# Manual toll operating methods in the telephone network

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## PREFACE

For many years after the inception of "long distance" (toll) telephone service in the early 1900s, toll calls were set up by operators working at manual telephone switchboards (generally special ones for use in this service). Various schemes of operation (known as "toll operating methods") were in use over that period. In general, the method of choice changed from time to time, becoming gradually less labor-intensive and more convenient to the users as various technical advances came into general use in the telephone network.

This article describes the major toll operating methods of that era and the network changes that permitted movement to more cost-efficient ,methods. The descriptions are elaborate, but there is no emphasis on details at the electrical circuit level. Considerable background is given.

## 1 CAVEAT

Information about this area is sparse today, and many authentic articles skip over important parts of the story, or are mutually contradictory. I have used my best judgment to fill in the missing parts and to interpolate among contradictory information. But I cannot guarantee that the descriptions and explanations here are wholly correct.

## 2 GENERAL

### 2.1 About "toll" calls

Generally speaking, "toll" calls in a telephone system are calls for which an explicit charge is made, typically depending both on the distance between the two points and the duration of the call. For most purposes, we can consider "toll" to be a synonym for "long distance".

### 2.2 Succession

For the most part, we can generally think of the various operating methods described here as representing a progression in the time of their introduction. But in most cases, the "earlier" method remained in use, on a diminishing basis, for quite a while after the introduction of its successor.

### 2.3 About manual toll switching

For many years, even after automatic ("dial") operation became widespread for local calls, toll calls were set up wholly by way of manual switchboards. The operating methods described in this article are totally creatures of that paradigm. However, in Section 8 I give a brief discussion of the impact of "dial" operation in the toll network on them.

### 2.4 About dial local service

At the beginning of the vaguely-defined era covered by this discussion, essentially all local telephone service was handled by manual switching, provided by human operators operating manual telephone switchboards. And of course this paradigm had an influence of the details of handling toll calls.

But, especially from about 1920 on, "automatic" ("dial") operation of local telephone networks began coming into significant use. This affected many details of the handling of toll calls. But it did not directly provoke the advance from one toll operating method to another (although it might well change some details of how those methods were applied).

In any case, here I will mostly limit the discussion of the various toll operating methods to their application in a context of manual switching of local calls, as they emerged in that context and their distinctive characteristics are perhaps most apparent there. But later, in Section 7, I will synopsize the effect of "mechanization" of local service on the various toll operating plans.

### 2.5 "Line" and "Station"

For simplicity, in this article I will speak of the calling and called *stations* as if each is served by an individual line (not as stations on a multi-party line). Thus we can consider *line* and *station* to be synonyms, and I will generally speak of the calling and called "parties" as associated with *lines*.

## 3 ABOUT "TOLL WORTHY" CONNECTIONS TO THE CALLING LINE

As we see the basic concepts of most of the toll operating systems, in the original contact of manual local switching, we will see that they begin with the calling subscriber asking the local operator who answers his "service request" to connect him to a "Long Distance" operator.

We might expect that the local operator would just plug the front cord of the cord circuit, with which she answered this call, into a trunk leading to the long distance switchboard.

But there would be several shortcomings to using this connection through the local switchboard as a "link" in the ultimate toll connection (the details of which need not concern us here). Some of these (such as the matter of the type of "talking battery" to be provided) have transmission implications. Another matter is the need for the toll operator to be able to ring the calling line, which could not be done from the toll switchboard backwards through a regular connection through the local switchboard.

To overcome those shortcomings, in some of the operating methods discussed here, in the final long distance connection, the connection from the calling line to the long distance switchboard is made in a different way, one in which various technical steps are taken to overcome those shortcomings. As we will, see, this often involved, as the connection is being completed, substituting a more suitable connection from the calling line to the toll switchboard for the initial "local" connection to the toll switchboard.

In this article, I will speak of connections with the calling line that were suitable as participants in an overall toll connection as "toll worthy connections" (my term, I think apt, but not to my knowledge used elsewhere in the literature).

As an aside, most of the considerations that disqualify the initial "local connection" as a participant in the ultimate toll connection are also at issue in the connection to the called line. But here, there is no "initial local connection" involved, and the arrangements for connecting to the called line for toll calls are inherently made "toll worthy".

## 4 MANUAL LOCAL TELEPHONE SWITCHING

### 4.1 Introduction

To set the stage for the various operating methods used for toll calls in the context of manual local telephone switching, I will review the handling of local calls by manual switching, in the degree of detail needed here.

#### 4.1.1 *The switchboard icons*

The illustrations that follow are peppered with icons representing manual switchboards of various types. Once I get rolling, these will be of a "black box" nature: lines and trunks are shown arriving at a switchboard or departing from it, but there is no hint as to whether these terminate on jacks or cords, nor how switchboard cord circuits fit into the journey of a connection.

Those details, although fascinating, do not play pivotal roles in understanding the principles of the operating methods being described,

and showing them each time would clutter up the illustrations, making them less useful for their intended purpose.

Nonetheless, in the first couple of illustrations I will illuminate those details to some degree.

### 4.2 An intraoffice call

Figure 1 shows the handling of an intraoffice call (a call to another line in the same central office) in the simplest mode, involving only a single switchboard. The fictional city is Clearview, and the fictional central office there is Maple.

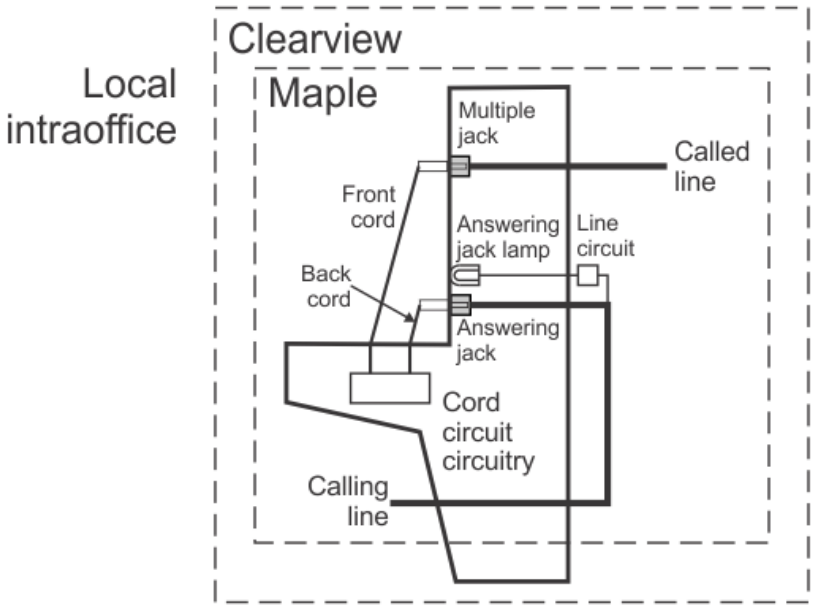


**Figure 1. Local intraoffice call (simplest mode)**

Here, I depart from my general later practice in this article of showing switchboards as "black boxes", but actually show (and speak in some detail about) the lamps, jacks, cords, and plugs that are involved, as these will be referred to (but not shown) later. This is in part for the benefit of the reader not already familiar with manual switchboard operation.

As to the clumsy-seeming label "cord circuit circuitry", I use that because "cord circuit" normally refers to the entire entity comprising two cords plus the attendant circuitry. So to mean that circuitry I resort to the term "cord circuit circuitry".

When the caller takes the telephone "off hook", the line circuit for this line recognizes that and lights a lamp at the line's answering jack at a certain position of the local switchboard at the serving central office. The operator plugs the back cord of an idle cord pair into the answering jack, operates the talking key for that cord circuit (which connects the operator's telephone set to it), and says, "Number,

please". The back cord provides DC voltage ("battery") to the calling line.

The caller gives the operator the number wanted, in this case, another "Maple" number. The "A" operator plugs the front cord of the cord circuit into the multiple[1] jack for the called number (and thus the called line). She operates a ringing key that applies ringing voltage to the front cord and thus to the called line.

