Message registers in telephone switching systems

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ABSTRACT

For many years, telephone companies in many cities offered subscribers a service plan called *message rate service*. Under this plan, the subscriber paid a monthly charge for basic local telephone service, which included the ability to make (each month) a certain number of local calls (perhaps 50 or 75). Calls beyond that quota were charged for at perhaps $0.05 each.

In elctromechanical telephone switching systems, the completed local calls made by each subscriber having this type of service were counted by elctromechanical counters called *message registers*. A number of ingenious circuit schemes were used to operate these, a matter that was complicated by the common use of 2-party lines, where two subscribers' telephones were connected in parallel to a single pair of conductors to the central office.

This article describes in fair technical detail these ingenious circuit schemes. Illustrative schematic circuits are shown, often simplified to best meet the needs of the discussion.

1 GENERAL

1.1 The context

The specify technical details I will discuss here pertain to the practices in the Bell Telephone System. Many of these apply (perhaps with minor differences) to the practices of non-Bell telephone companies, but in some cases the practices differed significantly between the two "worlds".

1.2 About the reader

I assume here that the reader has a general familiarity with the operation of telephones and telephone switching systems. Readers without that background who wish to become more informed about these matters may wish to look into other technical articles by the same author, probably available where you got this.

Nonetheless, here I will try and give here in concise form much of the critical background for the various topics.

2 "FLAT RATE" AND "MESSAGE RATE" SERVICE

For many years, telephone companies in many cities offered subscribers two "service plans". In one, called *flat rate* service, the subscriber paid a monthly charge for telephone service, and was entitled to make any number of "local" telephone calls without additional charge.

In the second plan, called *message rate* service, the subscriber paid a smaller basic monthly charge for telephone service, and was entitled to make a certain number of "local" telephone calls in any month (perhaps 50 or 75) without additional charge. Calls beyond that quota were charged for at perhaps $0.05 each.

In either case, incoming calls had no cost impact. Outgoing long distance ("toll") calls were charged *à la carte*.

In an era in which the typical residential telephone subscriber only infrequently used the telephone, the message rate plans offered a worthwhile cost saving. The introduction of this mode is considered to have been a major factor in the expansion of telephone usage,

3 MESSAGE REGISTERS

3.1 Concept

For each subscriber having message rate service, there was at the central office an electromechanical counter (a *message register*) that advanced one count for each completed local call.

3.2 About "messages"

At one time, in certain contexts, telephone calls were spoken of as "messages". I have no authentic information about the origin of this usage. It may have been (not aptly) carried forth from the arena of the *message telegraph service* (the formal name for what we might call the "telegram" service). In any case, this is the premise for the name *message register*.

3.3 Other uses of the same device

In the Bell Telephone System, the units of which I speak here in fact had Western Electric apparatus codes with the noun part as "message register", for example, "14A message register".

But essentially-identical units of this type (with that same family of apparatus codes) were used in other applications in the telephone system. For example, the operations of some switching system unit might be counted (for traffic analysis purposes), or occasions of failures of a unit to perform properly might be counted for maintenance analysis purposes.. So the moniker "message register" might not be so apt for those registers, but that was still their nomenclature.

But to make it clear, when needed, that we are speaking of, in a general way, the message registers for subscribers having message rate service, they are called “line message registers” (even though, in the case of 2-party lines, they are associated with *stations*, not, *lines*).

From here on in this article, I will only be speaking of line message registers, but for the most part I will omit the “line” and just speak of “message registers”.

3.4 Numbering of the message registers

As we will see shortly, each message register has stamped on it an identifying number. Since in operation each message registers is associated with a certain telephone number (and thus that subscriber’s account) we might expect the number on the message register to be that telephone number.

But for a central office equipped to handle, say, 8000 subscribers), there would have to be 8000 message registers, while at any given time perhaps only 4000 of them would be in use (since not all subscribers would choose message rate service).

Nonetheless, in some central offices, certain blocks of perhaps 1000 numbers were reserved for message rate subscribers. Imagine that for the case mentioned just above, there were 4000 numbers reserved for message rate subscribers. Then, there could quite reasonably be 4000 message registers equipped, and the wiring arrangements permanently associated them with those 4000 telephone numbers, which would be the numbers on the message registers themselves.

But in many cases, the overall telephone number administration plans of the telephone company did not accommodate reserving certain blocks of numbers for message rate subscribers.

To otherwise avoid the hardly-economical need to, in the first example, provide 8000 message registers in an office where it was expected to have at most 4000 message rate subscribers, only 4000 message registers would be installed, and there were “cross-connecting’ faculties on one of the distributing frames whereby an available message register could be associated with any message rate telephone number.

The numbers stamped on the message registers were then arbitrary (but certainly done in sequence).

There are two “costs” of this latter scheme:

- The cross-connecting facilities involved additional terminal blocks on, and enlarged the overall size of, the pertinent distributing frame, and involved considerable additional wiring labor during installation.
- In processing the message register readings, the revenue accounting center needed to translate between the message register numbers (in terms of which the readings are reported) and the corresponding telephone numbers, an easy task once computers entered the picture, but before that very labor-intensive.

