"TOUCH-TONE" CALLING
GENERAL DESCRIPTIVE INFORMATION

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1. INTRODUCTION

1.01 TOUCH-TONE calling introduces two charges into the existing telephone plant. One is in the physical makeup of the station set — a pushbutton device instead of the rotary dial (Fig. 1); the other, in the method of signaling — audible tones instead of dial pulses transmit the called number to the local central office.

Fig. 1 – TOUCH-TONE Station Set

1.02 The TOUCH-TONE dial consists of a rectangular array of pushbuttons, a mechanical arrangement to cause contact closure for tone generation, and an oscillator circuit to generate these tones. To place a call, a TOUCH-TONE customer depresses the buttons, in sequence, corresponding to the digits of the called number. Depression of a button causes a 2-frequency tone to be generated within the station set.

1.03 TOUCH-TONE calling is faster than rotary dialing. A digit is transmitted to the central office while the button is depressed; the speed depends mainly on the customer.

1.04 The TOUCH-TONE method of signaling uses what has been called the four-by-four code which is based on two groups of four frequencies each:

Low group (cps): 697, 770, 852, 941

High group (cps): 1209, 1336, 1477, 1633

Each TOUCH-TONE signal is composed of one frequency out of the low group and one frequency out of the high group. This yields 16 combinations, of which ten are used to represent the digits one through zero (Fig. 2). Since only three of the frequencies in the high group are used in these ten combinations, the TOUCH-TONE signaling code is referred to in this section as the four-by-three (4 x 3) code.

1.05 The electromechanical switching systems were designed for dial pulse operation. Since the TOUCH-TONE signaling method is entirely different, equipment additions and modifications are necessary to enable the local central office to respond to the tone signals. With the arrangements described in this section, the central office can operate with either rotary dial or TOUCH-TONE station sets. Both types of station sets are permitted on the same central office line.

2. PRINCIPLES OF OPERATION

A. General

2.01 The major equipment units associated with TOUCH-TONE calling are the receiver and the converter. The receiver detects

the two frequencies of a TOUCH-TONE digit and provides a dc output on the leads to the associated converter. The converter takes the digit indications from the receiver and converts them into a form that the switching equipment can use. While the receiver is standard for all switching systems, the type of converter differs depending on how a particular switching system handles incoming information.

2.02 In common control systems a receiver-converter is directly associated with an originating register or sender. In the step-by-step system a linkage arrangement provides access between the switch train and the TOUCH-TONE equipment. The TOUCH-TONE arrangements have been developed so that an office may be either partially or completely converted for TOUCH-TONE calling. With partial conversion, only enough equipment to handle the estimated TOUCH-TONE development and maintain traffic balance is converted. Lines with TOUCH-TONE station sets are segregated in such a way that these lines will always be served by the converted equipment. In complete conversion all originating equipment is modified for TOUCH-TONE calling and no line segregation is required. Factors to be considered in choosing between partial and complete conversion are the estimated growth, amount of originating equipment to be converted, number of lines to be relocated in providing line segregation, and additional equipment required for split group operation.

2.03 The new 807D dial tone power supply is required in all offices with TOUCH-TONE station sets. The frequency composition and level of the dial tone used for dial pulse operation blocked the reception of the initial TOUCH-TONE digit. The new dial tone, a combination of two frequencies, 350 and 440 cps, will serve the entire office for both TOUCH-TONE and rotary dial customers.

2.04 In addition, service observing, maintenance, and station test facilities are modified to measure TOUCH-TONE performance.

B. TOUCH-TONE Receiver

2.05 The receiver is bridged across the tip and ring leads of the telephone connection during the dialing interval. It is arranged to detect TOUCH-TONE signals and to ignore other signals. For each TOUCH-TONE signal received, the receiver provides the converter with three dc indications (Fig. 3). Two of these indications tell which frequency in the low group and which in the high group were received. The third is used to control the transfer of digital information.

2.06 The receiver determines the validity of the signals by requiring a combination of one high-group frequency and one low-group frequency to persist uninterrupted for a fixed period of time (22.5 msec), in addition to an absence of power in the remainder of the speech band. The receiver ignores dial pulses and is arranged to minimize the effects of crosstalk, impulse, and power noise that might be present during the dialing interval.

C. No. 5 Crossbar

2.07 In No. 5 crossbar offices a receiver-converter is directly associated with an originating register (Fig. 4). The converter, in this case, is a translating and control unit. For each TOUCH-TONE digit received, the receiver places −22 volts on the steering lead and two of the frequency leads to the converter. Translating relays in the converter operate corresponding to the frequencies of this digit. The operation of these relays translate the 4 x 3 encoded information received from the receiver into two-out-of-five indications. These indications are transferred on a multilead basis into the digit registers of the originating register. Dial pulses from a rotary dial are ignored by the receiver and handled by the originating register. The originating register continues to perform such functions as applying dial tone, coin, and party tests on both TOUCH-TONE and rotary dial calls.

2.08 No. 5 crossbar is so designed that to partially equip an office for TOUCH-TONE calling, two groups of originating registers are provided. One group handles rotary dial calls only. The originating registers in the other group are associated with receiver-converters so that they are capable of handling both TOUCH-TONE and rotary dial calls. TOUCH-TONE lines are segregated on a vertical group basis. A vertical group check by the dial tone marker assures that a TOUCH-TONE call will be served by the proper type of originating register.

2.09 As the first digit is received by the converter, it notifies the originating register that this is a TOUCH-TONE call. This indication is used to measure TOUCH-TONE traffic when the originating register handles both TOUCH-TONE and rotary dial calls.

D. No. 1 Crossbar and Panel

2.10 The No. 1 crossbar and panel converters are more complex than the translating and control type used for No. 5 crossbar. In addition to translation features the No. 1 crossbar and panel converters provide the digit storage and outpulsing facilities required by these systems. Digit storage is necessary because it is possible for the digit transmission rate from a TOUCH-TONE station set to slightly exceed the registration speed of the sender. Outpulsing on a dial pulse basis is used to avoid modification to the auxiliary sender operation.

2.11 In No. 1 crossbar a receiver-converter is connected in multiple with the originating sender (Fig. 5). On a rotary dial call the dial pulses are presented directly to the sender for registration. On a TOUCH-TONE call the receiver detects the frequencies and indicates them to the converter. Translating relays in the converter operate and translate the 4 x 3 encoded information into two-out-of-five indications. These signals are then passed through the insteering circuit and stored in the proper digit registers. The converter then outpulses the digits to the sender for registration. Digits are outpulsed at the rate of 20 pulses per second. The converter has 7-digit registers with a recycle arrangement to reuse the digit registers when more than seven digits are required to complete the call.

2.12 For partial conversion of a No. 1 crossbar, office (Fig. 6) lines with TOUCH-TONE station sets are segregated on a horizontal group basis. These TOUCH-TONE horizontal groups contain all TOUCH-TONE lines and the rotary dial lines required for traffic balance. Each sender subgroup contains three classes of senders.

(a) Rotary dial senders serve traffic from rotary dial horizontal groups.

(b) TOUCH-TONE senders are associated with receiver-converters and serve traffic from TOUCH-TONE horizontal groups.

(c) Overflow senders are also associated with receiver-converters and may be used by either the rotary dial or the TOUCH-TONE horizontal groups when all the other senders that they have access to in this subgroup are busy.

The line link controllers and sender link controllers are modified to differentiate between lines in the TOUCH-TONE horizontal groups and the lines in the rotary dial horizontal groups and to establish the connection to the proper type sender. In partially converted offices dialing through an operator district junctor or a step-by-step district junctor will not be on a TOUCH-TONE basis.

2.13 In panel the customer tip and ring leads are connected directly to the receiver-converter (Fig. 7). This connection is made in such a way that it does not interfere with the toll diverting and coin features of the senders. This receiver-converter handles TOUCH-TONE signals in the same way as No. 1 crossbar. On rotary dial calls, however, the dial pulses are presented to the converter. A pulsing relay in the converter follows the dial pulses and repeats them by operating the line relay in the sender.

2.14 For partial conversion of a panel office (Fig. 8), lines with TOUCH-TONE station sets are segregated by line finder groups. The TOUCH-TONE line finder groups contain all TOUCH-TONE lines and the rotary dial lines necessary for traffic balance. Two groups of senders are provided. One group handles only rotary dial calls while the other is modified to handle both TOUCH-TONE and rotary dial calls. The sender multiple is rearranged so that the TOUCH-TONE line finder groups can only reach the converted sender group and the rotary dial line finder groups can only reach the rotary dial sender group. Operator dialing selectors will not be arranged for TOUCH-TONE calling.

2.15 Auxiliary sender operation and the methods of making coin and party tests in either No. 1 crossbar or panel offices are unchanged. Indications of TOUCH-TONE calls for traffic measuring purposes are obtained from the receiver-converters.

E. Step-by-Step

2.16 In step-by-step offices the TOUCH-TONE equipment is interposed between the line finder and first selector. For partial conversion to TOUCH-TONE calling, lines with TOUCH-TONE telephones are segregated into separate line finder groups. Only these groups have access to the TOUCH-TONE equipment. Rotary dial lines may also be assigned to these groups.

2.17 Two types of TOUCH-TONE equipment are available for step-by-step offices. The first arrangement (noncommon control) gives a step-by-step office TOUCH-TONE capability. The other arrangement (common control) incorporates TOUCH-TONE calling with certain "common control" features.

Noncommon Control TOUCH-TONE Calling

2.18 In noncommon control TOUCH-TONE calling a converter trunk is interposed between the line finder (or line switch or message rate trunk) and the associated first selector (Fig. 9). Depending upon the traffic requirements of the office, converter trunks have access to a common group of receiver-converters through one or two stages of concentration. The converter trunks are connected to the bank terminals of 100-point 8-wire trunk finders. In single-stage concentration these trunk finders are directly connected to receiver-converters. In two-stage concentration the trunk finders are connected back-to-back to converter finders with the receiver-converters appearing on the banks of the converter finders. The converter trunk splits the paths between the line finder and first selector and presents these leads through the finder link to the converter.

2.19 Of all the converters this one is the most complex (Fig. 10). Dial pulsing at the rate of ten pulses per second is necessary to drive the step switches. This rate of outpulsing digits cannot keep pace with TOUCH-TONE signaling and temporary storage of digits is required. These step-by-step offices do not have common control circuits to supervise call progress, and as a result, some additional features were built into the converter. These include some pretranslation ability to determine the number of digits to expect on each call, party testing for AMA and ANI offices, and timing to measure the intervals for work functions, partial dials, and permanent signals.

2.20 On a TOUCH-TONE call the receiver detects the tone signals and transmits the dc indications to the translator in the converter. The relays in the translator translate this information from a 4 x 3 basis to a two-out-of-five basis. These signals are then passed through the insteering circuit and stored on the digit registers. The dial pulse generator and counter along with the outsteering and read-out circuit are used to outpulse the stored digits. When the last digit has been outpulsed, the control circuit signals the converter trunk to cut through, and the TOUCH-TONE equipment releases.

