SECTION NO. 3

DIALING THE CALLED NUMBER

DIALING THE CALLED NUMBER

NO. 5 CROSSBAR OFFICES

CONTENTS

FIGURES

A. GENERAL

1.01 This section is one of a group which describes the detailed circuit operation of the various types of calls handled by the No. 5 Crossbar System with wire spring relays.

1.02 When the dial tone marker completes the dialing connection, it releases. The originating register is now ready for customer dialing. It sends dial tone to the customer as a "start dialing" signal, and then the customer dials the number he wants. This section of the text describes the operation of the dial pulse originating register as it receives and stores the digits of this number.

1.03 The originating register counts the dial pulses of each digit and translates the count into a two-out-of-five code. It stores this information until all the digits are dialed, then it calls in a completing marker and gives it the dialed number. Fig. 1 is a block diagram of the various parts of the originating register circuit.

1.04 In areas where a fixed number of digits is always dialed, the originating register summons a marker as soon as this number of digits is received. However, if the number of digits varies for different called offices, or varies because some lines have party letters, then the originating register must determine from the office code the number of digits to expect. This operation is called pretranslation. If the numbering arrangement of the dialing area is simple, and pretranslation of the A digit or the A and B digits can provide the required information, then the originating register may be arranged to perform these functions. In areas where the 2-5 numbering plan is in use, it is impracticable to have each originating register do its own pretranslation. When the pretranslation of these codes is involved, a separate circuit - the pretranslator - is used.

1.05 Where an originating register serves a 2-party customer, it has an additional task. It must find which of the two parties is dialing - the tip or ring party. The tip party is identified by a resistance ground on the tip side of the line in the telephone set. The ring party has none. So that the register doesn't make this test needlessly on every call, the dial tone marker gives it an indication when to make the test. The indication is the 2P (two party) relay in the originating register. The dial tone marker operates this relay in the originating register when it handles a 2-party line.

1.06 The originating register makes two party test before sending dial tone to a 2-party customer, and makes it again after the customer finishes dialing. There is a detailed description of the operation of the 2-party test circuit in the circuit description of the originating register - CD-26040.

1.07 When an originating register serves a call from a coin line, its action depends upon the options provided in the register circuit. The various conditions for coin line service are discussed in the originating register circuit description - CD-26040-01.

1.08 When dialing is over, the register puts out a demand for a completing marker. The marker answers the demand and completes the connection for the subscriber. The completing marker holds the originating register connection

to the subscriber until it is sure it can complete the call. If the completing marker has trouble finding an idle line link in the calling customers line link frame, it may have to use the one in the dial tone channel. By maintaining the dial tone connection throughout the completing job, it has this line link circuit available. Also, if for some reason, the call can not be completed, the marker then signals the originating register to send busy tone to the subscriber.

1.09 A timing circuit times the completion of the important originating register functions. If a function is not completed in the allotted time, time-out occurs and the register takes appropriate action. A detailed description of the timing circuit is in CD-26040 - Originating Register - Dial Pulsing.

B. DIAL PULSE COUNTING

1. General

1.01 Dial pulse counting consists of detecting and counting momentary opens (dial pulses). These pulses are generated by the subscriber's telephone dial as it returns to normal during the dialing process. One dial pulse is produced for the digit "one", two for the digit "two", and so on. Dialing a zero produces a train of ten dial pulses. Most telephone dials generate pulses at a rate of about ten per second. Certain PBX and switchboard dials produce pulses at a rate of twenty per second.

1.02 The number of pulses which make a digit is called a "train" of pulses. The pulses are equally spaced in time by the governor action of the dial as it returns to normal. The pulses of a dialed digit are separated from the pulses of another digit by a much longer period of time. This interval is called the interdigital period. This period of time between digits, depends on how long it takes the subscriber to spin the dial off normal after it has come to rest for the preceding digit. The period of time between any two pulses of a digit is less than one tenth of a second. The time between digits is much longer. The originating register recognizes this time difference as an indication of the end of a digit.

