Installation of crossbar toll switching equipment in the Long Lines Department's headquarters building in New York—another step in the Bell System's operator toll dialing program. *See the article beginning on the opposite page*

A Program Is in Progress throughout the Industry Which Will Increase the Speed and Accuracy with Which Toll Calls Go Through to the Called Telephone

Nation-wide Operator Toll Dialing—the Coming Way

Ralph I. Mabbs

This is the text—with minor editorial revisions—of a talk which was given in Chicago on October 14, 1947, in connection with the Fiftieth Anniversary Meeting of the United States Independent Telephone Association—EDITOR.*

OPERATOR TOLL DIALING is a very promising development for toll telephone service.

Equipment that will do the job costs about the same as other types of dial equipment. Although not available in quantity now, it takes about the same time to manufacture and install. And once it is in, its effect on service is immediately noticeable. Those of you who have seen it are no doubt well aware of its greater speed in handling direct-circuit calls. You may have noticed, too, that switched calls may be put through almost as quickly as direct-circuit calls.

There were, of course, many engineering problems involved in the introduction of operator toll dialing. But most of them have been solved. The program is progressing satisfactorily on an industry-wide basis, and right now more than five percent of the country's traffic between toll centers is handled by this method. Once the material scarcities are overcome and enough time has elapsed to permit more of this equipment to be installed, telephone customers are going to be greatly pleased with the speed and accuracy with which their calls are handled.

Before discussing the operator toll dialing plan as it is now foreseen, I should like to take a moment or so here to review the steps in the present and familiar manual method of handling toll calls—the so-called ring-down method. I think it might help

* See also "A Dial Switching System for Toll Calls," MAGAZINE Winter 1943–44; "Operator Toll Dialing—A New Long Distance Method," MAGAZINE Summer 1945.

provide a good platform on which to make comparisons with the dialing method, and at the same time point up some of the objectives for toll dialing.

Steps in Handling Ring-down Toll Calls

LET US TAKE, first, the direct circuit call.

After the calling operator gets the call details, she asks the calling party to hold the line. She then determines the route to the called place. Usually, 85 or 95 percent of the time, she gets that information from the bulletin right in front of her. On the rest, she obtains the route from the route desk. The customer in either case is holding the line.

Here are the rest of the steps. She selects a circuit and rings. Then when the inward operator in the called office answers, the calling operator passes the called telephone number, or the name and address. And as you know, if the called telephone number is not known by the calling operator, and the inward operator cannot supply the number from memory or from a bulletin at her position, inward connects her to an information operator.

Now the inward operator secures the called line on a switching trunk, rings the called station, and reports to the calling operator if the called line is busy or does not answer. In the meantime, while the inward operator is ringing the called number, the outward operator is requesting the calling number and completing the ticket details.

If the called station answers and it is a station-to-station call, the operator starts timing the conversation, cuts herself out of the connection, and proceeds with other work. If it is a person-to-person call, of course, she first reaches the desired party. When the call is ended, the calling operator receives a signal by means of a switchboard lamp associated with the cord of that connection. She then stamps or times her ticket, releases the connection, and sends the ticket to the filing position.

That's the direct circuit call.

If the call is to a built-up point, the originating operator asks the operator at an intermediate office for a circuit to the called office. This operator then selects a circuit and rings the called office. And in those cases where there is more than one intermediate office, the calling operator reaches each of the intermediate offices in turn and obtains a circuit to the next point.

If a no-circuit condition exists at the originating office, the operator holds the calling party on the line for one minute while she attempts to obtain a free circuit on any authorized route. At the end of that minute, if no circuit can be obtained, the customer is given a report and released. The operator holds his line for ten minutes, and during that interval she makes further attempts to secure a circuit. If she cannot obtain a circuit within the ten minutes, she releases the calling line and sends the ticket to a delayed-call position, where further circuit attempts are made.

There is one more condition I'd like to mention: no circuit at an intermediate office. Circuits to intermediate offices are usually held for five minutes while the intermediate

operator attempts to secure one. If she cannot, she records a call order and the calling circuit is released. The intermediate operator continues in her attempts to secure a circuit to the called office and, when she does so, she connects the calling office with the next office.