3.5 The thing itself

In Figure 1 we see 10 message register of a typical type, mounted on a steel plate by which they are mounted in racks at the central office.

Figure 1. Strip of message registers

Typically there might be 500 registers (50 plates of 10 each) in a single “bay”, with two bays side by side making up a *message register rack* (with 1000 registers).

As we can see in this example, the normal message register had four digit wheels and thus could display numbers from 0000 through 9999, after which the sequence started over from 0000. They were non-resettable. Just as with electric watthour meters or gas or water meters, the count on the register proceeded uninterrupted, and the number of calls for a month was determined as the difference between two monthly readings.

3.6 “Reading” the message registers

In the vary early days of the use of message registers, once a month a clerk (perhaps a squadron of clerks) would read the numbers on all the message registers in the central office, recording the current readings on a sheet on a clipboard.

Before long, it became the practice to capture the readings of the message registers, eventually 100 at a time, with a special camera.

This had a rectangular hood whose "mouth" would embrace a block of 100 registers and capture the image on a frame of 35-mm film, and which contained an electronic flash unit to illuminate the "subjects".

Then, at the accounting center, a clerk would read the processed film in a microfilm viewer and transcribe the entries onto a paper form, or later key-punch the readings onto a tabulating card, or later yet enter them into a computer via the keyboard on a data terminal.

3.7 "Scoring"

In technical discussions of message registers, the action of causing a message register to advance by one count is often spoken of as "scoring" the register. I will use that term here from time to time.

4 TWO-PARTY LINES

A popular type of residential telephone service for many years, in metropolitan areas, was the 2-party line. Here, two subscribers' telephones were connected to the same pair of conductors from their neighborhood to the central office, where they terminated in a single "port" on the originating end of the switching system. Ordinarily, the two "parties" has independently separate telephone numbers, which was provided for in different ways by the different switching systems.

Fore our purpose here, what is important is that if subscriber 1 on a certain line took the phone off-hook to place a call, or if subscriber 32 on that line took the phone off-hook to place a call, it looked the same to the central office. And insofar as actually setting up the calls, that was no problem.

But as soon as message rate service comes into the picture, it **is** a problem. Clearly, for a given call, assuming the call is completed (that is, does not reach "busy" or go unanswered), and thus is to be counted for the calling subscriber, the central office needs to know which party is placing the call so that the corresponding message register can be scored.

The solution was very ingenious. At the first party (called the "ring" party, from the name of the line conductor on which the ringing signal for it is sent), the telephone set is "conventional". But at the second party (the "tip" party), a special telephone set (or special wiring) is used. When it is off-hook, it presents a high resistance (and high impedance) path from the line to ground.

When either station on such a line originates a call, at some early stage, some circuitry at the central office tests for the presence of such a high-resistance path to ground. If such is found, a relay remembers that this is the tip party calling. If none is found, the remembrance is that this is the ring party calling.

5 WHEN WAS THE CALL "COUNTED"?

In all local switching systems, when the called line answered, a continuing indication that the called line was now "off hook" was sent rearward over the connection, and this could be observed by the circuitry at the originating (calling) central office for various purposes.

In the earliest days or message rate service, as soon as this "answer supervision" indication was noted, the equipment at the originating office considered the call to have been completed, and it made arrangements, if the calling line had message rate service, for scoring the associated message register. This might actually be done forthwith, or perhaps at the end of the call.

But there were some problems with this. As local telephone networks expanded, and new switching, transmission, and signaling systems came into the picture, it turned out that as a connection was being set up, there might be brief (albeit meaningless) periods of the "off-hook" supervisory signaling state sent rearward (before the call was answered, or even if it was not answered).

The first of these would be (incorrectly) interpreted by the equipment at the originating office as a sign that the call had been answered, and so the message register would be (improperly) scored.

This gremlin was exacerbated as various ways of handling long distance calls came into the picture. One was that if a call reached "busy", the rearward supervisory state was put to the "off-hook" state once per second (for about 0.5 seconds each time).

The intent was that this would flash the "supervisory" lamp on the pertinent cord circuit at an operator's switchboard (if the call had been placed by an operator), telling her that the call had reached busy.[1]

But, on a directly-dialed local call, the first burst of this rearward supervisory signal would be interpreted by the originating office as a sign that the call had been answered, and so again the message register would be (improperly) scored.

To avert this, the pertinent circuits in central office switching systems were modified so that unless and until the rearward supervisory state

[1] She would by that time no longer be listening on this call, having moved on to setting up other calls; thus she could not hear the regular audible "busy signal".

went to “off hook” for a period of about 3 seconds, the call would not be considered answered.

This new behavior was spoken of as the “delayed charge” feature.

6 OPERATION OF THE MESSAGE REGISTERS

6.1 General

In this section we will see the various clever circuit schemes used to actually operate the message registers.

6.2 The circuit schematic drawings

In this section I will present a number of circuit schematic drawings. Parts of these have been simplified from the actual circuits involved, since the objective is to clearly show the ways in which message registers were operated, not to explain the often tedious details of the actual circuits.

In many case, especially in the “interior” portions of the switching systems involved, I have taken the liberty of showing a certain path as being opened or closed by a single relay contact, whereas in fact this action often results from a complicated mesh of relay contacts or even (in the case of the panel dial system) contacts on a motor-driven sequence switch.

