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CROSSBAR SYSTEMS
NO. 5
INCOMING REGISTER CIRCUIT
DIAL PULSING

CHANGES

D. Description of Changes

D.1 A change is made in the option table of the SD in order to eliminate confusion as to the capability of the dial pulse incoming register to translate the information code 411 over tandem intertoll or CAMA trunks for a marker start. The reference to Home NPA (before 411) is removed from Circuit Notes 102 and 115. This means the register will receive 411 and not the local NPA code plus 411. Note

410 is modified to show the operate path of MST on 411 (N11) information code.

D.2 A change is made to Circuit Note 109 to remove the requirement to provide the ground on lead TCA in this circuit for interchangeable codes. The marker connectors can provide the ground when required.

D.3 Minor changes are made to the CAD figures so they will agree with Western Electric T drawings.

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DEPT 5241-CML-RBC-JNC

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D. Description of Changes

D.1 Changes are made to correct minor drawing errors appearing on Issue 27D of the Schematic Drawing. These changes bring the drawing into agreement with Western Electric drawings and are made on a D no-record basis per agreement with Western Electric Company.

D.2 A change is made to operate relay CMB when the pretranslator operates relay TR due to a trouble condition. Relay CMB will set the register for 7 digits with delay for 10 digits. Relay TR will also release CMA and CM3 if operated. This arrangement will guard against completion of calls to 7-digit numbers when 10 digits are dialed. This is a wiring change only and is completed on a D no-record basis per agreement with Western Electric Company.

D.3 A change is made to prevent relay CK from operating if a false ground should operate relay PRL. Failure of relay CK to operate will cause the LR timer to function. This arrangement will guard against completion to 7-digit numbers when 10 digits might be dialed. If relay PRL is operated falsely and prematurely then the pretranslator would never be called in and the register would always be set for the 7 digits basic setting. With the register passing the marker the LR failure indication a trouble record will be taken and the customer will be routed to overflow. The

trouble record will indicate which register is in trouble with the LR failure indication. This change is minor wiring only and is completed on a D no-record basis per agreement with Western Electric Company.

F. Changes in CD SECTION II

F.1 In 4.7 Pretranslators, remove the following from the fourth sentence of the fifth paragraph:

. . . through a break-contact of the TR relay. . .

F.2 In the sixth paragraph of 4.7 change the third and fourth sentences to read:

. . . The TR relay will release relays CM3 and CMA if operated and will operate relay CMB. . . .

F.3 Add the following paragraph to 7.4 Link Release Timing:

When pretranslators are provided a break-contact of relay PRL is added in the relay CK operate path. If a false ground should appear on the PRL lead, the PRL relay will operate prematurely and relay CK will fail to operate, causing an LR time out. When the marker receives an LR indication the call will be routed to reorder and a trouble record will be taken showing the register involved. This will guard the completion of calls to wrong numbers.

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B. Changes in ApparatusB.1 Superseded

A411 Relay AJ15 - Fig. 9
 A411 Relay AJ15 - Fig. 17
 MST1 Relay AF100 - Fig. 1
 MST1 Relay AF100 - Fig. 18

A411 Network 185A - Fig. 9
 A411 Network 185A - Fig. 17
 MST1 Network 185A - Fig. 1
 MST1 Network 185A - Fig. 18

D. Description of Changes

D.1 A change is made to remove the feature for foreign NPA-411 information from the 102 note and to rate this feature Mfr Disc. It has been decided that this will not be a standard arrangement. This feature appeared as option ZZ when (incoming register) pretranslators are not required and as App Fig. 17 and 18 when pretranslators were provided. Wiring XG should be removed if App Fig. 17 and 18 are removed.

D.2 A change is made in the Circuit Requirement Table to insure that relay

ON1 is operated before starting to test for the operate time of the transistor timer DT. Without relay ON1 being operated relay DT would operate, with no time delay, if option YY was provided.

D.3 A change is made so that where registers are equipped with the electron tube (DT) timers, option YB, they may be modified on a Mfr Disc. basis, where timing is required to distinguish between interchangeable local and NPA codes. This modification permits the electron tube timer to be used where local traffic conditions do not require changing to the precision transistor digit timer. Where incoming register pretranslators are provided minor wiring XH must be added to YE and XC or where pretranslators are not provided wiring XH must be added to YB and YE.

D.4 Changes are made in CAD Fig. 2 and 26 to include the master test frame auxiliary control bay as a terminating point for some of this circuits outgoing leads.

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B. Changes in ApparatusB.1 Added

CM3 Relay - AJ15 - Fig. 16
 CMA Relay - AJ15 - Fig. 16
 CMB Relay - AJ15 - Fig. 16
 LCM Relay - 1/2AK30 - Fig. 16
 PRL Relay - AJ15 - Fig. 16
 PST Relay - AJ15 - Fig. 16
 TR Relay - AJ15 - Fig. 16

(7) Networks - 185A - Fig. 16

D. Description of Changes

D.1 Provision is made for full utilization of digits NXX as local office and numbering plan area codes on an interchangeable basis. This is accomplished by providing for operation with pretranslators. A pretranslator will operate none, one, or two of the CM3, CMA, and CMB relays in the register to indicate how many digits the register should expect. Where pretranslators are provided, the A, B, and C digit translation in the register is not needed. This change involves the addition of App Fig. 16, and options YZ, XB, and XC. If foreign NPA information calls (NXX-411) are required App Fig. 17 and 18 in addition must be provided. Existing wiring is designated options XA and YE. All apparatus figures and options are rated feature Standard. Prior to Issue 25D: Option YZ was shown as part of option ZW; option XB was shown as part of App Fig. 15 wiring; App Fig. 17 was shown as option ZZ in App Fig. 9; and App Fig. 18 was shown as option ZZ in App Fig. 1.

D.2 Provision is made for operation in a wire spring relay marker group arranged for up to 4000 trunk numbers. This involves the addition of two terminals and two leads (designated XD option rated after-date Standard) to the incoming register marker connector circuit register part.

D.3 A change is made to add the TT1 lead which will permit this circuit to function with the new solid state ringing

and tone plant. The new lead is designated option XF while the existing IT2 lead to the regular tone supply is designated option XE. Both options are rated feature Standard.

F. Changes in CD SECTION II

F.1 Add the following 4.7:

4.7 Pretranslators

In offices where the determination of the number of digits required for various codes is uneconomical or, in some cases, impossible when using the translators built into the individual registers, pretranslators will be provided. These circuits can translate as many codes as required, and are common to the group of registers. This translation is transferred to the register so that the register can connect to the marker after the proper number of digits have been registered.

The operating path for the pretranslator start relay PST is closed by the operation of a TOL, TAN, or CAMA trunk class relay on a cross connect basis. Thus, trunk classes accepting only a fixed number of digits are not referred to a pretranslator.

The following description assumes that the connection is made to the pretranslator after the third digit has been registered.

When the C digit has been registered, the DS relay will operate. The DS operates the pretranslator start relay PST which locks to ON1 ground and starts selection of a pretranslator by connecting battery to the start ST lead to the pretranslator connector circuit. The PST grounds the TM lead to the pretranslator connector to start its timer, connects battery to the ST1 lead to the pretranslator connector, and opens the operating circuit of the overload timing relay OVL to insure that register timing during the pretranslator stage of the call will be at the 25-second nominal rate.

When a connection has been established to the pretranslator, it translates the code recorded in the A, B, and C positions of the register to determine the number of digits to be expected on the call. The pretranslator then operates none, one, or two of the CM3, CMA, and CMB relays. (See Fig. 1.) The pretranslator then checks the CMK lead to see if the CM- relays have operated properly. Upon a satisfactory check the pretranslator will ground the LK1 lead to operate the LCM relay which locks to PST through a break-contact of the TR relay and provides a locking ground for any CM- relays which have operated. On completion of these functions, the pretranslator grounds the PRL lead to operate the PRL relay which locks to PST. The PRL recloses the operating path of the OVL relay to permit short interdigital timing to start if an overload condition exists, closes a point in the MST circuit which has been established through the CM-relays, and opens the ST and TM leads to the pretranslator connector which releases the pretranslator and pretranslator connector circuits.

* Where NPA - 411 information calls are handled, the number of digits is six and the translation mark is XII.

In the case that a trouble is encountered, the pretranslator connector is arranged to attempt a second trial. If trouble is encountered on a second trial, the TR lead will be grounded operating the TR relay. The TR will release the LCM relay, if operated, which in turn will release any CM- relays which were operated. This places the register into a basic setting condition and the register will call in a marker after seven digits have been registered. The TR relay also restores the operating path of the OVL relay to permit short interdigital timing to start if an overload condition exists.

Typical cross-connections for the pretranslator associated terminals are illustrated in the cross-connection figures.

CM- Relays Operated	No. of Digits	Translation Mark	Typical Code
CM3	3	LT	1X1, Vacant
CM3, CMB	3+ Time	LT	0/1XX
CMA, CMB	4	LT	11XX
None	7	LT	NXX
CMA	10*	LT	NXX
CMB	7 or 10*	LT or TT	NXX

FIG. 1

Where interdigital timing is required, the DL relay is operated through CM- relay contacts and the timer functions normally.

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B. Changes in Apparatus

<u>B.1</u>	<u>Superseded</u>	<u>Superseded By</u>
	AC1 - KS-13368,L3 Capacitor - Fig. 1	AC1 - KS-13367,L30 Capacitor - Fig. 1
	DT1 - KS-13368,L3 Capacitor - Option YB - Fig. 4	DT1 - KS-13367,L30 Capacitor - Option YB - Fig. 4
	TMA - KS-13368,L3 Capacitor - Option YB - Fig. 4	TMA - KS-13367,L30 Capacitor - Option YB - Fig. 4

D. Description of Changes

- D.1 To obtain a cost reduction in shop labor and material, the KS-8515 electron tube sockets are being replaced by KS-16481,L1 electron tube sockets.
- D.2 A 300 series information note is added to describe the procedure for using the KS-16751 indicator to check the operation of dry-reed relays used in this circuit.
- D.3 The R2 resistor of the DT transistorized time delay control circuit

is constantly dissipating approximately 0.8 watts. With the register in an idle condition, a dc path exists from ground through back contact 8 of the DL relay, the R2 resistor, the base to emitter circuit of transistor Q1 to -48 volts. Consequently, the R2 resistor is constantly carrying current. No ill effects have been noted or reported due to this type of operation, however, with a minor wiring modification, the heating of the R2 resistor can be reduced by energizing the timer only when the register is off-normal. To accomplish this, battery is applied to the timer through contact 12 of the ON1 relay. The new wiring, designated option YY, is rated after-date Standard. Existing wiring, designated option YX, is rated Mfr Disc prior to drawing issue 25D, option YX was shown as part of option YC.

D.4 The capacitors, per list 1 through 14 of KS-13365 to KS-13369, are being rated Mfr Disc and are being replaced by additional numbered lists 21 through 35. This involves a code addition only for the AC1, DT1, and TMA capacitors.

D.5 The before-turn-over-test requirement for the 293A dry-reed relay packs is removed from the circuit requirements tables since these units are sealed and this test is not necessary.

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B. Changes in ApparatusB.1 Added

TMB Diode - 446F - YU Option - Fig. 4

D. Description of Changes

D.1 The TM timer is used to time for the receipt of the first digit after register seizure and is recycled after the receipt of each subsequent digit. This timing is 19.6 to 37 seconds for normal traffic and a reduced interval for heavy traffic. After register seizure, failure to receive the first or subsequent digits will cause the TM timer to time out and call for a marker start. The start and recycle of this timer is under the operation and release of relay TMA. Relay TMB, a slow release relay, is an auxiliary to TMA operation and is wired in such a manner that it aids in controlling the time TMA is down to insure the TM timer network is recycled and that tube TM is deionized. If relay TMA became improperly adjusted (insufficient back tension making it slower release than circuit design called for) it may result in reducing the recycle time of the TM timer. This reduction in recycle time could reduce the timing intervals of the timer and cause premature partial dial time-outs or where the TM tube has an abnormally long deionization time, would cause it to refire immediately after recycle. It is possible that once a register is placed in service it might be difficult to differentiate between a register with maladjusted relays causing premature partial dial time-outs and a customer with poor dialing habits causing partial dial time-outs.

D.2 As part of the register wiring arrangements, the secondary winding

of TMA and the winding of TMB are in parallel. When relay RAI releases during pulsing or MST operates at the end of dialing, relays TMA and TMB are released in parallel. During their release a current flow occurs between the two windings which causes TMA to release later and TMB sooner than if they were not in parallel. If for some reason either of the relays became out of adjustment this could cause them to release at approximately the same time. Since TMA is reoperated from a back contact of TMB this results in TMA not being released sufficiently long enough to recycle the TM timer properly. As a circuit improvement the TMB diode is added in the winding path of TMB, which reduces the current flow between TMA and TMB windings during their release interval. This results in TMA always releasing before TMB and for a period long enough to insure the proper recycle of the TM timer network and deionization of the TM tube. This change (designated as option YU) replaces the existing wiring (designated as option YT) and is rated after-date Standard.

D.3 A change is made to permit this register to be associated with a marker connector which handles wideband (PICTUREPHONE[®]) service. This change involves a minor wiring modification. The new wiring (designated option YW) provides a new control for the SPL lead to the marker connector circuit. The existing wiring is designated option YV. Both options are rated feature Standard.

D.4 A change is made to correct an inadvertent drafting error appearing on Issue 22D. Option YQ is corrected to connect punching P20 to contact 1 of the TAN relay instead of connecting it to punching P2. This change brings the SD into agreement with the WECO drawings.

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D. Description of Changes

D.1 Relay TTC option "ZX" was added on Issue 20D as part of the new numbering plan. Relay TTC is operated when any of the TAN, TOLL, OR CAMA relays operate. With the toll code translator relays provided and a toll code such as 1x1 or 1lx(x) is received a path through operated TTC and the toll code translator relays will cause a marker start. When any TAN 1-4 class is assigned to trunks, such as coming from SxS 2nd or 3rd selectors and digit combinations received look like toll codes, such as 1x1 or 1lx(x), a premature marker start will occur. To prevent this from happening a change is made to add,

as part of option "ZX", cross-connect terminal TTC and associated cross-connect information. This permits the register to receive over TAN 1-4 classes digit combinations sent from selectors that look like toll code combinations without causing a premature marker start. With the cross-connects provided it still allows the TOLL, TAN, or CAMA classes the translation of toll codes for marker start where required. This change involves minor wiring only and must be applied on an "A" basis where option "ZX" is provided and trunking from SxS selectors or dial pulse senderized offices that send only 1 or 2 digits of an office code and TAN 1-4 classes are assigned. It must be provided on an "AR" basis on all other jobs where option "ZX" has been provided.

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interchangeable codes when Fig. 15 is provided and option "ZZ" is not provided.

D. Description of Changes

D.1 A change is made to provide a new translator lead ("LT3") from the incoming register to the completing marker. The register grounds this lead to inform the marker that the incoming trunk is serving a private network which requires the use of the route translator. This involves the addition of minor wiring only.

This change is made on a no record basis per agreement with WECO.

D.1.1 The following will be added to the CD on the next reissue.

D.5 Where provision is made for interchangeable codes in existing registers equipped for toll and tandem classes and wired with option "G" (rated "Mfr Disc." on Issue 6D) and using toll trunks which transmit 10X test codes and where the register functions with the Automatic Monitor, Register, and Sender Test Circuit (SD-25680-01) the 10X code will cause a monitor mismatch. This is because the monitor will record the initial one as a prefix and the register will record it as the A digit. This condition is corrected by modifying Circuit Note 115 to specify the use of existing standard options "F" and "J" since the mismatch does not occur when these options are provided for interchangeable codes.

