My Demonstration SXS Switching Unit
By Len Hicken

Hello, my name is Leonard (Len) Hicken and I'm located in London, Ontario Canada. This is a long article describing my recently completed demonstration SXS switching unit. First, let me fill you in on my telephony background. I started with The Bell Telephone Company Of Canada in the city of Oshawa, Ontario in 1965. My first job was as a "frameman", running the jumpers on the distributing frames for the "In" and "Change" service orders and removing jumpers for the "Out" orders. I quickly moved up to the position of "C.O. man", performing maintenance routines and troubleshooting problems on the switching equipment. The Oshawa central office was a combined class 4 (toll) and class 5 (local) switching centre. It contained a large, thirty thousand line step-by-step, a 3CL toll switchboard and a large #5 crossbar equipped with toll trunking, CAMA (Centralized Automatic Message Accounting), LAMA (Localized Automatic Message Accounting), DID (Direct Inward Dialing to PBX's) and Phase III Centrex (for General Motors). All this equipment presented quite a challenge to a kid fresh out of high school, but I enjoyed it thoroughly. After a few years I moved into the switch traffic engineering position. This job entailed calculating in detail the switching equipment requirements for upcoming jobs to be installed, either as new installations or as extensions to existing equipment. I remained in this job for many years, preparing Traffic Orders for 3CL switchboards, SXS, #5 crossbar, SA1 crossbar, SF1 crossbar, N5-1 crossbar, N5-2 crossbar, SP-1 (digital central control, analogue crossbar network), and DMS 100 (Digital Multiplex Switching). In the early 1980's, I spent 2 years in Detroit, assisting with the General Motors conversion of its private network from analogue to digital. When I returned to Bell I became the traffic engineering group "methods" person and training instructor. I took an early retirement from Bell Canada in 1997. I then joined Nortel and worked as an SAE (Systems Application Engineer) preparing equipment specifications for the DMS 100 product line for independent telcos all across the U.S.A. This lasted about 4 years, but with Nortel's demise, I was made redundant . Thereafter, I did some consulting work off and on, but with technology advancements and modernization programs, everything I knew was getting old pretty fast. So I retired.

In the mid nineties, before I left Bell, I managed to get a small amount of equipment out of a SXS C.O. that was being decommissioned. I also obtained a small SXS demonstration unit that had been used for training purposes. Unfortunately, there was little of value in the demo unit. It was crudely put together and mounted on a wooden framework, which was falling apart. The switches were old and worn, the bank assemblies had been stripped of cabling and butchered. The only items I kept were the power supply, oscillator, 2 interrupters, 2 line circuits and one switch. With these and the parts from the SXS office, I intended to build a new demo unit. But times were busy, so I loaded everything into cardboard boxes and placed them on storage shelves in the fruit cellar. There they remained, more or less forgotten, for twenty years.

Our basement looks like something you'd see on the "Hoarders " TV show. Early this year, I was on orders from she who must be obeyed to clean up and get rid of stuff. Looming large in the fruit cellar, like the proverbial elephant in the room were about

10 shelves of cardboard boxes full of SXS switchgear. I just stood looking at it for some time. I was overwhelmed with sadness that I had not done anything with this. After 20 years in an unheated fruit cellar, it was probably junk now, so I told my wife I would haul it down to the scrap metal dealer. Surprisingly, she said "No, build your switch." I looked at the boxes again and a daunting fear came over me that I was no longer capable of doing this. Too much time had passed and my SXS knowledge had diminished to a tiny fragment of what it once was. I examined one of the switches. It seemed to be in good shape, even had retained some lubricant. Fortunately, I had kept most of the printed resources I would need, including all the switch CD's (Circuit Descriptions), SD's (schematic Drawings), Bell System SXS Practices, and a variety of training material. So, with my wife's blessing I decided that I would give it a shot. Little did I know that it would consume me for the next 6 months. I spent a considerable amount of time planning out what I wanted to build, figuring out the wiring and making up the wiring diagrams.

I used an all iron framework. I already had the shelving ironwork from the salvaged CO equipment. All I needed was iron supports for these shelves. So off I went to Home Depot to buy some angle iron.

I employed a fully equipped switch train. That is, a linefinder, 1st, 2nd, 3rd, 4th and 5th selector and a connector. After all, this was going to be a demonstration unit and I wanted to demonstrate the buildup of the switch train through each digit dialed.

I equipped 2 working lines so that a call could be placed from either line to the other. I already had two working 302 telephone sets that would be a perfect fit for this setup.

I designed the demonstration unit to be portable, so that I could transport it and set it up at show locations.

The demonstration unit I built contains the following parts:

- 1 Linefinder Switch
- 5 Selector Switches
- 1 Connector Switch
- 2 Subscriber Line Circuits (Line & Cutoff Relays)
- 1 Combination 48 Volt D.C. Power & 20 Hertz A.C. Ringing Supply
- 1 Ringing Interrupter Supply (2 Sec. ON & 4 Sec. OFF)
- 1 Tone Oscillator
- 1 60 I.P.M. Tone Interrupter
- 1 200 Point Bank (for the Linefinder)
- 7 100 Point Banks (1 for the Connector, 5 for the Selectors and 1 spare)
- 7 Jack Spring Assemblies (one per switch)
- 2 Linefinder Bank Multiple Terminal Strips (with a capacity for 100 lines each)
- 1 1st and 2nd Selector bank multiple Terminal Strip (with capacity for 100 trunks)

- 1 3rd, 4th and 5th Selector Bank Multiple Terminal Strip (with capacity for 100 trunks)
- 1 Connector Bank Multiple Terminal Strip (with capacity for 100 telephone lines)
- 1 Miscellaneous Terminal Strip
- 1 Base Mounted Terminal Strip
- 1 Angle Iron Mounting Framework Equipped with 2 Shelves and 2 Relay Mounting Plates
- 2 Model 302 Rotary Dial Desk Telephone Sets
- 2 Dual Cassette Analogue Answering Machines
- 1 25" by 25" plywood base
- 4 swivel wheels

The unit contains three types of switches; 1 Linefinder, 5 Selectors and 1 Connector.

The Linefinder is a 3-wire, 200-point switch, manufactured by Northern Electric in 1965. Its schematic drawing number is SD-33013.

The 1st Selector is a 3-wire, 100-point, digit-absorbing switch, manufactured by Northern Electric in 1962. Its schematic drawing number is SD-30976.

The 2nd Selector is a 3-wire, 100-point, digit-absorbing switch, manufactured by Northern Electric in 1975. Its schematic drawing number is SD-30976.

The 3rd Selector is a 3-wire, 100-point, digit-absorbing switch, manufactured by Northern Electric in 1974. Its schematic drawing number is SD-30976.

The 4th Selector is a 3-wire, 100-point, digit-absorbing switch, manufactured by Northern Electric in 1969. Its schematic drawing number is SD-30976.

The 5th Selector is a 3-wire, 100-point, digit-absorbing switch, manufactured by Northern Electric in 1971. Its schematic drawing number is SD-30976.

The Combination Local and Toll Connector is a 3-wire/4-wire, 100-point switch, manufactured by Northern Electric in 1955. Its schematic drawing number is SD-30228.

I have the Schematic drawings and circuit descriptions for all the switches.

The two model 302 telephone sets are equipped with zinc alloy housings, phenol plastic type F1 handsets, type HA1 receivers, type F1 transmitters, type 5 or 6 dials, type B1A ringers, type 195A capacitors and type 101A or 101B induction coils. They were both manufactured by the Western Electric Company for the Bell System. One set was manufactured in 1941 and the other in1949, but internal parts have varying dates due to repair replacements.

The Build

Two big issues were size and weight. My salvaged shelf assemblies were 23” wide and could accommodate 4 switches, so I would need to mount 2 shelves to accommodate the 7 switches. Below that I would need to mount two line circuits (2 line relays and 2 cutoff relays), an oscillator, a 60 IPM interrupter, a ringing interrupter, 2 phone jacks, and the power supply. I made a square base using 3/4” plywood, 25” by 25” mounted on 4 swivel wheels. Each angle iron upright is about 4’ high and is bolted to an angle iron crosspiece bolted to the plywood base in an upside down “T” configuration. Two straight iron bars join the uprights to the crosspieces to form triangles to provide extra support. So I have a 25” by 25” footprint and an overall height of about 4’ 3”. The power supply simply rests on the base. With all the switches and the power supply removed, the unit only weighs 90 lbs. Fully equipped, the unit weighs 210 lbs. I have a 500 lb. capacity scissor table that can be used to raise the unit to the most suitable level for demonstrations.

Drilling all the holes in the angle iron was very time consuming, starting with 1/8 “ bits and working gradually up to 5/16” bits. I had to replace my power drill before I was done.

I bolted the two shelf assemblies into place. I had to hack saw a piece from another shelf assembly to bolt into position where the connector would sit to accommodate the extra height of the connector.

For the selectors, I had two sets of 3-bank multiple assemblies, complete with all the wiring to their terminal strips. Thankfully, these did not have to be cut or modified in any way. I mounted one assembly on each shelf and bolted the terminal strips to the rear of the shelves.

For the linefinder, I had a 3-bank multiple assembly complete with all the wiring to two terminal strips. I only had room for one LF bank assembly and had to cut away 2 of the banks and carefully trim the cuttings on the remaining bank to make for a neat appearance. I mounted the LF bank on the leftmost switch position on the lower shelf and bolted the two terminal strips to the rear of the shelf.

For the connector, I had a 3-bank multiple assembly complete with all the wiring to its terminal strip. I only had room for one connector bank assembly and had to cut away 2 of the banks and carefully trim the cuttings on the remaining bank to make for a neat appearance. I mounted the connector bank on the rightmost switch position on the top shelf and bolted the terminal strip to the rear of the shelf.

I bolted a mounting plate to the framework below the shelf units. On it were 2 line circuits, each containing a line and cutoff relay.

Another mounting plate was bolted into position below the line circuits. On its front I mounted the oscillator, the ringing interrupter, the 60 IPM interrupter and two phone jacks. On its rear I mounted a Miscellaneous Terminal Strip. The purpose of the Misc. T.S. was to provide a convenient point to terminate a multiplicity of -48V and ground Connections.

I mounted a Terminal Strip to the plywood base to provide a convenient place to terminate power supply and interrupter wiring.

You Tube

I have 4 videos on You Tube involving this demo unit. The names and URL's are:

Dial Tone In The Step-by-Step Telephone Switching System
https://youtu.be/TwF4BHTNX54

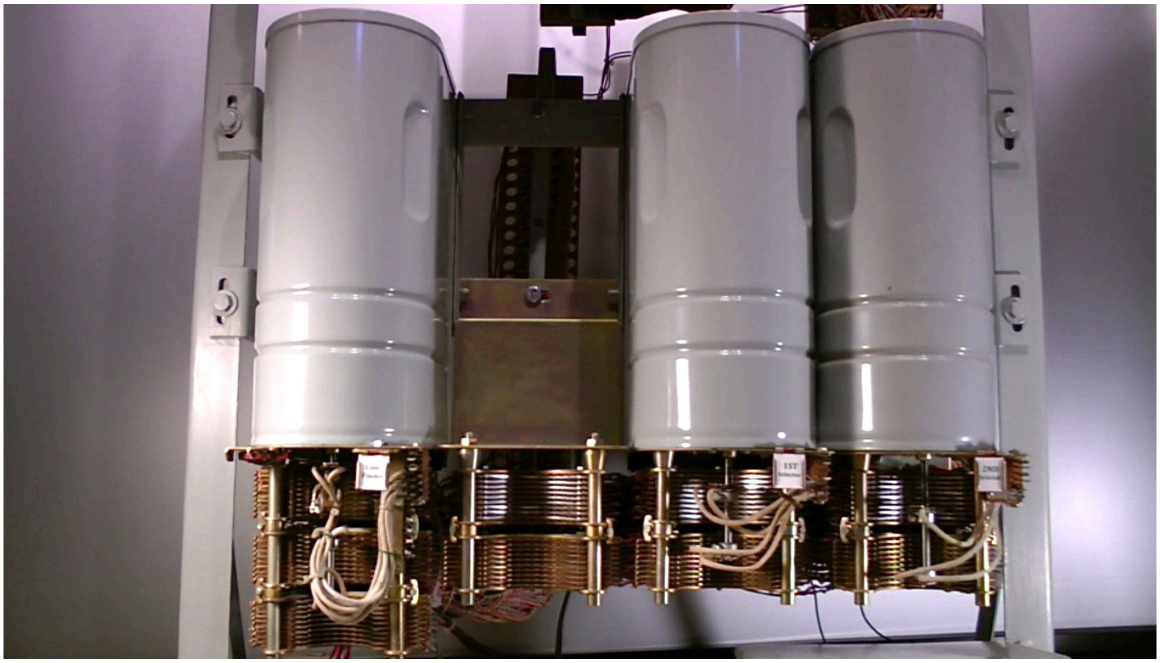
The Rotary Dial In The Step by Step Telephone Switching System
https://youtu.be/BXVknodalT4

Dialing Through The Step-by-Step Telephone Switching System
https://youtu.be/QOTQic5231w

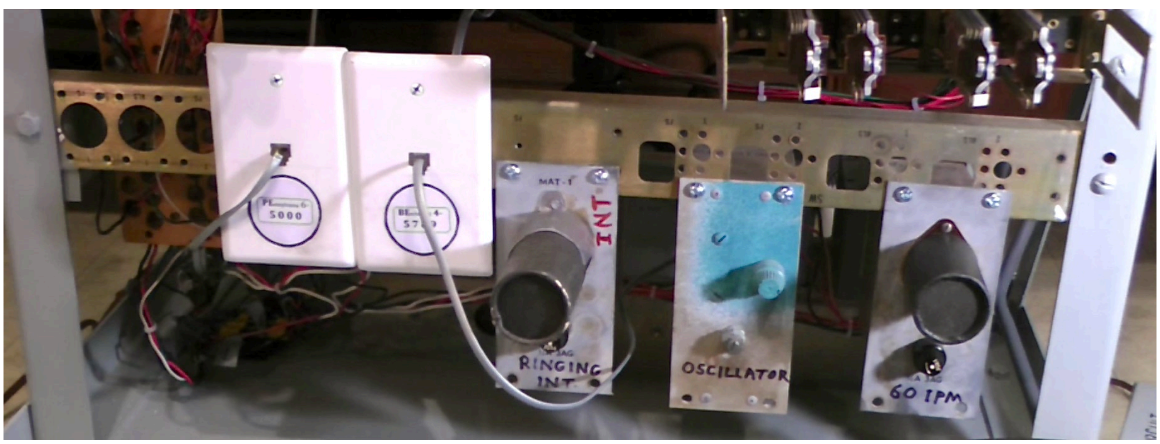
A Call To PEnnsylvania 6-5000 Through The Step-by-Step Telephone Switching System
https://youtu.be/FkWVcNOYMyE

Photos

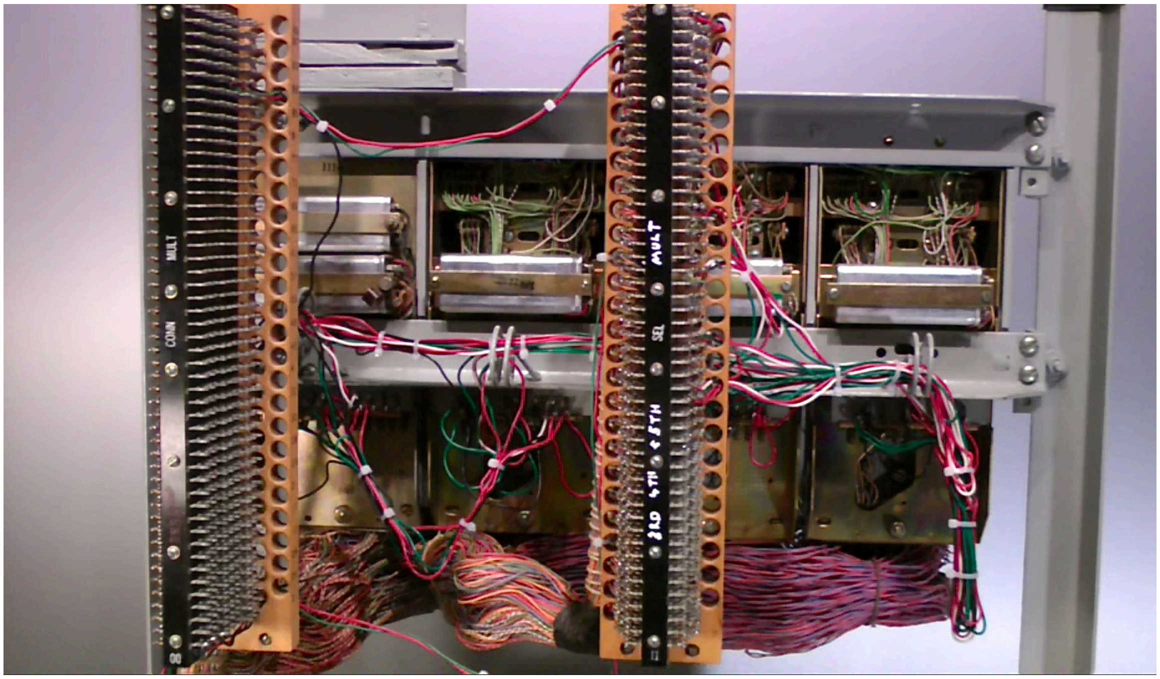
Top Shelf (3rd, 4th & 5th Selectors and Connector)