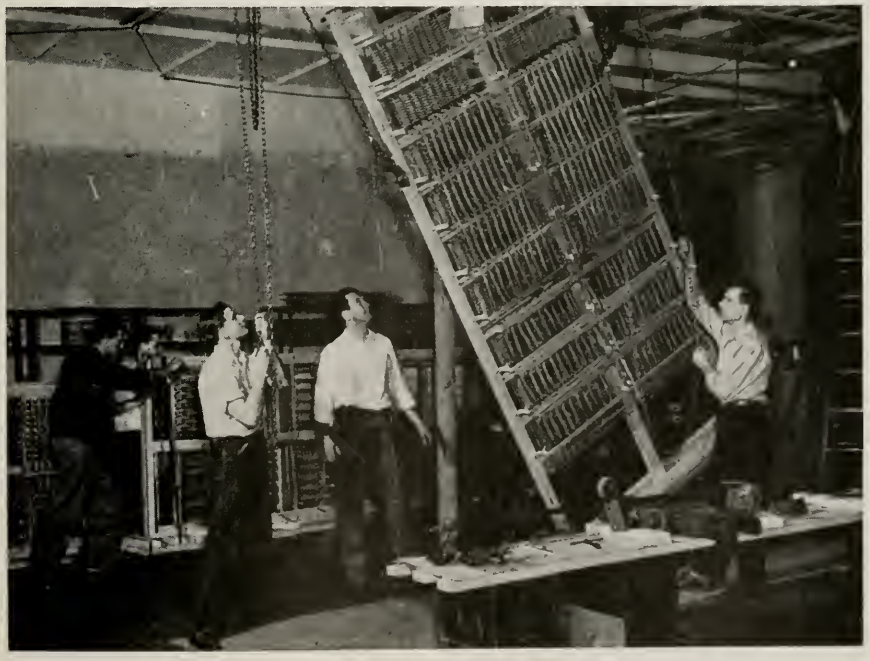
Ring-down Routing Plan

BEFORE we get into operator toll dialing, there is one other phase of ring-down operation I should like to point up: the routing of calls. To facilitate routing arrangements, toll centers are grouped into two classifications. Those designated as Class One are strategically located on main circuit routes. There are about 350 of these. The rest are grouped around these Class One offices, and are called Class Two.

In every Class One office, there is a simple route sheet which shows the route to every other Class One office, and many of these are direct routes between Class One toll centers. If you wanted to know the route to a most remote locality, all you'd have to know is the toll center and the Class One office through which it is reached. Both of these you could find in the Rate and Route Guide for every point.

Actually, in the day-to-day job you would need to refer to the Guide only rarely—on generally less than five percent of the calls. Routing bulletins, provided at each position, show all direct circuit points and as many of the others as can be usefully included. In addition there is a quick reference file at the Route Desk which lists additional places.

Percentage-wise, here is the way it breaks down:—



Erecting a crossbar frame in the Long Lines building in New York

The routing of 82 percent of long distance calls is direct. Frequently an alternative route is provided through an intermediate office.

Calls which go through one intermediate office are about 16 percent of the total, and there is often an alternative route through a different intermediate office.

The rest of the calls, less than two percent, require two or more switches. These usually involve far distant or very small places between which there is infrequent calling.

Circuit engineers and control bureaus constantly study the flow of traffic, and in order to maintain a balanced load on available circuit groups, routing arrangements undergo frequent change. Circuits are shifted from group to group. New direct circuit groups are created. And traffic is routed to other groups. To meet changes in traffic distribution between day and evening periods, for holidays, and as a result of out-of-order conditions, circuits are frequently shifted on short notice.

There are three ways in particular that operator toll dialing smooths the way for faster completion of calls:

1), Improvement in the speed with which the operator obtains the routing on a call;

2), Lamp signal supervision of the called station (i.e., visual indication that the called telephone has answered); and,

3), The elimination of delays at the intermediate toll centers on switched calls.

The first one, improvement in the speed with which routings are obtained, is brought about by the nation-wide numbering plan.

Nation-wide Numbering Plan

UNDER operator toll dialing, it is proposed not to increase the number of digits that a customer must dial on a local call merely because of the introduction of toll dialing.