Add to 2.5 of SECTION II just ahead of the summary table.

The LT3 translator indication is used to inform the marker of a private network call which requires the use of the route translator.

The tandem trunks assigned to the register TAN class relay have been arranged for transmitting 11X service codes where the initial ones are recorded on the register prefix counter. Where the register functions with the monitor, the monitor receives a signal on the "TAN" lead that any prefix ones should be recorded on the monitor prefix counter. The register gives this signal to the monitor on all calls received from trunks assigned to the register TAN class relay. In offices where it is not required to handle 11X service codes on these TAN class trunks it is possible to handle 10X type test codes in which case the initial one is recorded in the A digit register. A change is made to place the "TAN" lead to the monitor under cross-connection control for the TAN relay so that either type code but not both can be handled. This involves minor wiring changes only.

D.2 A new equipment arrangement of the master test frame recorder, control, and jack bays is being made to provide spare equipment space for future growth. This new arrangement requires a connecting circuit information change of the CADs in this circuit.

D.3 To eliminate some possible confusion when ordering Fig. 9 (code translator), the Circuit Note 104 is changed to clarify that all the features listed in that note for Fig. 9 are good for only those calls being served over tandem, intertoll, or CAMA trunks. This change is made per request of WECO.

D.4 On Issue 20D, provision was made for the new numbering plan (NPA), however, the loop on the 6 back contact of the A411 relay was inadvertently omitted. This contact is in the operate path of the DL relay and must be looped for handling of

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D. Description of Changes

D.1 Provision was made on Issue 18D for operation with the office test frame. The 1700 cycle identification tone, applied by the office test frame to the "CO" lead of bylink type trunks and passed through the incoming register link and the dial pulse incoming register to lead "T" of the incoming register marker connector, is being shunted below an acceptable level by a parallel application of 226 ohm resistance battery applied at the register and the trunk. This tone can be raised to an acceptable level by removing the registers 220 ohm resistance battery during bylink operation. This is accomplished by rearranging the assignment of the BL relay contacts #2 and #6 in order to obtain a break contact to remove the resistance battery from the "T" lead to the incoming register marker connector on bylink operation. The former wiring is designated "YM" option rated a

feature Standard provided where the office test frame is not provided. The new wiring is designated "YN" option rated a feature Standard provided where the office test frame is provided. Both options are made retroactive to Issue 18D.

This change must be applied to all offices equipped with the office test frame. It must be applied on an A basis to offices having bylink trunks and can be applied on an AR basis to offices now having only direct pulsing trunks.

D.2 A change is made to simplify WECO ordering information. The feature options "YN" (office test frame provided) and "YM" (office test frame not provided) are being rerated. In the previous paragraph these options were rated feature Standard from Issue 18D. Effective for Issue 20D the "YN" option is rerated after-date Standard and the "YM" option is rerated "Mfr Disc.".

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SECTION I - GENERAL DESCRIPTION1. PURPOSE OF CIRCUIT

The dial pulse incoming register is used to receive information in the form of dial pulses over a trunk from another office and when the entire number is received to transfer this information to the marker so that a connection can be set up between the incoming trunk and the called line or between the incoming trunk and an outgoing trunk to the called office. The marker then controls the completion of the call directly or with the aid of a sender. A block diagram showing the connections of a dial pulse incoming register on a completing call is shown in Fig. 1 in Information Note 301 in the SD and a block diagram showing the connections of a dial pulse incoming register on a tandem connection is shown in Fig. 2.

2. GENERAL METHOD OF OPERATION2.1 Operation with Register Link

When the incoming trunk is selected at the distant office, a connection is established from the incoming trunk through a register link to an incoming register circuit.

The trunks appear on the verticals of the register link crossbar switches with each switch accommodating a maximum of 20 trunks wired in a trunk preference chain circuit. These trunks have access to a maximum of 10 registers which appear on the horizontal levels of the crossbar switch. A register link consists of a number of crossbar switches sufficient to accommodate the trunks and these switches are assigned to horizontal groups. The registers are multiplied to similar levels on all the horizontal groups and the access to a particular group is under control of a register preference chain circuit. The register is equipped to function with a maximum of 10 register link horizontal groups. The basic switch of the horizontal group accommodates 20 trunks but the group can be extended to 40 trunks by the addition of a supplementary switch and an extension of the trunk preference circuit. The initial connection of a trunk to a register is made through the control relays of the link circuit which consists essentially of two preference chains. One preference chain is provided for each horizontal group of 20 or 40 trunks to control access of these trunks to a register. A second preference chain controls access of the 10 maximum horizontal groups of trunks to the register. When a connection has been established from a

trunk to a register through the link switch contacts and certain information which is received through the link control relays has been recorded in the register, the link control relays are released. Other trunks in this link group can then connect to other registers which are not busy.

2.2 Types of Trunk

The register is arranged to receive pulsing from two different types of trunks. Bylink pulsing trunks are those originating principally in SXS offices on which pulsing may start soon after the trunk is seized. For these trunks an early or bylink pulsing path is established through the control relays of the link to carry the pulsing signals until the switch contacts close the regular path. Pulsing is repeated to the register from the line relay of the bylink trunk. Direct pulsing trunks are those on which pulsing will not start until a signal, either dial tone or a trunk reversal, is returned by the register. When a direct pulsing trunk is connected to the register a relay is operated in the trunk which gives the register sole access to the tip and ring from the calling office and it receives pulses directly from that source. All trunks on a particular switch must be of the same type in respect to the type of pulsing.

2.3 Link Control

When a trunk of one of the link horizontal groups is connected to a register, the register makes itself busy to the remaining link groups. In cooperation with the link circuit the register establishes a connection from the trunk to the register through the link switch contacts, checking that there is no double connection. The register prepares to receive pulses and distinguishes whether the connection is to a bylink or direct pulsing trunk. After all required information has been received the link control relays are released. If a direct pulsing trunk is connected to the register, the battery and ground supplied by the register to the tip and ring of the trunk are reversed after a timed interval and dial tone is connected if required by the trunk as a start pulsing signal.

2.4 Digit Counting and Registration

The register then counts the number of pulses in each digit and when the dialing of a digit is completed transfers this count to the digit register and recycles to make itself ready for reception of the next digit. By recognizing the start and completion of each digit it controls the

progress of the register steering circuit. A digit register unit with five elements is provided for each digit and the elements operated on a two-out-of-five basis. A steering circuit which is controlled by a register advance relay progressively associates the register units with the counting circuit as digits are received. The steering circuit consists of one relay for each group of register relays. When all digits have been received, the register operates a marker start relay to start seizure of a marker. After the last digit an end signal is given to the marker enabling it to detect the absence of digits which might result from certain trouble conditions in the register or marker. This end signal is supplied from the steering relay of the last registered digit.

2.5 Trunk Cut-Through

Before the marker can complete the call, the trunk must be changed from its pulsing condition to its transmission condition so that it can assume supervision. When a signal is received from the trunk that this trunk cut-through has been completed the register connects to a marker and transfers to it the information recorded in the register. The trunk link frame number indicates to the marker the trunk link frame on which the trunk is located. For tandem and intertoll trunks a 3 digit trunk number enables the marker to obtain the line link location of the trunk from the number group circuit. In addition the called number and certain trunk class information are transferred to the marker.

2.6 Connection to Marker

The marker proceeds to establish a connection from the trunk to the called destination. For local trunks or local calls on tandem trunks this involves establishing a linkage between the trunk link frame appearance of the trunk and the line link appearance of the line. For through

calls on tandem and intertoll trunks, this involves establishing a linkage between the line link appearance of the incoming trunk and the trunk link appearance of an outgoing trunk to the desired office. When a call has been thus completed or the trunk set in an overflow condition if the call could not be completed, the marker operates a release relay in the register to disconnect it from the marker. The register then releases the link connection between the trunk and the register. The register is then ready to serve another trunk.

2.7 Prefix Counter

In conjunction with the class relays the pulse counting circuit determines whether any "one" digits received initially should be registered on the prefix counter as a foreign area directing code or whether all the digits should be recorded on the regular digit registers. If a "one" is registered on the prefix counter the translator indication to the marker is changed to show this registration.

2.8 Trouble Timers

When the register is seized two trouble condition timers are started. These are the link release and over-all (interdigital) timers. The link release timer will detect a trouble condition which prevents the link from completing its functions and indicates this to the marker so that the appropriate action can be taken. The over-all timer will detect any condition which prevents completion of the call in the normal time. This timer is recycled on an interdigital basis and a time-out will cause release of the register. Under office overload conditions the time-out period of the overall timer is reduced.

SECTION II - DETAILED DESCRIPTION1. SEIZURE OF THE REGISTER1.1 Register Link

When the incoming trunk is selected at the calling office, action is started which results in a connection being established from the incoming trunk through a register link to an incoming register circuit. Operation of the register preference relay constitutes seizure of the register and starts a chain of events which results in the register recording the trunk class, the trunk link frame number on which the trunk appears, the location of the trunk on the register link for translation into a trunk number for trunks with appearances on the line link frame, the type of pulsing to be received and operation of the select and hold magnets on the register link switch.

When the crosspoints are closed and all the information is received, the link control relays are released so that other trunks in the link group can connect to other registers which are not busy. Additional trunks can be assigned to the register link by extending each horizontal group to include a supplementary switch for additional trunks. The register is also equipped to function with two register link frames each of which may consist of 4 horizontal groups for the wire spring relay register link serving direct pulsing trunks or 5 horizontal groups for the U type relay register link. The wire spring register link frame serving bylink pulsing trunks consists of a maximum of 6 horizontal groups. Figure 3 in information Note 302 in the SD shows the arrangement of the register link.

The initial connection of a trunk to a register is made through the control relays of the link circuit which consists essentially of two preference chains. One preference chain is provided for each horizontal group of trunks to control access of these trunks to a register. A second preference chain controls access to the horizontal groups of trunks to the register. The incoming trunks appear on the verticals of crossbar switches with each switch providing for a maximum of twenty trunks. The twenty trunks on the basic switch constitute a horizontal group but this group may be extended to forty trunks maximum by the addition of a supplementary switch.

The trunks on each switch have access to a maximum of 10 incoming registers which appear on the horizontal levels with each register being multiplied to the corresponding level of the other switches in the link.

1.2 Types of Pulsing

The register is arranged to receive pulsing from two different types of trunks, direct pulsing and bylink. The direct pulsing type is used on calls which await a start pulsing signal, either a line reversal or dial tone, before the start of pulsing. The bylink type is used on calls which do not await a start dialing signal and on these trunks a bylink pulsing path is established early to allow registration of any pulsing occurring before the regular path through the link crosspoints is closed. These trunks originate principally in step-by-step offices and are selected by the step-by-step selectors during interdigital intervals.

1.3 Seizure by Direct Pulsing Trunks

Closure of the tip and ring leads at the calling office causes operation of the line relay A of the incoming trunk. The trunk A connects battery to the start lead to the link causing operation of the associated register link trunk preference relay TP. TP in turn closes a circuit to cause operation of a link register preference relay RP. Once the register preference relay is operated the call is locked in until the seizure of the register is complete. This lock in is controlled by the connection of resistance battery to the "LK" lead. Operation of the link RP relay causes operation of the link C and CA relays of the wire spring link or CL, TF, and TN relays of the U type link from ground on lead "TF". These relays close ground to a trunk class lead for operation of one of the trunk class relays OA, TAN etc.; close ground to trunk link frame number leads for operation of the FGO, FGL, or FG2 and two of the relays TFO, 1, 2, 4, 7 and close the trunk location leads, if required, for operation of two of the relays LUO, 1, 2, 4, 7 and one of the relays LTO-9.

RP closes the battery on lead "SM" to cause the operation of the link select magnet associated with the register. RP also closes ground to lead "ON" to the register where off-normal ON and register busy RB operate in parallel. RB connects resistance battery over an "RB-" lead to each of the link horizontal group of trunks as a register busy indication. Link RB relays operate in each of the horizontal groups except the one in which the call originated. In this group the RB relay is prevented from operating by a shunting ground connected to the lock out lead "LO". The function of the link RB relays is to advance the preference around busy registers in the link groups.

The register ON relay operates the auxiliary off-normal relay ON1 and these two relays provide off-normal grounds for all parts of the circuit. ON operates TMA to start the tube timer TM timing for receipt of the first digit and ON1 starts the tube timer LR timing for the completion of the link functions. ON also operates the first digit steering relay AS.

ON closes ground through a back contact of "H" to lead "OH" to the link where it is closed through the operated select magnet off-normal contacts and through the operated TP relay contacts to cause operation of the hold magnet associated with the calling trunk.

When the crosspoints close, the hold magnet operating ground is extended over lead "HM" to cause operation of H. H closes the low resistance primary winding of the double connection check relay DCK in series with the "HM" lead and removes the ground from lead "OH" with a continuity transfer contact. DCK operates, locks on its high resistance secondary winding and closes a short on its primary winding. Operation of DCK insures that no double connection at the line exists. If there were a double connection, a solid ground would have been connected to the hold magnet and to lead "HM" so that DCK could not operate. Such a condition would prevent completion of the link functions and would result in a link release timeout. DCK closes ground to lead "DCK" to the marker connector to indicate that no double connection exists.

The H relay disconnects the battery from lead "SM" to cause release of the select magnet and closes the circuit to the direct pulsing relay DP which operates from ground on lead "DPG" from the register link if the link serves both bylink and direct pulsing trunks or from an ON ground directly if the link serves only direct pulsing trunks.

DP locks, operates the slow release reversal relay RV1, closes the windings of the line relay L to the tip and ring leads, disconnects the "BL" lead from the L relay and connects it to the check relay CK circuit and closes ground on lead "CO" to operate the cutoff relay of the trunk.

The cutoff relay in the trunk disconnects the trunk A relay from the tip and ring conductors thus allowing the register L relay sole access to these leads. The cutoff relay grounds lead "BL" to cause operation of the check relay CK provided the trunk link frame number and a completing trunk class have been registered or a tandem trunk class and trunk location information have been registered.

CK locks, disconnects ground from the "TF" lead allowing release of the link relays from which the trunk class and trunk frame number information was received, starts the line reversing RV timer and operates the release link relay RLK provided the H, RB, and DCK relays have operated.

RLK disconnects battery from the "LK" lead to allow release of the link TP relay, disconnects ground from lead "LO" to cause operation of the link RB relay for the selected horizontal trunk group, closes a holding circuit to the RB and ON relays and stops the LR timer by connecting a shunt to the LR capacitor. After the operation of RLK the control relays of the link are free to serve other trunks and the only connection between the trunk and register is through the switch crosspoints.

When H operated, the L relay was connected to the tip and ring leads and at this time the trunk A relay was also connected to the tip and ring leads. The polarity of the battery and ground supplied by the L relay, however, was in a reverse direction to that supplied by the A relay. This caused operation of L. Operation of the trunk CO removes the trunk A relay from the tip and ring but the L relay holds to the closure at the calling office. L operates the abandon call control relay ACC, releases the register advance relay RA which in turn operates the register advance auxiliary relay RA1.

Relay DP causes operation of RV1 and removes the discharge shunt from the RV capacitor. With DP, RV1, and CK operated the RV timer is enabled and a circuit is closed for charging the RV capacitor from 130 volts through the RV3 resistor to ground through the winding of relay RV.

