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Switching Development

Trunk selection by No. 5 crossbar markers

In the No. 5 crossbar system* the trunks of all routes are distributed as far as possible over all the trunk link frames.† Because of this distribution of the trunks, and because some of the frames may be busy with other markers, a marker in searching for an idle trunk has to find a frame not busy with another marker—or an idle frame as it is called—that has an idle trunk of the desired group.

If markers were required to seize frames to find whether or not idle trunks were available, many unnecessary frame seizures would occur. These would not only waste the time of the marker but would delay other markers that might wish to use that frame, thereby increasing their holding time. The circuits are arranged, therefore, so that the marker may locate idle frames that have idle trunks of the desired group before seizing a frame.

Originating registers are also distributed among all the trunk link frames, and thus so far as the work of the markers in selecting trunks is concerned, the originating registers may be considered as trunks of one route. In what follows, therefore, the term trunk will be considered to include also the originating registers.

There may be from two to twenty trunk link frames in a No. 5 crossbar office, and from three to twelve markers. Each trunk link frame has capacity for 160 trunks of which 120 can be outgoing and intraoffice trunks, including registers, and after a marker has seized a frame, it must determine which trunks of the desired group are idle and then select one of these. The work of the marker in finding an idle trunk is thus divided into two steps. It first locates an idle frame that has at least one idle trunk of the desired route without establishing a connection to the frame through its connector. The marker then connects to that frame and selects and seizes one of the idle trunks of the desired route.

The arrangement of trunks, frames, connectors, and markers, and some of their interconnecting paths, is illustrated in a diminutive scale in Figure 1, which shows only three trunk link frames and two markers. The red and black lines represent those paths over which the marker tests for idle trunks and frames, respectively, before seizing, while the other paths are those used after a frame has been seized.

An FT lead (red) runs from each trunk to one of a set of FT terminals on the trunk link frame. When the trunk is idle, the FT lead will be grounded. From an adjacent set of terminals, marked FTC, leads run directly to all the markers without passing through the frame connectors. Each FTC terminal represents the trunks of a single route, and on each frame an FTC terminal is cross-connected to the FT leads of all the trunks of that group. By looking at the FTC leads to the desired route from each of the frames, therefore, the marker may determine which frames have idle trunks.

Each frame connector, as indicated in Figure 2, has an MC relay that is operated when the frame with which that connector is associated is in use by a particular marker, and when an MC relay is operated, it grounds an FB lead (black) through one of its front contacts. The FB leads from all the connectors associated with one frame are connected together and carried to all the markers. By looking at these FB leads, therefore, the marker can determine which frames are busy.

How the marker selects an idle frame that has an idle trunk of the desired route may be followed with the help of Figure 2. Each marker has a route relay—not shown

* See page 5.
† See page 20.

