Trunking plan for No. 5 crossbar

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A basic objective of the trunking plan for any switching system is to permit interconnections to be made between the subscriber lines in the same office, and between the subscriber lines and the trunks to and from other offices. In a crossbar system, these connections are made by crossbar switches, which establish a path by interconnecting a series of links and junctors. The number of links and junctors provided must be great enough not only to handle the largest number of calls likely to be in progress simultaneously, but to make it unlikely that a call will find all connecting paths busy when the line or a suitable trunk is idle.

In the No. 5 crossbar system, the trunking plan is simple and yet very flexible. Only two types of switching frames are required: the line-link frame and the trunk-link frame. These basic frames consist of two bays of ten crossbar switches each—the two bays being interconnected in much the same manner as the primary and secondary bays of the No. 1 crossbar system. Instead of being called primary and secondary bays, however, they are called line and junctor bays on the line-link frame, and junctor and trunk bays on the trunk-link frame.

The arrangement of the line-link frames is indicated in Figure 1. The switches of the junctor bay have their horizontal multiple cut so as to give the equivalent of two crossbar switches of ten verticals instead of one switch of twenty verticals. One-half of each switch is used for junctors, and the other half, for lines. The horizontals of the right half of the ten switches in the junctor bay are connected directly across the horizontals of the line bay, and thus provide what is in effect a crossbar switch with thirty verticals. The subscriber lines are connected to twenty-nine of these verticals of each row of switches, and thus each such basic line-link frame will accommodate as many as 290 lines. The one vertical of each switch not used for lines is employed for "no test" connections.

Provision is also made for extending this horizontal multipling of the line switches to additional or supplementary bays, which may have switches of either ten or twenty verticals. To what extent supplementary bays are employed depends on how much the particular lines are used. With lines having high calling rates or long holding times, lines on the basic frame may provide sufficient traffic, and thus supplementary bays may not be required; while with lines of low calling rates, the capacity of a line-link frame may be increased to as

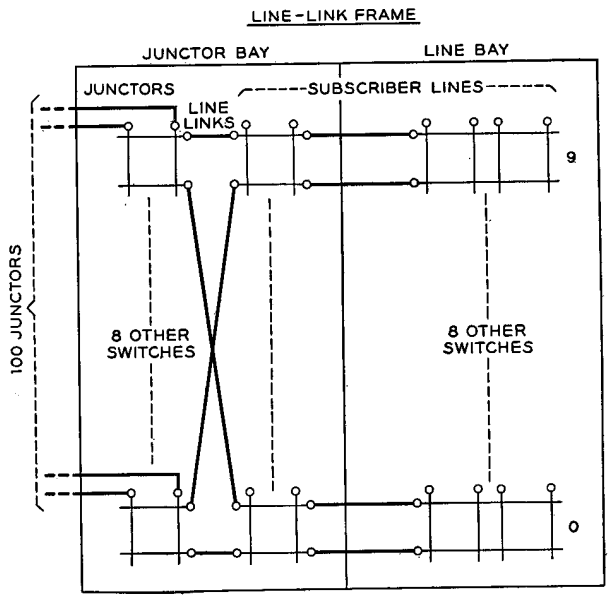

Fig. 1—Line-link frame for No. 5 crossbar

much as 590 lines by the use of supplementary bays. In each case the number of bays is adjusted to give an adequate load for the junctors by which the line-link frames are connected to the trunk-link frames.

Verticals on the left half of the switches on the junctor bay are connected to junctors. Since each of these ten half switches has ten verticals, there are 100 junctors from each line-link frame. Over them pass all calls from or to the lines associated with that frame.

The horizontals of the junctor switches are connected to the horizontals of the line switches to provide the "primary-secondary" linkage as indicated in the diagram. Here each crossbar switch is represented by its top and bottom horizontal and by its first, tenth, eleventh, and twentieth vertical, and only the top and bottom switches of a bay are shown. Each of the ten horizontals of a line switch connects to a different junctor switch in regular order, as indicated. Each line switch thus has one link to each of the ten junctor switches. In this way every line has access to every junctor.

Since the ability to meet a wide variety of conditions is one of the features of the No. 5 system, provision has been made for subscriber lines to have as many as thirty classes of service. Each such class of service identifies the type of line, such as flat rate, message rate, or coin service. Covered also by the class are the number of parties per line—single, two, four, eight, or ten—various calling zones, and other factors that affect the type of service or the rates paid. Lines of any of these classes may be connected to any line-link frame, the only restriction being that all the lines in the same vertical file of a bay, that is the corresponding verticals of each of the ten switches of a bay, be of the same class. Cross-connecting strips at the top of each line-link frame permit the class of each file of verticals to be identified to the marker.

