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Switching Development

Senders for No. 5 crossbar

One of the features of the No. 5 crossbar system that distinguishes it from other common control switching systems is that intraoffice calls—calls originated by and completed to subscribers within the office—are established without the use of senders. Neither are senders required on incoming calls. All calls outgoing, however, except those requiring operator assistance, require a sender. Where the called and calling offices are in the same building but are served by different marker groups, inter-marker-group senders may be used, but for all other calls outgoing senders are used.

The chief function of the outgoing sender is to transmit the number to the called office, and since No. 5 crossbar is designed to connect to all existing types of offices, provisions must be made for multi-frequency pulsing, dial pulsing, revertive pulsing, and call-indicator pulsing. This could have been done by providing a single design with a multiplicity of classes, but to reduce the complexity of the design, four general types of outgoing senders are provided, and are designated according to the method used for transmitting the number. Thus there are multi-frequency, dial pulse, revertive pulse, and call-indicator pulse senders.

Unlike the No. 1 crossbar senders, the senders of the No. 5 office do not receive and record the digits one at a time as dialed by the subscriber, but receive them all simultaneously through the marker from either the originating or incoming registers. While the number is being recorded, the sender also records, under control of the marker, class marks denoting any special handling of the call such as fast dial speed or compensation to be added to the loop. The sender also receives from the marker information for the initial entry on the automatic message accounting tape in offices where this system is used. It records this information at the same time it receives the called number and class information, and transmits it to the automatic message accounting circuits as soon as it receives a "go ahead" signal from the marker. This latter signal indicates that the marker has connected the calling line to a suitable outgoing trunk, and that the sender should proceed with its part in completing the connection.

A set of five relays is provided in the sender for recording each digit of the called number, but two, and only two, relays of each set are used to record any one digit. For some types of calls, only four digits are included in the called number, while for nation-wide dialing, eleven digits may be required. The senders may thus include from four to eleven sets of recording relays. The five relays of each set are marked 0, 1, 2, 4 and 7. For digit 0, relays 4 and 7 are operated, but for all other digits, the sum of the two operated relays indicates the digit. Thus 0 and 1 are operated for digit 1, 0 and 2 for digit 2, 1 and 2 for digit 3, and so on. This 2-out-of-5 method of recording provides a check on correct operation, since if fewer or more than two relays are operated, it is evident that an error exists, and a trouble record will be made.

In the registers, digits are also recorded on 2-out-of-5 sets of relays and in the same order in which they are dialed. A particular set of recording relays, therefore, does not always record digits of the same significance. For a call to a local office in an area with only two-digit office codes, for example, the fourth set of relays would record the second digit of the number in the office called. In an area with three-digit office codes, the fourth set of relays would record the first digit of the number in the called office, while with nation-wide dialing systems, the fourth set of relays would record the first digit of the office code. Because of this lack of functional identity, the sets of recording relays are designated A, B, C. and so on, up to L, but excluding I, when the full eleven sets are required.

These digits are transferred from the register to the marker and from the marker to the sender in the same order in which they were dialed, and in both marker and sender are recorded on similarly designated sets of relays. In general, however, the sender does not transmit all the digits it records. To an office in the same area reached over a direct group of trunks, for example, only the subscriber's number is transmitted, even though the office code had been recorded, since the marker has selected a trunk to that office. Although the markers could have been designed to transfer to the will begin with the B digit; while if the No. 3 delete relay is operated, it will begin with the D digit, and so on. Thus, if the number CH3-2468 has been transferred to the sender, the marker, after selecting a trunk to the CH3 office, would operate the No. 3 delete relay in the sender. When the sender is given the "go ahead" signal, therefore, it will begin its transmission with the fourth digit, 2. When automatic message accounting is not provided, however, and when there are no routes to a toll or tandem office, the senders are not equipped to record the digits for the office code.