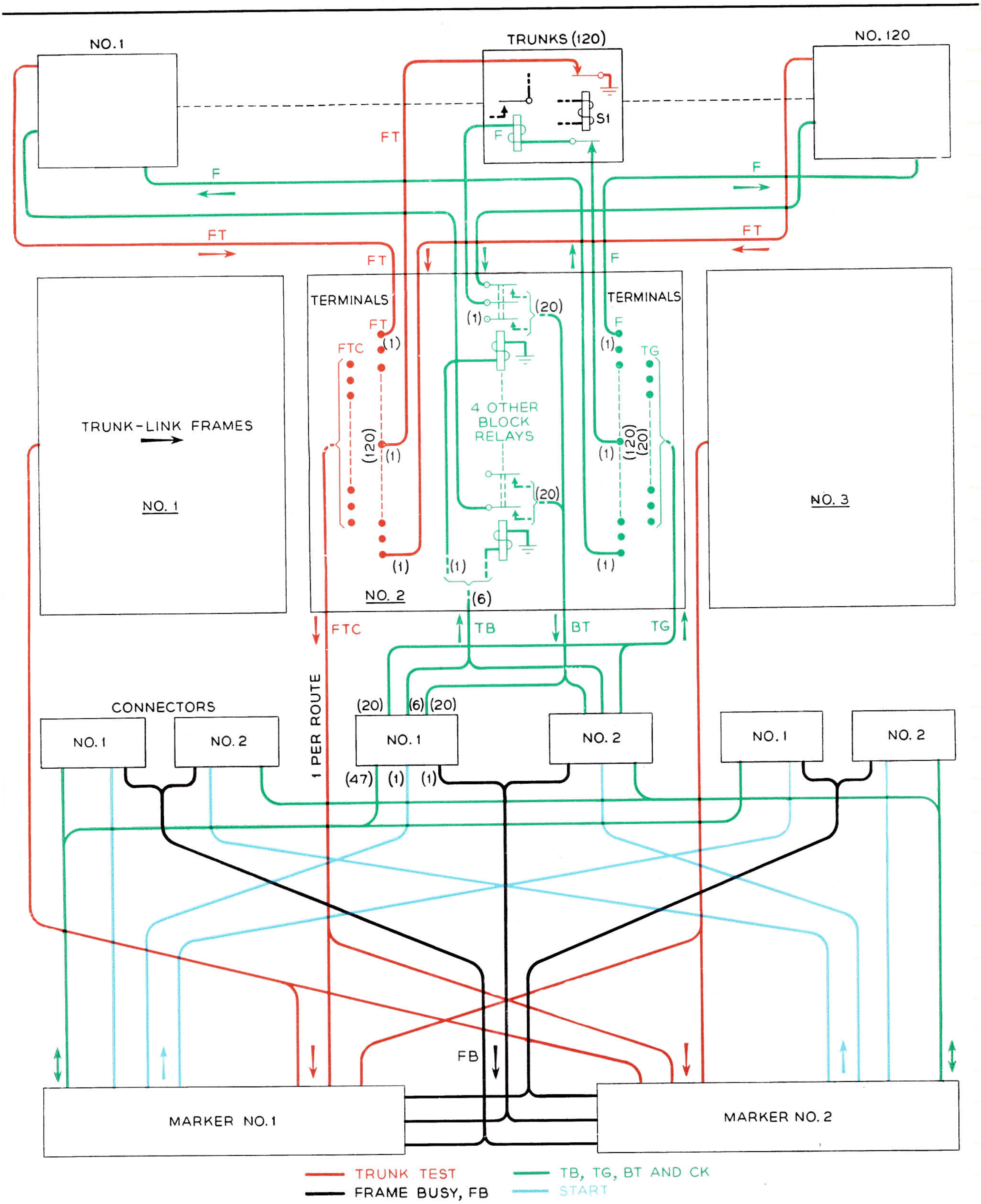

Fig. 1—Simplified diagram indicating some of the interconnections between trunks, trunk link frames, connectors, and markers in the No. 5 crossbar system.

