Number group frame for No. 5 crossbar

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Switching Equipment

As in the No. 1 crossbar system, there is no permanent or prearranged association of directory numbers with switch positions on the line link frames of a No. 5 crossbar office.

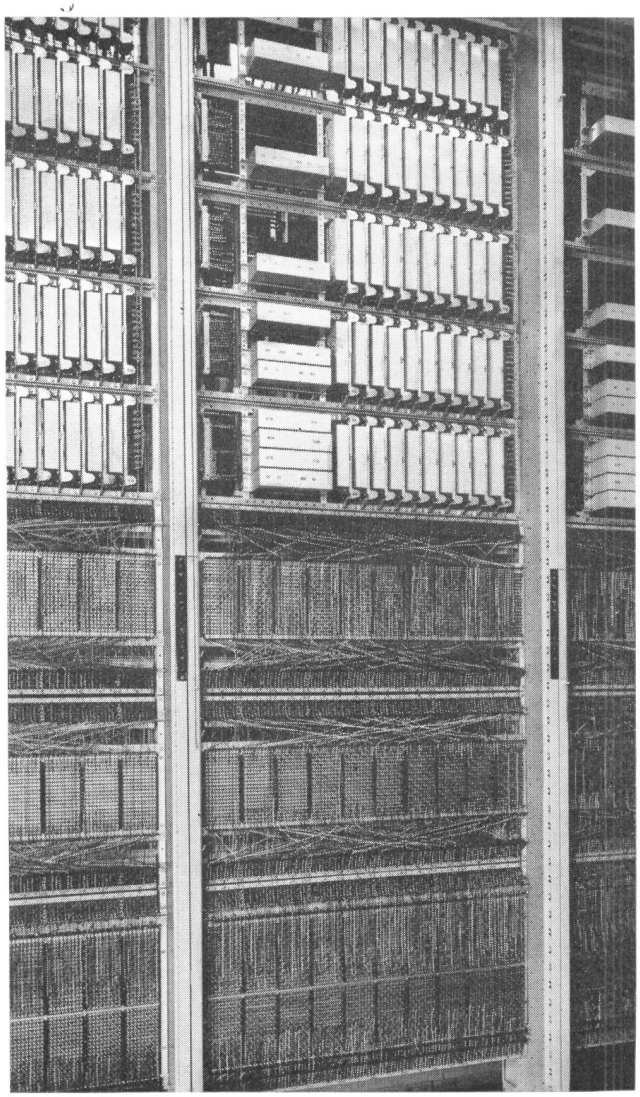

Fig. 1—A number group frame of the No. 5 system.

A marker upon receiving the number for a terminating call must therefore ascertain which one of the many switch verticals in the office is associated with that particular directory number so that a connection may be established. The marker obtains this information from the number group frame. This frame, in a manner of speaking, is a large central file, kept up to date with the latest directory number assignments, to which each marker in turn applies for the necessary information, asking, in effect, on which line link frame and where on that line link frame will the line corresponding to this directory number be found. While getting this information, the marker must also be told the type of ringing required for this number—or the ringing combination as it is called. After this information is received, the marker disconnects itself from the number group, and proceeds to establish connection to the called line.

The position of a particular number on a line link frame is identified by giving the line link frame number, the horizontal group, the vertical group, and the vertical file, while the type of ringing is given as one of fifteen possible ringing combinations. A horizontal group represents the lines associated with all the crossbar switches in the same level of a line link frame, and there are ten such horizontal groups on each frame. A vertical group represents five verticals in the same vertical column on all ten switches of a frame. Any particular frame may have from six to fourteen vertical groups: six when no supplementary bays are used, and fourteen when the full complement of supplementary bays is used. A vertical file represents a single column of verticals, and there are thus five vertical files in each vertical group.

