The TOUCH-TONE telephone and other telephone devices are helping to make today's communications network more versatile. Now such tasks as ordering supplies, retrieving information, or controlling machines, can be done more conveniently - by telephone.

Machines at your Fingertips

J. H. Soderberg

COMPUTER: This is Smith & Sons. Please send your identification number.

MR. BLISS: Beep . Beep ... Beep .. Beep . . . . . Beep . Beep

COMPUTER: Thank you, Mr. Bliss. I am ready to receive your order. Please send the item number followed by quantity and star.

MR. BLISS: Beep ... Beep . Beep . Beep Beep ... Beep ... Beep .... Beep

COMPUTER: You ordered twelve of item number six-five-eight-three-three-six. Please proceed.

MR. BLISS: Beep . Beep ... Beep ... Beep . Beep . . Beep ... Beep ... Beep

No, this isn't the scenario from the latest underground play, but a true-life dialogue as a human "talks" to a machine in a language understood by the machine, and the machine replies in a language understood by the human. How did it all come about?

With the invention of the transistor and the development of a multifrequency oscillator adaptable to the low and variable power from a telephone central office, pushbutton tone signaling became a reality in the telephone plant. Although tone signaling was initially used for dialing (see *Central-Office Receiver for* TOUCH-TONE® *Calling*, RECORD, *June 1961)*, telephone engineers immediately set to work designing equipment that would allow machines at the other end to "hear" the tones, translate them, and take appropriate action. To these engineers, the possibility of "end-to-end" signaling (i.e., telephone-to-telephone as opposed to the common practice of office-to-office signaling) meant a whole new world of exciting and commercially attractive services. For example, they could see the day when you could "talk" across the country to machines such as computers from a pushbutton telephone.

But that day couldn't come about as long as the rotary telephone dial continued to be predominantly used. With the rotary dial, signaling consists of periodic interruptions of a direct current supplied from the telephone central office. The number of interruptions per rotation of the fin-

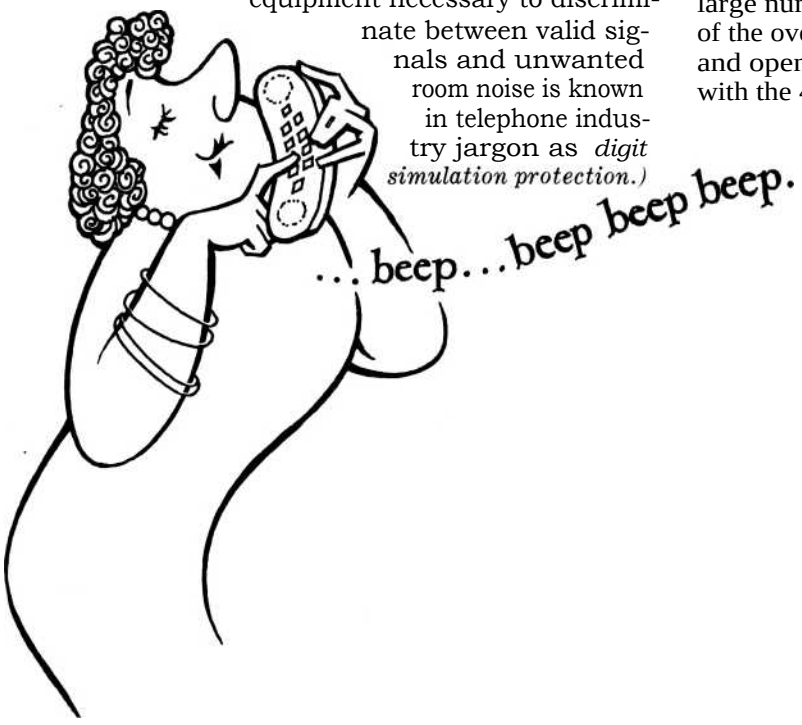
ger wheel tells the central office which number you are dialing. The dc interruptions, however, cannot travel easily beyond the central office.

With TOUCH-TONE® signaling, the procedure is different. The Touch-Tone telephone produces musical tones instead of the familiar clicks of the rotary dial. Since the tones are in the range of frequencies of the human voice, they can travel over any established connection used for voice transmission-even beyond the central office.