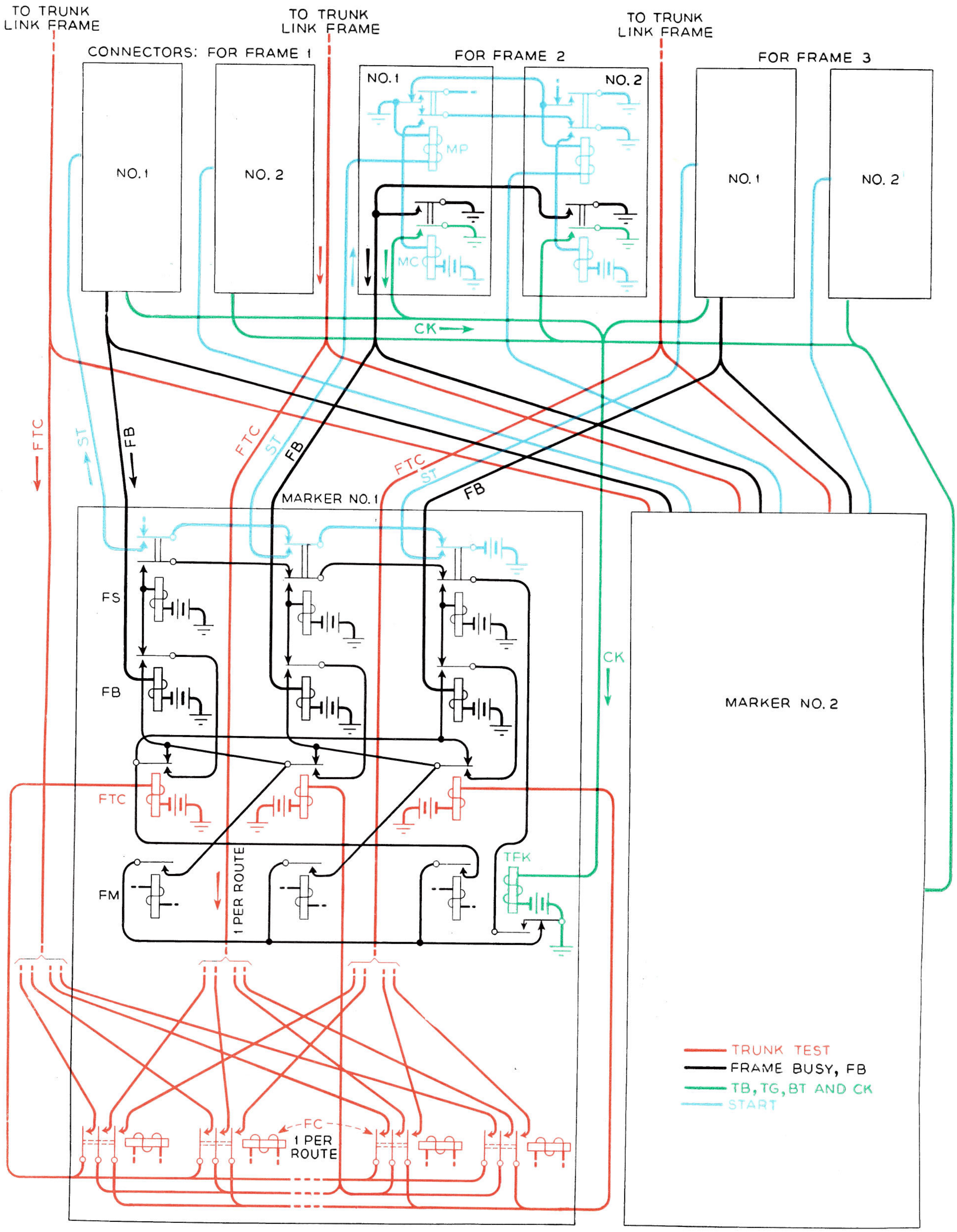

Fig. 2—Simplified diagram indicating some of the relays in the connectors and markers and their interconnections in the No. 5 crossbar system.

in the diagram—for each of the trunk routes in the office, and when a marker is seized, it operates the route relay required for the call. When the marker is seized by a calling line, it operates the route relay for the originating registers, while when it is seized by a register after a number has been recorded, it operates the route relay that corresponds to the office code data passed to it from the register. One contact on the route relay operates an FC relay in the marker, and the operation of this relay connects the FTC leads (red) for that route of trunks on all the frames to the windings of a set of FTC relays—there being one FTC relay for each frame. The FB leads from the connectors for each frame run to the windings of a set of FB relays in the marker. In addition, there is also one of these relays for each frame.

The FB and FTC relays for each frame are associated with an FS and an FM relay to form an interconnected set, and there is one of these sets of four relays for each frame. They are all interconnected as shown in the diagram. For each frame that is busy, the FB relay will be operated, and for each frame that has idle trunks of the desired route, the FTC relay will be operated. The FM are memory relays, and the FM relay associated with the frame last used by the marker will be operated when the new call comes in.

Should all the trunks of a route be busy, the marker—after a short interval—will advance to the next route, which may be an alternative route, to the desired destination or an overflow trunk, which gives an "overflow" tone to the calling subscriber. This action is under control of a timing circuit that starts operating when the frame connector relays operate. If an FTC relay operates—indicating an idle trunk—the timer will be stopped and the marker will not advance.

Ground from a back contact on the TFK relay passes through a front contact of the operated FM relay to the armature, contact of the FTC relay of the next higher numbered frame. If this relay is operated, indicating at least one idle trunk on that frame, the ground will be continued to the armature contact of the FB relay for that frame. If this relay is not operated, indicating that the frame is idle, ground will pass through its back contact and operate the FS relay for that frame, thus selecting the frame. From the interconnections between these sets of relays, it will be noticed that if the FTC relay had not been operated, or if the FB relay had been operated, the ground would have been extended to the FTC relay of the next higher numbered frame. With this circuit, therefore, the FS relay is operated for the first frame encountered—following that of the operated FM relay—that is not busy and that has idle trunks in the desired group.

When an FS relay operates, it connects battery to the start lead (blue) running to that marker's frame connector for that particular frame. This operates the MP relay in the connector which in turn operates its associated MC relay. Operation of MC grounds the FB lead (black) to indicate that that frame is now busy (occupied by a marker), connects to the marker a group of leads that the marker will use in subsequent handling of the call, and grounds a CK lead (green) to the marker. Ground on this latter lead operates relay TFK in the marker. This locks the FS relay that was operated, and removes the ground from the FM relay contacts.

If the only idle trunks of the desired route are on trunk link frames in use at the time by other markers, the marker—under control of its timing circuit—will wait a short interval for one of these frames to become idle. Should none of the required frames become available within the established time intended, the marker will cause a trouble record to be taken and then give the connector a trouble release.