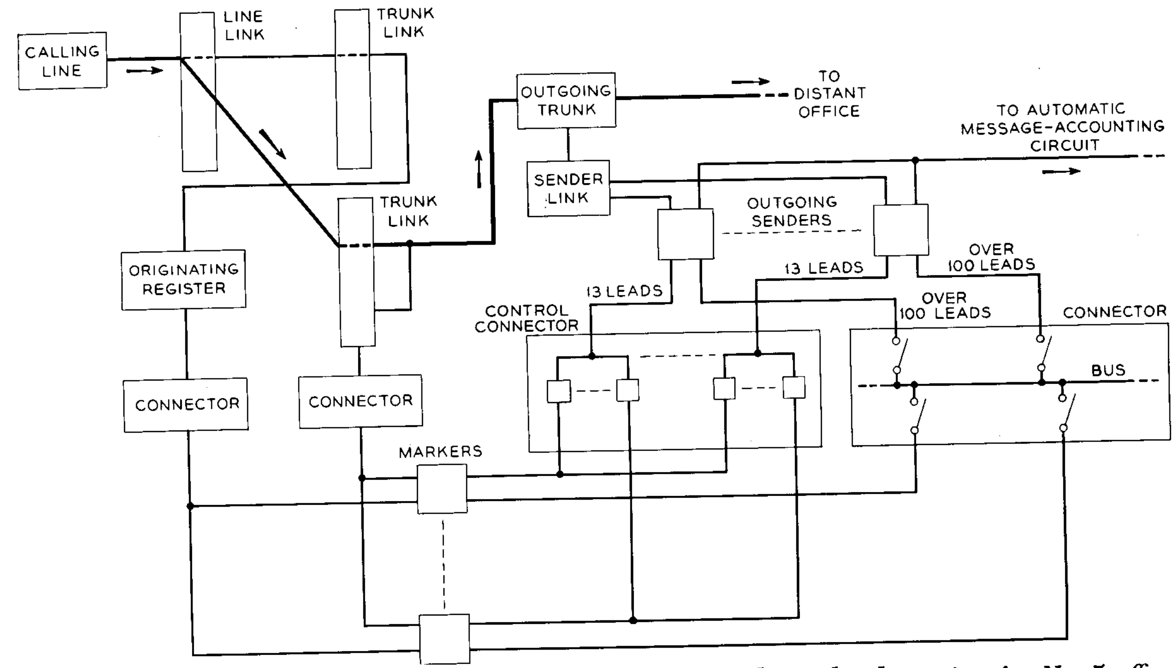


Fig. 1—A block diagram showing lines of association of the sender with other units of a No. 5 office.

sender only the digits it required, or to shift the order in which it transferred them so that in the above example the called station-number digits would have come first, it was found simpler to allow the marker to transfer the complete set of digits it received and in the same order, and then to indicate to the sender the point in the recorded chain of digits at which it should begin sending. This is accomplished by delete relays, of which there may be as many as six in the sender. If the marker operates the No. 1 delete relay, the sender

The first three delete relays are commonly used, but the higher numbered ones are employed chiefly to take care of situations that may occasionally arise with nation-wide or extended-area dialing. The marker can also order the sender to add one arbitrary digit or to prefix "one-one" as special codes under certain conditions.

The lines of association of the sender with other units of the system are indicated in Figure 1. When a subscriber lifts his handset, a marker is seized and connects the calling line through the line-link and trunk-link frames to an idle originating register, which returns dial tone and then records the number dialed. The register then seizes a marker, transfers the digits to it, together with certain other information, such as the equipment location of the calling line. The path through the link frames, over which the register was connected to the calling line, is broken down after the trunk has been selected. The marker, knowing from the office code digits the type of sender that will be needed, seizes an idle sender of this type, and transfers the digits to it. Communication between the marker and sender is established over two sets of channels, a connector, and a control circuit. The connector, when fully equipped, includes more than 100 leads and is common to all senders and to all markers. Over these leads all the digits and certain other information, such as the class and automatic message accounting information, are transferred simultaneously. Only a fraction of a second is required for the transference of this information and for checking the recording, and then the channel is released for use by other markers and senders.

The control channel between the marker and the sender, when fully equipped, includes thirteen leads. It is individual to each sender and each marker and is held until the marker is satisfied that the proper connections have been made to the sender. This channel is also used for passing certain class information pertaining to the trunk which the marker obtains from the trunk-link frame on which the trunk appears and which may not be obtained in time for passage through the common channel.

The marker, at the same time it records the number in the sender, selects an idle outgoing trunk to the called office and causes the trunk to be connected to the selected sender through the outgoing sender link. This connection places the sender under control of supervision in the outgoing trunk, and when the marker has connected the calling line to the outgoing trunk over the line-link and trunk-link frames, it gives

