

DETAILED CIRCUIT OPERATION
 CALL FROM AN OUTWARD SWITCHBOARD TO A SXS SUBSCRIBER
 OVER AN INTERTOLL TRUNK WITH CX SIGNALING
 VIA A NO. 4A TOLL OFFICE - 3-DIGIT TRANSLATION
 NO. 4A TOLL SWITCHING OFFICES

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		1.01 This section is one of a group of sections, all having the base number A828.121. These sections describe the detailed circuit operations of the No. 4A Toll Switching System.	
		1.02 The circuit operations described in this section cover a toll call from a subscriber in the local area of Newark, N. J. to a subscriber in Cape May, N. J. which is in the same basic numbering plan area. The calling subscriber reaches a Newark toll operator by dialing 211. The operator determines the called subscriber's national number (CA3-2346), and then originates the call to the called subscriber. The call is switched through the Newark 4A office to an intertoll selector at Wildwood via an intertoll trunk. Then the call is completed to the Cape May 3 step-by-step office as shown on Fig. 1. Since the call is originated and completed within the same numbering plan area, 3-digit translation is used. Section A828.101.2 gives a general description of this call. Also, SC 127-1 shows the key relays which operate on this call.	

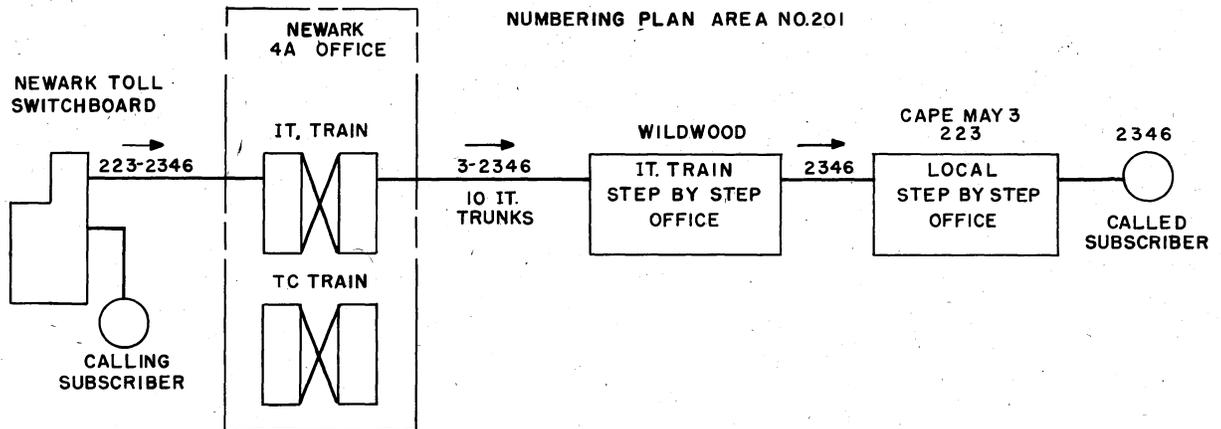


FIG.1- 3-DIGIT TRANSLATION CALL

1.03 In describing the circuit operations, the outward switchboard is assumed to be equipped with dials and toll tandem trunks to the Newark 4A toll switching office. The Newark 4A office is a 2-train office. The toll tandem trunks designated intertoll at the switchboard are terminated only on the intertoll train while those designated toll-completing are terminated only on the toll-completing train.

1.04 The description of the circuit operations is presented in the following order:

(a) Connecting Toll Tandem Trunk to a DP Incoming Sender. The operator selects an idle intertoll toll-tandem trunk, that is terminated on a primary switch of an incoming sender link frame. Through the use of a controller connector and a link controller the toll tandem trunk is connected to an incoming dial pulse sender terminated on a secondary switch of the sender link frame. The DP lamp of the switchboard cord is lighted when the sender is attached to the trunk. This gives the operator a start dialing signal. The operator then dials the three digits of the national office code (CA3) and the four numerals of the subscriber number (2346).

(b) DP Incoming Sender - Impulsing. The dial pulse incoming sender counts the pulses and records the digits as received from the operator's dial. This is also called impulsing.

(c) Decoder Connector Operations. When the first three digits dialed by the operator have been recorded in the incoming sender, the sender directs the decoder connector to connect a decoder to the sender.

(d) Decoder Operations. The first three digits (223) recorded in the sender are transferred to the decoder. The decoder then connects to its home card translator where a card associated with the three digits is dropped and read. The card translator sends the card information to the decoder.

(e) Marker Connector Operations. On this call the decoder connects to a marker connector which seizes an intertoll marker.

(f) Marker Operations. The marker receives information from the card through the decoder. The marker selects an idle outgoing trunk to the proper destination and establishes a connection between it and the incoming trunk. The marker also transfers information about outpulsing to the incoming sender.

(g) DP Incoming Sender - Outpulsing. When the outgoing trunk has been connected to the incoming trunk the sender outpulses the correct digits (3-2346) to the Wildwood office. The 3 is used by an intertoll selector at the Wildwood office to select a trunk to the Cape May 3 office. Then the 2346 digits are passed on to the Cape May 3 office to complete the call to the distant subscriber.

(h) Supervision. The 4A toll system is arranged to operate with both loop, CX (composite) and SF (single frequency) signaling. For this call, CX signaling is used between the Newark 4A office and the Wildwood office.

2. CONNECTING TOLL TANDEM TRUNK TO A DP INCOMING SENDER

(A) Equipment Arrangement

2.01 Before the operator can be given a start dial signal, the toll tandem trunk must be connected to a dial pulse incoming sender at the Newark 4A office. The functions of the frames used in connecting the trunk to the sender are briefly described below.

(a) The incoming sender link frame consists of primary and secondary crossbar switches and two groups of connector relays. The connection between the trunk and a sender is established through the switch crosspoints on the sender link frame.

(b) The link controller and connector frame consists of two link controllers and two controller connectors. A link controller is used to test and select an idle sender and to cause the crosspoints on the sender link frame to operate, thus connecting the selected sender to the trunk. A relatively small group of link controllers commonly serve a large number of sender link frames. A group of connector relays on a sender link frame and a controller connector are used to interconnect the sender link frame and a link controller.

2.02 Eight primary and eight secondary crossbar switches are mounted on each incoming sender link frame. Certain control leads of 100 trunks (toll tandem, incoming intertoll, two-way intertoll or any combination of them) are terminated on the horizontal levels of the primary switches. Leads from 40 dial pulse or multifrequency senders are terminated on the horizontal levels of the secondary switches. Only one type of sender is terminated on any one sender link frame; therefore, all trunks appearing on that frame are of the type that require that particular type of sender.

2.03 Forty links are provided between the verticals of the primary and the verticals of the secondary switches to connect the senders to the trunks. The linkage is explained in Function of Principal Equipment Elements in Section A828.101.1.

2.04 As mentioned above, the sender link frame must be connected to a controller through multicontact connector relays mounted on the sender link frame and a controller connector. Fig. 2, attached, illustrates this arrangement. On this figure the multicontact relays designated FCO-9 and 1st CA, CB, CC may be referred to as the first (sender link) connector and the relays designated SCO-9 and 2nd CA, CB, CC may be referred to as the second (sender link) connector. Note that the connectors referred to here are part of the sender link and connector circuit and are not considered separate circuits like the controller connectors.

2.05 Each sender link frame has access to two controller connectors on an alternating preference basis. (See Fig. 3.) Connection is made to one controller connector through an FC- relay first CA, CB, and CC connector relays and to the other controller connector through an SC- relay and the second CA, CB, and CC connector relays.

2.06 The controller connectors are so designed that a maximum of 11 sender link frames may be associated with one given controller connector. This is also shown on Fig. 2. Since the maximum number of controller connectors in a group is 6, this means that $\frac{6 \times 11}{2}$ or 33 frames could be served by this group. (The total is divided by 2 since each link frame is connected to two separate controller connectors.) Very seldom will more than approximately 20 sender link frames be provided for a single controller group, however.

2.07 It is possible for an office to be equipped with more than one group of link frames, and in this case each

SDR.LK. FR.	0		1		2		3		4		5		6		7		8	
SDR.LK. CONN.	1ST	2ND																
4 CONT. CONN.	0	1	2	3	0	3	2	1										
6 CONT. CONN.	0	1	2	3	4	5	0	3	2	5	4	1	0	5	2	1	4	3

REPEAT PATTERN AS REQUIRED

FIG.3-RELATION BETWEEN SENDER LINK FRAMES AND CONTROLLER CONNECTORS SHOWING CONTROLLER CONNECTOR NOS. ASSOCIATED WITH EACH SENDER LINK FRAME FOR A GROUP HAVING 4 CONNECTORS AND A GROUP HAVING 6 CONNECTORS

group is associated with a separate group of controller connectors and link controllers. In this case, the equipment is arranged so that the usage in each group is nearly uniform. It should be noted that each group is complete in itself and there is no multiplying of sender link frames between groups.

2.08 Each link controller and connector frame contains two link controller circuits and two controller connector circuits. If more than one group is involved, the two link controllers on the same frame are in different groups for safety reasons. The left connector on the frame always has the same designation as the lower controller and the right connector the same as the upper controller. See Fig. 4 for an example of this arrangement, showing three maximum size groups of controllers and connectors, each group consisting of six controllers and six connectors. Where it is known that no more than four will be needed, that number will be installed. An even number of connectors is always installed in order to avoid an uneven load distribution. Controllers are furnished to meet the traffic requirements of the office. They may be added as the office grows.

2.09 The controller connector consists primarily of multicontact relays used to cut through control and test leads from the sender link frame to the selected controller. The wiring used to multiple these leads from the sender link frames to the multicontact relay associated with each link controller is known as banjo wiring because of its physical appearance. Fig. 5 is a typical example of this wiring, although the equipment shown is not part of a controller connector. (A controller connector has relays of 60 sets of contacts per relay instead of 40.)

2.10 Referring to Fig. 5, the leads from the sender link frame terminate on the terminal strip at the extreme left. These leads are then multiplied to the armatures of each multicontact relay by means of the horizontal bare wires. Fig. 6 shows the details of an enlarged view of the soldering lugs on the operating springs for the banjo strapping. Leads from the stationary contacts of each multicontact relay go to the outgoing link controller circuit associated with that relay. Thus, the sender link frame can be connected to any one of the link controller circuits by operating the proper multicontact relay. Each connector which, (as stated before) can be seized by any one of a maximum of 20 sender link frames must have access to all of the controllers in the group. The particular controller seized depends on the permanent order of preference established for each connector. Fig. 7 shows the order in which controllers are preferred, for each connector in a group of six

connectors and six controllers. Fig. 8 shows the assignment of first choices in controller groups of various sizes.

(B) General Sequence of Operation

2.11 The operations involved in connecting a toll tandem trunk to an incoming dial pulse sender may be summarized as follows:

- (a) Operator seizes a toll tandem trunk.
- (b) Trunk operates the start relay in the incoming sender link and connector circuit.
- (c) Incoming sender link and connector seizes the preferred controller connector.
- (d) Controller connector seizes the preferred link controller.
- (e) Link controller identifies the trunk groups that have calls waiting, then closes gate circuit to lockout other groups.
- (f) Link controller identifies the trunks in the selected group having waiting calls and then causes gate circuit to lockout other trunks.
- (g) Link controller tests for idle senders and prepares to connect the preferred sender to the calling trunk.
- (h) Link controller makes the preferred sender busy to other link controllers after checking for a double connection.
- (i) Link controller causes operation of the primary and secondary select and hold magnets of the incoming sender link and connector circuit, thus connecting the sender to the trunk.
- (j) Link controller and controller connector release if no other calls are waiting within the gate circuits.

2.12 The following paragraphs describe in detail the circuit operations involved in connecting an incoming toll tandem trunk to a dial pulse incoming sender.