When the charge on the capacitor reaches approximately 72 volts the RV tube will ionize through the control gap terminals 1 and 4 and current will then flow in the main gap terminals 2 and 4 to operate the RV relay. The values of the RV capacitor and the RV3 resistor are designed so that the RV will operate in 140 minimum, 190 nominal and 300 maximum milliseconds after CK operates.

RV locks, reverses the polarity to the tip and ring leads and opens the circuit to the slow release relay RVL. RVL operated, provides a supplementary holding path for L to prevent the release of L during the tip and ring reversal and for an additional short time interval. This additional interval will prevent a false release of L and a possible false registration which might result from the reaction of the line reversal on certain types of trunks, notably those from step-by-step offices having bridged impedance type repeaters or from manual switchboards having out trunks with bridge impedance type transmission. When RVL releases the supplementary holding path to the L is removed and the back contact No. 4 of L is closed to the pulse counting P1 relay. RVL closes dial tone to the secondary winding of the tone coil, if required, and opens the operating circuit to RV so as to extinguish the tube to conserve its life. The circuit is now ready to receive dial pulses.

1.4 Seizure by Bylink Trunks

The bylink type of pulsing is required on trunks from step-by-step offices where the trunk is seized during an interdigital interval after one or more digits have been dialed and it is necessary to establish an early pulsing path through the link so as to be able to register the next digit without waiting for the link select and hold magnets to operate. In this case an early pulsing path is established through the TP and RP relays of the link over the "BL" lead.

When the trunk is selected and the repeater at the step-by-step office closes the tip and ring leads, the incoming trunk A relay operates to close battery to the start lead to the register link causing operation of the associated register link trunk preference relay TP. TP in turn closes a circuit to cause operation of a link register preference relay RP. Operation of RP closes resistance battery on lead "LK" to operate the trunk RL relay which locks and transfers the TP circuit from the "ST" lead to the "LK" lead thus locking in the call at least until the link functions are complete.

The trunk A relay connects ground to lead "BL" to the link and TP and RP connect BL to the register where it connects through the BL resistor to a winding of the line relay L causing its operation. L operates the abandon call control relay ACC.

Operation of RP causes operation of the link C and CA relays of the wire spring link or CL, TF and TN of the U type link from ground on lead "TF". Operation of C or CL will cause operation of bylink relay BL. These relays also close ground to a trunk class lead for operation of one of the trunk class relays OA, TAN etc., close ground to trunk link frame number leads for operation of the FGO, FGI or FG2 and two of the relays TFO, 1, 2, 4, 7, and close trunk location leads if required, for operation of two of the relays LUO, 1, 2, 4, 7 and one of the relays LTO-9.

BL locks and closes the back contact No. 4 of L to the pulse counting relay P1 and connects resistance battery to the "T" lead for holding the trunk RL relay when the crosspoints close.

RP closes the battery on lead "SM" to cause operation of the link select magnet associated with the register and closes ground on lead "ON" to the register where off-normal ON and register busy RB operate in parallel. RB connects resistance battery over an "RB-" lead to each of the link horizontal group of trunks as a register busy indication. Link RB relays operate in each of the horizontal groups except the one in which the call originated. In this group the RB relay is prevented from operating by a shunting ground connected to the lockout lead "LO". The function of the link RB relays is to advance the preference around busy registers in the link groups.

The register ON relay operates the auxiliary off-normal relay ON1 and these two relays provide off-normal grounds for all paths of the circuit. ON operates TMA to start the tube timer TM timing for receipt of the first digit and ON1 starts the tube timer LR timing for the completion of the link functions. ON also operates the first digit steering relay AS.

ON closes ground through a back contact of "H" to lead "OH" to the link where it is closed through the operated select magnet of normal contacts to cause operation of the hold magnet associated with the calling trunk.

When the crosspoints close, the hold magnet operating ground is extended over lead "HM" to cause operation of H.

H closes the low resistance primary winding of the double connection check relay DCK in series with the "HM" lead and removes the ground from lead "OH" with a continuity transfer contact. DCK operates, locks on its high resistance secondary winding and closes a short on its primary winding. Operation of DCK insures that no double connection at the link exists. If there were a double connection a solid ground would have been connected to the hold magnet and to lead "HM" so that DCK could not operate. Such a condition would prevent completion of the link functions and would result in a link release timeout. DCK closes ground to lead "DCK" to the marker connector to indicate that no double connection exists.

The H relay disconnects the battery from lead "SM" to cause release of the select magnet.

The circuit is ready to receive pulses as soon as ON and BL operate. ON is necessary since it controls the register advance relay RA and BL is necessary since it connects the back contact of the L to the P1 relay. The trunk is arranged so that if there is a delay in selecting a register and pulsing starts before the trunk RL relay operates from RP, the trunk busy relay will operate to return overflow to the calling line.

When BL and H have operated a circuit is closed to cause operation of CK provided the ACC has operated and the trunk link frame number and a completing trunk class have been registered or a tandem trunk class and trunk location information have been registered.

CK locks and disconnects ground from the "TF" lead allowing release of the link release relays from which the trunk class and trunk frame number information was received, operates the release link relay RLK provided the H, RB, and DCK relays have operated and disconnects the bylink lead check relay BLK from the "R" lead and connects the "R" lead in parallel with the "BL" lead to the L relay.

The "BL" lead check relay BLK is for checking that the "BL" lead is continuous through the link and BLK normally does not operate. The "BL" lead is closed through the link relays to obtain an early pulsing path and if this lead were open and the first closure came over the "R" lead, a part of the first digit might not be detected. The circuit is arranged so that on each call that is not abandoned a closure is required on the "BL" lead. When this closure occurs L operates to operate ACC. CK cannot operate until ACC operates

and with CK normal the "R" lead is connected to BLK. If no closure appears on the "BL" lead, a closure on the "R" lead will operate BLK. BLK connects a shunt around the AC capacitor to prevent the abandoned call timer from functioning and since CK is not operated RLK will not operate and the LR timer will function to cause a connection to a marker for the appropriate action.

RLK disconnects battery from the "LK" lead to allow release of the link TP relay, disconnects ground from lead "LO" to cause operation of the link RB relay for the selected horizontal trunk group, closes a holding circuit to the RB and ON relays and stops the LR timer by connecting a shunt to the LR capacitor. After the operation of RLK the control relays of the link are free to serve other trunks and the only connection between the trunk and register is through the switch crosspoints.

Pulsing is repeated by the A relay of the trunk over the "R" lead to the L relay and digit registration, marker start and other register functions are the same as for a direct pulsing call.

2. REGISTRATION OF TRUNK LINK FRAME NUMBER, TRUNK CLASS AND TRUNK LOCATION

2.1 General

The trunk link frame number, trunk class and trunk location information is received from the control relays of the link. The trunk link frame number is used by the marker in locating the trunk on the trunk link frame so that a terminating connection may be established. The trunk class information is recorded to give the information on each call to the register and to the marker for the proper translation of the registered digits for completing the call. The trunk location information is translated by the register to a three digit number which is used by the marker on through calls to obtain from the number group the line link appearance of the trunk so that a connection can be established between it and an outgoing trunk on the trunk link frame.

2.2 Trunk Link Frame Number Registration

One of the leads "TFO" to "TF9" to the register link will be grounded on each call when the connecting relay of the register link horizontal group associated with the selected incoming register operates. This ground operates one of the five TFO, 1, 2, 4, 7 relays. The TF- relay in operating locks and operates the trunk frame transfer relay which transfers each of the ten incoming "TF" leads from one TF- relay to another TF- relay. The two TF- relays connected to each lead have the numerical

suffixes of the two-out-of-five combination for the numerical designation of the lead. For example, a ground on lead "TF2" will initially cause operation of relay TF2. TF2 will operate TFT to connect the lead "TF2" to relay TFO.

Each of the operated TF- relays will ground a correspondingly numbered lead to the marker connector.

A contact of TFT is placed in the CK relay operating path to insure that TFT is operated before the link release check relay RLK is operated. This insures that a ground has been received on one of the "TF-" leads. If the ground is not present on one of the "TF-" leads, TFT will not operate and the link release timer will function to cause connection to a marker with a link release failure indication. If a trouble record is taken at this time, it will indicate the link group involved on the call.

If the ground is present on the "TF-" lead and TFT operates but the second TF-relay does not operate, the marker will detect the condition when the marker is summoned after digit registration and the resultant trouble record will indicate the number of the register in which the trouble condition exists.

The FGO and FGI relays are used for indicating the tens number of the line link frame on which the trunk appears.

2.3 Trunk Location - Trunk Number

Tandem and intertoll trunks handling calls which can be switched through the office have an appearance on the line link frame so that a connection can be established to an outgoing trunk. The line link location of the trunk is represented by a decimal number, the same as a subscriber line and in order to reach this trunk the marker must have this number. The register receives the physical location of the trunk on the register link frame and translates this into a three digit number which is passed to the marker. The marker then selects a predetermined number group representing the fourth or thousands digit and from this receives the physical location of the trunk on the line link frame.

Although the dial pulse incoming register may serve two frames with a maximum of 400 trunks the number of tandem or intertoll trunks with appearances on the line link frame are limited to a maximum of 200 because of the greater holding time. These 200 may, however, be spread over the two frames if certain basic rules are followed.

Each trunk is identified by three marks: the frame group, the link or half switch tens, and the link or vertical unit. Each trunk can be given a distinctive number provided at least one item of information concerning these three marks is different from that for all other trunks. An illustration of the register link is given in Fig. 3 and 4 in information Note 302 in the SD.

The frame group marks are REG and SUP and functionally take their designation from the U-type link where the entire frame was assigned to the same mark. On the U-type link one of the two basic or regular frames was assigned to the REG mark and one of the two supplementary frames was assigned to the SUP mark. In the wire spring link the frame group marks are cross-connectible within each frame and within the basic and supplementary switch divisions on a horizontal group basis and any horizontal group can be assigned to give either the REG or SUP mark.

The link or half switch tens mark comes from the physical location of the trunk on the register link. The trunk groups are divided into half switches or subgroups of ten and are numbered from 0 to 9. The basic switch of horizontal group 0 comprises the link tens subgroup 0 and 1, the basic switch of horizontal group 1 comprises the link tens subgroup 2 and 3, etc. These link tens subgroups are duplicated in the supplementary switches.

The link or vertical unit mark comes from the physical location of the trunk in the half switch or subgroup of ten and is the same as the units number of the corresponding TP relay.

The wire spring register link serving bylink trunks has 6 horizontal groups with basic switches but has no provision for supplementary switches. For this link, where trunk numbers are required for all trunks, it is necessary to assign at least one of the horizontal groups to the SUP mark.

When the register is seized the C and CA relays of the wire spring register link operate or the CL and TN relays of the U-type register link operate causing operation of one of the frame group relays REG or SUP, one of the relays LTO-9 and two of the relays LUO-9. For operation with a U-type register link which has tandem or intertoll trunks appearing only on the basic register link frame or only on the first auxiliary register link frame, the REG frame group relay will be operated locally by means of "Q" option.

The single LTO-9 relay is operated from ground on the "LTO-9" lead representing the subgroup or half switch position of the trunk. The two LU- relays operated represent the two-out-of-five code of the number of the "LUO-9" lead grounded by the register link and represents the position of the trunk in the subgroup of ten. Initially the lead is connected to one of the relays which operates and operates LUT. LUT transfers each of the leads to another of the LU- relays so that two are operated on each call. For example, if the "LU4" lead is grounded LUO operates initially operating LUT and then LU4 operates.

Facilities are provided in the register for translating the identifying marks into trunk numbers but because the facilities are limited to some degree, certain restrictions as to trunk number assignments are required.

The units digit is not cross-connectible and is the same as the vertical unit position of the trunk on the half switch. This number is transferred to the marker on a two-out-of-five basis with each of the operated LU- relays grounding a correspondingly designated lead.

The tens number is obtained by cross connecting the TA- and TB- terminals wired to the contacts of the LTO-9 relays. Each LT- relay has two terminals for a tens cross-connection and these are cross connected on a two-out-of-five basis to the "TTO, 1, 2, 4, 7" leads to the marker connector. Since the LT- relay is operated for both the basic switches and the supplementary switches, this means that the tens number assigned for an LT subgroup on the basic switches will also obtain for the same LT subgroup on the supplementary switches.

The hundreds number for the LT subgroup assigned to the REG mark is obtained by cross connecting the HA- and HB- terminals wired to the contacts of the LTO-9 relays. Each LT- relay has two terminals for a hundreds cross-connection and these are cross connected on a two-out-of-five basis to the "HTO, 1, 2, 4, 7" leads to the marker connector. These terminals are enabled by the REG relay and for the horizontal groups assigned to the relay an independent hundreds number can be assigned for each subgroup of ten trunks. The SUP relay has two terminals EHA and EHB wired to its contacts for cross-connection on a two-out-of-five basis to the "HTO, 1, 2, 4, 7" leads. This means that only one hundreds number can be assigned to the subgroups of trunks assigned to the SUP mark.

These cross-connections are illustrated in Fig. 4 in information Note 302 on the SD where cross-connections are shown for four trunks. It is assumed that it is required that the trunks on the left half of the second basic switch be assigned to the numbers 610 to 619 and the trunks on the right half of the fourth switch be assigned to the numbers 560 to 569. The trunks on the left half of the second switch are represented by LT2 hence the two H- terminals connected to the contacts of LT2 are connected to the HT2 and HT4 respectively for the hundreds digit 6 and the two T- terminals connected to contacts of the LT2 relay are connected to the TTO and TT1 terminals respectively for the tens digit 1. Similarly the H- and T- terminals connected to the LT7 relay which represent trunks on the right half of the fourth switch are connected to the HT1, HT4, TT2, and TT4 respectively for the hundreds digit 5 and the tens digit 6. Any trunks on similarly numbered supplementary half switches receive the same tens number. In this illustration the EHA and EHB terminals are connected to the HTO and HT4 terminals respectively to give all the trunks on the supplementary switches the hundreds digit 4.

On the tandem and toll class calls, a check is made that the trunk number information has been received from the link by placing contacts of the REG, SUP, LTO-9, and LUT relays in the operating path of the CK relay. The LUT relay in operating checks that a ground has been received on one of the "LU-" leads indicating that the register link is functioning satisfactorily. The marker, when seized at the completion of dialing, will check for the operation of the two-of-the-five LU- relays.

2.4 Trunk Class Information

The trunk class information is received from the register link over the eleven leads "CLO-10", with one lead being grounded on each call. Provision is made in the register for recognizing thirteen nontandem or completing classes, five toll classes, five tandem classes, and two CAMA classes of trunks. Since there are only eleven leads through the register link only eleven of these classes can be used in any link group.

On each trunk class, information must be recorded as to the number of digits expected on the call, the type of translator to be used by the marker, the class of call; incoming, toll, or tandem, whether or not the services of a special marker are required and whether or not dial tone is required as a start dialing signal.