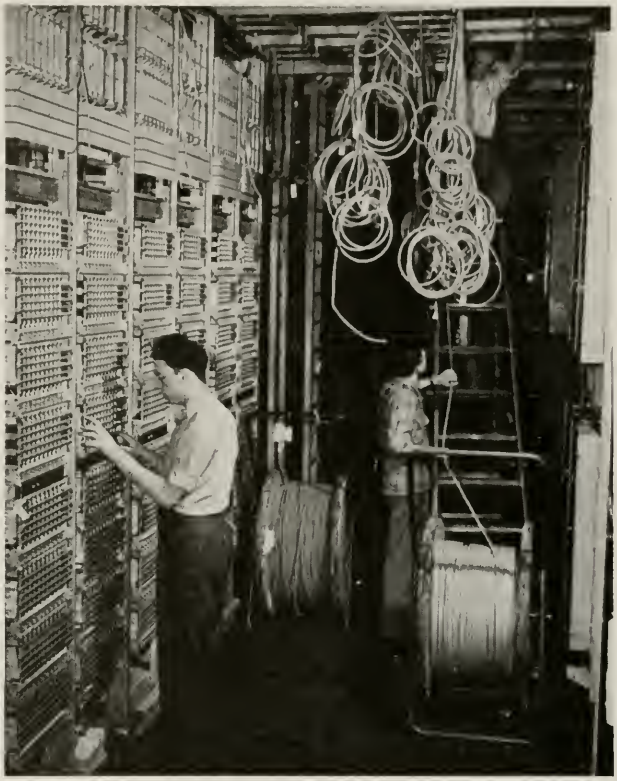
Under this plan, an operator will dial seven digits to reach a number in her own state or numbering-plan area, or ten digits to reach a number in another state or numbering-plan area. An individual designation, called a routing code, must therefore be created, by the selection of a three-digit number, for each central office, for both Bell System and independent companies, in the United States and other adjacent countries included in the operator dialing plans. It is this three-digit code which a calling operator will dial in order to reach a given central office.

Local numbers vary by places from three digits in the smaller towns to seven digits in the larger cities. In many cases, some numbers are four digits and others are five in the same place, and in other places there are five- and six-digit numbers. In some mixed five- and six-digit places, the numbers consist of all numerical digits, while in others they consist of one letter and four or five numerals. Mixed six- and seven-digit places may have two letters and four or five numerals in the number. Seven-digit cities may have three letters and four digits in the local number or two letters and five digits.

All of these arrangements are appropriate for the places in which they exist, but I believe it is clear that a long distance operator in a distant city might well be uncertain what to dial in many cases unless rules are given for her guidance.

Perhaps you can see from this description of the present numbering arrangements that there is a problem of choosing central-office routing codes for operator toll dialing which must be superimposed on the present numbering arrangements.

That problem will be met in this way: The United States and Canada will be divided into 82 numbering-plan areas and, where practical, these areas will include an entire state or province. Each area will include up to approximately 500 central offices, and each office will be assigned a three-digit routing code which does not conflict with any other routing code in its area. Each numbering-plan area will *itself* be reached by means of a three-digit code that does not conflict with any other area code or with any central-office routing code (see page 188).



Installation progresses: frames of crossbar equipment at the left

Thus, each central office in this country and in Canada will be designated by six digits which will distinguish it from every other central office in the two countries. A maximum of ten digits dialed by the originating operator will reach any telephone: three digits for the area code, three digits for the central-office code, and four digits for the called line number. The few exceptions to this ten-digit standard include principally the party-line designations and three-digit central office numbers. To change these would, of course, result in considerable expense and annoyance to telephone customers.