(C) Trunk Start and Controller Connector Seizure (SC 101-1)

Trunk Seizure

2.13 The toll tandem trunks and the 2-way and incoming intertoll trunks appear on the primary switches of the incoming

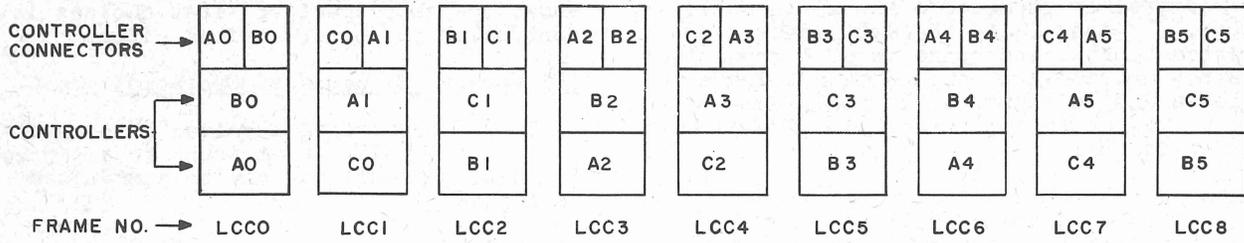


FIG. 4 - EQUIPMENT ARRANGEMENT FOR 3 GROUPS A, B, AND C OF LINK CONTROLLERS AND CONTROLLER CONNECTORS

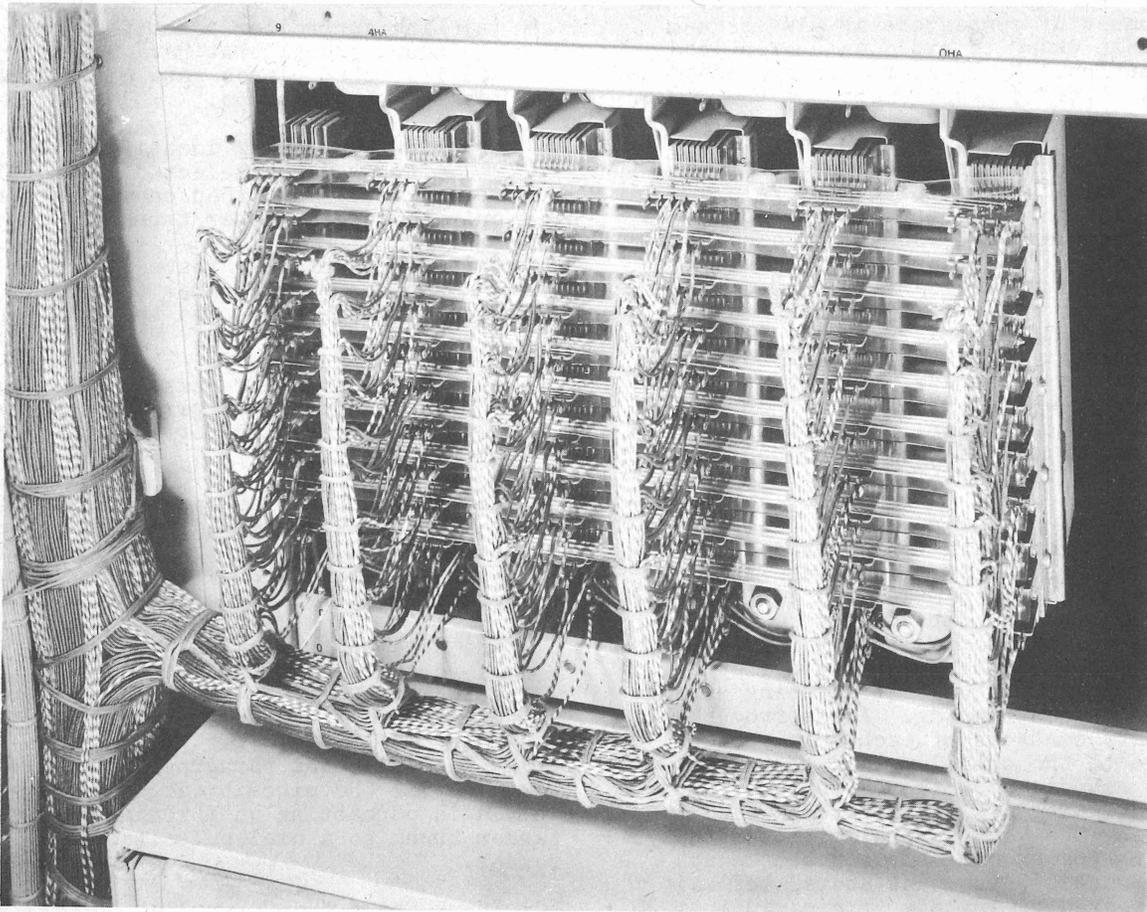


FIG. 5 - BANJO STRAPPING ON A BANK OF FIVE MULTICONTACT RELAYS - TYPICAL (40 SETS OF CONTACTS PER RELAY)

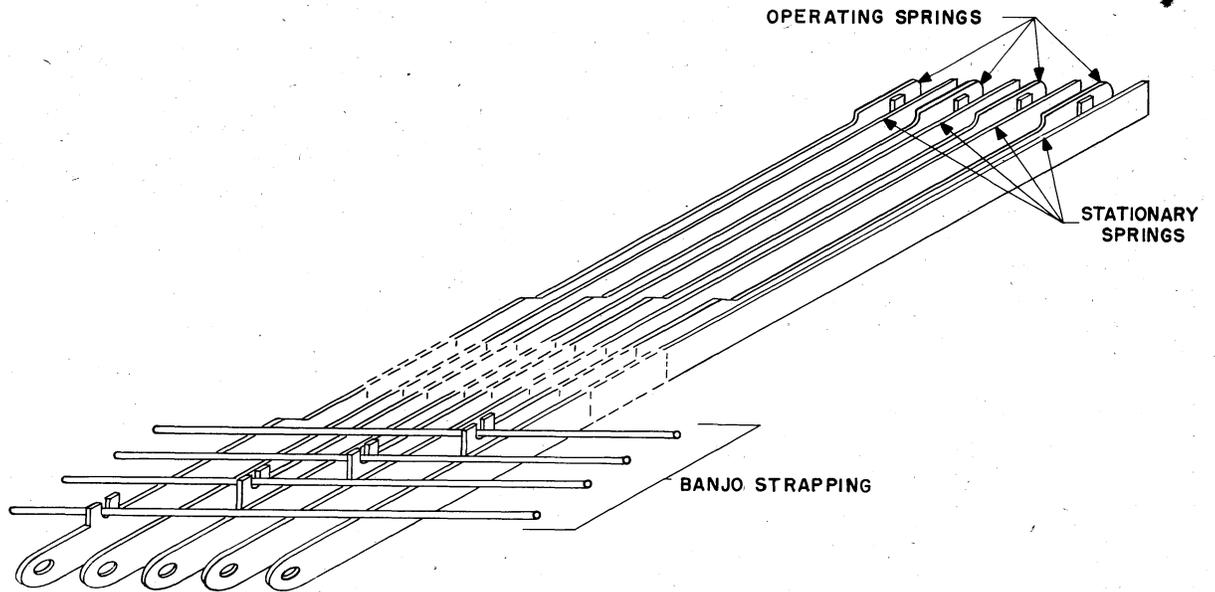


FIG. 6- DETAILED SKETCH OF SOLDERING LUGS FOR BANJO STRAPPING ON MULTICONTACT RELAY OPERATING SPRINGS

CONTROLLER CONNECTOR	CONTROLLER NO.	PREFERENCE					
		1 ST	2 ND	3 RD	4 TH	5 TH	6 TH
0	0	0	1	2	3	4	5
1	1	1	2	3	4	5	0
2	2	2	3	4	5	0	1
3	3	3	4	5	0	1	2
4	4	4	5	0	1	2	3
5	5	5	0	1	2	3	4

FIG. 7- ORDER IN WHICH CONTROLLERS ARE PREFERRED BY CONTROLLER CONNECTORS

CONNECTOR NUMBER	1ST CHOICE CONTROLLER	NO CONTROLLERS PER GROUP				
		2	3	4	5	6
0	0	0	0	0	0	0
1	1	1	1	1	1	1
2	2	0	2	2	2	2
3	3	1	1	3	3	3
4	4		2	0	4	4
5	5		0	1	1	5

FIG. 8- ASSIGNMENT OF FIRST CHOICES IN CONTROLLER GROUPS OF VARIOUS SIZES

sender link frames. Each frame accommodates 100 trunks divided into ten groups of ten trunks each. (See Fig. 1.) Each group of ten trunks has an associated ST- (start) relay (OS 101-1). Thus, a sender link frame has ten ST- relays.

2.14 The outward operator at Newark, when originating the call, selects an idle toll tandem trunk on her switchboard. This causes the H (hold) relay in the trunk circuit to connect ground to its ST- (group start) lead, operating the associated ST- relay in the sender link and connector circuit.

Controller Connector Seizure

2.15 As previously described, each sender link frame has access to two controller connectors in the same group, on a preference basis. This insures access to a link controller if one of the controller connectors is disabled or handling a call from another link frame. The sender link frame is arranged to alternate the preference in connecting to one of the two available controller connector circuits. This preference arrangement is obtained with the PC (preference change) and PF (preference) relays, a W and Z relay combination. More information about preference control is given later.

2.16 Since it is possible to have up to a maximum of eleven sender link frames served by a given controller connector, a double-transfer lockout arrangement is provided to insure that one and only one sender link frame is connected to a controller connector at a time. This is the function of the L (frame lockout) relays (two per frame) of the sender link and connector circuit. One L relay is associated with the first or A choice connector relay chain and the other with the second or B choice chain.

2.17 The preference order for the various sender link frames associated with a controller connector is fixed at the time of installation by the relative position of their L relays in the chain. The wiring of the L relays for a typical installation is shown on OS 102-1. The association of sender link frames and controller connectors is given for any particular job on the Wiring List and Equipment Drawing for the controller connector frames*.

*Figs. 9A and 9B, attached, shows a typical wiring list and equipment drawing. The numbers of the drawings containing the above information vary from job to job. For example, T9007-06-9850 would be the drawing for an office with the Drawing code 9007. The letter T and the last 4 digits is the same for all offices. The two middle digits indicate the floor where the equipment is found. If more sheets are required, they are numbered 9851, 9852, etc.

2.18 When the ST- relay in the sender link and connector operates, a path is closed from resistance battery to operate either one or the other of the L relays, depending on the preference conditions (OS 101-1). With the PF relay normal, battery through resistance F, through the operated ST- relay, operates the L relay associated with the first controller connector if it is idle. If the associated controller connector is busy from a call on another link frame, the A (A choice connector busy) relay has operated through the make contacts of the B1 or B2 relay in the first controller connector. This transfers the battery through resistance F to the L relay associated with the second controller connector.

2.19 Eventually, when a connection to a link controller is established, the RA (release alarms) relay operates (OS 104-1). The RA relay (with PF normal) in turn operates the PC relay (OS 101-1), which locks. Under this condition the PF relay cannot operate because its winding is short-circuited. Either the FC- or SC- relay also operates on every connection to a link controller and connects ground to hold the PC and PF relays operated. Thus, any premature release of the RA relay will not affect the PC and PF relays.

2.20 When the controller has completed all its functions, relays RA, FC- and SC- release removing the short circuit from the winding of relay PF, described above, thus allowing it to operate. The PF relay remains operated after the controller and controller connector release. Now, if another call comes in, an ST- relay operates as before. In this case, battery through resistance G, through the operated ST- relay, through the operated PF relay operates the L relay associated with the second controller connector if it is idle. Similar to the case in the preceding paragraphs, if this connector is busy serving a call from another link frame, the B (second choice connector busy) relay has operated from a B1 or B2 relay in the second choice controller connector. This transfers the battery, through resistance G, to the L relay associated with the first controller connector.

2.21 If both A and B relays are operated because both connectors are busy (from other link frames), the call is delayed until a connector does become available. The ST- relay, in conjunction with the TC interrupter, automatically changes the condition of the PF relay as follows. With the ST- relay operated and the interrupter TC on its B (back) contact, relay TC (timed preference chain) operates and locks. When the interrupter closes the F (front) contact approximately six seconds later, ground is closed to the preference relays PC and PF, to operate or release PC.