2.41 Trunk Classes

The trunk classes as identified by the designations of the cross-connecting terminals are as follows:

- OA - Four digit incoming calls are received for termination in a single office or in office A of a multioffice marker group.
- OB - Four digit incoming calls are received for termination in office B of a multioffice marker group.
- AB - Five digit incoming calls are received and the initial digit indicating the required number series office A or office B.
- OAS - Same as OA, OB, or AB respectively except that calls are received on a special call basis (no hunt, no test, and trunks from the test desk).
- OBS
- ABS
- OAI - Same as OA, OB, and AB respectively except that the trunks require dial tone.
- OBI
- ABI
- OAS1 - Same as OAS, OBS, and ABS respectively except that the calls require dial tone.
- OBS1
- ABS1
- NTAN - Incoming only calls are received but all of the code digits are received as on a tandem class. Trunks have no appearance on the line link frame.
- TAN - Tandem calls are received and the trunks transmit all the digits of the office code and no screening or restrictions apply.
- TAN1 - These classes may be assigned to
- TAN2 any of the following types of
- TAN3 trunks:
- TAN4

- (a) Five digit FVD tandem calls are received and the trunks transmit only one digit of three digit home area office codes.
- (b) Six digit 2DT tandem calls are received and the trunks transmit two digits of three digit home area office code.
- (c) Tandem calls are received and the trunks transmit all the digits of the office code and screening or restrictions apply to some calls.

TOL - Intertoll trunks (the No. 5 office is used as a toll center and dial pulse signaling is used).

TOL1 - These classes may be assigned
 TOL2 where five digit (FVD) toll
 TOL3 class calls and/or six digit
 TOL4 (BX) toll class calls are received and/or toll screening or restrictions apply.

CAMAO - Where the register serves CAMA
 CAMAL trunks.

The twelve OA, OB, and AB class combinations are registered on either one operated or two operated out of six relays. These relays are OA, OB, and AB which provide the class and translator marks to the marker and provide for determining the number of digits; CLL which provides for connecting dial tone to the trunk; CLS which provides for requesting the services of a special marker; and CLS1 which provides for connecting dial tone to the trunk and for requesting the services of a special marker.

If the trunk class is OA, OB, or AB the desired relay operates directly from the ground on the class lead connected to the respective "OA", "OB", or "AB" terminal. If the trunk class is one of the other -1, -S, or -S1 combinations the corresponding CLL, CLS, or CLS1 relay will operate from the ground on the class lead connected to the respective -1, -S, or -S1 terminal. The CLL, CLS, or CLS1 relay in operating locs and operates the class transfer relay CLT which connects each of the nine leads to the proper OA, OB, or AB relay winding. In this manner two relays will be operated for each of the 9 dial tone and/or special marker classes of nontandem trunks.

A single class relay is operated directly for the nontandem NTAN, the toll and the various tandem trunks.

2.5 Trunk Class Indication to Completing Marker

The class of trunk is indicated to the completing marker by ground on one of the leads "INC", "PCR", "TAN", "TAN1-4", or "TOL", and either the "TCA" or "TCB" lead. The "TCA" and "TCB" leads provide for operation in a marker group that is arranged for CAMA and/or a multiple of toll trunks. If the marker is so arranged but the register does not serve CAMA and/or a multiple of toll trunks, the "TCA" lead is grounded on all calls. If the register does serve such trunks, either the "TCA" or "TCB" lead will be grounded depending on

the trunk class. The "PCR" and "TCB" leads are used to send a CAMAL (toll) trunk class indication to the marker and the "INC" and "TCB" leads are used for the CAMAO (tandem) trunks. INC and TCA are used for all trunks which carry only terminating calls. TOL is used for the intertoll trunks and TAN is used for all tandem trunks on which no screening or restrictions are placed on any calls. This includes the five digit FVD and the six digit 2DT trunks. TAN1, TAN2, TAN3, and TAN4 are used as required, for toll or tandem trunks on which calls are screened and certain restrictions applied by the marker.

The type of translator is indicated on one of the leads "TT", "LT", "11", "OA", "OB", "FVD", "X11", or "2DT". The nonrestricted tandem class will normally ground the local translator lead "LT" but registration of the one-one prefix in areas using the one-one prefix as a foreign area directing code will cause the ground to be placed on the "11" lead. The "TT" lead

was associated with the TOL relay with option "YD". This lead was provided to take care of three digit toll codes in an office with two digit local codes. Where there were three digit local codes the "LT" and "TT" leads were connected together in the marker. With option "YE" the "TT" lead represents NPA digit codes while LT represents non-area codes. The OA and OB class relays ground the "OA" and "OB" translator leads respectively. The "FVD" and "2DT" leads are used when any of the universal tandem class relays are assigned for use with five digit or six digit trunks. The "X11" lead is used to indicate an NPA information code.

A summary of the register classes is given in the following table with option "YE" wired.

Class Relays Operated	Class Lead To Marker	Class Group To Marker	Translator Lead To Marker			Type of Marker
			Non-Area Code	Area Code	Area Code + 411	
OA	INC	TCA	OA			
OB	INC	TCA	OB			
AB	INC	TCA	FVD			
OA,CL1	INC	TCA	OA			
OB,CL1	INC	TCA	OB			
AB,CL1	INC	TCA	FVD			
OA,CLS	INC	TCA	OA			SPL
OB,CLS	INC	TCA	OB			SPL
AB,CLS	INC	TCA	FVD			SPL
OA,CLS1	INC	TCA	OA			SPL
OB,CLS1	INC	TCA	OB			SPL
AB,CLS1	INC	TCA	FVD			SPL
NTAN	INC	TCA	LT,2DT or FVD			
TAN	TAN	TCA	LT or 11	TT	X11	
TAN1-4	TAN or TAN1-4	TCA	LT or 11	TT	X11	
		TCA	LT or 2DT or FVD	TT	X11	

<u>Class Relays Operated</u>	<u>Class Lead To Marker</u>	<u>Class Group To Marker</u>	<u>Translator Lead To Marker</u>			<u>Type of Marker</u>
			<u>Non-Area Code</u>	<u>Area Code</u>	<u>Area Code + 411</u>	
TOL	TOL	TCA	LT	TT	X11	
TOLL-4	TAN1-4	TCA or TCB	2DT or FVD	TT TT	X11	
CAMAO	INC	TCB	LT	TT	X11	
CAMAL	PCR	TCB	LT	TT	X11	

Each class relay must also indicate to the register how many digits to expect on the call. For example, the OA and OB relays prepare the register for the reception of four digits and after the fourth digit is registered the marker is called to complete the call. For trunk classes such as tandem and toll this sometimes becomes quite complicated and occasionally requires the use of translators which translate some or all of the A, B, and C digits. This is described in detail in the paragraph on determination of number of digits to be received.

A check is made that the trunk class information is recorded in the register before the link release check relay is operated. This is done by inserting make contacts of each of the basic class relays in the operating path of the CK relay.

3. DIAL PULSE COUNTING AND REGISTRATION

3.1 General

The dial pulse counting circuit counts the number of pulses in each digit and when the dialing of the digit is completed, transfers this count to the digit register then recycles to make itself ready for reception of the next digit. For any digit, a train of pulses consisting of from one to ten approximately equally spaced momentary line openings is generated at the calling office for direct pulsing trunks or repeated by the incoming trunks for by-link trunks. By recognizing the start and completion of these pulses for each digit the circuit controls the digit registration, the progress of the digit steering circuit, the recycling of the register timing circuit and the functioning of the marker start circuit.

3.2 Pulsing Relay

The L relay is a magnetically biased polarized mercury contact type relay with four windings. This relay has a single armature spring, number 3, making contact

with two independent front contacts, numbers 1 and 2 and two independent back contacts, numbers 4 and 5. The primary and secondary windings are balanced and are connected to the tip and ring leads so that pulsing on direct trunks is controlled by both the tip and ring. This tends to minimize any reaction due to longitudinally induced currents in the cable pair. The quaternary winding is a bias winding and is wired so that it causes the relay to be stiffer or easier to release when the front contacts are closed and weaker or easier to operate when the front contacts are open. The value of the L resistor is chosen so that the optimum benefit is obtained from this winding. The tertiary winding is a pulse help winding and is wired in series with the PH capacitor so that whenever the front contact of L closes, the capacitor will charge and the current in the T winding will be in a direction to hold the front contacts closed. This current decreases to zero as the capacitor charges. Whenever the front contacts of L open the capacitor will discharge and the current in the T winding will be in a direction to hold the front contacts open and the back contacts, closed. This current decreases to zero as the capacitor discharges. The net result is a pulse correcting action which causes the L relay once it operates to remain on the front contact for a definite minimum interval and once it releases to remain on the back contact for a definite minimum interval.

3.3 Pulse Counting Relays

The pulses of each digit as detected by the release and reoperation of the L relay are counted on the P1 to P5 relays. The P1 and P2 relays are wired as a pulse divider and contacts on these relays control the P3, P4, and P5 relays. The first release of L closes ground through L contacts No. 3 and 4 and through a break contact of P2 to operate P1. P1 locks to an ON contact. When L reoperates, ground through L contacts No. 3 and 2 through a P1 make contact operates P2.

P2 locks to the ON ground and opens its operating circuit on a continuity contact and transfers the holding circuit for P1 on a continuity contact from the ON ground to the ground at the L No. 2 contact. On the next release of L, P1 releases. P1 in releasing opens the holding circuit to the ON ground for P2, but P2 is held to the ground at the L No. 4 contact. When L re-operated on the second pulse P2 releases. This cycle will then repeat with P1 and P2 remaining operated at the end of each odd

number of pulses and remaining normal at the end of each even number of pulses.

At the beginning of the second pulse when P1 releases with P2 operated, P3 is operated. P4 and P5 operate at the end of the third and sixth pulses respectively. A separate and distinct combination of these five relays remains operated at the end of each digit. The sequence of operation for these relays is given in the following table and is given in graphical form on sequence chart SC7.

<u>Pulse</u>	<u>L</u>	<u>P1</u>	<u>P2</u>	<u>P3</u>	<u>P4</u>	<u>P5</u>	<u>Counting Relays Remaining Operated</u>	<u>Register Leads Grounded</u>
1 BK MK	R O	O	O				P1, P2	0,1
2 BK MK	R O	R	R	O			P3	0,2
3 BK MK	R O	O	O		O		P1, P2, P3, P4	1,2
4 BK MK	R O	R	R				P3, P4	0,4
5 BK MK	R O	O	O	R			P1, P2, P4	1,4
6 BK MK	R O	R	R			O	P4, P5	2,4
7 BK MK	R O	O	O				P1, P2, P4, P5	0,7
8 BK MK	R O	R	R	O			P3, P4, P5	1,7
9 BK MK	R O	O	O		R		P1, P2, P3, P5	2,7
10 BK MK	R O	R	R				P3, P5	4,7
11 BK MK	R O	O	O	R			P1, P2, P5	0
12 BK MK	R O	R	R				P5	0

It should be noted from this table that if due to some trouble condition the counting circuit counts more than 10 pulses it grounds the single "0" lead.

The auxiliary P2A relay is provided to tell the register when to record the digit on the A digit register and operates on the first or second pulse depending on the class of trunk. A tandem class trunk wired to ground local translator lead "LT" will never receive a one as the A digit and for these trunks the P2A is connected in parallel with P3 during the counting of the second pulse. All other trunks may receive a one as the A digit and for these trunks the P2A is connected to operate in parallel with P2 during the counting of the first pulse. P2A locks and opens its operating circuit on a continuity transfer contact.

3.4 Register Advance Relays

The register advance relay RA is a fast operate - slow release relay which operates during the first pulse, remains operated during pulsing and then releases during the interdigital interval. This relay is equipped with two windings. The primary winding is used for energizing the relay and is controlled by the No. 5 back contact of the L relay through a contact on the ON relay. The secondary winding is used to delay the release of the relay by retarding the decay of flux when the circuit to the primary winding is opened when L operates. This winding is precision wound with a resistance tolerance of only $\pm 3\%$ so that the release time variation is held to reasonably close limits.

When RA operates, the secondary winding is short circuited by a contact on RA to cause this reaction. By having the short circuit removed during the operation of the relay the operating time is reduced. RA operates at the start of a digit to provide a locking circuit for the P-relays and releases at the end of a digit to cause transfer of the count from the counting relays to the digit registers. The auxiliary register advance relay RAL works in reverse to RA, operating when RA is normal between digits and releasing when RA is operated during the counting of a digit. RAL aids in holding the counting relays and in transferring the count to the digit registers, controls the steering advance from one digit to the next, controls the digit timing circuit and recycles the register timing circuit at the start of each digit.

3.5 Digit Steering Circuit

The digit steering circuit consists of a single relay per digit and is wired so as to connect the five output leads from the counting circuit progressively to the digit register units. When ON operates, AS is operated through a back contact of P2A. AS locks through a back contact of BS and through the contacts of all the steering relays to an ON ground. When P2A operates it opens the operating path of AS and closes a path to operate BS when RAL operates at the end of the A digit. BS operates, locks on its continuity transfer contact and opens its operating circuit. BS on a continuity contact transfers the locking circuit for AS from the ON ground to the front contact of RAL. When RAL releases at the start of the B digit, AS releases, closing the digit leads to the B digit register through the operated BS relay. On subsequent digits when RAL operates, the next steering relay is operated through contacts on the operated steering relay and when RAL releases, the steering relay for the digit last registered releases. In this manner the circuit advances under control of RAL.

3.6 Digit Register Unit

The digit register unit consists of a dry reed relay with five independent coils enclosed in a can and with each coil associated with two make contacts. One side of each of the coils is wired internally to one of its associated contacts for locking purposes and a single lead wired to a terminal. One contact of the locking contact pair, one side of the coil and both contacts of the load contact pair are wired to individual terminals. These terminals extend to both front and rear of the relay. For ease of wiring three sets of terminals are strapped internally. These are the battery side of the coils, the locking contact of the relays and one side of the load contacts. Eleven of these digit register units are provided.

3.7 Digit Registration

After a short interval, long enough to insure that no more pulses are to be received after L operates for the last closure of a digit, RA releases and through two separate break contacts closes an ON1 ground to the translating contacts of the P-relays. The contacts of the P-relays are wired so that two of the output leads "0", "1", "2", "4", and "7" will be grounded

depending on which combination of relays is operated. These five leads are carried through separate transfer contacts on the steering relays to the register unit where two of the relays will be operated and locked. Another back contact on RA operates RAL which opens the five leads at the output of the counting relay translating contacts and releases the counting relays. The register relays are required to operate during the operate time of RAL. RAL operates the next steering relay and reoperates TMB in preparation for recycling the TM timer. RAL also may perform certain functions with regard to operation of the marker start relay. This is described in detail in the paragraph on determination of number of digits to be received. The pulsing circuit is now ready to count the next digit and when the L relay releases on the first pulse, RA operates and releases RAL. RAL releases the steering relay for the digit just registered and releases TMA and TMB to recycle the TM timer. This timer is described in detail in the paragraph on register timers.

3.8 Prefix Counter

In certain areas the prefix one-one is used to indicate that the code digits received on the A, B, and C digit registers represent an office in a foreign numbering area. When an office is arranged to handle such calls the prefix counter consisting of the 11A relay is provided for recording an initial one. The one-one code is used to distinguish the one-one prefix foreign area code from a single one which might be recorded in the originating register due to an accidental switchhook fumble as a call is originated. In the incoming register it is not necessary to guard against a false one and the first one received is recorded and any further ones are ignored.

The tandem class relays handling calls to the one-one prefix foreign area will be wired so that P2A will not operate until a digit of two or greater is counted. If a one is counted P2A will remain normal and when RA releases ground will be connected to the "1" lead but will be connected through a back contact of P2A and through cross-connections 11N and 11P to operate 11A and no ground will appear on the leads to the A digit register. Since P2A is not operated the steering circuit will not advance. The 11A relay locks and removes ground from the LT translator lead and connects it to the 11 translator lead. The operation of RAL releases the counting relays. Any additional ones will cause operation of the counting relays but will not be recorded.

