

TONETALKER: A TEXT TELEPHONE DEVICE FOR THE HEARING IMPAIRED

A text telephone device that deciphers and displays messages transmitted to it by any Touchtone telephone provides an alternative means of telephone communication for people with impaired hearing.

INTRODUCTION

During the last decade, technology has provided some solutions to the communication problems of the hearing impaired. Improved hearing aids, cochlear implants, and closed-captioned television have enhanced the lives of many hearing-impaired people. The telephone, however, still remains one of the greatest obstacles to communication for hearing-impaired people. The Telecommunication Device for the Deaf (TDD), which typically uses teletype code, has been improved and has become more portable, but a TDD is needed both to receive and to transmit the code; therefore, the number of people a hearing-impaired person can reach by telephone is limited. Third-party relay systems, which provide a service connecting TDD users to any phone, are available in some states and have made telephone communication more accessible to the hearing impaired in those areas. Facsimile (FAX) machines and computer modems are other alternatives. Direct and private telephone communication between a hearing-impaired person who can speak and a hearing person is still not possible, however. People who can hear have access to several choices of telephone communication—pay phones, cordless telephones, even cellular car telephones. Hearing-impaired people are limited to phones that work with a TDD. The invention of Tonetalker, a text telephone device for the hearing impaired, offers an additional means of telephone communication for these people.

BACKGROUND

When my daughter, Jill Podolsky, came home from school and called me at work, our conversations were mostly one-way. Although born with a profound hearing loss, Jill was able to use her residual hearing enough to have limited success with the telephone. She recognized my voice and even understood some words and familiar phrases. She usually did most of the talking, with my responses limited to “yes” or “no.” Frequently, I wished I could tell her I might be home late, or ask her to start something for dinner, or comment on something she had said. Because it was unlikely that Jill would understand, I usually did not try. Jill has a TDD at home, but I do not have a TDD at work, and none of Jill’s friends has one. I enjoy listening to her, and thought, “If I could type only the words she has a hard time understanding, we could

carry on a somewhat normal conversation, without both of us having to type everything on a TDD.” I often used the keys on my Touchtone telephone to get information about my checking account from the bank, and I noticed that the use of these telephones was becoming more and more common in business calls. The use of the Touchtone keypad to communicate with my hearing-impaired daughter seemed an obvious solution to our telephone communication difficulties. When Jill entered high school and needed help with her phone calls to her friends, I saw yet another need—for Jill to be able to have private telephone conversations.

I searched through magazines, newsletters, and catalogs of aids for the hearing impaired, and at the 1988 Alexander Graham Bell Convention exhibit hall. I asked TDD manufacturers if they knew of any device that used tones sent from a Touchtone telephone to display messages. No such device seemed to be available. After three years of thinking and talking about it, I decided to explore the possibility of making it myself. I am a software engineer at a company that designs, develops, and manufactures electronic equipment, so I had the necessary technical background to envision such a product. With the cooperation of my employer and some engineering and technical help from my fellow employees, I developed the Tonetalker in my spare time. Actual design work began in January 1991, and a working prototype was completed in July 1991.

DEVELOPMENT

The objective of Tonetalker was to enable a hearing-impaired person who speaks, but who has insufficient hearing to understand the spoken word over the telephone, to communicate with another person using normal telephones. Voice communication should not be affected. Tonetalker was to be a text supplement to telephone communication, not the sole means. The device needed to be self-contained, portable, and useful with any normal telephone combination, so the hearing-impaired person could take it anywhere and use it with any phone. It also had to be simple to use, especially for the person using the telephone keypad to “type” messages.

Tonetalker is six inches long, three inches wide, and two inches high—small enough to be portable. It is pow-

ered by a 9-V battery, so it does not need an external power supply. A telephone pickup device encapsulated in a suction cup attaches to the back of the telephone receiver (see Fig. 1). The telephone style is therefore not crucial to the connection. This adaptability means that the device can be used on pay telephones as well as personal telephones (see Fig. 2). The code to spell the words using the telephone keypad is simple and quickly learned.

