STEP BY STEP SYSTEMS NO. 1 350A AND 355A PUSH BUTTON CALLING SIGNAL TO DIAL PULSE CONVERTER CIRCUIT

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SECTION I - GENERAL DESCRIPTION

1. GENERAL USE

1.1 This circuit is for use in step-by-step offices that serve customers having pushbutton station sets.

1.2 This circuit receives the output of the multifrequency receiver circuit associated with it, or the pulses of the first digit on a dial pulse call. After the completion of dialing a single digit this circuit will disconnect thereby permitting subsequent digits to be registered directly on the step-by-step switches. This circuit is arranged to translate the output of the associated multifrequency receiver into dial pulses that are transmitted to the step-by-step switches.

1.3 This circuit will function with service codes, area codes and two or three digit office codes. Design options permit the use of either 112 or 1 as an access code. The number of customer keyed digits which the converter will accept cannot exceed thirteen.

1.4 Party identification, for two party flat rate key pulse customer lines, may be made in this circuit when the office is equipped for AMA or ANI.

2. GENERAL METHOD OF OPERATION

2.01 The converter recognizes seizure by a converter finder or trunk finder when ground is connected to the sleeve lead. When seized, the converter sets itself off normal, lights the in-use lamp at the jack, key and lamp panel and "turns on" the MF receiver.

2.02 The signal received by the converter on the IC lead causes it to make party test o not make party test. When the converter is required to make party test a "first party" test is made at the start of the call and under certain conditions a "party retest" is made just prior to outpulsing the last digit.

2.03 Dial tone is furnished the customer after the converter has determined that party identification has been made, is not required or will be made externally.

2.04 When the converter is to serve a dial pulse call it will count and record only the first pulse of the first digit and disconnect after this digit is dialed. The pulses of this digit are repeated to the switch train as they are dialed.

2.05 The converter is designed to handle calls requiring from 1 to a maximum of 13 key pulsed digits. The signals generated by key pulse stations are recognized in the multifrequency receiver associated with the converter and are stored on memory relays on the two out of five code after translation within the converter. A nine position in-digit steering chain circuit is successively advanced as each digit is keyed. When more than 9 keyed digits are required for call completion the in-digit steering relay chain is recycled to make available the first four positions for recording the 10th to 13th digits. The memory of the first four key pulsed digits will have been erased as each of these digits is outpulsed; making these memory positions available for storing the 10th to 13th digits.

2.06 A nine position out-digit steering relay chain is used in connection with outpulsing. When permanent signal trunks are provided the first three positions in the out-digit steering relay chain may be used to transmit cross connectable information for the permanent signal trunk route. The nine position out-digit steering chain is recycled when more than nine digits are to be outpulsed. This feature enables the converter to handle thirteen digit key pulsed calls.

2.07 Outpulsing is started immediately after the completion of keying the first bit of information. Outpulsing is accomplished by transferring information to digit readout relays where a two out of five check is made. A satisfactory check enables the pulse generating circuit. Pulses are simultaneously transmitted to the switch train and counted by the converter. When the number of pulses counted is equivalent to the number of the digit stored on the readout relays the pulse generator is disabled. Interdigital timing is then started. During the interdigital time the pulse counting circuit is reset, the out-digit steering chain is advanced to the next position, memory of the digit just outpulsed is erased and the readout circuit is reset. Outpulsing a succeeding digit may be started while the digit is being keyed. This action is possible only when the rate of customer keying coincides with the machine time required by the converter to complete its functions. In the majority of cases digits will be keyed in more rapidly than they are outpulsed and this feature will not be brought into use. When the last digit required for the call is outpulsed the converter is released. Sufficient time is allowed during release to furnish traffic data information for dial and key pulse calls and also permanent signal calls. Converter seizure peg count data is furnished when the converter is set off normal.

2.08 A built in code translator furnishes the converter with information on the number of digits required for call completion. Cross-connection facilities

are provided for handling 11X calls, excluding 112, on the three, four or five digit basis. As 112 code calls may require either 10 or 13 digits the converter awaits the start of outpulsing the fifth digit before making translation. This feature permits distinguishing between 112 ABX and 112-XO/1X calls. The number of digits required for a call, obtained by translation is recorded on one of the -DG relays. This information is used by the converter for determining when outpulsing has been completed.

2.09 The two timing intervals, controlled from a common timing circuit, provide a work time interval used for monitoring the completion of converter work operations and a partial key, permanent signal timing interval. From converter seizure to the return of dial tone the work timing interval is effective. Timing control is switched from work to partial key, permanent signal timing when the converter connects dial tone. A permanent signal time out only occurs when no digits are dialed or keyed within the interval allowed. When this interval is exceeded the call connected to the converter is given permanent signal treatment. Timing for partial keying is recycled each time a digit is keyed within the allowable time interval. When the required number of digits have been keyed timing control is switched back to the work time interval. Failure to complete a converter function within the allowable work time interval will result in closing reorder tone to the connection and switching the timing control to the partial key timing interval. If the connection is not released during the time reorder tone is being returned a disconnect signal occurs at the end of the timing interval.

2.10 A cancel timed release feature is provided to permit holding "N" converters that time out during the work time interval. When a time out occurs the converter checks the condition of the converter jack, key and lamp circuit to determine if the stuck converter is to be held. When the hold signal is detected by a converter it will remain stuck after the switch train releases until released by a maintenance man. The associated "in use" lamp will change from steady to flashing and an alarm will be sounded. When the hold signal is not detected by a converter and a work time occurs it will release at the end of the timing interval. When the holding feature is in operation only up to "N" converters will be held. Converters that become stuck in excess of "N" will not be held.

