructions; camera instructions **270** to facilitate

camera-related processes and functions; and/or other software instructions **272** to facilitate other processes and functions, e.g., security processes and functions. The memory **250** may also store other software instructions (not shown), such as web video instructions to facilitate web video-related processes and functions; and/or web shopping instructions to facilitate web shopping-related processes and functions. In some implementations, the media processing instructions **266** are divided into audio processing instructions and video processing instructions to facilitate audio processing-related processes and functions and video processing-related processes and functions, respectively. An activation record and International Mobile Equipment Identity (IMEI) **274** or similar hardware identifier can also be stored in memory **250**.

Language data **276** can also be stored in memory **250**. Language data **276** can include, for example, word dictionaries (i.e., list of possible words in a language) for one or more languages, dictionaries of characters and corresponding phonetics and characteristics (e.g., stroke positions and order, etc.), one or more corpuses or dictionaries of characters and character compounds (e.g., words, phrases), and so on. In some implementations, memory **250** stores instructions for a handwriting recognition engine **277** for recognizing handwritten input and matching the input to one or more candidate characters.

Each of the above identified instructions and applications can correspond to a set of instructions for performing one or more functions described above. These instructions need not be implemented as separate software programs, procedures, or modules. The memory **250** can include additional instructions or fewer instructions. Furthermore, various functions of the mobile device **100** may be implemented in hardware and/or in software, including in one or more signal processing and/or application specific integrated circuits.

Handwriting Interface

FIGS. **3**A-**3**B illustrate an example user interface for entering characters using handwriting recognition on a mobile device **100**. Mobile device **100** can display a composition area **302** and a handwriting area **304** on the touch-sensitive display **102**. Input text can be displayed in the composition area **302**. In some implementations, the composition area **302** is the area in an application (e.g., a note-taking application, an email application, etc.) where input text is displayed.

For convenience, the implementations described in this specification are described in reference to entry of Chinese characters (simplified and/or traditional). It should be appreciated that the described implementations can be adapted to entry of text in other languages or even a mix of multiple languages.

The handwriting area **304** provides a region on the touch-sensitive display **102** where a user can draw or handwrite an input. The touch-sensitive display **102** can display one or more virtual keys, buttons, or the like, that provide additional functionality. In some implementations, the additional keys include one or more of: a delete/backspace key **303** for deleting input characters; a space key **308** for entering white space; a return key **310** for entering a line break, paragraph break, or the like; and numbers and punctuation keyboard toggle key **314** for toggling between the handwriting area **304** and a virtual keyboard with number and punctuation keys, and an input method key **316** for switching between a plurality of input methods for one or more languages (e.g., QWERTY keyboard, Japanese kana keyboard, etc.). Other keys for other functionality are possible.

In some implementations, the handwriting area **304** is accompanied by one or more virtual candidate keys **306**. In some implementations, the virtual candidate keys **306** are arranged in a vertical column adjacent to the handwriting area **304**. A candidate for a handwritten input can be selected using the candidate keys **306**; the selected candidate confirms the character that the user attempted to draw in the handwriting area **304**.

FIG. **3**B illustrates an example handwritten input **318** written in the handwriting area **304**. A user can write a handwritten input **318** into the handwriting area **304** by writing one or more strokes (e.g., lines, curves, etc.) in the handwriting area **304**. After the drawing of the input **318** into the handwriting area **304**, one or more candidate characters **320** for the input **318** are presented in the candidate keys **306**. In some implementations, the candidate characters **320** are identified by a handwriting recognition engine (e.g., handwriting recognition engine **277**) based on the handwritten input **318**. The handwriting recognition engine recognizes handwritten input and, based on the characteristics of the handwritten input **318**, identifies one or more candidates from a dictionary. In some implementations, the candidates identified by the handwriting recognition engine are, according to the engine, the "best" matches to the handwritten input **318**. The characteristics can include the strokes and the start/end points of these strokes, the positions of the strokes and start/end points relative to each other, and the order in which the strokes were written. An example of a handwriting recognition engine is disclosed in Liu et al., "Online Recognition of Chinese Characters: The State-of-the-Art," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, Vol. 26, No. 2, pp. 198-213, February 2004. Another example of a handwriting recognition engine is disclosed in Sacher, "Interactions in Chinese: Designing Interfaces for Asian Languages," Interactions Magazine, Volume 5, Issue 5, September-October 1998, pages 28-38.