1.03 The L relay detects the dial pulses, the P1 to P5 relays count the dial pulses and the RA relay detects the end of a digit. Relay RA is a slow release relay. It is first operated by the release of the L relay during the first pulse of a digit. The relatively short closure periods of the L relay between pulses are not long enough for the RA relay to release. However, the much longer closure period between digits does allow the RA relay to release. In this way the originating register recognizes the last pulse of a digit by the long closure period which follows the last pulse. The SR relay supervises the connection for the originating register. It recognizes an abandoned call (subscriber disconnect) through its slow release time. The SR is operated through operated L relay contacts. Even though the L is released for each dial pulse, the release time is not long enough to release the SR relay. The SR relay is re-energized each time the L operates. However, if the subscriber hangs up before he finishes dialing, the L goes down and stays down. The slow release relay, SR, finally releases and disconnects the originating register.

1.04 The originating register receives a train of one to ten pulses for any dialed digit. The pulse detecting relay (L) responds to these dial pulses and the counting relays (P1 to P5) count the number of pulses in each digit. At the end of a digit the counted pulses are transferred to the proper digit register relays. The first digit is stored in the A register, the second in the B, and so on. This transfer happens during the interdigital period. When the digit number has been stored in the proper digit register, the operated counting relays (P1 to P5) are released. After this, the originating register is ready to receive the next digit.

2. Pulse Detecting Relay

2.01 Relay L is the dial pulse detecting relay. It is a magnetically biased, polarized, mercury contact relay. It has three windings. The primary, which is the line winding, is in series with the circuit to the subscriber. It operates when this circuit is closed through the subscriber's telephone switchhook contacts. The tertiary is a pulse aiding winding and is wired in the circuit to insure that the L relay remains operated for a short interval once it is operated, and also insures that it will remain released for a short interval once released. The purpose of this feature is to overcome bouncing of the L contacts. The secondary winding is poled opposite to the primary and acts as a biasing winding. When relay L is operated, the effect of the secondary makes it easier to release; once it is released, the secondary makes it easier to operate.

3. Pulse Counting Relays

3.01 Relays P1 to P5 and relay P2A are the pulse counting circuit relays. P1 relay operates on every other release of the L relay and P2 relay operates on every other operation of the L relay. In this manner, relays P1 and P2 follow the L at half the dial pulse rate and act as a pulse dividing circuit. For a digit six (six dial pulses) the L will release and operate six times. The P1 and P2 relays each will operate and release three times. The operation of the pulse counting relays is charted on SC 36 of SD-26040 - Originating Register Dial Pulsing.

4. Digit Steering

4.01 The digit steering relays (AS, BS...LS) connect the output of the operated pulse counting relays (P1 to P5) to the digit register relays (A0, 1, 2, 4, 7 - B0, 1, 2, 4, 7 ... L0, 1, 2, 4, 7). The steering relay circuit also tells the register when dialing is completed. The advance of the digit steerers AS, BS, etc., is controlled by the RA1 relay during the interdigital period.

4.02 We will follow the operation here of the steering relay advance on OS 711-1. Relay AS (A digit steering relay) operates from operated ON relay when the originating register is set off normal by the dial tone marker. It locks through its own number eight contact and number six normal contacts of BS, CS ... LS relays to the ON ground. At the end of the first digit the L relay will remain operated long enough to allow RA to release. Released RA operates RA1. If two or more pulses were counted for the first digit, relay P2A is operated during the second pulse. Now there is an operating path for the BS relay. It is through its own normal number eight contact, operated number eleven contact of AS, operated number two contact of RA1, operated number four of P2A to ON

ground. Number six contact of the steering relays is a continuity transfer contact (early make-break). That is, the make part is closed before the break part opens. This allows the AS to hold up over a new locking path under control of the operated BS and RA1 relays. The BS relay once operated, locks through its own operated number eight contact and through normal number six contacts of successive steering relays to ON ground.

4.03 When the first pulse of the next digit is received, the L releases, operating RA which in turn releases RA1. RA1 opens the locking path of relay AS. With the AS relay released and the BS operated, the originating register is ready to store the second digit in the B digit register after it has been received and counted. The advance of the succeeding steering relays continues during the interdigital period of successive digits in the same way as described for AS and BS relays.