After the ringing signal, the front cord provides DC voltage to the called line. An audio transformer (called in this work a "repeat coil") couples the speech signals between the two cords and thus between the two lines.

The connection is complete.

I note for completeness that of course the calling line also has an appearance on a set of multiple jacks, and the called line also has an appearance on an answering jack, but those don't figure into this story so I have not shown them on the figure.

### 4.3 An intraoffice call

Figure 2 shows at the same level of detail the handling of a call from a subscriber served by one central office in a city to one served by a different central office in the same city, a "local intraoffice call".

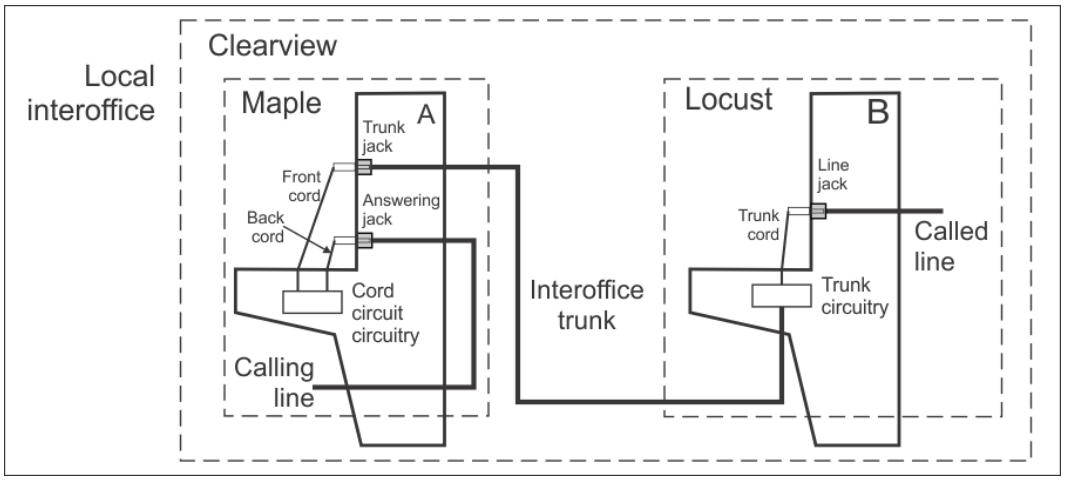


**Figure 2. Local interoffice call**

When the caller takes the telephone "off hook", this lights a lamp (not shown) at the line's answering jack at a position of the "A" switchboard at the serving central office (the Maple office in the city

[1] It has that name because for each line there are multiple jacks, spaced along the switchboard so that any operator can reach the jack for any wanted line. Thus the entire array of line jacks is called the "line multiple", and any jack in it is a "multiple jack".

of Clearview). The operator plugs the back cord of an idle cord pair into that answering jack, operates the talking key for that cord circuit (which connects the operator's telephone set to it), and says, "Number, please".

The caller gives the "A" operator the number wanted, in this case, a "Locust" number (also in Clearview). The "A" operator plugs the front cord of the cord circuit into the trunk jack for an idle interoffice trunk that leads to a position at the "B" switchboard at the Locust central office. There the trunk appears on its own cord (the cord circuits in the "B" switchboard have only one cord.).

As we saw in the previous example, At the "A". switchboard, the cord circuit circuitry provides DC current ("talking battery") to the front cord (and thus to the calling line), and provides for coupling the speech signals between the two cords

At the "B" switchboard a lamp on the cord circuit indicates that there is an incoming call over that trunk. The "B" ator's telephone set is automatically connected to that trunk's circuitry. But probably, rather than the "B" operator "answering" by voice, the trunk circuitry[2] sends an *order tone*, in this case two quick short beeps, meaning, to the "A" operator, "pass only the numerical part of the wanted number". The "B" operator also hears the order tone, which alerts her that she is connected to the trunk and should expect to hear the wanted number spoken by an "A" operator.

The Maple "A" operator gives the "B" operator at the Locust office the number wanted. (The "Locust" part is not said, as it is not needed, the connection already having arrived at the Locust office.)

The Locust "B" operator plugs this trunk cord into the line lack for the wanted number. The trunk circuitry applies the ringing signal. When the calling line answers, the ringing signal is stopped, talking battery is supplied to the called line, and there is a transmission path for speech signals through the trunk circuitry.

The connection is complete.

For continuity's sake, Figure 3 is how that connection would be shown with the simplified switchboard conventions used from here on.

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[2] Again I use the odd-sounding term "trunk circuitry", since what I call her for short a "trunk" is itself in the entirety properly called a "trunl circuit".

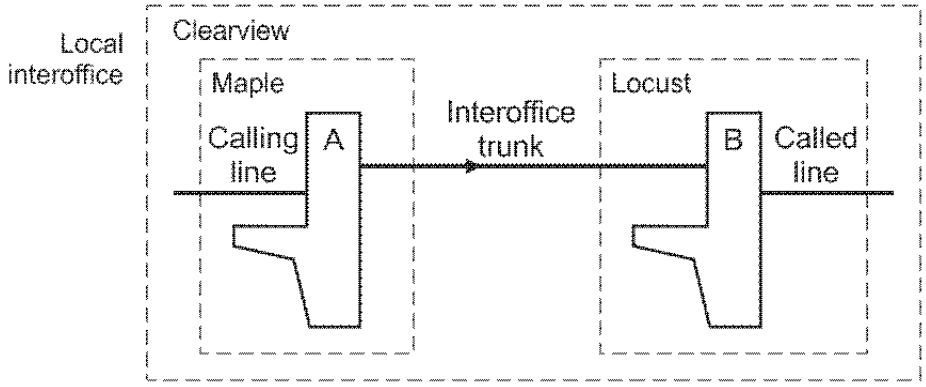


**Figure 3. Local interoffice call—simplified presentation**

### 4.4 Another option for intraoffice calls

It really has no effect on the story here, but in the interest of thoroughness I point out than in many large central offices intraoffice calls are handled just like the interoffice call we saw in Figure 3: the Clearview Maple "A" operator routes the call over an intraoffice trunk to the "B" board in the same office, which completes the connection. The details of signaling over the trunk may differ slightly from the interoffice case.

## 5 TOLL OPERATING METHODS

### 5.1 Introduction

In this section, I will describe in some detail the working of several different "toll operating methods".

In the illustrations, the heavier path lines are paths that are part of the completed connection. The lighter path line are paths that exist during some phase(s) of the setup of the call, but are not part of the ultimate completed connection.

### 5.2 The "two number" toll operating method

#### 5.2.1 *Introduction*

It is suspected that this may have been the first widely-used method of toll operation.

#### 5.2.2 *Operation*

Figure 4 shows the setup for a toll call handled by what was technically called the "two number" operating method, which was seemingly relatively popular in the early 1900s.

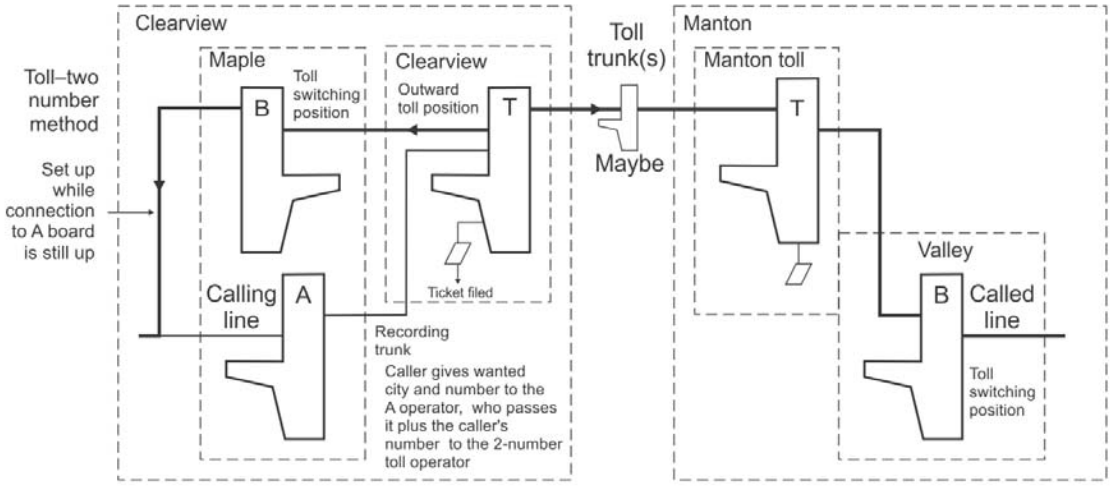


**Figure 4. Toll call via the *two number* operating method**

Here our caller in the Maple office in Clearview wants to call someone in the city of Manton (which will be a toll call). That person is served by the Valley central office in Manton.