2.11 In offices equipped with converter finders a converter may be removed from service by inserting a make busy plug in the associated jack at the jack, key and lamp circuit. When converter finders are not used a converter may be removed from service by inserting a make busy plug in the associated jack at the jack, key and lamp circuit or by making the associated trunk finder busy.

2.12 Traffic data information is furnished by the converter on good calls just prior to disconnecting. Partial key and permanent signal traffic data is furnished during the timing interval. Converter seizure traffic data is furnished before dial tone is connected. Converters that become stuck will score a plant register.

2.13 Test facilities are provided for making maintenance tests and operational routines. These facilities consist of rack mounted equipment and a portable test set.

SECTION II - DETAILED DESCRIPTION

1. CONVERTER SEIZURE

1.1 When a converter is seized the off normal relays (ON) and (ON1) furnish off normal battery and ground. The ON relay operates in response to sleeve closure, while the ON1 relay is a slave of the ON. The polar relay (T) is connected in the tip, ring, fundamental tip and fundamental ring leads that connect the customer station and the first selector so that it will only respond to proper polarity upon loop closure. The auxiliary tip relay (T1) operates under control of relay T and locks operated under control of relay ON1.

Relay ON1 conditions the converter for handling a call by operating the in-digit steering relay (IS1), the out-digit steering relay (OS1), and the line supervisory relay (L1). Relay L1 controls relay L2 which is slow release and is required to hold during dial pulses. Relay ON1 also primes the pulse generating circuit by operating relay PG1 which places relay PG2 on its back contact.

2. PARTY TEST

2.1 General

The converter is required to recognize which of two signals is connected to the IC lead as the means of determining whether or not party test is to be made by the converter. When the converter detects a ground on the IC lead this condition is interpreted as a signal to make party test in the converter. When the converter detects -48V battery on the IC lead it interprets this condition as a signal not to make party test.

2.2 Party Test Made by M.R. Trunk

When converter seizure involves the use of a two party message rate trunk the TC1 relay operates from battery connected to the IC lead. This battery is furnished through the winding of the two party message rate trunk E relay. The E relay however does not operate at this time.

When relay T1 operated, following seizure, a circuit was closed to operate the slow release relay TC3, checking that relay TC4 is normal. With the TC1 and TC3 relays operated a circuit is closed for operating relay TC4 checking that relay TC2 is normal. Relay TC4 locks operated under control of the T1 and ON1 relays. Relay TC4 operating opens the operating circuit for relay TC3. Relay TC3 is made slow release so that an 800 ohm ground can be connected toward the two party message rate trunk over the IC lead. This ground remains connected to the IC lead under control of the operated TC4 relay until relay TC3 releases. The 60MS to 175MS release time of relay TC3 permits a soak condition to be applied to the two party message rate trunk E relay. Party test now proceeds to completion in the two party message rate trunk.

The circuit for operating the slow operate REC relay (25-80MS) was closed when relay TC1 operated. Relay REC closes through the tip and ring leads to the associated multifrequency receiver, disconnects the local operating circuit for the L1 relay, and connects it under control of the customers instrument. When party test is completed in the two party message rate trunk dial tone will be returned to the customer.

The converter checks that the two party message rate trunk has advanced to make party test by presenting the TC1 relay to the IC lead after relay TC3 has released. If the two party message rate trunk K relay has operated relay TC1 operates and closes a circuit for operating relay TC5. With both relays TC5 and REC operated the converter concludes that party test has been completed. Converter timing is now switched from work to permanent signal, partial key timing.

2.3 Party Test Cancelled

When party test is not required the converter trunk will be arranged to connect -48 volt battery to the converter IC lead. The sequence of operations in the converter up to the return of dial tone is the same as described in Paragraph 2.2.

2.4 Party Test Made by Converter

When party test is to be made by the converter the converter trunk will connect ground to the IC lead. This ground is recognized in the converter by the operation of relay TC2. Relay TC2 closes the operating circuit for relay TC5 which locks to off normal ground under control of relay T1. Relay TC5 operating closes the circuit to the primary winding of relay PT establishing the biasing current which sets the relay on its back contact. With both the TC2 and TC5 relays operated ground is connected to the positive secondary winding of relay PT1 causing it to operate. This same ground discharges the C5A, C5B capacitors. Relay PT1 operated closes the circuit for operating relay PT2. Relay PT2 operated, switches the customers station tip and ring leads to the secondary winding of the PT relay for party test and identification and releases relay T. The PT2 relay closes a 200 ohm short to the fundamental tip and ring leads toward the first selector to prevent the selector from advancing or releasing.

When the call is originated by the ring station relay PT will remain normal. Relay PT1 slow releases when PT2 operates and after 50 to 68MS, completes the circuit for operating relay RP. Release time of PT1 is controlled by the charging time of capacitors C5A and C5B.

When the call is originated by the tip station relay PT will operate under control of the station ground. Tip party identification is recorded in the converter by operation of relay TP.