In some implementations, when candidate characters are shown in the candidate keys **306** and there are more candidate characters available than can be shown all at once in the available virtual candidate keys **306**, the space key **308** can be replaced by a "more candidates" key **309**. By hitting the "more candidates" key **309**, the user can page through or cycle through the "list" of candidates. In some implementations, the user can also scroll through the list of candidates by performing a flicking gesture (up or down) on the touch-sensitive display **102**.

In some implementations, the candidates are identified and ordered using predictive text and/or error correction techniques. Examples of predictive text techniques are disclosed in Masui, "An Efficient Text Input Method for Pen-based Computers," in Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '98), Addison-Wesley, April 1998, pp. 328-335; and Masui, "POBox: An Efficient Text Input Method for Handheld and Ubiquitous Computers," in Proceedings of the International Symposium on Handheld and Ubiquitous Computing (HUC '99), pp. 289-300, September 1999.

The user can select one of the candidate characters **320** to enter that character. For example, if the user selects candidate character **320**-A (in FIG. **3**B, the character "中"), then that character is displayed in the composition area **302** as part of the current input **322**, as shown in FIG. **3**C. In some implementations, if the user does not select a candidate character for the input and does not cancel the input, the first candidate character (e.g., the candidate character that is displayed in the topmost candidate character key **306** at the moment, or the "best match" candidate character) is automatically selected by the device **100** after a predefined amount of time has

elapsed (e.g., 3 seconds). After a candidate is selected, the handwriting area **304** can be cleared so that the handwriting area **304** can be ready to receive another handwritten input.

In some implementations, after a candidate character **320** is selected (or more generally, after any character is entered), additional candidates can be shown in the candidate keys **306**. For example, completion candidates **324** can be shown in the candidate keys **306**, as illustrated in FIG. **3**C. Completion candidates are candidates (each having one or more characters) that "complement" a string of one or more characters in the current input **322** (e.g., one or more characters at the end of the current input **322**, one or more characters selected by the user, etc.) to form multi-character words or phrases, or more generally, to form compounds of multiple characters. For example, for the character "中" in the current input **322**, completion candidates **324** can include "國" (to form the word "中國" (China)), "華" (to form the word "中華" (China)), "心" (to form the word "中心" (center)), and "央" (to form the word "中央" (central)), as shown in FIG. **3**C. The user can select any of the completion candidates **324** (by hitting a candidate key **306** with the desired completion candidate **324**) to form the word, or the user can write a new input into the handwriting area **304** (i.e., ignore the completion candidates **324**). In some implementations, the completion candidates are identified by searching a dictionary for multi-character words/phrases that contain the pertinent character(s) in the current input **322** (e.g., the last character(s) in the current input **322**). In this way, the completion candidates **324** provide a word or phrase "auto-complete" functionality to the entry of Chinese text.

In some implementations, additional candidate characters beyond those identified by the engine can be identified and presented. In some implementations, the additional candidate characters include extension candidates, synthetic candidates, and/or composition candidates, further details of which are described below.

Synthetic Candidates

FIG. **4** illustrates an example of synthetic candidates. In FIG. **4**, a handwritten input is written into the handwriting area **304**. One or more candidate characters **320** are identified by a handwriting recognition engine and presented in the candidate keys **306**. In addition to the candidates **320**, one or more synthetic candidates **402** can be identified and presented in the candidate keys **306**. In some implementations, the synthetic candidates **402** for a particular candidate **320** are presented right after the particular candidate **320** in the "list" of candidates. The user can select a synthetic candidate **402** by hitting the appropriate candidate key **306**.

For example, for the handwritten input **318** as shown in FIG. **4**, candidates **320** are identified by the handwriting recognition engine. For candidate **320**-B ("圶"), synthetic candidate **402** ("堃"), which resembles candidate **320**-B, is identified and presented to the user for possible selection by the user.

