In this modern whirlwind world we welcome any device that saves us time. The latest candidate for stretching our days is an automatic card instrument designed to speed up the dialing of commonly called telephone numbers.

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The Automatic Card Dialer

A new member has been added to the Bell System family of dialing instruments. This is the 40A card dial, recently developed to join the family of dialing arrangements as a customer-controlled signalling device. The new dial provides fast, automatic, and convenient service. Placing a call requires only inserting a small plastic card into a slot in the telephone, waiting for dial tone and depressing the "start" button. The automatic dial does the rest—sensing the code on the card and generating a train of dial pulses for detection by central-office equipment in establishing the connection.

Telephone engineers recognized the need for an aid to dialing soon after the introduction of the finger wheel dial. For example, a patent granted around 1900 shows spring-driven commutators for reading codes established by selective wiring. The early proposals were prohibitive, however, because they were expensive and inflexible, but they did indicate that three essential elements are required for automatic dialing. These elements—memory, power for code reading, and pulse generation—have been resolved in many different ways. During the 1930's, an automatic dial was developed that used brass disks for memory, a clock spring wound by the telephone user for power, and a rotary-dial pulse generator. More recently, a plastic disk dial powered locally was designed at Bell Laboratories and placed on limited trial in Akron, Ohio. A Laboratories designed magnetic-drum automatic dialing telephone is now being developed, and a limited trial of the unit has been planned for the near future.

All of these dials, while providing added convenience for the customer, are relatively large and expensive. A prime objective in designing the new dial was to provide automatic calling as economically as possible. This objective has been met at Bell Laboratories through new types of memory, power and pulse generation and by combining the new dial with the other telephone instruments to make an integrated set.

What type of memory to use has always perplexed the designer as seen from the wide range

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of types employed in the past. Chief among them are paper rolls, magnetic tape, and plastic and metal discs. These memories require an auxiliary way to code a telephone number and an additional way to identify the entry. Furthermore, these are "internal" memories, and the coding, access, and display equipment required for them add to the cost of the automatic dial.

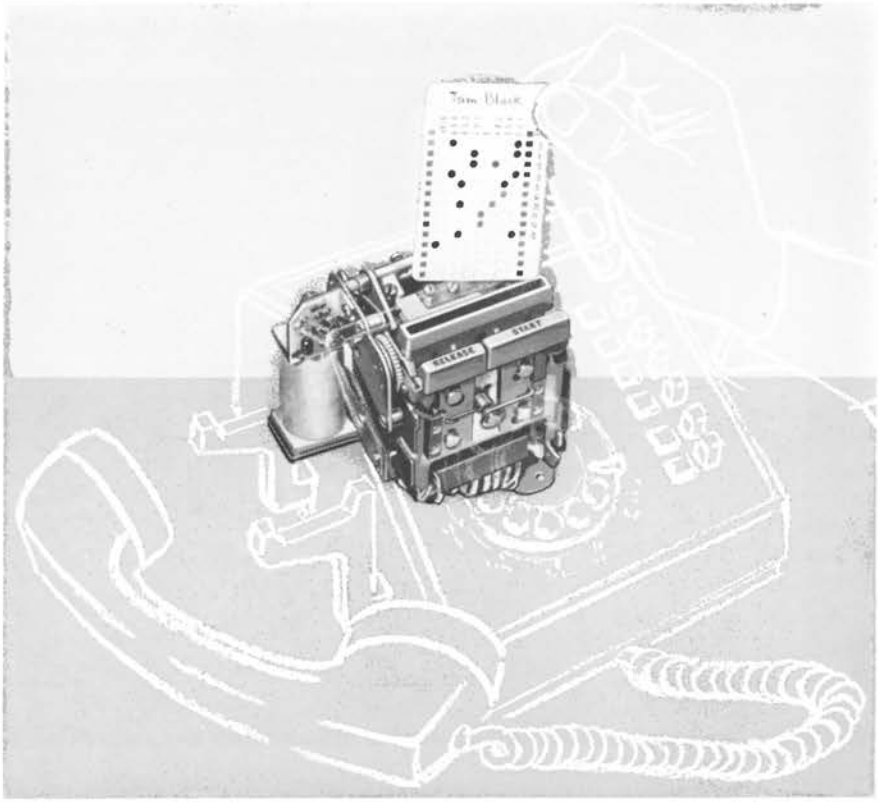
This expense is eliminated in the 40A card dial by using a memory card coded by the customer. A card for each telephone number is inexpensive and permits easy growth of and complete access to the memory. Pockets in the telephone housing permits frequently used cards to be displayed. Additional cards can be kept at any conveniently close point. Customer control of the coding of cards and arranging of cards in the store permits maximum flexibility in repertories.

