

# Bell's great invention: the first 50 years

*Alexander Graham Bell should be credited with two inventions: the telephone instrument, and what we now call a system concept. Here's the story of the first—before the second became a reality.*

Bell envisioned two-way voice communication between two people, wherever located—with no special skills required of them. He built into his telephone instruments all of the technology to achieve this magnificent simplicity. And implicit in his system concept was the eventual development of progressively complex transmission, switching, and signaling subsystems.

But a century ago these complex subsystems did not exist. From the springboard of Bell's astounding invention he, his associates, and his successors launched the telecommunications industry with a single instrument, the telephone set.

Those pioneers crowded one achievement upon another and made the evolution of the "talking machine" an imaginative, exciting, sometimes amusing, occasionally aggravating, always rewarding experience. This article, first of a two-part series, tells some of their story—the first 50 years, during which the customer's telephone came into its own, and became the personal representative of the Bell System to most of the world.

This material has been drawn from *A History of Engineering and Science in the Bell System*, published this year by Bell Laboratories and edited by M. D. Fagen.

**R**EACH FOR YOUR TELEPHONE, tap out a number, and say hello. It's so simple, so efficient—and so commonplace.

Now try it another way. Take another telephone—an "iron box" about the size of a small breadbox, with a mouthpiece at one end. You don't have to dial; just say hello. In fact, shout your hello, because your telephone is connected to only one other similar instrument, only as far away as a bare iron wire can carry your voice signal. At the other end, your "partner" will be alerted to your call only by the sound of your voice, so shout.

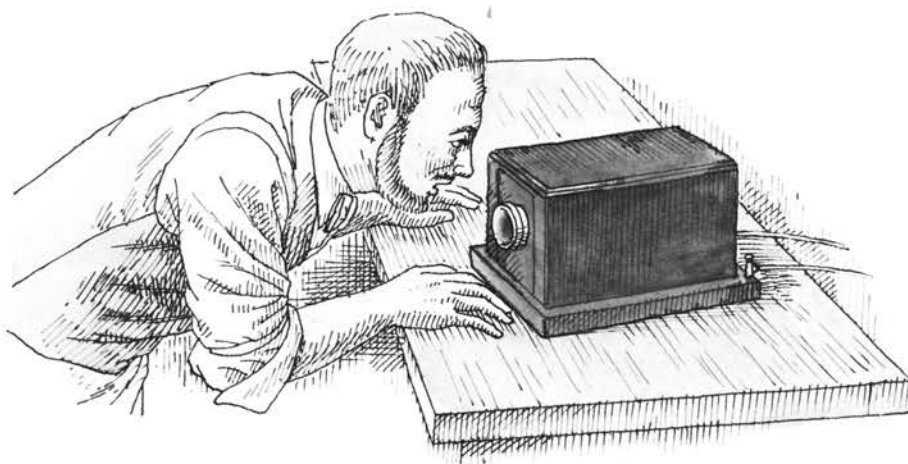
You've just gone back a hundred years.

Primitive? Not in 1876. Before Alexander Graham Bell demonstrated his first "gallows" telephone and then quickly developed the "iron

box" for general use, people had only handwritten letters, the telegraph for businesses or emergencies, or fleet-footed urchins memorizing oral messages.

So the iron box was revolutionary, and more than welcome. About 6000 units were built for customer use. But this set used the same electromagnetic converter alternately as transmitter and receiver, making a telephone call literally a head-spinning experience.

There was no lingering among Bell's associates and successors. The need was for a commercially practical instrument—and that meant then, as now, that the customer's needs had to be met. The infant Bell Company quickly introduced an instrument much easier to use than the iron box: the "butterstamp" telephone, so named because it re-



sembled a kitchen implement used in the 1800s to mold bulk butter into small pats for table use.

The first butterstamp phone used a single, hand-held instrument for both transmitting and receiving. While it was an improvement, it was inconvenient and occasionally confusing, because it forced the customer to keep changing the receiver back and forth between mouth and ear. To eliminate this situation, early in 1878 (only two years after Bell's gallows-phone demonstration!) the Bell Company introduced a wall set with two hand-held butterstamps, one for listening and the other for speaking. This set's circuitry was contained in a wooden wall box, dubbed "Williams' coffin" after its maker.

