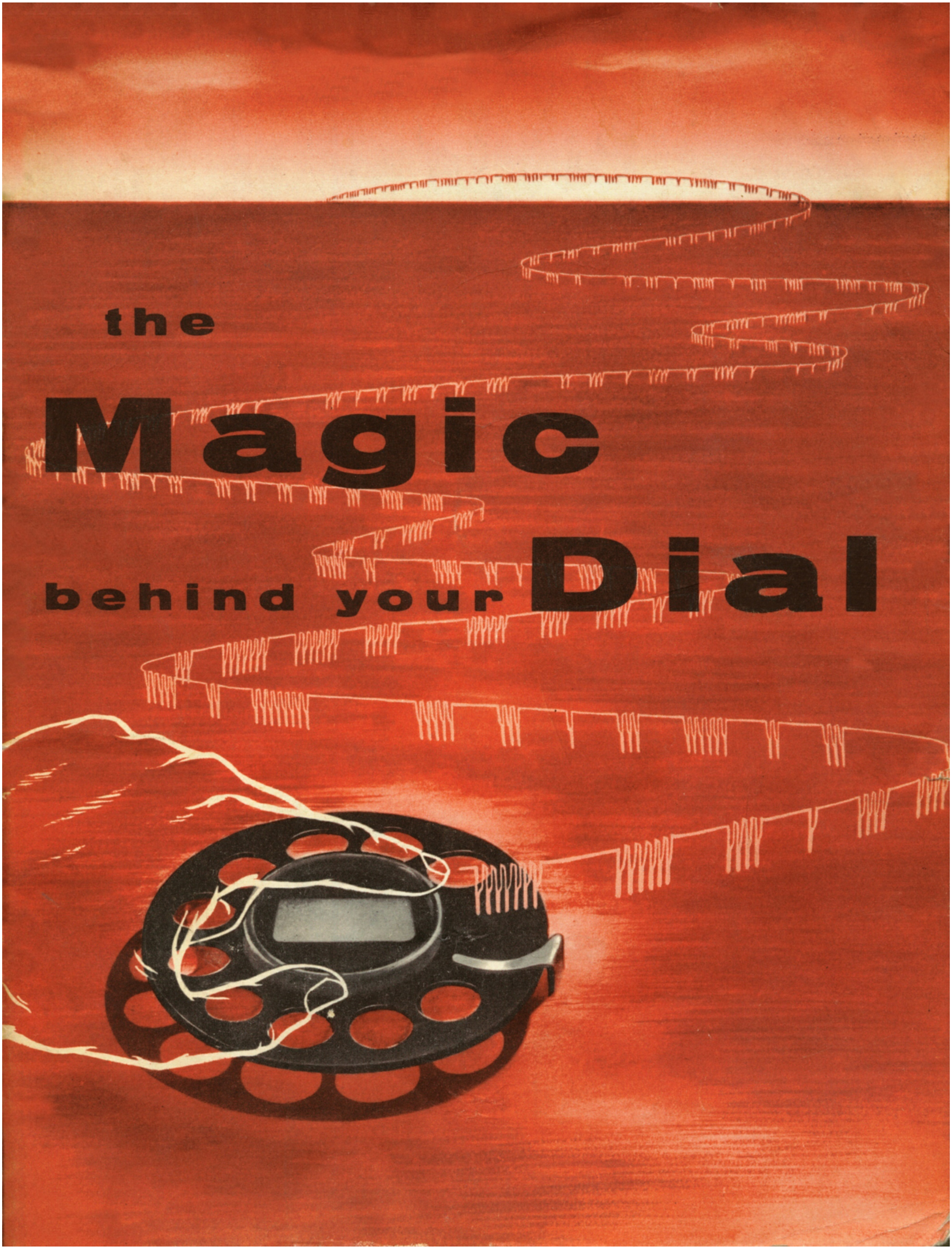
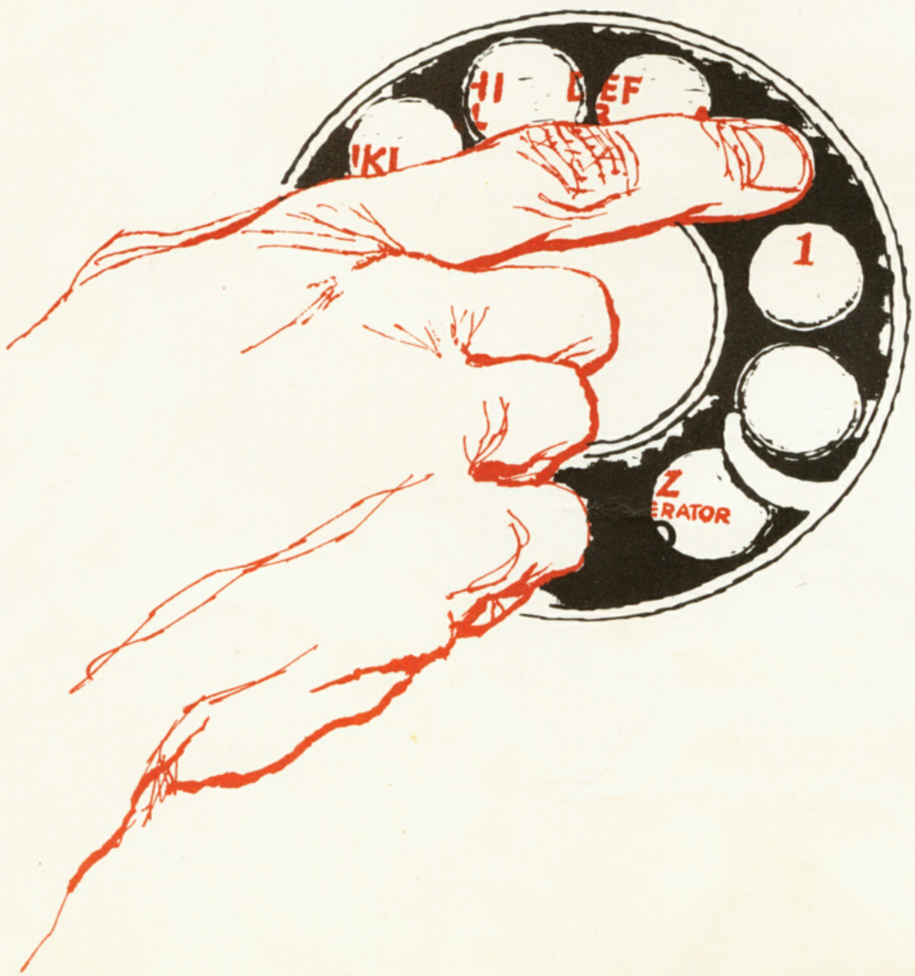
# the Magic behind your Dial



# You're the

To participate in one of the miracles of our time requires only a few measured flicks of your forefinger on a telephone dial.

Seconds later your voice goes zipping through wires, through hundreds or thousands of electrical devices, until it comes to someone's ear, across the street or across the continent. Often, the other person recognizes your voice when you've said no more than "Hello."



# Magician

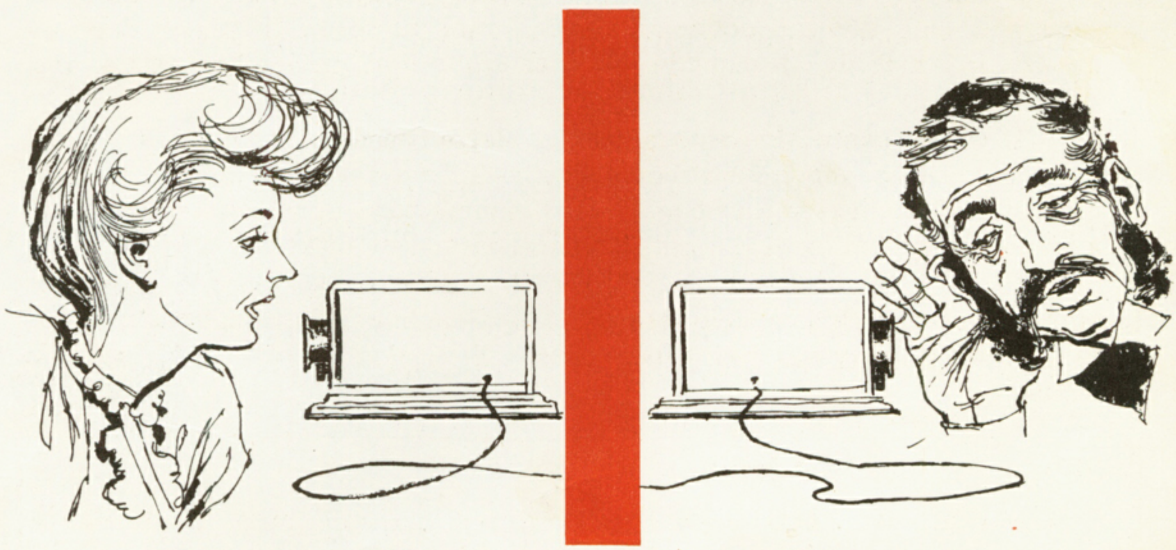
But this remarkable occurrence can happen only if you get the *right* connections and *good* connections. Today the users of more than 49 million Bell telephones in the United States get good connections with each other whenever they want, night or day. Takes only seconds. And it happens over 180 million times in the Bell System every twenty-four hours. It happens with amazing speed and efficiency, but with such ease that few telephone users think—few know, as a matter of fact—anything of the intricate, tremendous system they command so casually.

The heart and brains of this system, designed by Bell Telephone Laboratories, built and installed by Western Electric people and operated by Bell Telephone Company people, are the telephone central offices that do the switching—that connect your telephone to others in this country or around the world.

To explain some of the communications magic you help create and to clarify some of the electrical and mechanical magic needed to switch calls accurately and to make telephone connections quickly—is the purpose of this booklet. It deals first with the early growth of switching, next with *manual* switching by telephone operators, and then with the types of *automatic dial* switching used most widely in the Bell System.

