UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF WASHINGTON
AT SEATTLE

TEGIC COMMUNICATIONS CORPORATION,

Plaintiff,

v.

BOARD OF REGENTS OF THE UNIVERSITY OF TEXAS SYSTEM,

Defendant.

No. C05 723L

COMPLAINT FOR DECLARATORY JUDGMENT OF: (1) PATENT INVALIDITY; (2) PATENT UNENFORCEABILITY; AND (3) NONINFRINGEMENT

Plaintiff Tegic Communications Corporation ("Plaintiff") brings this action for declaratory judgment to resolve contested issues relating to Plaintiff's T9 Text Input software, and complains as follows:

Introduction

1. In March of 2005, the Board of Regents of the University of Texas System ("Defendant") brought two lawsuits in the United States District Court for the Western District of Texas ("Texas Litigations"). In these actions, Defendant claims that 24 customers of Plaintiff have infringed its patent for a so-called "Character Pattern Recognition and Communications Apparatus" by making, using, selling, offering for sale, and/or importing in or into the United States, without authority, products that fall within the scope of the claims of its patent. Complaint ¶¶ 23-37, Board of Regents v. BenQ, et al., A-05-CA-181 SS (W.D.

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Tex., March 11, 2005); *Complaint* ¶¶ 28-42, Board of Regents v. Alcatel, et. al., A-05-CA-198 SS (W.D. Tex., March 22, 2005). Defendant specifically listed cellular telephones manufactured or sold by Plaintiff's customers. Id. All of these cellular telephones produced by Plaintiff's customers that are named in Defendant's complaints utilize Plaintiff's T9 Text Input software for inputting text into cellular telephones, as Plaintiff has licensed its T9 software to its customers. Defendant's misplaced claims of infringement are directed at the T9 software.

2. Although Defendant has brought these actions against many of Plaintiff's customers for alleged patent infringement caused by Plaintiff's T9 software, Defendant has chosen not to bring suit against Plaintiff. Defendant's claims in the Texas Litigations jeopardize Plaintiff's business in several ways, including threatening Plaintiff's customer relationships. In addition, Plaintiff's customers have demanded indemnification from Plaintiff pursuant to customer contracts as a result of Defendant's infringement claims.

3. Plaintiff denies that its T9 software, and the use of the T9 software by its customers who are defendants in the Texas Litigations, infringes Defendant's patent. Plaintiff further contends that Defendant's patent is invalid and unenforceable. Plaintiff seeks a declaration confirming its continued right to license, make, use, sell, import and offer to sell its T9 software, just as it has from its Seattle-based offices since at least 1996.

Parties

4. Plaintiff Tegic Communications Corporation is incorporated in the State of Washington and has its principal place of business in Seattle, Washington.

5. Defendant Board of Regents of the University of Texas System is an agency of the executive branch of the State of Texas.

Jurisdiction

6. This action arises under the patent laws of the United States, 35 U.S.C. §§ 1 et seq.

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7. This Court has subject matter jurisdiction under the provisions of 28 U.S.C. §§ 1331 and 1338(a).

8. This Court can enter the declaratory relief sought in this Complaint because this case presents an actual case and controversy and is within this Court's jurisdiction pursuant to the provisions of the Federal Declaratory Judgment Act, 28 U.S.C. § 2201. An actual case and controversy exists because Defendant has brought two patent infringement actions against Plaintiff's customers that appear to be based upon the allegedly infringing function of Plaintiff's T9 software. Defendant has thereby harmed Plaintiff's economic interests by impairing its ability to license its T9 software to its current and any future customers. Therefore, Plaintiff is the real party in interest to the Texas Litigations because it will be forced to expend considerable time, effort, and money in defending these actions.

Venue

9. Plaintiff is a Washington corporation with its principle place of business in Seattle, Washington, which is within this District.

10. Plaintiff developed its T9 software for inputting text on cellular phones in Seattle, Washington, which is within this district. The T9 software gives rise to these claims of patent invalidity, unenforceability, and noninfringement.

11. Venue is therefore proper in this judicial district under the provisions of 28 U.S.C. § 1391(b), because Defendant has brought two patent infringement actions against the customers of Plaintiff's T9 software, which was developed and produced in this judicial district, as well as other actions. The customers of Plaintiff whom Defendant sued for infringement have all entered into customer agreements with Plaintiff, who is a resident of this judicial district. As such, a substantial part of the events or omissions giving rise to the claims occurred, or a substantial part of the property that is the subject of the action is located, in this judicial district.

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Nature of Action

Plaintiff's Complaint for Declaratory Judgment

12. In this action, Plaintiff seeks a declaration that Defendant's United States Patent No. 4,674,112 (the "'112 patent"), attached as Exhibit A, is invalid and unenforceable. Plaintiff also seeks a declaration that its T9 software does not infringe, contribute to infringement, or induce infringement of the '112 patent.

Defendant's '112 Patent

13. Defendant contends that in 1987, it obtained the '112 patent entitled "Character Pattern Recognition and Communications Apparatus." The '112 patent, allegedly designed to help hearing and speech impaired individuals communicate via a telephone, describes an apparatus and device that allows telephone users to use a number keypad on the telephone to enter "syllabic elements" in order to attempt to form representations of words.

Tegic's T9 Software

14. In the mid-1990s, Plaintiff developed its T9 software, a predictive text input program that, among other things, allows cellular phone users to send text messages using the keypad of their cellular phones, using one key-press per letter.

15. Plaintiff filed for its first patent for the T9 software on July 26, 1995. During the prosecution, Plaintiff cited Defendant's '112 patent as information that may be material to the prosecution of the subject application. The U.S. Patent and Trademark Office found that the T9 software was new and unique, and issued U.S. patent 5,818,437 (the "'437 patent") for the T9 software on October 6, 1998. Tegic has since obtained subsequent patents for its T9 technologies.

16. Tegic began marketing and advertising the T9 software as early as 1996, when Tegic obtained its first license for the use of T9 software on a personal digital assistant ("PDA"). Public information concerning T9, such as articles and press releases, were available at least as early as the Fall of 1996. In 1997, T9 was first licensed for use on a

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wireless cellular phone. By the end of 1999, T9 software had been licensed to several manufacturers worldwide.

Texas Litigations

17. Prior to the filing of the two Texas Litigations, Defendant had not, to the best information available to Plaintiff, ever sought to license or enforce the '112 patent to or against Plaintiff or any of its customers.

18. On March 11, 2005, Defendant filed a claim of patent infringement regarding the '112 patent in the Western District of Texas (Case No. A05CA181 SS) against several of Plaintiff's customers, including BenQ America Corp., HTC Corp., Innostream Inc., Kyocera Wireless Corp., LG Electronics MobileComm U.S.A., Inc., NEC USA, Inc., NEC America, Inc., Sagem S.A., Sanyo North America Corp., Sendo America Inc., Siemens Communications, Inc., Sony Ericsson Mobile Communications AB, Sony Ericsson Mobile Communications (USA) Inc., and Spreadtrum Communications Corp.

19. On March 22, 2005, Defendant filed a second complaint for patent infringement regarding the '112 patent in the Western District of Texas (Case No. A05CA198 SS) against several other customers of Plaintiff, including Alcatel, Alcatel USA, Inc., Arima Communication Corp., Arima Computer (Texas) Corp., Curitel Communications, Inc., Haier Group Co., Haier America Import L.L.C., Haier America Trading L.L.C., Hon Hai Precision Industry Co., Ltd. d/b/a Chi Mei Communication Systems, Inc., and Sharp Corporation, a.k.a. Sharp Kabushiki Kaisha.

20. All of Plaintiff's customers that are named by Defendant in the Texas Litigations have licensed Plaintiff's T9 software. The products of Plaintiff's customers that are listed in the complaints of the Texas Litigations utilize T9 software. On its face, Defendant's complaints in the Texas Litigations appear to allege that it is Plaintiff's T9 software, as incorporated into Tegic's customers' cellular phones, that infringes the '112 patent.