Pressing a button on a Touch-Tone telephone generates two voice-frequency tones. Each digit is represented by a different combination of two out of seven distinct tones. The frequency of each tone was very carefully chosen to minimize interference from harmonics of these tones or from combinations of frequencies found in speech, music, and noise.

Touch-Tone dialing requires a receiver at the central office to translate the incoming digit frequencies into signals that can be used by the switching equipment. The receiver must be sensitive enough to detect tone signals that may have been attenuated over long telephone loops between the customer and the central office, and it must discriminate between valid dial signals and speech or noise on the line.

To use the Touch-Tone telephone for data applications, a similar but more complex receiver is needed at the end of the long-distance telephone call. One reason the receiver is more complex is that more sensitivity is needed due to the greater length of the circuit (it could be transcontinental) . Another reason is that data messages are usually longer than central office signals and hence the end-to-end receiver is exposed to longer periods of room noise and voice energy entering the transmitter of the telephone handset, thus increasing the likelihood of noise simulating the digital information. (The electronic equipment necessary to discriminate between valid signals and unwanted room noise is known in telephone industry jargon as *digit simulation protection.)*



Thus, the new receiver was designed with added sensitivity, greater bandwidths, echo protection, digit simulation protection, answerback channels, line control functions, and terminating facilities to connect to a large variety of business machines. This new receiver has become a member of the Bell System's family of DATA-PHONE® data sets and is known as the 403 data set.

With the addition of the 403 data set, the Touch-Tone telephone does more than permit easier, faster dialing-its ability to signal with tones through the switched network equips the telephone customer with an excellent low-speed data transmitter, and at a lower cost than earlier data sets.

The ability to transmit and receive tone signals over any established connection with a Touch-Tone telephone has led to many interesting applications. Now the Touch-Tone telephone can be used not only to dial a computer, but once the connection is established it can be used to feed in data. One such application, where the Touch-Tone telephone first made its impact, is in the area of data collection systems. As the name implies, data collection systems use a large number of outlying stations, each sending data to a central collection point for subsequent processing. These systems handle such diverse operations as commercial and hospital billing and bookkeeping, sales ordering and purchasing, production and inventory control, and time and attendance reporting.

Initially, data collection systems used the 401 Data-Phone data sets, which operate, in part, with the same frequencies as the tones from a Touch-Tone telephone. Thus, the Touch-Tone telephone and the 403 data set could replace the 401 system in many applications which can be satisfied by a simpler format. The savings brought about by this substitution, when multiplied by the large number of input stations, reduced the cost of the overall data collection system significantly and opened markets that were not economical with the 401 system.

Since the human input to a data collection system is slow, systems using Touch-Tone calling are found largely in local dial areas where there are no toll charges. For national data collection, local collection centers are used as a first step. The local centers are polled periodically by a regional center, and the data stored by each local center is, in turn, transmitted at high speed to the regional center. This avoids long holding times on toll circuits.

Touch-Tone data signaling has had an even greater impact in an information retrieval system known as DIVA (for Digital Inquiry-Voice Answer) . About 67 percent of the Touch-Tone data systems in use today, primarily in banks, use the DIVA system. In a typical DIVA system, a call is placed from a Touch-Tone telephone to a central computer location, which serves many lines. Each line usually terminates at a 403 data set, which is controlled by the computer. When the computer tells it to, the data set answers the call and sends an answer tone to the originating party to confirm that the call has been answered. By tapping the appropriate buttons on the Touch-Tone telephone, the caller then sends an "inquiry code" to the computer. The computer, which immediately finds the necessary information by searching its memory, replies to the query in the language of humans. It performs this feat of translation by going to words and phrases prerecorded in an audio response unit, arranging them in proper sequence, and returning them to the caller.