Each plastic card, which measures 3-7/16 by 2-7/32 inches, is injection molded to permit shaping the circular knock-outs for coding. A rack configuration down either side of the card meshes with sprocket wheels inside the dial mechanism to wind up a spring during insertion. The rack then orients the card properly for row-by-row ejection during dialing.

To code a card, the customer first writes the name of a person or concern he often calls across the top of the card. He then writes each of the digits of the telephone number (translating any letters to their corresponding numbers) down the right side of the card, starting with the first digit at the top. The code, a modified 2-out-of-7 one, was chosen over a 10-position code to simplify the mechanism and permit a minimum number of scanning contacts. It means that digits 1 to 9 require the two knock-outs to be removed while digit zero is coded by removing a knock-out from the center row only. The customer can use a pencil or ball point pen to press out the plastic knock-out discs.

A card with a code for direct distance dialing (DDD) plus the seven-digit exchange number, is shown in the illustration below. A knockout has been removed from one of the three columns of each 1 to 9 group at the point where the column which contains the digit being coded intersects the row for that digit. The holes in the center column code the two zeros in the telephone number.

This coding arrangement would permit TOUCH-TONE Calling signals to be generated where this dialing is available. A tone card-dial, planned for the future, will operate with similar cards



Customer-coded card is inserted into slot atop the 40A dial mechanism, shown here in its relation to rest of the telephone set.

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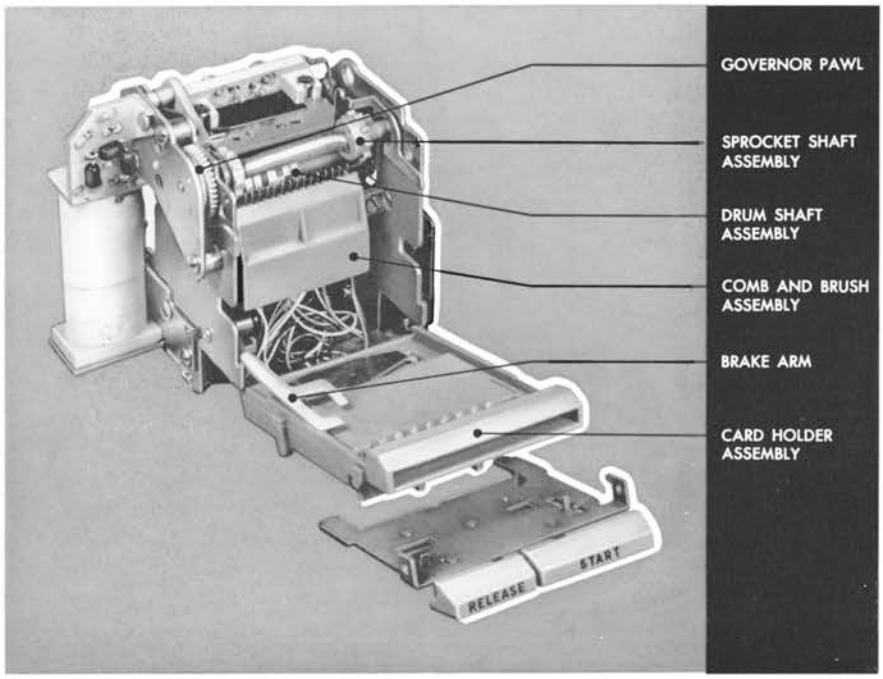
coded in the same manner as for pulse dialing. This combination card was planned for system-wide use of a single type card. The 14-digit capacity of the card permits coding the longest number expected for DDD and world-wide dialing. For the more frequently called shorter numbers, a knock-out in the "stop" column on the left side of the card is removed after the last coded row. Contacts sense this column to stop the dial. The stop column is also used to interrupt the dial after pulsing special access codes and permits the user to detect second dial tone before restarting the instrument by depressing the "start" button a second time.

Previous automatic dials have used either heavy clock springs or electric motors powered locally to read the code for dialing a number. Considerable energy is required for this function and, for an average digit (the "5"), must be controlled for a pulsing and interdigital time of 1.1 seconds. In the new dial, power from the telephone line is used to scan the code and generate the pulses. It is done by a self-stepping electromagnet. This also releases energy stored in a motor spring when the card is inserted, to advance the card row-by-row out of the dial. Using central-office power eliminates problems caused by local-power wiring and gives the dial the reliability of other telephone functions powered at the central office.

To dial a telephone number, the customer pushes the previously coded card into the dial until the top edge of the card is flush with the top of the gauge. He then depresses the "start" button to remove the talking circuit from the line and to substitute the 40A dial. As the card begins to move out, small plastic rollers, one for each column, press against the card, moving into the coded holes to operate the card-sensing contacts. These contacts and other functional elements of the automatic dial and telephone are shown on the block diagram on the next page.