The arrangement of the trunk-link frame is shown in Figure 2. The wiring for the "primary-secondary" linkage between the trunk and the junctor switches connects to the verticals instead of the horizontals, but the arrangement is similar in effect to that of Figure 1. In this frame, also, the switches of the junctor bay have their horizontal multiple cut to provide the equivalent of two switches of ten verticals. In this case,

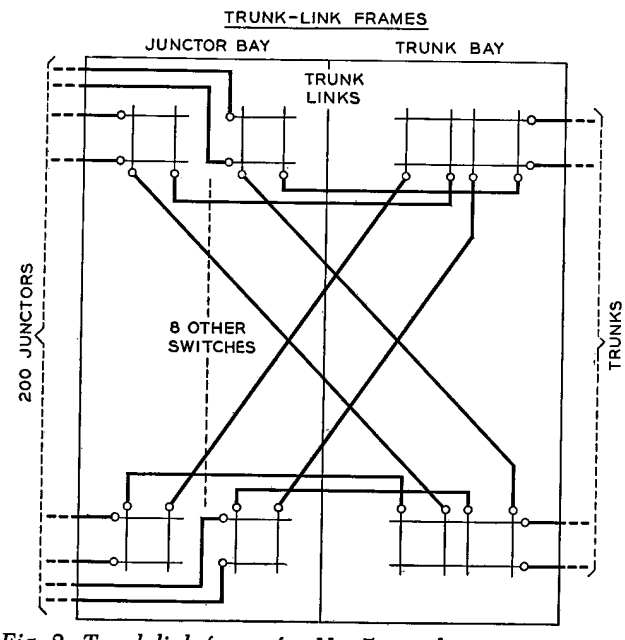

Fig. 2—Trunk-link frame for No. 5 crossbar

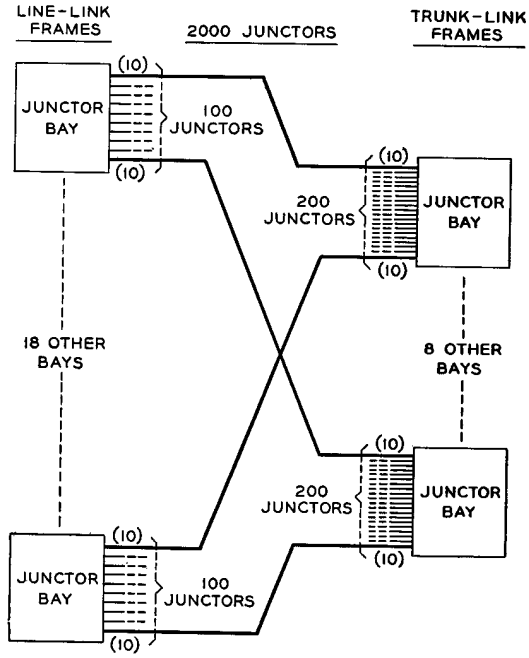

Fig. 3—Distribution of junctors

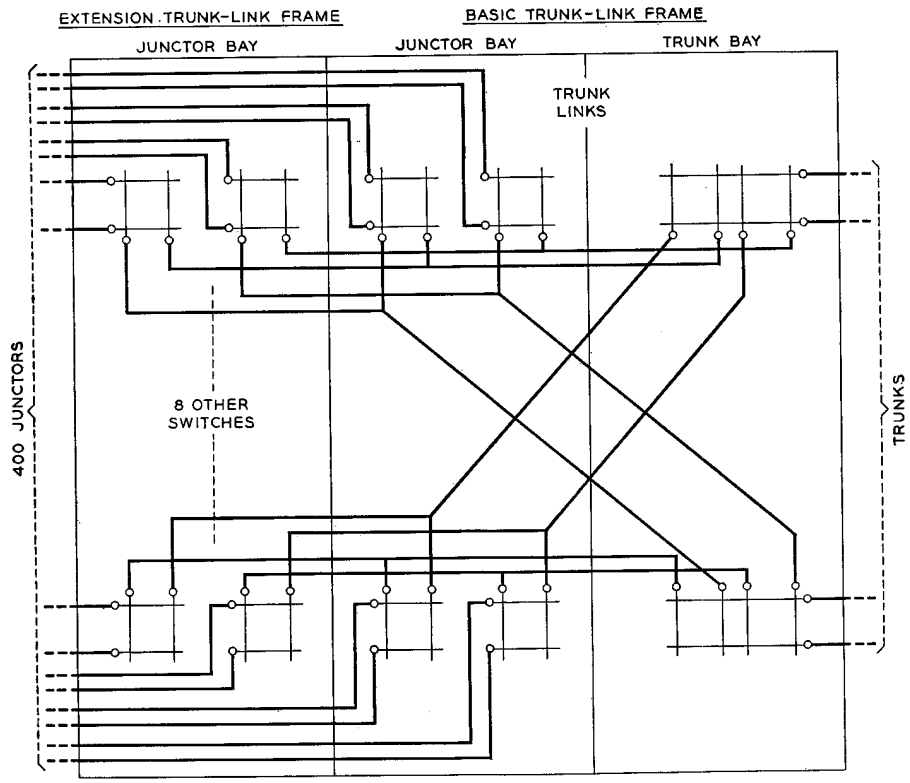

Fig. 4—Trunk-link frames where extension bays have been employed

the split is made to provide terminations for 200 junctors, which connect to the twenty horizontals of each of the ten junctor switches. Each twenty-vertical trunk switch has access to each half of the split junctor switch over one link. The trunks connect to the horizontals of the trunk switches. These latter switches are of the six-point type, already described in the RECORD;* and thus each horizontal is capable of providing terminations for two trunks. The two lower horizontals of each switch are used to select one or the other of the two trunks associated with each of the upper eight horizontals, and thus there are terminations for sixteen trunks on each switch or 160 on a bay.

Of these 160 trunk terminations, a few—perhaps five or six—will be used for originating registers; the rest will be used for outgoing, incoming, or intraoffice trunks. Not more than 120 of the terminations on a frame may be used for outgoing trunks, however, and not more than 80 for incoming or the incoming end of intraoffice trunks. Intraoffice trunks require two terminations on each frame: one for the connection going back to the calling subscriber and one for the connection going forward to the called subscriber. The trunks to a particular destination are distributed as evenly as possible over all the trunk-link frames. The marker is able to select any idle trunk on any of these frames to complete a call, so that all trunks to any destination, regardless of their number, are in one efficient group. Another advantage of this arrangement is that when trunk frames are added, in the course of normal growth, the additional trunks required can generally be assigned without disturbing the existing trunk distribution.