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21. Many of Plaintiff's customers have demanded indemnification from Plaintiff with regard to the Texas Litigations. Also, by suing many of Tegic's customers of the T9 software, the University of Texas has significantly harmed Tegic's business relations with its current customers as well as hampered Tegic's efforts to license its T9 software to new customers.

First Claim For Relief

(Declaratory Judgment of Patent Invalidity -- 28 U.S.C. §§ 2201, 2202; 35 U.S.C. §§ 101, et. seq.)

22. Plaintiff realleges and incorporates by reference Paragraphs 1 through 22 of this Complaint as though fully set forth at length.

23. Based upon the prosecution file history of the '112 patent, the articles and prior art cited during prosecution, as well as other prior art, the '112 patent's claims are invalid.

24. The '112 patent, and each of the claims therein, are invalid for failure to comply with one or more of the requirements of 35 U.S.C. §§ 101 et seq.

25. There is an actual controversy, within the meaning of 28 U.S.C. §§ 2201 and 2202, between Plaintiff and Defendant as to whether there exists any valid and enforceable claim of the '112 patent.

26. Plaintiff is entitled to a declaratory judgment that all claims in the '112 patent are invalid.

27. This is an exceptional case, and Plaintiff is entitled to an award of attorneys' fees pursuant to 35 U.S.C. § 285.

Second Claim For Relief

(Declaratory Judgment of Unenforceability-- 28 U.S.C. §§ 2201, 2202; 35 U.S.C. §§ 102-103, 112, 282)

28. Plaintiff realleges and incorporates by reference Paragraphs 1 through 28 of this Complaint, as though fully set forth at length.

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29. Plaintiff has been marketing, advertising, selling, and licensing its T9 software for at least eight years, and its customers have advertised the T9 Text Input features on their phones. If Defendant's allegations of infringement are to be believed, Defendant knew or should have known of the existence of the cellular phones incorporating the T9 software.

30. Defendant contends it obtained the '112 patent in 1987. Even though Defendant knew or should have known that Plaintiff has been actively marketing, advertising, selling, and licensing the T9 software for at least eight years, Defendant has never brought an infringement action nor informed Plaintiff of its allegedly infringing activity.

31. Plaintiff has been prejudiced by Defendant's delay in bringing an infringement action. Plaintiff already has spent substantial resources on marketing, advertising, selling and licensing its T9 software for at least the last eight years, without knowledge of Defendant's potential infringement claims, and has subjected itself to potential liability.

32. The '112 patent is unenforceable due to laches, as Defendant delayed filing the Texas Litigations an unreasonable and inexcusable length of time after it knew or reasonable should have known of its claim against the Plaintiff, and the delay resulted in material prejudice or injury to Plaintiff.

33. There is an actual controversy, within the meaning of 28 U.S.C. §§ 2201 and 2202, between Plaintiff and Defendant as to whether there exists any valid and enforceable claim of the '112 patent.

34. Plaintiff requests a declaratory judgment that the >112 patent is unenforceable and that Defendant's claims to Plaintiff and third parties that Plaintiff infringes the >112 patent are false and without legal basis.

35. This is an exceptional case, and Plaintiff is entitled to an award of attorneys' fees pursuant to 35 U.S.C. § 285.

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Third Claim For Relief

(Declaratory Judgment of Non-Infringement 28 U.S.C. §§ 2201, 2202; 35 U.S.C. § 271)

36. Plaintiff realleges and incorporates by reference Paragraphs 1 through 36 of this Complaint, as though fully set forth at length.

37. Plaintiff does not make, use, offer for sale, or sell, and has not ever made, used, offered to sell or sold, a method, device or apparatus that infringes, contributes to, or induces infringement of any valid and enforceable claim of the '112 patent, either literally or under the doctrine of equivalents.

38. There is an actual controversy, within the meaning of 28 U.S.C. §§ 2201 and 2202, between Plaintiff and Defendant concerning the infringement of the '112 patent.

39. Plaintiff is entitled to a declaratory judgment that its T9 software does not infringe, contribute to, or induce infringement of any valid claim of the '112 patent, either literally or under the doctrine of equivalents.

40. This is an exceptional case, and Plaintiff is entitled to an award of attorneys' fees pursuant to 35 U.S.C. § 285.

Prayer For Relief

WHEREFORE, Plaintiff prays that this Court enter judgment as follows:

1. For a declaration of this Court that the '112 patent, and each of the claims therein, is invalid and unenforceable.

2. For a declaration of this Court that Plaintiff's product does not infringe, contribute to, or induce infringement of any valid and enforceable claim of the '112 patent;

3. For costs and attorneys' fees incurred in connection with this lawsuit pursuant to 35 U.S.C. § 285; and

4. For such other and further relief as this Court deems just and proper.

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DATED: April 15, 2005.

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Attorneys for Plaintiff
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United States Patent [19]

Kondraske et al.

[11] **Patent Number: 4,674,112**

[45] **Date of Patent: Jun. 16, 1987**

[54] **CHARACTER PATTERN RECOGNITION AND COMMUNICATIONS APPARATUS**

[75] Inventors: **George V. Kondraske**, Arlington; **Adnan Shennib**, Lake Jackson, both of Tex.

[73] Assignee: **Board of Regents, The University of Texas System**, Austin, Tex.

[21] Appl. No.: **773,371**

[22] Filed: **Sep. 6, 1985**

[51] **Int. Cl.**[4] **H04M 11/00**

[52] **U.S. Cl.** **379/96**; 379/97

[58] **Field of Search** ..... 179/2 A, 2 DP, 6.11; 340/825.48, 825.74; 379/52, 77, 93, 96, 97, 105

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,307,266	12/1981	Messina	179/2 DP
4,578,540	3/1986	Borg et al. .	
4,608,460	8/1986	Carter et al. .	
4,633,041	12/1986	Boivie et al. .	

OTHER PUBLICATIONS

Rabiner et al., "Digital Techniques for Computer Voice Response: Implementations and Applications", *Proceedings of the IEEE*, vol. 64, No. 4, Apr. 1976, pp. 416–433.

Smith et al., "Alphabetic Data Entry Via the Touch-Tone Pad: A Comment", *Human Factors*, vol. 13(2), Apr. 1971, pp. 189–190.

Primary Examiner—Keith E. George

Attorney, Agent, or Firm—Arnold, White & Durkee

[57] **ABSTRACT**

A communication apparatus and method designed to interface with a standard, twelve key, dual tone, multiple frequency telephone, which allows easy, non-verbal entry of a message. Although particularly designed for use by the hearing and/or speech impaired with a dual tone telephone, the apparatus is equally adapted for use with practically any communication network where a keyboard with a limited number of keys is utilized and ambiguity resolution necessary. Generally speaking, the apparatus is connected to the earpiece of a receiving telephone and includes a tone pickup and decoder, a pre-programmed microcomputer and a message display panel. The message sender depresses a single key which corresponds to the alphabetic letter in the word being sent - because most keys on a telephone represent three letters, such a word is ambiguous when sent. The apparatus receives the ambiguous word and resolves the ambiguity in favor of a preprogrammed word which is displayed to the person receiving the message. Although the apparatus can be programmed to recognize words, the apparatus is programmed with a vocabulary of syllabic elements which are used to reconstruct the word. This approach enables an expanded word recognition capability while minimizing memory requirements.

