The Versatility of

The fact that TOUCH-TONE Calling can be made to work with systems designed for rotary dials only begins to show its versatility. A host of applications in information processing await this system which transmits signals as musical tones.

H. E. Noweck

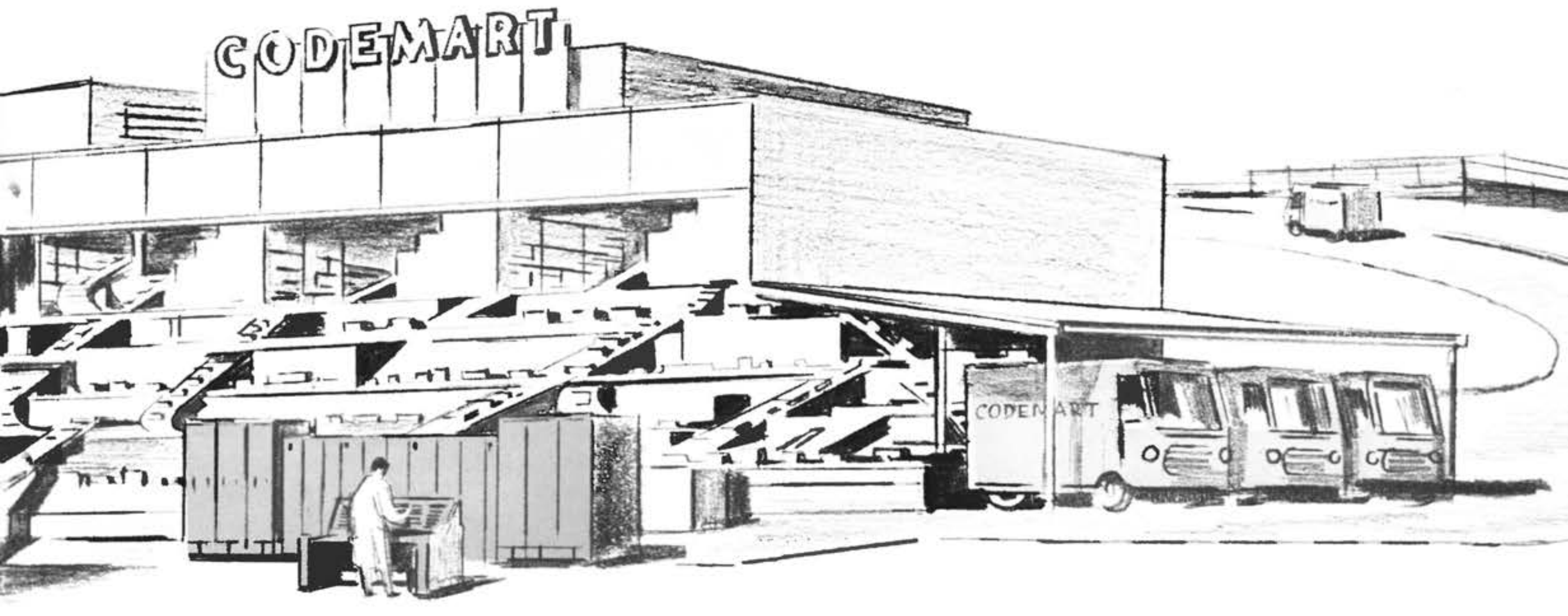
TOUCH-TONE Calling

The "pushbutton," once a symbol of relaxed living in the distant future, is rapidly becoming an accepted fact in our every-day life. By pushing buttons we can drive our car, tune in our favorite radio or TV program, or control any number of other electrical appliances. The word "pushbutton" has become practically synonymous with speed—convenience—the effortless accomplishment of laborious tasks.

To most Americans, the symbol of telephone service—the home telephone set—is facing an evolutionary change of marked importance. In place of the spinning dial with its circle of holes, the new telephone will have a series of ten pushbuttons to transmit the called number to the switching equipment in the central office. These ten pushbuttons will be lettered and numbered in the same way as the holes in the present dial, and will be arranged in three rows of three buttons each for numerals one through nine, with the tenth button—the "zero-operator" button—centrally located in a fourth row.