When party identification has been made as indicated by either relay RP or TP being operated relay PT2 then releases in from 90 to 235MS to provide a time interval for line voltage stabilization. During this interval -48 volt potential supplied by the PT resistance lamp is connected to the tip and ring. Release of the PT2 relay transfers the tip and ring leads from the party test circuit and recloses them to the fundamental tip and ring leads respectively. Relay T reoperates at this time. Relay PT1 reoperates following release of relay PT2 and closes a check circuit for determining that either relay RP or TP has operated. Relay PT3 by operating satisfies this check and indicates completion of first party test. Relay PT1 releases and REC operates under control of relay PT3. In addition to the action ascribed in Paragraph 2.2 to operation of relay REC; a party test check is now made.

2.5 Party Test Check

The ability of relay PT to operate is checked on calls on which RP operated. This check is made by connecting a simulated tip party line condition to the winding of relay PT. Relay PT operating completes the circuit for operating relay PT5 which then releases relay PT3. On tip party calls a nonoperate test of relay PT is made by using relay PT4 when the TP relay is operated. Closure of this circuit should cause relay PT4 to operate while relay PT remains normal. Relay PT4 closes a circuit for operating relay PT5. Relays PT3 and 4 now release in preparation for making party retest. Completion of first party test partially closes the circuit for operating relay RK.

2.6 Party Retest Made by the Converter

Party retest, or second party test, is made just prior to outpulsing the last digit. The converter is prepared for making party retest after the fifth digit has been outpulsed and relay OS6 is operated. The party retest relay (PR) operates at this time checking that relay PT5 is operated and PT7 is normal. Relay PR locks to off normal ground. During the interdigital time between the last two digits relay PT7 operates checking that relay PR is operated, and W is released and that one of the translator relays 8, 10, 11 or 13DG is operated. Relay 7DG performs a similar function when the office is arranged for local AMA. Relay PT7 connects a holding circuit for relay PG1 thereby disabling the pulse generator and stopping any further outpulsing. Completing party retest awaits operation of relay PKC. Relay PKC completes a circuit to operate relay PT1 which in turn operates relay PT2. Party retest is now made by presenting relay PT to the customer's line. Timing for completion of party retest is controlled by relay PT1 as previously described. When the results of party retest and the first party test match relay PR is shunted down. Relay PR normal removes the holding circuit for the PG1 relay in preparation for outpulsing the last digit. The matching of the two party tests is determined by the position of the PT relay. When a tip party identification is made during first party test a match can only occur if relay PT operates during party retest. Conversely, for a match, the PT relay must not operate during party retest when results of the first party test are for a ring party. When the two party tests do not match, reorder is returned to the customer for a measured interval after which the call is disconnected.

3. DIAL TONE

3.1 General

Before dial tone is returned to the customer the converter must be satisfied that party test has been completed or that no party test is required.

3.2 Furnishing Dial Tone

Operation of relay REC returns dial tone to the customer, releases the T relay, transfers control of relay L1 to the customer's station set and closes the tip and ring leads to the multifrequency receiver.

4. DIAL PULSE CALL

4.1 General

Call progress in the converter, from seizure to the return of dial tone to the customer, is the same for both dial and key pulse calls. When a call from a dial pulse customer is to be served by the converter, relay L1 responds to the dial pulses, releasing when the tip and ring leads are opened and reoperating when these leads are reclosed. The converter is designed to count only the first dial pulse and to release upon completion of dialing the first digit. The pulses of a dialed digit are repeated to the selector switch up to the time the converter disconnects. Following converter disconnect the dial pulses are fed directly to the switches.

4.2 Counting Dial Pulses

When the first dial pulse releases the L1 relay, slow release relay L3 operates which then closes a circuit for operating relay L4. Relay L4 locks operated to off normal ground. Relay L3 is made slow release by shorting the secondary winding so that it will hold over dial pulses. At the completion of dialing this digit relay L1 will be operated and relay L3 will release during the interdigital time. Release of relay L3 with L1 and L4 operated is translated by the converter as a disconnect signal and relay RL is operated.

4.3 Traffic Information and Release

Converter release is started by relay RL operating which opens the TC lead toward the finder circuit. The finder circuit releases, breaking the connection to the converter. Converter relays L1 and ON release followed by relay ON1. Release of relay ON and ON1 removes off normal battery and ground allowing all locked up relays to release, returning the converter to normal. When relay RL operated it closes a circuit for furnishing traffic data information. Relay RL is made slow release, by shorting the secondary winding, to insure a pulse of sufficient duration to operate the traffic registers.

5. KEY PULSE CALL

5.1 General

Calls originated by customers having key pulse station sets require the use of the multifrequency receiver associated with the converter. The receiver is designed to identify, in combinations of two frequencies, the output of the station set. The output of the receiver controls relays in the converter which supply a translation on the two out of five code.