A number group frame, as pictured in Figure 1, is arranged to serve 1000 consecu-

tive directory numbers. Thus, a 10,000-number office would have ten such frames, the first serving numbers 0000 to 0999, the second 1000-1999, etc., up to the last for numbers 9000-9999. The upper part of the frame is filled with relays which receive the directory number from the marker. They in turn extend leads from the marker to three cross-connecting fields occupying the lower half of the frame, where the actual translation from directory number information into equipment location is made. The bottom field serves to identify the line link frame number and is known as the "LL" field. The middle, or "RF," field, identifies the ringing combination and vertical file. The top, or "VHG" field, identifies the vertical and horizontal groups.

Each of these cross-connecting fields consists of an array of terminals in numerical sequence representing directory numbers, and an array of terminals representing specific equipment locations or ringing combinations. A translation is accomplished by means of a jumper wire which connects a particular directory number terminal to the terminal associated with its equipment location or ringing-combination terminal. Figure 2 shows the simplest form such a translating scheme may take, wherein these cross-connections are shown for directory number 2435 to LL 25 (line link frame 25), RF 024 (ringing combination 02, vertical file 4) and VHG 078 (vertical group 7, horizontal group 8). The marker, through paths WL, WF, and WG "wets" or places a potential on the proper directory number terminals, those of number 2435 in this example, whence the jumpers extend this potential to the equipment location terminals. The marker receives this potential back over leads FU, FT (frame units, frame tens), RC, VF (ring combination, vertical file), and HG, VG (horizontal group, vertical group) and thereby recognizes the translation.

A marker gains access to the proper number group frame, in competition with other markers, through its associated number group connector. The choice of number group frame is dictated by the thousands digit of the called directory number. Thus, the number 2435 would be found in number group frame 2; the marker summons that particular number group and is then concerned only with number 435 within that group. For transmitting this number to the number group frame, three sets of ten leads are employed: an HB set to indicate the hundreds digit; a TB set to indicate the tens digit; and a U set to indicate the units digit. As a result of a potential placed on one lead in each of these sets in the marker, relays in the number group connect three other leads from the marker, designated WL, WF, and WG, respectively, to the terminals in the three directory-number arrays representing the particular number wanted. Thus, if the marker has placed a potential on the NO. 4 hundreds lead, the NO. 3 tens lead, and the

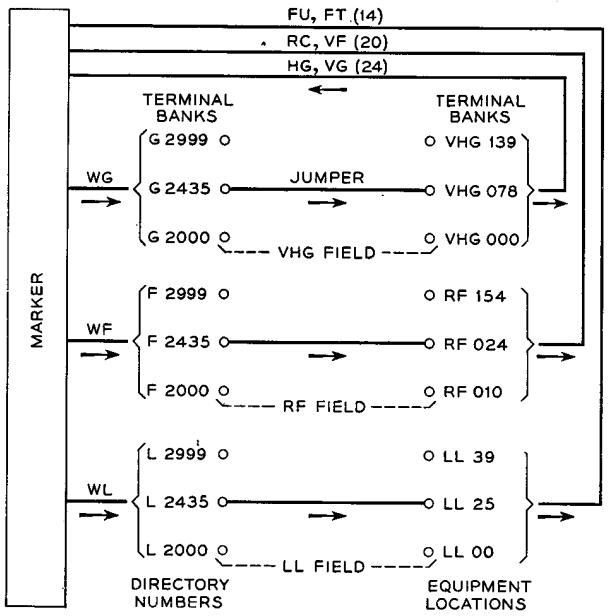

Fig. 2—Simplified diagram of the method of translating from directory numbers to the information the marker needs in locating a line.

NO. 5 units lead, the WL, WF, and WG leads will be connected to terminal NO. 435 of each of the three directory-number arrays. The WL lead will be connected to the array associated with the LL field; the WF lead to the array associated with the RF field; and the WG lead to the array associated with the VHG field.