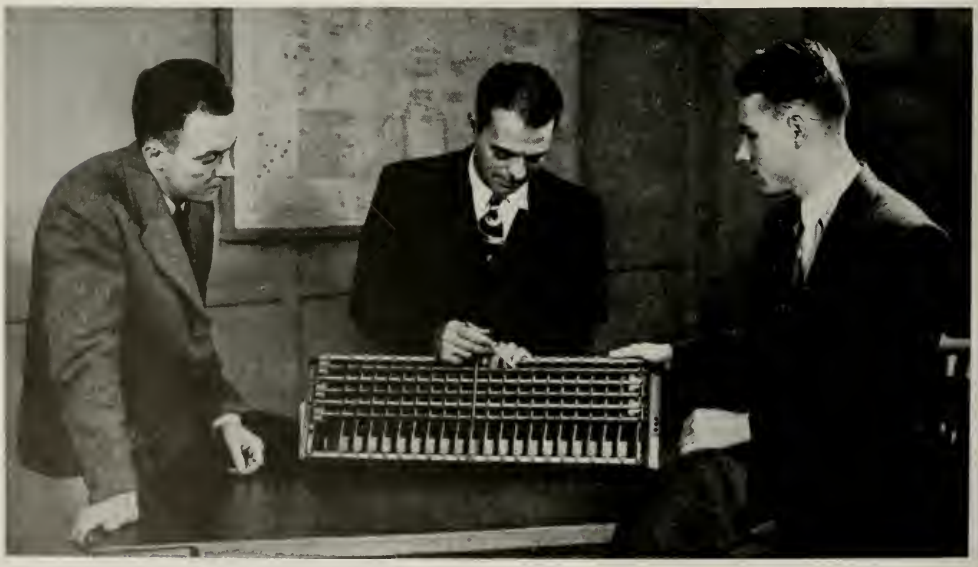
Now let us look at the make-up of the codes themselves. In the Bell System, and in many of the independent telephone companies, "o" (zero) is reserved as a special code by which a customer reaches the operator. "Zero" therefore is not available as the first digit of a routing code. The figure "1" (one) is avoided as a first digit of a code because our equipment is arranged so that an initial pulse of "1" is ineffective. These figures, "o" and "1," are not used in central-office names and there are no letters

on the dials in the "0" and "1" positions. (You may have noticed that in some places the dial number plate has the letter "Z" in the "0" position, but it is not used as part of a central-office name.)

Just because we cannot use them to start a central-office code, however, does not mean we cannot use them in the numbering-plan area codes. With "0" and "1" in the area code, this code is distinguished from all central-office routing codes. Area codes with a "0" in the middle will be assigned to numbering-plan areas which include all of a state. Codes with "1" in the middle will be assigned to numbering plan areas in states which have more than one numbering-plan area.

In the central office, the operator will have a bulletin at her position which shows the numbering-plan area codes for all of the single-area states and for the larger cities in each numbering-plan area of the multi-area states. If she is handling a call to a distant city in a state in which the area code has a "0" in the middle, and the number given by the customer has more than four digits, she will know that she may proceed with the call without reference to the routing operator, since the "0" in the code indicates that it gives access to the entire state.

When she receives a call for a city listed on her bulletin and the area code for that call has a "1" in the middle, she knows that she may proceed with that call but may not go ahead with any other call to points in that state not listed in her bulletin without reference to the routing operator. On calls for which neither the state nor the city is listed on the bulletin, she must of course refer to the routing operator.



Students examining a crossbar switch. The installation of toll dialing equipment in New York has brought about the largest single plant training project in Long Lines's history

Since each call which must be referred to the routing operator is delayed by the additional seconds that must be added to the time required to establish the connection, any plan that can be followed in the assignment of routing codes that makes it unnecessary to refer to the routing operator will improve the quality of the service.

As mentioned earlier, numbering-plan area boundaries will, in general, coincide with state boundaries. In each of the fourteen states which have more than five hundred central offices, including independent company offices, there will be anywhere from two to five numbering-plan areas. In determining the locations of boundaries between numbering-plan areas, a few general rules were followed. All tributaries of a toll center are included in the same area as the toll center. And as much as possible, boundaries within a state are located so as to avoid cutting across heavy toll routes.

Assigning Routing Codes to Central Offices

AT THIS POINT, I should like to speak of the plan followed in assigning routing codes to the central offices within a numbering-plan area.

Please bear in mind, now, that the objective is to establish central-office routing codes that will minimize the number of calls on which the operator must refer to a bulletin or to the routing operator to obtain the route. Also, it would be most advantageous, if possible, to assign all central-office routing codes so that the operator could tell the routing code from the number given by the customer—since the customer gives the number on about 80 percent of the calls placed.