2.21 Digits are outpulsed by the converter at the rate of ten pulses-per-second. Nine-digit registers with a recycle arrangement are provided. When more than nine digits are required to complete a call, the insteering circuit is recycled and the first four registers are used for the succeeding digits. This enables the converter to handle up to 13 digits.

2.22 To enable the converter to release as soon as possible, the code translator looks at the first few digits to determine how many digits to expect on a call. When the numbering plan incorporating 0+ and 1+ dialing is used, the converter will use, in addition to this pretranslating ability, timing to determine the number of digits.

2.23 The converter also times the intervals for its work functions, partial dials, and permanent signals. If a converter fails to complete a work function within the allotted time, the customer receives a reorder signal and the converter is released. For partial dials the converter times out and releases. The converter may be arranged to treat permanent signals in either of two ways. After timing out, the converter can release or it can outpulse a preset code to connect the line to a permanent signal trunk and then release.

2.24 On a rotary dial call the dial pulse detector responds to the pulses from the telephone and repeats the first digit to the first selector. During the first interdigital interval the control circuit signals the converter trunk to cut through and the TOUCH-TONE equipment releases. Succeeding digits are dialed directly into the step-by-step switches.

2.25 In AMA or ANI offices the party test is made while the customer is dialing. The TOUCH-TONE equipment is inserted in the transmission path at this time. The converter trunk signals the converter (a) as to whether the party test is not required, (b) will be made by the 2-party message rate trunk, (c) or must be made by the converter. The converter makes party identification on 2-party flat rate lines. After the converter determines that party test has been made or is not necessary, the converter returns dial tone to the customer. The converter simulates the customer's line condition to satisfy the charging equipment.

Common Control TOUCH-TONE Calling

2.26 Common control equipment provides a step-by-step office with the capabilities for TOUCH-TONE calling, digit translation, code conversion, alternating routing, and MF signaling to other common control offices. This equipment is designed so that TOUCH-TONE calling or the common control features may be added to an office, either individually or in a single package. This section describes the case where only TOUCH-TONE calling capability is provided. A separate section will describe the complete common control system.

2.27 The common control equipment for TOUCH-TONE calling includes the register trunk and link, originating register, receiver-converter, translator, translator connector, and test facilities (Fig. 11). With this arrangement a register trunk is provided for each line finder in the line finder groups which have TOUCH-TONE lines. This trunk is interposed between the line finder (or line switch, coin, or message rate trunk) and the first selector. The register trunks have access to the originating registers through a 2-stage crossbar link. Each originating register is directly associated with a receiver-converter. The originating registers have access to the translators through a connector.

2.28 The converter, in this case, is a translating unit similar to the No. 5 crossbar converter. The originating register does the major part of the work. It performs such functions as returning dial tone, storing and outpulsing of digits, determining with the help of a translator the number of digits to expect on each call, party testing for AMA and ANI offices, and timing to measure the intervals for work functions, partial dials, and permanent signals.

2.29 On a TOUCH-TONE call the receiver-converter detects the TOUCH-TONE signals, translates them into two-out-of-five indications, and transfers these on a multilead basis to the originating register for storage in the proper digit register. The originating register is designed to work with 0 or 1 prefix access codes and has storage for 11 digits. After the first digit has been registered, the originating register begins outpulsing to the switch train. This outpulsing is in the form of dial pulses at the rate of ten pulses-per-second. When the first three digits have been registered (in excess of a prefix digit), the originating register calls in a translator and passes these initial digits to it. The translator determines the number of digits that the originating register can expect. If an area code conflicts with an office code, the translator signals that the originating register should time after the eighth digit to determine if the call is 8 or 11 digits. Timing is also used after an initial digit 0 to differentiate between 0 and 0+ traffic.

2.30 On a rotary dial call, the originating register repeats the first digit to the first selector, then cuts through the register trunk and releases during the first interdigital interval. The remainder of the rotary dialed digits directly control subsequent stages of selection.

2.31 The originating register measures the time-out intervals for permanent signals or partial dials. When an originating register times out on a permanent signal, it can either release and transfer the permanent signal to the first selector, or it can outpulse a preset code (maximum of three digits), which routes the permanent signal to a permanent signal trunk, and then releases. On a partial dial time-out the originating register returns no-such-number tone to the customer, and if the customer still does not hang up, it releases. This causes a second originating register to be seized, and the call is treated as a permanent signal.

2.32 The originating register makes party identification on 2-party flat rate lines and simulates the customer's line condition to satisfy the AMA or ANI charging equipment. This is necessary because the register is in-

serted in the transmission path at the time the party test is normally made by the AMA or ANI equipment.

3. EQUIPMENT ELEMENTS

GENERAL

3.01 TOUCH-TONE calling requires equipment in addition to that supplied for rotary dial operation. This part describes the functions and physical appearances of this equipment.

3.02 The major equipment units for TOUCH-TONE calling are the receiver and the converter. The receiver is standard for all systems, with the converter differing for each system. Two receivers are mounted in an outer cabinet. The receiver pair is on the frame with one of the associated converters below this outer cabinet and one above it.

"TOUCH-TONE" RECEIVER

3.03 The function of the receiver is to detect the frequencies from the TOUCH-TONE set and convert them into dc indications which operate the translating relays of the associated converter.

3.04 Two receivers are individually mounted in an outer cabinet. Each receiver is removable as a unit. This outer cabinet occupies 6 inches of a standard 23-inch relay rack and is 10 inches deep (Fig. 12). Circuit components of a receiver are mounted on modular-type circuit packs which plug into the receiver cabinet. The circuit packs are printed wiring boards on which the circuit elements are mounted. The plugs are an integral part of the printed circuit. All circuit packs (with the exception of the band elimination filter) are individually removable to facilitate maintenance and testing.

NO. 5 CROSSBAR

3.05 The converter for No. 5 crossbar accepts the digit indications from the receiver, translates them into two-out-of-five indications, and transfers them on a multilead basis to the originating register for storage in the proper digit register.

3.06 The converter requires the space of one mounting plate. The receiver-converters are mounted on miscellaneous relay rack frames.

NO. 1 CROSSBAR AND PANEL

3.07 The No. 1 crossbar and panel converters accept the digit indications from the receiver, temporarily store the digits on a two-out-of-five basis, and outpulse the digits at the rate of 20 pulses per second into the pulse counting circuit of the sender. The panel converter also functions on rotary dial calls and repeats the dial pulses to the sender.

3.08 The No. 1 crossbar converter consists of five 23-inch mounting plates. The receiver-converters are mounted on miscellaneous relay rack frames.

3.09 The panel converter consists of five mounting plates. A receiver-converter frame can be equipped with eight of these units.

3.10 For partial conversion of a No. 1 crossbar office all line link and sender link controllers in the marker group must be modified. The major part of these modifications entails the addition of one plate of apparatus to the first primary bay of each line link frame, one plate of apparatus to the sender link frame, and one relay to each sender selector circuit. For a partially converted panel office, the sender multiple must be rearranged to permit the division of senders into TOUCH-TONE and rotary dial groups.

STEP-BY-STEP NONCOMMON CONTROL

A. Converter Trunks

3.11 The converter trunk serves as the gateway between the step-by-step dial equipment and the receiver-converters. A converter trunk is placed between the line finder, or the message rate or coin trunk, and the associated first selector. When a customer originates a call, the converter trunk signals the link to establish a connection to a receiver-converter. This trunk splits the pulsing, transmission, and supervisory paths between the line finder and the first selector and presents the leads from each switch to the converter through the trunk finder and, if provided, the converter finder. The converter trunk signals the receiver-converter unit what action is required on party testing.

3.12 A converter trunk is provided for each line finder in a group arranged for TOUCH-TONE calling. The trunks are associ-

ated with the line finder-first selectors through a cross-connection field. A converter trunk unit consists of twenty trunks.

3.13 The converter trunk frame (11-foot 6-inch) has the capacity of ten converter trunk units with associated cross-connection fields. TOUCH-TONE test and maintenance equipment is also mounted on this bay. The 9-foot 0-inch frames mount ten trunk units with the cross-connection fields. For more than 200 converter trunks, a supplementary frame must be provided.

B. Finder Concentration Equipment

General

3.14 A converter trunk is connected to a receiver-converter through a finder arrangement. This permits a number of converter trunks access to a common group of receiver-converters. Because of varying traffic conditions, the following arrangements for concentration between converter trunks and receiver-converters have been provided. In all cases the converter trunks are multipled to the bank terminals of 100-point, 8-wire finders.

3.15 Single-stage concentration: one trunk finder shelf provides complete access between a maximum of 100 converter trunks and ten receiver-converter units. Each trunk finder is connected to a receiver-converter unit.

3.16 Two-stage concentration: this arrangement provides complete access for more than ten receiver-converters. Each trunk finder is connected to a converter finder. The receiver-converters are multipled to the banks of 100-point, 8-wire converter finders.

Trunk Finders

3.17 The trunk finder is a 100-point, 8-wire switch and provides a single stage of concentration. This switch connects the eight leads through from the converter trunk to the converter or to the converter finder. The converter trunks are multipled to the trunk finder bank terminals. The switch jacks of the trunk finders are cabled to a converter or a converter finder. A trunk finder shelf has the capacity of ten switches and is equipped with switches in accordance with traffic requirements.

Converter Finders

3.18 The converter finder is a 100-point, 8-wire switch and provides the trunk finders with access to all receiver-converters in a group of 100. When a trunk finder starts to hunt for the converter trunk requesting service, the associated converter finder acts simultaneously to find the first idle receiver-converter. Receiver-converters are assigned by vertical file to the bank terminals of the converter finders. A converter finder shelf has the capacity of ten switches and is equipped with switches in accordance with traffic requirements.

C. Converter

3.19 The step-by-step converter accepts the digit indications from the receiver, temporarily stores the digits on a two-out-of-five basis, and outpulses the digits at the rate of ten pulses per second. The converter also has timing features, some pretranslation ability and, if required, party testing. Four receiver-converters and, if required, party test facilities are mounted on an 11-foot 6-inch frame. The 9-foot 0-inch frame mounts three receiver-converters. The party test facilities for these converters are mounted on a miscellaneous relay rack frame.

STEP-BY-STEP COMMON CONTROL

A. Register Trunk and Link

3.20 The link consists of primary to secondary switch arrangement. Six-wire 20 x 10 crossbar switches are used. Two verticals and two horizontals are used together to permit 12-wire operation. Each primary frame mounts ten crossbar switches and relay equipment for 100 register trunks. The link preference and control functions are performed by the register trunk relays. The secondary frame mounts the crossbar switches and control relays for 50 originating registers. These originating registers are divided into five subgroups of ten registers. The control circuit permits the setup of a maximum of five simultaneous calls — one to each register subgroup. Each group of ten register trunks on a primary frame has two links to each register subgroup. These links are extended from frame to frame for a maximum of ten primary frames. This allows the link to connect a maximum of 1000 register trunks to 50

originating registers. Both 11-foot 6-inch and 9-foot 0-inch high frame arrangements are available.