How this is accomplished is indicated in Figure 3. There are ten hundreds block relays, and each of the ten leads over which the marker transmits the hundreds digit will

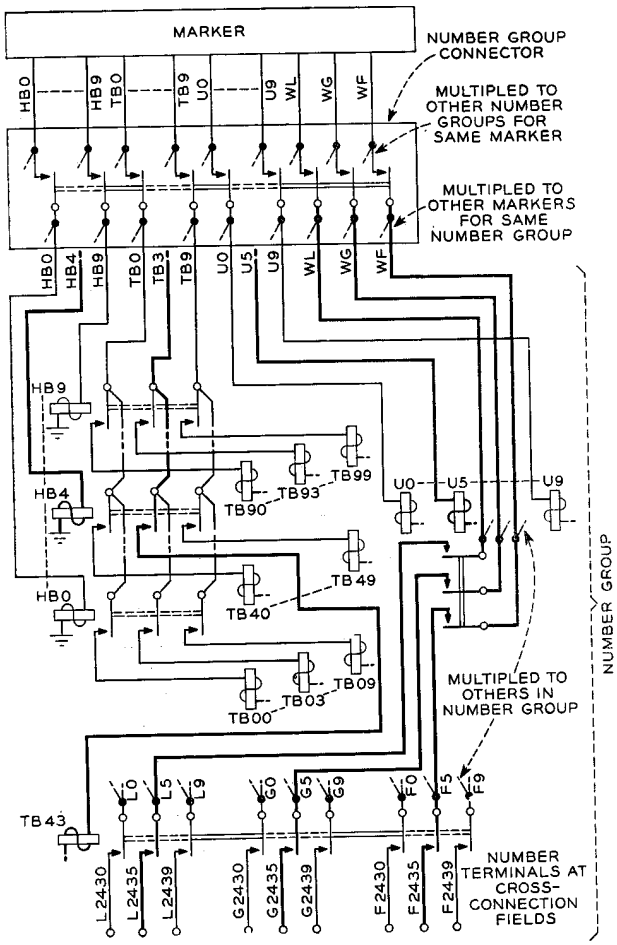

Fig. 3—Simplified schematic of relay circuit in number group that extends battery on WL, WG *and* WF *leads from marker to called directory number terminations of cross-connecting field.*

be connected to the winding of one of them. Each of the hundreds block relays has ten springs, and the ten leads over which the marker transmits the tens digit are connected in multiple to the springs of all the hundreds-block relays. The ten front contacts of each hundreds-block relay are connected to the windings of ten tens-block relays. In all there are 100 tens-block relays —ten for each of the hundreds block relays. Each tens block relay thus represents ten consecutive directory numbers. The NO. 43 tens-block relay, for example, represents directory numbers from 430 to 439, inclusive, since it is operated only when the NO. 4 hundreds lead and the NO. 3 tens lead have potential on them. Each tens-block relay has thirty springs, or three sets of ten, and each set is connected to one of the three arrays of directory number terminals already mentioned.

Multicontact relays are used for the tens-block relays. Each of such relays has sixty contacts and two operating magnets, but by controlling the magnets independently, each multicontact relay becomes the equivalent of two thirty-contact relays. Fifty multicontact relays are thus required to furnish the 100 tens-block relays, and they are mounted in five rows of ten each on the upper part of the number-group frame as may be seen at the upper right of Figure 1.

Besides the hundreds-block and tens-block relays, designated HB and TB for convenience, there is a group of ten units relays, and the winding of each is connected to one of the ten units leads from the marker. Each of the units relays has three springs, and the WL, WF, and WG leads from the marker are connected in multiple to the three springs of each relay. From the front contacts of the ten units relays there are thus a total of thirty leads, three from each—and these thirty leads are connected in multiple to the thirty springs of each tens-block relay. When a units relay is operated, therefore, the WL, WF, and WG leads will be extended to all the tens-block relays, and through the particular tens-block relay operated will be extended to the three arrays of directory number terminals. In the example taken, only the NO. 43 tens-block relay is operated, and if the NO. 5 units relay is operated, the WL, WF, and WG leads will be extended through the NO. 43 tens-block relay to the terminals of the three directory number arrays that represent NO. 435. Of the 1000 terminals in each of the three arrays, therefore, only terminals numbered 435 will be connected to the WL, WF, and WG leads and will thus have potential on them. Three jumpers then extend this potential to the terminals representing the equipment location and ringing combination and thence back to the marker.