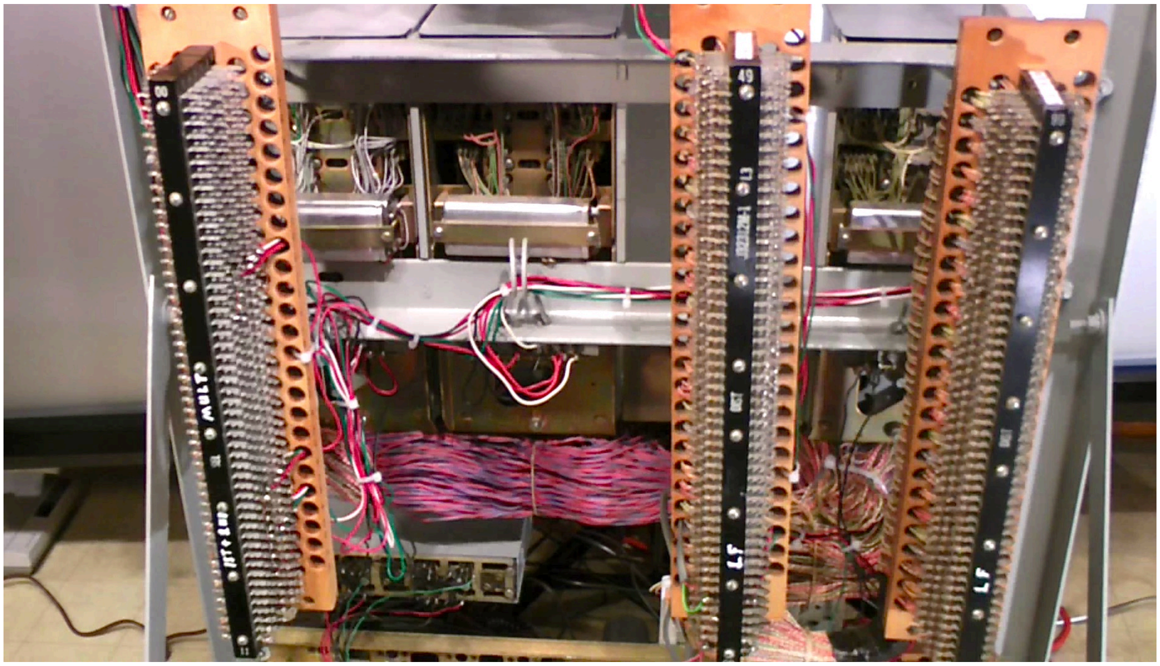
Lower Shelf (Linefinder and 1st & 2nd Selectors)



Mounting Plate Assemblies (Line Circuits, Phone Jacks, Ringing Interrupter, Tone Oscillator, 60 IPM Interrupter)



Rear of Top Shelf Showing the Connector Multiple Terminal Strip and the 3rd, 4th & 5th Selector Multiple Terminal Strip



Rear of the Lower Shelf Showing the 1st & 2nd Selector Multiple Terminal Strip and the Two Linefinder Multiple Terminal Strips.

Power, Tone & Ringing Wiring

The main power supply is very heavy (33 lbs). The 48-volt and AC ringing supplies are both contained in this one unit. In order to easily remove it from the base for transportation, I have connectorized the eight extending wires. A ground strap connects the iron framework to the chassis of the power supply and the chassis is also connected to the ground prong on the AC supply cord. There are 5 fuses inside the power supply, ranging from 1A to 2A as follows:

FUSE	RATING
Power Supply F1	1A
Power Supply F2	2A
Power Supply F3	2A
Power Supply F4	2A
Power Supply F5	2A SB

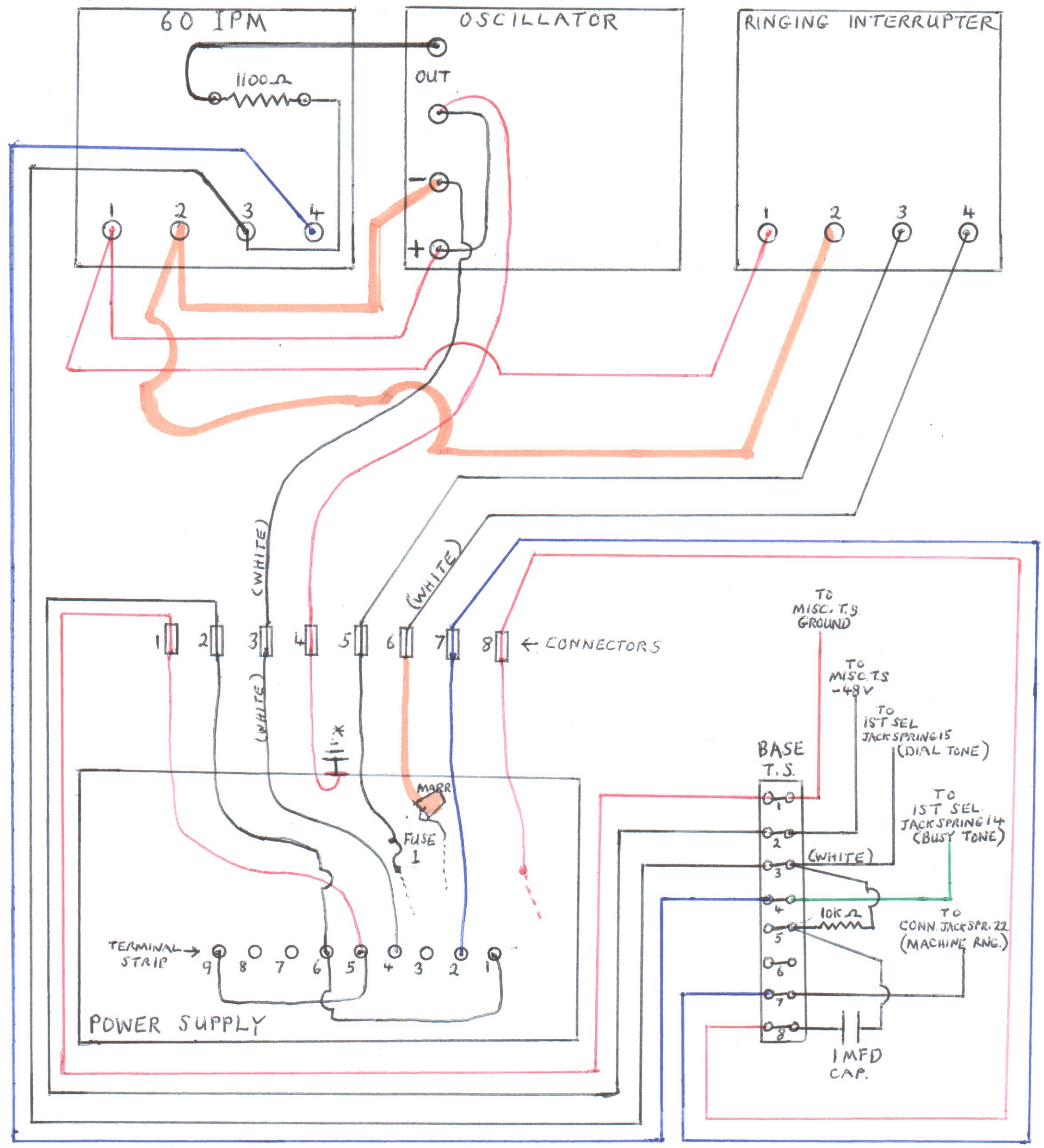
There are no identifying marks on the power supply and I have no CD's or SD's for it.

The Tone Oscillator, 60 IPM Interrupter and Ringing Interrupter are all manufactured by Pylon Electronic Development Company Ltd. I have no CD's or SD's for these units. The 60 IPM Interrupter and the Ringing Interrupter each have ¼ A fuses. The Oscillator has a 6A fuse (I'm sure this is not the correct fuse, but the rating is not marked and this is the fuse it came with). All the power wiring is shown in the following diagram. I have merely replicated the wiring from the original demonstration unit that I had dismantled.

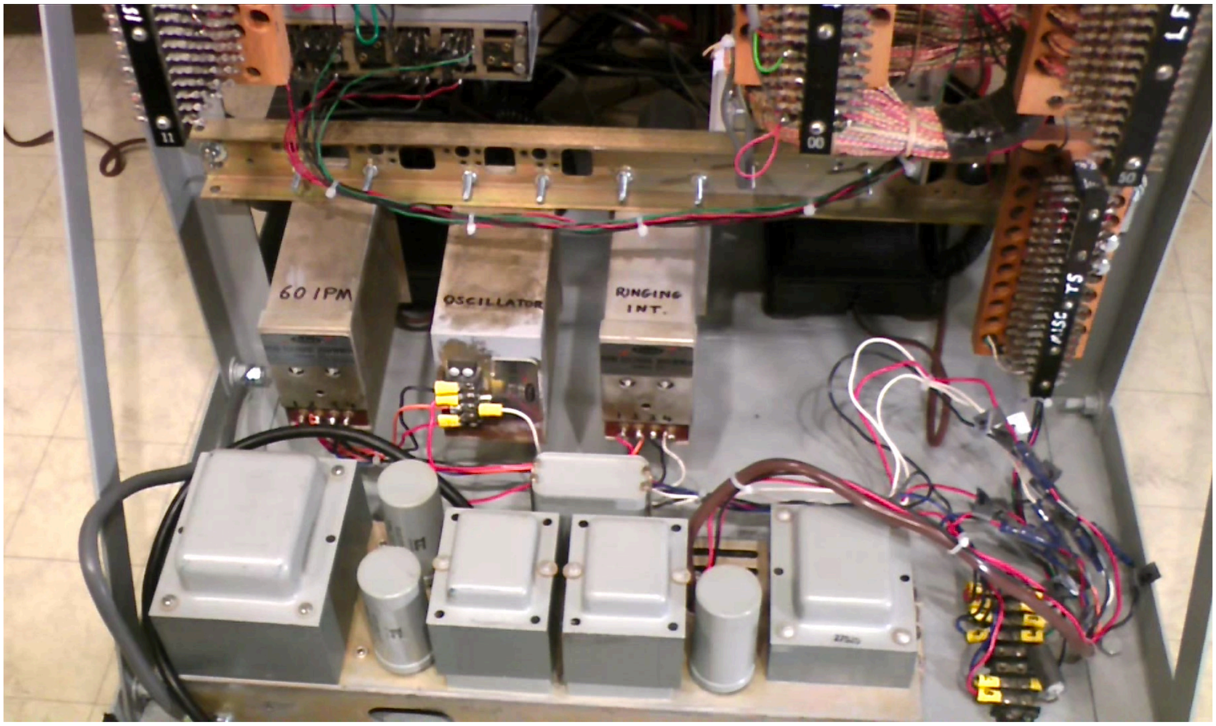
-48 V for the switch train is provided from TS terminal 6 in the power supply, which in turn is fed from fuse F3. Ground for the switch train is provided from TS terminal 5 in the power supply.

-48 V for the 60 IPM unit, Oscillator and Ringing Interrupter is provided from TS terminal 4 in the power supply, which in turn is fed from fuse F2. Ground for these 3 units is provided directly from the power supply chassis.

Power, Tone & Ringing Wiring



* NOTE: THE POWER SUPPLY CHASSIS IS GROUNDED TO THE COMMERCIAL A.C. SUPPLY GROUND.

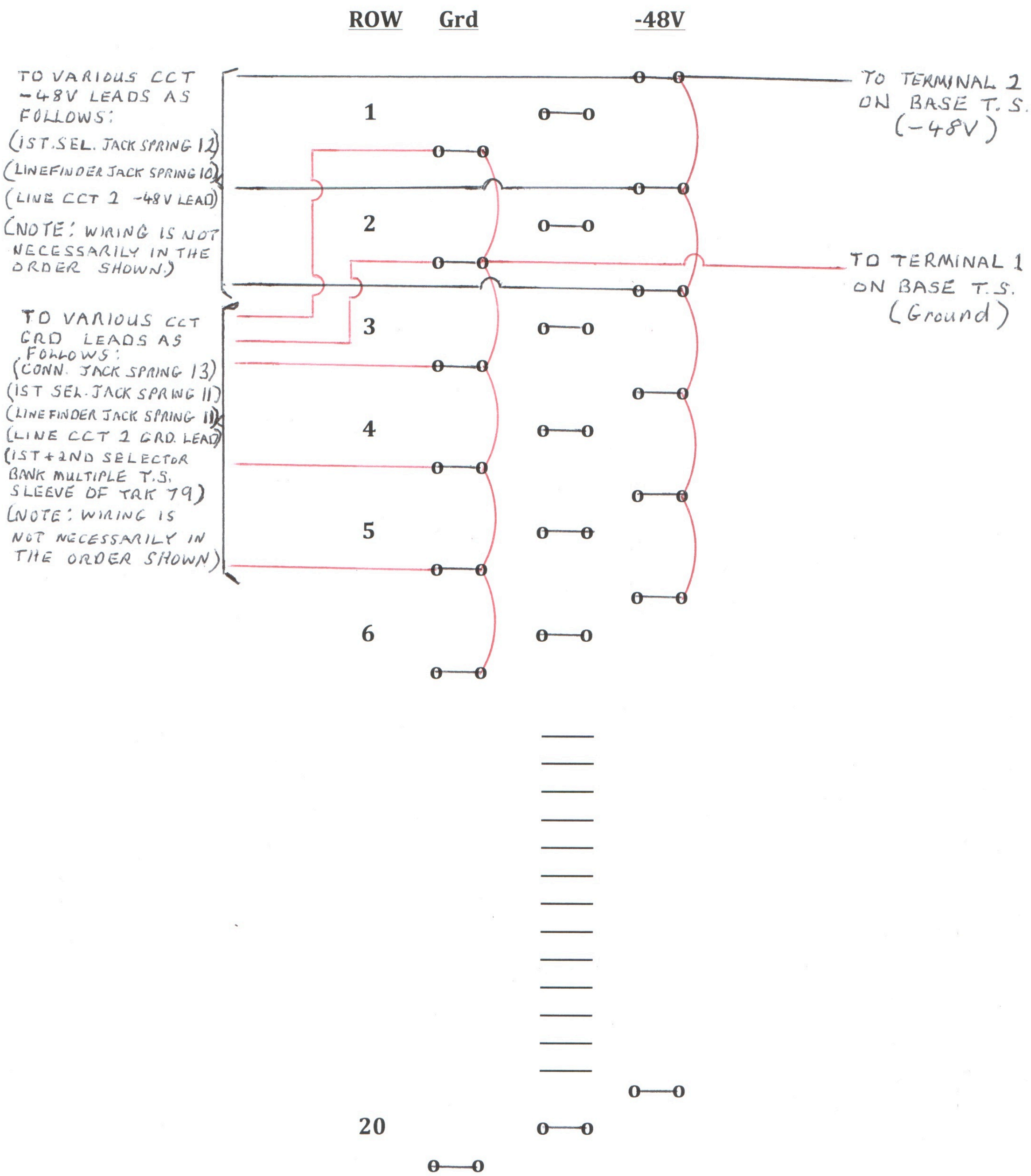


Connectorized Power Supply, Rear of Interrupters and Oscillator, Miscellaneous Terminal Strip and Base Terminal Strip

Miscellaneous Terminal Strip Wiring

I have wired -48V and Grd from the Base Terminal strip to the Misc. Terminal Strip. I have strapped each of these connections across 6 lugs to provide a convenient way to terminate battery and ground wiring from various jack springs, line circuits and selector Terminal Strips as shown in the following diagram.