The telephone user will operate the buttons sequentially to establish a connection in the same way he dials digits sequentially at present. In contrast, however, the pushbuttons may be operated at a speed limited only by the capability of the user; there will be no waiting period as is now needed to let the dial return to normal before dialing successive digits.

The customer will be conscious of the change in his station set. But this is a small part of the totally new signaling system that has had to be developed—a new type of signal generator in



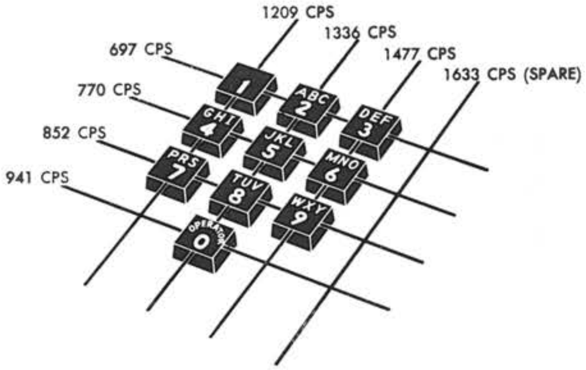
The supermarket of the future may be marked by the absence of clerks and shoppers and presence of automatic equipment operating under orders of TOUCH-TONE signals coming from customers.

the station set, a new signaling method, and a new type of signal receiver in the central office. The new signal generator and receiver use the latest achievements in electronic components and techniques.

In the new system, depressing a button momentarily generates musical tones that identify the digit. Each digit is represented by a different combination of two out of a total of eight tones. Although this system has a maximum of 16 different tone combinations, only ten are required for transmitting the necessary digital information to establish a connection to the called number. This leaves six combinations available for anticipated, but as yet unfocused, needs. Some possibilities are discussed later. Designers have selected frequencies for the signaling system to minimize the possibility that similar frequencies, present in speech, music, and noise, could imitate a legitimate digit and thus cause wrong numbers.

The signaling "language" of the present dial and that of TOUCH-TONE Calling are totally dissimilar. Since our existing central-office equipment was designed to understand dial "language," an automatic "translator" has been designed to translate TOUCH-TONE language into one that present central-office equipment can understand. This will allow the Bell System to introduce TOUCH-TONE Calling gradually while it continues to use equipment in which it has a multi-billion-dollar investment.

The method of access to these translators, or converters, and indeed the converters themselves, differs with the various switching systems. In this respect, the major divisions among systems are step-by-step and common control; that is, panel and crossbar.



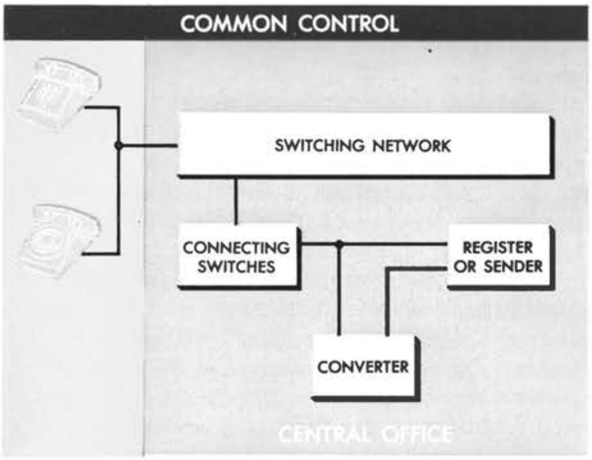
Each digit is represented by a combination of two unique tones. Six combinations are future spares.