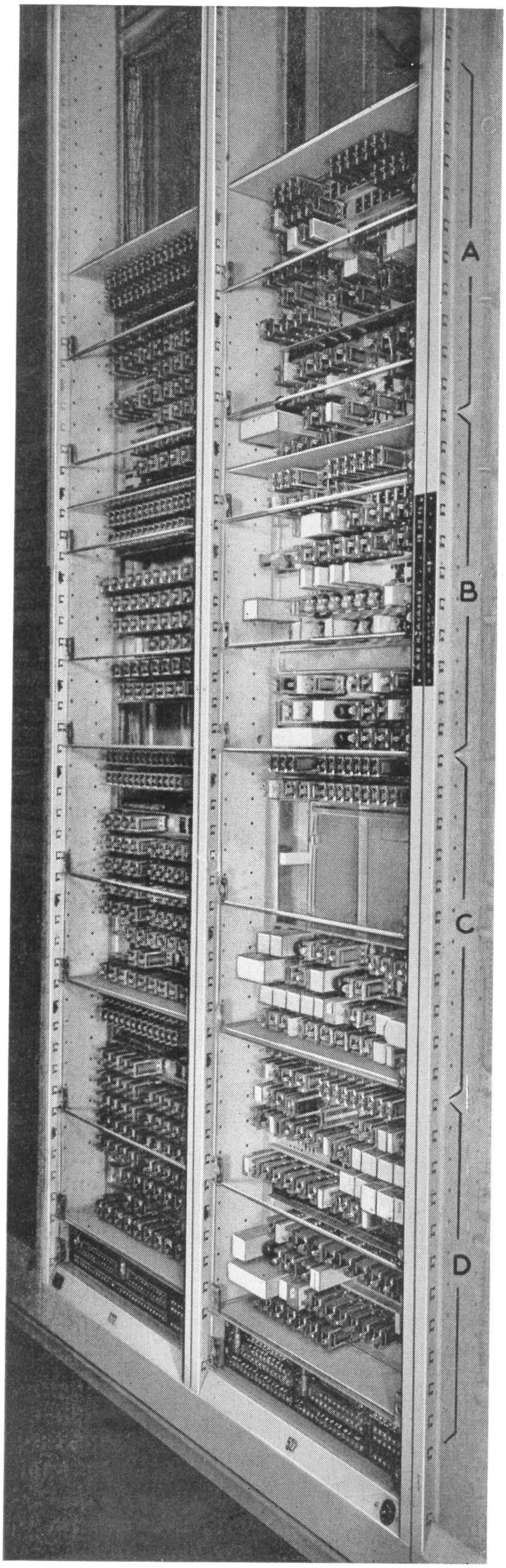


Fig. 2—A sender frame of the Laboratories' installation of No. 5 crossbar: A—call-indicator sender; B—revertive sender; C—multi-frequency sender; and D—dial-pulse sender.

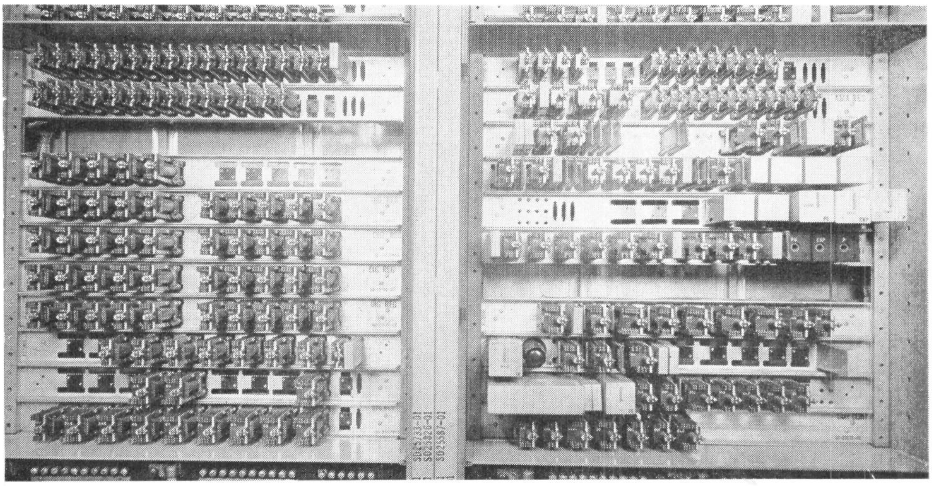


Fig. 3—A dial-pulse sender with the front covers of transparent plastic removed.

the sender a "go ahead" signal, and releases. At this time, the sender starts an AMA initial entry, if one is required, and starts timing an interval for allowing the distant end of the trunk to become normal. This is necessary since the trunk may have been seized immediately on appearing idle. The time between selection of a trunk by the marker after being released from one call, and the connection to a sender for another call, is insufficient to allow the complete release of the trunk supervisory relays at the called office, and the sender allows approximately one-half second before closing the trunk tip and ring conductors as a seizure signal. When this interval has elapsed, the sender connects the tip and ring leads to its supervisory circuit, and when this circuit detects the proper polarity, the number is transmitted and the sender released.