3.21 An 11-foot 6-inch primary frame is a single bay frame 3 feet 0-1/4 inch long and is equipped for 100 register trunks. The 11-foot 6-inch secondary frame is a double bay frame 5 feet 0-7/8 inch long. The secondary frame mounts the line finder-register trunk cross-connection fields, ten crossbar switches, and the control and preference relays for a maximum of 50 originating registers.

3.22 The equipment arrangement for the 9-foot 0-inch frame is similar to the 11-foot 6-inch frame except for the quantities. Two single bays, each 3 feet 0-1/4 inches long, are paired for the primary link of 100 register trunks. Each bay mounts five crossbar switches and relay equipment for 50 register trunks. For the secondary link, a double bay frame 5 feet 0-7/8 inches long is used in conjunction with a single bay frame 3 feet 0-1/4 inches long. The double bay frame mounts all cross-connection fields, the control and preference relays for a maximum of 50 originating registers, and four crossbar switches for 20 originating registers. The supplementary single bay frame mounts the crossbar switches for 30 originating registers.

3.23 When the register trunks require access to less than 20 originating registers, partially equipped primary and secondary frames may be used. The 11-foot 6-inch primary frame can be equipped for a minimum of 40 register trunks, and additions made in increments of 20 register trunks. The associated secondary frame has the equipment for two register subgroups. In the 9-foot arrangement the first frame in a primary pair can be equipped for 40 register trunks. Additions to this primary pair are made in increments of 20 register trunks. The double bay secondary frame is arranged for two register subgroups; the supplementary single bay frame is not required. With the partially equipped link a maximum of two simultaneous calls may be set up. When the limit of 20 originating registers is exceeded, all link frames must be fully equipped.

B. Originating Register

3.24 The originating register provides the digit storage and outpulsing facilities for TOUCH-TONE calls. The originating register uses a translator or timing to determine the number of digits to expect on each call. Timing is used after an initial digit 0 to differentiate between 0 and 0+ traffic and after the eighth digit where area and office codes conflict. The register also times for partial dials and permanent signals. If required, the originating register can be arranged for party testing.

3.25 Three originating registers can be mounted on an 11-foot 6-inch frame. Space is left for the associated outpulsing controllers. The outpulser controller is a unit which is used when common control features are provided. A 9-foot 0-inch frame can mount two originating registers and has the additional space for two associated outpulsing controllers.

3.26 Party test by the originating register is required in AMA or ANI offices. A party test unit (three 23-inch mounting plates) for two originating registers is mounted on a miscellaneous relay rack frame.

C. Converter

3.27 The converter accepts the digit indications from the receiver, translates them into two-out-of-five indications, and transfers them on a multilead basis to the originating register for storage in the proper digit register. Twenty receiver-converters can be mounted on an 11-foot 6-inch frame; fourteen on a 9-foot 0-inch frame.

D. Translator

3.28 The translator accepts three digits (four if a prefix digit is dialed) on a multilead basis from an originating register. From these digits the translator determines:

(a) The total number of digits when the code dialed is unique.

(b) The need for timing when a code conflict exists.

(c) When a reverting code or vacant code has been dialed.

The 11-foot 6-inch translator frame and the 9-foot 0-inch frame mount one translator with space available for the addition of a decoder, a unit required when common control features are added. An office has a minimum requirement of two translators.

E. Translator Connector

3.29 The originating registers have access to a common group of translators through a connector. The connector is a group of multicontact relays capable of connecting the leads between the originating registers and the translators. Each originating register has an appearance in only one translator connector. Each connector serves a maximum of 20 originating registers and can handle one call at a time. In case of a simultaneous demand on one connector, the originating registers take their turn in a fixed order that is determined by their position in register preference chain in the connector. A translator preference chain between connectors insures that only one connector at a time enters a particular translator. The minimum requirement is two connectors per office. Five connectors can be mounted on an 11-foot 6-inch frame; three connectors on a 9-foot 0-inch frame.

4. METHOD OF OPERATION

NO. 5 CROSSBAR

A. General

4.01 When a customer originates a call in a No. 5 crossbar office, a line relay operates and causes a dial tone connection to be established. This connection is established from the calling line, through the line link frame and trunk link frame, to an idle originating register. The dial tone marker directs the establishment of this connection. When the dialing connection has been established and calling line identification passed to the originating register, the marker releases itself and its associated connectors. The originating register now furnishes dial tone to the customer and is ready to receive the digits of the called number.

4.02 In an office partially equipped for TOUCH-TONE calling, TOUCH-TONE lines are located in separate vertical groups over the line link frames. Two groups of originating registers are provided. One group handles rotary dial calls only. The registers in the other group are associated with receiver-converters and handle all TOUCH-TONE traffic and any rotary dial traffic in these vertical groups. Each group of registers is assigned to trunk link appearances across the trunk link frame where the marker will pick one or the other group. When the marker is seized by a line link frame having both TOUCH-TONE and rotary dial lines, the marker makes a vertical group check. If this vertical group contains any TOUCH-TONE lines, the marker sets up the connection to a register arranged for TOUCH-TONE calling.

B. TOUCH-TONE Call

4.03 On a TOUCH-TONE call, the digits of the called number are detected by the receiver. The receiver indicates to the converter the frequencies of the digit it has received. Each digit is converted into a two-out-of-five indication and transferred on a multilead basis to the originating register for storage in the proper digit register unit. As soon as all the digits are registered, the originating register calls in a marker to complete the call. In addition to passing to the marker information necessary to complete the call, the originating register passes a TOUCH-TONE call indication to the marker. This indication is used for traffic measuring and trouble recording purposes. Completion of the call by the marker is unchanged.

C. Rotary Dial Call

4.04 If a rotary dial call is handled by a register arranged for TOUCH-TONE calling, the dial pulses are ignored by the receiver and detected by the pulse relay in the originating register. There is no change in the operation of a register arranged for dial pulsing only.

NO. 1 CROSSBAR

A. General

4.05 When a customer in a No. 1 crossbar office originates a call, a line relay operates and causes the operation of the line link controller. The line link controller identifies the horizontal group and vertical group in which this line appears.

4.06 In an office where a receiver-converter is associated with each sender there is no need to identify the type of line originating the call. The line link controller, with the assistance of the sender link controller, selects an idle sender and district junctor and connects the calling line to them. The sender returns dial tone through the sender link, the district junctor, and the line link.

4.07 In an office where only some of the senders in each subgroup are capable of serving a TOUCH-TONE call, the horizontal group identity is used by the line link controller to distinguish between rotary dial lines and TOUCH-TONE lines. If the horizontal group contains any TOUCH-TONE lines, the sender link controller will select a sender subgroup which has an idle sender capable of handling TOUCH-TONE signals. The idle sender may be either one of the senders dedicated to TOUCH-TONE or an overflow sender. If the horizontal group indicates rotary dial lines only, the sender link controller selects a subgroup that has a rotary dial sender or an overflow sender idle. In all cases, either on rotary dial or TOUCH-TONE indications, where both a rotary dial or a TOUCH-TONE sender and an overflow sender are available, the rotary dial or TOUCH-TONE sender will be selected. The overflow senders always appear as last choice. The line link controller and sender link controller then establish the connection between the calling line and the sender and a district junctor. The sender returns dial tone.

B. TOUCH-TONE Call

4.08 On a TOUCH-TONE call, the receiver detects the frequencies of the digits. Indications of these frequencies are passed to the converter. These digit indications are converted into two-out-of-five indications and stored on the digit registers. The converter outpulses the digits at the rate of 20 pulses per second into the pulsing counter circuit of the sender. The sender completes the call in the usual way.

C. Rotary Dial Call

4.09 On a rotary dial call, no action takes place in the receiver-converter. Dial pulses have no effect on either the receiver or the converter.

PANEL

A. General

4.10 The method of selecting a sender in either a completely converted or a partially converted panel office is not changed. In a partially converted office a sender group is divided into two parts: one TOUCH-TONE and one rotary dial. The line finder groups that contain TOUCH-TONE lines have access only to the senders associated with receiver-converters. The other line finder groups that have only rotary dial lines have access only to rotary dial senders. In a completely converted office there is no change in the access between the line finder frames and senders — all senders are capable of handling TOUCH-TONE calls.

B. TOUCH-TONE Call

4.11 In panel the TOUCH-TONE signals are handled in the same way as in the No. 1 crossbar.

C. Rotary Dial Call

4.12 On rotary dialed calls, a pulsing relay in the converter follows the dial pulses and repeats these pulses to the sender. The converter causes the pulsing relay of the sender to alternately release and operate as this relay did when it was directly controlled by the customer's rotary dial. The sender registers these digits and completes the call.

STEP-BY-STEP NONCOMMON CONTROL

A. General

4.13 When a customer in a TOUCH-TONE line finder group originates a call, a line relay operates and an idle line finder starts to hunt for the calling line. The converter trunk signals for a connection to a receiver-converter. The line finder, trunk finder, and converter finder start hunting at approximately the same time. When a receiver-converter is attached, the converter trunk splits the paths between the line finder and first selector and presents the leads from each switch to the converter. The converter trunk signals the converter what action is required on party test. After the converter is satisfied that party test has been made or is not required, the converter returns dial tone to the customer.

B. TOUCH-TONE Call

4.14 TOUCH-TONE digits are detected by the receiver. The 4 x 3 encoded information from the receiver is translated by the converter into two-out-of-five information for storage on its digit registers. After the first digit is regis-

tered, outpulsing to the switch train begins. This outpulsing is in the form of dial pulses at the rate of ten pulses per second. When the last digit, determined by translation or timing, has been outpulsed, the converter signals the converter trunk to restore the connection between the line finder and first selector. The receiver-converter and finder arrangement release.

C. Rotary Dial Call

4.15 On a rotary dial call, the converter repeats the pulses of the first digit to the first selector. The converter signals the converter trunk to restore the connection between the line finder and the first selector and releases during the first interdigital time. Following receiver-converter disconnect, the dial pulses from the customer set directly control the subsequent stages of selection.

STEP-BY-STEP COMMON CONTROL

A. General

4.16 When a customer in a TOUCH-TONE line finder group originates a call, a line relay operates and an idle line finder starts to hunt for the calling line. The register trunk associated with this line finder operates. This causes a crossbar linkage to be set up between this trunk and an originating register. When the originating register is attached, the register trunk splits the connection between the line finder and first selector and presents these leads through the crossbar link to the originating register. The register trunk signals the originating register what action is required on party testing. After the originating register is satisfied that party test has been made or is not required, the originating register returns dial tone to the customer.