# IN THE GROWTH OF SWITCHING
## early telephones were "thumpers"...

In the "primitive" era of telephony, 1877, less than a year after Alexander Graham Bell obtained his original patent for an "improvement in telegraphy," a telephone hook-up was pretty simple. It looked something like this:



Iron wires connected box-shaped telephones like these and batteries provided the "talking" current. To get a called party's attention each telephone had a built-in "thumper" the knob for which was located below and left of the mouthpiece. When you pushed the knob a "hammer" within the box made a thumping sound which was transmitted to the called telephone!

These early telephones were used in pairs. But as the instruments improved and more and more people became interested in telephony, the necessity for tying many telephones together rapidly became apparent.

The most obvious method was to connect every telephone individually to every other telephone. But this procedure would quickly become very complicated. Over a thousand different connections would be required to interconnect only 50 telephones! This was certainly impractical.

It was plain that the logical and sensible way to lick the problem of interconnecting telephones was simply to gather up their wires and bring them together in a central place. Then all that would be required would be a means of connecting the right telephone wires together when people wanted to talk. And upon this ability—the ability to interconnect any two of a great number of telephones—rested the value of telephone service to the public.

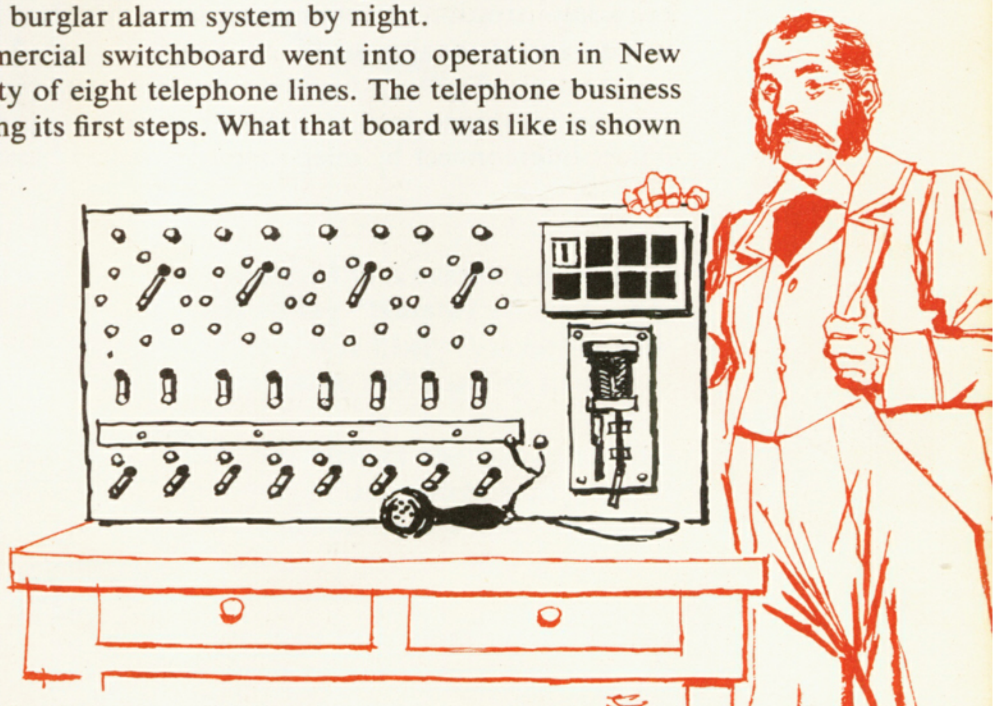
# Switchboards solve connection problems . . .

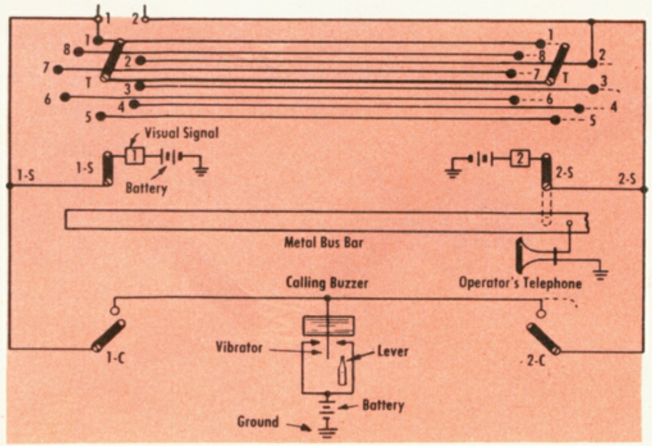
The basic principles of switching were grasped by communications people shortly after the telephone was born.

Actually, there were already in operation in many places telegraph signaling systems connecting customers with central stations. These were used for messenger calls, fire and police calls and similar purposes. They were one-way systems in which signals came in to the central points, were taken care of and recorded.

It was in connection with a burglar alarm business that in May of 1877 the first crude telephone switchboard was installed in the office of E. T. Holmes of Boston. It connected four banks and a manufacturing concern and served as a telephone system by day, a burglar alarm system by night.

In 1878 the first commercial switchboard went into operation in New Haven, Conn., with a capacity of eight telephone lines. The telephone business as we know it today was taking its first steps. What that board was like is shown below.





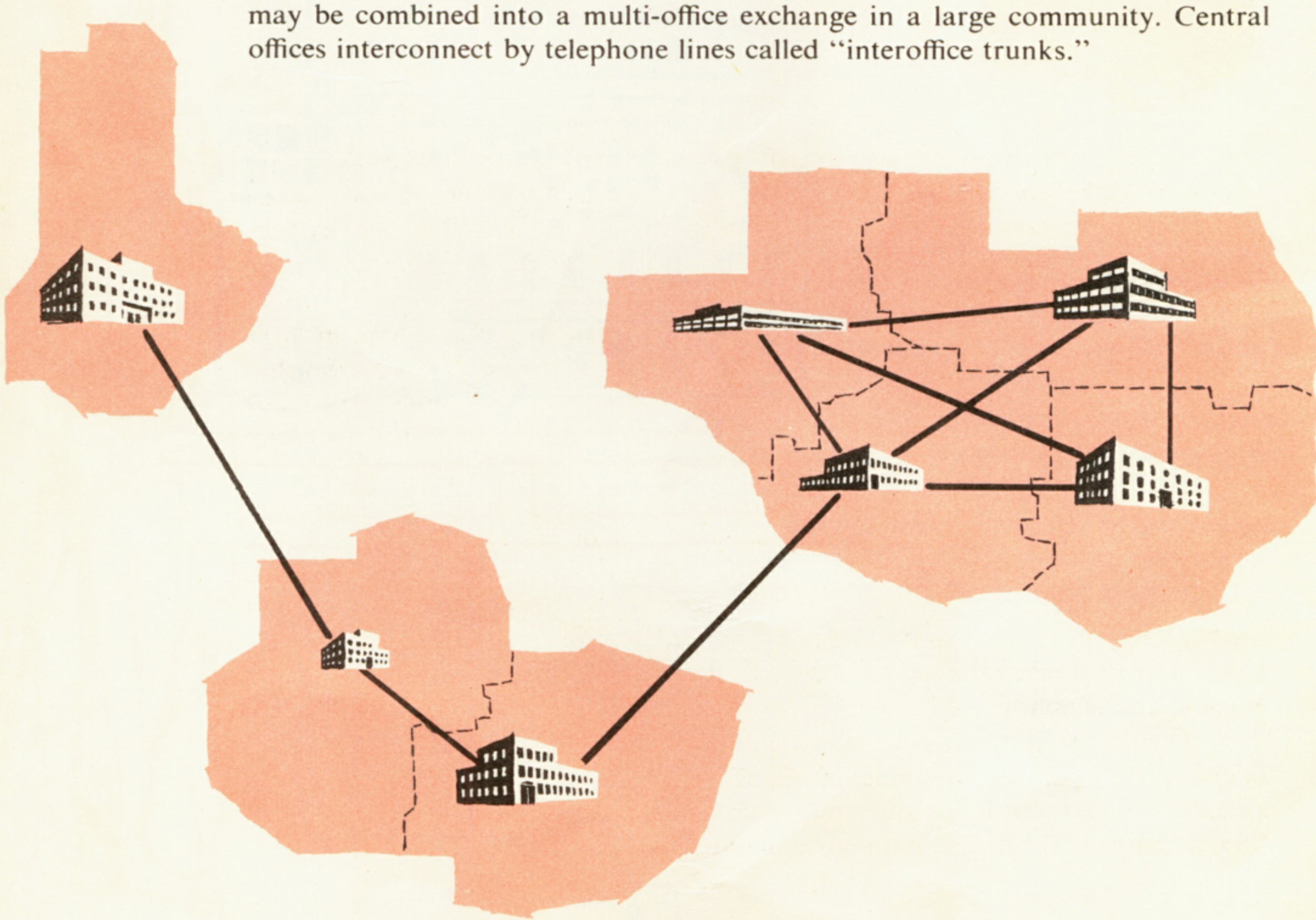

If you are technically inclined, this wiring diagram will tell you how telephone connections were made on this ancient board.

# Central Offices—today . . .

From the humble beginnings made in Boston and New Haven three quarters of a century ago, facilities for making connections for telephone calls have grown enormously.

For many years our telephone connections in central offices were made by hand by the "Voice with a Smile," the girl called "Central." Today, however, about eight out of ten Bell System telephones are dial telephones and are connected to central offices where automatic equipment performs the switching job.

The term "central office" is used to describe a setup of one or more switchboards or switching equipments and the operating arrangements required to terminate and interconnect lines and trunks. An "exchange" is a basic unit for the administration of communication service in a specified area, a village, town or city and its environs. An exchange in a small community may include only one central office together with the associated plant, while a number of offices may be combined into a multi-office exchange in a large community. Central offices interconnect by telephone lines called "interoffice trunks."