Th caller takes the phone off-hook, and an "A" operator in the Clearview Maple office answers, The caller tells her she want to make a long distance call, and gives her the city and the number. She asks the caller for his number (which was not earlier known to her–it is not normally indicated on the answering jack, for various reasons).

The "A" operator extends the connection to the cognizant "two-number" toll switchboard (perhaps some place in Clearview). When the operator there answers, the "A" operator passes to her the city and number being called, and as well the number of the caller (so now we can see where the moniker "two number" for this operating method comes from).

I digress for a moment to point out that, as discussed earlier, various aspects of the connection through the "A" switchboard (originally used only for local connections) were not ideal from a transmission and ringing control standpoint as part of a toll connection (were not what I call here "toll-worthy"). We need not here be concerned with the details of that, but the concept will prove important.

In order to provide a "toll worthy" connection between the calling line and the nascent toll connection, the Clearview outward toll operator then makes a connection to the "B" switchboard in the Clearview Maple office. Its job is to complete calls to numbers in that office (mostly for local calls, but not so in this case).

In fact this call probably comes to one of a few positions in the Maple "B" switchboard that are set up to complete toll calls, and the transmission arrangements there are those that are desirable for a link in a toll connection (are "toll-worthy").

The outward toll operator gives that "B" operator the caller's number, and the "B" operator extends this branch of the connection to that line. No ringing is applied; the caller is already "on the line" (on a connection to the "A" switchboard).

This having been done, the outward toll operator releases the trunk from the "A" switchboard, the "A" operator gets a disconnect indication on a supervisory lamp in the cord circuit, and she takes the connection there down.

Now the outward toll operator extends the connection (in various ways, perhaps involving an intermediate toll switchboard) to the *inward toll switchboard* for the called city, Manton. When the Manton toll operator takes up that trunk, the trunk circuit sends an *order tone* (in this case, a single "beep"). That is the cue to the outward operator in Clearview to give the Manton inward toll operator the wanted number (including the central office name, here "Valley"). The Manton inward toll operator makes a note of the number on a toll ticket, for future reference.

The inward toll operator the extends the connection to the "B" board at the Valley office (again likely to one of a few positions there equipped to complete toll calls). When the Valley "B" operator answers, the inward toll operator tells her the wanted number. (The "Valley" part is not said; it is not needed, the connection having already arrived at the Valley office.)

The Valley "B" operator completes the connection to the wanted line, and ringing is applied. You can guess the rest.

The outward toll operator prepares a paper toll ticket with the call details (eventually including th time of answer and the time of disconnect), which will be used to bill the caller for the call.

### 5.2.3 *The name of the method*

The name of this method supposedly came from the fact that the "A" operator passes two numbers (the called and calling numbers) to the toll operator.

I note that other methods, described shortly, equally depend on the outward toll operator getting both those numbers (albeit not necessarily from the "A" operator). So, as is so often the case, the name here is not inherently definitive.

### 5.2.4 *The name of the switchboard and its operator*

In some "official" writing about this method (and there isn't much available to me today), the switchboard is spoken of as a "two-number" switchboard (not any sort of "toll" switchboard"), and

its operator as the “two-number” operator (not, for example, as the “outward toll” operator, as would be the case elsewhere).

But in the description above I have used terms that are consistent with those used for other operating methods.

### 5.2.5 *In a “dial” setting*

I have no actual information on this, but I suspect that this operating method was not applicable to a dial local service setting.

## 5.3 The “two-ticket” toll operating method

### 5.3.1 *Introduction*

A disadvantage of the two-number toll operating method was the need for the “A” operator to receive the desired city and number from the caller and then pass it to the toll recording operator.

That effort was eliminated by a toll operating methods that was technically called the “two-ticket” operating method once there was an even later method from which it had to be distinguished. It was seemingly relatively popular in the early 1900s.

### 5.3.2 *Operation*

Figure 5 shows the setup for this operating method. The fictitious cities and offices are the same as before.

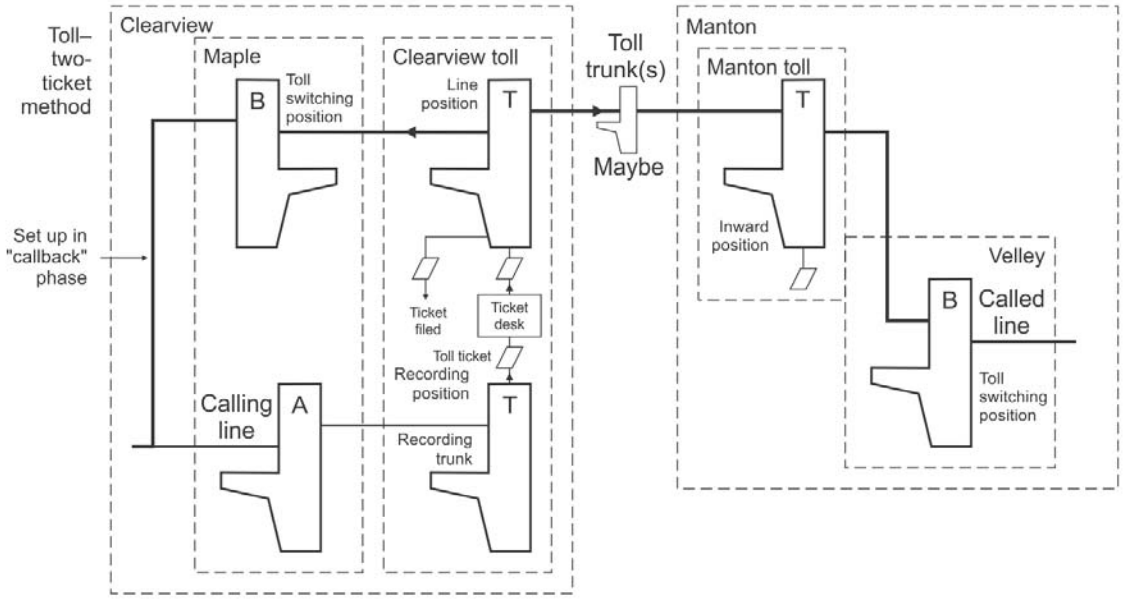


**Figure 5. Toll call via the *two-ticket* operating method**

As before, we start with the caller (here served by the Maple office in Clearview) taking his phone off hook. An “A” operator answers. The caller tells her he wants to make a long distance call. The “A operator

extends the connection (over a *recording trunk*) to a position in the *recording* section of the Clearview toll switchboard.

When the "Long Distance" operator there answers, the caller gives her the wanted city and number (here a "Valley" number in the city of Manton). She asks the caller for his number. She starts a paper "toll ticket" with the call details. She thanks him and tells him to hang up; he will be called back when the connection is ready.

The partially-completed toll ticket is sent by various ways to a *ticket desk*. The clerk there will, perhaps right away, but not always, send the ticket to a position in the *line* section of the toll switchboard (also spoken of as the *completing* section).

That will be a position in that section of the switchboard that is equipped to access toll trunks ("lines") to the destination city (or to the proper next intermediate city in the route to the destination city). This completing (or "line") operator becomes the *outward toll operator* for this call.