C. DIGIT REGISTERS

1. General

1.01 Originating registers are equipped for eight to eleven digits. The register is able to detect, count and store less than eight digits but the A to H register units are the minimum set supplied in an originating register. The additional relays required for extra digits are added as an option.

1.02 Each digit register is a unit consisting of five relay coils and associated contacts which are all enclosed in one cover. The coils are assigned the numbers 0, 1, 2, 4 and 7 so that the two-out-of-five numbering system can be used. We get a total of ten combinations using the two-out-of-five system. Now we can store any of the ten digits - zero through nine in a digit register. There is a digit register for each of the digits which the originating register is expected to store.

1.03 The units of the digit registers are called dry reed relays. The five coils of a digit register have one side of their windings connected to a common strap (OS 711-1). The end of this strap is brought out to a battery connection. The other side of each coil is connected to one of its own contacts. The mates of each of these sets of contacts are strapped together, brought out to a terminal, and connected to ON ground. This arrangement provides a locking path for each coil through its own make contacts. When the coil is energized. The other set of contacts also operate. They provide the information ground which is sent to the completing marker when dialing is finished. The two sets of make contacts for each unit of a digit register are mounted on metallic reeds and placed in separate glass tubes. The winding of each digit register coil is wound around the outside of the pair of glass tubes which make up the set. The winding of coil A0, for instance, is wound around the two sets of contacts (each set in a separate glass tube) which are associated with coil A0. When the relay coil is energized, the magnetic field of the coil bends the reeds so that they make two sets of operated contacts. These relays operate very fast - about 2-3 milliseconds. One set of contacts are a locking path, the other provides "information" ground to connecting circuits.

2. Digit Registration

2.01 Digit registration is the process taking place when an originating register after having counted the dialed pulses of a digit number, and after having recognized the last pulse as the completion of the digit, passes the counted number of pulses to the proper digit register for storing.

2.02 The L relay reoperates when the tip and ring are closed at the end of a dial pulse. Whenever the L relay operates, it opens the path of the slow release relay RA (OS 711-1). The RA relay will not release on operations of the L relay between pulses because the time the L is operated is not long enough to allow slow release RA to release. Each time the L relay releases during a pulse, it re-energizes the RA relay winding. After the last pulse of a digit however, the L will remain operated much longer - long enough for RA to release. The released RA relay closes ON ground through to the operated contacts of the pulsing relays (P1 to P5), through normal RA1 contacts to the windings of the digit register relays. The released RA relay also operates the RA1 relay, which opens the leads from the pulse counting relay contacts to the digit register. The digit register relays must operate and lock between the release of the RA and operation of RA1. Because they operate so fast, they can do it in this short period of time.

2.03 The operated RA1 relay and released RA relay open the locking path for all operated counting relays during the interdigital period. After the counting relays have released and the digit register relays have operated and locked, the originating register is ready for the first pulse of the next digit. It does all this with time to spare during the interdigital period.

2.04 Fig. 2 shows the relay operations if the numbers 421 are dialed into an originating register. The periods of operation of the various relays are shown by horizontal lines. The left end of each line represents the point at which the relay is operated; the right end of the line represents the point where it is released.

3. Preliminary Pulses

3.01 If the subscriber accidentally jiggles the switchhook after receiving dial tone but before beginning to dial, it is quite possible that he will generate a false dial pulse. If the switchhook momentarily opens the line, the L relay will detect one pulse. This false pulse is not counted as a digit because if it were, it would cause a wrong number. The originating register is designed so that a digit of one pulse can't be stored in the A digit register.

3.02 If a pulse is accidentally sent by a jiggled switchhook, it is received in the originating register and detected by the L relay. When L releases it operates P1 and RA which in turn releases RA1. At the end of the false pulse, L will operate and remain operated since only one pulse is being sent. Operated L opens the path of RA, which being slow release, provides the time interval long enough so that the originating register can recognize the end of the digit. However, since only one pulse is counted, P2A relay hasn't operated. The paths for transmitting ground to the A0 and A1 register relays are open at the contacts of the P2A relay.