# IN MANUAL SWITCHING
## it's "Number please"...

If your telephone does not have a dial, it is connected to a central office where operators sit before manual switchboards ready to say "Number please," when you lift your receiver. If your community is small, it is likely that all the telephones in town are connected to the same central office and possibly to a single switchboard with but one operator.

At any rate, from your telephone and from each of the others in your community extends a pair of wires which terminate at the switchboard. So that good connections can be made easily and quickly between telephones, the wires terminate in the face of the board in "jacks" which appear to be just so many holes within reach of the operator.

To connect two telephones the operator uses two plugs connected by flexible cords extending beneath the shelf in front of her. When you call, the operator selects an idle "answering" plug and pushes it snugly into the jack connected to your line. When you've given her the number you want, she inserts the "calling" plug into the jack of the telephone you're calling. She makes what amounts to an electrical bridge between the wires of your telephone and the wires of the telephone of the party you want.

This is the simplest sort of switchboard connection. In actual operation, however, the operator does much more, for handling a call is not quite as simple as this. The text and illustration on the following pages describe in more detail how a call goes through a manual switchboard.

# Making a call through a manual central office . . .

You lift your receiver to make a call:

A switch in your telephone works to light the line lamp by your jack on the switchboard.

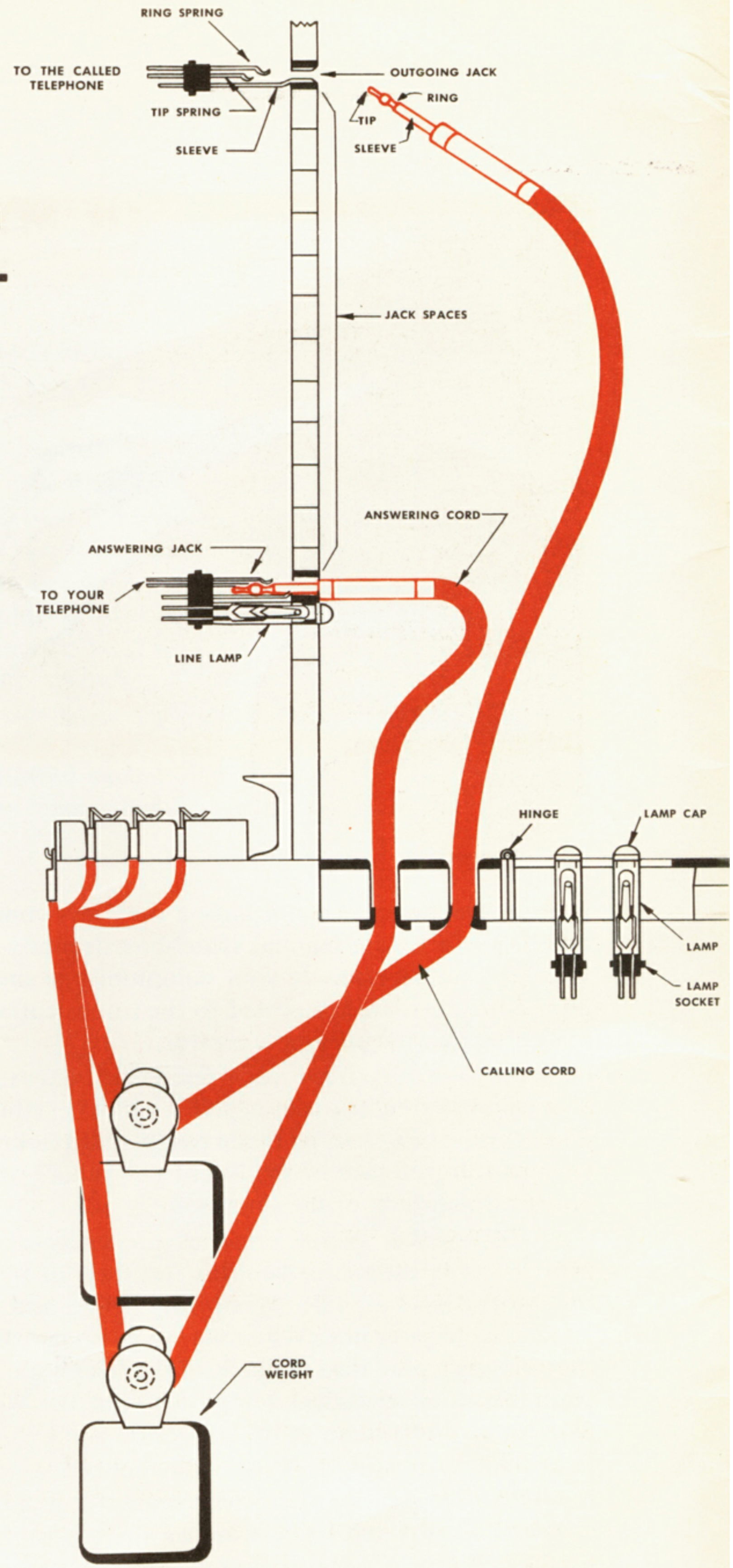
The operator sees the lighted lamp and inserts the plug of an "answering" cord into your jack. The line lamp automatically goes out.

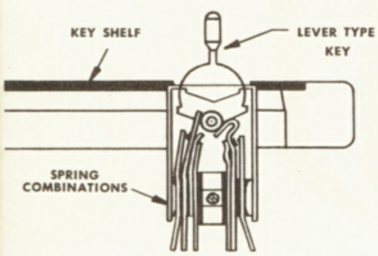
At the same time the operator flips the "key switch" which connects her telephone headset to the connecting cord.

She says, "Number please," and you reply. A pleasant "Thank you," and she plugs the "calling" end of the cord into the jack for the called telephone, and flips the key switch in the other direction to send a ringing current down the wire to sound the bell of the called party.

A signal lamp associated with the calling end of the cord lights up when she inserts the plug. It stays lighted until the called party lifts his receiver; then it goes out, telling her that your call is answered.

When the call is completed and you and your friend replace your receivers, signal lamps associated with both calling and answering ends of the cord light, telling the operator to remove the plugs.






## More telephones—bigger boards . . .

Manual switchboards range in size from those handling as few as half a dozen telephones to big ones having as many as several thousand jacks within reach of an operator. One as big as the latter would be a "multiple" board in a large central office where your telephone would have several—or "multiple"—connections throughout the switchboard, being connected to jacks at several operator positions. This allows the first operator who is not busy to say "Number please" when you pick up your telephone.

The city in which you live may be large enough to be served by several central offices. In that case the switchboard to which your telephone is linked has access through inter-office trunks to other offices. If the person you're calling is in an area served by another office, then your operator plugs into the proper inter-office trunk; a moment later a sound on the line tells her that the other operator is ready to complete the connection. Then your operator repeats the number and the other operator connects the trunk—and you—with the line of the person you want.

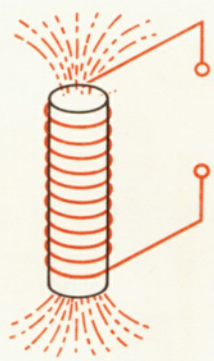
# IN AUTOMATIC SWITCHING
## robots work in central offices . . .

Ever go "backstage" in a dial central office?

It's a world of robots. Thousands upon thousands of them are perched side by side, row upon row, in racks that reach from the floor to the ceiling. They're "alive" and at work. And as you watch, you can see some of them move and hear them make soft clicking sounds.

It's mysterious and strange to the uninitiated. For nearly all the tasks (and a few extra as well) that telephone operators perform at manual switchboards are being handled without hands, accurately and precisely, as these electrical and mechanical devices respond to signals from dialing forefingers located blocks and even miles away!

The signals that operate these robots are pulses of electricity. Listen to the clicks of your dial as the wheel spins back: they're the switch contacts opening and closing in your telephone. One click for the numeral "1," two for "2," five for "5," and so on. These are the dial system code signals that control the robots in central offices.



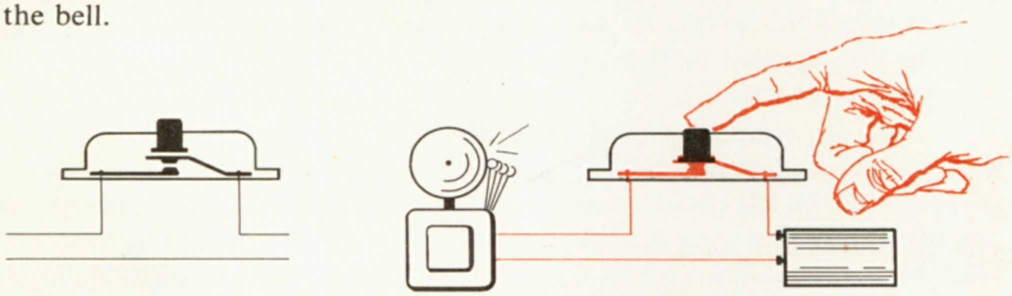
### Electromagnets

Generally speaking, the bewildering assortment of switches, relays and other items of automatic switching equipment have one characteristic in common: they depend upon *magnetism* for their ability to function. And the magnets perform in a most remarkable way: they acquire and lose their magnetism in response to electrical signals.

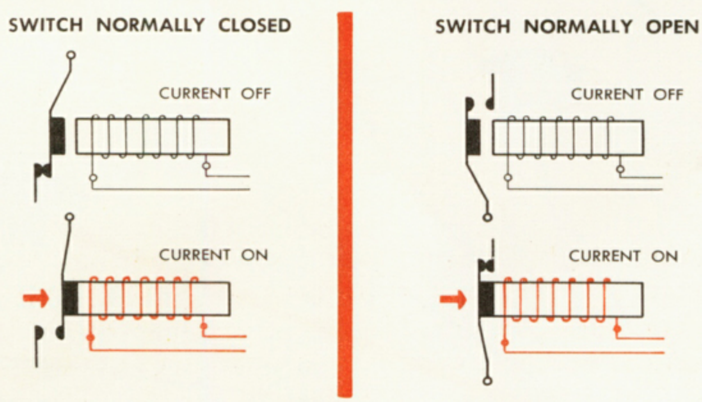
This is a phenomenon discovered about 125 years ago by an Englishman named William Sturgeon who found that if he wound wire about a piece of iron and connected the ends of the wire to a battery, the iron became magnetized; when the battery was disconnected the magnetism disappeared! His device became known as an *electromagnet*. And the trick of coiling wire about a piece of iron to make the working heart of a working device has long been fundamental to telephony.

