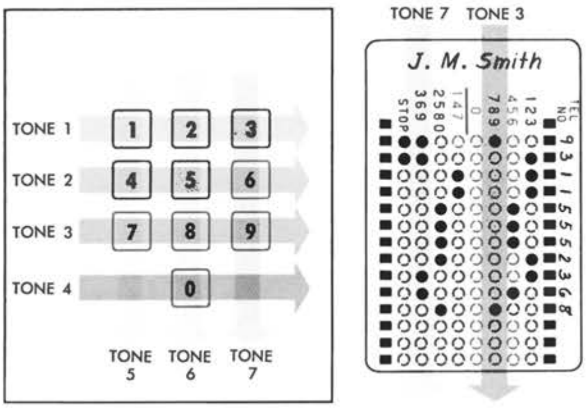
ABC
DEF
GHI
JKL
MNO
PRS
TUV
WXY

J. H. Ham and J. F. Ritchey

TOUCH-TONE CARD DIALER Set

FOR MANY YEARS the Bell System has been experimenting with various forms of automatic dialing, to improve speed and accuracy, and to ease the burden of dialing the many digits which are becoming necessary in the modern switching plant. The TOUCH-TONE* signaling system, which transmits audible multifrequency dialing pulses instead of the DC pulses generated by conventional dial mechanisms, offers a means by which dialing can be performed at a relatively high rate, approaching ten digits per second. The TOUCH-TONE CARD DIALER* set now provides a means by which this dialing can be done automatically, using a plastic card which has been prepunched or encoded by the customer. A separate card is punched for each frequently-called number; the cards are stored with the telephone in a convenient storage pocket.

*Bell System Service Marks



Pushing button generates two tones for signaling; holes punched in two columns on plastic card perform same function.

The TOUCH-TONE CARD DIALER set is a combination of a card reader and a standard TOUCH-TONE push-button dial, and can be used to place calls both automatically and manually, using TOUCH-TONE Calling signals. Although the TOUCH-TONE CARD DIALER set uses the card and reading mechanism principles developed for the 661A telephone DC CARD DIALER (RECORD, *October*, 1961), the concept of card dialing actually began with the TOUCH-TONE pushbutton version and the 3 by 4 coded card followed from it. Exploratory models of TOUCH-TONE CARD DIALER sets were tested in Hagerstown Md., during the spring of 1960. Because of delay in introducing multifrequency signaling, however, the DC pulse dialer was developed for service first. While the cards and outward appearance of the TOUCH-TONE and the DC sets are similar, basic differences exist.

When using either the TOUCH-TONE CARD DIALER set, or the 661 telephone set dialer, the customer selects a card, previously encoded with the desired number, from storage pockets in the set, and inserts it into the card slot. He then lifts the handset, and when dial tone is received, pushes the "Start" bar. Here the similarity to the 661 telephone set mode of operation ends.

Signaling by Multifrequency Tones

As the card is ejected automatically in the TOUCH-TONE CARD DIALER set by a drive mechanism, holes in the card are "read" and translated into multifrequency dialing signals. (These signals are the same tones heard in manual TOUCH-TONE dialing).

The frequencies of these tones are determined by the closure of two switches in the 3 by 4 multifrequency signaling matrix. In manual dialing, each of the ten buttons operates a unique pair of switches. With the CARD DIALER signaling unit, holes in the card operate similar switch pairs. Thus, to call a number on the new telephone set, one may either push buttons sequentially, or encode the digits required on successive lines of a 14-line card.

The digit-frequency relationship with respect to the buttons on the manual dial can be considered in terms of horizontal rows and vertical columns: four frequencies are associated with the rows and three with the columns. The column frequencies are all in one group, while the row frequencies are in another. Operating a button transmits a signal made up of the frequencies corresponding to the row and the column which intersect, as shown above.