When the F contact opens approximately one second later, relay PF operates or releases depending on the position in which this relay was left in the last call served. The release or operation of relay PF changes the connector preference. (This timing sequence requires approximately 6 to 13 seconds depending on the position of the armature of the TC interrupter when the ST- relay operates.) The preference then continues to alternate about every six seconds until a controller is seized, at which time the preference circuit is stabilized by the operation of relay RA (release alarms). Note that, regardless of the position of relay PF, the first connector to become available will be seized unless a trouble condition exists.

2.22 With option B provided as shown on OS 101-1, an audible alarm is operated and a frame lamp is lighted if an idle controller connector and a link controller are available to the sender link frame and a call is not served within approximately one to two seconds. (If option A is provided, an idle sender must be available also.) The alarm is under control of relays TM (timing), TM1 (timing auxiliary), PU (pickup) and AL (alarm). Relay TM operates from the ST- relay and connects the MB leads from the associated controller connectors to the primary and secondary windings of relay TM1. If there is an idle link controller and controller connector available, relay TM1 operates on either or both the primary and secondary winding. Relay TM1 connects ground to the TA interrupter and, when the B (back) contact of the interrupter closes, operates relay PU which locks. When the interrupter closes the F (front) contact about one second later, relay AL operates if no link controller has been connected to the link frame by this time as indicated by relay RA remaining unoperated. Relay AL operated brings in the alarm and lights the AL lamp on the sender link frame. It also opens the path which controls the normal action of the preference relays PC and PF. The relay AL remains operated under control of the AR (alarm release) key so that the link frame involved in the trouble can be identified.

(D) Controller Seizure by Controller Connector

Controller Connector Operation

2.23 When one of the two L relays on the sender link frame operates, the associated MC (multicontact cut-in) relay is operated if the associated controller connector is idle and if the sender link frame is successful in competing with the other link frames associated with this controller connector (OS 102-1 and 103-1). The L relay connects ground to hold the opposite A or B (connector busy) relay

operated (if it is operated), in order to prevent the operation of the L relay associated with the other controller connector while this call is being served (OS 101-1). In addition, the L relay operates the CSA (connector start) relay in the controller connector (OS 103-1).

2.24 The MC relay operates the associated CA, CB and CC (connector cut-in) relays of the sender link and connector which connect the various control leads of the sender link frame to the controller connector (OS 103-1). Also, the CA, CB and CC relays operate the B1 and B2 (busy indication) relays (OS 104-1). Relay B1 grounds the CB leads of the first 12 associated sender link and connectors, (OS 101-1) and relay B2 grounds the CB leads of the remaining associated sender link and connectors, thus operating the A or B relays of all associated sender links except the one originating the call. This, of course, makes the connector busy to all other sender link and connectors. The operation of the A or B relay in the sender link under discussion is prevented by the operation of the MC relay in order to avoid operating both L relays on a sender link frame.

Controller Seizure

2.25 The following is a description of controller seizure by a controller connector under three different conditions:

(1) All Controllers Idle. Assuming that there is only one call in the office at this time and that all the equipment is functioning properly, the operation of the CSA relay connects battery via the PS and CBT punchings to operate the first choice CS (controller selected) relay (OS 103-1). The CS relay, in operating, locks to ground and operates the CA1 and CA2 (controller cut-in) relays which in turn operate the CBI, 2 and CCI, 2 (controller cut-in) relays. These controller cut-in relays connect the many control and test leads from the multicontact relays on the sender link frame to the associated link controller. The CA1 relay also operates the MB (make busy) relay in the link controller; the purpose of this relay is to make this controller busy to all the other connectors in this group. This is done by grounding the CB leads to all the connectors which operate the CBT relays in all connectors except the one handling this call. The CBT relay associated with the selected controller in this connector remains normal because its winding is shunted to the ground on the make contacts of the CA2 relay.

(2) First Choice Controller Busy. Assuming that the first choice

controller for this particular connector is busy, the CBT relay associated with the first choice controller will already be operated when the connector is seized. Now, when the CSA relay operates and places battery on the CBT punching, that battery is transferred through operated contacts of the CBT relay to the CS relay associated with the next controller in the preference chain. This CS relay then operates, seizing the second choice controller in the same manner as described above for the first choice controller. In case the second controller is also busy, battery will again be advanced through operated contacts of this second CBT relay to the next CS relay, which is associated with the third choice controller. This preference chain always advances from a lower to a higher numbered controller. The first choice controller for a given connector is determined by the strapping of the PS and CBT punchings. Furthermore, each connector has a different first choice controller. (See Fig. 7.) This arrangement is provided uniformly over the link controllers.

(3) Two or More Connectors Attempting to Seize the Same Controller. Assume that two connectors simultaneously operate their CS relays associated with the same controller. That this is possible can best be verified by tracing the operating and locking paths for the CS relay through the make-before-break contacts on the CS relays as shown on OS 103-1. To prevent both of these connectors from seizing the same controller, a double transfer lockout arrangement is provided. This arrangement allows only one set of controller cut-in relays CA1 and CA2 to operate. The strapping of the F, G and H punchings determines which connector will succeed in operating its CA1 and CA2 relays. The successful connector is the one closest to the grounded H punching. From here on the seizure of the controller is the same as described where only one call is involved.

2.26 As soon as the CBT relays operate on the other connectors (including the connector that was unsuccessful in operating the CA1 and CA2 relays), the operated CS relay releases and battery from the CBT punching is transferred to the CS relay associated with the next controller in the preference chain. If more than two connectors are involved in a simultaneous seizure, the above sequence is repeated over and over until all connectors have succeeded in seizing a controller.

2.27 The double transfer lockout arrangement is also used when one connector attempts to operate a CS relay associated

with a given controller shortly after another connector has operated its CS relay, but before the associated CBT relays are operated; i.e. before the operating battery of the second CS relay can be transferred to the next CS relay in the preference chain. Here again, it will be seen that only one connector operates its CA1 and CA2 relays, while the remaining connectors having calls waiting advance to the next choice controller, where they will go through the same sequence.

(E) Link Controller Circuit Operation

Controller Start

2.28 The operation of the CA1, 2, CB1, 2 and CC1, 2 relays in the controller connector extends the leads from the connector into the link controller (OS 104-1) and causes the following:

- (a) Relay CA1 operates the MB (make busy) relay as described previously.
- (b) Relay CA1 operates the NX (normal cross test) relay. (Explained under Controller Timing, Section A828.121.15.)
- (c) Operates the OC (occupied connector) relay in the connector. (Explained in Section A828.121.15.)
- (d) Relay CB2 operates relay ON (off-normal) which starts the over-all timing of the controller (explained in Section A828.121.15) and performs other functions to be discussed later.
- (e) Operates the RA relay. This relay, as previously stated, opens the ground supply for the interrupter TA, preventing the sender link frame from operating the time alarm, and connects ground to stabilize the preference changing arrangement (OS 101-1). It also operates the LC (connector choice lockout) relay in the sender link and connector circuit (OS 102-1 and 103-1).

Identification of Calling Trunk Groups

2.29 The controller is arranged to recognize the groups of ten trunks on a sender link frame that have calls waiting to be served. As soon as these groups have been identified, the controller locks out all other groups in which no calls are waiting. These operations are controlled by the gate circuit consisting of the GO-9 (group identification) relays, the GE (trunk group end) relay, and the G (trunk group selected) relay (OS 105-1)

2.30 When the link controller is connected to the sender link frame, ground is connected to one or more of the GPO-9 leads (OS 105-1) depending upon which ST- relays are operated. This causes the corresponding GO-9 relays to operate and lock to their GPO-9 leads, thus identifying the groups in which trunks are awaiting a sender.

2.31 The link controller changes the order of serving trunk groups with waiting calls on a preference basis. This is the function of the PO-5 (preference chain) relays and the AP to EP (trunk group and sender preference) relays. These relays constitute a walking circuit by which the preference is advanced each time the controller is used (OS 104-1). This same preference circuit also serves to distribute the load over the various senders, as described later. Initially the PO and AP relays are operated, and when seizure of the link controller takes place, a preference will be indicated. When the controller releases, the P1 and BP relays remain operated so that B preference will be indicated when the controller is seized again. When the controller releases after the fifth seizure, the P5 relay releases and the original set of relays (PO and AP) operate, starting the preference over again. The way in which the controller seizure and release affects the walking circuit is shown on the sequence chart of OS 104-1.

2.32 The operated GO-9 relay nearest the operated contacts of the preference relay AP to EP (OS 105-1) operates the G (trunk group selected) relay, indicating that one or more GO-9 relays have operated. The G relay then operates the GE (trunk group end) relay to lock out those trunk groups that do not have their corresponding G- relays locked operated. This happens after the operated GE relay opens the operating paths for the GO-9 relays. By opening the GO-9 relay operating paths, the controller has closed the gate circuit that identifies groups with calls waiting. The controller will serve only those groups that have their G- relays locked operated.

2.33 The GE relay also operates the AR1 (auxiliary release auxiliary) relay which supplies a holding circuit for the GE relay. The G and GE relays, in operating, connect battery through resistor AA, through the contacts of the preferred operated GO-9 relay, to operate the associated FC- (or SC-) (connector group cut-in) relay on the sender link and connector frame.

Selection of Trunk from Preferred Group

2.34 When the first (or second) connector group cut-in relay (FC-, SC-) on the link frame operates, the trunk group

control leads are connected to the link controller. Included in these leads are the ten trunk identification leads LO-9 for the ten trunks served by a group, and a common start lead ST (OS 106-1). Ground on any one of the ST- leads from a trunk in the selected group is extended through the normal contacts of the D- (divide start leads) relay and the operated FC- (or SC-) relay is placed on the LO-9 and ST leads to the controller. Ground on these leads causes the ST (start) relay and the LO-9 (primary switch level) relays to operate. All LO-9 relays are locked operated from ground on the make contacts of the ST relay and also from ground on the LO-9 leads.

2.35 An automatic check to insure the continuity of the LO-9 leads is made on each call by requiring all LO-9 relays to operate before permitting the link controller to proceed. When the LO-9 relays and the ST relay have operated a path is closed to operate the OD (operate link D) relay. This in turn operates the LE (line end or gate) relay, opening the operating path of all LO-9 relays but not the holding path. The OD relay also supplies battery through the winding of the GR* (release portion of group not used) relay over the D- lead to operate the corresponding D- relay in the sender link and connector and the GR relay in the controller. The operation of the D- relay opens the path which made all the start leads common, leaving grounded only those LO-9 leads associated with trunks whose start leads are grounded. The operation of the D- relay also causes the release of the associated ST- relay in the sender link and connector (OS 101-1), and the ST relay in the link controller. The release of the ST relay removes a locking ground for the LO-9 relay and causes the release of all LO-9 relays except those having grounded L- leads (OS 106-1). Note that since the LE relay has operated, no additional LO-9 relays may operate even though ground may appear on their respective LO-9 leads. Thus, the gate circuit is closed to new calls in the selected group after the operation of the LE relay.

2.36 With the ST relay released a path is closed to operate the L (trunk selected) relay from ground on the lowest numbered LO-9 lead under control of its associated L- relay. Each of the LO-9 relays represents one trunk of the group of ten trunks being served. The operation of the L relay connects the winding of the SC (sleeve continuity) relay to the SO-9 lead corresponding to the lowest numbered operated LO-9 relay (OS 106-1). The S- (sleeve) lead should not be grounded at this time and the SC relay should remain normal for the call to proceed. This serves as a test for a premature sleeve ground and is used to determine whether the trunk

is already connected to a sender. The L relay also supplies an auxiliary holding circuit for the LE relay, and connects ground from the normal CL (class) relay contacts (OS 107-1) to one of the CO-9 leads corresponding to the lowest numbered operated LO-9 relay. This ground operates the CLO (class) relay. The CLO relay supplies a ground for holding the L relay and the preferred LO-9 relay operated.

2.37 At this point the link controller has selected the trunk to be served. Consequently, the next group of operations is to select an idle sender and then close the crosspoints to connect this sender to the trunk through one of four links.

Identification of Idle Links and Idle Senders

2.38 The controller must determine which links, if any, between the trunk group and senders are already busy. Referring to Fig. 40 of Section A828.101.1, it can be seen that there are two links (0 and 1) between the A switches and two links (0 and 1) between the B switches for each group of ten trunks. Furthermore, each link has access to ten senders. Thus, any trunk can reach any one of the 40 senders by using the proper one of the four links.