A synthetic candidate, as used in this specification, is a candidate character that resembles a candidate **320** identified by the handwriting recognition engine. A synthetic candidate can be a better actual match to the handwritten input **318** than any of the engine-identified candidates **320**, but is not identified by the recognition engine because, for example, the synthetic candidate character is not in the dictionary used by the recognition engine.

In some implementations, possible synthetic candidates are stored in memory **250** as a table or another dictionary (e.g., in language data **276**) that maps characters in a dictionary that is used by the recognition engine **277** to characters that resemble the characters in the recognition engine dictionary. When a candidate **320** is identified by the recognition engine **277**, the synthetic candidates table/dictionary can be searched for the candidate **320**, and the synthetic candidate(s) to which the candidate **320** is mapped are identified and presented.

In some implementations, the functionality of the identification and presentation of synthetic candidates is affected by how the handwriting recognition engine handles a handwritten input that the engine does not recognize. For example, if the handwriting recognition engine, when presented with a handwritten input that it cannot recognize, outputs a relatively small set of "best guess" characters as candidates, then synthetic candidates can be identified and presented. If, on the other hand, the handwriting recognition engine, in the same situation, outputs a relatively large, random set of characters, then identification of synthetic candidates can be inefficient (because synthetic candidates would need to be identified for a large, unpredictable set characters) and thus not performed.

Extension Candidates

FIG. **5** illustrates an example of extension candidates. In FIG. **5**, a handwritten input **318** is written into the handwriting area **304**. One or more candidate characters **320** are identified by a handwriting recognition engine and presented in the candidate keys **306**. In addition to the candidates **320**, one or more extension candidates **502** can be identified and presented in the candidate keys **306**. In some implementations, the extension candidates **502** are presented at the end of the "list" of candidates for the handwritten input **318**. The user can select an extension candidate **502** by hitting the appropriate candidate key **306**.

For example, for the handwritten input **318** as shown in FIG. **5**, candidates **320** are identified by the handwriting recognition engine. For candidate **320**-C ("人"), extension candidates **502** ("仌", "众") are identified and presented to the user for possible selection by the user.

An extension candidate, as used in this specification, is a candidate character that is related to a candidate **320** identified by the handwriting recognition engine. In some implementations, the relation is based on related semantics or meaning. For example, returning to the example described above, the character "人" means person or people, and "众" (simplified form of "衆") conveys the semantics of "the public" or "the masses (of people)." As another example, for the character "一" (the Chinese character for the numeral one), the Arabic numeral "1" and the Roman numeral "I" can be identified and presented as extension candidates based on related semantics/meaning.

In some implementations, the relation is based on structure; a character that is structurally composed of another character (e.g., structurally composed of multiple instances of that another character) can be identified and presented as an extension candidate for that another character. For example, for the character "金", extension candidates "鉴" and "鑫" can be identified as extension candidates. As another example, "龖" and "龘" can be example extension candidates, based on structure, for "龍".

In some implementations, possible extension candidates are stored in memory **250** as a table or another dictionary (e.g., in language data **276**) that maps characters in a dictionary that is used by the recognition engine **277** to related characters. When a candidate **320** is identified by the recog-

nition engine **277**, the extension candidates table/dictionary can be searched for the candidate **320**, and the extension candidate(s) to which the candidate **320** is mapped are identified and presented.

Composition Candidates

FIG. **6** illustrates an example of composition candidates. In FIG. **6**, a plurality of characters has been entered serially into a string (e.g., by handwriting recognition and selection of candidates as described above) and is shown as the current input **322**. One or more completion candidates **324** for the last character ("土") in the current input **322** are identified and presented in the candidate keys **306**. In addition to the completion candidates **324**, one or more composition candidates **602** can be identified and presented in the candidate keys **306**. In some implementations, the composition candidates **602** are presented at the end of the "list," after the completion candidates **324**. The user can select a composition candidate **602** by hitting the appropriate candidate key **306**. In some implementations, a composition candidate **602** is displayed in a candidate key **306** with an arrow, as shown in FIG. **6**, to distinguish the composition candidate from other types of candidates (e.g., the same character provided as synthetic candidate).