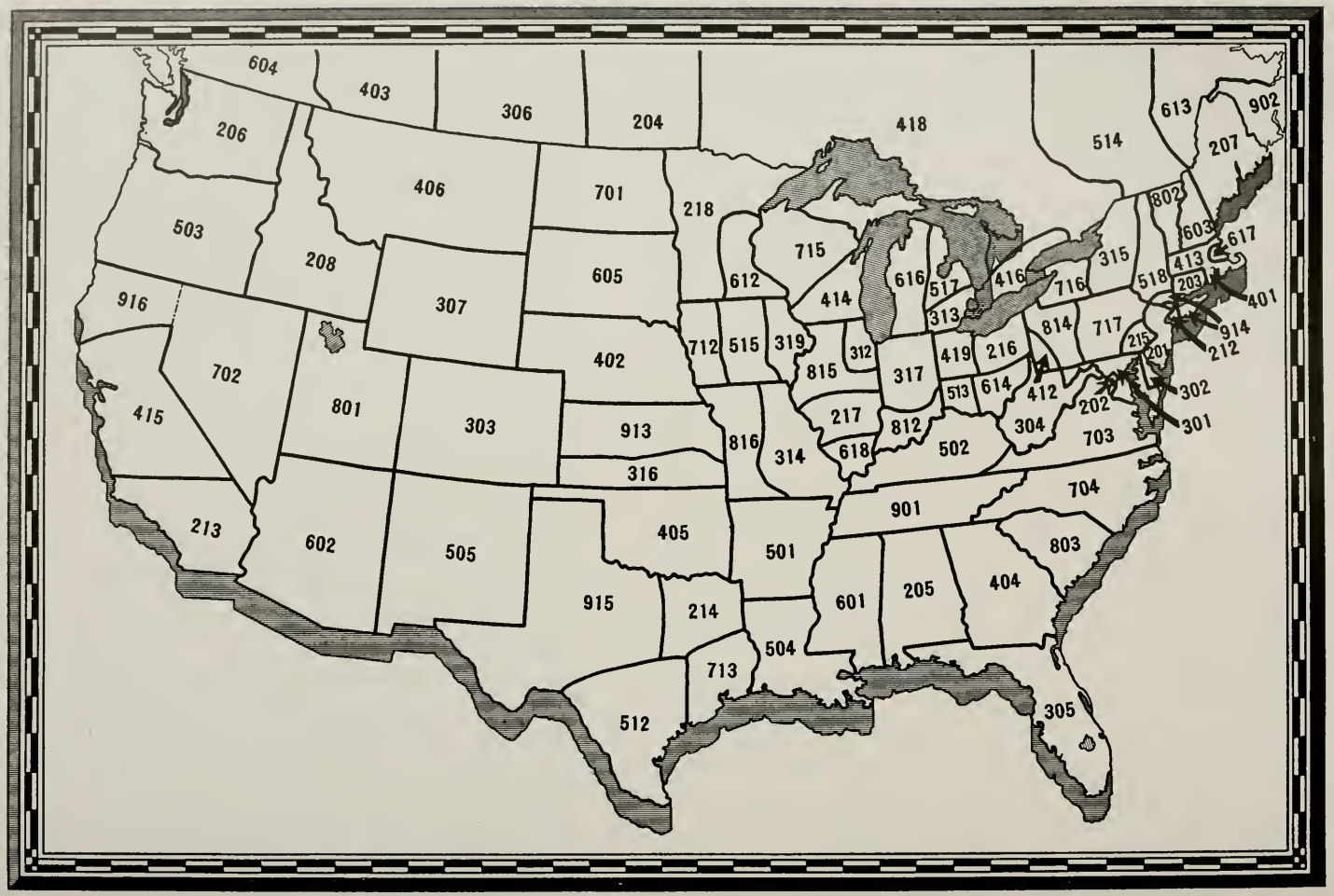
In the seven-digit cities, all central offices have names. In some cities, the first two letters of the office name and a numeral form the office designation—CO(rtlandt)7–1234 in New York City, for example. In others, the first three letters of the office name form the designation—as in Chicago's CEN(tral)–5678. Central-office routing codes are made to conform with the central-office designations in these cities.

In six-digit cities, which have office names, the code is made to correspond with the first three letters of the office name—HOP–1234 to reach HO(pkins)–1234 in Providence, R. I., for instance.

In cities with five-digit numbers (these central offices do not have names) the first two letters of the city name and the first digit of the telephone number are used as the central-office routing code. In Albany, N. Y., by way of example, this would be (AL)3–4567.

Cities with four or less digits will be given three-digit numerical codes which will be based on the first two letters of the city name, as far as this is possible without introducing code conflicts within an area. For Salem, Ore., the central-office routing code would be 725, corresponding to SAL. In some states there are many cities whose names begin with a word such as "San," "Saint" or "New." This makes it impossible to follow the city name rule in many cases.