Wiring on the MISC. Terminal Strip



Telephone Numbers

I felt that the use of telephone numbers with central office names would be most appropriate for this equipment and would generate some discussion during a demonstration. Two numbers came to mind, both well known in their day since they were the titles of hit songs. The first number was PEnnsylvania 6-5000, which was a song that came out in 1940 and made popular instrumentally by Glenn Miller and lyrically by the Andrews Sisters. The second number was BEechwood 4-5789, which was a 1962 hit single for the Motown group, The Marvelettes. I tried to think of ways to incorporate the significance of this music into the demonstration. Then it came to me. Why not put answering machines on each phone with a 30 second excerpt of the appropriate song as the answering announcement. An Internet search indicated that the selection of new answering machines was small and that they were digital. I tried a couple, but found that while they worked well for voice signals, musical signals were distorted. What I really needed was two older answering machines that used dual cassette tapes, one for the answering announcement and one for the incoming messages. I found some on ebay and within a couple of weeks I had two working machines (Panasonic KX-T1450). I downloaded the two songs to iTunes, burnt them onto a CD and played the CD into my old cassette tape recorder, putting about 30 seconds of each song onto two blank cassette tapes. These tapes were placed into the “Outgoing Message” slots of the answering machines.

The PEnnsylvania 6 – 5000 set is connected to terminal 00 on the linefinder bank. This has been done on purpose in order to force the linefinder to step up 10 levels and hunt across ten terminals. After all, this is a demonstration unit.

The BEechwood 4 – 5789 set is connected to linefinder terminal 05, which also creates a great deal of motion on the linefinder. The numbering of the linefinder bank terminals is shown below, followed by the jumper wiring on the Linefinder Terminal Strip and the jumper wiring on the Connector Terminal Strip.

Although the demonstration unit was designed to call just two telephone numbers, there are actually 16 numbers that can be dialed to ring the two telephones (8 numbers per telephone).

For the PEnnsylvania 6 – 5000 telephone set, the numbers are 234-5700, 234-5000, 236-5700, 236-5000, 734-5700, 734-5000, 736-5700 and 736-5000.

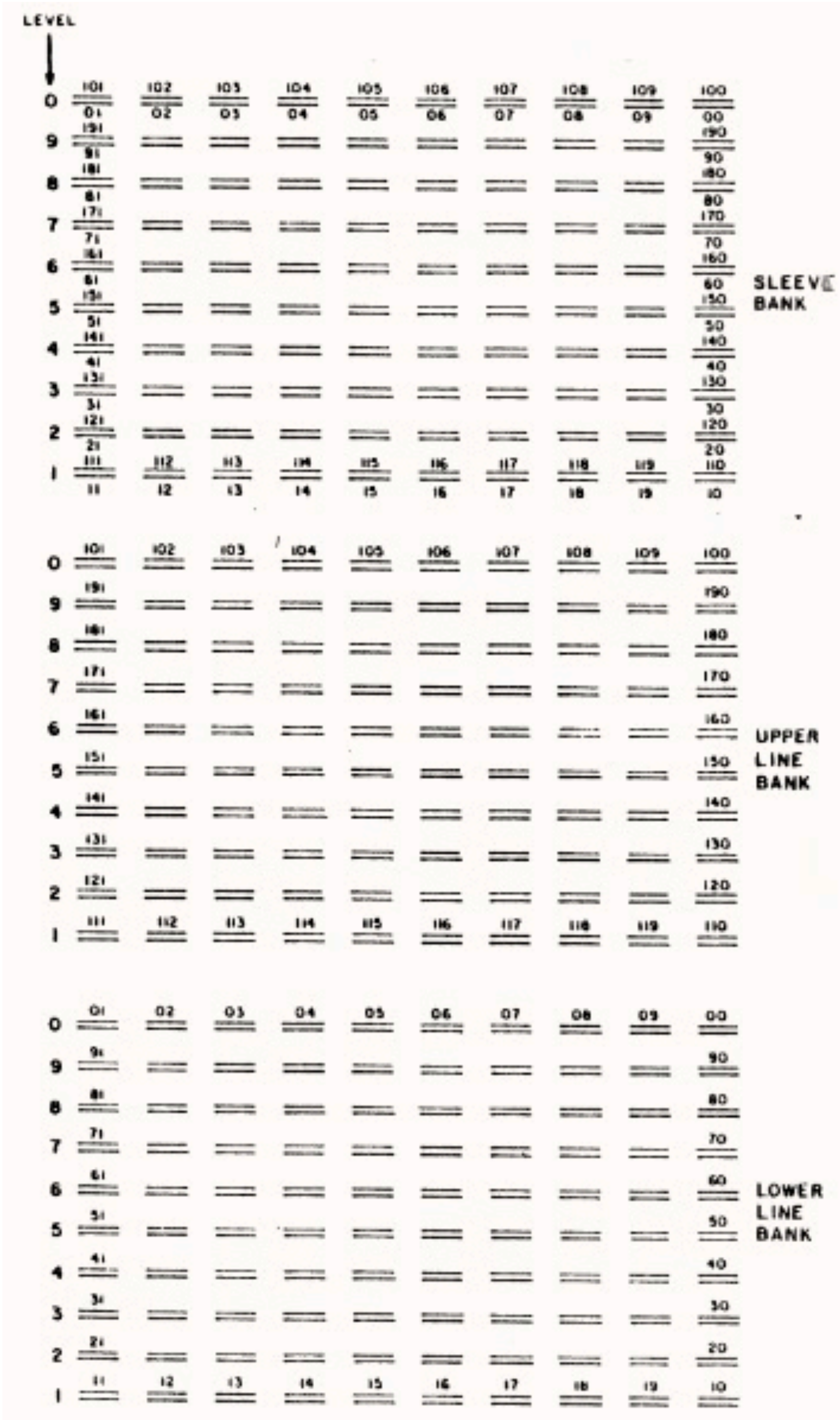
For the BEechwood 4 – 5789 telephone set, the numbers are 234-5789, 234-5089, 236-5789, 236-5089, 734-5789, 734-5089, 736-5789 and 736-5089.

The BEechwood 4-5789 Model 302 Telephone Set

The PEnnsylvania 6-5000 Model 302 Telephone Set

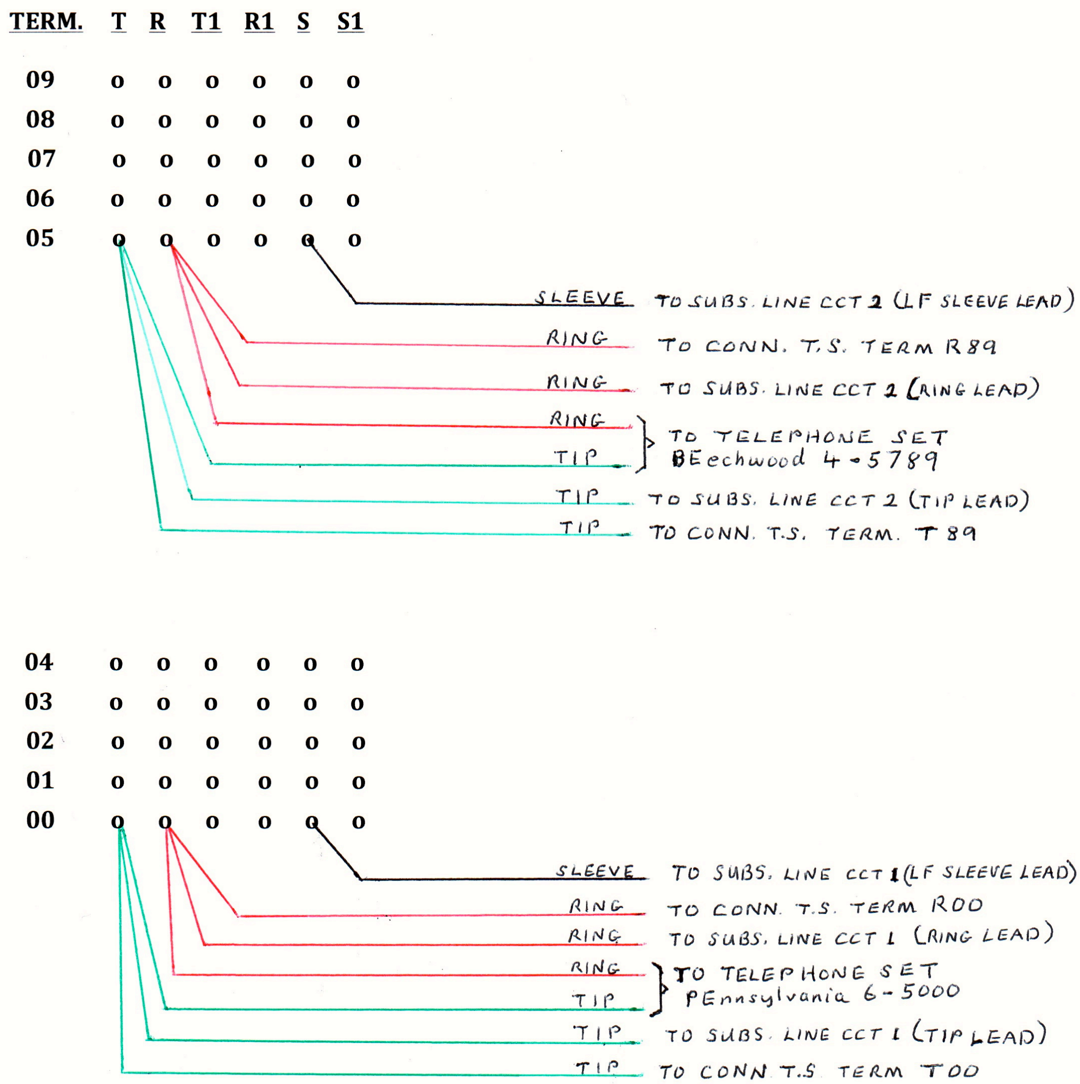
The Panasonic KX-T1450 Dual Cassette Analogue Answering Machine

Numbering of the Terminal Contacts on the Linefinder Bank Assembly

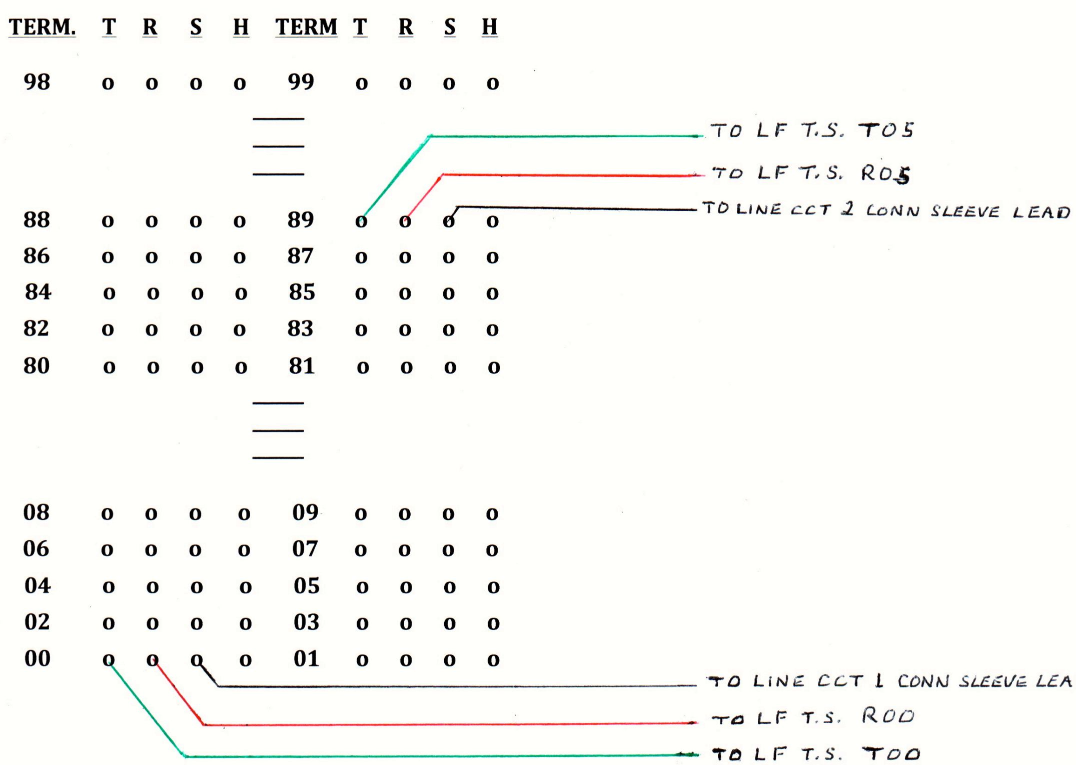


Telephone set **PE**nnsylvania **6- 5000** is connected to terminal 00.
Telephone set **BE**echwood **4- 5789** is connected to terminal 05.

Jumper Wiring on Level 0 of the Linefinder Terminal Strip



Jumper Wiring on the Connector Terminal Strip

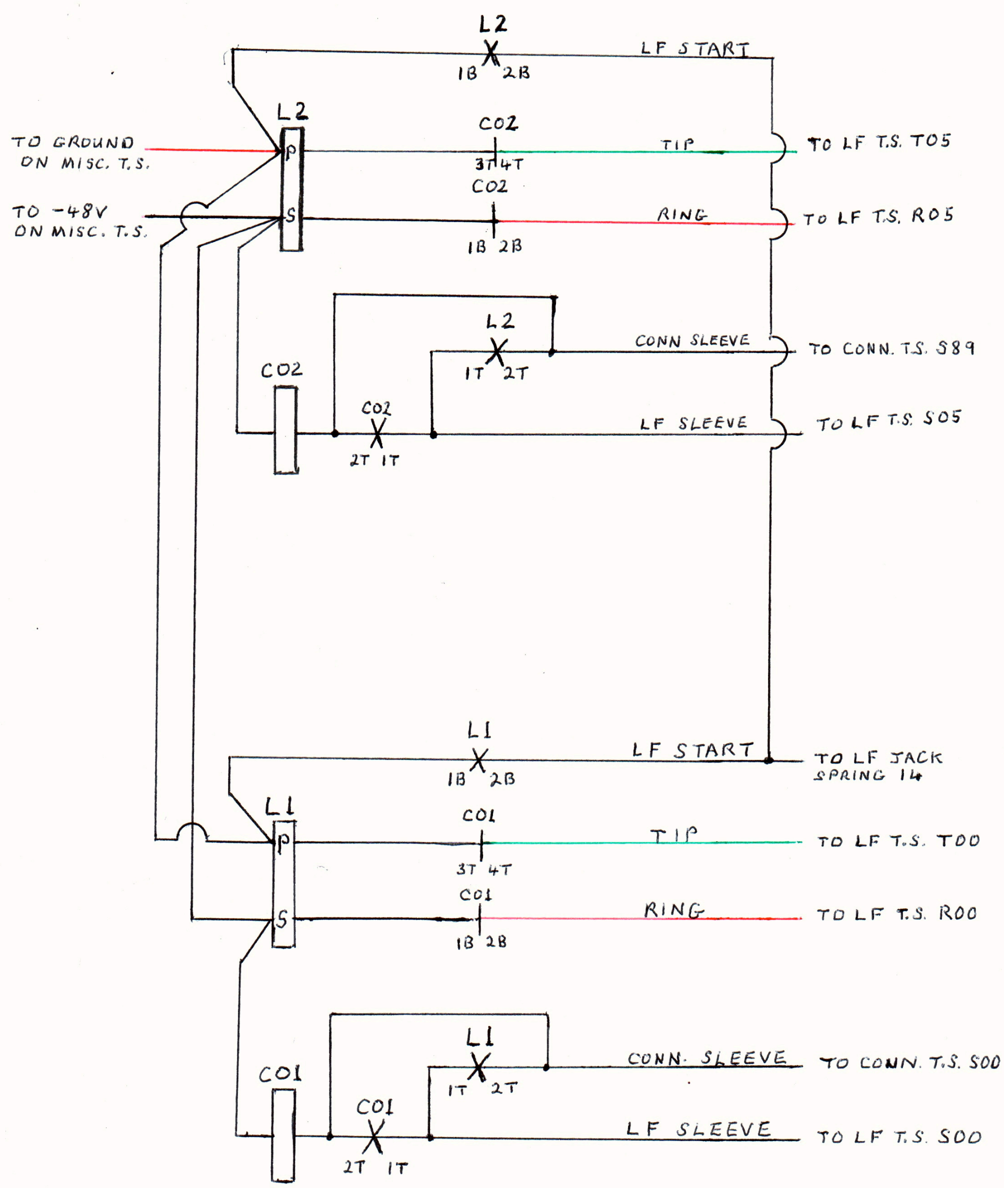


On the connector bank multiple, telephone set **PE**nnsylvania **6- 5000** is connected to terminal 00 and telephone set **BE**echwood **4- 5789** is connected to terminal 89.

