Incoming register circuits for No. 5 crossbar

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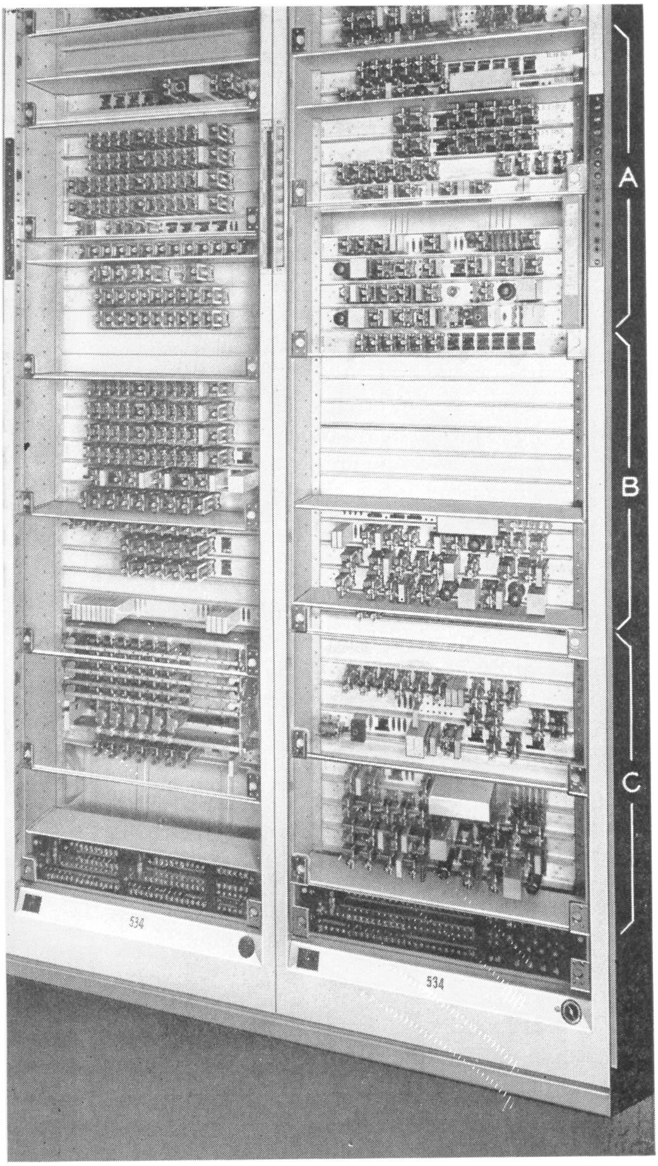

Fig. 1—A frame of incoming registers installed in the Laboratories for test: a dial-pulse register at A; a multi-frequency register at B; and a revertive-pulse register at C.

In a No. 5 crossbar office, a call coming in from another office can be completed to the called line by a marker in a fraction of a second. A much longer time is usually required, however, to receive from the incoming trunk the number of the called line, since the several digits of the number are pulsed one at a time over the two wires of the trunk. To avoid holding the marker during the pulsing time, a circuit is required to receive and remember the various digits, and then to transmit all of them to the marker at once, using as many paths as needed. Such circuits are called incoming registers. In general function and purpose, they are thus like the originating registers.*

When an incoming trunk receives a call from its distant end, it signals a link circuit†, which connects it to an idle incoming register. The link transmits to the register a trunk class signal, a frame number, and, for tandem trunks, a number-group location. Class indications give such information as whether the register should send dial tone over the trunk; the number of digits to be received; whether the trunk is arranged for local, tandem, or toll service; any restrictions which may apply to the trunk in completing to various groups of lines; and whether the trunk is of a special purpose type used by certain operators or test men. Some of these items will affect register functions, but most of them are merely recorded to be passed on to the marker after the line number has been received. The frame number is the number of the trunk-link frame where the trunk appears. It is required by the marker in connecting the trunk to a local subscriber. The number group location is used by the marker to obtain the line-link frame location of a

* See page 39. † See page 72.

tandem or toll trunk. Such trunks appear on both the trunk-link and line-link frames. The latter connection is used when the call is to pass through the office, and the former when it is to be completed to a local subscriber. The register records this information, checks for any possible double connection in the link, and then signals the trunk that pulsing may commence.

Incoming registers may receive pulses from a step-by-step subscriber's dial, from a sender, or from an operator's dial or keyset. Three types of pulsing are encountered: dial pulse, from a dial or sender; revertive, from a panel or crossbar sender; and multi-frequency, from a keyset or sender. Other types may be added as required without affecting the marker. A separate type of register is used for each type of pulsing. A frame with the three types of registers is shown in Figure 1 as installed in the Laboratories for test purposes.

Each dial-pulse digit is a train of from one to ten open-circuit pulses sent from the calling office; each revertive digit is a train of shunting pulses sent from the called office and stopped by a signal from the point of origin when the correct number has been sent; each multi-frequency digit is a single pulse containing two out of five frequencies in the audible range. A dial-pulse register need merely count pulses and recognize the end of each digit, while a revertive register must generate pulses, count them, and recognize an open circuit signal which marks the end of a digit. These functions are performed by relays within the registers; pulse generation as described in connection with revertive pulsing,* and counting as described for the originating registers.† Multi-frequency registers are not at present equipped with relays to sort out the a-c frequencies contained in their pulses, but instead employ an electronic multi-frequency receiver, shown in Figure 2, which amplifies the pulses, limits their amplitude, checks for spurious and missing frequencies, separates and detects the frequencies, and furnishes the register with d-c pulses on two at a time out of five leads. A sixth frequency and its associated lead are used only for start and stop signals and not for numerical digits.