You will note that, by applying these rules, the operator can tell on a high percentage of calls what the central-office routing code is from the number in the distant city given by



Numbering-plan areas and their codes in the United States and Canada

the customer, and can proceed at once with the handling of the call without reference to bulletin or to the routing operator.

Steps in Handling a Dialed Toll Call

NOW LET ME FOLLOW the steps in the handling of a call under the proposed numbering arrangement.

The customer reaches long distance in the usual manner, and the operator records his call just as she does today. If he gives a seven-digit called number and the call is to a city within her own numbering-plan area, the operator selects a trunk connected with the switching equipment and dials the number, using two or three letters of the office name as required to make seven digits. If the number he gives has less than seven digits, the operator makes up seven digits in one of the ways described in the preceding section.

When the call is to a city in another numbering-plan area, the operator obtains the area code from her position bulletin or, if necessary, from the routing operator, and dials this code plus the seven-digit number.* If the customer does not give the called number, she obtains it from the information operator at the called place and proceeds as described before.

On station-to-station paid calls, she does not remain connected to the circuit after dialing the number, but

NUMBERING-PLAN REQUIREMENTS

* * *

A distinctive telephone number for each telephone in the United States and Canada

*

The minimum number of digits which will provide for

Growth

New services

*

Minimum changes in customers' numbers

Minimum changes in local dialing practice

Least cost for equipment changes

*

Minimum reference to Bulletins and Route Guide

To gain speed-of-service advantage

times the conversation from signals which indicate when the called station has answered. On person-to-person calls, she remains in on the connection to supervise the start of conversation. When the signals indicate that both calling and called stations have hung up, she takes down the connection.

The proposed numbering arrangement must, of course, make provision for the operator to reach other operators at distant toll centers. She may want to reach an information operator to obtain the telephone number on a call placed by name and address, or she may want to ask an assistance operator at a distant point for help in completing a call or in

*A very high percentage of the calls are handled over direct circuits between the calling and called places. In a majority of the toll centers, these direct circuits appear in the multiple before the operator. Because of this, the operator in many cases need not dial the area code to reach the distant office, even though it is in a different numbering-plan area. She merely plugs into the direct circuit and dials the called number.

verifying a busy or don't answer condition. Also, the operator may need to reach a delayed-call operator when a customer reports he is ready to talk on a call which reached his telephone while he was not available.

Each toll center will have assigned to it a three-digit toll office code similar to the local office codes already described. These codes will not conflict with any other toll or local office codes in the numbering-plan area. When the operator wishes to reach an operator at the distant toll office, the toll office code will be used.

Methods of Eliminating Code Conflicts

SINCE the numbering-plan arrangements are necessary to successful operation of the plan, the first step in preparation for its introduction is to assign non-conflicting routing codes to each central office.

In the transition from the present to the proposed numbering, there will be some code conflicts. Such conflicts, however, will be eliminated in some cases by changing central office names, and in others, by using numerical codes not related to the town name.

An example of this is the State of Washington numbering-plan area, where there are three cities which have a central office designated as MAIN. Two of these must be changed. In a few of the smaller cities without central-office names, equipment changes will sometimes need to be made to eliminate conflicts between towns whose names start with the same two letters.

IN CONCLUSION, I should like to note that under the operator toll dialing plan there are numerous equipment and inter-toll trunk layout arrangements which have important functions in achieving the general service improvements.

To mention a few—

All of the important switching points will be equipped with facilities which will complete intermediate switches in a second or two.

Automatic alternative routing will be provided at the switching centers. Calls encountering all circuits busy over the first route will automatically and immediately be offered to other routes, so that in the end only a very few of them will be delayed because there is no idle circuit.

Terminating equipment will select and ring the called number, and through supervisory signals will then indicate to the originating operator when the called station answers or whether it is busy.

I said earlier that operator toll dialing makes for improvement in three ways in the speed with which long distance calls are handled. The numbering arrangements improve the speed with which an operator obtains the routing of a call; the switching facilities at intermediate offices, and the automatic alternative routing, speed the connection at intermediate offices; and the through supervisory signals enable the operator to determine the status of a call at a glance rather than having to wait for a report of its status from the terminating operator.

It is these features which make operator toll dialing "the coming way."