These drawings use a circuit convention called the “detached contact schematic system”, developed by Bell Telephone Laboratories in the 1950s. Its major feature (from which it gets its name) is that the coil of a relay and its contacts are not shown adjacent (suggesting the actual unitary physical construction of the relay). Rather, each element is placed on the drawing to most clearly show the circuit paths in which it participates.

Further, the symbols used for the relay coil and its contacts are no longer evocative of the actual physical construction of those elements, but are “symbolic” and much simpler to draw.

For the benefit of the reader who may not have previously been introduced to this convention (or may not recall its particulars), Figure 2 is a concise guide to the system.

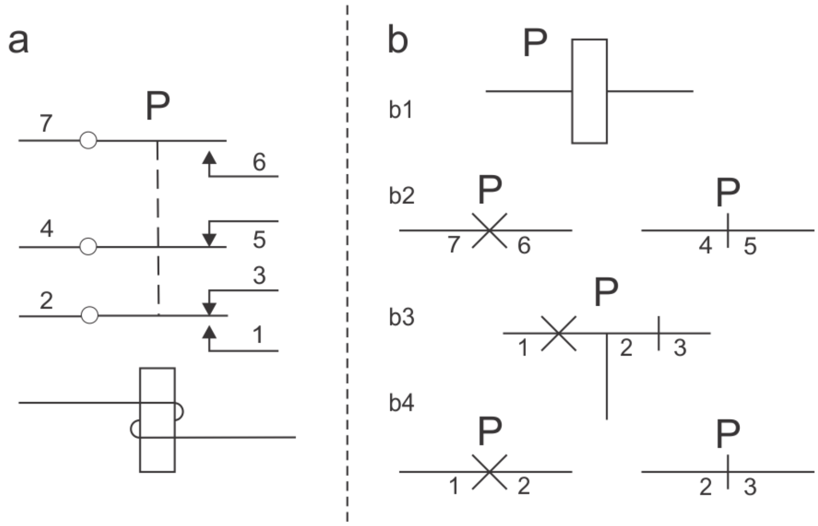

Figure 2. Detached contact schematic system

On the left (panel "a") we see a relay with a single winding coil and three sets of contacts, of the three most common types, drawn in the "traditional" form.[2] The contact springs are identified by number.

On the right (panel "b") we see the elements of that relay as drawn, typically not adjacently, under the newer detached contact system. The relay has a designation ("P" in this example), which is used to identify all its far-flung elements.

Note in particular that the "transfer" contact set comprising contact springs 1, 2, and 3 might be drawn unified (as seen at b3) or with its two portions separated (as suggested at b4) when the latter best suits illustrating the circuit paths in which they participate.

6.3 In the step-by-step switching system

6.3.1 *Introduction*

The step-by-step (SXS) switching system, derived from the Strowger switching system originating outside the Bell System, was used by the Bell System for dial service in small and medium-sized cities (some of which, of course, grew quite large.

For the moment, I will assume that the subscriber lines in involved are individual lines, not 2-party (or possibly even 4-party) lines. Thus, only a single message register had to be associated with a given message-rate line. (I will later look into the situation with respect to 2-party lines.)

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[2] Spoken of, once the "detached contact" system was introduced, as the "attached contact" system.

6.3.2 *Operation of the message register*

Two different basic schemes were used for operation of the message registers in SXS central offices. One is illustrated in Figure 4. The surrounding circuitry has been simplified to only include those aspects of interest to this story.

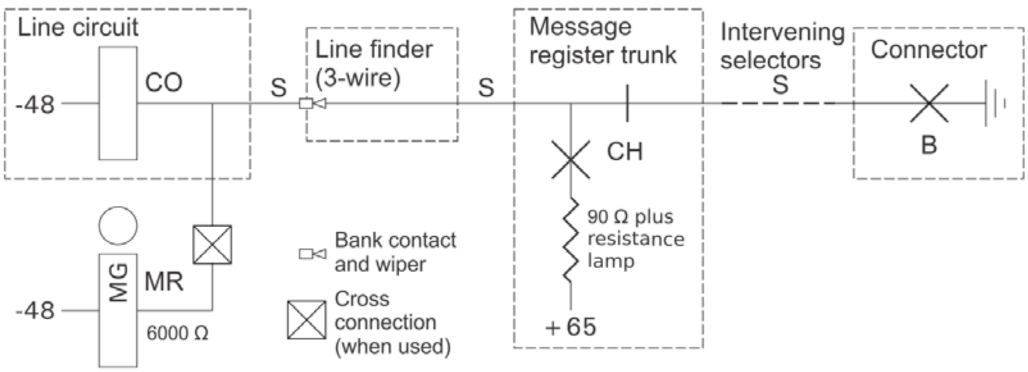

Figure 3. Step-by-step system–operation over the sleeve

I note that here (and in similar drawings to follow), the message register is represented by the detached-contact relay core and winding symbol, with the addition of a circle (evocative of the digit wheels in a message register).

In this scheme, the message resister for a line is operated over the sleeve (S) conductor. It is operated by a *message register trunk*, a circuit interposed between the line finder and the 1st selector for line finders used for message rate lines. It is in a place where for line finders not used for message rate lines there is only a set of wires.