Since each trunk-link frame provides 200 junctors, and each line-link frame only 100, there are normally twice as many line-link as trunk-link frames. The junctors between line-link and trunk-link frames are distributed in much the same manner as are the links in each frame. Each line-link

*RECORD, *January*, 1942, *page* 114.

frame has a group of junctors to each trunk-link frame. For twenty line-link and ten trunk-link frames, the distribution is indicated in Figure 3. One junctor from each of the ten switches of a line-link frame connects to each trunk-link frame. In Figure 3, each line represents ten junctors, one from each switch of each line-link frame to each of the ten switches of each trunk-link frame. All calls, either outgoing or incoming, are connected over a circuit consisting of a line link, a junctor, and a trunk link, with the marker selecting the combination of junctor and links that is used for each call.

In the junctor arrangement indicated in Figure 3, where there are twenty line-link and ten trunk-link frames, there are ten junctors from each line-link frame to each trunk-link frame, since the 100 junctors from each line-link frame provide ten groups of ten. This is the smallest inter-frame group that will keep the probability of a call finding all possible paths busy to the low value desired. The number of junctors from each line-link frame to each trunk-link frame, however, depends on the number of trunk-link frames, since with n trunk-link frames, the 100 junctors from each line-link frame will be divided into n groups, and the number of junctors in each group will thus be 100 divided by n. As long as the number, n, of trunk-link frames is not more than ten, there will be ten or more junctors per group, and thus the requirement of at least ten per group is met. If there were more than ten trunk-link frames, however, this requirement would not be met with the type of distribution shown in Figure 3.

