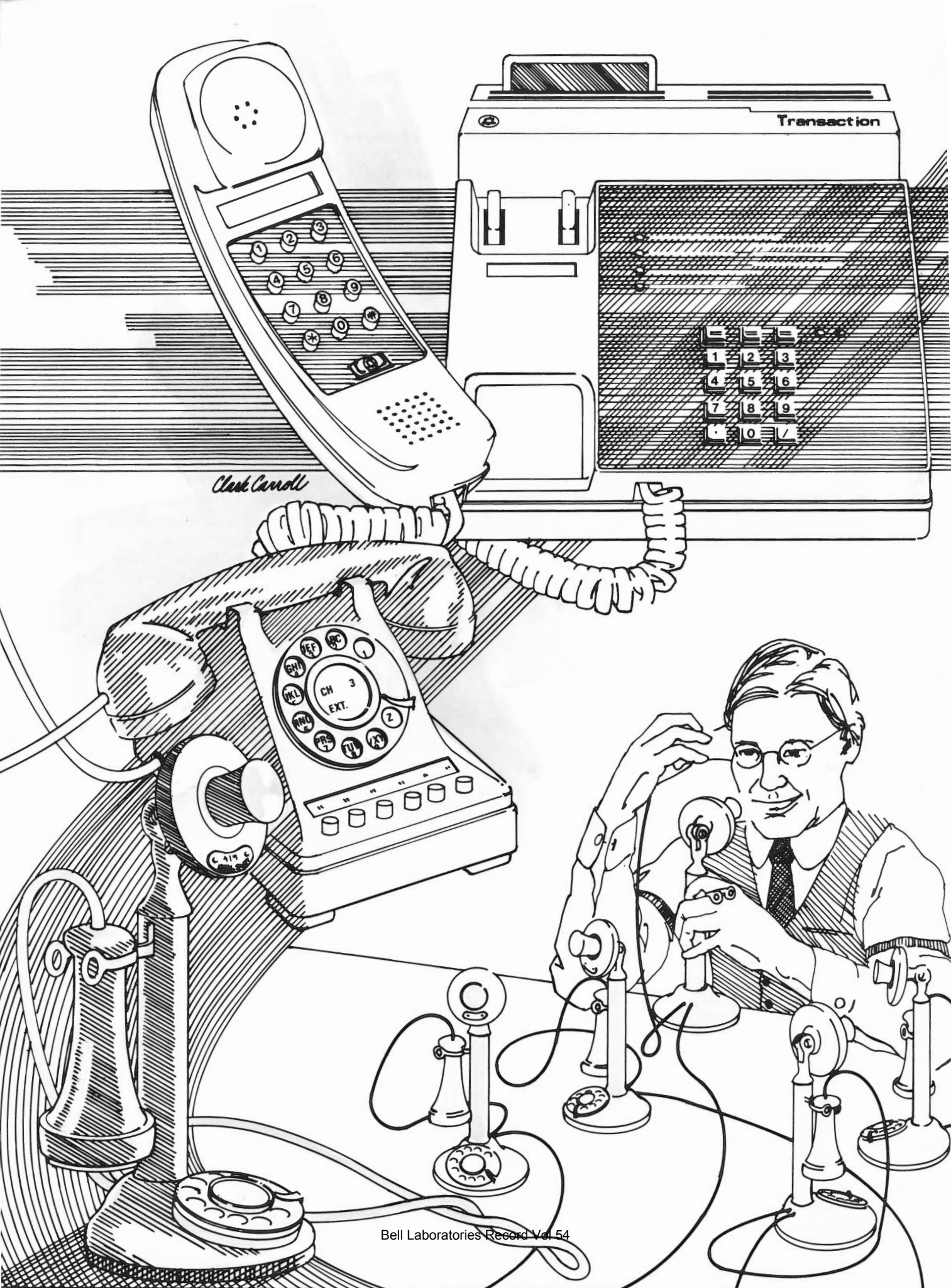

Transaction
Clark Carroll

# Bell's great invention: life begins at 50

*Finally established as a successful carrier of conversations, the telephone in its second half century improved the transmission of voice signals, performed a wide variety of new services, and came in many attractive styles and colors. These past 50 years have been an exciting prelude to the future.*

IT WAS the jazz-bewitched 1920s. Movies became talkies in 1926 with the first full-length motion picture using equipment developed by Bell Labs. The same year the telephone, a necessity now in millions of homes and businesses, celebrated its 50th birthday.

