Incoming register link for No. 5 crossbar

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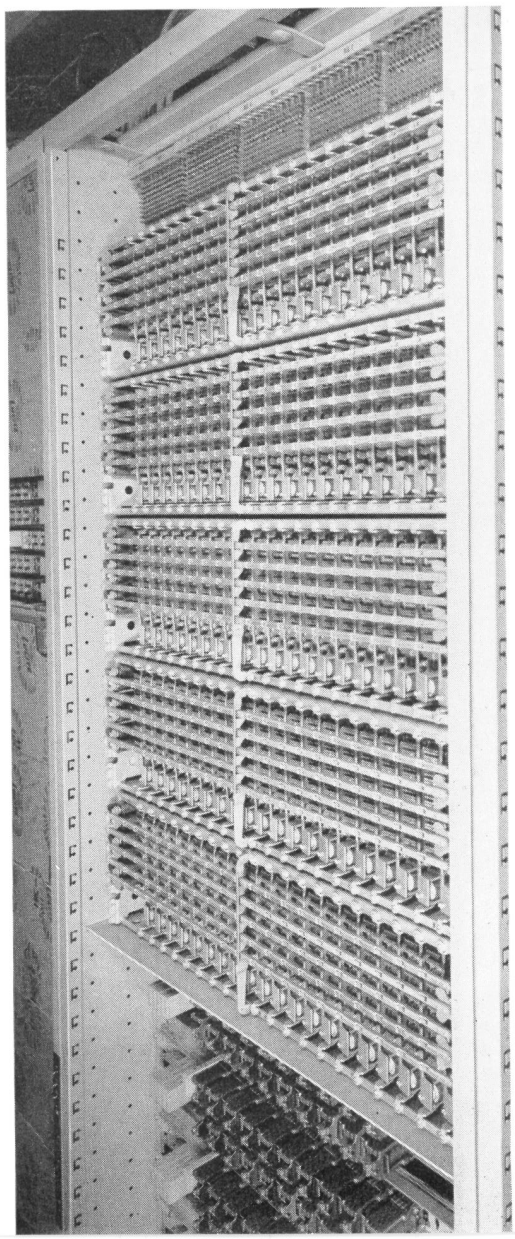
Calls incoming to the No. 5 crossbar system* from other offices terminate on incoming trunk circuits, which have appearances both on a trunk link frame for completion of the talking path to the called subscriber, and on an incoming register link frame for connection to an incoming register. A separate group of register link frames is required for each of the various types of registers, such as dial, multifrequency, and revertive pulsing, and for each ten registers of the same type. Incoming register link frames mount five twenty-vertical crossbar switches together with their control relays as shown in Figure 1. One hundred incoming trunks, one per switch vertical, have direct access to a group of ten incoming registers, each register being multipled to one horizontal on each of the five switches. To this basic frame a supplementary frame of five additional twenty-vertical switches may be added to increase to two hundred the number of trunks connecting to the same ten registers. A further increase in trunk capacity may be obtained by associating a second basic frame and its supplementary frame with the same registers. The number of trunks and registers varies with traffic, but the combination of capacities of one hundred or two hundred trunks and ten registers satisfies the average office.

Reduced to its simplest form, such a frame could be represented as shown in Figure 2. It differs from the sender link frame in the No. 1 crossbar system and from most crossbar frames in consisting of only a single switching stage instead of using a primary and secondary switch for the completion of a connection.

A single-stage link frame seemed essential because of the rapidity with which a register must be connected to trunks carrying subscriber-dialed traffic from a step-by-step office. On calls from panel or crossbar offices, the pulses indicating the number wanted are transmitted by a sender, and they are



* See page 5.

Fig. 1—Incoming register link frame for No. 5 crossbar system.

not transmitted until the sender gets a signal indicating that a register is ready to receive them. With subscribed-dialed step-by-step traffic, however, the pulses are sent directly from the subscriber's dial, and those for the first digit of the called number follow immediately after those for the last digit of the office code. The only time available for connecting an incoming register to the circuit, therefore, is part of the interdigital time between the last digit of the office code and the first digit of the subscriber's number.