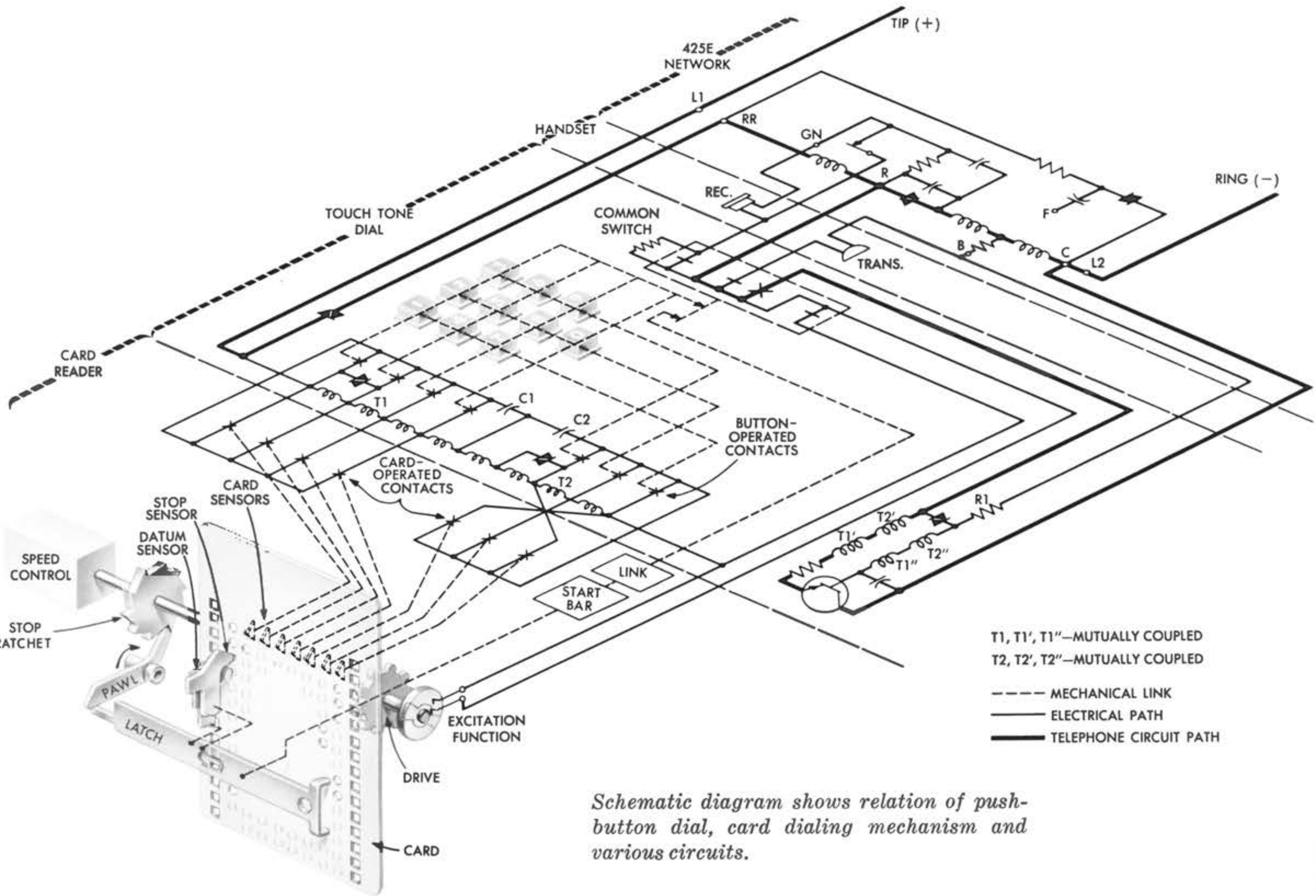
This relationship also forms the basis for the arrangement of the card used in the TOUCH-TONE CARD DIALER set. A telephone number can be encoded by punching two holes in each line to represent the value of the digits. When the card is "read", mechanical sensors fall into the holes in each of the 14 lines sequentially, and close coil-tap contacts to select the proper signal frequencies for each digit.

Card Reader Parallels Push-button Dial

The functional schematic on page 271 shows the relationship between the card reader, the TOUCH-TONE push-button dial, and the standard telephone set network. Since the button-operated contacts are normally open, the contacts operated by the card sensors can be connected in parallel with the corresponding button contacts. In addition to selecting frequencies, every button operates a common switch which disconnects the handset transmitter to guard against voice simulated dialing errors and connects the TOUCH-TONE Calling circuit into the telephone set network. It also switches an attenuating resistor in series with the receiver, and then interrupts a DC path through the inductor windings T1 and T2 to initiate the signal at full amplitude by shock excitation.

When a customer dials with a card, the start bar moves a mechanical link to hold the common switch in its operated position for the entire dialing sequence. However, since the excitation function must occur for every digit or line on the card, a rotary switch, synchronized with the action of the hole sensors, opens and closes the T1-T2 path as each line of the card is read.

This rotary excitation switch and the mechan-



Schematic diagram shows relation of push-button dial, card dialing mechanism and various circuits.