5.2 In-Digit Recording and Steering

When the converter is seized relay ON1 operating "turns on" the multifrequency receiver. The nine position in-digit steering relay chain is prepared for digit transmission by the operation of relay IS1. When the translation of a keypulsed digit is received by the converter an LF-, HF- and the STR relays operate. The STR relay closes a circuit for operating relay MF1 which locks operated. Relay MF1 operating disconnects dial tone, opens the operating circuit for the IS1 and PS relays and serves as a control relay. Relay IS1 remains operated under control of its locking contact and the operated STR relay. Relays STR and IS1 operated close a circuit for operating relay IS2 in preparation for advancing the in-digit steering relay chain. The STR relay closes off normal ground to the operated LF-, HF-relays for transmitting the keyed digit information, on the two out of five code, to the "A" digit memory relays. The STR, LF-, HF- relays are required to remain operated a minimum of 40MS to permit proper digit registration. When relay STR releases the in-digit steering chain is advanced by the release of the IS1 relay. A locking circuit controlled by the out-digit steering relay chain prevents the digit memory relays from releasing when the LF-, HF- relays released. As each successive digit is keyed the STR and an LF- and an HF- relay operates and releases. The STR relay controls advancing the in-digit steering relay chain, operating the succeeding in-digit steering relay at the start of digit keying and opening the locking circuit for the preceding in-digit steering relay at the end of digit keying. The keyed digit, resented by the operated LF-, HF- relays is stored on the proper digit memory relays on the two out of five code until after the digit has been outpulsed.

When the first or "A" digit is keyed this information is recorded on the readout relays (R-), in preparation for outpulsing, at the same time the "A" digit memory relays are operated. Transmitting digit memory information to the readout relays is controlled by the particular out-digit steering relay which is operated. As relay OS1 operated when the converter was seized the circuit is fully prepared to accept complete registration of the "A" digit when it is keyed and to start outpulsing upon the completion of readout check.

5.3 Recycling In-Digit Steering

When the STR relays operates in response to keying the ninth digit the RSI relay operates to recycle the in-digit steering relay chain in anticipation of keying up to four additional digits. When more than nine digits are required for call completion the first four positions of the in-digit memory relays are used for recording these digits. The relation between the time required for keypulsing and outpulsing digits provides sufficient margin to insure there will be no conflict introduced by recycling the in-digit steering relay chain. Outpulsing the first digit will be completed and the in-digit steering relay and associated memory relays used for this digit made available for properly handling the tenth digit. Similarly, if eleventh, twelfth and thirteenth digits are keypulsed they will be served by the second, third, and fourth in-digit steering positions.

When relay RSI operated it operated relay RCY. The STR relay releasing upon the completion of keying the ninth digit allows the IS9 relay to release. Relay IS1 now reoperates checking that relay RSI is operated and that the IS2, 3, 4, 9 and PKC relays are nonoperated. The in-digit

steering relay chain and associated memory relays function as previously described in handling the eleventh, twelfth and thirteenth digits. The locking circuit for relay RSI is opened when relay IS2 operates. When the number of digits have been keyed, as indicated by the translation, the partial key check relay (PKC) operates. After relay PKC operates further advance of the in-digit steering relay chain is prevented as it removes the control ground from the STR relay.

5.4 Digit Readout and Check

When the converter is seized the out-digit steering relay OS1 operates under control of relay ON1, checking that relay MF1 is normal. Relay OS1 controls the outpulsing of the first digit, and , if required the tenth digit. Prior to the start of digit outpulsing the information stored on the two out of five code on the digit readout relays (R-) through the operated OS- relay for the particular digit and with all preceding OS- relays normal. A variation in this sequence of operations occurs in handling the first or "A" digit. As indicated in Paragraph 5.2 the readout relays operate in response to the keyed digit. With this arrangement the converter will start outpulsing the first digit immediately after registration check is made thus reducing converter holding time. Registration check is dependent upon only two out of five readout relays (R-) operating. Outpulsing the first or "A" digit must also await completion of first party test when this test is made by the converter. Relay RK operates when the conditions for registration check are met and starts the pulse generator circuit.

5.5 Pulse Generating and Counting

When relay ON1 operated a circuit was closed through the IC, W and RK relays normal to operate pulse generator relay PG1. Relay ON1 also supplies -48V battery to the negative primary and positive secondary windings of relay PG2 through resistor PG6 or PG6 to PG8 and also the the negative secondary winding through resistor PG2 or PG2 to PG5. Relay PG1 operating supplies ground to the C3A, to C4F, capacitors connected to the positive primary winding of relay PG2. Current in the PG2 relay primary winding while the C- capacitors are charging is sufficient to operate it. When the capacitors are charged current ceases to flow in the primary winding and the relay is driven to its back contact by the secondary winding. When relay RK operates PG1 releases switching the control ground for the PG2 relay. Capacitors C- discharge through PG2 primary winding maintaining the relay on its back contact. When the capacitors are discharged current in the secondary winding of relay PG2 operate it to the front contact. Relay PG2 operating closes a circuit for reoperating relay PG1. This pulsing cycle is repeated with the pulses being counted by the P- relays with each release of relay PG1. A self recycling five relay pulse counting circuit designed to count up to ten pulses is used.

5.6 Out-Digit Steering

When the converter is seized the nine position out-digit steering relay chain is prepared for outpulsing by operation of relay OS1. This relay remains operated awaiting outpulsing the first digit. Advancing the out-digit steering relay chain is controlled by relay W. At the start of each interdigital timing period the succeeding OS- relay operates and at the end of the period the preceding OS- relay is released. The out-digit steering relay chain can serve calls of nine or fewer digits without recycling.

5.7 Recycling Out-Digit Steering

When more than nine digits are required for call completion the recycle feature of the out-digit steering relay chain must be used to make available the first four positions for handling the 11th to 13th digits. At the start of interdigital timing, after outpulsing the 9th digit, relay RS0 operates. After RS0 operates and with relay W and OS9 still operated a circuit is closed for operating relay OS1. Relay OS9 releases with release of relay W, completing the recycling of the out-digit steering relay chain.