The frame number is indicated to the marker over two sets of leads: a set of four FT leads to indicate the tens digit of the frame number, and a set of ten FU leads to indicate the units digit. This implies that for

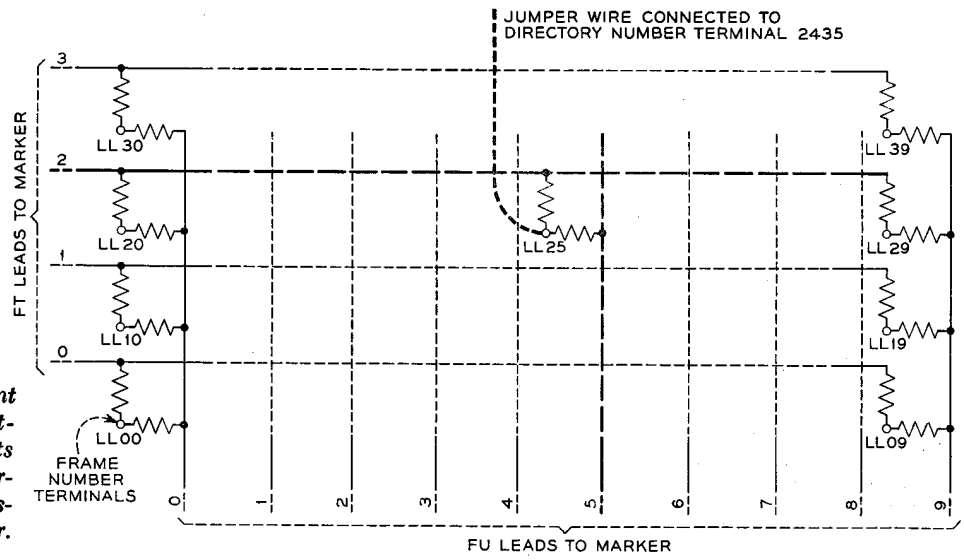

Fig. 4—Arrangement of resistance networks that permits two pieces of information to be translated by one jumper.

a line link frame number, it is necessary to convey two pieces of information—the frame tens and the frame units numbers. At first glance it would seem that two cross-connections would be required, one for each piece of data, instead of only the single cross-connection shown in Figure 2. By use of a resistance network as shown in Figure 4, however, it is possible to couple these two pieces of data with only one jumper connection. Here each of the line link frame number terminations, to which the directory numbers are cross-connected, is associated with the frame tens and units leads to the marker through a pair of resistances. Thus when a potential is applied through the relay tree, through the jumper wire associated with 2435, and thence to line link frame terminal 25, a current will flow through the FT2 resistance to the FT2 lead into the marker, where it is recognized as a frame in the twenties, and current will also flow through FU5 resistance to the FU5 lead into the marker, where it is recognized as a frame with a five units digit. These two facts inform the marker that it is frame 25.

An arrangement similar to that of Figure 4 is used for combining the vertical and horizontal group information. The possible 140 combinations can be accommodated by ten HG leads for the horizontal groups and fourteen VG leads for the vertical groups. Similarly for vertical file and ringing combination information, the 75 possibilities are cared for by twenty leads, five VF leads for vertical files, and fifteen RC leads for ringing.

There is still another function that the number group must perform for the marker. Some of the lines of any number group may be PBX trunks. The directory number given the marker will ordinarily be that of the first of the terminal hunting group, and this particular trunk and perhaps several adjacent ones may be busy while others in the group are idle. If the number group gave the location of the first trunk to the marker, the marker—after disconnecting from the number group—might find the trunk busy and would have to reconnect to the number

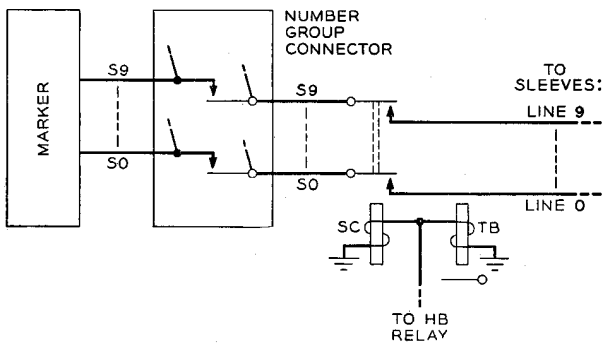

Fig. 5—Simplified circuit indicating method by which marker tests for idle PBX trunks.