2.39 The four links which serve each group of ten trunks are represented by the HAO, 1 and HBO, 1 leads (OS 108-1). When the FC- or SC- relay operates, these leads are extended to the sender link and connector circuit. If the four links from the group being served are idle, the HAO, 1 and HBO, 1 leads are ungrounded and the BTO, 1, 3 and 4 (sender busy test) relays associated with these leads do not operate at this time. If any of the links are busy, the corresponding HA- or HB- lead is grounded thus causing the associated BT- relay to operate.

2.40 The BT- relays are also operated when the A or B group of switches on the sender link frame are manually made busy. A plug in the A or B make busy jack (sender link frame) operates the HA or HB (hold magnet A or B subgroup excluded) relay. Relay HA operates the BTO and BT1 relays while relay HB operates the BT3 and BT4 relays. This prevents any senders in the corresponding subgroups from being tested. Note that only one subgroup may be made busy at a time.

2.41 The link controller, in testing for an idle sender, tests only 20 of the 40 senders on the sender link frame at one time. The 20 senders tested are those terminated on either the lower or upper halves of the secondary switches, the lower consisting of levels 0-4 and the upper of levels 5-9. The 20 senders are

accounted for by testing the senders on the lower or upper levels on each switch as follows: Five senders on switches OA and O'A, five on switches 1A and 1'A, five on switches OB and O'B, and five on switches 1B and 1'B. Reference to Fig. 40 of Section A828.101.1 will aid in understanding this. A preference circuit consisting of the controller PA and PB (preference) relays determines which 20 senders are tested first.

2.42 When the controller is seized, the ON relay operates and in turn operates the RT (route transfer of PA and PB) relay (OS 104-1). The sequence chart on OS 107-1 shows that if the PA and PB relays are normal at the time of controller seizure, the RT relay operates the PA relay. The RT and PA relays then operate the LC (lower choice) relay to indicate that the controller should test the 20 senders on the lower levels of the secondary switches first. If both the PA and PB relays are operated at the time of controller seizure, the RT relay releases the PA relay, and leaves the PB relay operated. The RT relay in conjunction with the operated PB relay operates the UC (upper choice) relay to indicate that the controller should test the 20 senders on the upper levels of the secondary switches first.

2.43 The operation of the LC or UC relay causes the sender link and connector to present the busy test (BT) leads of the 20 senders in the lower or upper levels of the secondary switches to the link controller for test. It does this by operating the TLO, 1 (test lower) or TUO, 1 (test upper) relays in the sender link frame (OS 107-1).

2.44 Those senders which are idle have ground standing on the associated BT- leads. The operation of the TLO, 1 or TUO, 1 extends ground on BT- leads to the contacts of the BT- relays in the link controller. Those BT- relays which are normal extend the grounded BT- leads to operate the associated T- (sender busy test) relays. If a BT- relay is operated, indicating a busy link, the BT- leads are opened and the five associated T- relays cannot operate. Thus, the operation of a T- relay indicates that the associated sender is idle and that a link is available to reach the sender.

2.45 The operation of the TLO, 1 or TUO, 1 relays also operates the OT (operated TL- or TU-) relay as an indication that those relays have operated. If no T- relays operate, the controller makes use of the OT relay to switch the PA and PB preference circuit in order to scan the other half of the senders. With the AS and AB relays normal, the OT relay operates the PC (preference control) relay, a slow operating relay, which releases the RT

(relay transfer of preference PA, PB) relay, a slow release relay. The release of the RT relay causes the PA, PB preference circuit to change from upper choice to lower choice or vice versa, as shown on the sequence chart of OS 107-1. Thus, the link controller will test all 40 senders, 20 at a time. The controller will keep switching the preference until an idle link and sender is found, as indicated by the operation of a T- relay and the AS or BS relay, or until the link controller times out.

2.46 During periods of peak loads, the T- relays may fail to operate because all four of the links are busy. When this condition is indicated by the operation of all four BT- relays, no preference change is made. Instead the controller releases after an elapsed time interval of 1.0 to 2.3 seconds, if no other calls are waiting. The detailed operations when all links are busy are discussed under Timing of Equipment Failures and Traffic Delays Section A828.121.15.

2.47 When one or more T- relays operate and lock to grounds in the idle senders, the operating paths for all T- relays are opened to lock out busy senders which may become idle later and thereby interfere with sender selection. The gate circuit for the T- relays operates as follows. Ground through contacts of one or more operated T- relays operates the TE (test end) relay (OS 107-1) which in turn operates all the BT- relays, thus opening the operating path of all T- relays (OS 108-1). Any T- relays that are now operated, remain operated, but a sender which becomes idle cannot operate its T- relay.

2.48 When all BT- relays are operated, the T (sender tested idle) relay operates (OS 109-1) as an indication that the preferred sender should be selected and a double test should be made to determine whether another controller is attempting to select the same sender.

Sender Selection and Test for Double Connection

2.49 Since more than one sender may be available, as indicated by more than one T- relay being operated, it is necessary to determine which one of the available senders is to be used to handle this call. A permanent preference circuit is provided in each controller for this purpose and it utilizes transfer contacts of the 20 T- relays. Even numbered controllers are provided with V- wiring which establishes an order of preference progressing from a lower to a higher numbered T- relay (OS 109-1). W- wiring is provided on odd-numbered controllers establishing

an order of preference progressing from a higher to a lower numbered T- relay (OS 109-2).

2.50 If the circuit involving W- or V- wiring were the only preference circuit used by the controller, the senders associated with the last choice T- relay would be used much less than any of the others. To distribute the load more evenly throughout the senders, contacts of the AP or EP preference relays, previously described in Par. 2.31, are used to change the first choice T- relay each time the controller is used. This preference arrangement can be seen on OS 109-1 which shows V- wiring. Note the arrangement of the 6T, 7T and 8T contacts of the T- relays, particularly the way the normal contacts form a closed chain circuit. The effect of the operated AP to EP preference relays in establishing first choice T- relays can also be seen on this drawing. The first choice T- relay is the one whose 7T contact connects directly to the 10T contact of the operated AP - EP relay. This holds true for either V- or W- wiring. The second, third, etc. choice T- relay is the next in line, progressing upward for V- wiring, and downward for W- wiring. The 6T contacts of the T- relays are wired to windings of the five A - E (secondary switch level) relays. The 6T contacts of the T0, T5, T15 and T20 relays, representing senders on levels 0 and 5, connect to the winding of relay A. In a similar manner, levels 1 and 6 are associated with relay B, levels 2 and 7 with relay C, levels 3 and 8 with relay D and levels 4 and 9 with relay E.

2.51 Still referring to OS 109-1 and 109-2, the operation of all the BT- relays (which open the operating paths of the T- relays) places ground through the one AP - EP relay that is operated, to the chain circuit consisting of the normal back contacts of the T- relays. If the first choice T- relay is operated; i.e., the one whose armature is adjacent to the operated AP - EP relay contacts, the ground will be transferred to the winding of the A - E relay and will operate that relay. If the first T- relay is normal, the current will pass through the back contacts until it comes to the contacts of an operated T- relay, where it will be transferred to the winding of one of the A - E relays, operating that relay. The operated A - E relay operates the corresponding AA - AE (A - E auxiliary) relay.

2.52 The operated A - E relay, together with the operated DU or DL (double test upper or lower) relay, closes a path which causes the operation of one of the DT- (double test connector) relays in the sender link and connector. The operating path of the DT- relay is arranged to check

that one, and only one, of the A - E relays is operated. Note that the operation of an A - E relay indicates only that the selected sender is on one of two possible levels; e.g., the operation of relay B indicates that the sender is on level 1 or level 6. The DU or DL contacts are used to operate one of the DT- relays associated with the particular level on which the selected sender is terminated.

2.53 The ten DT- relays in the sender link and connector circuit control the DT leads of the 40 senders connected to that frame; i.e., one DT- relay controls the DT leads of four senders on the same level of the A and B secondary switches. The number of the DT- relay corresponds to the level of the associated senders. The operation of any one of the DT- relays in the sender link and connector operates the DTC (double test connect) and the DTCA (double test connect auxiliary) relays in the link controller, which lock under control of the AA - EA relay.

2.54 The operation of a DT- relay connects the DT leads of the four senders located on a particular level of the secondary switches to the link controller for test. The DT leads from these senders appear to the link controller as DT0,1 and DT3,4.

2.55 The DT- lead of the selected sender is connected to the double test circuit through contacts of the operated AA - EA relay, the operated T- relay, and the operated AP - EP relay to the double test circuit. Note that here again contacts of the T- and AP - EP relay make up a preference circuit similar to the one previously discussed. Since the selected sender is idle, battery appears on the DT-lead.

2.56 The DT- lead is connected to the double test circuit to determine if the preferred sender is being tested by another link controller and to prevent a double seizure of the sender by two controllers. The TST (sender test) and AT (auxiliary test) relays and the DT tube are provided to make this test.

2.57 The operation of the double test circuit is described under three different sets of conditions as follows:

(1) One Link Controller Connected to the Sender at Time of Testing. The operation of the DT- relay applies -48 volts from the sender to the DT- lead, through the winding of the AT relay, to the cathode (terminal A) of the DT tube (OS 109-1). With the DTC relay operated, resistors RA and RB provide a potentiometer arrangement to apply approximately +50 volts to the control anode (terminal 1). With a potential

difference of 98 volts on the control gap, the tube will conduct current or "fire", thus allowing the TST and AT relays to operate. The current flow reduces the high breakdown potential (148 volts) across the main gap to a sustaining potential of 76 volts.

(2) Two Link Controllers Simultaneously Testing the Same Sender (OS 109-1). The operation of the DT- relay in two controllers applies -48 volts from the sender to the DT- leads, through the windings of the two AT relays, to the cathodes of the two DT tubes, one in each controller. The control gaps in both tubes fire, which in turn causes the main gaps to fire. (See Fig. 10.) In this case, however, the current flow is so low that only the AT relays operate. The TST relays do not operate (OS 109-1). This starts a recycling circuit in both link controllers, using the RC (recycle double test) relay, which opens the operating path of the TST relay through the tube, and then closes it again. Eventually, one link controller will get out of step with the other, fire its tube alone, as described in (3), and seize the sender.

(3) One Link Controller Testing a Sender Slightly After Another Link Controller, but Before the Sender Involved Has Been Made Busy. Referring to Fig. 10, the first link controller can fire its DT tube if it operates its DTC relay slightly ahead of the second controller. When the first link controller fires its DT tube current flows through the DT- lead and causes a voltage drop across the BB resistance in the sender. Consequently, the potential on the DT- lead is changed from -48 volts to approximately +20 volts. When the DTC relay in the second controller is operated +50 volts is applied to the control anode but the cathode of the DT tube in the second link controller will now have a potential of about +20 volts (with respect to ground). The DT tube will not fire and neither the AT nor the TST relay will operate. This causes the second link controller to block until the selected sender has been made busy, by the operation of its S relay. This removes the ground from the BT- lead, releasing the associated T- relay. Then the second link controller attempts to select the next available sender, as determined by the remaining operated T- relays.

2.58 Since the purpose of the TST relay is to allow the link controller to determine that it has seized an idle sender, an automatic test of the TST relay biasing winding is made during each controller

switches. The PSA or PSB relay partially closes the operating path of the primary select magnets of the associated subgroup and operates the P (primary select magnet leads closed) relay. The SSA or SSB relay partially closes the operating path of the secondary select magnets of the associated subgroup and operates the LM (lower magnets) relay or the UM (upper magnets) relay (OS 111-1).

2.61 If only one of the AS or BS relays is operated, the PSA or PSB and the SSA or SSB relays operate when the T relay operates and relay TC operates relay P and relay LM or UM immediately.

2.62 Relay P, in operating, connects a supplementary holding ground to the preferred operated L- relay (OS 106-1), and causes the operation of the SMO (select magnet operate) relay (OS 110-1). The SMO relay connects battery to one of the PAO-9 or PBO-9 leads, through the lowest numbered operated L- relay; this operates the associated primary select magnets that correspond to the level on which the selected trunk is terminated on the four A or the four B primary switches on the sender link frame (OS 110-1). The operation of the primary select magnets connects ground to the PA or PB lead to operate the PAO (primary select magnet A switch operated) or PBO (primary select magnet B switch operated) relay as a check that the proper magnets have operated.