3.9 End 7 Signal

The two-out-five method of registration represents a self checking means for transferring the number from one circuit to another. In the transfer of a series of digits the number of which may be variable, an additional checking feature is incorporated. This is the so-called end 7 signal, which is a single -7 in the digit position one beyond the position of the last registered digit, and is used for checking that all the digits have been transferred properly and that none have been omitted entirely. This end 7 is registered by the operation of the marker start relay MST in connection with the steering relays. When MST operates at the end of digit registration, it closes a circuit through the steering relays, to ground the single seven lead of the digit one beyond the last registered digit. For example, if MST operates after four digits have been registered DS would remain operated and lead "E7" would be grounded.

4. DETERMINATION OF NUMBER OF DIGITS TO BE RECEIVED

4.1 General

When all digits have been received the register operates the marker start relay MST to start seizure of a marker. The steering relays are used to indicate when particular digits have been registered. As these relays operate they ground the C to L terminals with the terminal designation corresponding to a digit being grounded following registration of that digit. For example, when the D digit is registered the ES relay is operated to ground the D terminal. These terminals with their cross-connections, and in some cases permanent wiring to contacts of the class relays, under varying degrees of intermediate control are used to operate MST. Since the register does not receive the same number of digits from all incoming trunks, the operation of MST is controlled either directly or indirectly by the class relays. For instance, for a four digit locally completing incoming trunk with the OA class relay operated, MST will be operated when ES operates after the fourth digit is registered and for a five digit locally completing incoming trunk with the AB class relay operated, MST will be operated when FS operates after the fifth digit CAMA is registered. For tandem toll and CAMA trunks, this class relay control is provided on a cross-connectible basis by the 11E- and 11F- and TE- and TF- terminals.

The MST terminal is connected directly to the MST relay winding and a ground at this terminal will cause selection of the marker without delay. The DL terminal is used when it is desired to await dialing one additional digit such as a party letter. This is covered in detail under the paragraph on digit timing. Whenever the toll and tandem code translator is provided, the MSTX and DLX terminals respectively are used in place of the MST and DL terminals for home area office codes.

4.2 One-One Prefix Translator

If the register receives one-one foreign area codes, the prefix counter relay 11A is used for distinguishing the one-one foreign area codes from the home area codes. The circuit between the 11A and 11B terminals is closed with relay 11A normal for home area code use, and the circuit between terminals 11C and 11D is closed with relay 11A operated and for one-one foreign area code use. An additional circuit is provided between terminals 11J and 11K for home area codes and between terminals 11L and 11M for one-one foreign area codes, for use if different treatment is required for different tandem class relays.

4.3 Toll Code Translator

The toll code translator consisting of the control relay TDL and the digit translator relays SA0, SA1, SA4, SAZ, SBO, SB1, SB4, SBZ, SCO, SC1, SC4, and SCZ is used to translate 11X or 11XX, 1XX, OXX, and 1X1 codes over toll class trunks and 11X, NOX, and NNO codes over toll, CAMA, and tandem class trunks. In some cases the marker seizure occurs after a definite number of digits but in other cases marker start is under control of a repetitive digit timer which is started after the third digit is registered and which is recycled after registration of each successive digit. This translator is described in detail in the section on toll calls.

4.4 A Digit Translator

When the number of digits to be received depends on the A code digit, the A digit translator may be used. This translator consists of the digit translator relays TAO, 1, 2, 4, and 7 and the cut-in relays TAA and TAB. The TAO, 1, 2, 4, and 7 relays operate directly from the load contacts of the A digit register relays. Two groups of ten paths each are provided through the TA2/5 relays and the groups are under control of the TAA and TAB relays.

One path of each group is closed by each two-out-of-five combination of operated relays. One group comprising the ten circuits between the AAO-9 and ABO-9 terminals is used in connection with relay TAA for translation of home area office codes, while the other group comprising the ten circuits between the ACO-9 and ADO-9 terminals is used in connection with relay TAB for translation of one-one foreign area codes. These terminals are cross-connected between the terminals corresponding to the digits registered and the MST or DL terminals for operation of the appropriate relay when the required number of digits as determined by the A digit has been registered. When this translator is used the terminals representing unused A digits will be connected to the vacant code terminal VC which is grounded by the operation of P2A. If an unused A digit code is registered, the marker will be seized as soon as the A digit is registered and the trunk will be set in an overflow condition.

4.5 A and B Digit Translator

In some cases it is necessary to translate both the A and B digits to determine the number of digits to be received. For this purpose, the B digit translator consisting of the TBO, 1, 2, 4, and 7, TBA, TBB, and TBC relays is used in conjunction with the A digit translator. TAO, 1, 2, 4, and 7 and TBO, 1, 2, 4, and 7 operate directly from the load contacts of the A and B digit registers respectively, and for each call, two-out-of-five of each group will be operated.

Two groups of ten paths each are provided through the TA2/5 relays and these groups are under control of the TAA and TAB cut-in relays. One group comprising the circuits between the AAO-9 and ABO-9 terminals is used in connection with relay TAA for translation of home area codes, while the other group comprising the circuits between ACO-9 and ADO-9 terminals is used in connection with relay TAB for translation of one-one foreign area codes.

Three groups of ten paths each are provided through the TB2/5 relays and these groups are under control of the TBA, TBB, and TBC relays. One group comprising the ten circuits between the BAO-9 and BBO-9 terminals is under control of the TBA relay. A second group comprising the ten circuits between the BCO-9 and BDO-9 terminals is under control of the TBB relay and the third group comprising the ten circuits between the BEO-9 and BFO-9 terminals is under control of the TBC relay.

By cross-connecting the proper AAO-9 terminals, for home area office codes, to the TBA, TBB, or TBC terminals for operation of corresponding relays and connecting the associated ABO-9 terminals to ground, a particular group of B digit leads can be selected and enabled for each A digit. Then by cross-connecting the BAO-9 to BBO-9, BCO-9 to BDO-9, or BEO-9 to BFO-9 terminals between the terminals corresponding to the digit registered and the MST or DL terminals the proper relay can be operated whenever the correct number of digits has been registered for the particular combination of A and B digits. For example, if it is desired to operate MST to seize the marker immediately after 6 digits have been registered for an A digit of 2 and a B digit of 4, terminal AA2 would be connected to TBA and terminal AB2 would be connected to ground so that TBA would operate for an A digit of 2. The cut-in relay TAA would be operated from the trunk class relay. The BA4 terminal would be connected to F, and the BB4 terminal would be connected to MST for operation of MST for a B digit of 4 and an A digit of 2. Other combinations of A and B digits would be handled in a similar manner.

Since there are three groups of B digit leads, three different treatments can be given to the A digits and since each group of B digit translators has 10 paths a combination of 3 times 10 or 30 different codes can be translated. However, since the 0, 1 are not normally used for the B digit for home area codes, the usable number of different codes is reduced to 24, representing three different treatments of A digits and eight different treatments of B digits. For unused A digits the vacant code treatment described in the paragraph on A digit translator can be applied. Similar treatment can be applied for unused combinations of A and B digits.

4.6 Digit Timing

The digit timing circuit consists of the delay relay DL and the DT tube timing circuit, or a transistorized time delay control circuit and is used for timing one or more additional digits to be dialed in cases where the number of digits cannot be determined by translators or other means. Where the terminating office has some stations identified by a party number or letter the station digit may or may not be dialed. On such calls the one digit delay circuit is used. If the additional digit is dialed the marker is seized after its registration and if it is not dialed the

marker is seized after a timed interval of approximately 3.5 seconds. For other cases where the number of digits on different calls may vary more than one digit, the repetitive delay is used. In these cases the timer is started after the third digit is registered and is recycled after each digit. When no digit is received during the timed interval the marker is started. The conditions of use of this type of operation are covered more fully in the section on code treatments.

The operation of the electron tube timer circuit on a one digit delay basis is as follows: when the DL terminal is grounded as a result of the operation of a steering relay after the last digit for the call with the minimum number of digits is registered, the DL relay will operate through operated contacts of RAL. DL locks, and starts the DT timer by removing a shunt from the DT capacitor and connecting the DT tube and capacitor to an ON1 ground through the DT relay winding. The DT capacitor starts to charge to 130 volts through the DT3 resistor and when the capacitor reaches a charge of approximately 72 volts, the DT tube will ionize between terminals 1 and 4. This will cause current to pass between terminals 2 and 4 to cause operation of relay DT. The time required for the DT tube to ionize is dependent on the tube constants and the value of the capacitor and the charging resistor. These are chosen to give a delay from the operation of DL to the operation DT of minimum 2.8 seconds, nominal 3.6 seconds and maximum 5.4 seconds. If the additional digit is not dialed during this interval, DT operates to transfer the DL operating ground to cause operation of MST. DT locks on a continuity transfer contact to the 130 volt battery through the current limiting resistor DT4 and opens the circuit to the DT tube to conserve its life.

The DT1 capacitor is wired across the No. 2 and No. 4 terminals of the DT tube to prevent any induced voltage in the control leads from affecting the operating time. This is necessary since the wires to the TDL and RAL contacts may be adjacent to other wires carrying heavy transient currents.

If a digit is received during the timed interval RAL releases to cause operation of DT to the 130 volt potential through resistor DT4, RAL normal and DL operated. When RAL operates at the end of the digit with DT operated MST will be operated.

When the timer is used on a repetitive basis, the locking contact of DL is opened by TDL and ground is supplied to the RAL contacts through the front contact of TDL. When RAL operates at the end of a digit, DL operates to start the timer and when RAL releases at the beginning of any subsequent digit, DL will release to recycle the timer. The DT operating circuit through the back contact of RAL is opened by a contact on TDL to prevent premature operation of DT. This action will continue until no digit is received during the timed interval and DT will operate to cause operation of MST.

Operation of the transistor time delay circuit is explained in CD-94420-01. However, its function in this circuit is similar to that of the electron tube timer. The interval timed depends on the values of capacitor DT and resistor DT3. When relay DL operates, ground is removed from one side of capacitor DT and from lead "I" to the timer, causing the timing interval to begin. At the end of the timed interval, (3.2 sec. min, 3.5 sec nom., and 3.3 sec. max) DT operates and transfers the DL operating ground to cause operation of MST. If DL releases before the end of the timing interval, ground is restored to capacitor DT and lead "I" causing the timing function to cease.

5. TRUNK CUT-THROUGH AND MARKER SEIZURE

5.1 General

When all digits have been received the register starts selection of a marker. However, before the marker can complete the call, the trunk must be changed from its pulsing condition to its transmission condition. This trunk cut-through function is completed by the register before the marker is seized. When connected to a marker by the marker connector, the register transfers to the marker the dialed number, trunk class information, trunk frame number, trunk number (for trunks with appearances on line link frames) and translator to be used. The marker then proceeds to gain access to the trunk and establishes a connection between it and the called line or, in the case of a switched through call, between it and the outgoing trunk.

5.2 Marker Start Relay

When all digits have been received the marker start relay MST operates. MST opens the circuit from the front contact of L to the P1 and P2 relays to prevent any further counting of pulses and closes a circuit to hold RAL operated to prevent any further

advance of the steering circuit in case an additional digit is dialed in error. MST also closes a circuit through the contacts of the steering relays to ground the single seven lead of the digit beyond the last registered digit. MST recycles the TM timer circuit.

5.3 Cut-Through of Direct Pulsing Trunks

MST closes ground through the primary winding of the TC1 relay to the "D" lead to the register link. The TC1 secondary winding is connected in parallel with the trunk D relay to the ground through the primary winding. The ampere turns of these two windings oppose each other and TC1 does not operate under this condition. The trunk D relay operates and reconnects the trunk A relay to the trunk conductors. MST also opens the holding path of DP and the release of DP disconnects the register L relay from the tip and ring leads. The trunk A relay operates and connects a ground to lead "D" to hold D and to short the TC1 primary winding so that TC1 operates on its secondary winding. TC1 operates TC2 which locks to MST and to H and opens the primary winding of TC1. TC2 closes ground to the "TM" lead to the marker connector or marker preference and control circuit to start the connector timer and connects battery to the connector battery supply lead "CBS" and to the start lead "ST" to cause the connector to connect the register to a marker. TC1 also connects a discharge circuit around the AC capacitor to stop the abandoned call timer. TC1 is held under direct control of the trunk supervisory relay and TC1 controls the abandoned call timer until the register releases.

5.4 Cut-Through on Bylink Pulsing Trunks

On these trunks the trunk line relay was not disconnected from the trunk, pulsing being repeated from this relay over the ring lead to the register L relay. MST closes ground through the primary winding of the TC1 relay to the "D" lead to the register link. The TC1 secondary winding is connected in parallel with the trunk D relay to the ground through the primary winding. The ampere turns of these two windings oppose each other and TC1 does not operate on this condition. The trunk D relay operates and establishes the transmission condition and locks to a contact on the trunk B relay which is held by the trunk A. This locking ground is returned on the "D" lead to short the primary winding of TC1 and TC1 operates on its secondary winding. TC1 operates TC2 which locks to MST and H and opens the primary winding of TC1. TC2 closes ground to

the "TM" lead to the marker connector or marker preference and control circuit to start the connector timing and connects battery to the connector battery supply lead "CBS" and to the start lead "ST" to cause the connector to connect the register to a completing marker. The L is held from the trunk A relay and exercises supervision until the register releases.

6. REGISTER RELEASE

When a marker has completed the connection to the called line or trunk or has established a busy or overflow condition in the trunk it operates the marker release relay MRL over lead "MRL". MRL locks to TC2, opens the battery from the "ST" lead to release the marker connector and marker. MRL opens the circuit to ON but closes a circuit to hold RB. ON opens the circuit to H, DCK and the link hold magnet and opens the "D" lead to prevent the TC1 circuit being broken at the crosspoints. ON also opens the "T" and "R" leads to prevent any breaking of current at the crosspoints on these leads. This might occur on a by-link trunk or on certain prematurely released direct pulsing calls. ON releases ON1 and these relays release most of the operated relays of the register. ON also releases H, TC1, and the operated steering relay which releases MST. The last one of these to release causes release of TC2 which releases MRL and in turn RB and RLK. RB releases the register busy relays of the link and the register can be selected for use on another call.

If the marker encounters trouble and cannot disconnect itself from the register by the regular release path or if the marker is seized as a result of the link release time out it will ground the BT lead, so-called because of its busy tone function in the originating register, to cause operation of the trouble release relay TRL. TRL performs the functions described for the MRL relay and in addition opens the link select and hold magnet circuits. This aids the release of the register in case the control relays of the link have not released. TRL also operates RLK if it is not already operated to aid the release of the register.

MRL may also be operated from TM as a result of a time out or from AC as a result of an abandoned call.

7. REGISTER TIMING CIRCUITS

7.1 General

There are five tube timing circuits in the register. These are listed in the following table which gives the minimum, nominal

and maximum times based on allowable voltage limits and include the time of operation of the timing relay.