The twenty trunk circuits connecting to one switch on the basic register link frame, or the forty trunk circuits connecting to one switch on the basic frame and the switch on the same level of the supplemental frame,

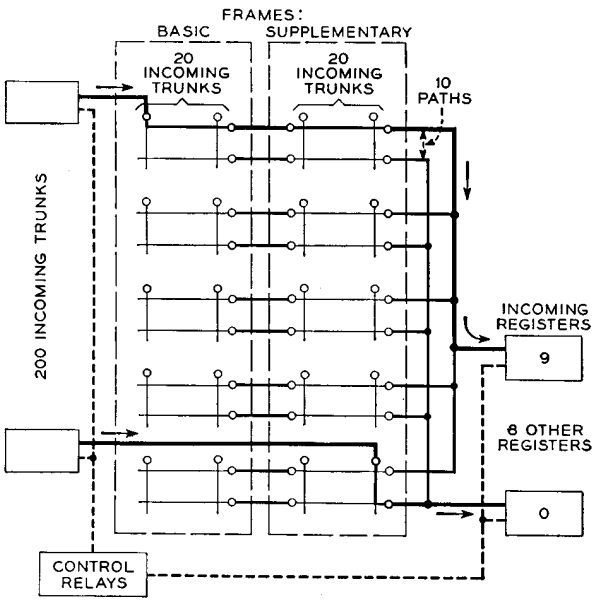


Fig. 2—Block schematic indicating the arrangement of trunks and registers on an incoming register link frame.

are called a horizontal group. The complete link frame is thus divided into five horizontal groups. Although all trunks of all the horizontal groups have access to all of the ten registers associated with the frame, each horizontal group of trunks is given a different order of register preference. The control circuit that connects the trunks to the registers consists in effect of five separate control circuits—one for each horizontal group. Simultaneous calls appearing in different groups may therefore be connected to registers simultaneously, but simultaneous calls in the same group cannot be. One or the other of them is given preference, and the other must wait the fraction of a second required to connect the first to a register.

In the control circuit for each horizontal group there is a trunk preference, TP, relay for each trunk of that group, a register busy, RB, relay and a register preference, RP, relay for each of the ten registers, and the twenty hold and the ten select magnets for the crossbar switches of that group. There is also a TF, a CL, and sometimes a TN relay through which the register receives additional information. These various relays are interconnected as indicated in Figure 3. For the sake of simplicity it is assumed here that a supplementary frame is not employed, and thus there are only twenty trunks to be considered in a horizontal group, and relays are shown for only the fourth horizontal group and only for the fourth register, which is the first preference for that group. Since there are ten registers and five horizontal groups, there are in all fifty RP relays—one for each horizontal group for each register. In Figure 3, only the five RP relays for register No. 4 are shown; each of the other registers has a similar group of five RP relays. Register busy relays in horizontal group 4 are indicated for all ten registers. A lead from a back contact of each of these relays runs to the No. 4 RP relay for each register, but only the RP relay for the No. 4 register is shown in the diagram.

To illustrate the action of the circuit, assume a call comes in on trunk No. 10, and that register No. 4—the preferred register for horizontal group 4—is not busy. The No. 10 TP relay will operate, and through its No. 2 spring will connect ground—through a back contact of the No. 4 RB relay—to the winding of the No. 4 RP relay of register No. 4, and this RP relay will operate. Through a front contact on the No. 2 spring of the No. 4 RP relay, battery applied in the register will operate the No. 4 select magnet on the crossbar switch of horizontal group No. 4. When the magnet operates, a connection will be established from ground in the register to operate the hold magnet for No. 10 trunk. In the meantime, relays TF and CL, and TN if one is required—for trunk frame, class,

and trunk number identification—have been operated through the No. 4 spring on the RP relay. These relays each close twelve sets of springs to make the necessary identifications, and through a set of cross-connecting terminals they are associated with leads from front contacts on springs 5 and 6 of the TP relays. From front contacts of the TF and CL relays leads run to the register to convey the required information.