## Switches and Relays

Among working devices in the telephone system none exist in greater quantity or variety than switches. Essentially a switch consists of contacts so arranged that they can be brought together by manual or by mechanical means. A most elementary form of switch is the sort you use when you press the button to ring your doorbell. It closes a circuit allowing current from the battery to reach the bell.



Telephone switches, however, are not so simple. Most of them are based upon the fact that a switch can be mechanized by putting its two arms next to an electromagnet with a piece of iron fastened to one of the arms. Then the switch can be closed or opened by turning the current to the electromagnet on or off. The magnet can be made to open switch contacts which are normally closed (illustration) or to close switch contacts which are normally open (illustration). Also, a number of switch contacts can be combined and operated with one electromagnet.




These combinations of electromagnets and switches are called *relays* and are used by the millions in the Bell System. An average dial central office serving 10,000 lines has about 70,000 relays in it!

Electromagnets are also used to do many other jobs. In large automatic dial switches, like those which figure prominently in the remaining pages of this booklet, electromagnets make parts rotate, move up and down, pivot, tilt, and perform numerous mechanical tasks essential to making telephone connections.

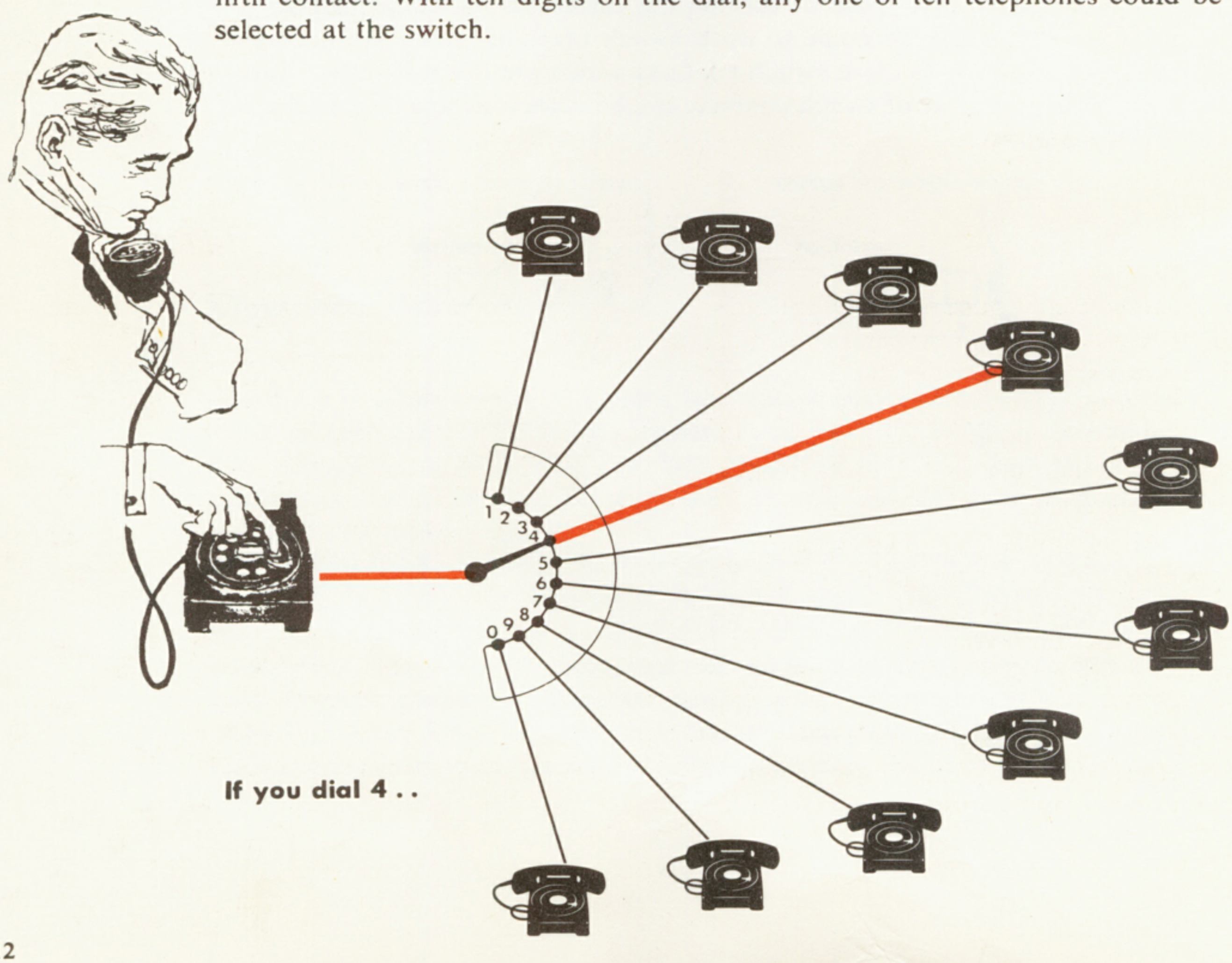
# "STEP-BY-STEP" IS THE NAME
## of one switching system . . .

Among telephone dial systems the one most widely used is known by the descriptive name "step-by-step."

The fundamental idea involved in a step-by-step system is easy to grasp. It is simply that telephone calls progress through switches or central office switching equipment in *steps*, each step being made in response to the dialing of a number or letter.

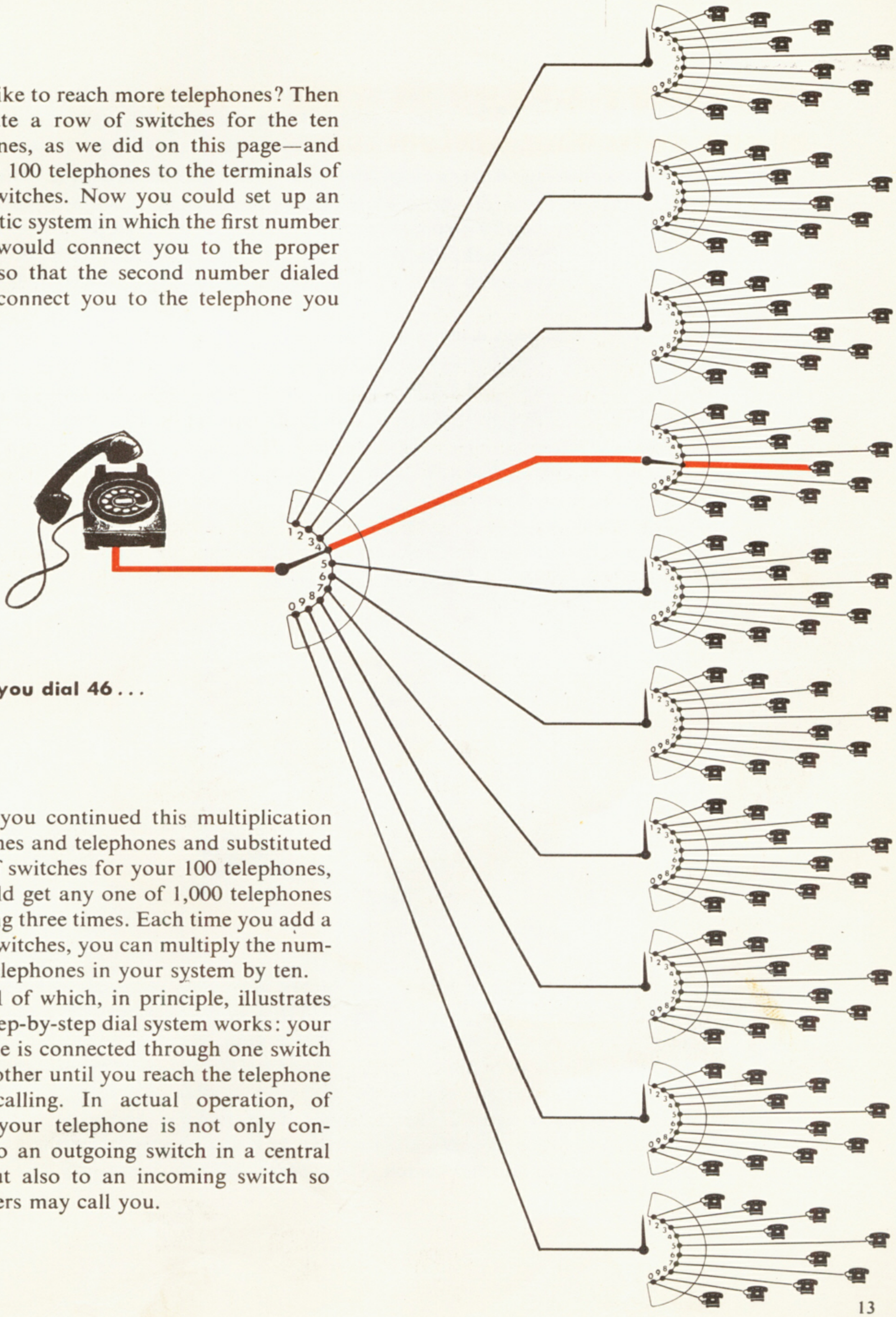
The very simplest dial system you might create would, in diagram form, look something like the drawing below. You can see from the diagram that the telephone at the left could be connected to any one of the telephones at the right by means of the rotating arm of the switch. The switch, of course, would have to be electro-mechanical with its arm moving from contact to contact in response to impulses from your dial.

