October 5, 2021

It's been a couple of days since I had the opportunity to play with the switchboard, silly things like work tend to interfere with my hobbies – a problem I probably cannot address until I reach actual retirement age!

Anyway, I've been working on cleaning the switchboard, sanding the wooden cabinet, and trying to put some resemblance of a finish on this ancient and honored bit of Mahogany. If you saw the little photo montage I posted to YouTube last month, you will hopefully see a bit of improvement. A previous owner of the switchboard had covered the poor thing in a layer of latex paint that had become rather grungy over the years. Literally days of sanding in my spare time revealed some very nice woodwork that makes the switchboard a fine piece of furniture (at the very least.)

At some point, the rear door of the cabinet was said to contain a complete schematic diagram of the switchboard, but the door is long gone, and examination of the wiring indicates it's been heavily modified in the distant past, so even the original schematics would be of little use in getting this beast up-and-running as the communications servant for a collection of aging computer gear.

There's a very nice demonstration of a similar switchboard on YouTube that has been lovingly restored by a retired phone guy. If anybody besides me has any interest in how the machine is SUPPOSED to function, take a few minutes to look up his video and give him an appreciative shout.

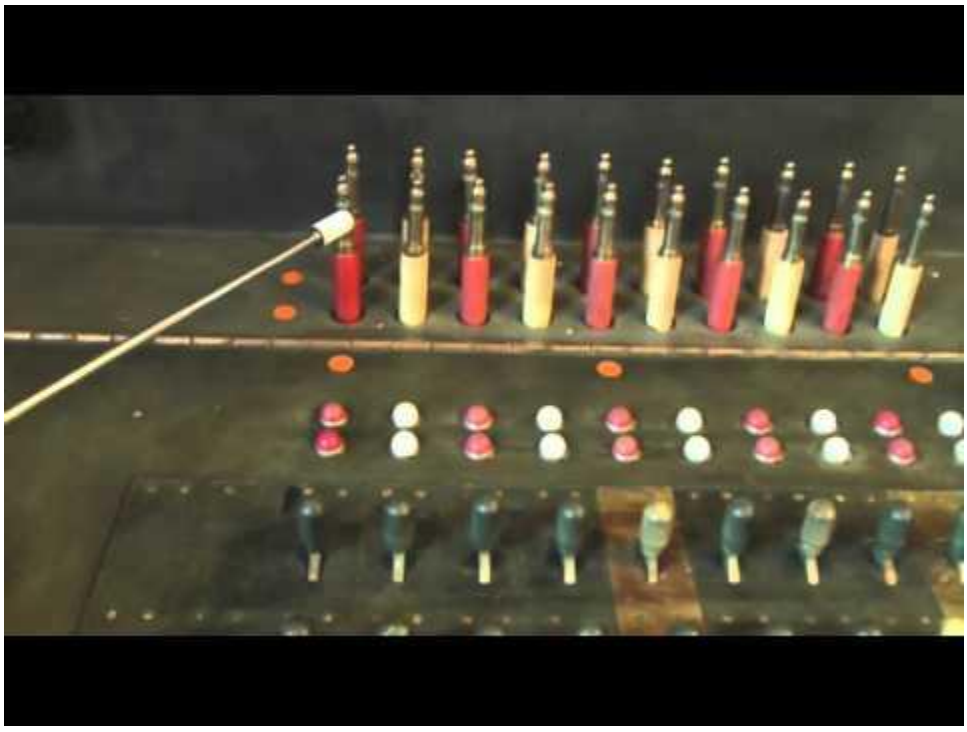

Figure 1 - Demonstration of the 551 PBX by Hicken65 (YouTube)

In very broad terms, the various functions of this switchboard can be broken down as follows:

1. The switchboard provides talk-battery current to each extension telephone.
2. Operator intervention is signaled by illumination of a lamp associated with each extension or central-office trunk (and optionally, a buzzer that sounds when an extension goes off hook.)
3. Upon receipt of an off-hook lamp, ring signal from a CO trunk, or the alerting buzzer, the operator selects an available (rear) cord circuit and plugs into the corresponding jack for the extension telephone or CO line.
4. After plugging in a cord circuit, the operator operates the associated listen key to connect her handset or headset to the calling party. After determining what the calling party wants, the operator can then connect the (front) cord circuit to the desired extension or trunk line.
5. If placing an outgoing call, the switchboard operator dials the number using the desktop dial and can either remain on the line to deal with other operators or drop-offline and let the original caller fend for themselves.
6. If placing a call to another (internal) extension, the operator operates the ring key associated with the cord-set to signal the called extension. After the called party answers, the operator can drop-out by disengaging the listen key associated with the cord circuit.
7. Two supervisory lights adjacent to the cord circuit show the status of the call currently in-progress. When either party hangs up their telephone, the circuit is broken and the supervisory light illuminates. If additional operator intervention is required, the party can "flash" the supervisory lights by momentarily closing the hook switch on their telephone to get the operator's attention. When both lights illuminate, the operator "takes down" the connection by removing the cord circuits plugs from the jacks and returning them to the key shelf.
8. Additional functions of the board provide "night service" to selected extensions by plugging them directly into a CO trunk line and operating the "night service" toggle on the cord set. This takes the switchboard out of the equation and allows direct access to a CO line by users of one or more extensions.

There are other things the operator can do with this switchboard, like take a request for a long-distance call, place (or schedule) the call, and then ring-back the original caller. In the days when long-distance service was expensive and not always available, it would be common for somebody to call the operator and arrange for a long-distance call. When the connection was finally established, the operator would then call the first party back.

This particular PBX was equipped for additional intercom circuits, separate from the telephone circuits, that could be used for intercommunication within the business. The "Squawk box" system could have various circuits switched in-and-out for

addressing various parts of the plant, or an individual intercom station could be addressed by the switchboard, but it does not appear that individual calls between intercom stations could be handled.

As the astute reader will note, the heart of the switchboard is really the individual cord circuits. There are only 15 cord circuits in total, whereas there are many more extensions and trunk lines available for use. The functions of the individual cord circuits are then where we need to examine the switchboard wiring in greater detail to see "how the switchboard works."

Any research into telecommunications will eventually expose the innocent bystander to one of the most malevolent acronyms that technology has to offer: BORSCHT

B represents the "battery feed." In a typical telephone system, the central office provides a DC voltage of about 48 volts to operate the telephones on a given line, measured between the "tip" and "ring" conductors. This serves for both talk current and signaling. The PBX uses a lower voltage of 24 volts, but the available line current of 15 to 80 mA is the same.

O stands for "overvoltage protection." Although lightning strikes and falling power lines are cited as the need for overvoltage protection, you need to protect your equipment from stray voltages, including those used within the system for signaling purposes – ring current in particular.

R is for ringing current. A legacy of Mr. Watson's original patent, ring voltage is generally around 100 volts at 20-30 Hz. Originally generated using a hand-operated magneto, other solutions include a ferro-resonant transformer in the PBX power supply and low-frequency switching solutions.

S is variously described as signaling or supervision. Monitoring loop current determines whether a circuit is on or off hook. In rotary dial systems (like our switchboard), we need to count dial pulses. Slightly more modern phones use DTMF tones to signal the number dialed. We also need to consider thinks like "hook flash" and CPC (Called Party Control) disconnect circuits.

C reminds us that CODING will be required for any interfacing with any digital communications system. While not an issue when this switchboard was originally constructed, various analog-to-digital and digital-to-analog conversions are a fact of life in modern communications. This includes the μ-Law coding used in North America, the A-Law coding used in Europe, not to mention the various parameters used for time and frequency division multiplexing for various systems of analog and digital trunking.

H is the hybrid function, that allows us to convert the four-wire telephone circuit used inside the telephone set to the two-wire balanced audio loop between the telephone and the central office. In a traditional telephone, this is accomplished using a transformer (or "induction coil" in the original literature.) Nowadays, there is usually a "network" of resistors, capacitors, and coils in the telephone that accomplishes the same function.

T is the final letter in our acronym, and this stands for "test." External tests are required to verify operation of the telephone set, the lines connecting it to the switchboard, and operation of the switching system. The typical central office was equipped with an impressive array of test gear, but our smaller private branch exchange, will have only limited test capability built into the system.

— *Paleoferrosaurus*