The pedestal—or candlestick—desk set was *the* instrument of the era, although many of the earlier wall phones were still in service. Nationwide calling using long-distance operators was commonplace. Some phones had dials that could be used for local calls.

But the world was moving faster, and customer demand for more and better communications facilities was swelling.

The newly formed Bell Labs had the job. Engineers and scientists set about improving the telephone set's voice transmission quality, improving its reliability, increasing the number of services a phone could provide, reducing cost, and designing a variety of instrument styles to satisfy every taste.

Just before the crash of '29, the second generation of desk phones made its debut for Bell System customers. It was a "new look" set—a milestone in telephone evolution. A streamlined version of European phones, the set was popularly known as the "French phone." It came in bronze, gold, silver, gray, ivory, and "basic black."

Depression clouds still hung over 1937 when the third generation of desk phones—the 300-type telephone set—was born. A much improved design, the set's bell and associated equipment were in the base instead of in a separate wall box. The 300 set was the first phone to have an anti-sidetone network that minimized the sound of your own voice in the receiver as you spoke. A new transmitter and a new receiver helped improve fidelity, and the set was less susceptible to line noise.

A year after the 300 set's introduction, six buttons were added to it—hold, plus five lines—making the phone the Bell System's first self-contained key telephone set.

It was a welcome change for businessmen. At the time they had a separate phone for every line and the result was often a desk cluttered with phones.

World War II turned a good part of Bell Labs effort to the nation's defense. But right after V.J. Day, development resumed on new station equipment for home and office. One of the first tasks was a new station set with higher receiving volume, a better dial, lighter handset, and an improved ringer with a volume control. Originally these were intended as improvements in the 300 set, but the Bell System decided to go for a completely new design.

That decision paid off. The 500-type set appeared in 1949. With years of research and development, plus human-factors engineering behind it, the fourth-generation 500 set added even more naturalness and intelligibility to speech. Styling was modern, and the adjustable ringer was more effective. The user could set it to ring loud or soft, and it was lower pitched. The improved transmission and ringer allowed the 500 set to operate on circuits with higher resistance. Thus, sets could be used at greater distances from switching offices, or at short distances using smaller diameter wires, saving copper. Western Electric manufactured the 500 set so efficiently that its price to Operating Telephone Companies was well below that of any other telephone in the world.

Available in many colors after 1954, the 500 set remains the most widely used telephone in the U. S. Exploiting newly developed materials and processes, Bell Labs and Western Electric have made more than 2500 changes to the 500 set in its lifetime, not just for the sake of appearance, but to make it work better and to keep its cost down. Nevertheless, with the exception of the TOUCH-TONE® dial, all telephones manufactured today contain components that have essentially the same characteristics as those of the 500 set.

**rom past to future:** Fifty years ago, only a battery of phones ould give a customer multiline service. Then came the six-button ey telephone with five lines plus hold. Today telephones do ven more—witness the Transaction telephone for the "cashless ociety's" banking and credit services and, of course, regular lephone service.

**Group calls** have been made easy with the Bell System's 4A speakerphone.

Realizing that many telephone users would like to keep their hands free for note-taking or to look up reference material during conversations, Bell System engineers developed the speakerphone. The first model appeared in 1954 (but the quality of the sound produced what some users described as the "barrel effect"). An automatic voice-switching circuit, added to the 1959 speakerphone, improved performance by eliminating "singing" from acoustic feedback. Further research produced a new, transistorized voice-switching circuit that included, among other improvements, a noise-operated, gain-adjusting device which discriminated between speech and noise signals at the microphone. The circuit was used in the 3-Type speakerphone which was introduced in 1960.

Speakerphones, of course, were commonly used for calls between groups of persons. And persons who liked to dominate the conversation soon learned to sit right in front of the microphone. Why? Because sometimes speech quality suffered if someone sat to the side of the microphone, or walked about while talking. To pick up voices well around a table or room, an omnidirectional microphone was incorporated in 1973's two-piece 4A speakerphone. The introduction of integrated circuits resulted in the elimination of a separate control box. The overall transmission was improved, providing more natural group discussions over the telephone; however the "barrel effect" still remains as a problem in the use of speakerphones.