If you dialed *1* the arm would move one step to the first contact and connect you to telephone number *1*. If, instead, you dialed *5* the arm would move to the fifth contact. With ten digits on the dial, any one of ten telephones could be selected at the switch.




**If you dial 4 . .**

Like to reach more telephones? Then substitute a row of switches for the ten telephones, as we did on this page—and connect 100 telephones to the terminals of these switches. Now you could set up an automatic system in which the first number dialed would connect you to the proper switch so that the second number dialed would connect you to the telephone you want.



**If you dial 46 . . .**

If you continued this multiplication of switches and telephones and substituted a row of switches for your 100 telephones, you could get any one of 1,000 telephones by dialing three times. Each time you add a row of switches, you can multiply the number of telephones in your system by ten.

All of which, in principle, illustrates how a step-by-step dial system works: your telephone is connected through one switch after another until you reach the telephone you're calling. In actual operation, of course, your telephone is not only connected to an outgoing switch in a central office but also to an incoming switch so that others may call you.

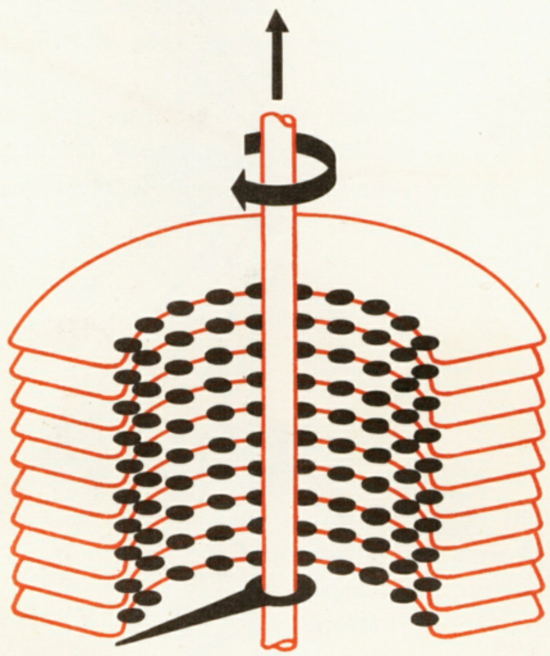
# Smart steppers . . .

Actual switches used in a step-by-step dial system are not as simple in design or appearance as those diagrammed on the previous page. They look in real life like the typical step-by-step switch pictured on the facing page.

Efficient and quick, this device uses electromagnets and relays in order to function. Like the setup on the preceding page it can take care of *100* lines or telephones.

What has been done is this: instead of being arranged side by side, ten sets of switch terminals have been stacked one above the other.

You will note that for ten levels of contacts there's only one contact arm. How can this one arm take care of making connections on all levels?



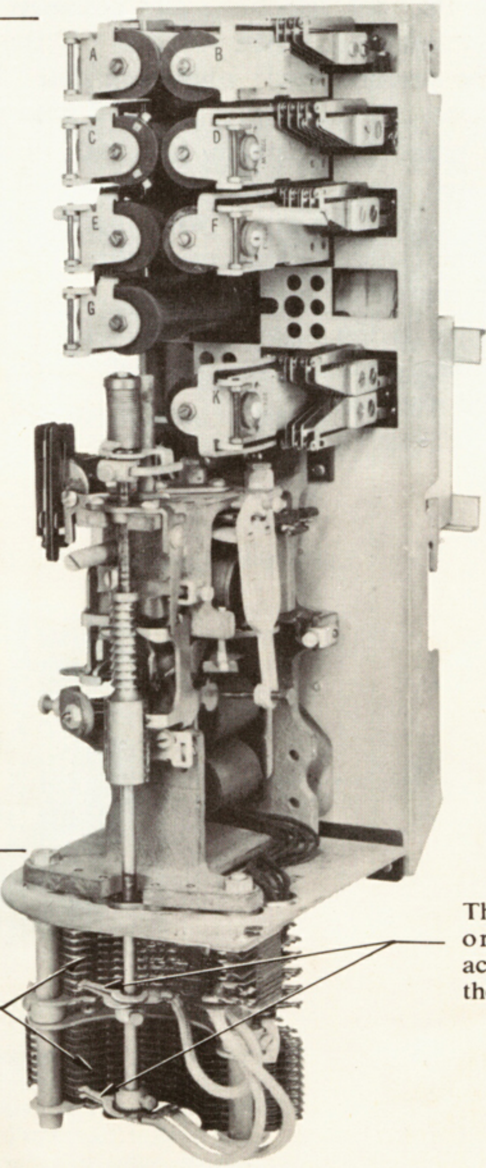
When you dial, the electrical pulses you originate cause the connecting arm to step upward to the proper level. The arm then sweeps in a rotary motion across the terminals, stopping at the right one; on some switches it moves in accordance with your dialed signal, while on others it moves automatically.

All step-by-step switches are basically similar, operating in a stepping motion vertically and then horizontally. They differ in design depending upon whether the job is to make a connection to a calling telephone, the called telephone or just to another switch. Their names tell which job each has.

A *line-finder* switch is one which automatically finds the terminal of *your* telephone when you lift your handset to make a call.

A *selector* switch is an intermediate switch. A series of *selector* switches operate one after the other to connect you through from your *line-finder* to the *connector switch.*

A *connector* switch is one to which the *called* telephone is connected. It operates in response to the last two numbers you dial, taking one step for each click as your dial rotates.




This is the "brain" of a step-by-step, 100-line connector switch. Here are mechanical parts, electromagnets and relays which receive signals and control the switch in action.

Here are two duplicate "banks" of terminals. Wires from 100 telephones are connected to the terminals of the two banks, ten to each level. Two wires are needed for a telephone circuit and these are connected to two terminals on the lower bank. A corresponding terminal for each line is used on the upper bank for testing to determine whether the called line is busy or idle.

These are the contact arms or wipers which sweep across the terminals until the correct ones are found.

# Making a call through a step-by-step office . . .

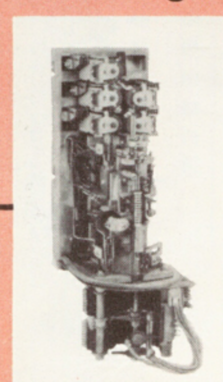
The progress of a telephone call through a step-by-step central office can be quite simple in a community of only a hundred telephones. Just two automatic switches might be called into play for a single call, a *line-finder* and a *connector*.

Let's suppose that your community has only 100 telephones and you're calling a neighbor whose number is 74. Your line-finder locates your line when you pick up your telephone and connects you to the connector switch which gives you dial tone. When you dial "7" the fingers of the connector switch step up to the seventh level; when you dial "4," the fingers move around to the fourth contact—and presto, you and your neighbor are connected.

In practice, of course, hundreds of switches are needed for the average step-by-step central office. You have line-finders, selectors and connectors in sizable groups, each group with specific responsibilities. All together they present a remarkably orderly maze through which, as you dial, calls thread their way in a matter of seconds.

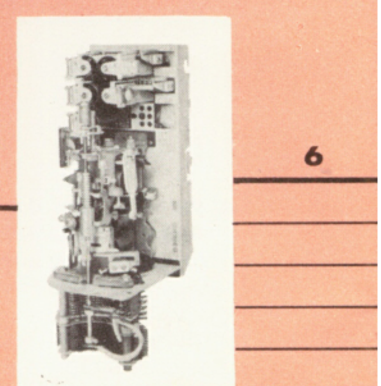
Below is the diagrammatic story of a call going through a step-by-step central office which serves 7000 telephones. Each telephone in this office has a four digit number.

**Let's say you're calling the number 6452**



**LINE-FINDER**

When you pick up your receiver your line-finder performs its job—locates your terminals, connects you with a "selector" switch, and you hear the dial tone. The line-finder is similar in operation to the connector, but does its work automatically.

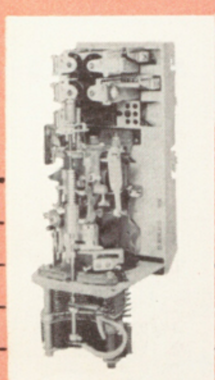


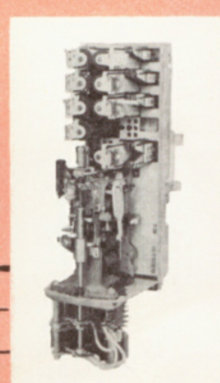

**FIRST SELECTOR**

You dial the first number, *6*. The first selector steps up to the sixth level. The ten terminals on this level lead to ten other selector switches leading to all numbers beginning with "6"—6000 to 6999. The selector automatically rotates until it finds an idle terminal and you're connected to a second selector.

Various types of step-by-step equipment have been devised from time to time to serve communities with as few as 100 lines or less, up to central offices with as many as 10,000 lines. One central office could be linked to other central offices by means of additional switches. Selector switches, for example, can be employed to shift calls onto outgoing trunks to other offices. Telephone numbers in this case would have to be one digit larger to take care of the additional step in switching.

General use of step-by-step in the Bell System began around 1919. Its use usually has been limited to smaller localities because such a system, without the provision of additional control equipment, is not easily adaptable to large cities which present complex switching problems. At about the same time, however, development was completed of the so-called "panel" system which possessed the desired operating features for heavily populated areas. General introduction of panel equipment began at this time for large city use and continued until the late 1930's when the faster and more efficient "crossbar" system became available. Crossbar is described in the following pages.




**SECOND SELECTOR**

As you dial *4*, your second number, the switch steps up to the fourth level. The ten terminals on this level lead to ten *connector* switches each of which has connected to it 100 telephones—those with the numbers from 6400 to 6499. The selector rotates till it finds an idle terminal and you are connected to an idle connector switch.