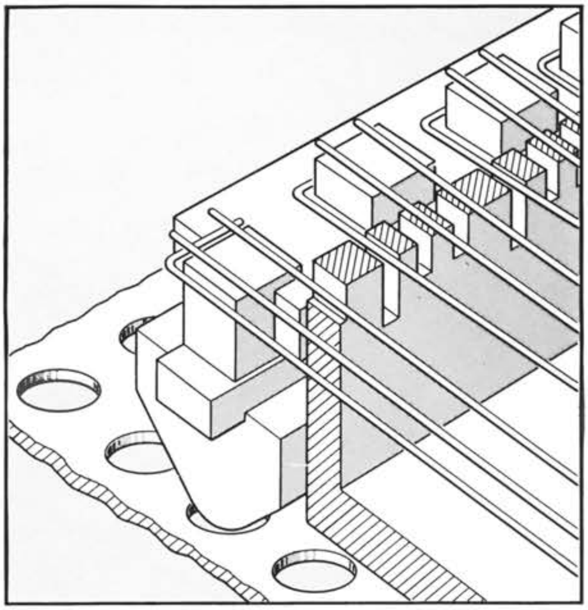
ical link for the common switch make it possible to provide both manual and push-button card dialing from a single circuit package. The mechanical link consists of a pair of plastic molded details, one of which is compliant. This application, incidentally, demonstrates that the spring or elastic properties of certain thermoplastics may be utilized wherever the time duration of loading is short. Excessive creep or stress relaxation characteristics, of course, prohibit long-term loading in tension of these materials.

Access Codes Interrupt Dialing

There are many situations in the telephone plant where a customer must dial a preliminary digit or digits to obtain a second dial tone before dialing can continue. Such digits are called "access codes," and are used most commonly in dialing through a PBX to a central office. Here the digit 9 is used to bypass the local board and obtain dial tone from the central office. Other exit codes, up to three digits, are used for access to special equipment such as AMA and CAMA. When using an automatic dialer from such locations, a "stop" must be provided to interrupt dialing after the exit code to await the second dial tone.

In TOUCH-TONE Calling using card dialing, a "stop" column is included on the card; a "Stop" hole punched in the line after the last digit of an exit code will stop the card reader before reading the next digit. To continue dialing, the customer must repush the "Start" bar after he hears the second dial tone.

As a card is inserted, it engages a sprocket on each side, and winds a spring to store sufficient energy to eject the card. When fully inserted, the card is locked by a ratchet assembly until the "Start" bar assembly is depressed. There, the mechanical link mentioned earlier has operated



Detail of hole sensing mechanism: sensors "cam" in and out of holes as card moves vertically.

the common switch on the dial to disconnect the transmitter. When the "Start" bar is released, it moves upward to a position determined by a latch bar and an overhanging step on the stop-hole sensor. In this position, not fully up, the latch bar has released the ratchet assembly and the card is driven upward; digit hole sensors scan the lines as they move by and operate a pair of coil-tap switches for each line. The speed at which the card is ejected is controlled by a small centrifugal governor similar to that used in the rotary dial.

If a hole has been encoded in the stop column in any digit line, the stop sensor will drop into the hole, releasing the latch bar at that point; the card motion is then stopped by the ratchet-stop assembly. If there is no hole in the stop column, the card proceeds out of the dialer. Because the bottom edge of the card "looks like" a hole to the stop sensor, it releases the latch to restore the start assembly and common switch.

Adjacent to the stop sensor is a datum arm which is positioned by the surface of the card. Its purpose is to maintain a constant distance between the latch bar and the card surface to prevent false operation which could result from dimensional variations or card warpage. Additionally, when the last line is read, the datum arm moves inward and prevents the ratchet assembly from stopping the card motion; the card continues to a final stop position at which the sprocket teeth have disengaged the card and the excitation switch has opened to permit manual dialing.

Special Hole Sensors Required

The hole sensing mechanism consists of seven sensors in a bar having corresponding rectangular openings as shown above. The ends of the sensors nearest the card are V-shaped to "cam" in and out of the holes as a card is either inserted or ejected. The bar rests on the shoulder of each sensor. L-shaped contact springs press the bar against the sensor; a pair of contact springs rest on each sensor as it sticks through the bar. When the sensors are resting against the unpunched surface of a card, the shoulders remain against the bar and all contacts remain in the open position. When a sensor enters a hole, however, the spring pair associated with that sensor makes contact with the L-shaped spring to accomplish a coil-tap closure and select one signal frequency. All coil-tap contacts are held open when the sensors are between card lines or when there is no card in the throat. The highest surface on which any two sensors rest determine the operate plane of the contacts, only a differential motion by sensors into the card produce a closure. If all sensors move together, as when a card is inserted or removed, the contacts remain open. This arrangement permits the hole sensing mechanism to adjust to the card positions and reduces to a minimum the need for absolute dimensional control between the card and coil-tap springs.