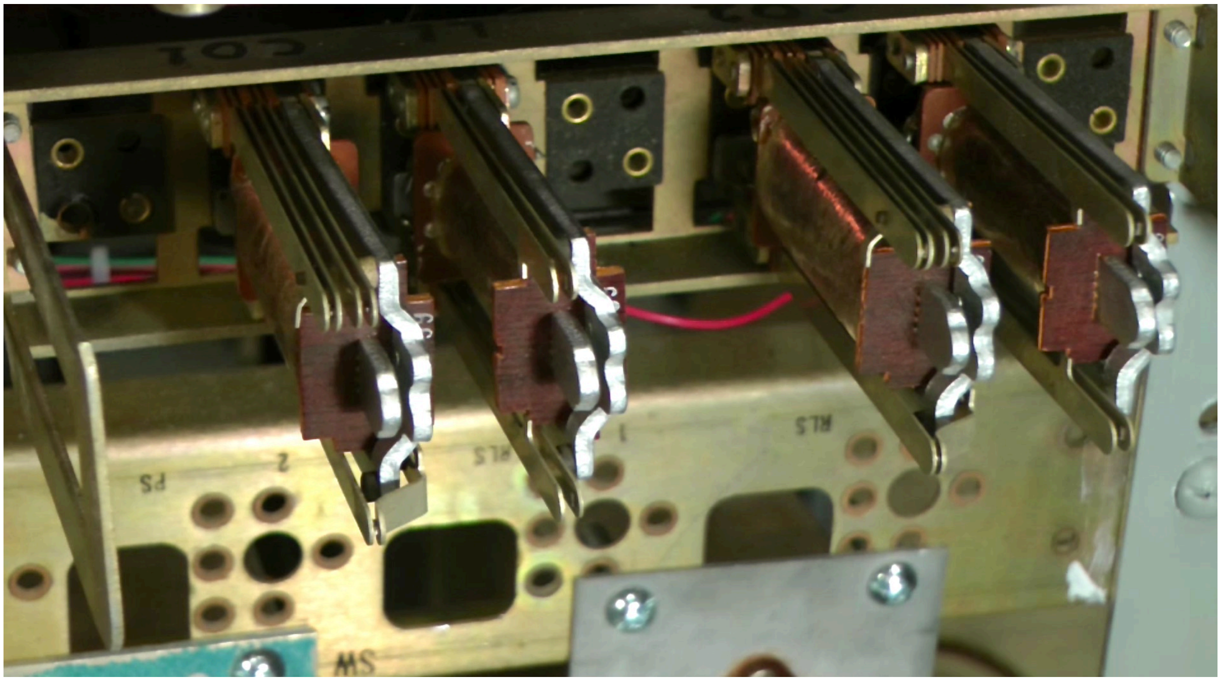
The Line Circuit

Each telephone line is connected to a dedicated line circuit, which has two relays, the line (L) relay and the cutoff (CO) relay. The line circuit wiring is shown below.

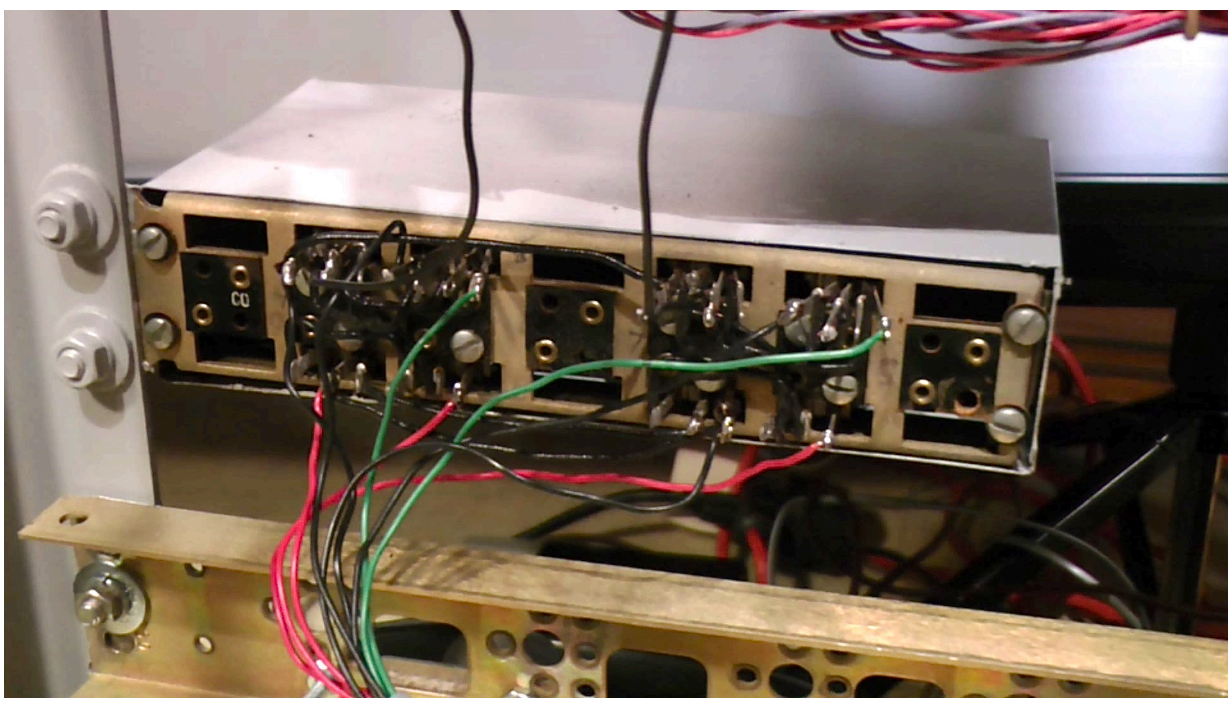
SUBSCRIBER LINE CIRCUIT WIRING



Telephone set **PE**nnsylvania **6- 5000** is connected to line circuit 01.
Telephone set **BE**echwood **4- 5789** is connected to line circuit 02.



Front of Two Line Circuits, Each Equipped With One Line Relay and One Cutoff Relay

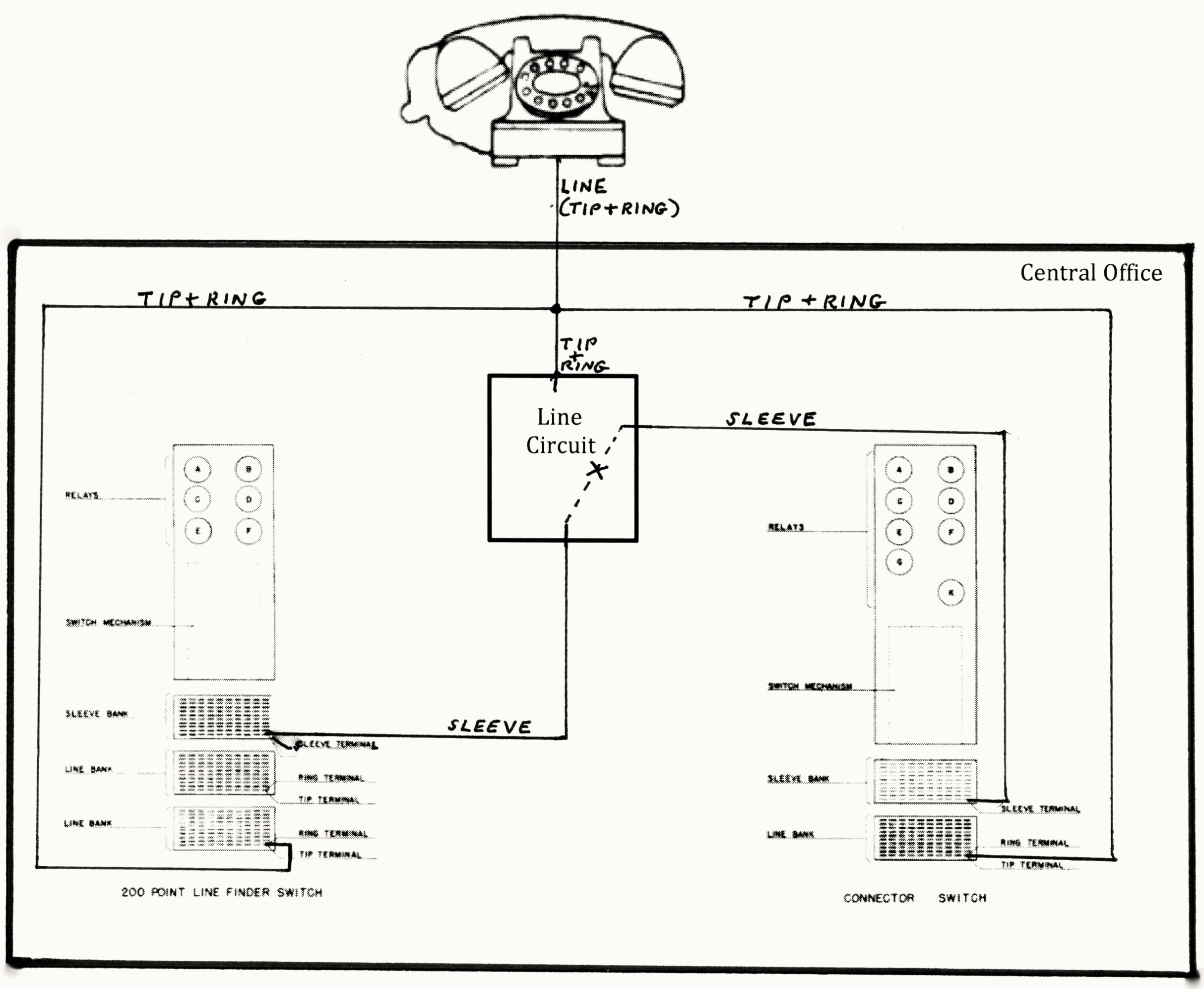


Rear Wiring Of Two Line Circuits

Telephone Line Interface To The SXS Switching System

Telephones are connected to switching systems at Central Offices over a pair of wires, which is generally referred to as the telephone line. This pair of wires handles all voice transmission and signaling (off hook, on hook, dial impulses, ringing, dial tone and busy tone). The two wires are designated as the tip and ring. At a SXS Central Office, each telephone line picks up a third wire called the sleeve. This wire becomes grounded throughout the duration of a telephone call and provides a "mark" to the switching equipment that this line is active and also provides the means to maintain the "set-up" of the switch train after the call is established. The points of interface of the telephone line to the SXS system are shown below.

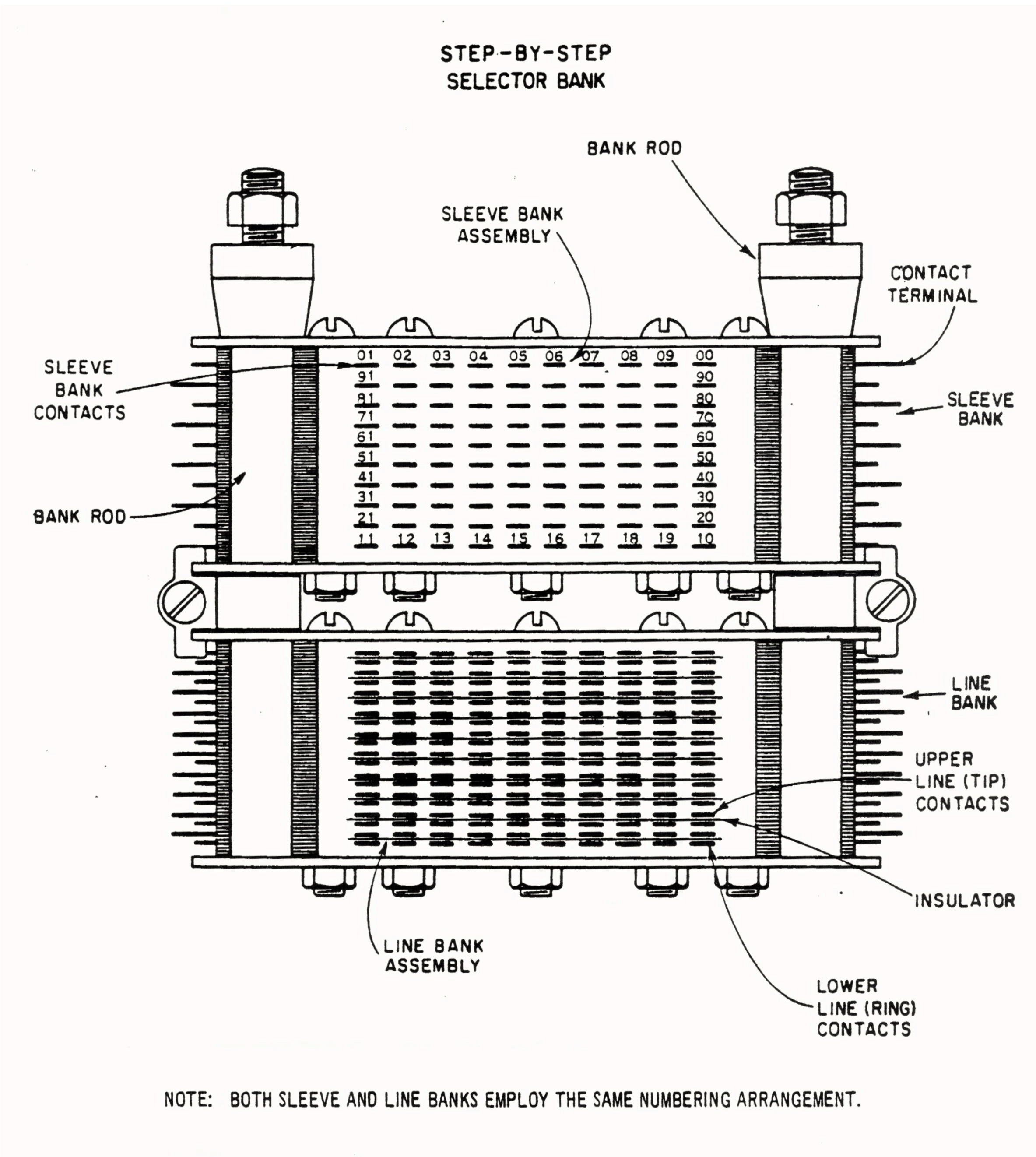
Telephone Line Connections To SXS Switching System



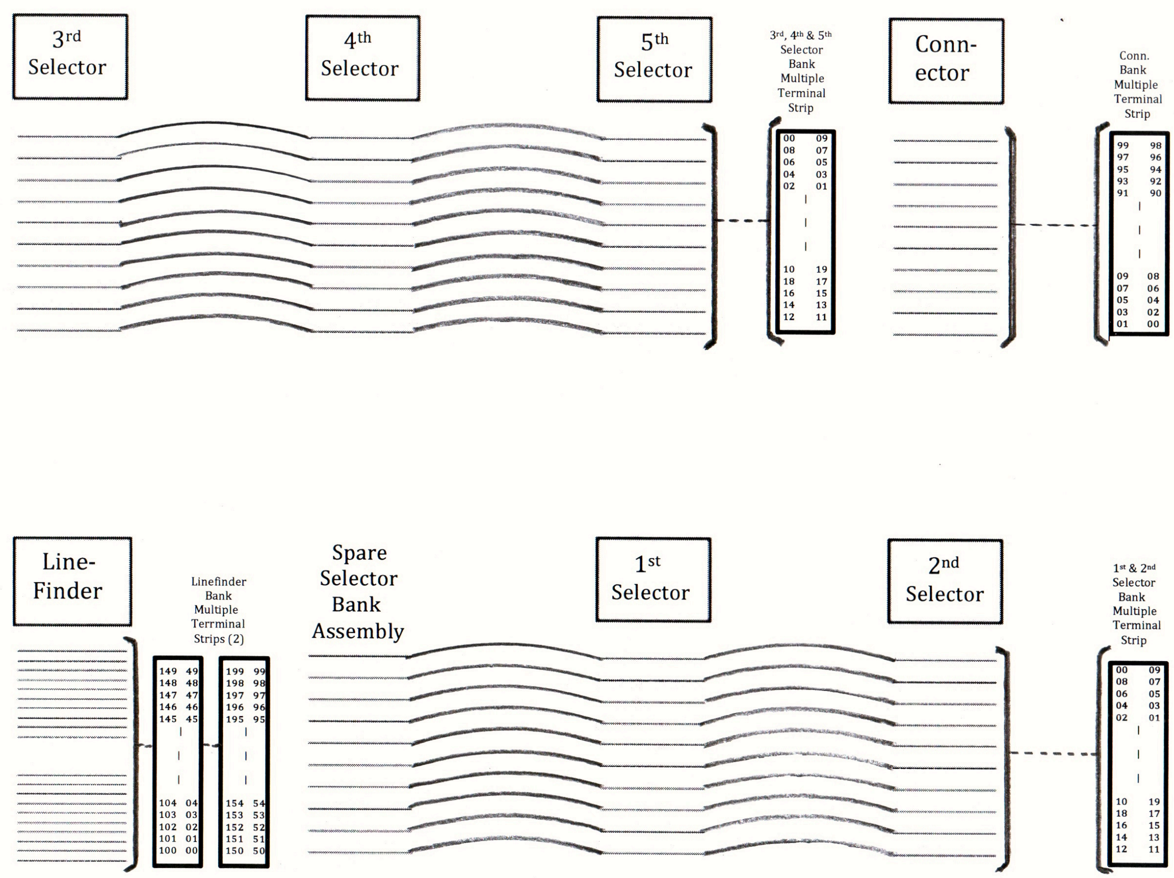
Selector Bank Wiring

The following 2 diagrams show the selector and connector terminal numbering and the selector multipling arrangements.