For example, for the characters "方方土" in the current input **322** as shown in FIG. **6**, completion candidates **324** ("地","方","木") are identified and presented based on the character "土". A composition candidate **602** ("堃") for the characters "方方土" in the current input **322** can be identified and presented to the user for possible selection by the user.

A composition candidate, as used in this specification, is a candidate character that is structurally composed of multiple characters in the current input **322**. In some implementations, the composition candidate is composed of multiple consecutive characters in the current input **322**. For example, returning to the example in FIG. **6**, the composition candidate character "堃" includes the characters in the multi-character string "方方土" as components.

In some implementations, possible composition candidates are stored in memory **250** as a table or another dictionary (e.g., in language data **276**) that maps characters in a dictionary that is used by the recognition engine **277** to characters that contain the possible composition candidates as components. The composition candidates table/dictionary is searched for one or more characters in the tail end of the current input **322**, and the composition candidate(s) to which the characters in the current input **322** are mapped are identified and presented.

In some implementations, the user can have the device **100** hide the completion candidates **324** and put the composition candidate **602** in the first candidate key **306** (as shown in FIG. **6**B, for example) by performing a predetermined gesture on the touch-sensitive display after the plurality of characters is entered (e.g., a pinching gesture in the handwriting area **304**).

In some implementations, a user can enter a composition candidate character by "dragging and dropping." For example, returning to the example in FIG. **6**, after the string "方方" is entered and the user handwrites "方方土" into the handwriting area **304**, the candidate "方方土" is displayed as a candidate **320** in the candidate keys **306**. The user can drag and drop the candidate "方方土" from the candidate keys **306** into the composition area **302** and into the proximity of the string "方方" in the current input **322**. In response the dragging and dropping, the composition candidate **602** is displayed in the candidate keys **306** instead of the completion candidates **324**.

In some implementations, the dictionary or dictionaries for synthetic, extension, and composition candidates are built empirically and installed into the device **100** by the developer or manufacturer of the device **100**.

In some implementations, if a user taps the handwriting area **304** while the handwriting area **304** is blank, one or more punctuation symbols **902** can be presented to the user as candidates in the candidate keys **306**, as shown in FIG. **9**. The user can enter a punctuation symbol into the text by selecting the candidate key **306** with the desired punctuation symbol.

FIG. **7** is a flow diagram illustrating a process **700** for identifying candidates related to another candidate character. Process **700** is described in reference to a device (e.g., device **100**) that performs the process.

An input entering a character is received (**702**). A user, in an attempt to enter a character, can handwrite an input into a handwriting area **304** of device **100**.

One or more first candidate characters are identified, based on the received input and using a first dictionary, and presented (**704**). The device **100** can recognize the handwritten input and identify one or more candidates from a dictionary that best matches the handwritten input, as recognized by the device **100**. The candidates can be presented to the user on a display **102** for selection.

One or more first candidate characters are identified, based on the received input and using a first dictionary, and presented (**704**). The device **100** can recognize the handwritten input and identify one or more candidates from a dictionary that best matches the handwritten input, as recognized by the device **100**. The candidates can be presented to the user on a display **102** for selection.

One or more second candidate characters that are related to a first candidate character are identified and presented (**706**). The device **100** can identify one or more second candidate characters that are related to any one of the first candidate characters with respect to appearance (e.g., synthetic candidates) or semantics/meaning (e.g., extension candidates). The second candidates can be presented together with the first candidates, so that the user can select the desired candidate.

FIG. **8** is a flow diagram illustrating an example process **800** for identifying and presenting a candidate character that includes multiple characters as components. Process **800** is described in reference to a device (e.g., device **100**) that performs the process.

Inputs entering a string having a plurality of characters are received (**802**). A user can enter a plurality of characters into a device **100** using handwriting and candidate selection as described above.

A candidate characters that is a combination of the plurality of characters is identified and presented (**804**). The device **100** can look up a table or dictionary for a composition candidate character that is a structural combination of the plurality of characters. The composition candidate can be presented to the user for selection.