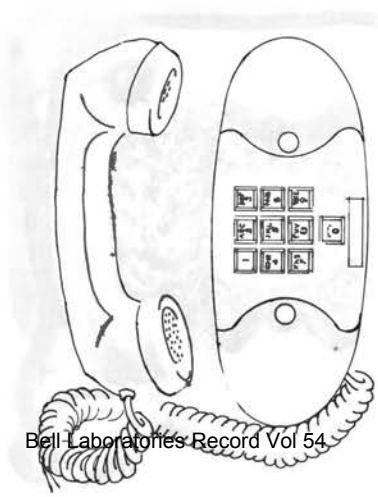
After years of using telephones that, except for different colors, looked alike, some Bell System customers were ready for a change—a new and different phone, smaller, more decorative. Sensing the mood, the Bell System introduced the PRINCESS® phone. (A name once considered for it was the "bedroom set.") Advertisements proclaimed "It's little, it's lovely, it lights," and the mold of traditional telephone design was broken when the phone bowed in 1959. Sporting a new look and a dial that lit when the handset was lifted, the phone was a successful addition to the product line. First offered in six colors, the set required redesign of the 500 set's ringer, speech network, and dial, and the addition of a lead weight in the base. Nevertheless, the Princess phone's performance was the same as the 500 set's. Two-line Princess phones with Touch-Tone dials and new colors made the scene in '63.

During this period the business customer's needs were also getting attention. Although six-button key sets provided five lines in a single telephone, there was a growing need for additional lines and improved service among businesses that were too small to warrant having their own "switchboard." To fill the vacuum, the Bell System introduced the CALL DIRECTOR® telephone in 1959. Employing the basic 500-set speech circuit and handset, it could serve as a regular office phone and handle several incoming, outgoing, and interoffice calls at once.

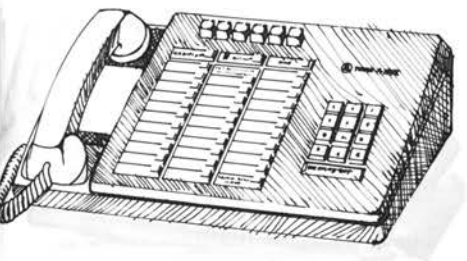
This single instrument serves as the receptionist's "extension" of each phone in a customer's office. Present models handle up to 29 lines and come with a variety of options for line selection, signaling, and built-in speakerphone.

In the whirlwind world of the late '50s, jets started cutting travel time in half. The stage was set for ways that would save telephone customers dialing time too. Telephones were being designed that would automatically dial often-called numbers. It happened in 1961 when the Bell System introduced the automatic card dialer, which used perforated plastic cards to store numbers. Automatic dialer design expanded in 1965 with the CALL-A-MATIC® set, which used tape cartridges to store 250 or 500 numbers.

Today's family of TOUCH-A-MATIC® telephones contain integrated circuits that perform memory, logic, and dialing functions. The first Touch-a-matic telephone, introduced in 1974, is slightly larger than a standard desk phone and stores 31 numbers permanently—



at least until changed by the user. Market studies revealed such a number would be adequate for the majority of customers. To dial a frequently used number, just press a button. But what about numbers you don't dial that often? Bell Labs engineers added another button that will automatically re-call the last manually dialed number if the line were busy or if the party didn't answer. In late 1975 a version of the phone was offered without a handset as an adjunct dialer for existing phones. The single-line Touch-a-matic 16 telephone for residential and small-business customers came out the same year.

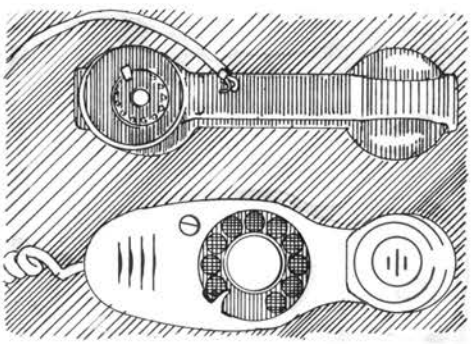


Of course, the venerable telephone dial was meeting competition in other quarters, too. The invention of the transistor in 1947 spurred development of other electronic devices, and soon a whole new array of miniature components became available. Putting them all together, engineers designed a compact, solid-state multi-frequency pushbutton tone oscillator. At the same time human-factors engineers made tests on volunteer "dialers" to determine the best button arrangement, size, spacing, travel, and operating force. Then, in 1963, the Touch-Tone telephone was born.

Touch-Tone service cuts manual dialing time in half and quickly releases switching machines to handle other calls. Touch-Tone phones allow people to "talk" with computers—to bank and to shop by phone, to verify checking-account balances, and to make it possible for stores to "dial up" the status of a customer's charge card. By the early 1980s, Touch-Tone service will be available to about 85 percent of Bell System customers.