<u>Numbering of the Terminal Contacts on the Selector and Connector Banks</u>



Bank Multipling Arrangement



As can be seen from the multipling diagram, the banks of the 1st and 2nd selectors are multipled together and the banks of the 3rd, 4th and 5th selectors are multipled together. This is an unorthodox arrangement. In a Central Office environment, banks of different ranks of selectors would not normally be multipled together. However, it works in the demonstration unit because there is only one selector in each rank (1st through 5th), only one working trunk on any level used and only one call can be in use at any given time. Because of this, the bank multipling presents no conflicts in the routing of calls. The reason for this multipling arrangement is that two 3-bank multiple assemblies along with their associated terminal strips were retrieved intact from a Central Office. Stripping them apart would have been a lot of unnecessary work. Also leaving them intact allows for demonstration of what Central Office bank multipling looks like and makes for a neat display.

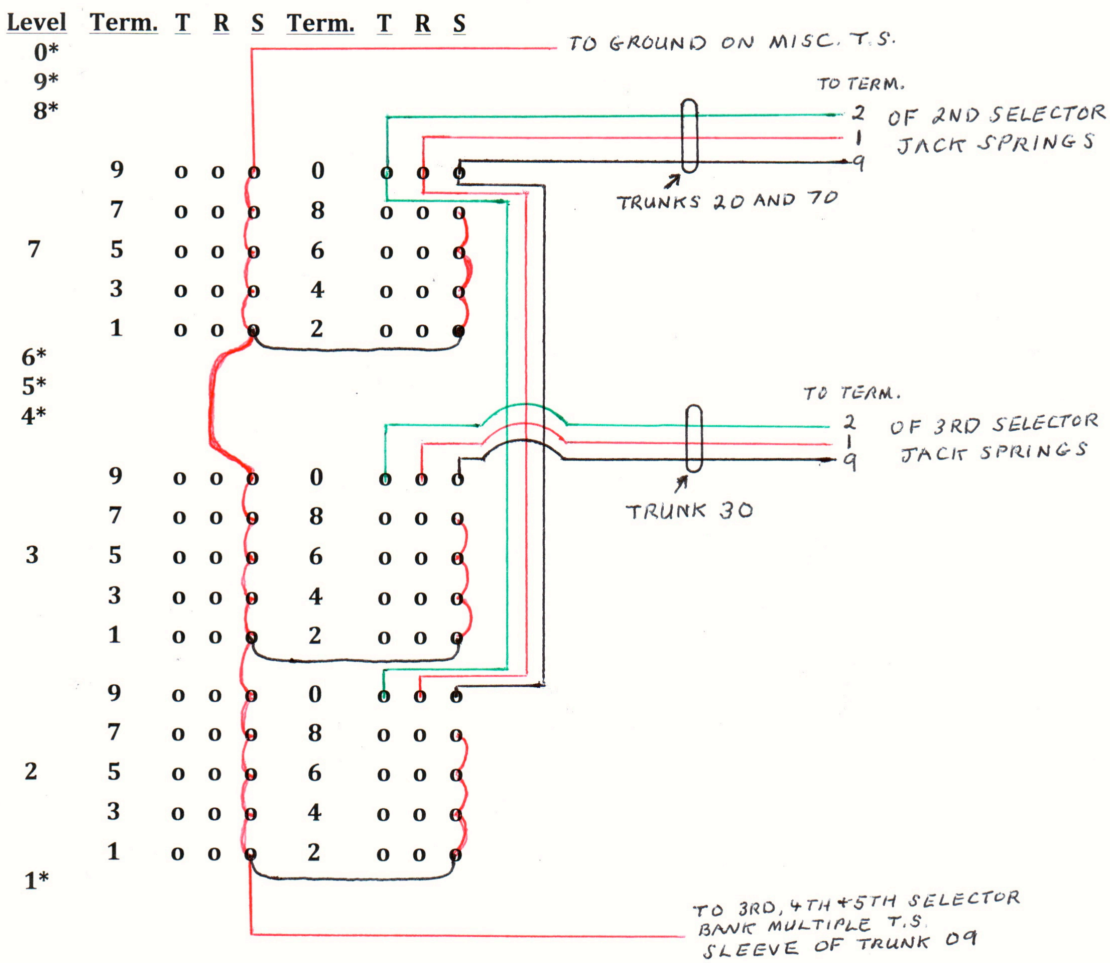
On each selector, only one trunk is wired on each level utilized. The wired trunk is always the 10th choice trunk on the level. This forces the selector to perform the maximum trunk hunting motion possible. Again, this is on purpose because this is a demonstration unit. This has been accomplished by grounding the sleeve terminals of trunks 1 to 9 on all selector levels utilized. Because only two telephone numbers are demonstrated, each selector will only have either one or two levels with a working trunk. Since the selectors are all of the digit absorbing type, the normal post cams have all been set to absorb repeatedly on all levels without a working trunk. If a number associated with a nonworking trunk is dialed, the switch shaft and wipers will drop back to their normal position, allowing the caller to recognize that an incorrect digit was dialed and that the mistake can be corrected by redialing the proper digit.

The jumper wiring for the 1st and 2nd selector multiple is shown below followed by the jumper wiring for the 3rd, 4th and 5th selector multiple.

.

.

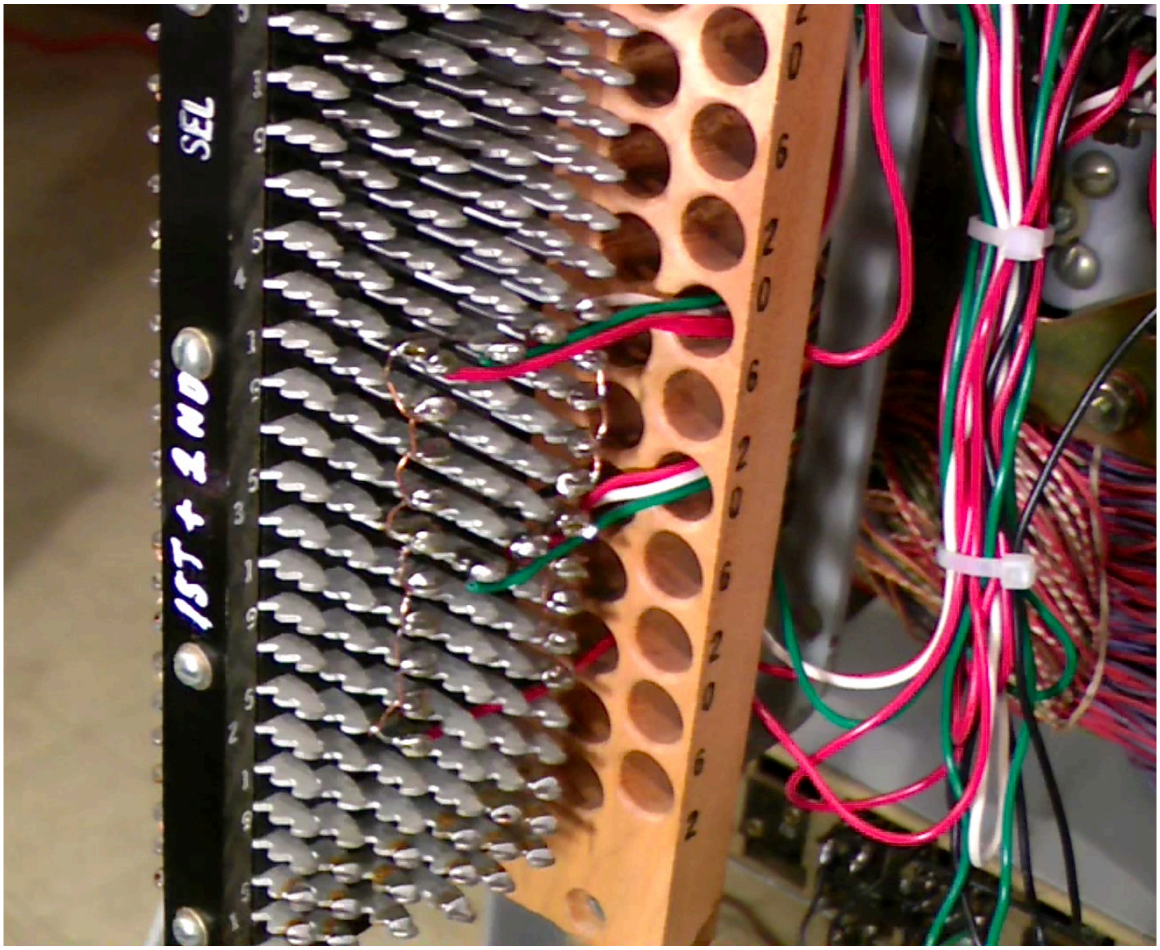
Wiring of 1st & 2nd Selector Bank Multiple Terminal Strip



* There are no jumper wires on any of the trunks on levels 1, 4, 5, 6, 8, 9 or 0.

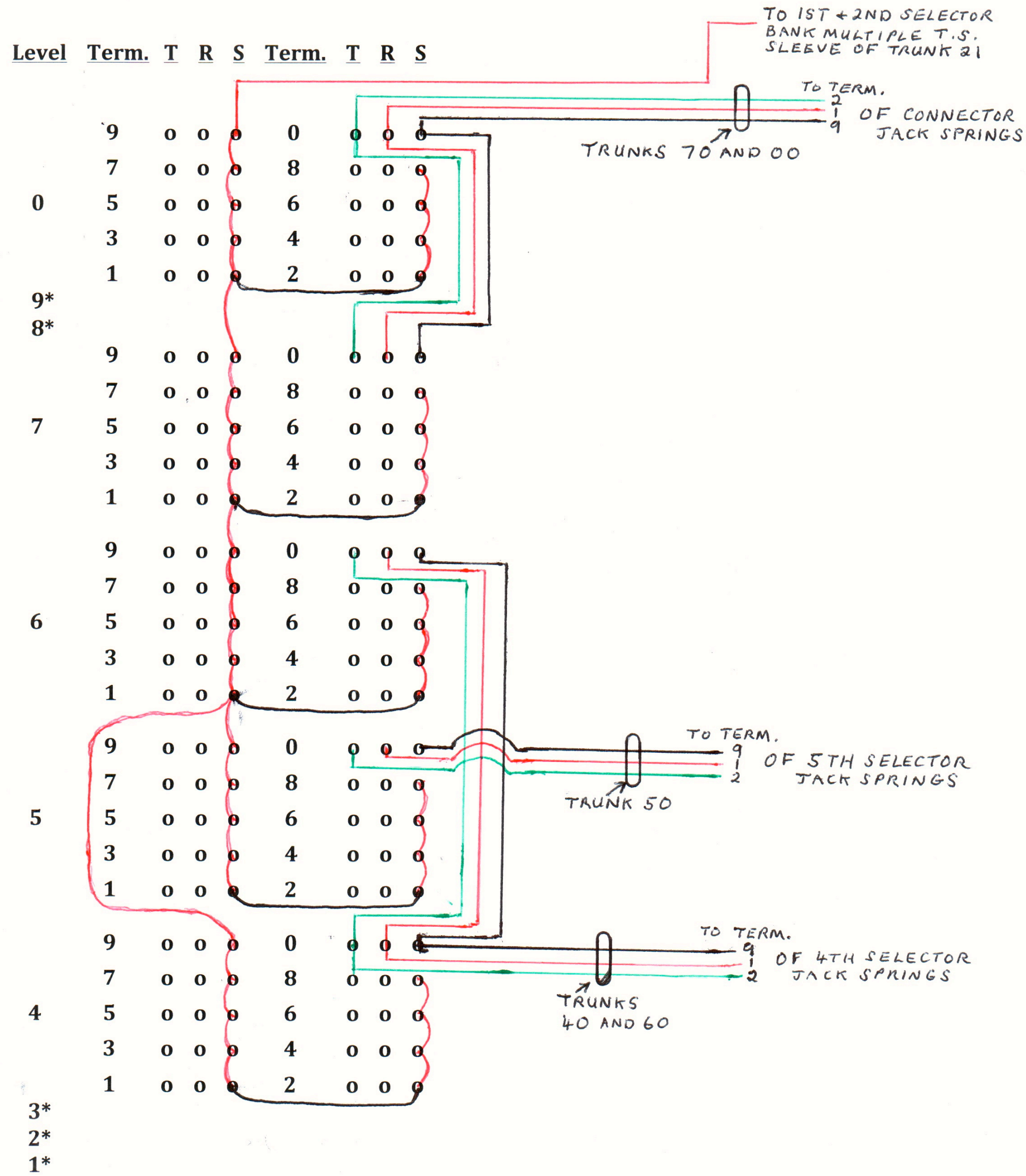
Note: On this diagram, the sleeve wires are shown in black. The actual sleeve wiring is white.

On the combined 1st & 2nd selector bank multiple, the trunks on terminals 20 and 70 are utilized to provide access from the 1st to the 2nd selector. On this same bank multiple, the trunk on terminal 30 is utilized to provide access from the 2nd to the 3rd selector. The trunks on terminals 21 to 29, 31 to 39 and 71 to 79 are artificially made busy with a permanently wired ground on their sleeve leads. This forces the selectors to rotate (hunt) to the tenth rotary position on these levels where the desired trunks are located.