First, a little review of the sleeve (S) lead. In step-by-step, as in most elctromechanical switching systems, its main job is to, when grounded, hold all the switches in the switch train (growing or completed) in their operated state until the call is ended. Additionally, this ground makes the line as "busy", so another call to it will be thwarted .

But in step-by-step it has another job (not shown on the figure). At the banks of the line finders serving this line, with the line idle, the sleeve conductor is open.

When the caller takes the telephone set off-hook, the current that flows in the line operates the L (line) relay in the line's line circuit. For one thing, this causes some common circuitry to start the line finder that is "next up" for this line, and arrange for that line finder to step up to the bank level on which the terminal for this line appears.

The L relay also makes a connection from the CO (cutoff) relay in the line circuit to the sleeve contact on the line finder bank terminal for this line. Since the other end of the CO real coil is connected to battery (-48 V), this in effect puts what we can think of as “resistance battery” on the sleeve contact, a situation that does not obtain for any other line, idle (where this sleeve lead would be open) or in a connection (where it would be grounded.

The line finder looks for this condition on the sleeve contact of each terminal it reaches, and find it on the terminal for this line, stops hunting and extends the line through to the 1st selector that is permanently mated to this line fiber (in our case, through a message register trunk).

The continuity across the line through the off-hook station operates the A relay in the 1st selector (not shown), which operates the B relay in the selector. This grounds the S lead rearward, through the line finder to the line circuit (we do see that in the Figure), where it operates the CO (cutoff) relay. This disconnects the line from the L relay, which has done its job and would just be an impediment to further operation.

The CO relay operated also makes “persistent” the connection from its coil to the S lead so that, after the A relay (which made that connection in the first place), has released, the CR will still be “held operated” to the grounded sleeve conductor.

As the connection proceeds through several selectors, at each stage the S lead rearward is held grounded by the selector B relay. Ultimately, with the connection compelled through the connector switch, the sleeve rearward is grounded by the B relay in the connector. This is the state shown on the figure.

But now back to the matter of the message register.

For this message-rate line, the S conductor is also connected, perhaps though a cross-connection facility, to the coil of the assigned message register the other end of which (as was for the CO relay) is connected to battery.

Accordingly, with the line now actually in a connection, there is a potential of 48 across the winding of that message register.

The message register does not, however, operate on the amount of current that then flows, Since we depend on its not operating with a certain current, and later operating from a certain greater current, it is consider to be a “marginal” device (as signified by the marking “MG” on the symbol for the relay coil).

Now we assume that the connection has been completed For one thing, the rearward ground on the S lead is now provided by the connector (the last switch in an SXS switch train).

Now we further assume that the calling line has answered, The connector returns rearward the off-hook supervisory signaling state and that is noted by the massage register trunk (hopefully delaying its decision for the now-specified 3 seconds of continuous off-hook.

The message resister trunk now scores the message register. It does that by contacts on what I have called the CH ("charge") relay transferring the S lead going rearward from the ground (arriving from the connector, wherever that is) to a local supply of +65 V, provided through a resistor (typically 90 ohms) and, in some cases, a current-limiting resistance lamp..

This means that there is now nominally 108 V (well, less by any drop in the resistance lamp) across the coil of the message resister (and across the coil of the CO relay as well). This causes nothing adverse at the CO relay (other than if it persisted for too long it would dangerously overheat the coil). But the current though the message register coil is now enough to operate the armature of its electromagnet, and a pawl and star wheel mechanism advances the "units" wheel by about half of the step toward the next digit.

After perhaps 300-500 ms, the CH relay in the trunk releases, putting the normal rearward ground on the S lead. The current that now flows through the coil of the message register is not enough to hold the armature operated. The armature releases, and the pawl advances the units wheel fully to the next digit. The "score" has been consummated.

This scheme is sometimes spoken of as "booster battery" operation of the message register.

6.3.3 *Another approach*

Another approach used to operate the message register in an SXS office is seen in Figure 4.

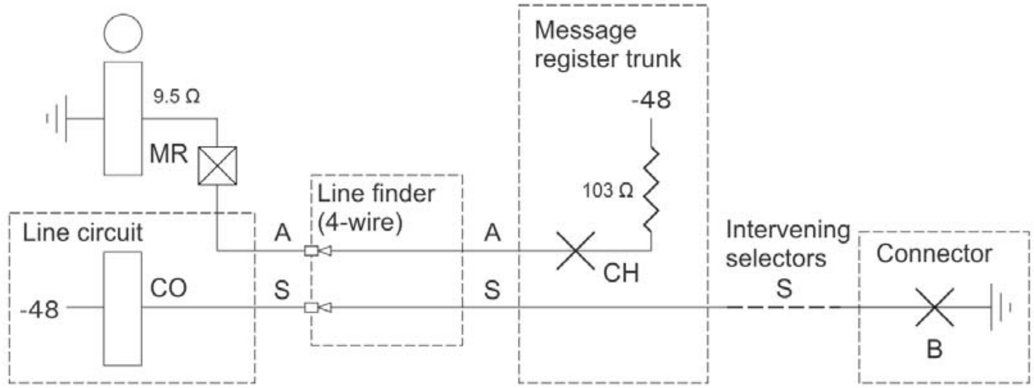

Figure 4. Step-by-step system–operation over a separate lead

Here, the message register is operated over a (new) dedicated le in the line finder bank terminal, often designated A. This of course requires that the line finder wiper and bank system carry 4 leads rather than the 3 usually needed.