Having thus selected and connected to a suitable frame, the marker now proceeds to select an idle trunk on that frame. For the purpose of finding and seizing a suitable idle trunk after the frame has been seized, the 120 possible trunks of a trunk link frame are divided into six blocks of twenty trunks each, and within each block from one to twenty groups are provided. As indicated on Figure 1, the blocks are physically represented by six block relays each with twenty contacts, and the formation of groups within each block will depend on the number of trunks of the various routes that are included in that block. Each group of a block will include all the trunks of one route on that trunk link frame. If there are many routes of only one trunk each, the block might include twenty groups, while if one route had more than twenty trunks, half of them would form a group in one block, and the remaining trunks of that route would form one group in another block but with the same group number. All the registers connected to a frame, usually five or six, will form one group in one of the blocks.

With this arrangement, the number of trunks per group may differ for each block, but in any block a group always includes only the trunks of one route, and it will include all the trunks of that route except when there are more than twenty trunks per route. In testing and seizing trunks, the marker designates one block and one group, and this combination always identifies the trunks of one route. The same group but a different block, or the same block but a different group, would, of course, identify trunks of a different route. It is

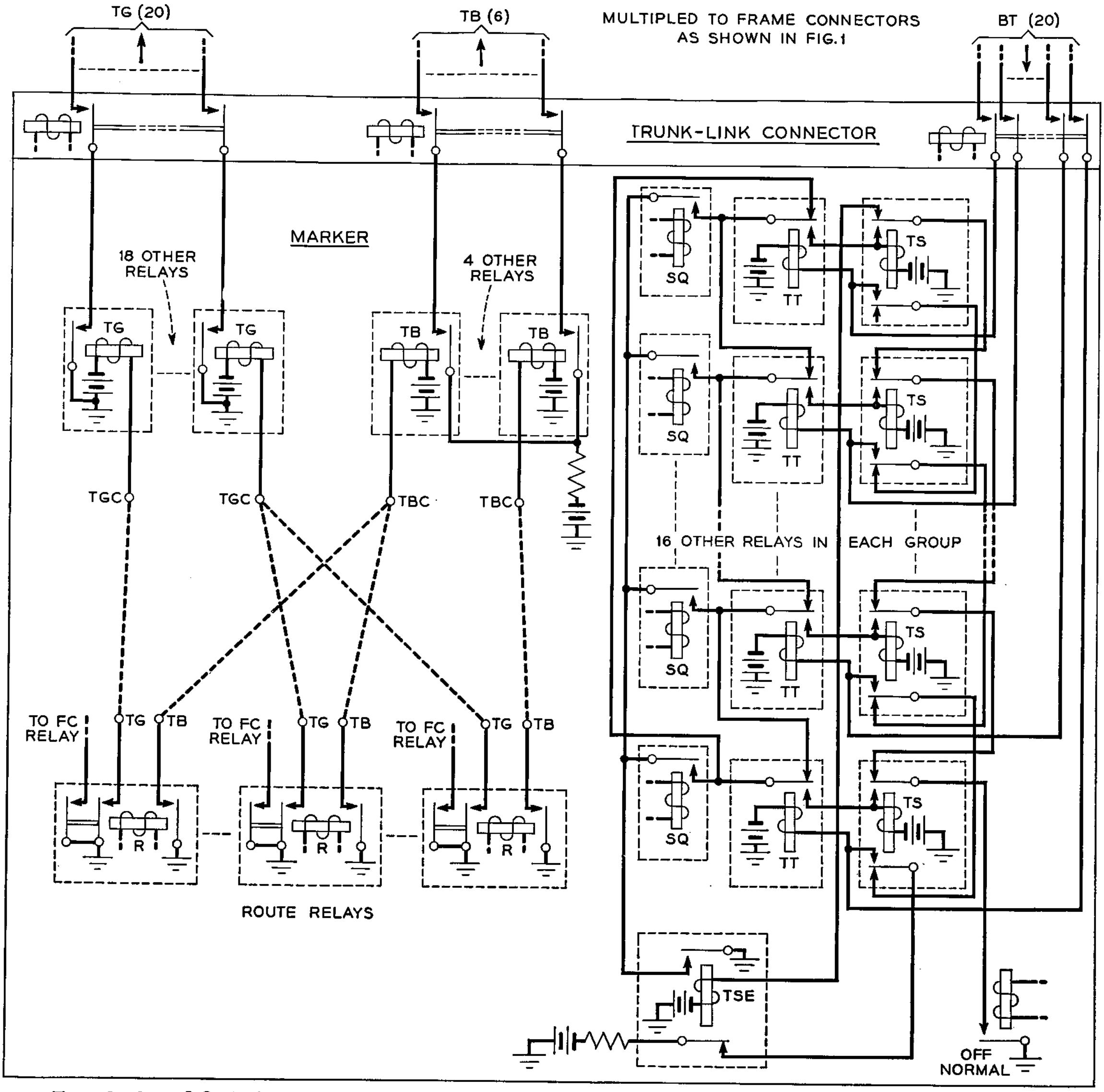

Fig. 3—Simplified diagram indicating some of the relays in the marker and trunk link connector.

because of this identifying method of the marker that the trunks are assigned as described above.