Another kind of telephone used the butterstamp as the receiver and the earlier iron box as the transmitter. In all, over a half-million butterstamp-type telephones were manufactured over a period of approximately 20 years.

These great new talking machines needed electrical power to operate. Until 1894, every phone had its own battery on the customer's premises. Most common were "wet" batteries using a more or less corrosive electrolyte. Today anyone accustomed to modern "dry-cell" batteries may be astonished, if not horrified, by these instructions from an 1896 Western Electric catalog for craft personnel setting up a battery cell:

"Make a paste by mixing up pulverized bichromate of potash with strong sulphuric acid in about equal parts by weight. Put about ten ounces of this paste into the outside jar, pour over it two or three ounces of sulphuric acid and fill up with water. Into the porous cell pour a teaspoonful of mercury, put the zinc in place and fill up with water. The zinc should be lifted out occasionally and the sulphate washed off. Keep a supply of mercury in the porous cell, so as to have the zinc always well amalgamated."

Those early telephone people were



courageous. Fortunately, by 1896 the dry-cell battery was being used more frequently, although its poor reliability and short life (about six months) gave it a bad reputation among telephone technicians. It's no surprise that a "common battery" to supply power from the central office was introduced in the mid-nineties.

How about ringing? As noted, the customer's lung power provided the signal for the iron box and its immediate successors. Since shouting was unsatisfactory both socially and technically, mechanical arrangements were tried. For example, one expedient was to tap the diaphragm of the transmitter. This was not too effective and could damage the instrument.

Then Thomas Watson designed his "thumper," a small hammer inside the telephone box, that was operated by an external knob. Then came electric tap bells, electric vibrating bells, even telegraph sounders. None was too effective and all needed frequent servicing.

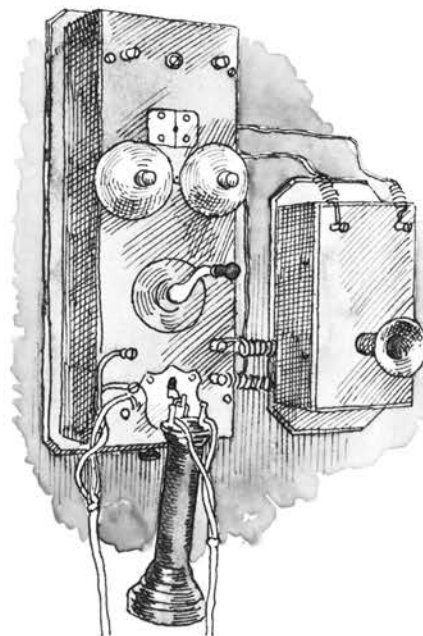
The next calling device was Watson's buzzer, which caused a loud, harsh, grating sound to be emitted by the receiver of the called telephone. It was used for operator receivers in central offices, the first in New Haven where it was called "Coy's chicken" in honor of the office manager who introduced it.

This raucous herald did not meet with public acceptance, and cus-

tomers' disapproval spurred Watson to develop the polarized call bell, still the basic design for today's ringers. This bell used a small alternating-current generator—a "magneto"—inside the telephone, operated by an external hand crank. Watson's design was improved, adopted by the Bell System in 1881, and was used with some modifications for the next 50 years.

In the early sets, the telephone circuitry was different during the talking and the standby condition. When the telephone wasn't in use, the transmitter battery was not needed and the circuit was opened to avoid unnecessary battery drain. Similarly, it was sometimes desirable to remove the ringer from the line during talking and reconnect it on standby. Originally, the customer carried out these functions by manually operating switches on the side of the box. Naturally, the operation was all too often overlooked, and the set was left in the wrong state, with unfortunate consequences.

H. L. Roosevelt, who was a founder of the first telephone company in New York, solved the problem. He designed a hook for holding the receiver when not in use. The weight of the receiver operated the switch to the standby condition, and a restoring spring transferred the switch to the talking condition when the receiver was lifted for use. This obvious, but fundamental, idea was ultimately used for a number