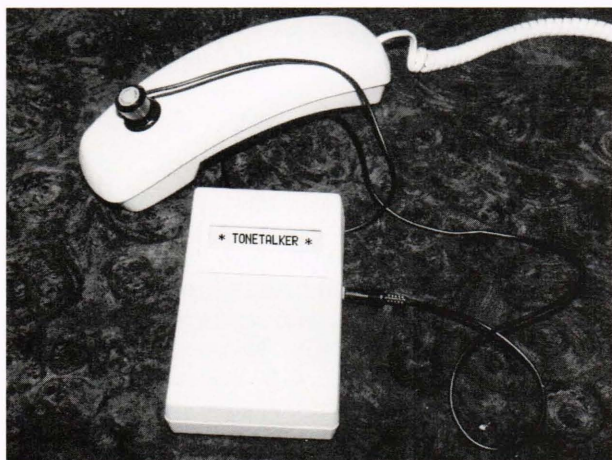


Figure 1. Tonetalker attached to a telephone receiver and ready for use.



Figure 2. Author's daughter, Jill Podolsky, using Tonetalker at a pay phone on a shopping trip to the mall.

As soon as a prototype Tonetalker was built, Jill began field-testing the device. Several additional features were added as a result of this testing period.

A "call progress" feature was added when Jill's hearing took a sudden turn for the worse, and she could no longer hear the dial tone, ringing, or the busy signal, or tell when someone had answered the telephone. This feature visually indicates the presence or absence of the dial tone or ringing sounds to the hearing-impaired person placing a call.

Another feature makes complete words and phrases accessible using a two-key code. A whole word or phrase, such as "Hello," "Good-bye," or "Hold on," is displayed by pressing just two keys. A natural progression from this feature makes it possible for Tonetalker to be customized by the owner who wishes to enter his or her own words and phrases, for example, the names of family and friends.

A few times Jill inadvertently left the Tonetalker on, resulting in a dead battery, so an automatic shutoff feature was added. Although battery usage did not seem to be excessive, an auxiliary power jack was added so that Tonetalker could be plugged into the wall when used at home.

DESCRIPTION

Tonetalker is a low-cost, portable, hand-held, battery-powered device that, when attached to a telephone, enables a hearing-impaired person to see messages sent from any Touchtone phone. It has a display screen and a microphone on a suction cup that attaches to the telephone receiver. The person who wishes to communicate with the hearing-impaired person needs only to press the keys on his or her Touchtone telephone to transmit words to the Tonetalker device attached to the hearing-impaired person's telephone receiver. The hearing-impaired person reads the typed message as it scrolls across (from right to left) on the display. No other computer, device, or special telephone is required. Tonetalker works with any telephone.

Because voice communication is not affected, Tonetalker is ideal for the hearing-impaired user who may be able to understand some speech over the phone, but occasionally needs some visual assistance.

TECHNICAL DESCRIPTION

The major physical components of Tonetalker are a telephone pickup microphone; an amplifying circuit; a dual-tone multifrequency (DTMF) receiver integrated circuit (IC); a microprocessor IC with a built-in electrically erasable, programmable, read-only memory (EEPROM) for the customer's word and phrase storage; an erasable, programmable, read-only memory (EPROM) IC for the software; and a sixteen-character, single-line, liquid-crystal display (LCD) IC. The software was written in assembly language by the author.

Tonetalker works by picking up the transmitted tone through the microphone attached to the telephone receiver. The signal is amplified for input to the DTMF receiver, which decodes the tones and sends the appropriate digital code to the microprocessor. The microprocessor executes

the software stored on the EPROM IC. The software determines the correct sequence of digital codes and selects the appropriate letter, number, punctuation character, or built-in or customized word or phrase, then passes it to the LCD, where it becomes visible. The characters appear on the right side of the display, and scroll from right to left as new characters are typed. When the message exceeds sixteen characters, characters on the left "scroll off" the display.

GENERATING MESSAGES ON THE DISPLAY

Tonetalker is easy to use. The most important thing to remember is that every letter requires two key presses. The first key press is the key with the desired letter. For example, the letter "H" is on the telephone "4" key (see diagrams in Fig. 3). The second key press is always the "1," "2," or "3" key, depending on the position of the desired letter on the key. The letter "H" is the second letter on the "4" key, so that letter is generated by the "4" and "2" keys. For example, to spell "Hello," one would press 4-2-3-2-5-3-5-3-6-3.

To type complete and intelligible messages, some characters are needed that do not appear on the telephone keypad. For example, "Q" and "Z" are not on any of the telephone keys. Other necessary characters include a space, numerical digits, and punctuation such as a question mark, a comma, a period, and an exclamation point. Note in Figure 3 that the "1" key has no letters associated with it. Tonetalker uses the first position on the "1" key for a space, the second position for a "Q" and the third position for a "Z." Specifically, a space is 1-1, Q is 1-2, and Z is 1-3.