5.8 Interdigital Timing

Measuring interdigital time starts when relay IC operates following completion of digit outpulsing. Relay PG1 operating closes this circuit checking that the operated P- relays match the digit information on the R- relays. Relay IC closes the operating circuit for relay W which operates the out-steering relay OS- for the succeeding digit. When operated relay OS2, 3 and 4 open the locking circuit for the A, B and C digit memory relays respectively. The locking circuit for the D, digit memory relay is controlled by relay OS5. The E and F digit memory relays are locked operated under control of relay OS7 and the G, H, J and K digit memory relays by relay RS0. Release of relay PG1 following digit matching permits all operated P- relays to release and with relay W operated closes the operating circuit for relay W1. Relay W1 opens the locking circuits for the R- relays allowing them to release. Relay RK will release following release of the R- relays. The pulse generating circuit continues to function and when relay PG1 reoperates relay IC releases opening the

shunt around relay Z allowing it to operate. Pulses are counted on the P- relays in the usual manner. When six pulses have been counted relay IC is reoperated which allows relay W to release followed by the W1 and the preceding OS- relays. The readout relays R- may now be operated in preparation for outpulsing the succeeding digit. The readout relays are operated when only one OS- relay is operated and the interdigital timing interval has progressed to the point where relay W1 releases. Operation of R- relays on the two out of five code permit relay RK to operate. Reoperation of relay PG1 at this time allows relay IC to again release followed by relay Z, ending interdigital timing. Pulse counting relays (P-) operated when counting the interdigital time are released following the release of relay PG1 after the second operation of relay IC. Outpulsing the next digit is started when registration check is satisfied and relay PG1 releases.

6. CODE TRANSLATION

6.1 General

The primary function of code translation is to determine the number of digits the converter should receive for the particular usage. When the number of digits determined by translation have been outpulsed by the converter it will disconnect. The number of digits required for a particular usage is indicated by the -DG relay which operates. The converter is designed to serve calls requiring from 1 to 13 digits. Cross-connection facilities are provided for the treatment of permanent signal calls and service codes; excluding 112. For any particular installation the converter will not be required to recognize the full range of translation. Through the use of options only the translating features required to provide adequate service should be furnished.

6.2 Translation

The end result of translation, which is the operation of a -DG relay, is accomplished by recognizing keyed digit information in combination with the in-digit steering relays and/or the readout relays on the two out of five code. When the first digit keyed is zero the "A" digit memory relays 4 and 7 provide a circuit for operating the 1DG relay, the translation for a zero operator's call. Auxiliary translator relays AD1, BD0,1, CD0,1 and 112 are provided to permit recognition, on a locked-in basis, of digits 0 or 1 in the A, B and C positions as required. Locking this information the memory relays for the possible storage of 11th, 12th and 13th digits without conflict with the 1st, 2nd and 3rd digits.

During the interval the channel receiving relays LF-, HF- are operated for the "C" digit a circuit is closed under control of relays IS3, 4, AD1 and BD1 to a 11X punching. A cross-connection to the 3, 4 or 5DG punching completes the operating circuit for the associated -DG relay. Service code 112 is not cross-connectable. When service code 112 is keyed the converter awaits keying the fifth digit before completing translation. When the fifth digit is either 0 or 1 relay 13DG is operated. When the fifth digit is other than 0 or 1 relay 10DG is operated. When relays AD1, BD0 and BD1 are not operated relay 7DG operates when the fourth digit is keyed. The 8 and 11 DG relays are furnished as an option when the digit 1 is used as an access code in place of 112. When this arrangement is used the 10 and 13 DG relays will not be furnished as their functions will be served by the 8 DG and 11 DG relays respectively.

7. CONVERTER DISCONNECT

7.1 Momentary Open and Abandoned Call

Key pulse calls abandoned after the start of keying or on which a momentary tip and ring open occurs are treated in the same manner. A momentary open must be treated as an abandoned call as it will cause split or false pulses with resulting wrong number connections. The L1 relay will release on either an abandoned call or a momentary open. In either case relay ROD operates, subsequent action however depends upon the particular condition. When the call has been abandoned relay L2 releases after the L1, and with relay L3 operated provides a circuit for operating relay L4. Relay L4 operating opens the fundamental tip toward the selector and the connection to the converter is broken down.

When relay L1 releases due to a momentary open L3 operates followed by ROD. Relay ROD furnishes reorder tone to the connection and if the customer hangs up the equipment will release as for an abandoned call. If the customer does not hang up reorder tone will remain connected for a measured interval followed by operation of relay L4 and release of the connection.

7.2 Regular Disconnect, Dial Pulse Call

Release of relay L3 during the interdigital time following the first dialed digit, with relay ROA normal and L4 operated closes a circuit for operating relay RL. Relay RL closes the circuit for scoring the "DP" traffic register and opens the TC lead toward the finder. Opening lead TC will release the finder, breaking all connections to the converter. Relay L1 releases when the T and R leads are

opened and opening the sleeve lead will release relay ON followed by the release of all operated relays. Release of relay RL makes the converter available for service.

7.3 Regular Disconnect, Key Pulse Call

Converter release is started when the W relay operates during the interdigital time following outpulsing the last digit. As the last digit may be any digit from the first to the thirteenth the converter must continually check during interdigital timing to determine which digit is the last. This check is made by matching the particular -DG relay that is operated with the out-digit steering relays. When the number of digits that have been outpulsed corresponds to the operated -DG relay, and the interdigital timing is started, relay RL operates. The converter now releases as in 7.2.