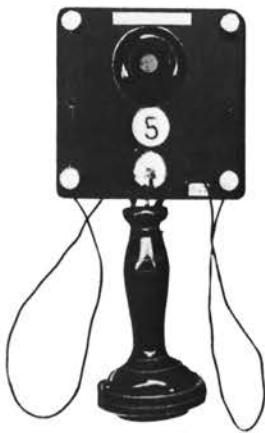




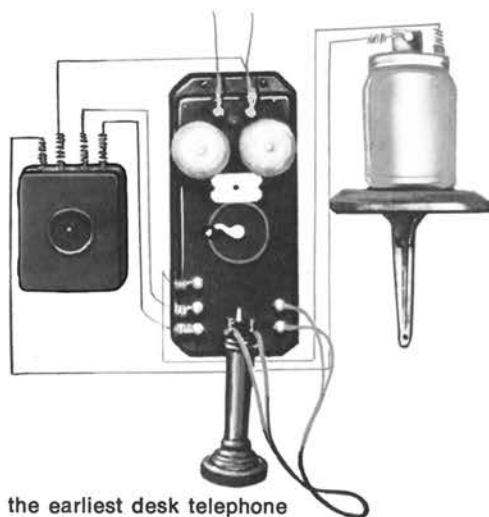
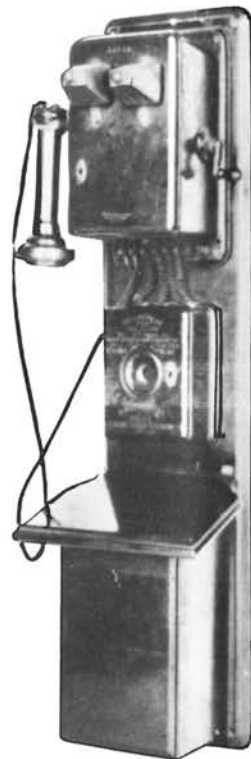
of signaling functions, such as controlling the talking battery, alerting the operator, terminating a call, and so forth.

To make the transition from the gallows telephone to the more sophisticated butterstamp phones, Bell and others—Watson, Edison, Blake, and Hunning to name a few—had to improve the parts of the telephone the customer didn't see: the transmitter and receiver. With a speed that's amazing even today, these pioneers developed Bell's principle of variable resistance and evolved the carbon transmitter. This transmitter provided enough "amplification" to overcome (to a degree) the biggest transmission problem of the day, attenuation—the reduction in strength experienced by the electrical waves as they traveled down the wire. Concurrently, the electromagnetic receiver was improved. Later, anti-sidetone devices were designed to reduce the echo of the telephone user's own voice. Within 15 years of Bell's invention, telephone technology had achieved the potential to meet Bell's long-range design goals: instruments with a usable quality of speech, efficient enough to transmit over a useful distance, simple enough to require no special training, stable enough to need little maintenance or adjustment, and producible by the thousands at a small unit cost.

Such technological advances

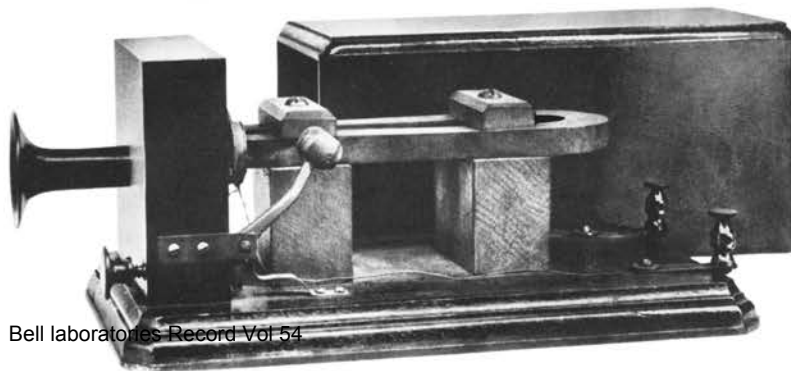


**Five years of progress:** in 1878, the first wall set (above) to be used with a commercial central office; in that same year, "Williams' coffin" (right), with two hand-held instruments, polarized call bells, and magneto crank; in 1882, the first telephone manufactured by Western Electric (far right).



**In 1879, the earliest desk telephone** (left), probably just a support for a transmitter; and the wall set (above), with wet-cell battery.

**Watson's "thumper" (1877), the first built-in mechanized signaling arrangement, for the box telephone.**





made possible the development of the desk telephone. Customers wanted greater convenience than that offered by a telephone fixed firmly in place. Wall telephones were inconvenient for business people, who wanted access to desk material while telephoning; the wall-sets were also difficult for people of varying heights, even though an adjustable transmitter support was often provided.