14 Claims, 8 Drawing Figures

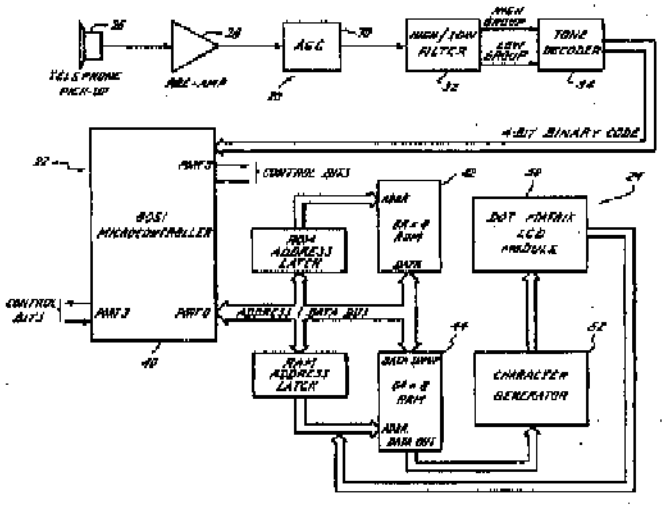


EXHIBIT A

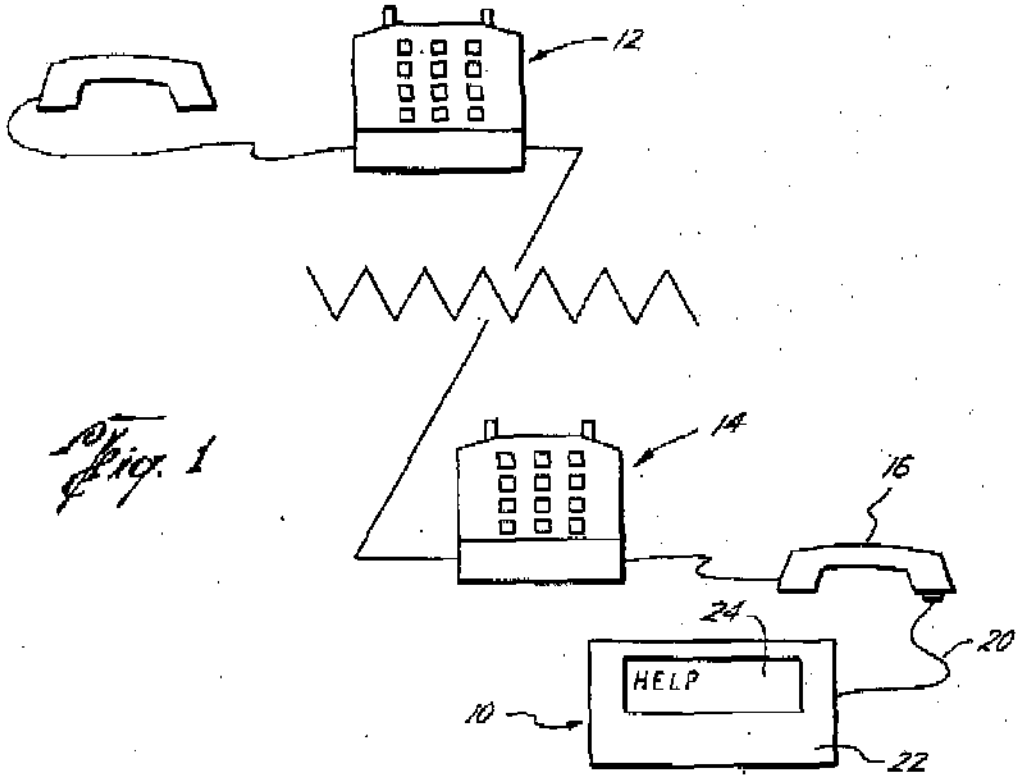


Fig. 1

Q Z 1	ABC 2	DEF 3	ROW 1
GHI 4	JKL 5	MNO 6	ROW 2
PRS 7	TUV 8	WXY 9	ROW 3
*	OPER 0	#	ROW 4
COL. 1	2	3	

18

Fig. 2

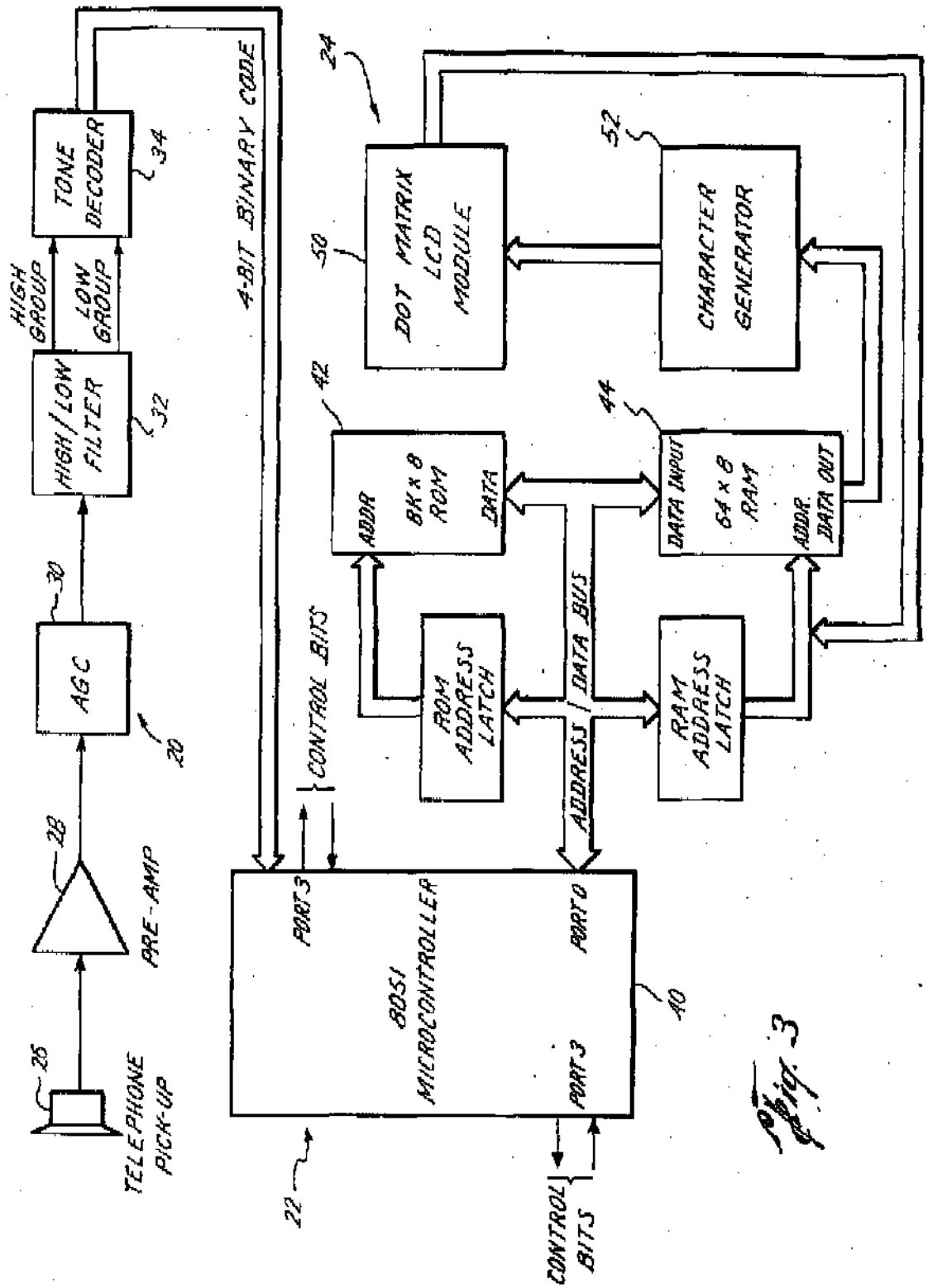

TELEPHONE PICK-UP
26
PRE-AMP
28
AGC
30
HIGH/LOW FILTER
32
TONE DECODER
34
HIGH GROUP
LOW GROUP
4-BIT BINARY CODE
CONTROL BITS
22
8051 MICROCONTROLLER
PORT 3
PORT 0
PORT 3
40
ADDRESS
DATA BUS
CONTROL BITS
ROM ADDRESS LATCH
RAM ADDRESS LATCH
ADDR
8K x 8 ROM
DATA
42
DATA INPUT
64 x 8 RAM
ADDR.
DATA OUT
44
DOT MATRIX LCD MODULE
50
CHARACTER GENERATOR
52
24