It will be noticed that when the RP relay operated, it opened the operating path to the windings of all the other RP relays for that register. Should a call in one of the other horizontal groups attempt to seize that register, it will thus be unable to do so. Immediately upon selection, the register operates its RB relays associated with the other four horizontal groups so that calls coming in by way of these other groups will not attempt to seize the No. 4 register. After the hold magnet has been operated, the register —through circuits not shown—releases its RP relay that had been operated and operates its RB relay in the horizontal group from which it was selected. After this time, all calls from

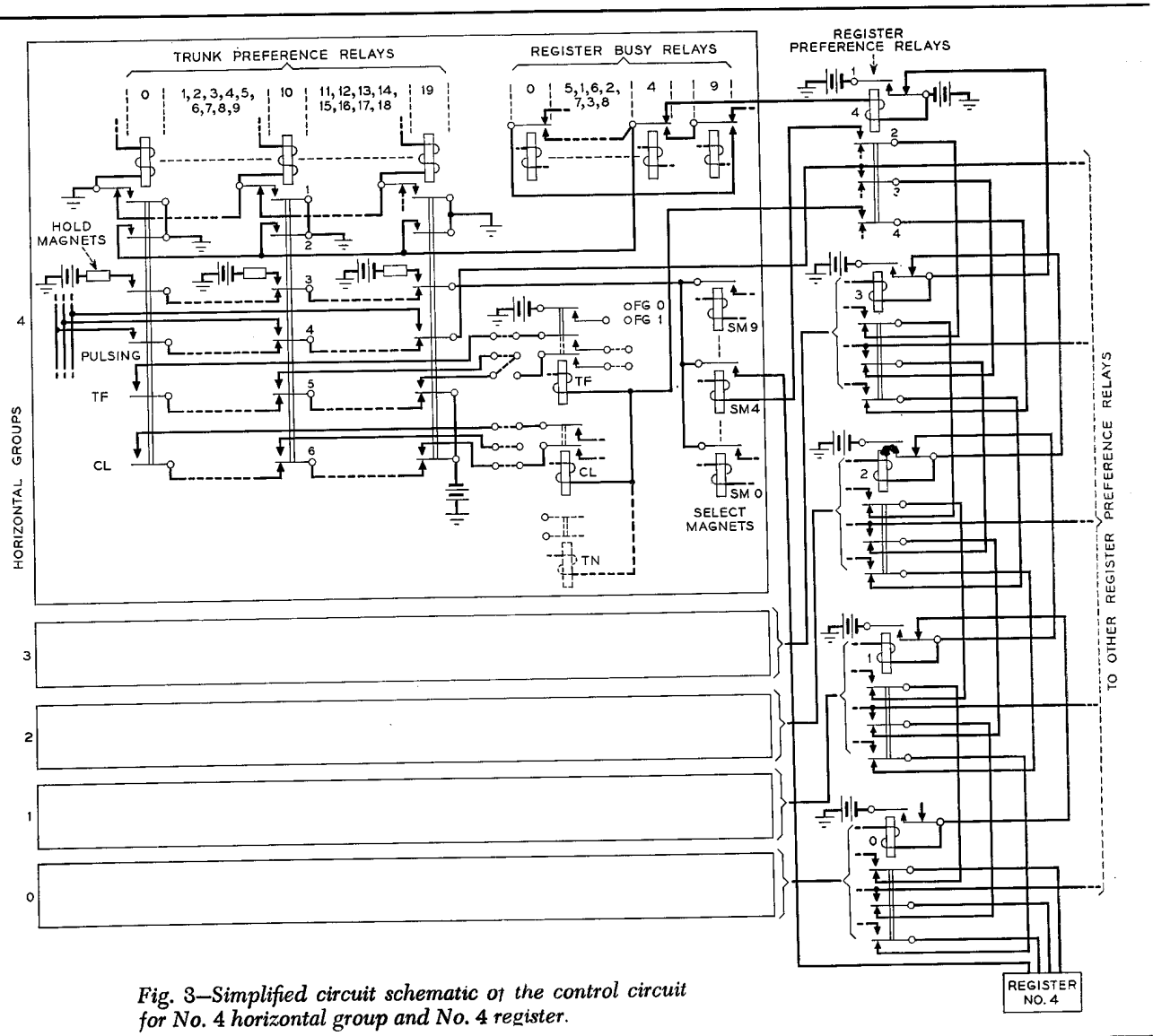


Fig. 3—Simplified circuit schematic of the control circuit for No. 4 horizontal group and No. 4 register.

that horizontal group will be passed to one of the other registers because of the operated RB relay.

In the fraction of a second between the operation of the No. 10 TP relay and the operation of the No. 4 RB relay, a call coming in on a higher numbered trunk of the same group—11 to 19, inclusive—could not operate its TP relay because the circuit to its winding would be open at the No. 1 spring of the No. 10 TP relay. A call on any of the lower numbered trunks—0 to 9, inclusive—could operate its TP relay, but the hold magnet for that trunk could not be operated since its circuit is opened by the No. 3 contact of the No. 10 TP relay. By these means complete lockout is secured.

When the hold magnet is operated, six leads are connected to the register from the trunk circuit. One of these is used to keep the hold magnet operated. Two are used for pulsing, two for passing information between trunk and register, and one over which the marker will operate a relay in the trunk circuit to identify the trunk when it completes the talking path through the trunk link frame. The select magnet and relays TP and RP are released after the crosspoints are closed so that other calls in the same horizontal group may be handled.

Reference was made earlier to the need for a quick connection when subscriber-dialled calls originate in step-by-step offices. Although with the frame idle, the connecting time of this link involves only the operating time of the control relays and one crossbar switch, even this interval of about 0.1 second may be too long on some connections. Because of this, a by-link circuit has been incorporated that permits dialing to proceed before the switch crosspoints