Recall that the usual line finder in fact can connect to any of 200 terminals, which it (normally) does by essentially having a 6-wire wiper and bank system, this using three 2-lead banks.

Now we must handle 8 conductors, and thus the bank array must have four 2-lead banks., This of course makes the line finder with its banks taller (and more costly, and of course there are a lot more leads to be connected during installation.

Why here do we not feed the message register coil from battery and just ground the A lead to operate it? And, having decided to operate it by placing battery on the A lead, why is that done through a resistor?

Suppose we in fact connected the bottom of the register coil to battery, and grounded the A lead to operate it. Well, there is a not insignificant chance that the bank A terminal would be inadvertently grounded by a technician making some sort of test. This would unintentionally score the message register, causing an improper charge to the subscriber (*quel horreur*!).

Next suppose that instead we connected the bottom of the register coil to ground, and put battery on the A lead to operate it. But if there were an inadvertent ground on that terminal while this happened, a large current would flow, perhaps blowing a fuse and putting several circuits out of commission, or even in the worst scenario starting a fire.

So instead we use a register with a fairly low-resistance coil, returned to ground, and put resistance battery on the A lead to score the register.

We will see this same philosophy at work in some of the switching systems to be subsequently described. I will not there again call attention to the philosophy of that arrangement.

6.3.4 *With 2-party lines*

I discussed earlier (in Section 4) how the central office can distinguish between the two “parties” that may originate a call over a 2party line. In SXS, this was done my the message register trunk, since (before the advent of Direct Distance Dialing and automatic message accounting) it was only when message registers were in the picture did the central office care.

Now we assume that call has been completed and it is time to score one of two message registers associated with the line.

The most common scheme is illustrated in Figure 5.

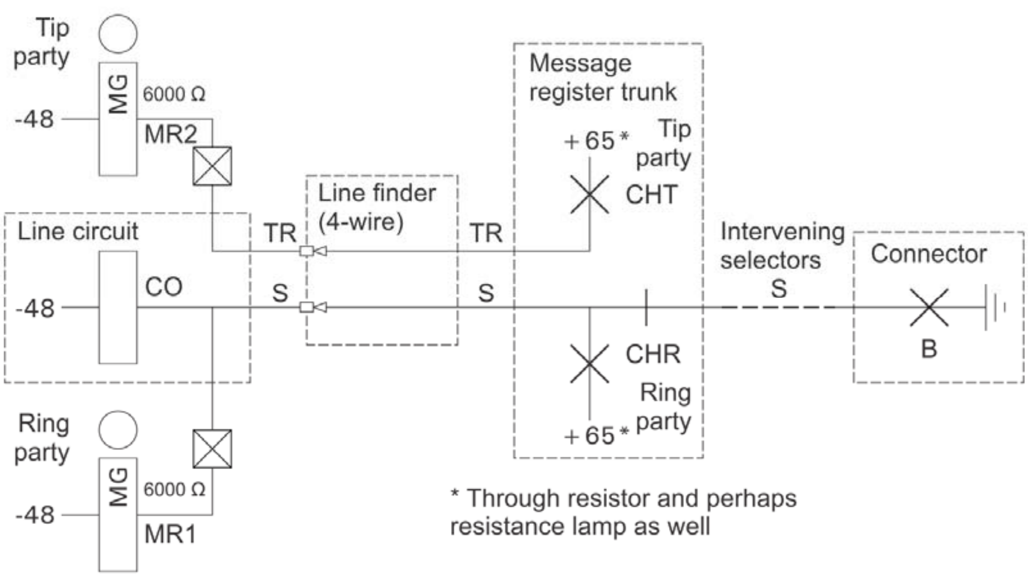

Figure 5. Step-by-step system–2-party message registers

Here, if the call is made by the ring party, its message register (MR1) is operated over the S lead by way of the +65 V “booster” battery, applied by relay CHR (charge ring), just as we saw in Figure 4.

But the message register for the tip party (MR2) is operated over the TR lead. I suspect that the lead designation “TR” is from “tip party message register”.

For consistency between the two message registers, this message register is also operated by way of the +65 V "booster" battery scheme.

6.4 In the panel dial switching system

6.4.1 *Introduction*

The panel dial switching system (to use its original formal name, but later generally just called "panel") was introduced in the 1920s in large cities (most of them in "the North"). Its name came from the fact that the banks for the various switches were made *en mass* as flat panels, across which selector shafts for many switches (perhaps 30 on each side) moved vertically.

We will here immediately consider the situation of a 2-party message rate line.