Imagine a complete phone in the palm of your hand—one with a dial right in the handset for comfortable calling from a chair, bed, or while working in the kitchen. Not requiring a long reach for the dial-in-base, the phone could be kept in places that would be awkward for standard phones. Such a dial-in-handset phone had been around since 1941, but it was a lineman's handset and not attractive enough for home or business use.

So Bell Labs engineers sat down at the drawing board. The first trial design of a dial-in-handset phone



for subscribers was called the Demitasse; it was a standard handset with a dial over the transmitter. In 1959, Bell Labs came up with another design with a standard dial between the transmitter and receiver. Still too bulky to be practical, the midriff bulge earned it the nickname "Schmoo" because of a resemblance to Al Capp's genial cartoon character. Further design effort by industrial designer Henry Dreyfuss culminated in 1965 with a phone that looked like a fine piece of sculpture. The Bell System's "beauty queen," it was called the TRIMLINE® phone and was chosen by the Museum of Modern Art in New York City for its Design Collection. Balancing technological and aesthetic considerations, the Trimline phone was the first to have the dial and transmission circuitry in the handset with the transmitter and receiver.

Another Trimline telephone "first" was the concept of modularity. That is, the phone's handset, base, and connecting cords are fitted with plugs and jacks. The phone company orders separate parts that the installer assembles on the customer's premises. Modularity reduces the inventory of phones on an installer's truck to handsets, desk bases, wall plates and cords in standard colors. When moving, customers can unplug the phones, pack them, then plug them into connecting blocks in their new homes. Incorporating a specially designed ringer, network, rotary dial (or Touch-Tone pad), and receiver, the Trimline phone now outranks the 500 set in production rate.

With an eye on easier, low-cost maintenance, the Bell System also in 1965 introduced the single-slot coin phone. Quite different both outwardly and internally from its three-slot predecessor, the phone is more resistant to vandalism, has a larger cash box, and provides im-

**Classroom** lectures reach distant groups with the Portable Conference Telephone.

proved coin-sensing to detect slugs. The single-slot coin entrance eliminates fumbling to get the coin in the right slot, making for faster deposits.

Since the introduction of speakerphones, the Bell System recognized the need for a similar but larger instrument for classrooms, conference rooms, and auditoriums. The result was the Conference Telephone Set in the mid '60s. Packaged in a small suitcase, it could be carried anywhere and plugged into a telephone jack, permitting a classroom lecturer to speak to remote classes. One university created a network of 50 sets using the 50A Portable Conference Telephone brought out in 1970. In 1975, the Bell System introduced the 50A1 Portable Conference Telephone.

A large step in communications was taken in 1970 when PICTUREPHONE® service was introduced on a limited basis, enabling users to see each other and to display graphic material. The Picturephone set was a technological challenge, involving the packaging of a TV camera and receiver. It is still being evaluated to find its place in business and the home.

Engineers were encouraged by the economics of modularity, introduced by Trimline phones, so they extended it to all phones in 1972. Modular phones have been the key to success of PhoneCenters where customers sign up for service, pick up their phones, bring them home, then plug them into pre-installed modular connecting blocks. Starting early this year, all single-line desk and wall phones installed will be modular.

The variety of phone styles available to Bell System customers grew larger in 1974 when DESIGN LINE® telephones were announced—there are colors and styles for every room, period, mood, decor, or whatever. Five models were offered first; now there are 11. The telephone company's investment is minimized because the phones can be shipped directly from Western Electric to the customer. They are also the first sets in which the "shell," or nonworking part of the telephone, is sold by the Bell System.

In response to requests from Bell System Operating Companies, Bell Labs designed a business telephone set that enables merchants and banks to check credit-card transactions in seconds. Developed with guidance from AT&T's marketing department and introduced in 1974 the Transaction telephone is two phones in one. The first is for normal calling, the other for information exchange with a computer, for check verification and credit authorization by stores and banks.

The phone will also allow depositors to verify their checking-account balances without a cashier. In one version this communication

## SPECIAL PHONES FOR SPECIAL NEEDS

Before we close out the century of telephone development, a few words about not-to-be-forgotten special-purpose phones for those unusual needs . . .

Police! Fire! An emergency reporting telephone for street use appeared in bright red or yellow cast-metal boxes in 1955; an improved model came out in '63. Opening the door and lifting the handset automatically connected you with the centralized reporting bureau.