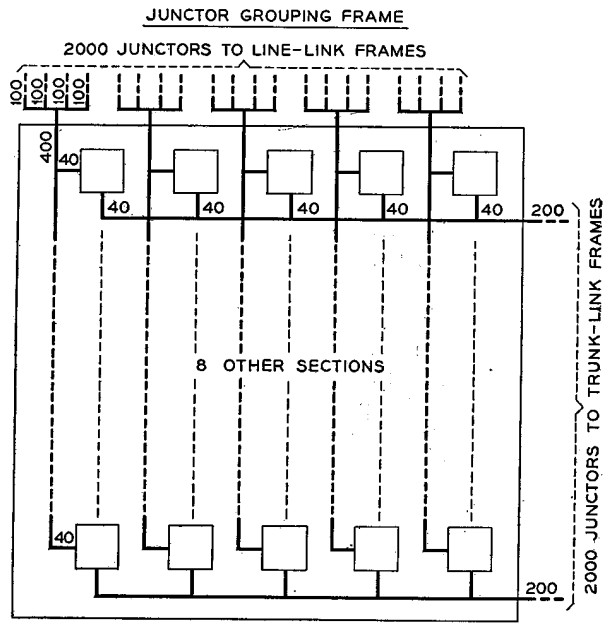

Fig. 6—Junctor grouping frame

When more than ten trunk-link frames are required to meet the needs of an office, each junctor from a line-link frame, therefore, is multipled to two trunk-link frames, which has the effect of doubling the number of junctors from the line-link frames. Then each line-link frame can supply a group of ten junctors to as many as twenty trunk-link frames, which is the maximum number for which a No. 5 crossbar office is designed.

With twice as many line-link as trunk-link frames, there would be forty line-link frames for an office having twenty trunk-link frames, and thus a total of 40 x 100 or 4,000 junctors from the line-link frames. Since each of these junctors connects to

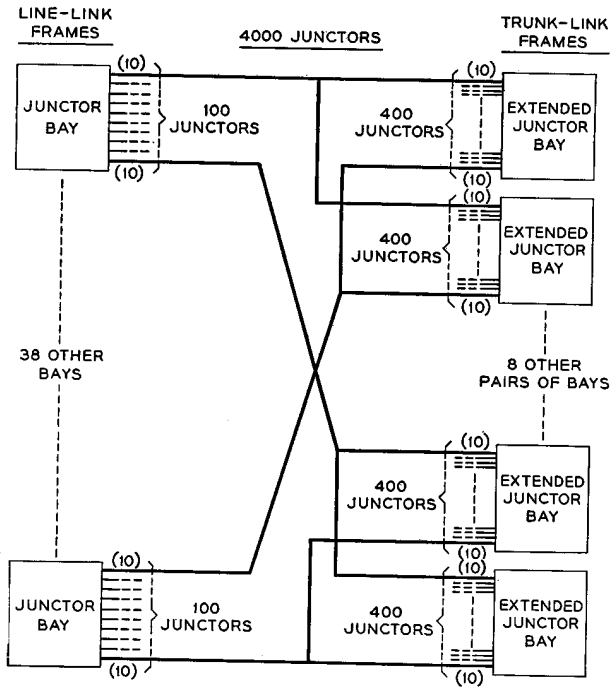

Fig. 5—Distribution of junctors when extension bays are used with the trunk-link bays

two trunk-link frames, there must be terminations on the twenty trunk-link frames for 8,000 junctors, which is 400 per frame—twice the number shown in Figure 2. To secure these additional junctor terminations, extension bays are added to the trunk-link frames, and are connected to them as indicated in Figure 4. These extension frames are arranged like the regular junctor bays of the trunk-link frames, and the verticals of the junctor bay and the extension bay are multipled. In this way terminations for 400 junctors are provided for each trunk-link frame. When such extension frames are used, the trunk-link frames are grouped in pairs, and each junctor from a line-link frame is connected in multiple to junctor terminals on both frames of a pair. This arrangement is indicated in Figure 5.

If there were always twenty line-link frames and ten trunk-link frames, the junctor terminals on the line-link frames could be permanently connected to the junctor terminals on the trunk-link frames—ten on each line-link frame being connected to each of the ten trunk-link frames. Since the number of frames in an office may vary over a fairly wide range, however, and may change from time to time, a junctor distributing bay is provided to which the junctors from both line-link and trunk-link frames are connected. Here they may be interconnected by jumpers in the best way for each set of conditions.