4. Prefix Counter

4.01 Certain codes use a "one" in the A and B digits - 11X service codes and 11 interarea directing codes for instance. Now we have a case where we must recognize and store a one in the first digit as well as the second. Yet we must guard against false preliminary pulses.

4.02 We use a 11 prefix counter to solve this problem. It is unlikely that two false ones will be generated by switchhook jiggling in such a way that they will be received as two distinct digits of one pulse each. Yet we must detect, count and store the 1-1 of 11X and 11 interarea codes.

4.03 The 11 prefix counter works like this. See SD-26040-01, FS 1, 2 and 4. When the subscriber dials the first one, the L relay releases. Released L operates P1 and RA. RA releases RA1. At end of the pulse, which is also end of the digit, L reoperates operating P2. After L remains operated long enough, slow release RA relay recognizes this as end of the digit and releases which allows relay 11A to operate. Path of 11A is through six normal 11B, two normal P2A, two operated P1, two normal P5, two operated P2, seven normal RA, six normal MST1 to ON ground. Relay 11A locks to ON ground. Released RA also operates RA1 which in turn releases P1 and P2. Release of P1 operates 11B through operated 11A, normal contacts of P1 to ON ground. Relay 11B locks to ON ground.

4.04 At start of the second one, L releases. P1 and RA operate through normal L contacts. RA releases RA1. At the end of the pulse, L reoperates. P2 relay operates through its own normal contacts, operated P1, normal RA1, normal MST1 through operated L relay contacts to ground. After L has remained operated long enough the originating register recognizes the end of the digit by the slow release time of RA relay. Released RA operates 11C relay. The path is through operated 11B, normal P2A, operated P1, normal P5, operated P2, normal RA, normal MST1 to ON ground. 11C locks to ON ground.

4.05 Now we have recognized a one in the A digit and a one in the B digit. We have stored them in a separate digit register circuit, the 11 prefix counter. Subsequent digits will be stored in the A, B...L digit registers. The first of these subsequent digits will be a two or more. The register can't store a one in the A digit register even after receiving a 11 prefix. The path for operating the A0 and A1 digit register relays is through the operated P2A relay. This relay operates after the second pulse of a digit is detected. Once the P2A relay operates, it remains operated until the originating register releases. This makes it possible to store a one in any of the remaining digit registers.

D. PRETRANSLATION

1. General

1.01 If an originating register can know just how many digits a subscriber is going to dial, then it knows which is the last digit and therefore, when to summon a completing marker. Of course it is impossible to know how many digits a subscriber is going to dial before he starts dialing. However, if we examine the central office code, which is the first, first two or first

three digits after they are received and registered, we might be able to anticipate the number of digits which will follow. If we can do this, we can save originating register holding time simply because we won't have to wait after each digit and see if our customer is going to dial some more.

1.02 Pretranslation is a method which uses relays to examine the office code digits. The intent of this examination is to determine from the first (if only one such digit is dialed) the first and second (if two office code digits are dialed) or the first three digits in larger areas, how many digits in all may be dialed.

1.03 For simple numbering plan areas, one digit is sufficient for determining the central office desired. In this case we use an A digit translator circuit in the originating register. For larger areas two office code digits may be used. Here we use a 2-digit translator circuit (AB translator) in the originating register or a separate circuit called a pretranslator. For large dialing areas, the 2-5 numbering plan is in use. This method gives us a three digit central office code. Since the pretranslating circuit for three digit codes is complex, the function is taken out of the originating register. If we were to equip our originating registers with three digit pretranslating circuits, each one would be a complex and costly device. We use separate pretranslator circuits in three digit office code areas. Originating registers pass the three digits of the central office code to the pretranslator. The pretranslator examines the digits and informs the originating register how many in all to expect.