Fig. 3

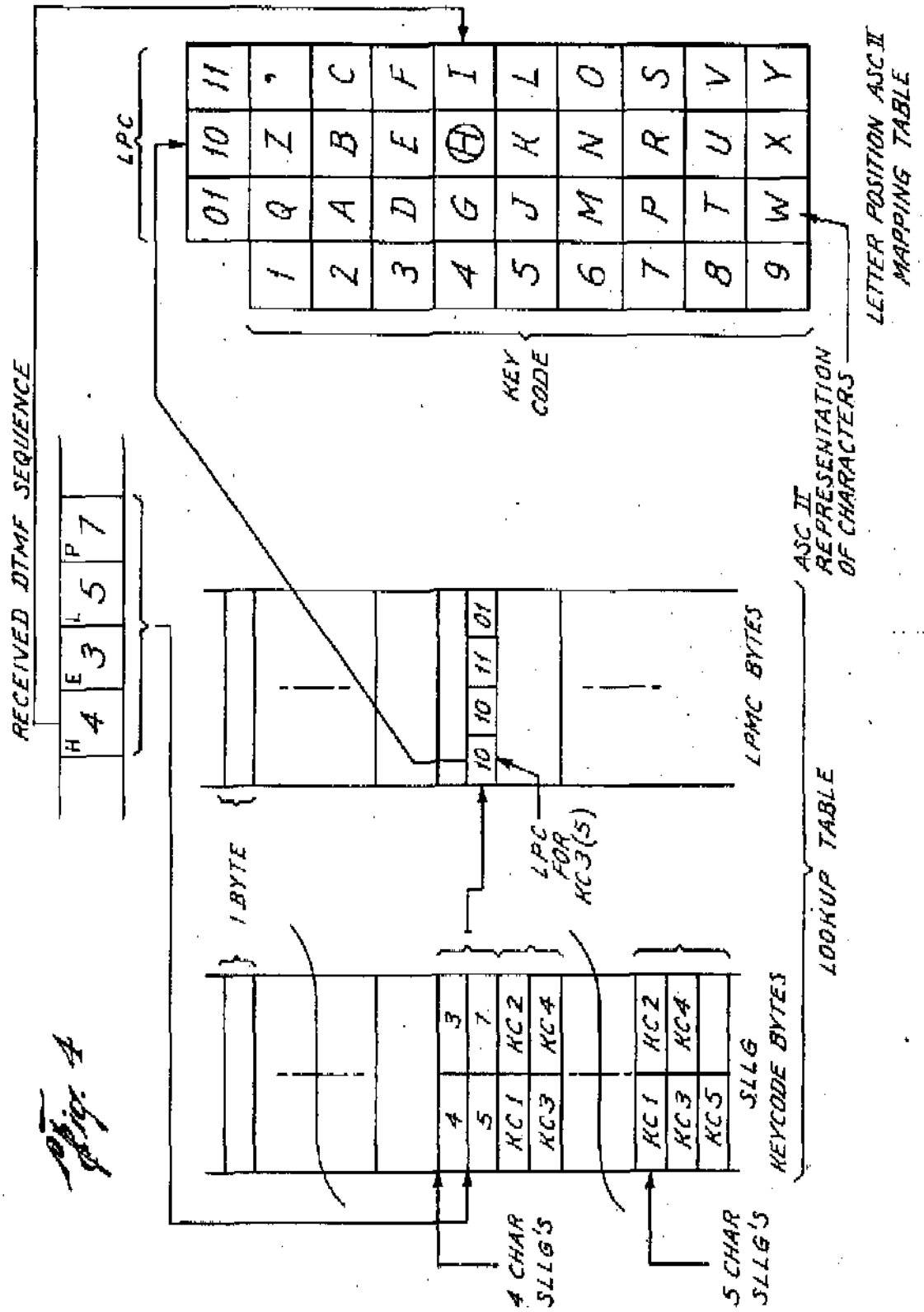

RECEIVED DTMF SEQUENCE
H 4
E 3
L 5
P 7
LPC
11 10 01
, Z Q
C B A
F E D
I ⊕ G
L K J
O N M
S R P
V U T
Y X W
1 2 3 4 5 6 7 8 9
KEY CODE
LETTER POSITION ASC II MAPPING TABLE
ASC II REPRESENTATION OF CHARACTERS
LOOKUP TABLE
LPMC BYTES
1 BYTE
LPC FOR KC3(S)
SLLG KEYCODE BYTES
4 CHAR SLLG'S
5 CHAR SLLG'S
KC1 KC2 KC3 KC4 KC5