This junctor grouping frame consists of fifty terminal blocks arranged in five columns of ten each, as indicated in Figure 6. Each terminal block provides double ended terminals for forty junctors—one end of each terminal projecting to the front of the bay and the other, to the rear. Junctor cables from four line-link frames are run vertically down the front of the frame adjacent to each column of terminal blocks, and ten junctors from each of the four cables are connected to the terminals of each block. Junctor cables from the trunk-link frames run horizontally across the rear of the bay; the 200 junctors from each frame are connected to the terminals of

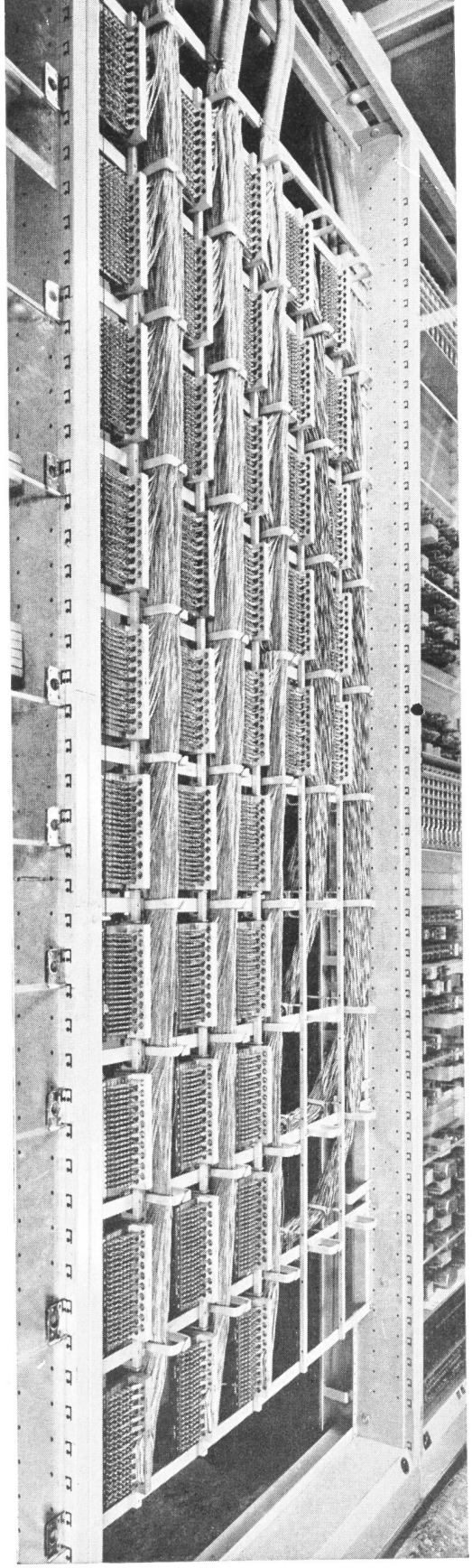

Fig. 7—A junctor grouping bay in the crossbar office at Media, Pennsylvania

each of the five blocks in one row. A front view of the junctor distributing bay in the Media Office is shown in Figure 7.

If there were twenty line-link frames and ten trunk-link frames, all the terminals would be filled and each junctor from the line-link frames would be permanently connected to a junctor from the trunk-link frame, in the manner already outlined. If there were a smaller number of frames, such as eight line-link frames and four trunk-link frames, the two left-hand columns of blocks would have junctors connected to their front end, and the four upper rows would have junctors connected to the rear terminals. The blocks in the two left-hand columns of the upper four rows would have junctors connected both front and rear, while the lower six blocks in the two left-hand columns would have junctors connected only at the front, and the blocks of columns three, four, and five of the upper rows would have junctors connected only at the rear. Jumpers are run from the upper right-hand section of the bay to the lower left-hand section to distribute the remaining junctors properly. When extension bays are used for the trunk-link frames, there would be two of these junctor grouping bays. The groups of 100 junctors from the line-link frames will be distributed to both of the junctor grouping bays, and the junctors from one trunk-link frame of each pair will go to one junctor distributing bay and those from the other frame of the pair to the other distributing bay—the junctors from the two frames of a pair being terminated on the same row of blocks.

Since the traffic capacity of the 200 junctors on a trunk-link frame is double that of the 100 junctors on a line-link frame, there are, in general, twice as many line-link as trunk-link frames. The size and number of the line-link frames required for a specific job is determined from originating and terminating peg-count and holding-time data from which the total load in CCS* is computed. By dividing the frame capacity, 1200 CCS, by the average originating and terminating CCS per line, and adding a provision for spare lines, the number of lines which a frame may serve can be determined, the actual size being governed by the fact that they are furnished in increments of 100 lines only. The number of frames of this size is obtained by dividing the total number of lines to be equipped in the office by the number per frame. Where no special requirements have to be met for terminating trunks, the number of trunk-link frames required will be one-half the number of line-link frames. Under certain conditions, trunk-link frames may be required merely to provide terminations for a large number of small trunk groups on which traffic is light. In this case, a greater than proportional number of trunk-link frames would be provided.

*100 Call-seconds. See RECORD, *March*, 1939, *page* 222.