1.04 A detailed description of the operation of the A digit translator, and AB digit translator functions in the originating register, is in the circuit description - CD-26040 - of the originating register. The translation of three digit codes by the pretranslator circuit is discussed in Section 4 of this text under Pretranslation.

2. Extra Digit Timing

2.01 After the codes for certain offices are examined, either by the originating register circuit or by a separate pretranslator circuit, it may be determined that the subscriber is calling a manual office. We must realize that a large majority of the calls dialed into the originating register have the same number of digits. All the intraoffice calls and many outgoing calls have seven digits in areas using the 2-5 numbering plan. We will limit our discussion to this plan in the following examples. We arrange the originating register circuit so that it expects this number of digits on most calls, and waits for an additional digit on some others. Since a manual office has individual lines (4-digit numbers) and party lines (four digits and a letter) the originating register can't tell how many digits to expect - seven or eight.

2.02 We use an extra digit timer or stations delay circuit to solve this problem. After the three digits of the central office code are stored in the originating register, it sends these digits to the pretranslator. The pretranslator examines the code. If it finds it is for a manual central office, it will send back to the originating register a "stations letter signal." This signal tells the originating register to wait for a possible party letter after the seventh digit is stored. This signal will be returned

to the originating register before the subscriber has completed dialing the O digit. After receiving the G digit the register starts the extra digit timer. This timer allows the subscriber about 3.6 seconds to dial the party letter digit if he intends to do it. If the originating register does not receive the party letter digit, the timer will operate and cause the originating register to summon a completing marker. However, if the digit is dialed, the first pulse will release the L relay which will operate RA. RA will release RA1. Released RA1 relay makes the marker start function of the extra digit timer ineffective. In this case, marker start occurs after the extra digit is received and stored in the originating register. A detailed description of the operation of the timer is covered in CD-26040.

E. MARKER START

1. General

1.01 The purpose of pretranslation is to tell the originating register how many digits to expect. The originating register can tell from the position of its steering relays when the last digit has been received on a seven digit call, and knows where to start the extra digit timer on a seven or eight digit call. After the first three digits were stored by the register, it summoned a pretranslator and passed these digits to it. The pretranslator examined the digits (office code) and told the register how many digits in all to expect. All this takes place very quickly. The register receives a signal from the pretranslator before the interdigital period between the third and fourth digits is completed. After the last digit is received, the originating register summons a completing marker and passes information to it. The marker completes the call or connection.

2. Example of Marker Start Operation

2.01 For instance, let us assume the subscriber is dialing a telephone number which is located in the same central office. In a 2-5 numbering plan area, the subscriber dials seven digits for this call. The first two digits are central office code letters, the third digit is the central office code number, and these are followed by four telephone number digits. Just as the C digit is stored, the DS steering relay operates. On OS 711-1 the DS operates the PST (pretranslator start). The pretranslator examines the A, B and C digits, finds they represent a seven digit call and informs the originating register to expect seven digits in all. The details of pretranslator seizure, operation and code translation are covered in another section of this text under the heading Pretranslation.

2.02 When the HS steering relay operates at the end of the G digit (last digit), ground is extended through its operated contacts (OS 713-2) through the G to CM1 cross-connection, normal CM3, CMC, CMB, CMA relay contacts, operated PST, normal DMS, normal SD, DMS to winding of MST (marker start) relay. Relay MST operates a register start relay RS - for this originating register in its marker connector.

2.03 OS 713-1 shows a path of the MST relay. Certain other options for coin service may be in series with this path. Their function is to have the register make coin tests, or return coins under certain conditions for coin

subscribers. The 2-party options makes the originating register do a 2-party test just before it operates the MST relay.

2.04 It is possible that a subscriber may dial a three digit code. Service codes such as 211, 411, etc. are in this class. The originating register sends the pretranslator the A, B and C digits as in the preceding call. However, the pretranslator recognizes that dialing is completed and then returns a signal to the originating register telling it to start for a marker right away - that is - after three digits. The path of the MST is through normal CR, 2P, SD, operated CM3, normal DMS, operated PST and RA1 relays.

2.05 There is more to the details of marker start functions in the originating register. These details are discussed in the circuit description of the originating register - CD-26040.