B. TOUCH-TONE Call

4.17 The receiver detects the TOUCH-TONE signals and indicates to the converter the frequencies that it has received. The converter takes this 4 x 3 encoded information and translates it into a two-out-of-five indication which is then transferred to the originating register on a multilead basis. After the first digit has been registered, the originating register begins outpulsing to the switch train. This outpulsing is in the form of dial pulses at the rate of ten pulses per second. When the first three digits (in excess of 0 or 1 prefix) have been registered, the originating register calls in a translator and passes these initial digits to it. The translator determines the number of digits that the originating register can expect. After the originating register has outpulsed the last digit, it signals the register trunk to restore the connection between the line finder and first selector. The register trunk remains operated for the length of the call. The crossbar link, the originating register, and its associated equipment release after outpulsing is completed.

C. Rotary Dial Call

4.18 On a rotary dial call the originating register repeats the pulses of the first digit to the first selector. The originating register signals the register trunk to restore the connection between the line finder and first selector. The originating register and associated equipment release during the first interdigital interval. The customer dials directly into the step switches. The register trunk remains operated for the duration of the call.

5. MAINTENANCE FACILITIES

THE STATION SET

5.01 Station sets may be tested by an installer or under the supervision of a testman. These tests will indicate whether or not the TOUCH-TONE signals generated at a customer's set and transmitted over the loop are capable of reliably operating the receivers at the local central office. The TOUCH-TONE facilities are used in conjunction with station ringer test facilities. A test connector provides access from a maximum of ten ringer test trunks and test desk appearances to a maximum of three TOUCH-TONE test circuits. Associated with each test circuit is a test receiver.

5.02 The amplitude of the TOUCH-TONE signals as received by a service receiver is dependent on the termination across which the receiver is bridged at the central office end of the loop. The nature of this termination is determined largely by the type of dial pulse receiving equipment (the originating register, for example) and therefore varies for each switching system. The station ringer test trunk matches

the service conditions encountered in the particular central office involved. The test receiver has narrower frequency bandwidths and less sensitivity than an ordinary TOUCH-TONE receiver. This will test if a station set is generating TOUCH-TONE signals of acceptable amplitude and frequency levels. On a test call the test receiver indicates to the test circuit the frequencies it has received. The test circuit translates this information into digit indications and, if all digits have been received correctly, returns a verification signal.

5.03 To test a TOUCH-TONE station set an installer dials the standard ringer test code, causing the central office to set up the call to the station ringer test trunk. The station ringer test trunk connects to the TOUCH-TONE test facilities. After dial tone has been returned, he dials a preliminary digit. This digit indicates the type of test he wants to make and the type of ringing. The installer dials all digits (1 through 0) in the proper order. All digits are dialed in the presence of dial tone. If all digits are received correctly, the test circuit returns a verification signal. If the installer wishes, he may repeat the test. Following this, he flashes the switchhook to disconnect the TOUCH-TONE test factilties and advance the station ringer test trunk for ringer test. The ringer test trunk checks and returns steady tone for tip party and interrupted tone for ring party. The installer hangs up. The test trunk returns ringing current to operate the station ringer. The installer lifts the receiver to trip ringing and then hangs up to disconnect the ringer test trunk.

5.04 When the TOUCH-TONE tests are to be performed under the supervision of a testman, he will call the customer and connect to the TOUCH-TONE test facilities in the central office. If the test desk is at a centralized location, the testman connects to station ringer test facilities at the customer's local office. The customer dials the digits in proper order. Verification signals will be returned to the test desk.

THE CENTRAL OFFICE

A. Receiver

5.05 The receiver has been designed for easy maintenance and testing. All circuit elements are on printed wiring boards which plug into the receiver cabinet. Each of these circuit packs (with the exception of the band elimination filter) is removable. Test points are mounted on each circuit pack and these points can be easily reached when the receiver cover is removed. Two receivers plug into an outer cabinet and can be removed as individual units. The receivers and the various types of circuit packs are universally interchangeable. This flexibility simplifies trouble-location and minimizes the amount of spare equipment that must be kept on hand. Only the outer receiver mounting cabinet is not removable since all permanent connections to associated equipment units are made here.

5.06 Tests have been set up to enable the maintenance personnel to determine if a defective receiver is in service and to localize the trouble within a receiver. These tests are also used in locating troubles in the associated converter. Depending on the type of central office involved, the following test equipment is used:

(a) No. 5 crossbar — master test frame with the automatic monitor, register, and sender test circuit, or with the register and CAMA sender test facilities.

(b) Package No. 5 crossbar (590, 980, 1960 line size) — office test frame

(c) No. 1 crossbar and panel — sender test frame

(d) Step-by-step — manual test circuit and portable test set

5.07 The receiver is a complex electronic device which must meet strict requirements. The characteristics of the TOUCH-TONE signals which most affect receiver operation are signal frequency deviation, amplitude, duration, and pulsing rate. The nominal and limiting values assigned to each of these characteristics define the operating capabilities of the receiver. Four digits 1, 5, 9, and 0 contain all the frequencies used in the 4 x 3 signaling code. In addition to generating all digits at the nominal values, the test equipment can generate these four digits, allowing them to take on all the limiting values of the signal characteristics.

5.08 To each receiver in the office the test equipment applies test calls with these four digits generated at minimum signal amplitude, maximum pulsing rate, and with maximum positive and negative frequency deviations.

If a receiver fails to pass this test, the test sequence is repeated into the suspect receiver, holding one or more of the signaling characteristics at their nominal values, until the trouble is localized. The test equipment can also generate all digits as they would be on a regular TOUCH-TONE call. To test the ability of the receiver to ignore signals that are not legitimate TOUCH-TONE combinations, the following tests may be used:

(a) Four digits (1, 5, 9, and 0) plus a frequency not used in TOUCH-TONE signaling.

(b) A single frequency from the low group.

(c) A single frequency from the high group.

5.09 These tests should localize the trouble to the circuit pack which then can be changed. If the entire receiver is not working, the voltages at the test points for each circuit pack can be checked until the trouble is localized.

B. No. 5 Crossbar

5.10 In a No. 5 crossbar office many irregularities encountered on a call may be indicated on trouble recorder cards. These cards are automaticially punched to provide information concerning failures on customer calls. They are also used to record the results of test calls. The trouble recorder indicates whether the card was for a TOUCH-TONE or a rotary dial call.

5.11 The receiver-converters are tested manually by either the automatic monitor equipment, or the test set type equipment, or the office test frame. Access to the receiver-converters is through the originating registers. Originating registers are selected in the usual manner from the master test frame or the office test frame. All tests prescribed for TOUCH-TONE signaling are manually controlled through the operation of keys. Valid digit information received by the receiver-converter is passed to the associated originating register. The register records this information and passes it on to the marker. If desired, a test record of this call may be made by the trouble recorder and examined to determine if the information passed from the receiver-converter to the register then to the marker is correct. The maintenance man has the same control on a TOUCH-TONE call as on a rotary dial call.

5.12 The automatic monitor is also used to check the dial pulse operation of originating registers on customer calls. The monitor compares the number received by the originating register with the number the originating register passes to the marker. If they do not match, a trouble recorder card is punched. This monitoring is done on an automatic sampling basis. The automatic monitor is not arranged to provide this check on an originating register that is arranged for TOUCH-TONE calling.

5.13 A receiver-converter may be removed from service by making busy the associated originating register at the master test frame.

C. No. 1 Crossbar and Panel

5.14 Senders are automatically tested on a dial pulse basis by the originating sender test frame in No. 1 crossbar and by the automatic sender test frame in panel. In completely converted offices operation of a control key will cause any test call other than the KP test to be outpulsed as TOUCH-TONE frequencies. In a partially converted No. 1 crossbar office, senders modified for TOUCH-TONE calling can be automatically selected and tested on a TOUCH-TONE basis. In a partially converted panel office, unless the senders modified for TOUCH-TONE calling are regrouped at the test frame, the selection and testing of these senders on a TOUCH-TONE basis must be made under the supervision of a testman.

5.15 The prescribed TOUCH-TONE test for all receivers is set up on the code keys and the control key is operated. The frequency combinations of these digits are outpulsed through the sender under test to the associated receiver-converter. The receiver-converter receives the TOUCH-TONE signals, converts them into corresponding dial pulses, and outpulses them to the sender for registration. The sender calls in a marker (decoder in panel) and transmits information to it. A check is made of the information passed between these units against the number registered on the code keys. The other special TOUCH-TONE tests are also key controlled. All tests (except in some partially converted panel offices) can be automatically performed until all TOUCH-TONE senders have been tested or a trouble condition is encountered.

5.16 If a receiver-converter encouters a trouble on a service call, outpulsing to the sender is stopped. For senders arranged for timed disconnect or automatic priming, the sender is held, a sender make-busy lamp lighted, and a minor alarm given. For senders arranged for automatic monitoring time-out, the stopping of outpulsing causes the sender to time-out.

5.17 Since each receiver-converter is associated with a particular sender, taking the sender out of service also takes the receiver-converter out of service.

D. Step-by-Step Noncommon Control

5.18 For testing receiver-converters, a portable test set is used in conjunction with a frame-mounted test circuit. Testing is controlled by means of a TOUCH-TONE dial, a rotary dial, and miscellaneous keys and jacks. A digital display unit and several lamps on the test set indicate the progress of the test.

5.19 The receiver-converter to be tested is selected by inserting a plug into the proper jack at the converter jack, key, and lamp panel. A key is thrown in the test set to initiate seizure. Dial tone is returned to the test set headphones. The receiver-converter appears busy to its associated circuits. A test call is made by using the TOUCH-TONE dial or rotary dial.

5.20 For a TOUCH-TONE test call the TOUCH-TONE signals transmitted by the oscillators in the test circuit are converted into dial pulses by the receiver-converter. Instead of the pulses being transmitted to the first selectors, the pulses are repeated and counted by the test circuit and displayed on the digital indicator. The rotary dial is used to check the ability of the converter to recognize a rotary dial call and to release after repeating the first digit. Tests can also be made to check converter operation on party testing, translation, timing, reverting calls, permanent signals, and partial dials. The test equipment can also check the ability of the converter to hold itself out-of-service in case of circuit failure.

5.21 Jacks are provided for taking the receiver-converters out-of-service. Control keys limit the number of receiver-converters to be held after time-out conditions. Release jacks restore the receiver-converters held after time-out. Lamps show in-use, alarm, and stuck converter conditions.

E. Step-by-Step Common Control

5.22 For offices that use common control equipment to provide only TOUCH-TONE calling, the testing equipment is quite similar to the noncommon control arrangements. When common control features are provided, these facilities will be expanded to include a trouble ticketer or complete automatic facilities.

5.23 A manual test frame is used with a portable test set. All tests are made through the originating register. An originating register and its associated receiver-converter is selected for test by patching from the portable test set to its test jack on the originating register frame or to its test jack at the jack, key, and lamp panel mounted on the manual test frame. Translators are selected on a regular preference basis by the originating register, or a particular translator may be selected by operating a switch at the manual test frame. A TOUCH-TONE dial or a rotary dial is used to set up the test. In addition to the TOUCH-TONE tests, the test equipment can also check the operation of the originating register and its associated equipment on party testing, rotary dial calls, translation, timing, reverting and service code calls, permanent signals, and partial dials. Lamps and a digital display indicate the progress of a test call.