Two relays in each trunk circuit are involved in busy testing and seizing a trunk; an F relay, which is operated to seize the trunk, and an S1 relay, which remains operated as long as the trunk is in use. One end of the winding of the F relay is carried through a back contact of the S1 relay to a set of F terminals, there being one terminal for each trunk of the frame. If the trunk is in use, this circuit will be open at the S1 relay. The other end of the F relay winding is connected to one of the armature contacts of one of the block relays. This arrangement is indicated in the upper part of Figure 1.

The front contacts of the six block relays are multiplied, and brought down through the connector to the marker as a group of twenty leads (green). Each of these leads connects to a winding of a TT relay as indicated in Figure 3. The other end of the winding of the TT relay is connected to battery. Only one block relay is operated at a time, and thus the BT leads will be connected only to the F leads connected to the block relay operated.

When the route relay operated in the marker, it in turn operated a TB and TG relay as well as the FC relay referred to in connection with Figure 2. There are six of the TB relays—one for every block relay on a trunk link frame—and there are twenty TG relays; which particular TB and TG relays are operated by any one route relay is determined by jumpers run between the two sets of terminals shown in the marker in Figure 3. An operated TG relay connects ground—after a frame has been seized—to one of a set of TG terminals on the frame as shown in Figure 1. These TG terminals are adjacent to the F terminals through which the trunk test leads are connected. Each TG terminal represents, a group, and jumpers are run between the TG and F terminals to form the groups of the six block relays. Group 1 in block 1 might be six registers; in block 2, it might be three trunks to office A; in block 3, one trunk to office B; in block 4, eight trunks to office C, and so on. Jumpers would thus run from the No. 1 TG terminal to the F terminals of all the trunks comprising group 1 in all the blocks. When a frame is seized, ground from the operated TG relay would thus be applied to the F leads of all these trunks, but only the trunks associated with the particular block relay operated at that time would have their circuits completed to the TT relay and battery in the marker, and these would be the trunks of only one route. For the busy trunks of that route, moreover, the circuit would be open at the S1 relay. When a frame is seized, therefore, a TT relay for each idle trunk of the desired route will operate.

As shown in Figure 3, each TT relay in the marker is associated with an SQ and a TS relay to form twenty sets of three relays. When a marker is seized, ground from a marker off-normal relay is carried through back contacts of the TS relays in series, and operates relay TSE, which puts ground on the armature contacts of the SQ relays. These SQ relays are part of a sequence circuit, whose function is to rotate the preference, and one is operated in turn for each call that the marker handles. When a frame is seized, therefore, current flowing over the BT and TG leads and through the trunk test leads of 1 group of 1 block, operates certain of the TT relays as a result. Ground from the operated SQ relay passing through the armature contact of its associated TT relay will operate the associated TS relay if that TT relay is operated. If that particular TT relay is not operated, the ground will pass to the next TT relay above, and either operate its associated TS relay, or be passed to the next TT relay. In this way, the first TS relay with an operated TT relay will operate. Actually there are only ten SQ relays instead of the twenty indicated, but their association with multiplier relays is such as to give the effect of an SQ relay for each TT relay, as indicated in Figure 3.

The current flowing over the trunk test circuit, although sufficient to operate a TT relay, is not sufficient to operate the F relays in the trunks. When a TS relay is operated, however, it opens the circuit to the TSE relay and thus releases it, and from a back contact of TSE, battery through a low resistance is applied to the BT lead of the selected trunk. This causes enough current to flow through F to operate it, and the trunk is thus seized. Relay TS also locks itself through the off-normal ground and thus it no longer needs to be held by the circuit through TT and SQ.

These selecting operations, which have taken considerable time to describe, would appear to one watching in the marker as occurring almost simultaneously. The operation of a route relay immediately after the marker is seized is followed by the immediate operation of an FC relay, and this by the operation of a number of FB and FTC relays and one FS relay that seizes the connector and frame. As soon as a trunk link frame is seized, paths are prepared for operating one or more of the TT relays, and through contacts of one of these, a TS relay operates. That in turn operates the F relay in one of the idle trunks, thus connecting a group of leads from that trunk to the marker over which the marker gives the trunk the information needed to complete the call. The operations from the time that the route relay operates until the F relay of the trunk operates take place in about 0.09 second.