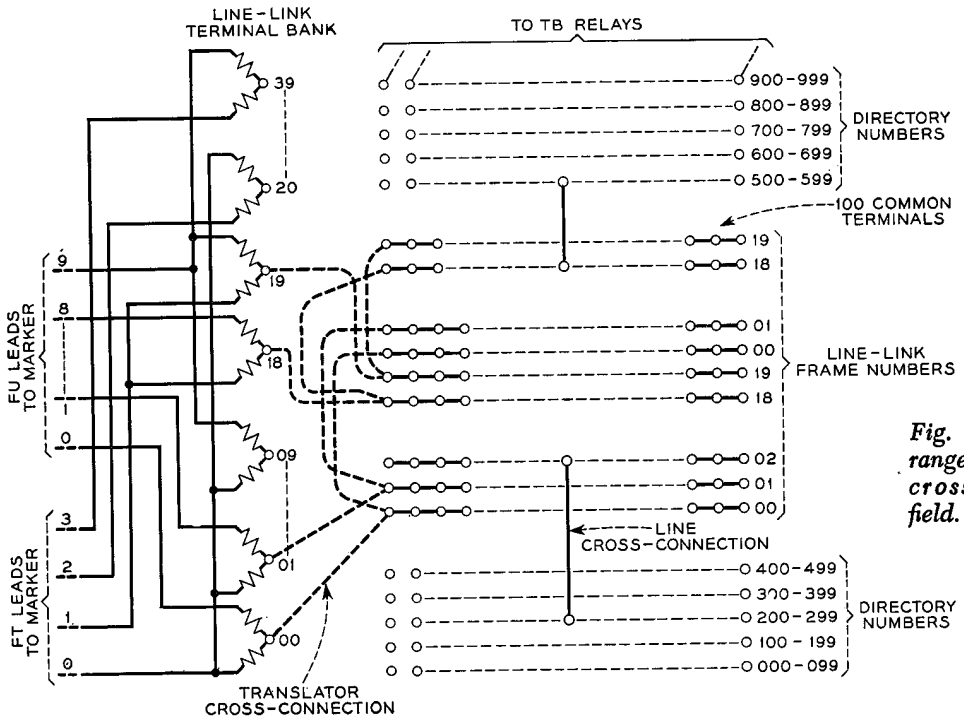

Fig. 6 — Typical arrangement of the LL cross-connecting field.

group to get the location of another trunk of the group. To avoid this loss of time, facilities are provided in the number group to permit the marker to test for an idle trunk before leaving the number group, and then to determine the location of only the first idle trunk found.

This is accomplished by extending the sleeve leads of all PBX trunks to the number group, and providing ten additional leads between the number group and the marker over which these sleeves may be tested. As shown in Figure 5, an SC (sleeve connect) relay is paralleled with each TB relay that has PBX trunks associated with it, and thus the SC relay is operated at the same time as the TB relay. There are ten springs on each SC relay, and the sleeve leads from the PBX trunks are connected to their front contacts, or to as many of them as may be required. The springs of the SC relays are connected, through the number group connector, back to the marker.

All terminal hunting groups have ringing combination NO. 10, and when the marker gets this code from the number group, it tests the ten sleeve leads, and then transmits a units code for the first idle trunk found. Where there are more than ten trunks in a PBX group, SC relays will be associated with all the TB relays that have trunks of that group, and provision is made for advancing from one to another if all trunks associated with one TB relay are busy.