Typically, when she receives the ticket, she will attempt to establish a connection to an inward toll position in the called city. She might at first not be able to establish the connection, as the toll network of the time was rather "thin" and there might not be any trunk available in some critical part of the route.

But right away, or maybe on a later try, the inward toll position is reached.

The outward toll operator passes to the Manton inward operator the number wanted (office name and all). The inward operator notes that on a toll ticket, which she will use for reference during her handling of the call.

The outward toll operator then, just as we saw earlier in the process of the prior example, sets up a connection to the caller, via the "B switchboard in the caller's office (again, probably one of only a few positions equipped for toll connection completion). In this case, the caller's line is rung right away.

That call is answered (hopefully by the original caller). She tells the caller that she will soon have the called party on the line.

Meanwhile, the inward operator (in Manton) makes a connection with the called number's line by way of the "B" switchboard in the Manton Valley office (again, presumably via a position of that switchboard that is equipped to complete toll calls).

When the line is answered, the Manton inward operator advises the outward operator in Clearview. That operator notes the time on the toll ticket for this call.

If this is a “person-to person” call, so there will have to be a conversation with the person answering about what person the call is for, that is done by the Manton inward toll operator. If the call is on a “collect” basis, and the called party, in “accepting the charges”, has asked to be advised, when the call is completed, of the amount that will be charged, the Manton inward toll operator does that.

When the call is ended, the Clearview outward toll operator receives a disconnect signal. She pulls down the connection there, notes the time of disconnect on the toll ticket, and sends her toll ticket on, to be used for billing.

The Manton inward toll operator gets a forward disconnect signal on the trunk and pulls down the connection there. The Manton Valley “B” operator gets a forward disconnect signal on the trunk.

I’m not sure what happens to the ticket used by the Manton inward operator.

### 5.3.3 *As to the name*

I call attention to the fact that in the “two-number” operating method, in the form described earlier, there are also two tickets used.

## 5.4 The “single-ticket” toll operating method

### 5.4.1 *Introduction*

A further simplification involved consolidating all call handling maneuvers with the outward toll operator, with the work of the inward toll operator now mostly limited to her most basic task, competing the connection toward the called line. The new operating method based on this concept was called the “single-ticket” method, since under it only the outward toll operator made a toll ticket.

### 5.4.2 *Operation*

Figure 6 shows the setup for that operating method.

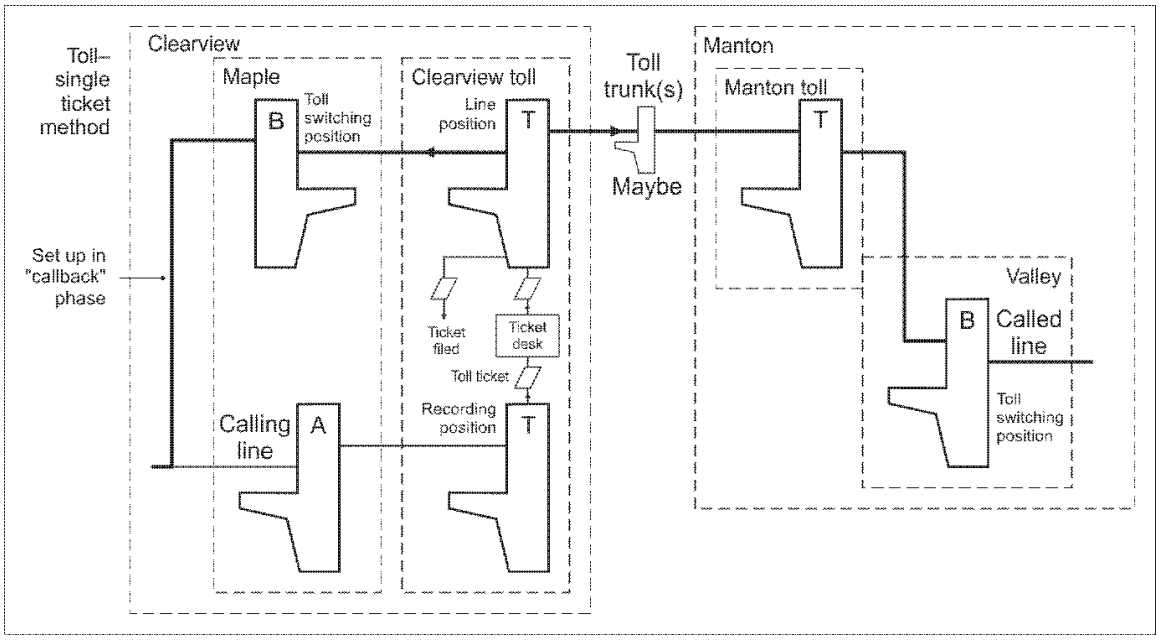


**Figure 6. Toll call via the *single ticket* operating method**

The initial drill is just as described for the two-ticket method, and I will not repeat it here.

In this case, when the inward toll operator at Manton takes up the trunk, the trunk, the trunk circuit sends an order tone signal[3], the outward toll operator at Manton just gives the desired central office (in this case, "Valley"). The inward toll operator makes a connection to a trunk leading to a position in the toll completing section of the B switchboard at the Valley office.

Note that she does this right away, unless it is not possible, in which case she so advises the outward toll operator, who advises the caller to hang up and try again later. She does not need to make a ticket to which she can later refer (and in fact she hasn't even heard the numerical part of the called number, nor does she ever need it).

So we see how this operating method gets its name.

When the Valley ""B" operator answers[4] the outward toll operator gives the numerical part of the wanted number. (The "Valley" part is not needed, given that the connection has already arrived at a Valley "B" switchboard.)

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[3] In this case likely a quick series of three short beeps, meaning "pass the office name only" .

[4] Actually, the system might just send an *order tone*, in this case likely a quick series of two short beeps, meaning "pass the numerical part of the number only"

Probably while this is happening, the outward toll operator, much as we saw in the prior example, sets up a connection to the caller, via the "B" switchboard in the caller's office (again, probably one of only a few positions equipped for toll connection completion). This time, the caller's line is rung.

That call is answered (hopefully by the original caller). The operator tells the caller that the connection is about to be completed. She cuts the connection through, and the conversation can begin.

She notes the time the connection is consummated on the toll ticket. When the conversation ends, she notes that time on the ticket, and then sends the ticket (in one of several ways) to where it will be processed for billing.

If this is a "person-to person" call, so there will have to be a conversation with the person answering about what person the call is for, that is done by the Clearview outward toll operator. If the call is on a "collect" basis, and the called party, in "accepting the charges", has asked to be advised, when the call is completed, of the amount that will be charged, the Clearview outward toll operator does that.

## 5.5 The "combined line and recording" (CLR) toll operating method

### 5.5.1 *Introduction*

At best, the single-ticket operating method was very labor-intensive and inconvenient to the user.

Several improvements in the telephone network (I will delay discussion of them so I can get on with the story) made it possible to think of a more direct way of handling calls. This was called the "combined line and recording" (CLR) method.

As you might guess from the name, in this method the *recording* function (learning and recording where the call was to, and from what number) and the *line* function (in which the outgoing connection was actually established), were done by the same operator.

### 5.5.2 *Operation–Original system*

We see the setup for the initial version of this operating method in Figure 7.