Circuit Action

As soon as the start button is depressed, current flows in the electromagnet in series with the dial-pulse generating contact. This contact and the electromagnet are paralleled by the card contacts in series with contacts operated by a printed-circuit commutator that is rotated by the electromagnet. Additional parallel paths around the electromagnet and card-commutator contacts provide pulse blanking and interdigital time. Each time the electromagnet operates, the dial-pulse contact transfers to complete a circuit around the electromagnet, and a pulse is generated if the card-commutator contacts are open to blanking or interdigital paths. The electromagnet steps itself to generate dial pulses at the required rate.



The 40A dial mechanism, designed to be integral with customer's set, combines the memory, power, and pulse generation units into one compact package.

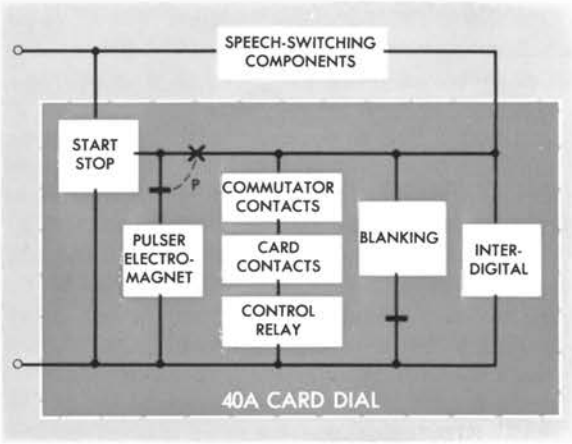
As a digit is dialed, the armature of the electromagnet moves a plastic pawl which rotates the commutator one sixteenth of a revolution. At each of the first ten angular positions of the commutator, a different contact array is placed in series with the card contacts. If no continuity exists through these two sets of contacts, a dial pulse is generated while the control circuit operates the pulser electromagnet. Since the electromagnet self-steps, pulses are continuously generated until the commutator is rotated to a position which permits a shorting circuit through the commutator and card contacts. This circuit causes the control relay to be energized and its contact to close the blanking path. This bistable contact remains operated and blanks the pulses during the remainder of the ten pulsing steps. During this blanking period, control-relay contacts permit the electromagnet to self-step at 20 pulses per second. This action shortens the total time required to scan a line on the card. The control relay employs glass-enclosed contacts magnetically biased and is mounted on the left side of the dial.

Interdigital Time

After the electromagnet generates pulses equivalent to the first digit coded on the card, and blanks the additional pulses, it returns to 10 pps operation while rotating the commutator through six interdigital positions. This guarantees sufficient interdigital time for the central office to sense the end of the digit. During two of these later steps, a cam on the commutator shaft operates an escapement which releases the gear train. This action permits the motor spring, previously wound up on insertion of the card, to rotate the sprocket wheel shaft. The card then moves so that the second coded row is positioned in front of the card-contact rollers.

The pulser continues to rotate the commutator. Pulses equivalent to the new digit are generated until the commutator and card contacts provide a path for current to operate the control relay. This sequence of operation—pulsing, blanking, and card advance during interdigital time—repeats until the complete telephone number is dialed. For the "stop" hole, the electromagnet circuit opens as the roller for this column moves into the hole. The action also re-connects the speech portion of the telephone so that the customer can begin his conversation.

At the end of the conversation and after replacing the handset, the customer pushes the release button to eject the card. The release button can also be used to eject a card during dialing if the customer decides to abandon the call.



Major components of 40A card dial as designed to be part of the circuit in the telephone-set itself.

Ideas embodied in the 40A dial were initially explored with field test units at Birmingham, Michigan during 1960. The instruments, built by the Western Electric model shop in Indianapolis, proved the technical feasibility of the proposal. Favorable comments by business and residential customers cooperating in the tests prompted the decision to proceed with development of new telephones equipped with the automatic dial.

The close cooperation between the development and appraisal groups at Bell Laboratories and the manufacturing engineers at Western Electric's Indianapolis plant permitted the business version of the automatic dial telephone to become available in a short time. Intricate, yet easily mass produced, components and contact assemblies were devised for the production design. Using plastic moldings for the card and many of the dial parts permits complex interacting details that have close tolerances and smooth surfaces for proper operation.

Early production units of the 661 type automatic dialing telephone, using the 40A dial, have been field tested at Richmond, Va., with favorable results. These units are presently being tested at Minneapolis, Minn., with an enlarged sample. The new telephone will be marketed on a limited basis during 1961. Favorable response from customers during the early trials, however, forecast a growing demand for the speed, accuracy and convenience of calling with this new customer product.

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