The principal objective in the equipment design of the number group frame was to arrive at a flexible grouping of the LL, RF, and VHG terminal arrays so that they may be varied in size as the demand for terminals requires. Figure 6 shows a typical arrangement of the LL cross-connecting field, arranged for 20 line link frames. As with the RF and VHG fields, the 1000 directory number terminals are arranged in ten rows of 100 each, five rows above and five below the equipment location terminals. The LL field has 4000 terminals in forty rows of 100 each. Each row consists of ten groups of ten common terminals, multiplied together so that the 100 terminals of the row are common. In the illustration, since only 20 line link frames are involved, two such rows may be multipled to represent one line link frame. Had forty frames been involved, each row would have represented a single frame. Similarly, had there been ten frames, four

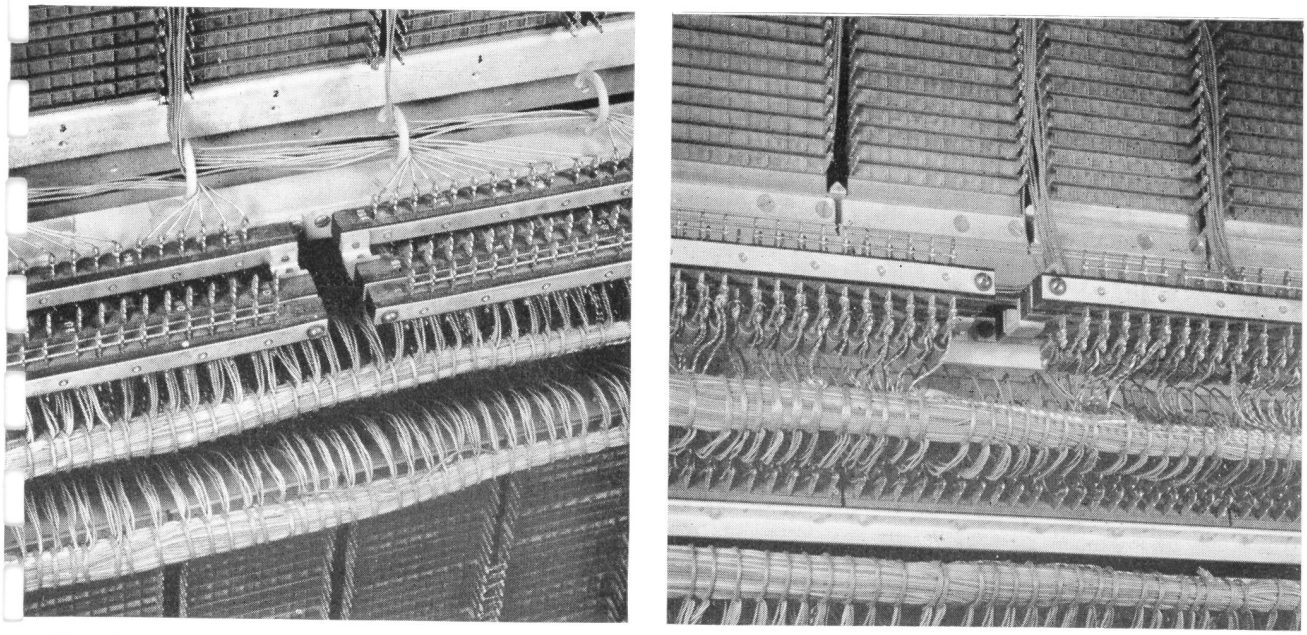

Fig. 7—Rear of number-group frame. Left, looking down on the terminal strips; right, looking at terminal strips from beneath. The resistors are just below the strips and are barely visible in the lower illustration

rows could be multipled to represent a frame, keeping in mind, however, the pattern required for future expansion. These rows, or multiples of rows, are then connected to the translator resistor networks, which are mounted on the rear of the frame in groups of 20. Figure 7 shows these connections and resistors, with the multipling of terminals in the RF field. These facilities are provided on the rear of the frame where they do not interfere with running jumpers on the front of the frame to associate line with directory number assignments. The RF and VHG fields have 2000 terminals in 20 rows, arranged for variable multipling in similar fashion to the LL field.

These arrangements make possible a fairly standardized design for economical manufacture, and yet provide the needed flexibility to meet many job variations.