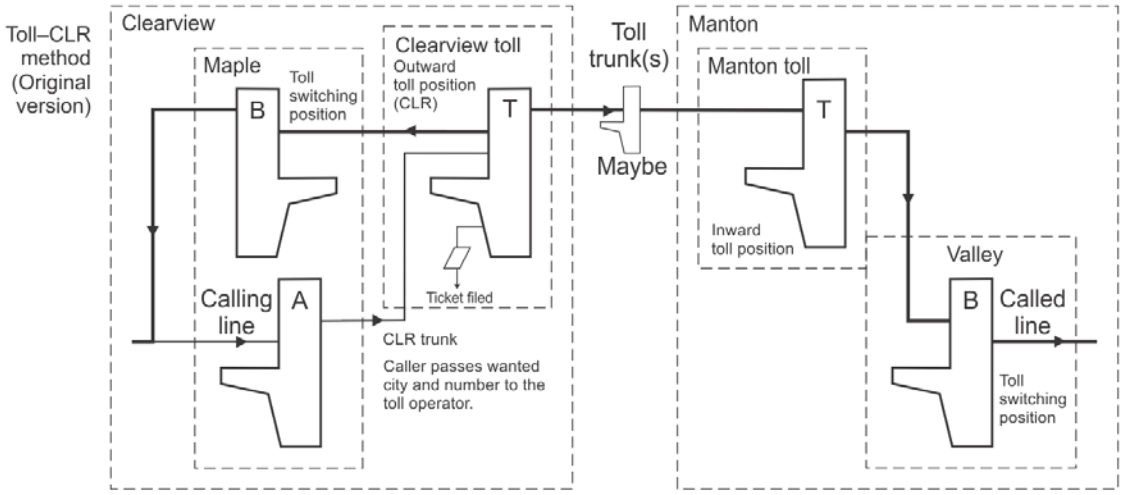


**Figure 7. Toll call via the *combined line and recording (CLR)* operating method (original version)**

Here, there are no longer both a *recording* and a *line* switchboard operator involved at the originating end. The two functions are done by a single operator, spoken of as a "recording-completing" operator (who is the outward toll operator here). But the synonymous moniker "combined line and recording" (CLR) is used to describe this method of operation, and to identify various ingredients associated with it.

As before, our caller takes his phone off the hook, and an "A" operator at his serving office (Clearview Maple) answers. He tells her that he wants to make a long distance call.

The "A" operator extends the connection over a CLR trunk to a recording-completing outward position of the Clearview toll switchboard. (This is not a "toll-worthy" connection.) The toll operator answers, "Long Distance".

The caller gives the toll operator the city and number wanted. The toll operator asks the caller for his number. All are noted on a toll ticket, which the operator has initiated for this call. While the caller remains on the line, the toll operator:

a. Makes a connection back to the calling line by way of the "B" switchboard at the callers' local office. This is a "toll-worthy" connection, The calling line is not, however, rung on by the B switchboard (the caller's telephone is already off-hook, so that would not even be possible). As soon as that connection is up, the toll operator disconnects from the CLR trunk from the "A" board. Th "A" operator gets a disconnect signal on the CLR trunk and pulls this connection at her board down altogether. From this point on, the "A" switchboard (and its operator) are not in the picture at all.

b. Proceeds to advance the connection over a toll trunk toward the destination city (essentially as described earlier for the *single-ticket* method of operation).

The outward roll operator marks on the toll ticket he of answer. When the call has ended, she marks on the ticket the time of disconnect, and sends the ticket on its on its way.

The fact that the caller remains on the initial connection the whole time is generally attractive from the standpoint of the caller. When it gets less attractive is when, owing to network congestion, the connection cannot be completed in a fairly short time. In such cases, the outward toll operator may ask the caller if he would like to be called back when the connection can be established.

### 5.5.3 *An implementation complication*

The introduction of this operating method required that now all switchboard positions (of the CLR outward toll switchboard) would have to be equipped to connect to any trunk needed to advance the call over whatever route applied. (Earlier, each "line" position might only be able to access trunks to certain points, and that position would only be given tickets for calls for which the route involved trunks accessible at that position.)

Now, any position on the CLR switchboard might receive a call for any city imaginable. For large toll offices, with thousands of outward toll trunks altogether, to hundreds of destinations, there was not room on the jackface of a single switchboard position for groups of trunks to each possible destination.

So in many cases a second stage of toll switchboards ("tandem" switchboards) would have to be established, each position there having access only to trunks to certain destinations. The CLR operator would the set up the outward connection to a position of the tandem switchboard having access to a trunk required to continue the connection (getting this information from her "position bulletin").

### 5.5.4 *Operation–Improved system*

An even more efficient version of the CLR operating method was later put into place. We see the setup for this in Figure 8.

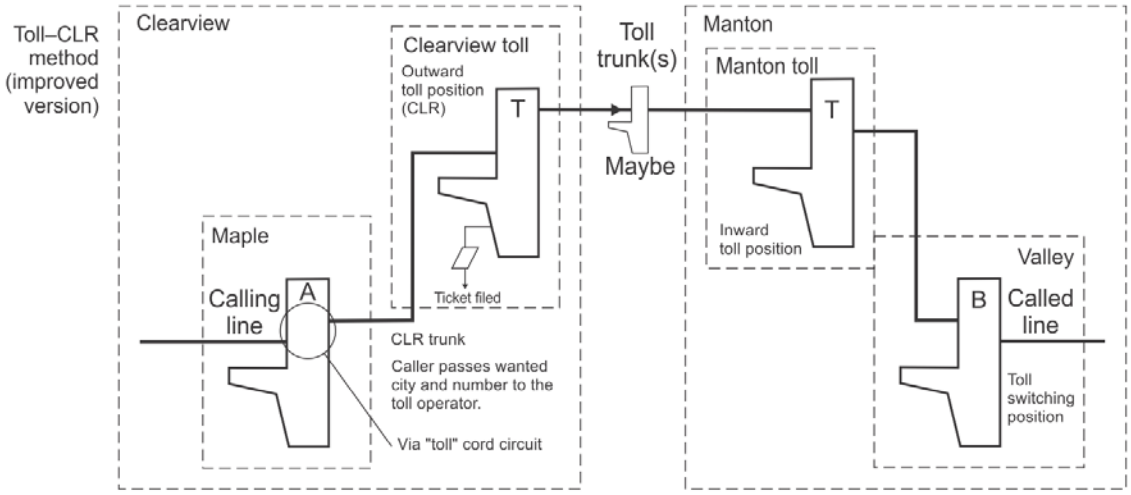


**Figure 8. Toll call via the *combined line and recording (CLR)* operating method (improved version)**

As before, the Caller asks the answering local “A” operator for Long Distance. Th A operator extends the call over a recording-completing trunk to a CLR toll position, but not using the cord circuit with which she originally answered the call.

Rather, she pulls the back cord of that cord circuit from the answering jack and instead plugs in the back cord of one of a few special “toll” cord circuits into that answering jack (yes, she has to remember which answering jack that was). That cord circuit will provide a ”toll worthy” connection through the “A” switchboard.

She then plugs the front cord of that cord circuit into the jack for an idle CLR trunk (sometimes called a “recoding-completing trunk”)..

As before, the CLR operator answers with “Long Distance”. The caller gives the wanted city and number, and the toll operator ask for his number. In this case, that is not needed so she can establish a “toll-worthy” connection back to the calling line (she is already connected to the calling line over a toll-worthy” connection. Here it needed to put on the toll ticket so that subscriber will be billed for the call.

The CLR operator extends the call to the destination city, and the connection is completed just as in the previous case.

In this case, although the “A” switchboard (that is, a toll cord circuit there) is still in the connection, the “A” operator has no further “call management” duties for this call. Any “negotiations” with the calling or called party are all done by the CLR operator.

When the call is over, the CLR operator disconnects from the CLR trunk. The “A” operator gets a “disconnect” supervisory signal on the cord circuit involved and pulls it down.

The advantage of this newer method is of course a saving in the additional labor of the toll operator, and of the local "B" operator, in establishing a new connection to the calling line, and the incremental cost of the usage of the equipment involved in that.

Countervailing that is that now all "A" positions must have added to them a few new cord circuits of the "toll" type. There is no free lunch.

## 5.6 The "A-B toll" method

### 5.6.1 Introduction

It was early realized that, especially for toll calls to relatively close cities, and if we limit ourselves to "station to station" calls, a method of operation that was much more like that used for local interoffice calls would be less costly (and in some case, speedier to the caller) than the toll methods of operation I have described so far).