8. TIMING

8.1 General

Timing converter functions is controlled by pulses generated in the common timing circuit. Pulses of two different frequencies are used for timing all converter functions. Pulses furnished at three second intervals are used for timing converter work operations. Pulses furnished at twenty second intervals are used for permanent signal, partial key, and reorder timing.

8.2 Work Timing

When the converter is off normal and relay TM3 is normal the first timing pulse on lead P3 will cause relay TM1 to operate. If relay REC and, also TC5 when provided, do not operate before the timing pulse is terminated relay TM2 will operate in series with relay TM1 to off normal ground when the timing pulse ends. Operation of relay REC or both REC and TC5 (when provided) before the next common timer pulse is received will cause the TM1 and TM2 relays to release. When the timing pulse occurs with the TM1 and TM2 relays operated it will cause relay TA1 to operate. Relay ROD now operates followed by relay ROA. Relay ROA completes a circuit for operating relay L4 which opens the FT lead toward the finder circuit. When the converter functions associated with furnishing dial tone are completed within the time out cycle described above relay TM3 operates to place the converter on permanent signal or partial key timing described in 8.3. The work timing cycle is again made controlling when the required number of digits have been keyed. Relay PKC operating releases relay TM3. Until the call is completed and the converter disconnects recycling the work time function is now controlled by its IC and W relays. The TM1, TM2 and TA1 relays will respond to pulse closures on the P3 lead as previously described. When a time out occurs and relay ROA operates the TM1 and 2 relays will release and relay TM3 operates. Relay TM3 operated switches the timing functions from the P3 to the P20 lead so the interval during which reorder tone is connected may be measured. Relay TM3 also completes the circuit for furnishing ground to timing control relays TM2 and 1. The first pulse cycle on the P20 lead will cause relays TM1 and TM2 to operate. The second pulse closure of the P20 lead will cause relay PK to operate followed by relay L4. Relay L4 opens the FT lead toward the finder circuit to release the converter.

8.3 Partial Key and Permanent Signal Timing

Timing for a permanent signal and partial key timing differ only in the end result. When relay REC operates a circuit is completed for operating relay TM3 which places timing under control of pulses received over the P20 lead. Relays TM1 and 2 respond to the first cycle of timing pulses. If no digits are keyed before the next timing pulse is received relay MF1 will be normal and the pulse will cause relay PS to operate. If permanent signal trunks are provided the timing functions are recycled to place the converter on work time during the outpulsing of the required digits. When permanent signal trunks are not provided relay PS operating completes a circuit for operating relay ROD. When this timing pulse ends, relay PS releases, allowing relay ROA to operate. Closure of the next timing pulse again operates relay PS which completes a circuit for operating relay RL, which causes converter disconnect.

When any digits have been keyed relay MF1 will be operated. Timing progresses as described above until the second timing pulse closure occurs. This pulse will cause relay PK to operate followed by relay ROD. When the second timing pulse ends relay PK releases followed by operation of relay ROA. The next timing pulse again operates relay PK followed by the operation of relay L4. Relay L4 opens the FT lead toward the finder to release the connection.

9. CANCEL TIMED RELEASE

9.1 When a converter is seized it makes a check of the condition of the HSC lead to the Jack, Key and Lamp circuit in preparation for holding, if a time out occurs. The TA1 relay normal provides a ground which is extended through the primary winding of relay CTR to the HSC lead under control of relay ON1. When the Jack, Key and Lamp circuit is set to hold a stuck converter, battery on the HSC lead

will cause relay CTR to operate. Relay TA1 operating following time out will lock relay CTR under control of relay RL normal. When trunk finders are used "Z" option is provided and the operated TA1 and CTR relays maintain a sleeve ground toward the switches. The switch train remains connected to the converter until the customer disconnects. The switch train releases following customer disconnect, however with relays TA1 and CTR operated the ON relay is held operated preventing release of the converter. A held converter is released by inserting a make busy plug in the RLS jack at the Jack, Key and Lamp circuit which operates relay RL. Relay RL opens the holding circuit for relay CTR which releases and disconnects the holding ground for relay ON. This allows the converter to return to normal.

10. TYPES OF CALLS

10.1 Zero Operator

A call to zero operator originated from a dial pulse customer will be served as described in Section II-2. When a key pulse customer keys zero as the first digit the two out of five code record on the "A" memory relay provides a circuit for operating the 1DG relay. Outpulsing takes place as described in Section II-5 followed by interdigital timing. With the 1DG relay operated a circuit is completed for operating relay RL under control of relay W. Relay RL operated controls release of the converter. Just prior to release the converter provides traffic data information.

10.2 11X (Excluding 112) Calls

Keypulsed 11X codes (excluding 112) are handled as 3, 4, or 5 digit calls depending upon traffic requirements. Translation of the particular code must await keying the third digit. When the first and second digits keyed are "1" the auxiliary translator relays AD1 and BD1 will be operated and locked. Immediately after the start of keying the third digit; while the channel relays are operated and the in-digit steering relay chain is primed to advance; the circuit for operating the -DG relay required for this call is operated and locked. Outpulsing the required number of digits occurs as described in Section II-5. When a match is reached between the operated -DG relay and an OS- relay the converter disconnects during the interdigital timing.