2.63 When relay LM or UM operates, battery is connected to one of the SAO-9 or SBO-9 leads through the contacts of one of the previously operated A-E relay. This battery operates the associated secondary select magnets that correspond to the level of the selected sender on the four A or the four B secondary switches (OS 111-1). The operation of the secondary select magnets connects ground to the SA or SB lead to operate the SAO (secondary magnets A operated) or SBO (secondary magnets B operated) relay.

2.64 Since the select magnets are now operated, the next series of operations cause the proper hold magnets to complete the connection of the sender to the trunk and to release all of the select magnets.

2.65 The TC relay operates the HT (hold magnet lead transfer) relay (OS 108-1), transferring the HAO,1 and HBO,1 leads from the windings of the BT- relays to the contacts of the T- relays (OS 108-1 and 112-1). This partially closes a path to operate the hold magnets on the sender link frame. After the select magnet check relays PAO or PBO and SAO or SBO have operated, the path for the hold magnets is closed from ground on the normal 4T and 5T contacts of the HO (hold magnet operated) relay (OS 112-1), through the operated

AP-EP relay, the one remaining operated T- relay, the operated HT relay, to the associated HAO,1 or HBO,1 lead, to operate the four hold magnets (two primary and two secondary) necessary to close the link through from the calling trunk to the selected sender. This closes the crosspoints on the primary and secondary switches, connecting twelve leads from the trunk to the incoming sender.

2.66 As the secondary crosspoints close, the S (sleeve) relay in this sender operates to the same ground (mentioned above) from the normal HC (OS 112-1, 120-1 and 134-1).

2.67 When the primary crosspoints close, the SC (sleeve continuity) relay operates from the same ground on the normal HO relay over one of the SO-9 leads (OS 112-1). This lead goes through contacts of the lowest numbered operated LO-9 relay as a further check for correct operation. The operated SC relay closes a path for holding the L and L- relays (OS 106-1 and 112-1).

2.68 The SC relay operates the HO (hold magnet operated) relay indicating that the hold and select magnets have operated. The HO relay, in operating, releases the CLO relay (OS 107-1) and also releases the P and SMO relays (OS 110-1) which release the primary select magnets. The HO relay also connects battery (OS 112-1) through the secondary winding of the HM (hold magnet locked) relay to the HA- or HB- lead to detect when the sender takes over control of the connection by grounding this sleeve lead. However, until the sender grounds the sleeve lead, the ground furnished through the primary winding of the HM relay causes current to flow in a direction to hold the HM relay on its back contacts.

Release of Link Controller and Controller Connector

2.69 If the group just served has other calls waiting as indicated by operated L- relays, or if other groups have calls waiting as indicated by operated G- relays, the link controller serves the calls as described in Section A828.121.13. The following discussion assumes that no other calls are waiting and that the controller can release at this time. After the link connection has been established, the three following conditions must be met before the RL (release) relay operates to cause the release of the controller:

- (1) the holding ground from the sender must be applied to the HA- or HB- sleeve lead,
- (2) ground must be removed from the ST- lead of the trunk which has just been served and
- (3) battery must be removed from the DT- lead of the selected sender.

These conditions are satisfied as described in the following paragraphs.

2.70 Check That Holding Ground is Applied to Sleeve on Established Connection:

When the secondary crosspoints have closed, the S relay in the seized sender operates and starts a series of relay operations that eventually cause a ground to be placed on the S lead for holding the hold magnets operated. This ground is also placed on the HAO,1 or HBO,1 leads to the controller. Until now, the HM relay has been held against its back contacts by current through its primary winding. At this point, the ground from sender on the HA- or HB- end shunts the primary winding and allows the HM relay to operate to its front contacts because of current through the secondary winding. The HM relay operates the RL (operates RL when HM releases) relay (OS 112-1) which partially prepares an operating path for the RL relay (OS 107-1).

2.71 Check That Ground is Removed From the ST- Lead: When the S relay in the sender operates, ground is applied to the CO lead, operating the CO (cut-off) relay in the trunk circuit (OS 120-1 or 134-1). This operated CO relay opens the ST- lead (OS 101-1) which opens one of the locking paths for the associated LO-9 relay in the link controller (OS 106-1). When the CLO relay has released and the HM relay has operated, the LO-9 relay releases and in turn releases the SC relay which was operated by the ground on the SO-9 lead (OS 112-1, 120-1 and 134-1).

2.72 Check That Battery is Removed from the DT Lead: When the S relay in the sender operates, it removes battery through 3200 ohms from the DT- lead (OS 109-1). This releases the TST and the AT relays.

2.73 The release of the SC, AT and TST relays and the operation of the RL relay closes a path to operate the RL (release) relay (OS 107-1) to start the release of the link controller as shown on SC 101-1.

2.74 At this point, the toll tandem trunk seized by the Newark toll operator is connected to a dial pulse (DP) incoming sender through crosspoints of switches on the sender link frame.

3. DP INCOMING SENDER - INPULSING
(SC 103-1)

(A) General

3.01 The principal functions of the DP incoming sender may be divided into two categories, namely, inpulsing and outpulsing. Inpulsing consists broadly of receiving the digit information pulsed on a dial pulse basis and of storing the

digits. Outpulsing consists essentially of outpulsing some or all of the stored digits on a DP, MF, or a DC basis as determined by the marker. The outpulsing operation for this call is described in Part 8 of this section.

3.02 On this call, the sender functions associated with inpulsing take place in the following order:

- (1) Sender seizure and operation of control relays.
- (2) Class registration.
- (3) Sending start dial signal to operator.
- (4) Receiving pulses and registration of A digit. These functions include:
 - (a) Detecting, dividing, and counting of pulses for A digit.
 - (b) Insteeering and registration of A digit.
- (5) Receiving pulses and registration of B digit.
- (6) Receiving pulses and registration of C digit.
- (7) Decoder connector and decoder seizure after registration of A, B, C digits.
- (8) Receiving pulses and registration of D digit and succeeding digits.

3.03 The DP incoming sender circuit components which are used to perform the above operations are described in the following paragraphs and are shown by the block diagram on Fig. 11.

3.04 Control Circuit: When the crosspoints on the sender link frame are closed, the leads from the trunk circuit shown on Fig. 11 are connected to the sender circuit. The S and SP leads start the operations of the control circuit. This circuit consists of the following relays which function principally to connect grounds to various parts of the sender:

- (a) The supervisory relays used chiefly for detecting abandoned calls.
- (b) The off-normal relays which aid in starting other sender functions and control the release of the senders.
- (c) The timing relays which require the sender to perform certain operations within a specified time.

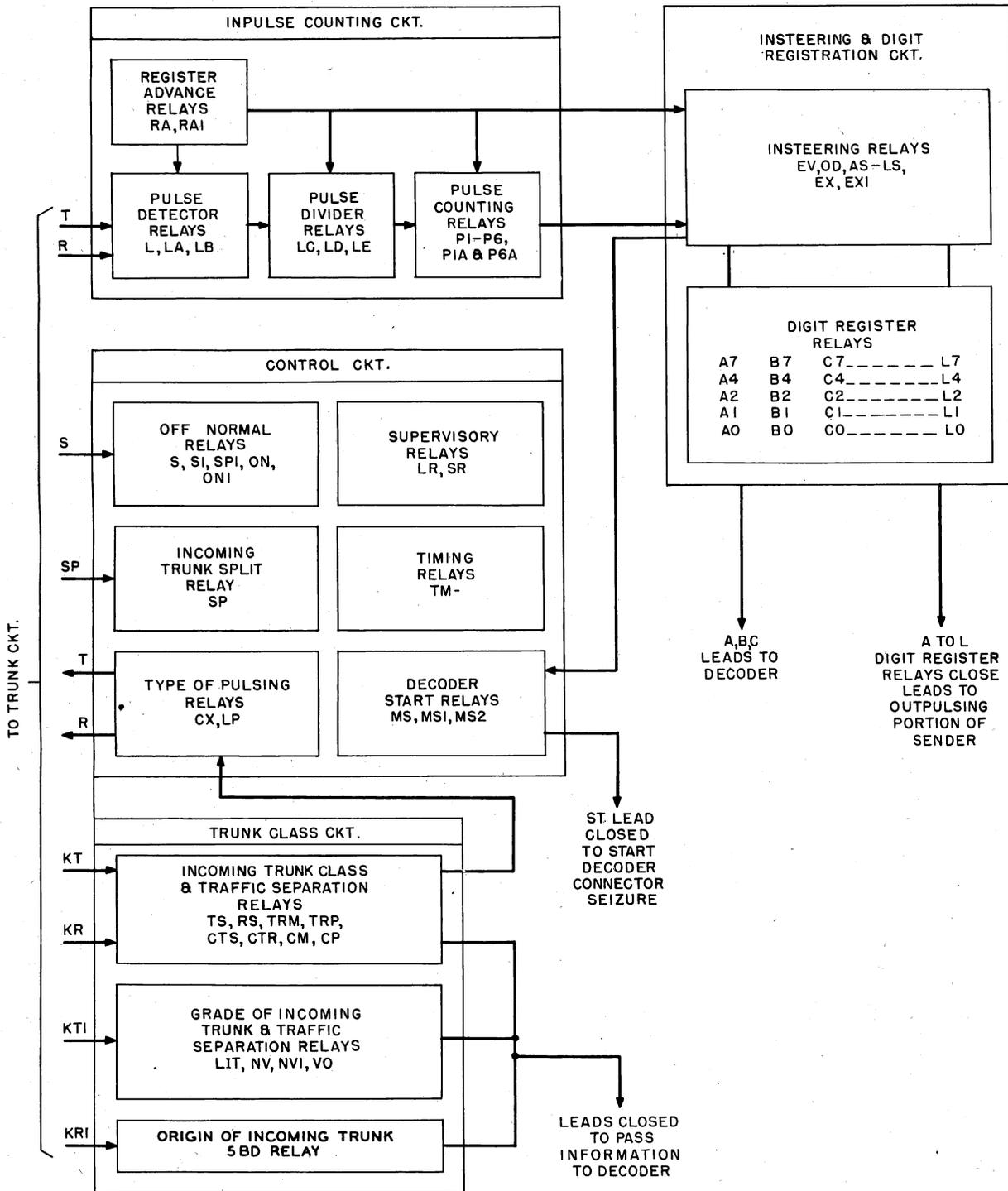


FIG. 11—CIRCUIT COMPONENTS OF DP INCOMING SENDER USED FOR IMPULSING OPERATIONS

(d) The incoming trunk split relay which controls the operation of the split relay in the incoming trunk relay circuit.

3.05 Class Circuit: The operations of the trunk class circuit are started just after the KT, KR, KTL, and KRL leads are connected to the sender. This circuit consists of various marginal, polar, and neutral relays for recording the trunk class information from the incoming trunk relay circuit. The class information received indicates to the sender which type of dial pulses (loop or composite) it is to receive, it also indicates whether the call is being originated at a No. 5 toll switchboard and whether the incoming trunk can be connected to a non-via grade trunk, and gives traffic separation information.

3.06 Impulse Counting Circuit: Through the operations of the control circuit and the class circuit, the sender prepares the impulse counting circuit to receive pulses. Then the operator or another sender is signaled to begin sending pulses on either a loop or a CX basis. On the call being discussed, the operator at Newark dials CA3-2346. When these digits are dialed the individual pulses of each digit are transmitted on a loop basis over the T and R leads. The function of the pulse detection relays is to detect these pulses by releasing and operating each time a pulse is received. The pulse divider relays are arranged so that the first pulse of a digit will be indicated to the pulse counting relays via one lead and the next pulse via another lead. These two leads are then used alternately for succeeding pulses of the digit. As each pulse is received, the pulse counting relays operate in a different combination so that when the pulsing for the first digit stops, the combination of operated relays indicates the total number of pulses received. When the pulsing stops the relays of the register advance circuit close paths to transmit the first digit to the insteering and register circuit.