The result was the adoption for "short", "station to station" toll calls of an operating method called "A-B toll" (the premise for which name will shortly become apparent). Althoiugh I have placed it last (because of its unique nature), it is believed to have been introduced very early for calls of the type mentioned.

### 5.6.2 *Operation*

We see the basic setup for the A-B toll method in Figure 9.

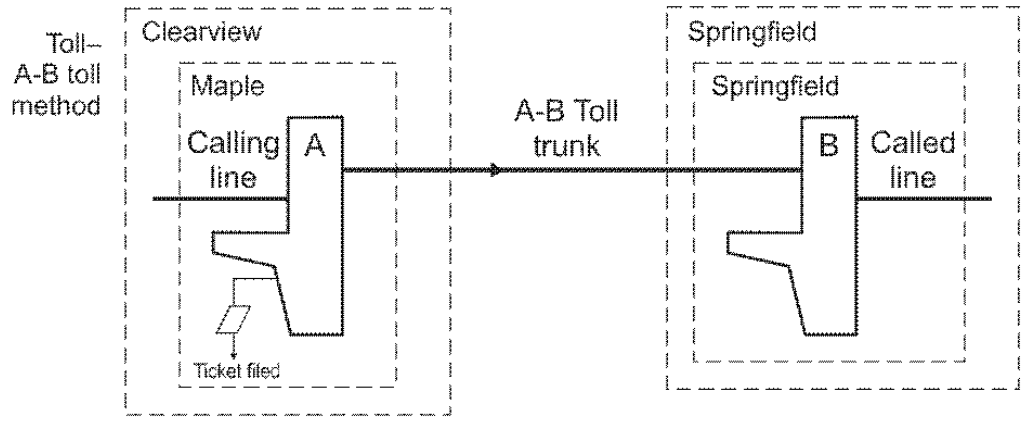


**Figure 9. Toll call via the *A-B toll* operating method**

Well, it certainly looks simple!

Here our caller, again in the Clearview Maple office, now wants to make a toll call to the fairly-nearby town of Springfield. We assume that, as is often the case for this situation, Springfield is a small city and has only a single central office (which would therefore itself be called "Springfield").

Here, as before, the caller takes the telephone off hook, and an "A" operator answers. The caller has learned (perhaps from calling instructions in the directory) that a "station to station" toll call to Springfield should be placed through the local operator (rather than through "Long Distance").

He gives the wanted city (Springfield) and number to the "A" operator. She extends the connection over an *A-B toll trunk* to the "B" switchboard at the Springfield office.

Recall that this "B" switchboard is a switchboard that primarily is used to complete local calls to numbers in the Springfield office (as we saw for the Springfield Locust office in Figure 2), but also is used to complete toll calls to that office, and here it does the latter (perhaps only certain positions are set up for, and even only used for, that).

Just as for a local call, the Clearview Maple "A" operator passes the wanted number to the Springfield "B" operator. She completes the connection to the wanted line, and ringing is applied.

At the outset, the "A" operator starts a toll ticket for this call. When the connection is answered (which she sees by a the front cord supervisory lamp on the cord circuit used for this call going dark), she notes the time on the ticket. When the parties disconnect (the front cord supervisory lamp lighting), she notes that time on the ticket, and sends it on to be used for billing the call.

Except for the matter of the toll ticket, the duties of he "A" operator here are essentially the same as on a local call. And the experience seems just like that to the caller.

We can of course now easily see the rationale for calling this the "A-B toll" operating method[5]. The connection is between an "A" switchboard and a "B" switchboard (both being "local" switchboards), no "toll" switchboards being involved.

### 5.6.3 *Why the limitation to "station to station" calls?*

Why that limitation to only station-to-station calls via this operating method? In the case of person-to-person calls, there are often a lot of "gymnastics" involved. Performing some of these would involve technical complications in the system equipment and switchboards, which would defeat the purpose of the A-B toll method. And in any case, it was not seen as desirable to have to train all the "A" operator in the myriad intricacies of handling such calls.

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[5] It is sometime referred to as the "AB toll" (no hyphen) operating method. It is also sometimes referred to as the "A-board" operating method

In some cases, the “person-to-person” option is just not offered (in any way) for calls to such fairly-nearby cities. There may have been little justification for it, given that the rates for such calls were quite low. And the “A” operator would advise the caller of that situation.

But where those calls are offered, but via the regular “Long Distance” service, the “A” operator might say, “You will have to place that call through Long Distance. I will connect you” (that is, to a “regular” outward toll operator). The rest of the scenario would be as earlier described for the CLR method of operation.

## 5.7 What happened to “toll worthiness”?

### 5.7.1 *Introduction*

In the operation of the A-B toll operating method with manual local service, the connection through a cord circuit at the “A” switchboard was with the regular type of cord circuit, not of the “toll worthy” type.

But, especially with the limitation of the distance to the destination office in force for calls to be handled by this method, the need for the connection to the calling line to have “optimal” transmission performance (which we look to a “toll worthy” connection to give) was not seen as vital.

The other main attribute of the “toll worthy” connection, that it supported ringing back to the calling line, by the toll operator through the local switchboard, was not an issue here. The local operator (who was the “toll operator” in this method of operation) could do that, if necessary, with the regular cord circuit involved in the connection (just as for a local call.

And in any case, with the usual limitations as to the type of calls that were handled with this method, it would rarely be necessary for the operator to ring back th calling line.

At the called end, at a “B” switchboard position, the transmission circuit is associated with that end of the trunk. Accordingly, for an A-B toll connection, the transmission circuit at the end of the A-B toll trunk was made inherently “toll worthy”. Thus there is no transmission compromise at that end of the connection from the use of the A-B toll method.

## 5.8 A separate service

In certain cities, at certain times, the telephone company for various reasons characterized what we now call “station-to-station” toll calls to fairly-nearby cities (handled by the A-B toll method) as a separate service, distinct from the “Long Distance” service.

The lower cost of using the A-B toll method (compared to one of what I call the "regular" toll operating methods) allowed calls handled this way to have lower rates than the "regular" long distance rates for station-to-station calls to such cities.

At the time, the terms "station-to-station" and "person-to-person" had not been generally adopted for those two "options" for a toll call. Rather, "station-to-station" calls were variously described as "particular number", "number", "number-to-number", or "two-number" calls. Person-to-person calls were variously described as "particular person" or "person" calls [6]

In some cases where the telephone company chose to characterize the handing of station-to-station calls to relatively-nearby cities as a distinct service, they chose to speak of that (in directory notices and such) as their "Two Number" service.

Thus., for this "service", "two-number" indeed indicated what we today would call "station-to-station", yet in this case it had a significance well beyond that: that the calls would be handled by what we know as the A-B toll method.

Although this distinct service only provided "two number" calls, it was not necessarily the only service that provided for such calls; they might also have been provided under the "Long Distance" service (but there maybe under a different synonym).

To the student of telephone operation (perhaps a reader of this article), the name "two-number" of course sounds like the name of a toll method of operation (one described above). But in fact the two uses of the term are not at all related. In fact, as mentioned previously, the method apparently used for the "Two Number" service is the "A-B toll" method, which is about as distinct as can be from the "two-number" method.

It is interesting that at least one telephone company, wishing to characterize their program of handling such calls as a separate service, met the technical nitty-gritty head on and called it the "A-B Toll Service". While that is nicely clear to, for example, readers of this article, it was probably completely mystifying to the telephone customers of the time.

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[6] Do not expect all of these (even "station to station" or "person to person") to make sense semantically.

### 5.9 For more information

The A-B toll operating method is described in greater detail in the article "The 'A-B toll' method of handling manual long distance calls", by this same author. It is probably available where you got this.

## 6 HISTORICAL TRENDS

Figure 10 is a chart from a special supplement to the Bell System Technical journal for May-June, 1936, "Technical Developments Underlying the Toll Services of the Bell System". It shows the relative usage of these four toll operating methods over the period from 1915 to 1934.