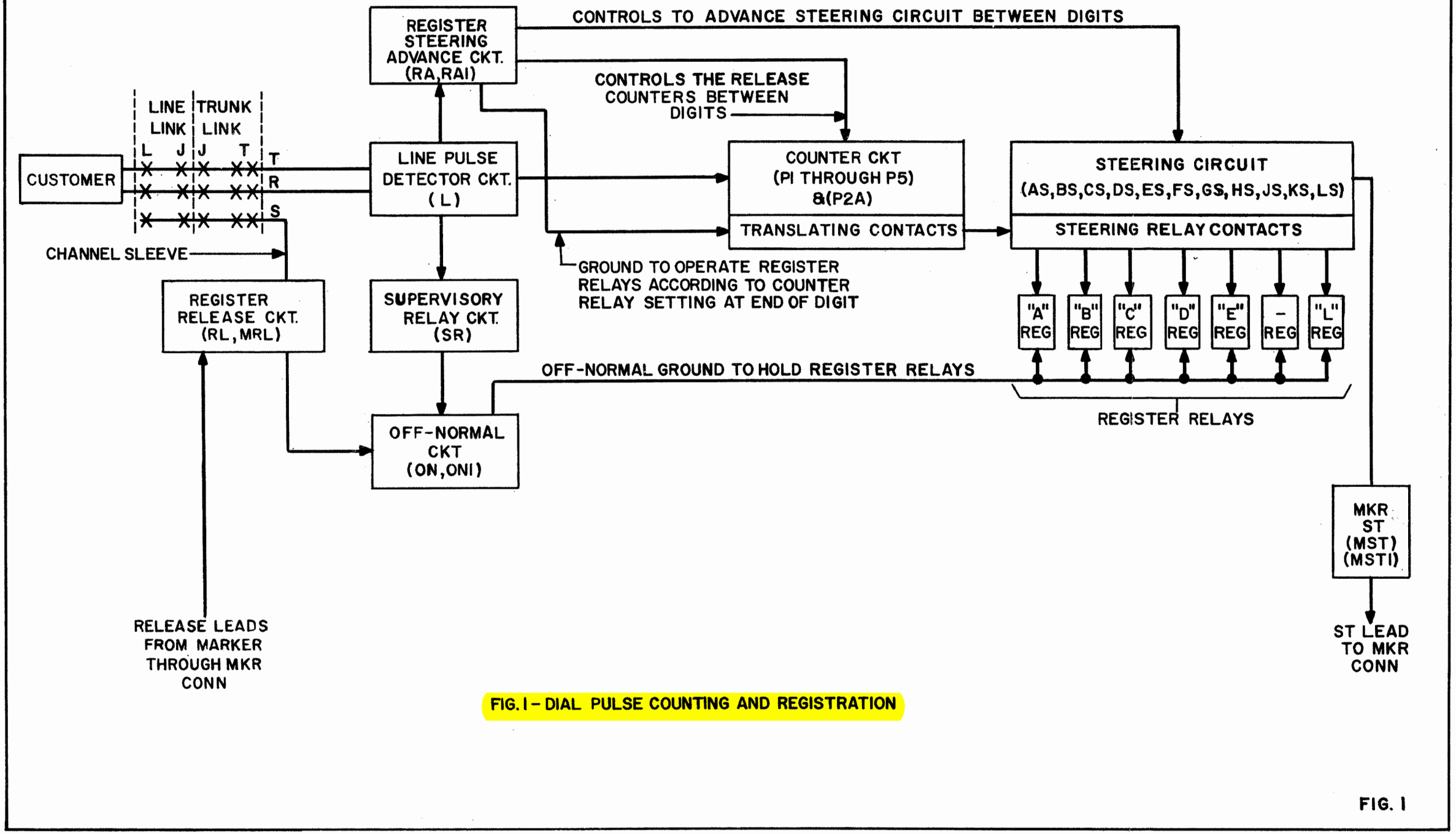

FIG. I – DIAL PULSE COUNTING AND REGISTRATION

FIG. I