3.07 Insteering and Digit Registration Circuit: By the time the pulses of the first digit have been counted, the insteering relays are prepared to steer the leads from the pulse counting relays to the A digit register relays in order to register or store the digit information. When the A digit has been registered, both the impulse counting circuit and the insteering and digit registration circuit must be prepared to receive the pulse indications of the B digit. The pulses of this digit are then detected and counted and the leads indicating the digit are steered to the B digit register relays. In similar fashion the C digit and other succeeding digits are registered in the sender.

3.08 When the A, B and C digits have been registered, the decoder start relays, which are a part of the control circuit, allow the sender to seize a decoder connector which in turn seizes a decoder. This is done so that the first three digits may be used to drop a 3D card in the home translator.

3.09 The remainder of this part explains in detail the sender impulsing operation as shown on SC 103-1 and OS 121-1 through 124-1.

(B) Control Functions

Connection to Incoming Trunk

3.10 As described in Part 2 of this section, the link controller determines whether a sender is idle over the BT- lead (OS 108-1) and the DT- lead (OS 109-1). After sender seizure, the proper cross-points in the sender link are operated and close through the following leads to the sender:

- (a) KT, KR, KTL, SP, IS, and CO leads (OS 121-1) which connect the sender to the trunk relay circuit.
- (b) KRL lead (OS 121-1) which connects the sender to the trunk relay circuit (used to operate the 5BD relay).
- (c) T and R leads (OS 122-1) which connect sender to trunk relay circuit.
- (d) S lead (OS 121-1) which provides a connection between the sender and the link controller.

3.11 In addition to closing through the ten leads listed above, the closure of the crosspoints extends the SMI and SMC leads directly to the decoder connector associated with the selected sender (OS 168-1). After decoder connector, decoder and marker seizure, the SMI and SMC leads are extended through the decoder connector to the decoder (OS 168-1) and the marker (OS 206-1) for use in frame identification of the incoming trunk.

3.12 After the closure of the sender link crosspoints, the ground which operated the hold magnets is extended over the S lead to operate the S (sleeve) relay in the sender (OS 121-1). The operation of the S relay opens the BT- and DT- leads (OS 108-1 and 109-1) to the sender link and connector circuit to indicate to other link controllers in the group that the sender is busy (presence of ground on the BT- and battery on the DT- leads indicate an idle sender). The S relay also starts the timing circuit by grounding the armature of the TM interrupter (OS 132-1) and operates the TM9 (timing) relay (OS 121-1); this prepares the timing circuit to perform certain functions in the

event of partial digit registration or a trouble condition as explained under Sender Timing, Section A828.121.15.

3.13 The SP lead from the trunk relay circuit extends 48-volt battery from the winding of the SP (split) relay in the incoming trunk to the windings of the SP (incoming trunk split) relay in the sender. When this connection is established by the operation of the S relay, the primary and secondary windings of the sender SP relay are in series. This operates the SP relay in the sender but, due to the high resistance of the secondary winding and the BE resistance, the SP relay in the trunk cannot operate at this time.

3.14 The operation of the SP relay in the sender operates the SP1 (incoming trunk split auxiliary) relay. The SP1 relay operates the S1 (sleeve auxiliary) relay, the ON and ON1 (off normal) relays, and closes the paths which place ground on the CO lead and the SP leads. The operated S1 relay removes the initial ground for operating the SP relay but the SP relay is held operated by the holding ground on the SP1 relay contacts.

(C) Registration of Class Information

Receiving Incoming Trunk Class Information

3.15 The operation of the S relay connects 24-volt battery to the windings of the TS and RS (tip and ring sensitive) relays, the TRM (trunk marginal) relay and the TRP (trunk polar) relay, to receive class information from the incoming trunk over the KT, KR, KT1, KR1 leads. Depending upon the wiring options used in the trunk relay circuit, these relays operate in the combinations shown in Table 1 on OS 121-1. The combinations that operate depend upon the direction and the amount of current.

3.16 Table 1 shows that class information from a toll tandem trunk is transmitted to the sender over the KT lead. This lead is extended to the marginal relay combination TS, TRM and TRP, causing the operation of the TS relay and possibly the TRM or TRP relay. The operated TS relay indicates that pulses are to be received on a loop basis via the T and R leads.

3.17 When an intertoll trunk is connected to a sender the class information is transmitted over the KR lead (OS 121-1). This lead is extended to the marginal relay combination RS, TRM and TRP, causing the operation of the RS relay and possibly the TRM or TRP relay. The operated RS relay indicates that the incoming trunk employs composite (CX) or single frequency (SF) signaling, and dial pulses will be received over one lead (the ring) from the signaling circuit via the trunk relay circuit.

3.18 As shown in Table 1, the operation of the TRM and TRP relays depends on the options in the trunk circuit. The TRM relay operates an auxiliary relay CM (class marginal), which locks to the S relay, and the TRP relay operates an auxiliary relay CP (class polar), which also locks to the S relay. Through combinations of the CM and CP relays, the TSA and TSB traffic separation leads are grounded (OS 160-1).

3.19 The KT1 lead from either a toll tandem or an intertoll trunk has a wiring option in the trunk circuit which controls another group of marginal relays (OS 121-1). These are the LIT (traffic separation), NV (non-via), VO (via only) and NV1 (non-via auxiliary) relays. They operate in various combinations depending upon the amount of current flow from the connected trunk in accordance with Table 2 on OS 121-1. When the incoming trunk is an intertoll trunk the VO relay operates, and the VO lead to the decoder is grounded. When the incoming trunk is a toll tandem trunk, the VO relay does not operate and the NVO lead to the decoder is grounded. The VO or NVO lead is used to operate the corresponding code bars in the translator. In combination with information from the first card dropped, the VO information is also used to operate a through traffic peg count register. In this example the incoming trunk is a toll tandem trunk and the NVO lead is grounded.

3.20 As shown on OS 160-1, the grounding of the TSC lead is caused by the operation of the LIT and NV1 relays. The TSA, TSB, and TSC leads are grounded in various combinations to represent information about the incoming trunk. This is later used in combination with information about the outgoing trunk to operate one of 28 traffic separation registers (OS 180-1).

3.21 The KR1 lead when grounded operates the 5BD (No. 5 board) relay which indicates that the call is being originated at a No. 5 toll switchboard trunk or at an equivalent call order trunk. The 5BD relay grounds the 5BD lead to the decoder. In combination with information from the first card dropped, this information is used later to operate a through traffic peg count register.

3.22 The operation of the TS relay which is described above operates the CTS (class tip sensitive) relay from ground on the IS lead from the toll tandem trunk circuit. When the RS relay is operated, the CRS (class ring sensitive) relay operates from ground on the IS lead from an intertoll trunk circuit.

3.23 The same ground which is extended from the trunk circuit over the IS lead to operate the CTS (or CRS) relay also

operates the FT (fundamental transfer) relay. The operated FT relay closes a path through either the operated CTS or CRS relay to operate the FT1 (fundamental transfer auxiliary) slow operating relay. If both the CTS and the CRS relays operate, the FT1 relay fails to operate and blocks the call.

3.24 The operation of the FT1 relay closes a direct ground through the primary winding of the SP relay to the winding of the SP (split) relay in the trunk circuit. The high resistance path through the secondary winding of the sender SP relay is now shunted and there is sufficient current to operate the SP relay in the trunk. The FT1 relay also places a locking ground on the S relay and extends this ground over the S lead to hold operated the sender link hold magnets to maintain the connection to the incoming trunk. This ground is also extended to the link controller to allow the controller HM relay to operate and start the release of the controller.

Class Information Cut-Off

3.25 The operated SP relay in the toll tandem trunk circuit operates the LU relay, which opens the KT and KT1 leads and cuts off the class information to the sender. Opening the KT lead allows the TS and the TRM or TRP relays to release. At this point loop dial pulsing is indicated by the operated CTS relay. Traffic separation information is indicated by the operated CM or CP relay. The other relays which operated via the KT1 lead are locked operated to ground on the ON1 relay contacts. When the incoming trunk is an intertoll trunk, the operated SP relay on the trunk circuit cuts off the class information to the sender, causing the release of the RS, TRM or TRP relays (OS 121-1).

3.26 The operation of the SP relay in the trunk circuit removes ground from the IS lead and allows the sender RT (relay transfer) relay to operate (OS 121-1). Until this time the RT relay has been shunted by the ground over the IS lead through the operated contacts of the FT relay. Operation of the RT relay transfers leads KT and KR from the class check circuit to a simplex of the SL (sleeve out) relay in the sender. The SL simplex is shown on OS 127-1. Later, this circuit makes an SL check to test the continuity of the path to the outgoing trunk.

3.27 At this time the KT1 and KR1 leads, which have been used for the purpose of registering class information in the sender, are removed from the class relays and transferred to the 4-wire transmission path of the trunk relay circuit (OS 127-1).

(D) Incoming Pulse Counting

Preparing Sender Counting Circuit to Receive Loop Dial Pulses

3.28 OS 122-1 shows the supervisory and dialing components of a DSA switchboard position connected to an incoming sender via a toll tandem trunk. The operator at the switchboard has plugged a calling cord into a jack associated with the toll tandem trunk. The operator has also operated a talk key which operated the SP (split) relay associated with the cord circuit. This has transferred the tip and ring conductors of the cord circuit to the dial circuit and has shunted these two leads through the winding of the RV (reverse) relay.

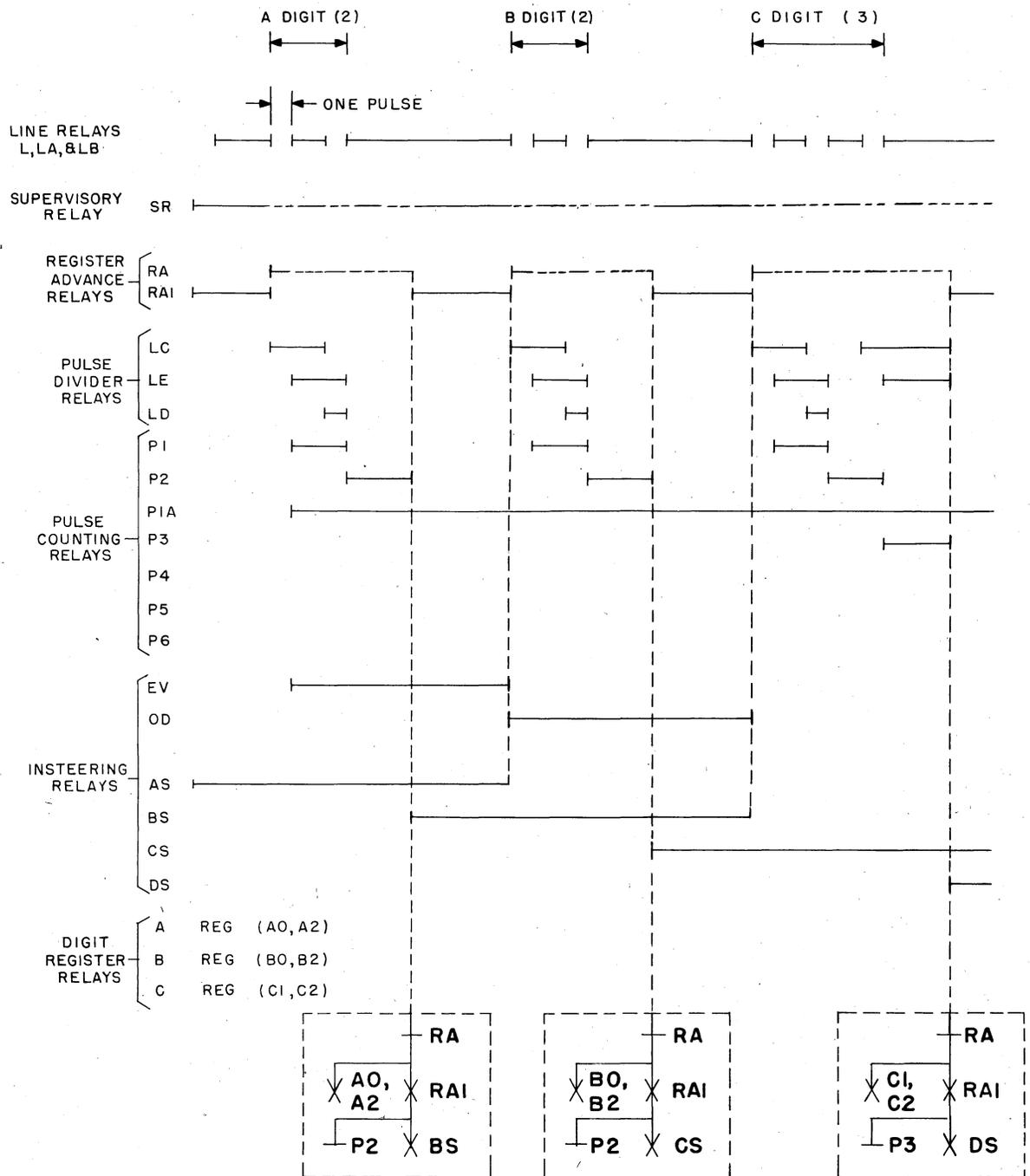
3.29 When the sender operates the SP relay in the toll tandem trunk a loop is closed through the T and R leads, through the operated SP relay in the dial circuit and the normal contacts of the operator's dial, causing the L (line) relay to operate by energizing its P1 and P2 windings. The function of the L relay is to release when the loop is opened, to indicate the start of a pulse, and then to reoperate when the loop is closed again. When the incoming trunk is an intertoll trunk, the L relay operates through the P2 winding alone from ground on the R lead. As shown on OS 122-1 this ground is supplied through contacts of either an operated CX relay in a composite set or a released RG relay in a single frequency set. A pulse is indicated by opening and closing the R lead, thus allowing the L relay to release and then reoperate.