**CONNECTOR**

You dial *5* and the connector switch steps up five levels. You dial *2* and the contact arm moves around on the fifth level to the second contact. At this point you've reached the terminal of the line 6452. The called party's bell rings until the telephone is answered or until you hang up.

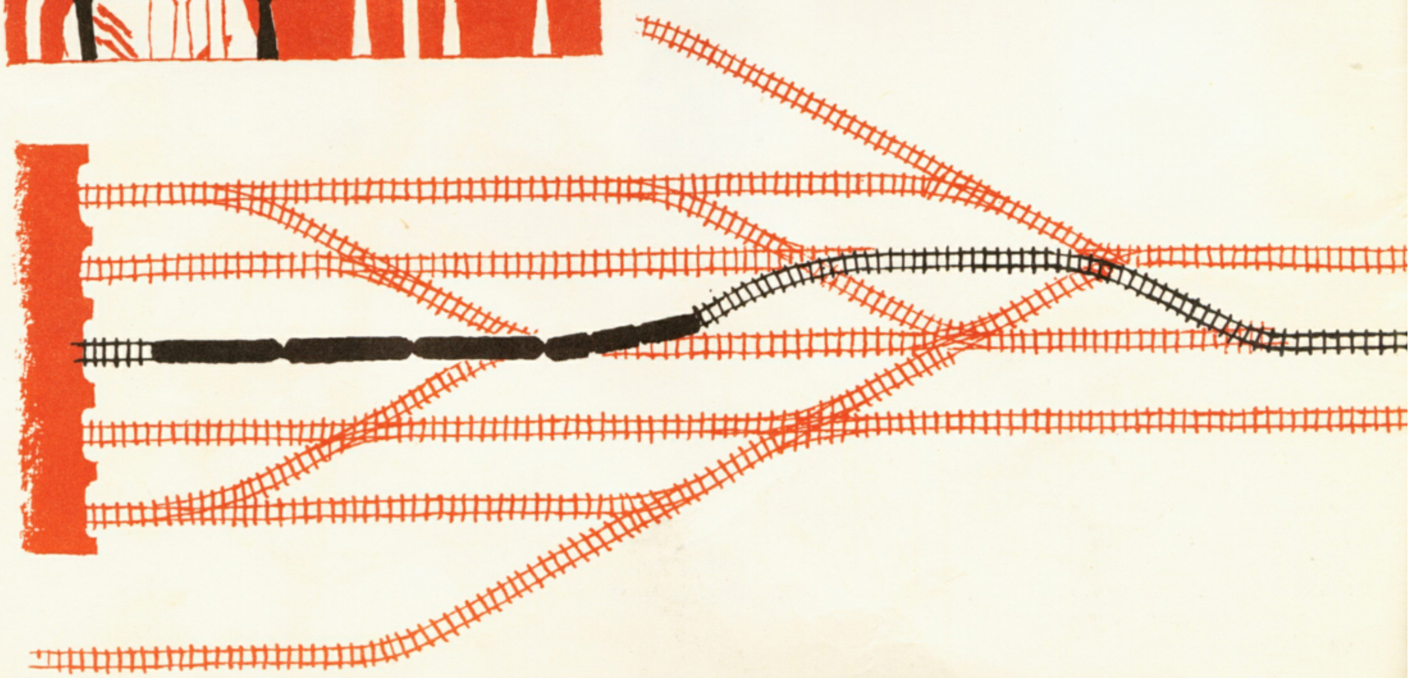
# IN CROSSBAR SWITCHING—
## it's a lot like switching railroad trains

When you start to think about crossbar dial switching, you quickly discover that this system is quite different from step-by-step. To complete a call through a crossbar network, switches are not tied together as links are added to a chain. Nor does crossbar equipment respond step by step to signals as you dial number after number.

The big point to understand about crossbar is that the system has two main divisions of equipment each with different functions: (1) the *control equipment* which establishes talking paths by causing the proper switches to operate; (2) the *switching network*, mostly crossbar switches through which the talking paths are set up. In other words, when you dial, you tell *control equipment* the number you want, and the *control equipment* finds the proper path through the *switching network* and closes the necessary switches to complete that path.

Actually there are marked similarities between this system of telephone switching and various phases of railroad switching. A crossbar system can be compared, for instance, to a busy railroad yard with the dispatcher in his control tower being the crossbar control equipment and the maze of tracks and switches being the crossbar switching network.

**A Crossbar System is like**



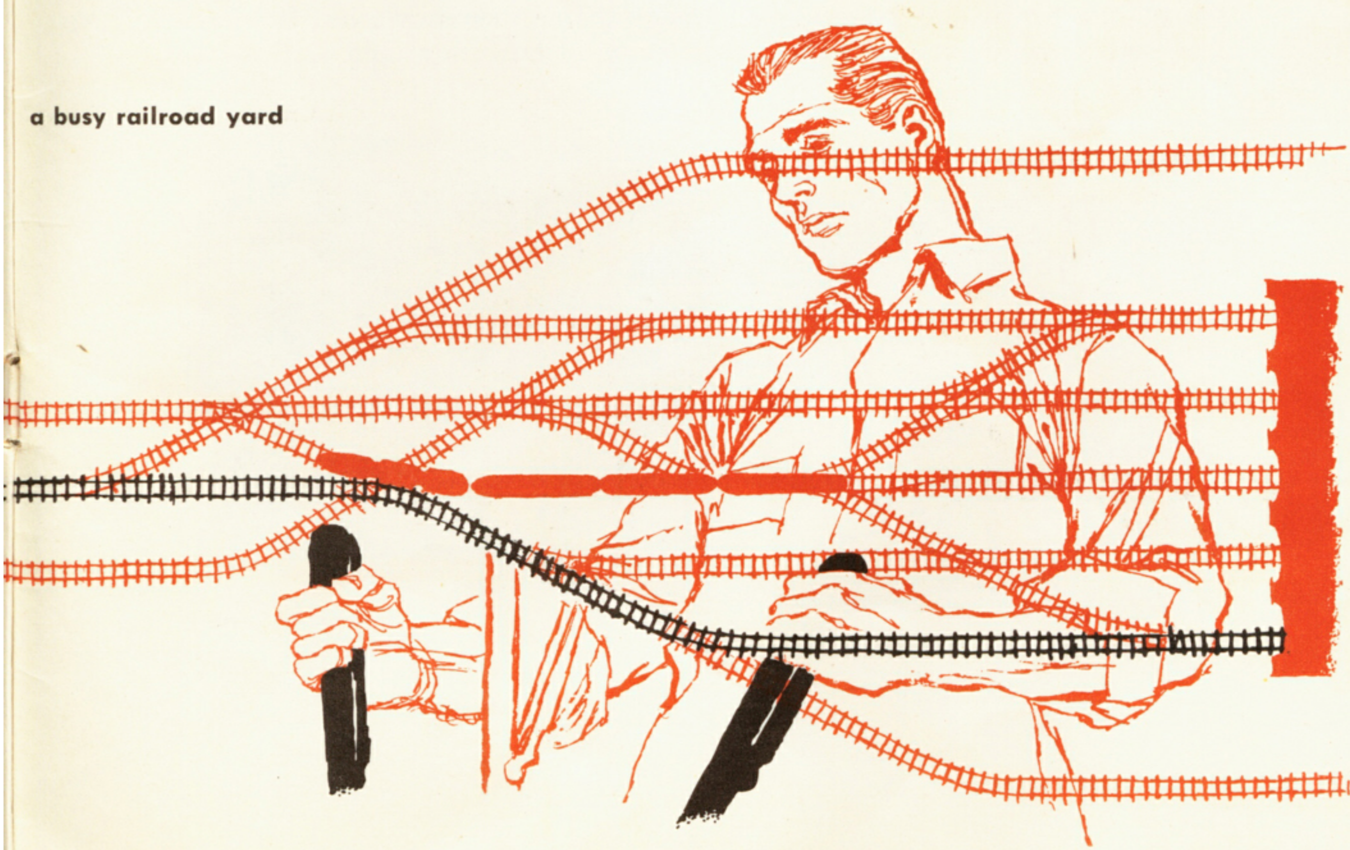
The dispatcher receives an order to move a locomotive from one track to another. He checks his elaborate control map which shows him the various routes through the yard which might be used. His map also shows him which tracks and switches are busy. He works out a route over idle tracks and switches and then throws the levers which cause the switches to operate and give a green light to the waiting locomotive engineer.

So, too, the crossbar control equipment in a central office takes your order as you dial, checks to determine the terminal to which the called telephone is connected, finds an idle path between the terminals of the two telephones and closes the switches to set up that path.

This comparison can be carried still farther, because main line railroad tracks between cities may be likened to telephone trunks between offices and exchanges. When a dispatcher's order calls for a train to go from one city to another, he throws switches to put the train on the proper main line track and notifies the dispatcher at the other end so that the latter can set up a clear route to the destination through his local switching network.

Similarly crossbar control equipment switches your call through to an outgoing trunk and automatically notifies the other office or exchange of the number you want so that the control equipment in that office can set up the circuits to complete your call.