Timer	Function	Time in Milliseconds		
		Minimum	Nominal	Maximum
AC	Abandon call	140	190	300
DT	Digit Timing Electron Tube Timer	2800	3600	5400
	Transistor Timer	3200	3500	3400
LR	Link Release	330	420	650
RV	Start dial reversal	140	190	300
TM	Overall (Interdigital) timer			
	Non-overload condition	19600	25000	37000
	Overload condition	4400	5650	400

All tube timing circuits work on the same basic principle. The 130 volt potential is connected to the anode No. 2 and the grounded load relay is connected to the cathode No. 4. No current will flow in this circuit until the tube becomes ionized and when this occurs the voltage drop in the tube is 75 volts nominal, allowing approximately 60 volts for the operation of the relay. The ionization of the tube is controlled by the control anode No. 1 and will occur when this anode reaches 72 volts nominal with respect to terminal No. 4. The voltage at the No. 1 anode is equal to the charge on the timing capacitor and this is controlled by both the value of the capacitor and the value of the charging resistor. Once the tube ionizes the control anode loses control and to de-ionize the tube it is necessary to open the circuit to the No. 2 or the No. 4 terminal or to reduce the voltage between the No. 2 and No. 4 terminal. The life of the tube varies in proportion to the length of time the current flows and for this reason the timers which have a high number of operations lock the relay around the tube and extinguish the tube.

7.2 Abandoned Call

7.21 Direct Pulsing Trunk

When the register is seized ON1 operates and connects the grounded AC relay to

the cathode No. 4 terminal of the AC tube. The AC capacitor, however, does not charge since a discharge path is maintained through the AC2 resistor until the CK relay operates. The break contacts of CK are shorted by make contacts of ACC and ACC will operate before CK operates to maintain the capacitor in a discharged state. After the line reversal start dialing signal is transmitted, the L is under control of the calling office and L controls ACC. During the dialing of each digit L will release to open the circuit to ACC. ACC may or may not release depending on the length of the open pulse but if it does release it will reoperate on the next closure. The time of the timer is such that it will not operate on the longest dial open but will operate if L and ACC remain normal somewhat longer than the time of the longest dial open indicating that the call has been abandoned.

After all the digits have been registered L and ACC will release but TCL will operate to prevent the timer from functioning. If the call is abandoned after TCL operates, the release of TCL will cause operation of the timer.

If the discharge shunt around the AC capacitor is removed for a nominal time of 190 milliseconds the tube ionizes and AC operates. AC operates MRL to cause release of the register. The release of CK will discharge the AC capacitor.

7.22 Bylink Pulsing Trunk

When the register is seized ON1 connects the grounded AC relay to the cathode No. 4 terminal of the AC tubes. At this same time L will operate to operate ACC to close the discharge path on the AC capacitor to prevent its charging. The capacitor is discharged between calls through normal contacts on the BL and CK relays and the operation of BL removes this path. During the dialing of each digit L will release to release ACC but ACC operates during the next dial closure. The time of the timer is such that it will not operate on the longest dial open but will operate if L and ACC remain normal somewhat longer than the time of the longest dial open pulse. For bylink type trunks L and ACC retain supervision even after the operation of TCL.

If the discharge shunt around the AC capacitor is removed for a nominal time of 190 milliseconds the tube ionizes and AC operates. AC operates MRL to cause release of the register.

The bylink lead check relay BLK is also wired to control the discharge path of the AC capacitor as explained under the paragraph on pulsing. On bylink trunks the BLK relay does not remain operated unless there is an open "BL" lead through the link. If BLK does remain operated, it prevents operation of AC to prevent an abandoned call release and allows the LR timer to function to call a marker for the appropriate action.

7.3 Digit Timing

The operation of the digit timing circuit was covered in a paragraph in the section on determination of number of digits to be received.

7.4 Link Release Timer

Since the register link is common to a large number of trunks and to a group of up to ten registers it is important that link troubles be detected as quickly as possible so that remedial action can be taken. Since the link has no common control circuit, timing for the completion of the link functions is done in the register.

The link release timer is started when ON1 operates at the start of the register seizure. ON1 removes the discharge shunt from the LR capacitor and connects the cathode No. 4 of the LR tube to the grounded LR relay. When all the functions of the link are completed the release check relay RLK is operated as described under seizure of register. RLK reconnects the discharge shunt around the LR capacitor thus preventing any further charging and consequently any operation of the LR relay.

In the event there is trouble in the link, RLK will not operate and the timer will function to operate LR. LR locks through the LR resistor to 130 volts dropping the voltage across the tube sufficiently to extinguish it and connects ground to the "D" lead to the link. This ground operates TCL and if the crosspoints have been closed, operates the trunk D relay to establish the trunk transmission condition. TCL operates TC2 which causes the marker connector to establish a connection to a marker. LR also grounds lead "LR" to indicate that the marker seizure is a result of an LR time out. If the DCK relay has operated on the seizure this condition is indicated to the marker by the connection of ground on lead "DCK". If the marker receives ground on this lead and on

the "LR" lead it attempts to set the trunk in a reorder condition. If a trouble record of the condition is caused to be taken by the marker, information as to the link group in trouble is furnished directly to the marker from the register link circuit.

When the marker has made the proper disposition of the call, it usually operates the register trouble release relay TRL although in some cases it may operate the regular release relay MRL. The operation of either TRL or MRL will release the marker and the ON relay followed by the release of all operated relays. RLK is operated by either MRL or TRL to simulate a release check so as to free the link. TRL opens the link select magnet path and the link hold magnet path to cause the early release of these magnets on the majority of the calls when TRL operates.

7.5 Start Dial Reversal

The operation of this timer is covered under the paragraph on start dial signal in the section on seizure of the register.

7.6 Overall Timer TM

This timer serves to prevent any trunk from holding the register out of service for a long period of time. It is recycled on an interdigital basis so as to keep its time reasonably short and yet allow sufficient time for normal functions.

The timer is controlled by the auxiliary timing relay TMA which when operating, removes the discharge shunt from the TM capacitor and connects the grounded TM relay to the TM tube circuit.

TMA operates initially on its primary winding from ON when the register is seized. ON1 operates RAL to energize the secondary winding locking circuit of TMA and to operate TMB. TMB opens the primary winding operating circuit of TMA. When the first open of the first digit occurs, RAL releases and allows TMA and TMB to release in parallel. TMB is a slow release relay and allows time for TMA to release and to discharge the TM capacitor before releasing to reclose the operating circuit for TMA. When TMB releases TMA reoperates to start a new timing cycle. TMB will reoperate at the end of each digit. Thus, the timer is recycled at the start of each digit. When all digits have been received MST operates to release TMA and TMB to cause an additional recycle so that a full timed interval will be allowed for the marker functions and release of the register.

In the event the seizure interval or any of the interdigital intervals exceed the allowable time, the TM relay will operate to operate the reorder relay RO. RO locks and releases TMA and TMB to cause a recycle of the timer and the release of TM. When TM releases with RO operated MST operates to cause connection with a marker. RO will ground the "RO" lead to the marker to indicate that a time out has occurred. RO also removes the ground from the translator and class indications to the marker. MST locks independently of TM and closes a circuit for the reoperation of TMA for timing the register release interval.

In the event the timer functions after MST operates, the operation of TM will cause operation of MRL to effect release of the register.

With TM operated the "LP" lead to the jack, lamp, and key circuit is grounded to cause a lamp individual to the register to be lighted. With TM operated and MB normal a ground is placed on the "ALM" lead to the jack, lamp, and key circuit to start a common timing circuit and if the ground persists for a timed interval an alarm will be brought in.

Provision is made for reducing the timed intervals if an overload condition exists in the incoming register group. A make contact on the RB relay of each register of a group is wired in a chain circuit to cause operation of a register busy relay in the group busy circuit in case all RB relays are operated simultaneously. This circuit then connects ground to the "OVL" lead to all the registers of the group. The group busy circuit is arranged so that the "OVL" lead will remain grounded until a timed interval has elapsed during which no ground was received on the chain lead through the RB relays.

With ground on lead "OVL", relay OVL operates whenever TMB is operated. OVL substitutes the TM4 charging resistor for the TM3 charging resistor to reduce the timed interval. OVL is under control of TMB so that when TMB releases after MST operates the interval for register release will be at the nonreduced rate.

Provision is made for operating a peg count of the number of time-outs occurring before marker start on toll trunks. A momentary ground will be connected to the permanent signal lead "PS" to the traffic register circuit through a front contact of AS as an indication that a time-out occurred with no digits or to the partial

dial lead "PD" to indicate that a time-out occurred after at least one digit was received.

Provision is made for operating a peg count of the number of time-outs including no digit time-outs occurring before marker start on CAMA trunks. A momentary ground will be connected to the partial dial PDL lead if such a time-out occurs.

Under certain dialing interrupter test conditions where the interdigital interval is short, the TMB relay may not have sufficient time to operate so as to cause a recycle of the timer at the start of each digit. Due to this limitation, it may not be possible to test the register during periods of office overload conditions (when the OVL relay in the register is operated) and using a large number of digits with each digit a high number. Under these conditions, the TM timer may function before the entire number is dialed. With the OVL relay unoperated, any number of digits, each of any number may be dialed.

8. CODE TREATMENTS

8.1 General

Provision is made for translation of various toll codes such as 1X1, 1XX, OXX, N1X, NOX, NNO, and 11X or 11XX. In addition, the register is arranged to translate codes such as 411 (home NPA information) and NPA 411 (foreign NPA information). All of these codes may be translated over the toll and CAMA trunk classes. On tandem trunk classes the register will not handle toll codes beginning with the digit "one" since the "one" cannot be registered for the A digit.

The N digit, in general, refers to the numbers 2 to 9 inclusive, and the X digit, in general, refers to the numbers 1 to 0 inclusive.

The numbering plan area (NPA) codes translated by this circuit are of the type N1X, NOX, and NNO. N1X and NOX codes are always considered NPA codes while the NNO codes may be NPA, local, or interchangeable (the same code used for both local and NPA) NPA calls are ten digit calls except for NPA information calls which consist of six digits. Where a zero or one appears in the A digit, the code is considered a nonarea code. These calls may have a variable number of digits up to ten total.

The translator relays of Fig. 9 are provided to detect the various toll codes. Calls over the toll, tandem, and CAMA trunk classes are recognized by the operation of relay TTC.

Many of the operations in connection with these translator relays are under control of cross-connections and reference to the illustrations in the cross-connection section of the schematic drawing will serve as an aid in understanding the various types of control that can be obtained.

8.2 TDL Control Relay

TDL is the control relay of the toll code translator and is operated when certain codes are received to open the local code marker start path and, in some cases, enable the repetitive digit timing feature. These codes include all NPA codes and other toll codes followed by a variable number of digits. TDL also opens the local code operating path of DL.

With TDL provided, the cross-connections involving local codes will be made to the MSTX terminal rather than the MST terminal or to the DLX terminal rather than the DL terminal. These MSTX and DLX terminals are connected to separate back contacts of TDL so that any ground on these terminals with TDL operated is ineffective.

TDL opens the locking circuit of DL and places the operate path of DL under control of RAL to ground at either contacts of the SA1 or SA2 relays or to ground through LAC operated to contacts of the HS relay operated or to contacts of A411 operated.

With TDL operated and DL controlled from ground at the SA1 or SA2 relays, DL will operate through RAL operated at the end of each digit to start digit timing. If a digit is received RAL will release and release DL to recycle the timer. If no digit is received the timer will function and DT will operate to operate MST.

Where interchangeable codes are handled, DL is controlled from ground at the HS contacts through LAC, TDL, and RAL operated. DL is operated at the end of the seventh digit after RAL operates; to start a one digit timing interval. If the timer times out, MST operates to start the marker. If another digit is received, RAL releases, releasing DL to stop the timer. The operation of JS at the end of the H digit and the release of HS on the following digit prevents further operation of DL on succeeding digits. The MST relay is then operated under control of the ten digit cross-connections.

For 411 home NPA information calls over the toll, tandem, and CAMA trunk classes, the second and third digits are detected by the operation of the SB1 and SC1 relays which cause operation of the MST relay to start the marker.

For local codes the TDL will not be operated except in special cases and MST is operated as described in section on determination of the number of digits to be received. In case it is desired that repetitive digit timing be used on local as well as toll codes, TDL will be operated after the registration of the third digit to start the timer. In these cases cross-connections from the TDL terminals associated with the class relays will be made to the TDL terminal which is connected directly to the TDL winding. In other cases cross-connections will be made to the TL terminal which is connected to the winding of the TDL only when certain codes are registered.

The translator lead "LT", "TT", or "X11" is grounded under control of the translator relays and the digit timer.

8.3 Toll Class Operator Codes

These codes consist of the outward or TX operator which may be either 11X or 11XX and inward operator 1X1. The SAO and SA1 relays are associated with corresponding output leads of the A digit register and SAO operates whenever the AO register operates. If the digit is one SA1 operates from the operated A1 register and through contacts of SAO. In a similar manner SB1 operates if a one is registered as the B digit. With both SA1 and SB1 operated a current is closed for operating MST from DS through cross-connections C and TX for 11X codes or from ES through cross-connections D and TX for 11XX codes.

SCO and SC1 provide for recognizing a one as the C digit. With SA1 operated SB1 normal and SC1 operated, indicating a 1X1 toll code, a circuit is provided for operating MST from DS.

8.4 1XX and OXX Codes

These codes are generally assigned for toll line and tributary use but are used for other purposes in some cases. They are usually followed by an indeterminate number of digits. 1XX codes are recognized by SA1 operated and SB1 and SC1 normal. A zero in the A digit is recognized by the operation of SAZ and OXX codes are recognized by the SAZ relay. For either of these conditions the toll code control relay TDL is connected to the TL terminal which will be cross-connected to the TDLT terminal associated with the class relay. This terminal will be grounded on toll class trunks from DS when the third digit is registered.

TDL operates for 1XX or OXX codes to start the repetitive digit timer after the third digit is registered, and MST will be operated as a result of a time out of the timer after the last digit is registered. The ground for controlling the operation of DL through contacts of RAL is supplied by contacts of SA1 or SAZ.

In case these codes are never followed by additional digits provision is made to cause operation of MST from DS through cross-connections X1, X2, and X3 after the registration of the third digit.

8.5 NIX, NOX, and NNO Codes

The NIX and NOX codes are assigned to numbering plan areas and as such represent a series of local codes. The NIX codes are recognized by the SB1 relay which operates for one as the B digit, and NOX codes are recognized by the SB relay which operates for a zero as the B digit. NNO codes may be used for NPAs and are recognized by the SCZ relay which operates for zero as the C digit.

Operation of one of these relays will connect the TDL relay to the TL terminal which is cross-connected to the TDL terminals associated with trunk classes handling such codes. These terminals will be grounded for trunks of the respective class when the third digit is registered to cause operation of TDL.

NNO codes are interchangeable with local codes so that, in certain cases, some assigned local and NPA NNO codes may be the same. In offices where such cases exist, the translator of Fig. 15 must be provided in order to distinguish between those NNO codes assigned to numbering plan areas only, those assigned for local use only, and those assigned to both the local and numbering plan areas.

Relays ATAO, 1, 2, 4, 7, BTAO, 1, 2, 4, 7, and BTB2 of Fig. 15 are used to translate the individual NNO codes. The output of each code is connected to separate cross-connection terminals with each terminal bearing a designation identifying the code. Relay LAC is used for codes assigned for local and area use and relay NPA is used for codes assigned for area only.

When an NNO code is received, the operation of SCZ will cause operation of the TDL relay. If Fig. 15 is provided, and the NNO code is interchangeable or NPA relay LAC or NPA will also be operated and

contacts of either relay included in the operate path of TDL. For interchangeable NNO codes with LAC operated a timing interval is started after the seventh digit is received. If the timer times out the code is considered seven digits. If another digit is received the code is considered NPA or 10 digits.