Fig. 4

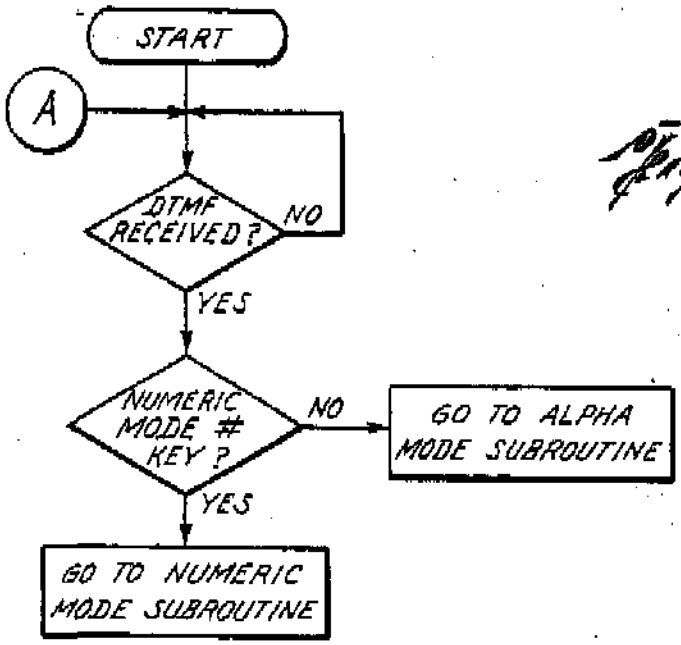

START
A
DTMF RECEIVED ?
NO
YES
NUMERIC MODE # KEY ?
NO
GO TO ALPHA MODE SUBROUTINE
YES
GO TO NUMERIC MODE SUBROUTINE

Fig. 5

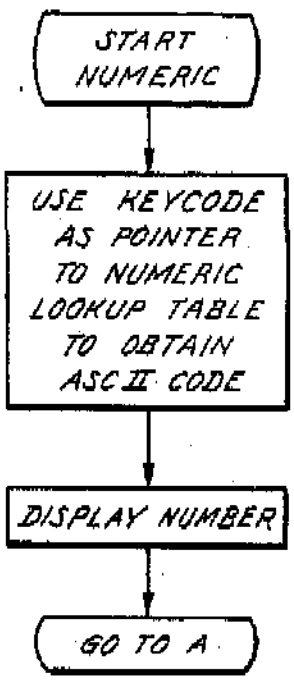
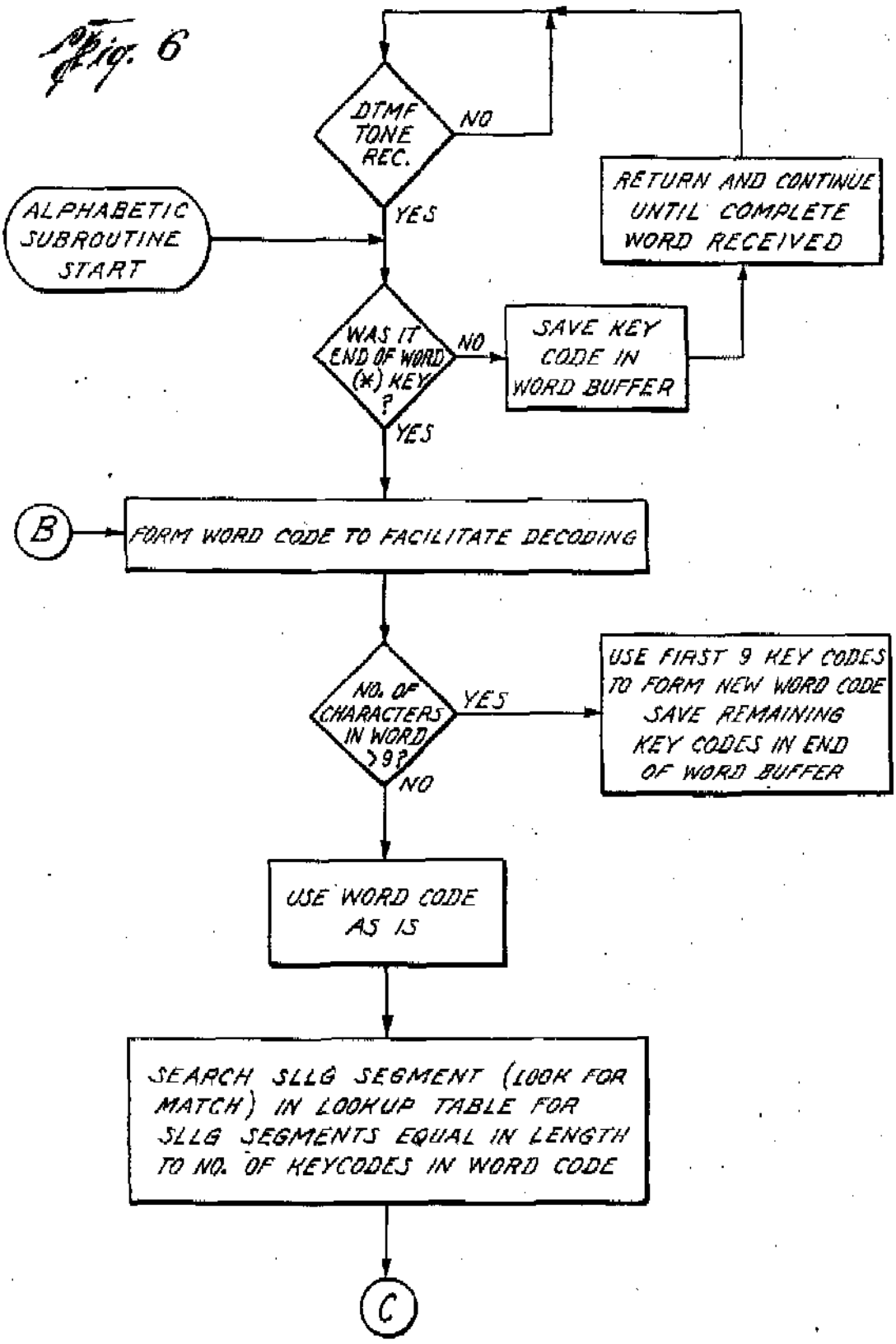

START NUMERIC
USE KEYCODE AS POINTER TO NUMERIC LOOKUP TABLE TO OBTAIN ASCII CODE
DISPLAY NUMBER
GO TO A

Fig. 8

Fig. 6


DTMF TONE REC.
NO
YES
RETURN AND CONTINUE UNTIL COMPLETE WORD RECEIVED
ALPHABETIC SUBROUTINE START
WAS IT END OF WORD (*) KEY ?
NO
SAVE KEY CODE IN WORD BUFFER
YES
B
FORM WORD CODE TO FACILITATE DECODING
NO. OF CHARACTERS IN WORD >9?
YES
USE FIRST 9 KEY CODES TO FORM NEW WORD CODE SAVE REMAINING KEY CODES IN END OF WORD BUFFER
NO
USE WORD CODE AS IS
SEARCH SLLG SEGMENT (LOOK FOR MATCH) IN LOOKUP TABLE FOR SLLG SEGMENTS EQUAL IN LENGTH TO NO. OF KEYCODES IN WORD CODE
C

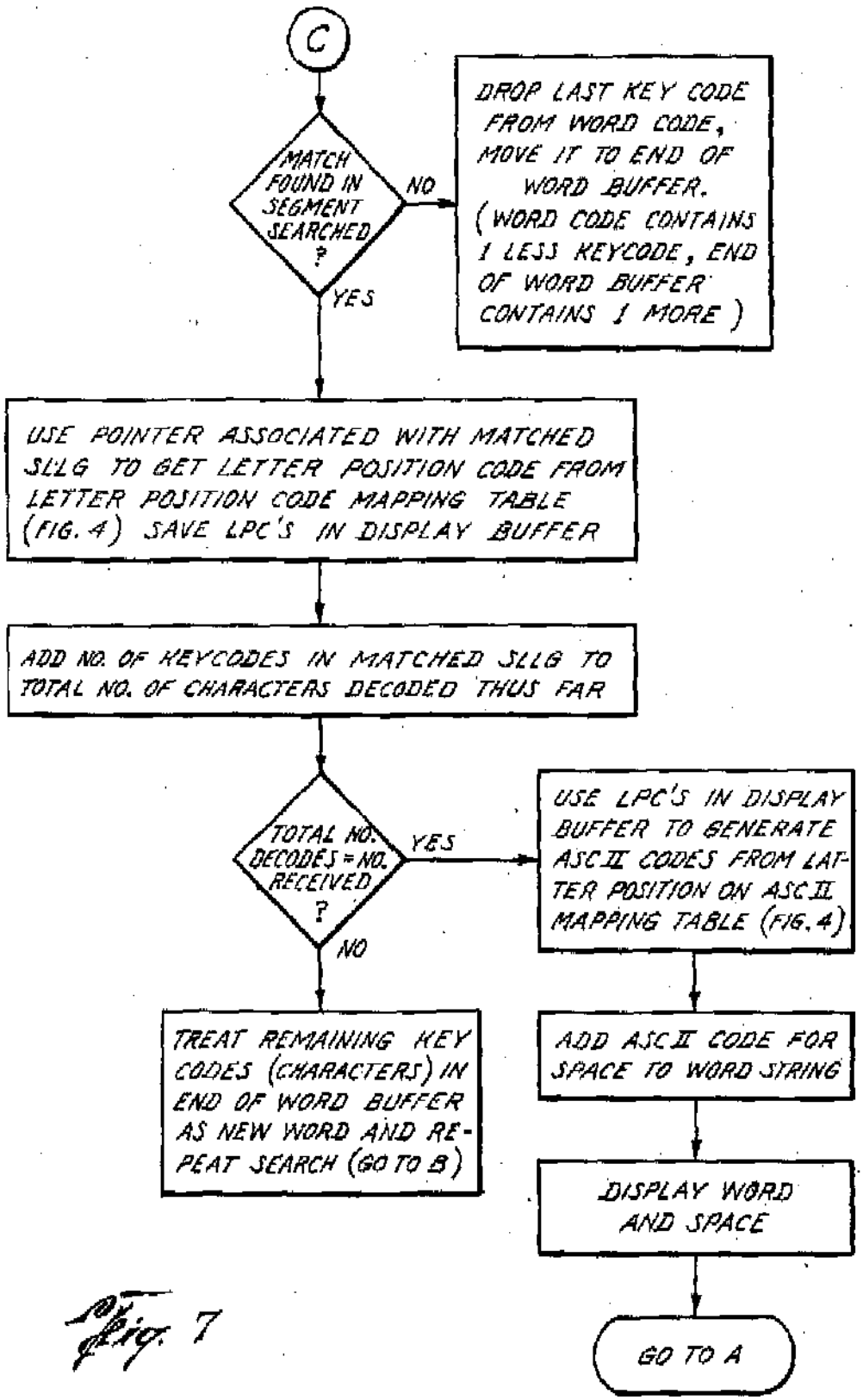

C
MATCH FOUND IN SEGMENT SEARCHED ?
NO
YES
DROP LAST KEY CODE FROM WORD CODE, MOVE IT TO END OF WORD BUFFER. (WORD CODE CONTAINS 1 LESS KEYCODE, END OF WORD BUFFER CONTAINS 1 MORE)
USE POINTER ASSOCIATED WITH MATCHED SLLG TO GET LETTER POSITION CODE FROM LETTER POSITION CODE MAPPING TABLE (FIG. 4) SAVE LPC'S IN DISPLAY BUFFER
ADD NO. OF KEYCODES IN MATCHED SLLG TO TOTAL NO. OF CHARACTERS DECODED THUS FAR
TOTAL NO. DECODES = NO. RECEIVED ?
YES
NO
USE LPC'S IN DISPLAY BUFFER TO GENERATE ASCII CODES FROM LATTER POSITION ON ASCII MAPPING TABLE (FIG. 4)
ADD ASCII CODE FOR SPACE TO WORD STRING
DISPLAY WORD AND SPACE
GO TO A
TREAT REMAINING KEY CODES (CHARACTERS) IN END OF WORD BUFFER AS NEW WORD AND REPEAT SEARCH (GO TO B)