In banking applications, the computer might be asked to retrieve information concerning several types of accounts such as demand deposits, savings, or mortgage and loan accounts. In a typical DIVA banking system, a teller keys from 25 to 31 digits for any given query. Here's how. The teller dials:

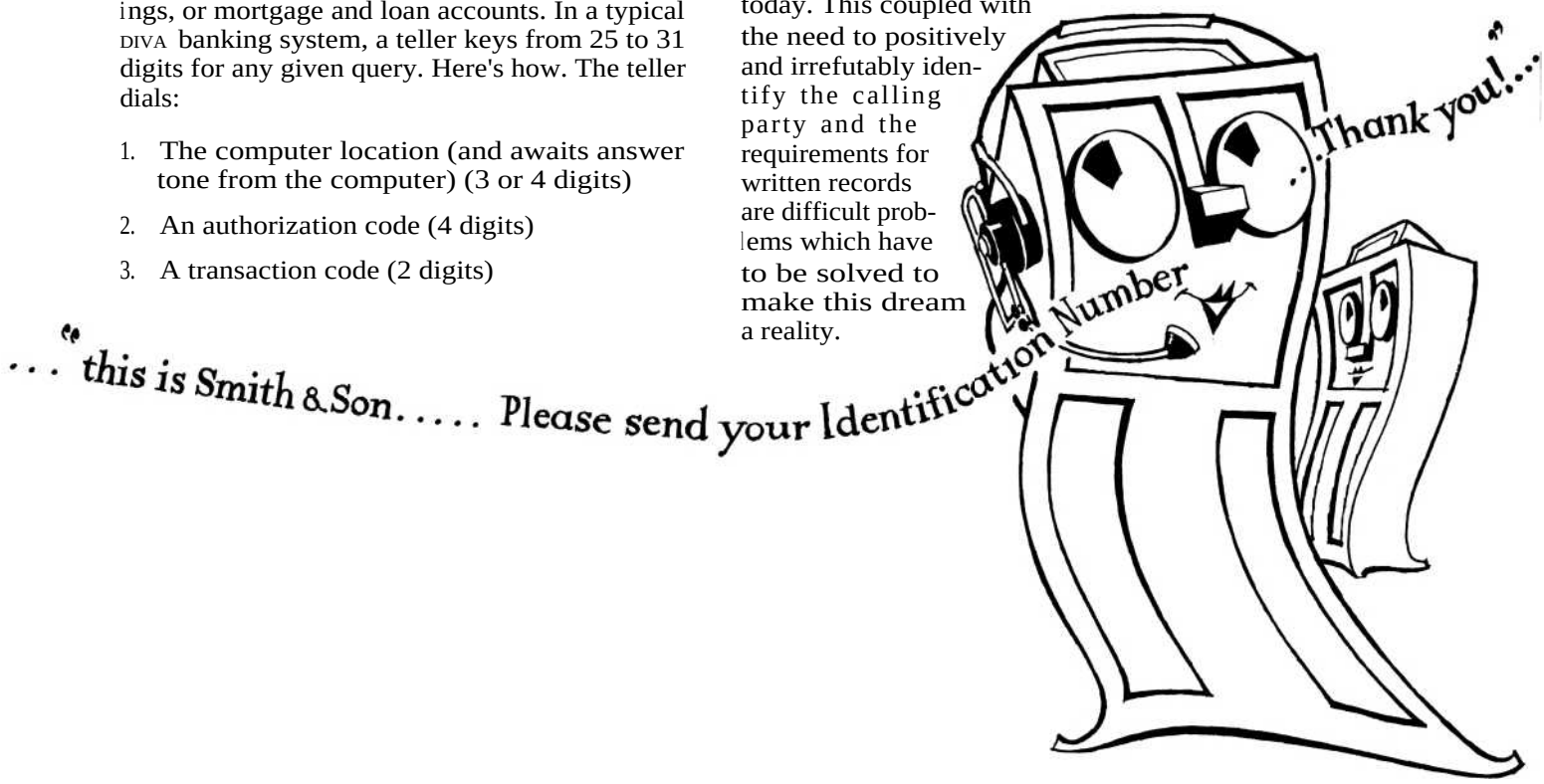
1. The computer location (and awaits answer tone from the computer) (3 or 4 digits)
2. An authorization code (4 digits)
3. A transaction code (2 digits)
4. The customer's account number (8 to 10 digits)
5. The query or other variable information (8 to 11 digits)

The average time to connect and enter information is approximately 25 seconds. The average number of words in any response to a query is about 20 words, which takes about 10 seconds. The audio response unit has a small vocabulary of from about 30 to 50 words. Although the vocabulary is limited, it is adequate to make such responses as

-BALANCE TO CLOSE LOAN .... ONE SIX EIGHT DOLLARS .... EIGHT NINE CENTS-

A system of telephones and computers will probably never completely eliminate the need for written records. And it should be noted that the computer in the DIVA system described here is not the "official" record but only a working tool to speed services and make them more convenient to use. In fact, the computer memory in this system is updated periodically from the written master records of the bank or credit agency, and processed checks or deposit and withdrawal slips are still used to update the master records.