There's a phone for elevators, and another for hospital patients. The hospital phone has keys that control a speakerphone (to the nurse's station), a nurse's call key, and a privacy key to prevent the room from being monitored by the nurse. Patients who can't reach the phone use a nurse's call button, plugged into the phone's base.

The 1878 lineman's handset, which the "French phone's" handset was modeled after, was updated in 1941 and again in 1968.

For hard-of-hearing persons, there are handsets with amplifiers to boost volume. Persons with soft voices can get a handset with an amplifier to boost the transmitter's output.

The Code-Com set enables deaf and blind-deaf customers to communicate by watching a flashing light or touching a vibrating disc. A key lets the persons "talk" by Morse code.

with a computer includes a computer-generated voice answer-back arrangement.

The Transaction II telephone will become available this year and, like its predecessor, will "read" magnetically encoded stripes on the merchant's dialing card and the customer's credit card. In addition to the computer-generated voice answer-back feature, the phone has an eight-character display that shows information about the transaction. All of these communication capabilities are achieved through the application of the latest solid-state, large-scale integration into the telephone.

Unquestionably, today's telephones are a far cry from the first commercial set. The terminals of a vast, complex communications network providing essentially instantaneous communications, telephones from the beginning have met a great social need, essential to the nation's growth and prosperity. □

## ALONG WITH THE TELEPHONE, OTHER BIG INNOVATIONS . . .

While the development of telephone sets was progressing, Bell Labs was making important advances in almost every other area of telephone technology. Here are some of those innovations:

**Transistor and Solid-State Electronics.** Modern solid-state electronics—commonplace today in the design of essentially all telecommunications equipment, computers, television sets, pocket calculators, pacemakers, and so on—was realized with the invention of the transistor by three Nobel Prize-winning scientists at Bell Labs in 1947.

**Logic Control Systems.** The early use of digital logic to store and interpret dialed information for telephone switching led to the design and operation at Bell Labs of the first electrical digital computer in 1937—and to a variety of electronic switching systems. The systems store instructions for new customer features and services in computer-like memories, easily changed without rewiring or replacing equipment.

**Improvements in Cable Transmission.** Since the invention of the coaxial cable system at Bell Laboratories in 1929, improvements in this transmission medium have continued to lower the cost of long-distance calls. Today, a single pair of coaxial conductors can accommodate over 10,000 simultaneous calls, about 20 times as many as when a coaxial system went into commercial service in 1941.

**Microwave Radio Transmission.** After years of research, the Bell System began using microwave radio commercially in 1948 to transmit telephone and television signals. With microwave radio, long-distance transmission was no longer solely dependent on cable, and each radio channel could carry many calls simultaneously. In 1962, with the launching of Telstar™, the principle of microwave transmission was applied to satellite communications.

**Negative Feedback.** Signal-boosting amplifiers were causing noise and distortion until, in the latter part of the 1920s, a technique was discovered at Bell Labs for "feeding back" part of the signal coming from the amplifier for comparison with the signal coming into it. It made possible multichannel cable systems.

**Direct Distance Dialing.** Bell System customers began dialing long distance calls without operator assistance in 1951, a change requiring the development of a nationwide uniform numbering plan and an automatic accounting system as well as new signaling techniques and switching equipment. Today, direct distance dialing is virtually universal and is being extended to international service.

**Encoding of Signals.** The formulation of an information theory at Bell Laboratories in the mid-1940s provided a complete mathematical theory of communications—and led to better understanding of the design of digital transmission systems, the first of which was introduced in 1962. The systems carry calls as encoded pulses rather than continuous signals.

**Quality Assurance.** Scientific methods of statistical quality control, now used by industry throughout the world, were developed half a century ago in the Bell System.

**Vacuum Tube Amplifier.** Research at Western Electric and General Electric Company created a higher vacuum in the three-element tube, invented by Dr. Lee De Forest, making it a useful amplifier. Vacuum tube amplifiers were placed at intervals along the first transcontinental telephone line, boosting voice signals before they weakened and faded away.

**Network Theory and Filters.** Theoretical investigations of electrical networks led in 1917 to the invention of the electric wave filter, which made it possible to carry many conversations on a line at the same time. A World War II shortage of high-grade natural quartz, from which the filters are made, prompted development of man-made quartz crystals by Bell Labs and Western Electric. The synthetic crystal could control frequencies with the same stability and precision as natural quartz.