Fig. 7

CHARACTER PATTERN RECOGNITION AND COMMUNICATIONS APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an apparatus and method for communicating by manual entry on a keypad using a minimum of key stroke entries. More particularly, the invention relates to an apparatus and method for use by the hearing or speech impaired to communicate over the telephone network using a standard twelve key, dual tone, multi-frequency telephone.

2. Description of the Prior Art

For the hearing or speech impaired to effectively communicate over a long distance, several methods have been devised which enable nonverbal communication over a communications network, such as a telephone grid. Such devices include relatively expensive and nonportable radio teletype terminals and communications-adapted computer terminals. Such terminal keyboards typically employ a standard "QWERTY" keyboard which enables the passage of messages by simply typing in the entire message. Such terminals are, of course, deficient in that they are not only expensive, but also are bulky and difficult to transport.

It has been recognized that it is desirable to use a standard 12 key, dual tone multiple frequency (DTMF or Touch-tone) telephone to communicate between the hearing or speech impaired. Utilizing such a standard "Touch-tone" telephone would be inexpensive and provide a partial solution to the problem of transporting bulky communication equipment. A primary difficulty with using such "Touch-tone" telephones is that the industry standard telephone keypad utilizes 12 keys. Ten of the keys represent a single numeric character, while 8 of the keys each represent 3 alphabetic characters.

To utilize such a standard "Touch-tone" telephone for nonverbal communication, past solutions have used multiple keystroke entries to identify a particular alphabetic letter. For example, a first depression identifies which key the desired letter appears on and a second depression identifies which letter of the three possibilities is desired for input.

The necessity for depressing two keys to identify one letter, is of course a major impediment to effective telecommunication using a standard "Touch-tone" telephone. That is, even short messages require a large number of keystrokes to enter the message.

SUMMARY OF THE INVENTION

The problems outlined above are in large measure solved by the communications apparatus and character pattern recognition method of the present invention. That is, the method and apparatus hereof provides for a single keystroke to identify which alphabetic character is desired. Because each keystroke can represent three possibilities, each keystroke transmitted—and therefore the composite word—is inherently ambiguous. The apparatus hereof receives the ambiguous word and reconstructs and displays the word based upon a preprogrammed ambiguity resolution. To simplify operation and memory size, the apparatus recognizes a particular word in terms of syllabic elements. The syllabic elements can comprise any number of alphabetic characters (for example, from 1 to 9 alphabetic characters).

Generally speaking, the apparatus hereof includes a receiving mechanism coupled to a telephone which receives a series of transmitted tones corresponding to an inputted word. With a standard "Touch-tone" telephone, each tone received by the receiving mechanism represents three possible alphabetic characters. The receiving mechanism translates each tone into a code—a series of codes corresponding to a word. A controller receives the series of codes and outputs a signal indicative of a particular word which corresponds to the series of codes. The controller advantageously has a recognition means which matches the series of codes received with a programmed code sequence indicative of the particular word. Once the particular word is identified, a signal representative of the particular word is passed to an indicating means which displays the word to the receiving person.

Preferably, the receiving mechanism amplifies the ambiguous tone and decodes the tone into binary code. The binary code is passed to the controller which is preferably a preprogrammed microcomputer. The microcomputer fetches the word or syllabic element vocabulary from memory and begins comparing the binary code with the vocabulary. The controller constructs a particular word corresponding to the received binary code and generates a signal to the indicating mechanism representative of that particular word.

Preferably, the indicating means comprises a liquid crystal diode display which visually represents the word or message to the user. In another embodiment, a speech synthesizer audibly communicates the word or message to the user.

The preferred communication method of the present invention contemplates inputting a word or series of words into a standard "Touch-tone" telephone keyboard by depressing a single key for each alphabetic character of the word. The characters are thus transmitted as a series of tones which are decoded by the apparatus hereof into a binary code. The binary code is matched with a preprogrammed vocabulary code representive of an alphabetic character string, such as a word or syllabic element. The word is then output to the receiving person. Although the preferred embodiment anticipates using the apparatus hereof as a receiving unit, it will be appreciated that the apparatus can be easily modified within the scope of the present invention to act as a transmission unit. For example, the apparatus can be modified to utilize a speech synthesizer, with the message sender inputting a word or a series of words into the telephone with the apparatus converting the input into an audible message.

Another important alternative is to utilize the apparatus and method for other modes of communication. For example, the apparatus and method hereof can be incorporated into a paging system network, radio telephone network, or practically any communications network where ambiguity resolution is necessary because of limited keystroke inputs.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagramatic view of a typical transmitting and receiving telephone to which the apparatus hereof is operably connected;

FIG. 2 is a plan layout of a dual tone, multiple frequency, twelve key telephone keyboard;

FIG. 3 is a block diagram of the system components of the apparatus hereof;

FIG. 4 is a schematic representation of the look-up table and ASCII mapping table utilized by the present invention; and

FIGS. 5–8 are flow-charts illustrative of the software utilized in the apparatus of the present invention, where-

FIG. 5 is a flowchart of the main program for determining whether a numeric or alphabetic character is input,

FIGS. 6 and 7 depict the alphabetic subroutine,

FIG. 8 illustrates the numeric subroutine.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to the drawings, a communications apparatus 10 is illustrated in FIG. 1 in conjunction with a telephone network having a sending telephone 12 and receiving telephone 14. Each telephone 12, 14 has a hand piece 16 and a twelve key "Touch-tone" key pad 18. Each telephone 12, 14 represents a common, industry standard touch tone system in which a key closure generates two tones according to the dual tone multiple frequency standard. As can be seen from FIG. 2, the standard industry key pad 18 presents twelve keys containing alphabetic and numeric characters, as well as the asterisk (*) and number ("#") characters. FIG. 2 differs slightly from the industry standard in that in a standard touch tone telephone, the alphabetic characters "Q" and "Z" are omitted. In FIG. 2, the letters "Q" and "Z" are carried by the key representative of numeral "1".

Comparing FIGS. 1 and 3, the communications apparatus 10 is shown in more detail. Broadly speaking (see FIG. 1), the apparatus 10 includes receiving means 20, controller means 22, and indicating means 24. In more detail, the receiving means 20 includes an inductive pick-up 26 attachable to the ear portion of the hand piece 16 by a suction cup. In the preferred embodiment, a preamp 28 provides a fixed gain of 60 dB to the automatic gain control amplifier 30. The automatic gain control amplifier 30 has a gain range of 0.1–20 dB resulting in a total gain for the amplifier section (28,30) in the range of 30–100 dB. The output of the automatic gain control (1.5 volts p—p) is fed to a filter section 32 (AMI S3525A intergraded circuit) to separate the high and low dual tone multiple frequency bands. As shown in FIG. 6, the high and low group filter outputs are fed to a tone decoder 34 (e.g., Mostek MK-5102). The tone decoder 34 provides a four-bit binary code to the controller means 22 for each signal received at its input.