Outgoing senders are arranged so that when an AMA record is required for the call, the transmission of the number will not be completed until the initial entry is completed. This is done on all except the call-indicator sender by delaying the transmission of the last digit, but on call-indicator senders by delaying the transmission of entire number. Usually, except for the call-indicator sender, the initial entry is completed in sufficient time so that it causes no delay in the call's completion.

The multi-frequency sender offers the fastest means for transmission of the number and, consequently, this sender is used whenever the called office is provided with means of receiving the multi-frequency pulses. At present, such services are available for crossbar No. 1 and No. 5, crossbar toll, and crossbar tandem offices. Transmission of multi-frequency pulses is at the rate of approximately seven digits per second.

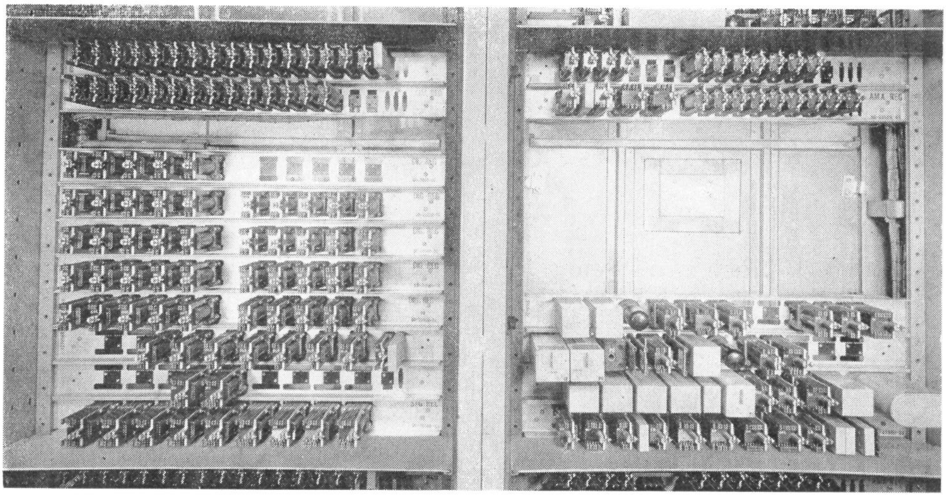
Dial-pulse senders are used for completing calls to step-by-step offices, and can be used for completion to No. 5 crossbar and to crossbar toll and crossbar tandem offices. Transmission of dialed digits is at an average of either one or two per second, depending on the capability of the terminating office to receive them.

Revertive-pulse senders are used for completing calls to panel offices and to No. 1 crossbar offices that are not equipped to receive multi-frequency pulses. The revertive-pulse sender is arranged to transmit only the four numerical digits of the number, but this is transmitted in five selections of the type required for guiding the panel selectors to the proper terminal. Revertive-pulse senders are arranged for operation in areas having office codes of two digits, three digits, or combinations of two and three digits.

Call-indicator senders are used for completing calls to manual offices equipped with call-indicator equipment, and to panel-tandem offices, which are similarly equipped. These senders are arranged for operation in areas having office codes of two digits or three digits, and the marker informs the sender whether to delete or to transmit the office-code digits.

A close-up view of the dial-pulse sender is shown in Figure 3, and of the multi-fre-

Fig. 4—A multi-frequency sender with the front covers of transparent plastic removed.



quency sender in Figure 4. The two rows of relays across the top of both bays of each sender are those used for the automatic message accounting system. In the left-hand bay section of each sender, the five rows of relays beneath the AMA are the digit register relays, while the delete relays are in the row next lower, and the steering relays that control the digit register are in the bottom two rows. In the right-hand bay section of the dial-pulse sender, the first row beneath the AMA relays includes the class relays; the next three rows include the dial-pulse generator, counting, and control relays; and beneath these are the general control relays. For the multi-frequency sender, the frequencies are generated in a separate circuit. Means for connecting these frequencies for each digit are included with the general control relays in the four lower rows.

The holding time of an outgoing sender on a normal call is only a few seconds, and as few as ten multi-frequency and ten dial-pulse senders are usually capable of handling the outgoing traffic for a 10,000-line office. To prevent a sender from being held for a long period, in case a trouble condition is encountered that prevents completion of the call, each sender has a timing circuit which allows each call sufficient time for normal completion. If the call is not completed within this interval, the timing circuit functions to give the calling party an overflow signal and then to release the sender. Under certain conditions, the sender can be held for maintenance attention after a timeout. All senders are equipped with make busy jacks and trouble lamps, and these are located at the maintenance center. All outgoing senders have provisions for connections to the automatic monitor, register, and sender-test circuit for automatic monitoring of service calls and for testing to insure that their respective functions are performed satisfactorily.