Interdigital Time Important

The minimum signal duration and the minimum interdigital time of the TOUCH-TONE central office receiver (RECORD, *June, 1961*) are each 40 milliseconds. To allow for variations in manufacturing and design, minimum values of 50 milliseconds for both signal duration and interdigital time were accepted as the design objective. This corresponds to a maximum dialing rate of ten digits per second. To achieve this maximum speed, the sensing contacts must be closed for at least 50 per cent of the line-to-line period, and the stop sensor and excitation functions must occur during the interdigital time. In early trials, dialers were adjusted so that the ratchet stop occurred before the excitation function. This proved to be wasteful of the reading period—the stop and excitation functions were performed sequentially, and required more than 50 per cent of the line-to-line motion. The best dialing speeds obtained were only of the order of 5 digits per second. Adjusting the excitation switch so that its closure occurred in parallel with the stop sensor action made possible a shorter interdigital period. With this arrangement, signal time was increased to more than 50 per cent of the line-to-line period and dialing speeds resulted which approach the 10 digit per second rate.

Just before a "Start"—with the card either in its fully inserted position or at any line stop—the stop sensor is out of a hole, the digit sensors are just entering holes in the next line, and the excitation switch is closed. When the "Start" bar is pushed, the common switch energizes the dial circuit, but no signal can be generated until the excitation switch opens. Release of the "Start" bar begins the reading cycle. After enough card motion occurs to insure that both digit sensors are in a hole, the excitation switch opens and a two-frequency signal is generated. This signal continues until the digit sensors are driven out of their holes by the rising card. If a stop is to occur after this line, the stop sensor will move in and out of the "stop" hole during the interdigital period to release the "Start" mechanism. If a stop is not encoded, ejection of the card continues with the excitation switch and digit sensors operating for each line. The excitation switch closes to begin the interdigital period 30 milliseconds before, and opens 10 milliseconds after, frequency contacts close. This interval is more than adequate to re-energize the tank circuits.

Field Trials Successful

A small number of TOUCH-TONE CARD DIALER sets, built by the Western Electric Model Shop, were put in a customer product trial at Findlay, Ohio, and a market trial at Greensburg, Pennsylvania, during 1962. The observed dialing times for seven digit familiar numbers were essentially the same for card dialing as for TOUCH-TONE manual push-button dialing; for ten digit numbers, however, card dialing was twice as fast. As would be expected, dialing errors from a card were very low, in the order of 0.3 per cent of initial attempts. The errors that were made resulted mainly from the customer selecting a wrong card or from an improperly punched card.

The general purpose TOUCH-TONE CARD DIALER set, made up of a manual push-button dial and a card reader, has been coded the 26B dial; it will be provided in the 1660 telephone set for residential use and in the 1662 set for multibutton key installations. The 26C dial, the first offered commercially, is currently being supplied in the attendants console for the Wide Area Data System (WADS). Present plans are for the complete line to be included in the displays at the New York World's Fair in 1964.

New Dial-in-Handset Ending Field Trials

A new telephone, its dial and almost all circuits transferred to the handset, is ending initial field trials in 200 homes outside Detroit.

The loaf-shaped device, known as the Dial-in-Handset, features a dial mounted midway between ear and mouth pieces. It was designed by Bell Laboratories and trial models were turned out in the model shop at Western Electric's Indianapolis Works. The new phone is not yet in production, nor is it available to the public.

Made in two plastic-covered models for wall or desk installation, the Dial-in-Handset is lighter, slimmer and almost a third smaller than phones now in use. The wall model, although slightly squared off at the top, follows the same streamlined pattern of the oblong, symmetrically-curved desk set.

The same handset is used in both models. It contains four of the phone's six major components (today's handsets contain only two) and yet it weighs only slightly more than conventional handsets. Heavy and bulky components, such as the bell and the switchhook remain in the base.

The set's most distinctive characteristic is the "space-saver dial" with movable finger stop. Instead of remaining stationary, the stop moves one space forward as each digit is dialed. With this, the dial wheel can be smaller but the finger holes remain virtually the same size.

New Dial-In-Handset centralizes dial and talking units to make calling more convenient then ever.