The controller means 22 preferably incorporates a microcomputer (Intel 8051) with on-chip RAM and ROM. In FIG. 3, the controller means 22 is illustrated somewhat schematically and depicts the microcomputer 40, ROM 42 (preferably 8K byte EPROM) and 64 bytes×8 RAM 44. Preferably, the programed vocabulary is stored on the ROM 42 with the RAM 44 used to store word codes as received, thus providing a buffer to the indicating means 24.

Preferably, the indicating means 24 includes a liquid crystal diode (LCD) display 50 capable of displaying two rows of alpha numeric characters of twenty characters per row. A character generator 52 is coupled to the RAM 44 and the LCD display 50 to generate standard dot matrix characters on the display 50. The LCD display 50 also addresses the RAM 44 to periodically scan ASCII character data in the RAM 44.

Software

FIGS. 4–8 generally refer to the implementation of the recognition process employed by the controller means 22. FIG. 4 illustrates an example of a recognition search initiated in a segmented look-up table (left-hand portion of FIG. 4). The right-hand portion of FIG. 4 illustrates the ASCII mapping table where the ASCII code for the proper character is stored and fetched for each alpha numeric character. It should be apparent that use of the mapping table results in a considerable memory saving over the alternative of storing complete ASCII strings in memory. FIGS. 5–8 illustrate the flow-charts for the operating programs. The flow-charts are self explanatory. The operation of the lookup table and ASCII mapping table is readily apparent from a comparison of FIGS. 4 and 6–7.

Operation

The initial problem addressed by the present invention was to provide a simple method for the hearing or speech impaired to communicate using standard "Touch-tone" telephones without the need for complicated equipment, such as teletypes, etc. Several devices and methods have been devised which allow for effective communication, but are slow and difficult to use; a large number of keystrokes are involved in inputting a message. As can be seen from FIG. 2, most keys represent three alphabetic letters. Therefore, in the past, a single letter has been input using two keystrokes. For example, to input the alphabetic letter "H" in the word "HELP", the Operator would first push the number "4" key (row 2 column 1) followed by the "0" key (row 4, column 2) to designate the second character on the number "4" key.

In a broad sense, the present invention recognizes the possibility of using a microprocessor-based device to enable a single keystroke per alphabetic letter. That is, it has been found that most English words are identified by the keystroke sequence required to enter the letters of the word—a character pattern recogniton. Of course, the invention is equally applicable to the identification of words in other languages as well.

For example, to enter the word "HELP" the numbered keys "4, 3, 5, and 7" are depressed followed by a "*". The "*" key is used to delineate the end of a word. The term "word code" is used to denote the key sequence for a particular word; that is "4357" is the word code for the word "HELP." Of the 3^4 possibilities (3 characters on each key, four keys to enter the word), there is only one English word—"HELP"—from the 3^4 possibilities involved.

Because each key on a standard "Touch-tone" keyboard presents three alphabetic characters per key, using the single keystroke entry contemplated by the present invention results in an inherently ambiguous key code. Thus, the dual tones for each key depression presents an ambiguous series of tones to the receiver. However, as with the word "HELP," it was found that over 96% of the most commonly used words could be identified by the word codes generated.

Therefore, in a broad sense, the apparatus 10 could incorporate a stored vocabulary of word codes and the corresponding ASCII representation for each word in a memory look-up table. When a sequence of word codes is entered followed by an "*", a search could be initiated in memory which points to the correct ASCII characters to be displayed. In practice, storing complete

word codes and ASCII representations in memory was found to limit word recognition capability to the stored word vocabulary, and even then, large memory size was necessary.

In the preferred embodiment, "syllabic elements" are stored in memory and combined to create the words. For example, the "CON" letter group in contest, silicon, conference, contact, etc. is such a stored syllabic element. Thus, the vocabulary stored in the preferred embodiment includes common letter-groups, suffixes, prefixes, single letters, and a few complete words, genericly referred to as "syllabic elements." In the preferred embodiment, it was found most efficient to include several letter strings which provide and enhance word recognition capability; therefore the vocabulary of syllabic elements in the preferred embodiment includes elements having one alphabetic letter to as many as nine alphabetic letters. Most syllabic elements have a three to six letter group size.

To further reduce memory size, the preferred embodiment enclosed incorporates an ASCII mapping table illustrated schematically in FIG. 4. That is, instead of allocating memory for the ASCII representation for each syllabic element, the ASCII representation is developed from the mapping table.

In use, the receiving individual must attach the conductive pick-up 26 to the ear portion of the hand piece 16 (see FIG. 1). The sending individual simply enters the desired alphabetic letters of the desired message on the touch-tone telephone 12 sequentially. The asterisk key "*" is used as a space to separate words. The number key "#" is used before or after any information that should be interpretated as numeric information. Of course, the sender cannot use abbreviations. The apparatus 10 responds in real time, beginning the recognition process as soon as the space key is received. The text of the message is displayed on the LCD display 50 from the lower left position to the right. When the lower row is filled the entire row is scrolled upward to allow new text to appear in the lower row.

As can be seen from FIG. 3, the series of tones constituting each word are decoded into a binary code. In the preferred embodiment each key depression represents a "key code" indicative of the key depressed. Two key codes are entered per byte, thus, the first byte contains the four bit binary code representation of the first two key codes of a word. The word code comprises a series of key codes entered between the asterisk "*," and in the preferred embodiment can occupy up to 7 bytes, accommodating word sizes up to fourteen characters. If the word has an odd number of characters, and therefore an odd number of key codes, the last key code is stored in the high order four bits of the last byte and the low order bits are set to zero.

The microcomputer 40 (FIG. 3) reads the four bit binary code upon receiving a latch signal from the tone decoder 34. The program (FIGS. 5–8) and stored syllabic element vocabulary are fetched from ROM 42. The word recognition process is initiated as soon as an entire word code is received (as indicated by the asterisk input).

Turning to FIG. 4, the recognition search is initiated in the segmented look-up table that contains the key codes in the four bit format for the syllabic element vocabulary. The look-up table is segmented according to syllabic element size with the size of the word to be decoded determining the point of entry into the look-up table. In the preferred embodiment, there are nine segments in the look-up table corresponding to syllabic elements ranging from one to nine characters in size. For words having more than nine characters, the search is initiated in the ninth segment and a new word code corresponding to the first nine keystrokes (key codes) of the word is formed (see also FIG. 6). Of course, the size of the syllabic element is known upon entry into a given segment, therefore the number of bytes required to store the key codes for each of the syllabic elements will also be known.

Although the word code typically occupies more than one byte, only the first byte is checked for a match initially. The other bytes are checked only when a match occurs for all the previous bytes for the given syllabic element. If no match is detected, the search proceeds to the next syllabic element in the segment of the table. If no match is found in the segment of the table for the syllabic element size equal to the size of the word, the search is continued in the segment of the next lower size. That is, the word code is recomputed to exclude the last received key code for later use in the recognition process. This procedure is repeated until a match occurs. At the latest, a match will occur upon entering the single character segment of the look-up table.

After the first syllabic element is identified, the search is repeated using a reduced word code. The reduced word code comprises the original word code less the first N characters, where N is the size of the first syllabic element identified. This cycle is repeated until the complete word is identified. Most words are identified by connected syllabic elements 2 to 4 characters in size. However, there are a limited number of large syllabic elements of 5 to 9 characters which are used to identify words that are difficult to separate into unambiguous short syllabic elements.

Some syllabic elements have the same word code and therefore can have multiple interpretations. Such multiple meaning syllabic elements are specially flagged in the look-up table and stored in a way that the most frequently occurring interpretation is decoded first. If the element displayed on the LCD display 50 does not make sense to the reader, he can replace the string with the alternate interpretation by pressing a retry button (such as the operator or "0" key). Of course, in many cases the user can interpret such alternative interpretations from the context of the other syllabic elements forming the word or other words in the message.