3.30 When the trunk SP relay operates the RT relay, the RT relay closes off-normal ground through the make contacts of the L relay to operate the LA (line auxiliary) and SR (slow release) relays (OS 123-1). The SR relay operates the SR1 relay. The SR1 relay operates the LB (line auxiliary) relay and at this point the L, LA and LB pulse detecting relays are operated.

3.31 The SR relay also closes a circuit through the operated CTS relay to operate the LP (loop) relay. Prior to the operation of the LP relay, the battery and ground on the T and R leads of the loop is of such polarity that the RV relay in the dial circuit cannot operate. When the LP relay operates to indicate that the sender is prepared to receive dial pulses, the battery and ground are reversed and the RV polar relay operates. The RV relay lights the DIAL LAMP at the switchboard position to indicate that the operator should begin dialing the national number of the called subscriber.

Preparing Sender to Receive Pulses on CX or SF Basis

- 3.32 When the sender is connected to an intertoll trunk the CRS relay is operated, indicating that pulses are to be received with either CX or SF circuits. Although this section is concerned with a call involving loop dialing, opportunity is taken to indicate the method used to prepare the sender to receive pulses over CX or SF facilities. This type of signaling is illustrated on OS 122-1 using either a type B composite signaling circuit or a single frequency signaling circuit with a 2-way intertoll trunk. The incoming portion of the trunk is capable of receiving dial pulses from a distant toll office.
- 3.33 A connect signal over the CX leg of the composite signaling circuit causes the operation of the CX relay. The CX relay in turn operates the SVP (supervisory) relay in the trunk circuit. The SVP relay returns a stop pulsing signal to either an originating operator or a sender by connecting battery to the M lead (OS 121-1). At this point, the stop pulsing signal indicates that pulsing should not be started.
- 3.34 As shown on OS 122-1 and 123-1, the E lead of the CX signaling circuit is extended as the ring conductor through the crosspoints of the sender link, and the previously operated ON1 relay contacts, to battery which is standing on winding P2 of the L relay. The L (line) relay now operates. The ON1 relay also extends the tip lead of the trunk to the grounded P1 winding of the L relay. This provides a holding ground on the SVP relay after the CO relay in the trunk operates.
- 3.35 Later, when the sender operates, the SR relay as indicated on the sequence chart of OS 121-1, the SR relay operates the CX (composite) relay through the operated CRS relay. When the CX relay in the sender operates, the tip lead is disconnected from the L relay and the SVP releases to send a start pulsing supervisory signal through the composite set to the originating end of the connection. This indicates that the sender is ready to receive pulses on a CX or SF basis. Note that the SF circuit employs the E and M leads in the same manner as used on the CX circuit (OS 122-1).
- Pulse Detection**
- 3.36 Pulses are received over the loop toll tandem trunk when the position dial is pulled off-normal and allowed to return to the stop, thus causing the dial contacts to break and make in accordance with the digit dialed. The L relay in the sender follows these pulses as may be noted on Fig. 12. As the dial contacts break, the L relay releases because the loop is open (OS 123-1). When the dial contacts reoperate, the path is again closed.
- 3.37 In the case of the intertoll trunk the pulses are produced either by a dial at a switchboard position or out-pulsed on a DP basis by a sender. In either case the pulses are followed by the RG relay in an SF circuit or by the CX relay in the composite signaling circuit at the receiving end, causing ground to be removed and replaced on the E lead. This releases and reoperates the LC relay in the trunk circuit (OS 122-1) and the L relay in the sender at the dial speed (normally 10 pps).
- 3.38 The CX inductor and BA resistor shown in the ring lead of the sender compensate for the difference in winding resistances of the LC relay in the trunk circuit and the L relay in the sender. Without this compensation the unbalanced inductive effect during CX or SF pulsing would cause an unstable L relay action. The operation and release of the L relay must be accurate in order to detect the proper number of pulses.
- 3.39 The operation of the SR relay (OS 123-1) extends ground through the normal contacts of the FPP (false pulse protection) relay to provide a holding path for the LA relay. If for any reason the L relay should release momentarily while the sender is being seized, the LA relay is held operated. The FPP relay operating path is closed when the LP (or CX) relay operates. However, the FPP relay is slow-operating to insure stability of the circuit before releasing control of the auxiliary LA and LB relays to the L relay. During pulse detection the LA and LB relays operate and release in unison with the L relay. The operated FPP relay also closes the path from the L relay to the pulse-dividing relays LC, LD and LE (line auxiliary).
- 3.40 The operation of the RT relay, as described previously, causes the release of slow-release relay RTA (relay transfer auxiliary). The released RTA relay closes, thus preparing an operating path for the LR (line release) relay. The release of the SR relay during or before pulsing would operate the LR, thereby opening the pulsing circuit (OS 122-1) and releasing the SP1 relay (OS 121-1). This may occur on an abandoned call or a trouble condition. The SP1 relay starts the release of all equipment.
- 3.41 Accurate operation and release of the L relay is further assured by the pulse-help feature of the sender circuit which consists of the PH capacitor and the BM resistor (OS 123-1). These two



- NOTES:
1. RELAY OPERATE & RELEASE TIMES NEGLECTED.
 2. _____ RELAY OPERATED (OPERATING PATH ENERGIZED).
 3. - - - - - RELAY OPERATED (OPERATING PATH NOT ENERGIZED)

FIG. 12 — SEQUENCE OF RELAY OPERATIONS FOR PULSE COUNTING & DIGIT REGISTRATION.

components work in conjunction with the secondary winding of the L relay and battery from the winding of the SR relay to assist the armature of the L relay in either releasing or reoperating. When the ON relay operated during seizure, this closed the biasing path of the 3600-ohm L relay secondary winding. Current flow in this winding tends to prevent the L relay from operating. Operating current through windings P1 and P2, or P2 alone, will overcome this biasing effect. When the L relay operates, a ground through its operated contacts and the LA winding is placed on one side of capacitor PH. Ground through the secondary winding of the L relay places ground on the opposite side of the PH capacitor. The capacitor is almost completely discharged at this point. At the instant the L relay releases during the first pulse, the capacitor is allowed to charge from the parallel battery sources BM resistor and SR relay winding. The momentary effect of current flow during the charging of the capacitor tends to strengthen the effect of the biasing winding, thereby assisting the armature travel toward its back contact. The reoperation of the L relay discharges the capacitor and the effect of current flow during discharge tends to nullify the biasing action. This causes the L relay armature to be held firmly on its front contact.

3.42 Fig. 12 shows the sequence of operations involved in sender impulsing. On this particular call, the operator dials CA 3-2346. This figure shows the detection, counting and registration of the first three digits (223). When the first digit (2) is dialed, the sender receives two pulses. Each pulse is detected by the release and reoperation of the L, LA and LB relays.

Pulse Divider and Pulse Counting

3.43 The function of the LC, LD and LE relays is to transmit the dial pulses, represented by the back contact closures of the L relay, over two leads alternately to the pulse counting relays. When the first pulse is received, the L relay releases and extends ground to the winding of the LC relay, which operates. When the L relay reoperates at the end of the pulse, the LE relay operates through its primary winding and in series with the operated LC relay. The operated LE relay extends ground from the operated SR1 relay, through operated contacts of the RA (register advance) relay and through normal contacts of the P4, P2, P3 and P5 (pulse counting) relays to operate relay P1. The P1 relay operates the P1A relay and indicates that one pulse of the first or A digit has been detected and counted.

3.44 When the L relay releases on the second dial break, the LD relay operates. The LC relay is then released, but

the LE relay is held operated through its secondary winding. The reoperation of the L relay at the end of the second pulse releases the LD and the LE relays. Ground from the SR1 relay through the operated RA relay, normal LE relay, normal RAL (register advance auxiliary) relay and operated P1 relay, operates the P2 relay. At this point two pulses have been counted. The P2 relay releases the P1 relay by removing the holding ground path through the operated SR1 relay, the normal RAL relay and a chain circuit originating at the P5 relay. When additional pulses are received, the counting relays are operated through the operated LE relay for odd pulses, and through the normal LE relay for even pulses.

Register Advance

3.45 The pulsing action of the LA relay has provided the slow-releasing RA relay (which operated at the first release of the LA) with enough current to keep it operated during the impulsing of the A digit which is the digit 2 on this call. When two pulses have been received, the pulsing momentarily stops, indicating the end of the digit, and the slow-releasing RA relay is released. The released RA relay operates the RAL relay and provides off-normal ground to two out of the five leads, shown below the P1 through P5 and P6A relays on OS 123-1, to the insteering circuit. The operated P2 relay directs this ground to leads 0 and 2, which are connected to corresponding leads in the insteering circuit. The register advance RA and RAL relays also perform functions related to the insteering circuit progress.

(E) Insteering and Digit Registration

Registering A Digit

3.46 The AS (A digit steering) relay is operated by the ON relay during the early part of sender seizure (OS 121-1). The EV relay is operated when the P1A relay operates at the end of the first pulse. With the RA relay normal, and the AS and EV relays operated, the grounded 0 and 2 leads are steered to the A digit register relays, causing the A0 and A2 relays to operate. The operation of this two-out-of-five relay combination indicates that the registered digit is the numeral two.

3.47 The operation of the RAL relay opens the locking paths for the counting relays. However, the digit register relays operate and lock before the counting relays release. The RAL relay also extends a ground to operate the BS steering relay which in turn operates the ADR (A digit registered) relay.

Registering Subsequent Digits

3.48 When the first pulse of the second digit is received the RA relay is

operated and the RA1 relay is released. The AS relay releases but the BS relay is held operated. The normal AS relay releases the EV relay which operates the OD relay. The circuit is now prepared to count pulses and register the B digit, as indicated on Fig. 12. Subsequent digits are registered until the seven digits dialed by the operator (CA 3-2346) are registered. Table 1 on OS 123-1 shows the progress of the insteering relays for a total of eleven digits, which is the maximum number stored by the sender. The registration of a twelfth digit indicates an error in dialing and operates the EX1 (extra digit auxiliary) relay, causing the call to be routed to a reorder trunk. The operation of the EX1 relay causes the ROA relay to operate (OS 131-1) followed by operation of the TM5 relay (OS 132-1). This causes the sender to engage a decoder and marker for routing the call to reorder as described in Part 4 of Section A828.121.15.

