

## INTRODUCTION

At one time in the evolution of the SXS system, local and toll calls were terminated to the called station through two entirely separate, and technically different, switch trains.

The need for a separate train for toll calls (at its terminating end) came from these properties of the "regular" connector:

### 1. The transmission circuit

The transmission circuit of a regular connector feeds talking battery to the called station (and to the calling station as well if this is an intra-office call), and couples the originating and terminating circuits for the transmission of speech (AC) signals.

The circuit is clever and economical. A relay with two windings feeds battery and ground ("talking battery") to the called station, and a second two-winding relay feeds talking battery "upstream" (to the calling station if this is an intra-office call). Two capacitors then couple the AC speech signals between the two sides of the connector.

But there are two properties of this arrangement that initially disqualified the regular connector from being the vehicle for delivery of a toll call:

a. There was a non-trivial loss to speech signals passing in either direction through this transmission circuit (perhaps 1.5 dB, not sounding like much, but at one time every extra dB of loss further deteriorated the overall transmission experience of the talkers.

b. The resistance of the battery feed relays was chosen so that on the shortest (low-resistance) loops, the loop current would be the most that could be safely tolerated by the transmitter circuits of the telephone sets. That meant that on the longer loops, with much higher resistance, the loop current would be much lower. The transmitter circuits in the telephone sets were of course energized by the loop current. So for a longer loops, where because of its greater loss, we would like the telephone set to put out as much electrical signal as possible from a given speech volume, the lower loop current made the transmitters less effective.

### 2. Flashing busy

In a regular connector, if the called station's line is busy, busy tone (*low tone* interrupted at 60 times a minute) is returned to the caller.

But in toll operation, it is desirable in the case of a busy situation to return flashing supervision—the rearward supervisor state (which would be put into a steady off hook state when the called station answered) was cycled between the off-hook and on-hook states 60 times a minute.

This resulted in the called party supervisory lamp of the outgoing toll operator;'s cord circuit flashing, which alerts her to the busy condition without requiring her to stay "on that connection" to see what happens.

## **THE SEPARATE TOLL TRAIN**

To deal with these "shortcomings" of the regular connector, a separate toll train was constructed to be used to terminate toll calls on the lines of an SXS office.

### The transmission circuit

This switch train used a different type of transmission circuit. It included a low-loss audio coupling transformer\* (yes, big and costly), through the windings of which the talking battery was sent to the called station, and which coupled the AC speech signal through the transmission circuit with relatively low loss (perhaps 0.5 dB).

\*Always spoken of as a "repeating coil" (or perhaps just "repeat coil").

In this improved transmission circuit, the taking battery current to the called party was resulted to a fairly constant (and fairly great!) value, regardless of the loop resistance, by a *ballast lamp*, a special type of incandescent lamps whose filament exhibited a fairly constant current vs. voltage characteristic.

But now consider this. When the toll competing train was "sized" from a traffic capacity standpoint, the result was that there were many more connectors in the train than selectors in the preceding stage.

So. considering the considerable cost of the "toll-worthy" transmission circuit, in the toll train the transmission circuit was moved back into the last selector stage. Then, after the called station had answered, when the connector "cut through" it just provided a direct metallic path from this prior selector to the called line.

This special type of "last" selector was called a *toll transmission selector*, and this special type of connector was called a *toll connector*.

Then. by contract, the "regular" kind of connector became called a *local connector* (but the regular type of selector was usually just called a *selector*).

### Flashing busy

A toll connector was arranged so that, if the called line turned out to be busy, it returned a "flashing supervision" electrical signal upstream. The toll transmission selector dutifully repeated it onward upstream.

## **THE COMBINATION LOCAL AND TOLL CONNECTOR**

Greater overall economy was achieved by the development of the *combination local and toll connector* (often

called just a *combination connector*). This has two input ports by which it could be "seized" by a selector. A regular (local) selector could seize it over one port, which would make it take on the behavior of a regular (local) connector. Thus it could complete calls of either the local or toll type.

A toll transmission selector could seize it over the other port, which would make it take on the behavior of a toll connector. When it was seized over either port, the other port would be marked busy so a selector of the other persuasion would not seize it.

A typical connector shelf might have, say, 15 connectors, of which perhaps 5 would be combination connectors and the rest local connectors.

## **BUT LATER**

Later improvement in telephone sets plus an improvement in the overall loss performance of toll connections, plus the use of "tone busy" even on toll calls, since most were caller-dialed (DDD), and a modest improvement of the transmission performance of the "local connector" transmission circuit, led to the special features of the separate toll train no longer being retired.

This led to the progressive retirement of separate toll trains, so toll calls were delivered through the terminating office just like any other inter-office call. There would no longer need to be toll (or combination) connectors nor toll transmission selectors

Special types of selector had to be used in the toll switching offices (if SXS) to mediate between the signaling modes of the toll network and those of the local network, but this was not a big complication..