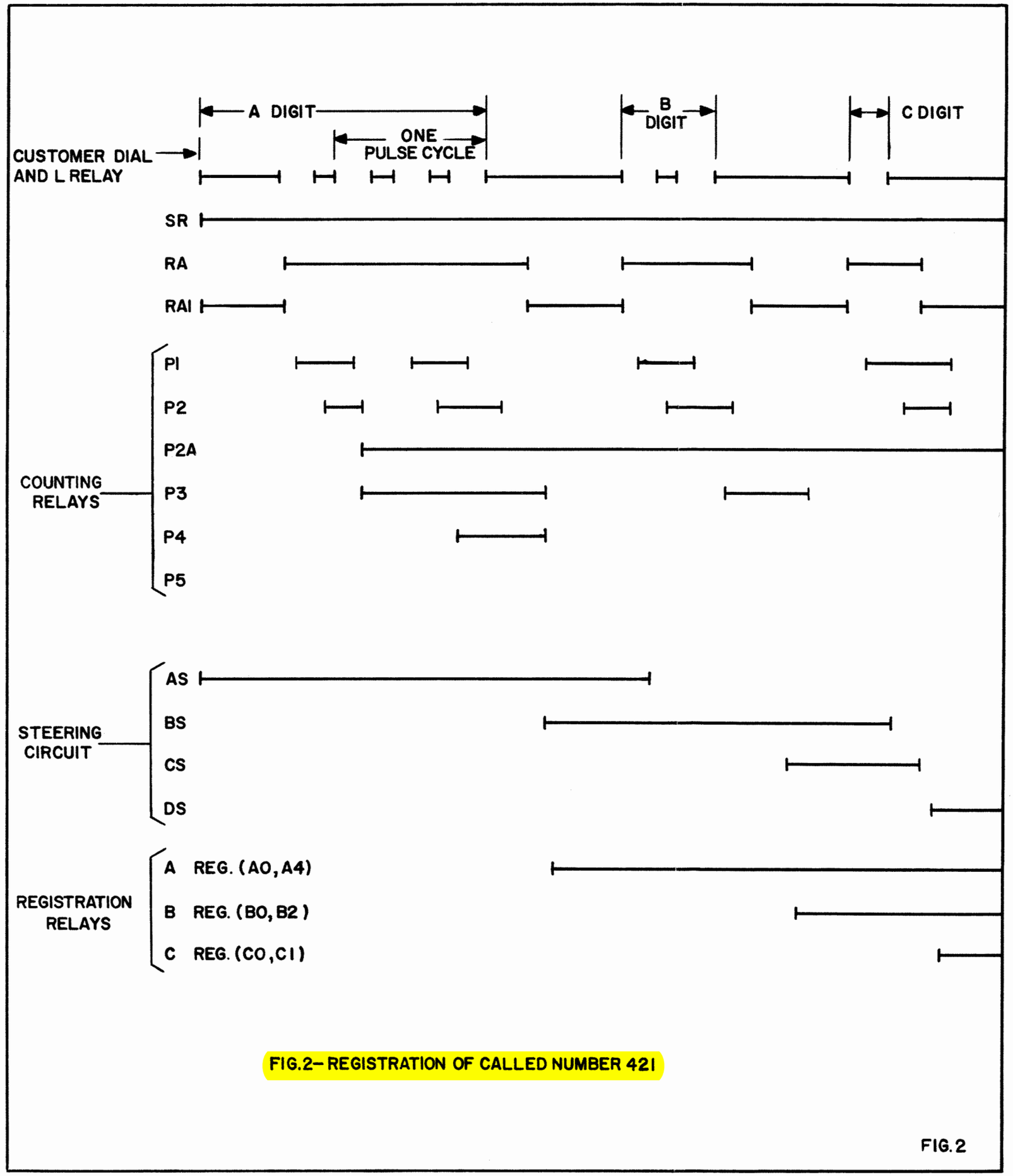

FIG.2– REGISTRATION OF CALLED NUMBER 421

FIG. 2