In Figure 6, we see the common scheme used for operation of message registers in this system. [3]

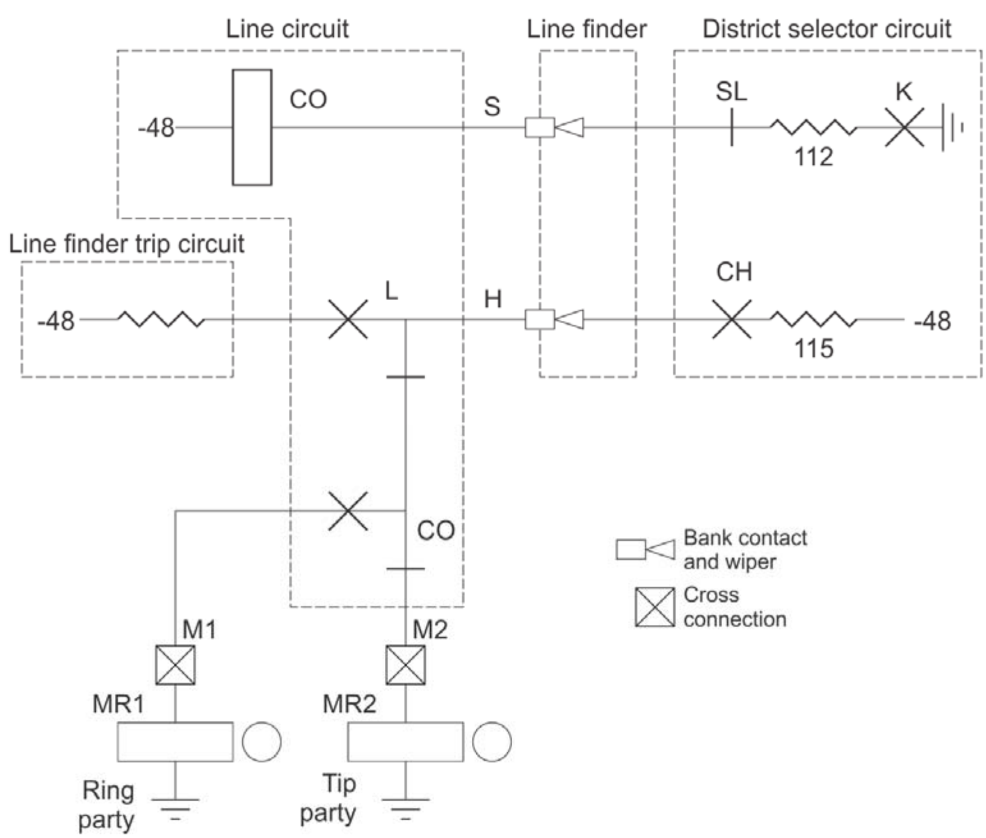

Figure 6. Panel system–2-party message registers

[3] For students of the panel system, I note that the details here are for the later ("BCO") version of the system as contrasted with its earlier ("GCO") version.

6.4.2 *Origination*

As I did for the SXS system, I will start with the origination of the call. Again when the calling station is taken off-hook to originate a call, the current that flows in the subscriber's line operates the L relay in the line's line circuit (that part of the circuit is not shown here, for conciseness).

In the SXS system, the "marking" of the calling line so the line finder could find it was done over the sleeve (S) lead, Here, there is a separate terminal on the line finder banks, H (for "hunt", of course) used principally for that purpose.

When the L relay of a line's line circuit is operated, one contact (not seen here) advises the line finder start circuit that a line served by this group of line finders wants service. A second contact of the L relay (seen here) takes -48 V (battery), which comes from the *line finder trip circuit*, and we can think of is as supplied through a resistor, and connects it to the H lead for this line circuit.

The line finder that is started looks for battery on the H contact of each line terminal it passes and when it finds that for this line it stops hunting and connects to the line.

Note that each line finder is permanently paired with a district selector (that being the first stage of the selection system), and in fact most of the "brains" of the line finder are actually in the district selector circuit.

In the district selector, a contact path established by a sequence switch (shown here as if a contact on a relay arbitrarily designated K) grounds the S (sleeve) lead rearward (through a resistor, the reason for which is not of concern to this story). Just as in SXS, this operates the CO relay in the line circuit, with essentially the same result as in the SXS system.

6.4.3 *Party test*

During the early part of the call, the district selector circuit, aware that the calling line is message rate, makes the test to determine which party has come off hook to originate this call. That finding is remembered buy a relay in th district circuit.

6.4.4 *Completion of the call*

When the connection is completed and the calling line has been rung and is answered, as discussed before in connection with the SXS system an off-hook supervisory status signal is sent rearward and is note by a relay in the district circuit and remembered.

At the end of the connection (this differing from the timing in SXS), the district selector circuit scores the appropriate message register.

The signal to operate either message register is given by repurposing the H lead. At the line circuit, the L relay is now released, and its contact seen here redirects the H lead to the message register part of the line circuit.

When the district selector circuit scores either one of the message registers, its CH (“charge”) contact closes, applying battery (-48 V), supplied through a resistor, to the H lead. This will operate one of the message registers, but which one?

In the district selector circuit, if the party test showed that it was party 1 (the “ring” party) that was placing the call, the SL relay does not operate at this time.

The district selector has not yet released the line finder and the calling line, and thus the CO relay is still operated there. A contact on the CO relay sends the signal arriving on the H lead to the coil of the ring party’s message register (MR1), thus scoring it.