In some implementations, the identification of synthetic, extension, and composition candidates is transparent to the user. That is, the user is presented with the candidates as if they are recognized by the recognition engine; the user does not know that the recognition engine does not necessarily include the synthetic, extension, and composition candidates.

It should be appreciated that while the implementations described above are described in reference to an input method

based on handwriting recognition, the described implementations can be adapted to other input methods (e.g., keyboard-based input methods).

While this specification contains many specifics, these should not be construed as limitations on the scope of what being claims or of what may be claimed, but rather as descriptions of features specific to particular embodiments. Certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable subcombination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a subcombination or variation of a subcombination.

Particular embodiments of the subject matter described in this specification have been described. Other embodiments are within the scope of the following claims. For example, the actions recited in the claims can be performed in a different order and still achieve desirable results. As one example, the processes depicted in the accompanying figures do not necessarily require the particular order shown, or sequential order, to achieve desirable results.

What is claimed is:

1. A method, comprising:

at a device with a touch-sensitive display, one or more processors, and memory:

receiving a handwritten input for a logographic character with the touch-sensitive display;

identifying and presenting one or more first candidate logographic characters for the handwritten input using a first dictionary; and

identifying and presenting one or more second candidate logographic characters based on a respective first candidate logographic character from among the one or more first candidate logographic characters, wherein the one or more second candidate logographic characters are identified using a mapping in a second dictionary that maps the respective first candidate logographic character to the one or more second candidate logographic characters based on related semantics or meaning of the respective first candidate logographic character.

2. The method of claim **1**, wherein the second dictionary, includes mappings from characters in the first dictionary to characters that resemble the characters in the first dictionary.

3. The method of claim **1**, wherein identifying and presenting one or more second logographic candidate characters based on the respective first candidate logographic character comprises identifying and presenting one or more extension candidate characters.

4. The method of claim **1**, wherein the logographic character is a Chinese character.

5. A device, comprising:

a touch-sensitive display;

one or more processors;

memory; and

one or more programs, wherein the one or more programs are stored in the memory and configured to be executed by the one or more processors, the one or more programs including instructions for:

receiving a handwritten input for a logographic character with the touch-sensitive display;

identifying and presenting one or more first candidate logographic characters for the handwritten input using a first dictionary; and

identifying and presenting one or more second candidate logographic characters based on a respective first candidate logographic character from among the one or more first candidate logographic characters, wherein the one or more second candidate logographic characters are identified using a mapping in a second dictionary that maps the respective first candidate logographic character to the one or more second candidate logographic characters based on related semantics or meaning of the respective first candidate logographic character.

6. The device of claim **5**, wherein the second dictionary includes mappings from characters in the first dictionary to characters that resemble the characters in the first dictionary.

7. The device of claim **5**, wherein identifying and presenting one or more second logographic candidate characters based on the respective first candidate logographic character comprises identifying and presenting one or more extension candidate characters.

8. The device of claim **5**, wherein the logographic character is a Chinese character.

9. A non-transitory computer-readable medium storing one or more programs, the one or more programs comprising instructions, which when executed by a device with a touch-sensitive display, cause the device to:

receive a handwritten input for a logographic character with the touch-sensitive display;

identify and present one or more first candidate logographic characters for the handwritten input using a first dictionary; and

identify and present one or more second candidate logographic characters based on a respective first candidate logographic character from among the one or more first candidate logographic characters, wherein the one or more second candidate logographic characters are identified using a mapping in a second dictionary that maps the respective first candidate logographic character to the one or more second candidate logographic characters based on related semantics or meaning of the respective first candidate logographic character.

10. The computer-readable medium of claim **9**, wherein the second dictionary includes mappings from characters in the first dictionary to characters that resemble the characters in the first dictionary.

11. The computer-readable medium of claim **9**, wherein identifying and presenting one or more second logographic candidate characters based on the respective first candidate logographic character comprises identifying and presenting one or more extension candidate characters.

12. The computer-readable medium of claim **9**, wherein the logographic character is a Chinese character.

* * * * *