**a busy railroad yard**



# Crossbar switches . . .

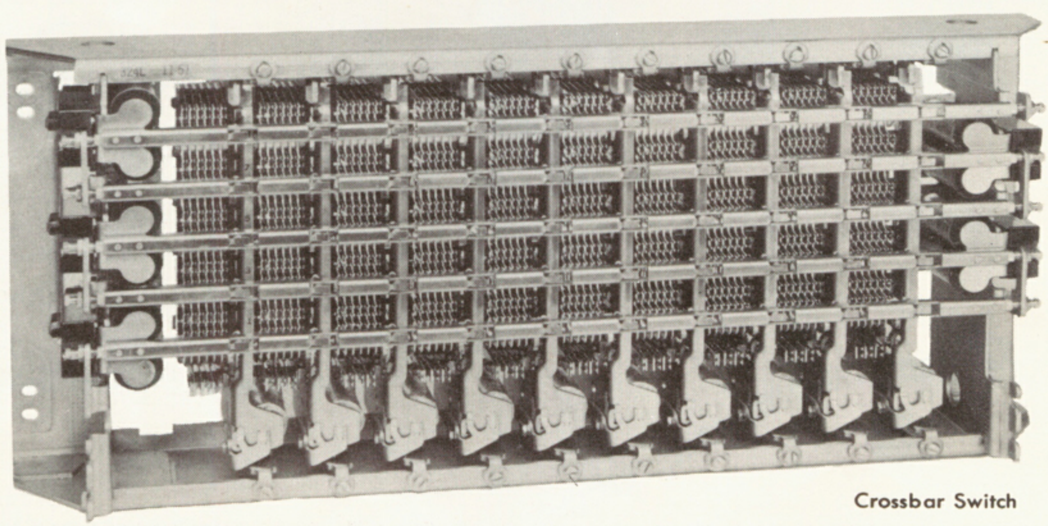
The crossbar switches themselves, which are the key units of a crossbar switching network, differ from step-by-step switches as radically as the two systems differ from each other.

Crossbar switches first went to work for the Bell System in a central office in Brooklyn in 1938. Eight years before this, Bell Laboratories engineers had launched studies of the switch which indicated that the device, or improved versions of it, would fit perfectly into plans then developing for a speedier, more efficient switching system than any yet devised to handle complicated switching problems. An extensive Bell System program was instituted to improve the switch and, more important, to create an entirely new switching system around it.

As can be seen from the illustration on this page, a crossbar switch is a rectangular device with horizontal and vertical bars crossing each other in latticework fashion. These bars are so mounted on the frame that they can move—can pivot or tilt—with their movements controlled by electromagnets.

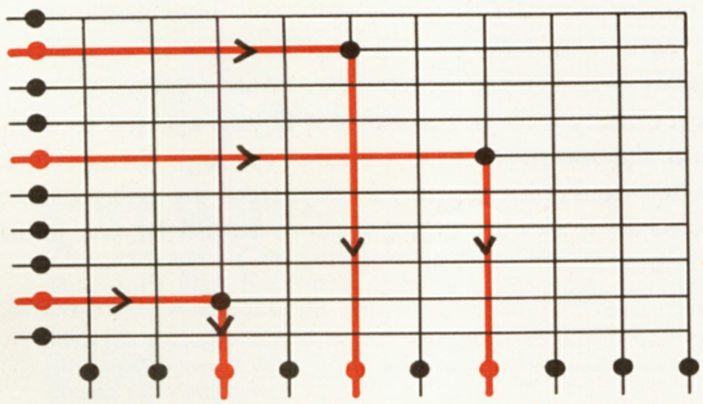
The principal components of the switch, however, are relay-type sets of contacts mounted one above the other behind the vertical bars. These sets of contacts are called crosspoints. To close a set of crosspoints and thereby complete a connection through the switch, first a horizontal bar moves and then a vertical bar. Just how this ingenious mechanism functions is shown in detail on the facing page.

The overall design of the switch results in a device possessing multiple possibilities for making connections. The switching unit shown has 100 sets of crosspoints, two associated with each crossing of horizontal and vertical bars.



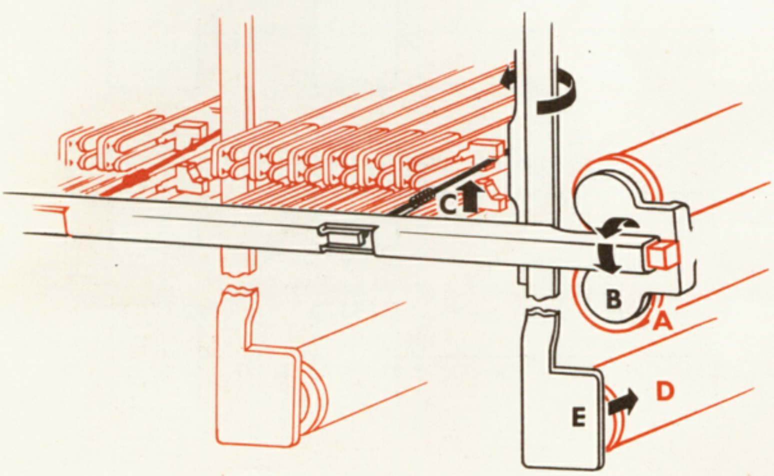
Crossbar Switch

When connections are made in a crossbar switch, electrical paths are established like those in the following illustration. Although only three completed connections are shown, as many could be made simultaneously as there are horizontal paths, ten in this case. (Each step-by-step switch accommodates only one connection at a time.)



The availability of so many useful connections in crossbar switches is an important asset. Engineers are able to devise unusually versatile central office switching networks in which many electrical paths are ready and waiting to be used in putting calls through.

Here's a perspective view of part of a crossbar switch. If you're curious about how it works, read (1) and (2) below.



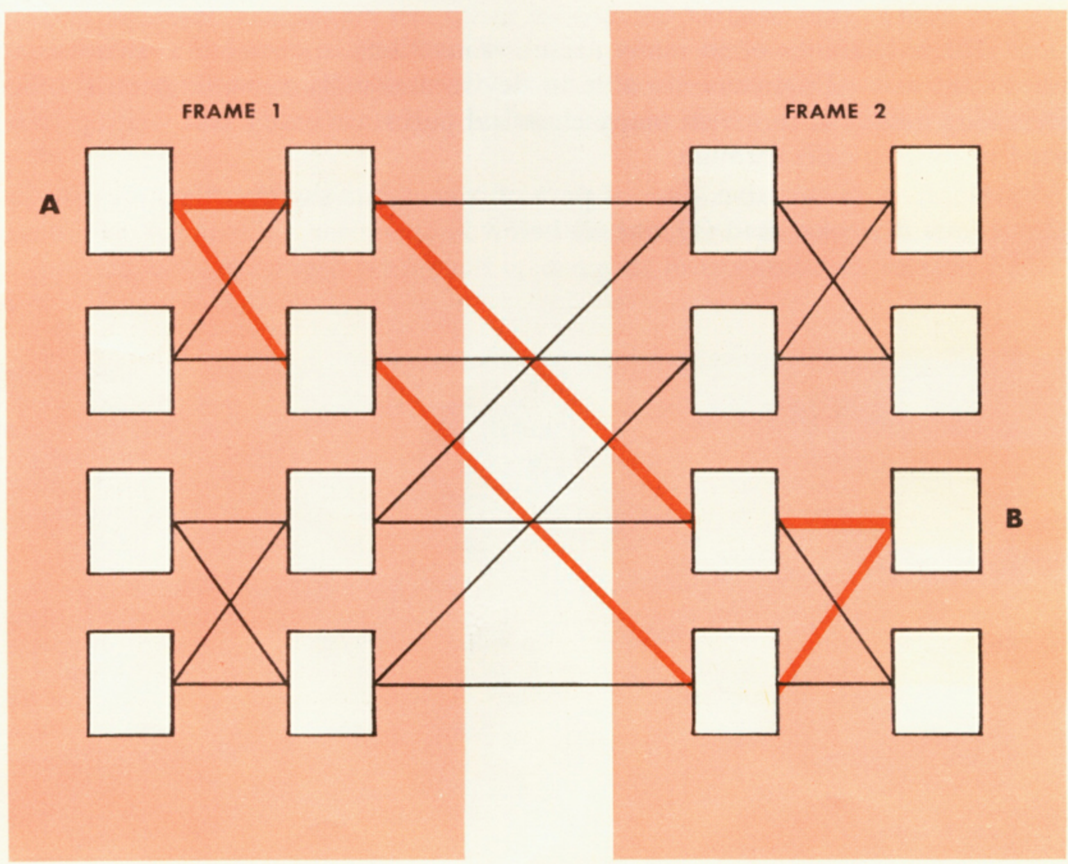

(1) The electromagnet marked (A) pulls the ear-like projection (B). This tilts the horizontal bar so that a wire (C) projecting from the bar into the switch mechanism is raised into position.

(2) The electromagnet (D) now operates and pivots the vertical bar (E) inward. The vertical bar pressing against the projecting wire (C) closes the contacts and completes the connection.

# Crossbar network . . .

The drawing below illustrates how multiple electrical paths can be set up in a crossbar switching network. Each small square represents a switch. Each group of eight switches represents those which might be mounted in a frame in a central office. To simplify the drawing, only two lines come from each switch, although in an actual switching setup ten lines would extend from each. It's easy to see that all switches are interconnected in a definite, geometric pattern.

Look more closely and you'll see that if you wanted to connect points A and B, you could choose either of two routes through the network. In a central office system, where ten-vertical-unit switches (like the one pictured on page 20) are interconnected in a similar pattern, there would be ten possible electrical paths between A and B.



# Components of a crossbar office . . .

A typical crossbar central office of 10,000 lines contains 1,800 crossbar switches! What's more, such an office requires almost 70,000 relays of all types and 29 million feet of wire, enough to stretch from coast-to-coast and back again.

The completed crossbar office consists of major components of equipment organized according to function as follows:

## Control Equipment

**MARKER**

*The Marker*—Crossbar's brain, the "dispatcher" described on pages 18 and 19. This brain of crossbar "marks" points in the switching network (like A and B in the drawing on the facing page) through which calls must go and selects and establishes paths between these points. This complex operation is performed by the Marker at the rate of about a *half-second* per connection.

**ORIGINATING REGISTER**

*Originating Register*—This is a sort of telephone operator who gives you a dial tone instead of saying "number please" and remembers the number you dial—using relays and switches instead of a human brain. *Incoming registers* perform the same function for calls from other central offices.

**NUMBER GROUP FRAME**

*Number Group Frame*—This is a mechanical telephone directory which knows the number of every telephone in the central office—knows to which terminals on which Line Link Frame each telephone is connected—and is prepared to give out this information anytime it is asked by the Marker.