8.6 NPA 411 Code

This code identifies an information code for a numbering plan area and relay A411 is provided to recognize when such a code is received. Contacts of the D, E, and F digit registers are arranged in series to form an operate path for the A411 relay when the digits 411 are registered, respectively in those registers. This operate path also includes contacts of the MST1 relay and contacts of other relays associated with the identification of NPA codes.

With A411 operated and with the first three digits identified as an NPA code, MST is operated to start the marker. MST operates the trunk D relay followed by TC1 and TC2. TC1 operates MST1 to open the operating path of A411 and to reconnect the individual grounds to the digit register output leads.

With A411 operated and with the first three digits identified as an interchangeable code by LAC operated, the DL relay is operated through TDL and RAL operated. DL locks and starts a digit timing interval. If no additional digit is received DT operates to operate MST to start the marker. If another

digit is received RAL will release and cause immediate operation of DT. DT locks. When RAL operates at the end of the digit, MST operates to start the marker. At the end of the seventh digit HS operates and releases A411 to ground the LT translator lead for a non area code.

8.7 Summary of Codes

The following tables list the different types of codes that are possible over toll, tandem, and CAMA class trunks. Local office codes are listed as ABX but might be AB or A. Where "4 or 5" appears under number of additional digits, it means that the register can be arranged to cause marker start after a predetermined number of digits, usually four, or after the predetermined number of digits plus one station digit. If the station digit is dialed, the marker will be started immediately but if it is not dialed the marker will be started after the interval timed by the digit timer. Where a "0 to 5" or "0 to 7" appears under number of additional digits it means that the marker start is under control of the repetitive digit timer started after the third digit is registered. In these cases the marker will be started by the timer after dialing has stopped except where a full complement of digits is registered in which case the register can be arranged to cause marker start immediately. Where "7" appears under number of additional digits, it means that the register can be arranged to require 7 additional digits before marker start. Where all calls require exactly 7 digits, the digit timer is not used.

REGISTER NOT EQUIPPED FOR INTERCHANGEABLE NOR NPA INFORMATION CODES

Toll Class Codes

Register Class Relay	Type of Code	Number of Additional Digits	Translator Lead to Marker	Class Lead to Marker
TOL	Local (A= $\frac{9}{2}$) (B= $\frac{9}{2}$) (C= $\frac{0}{1}$)	4 or 5 or 0 to 5	TT	TOL, TCA
TOL	Outward Operator 11(C= $\frac{9}{1}$) or 11(C= $\frac{9}{1}$) (D= $\frac{0}{1}$)	0	TT	TOL, TCA
TOL	Inward Operator 1(B= $\frac{0}{2}$)1	0	TT	TOL, TCA
TOL	Toll Line and Trib. 1(B= $\frac{0}{2}$)(C= $\frac{0}{2}$) and 0(B= $\frac{0}{1}$) (C= $\frac{0}{1}$)	0 or 0 to 7	TT	TOL, TCA
TOL	Area (A= $\frac{9}{2}$)1(C= $\frac{0}{2}$) or (A= $\frac{9}{2}$)0(C= $\frac{0}{1}$)	0 to 7 7	TT	TOL, TCA

Tandem Class Codes

TAN*	{ Local (A= $\frac{9}{2}$) (B= $\frac{9}{2}$) (C= $\frac{0}{1}$)	4 or 5 or 0 to 5	LT	TAN, TCA
TAN1)* TAN2} TAN3} TAN4	{ Service (A= $\frac{9}{2}$)11 and Area (A= $\frac{9}{2}$)1(C= $\frac{0}{2}$) and (A= $\frac{9}{2}$)0(C= $\frac{0}{1}$)	0 0 to 7 or 7	LT TT	*{TAN1, TCA {TAN2, TCA {TAN3, TCA {TAN4, TCA
	{ One-One Prefix Area 11(A= $\frac{9}{2}$) (B= $\frac{9}{2}$)(C= $\frac{0}{1}$)	4 or 5 or 0 to 5	11	
	{ Five Digit (A= $\frac{0}{1}$)	4 or 5 or 2 to 5	FVD	
	{ Six Digit (A= $\frac{9}{2}$) (B= $\frac{0}{1}$)	4 or 5 or 1 to 5	2DT	

*TAN is always used with the LT translator but TAN1 to TAN4 may be used for any translator and any TAN class lead.

REGISTER EQUIPPED FOR INTERCHANGEABLE AND NPA INFORMATION CODES

Toll, Tandem, and CAMA Class NPA Codes

<u>Register Class Relay</u>	<u>Class Lead to Marker</u>	<u>Code</u>	<u>Number of Additional Digits</u>	<u>Translator Lead to Marker</u>
TOL	TOL, TCA	Any Local Code	4	LT
TAN	TAN, TCA	$(A=\frac{9}{2}) 0 (C=\frac{9}{2})$	7	TT
TAN1	TAN1-4, TCA	$(A=\frac{9}{2}) 1 (C=\frac{9}{2})$	7	TT
TAN2	TAN1-4, TCA	$(A=\frac{9}{2}) (B=\frac{9}{2}) 0$	4 or 7	LT or TT
TAN3	TAN1-4, TCA	Any NPA Code	+ "411"	X11
TAN4	TAN1-4, TCA	$1 (B=\frac{0}{2}) (C=\frac{0}{2})$	0-7	LT
CAMAO	INC, TCB	$0 (B=\frac{0}{2}) (C=\frac{0}{2})$	0-7	LT
CAMA1	PCR, TCB	$1 (B=\frac{9}{2}) 1$	0	LT
		$(A=\frac{0}{2}) 1 1$	0	LT
		$1 1 (C=\frac{0}{1})$ or	0	LT
		$1 1 (C=\frac{0}{1})(D=\frac{0}{1})$		

TAN trunks will not accept a "one" as the A digit.
 TAN1-4 trunks may not accept a "one" as the A digit depending on the cross-connections at terminals.

9. MAINTENANCE FEATURES

9.1 Register Make Busy

An individual jack per register is provided at the master test frame for making the register busy. If a make busy plug is inserted in this jack the MB relay operates. MB operates RB which operates register busy relays in the associated link trunk groups to make the register busy to these trunks. If MB is operated during a call it holds the RB relay at the completion of the call. MB also opens the "ALM" lead to prevent or restore the office alarm.

9.2 Trunk Test Calls

One of the test made on the associated incoming trunks requires that the marker be selected without the necessity of dialing the number of a test line. To

accomplish this the "D" lead to the register is grounded at the time the trunk seizes the register. This ground operates TC1 which operates TC2. TC2 operated causes a marker to be selected. Since MST does not operate, ground from its back contact is connected to the "TST" lead to indicate to the marker that it is a test call and the marker should select the master test control circuit to obtain information for completing the call. To prevent registration of any digits TC2 opens the pulse counting circuit at the front contact No. 2 of the L relay. TC2 is locked to H so that if a test call is abandoned the register will not release from the marker prematurely.

9.3 Connections to Incoming Register Test Circuit

The incoming register test circuit is used for selecting and testing an incoming register. The register is associated with

the incoming register test circuit by the M relay of Fig. 11. When a register is to be tested a ground is connected to the "M" lead by the register test circuit. This operates the M relay which locks to the "ML" lead. The M relay operates the MB relay to cause the register to appear busy to service calls but permits access to the register test circuit. The function of the leads which the M relay connects to the incoming register test circuit is as follows:

- MON Indicates the marker when the call is a test call.
- H Indicates to the incoming register test circuit that the register is off-normal and is also used to hold the register under certain conditions.
- DPG Indicates to the incoming register that a direct pulsing type of trunk is simulated in the register test circuit.
- BLG Indicates to the incoming register that a bylink pulsing type of trunk is simulated in the register test circuit.
- RP Provides a means by which the incoming register test circuit can gain access to the register through the register link.

9.4 Connection to the Automatic Monitor, Register and Sender Test Circuit

The automatic monitor, register and sender test circuit, abbreviated monitor, when provided is used to monitor on service calls incoming to the register and to initiate test calls to the register. The test function of the circuit checks the call to determine that it is completed satisfactorily. The monitor function of the circuit checks the pulsed number independently and compares it with that received by the register. The register is associated with the monitor by the M relay of Fig. 10. The monitor in combination with the register link associates the register with the monitor by grounding the "M" lead to cause operation of the M relay. The M relay receives its battery from the monitor over lead "BS". For monitoring purposes the monitor is equipped with an electronic dial pulse amplifier which monitors the pulsing over the tip and ring leads through the M relay and the tone coil is provided even though no trunks require dial tone to provide sufficient voltage to function the amplifier.

For test calls this amplifier is not used and a check is made of the number received by the marker with that dialed to the register. The functions of the leads which the M relay closes between the register and the automatic monitor, register and test circuit are as follows:

- T R Connect the monitor circuit to the tip and ring leads of the register so that a check of the number dialed can be made on monitored calls.
- RG FR CN Indicate the position of the register in its marker connector, the frame on which the marker connector is located and the position of the marker connector on that frame, respectively.
- MON Indicates to the marker that the call is a monitored or test call.
- TAN Indicates to the monitor circuit that it is a tandem class call with transmission of the full local office code for the area.
- MST Indicates to the monitor circuit that the register is selecting a marker.
- H Indicates to the monitor circuit that the register is off-normal and is also used to hold the register under certain conditions of failure to check.
- SP Indicates to the monitor circuit that the register has given the distant end the "start pulsing" signal.
- DPG Indicates to the monitor circuit that a direct pulsing type trunk is connected to the register.
- BLG Indicates to the monitor circuit that a bylink pulsing type of trunk is connected to the register.
- MB Enables the monitor circuit to make the register appear busy to service calls.

9.5 Connections to the Traffic Usage Recorder Circuit

The traffic usage recorder circuit is used for measuring the time in use of the various circuits of the office.

The register busy lead "RB" is connected to the winding of the RB relay and is grounded whenever the register is busy in service, by test or made busy.

The register busy for maintenance lead "RBM" is connected to the winding of the MB relay and is grounded whenever the register is made busy. This lead is also grounded whenever the circuit is being monitored or tested.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

1.1 The use of this circuit is limited as to the loop toward the originating end by the operating limits of the L relay. The operating limits of this relay are as follows:

<u>PPS</u>	<u>Max. Ext Ckt Loop</u>	<u>Max. Trk Cond Res</u>	<u>Max. Cable Mileage</u>	<u>Allowable Bridge Cap.</u>	<u>Minimum Ins Res</u>	<u>See Note</u>
10-20	4500 ohms	4200 ohms	42	0	30,000 ohms	2
10-20	4500 ohms	4200 ohms	42	2 UF	30,000 ohms	1,3 and 7
10-20	4500 ohms	3800 ohms	32	2 UF	30,000 ohms	4 and 7
10-20	2400 ohms	1800 ohms	20	2 UF	30,000 ohms	6 and 7
10	4500 ohms	3800 ohms	32	2 UF	30,000 ohms	5 and 7
10	4500 ohms	3900 ohms	35	0	30,000 ohms	3

NOTES

1. Source of Pulses - Dial or equivalent from DSA boards using SP R13 or DL E330 cord relay and equipped with a cord test set circuit with a false pulse generation test loop resistance of 2800 ohms.
2. Source of Pulses - Dial or from S522 repeater relay or equivalent.
Holding bridge - 54AB inductor in series with 206 FF relay or equivalent.
3. Source of Pulses - Dial or equivalent.
Holding bridge - noninductive resistance of 300 ohms or less or polar relays with no inductors.
4. Source of Pulses - Dial or equivalent.
Holding bridge - 54H inductor (windings in series) in series with 206C relay or equivalent.
5. Source of Pulses - Any repeater relay used in existing subscriber switchboard No. 1, or equivalent relay.
Holding bridge - 54C inductor in series with 206C relay or equivalent, for use in switchboard No. 1 only.
6. Source of Pulses - Dial or equivalent from DSA boards equipped with SP R183 or DL E330 cord relay.
7. Bridged capacity must be a capacitor of 2 UF or less in series with noninductive resistance. Bridged capacity of 2 UF to be used only with 10 PPS dials.
8. Source of Pulses - UA37 repeater relay with 1 UF in series with 160 ohms around its winding, receiving 9 minimum to 11 maximum pulses per second with 41 to 72% break from CX or SX signaling circuit.

1.2 Maximum resistance in the "D" lead from incoming register to incoming trunk - 10 ohms.

Relays

Functional Meaning

11A

ONE-ONE PREFIX (Foreign Area Directing Code)

2. FUNCTIONAL DESIGNATIONS

The functional meanings of the designations of the operating elements of the register are given in the following list:

2
A₅

A Digit Register

A411

Area Information Code

<u>Relays</u>	<u>Functional Meaning</u>	<u>Relays</u>	<u>Functional Meaning</u>
ATA $\frac{2}{5}$	A Digit Translation	FS	F Digit Steering
BTA $\frac{2}{5}$	B Digit Translation	G $\frac{2}{5}$	G Digit Register
BTB2	B Digit Translation Auxiliary	GS	G Digit Steering
AB	(Trunk Completing to) A and B Offices	H	Hold Magnet
AC	Abandoned Call	H $\frac{2}{5}$	H Digit Register
ACC	Abandoned Call Control	HS	H Digit Steering
AS	A Digit Steering	J $\frac{2}{5}$	J Digit Register
B $\frac{2}{5}$	B Digit Register	JS	J Digit Steering
BL	By-Link	K $\frac{2}{5}$	K Digit Register
BLK	BL Lead Check (on By-Link Trunk)	KS	K Digit Steering
BS	B Digit Steering	L	Line
C $\frac{2}{5}$	C Digit Register	L $\frac{2}{5}$	L Digit Register
CAMA0, CAMA1	CAMA Class Trunks	LAC	Local or Area NNO Code
CK	Class Check	LR	Link Release (trouble)
CL1	Class-Dial Tone	LS	L Digit Steering
CLS, CLS1	Class-Special Marker	LT 0-9	Link Tens (trunk location on register link)
CLT	Class Transfer	LU $\frac{2}{5}$	Link Units (trunk location on register link)
CS	C Digit Steering	LUT	Link Units Transfer
D $\frac{2}{5}$	D Digit Register	M	Monitor or Test
DCK	Double Connection Check	MB	Make Busy
DL	Digit Delay (Await additional digit or digits)	MRL	Marker Release
DP	Direct Pulsing (trunk)	MST, MST1	Marker Start
DS	Digit Steering	NPA	Numbering Plan Area
DT	Digit Timing	NTAN	Non Tandem Trunk
E $\frac{2}{5}$	E Digit Register	OA	(Trunk Completing to) Office A
ES	E Digit Steering	OB	(Trunk Completing to) Office B
F $\frac{2}{5}$	F Digit Register	ON, ON1	Off Normal
FGO, 1, 2	Frame Group (tens)	OVL	Overload (condition present on incoming register group)
		P1-5, P2A	Pulse Counting

<u>Relays</u>	<u>Functional Meaning</u>	<u>Tubes</u>	
RA, RA1	Register Advance	AC	Abandoned Call Timer
RB	Register Busy	DT	Digit Timer
REG	Regular or Basic (trunk location on register link)	LR	Link Release Timer
RLK	Release Link Check	RV	Reversal Timer
RO	Reorder	TM	Register Timer
RV, RV1	Reversal (of tip and ring polarity)		
SA0, 1	Service (treatment for) A Digit One		
SA4, SAZ	Service (treatment for) A Digit Zero		
SBO, SBI	Service (treatment for) B Digit One		
SB4, SBZ	Service (treatment for) B Digit Zero		
SCO, SC1	Service (treatment for) C Digit One.		
SC4, SCZ	Service (treatment for) C Digit Zero		
SUP	Supplementary (trunk location on register link)		
TA ₂ ₅	Translator for A Digit		
TAA, TAB	Translator for A Digit Cut-In		
TAN, TAN1-4	Tandem Class Trunks		
TB ₂ ₅	Translator for B Digit		
TBA, TBB, TBC	Translator for B Digit Cut-In		
TC1, TC2	Trunk Cut-Through on Completion		
TDL	Toll Code Digit Control		
TF ₂ ₅	Trunk Link Frame Units		
TFT	Trunk Frame Units Transfer		
TM	Time Measure		
TMA, TMB	Time Measure Auxiliary		
TOL, TOL1-4	Toll Class Trunks		
TRL	Trouble Release		

3. FUNCTIONS

The register is designed to perform the following functions:

- 3.01 To make itself busy while handling a service connection or while made busy by a plug into the associated make busy jack.
- 3.02 When seized by the control relays of the incoming register link circuit.
 - 3.021 To establish a connection to the trunk through the link switch.
 - 3.022 To check for a double connection at the link switch.
 - 3.023 To lock the trunk to the register through the control relays and through the link switch.
 - 3.024 To prepare the register for functioning with either bylink pulsing trunks or direct pulsing trunks as indicated by a signal from the link trunk group.
 - 3.025 To record the number of the trunk link frame on which the trunk appears.
 - 3.026 To record the trunk location for trunks with line link appearances.
 - 3.027 To record information peculiar to the trunk such as number of digits to be received, local, toll, tandem, or CAMA class.
 - 3.028 On connections to direct pulsing trunks, to operate and check for the operation of the cutoff relay which opens the start lead and prepares the trunk to receive pulses.
 - 3.029 To release the control relays of the link when the above functions have been completed.
- 3.03 To time for the completion of the link functions and if they are not completed within a certain interval, to

call a completing marker for the proper disposition of the call and to indicate the nature of the trouble to the marker.