Ground Strapping On The Sleeve Leads Of Trunks 21 To 29 And 31 To 39 On The 1st & 2nd Selector Multiple Terminal Strip

Jumper Wiring of 3rd, 4th & 5th Selector Bank Multiple Terminal Strip

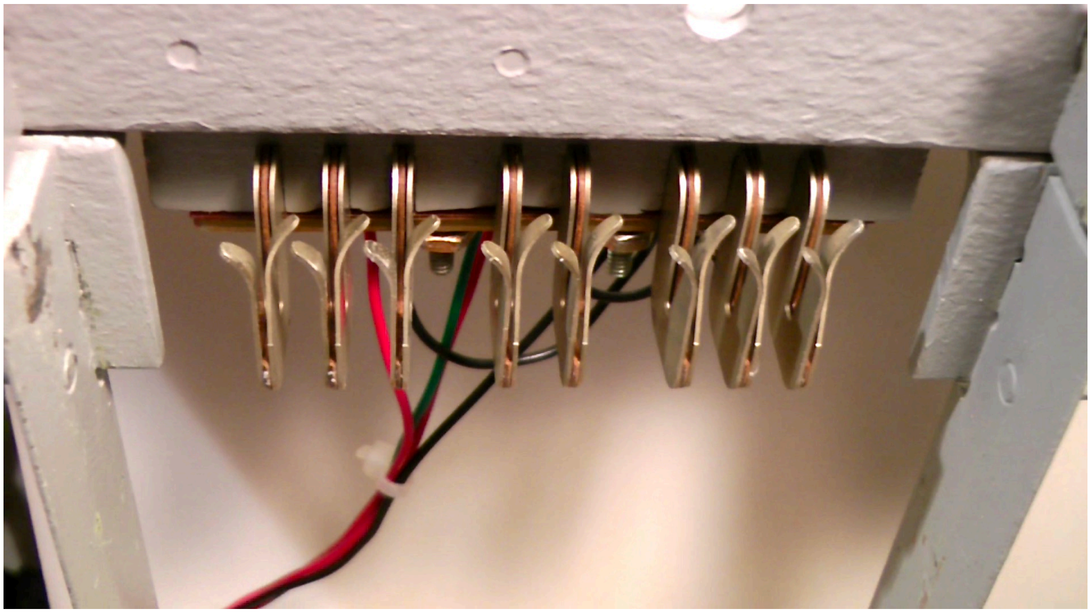


* There are no jumper wires on any of the trunks on levels 1, 2, 3, 8 or 9.

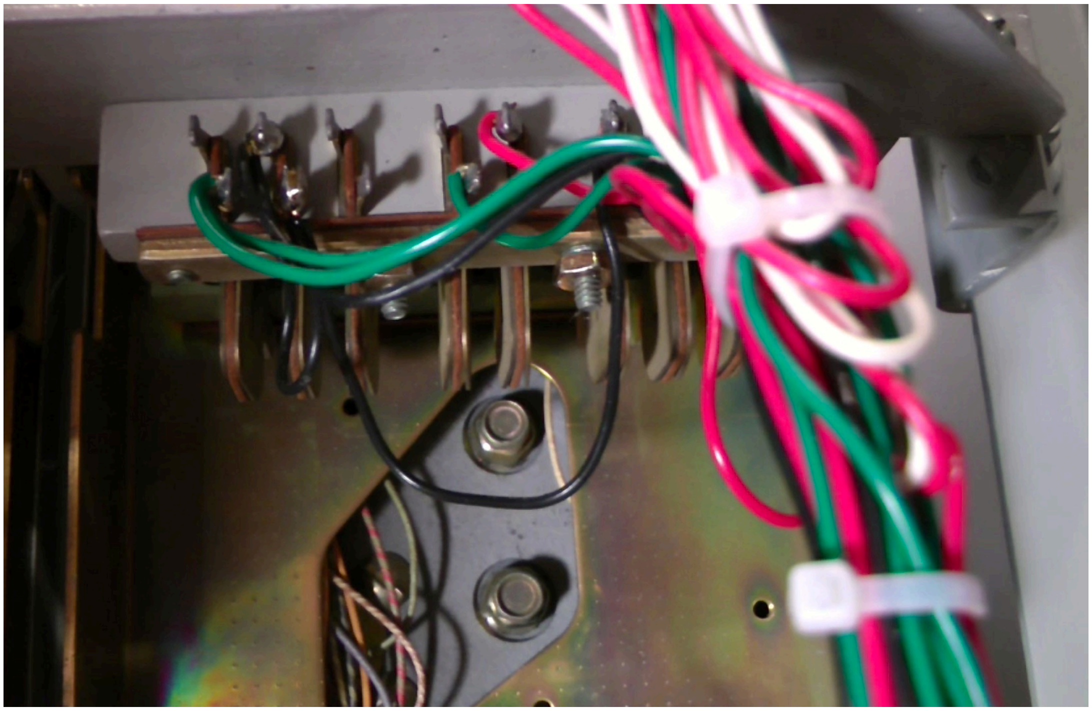
Note: On this diagram, the sleeve wires are shown in black. The actual sleeve wiring is white.

On the combined 3rd, 4th and 5th selector bank multiple, the trunks on terminals 40 and 60 are utilized to provide access from the 3rd to the 4th selector. On this same bank multiple, the trunk on terminal 50 is utilized to provide access from the 4th to the 5th selector. Again on this same multiple, the trunks on terminals 70 and 00 are utilized to provide access from the 5th selector to the connector. The trunks on terminals 41 to 49, 51 to 59, 61 to 69, 71 to 79 and 01 to 09 are artificially made busy with a permanently wired ground on their sleeve leads. This forces the selectors to rotate (hunt) to the tenth rotary position on these levels where the desired trunks are located.

Shelf Jack Spring Wiring

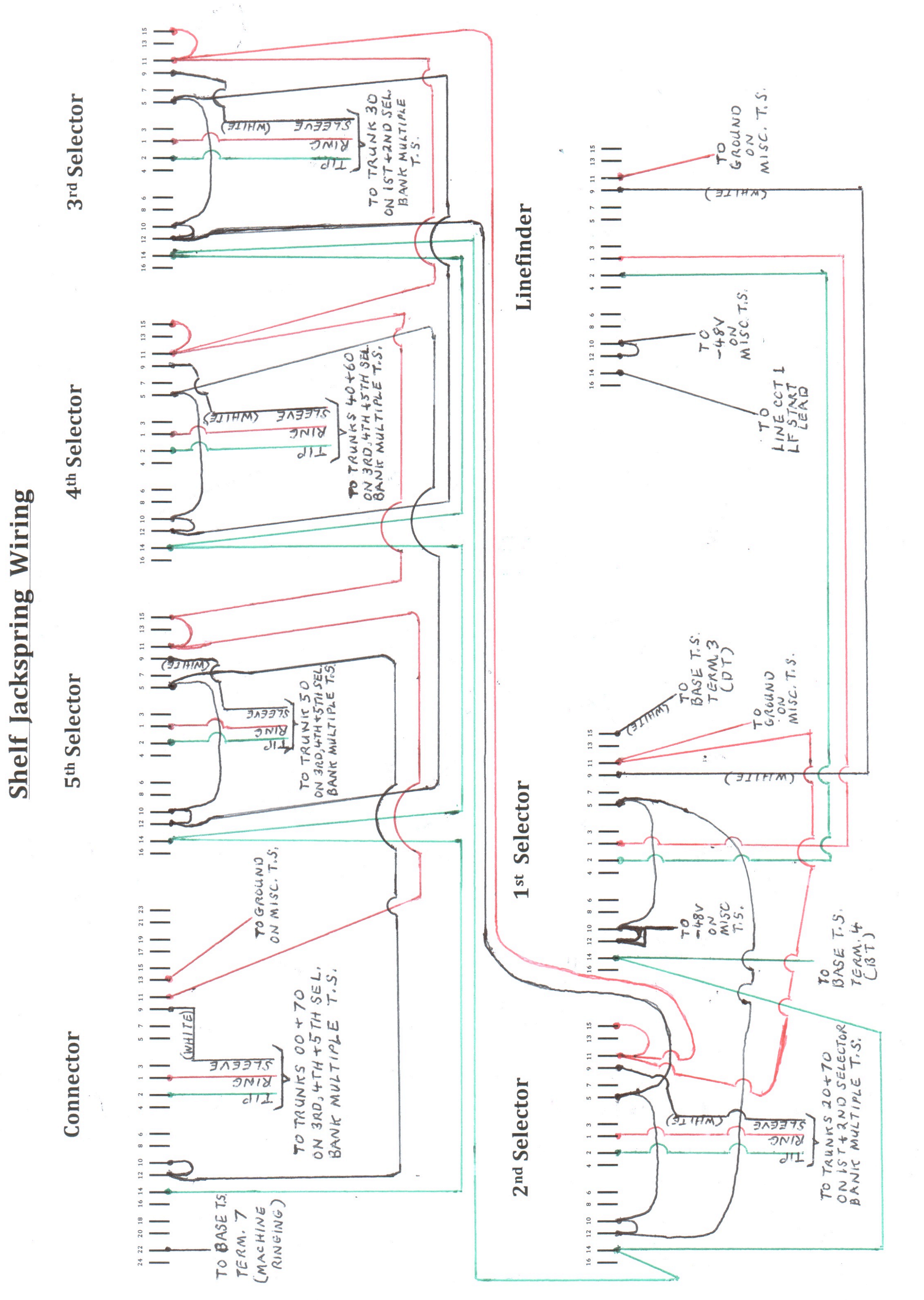


A Set Of Jack Springs Viewed From The Front Of The Unit

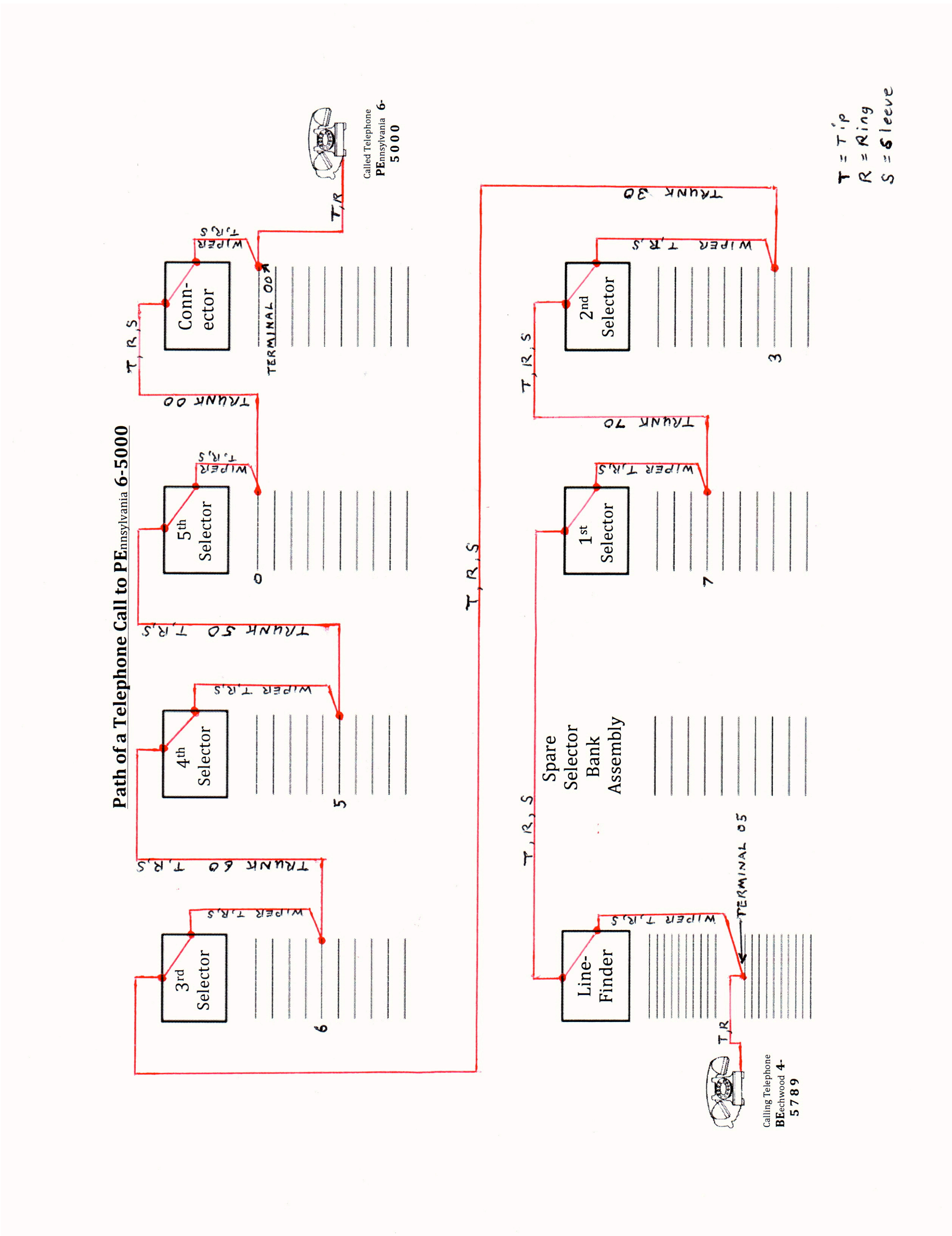


Jack Spring Wiring Viewed From The Rear Of The Unit

The shelf jack spring wiring is shown in the following diagram.



Call Progression From BEechwood 4 – 5789 to PEnnsylvania 6 – 5000



The caller lifts the handset of the BEechwood 4 – 5789 telephone off the switchhook. This closes a loop on the line, which seizes the associated line circuit. Operation of the L relay in the line circuit seizes the linefinder. The line circuit puts battery (-48v) on the sleeve of the line's terminal on the bank multiple and also causes one of the linefinder's ten commutator contact to be grounded to indicate what level on the bank multiple the line appears. This particular line appears on terminal 05 of the bank multiple, which means it is located on the 5th horizontal position of the 10th level. The seizure of the linefinder activates the appropriate relays to cause an upward vertical movement of the shaft. As the shaft with its wipers moves upwards, the commutator wiper slides over the commutator contacts looking for a ground that marks the level of a telephone line requesting service. Only one line is requesting service and it appears on level 0. So there are no grounds present on commutator contacts 1 through 9 and the shaft continues its upwards movement. When it reaches the 10th level, there is a ground on the commutator contact indicating that a line on this level is requesting service. The commutator wiper connects the ground to the appropriate part in the switch relays that causes vertical movement to stop and rotary movement of the shaft to begin. The line (tip and ring) wipers and the sleeve wipers rotate with the shaft, brushing against the tip ring and sleeve contact sets on level 0, one set at a time. The sleeve wiper is looking for battery, which indicates a line requesting service. There is no battery present on contacts 1 through 4 and so rotary motion continues. When the 5th terminal is reached, there is battery on the sleeve contact and the wiper connects it to the appropriate part in the switch that causes rotary motion to stop. The wipers are now in a holding position on bank terminal 05. The tip, ring and sleeve leads of the calling telephone are now connected through the linefinder via its incoming path at the bank multiple, through the wipers, through closed contacts on the linefinder relays to the outgoing tip, ring and sleeve of the linefinder. The linefinder output is connected directly to the 1st selector. The 1st selector is now seized by virtue of the closed loop at the telephone set and its "A" relay operates. The 1st selector assumes control of the switch train and grounds the sleeve lead to keep the linefinder held up in its off-normal position. The power supply generates dial tone, which is permanently connected to the 1st selector. Upon seizure, the first selector connects the dial tone to the incoming tip and ring leads, which can be heard through the receiver of the calling telephone as an indicator that the switching system is ready to for the caller to begin dialing.

The caller inserts a finger into the finger-wheel hole of the dial position for the letter "P", which is also the numerical position "7". The caller rotates the dial clockwise to the stop position. At this point there has been no relay activity at the SXS switch. The finger is removed from the dial and the dial automatically rotates anticlockwise towards its normal resting position. As it does this, it pulses (opens and closes) the line loop seven times, which corresponds to the numeric value of the digit that was dialed. The 1st selector "A" relay reacts to these pulses by releasing and re-operating seven times. This causes the 1st selector's vertical magnet to operate and release seven times, which steps the shaft with its wipers upwards seven steps so that the wipers are aligned with the seventh level of the bank multiple. The selector recognizes that vertical motion has stopped and starts hunting for an idle trunk on level 7 by rotating the shaft. The line (tip and ring) wipers and the sleeve wipers rotate with the shaft, brushing against the tip ring and sleeve contact sets on level 7, one set at a time. The sleeve wiper is looking for an idle trunk condition, which means there should not be any electrical potential (either battery or ground) on the sleeve contact of the trunk. A busy trunk (i.e. one that is being used) will have a ground condition on the sleeve contact of the bank multiple. There are no trunks wired to contacts 1 through 9 on level 7 of the bank multiple. However, the wiring of the demonstration unit has connected ground to sleeve contacts 1 through 9 of level 7. This simulates busy trunks and causes the shaft to continue rotating until it reaches the 10th contact. When the 10th contact is reached, there is no ground on the sleeve and the wiper connects it to the appropriate part in the switch that causes rotary motion to stop. The wipers are now in a holding position on trunk 70. In this application, a trunk is merely a set of three wires (tip, ring and sleeve) joining two selectors. The tip, ring and sleeve leads of the calling telephone are now connected through to trunk 70 via the linefinder bank multiple, wipers and relay contacts and the 1st selector relay contacts, wipers and bank multiple. Trunk 70 is connected directly to the 2nd selector. The 2nd selector is now seized by virtue of the closed loop at the telephone set and its “A” relay operates. The 2nd selector assumes control of the switch train and grounds the sleeve lead to keep the linefinder and 1st selector held up in their off-normal positions.