On the other hand, if the party test showed that it was party 1 (the ”ring” party) that was placing the call, SL will be operated at this time. This removes the ground on the S lead, and the CO relay in the line circuit releases.

Now, the contact on the CO relay sends the signal arriving on the H lead to the coil of the tip party’s message register (MR2), thus scoring it.

6.4.5 *For individual message-rate lines*

In the case of individual (single-party) message rate lines, a degenerate form of this system is used. There is only one message register associated with the line, but it is operated by the same electrical signal over the H lead. The contact of the CO relay used, in 2-party service, to control which message register is scored is not present.

6.5 In the No. 1 crossbar system

6.5.1 *Introduction*

The No. 1 crossbar switching system introduced in about 1939, essentially superseded the panel system. It used a wholly different apparatus for completing connections.

6.5.2 *Operation of the message registers*

The circuit arrangement used is illustrated, in simplified form, in Figure 7.

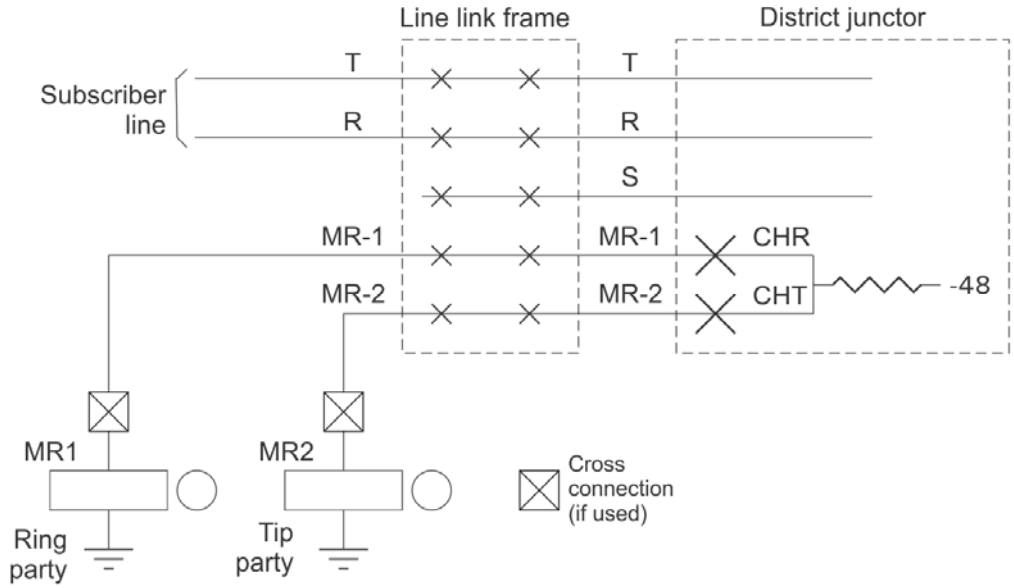

Figure 7. No. 1 crossbar–2-party message registers

Operation of the message registers is in the hands of the *district junctor circuit*, sort of an internal trunk circuit partway through the originating portion of the switch train.

In the switch train up to that point, there are five leads carried and switched, beginning with the tip (T) and ring (R), which carry the telephone line itself, and the sleeve (S) lead, whose main job is to hold the various switches in their operated state until released at the end of the call (not shown here). But there are two further leads (a total of 5), designated MR-1 and MR-2. Their sole jobs are to operate the two message resisters, which is done in a very straightforward manner.

One end of the two message registers' coils are connected directly to the respective MR- lead, and the other ends go to ground.

In the case of a completed call, the district junctor circuit (again now at the end of the call), by the operation of one of the relays I have here called CHR (charge, ring party) and CHT (charge, tip party) applies battery (-48 V), supplied though a resistor, to the proper MR- lead, operating the appropriate message register.

A disadvantage of this scheme was that the crossbar switches in the earliest stages of the switch train had to have 5-lead contact sets, which made the switches more costly, in fact made them able to have fewer crosspoints in the standard physical size, and of course led to more labor in wiring the switch frames in manufacture and in connecting them during installation.

Hold that thought.

6.5.3 *For individual message-rate lines*

In the case of individual (single-party) message rate lines, a degenerate form of this system is used. There is only one message register associated with the line, which is operated over the M1 lead. The M2 lead is not used.

6.6 In the No. 5 crossbar system

6.6.1 *Introduction*

The No. 5 crossbar switching system introduced in about 1950, Used the same kind of switch used in the No. 1 crossbar system,. but within a different architecture, it was economical to use in smaller offices than would justify the use of No. 1 crossbar, and in fact eventfully came to displace No. 1 crossbar as the “workhorse” switching system in large cities.

6.6.2 *Operation of the message registers*

The designers of the No. 5 crossbar system were haunted by, in the No. 1 crossbar system, the need to carry two extra leads through much of the switch train to operate the message registers (including for 2-party lines).

The result was an entirely new and ingenious approach that could operate two different message registers over the S conductor of a three-lead switch train.

A key player on this scenario is the *trunk circuit*, which, in a completed intra-office call, provided talking battery to both stations, provided and administered ringing to the called line, managed the connection so as to release it when appropriate, and, in the case of a call from a message rate line, scored the proper message register at th end of the call.