5.24 Jacks are used to take originating registers and translators out-of-service. Taking an originating register out-of-service automatically removes the associated receiver-converter from service. Lamps and alarms indicate trouble conditions.

6. OBSERVING FACILITIES

6.01 To observe TOUCH-TONE lines, a receiver-converter is associated with the service observing equipment at the local central office. The TOUCH-TONE signals are received and converted into dial pulses which are transmitted to the central observing desk (No. 7 or No. 12 type). These dial pulses are recorded on paper tape by pen registers. The receiver-converter releases if the call is from a rotary dial set.

7. TRAFFIC MEASURING FACILITIES

NO. 5 CROSSBAR

7.01 For No. 5 crossbar offices with both rotary dial and TOUCH-TONE lines, peg count registers are provided for:

(a) Total originating TOUCH-TONE calls

(b) Total originating rotary dial calls

(c) Partial dials — TOUCH-TONE

(d) Partial dials — rotary dials

(e) Foreign area TOUCH-TONE calls

(f) Foreign area rotary dial calls

(g) Local translation TOUCH-TONE calls

(h) Local translation rotary dial calls

(i) Abandoned partial dials—TOUCH-TONE

(j) Abandoned partial dials — rotary dial.

7.02 Connections are provided in the traffic usage recorder to measure the usage of:

(a) Dial pulse originating registers

(b) TOUCH-TONE originating registers on TOUCH-TONE calls

(c) TOUCH-TONE originating registers on both TOUCH-TONE and rotary dial calls.

NO. 1 CROSSBAR AND PANEL

7.03 In No. 1 crossbar peg count registers are provided to record the following:

(a) Usages of the receiver-converters (one register per 10 units)

(b) Seizures of an originating marker on TOUCH-TONE calls

(c) TOUCH-TONE calls according to class of service

(d) Rotary dial calls according to class of service

(e) Foreign area rotary dial calls.

Load registers measure the length of times a fixed number of TOUCH-TONE sender subgroups are busy.

7.04 In panel the following facilities have been provided:

(a) A register per 8 receiver-converters to record TOUCH-TONE usages

(b) A register per 8 receiver-converters to record ten-digit TOUCH-TONE calls.

These registers in conjunction with existing facilities will enable the traffic personnel to obtain counts on various types of calls.

7.05 In both these systems the traffic usage recorder measures sender usage on all calls and on TOUCH-TONE calls.

STEP-BY-STEP NONCOMMON CONTROL

7.06 Peg count registers are provided for:

(a) Total seizures of the receiver-converters

(b) Total TOUCH-TONE calls

(c) Rotary dial calls handled by receiver- converter units

(d) Permanent signals for TOUCH-TONE line finder groups

(e) Partial dials — TOUCH-TONE.

7.07 Traffic usage recorder measures the usage of the receiver-converters.

STEP-BY-STEP COMMON CONTROL

7.08 Peg count registers are provided for:

(a) Total seizures of the originating registers

(b) Total calls

(c) Total TOUCH-TONE calls

(d) Permanent signals from TOUCH-TONE line finder groups

(e) Partial dials — TOUCH-TONE

(f) Total seizures of the translators.

7.09 Leads to the traffic usage recorder are provided to indicate:

(a) All busy conditions of the originating registers or alternatively only service busy conditions.

(b) Maintenance use of the originating registers

(c) Service use of the originating registers on TOUCH-TONE calls.

8. POWER

8.01 The only power supply required for the receiver is the regular NEG 48-volt central office battery supply. All other operating voltages required are derived from the NEG 48-volt supply within the receiver. The converters also operate on the NEG 48-volt central office.

8.02 A new central office dial tone generator is required for TOUCH-TONE calling. The dial tone is composed of two frequencies, 350 and 440 cps, and is applied to both rotary dial and TOUCH-TONE lines. Dial tone is applied in various systems by:

(a) No. 5 crossbar originating register

(b) No. 1 crossbar originating sender

(c) Panel converter under the control of the subscriber sender

(d) Step-by-Step noncommon control converter for TOUCH-TONE line finder groups and the selector switch for rotary dial line finder groups

(e) Step-by-Step common control originating register for TOUCH-TONE line finder groups and the selector switch for rotary dial line finder groups (when common control features are provided, the originating register applies dial tone to all lines).

In step-by-step offices arranged for TOUCH-TONE calling the method of detecting dial tone speed is changed from recognizing seizure of the first selector to detecting the application of dial tone from the dial tone generator.

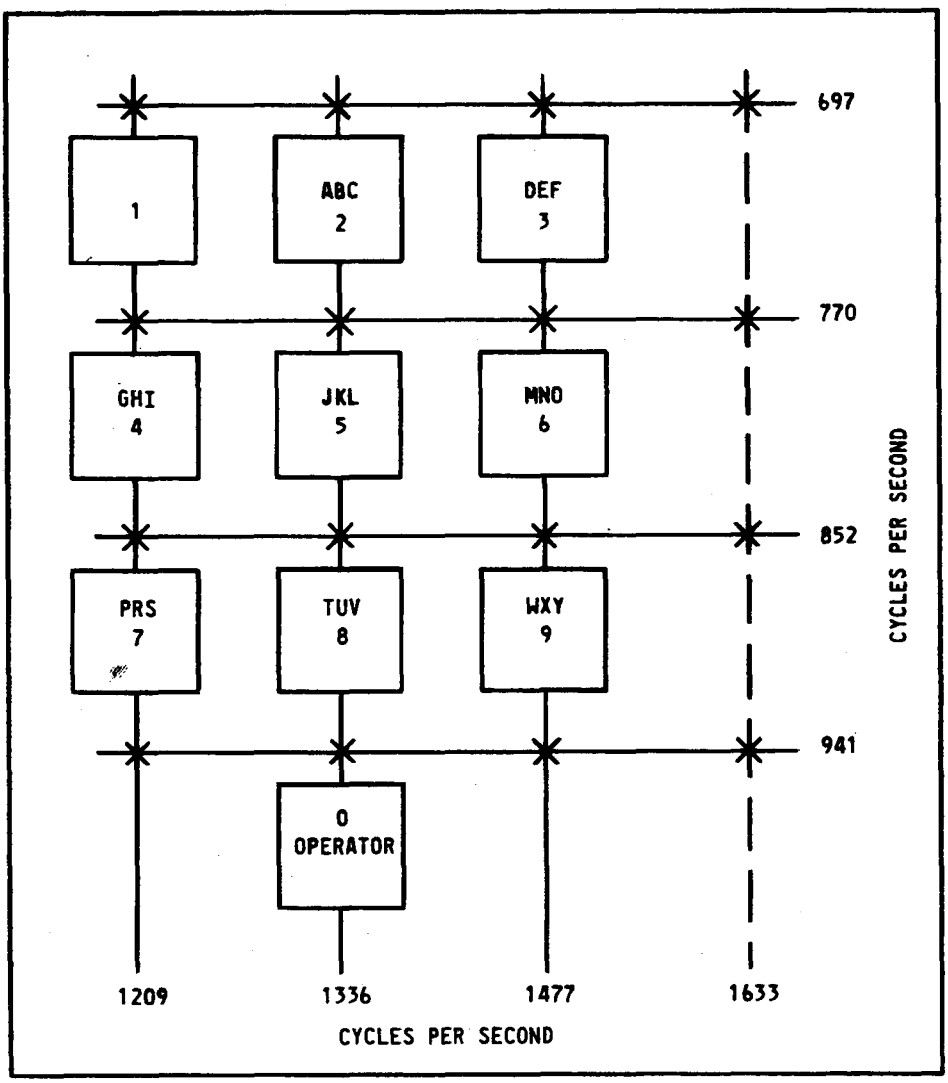

Fig. 2 – TOUCH-TONE Station Set, 4 x 4 Tone Frequency Arrangement (4 x 3 Arrangement for Ten Digits)