Although the display could be generated by storing a pointer to the proper ASCII string representing each syllabic element in the look-up table, the preferred embodiment utilizes an indirect referencing technique. As illustrated in FIG. 4, an ASCII mapping table is utilized to identify the proper ASCII string for the syllabic element recognized in the look-up table. The first input to the ASCII mapping table is the key code which is known and limits the possible choices for the alphabetic character to a maximum of three.

The second pointer to the ASCII mapping table is generated to correspond with the position of the alphabetic character on the particular key depressed. To this end, a series of letter position mapping codes (LPMC) bytes are formulated for each word code. Each LPMC byte contains four 2-bit letter position codes (LPC). Each LPC can take the value of either 1, 2, or 3 depending upon the letter position on the key. As can be seen from FIG. 4, the binary representation of the letter position is used to enter the ASCII mapping table, 01

for the first letter positioning, 10 for the second letter positioning and 11 for the third letter positioning. Thus, the key code (KC) and letter position code (LPC) act as column and row pointers into the ASCII mapping table to find the proper ASCII code for the character. The ASCII code is fetched and moved to an output buffer. This method requires only 27 bytes of ASCII character storage as each possible character is stored only once, and an additional 8 bits per 4 characters to store the letter position codes (LPC).

FIG. 4 illustrates the recognition process for the word "HELP". The word code, "4357" is passed to the four character segment of the look-up table. As previously discussed, the microcomputer 40 begins the search process until a match is formed. The matched word code points to a letter position mapping code (LPMC) byte. As illustrated in FIG. 4, the first letter position code (LPC) in the letter positioning mapping code (LPMC) byte has the binary code (10) for "2" which is the letter position of "H" on the number "4" key. The LPC is used as the column pointer in the ASCII mapping table with the key code used as the row pointer to identify the letter "H".

In practice, the apparatus 10 recognizes the entered words as fast as the words can be entered by the sender. Thus, the apparatus 10 is real time, displaying the decoded word on the LCD display 50 less than 1 second after the asterisk key is depressed. A prime advantage of the method and apparatus 10 is that single character entry is sufficient for communication. This represents a significant advance as a communication aid for the handicapped.

Of course, the apparatus 10 hereof is equally adaptable for use in many other situations. For example, with a paging system where space is limited, a small number of keys could be incorporated to efficiently send a message using the single character entry recognition of the present invention.

Although the present invention contemplates that the sender will simply use a standard touch-tone telephone and the receiver will utilize the apparatus 10, roles could be reversed. The apparatus 10 can be used as a sending device which incorporates a speech synthesizer. That is, the sender would couple the device 10 to the mouth section of hand piece 16 of the sending telephone 12 and generate the message on the key pad 18. Apparatus 10 would generate synthetic speech audibly conveyed to the receiving telephone 14.

Still another alternative would be to use the apparatus 10 of the present invention for remote computer control by non-handicapped individuals. For example, using the single character entry, words like PRINT, LIST, SAVE could be easily recognized and the output controlled. If fact, better results and an expanded vocabulary can be obtained if the characters on the standard telephone key pad 18 are distributed differently. That is, the sender could use an overlay with optimum character distribution to send his message. While this approach may be feasible for remote computer use, simplicity considerations for the handicapped dictate using the standard key pad 18 with suboptimum character distribution.

The apparatus 10 could also be used for consumers to enter orders to a vendor's computer. Many variations exist; the apparatus 10 enabling the entry of messages easily into a computer or practically any message receiver.

We claim:

1. A communications apparatus comprising:

receiving means operably connectable to a telephone or the like for receiving a series of transmitted tones corresponding to an input word and for decoding the tones into a series of codes, each tone being representative of a letter of the word, which letter is one of two or more alphabetic characters corresponding to the tone;

controller means coupled to said receiving means for processing said series of codes and outputting a signal indicative of a particular word which corresponds to said series of codes, said controller means including, recognition means for matching said series of codes with a programmed code sequence indicative of said particular word,

said recognition means including a stored vocabulary comprising a plurality of syllabic elements, each being representative of one or more alphabetic characters, said recognition means being operable for matching said series of codes with one or more syllabic elements and outputting a signal indicative of a particular word represented by said one or more syllabic elements; and

indicating means for receiving said signal and communicating the signal in a form perceptible to the user.

2. The apparatus according to claim 1, wherein said receiving means includes an inductive pickup couplable to the ear piece of a telephone receiver.

3. The apparatus according to claim 1, wherein said receiving means includes an amplifier section for receiving and amplifying said tones.

4. The apparatus according to claim 1, wherein said receiving means includes a tone-decoder for decoding the tones into a binary code.

5. The apparatus according to claim 1, wherein said indicating means includes a visual display for communicating said particular word.

6. The apparatus according to claim 5, wherein said indicating means comprises a liquid crystal display module.

7. The apparatus according to claim 1, wherein said receiving means is operable for receiving tones indicative of numeric characters, said controller means is operable for receiving and processing said numeric-representative tones and outputting a numeric-representative signal, and said indicating means being operable for displaying said numeric-representative signal.

8. The apparatus according to claim 1, said recognition means including mapping means operably coupled to said receiving means and operable for identifying the two or more alphabetic characters represented by a discrete tone.

9. The apparatus according to claim 8, said mapping means operable for utilizing said programmed code sequence and said identified two or more alphabetic characters for generating an ASCII code representative of each character of said particular word, said plurality of ASCII codes generated being output from said controller means as a portion of said signal.

10. A method of communicating, utilizing a signal-generating keyboard where at least some of the keys represent two or more alphabetic characters, comprising the steps of:

inputting a word into said keyboard by depressing a single key for each alphabetic character of said word;

transmitting signals generated by the key depressions;

receiving said transmitted signals and decoding the signals into binary code;

matching said binary code with one or more pre-programmed codes, each pre-programmed code being representative of a syllabic element;

Forming a representation of the word from the one or more syllabic elements represented by the matched one or more pre-programmed codes; and

outputting the word representation in a form perceptible to the user.

11. The method of claim **10**, wherein the outputting step includes displaying said word in a visually perceptible form.

12. The method of claim **10**, wherein the signal generated by the keyboard is a dual tone multiple frequency and the keyboard comprises a touch-tone telephone.

13. The method according to claim **10**, wherein each pre-programmed code of the syllabic elements corresponds to the key depressed and the position of the character of the syllabic element on that key including the steps of:

providing an ASCII mapping table presenting the ASSCII strings corresponding to respective alphabetic characters;

identifying the ASCII string for each character of each matched syllabic element by

entering the mapping table with reference to the key depressed on the keyboard for each character of the matched one or more syllabic elements,

cross-referencing the position of the character on said depressed key to determine the discrete ASCII string for the alphabetic character; and

outputting the ASCII string for each character of each syllabic element to an output buffer.

14. A method of recognizing an input word from an input series of codes in which each input code represents one letter of the word which letter is one of two or more letters that the code corresponds with, comprising the steps of:

establishing a limited vocabulary of syllabic elements representing one or more letters and comprising one or more codes in a lookup table, in which said word is not represented by a single syllabic element in the lookup table,

the lookup table being separated into segments according to the number of letters of the syllabic elements;

matching the series of codes to two or more syllabic elements comprising the substeps of considering two or more successive codes of said word as a group,

entering the lookup table in the segment corresponding to the number of codes in said group,

comparing said group of codes with the codes of each syllabic element in said segment until a match is found, or if no match is found, decrementing the number of codes in the group, entering the lookup table in another segment corresponding to the number of codes in said decremented group, and comparing the decremented group of codes with codes of each syllabic element in said another segment until a match is found, or if no match is found, successively decrementing the number of codes in the group and comparing the decremented group of codes with the codes of each syllabic element in another segment until a match is found, and

considering the remaining unmatched codes in said word as one or more additional groups and repeating the entering and comparing steps using each additional group until all of the syllabic elements of the word are identified; and

outputting the two or more matched syllabic elements as said word.

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