are closed, thus reducing the time to about 0.04 second. The by-link path is closed through the No. 4 springs on the TP and the No. 3 springs on the RP relays as soon as the trunk preference and the register preference relays operate. The by-link path and the regular pulsing path through the crosspoints are in multiple so that there is no discontinuity in the reception of pulses when the crosspoints close. This by-link path, being part of the control circuit, is released as soon as the switch path is established, and is thereby made immediately available for use with the next call.

Some calls may arrive while the link is being used to set up one or more calls which have preference in the chain. When this occurs or when the dial pulses are received too soon for the register to have been attached, the trunk circuit will send back an overflow or paths-busy signal to the subscriber.

As mentioned in the article already referred to, the No. 5 crossbar system is arranged to serve as a tandem office or a toll center to switch calls through it to other distant offices. In such cases the incoming trunks have connections to both line link and trunk link frames, the former for calls passing through the office. The register link then has the additional function of indicating to the register, for use by the marker, the line link location in the form of a trunk number. The circuit for passing this information is not shown, but is similar to that for trunk frame and class, that is, by cross-connection from the trunk preference relay through another connector relay TN shown dotted in Figure 3. The equivalent of the three digit number, which is required to identify any one of the two hundred trunks, is derived on a link location basis. Because of the additional contacts needed for this purpose on the trunk preference relays, auxiliary relays are provided, one for each tandem trunk, and the contacts on these relays are cross-connected to a tandem connector relay. One set of contacts is connected to indicate whether the trunk is on the basic frame or the supplementary frame, thus indicating in which hundred the trunk is located. The frames are further subdivided into even and odd tens in each horizontal group. One of two leads from each horizontal group, therefore, identifies the second digit, and one out of ten leads identifies the unit or third digit.

The five horizontal groups of crossbar switches can be seen in Figure 1 at the top of the frames and below them some of the trunk preference relays in the control circuit.