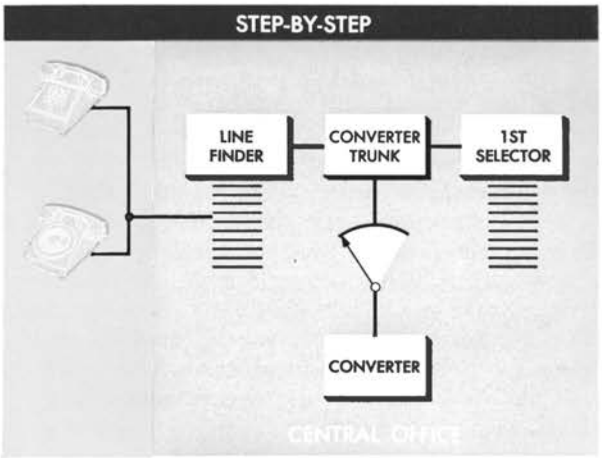
Let's first take a look at common-control type offices. In these offices, at the start of every call, switches connect a register or sender to the calling line to receive and register the called number as dialed by the customer. Modification for TOUCH-TONE Calling consists of permanently associating a converter with each register or sender that is to receive pushbutton signals. And here there is a very vital and fundamental difference among the different common-control systems. In No. 5 crossbar, for example, the originating registers may be readily subgrouped into pushbutton and dial-pulse subgroups, so that only registers required to handle traffic from pushbutton lines need be equipped with converters. The selection of a register of the proper type is assured by a "class-of-service" indication given by the calling line. In panel and No. 1 crossbar, however, it is not economically feasible to segregate senders according to a class-of-service; therefore, all senders must be equipped initially with converters.

It is the function of the converter to change TOUCH-TONE Calling signals into a form usable by the register or sender regardless of the type of common-control system involved. However, the converters become increasingly more complex as we go from the No. 5 crossbar converter, the simplest, through panel and No. 1 crossbar, and finally to the most sophisticated converter in the step-by-step switching system.

The converter for the No. 5 crossbar system consists of the basic building block common to converters of *all* switching systems—a multi-frequency receiver—and a "buffer" unit whose function is to transform the 2-out-of-8 output of the electronic TOUCH-TONE portion of the receiver into a 2-out-of-5 input. The latter is recorded directly on the existing digit registers of the No. 5 crossbar originating register.

Now let's look at panel and No. 1 crossbar systems. Here, the converter is associated with originating senders, and is a bit more complex since digit storage and outpulsing facilities are added. This is done for two reasons. First, the speed at which digits can be transmitted with a pushbutton set can exceed the capabilities of the devices that register the digits. This is particularly true in the case of No. 1 crossbar senders where the digits are registered on a crossbar switch. Second, by having the converter outpulse at 20 pulses per second, the conversion to dial pulses can be made with a minimum of modification to the sender and with *almost* full advantage being taken of the greater speed inherent in pushbutton operation.





In common-control systems, converters are appliqued directly to senders or registers. In the step-by-step system, access to the converters is through trunk interposed in switching network.

So, in the case of panel and No. 1 crossbar, the most economical arrangement is that in which the converter receives multifrequency signals from the pushbutton set, stores them on digit registers, and outpulses them into the senders at 20 pulses per second.

In step-by-step offices, a converter trunk is interposed between the line finder and the first selector. The trunks have access to the converters through an added switching linkage which serves to reduce the number of converters by as much as twenty to one.

Converter Action

The converter accepts pushbutton signals and generates dial pulses to operate the step-by-step switches. In the case of a call from a rotary dial station, the converter repeats the first digit to the first selector and then "cuts-through" the converter trunk and releases during the first interval between digits. The rest of the dialed digits directly control subsequent stages of selection in the usual manner.

As in the case of No. 5 crossbar, the step-by-step conversion arrangement lends itself readily to partial conversion by segregating pushbutton lines in separate line-finder groups. This results in substantial economies in the early stages of conversion as compared to converting the entire office.

Since a step-by-step office cannot do its own translating, the converter includes a modest amount of pretranslation ability. This permits the converter to look at the initial digits and determine how many more to expect on each call. Pretranslation minimizes converter holding time, and thus the number of converters required, by permitting the converter to release as soon as it has received and outpulsed the expected number of digits. Outpulsing in this case is at a rate of 10 pulses per second because of the limitation imposed by the step-by-step switches.