**SENDER**

*Sender*—Equipment required in handling calls to other offices. Senders transmit numbers in the special codes other offices are set up to receive. Different types of senders are provided to transmit signals to the different types of central offices, such as step-by-step, crossbar and manual offices.

## Switching Network

**LINE LINK FRAME**

*Line Link Frame*—This is a unit, consisting principally of crossbar switches, to which telephones are connected. A Line Link Frame is the first link in the call that you make . . . and the last too, since any telephone you call is also connected to a Line Link Frame.

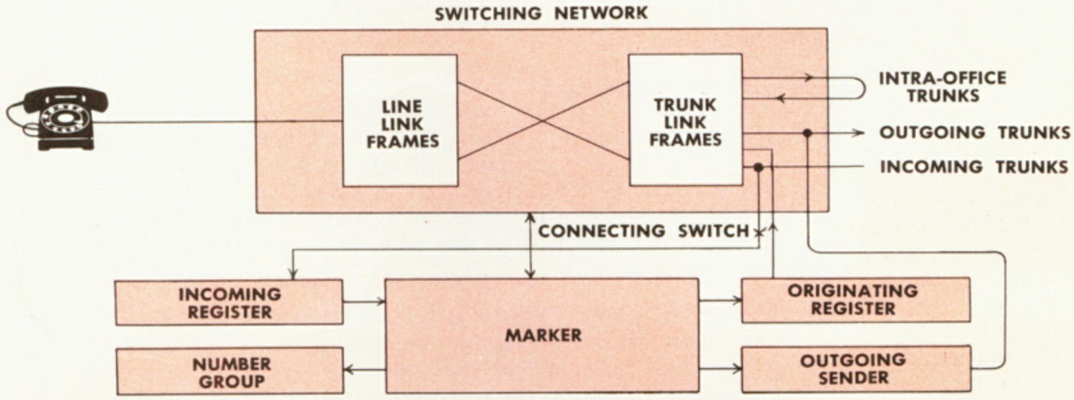
**TRUNK LINK FRAME**

*Trunk Link Frame*—This is a unit to which trunks in the central office are connected. A trunk is simply a telephone line or circuit leading from one place to another. Such a line which begins and ends in the same central office is called an Intra-office Trunk. Lines or circuits which lead to or from other central offices are called outgoing or incoming trunks.

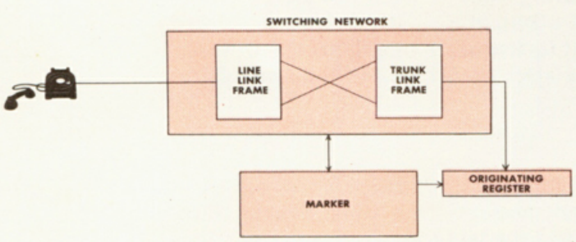
How all this equipment is used in putting a call through a central office is shown on the next two pages.

# Would you like to follow a call through a crossbar office?

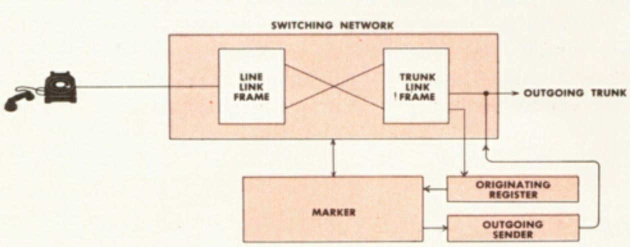
All readers may not be satisfied with the analogy of the railroad switching system. Those who prefer a more precise explanation of crossbar operation can follow a call through a crossbar dial system in the paragraphs and drawings on this page and the next.




Here is a block diagram showing how the different units in a crossbar office are interconnected (through crossbar switches) for an inter-office call. The diagram and captions which follow show how the units are switched into the circuit in the proper sequence to perform their various functions.

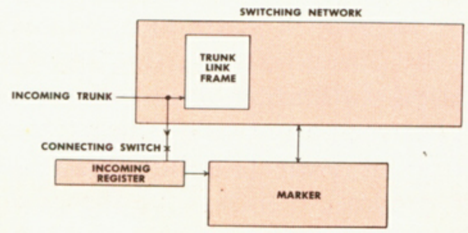



When you pick up your handset you are connected to your crossbar switch in a Line Link Frame. A Marker is signaled post haste and the latter connects you to an Originating Register. The Marker now disconnects itself to handle other calls. You hear the dial tone and dial the number you want which is recorded by the relays of the Originating Register.

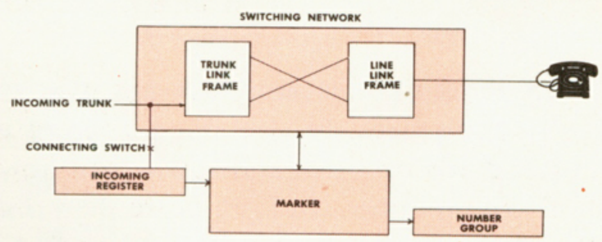



The Originating Register now connects to an idle Marker and transmits the number you want to the Marker. The first three digits of the number (known as the office code) tell the Marker the name of the office called. Assume that the called number is in another central office. The Marker, therefore, disconnects your line from the Originating Register, connects the proper Sender to the proper Outgoing Trunk and connects your line to the trunk through the Line Link and Trunk Link frames. The Sender transmits the number you want to the other central office.

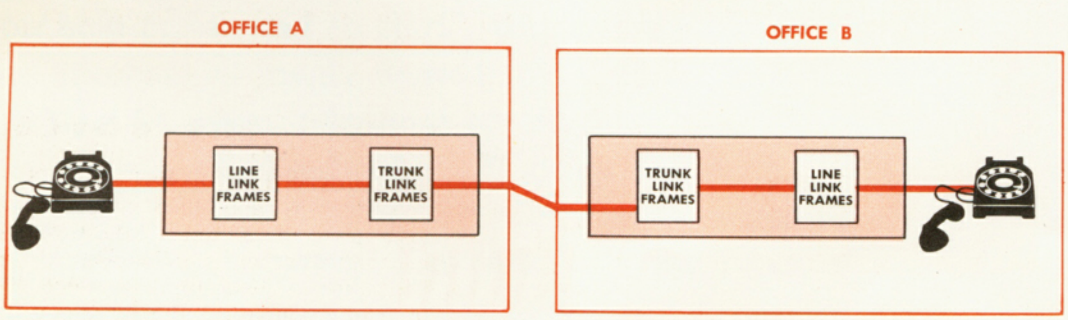
In the second central office, an Incoming Register records the number from the distant Sender after which it connects to a Marker. The Marker receives the number from the Register.




The Marker must now locate the called number in its office. To do this it checks the Number Group Frame; this "electrical telephone directory" tells the Marker the location of the number—the right Line Link Frame, the crossbar switch and so on. The Number Group Frame and Incoming Register are dismissed by the Marker which now connects the Incoming Trunk to the called number—through a Trunk Link Frame and Line Link Frame. Since the connection is now complete, the Marker disconnects itself and goes on about other business. The Incoming Trunk rings the called line. The call is complete when the called party lifts the receiver.




Here is the completed connection through the switching networks of the two crossbar central offices.



# 1,700,000,000,000,000,

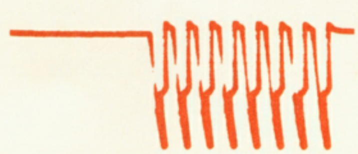
We've come a long way since the first commercial switchboard of eight lines went to work in New Haven 78 years ago. Today with more than 49 million Bell telephones in the United States, the Bell System is prepared to make any of over 17 hundred million, million different connections so that a conversation can be held between any two of these telephones—without any more notice than the lifting of your telephone receiver! That's a sizable number. With all its digits showing it looks like the number above, fourteen zeros with the numeral 17 at the front end.

This tremendous potential is achieved with the help of dial equipment in most communities. Nearly 90 per cent of Bell telephones today are dial operated and the number increases daily.

Nevertheless, despite this mechanization, there are more telephone operators in the Bell System today than ever before. For even with a dial telephone, you sometimes need the help of an operator. Telephone usage has grown so greatly, the number of operators is now about double what it was thirty years ago.

As more and more communities today are cut over to dial operation, automatic switching is simultaneously stretching beyond city limits. Long distance operators in hundreds of cities and towns can now dial calls direct to telephones in distant communities. In fact, more than one-half of the Bell System's long distance calls currently are being handled by faster, more direct operator toll dialing. What's more, it is already possible in many areas for telephone *users* to dial calls directly to telephones in other cities without the help of operators just as they dial local calls.

## THE COVER



With the proper type of recording device, such as a recording oscillograph, you can make a visual record of dial pulses on a chart. The line produced looks much like the wavy line in the cover drawing. Such a line is a record of how the continuity of current through a central office is broken by the dialing.

# 000 CONNECTIONS

This is a program national in scope which is being pushed forward by all members of the Bell System team. The Bell operating company people are constantly finding ways to make telephone service of greater use and greater value. Western Electric people are making and installing more dial equipment for the telephone companies than ever before. The Bell Laboratories are not only improving existing equipment but discovering new ways of doing things with the help of such devices as the revolutionary transistor. The result is that the Bell Telephone System is bringing to the people of America better, faster, more dependable telephone communications than ever before.

This story of switching, big as it is, is nevertheless only one facet of the Bell Telephone story of how people communicate as they please, when they please, at a cost which is a bigger bargain today than ever before. That America's telephones are able to do an increasingly better job, more easily and dependably, is due to the efforts of the able team behind them:

> Bell Telephone Laboratories people who are responsible for research and development;
>
> Western Electric people who manufacture and supply communication facilities for the Bell System;
>
> Bell Telephone Company people who operate these vast facilities . . .

all of whom, working together, create the Magic Behind Your Dial.

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