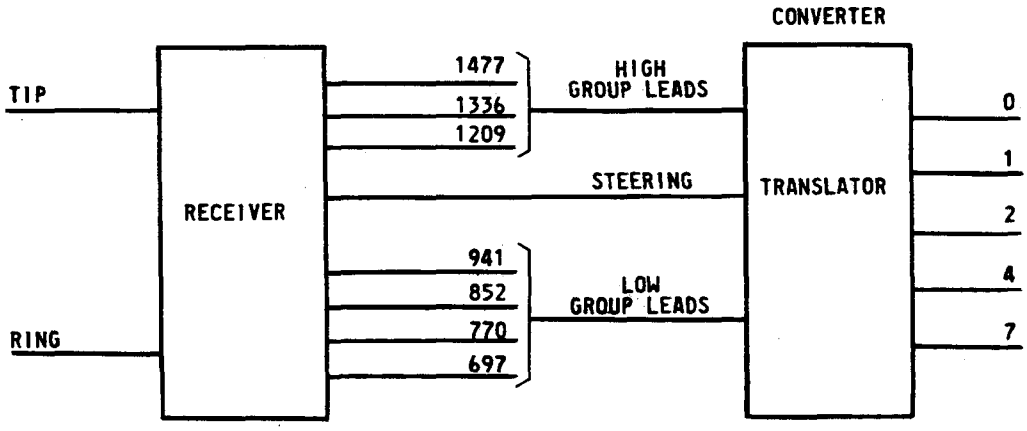

Fig. 3 – Receiver-Converter

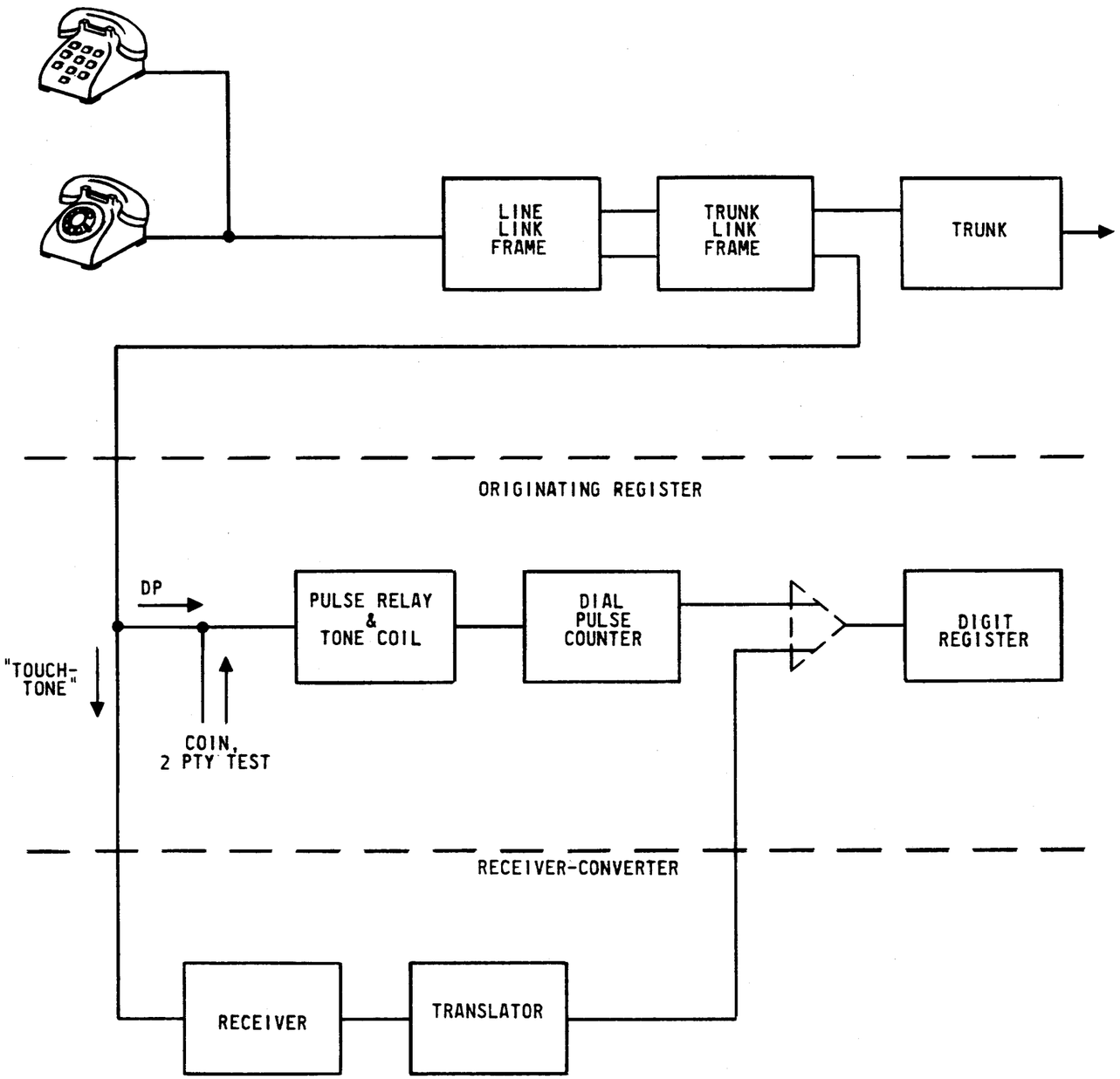

Fig. 4 – No. 5 Crossbar

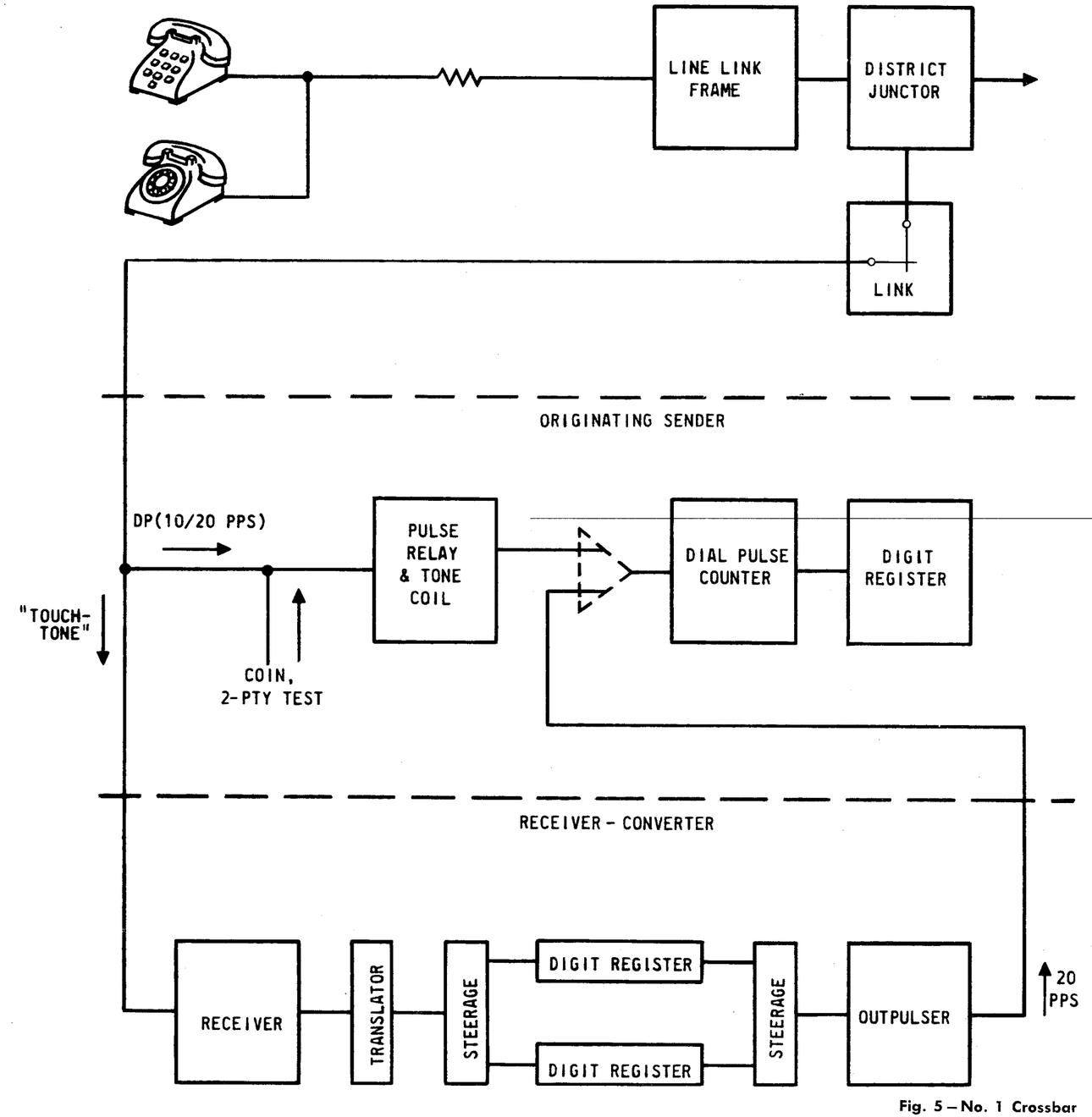

Fig. 5 – No. 1 Crossbar

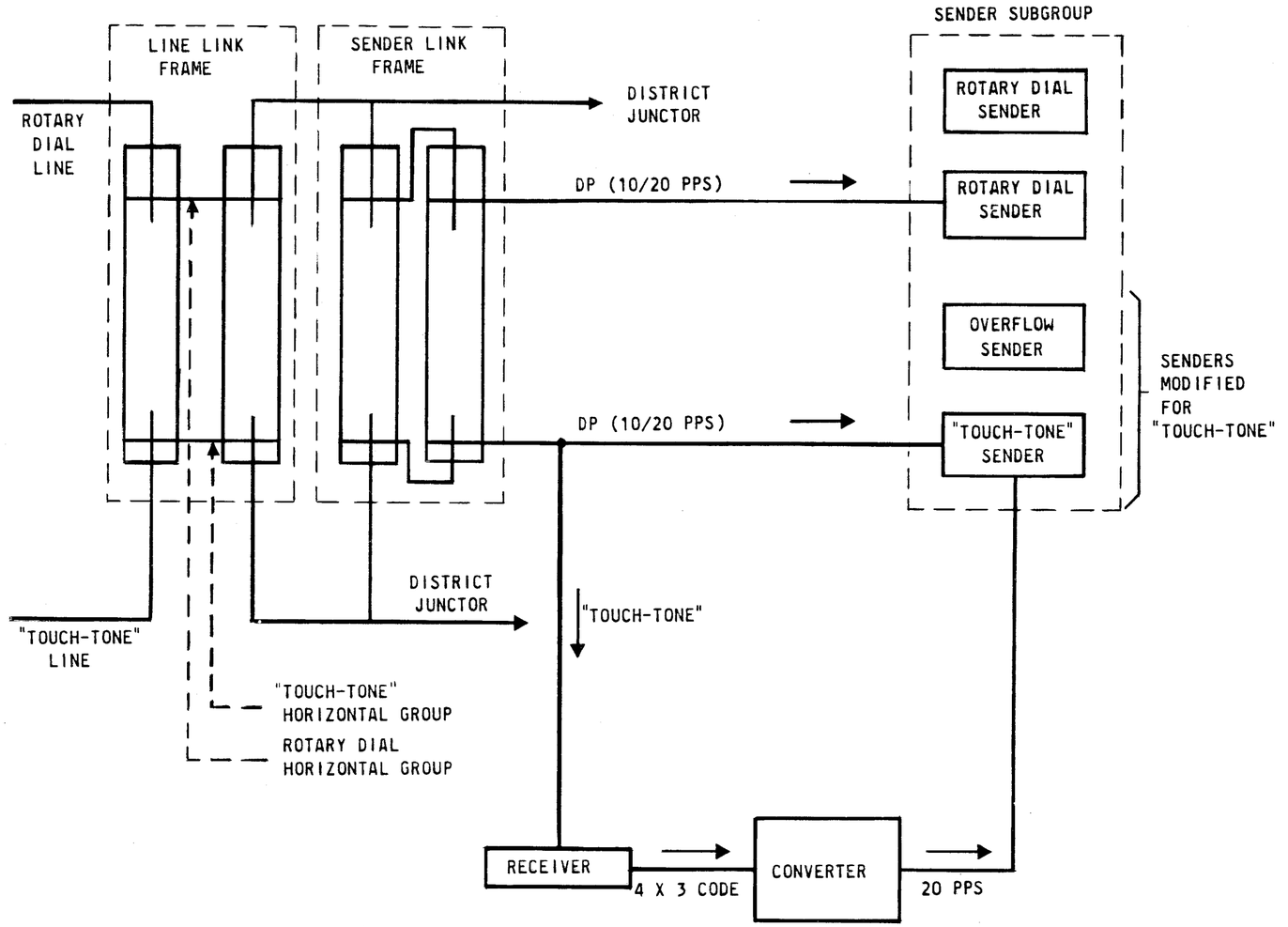

Fig. 6 – Partial Conversion — No. 1 Crossbar

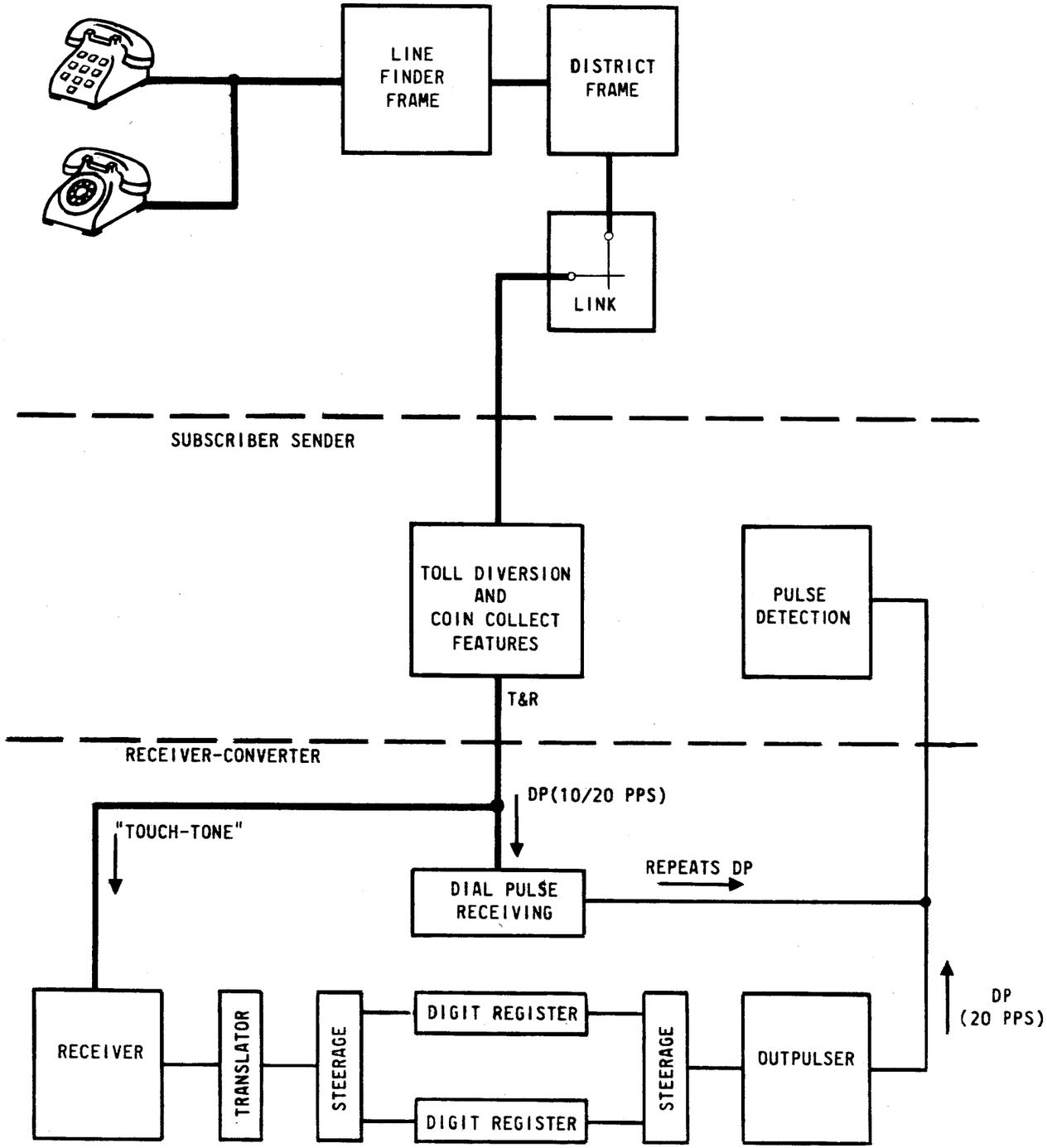
LINE FINDER FRAME
DISTRICT FRAME
LINK
SUBSCRIBER SENDER
TOLL DIVERSION AND COIN COLLECT FEATURES
PULSE DETECTION
T&R
RECEIVER-CONVERTER
DP(10/20 PPS)
"TOUCH-TONE"
REPEATS DP
DIAL PULSE RECEIVING
DP (20 PPS)
RECEIVER
TRANSLATOR
STEERAGE
DIGIT REGISTER
DIGIT REGISTER
STEERAGE
OUTPULSER