Eventually, an information retrieval system such as DIVA might be used in any number of similar applications including retail stores, libraries, or doctors' offices. And many people envision a "checkless society" of the future, where goods may be purchased or bills paid from the telephone. It is not obvious that it will be to the customer's economic or operational advantage to pay his bills faster than he does today. This coupled with the need to positively and irrefutably identify the calling party and the requirements for written records are difficult problems which have to be solved to make this dream a reality.



There are many other areas in which a Touch-Tone telephone/computer system can be used to help make life more efficient and comfortable. One such use enables the human and the computer to carry on a conversation, as illustrated in the opening paragraph of this article. Although this use requires more sophisticated computer programming, it has a distinct advantage-the computer can help the inquirer in his own language. Real estate multiple listing services are currently using such a system. In this case, a potential customer goes to a member realtor, who checks his real estate listings using the Touch-Tone telephone. To assure that nothing is left to chance, the computer can ask questions regarding the type of house wanted (ranch, split level, colonial, for example), the number of rooms, acreage, price range, and all other pertinent data. Once the computer has digested this information, it suggests a list of houses which hopefully includes the customer's "dream house."

Still another application using the Touch-Tone telephone for end-to-end signaling is recorded dictation service. For many years the Bell System has offered a dial dictation service which uses the rotary dial to control the dictate mode, playback, end of message, and other functions. This system was restricted to use within a PBX because of the difficulty in passing the do interruptions of the rotary dial over the switched network. When Touch-Tone signaling was introduced, a new circuit was added so that the Touch-Tone phone could be used to send control signals. Although at the present time this service can only be used within a PBX system, a new dictation service, under development, will accept calls from any Touch-Tone telephone on the switched network. Soon doctors, businessmen, and others will be able to dictate from their homes, coin stations, or motel rooms as well as their offices.

The possibilities for using the Touch-Tone telephone for control purposes are virtually unlimited. Not only can the Touch-Tone telephone bring the computer revolution into every living room or office across the nation, but it can perform many other simpler control functions. It is even conceivable that future systems will permit you to turn on your home air conditioner so that your home will be comfortable when you return from a trip, or let you "shop by phone"-merely by pushing a few buttons on your telephone. The result could be a dramatic simplification of everyday tasks.

As Touch-Tone dialing becomes more widely available, the use of data systems using Touch-Tone calling is increasing. Today, 30 percent of all local central offices are equipped to handle Touch-Tone service. By the end of 1972 that number is expected to increase to 60 percent, and to 90 percent by 1976. And since their introduction, data systems using Touch-Tone calling have doubled each year. But the need for improved service continues as customers make greater use of the increasingly complex communication machine. Thus, studies are now underway to determine the human factors involved in such data systems. The results will be used to improve future service and make it available to those who need it.

Many businesses are using the double-duty TOUCH-TONE® telephone and a computer to speed customer services and develop new ones as well. Banks use the Touch-Tone phone in an information retrieval system known as DIVA (for Digital Inquiry-Voice Answer). With this system, for example, a teller can query the bank's central computer for a customer's up-to-date balance before cashing a check (upper left) . He dials the computer, taps a few buttons to identify the account number (or, if his phone is a card-dialer model as shown, inserts a DIVA account card) and the code for current balance. The computer responds with a voice answer. Data systems using the Touch-Tone telephone are being used by clerks in retail stores as well. As shown (upper right), the clerk telephones a computer to record each sale she makes. In this case, she sends the account number (for credit sales), the price, merchandise code, and her own clerk number. Billing and accounting are then handled automatically. Eventually, even a housewife (left) may use the Touch-Tone telephone to "shop by phone," pay bills, or check her bank balance.