- 3.04 To furnish dial tone to trunks requiring it.
- 3.05 To reverse the polarity on the tip and ring toward a direct pulsing trunk as an indication that the register is prepared to receive pulses.
- 3.06 To count the number of dial pulses in each digit.
- 3.07 To register this count on a digit register on a two-out-of-five basis.
- 3.08 To steer each digit count to the digit register corresponding to the digit being received.
- 3.09 To register the initial 11 of a one-one foreign area directing code over tandem trunks on a prefix counter instead of on the regular A digit register.
- 3.10 To determine when all digits have been received:
- 3.101 By an indication received from the trunk class relay in the link circuit.
- 3.102 By timing for additional digits to be dialed.
- 3.103 By distinguishing between tandem codes preceded by the 11 prefix and tandem codes not preceded by the 11 prefix.
- 3.104 By recognizing 1X1 and 11X or 11XX codes over intertoll trunks.
- 3.105 By recognizing NLX, NOX, and NNO codes over tandem, CAMA and intertoll trunks.
- 3.106 By recognizing 1XX and OXX codes over intertoll trunks.
- 3.107 By translating the A code digit.
- 3.108 By translating the A and B code digits.
- 3.109 By registering the last equipped digit.
- 3.11 To ground, as an end signal, the "-7" lead to the completing marker of the next digit beyond the final digit received on a call.

- 3.12 To select a completing marker when the required number of digits has been received.
- 3.13 To establish the transmission condition in the trunk when all digits have been registered.
- 3.14 To prevent the register from responding to extra digits.
- 3.15 To furnish the completing marker with such registered information as is necessary for it to complete the call.
- 3.16 To recognize an abandoned call by the subscriber and to restore the register to normal under this condition.
- 3.17 To provide a regular and an alternate release circuit by which the completing marker can release itself from the register.
- 3.18 To restore the register to normal when the release signal is received from the marker.
- 3.19 To time for undue delays during each stage of the call.
- 3.20 To select a marker and request a re-order signal for the trunk if the register times out.
- 3.21 To recognize a test call on a trunk and immediately select a marker indicating to the marker that it is a trunk test call.
- 3.22 To provide means whereby the automatic monitor, register and sender test circuit or the incoming register test circuit can connect to the register.
- 3.23 To provide peg count and all register busy indications.
- 3.24 To shorten the interdigital timing interval when all registers are busy.
- 3.25 To provide for operating intertoll trunk partial dial and permanent signal peg count registers.
- 3.26 To provide for registering up to five tandem and five toll classes to enable the marker to screen or restrict calls on certain trunk groups.
- 3.27 To provide for functioning with up to four digit terminating class trunks.

- 3.28 To provide for functioning with up to 4 five digit terminating class trunks.
- 3.29 To provide for functioning with terminating or nontandem class trunks which transmit two digits of 3 digit home area office codes or which transmit the full home area office code.
- 3.30 To provide for operation with the Traffic Usage Recorder Circuit.
- 3.31 To translate NPA codes of the type NIX, NOX, and NNO.
- 3.311 To detect the code NPA-411 as an area information code.
- 3.312 To recognize all codes with 0 or 1 in the A position as nonarea codes.
- 3.313 To distinguish between NNO codes assigned for NPA only, local only, or for both NPA and local use.

4. CONNECTING CIRCUITS

When this circuit is listed on a key-sheet, the information thereon is to be followed.

This circuit will function with the following crossbar system circuits.

- 4.01 SD-26048-01, SD-255 5-01 - Register Link Circuit with Bylink Operation.
- 4.02 SD-25762-01 - Master Test Frame, Jack, Lamp, and Key Circuit.
- 4.03 SD-255 6-01 - Marker Connector.
SD-26026-01 - Incoming Register Marker Connector Register Part.
SD-26029-01 - Preference Control Circuit for Marker Connectors.
SD-26025-01 - Incoming Register Marker Connector - Marker Part.
- 4.04 SD-25680-01 - Automatic Monitor Register, and Sender Test Circuit.
- 4.05 SD-25672-01 - Traffic Register Circuit.
- 4.06 SD-25805-01 - Master Test Frame Connector Circuit.
- 4.07 SD-25795-01 - Group Busy Circuit for Originating and Incoming Registers.
- 4.08 SD-26077-01, SD-25581-01 - Incoming Trunk Circuit from SXS Office - Bylink.

- 4.09 SD-26070-01, SD-25583-01 - Incoming Trunk Circuit - Direct Pulsing (Typical).
- 4.10 SD-809 9-01 - Signaling Circuit - Tone Supply.
- 4.11 SD-259 8-01 - Incoming Register Test Circuit.
- 4.12 SD-26050-01, SD-25579-01 - (Typical) Outgoing Sender Circuit - Dial Pulse.
- 4.13 SD-26002-01, SD-25550-01 - Completing Marker Circuit.
- 4.14 SD-9573 -01 - Traffic Usage Recorder Circuit.
- 4.15 SD-27633-01 - Office Test Frame Test Circuit.
- 4.16 SD-94 20-01 - Time Delay Control Circuit.

5. MANUFACTURING TEST REQUIREMENTS

- 5.1 The incoming register shall be capable of performing all the service functions specified in this circuit description and meeting all the requirements of the circuit requirements table and also shall be capable of functioning under test conditions listed below.
- 5.2 The pulsing and counting functions of the register shall be checked with the following conditions.
 - 5.21 A precision pulse generating circuit such as SD-25680-0114 (or equivalent) capable of generating dial pulses within the limits of accuracy given by Fig. 6 in information Note 304 in the SD.
 - 5.22 Trunk loop circuits (or equivalent) as shown by Fig. 7 in information Note 304 in the SD.
- 5.3 Nominal circuit conditions may be employed in these tests except as specified in the following paragraphs.
- 5.31 The pulsing and counting features of the register circuit under test shall be checked using the pulsing loop and leak condition covered by the Fig. 6 and 7 for at least 4 digits; two digits or less than 5 pulses, preferably ones or twos, followed by two digits of more than 5 pulses, preferably nines or zeros, shall be dialed under each condition and all digits dialed shall be correctly registered.

5.32 The test circuit shall provide an interdigital interval of 133 ± 13 milliseconds for the pulsing conditions covered in Fig. 6-D. For other pulsing conditions this time may be exceeded.

5.4 Under certain dialing interrupter test conditions where the interdigital interval is short, the TMB relay may not have sufficient time to operate so as to cause a recycle of the TM timer at the start of each digit. Due to this limitation, it may not be possible to test the register with the overload timing relay OVL operated and using a large number of digits, each with a high number. Under these conditions, the TM timer may function before the entire number is dialed. With the OVL relay unoperated, any number of digits, each of any number may be dialed.

6. TAKING EQUIPMENT OUT OF SERVICE

6.1 Method of Taking Equipment Out of Service

In order to take the register circuit or any of its associated apparatus out of service insert a No. 322A plug in the associated Incoming Register Make Busy Jack IRMB at the jack bay of the Master Test Frame.

6.2 General Precautions to be Followed when Working on the Apparatus

When working on the apparatus, the register should be made busy by inserting a No. 322A plug in the associated IRMB jack at the master test frame. No further precautions are necessary unless otherwise specified in the circuit requirements table.

7. ALARM INFORMATION

7.1 Time Out Alarm

7.11 Condition

If a dial pulse incoming register encounters a delay in the progress of a call, the register timing circuit will operate

and attempt to release the register as described under overall timing.

7.12 Indication

If the register releases satisfactorily the only indication of the condition will be the momentary lighting of the time out lamp TO for the register on the master test frame. Should the register fail to release, the TO lamp will remain lighted and the common alarm timing circuit will begin to function and, after 10 to 15 seconds, operate the major alarm and light the register and sender time out lamp R-S TOA.

7.13 Action Required

If in response to a major alarm a lighted TO lamp is found, insert a No. 322A plug in the Incoming Register Make Busy Jack IRMB associated with the TO lamp to silence the alarm and remove the register from service.

7.2 Link Release Trouble

In addition to the time out feature covered under alarm information there are also link release and double connection checking features provided to check that the link functions are completed in the allotted time and that there are no double connections on the link path. The operation of this timing circuit causes the seizure of a completing marker for appropriate action which may result in a trouble recorder alarm. The marker then causes release of the register. The procedure to be followed in response to the trouble recorder alarms which may result from the operation of this timing circuit is covered in Section A374.636 trouble recorder alarm routine No. 5 crossbar offices.

7.3 Fuse Alarm

If in response to a major alarm an FA lamp is lighted at an incoming register frame, it is an indication that a fuse has operated at the associated frame.

Replace the operated fuse to restore the alarm and extinguish the FA lamp.

SECTION IV - REASONS FOR REISSUE

CHANGES

A. Changed and Added Functions

A.1 Provision is made for operation with numbering plan area (NPA) codes. With this feature, the register will translate N11 local information codes, NPA411 area information codes, and NNO codes assigned for NPA only, local only, or both NPA and local use.

A.2 The interdigital electron tube timing circuit (DT) is superseded by a transistor timing circuit (DT) to provide closer timing tolerances.

B. Changes in Apparatus

B.1 The following apparatus changes are required to provide for operation with the numbering plan area feature.

Relays

Superseded

SAZ - AF59 -
Option "YK"

SB1 - AF115 -
Option "YK"

SBZ - AF59 -
Option "YK"

SC1 - AF15 -
Option "YK"

Superseded By

SAZ - 1/2 AK4 -
Option "YL"

SB1 - 1/2 AK4 -
Option "YL"

SBZ - 1/2 AK4 -
Option "YL"

SC1 - 1/2 AK4 -
Option "YL"

Added

A411	- AJ15	- Option "ZZ"
ATAO, 1	- AK4	- Fig. 15
ATA2, 4	- AK4	- Fig. 15
ATA7	- 1/2AK4	- Fig. 15
BTAO,1,2,4,7	- (5)AJ202	- Fig. 15
BTB2	- AF83	Fig. 15
LAC	- 1/2AK13	- Fig. 15
MST1	- AF100	- Option "ZZ"
NPA	- 1/2AK13	- Fig. 15
SC4	- 1/2AK4	- Option "ZY"
SCZ	- 1/2AK4	- Option "ZY"
TTC	- 1/2AK30	- Option "ZX"

Networks

(22) 185A - 1 for each relay added above.

B.2 The following apparatus changes are required to replace the DT electron tube digit timing circuit with a transistor timing circuit.

Superseded

DT - 4390A -
Option "YB"

DT1 - KS-13368,
L3 - 1000 uuf -
Option "YB"

Superseded By

DT - (2)4370A -
Option "YC"

Capacitors

Electron Tube

DT - 313CC -Option "YB"

Resistors

DT1 - KS-13490, L3 -
0.1 meg. - Option "YB"

DT2 - KS-13490, L3 -
1K - Option "YB"

DT3 - 145A - 2.21 meg. - DT3 - 221A - 569K -
Option "YB" Option "YC"

DT4 - KS-13492, L2 - DT4 - 14AF -
12K - Option "YB" Option "YC"

Relay

DT - AF67 - Option "YB" DT - AJ3 - Option
"YC"

D. Description of Changes

D.1 The register is arranged to handle numbering plan area (NPA) codes of the type NNO, in addition to NIX and NOX area codes over toll, tandem, and CAMA trunks. Provision is also made to handle codes such as 411 (home NPA information) and NPA 411 (foreign NPA information) and to distinguish between NNO codes assigned for NPA only, local only, or interchangeable (both NPA and local) use.

For this feature, relay TTC is provided to recognize calls received over toll, tandem, or CAMA trunks, and relays SC4 and SCZ are provided to detect the digit zero as the C digit. In addition, relays A411 and MST1 are provided for translation of NPA information codes, and the relays of Fig. 15 are provided for translation of NNO codes where these codes are used on an interchangeable basis. Option "ZX" replacing

ZW, and options "XY", "ZZ", and Fig. 15, all rated feature standard, are required in providing these relays.

This feature also involves a code change of the SAZ, SB1, SBZ, and SCl toll code translator relays to provide more contacts, and certain wiring options designated "YE" and "YJ", must replace wiring options "YD" and "YH", respectively. Options "YJ" and "YH" are rated feature Standard, option "YE" is rated Standard for all future jobs, and option "YD" is rated "Mfr Disc.". In addition, the DT transistor timing circuit described in paragraph D.2 must also be provided for this feature.

D.2 The DT electron tube digit timing circuit is replaced by a transistor timing circuit to provide closer timing tolerances during interdigital intervals. The new timing interval is 3.2 seconds minimum, 3.5 seconds nominal, and 3.8 seconds maximum, replacing the former timing interval of 2.8 seconds minimum, 3.6 seconds nominal, and 5.4 seconds maximum.

The new DT timing circuit is assigned option "YC", and rated standard for all future jobs. This circuit must also be provided when the register is arranged for operation with the NPA features. The former DT timing circuit is designated option "YB", and rated "Mfr Disc.". This involves the apparatus changes shown in paragraph B.2.

D.3 The KS-19150-52 group and the KS-13490-92 group of resistors are similar but the KS-19150-52 group is preferred and is, therefore, replacing the KS-13490-92 group in all No. 5 crossbar circuits. This involves a code change of all KS-13490-92 resistors used in this circuit. Since the resistors are physically similar and the code is not marked on the apparatus, this change is made on a no record basis.

D.4 Circuit Note 109 is modified to include the use of option "A" where markers are arranged to handle interchangeable codes.

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