Fig. 7 – Panel

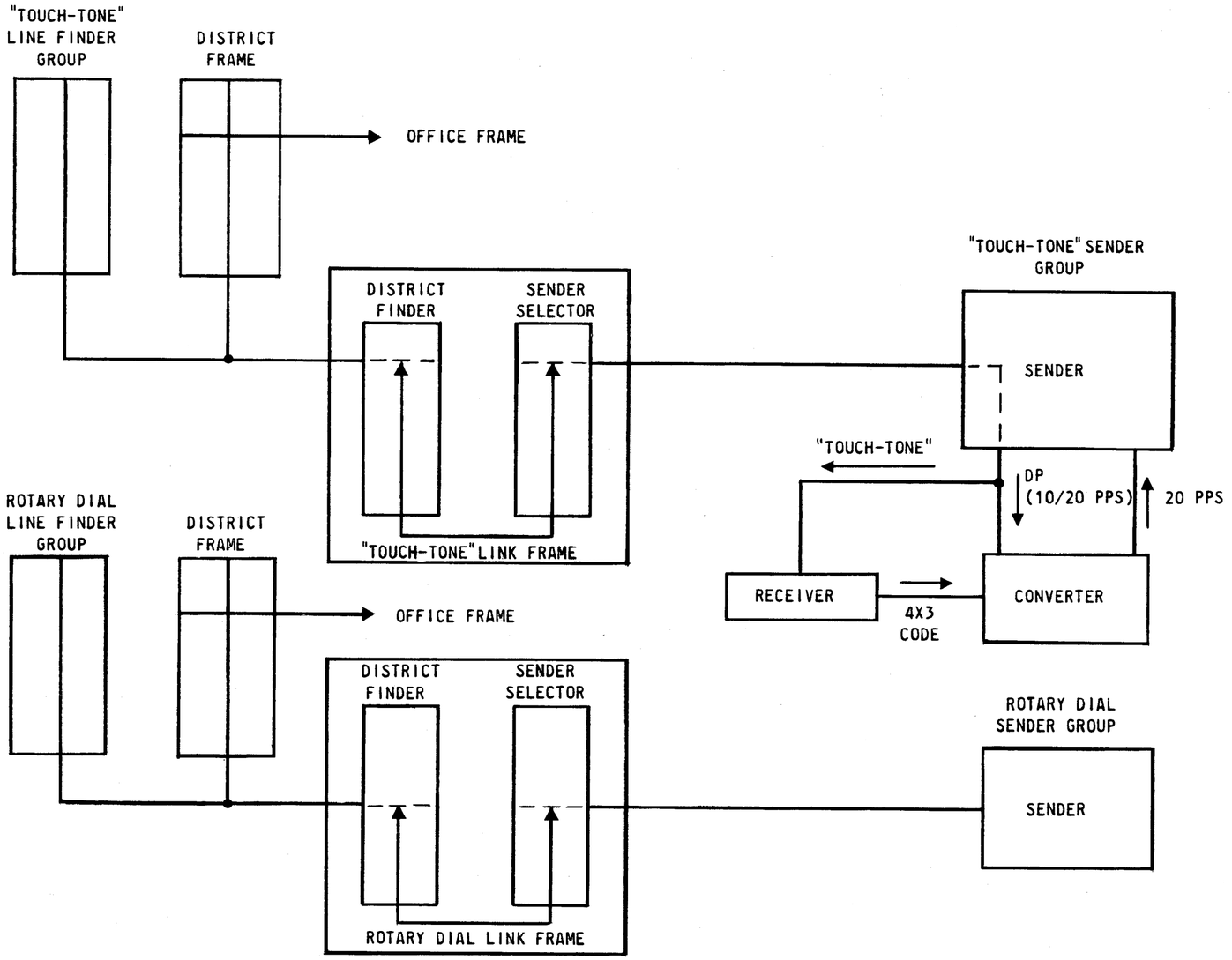

Fig. 8 – Partial Conversion — Panel

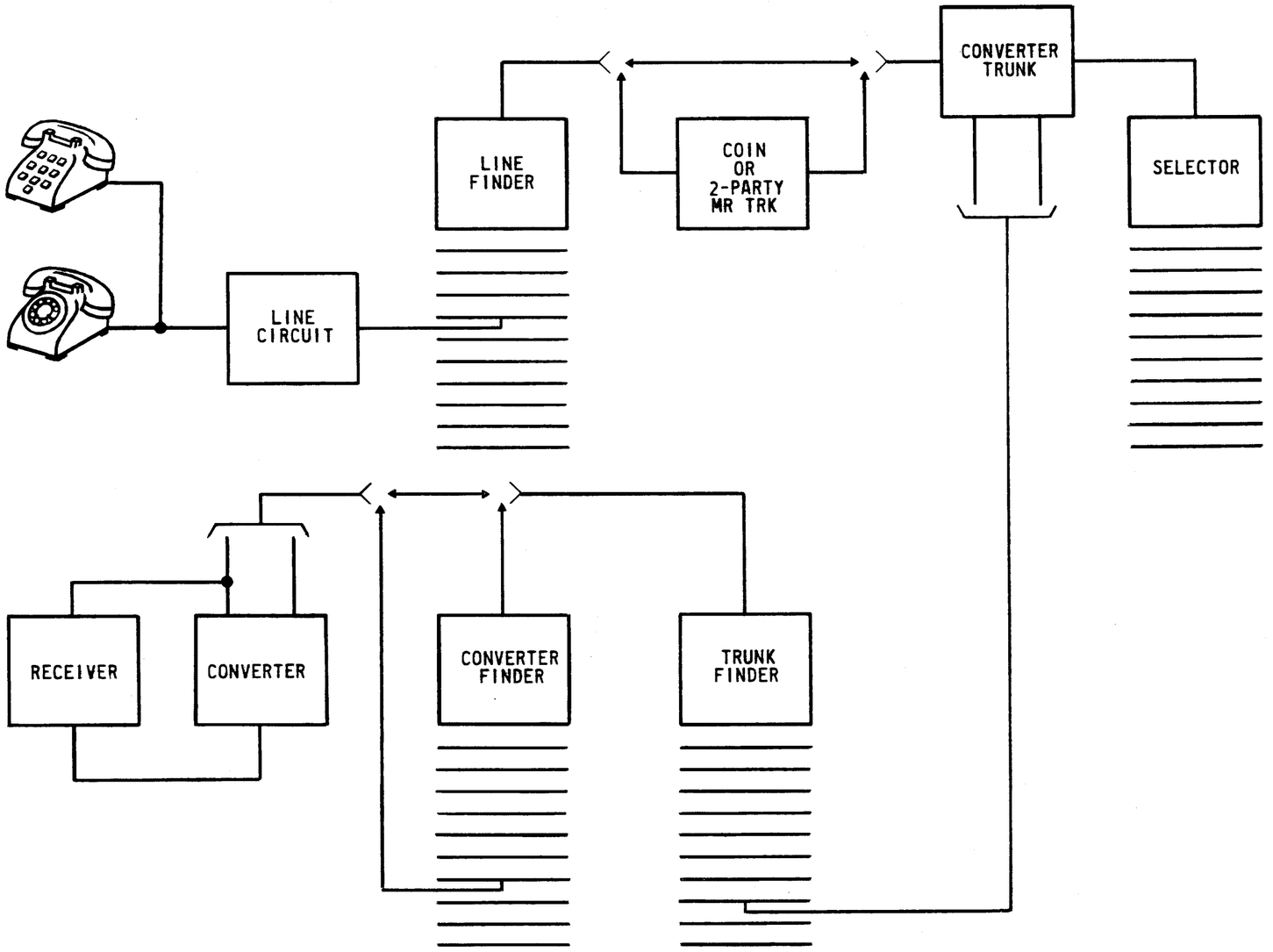

Fig. 9 – Step-by-Step Noncommon Control

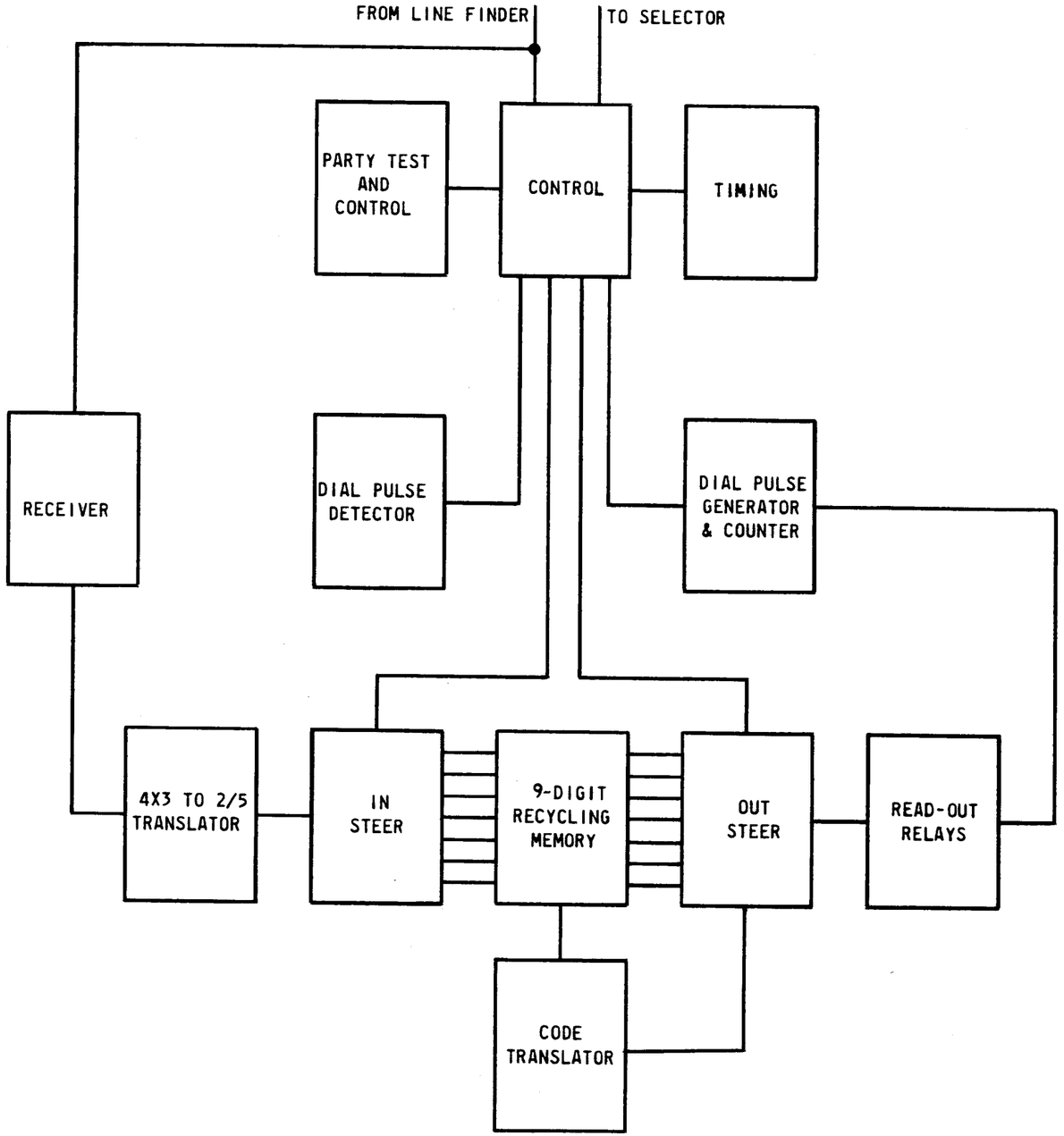