The earliest desk telephone was built in 1879, but was apparently only a support device for a transmitter, and wall telephones continued as the mainstay of the Bell System's customer-product line for a decade. In 1891, however, Western Electric did produce a true desk telephone—one actually built into a desk. This "cabinet" phone was intended for use at prestigious locations where heavy long-distance calling was anticipated, and used a special transmitter and three wet-cell batteries.

More practical for everyday use was the "deskstand" telephone, which came into its own in the 1890s. The deskstand phones at first were rather ornate, with curved supporting pillars and external

switchhooks, but later with a simple tubular support and enclosed switchhook contacts, and angular transmitter adjustment.

The ultimate mechanical design for the deskstand came around 1890 with a removable assembly inside the tubular support for the switchhook mechanism and binding posts for wiring. This highly functional design became a standard for the next 40 to 50 years.

In just a few early deskstands, some of the speech-circuit components were placed in the base of the telephone. One such telephone was a 1904 model, a portable set (probably the first of its kind) designed particularly for restaurant use. Ordinarily, however, the speech circuit and ringers were installed in a separate box, called a "subscriber set," for either wall or underdesk mounting.

Speech quality with the deskstands was acceptable, though not perfect. Until the electron tube was invented in 1907, the problem of amplification plagued telephone designers, and speech quality was sometimes "traded off" to some degree in favor of increasing transmission range. Customers appar-

ently didn't object. The sidetone problem was somewhat controlled, and acoustic coupling between separated transmitter and receiver presented no problem. (Pranksters, though, soon found that they could annoy callers by placing the receiver and transmitter together to produce "howling.")

The mid-1890s also saw the emergence of a new kind of "switching:" the telephone dial. During the 1880s, several schemes had been devised to convey information to the operator mechanically rather than orally. The most practical idea was to use a series of direct-current pulses to indicate successive digits. In early mechanisms the telephone user (demonstrably a patient soul) pressed pushbuttons, one for each digit (for example, three pulses for the number 3). In 1896 a "fingerwheel" replaced the pushbuttons, but the wheel required adjustment for each number to be dialed. Finally the Bell System introduced a full-circle dial with fingerholes, and although many modifications and improvements were made in the course of time, this device remained standard until TOUCH-TONE® dialing was introduced commercially in 1963.

While the wall sets and deskstands, even with dials, were highly functional, having a telephone with the receiver and transmitter on a one-piece handle would obviously be even more convenient. Some attempts were made to design this "handset"—one model, known as the "French phone," was widely used in Europe. But the American wall and deskstand phones still outperformed the European handsets, which were not adopted by the Bell System. Western Electric did pro-



duce handsets for craftspeople in 1902, but none for the American market until the late 1920s.

Why? The early handsets could not meet the Bell System's rigorous requirements for transmission over distances of 3000 or more miles. To overcome this problem, engineers at AT&T and Western Electric (Bell Labs had not yet been formed) launched a research effort that ranged from basic materials science and acoustics through electron-tube amplification for transmission lines to the physical design of the final handset. By the 1920s, the solutions were at hand: an almost total redesign of the transmitter and receiver, the development of a vastly improved anti-sidetone circuit, and, of course, the use of electron-tube amplifiers to increase transmission range. In 1926, 50 years ago, Western Electric began producing the first general-use handset found to be "free of gross fault."

The physical configuration of the American handset, incidentally, was the product of one of the first "human factors" studies in the Bell System, and one of the earliest applications of anthropological measurements in industry.

All of the telephones we've looked at were designed for use in homes or business locations, with use restricted to the customer who "subscribed" to the service. There was, therefore, a need for a pay-as-you-go service for the general public. This was the first motivation for "public telephone service," but another, even more important reason soon arose: readily available service to anyone whenever and wherever the need occurred. And so the "public telephone" evolved, from the "pay stations" of 1878, with attendants collecting fees, through several variations of the coin-box phone.

The basic coin-box scheme had two main variants. In one, the prepayment system, a coin deposit was required before the user could contact the operator. In the second, or



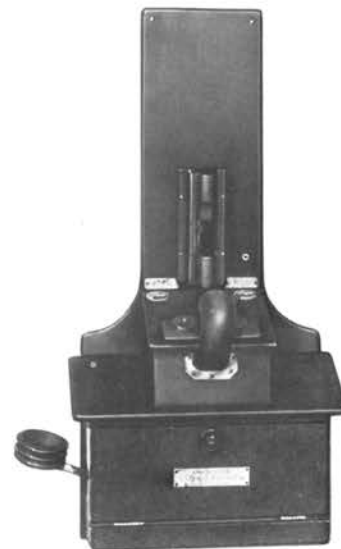
**Gay 90s** phone booth was used with a standard wall set in "public" places—offices and hotels.