Entering a number is easy. First press the key with the pound (#) sign, and then press whatever number you want. For example, the number 74 is generated by #7-#4. The "#" key must be pressed before each digit (see diagrams in Fig. 3).

The same rule of two key presses also applies when generating punctuation on Tonetalker. The first key press is always the "0" key. A question mark is 0-1, a period is 0-2, and an exclamation point is 0-3. See Figure 4 for additional punctuation codes.

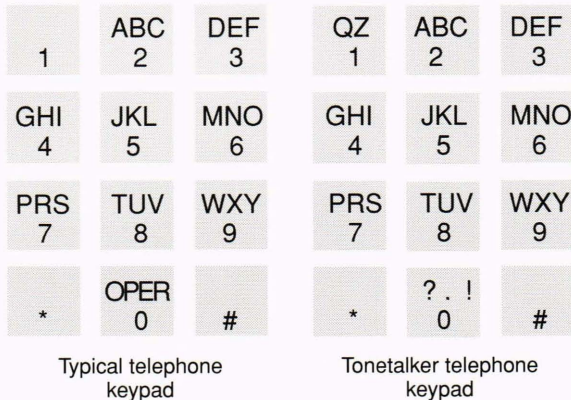


Figure 3. (Left) A typical telephone keypad. (Right) A telephone keypad with the letters Q and Z and punctuation, as used to type messages with the Tonetalker device.

The asterisk (*) key has two uses. Pressing this key once will reset the key press sequence. Since a two-key sequence is always used, if a tone is missed or the person entering a word presses the wrong key, Tonetalker will get "out of sync." If one key press is missed for any reason, the following keys will result in some odd messages. When Tonetalker is not displaying correctly, the asterisk key is pressed to restart the two-key code. Pressing the asterisk key twice in succession will reset the key sequence and clear the display.

Tonetalker has several built-in words and phrases that are accessible through a two-key code. Some of the built-in phrases are shown in Figure 4. Tonetalker can also be customized with desired words and phrases to be accessed by a two-key code. For example, the names of friends and relatives can be entered so that they may quickly identify themselves to the Tonetalker user. Twenty of the two-key codes are reserved for this use. When a word or phrase has been entered (programmed) into Tonetalker, it remains, even if the battery is dead, until it is removed or reprogrammed with a new word or phrase.

To aid the user in placing a call, Tonetalker indicates the presence of a dial tone or a ringing or busy signal. The "less than" symbol (<) appears in the leftmost space of the display when a tone or sound is present, and the space is blank when no tone or sound is present. The symbol flashes at the same frequency as a ringing or busy signal and is steady for a dial tone. An erratic flashing symbol that appears after a "ringing" flashing symbol indicates that someone has answered the phone.

Punctuation	Built-in words and phrases
Keys	Keys
0 1 ?	2 4 Hello this is
0 2 .	2 5 Is everything ok?
0 3 !	2 6 Where are you?
0 4 +	2 7 Where are you going?
0 5 -	2 8 Will call you
0 6 =	2 9 What time will you be home?
0 7 ,	4 4(G G) Goodbye...
0 8 :	4 6(H O) Hold on...
0 9 '	5 5(L L) Ha Ha Ha...
0 0 \$	5 8(L U) I love you!
	6 6(N N) No
	9 9(Y Y) Yes
	Special codes
	Keys
1 1	space
1 2	Q
1 3	Z
*	resets Tonetalker key input sequence
**	erases entire display
# # 7 7 6 4	enter program mode for custom words or phrases (7764 spells PROG for program)

Figure 4. The two-key codes for punctuation, a few of the built-in words and phrases, and other special codes used by Tonetalker.

Other features include an automatic shutoff if Tone-talker has been left on for a few minutes without any tone activity, and an auxiliary jack that may be used with a 9-V ac power adapter.

FUTURE DEVELOPMENT

The Tonetalker device described in this article is being made commercially available. Its reception by the hearing-impaired community will direct future development efforts. Since this device was developed for a specific need in one family, it remains to be seen whether other hearing-impaired people will find it equally useful.

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THE AUTHOR



CAROL J. SANFORD lives in Jupiter, Florida. She has a B.A. in mathematics from the University of Colorado and has worked in software development since 1968. Since 1980, she has been a senior software engineer at Photo Electronics Corporation. Problems of the hearing impaired have been a concern to her since her daughter Jill was born with a profound hearing impairment in 1975. As a result of her experiences with the Johns Hopkins National Search, a company called Mainstream Designs, Inc., has been formed to produce Tonetalker and to research and develop computer-assisted technology for the disabled.