10.3 112 Call

When the first three keypulsed digits are "112" the converter awaits priming for outpulsing the fifth digit before code translation is made. If the fifth digit is a "0" or "1", this digit in combination with 112 is translated as a thirteen digit call. When the fifth digit is neither a 0 or 1 translations is for a ten digit call. When the third digit keyed is "2", preceded by "11" a circuit is completed for operating relay 112 which locks to off normal ground. When relay OS5 operates and the readout relays R- for the fifth digit to be outpulsed represent 0 or 1, ground from the operated 112 relay provide a circuit for operating relay 13DG. When either readout relay R2 or R7 is operated and R4 is not operated this digit can be neither a 0 or 1. Under this condition translation is for a ten digit call. Outpulsing and disconnect occur as previously described in Section II-5.

10.4 1X Call

When the converter is not equipped to recognize the digit 1 as an access code it must treat 1X as a two digit unassigned code. After outpulsing the second digit "X", relay OS3 operates during the interdigital time and completes a circuit for operating relay ROD. Reorder tone is connected to the connection for a measured interval followed by disconnect.

10.5 Reverting Call

Facilities are provided in the converter for completing four or five digit reverting type calls. A customer keying a reverting type call will hang up after keying is completed. Hang up will occur before the converter has completed outpulsing the last digit. Relay L1 does not release at this time as a local holding circuit is completed when relay PKC operates upon the completion of keying. The converter will outpulse 4 or 5 digits depending upon the particular -DG relay which is operated and disconnect when a match occurs between the operated -DG relay and the correspondingly numbered out-digit steering relay OS- in a normal manner.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

Key pulse station, Type of dial	45V. Min. Pulsing from Sub. 2,4 or 5	6	7	2,4 or 5	6	7
Max. Ext. Ckt. Loop*	850Ω	1400Ω	1300Ω	1000Ω	1500Ω	1500Ω
Max. Ext. Ckt. Loop**	1000Ω	1400Ω	1400Ω	1115Ω	1500Ω	1500Ω
Min. Ins. Res.	15000Ω				15000Ω	

*When using 1200Ω loop-leak A in pulsing test set.
**When using 1400Ω loop-leak A in pulsing test set.

2. FUNCTIONAL DESIGNATIONS

Relay Designation	Circuit Function
112	Access code translation.
1DG	Code translation for a one digit call.
3DG	Code translation for a three digit call.
4DG	Code translation for a four digit call.
5DG	Code translation for a five digit call.
7DG	Code translation for a seven digit call.
8DG	Code translation for an either digit call.
10DG	Code translation for a ten digit call.
11DG	Code translation for an eleven digit call.
13DG	Code translation for a thirteen digit call.
A0,1,2,4,7	"A" digit storage, two out of five code.
AD1	"A" digit one storage for code translation
B0,1,2,4,7	"B" digit storage, two out of five code.
BD0,BD1	"B" digit storage for code translation.
BRA	"B" digit register auxiliary lock.
CD01	"C" digit storage for code translation.
C0,1,2,4,7	"C" digit storage, two out of five code, and code translation.
CRA	"C" digit register auxiliary lock.
CT1, CT2	Converter test circuit connector.
CTR	Cancel time release control.
D0,1,2,4,7	"D" digit storage, two out of five code.
DRA	"D" digit register auxiliary lock.
E0,1,2,4,7	"E" digit storage, two out of five code.
F0,1,2,4,7	"F" digit storage, two out of five code.
G0,1,2,4,7	"G" digit storage, two out of five code.
H0,1,2,4,7	"H" digit storage, two out of five code.
HF1,2,3	High group MF pulse repeating relays.
IS1	In-digit steering control for 1st and 11th digits.
IS2	In-digit steering control for 2nd and 12th digits.
IS3	In-digit steering control for 3rd and 13th digits.
IS4,5,6,7, 8,9	In-digit steering control for 4th to 9th digits.
IC	Interdigital timing control.

Relay Designation	Circuit Function
J0,1,2,4,7	"J" digit storage, two out of five code.
L1	Line supervisory relay for T & R of customers line and dial pulse repeating.
L2	Line supervisory auxiliary, holds over dial pulse.
L3	Line supervisory auxiliary, dial pulse counter and disconnect control.
L4	Line supervisory auxiliary, dial pulse counter.
LF,0,3,6,9	Low group MF pulse repeating relays.
MB	Make converter busy.
MF1	Identify key pulse call (MF) and control off normal functions.
ON	Recognize seizure and furnish off-normal battery and ground.
ON1	Off-normal auxiliary.
OS1 to OS9	Out-digit steering control for A to H digits.
P1 to P5	Out-digits pulse counting control and matching.
PG1, PG2	Pulse generating control for out-digit pulsing.
PK	Partial key timeout control.
PKC	Partial key check.
PR	Party retest control.
PS	Permanent signal call routing control.
PT1	Party test timing control.
PT2	Party test auxiliary. Closes T & R for party test.
PT3	Party test auxiliary, signals completion of party test.
PT4	Party test auxiliary, checks PT relay operations on tip party calls.
PT5	Party test auxiliary. Prepares converter for party retest and partially controls registration check.
PT6	Tip party auxiliary. Transmits tip party identification on AMA or ANI call.
PT7	Party test auxiliary. Controls party retest.
PT	Party identification test. Responds to tip party ground.
R0,1,2,4,7	Digit readout control and out-digit pulsing matching.
RCY	Recycle control for in-digit steering when more than 10 digits are keyed.
REC	Receiver cut through to customer line.
RK	Registration check of readout relays for two out of five code. Start pulse generator when check is satisfactory.
RL	Release converter by disconnecting TC lead battery.
ROA	Reorder auxiliary, controls reorder tone interval.
ROD	Reorder tone.
RP	Identifies calling customer as ring party.
RSO	Recycles out-digit steering chain when more than 10 digits are to be outpulsed.
RSI	Recycles in-digit steering chain when the tenth digit is keyed.
STR	Responds to digit keying and controls advancing in-digit steering chain.
T	Tip lead continuity check.
TA1	Recognizes trouble time outs.
TC1, 2	Test control for informing converter of condition on IC lead. This information determines action required for party testing.
TC3,4,5	Test control auxiliary.
TM1,2,3	Timing control.
TP	Records party test result as tip party.