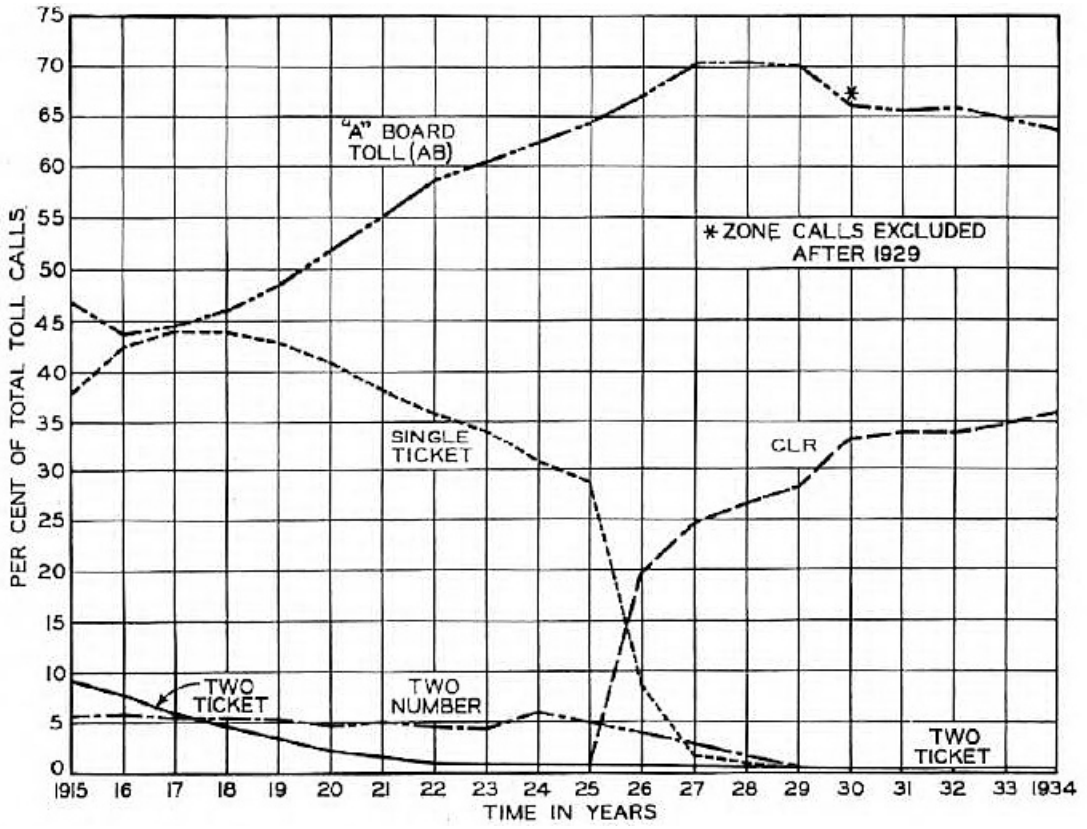


**Figure 10. Distribution of use of toll operating methods**

We see that by 1915 most of the toll calls were handled by either the single ticket method or the A-B toll method (labeled here as "A" board toll). The A-B toll method was by then the "go to" method for station-to-station toll calls to relatively-nearby cities (and a lot of the toll calls were of that kind). The single-ticket method was the "go to" method for the rest of the toll traffic. The two-number and two-ticket methods were also-rans by that time.

During the 1920s, the amount of toll traffic to fairly-nearby cities increased, with much of it being handled by the *A-B toll* method, thus the progressive increase in its proportional standing..

The highly efficient CLR method came into general use for toll calls not best suited to the A-B toll method, starting in 1925, and as it was implemented widely it essentially took over from the single ticket method. Two-number operation essentially disappeared, but, for some reason, two-ticket operation lingered on for a small fraction of the calls.

## 7 LOCAL SERVICE MECHANIZATION

The discussion of the four toll operating methods given above is predicated on manual switching of local calls.

As mechanized ("dial") operation for local calls came progressively into use, all of these toll operation methods were adapted to that context. I will not discuss the details of that here. But, in synopsis, first for all operating methods other than "A-B toll":

- When a subscriber wished to make toll call, he would dial 110 (if served by a step-by-step switching system) or 211 (if served by a common-control switching system, such as panel dial or crossbar) to reach the toll operator.

- These switching systems were arranged so that this connection was made on a "trunk", rather than "line", basis, and thus it was possible to make these connections inherently "toll worthy". Thus for a toll call that was not delayed in completion, for any of the these operating methods, the outward toll operator would not have to subsequently set up the "toll worthy" connection from the calling line.

For calls to be handled by the A-B toll method, the caller would dial "0" to reach the "local operator". That was actually what was formally called the "DSA switchboard" [7]. She would then handle the call essentially as described earlier for the local switchboard operator. The connection to the DSA switchboard was inherently "toll worthy", so it could without any compromise remain as a part of the ultimate toll connection.

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[7] The original formal name of this switchboard was the "dial system A" switchboard, from which that abbreviation came. It was so-called because it was the closest thing to a "A" switchboard that a dial office had, and its operator provided many of the supporting services which were done, in a manual office, by the A operator. Later, when that historical connection to a real "A" switchboard had faded, the formal name was changed to the "dial service assistance" switchboard (still, conveniently enough, abbreviated "DSA").

## 8 OPERATOR DIALING

The discussion of the toll operating methods above is predicated on manual switching of toll calls, which might in fact involve switchboards at one or more intermediate points in the route.

But starting in the late 1930s, the Bell Telephone system began to introduce dial switching into the toll network, this all implemented using the "step-by-step" type of switching equipment. The scheme revolved around arbitrary codes that would be dialed by the outward toll operator, in sequence, to direct the switching from office to office over the entire route, and perhaps even (by concluding the sequence with the wanted party's local number) directly to the called line. This was often spoken of as the "intertoll dialing" system.

Nonetheless, from the standpoint of the caller, this all worked like the CLR operating method with wholly-manual switching, and the outward toll switchboards were indeed considered (quite properly) "CLR switchboards".

Staring in about 1947, the Bell Telephone System began an ambitious program described as "operator toll dialing" [8]. Its premise was that the outward toll operator, having received the destination city and number from the caller (or having determined it from some sort of directory assistance desk) would key into a new kind of "intelligent" switching machine the called number, prefixed in most case by a *numbering plan area* (NPA) code (what came to be known later to civilians as an "area code").

The detailed route to be followed would be determined "on the fly" from "tables" in the switching machines, pursuant to a clever overall plan. The plan involved an "alternate routing" concept that was followed by the switching machines. That aspect provided for an economic optimization of calls routing as traffic varied, and in addition overcame the possible failure of, say, all toll trunks between two points in the network.

From the standpoint of the caller, this all worked like the CLR operating method with wholly-manual switching.

## 9 DIRECT DISTANCE DIALING

Under the Direct Distance Dialing system, users could directly dial toll calls. In this paradigm, the toll operating methods discussed in this article were not at all applicable.

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[8] Yes of course this was "intertoll dialing", but it got a new name.

When operators were involved (as for “person-to-person” or “collect” calls), or if the calling number could not be automatically discerned by the originating local office, an operator was brought into the picture by an early switching machine in the chain, and they generally operated at what we would today call “consoles”, not having any cords nor jackfields; all the actual “connections” were made by the switching machine, responding to numbers entered into the machines from “keypads” on the consoles (if the call was not caller-dialed).

## 10 APPENDIX

Appendix A discusses at some length the matter of the properties that would be expected of what I call a “toll worthy” connection with the calling (and called) lines.

## 11 ACKNOWLEDGEMENT

Many thanks to my colleague John Haralson for bringing to my attention the practice of considering short-distance person-to-person toll calls handled by the A-B toll operating method as a service separate from the “Long Distance” service, as discussed in Section 5.8.