Some step-by-step offices are arranged for Automatic Message Accounting, and the recently developed Automatic Number Identification system. These arrangements require "party test" action which is normally made by the outgoing trunk. However, for pushbuttons, the converter is inserted in the transmission path at the time that party test is normally made. Thus the converter must make the party test and simulate the proper condition toward the trunk connecting the system to AMA or ANI. In all systems, the converter is "transparent" to dial pulses so that both dial and TOUCH-TONE types of stations can be associated with a given line.

There are apparently, then, no barriers to linking TOUCH-TONE Calling to present telephone equipment. However, a compatible customer service only begins to tap the potential usefulness of TOUCH-TONE Calling.

Signals generated by a dial cannot travel easily beyond the local central office. But the tones generated by a pushbutton set are in the voice-frequency range and may therefore travel over any established connection used for voice transmission. Thus the possibility of "end-to-end" signaling and the availability of spare signals will open up a whole new world of exciting and commercially attractive customer services. These will be based on the remote control of devices, particularly those of the computer type.

Already the Bell System has put to work one of these services in Western Electric Company distributing houses. Operating Company installers at the present time prepare written orders for needed equipment. These orders are received at the Western Electric distributing house where clerks process the order. This manual handling is time consuming, error-prone, and expensive. To solve this problem Western Electric designed a new system using a new simple card reader which works with a DATA-PHONE data set to transmit the required ordering information over telephone lines to a central card punch. The punched cards are fed into a card reader associated with a computer.

Each installer (or other authorized person) has his own number to uniquely identify him. The computer is programmed to recognize his number, not only as a name, but also his ordering authorities in terms of total dollars and specific quantities of individual items, and his delivery address. Each item to be ordered has its own number as well.

Ordering Operation

In using the system, the installer places a telephone call to the central point, inserts his identity card and follows it with cards of each item to be ordered. He uses a keyset on the card reader to key in the quantity of each item. The system uses error checking and different tones to indicate an "OK" transmission or one in error. In case of error, the operation is repeated.

It is possible to extend the idea of using the TOUCH-TONE set as a manual slow-speed data transmitter to many fields including telemetering, supervisory control, and control of information storage. In the latter category would be uses for air line and hotel reservations systems, interrogation and changes in inventory accounts, production accounting, and mechanized filing systems.

One particularly intriguing application of TOUCH-TONE Calling is the concept of an "automatic store" which is in reality an automatic supermarket. Present-day shoppers, however, would not recognize such a supermarket. There would be no check-out clerks, no shopping carts, and most significant of all, no customers. Instead, the supermarket would resemble a warehouse with enormous storage bins, conveyor belts, and automatic packaging machines.

The busy housewife of tomorrow would simply take her TOUCH-TONE set and, using a coded grocery list appearing in the daily papers, order the food supply for her family from this automatic store. She would not have to identify herself or the order verbally. Instead, automatic number identification would be used for identification and billing; the TOUCH-TONE set would be her slow-speed data transmitting, or ordering, device. Special equipment at the supermarket would be able to identify the housewife, and select and package her order. The order would then be delivered to her house, almost free of human intervention.

Whether the uses of the end-to-end signaling capabilities of a TOUCH-TONE set are immediate or lie in the future, they bring problems the system engineer must study and be prepared to answer. Among these are the effects of transmission facilities on the frequency and levels of the signals, compatibility with data receiving equipment, effects of polarity reversals encountered in some switching systems, and ways to make the system resistant to customer errors.

Tentatively, some of these problems have already been solved. For example, encoding plans have been derived which circumvent the customer's tendency to transpose digits. Also, plans have been drawn to make the oscillator in a TOUCH-TONE set independent of the normal signaling conditions in the switching system.

Conversion of a telephone system to TOUCH-TONE Calling is a long-range problem involving tens of millions of telephones, hundreds of millions of dollars, and years of time. Thus, planning and implementing the uses of this facility will require the most careful thought to insure that we take full advantage of all its potentialities.

D. G. Tweed demonstrates model of TOUCH-TONE telephone that has had experimental trials.