Relay Designation	Circuit Function
T1	Verification check of continuity of tip and ring leads.
W	Controls advancing out-digit steering during interdigital time.
W1	Interdigital auxiliary.
Z	Control the duration of interdigital timing.

3. FUNCTIONS

3.01 Recognize seizure when the sleeve lead is grounded and set the converter off normal.

3.02 Make a continuity check of the tip and ring leads.

3.03 Determine from the potential on the IC lead whether or not party test is to be made by the converter.

3.04 Await satisfying requirements for party testing and completion of continuity test and then return dial tone to the customer.

3.05 Upon seizure, start timing for the connection of dial tone.

3.06 Upon the return of dial tone start timing for permanent signal.

3.07 Monitor customers line to identify calling station as either dial or key pulse.

3.08 When serving a dial pulse station to repeat the pulses to the switches and simultaneously count and store one pulse.

3.09 Disconnect dial tone after counting the first pulse.

3.10 After one dial pulse to disconnect during the interdigital time.

3.11 When serving a key pulse customer to accept the MF receiver output and store the keyed digits on memory relays on the two out of five code.

3.12 As each digit is keyed to advance the in-digit steering relay chain through ten positions and recycle timing as partial key timing.

3.13 When more than nine digits are required for call completion to recycle the in-digit steering relay chain to permit reusing the first four positions.

3.14 Recognize digit readout check on the two out of five code as the signal to start the pulse generator for outpulsing.

3.15 Outpulse from one to thirteen digits at 10 pulses per second.

3.16 Measure an interdigital interval of 0.6 seconds.

3.17 On seven digit calls measure only 0.4 seconds interdigital time between the 6th and 7th digits.

3.18 Advance the out-digit steering relay chain during the interdigital interval.

3.19 Release the readout relays for the digit outpulsed and reoperate them for the succeeding digit during interdigital timing.

3.20 Recognize the end of the digit when the operated pulse counting and readout relays match.

3.21 Determine the number of digits required for the call by translating the first three and the fifth digits.

3.22 Recognize that the required number of digits have been outpulsed by matching the operated -DG relay with the appropriate out-digit steering relay.

3.23 Furnish traffic data.

3.24 Start converter release by opening the TC lead toward the finder.

3.25 Return reorder for a measured interval when a time out occurs.

3.26 Route to permanent signal, calls on which neither dial or key pulses are received.

3.27 Recognize that the converter is or is not to be held if a timeout occurs.

3.28 Release under control of the RLS jack after becoming stuck.

3.29 Recognize a momentary open on key pulse calls as an abandoned call.

3.30 Return reorder for a measured interval on abandoned calls followed by disconnecting.

3.31 Transmit forward party indication on AMA or ANI calls.

3.32 Generate up to three digits on permanent signal calls.

3.33 When party test is made by the converter party retest is made before the last digit is outpulsed.

4. CONNECTING CIRCUITS

When this circuit is listed on a keysheet the information thereon is to be followed.

4.01 Converter Finder Circuit - SD-33028-01.

4.02 Trunk Finder Circuit - SD-31953-01.

4.03 Converter Jack, Key and Lamp Circuit - SD-32333-01.

4.04 Traffic Call Data Circuit - SD-32332-01.

4.05 Miscellaneous Circuits Converter Frame - SD-32331-01.

4.06 Converter Test Circuit - SD-32329-01 and Test Set - SD-32330-01.

4.07 Push Button Calling Receiving Circuit - SD-95280-01.

4.08 Common Alarm - SD-96188-01.

5. ALARM INFORMATION

5.1 When a converter times out due to a failure and is held as a stuck converter the minor audible alarm will be sounded and an appropriate aisle pilot lamp lighted. The individual converter "C" lamp at the jack, key and lamp circuit will change from steady to flashing.

5.2 When the maximum number of converters to be held become stuck the major audible alarm will be sounded.

5.3 Operation of 48V fuse will ight the fuse alarm lamp and sound an audible alarm. The lamp and alarm will be retired when the blown fuse is replaced.

6. MANUFACTURING TEST REQUIREMENTS

The converter shall be capable of performing all the service functions specified in the circuit description and meeting all the requirements of the Circuit Requirements table.

7. TAKING EQUIPMENT OUT OF SERVICE

When any of the converter apparatus is being worked on, the converter should be made busy by the insertion of a No. 322A make busy plug into the make busy jack of the jack, key and lamp circuit. No further precautions, other than those listed in the Circuit Requirements table, are necessary.

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