As each successive digit is received, the register records it for future reference. Dial-pulse and multi-frequency registers use five relays to record each digit, two relays operating for each numeral from 0 to 9. This scheme matches both the two-out-of-five arrangement of frequencies in multi-frequency pulses and the pattern of grounded leads by which the digits will be transferred to the marker. Its main advantage is that it is self-checking, since ordinary trouble conditions would result in one or three out of five instead of two—a difference easily recognizable. These registers may be equipped for from four to eleven digits, depending on traffic requirements. In a single-office unit with only local incoming traffic, four digits are sufficient, while a No. 5 unit used as a combined local office and toll center may require eleven digits to accommodate a three-digit national dialing code, a three-digit local area code, four numerical digits and a party letter. Revertive pulse registers at present re-

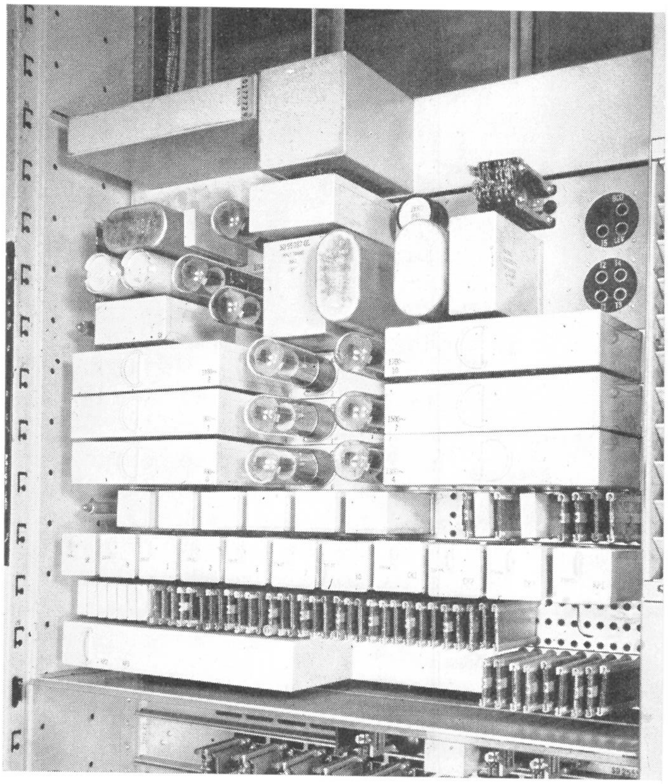

Fig. 2—A receiver for the multi-frequency register.

* RECORD, *August*, 1943, *page* 448.
† See page 39.

cord only the pulses designating the four digits of a line number, although plans envisage additional digits for tandem operation in the future. Instead of recording the digits on sets of two-out-of-five relays as in the other types of registers, however, the revertive-pulse registers record them on a crossbar switch, using apparatus and circuits essentially the same as those used in terminating senders of the No. 1 crossbar system.

To determine when the last digit has been received is no problem for revertive and multi-frequency registers, since the former are arranged for a fixed number of digits, and the latter always receive an end-of-pulsing signal after the last digit. Dial-pulse registers, however, may receive any number of digits from three to eleven and do not receive any end-of-dialing signal from the trunk. Dial-pulse registers, therefore, must look for every possible clue as to the number of digits to be received. On calls from local trunks, the trunk class indicates the expected number of digits—either four or five depending on the class. On tandem and toll trunks, an office code always precedes the line number. However, there may be both two and three-digit codes within the numbering area, and some offices reached by tandem may have some lines with party letters. Still more variation occurs on toll calls, since they may be directed to either subscribers or toll operators in either the local area or some distant area.

To take care of these variations, the dial-pulse register has facilities for looking at the first one or two digits of the office code, which may indicate the number of digits in the code and also identify the code sufficiently to tell whether the called office has party letters. If it has or may have, there is still no assurance that a letter will be dialed on this particular call, but the register will allow time for a possible additional digit. On toll trunks, the code may be either a local area code or a toll code. The register can recognize the difference by looking for a toll-indicating zero or 1 in the first or second position. Local-area codes are treated as are those received on tandem trunks, but most toll codes may be followed by an indefinite number of digits. When such a toll code is recognized, therefore, the register times after every digit received, and recognizes the last digit by the lack of dialing within the succeeding few seconds. An exception is made for certain toll service codes that are never followed by any digits. Such codes, recognized by 1's in certain positions, indicate the end of pulsing without timing after the third digit.

When the register is satisfied that all digits have been received, it must pass them to a marker. The register signals a marker connector circuit, which seizes an idle marker and connects it to the register by a large number of wires. Using these many paths simultaneously, the register is able to tell the marker in a few milliseconds all the information which it has accumulated in perhaps as many seconds. Trunk class, frame location, number-group location, and the several digits go into the marker all at once, enabling it to complete the call immediately and to free itself so quickly that it can handle thousands of calls per hour.