Even more ornate was the luxurious long-distance booth designed for the cabinet telephone.



**Portable** telephone of 1904 (above) was designed for restaurants, with the pedestal design—forerunner of the 1919 "candlestick"—but with speech-circuit components in the base. At right is the first public coin phone of 1889.



"postpayment" system, the call was set up in the usual manner without a coin deposit, but the connection was not completed until payment was made. This not only required more operator time but also frequently left the called party waiting on the line while the caller fumbled for change. Most significantly, postpayment was a distinct advantage in an emergency (but also gave rise occasionally to endless arguments with the operator under non-emergency situations). The Bell System

has used both plans, but prepayment was the preferred arrangement from about 1906 until the 1960s. Then, as we know, the increase in both highway accidents and street crimes caused the Bell System to return to the postpayment plan and give the public a fast, practical means of emergency communication.

Strangely enough, the public pay telephone did not engender the telephone booth, but soon became its inseparable partner. At first the tele-





phone booth was intended only to give the user a degree of privacy. In the early days the need to shout, particularly on long-distance calls, caused the user to be rather a nuisance to those nearby, and booths were sometimes used in business offices to reduce the disturbance as well as to provide privacy. They were generally considered as pieces of office furniture.

The first booth patent, filed in 1883, described a rather large booth with domed roof and ventilator, mounted on wheels—presumably on the basis that a piece of furniture was sure to be moved about.

The booths of the 1890s were quite elegant. Oak or cherry structures, with ornate windows, had double walls and doors and domed roofs. Available fixtures included Wilton rugs, leather-topped revolving stools, and draperies.

Early in this century, smaller, simpler booths were designed with single walls lined with sound-deadening material and sheet-metal walls. Eventually the double-hinged door was added (too many customers were inept at working the

track-mounted door, with unhappy consequences). Since then, the design has been standardized except for a few places which warrant special designs—the famous “Pagoda” booth in San Francisco’s Chinatown, for example.

And what of the operator? The “voice with a smile” began greeting customers around 1878, when the first rudimentary switching systems began operation. Operators at those early central offices made all of the connections manually, and had the same kind of ringing arrangements as the customers—hand cranks to activate call bells. This required considerable operator effort, not to mention dexterity, and other arrangements were substituted—one, for example, was a foot-operated treadle to drive the call-bell generator.

The first operator sets were hand-held, which made switching functions rather awkward: In 1878 the operator used a single butterstamp as both transmitter and receiver. About a year later, another operator set used a transmitter suspended by an arm in front of the operator,

and a hand-held butterstamp for a receiver.

But the operator needed *both* hands for the switchboard. In 1881 a great new idea was proposed: a transmitter and hand receiver supported by a device on the operator’s shoulders. Unfortunately, the device weighed a full six pounds. Next, both transmitter and receiver were suspended by an arm in front of the operator—somewhat more comfortable, but difficult to use since the operator had to freeze in position close to the instruments at all times.

The need was obvious, and so was the solution—receiver headsets. During the first half century of telephony some 60 different models were produced, most of them using headbands to support them in position on the ear. (One, however, showed a flair for fashion—it was attached to a silk cap worn by the operator.)

In 1900 a “breastplate” transmitter was introduced and, combined with a new receiver headset, became the first efficient and practical operator set. Technically, it was highly satisfactory. It was easily adjusted, weighed less than one pound, and was easy to keep hygienic—the neck straps were readily and inexpensively replaced and the mouthpiece was removable for washing. This set continued in use with some modifications and improvements for the next 40 years.

In 50 years Bell’s little gallows phone grew from a curiosity, a rarity, to a ubiquitous necessity. That growth, as we noted, depended almost entirely on the development of the telephone set itself. The next 50 years would see the realization of Bell’s “Grand Plan,” the system concept, in which the telephone instrument would play many roles. One thing did not change: The telephone set is, to most customers, the telephone company, the Bell System, and keeping its position as the finest in the world is a constant challenge to the people of the Bell System. □