The caller inserts a finger into the finger-wheel hole of the dial position for the letter “E”, which is also the numerical position “3”. The caller rotates the dial clockwise to the stop position. At this point there has been no relay activity at the SXS switch. The finger is removed from the dial and the dial automatically rotates anticlockwise towards its normal resting position. As it does this, it pulses (opens and closes) the line loop three times, which corresponds to the numeric value of the digit that was dialed. The 2nd selector “A” relay reacts to these pulses by releasing and re-operating three times. This causes the 2nd selector’s vertical magnet to operate and release three times, which steps the shaft with its wipers upwards three steps so that the wipers are aligned with the third level of the bank multiple. The selector recognizes that vertical motion has stopped and starts hunting for an idle trunk on level 3 by rotating the shaft. The line (tip and ring) wipers and the sleeve wipers rotate with the shaft, brushing against the tip ring and sleeve contact sets on level 3, one set at a time. The sleeve wiper is looking for an idle trunk condition, which means there should not be any electrical potential (either battery or ground) on the sleeve contact of the trunk. A busy trunk (i.e. one that is being used) will have a ground condition on the sleeve contact of the bank multiple. There are no trunks wired to contacts 1 through 9 on level 3 of the bank multiple. However, the wiring of the demonstration unit has connected ground to sleeve contacts 1 through 9 of level 3. This simulates busy trunks and causes the shaft to continue rotating until it reaches the 10th contact. When the 10th contact is reached, there is no ground on the sleeve and the wiper connects it to the appropriate part in the switch that causes rotary motion to stop. The wipers are now in a holding position on trunk 30. In this application, a trunk is merely a set of three wires (tip, ring and sleeve) joining two selectors. The tip, ring and sleeve leads of the calling telephone are now connected through to trunk 30 via the linefinder bank multiple, wipers and relay contacts; the 1st selector relay contacts, wipers and bank multiple; and the 2nd selector relay contacts, wipers and bank multiple. Trunk 30 is connected directly to the 3rd selector. The 3rd selector is now seized by virtue of the closed loop at the telephone set and its “A” relay operates. The 3rd selector assumes control of the switch train and grounds the sleeve lead to keep the linefinder, 1st and 2nd selectors held up in their off-normal positions.

The caller inserts a finger into the finger-wheel hole of the dial at numerical position “6”. The caller rotates the dial clockwise to the stop position. At this point there has been no relay activity at the SXS switch. The finger is removed from the dial and the dial automatically rotates anticlockwise towards its normal resting position. As it does this, it pulses (opens and closes) the line loop six times, which corresponds to the numeric value of the digit that was dialed. The 3rd selector “A” relay reacts to these pulses by releasing and re-operating six times. This causes the 3rd selector’s vertical magnet to operate and release six times, which steps the shaft with its wipers upwards six steps so that the wipers are aligned with the sixth level of the bank multiple. The selector recognizes that vertical motion has stopped and starts hunting for an idle trunk on level 6 by rotating the shaft. The line (tip and ring) wipers and the sleeve wipers rotate with the shaft, brushing against the tip ring and sleeve contact sets on level 6, one set at a time. The sleeve wiper is looking for an idle trunk condition, which means there should not be any electrical potential (either battery or ground) on the sleeve contact of the trunk. A busy trunk (i.e. one that is being used) will have a ground condition on the sleeve contact of the bank multiple. There are no trunks wired to contacts 1 through 9 on level 6 of the bank multiple. However, the wiring of the demonstration unit has connected ground to sleeve contacts 1 through 9 of level 6. This simulates busy trunks and causes the shaft to continue rotating until it reaches the 10th contact. When the 10th contact is reached, there is no ground on the sleeve and the wiper connects it to the appropriate part in the switch that causes rotary motion to stop. The wipers are now in a holding position on trunk 60. In this application, a trunk is merely a set of three wires (tip, ring and sleeve) joining two selectors. The tip, ring and sleeve leads of the calling telephone are now connected through to trunk 60 via the linefinder bank multiple, wipers and relay contacts; the 1st selector relay contacts, wipers and bank multiple; the 2nd selector relay contacts, wipers and bank multiple; and the 3rd selector relay contacts, wipers and bank multiple. Trunk 60 is connected directly to the 4th selector. The 4th selector is now seized by virtue of the closed loop at the telephone set and its “A” relay operates. The 4th selector assumes control of the switch train and grounds the sleeve lead to keep the linefinder, 1st, 2nd and 3rd selectors held up in their off-normal positions.

The caller inserts a finger into the finger-wheel hole of the dial at numerical position “5”. The caller rotates the dial clockwise to the stop position. At this point there has been no relay activity at the SXS switch. The finger is removed from the dial and the dial automatically rotates anticlockwise towards its normal resting position. As it does this, it pulses (opens and closes) the line loop five times, which corresponds to the numeric value of the digit that was dialed. The 4th selector "A" relay reacts to these pulses by releasing and re-operating five times. This causes the 4th selector's vertical magnet to operate and release five times, which steps the shaft with its wipers upwards five steps so that the wipers are aligned with the fifth level of the bank multiple. The selector recognizes that vertical motion has stopped and starts hunting for an idle trunk on level 5 by rotating the shaft. The line (tip and ring) wipers and the sleeve wipers rotate with the shaft, brushing against the tip ring and sleeve contact sets on level 5, one set at a time. The sleeve wiper is looking for an idle trunk condition, which means there should not be any electrical potential (either battery or ground) on the sleeve contact of the trunk. A busy trunk (i.e. one that is being used) will have a ground condition on the sleeve contact of the bank multiple. There are no trunks wired to contacts 1 through 9 on level 5 of the bank multiple. However, the wiring of the demonstration unit has connected ground to sleeve contacts 1 through 9 of level 5. This simulates busy trunks and causes the shaft to continue rotating until it reaches the 10^{th} contact. When the 10^{th} contact is reached, there is no ground on the sleeve and the wiper connects it to the appropriate part in the switch that causes rotary motion to stop. The wipers are now in a holding position on trunk 50. In this application, a trunk is merely a set of three wires (tip, ring and sleeve) joining two selectors. The tip, ring and sleeve leads of the calling telephone are now connected through to trunk 50 via the linefinder bank multiple, wipers and relay contacts; the 1^{st} selector relay contacts, wipers and bank multiple; the 2^{nd} selector relay contacts, wipers and bank multiple; the 3rd selector relay contacts, wipers and bank multiple; and the 4th selector relay contacts, wipers and bank multiple. Trunk 50 is connected directly to the 5th selector. The 5th selector is now seized by virtue of the closed loop at the telephone set and its "A" relay operates. The 5th selector assumes control of the switch train and grounds the sleeve lead to keep the linefinder, 1^{st}, 2^{nd}, 3^{rd} and 4th selectors held up in their off-normal positions.

The caller inserts a finger into the finger-wheel hole of the dial at numerical position "0". The caller rotates the dial clockwise to the stop position. At this point there has been no relay activity at the SXS switch. The finger is removed from the dial and the dial automatically rotates anticlockwise towards its normal resting position. As it does this, it pulses (opens and closes) the line loop ten times, which corresponds to the numeric value of the digit that was dialed. The 5th selector "A" relay reacts to these pulses by releasing and re-operating ten times. This causes the 5th selector's vertical magnet to operate and release 10 times, which steps the shaft with its wipers upwards 10 steps so that the wipers are aligned with the tenth level (called level 0) of the bank multiple. The selector recognizes that vertical motion has stopped and starts hunting for an idle trunk on level 0 by rotating the shaft. The line (tip and ring) wipers and the sleeve wipers rotate with the shaft, brushing against the tip ring and sleeve contact sets on level 0, one set at a time. The sleeve wiper is looking for an idle trunk condition, which means there should not be any electrical potential (either battery or ground) on the sleeve contact of the trunk. A busy trunk (i.e. one that is being used) will have a ground condition on the sleeve contact of the bank multiple. There are no trunks wired to contacts 1 through 9 on level 0 of the bank multiple. However, the wiring of the demonstration unit has connected ground to sleeve contacts 1 through 9 of level 0. This simulates busy trunks and causes the shaft to continue rotating until it reaches the 10th contact. When the 10th contact is reached, there is no ground on the sleeve and the wiper connects it to the appropriate part in the switch that causes rotary motion to stop. The wipers are now in a holding position on trunk 00. In this application, a trunk is merely a set of three wires (tip, ring and sleeve) joining a selector and a connector. The tip, ring and sleeve leads of the calling telephone are now connected through to trunk 00 via the linefinder bank multiple, wipers and relay contacts; the 1st selector relay contacts, wipers and bank multiple; the 2nd selector relay contacts, wipers and bank multiple; the 3rd selector relay contacts, wipers and bank multiple; the 4th selector relay contacts, wipers and bank multiple; and the 5th selector relay contacts, wipers and bank multiple. Trunk 00 is connected directly to the connector. The connector is now seized by virtue of the closed loop at the telephone set and its "A" relay operates. The connector assumes control of the switch train and grounds the sleeve lead to keep the linefinder, 1st, 2nd, 3rd, 4th and 5th selectors held up in their off-normal positions.

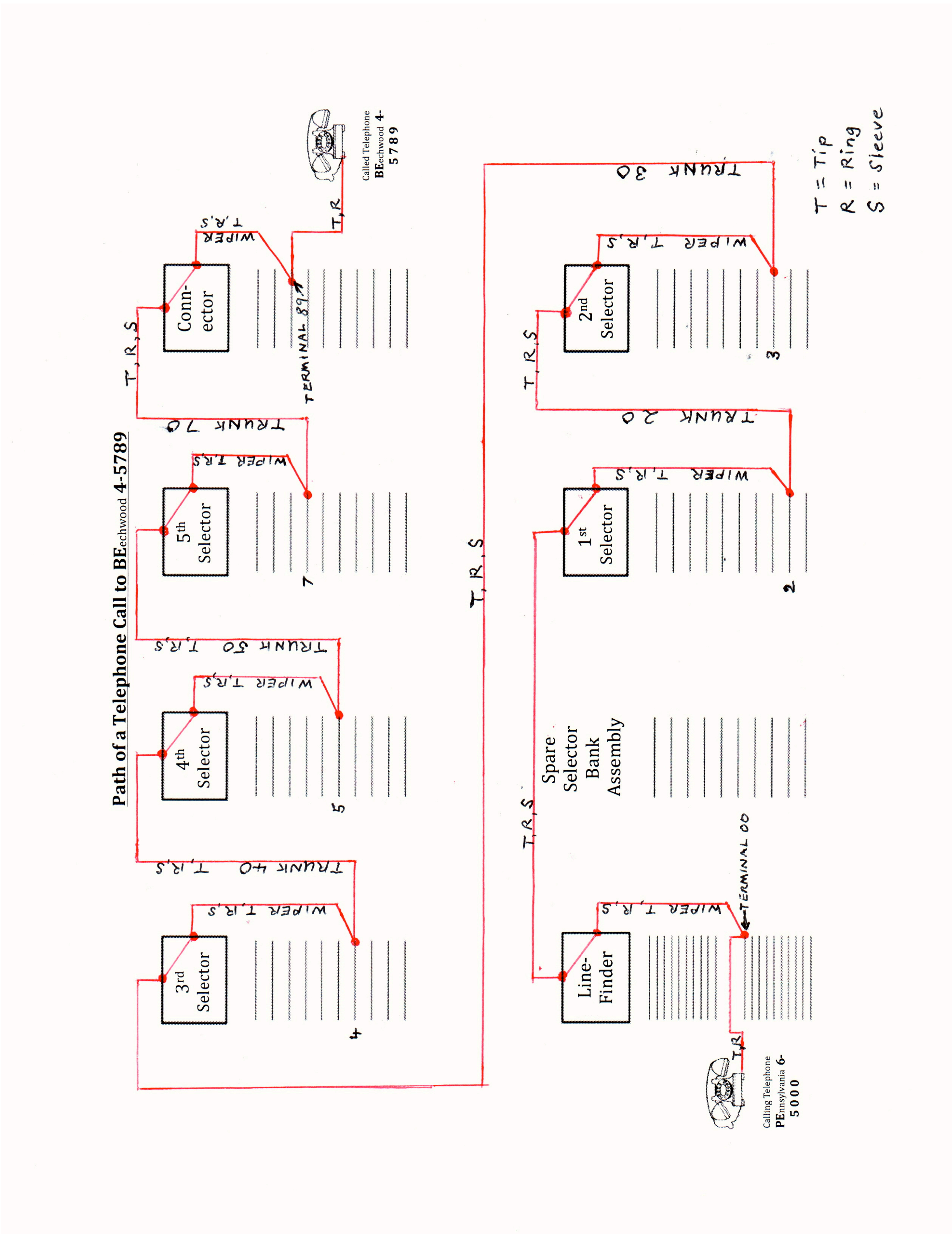
The caller inserts a finger into the finger-wheel hole of the dial at numerical position "0". The caller rotates the dial clockwise to the stop position. At this point there has been no relay activity at the SXS switch. The finger is removed from the dial and the dial automatically rotates anticlockwise towards its normal resting position. As it does this, it pulses (opens and closes) the line loop ten times, which corresponds to the numeric value of the digit that was dialed. The connector "A" relay reacts to these pulses by releasing and re-operating ten times. This causes the connector's vertical magnet to operate and release ten times, which steps the shaft with its wipers upwards ten steps so that the wipers are aligned with the tenth level (called level 0) of the bank multiple. The connector recognizes that vertical motion has stopped and prepares the connector shaft for rotary motion and awaits the last number to be dialed. The caller inserts a finger into the finger-wheel hole of the dial at numerical position "0". The caller rotates the dial clockwise to the stop position. At this point there has been no relay activity at the SXS switch. The finger is removed from the dial and the dial automatically rotates anticlockwise towards its normal resting position. As it does this, it pulses (opens and closes) the line loop ten times, which corresponds to the numeric value of the digit that was dialed. The connector "A" relay reacts to these pulses by releasing and re-operating ten times. This causes the connector's rotary magnet to operate and release ten times, which steps the shaft with its wipers horizontally ten steps. The line (tip and ring) wipers and the sleeve wipers rotate with the shaft, brushing against the tip ring and sleeve contact sets on level 0, one set at a time. When the 10th contact is reached, rotary motion stops since there are no more pulses being received. Since the called telephone is idle (i.e. on-hook), there will be battery on the sleeve contact of the bank multiple supplied from the called telephone's line circuit. The power supply ringing current is permanently connected to the connector. When the connector recognizes battery on the sleeve, it connects the ringing current to the called line. A small portion is also sent back to the calling telephone to provide an audible ringing signal. The PEnnsylvania 6 – 5000 telephone set now begins to ring. The ringing current has a cadence of 2 seconds on and 4 seconds off.

When the called party answers, it closes the loop on the called line. This is recognized by the connector and it removes ringing current from the line and connects the incoming tip, ring and sleeve from the 5th selector to the outgoing tip, ring, and sleeve of the called line. The calling and called parties are now connected and may begin their conversation.

If the called party was already busy when this call came through, there would be ground on the sleeve instead of battery. The power supply busy tone (a 60 interruptions per minute tone) is permanently connected to the connector. When the connector recognizes ground on the sleeve, it connects busy tone to the calling line.

The entire switch train is held up for the duration of the call by a ground supplied through the connector. The connector itself is under control of the calling party. When the calling party hangs up, the loop on the line opens, which causes the "A" relay in the connector to release and all other connector relays follow suit. This removes the ground from the sleeve and all the switches release to their normal (idle) position. If only the called party hangs up, the entire switch train remains held up. In Central Offices, an option was available to cause the switch train to return to normal when either party hangs up.