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# Appendix A
# About "toll-worthy" connections

## A.1 INTRODUCTION

In the descriptions in the body of this article of several toll operating methods, I called attention to the fact that the initial connection between the calling line and the "outward" toll switchboard, made though the local "A" switchboard in the usual way, was not wholly suitable to become a link in the completed toll connection, as it was not what I called "toll worthy" (my term and not one likely found elsewhere in the literature). In this appendix I will expand on that matter

## A.2 TWO ISSUES

At issue in this matter are mainly these two considerations, which I will here just list by a short name:

- Talking battery
- Ring back

I will discuss each in the sections to follow

## A.3 TALKING BATTERY

### A.3.1 The transmitter

Until relatively modern times, the transmitter ("microphone") of a telephone set was almost always of the carbon variable-resistance type. In it, the diaphragm that responded to the acoustic signal, as it moved, changed the resistance of the transmitter.

If we then run a nominally constant DC current through the transmitter, the voltage across the chamber would vary with the instantaneous acoustic pressure on the diaphragm. The AC component of that voltage would then be the "speech signal" that would be sent from the telephone.

### A.3.2 Energizing the transmitter

In the earliest widely-used telephones, this DC current (said to "energize" the transmitter) was propelled by a battery of two or three "dry cells" located in a compartment at the bottom of the telephone (these telephones were almost uniformly of the wall type). There were the large type of cell later known in general usage as the "Number 6" dry cell, each about the size of a small bottle of milk.

As an aside, note that on the lines used with this type of telephone there was no DC voltage or current.

There were a number of disadvantages of this scheme, not the least of which was that these cells had to be replaced from time to time (these were not rechargeable cells).

As the telephone “business” took shape, most telephone companies adopted the view that only they could provide the telephone set, which would remain their property. The subscriber was entitled to its use by the monthly charge he paid for telephone service. In turn, the telephone company was responsible for the maintenance of the telephone.

And that of course included the replacement when required, of these dry cells, which turned out to be a gigantic pain. (A fabulous oil painting that at one time hung in one of the conference rooms of AT&T headquarters in New York City showed a horsedrawn wagon filled with hundreds of these cells.)

### A.3.3 Common battery operation

An important development in telephone technology was “common--battery operation” (originally called the "central energy” system). In this system, a DC voltage was applied to each line at the central office. When the telephone was “off hook” (active), there was a DC path through the telephone and so current flowed in the line.

This current “energized” the transmitter in the telephone. The central officer equipment noted with relays whether current was flowing in the line or not.

There were two important advantages to this arrangement:

a. There was no longer a need to have the bulky dry cell battery in the telephone, and thus, even more importantly, there was no longer need to replace those cells periodically.

b. By noting whether current flowed in the line or not, the central office equipment could ascertain the on-hook vs. off-hook status of the telephone, which greatly assisted in the working of efficient switching schemes.

### A.3.4 The line current as “talking battery”

Given that an important function of the DC current in the line was to energize the transmitter in the telephone, it became common (at least in certain contexts) to speak of the DC line current as “talking battery”.

### A.3.5 Talking battery supply schemes

In discussing the working of local telephone switching, I pointed out that in, for example., a completed intraoffice connection, the DC

current was supplied to both the two connected lines by the switchboard cord circuit.

This normally consisted oft taking the central office battery voltage (normally nominally 24 V in manual switchboard systems) and supplying it to the two line conductors through fixed resistances, typically the resistance of two halves of one winding of the coupling repeat coil (transformer), this perhaps amounting to 400 ohms altogether.

Of course, added to the circuit current equation was the resistance of the line itself, which might range from essentially zero (for a station located adjacent to the serving central office) to perhaps 1500 ohms (for a line that was, from a resistance standpoint, the longest that would be used). In addition, there was the effective DC resistance of the telephone set itself (perhaps on the order of 200 ohms).

Thus, the current in the line might vary from about 11 mA to about 40 mA.

### A.3.6 Effect on transmission

What we might call the "conversion factor" of a telephone transmitter (the amount of output signal power for a given strength of the incident acoustic signal) depends greatly on the excitation current (and thus, in common-battery operation, on the current in the line).

Thus, for the range of local calls that might occur, there would be a wide range of end to end "transmitter to receiver" acoustic attenuation, this being pricipally influenced by:

a. The line current in the "sending" telephone.

b. The actual attenuations in the two telephone lines.

c. The attenuation in the interoffice trunk, if one is involved.

d. The properties of the transmitter and receiver of the two telephone sets, which would vary between types of telephone.

Nonetheless, for local calls, the resulting large range of acoustic-to-acoustic attenuation was acceptable, in part owing to the wondrous ability of the human hearing system to deal with acoustic signals on the ear with an enormous range of powers.

But when we get into the toll network (as it existed in the era of interest here), various factors led to the attenuation between the two serving central offices often being much greater than for a local call. As a result, we could not be as sanguine about the various other factors involved.

Some of these could not practically be improved upon, such as the attenuation of the subscribers' telephone lines themselves. But one that could be optimized was the current of the "talking battery". If, on a toll connection, this could be assuredly made a fairly uniform value, and in fact perhaps greater than was ever encountered in a local call, then this could confer an overall improvement in the transmission situation for toll calls.

Thus, in the parts of a toll connection that fed talking battery to the to lines, arrangements were made to that end. These included:

a. Using a 48 V supply rather than a 24 V supply, to feed the battery feed circuits.

b. Making the feed paths (for example, the windings of a repeat coil) have a lower resistance.

c. Providing for a current regulator in the feed path, this often being a special kind of filament lamp, whose operating current would be fairly constant over a wide range of voltage drops across the lamp.

Thus we would have a more uniform current over the range of subscriber line resistances, with that current perhaps being greater than the current on a local connection with even the shortest subscribe lines.

Battery feed arrangements of this sort were spoken of as providing "toll grade battery", one aspect of what I call a "toll worthy" connection.

### A.4 RING BACK

In most of the toll operating methods described in the body of this article, at many times and for many reasons it would be necessary for the outward toll operator to be able to "ring back" on the calling line. Two notable such cases are:

a. Because of congestion in the toll network, the outward toll operator might not be able immediately to complete the connection to the called line. If the prospect was that she would, however, be able to do so fairly soon, it was desirable to "keep the calling party on the line", and ring that line when it looked as if a connection could in fact me made.

b. Perhaps the calling party had been asked to be advised of what the actual charge would be made for a toll call. When the call ended, and the disconnect time had been noted on the toll ticket, the outward toll operator could. in various ways, reckon the charge to me made (but this might take a minute or so). In this situation, the toll operator might "keep up" the connection from the calling line,

and “ring back” on that line when she wqs ready to advised of the charges.

Now of course in a local call, if the operator (or “A” operator) wanted to “ring back” the calling party after the end of the call, she can easily do that by operating the ringing key for the back cord of the cord circuit involved.

But if a connection had been made through the local switchboard to the toll switchboard, and that connection remained in place as the first link in the overall toll connection, there is no way the toll operator can, through the cord circuit at the local switchboard, ring the calling line.

Thus, in the replacement connection between the calling line and the toll switchboard that we saw in several of the illustrations, there were provisions for the toll operator to send a signal to the equipment that would cause it to ring the calling line.

And this was another important property of what I call the “toll worthy” connection that was put in place as the first link of the completed overall toll connection.

## A.5 AT THE CALLED LINE END

How does this all get taken care of at the called line end of the toll connection?

That part of the connection is only made through links that are solely used for toll calls (such as a trunk from the inward toll switchboard to the “B” board serving the calling line). Thus they can be made inherently “toll worthy”. In this case, that mostly includes the following:

a. The talking battery feed is “toll grade” (as discussed above).

b. In some scenarios, there is the possible need for the outward toll operator to “re ring” the called line after the call ends. These links had provision for a signal from the outward operator that caused the equipment at the far end to again apply the ringing signal to the line.

c. In some scenarios, it is desirable for the outward toll operator, having completed the connection to the called line, to delay ringing on it. (Perhaps this connection has been “delayed”, and it is appropriate to get the caller back on the line before disturbing the called line’s household.) These links had provisions for waiting for a signal from the outward toll switchboard before ringing the called line.

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