Fig. 10 – Step-by-Step Noncommon Control Receiver-Converter

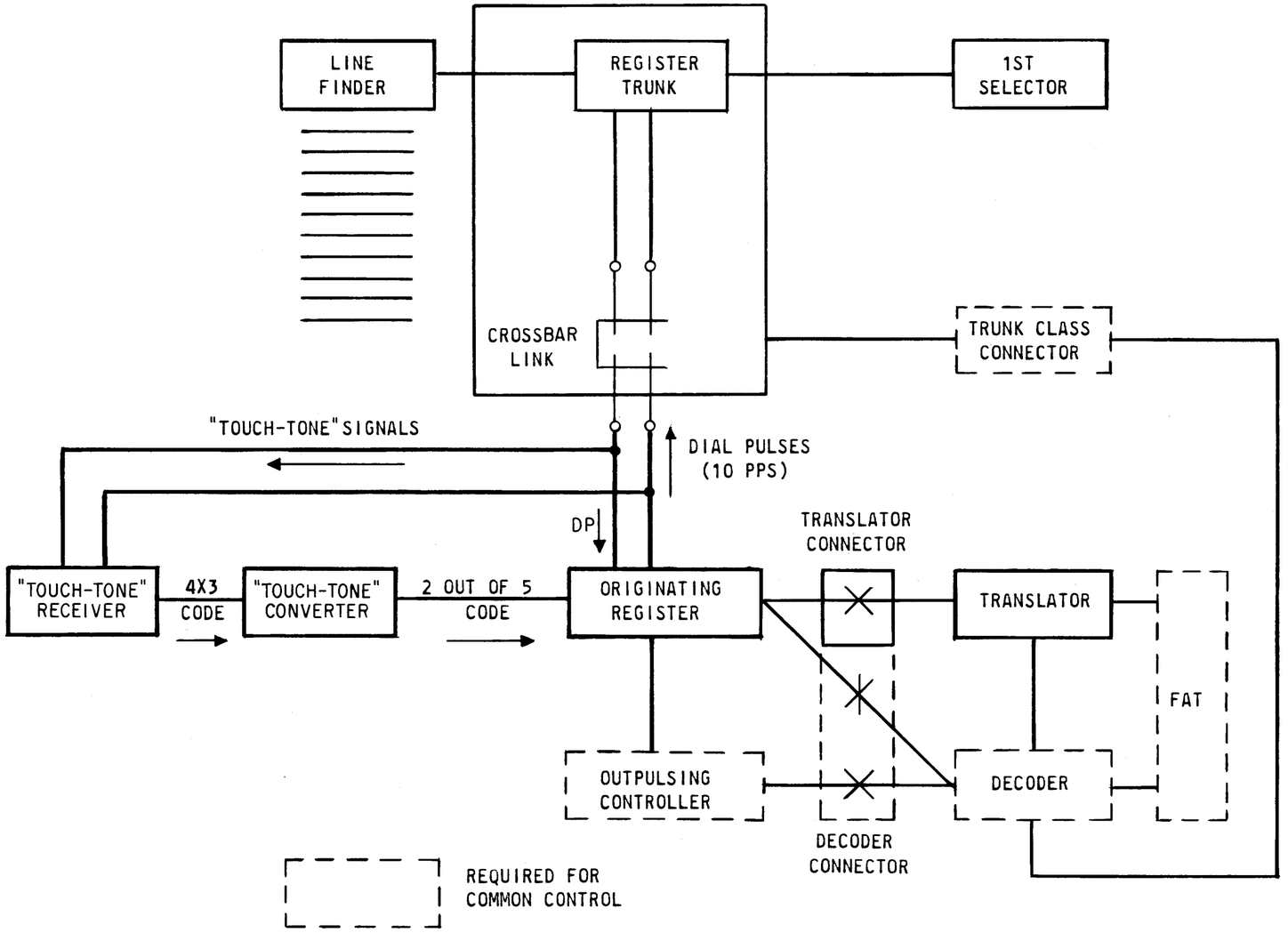

Fig. 11 – Step-by-Step Common Control

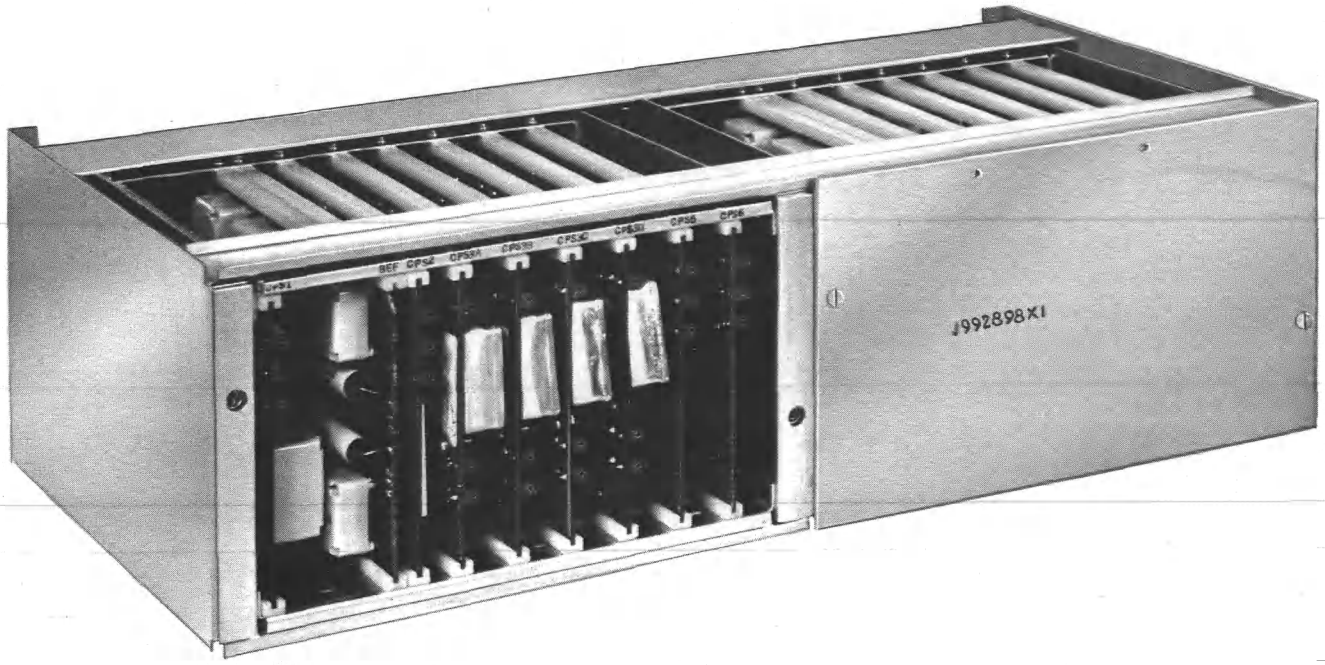

Fig. 12 – TOUCH-TONE Receiver