Call Progression From PEnnsylvania 6 – 5000 to BEechwood 4 – 5789



The caller lifts the handset of the PEnnsylvania 6 – 5000 telephone off the switchhook. This closes a loop on the line, which seizes the associated line circuit. Operation of the L relay in the line circuit seizes the linefinder. The line circuit puts battery (-48v) on the sleeve of the line's terminal on the bank multiple and also causes one of the linefinder's ten commutator contact to be grounded to indicate what level on the bank multiple the line appears. This particular line appears on terminal 00 of the bank multiple, which means it is located on the 10th horizontal position of the 10th level. The seizure of the linefinder activates the appropriate relays to cause an upward vertical movement of the shaft. As the shaft with its wipers moves upwards, the commutator wiper slides over the commutator contacts looking for a ground that marks the level of a telephone line requesting service. Only one line is requesting service and it appears on level 0. So there are no grounds present on commutator contacts 1 through 9 and the shaft continues its upwards movement. When it reaches the 10th level, there is a ground on the commutator contact indicating that a line on this level is requesting service. The commutator wiper connects the ground to the appropriate part in the switch relays that causes vertical movement to stop and rotary movement of the shaft to begin. The line (tip and ring) wipers and the sleeve wipers rotate with the shaft, brushing against the tip ring and sleeve contact sets on level 0, one set at a time. The sleeve wiper is looking for battery, which indicates a line requesting service. There is no battery present on contacts 1 through 9 and so rotary motion continues. When the 10th terminal is reached, there is battery on the sleeve contact and the wiper connects it to the appropriate part in the switch that causes rotary motion to stop. The wipers are now in a holding position on bank terminal 00. The tip, ring and sleeve leads of the calling telephone are now connected through the linefinder via its incoming path at the bank multiple, through the wipers, through closed contacts on the linefinder relays to the outgoing tip, ring and sleeve of the linefinder. The linefinder output is connected directly to the 1st selector. The 1st selector is now seized by virtue of the closed loop at the telephone set and its "A" relay operates. The 1st selector assumes control of the switch train and grounds the sleeve lead to keep the linefinder held up in its off-normal position. The power supply generates dial tone, which is permanently connected to the 1st selector. Upon seizure, the first selector connects the dial tone to the incoming tip and ring leads, which can be heard through the receiver of the calling telephone as an indicator that the switching system is ready to for the caller to begin dialing.

The caller inserts a finger into the finger-wheel hole of the dial position for the letter "B", which is also the numerical position "2". The caller rotates the dial clockwise to the stop position. At this point there has been no relay activity at the SXS switch. The finger is removed from the dial and the dial automatically rotates anticlockwise towards its normal resting position. As it does this, it pulses (opens and closes) the line loop twice, which corresponds to the numeric value of the digit that was dialed. The 1st selector "A" relay reacts to these pulses by releasing and re-operating twice. This causes the 1st selector's vertical magnet to operate and release twice, which steps the shaft with its wipers upwards two steps so that the wipers are aligned with the second level of the bank multiple. The selector recognizes that vertical motion has stopped and starts hunting for an idle trunk on level 2 by rotating the shaft. The line (tip and ring) wipers and the sleeve wipers rotate with the shaft, brushing against the tip ring and sleeve contact sets on level 2, one set at a time. The sleeve wiper is looking for an idle trunk condition, which means there should not be any electrical potential (either battery or ground) on the sleeve contact of the trunk. A busy trunk (i.e. one that is being used) will have a ground condition on the sleeve contact of the bank multiple. There are no trunks wired to contacts 1 through 9 on level 2 of the bank multiple. However, the wiring of the demonstration unit has connected ground to sleeve contacts 1 through 9 of level 2. This simulates busy trunks and causes the shaft to continue rotating until it reaches the 10th contact. When the 10th contact is reached, there is no ground on the sleeve and the wiper connects it to the appropriate part in the switch that causes rotary motion to stop. The wipers are now in a holding position on trunk 20. In this application, a trunk is merely a set of three wires (tip, ring and sleeve) joining two selectors. The tip, ring and sleeve leads of the calling telephone are now connected through to trunk 20 via the linefinder bank multiple, wipers and relay contacts and the 1st selector relay contacts, wipers and bank multiple. Trunk 20 is connected directly to the 2nd selector. The 2nd selector is now seized by virtue of the closed loop at the telephone set and its “A” relay operates. The 2nd selector assumes control of the switch train and grounds the sleeve lead to keep the linefinder and 1st selector held up in their off-normal positions.

The caller inserts a finger into the finger-wheel hole of the dial position for the letter “E”, which is also the numerical position “3”. The caller rotates the dial clockwise to the stop position. At this point there has been no relay activity at the SXS switch. The finger is removed from the dial and the dial automatically rotates anticlockwise towards its normal resting position. As it does this, it pulses (opens and closes) the line loop three times, which corresponds to the numeric value of the digit that was dialed. The 2nd selector “A” relay reacts to these pulses by releasing and re-operating three times. This causes the 2nd selector’s vertical magnet to operate and release three times, which steps the shaft with its wipers upwards three steps so that the wipers are aligned with the third level of the bank multiple. The selector recognizes that vertical motion has stopped and starts hunting for an idle trunk on level 3 by rotating the shaft. The line (tip and ring) wipers and the sleeve wipers rotate with the shaft, brushing against the tip ring and sleeve contact sets on level 3, one set at a time. The sleeve wiper is looking for an idle trunk condition, which means there should not be any electrical potential (either battery or ground) on the sleeve contact of the trunk. A busy trunk (i.e. one that is being used) will have a ground condition on the sleeve contact of the bank multiple. There are no trunks wired to contacts 1 through 9 on level 3 of the bank multiple. However, the wiring of the demonstration unit has connected ground to sleeve contacts 1 through 9 of level 3. This simulates busy trunks and causes the shaft to continue rotating until it reaches the 10th contact. When the 10th contact is reached, there is no ground on the sleeve and the wiper connects it to the appropriate part in the switch that causes rotary motion to stop. The wipers are now in a holding position on trunk 30. In this application, a trunk is merely a set of three wires (tip, ring and sleeve) joining two selectors. The tip, ring and sleeve leads of the calling telephone are now connected through to trunk 30 via the linefinder bank multiple, wipers and relay contacts; the 1st selector relay contacts, wipers and bank multiple; and the 2nd selector relay contacts, wipers and bank multiple. Trunk 30 is connected directly to the 3rd selector. The 3rd selector is now seized by virtue of the closed loop at the telephone set and its “A” relay operates. The 3rd selector assumes control of the switch train and grounds the sleeve lead to keep the linefinder, 1st and 2nd selectors held up in their off-normal positions.

The caller inserts a finger into the finger-wheel hole of the dial at numerical position “4”. The caller rotates the dial clockwise to the stop position. At this point there has been no relay activity at the SXS switch. The finger is removed from the dial and the dial automatically rotates anticlockwise towards its normal resting position. As it does this, it pulses (opens and closes) the line loop four times, which corresponds to the numeric value of the digit that was dialed. The 3rd selector “A” relay reacts to these pulses by releasing and re-operating four times. This causes the 3rd selector’s vertical magnet to operate and release four times, which steps the shaft with its wipers upwards four steps so that the wipers are aligned with the fourth level of the bank multiple. The selector recognizes that vertical motion has stopped and starts hunting for an idle trunk on level 4 by rotating the shaft. The line (tip and ring) wipers and the sleeve wipers rotate with the shaft, brushing against the tip ring and sleeve contact sets on level 4, one set at a time. The sleeve wiper is looking for an idle trunk condition, which means there should not be any electrical potential (either battery or ground) on the sleeve contact of the trunk. A busy trunk (i.e. one that is being used) will have a ground condition on the sleeve contact of the bank multiple. There are no trunks wired to contacts 1 through 9 on level 4 of the bank multiple. However, the wiring of the demonstration unit has connected ground to sleeve contacts 1 through 9 of level 4. This simulates busy trunks and causes the shaft to continue rotating until it reaches the 10th contact. When the 10th contact is reached, there is no ground on the sleeve and the wiper connects it to the appropriate part in the switch that causes rotary motion to stop. The wipers are now in a holding position on trunk 40. In this application, a trunk is merely a set of three wires (tip, ring and sleeve) joining two selectors. The tip, ring and sleeve leads of the calling telephone are now connected through to trunk 40 via the linefinder bank multiple, wipers and relay contacts; the 1st selector relay contacts, wipers and bank multiple; the 2nd selector relay contacts, wipers and bank multiple; and the 3rd selector relay contacts, wipers and bank multiple. Trunk 40 is connected directly to the 4th selector. The 4th selector is now seized by virtue of the closed loop at the telephone set and its “A” relay operates. The 4th selector assumes control of the switch train and grounds the sleeve lead to keep the linefinder, 1st, 2nd and 3rd selectors held up in their off-normal positions.

The caller inserts a finger into the finger-wheel hole of the dial at numerical position “5”. The caller rotates the dial clockwise to the stop position. At this point there has been no relay activity at the SXS switch. The finger is removed from the dial and the dial automatically rotates anticlockwise towards its normal resting position. As it does this, it pulses (opens and closes) the line loop five times, which corresponds to the numeric value of the digit that was dialed. The 4th selector "A" relay reacts to these pulses by releasing and re-operating five times. This causes the 4th selector's vertical magnet to operate and release five times, which steps the shaft with its wipers upwards five steps so that the wipers are aligned with the fifth level of the bank multiple. The selector recognizes that vertical motion has stopped and starts hunting for an idle trunk on level 5 by rotating the shaft. The line (tip and ring) wipers and the sleeve wipers rotate with the shaft, brushing against the tip ring and sleeve contact sets on level 5, one set at a time. The sleeve wiper is looking for an idle trunk condition, which means there should not be any electrical potential (either battery or ground) on the sleeve contact of the trunk. A busy trunk (i.e. one that is being used) will have a ground condition on the sleeve contact of the bank multiple. There are no trunks wired to contacts 1 through 9 on level 5 of the bank multiple. However, the wiring of the demonstration unit has connected ground to sleeve contacts 1 through 9 of level 5. This simulates busy trunks and causes the shaft to continue rotating until it reaches the 10^{th} contact. When the 10^{th} contact is reached, there is no ground on the sleeve and the wiper connects it to the appropriate part in the switch that causes rotary motion to stop. The wipers are now in a holding position on trunk 50. In this application, a trunk is merely a set of three wires (tip, ring and sleeve) joining two selectors. The tip, ring and sleeve leads of the calling telephone are now connected through to trunk 50 via the linefinder bank multiple, wipers and relay contacts; the 1^{st} selector relay contacts, wipers and bank multiple; the 2^{nd} selector relay contacts, wipers and bank multiple; the 3rd selector relay contacts, wipers and bank multiple; and the 4th selector relay contacts, wipers and bank multiple. Trunk 50 is connected directly to the 5th selector. The 5th selector is now seized by virtue of the closed loop at the telephone set and its "A" relay operates. The 5th selector assumes control of the switch train and grounds the sleeve lead to keep the linefinder, 1^{st}, 2^{nd}, 3^{rd} and 4th selectors held up in their off-normal positions.

The caller inserts a finger into the finger-wheel hole of the dial at numerical position "7". The caller rotates the dial clockwise to the stop position. At this point there has been no relay activity at the SXS switch. The finger is removed from the dial and the dial automatically rotates anticlockwise towards its normal resting position. As it does this, it pulses (opens and closes) the line loop seven times, which corresponds to the numeric value of the digit that was dialed. The 5th selector "A" relay reacts to these pulses by releasing and re-operating seven times. This causes the 5th selector's vertical magnet to operate and release seven times, which steps the shaft with its wipers upwards seven steps so that the wipers are aligned with the seventh level of the bank multiple. The selector recognizes that vertical motion has stopped and starts hunting for an idle trunk on level 7 by rotating the shaft. The line (tip and ring) wipers and the sleeve wipers rotate with the shaft, brushing against the tip ring and sleeve contact sets on level 7, one set at a time. The sleeve wiper is looking for an idle trunk condition, which means there should not be any electrical potential (either battery or ground) on the sleeve contact of the trunk. A busy trunk (i.e. one that is being used) will have a ground condition on the sleeve contact of the bank multiple. There are no trunks wired to contacts 1 through 9 on level 7 of the bank multiple. However, the wiring of the demonstration unit has connected ground to sleeve contacts 1 through 9 of level 7. This simulates busy trunks and causes the shaft to continue rotating until it reaches the 10th contact. When the 10th contact is reached, there is no ground on the sleeve and the wiper connects it to the appropriate part in the switch that causes rotary motion to stop. The wipers are now in a holding position on trunk 70. In this application, a trunk is merely a set of three wires (tip, ring and sleeve) joining a selector and a connector. The tip, ring and sleeve leads of the calling telephone are now connected through to trunk 70 via the linefinder bank multiple, wipers and relay contacts; the 1st selector relay contacts, wipers and bank multiple; the 2nd selector relay contacts, wipers and bank multiple; the 3rd selector relay contacts, wipers and bank multiple; the 4th selector relay contacts, wipers and bank multiple; and the 5th selector relay contacts, wipers and bank multiple. Trunk 70 is connected directly to the connector. The connector is now seized by virtue of the closed loop at the telephone set and its “A” relay operates. The connector assumes control of the switch train and grounds the sleeve lead to keep the linefinder, 1st, 2nd, 3rd, 4th and 5th selectors held up in their off-normal positions.

The caller inserts a finger into the finger-wheel hole of the dial at numerical position “8”. The caller rotates the dial clockwise to the stop position. At this point there has been no relay activity at the SXS switch. The finger is removed from the dial and the dial automatically rotates anticlockwise towards its normal resting position. As it does this, it pulses (opens and closes) the line loop eight times, which corresponds to the numeric value of the digit that was dialed. The connector “A” relay reacts to these pulses by releasing and re-operating eight times. This causes the connector’s vertical magnet to operate and release eight times, which steps the shaft with its wipers upwards eight steps so that the wipers are aligned with the eighth level of the bank multiple. The connector recognizes that vertical motion has stopped and prepares the connector shaft for rotary motion and awaits the last number to be dialed. The caller inserts a finger into the finger-wheel hole of the dial at numerical position “9”. The caller rotates the dial clockwise to the stop position. At this point there has been no relay activity at the SXS switch. The finger is removed from the dial and the dial automatically rotates anticlockwise towards its normal resting position. As it does this, it pulses (opens and closes) the line loop nine times, which corresponds to the numeric value of the digit that was dialed. The connector “A” relay reacts to these pulses by releasing and re-operating nine times. This causes the connector’s rotary magnet to operate and release nine times, which steps the shaft with its wipers horizontally nine steps. The line (tip and ring) wipers and the sleeve wipers rotate with the shaft, brushing against the tip ring and sleeve contact sets on level 8, one set at a time. When the 9th contact is reached, rotary motion stops since there are no more pulses being received. Since the called telephone is idle (i.e. on-hook), there will be battery on the sleeve contact of the bank multiple supplied from the called telephone's line circuit. The power supply ringing current is permanently connected to the connector. When the connector recognizes battery on the sleeve, it connects the ringing current to the called line. A small portion is also sent back to the calling telephone to provide an audible ringing signal. The BEechwood 4 – 5789 telephone set now begins to ring. The ringing current has a cadence of 2 seconds on and 4 seconds off.

When the called party answers, it closes the loop on the called line. This is recognized by the connector and it removes ringing current from the line and connects the incoming tip, ring and sleeve from the 5th selector to the outgoing tip, ring, and sleeve of the called line. The calling and called parties are now connected and may begin their conversation.

If the called party was already busy when this call came through, there would be ground on the sleeve instead of battery. The power supply busy tone (a 60 interruptions per minute tone) is permanently connected to the connector. When the connector recognizes ground on the sleeve, it connects busy tone to the calling line.

The entire switch train is held up for the duration of the call by a ground supplied through the connector. The connector itself is under control of the calling party. When the calling party hangs up, the loop on the line opens, which causes the "A" relay in the connector to release and all other connector relays follow suit. This removes the ground from the sleeve and all the switches release to their normal (idle) position. If only the called party hangs up, the entire switch train remains held up. In Central Offices, an option was available to cause the switch train to return to normal when either party hangs up.