The system depends on the use of four special waveforms, generated in the common power equipment of the office, We see them In Figure 8 (the designations are mine)

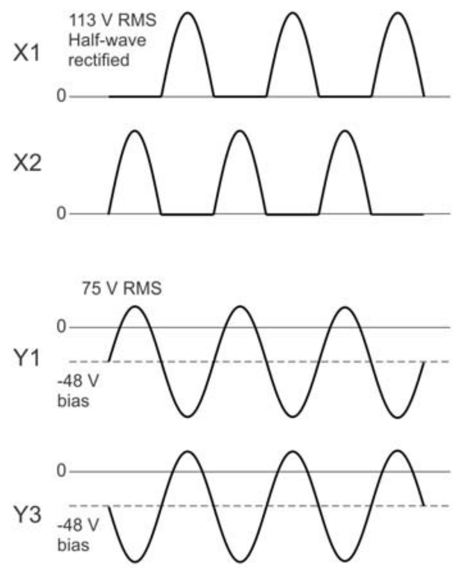

Figure 8. No. 5 crossbar–message register control waveforms

Figure 9 shows in simplified form the operating scheme.

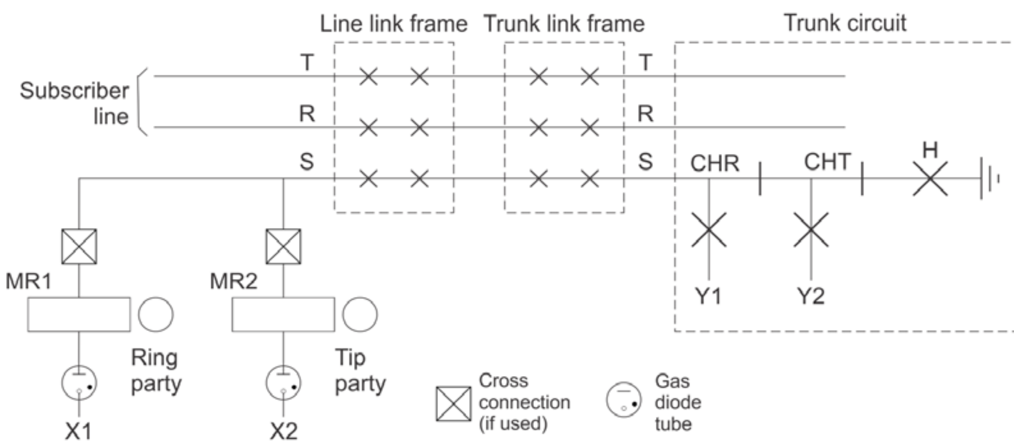

Figure 9. No. 5 crossbar–message register control waveforms

The operation of the message registers is in the hands of the trunk circuit, which among other things proves talking battery to the calling line (not shown here).

The message registers for a line have the “top” of their coils connected to the S lead of the associated line.

All the “ring party” message registers have the “bottom” of their coils connected though a gas diode tube to a bus carrying waveform X1 as seen in figure 8. All the “ring party” message registers have the “bottom” of their coils connected though a gas diode tube to a bus carrying waveform X2 as seen in figure 8.

When it is time to score one or the other message registers on the calling line, relay CHR (charge ring party) or relay CHT (charge, tip party) the trunk circuit briefly takes the rearward sleeve (S) lead from ground (where it has been kept, by contact H, to hold all the switches in their operated state) and connects to a bus carrying waveform Y1 or Y2, as seen in figure 8, respectively.

Suppose that the call has been made by the ring party and thus charge relay CHR is operated. The coil of the ring party message resister (MR1) is now connected between waveforms Y1 and X1. That net voltage has a peak great enough to cause the gas tube for that register to "fire", allowing a pulse of current to flow though the register coil. This recurs for each cycle of the waveforms, and the register operates.

These message registers have a copper sleeve over the core to make them "slow-release" so the armatures do not follow the individual pulses but remain operated until shortly after the pulse series has ended.

But the message register for the tip party on this line (MR2) is now connected between waveforms Y1 and X2. That net voltage does not have a peak great enough to cause the gas tube for that register to "fire". Thus no current flows though the coil of that register.

If the call had been made by the tip party, exactly the opposite would take place. The result would be that the tip party message register, MR2, would operate and the ring party register (MR1) would not.

6.6.3 *For individual message-rate lines*

In the case of individual (single-party) message rate lines, a degenerate form of this system is used. There is only one message register associated with the line, but it is operated by the same electrical scheme over the S lead.

7 ZONE REGISTRATION

This matter does not directly affect the various message register operating schemes I have discussed above, but is tangentially related, so I will discuss it briefly in the interest of completion.

In some large metropolitan area, calls from one area to a distant one were still classified as local calls, rather than "long distance" ("toll") calls.

But for message rate subscribers, there were extra costs associated with such calls. For one thing, for a call of any duration, the message register was scored more than once.

In addition, in some cases, if the call lasted longer than some predetermined time (perhaps 5 minutes), the message register would be scored again (once or perhaps several times), and this would recur for each further such increment of time the call lasted.

Especially when this mode was in use, the “counts” of a message register were sometimes described as “message units”.

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