(F) Decoder Start

3.49 During insteering and registration, as explained above, the sender seizes a decoder connector and a decoder when three digits (223) are registered in the sender. When the C digit is registered the DS (D digit steering) relay operates after the reoperation of the RA1 relay. The DS relay operates the MS (decoder start) relay (OS 124-1) which locks to the S1 relay ground and releases the slow release relay MS1 previously operated by the S1 relay. The MS1 relay releasing operates relay MS2, which places 48-volt battery on the ST lead to the associated decoder connector, operating the SP (sender preference) relay in the decoder connector (OS 124-1). The decoder connector selects and seizes an idle decoder, thus connecting the sender to a decoder. The sender then transmits the A, B and C digit information to the decoder on a two-out-of-five basis (OS 162-1). The decoder uses this information to select and drop a card in the card translator as explained under decoder operations in Part 4 of this section. For the call under consideration, the three digits are sufficient for the decoder to call a marker and complete the call.

4. DECODER CONNECTOR OPERATIONS (SC 113-1)

(A) General

4.01 The circuit operations resulting from the Newark outward operator plugging into an idle toll tandem trunk are described in Part 2 of this section. These operations cause a DP incoming sender to be connected to the trunk. As the digits are dialed by the operator, they are registered in the sender as explained in Part 3 of this section. After the first three digits of the called number are registered, the sender directs the associated decoder connector to

select and seize an idle decoder. After completion of these operations, approximately 65 leads are cut through from the sender to the decoder, thus permitting the decoder to proceed with its functions.

4.02 The primary purpose of the decoder connector is to close through leads between any one of five incoming senders, any decoder, and any marker. This requires two 60-contact multicontact relays per sender, one per marker per decoder connector, and a 60-contact relay plus a 30-contact relay per decoder per decoder connector. (See Figs. 13 and 14, attached.)

4.03 Five senders have access to a decoder connector, one at a time. These may be any senders in the office regardless of type and frame location. They may be on five different sender frames and may be all DP senders, all MF senders, or a combination of both. A particular sender is associated with but one decoder connector but each decoder connector can be connected to any one of the decoders and any one of the markers in the 4A office. Thus, all senders have access to all decoders and markers.

4.04 In the event of simultaneous demand by two or more senders for the same decoder connector, the senders take their successive turns in a fixed order, depending on their positions in the sender chain circuits.

4.05 As many connections through different decoder connectors can be made simultaneously as there are decoders. Each decoder connector prefers decoders in a fixed order, which differs between connectors. This tends to distribute the load evenly over the decoders.

4.06 In case of simultaneous demands for decoders from two or more connectors when all decoders are busy, the connectors tend to take their turns in connecting to decoders in a fixed order. After a connector has released from a call, it is prevented from re-entering with a new call until all other waiting connectors have been served.

4.07 When an incoming sender requires a decoder, the decoder connector upon receiving a signal from the sender connects the sender to an idle decoder. Later, the decoder connector connects the incoming sender to a marker. Where offices have separate groups of intertoll and toll completing markers, the decoder, on the basis of information received from the trunk and from a card translator, selects the proper type of marker through a marker connector. The marker connector used for this connection causes the decoder connector to connect the incoming sender to the same marker.

(B) Equipment Arrangements

4.08 The access arrangement between incoming senders of any type and the decoder and markers are shown on Fig. 13, for a combined train office, and on Fig. 14, for a 2-train office. The marker access arrangement is described in Part 6 of this section.

4.09 Leads from an incoming sender are brought into a decoder connector circuit and terminated on the stationary springs of the multicontact SC and SC1 (sender connector) relays. Most of the operating springs on this pair of SC and SC1 relays are multiplied by banjo wiring to similar contacts on the other four pairs of SC and SC1 relays associated with the other four senders. Part of this multiple is connected to a similar multiple on the operating springs of the multicontact relays designated DC and DC1 (decoder connector). The rest of the multiple is connected to a similar arrangement on multicontact relays designated MC (marker connector).

4.10 As many DC and DC1 relays are furnished as there are decoders, and as many MC relays are furnished as there are markers. The stationary springs of the DC and DC1 relays are connected to decoders. The stationary springs of the MC relays are connected to markers.

4.11 While the DC1 relays do give the connector access to a few leads to the decoders, their primary purpose is to connect the windings of the MC relays to the marker connector associated with each decoder. This feature is not shown on Figs. 13 and 14.

4.12 The stationary springs of the DC, DC1 and MC relays are connected to a multiple going to all decoder connectors, thus connecting all decoders and markers to all decoder connectors.

(C) Sender Preference Circuit (SC 113-1)

4.13 When the sender has registered the first three digits, the MS2 (marker start) relay operates (OS 124-1) and battery is connected to the decoder connector start lead. This operates the SP (sender preference) and CA1 (connector alarm) relays in a decoder connector (OS 155-1). As mentioned above, one decoder connector is provided for every five senders to give access to all decoders and markers. Each decoder connector is provided with five SP relays, one associated with each sender. The five SP relays are arranged in a double transfer lockout circuit which regulates sender preference in seizing the connector. This insures that only one sender at a time can use the connector.

4.14 The CA1 relay operates the GR2, GR3 and GR4 (ground test) relays which disconnect a standing test for false ground from a number of leads about to be used (OS 158-1). The operated CA1 relay also starts timing for decoder seizure (OS 157-1). The GR2, GR3 and GR4 relays extend a path from the operated SP relay to operate its associated multicontact relay SC (sender connector) which in turn operates SC1 (sender connector auxiliary) (OS 155-1). These two relays connect the sender to the receiving and transmitting leads in the connector. The SC relay operates the GS (ground supply) relay which grounds various leads for future use.

(D) Decoder Preference Circuit (SC 113-1)

4.15 After a sender has cut through its transmitting and receiving leads to the common multiple of the decoder connector, the next step is to select and seize an idle decoder and then extend certain of these leads into this decoder.

4.16 All decoder connectors have access to all decoders. Two relay chain circuits are provided to establish within a decoder connector an order of preference in the selection of a decoder, and to guard against the possibility of two separate connectors connecting to the same decoder (OS 155-1). One chain circuit runs between the CB (connector busy) relays within a decoder connector, and the other, associated with a particular decoder, runs between decoder connectors.

4.17 The chain circuit which establishes the order of decoder preference is made up of CB relays, one for each decoder. In each connector, the CB relay operates when the decoder with which it is associated becomes busy. However, the CB relay in the connector that is actually handling the call does not operate; this is further explained later in this part. In selecting a decoder, entry into the chain may be made at any CB relay through a cross-connection which fixes the order of preference. An unoperated CB relay permits the seizure of its associated decoder. An operated CB relay transfers the chain to the next higher numbered CB relay. However, when the highest numbered CB relay is operated, it transfers the chain back to the lowest numbered CB relay.

4.18 The chain circuit, which guards against the possibility of two decoder connectors connecting to the same decoder, is made up of DP (decoder preference) relays. There is a DP relay for each decoder in each connector. The DP relays for a particular decoder are arranged in a double-transfer lockout circuit running from connector to connector. This regulates preference between connectors in seizing the decoder and insures

that only one connector at a time can use a given decoder.

4.19 As soon as relay SC operates, the sender start battery operates a DP relay. This relay in turn operates the associated DC (decoder connector) multi-contact relay which then operates the DC1 (decoder connector auxiliary) relay. These two multicontact relays complete extension of the necessary leads from the connector into the decoder. In addition, the DC1 extends leads from the decoder connector to the marker connector for future use.

4.20 The DP relay also operates relays CKG, CKG1 and CKG2 (check ground) in the decoder, which prepare it for handling the call. Another function of the DP relay is to open both sides of the double-transfer chain, which causes the release of the standing test relays DA1 and DA2 in the decoder to start the decoder work timer (OS 160-1).

4.21 The DC1 relay operates the GRA (ground test) relay (OS 155-1). The operated GRA relay disconnects a standing test for false ground from some of the leads about to be used (OS 158-1), stops decoder seizure timing, starts connector release timing (OS 157-1), and operates the GT (gate) relay which in turn operates the GT1 (gate auxiliary) relay. The GT and GT1 relays remain operated as long as calls in any other connectors are waiting for a decoder. This prevents the connector from serving any additional calls until the waiting connectors have each served one call (OS 156-1).

4.22 The DC1 relay also operates the decoder OAT (over-all timing) and CBR-W (connector busy) relays. The CBR-W relays provide the path for operating the CB relays associated with this decoder in all connectors except the connector serving this call. The CB relay in the connector which has seized this decoder cannot operate since both sides of the primary winding is grounded, thus preventing the transfer of the sender start battery to the DP relay of another decoder (OS 155-1).

4.23 Any CB relays in the connector that are operated at the time the SC relay operated are locked to the make contacts on the SC relay. Thus, if a decoder associated with one of the operated CB relays becomes idle, the CB relay cannot release. This prevents transferring the start battery back to the DP relay associated with the decoder that has just become idle. However, if all CB relays in the connector are operated, the locking path, which requires at least one CB relay to be normal is opened.

5. DECODER AND HOME TRANSLATOR OPERATIONS

(A) General

5.01 Thus far the call has progressed to a point where the first three digits dialed by the operator have caused the sender to be connected to an idle decoder through a decoder connector.

5.02 The decoder can gain access to its home translator, its decoder foreign area translator (if provided), or any one of foreign area translators. Each type of translator is described in Section A828.101.1. The principal functions of the decoder, together with a card translator, are:

- (a) Receiving code digit and other information from the sender.
- (b) Translating 3- or 6-digit codes into information which can be used in selecting an outgoing trunk.
- (c) Informing the marker that the sender should connect as many as three digits of the dialed code to another code.
- (d) Directing the marker to employ certain alternate routes, if needed.
- (e) Informing the marker as to the number of digits the incoming sender is to output.

5.03 This call is to be completed using 3-digit translation, so only the home translator will be required by the decoder. For such a call the decoder and the home card translator require approximately 350 milliseconds to complete their functions.

5.04 On this call the decoder and home translator operations take place in the following sequence and are discussed in this order on the subsequent parts:

- (a) The decoder connector seizes the decoder, allowing certain information from the sender to be registered in the decoder.
- (b) The decoder performs an integrity check to test the continuity of certain leads between the decoder and the sender.
- (c) The decoder connects to the home translator while the integrity check is being made.
- (d) The decoder uses the first three digits (223) impulsed to the sender to operate code bars in the home translator, causing a 3-digit card to drop.

(e) The information on the 3-digit card is read by firing cold cathode tubes associated with enlarged punches in the card. Relays corresponding to the fired tubes are then operated in the decoder to register the information.

(B) Decoder Operations Following Seizure

5.05 As described in Part 4 of this section the decoder connector seizes a decoder by operating the DP relay associated with that decoder. The DP relay operates the DC relay, which in turn operates the DC1 relay. The operated DP, DC, and DC1 decoder connector relays cause the following operations to take place on the decoder (SC 113-1).

DP Relay Functions

5.06 The operated DP relay operates the CKG, CKG1 and CKG2 (off normal ground supply and start circuit) relays from ground on the make contacts of the SC relay (OS 155-1). The operation of the CKG1 relay enables the decoder to start the integrity check of leads from the sender and to start seizure of the home translator. These operations are described later.

5.07 The operation of the DP relay removes ground from the DA1 and DA2 leads by opening the chain circuit which is wired through the normal contacts of all DP relays associated with this decoder (OS 155-1). This action releases the DA1 and DA2 (decoder preference chain alarm) relays in the decoder. The normal DA1 and DA2 relays operate the SWT (start work time) relay to initiate the "work time" or short time-out period. Decoder timing is covered in detail in Section A828.121.15.

5.08 The release of the DA1 relay also lights the BD (busy decoder) lamp on the trouble recorder frame. The circuit arrangement involving the DA1 and DA2 relays is a standing check on the DP relays which determines whether the DP relays are normal when the decoder is idle.

5.09 The normal DA2 relay operates the DA3 relay. A chain circuit is wired through the make contacts of the DA3 relays of all decoders so that if all decoders are busy a circuit is closed through to the decoder timing control circuit over the ADB (all decoders busy) lead (OS 158-1). This lights the ADB lamp on the trouble recorder frame. If all decoders stay busy for approximately 50 seconds, a minor alarm is given and the DBA (decoders busy alarm) lamp on the trouble recorder frame is lit. This alarm and lamp must be retired manually.

5.10 The operated DA3 relay also energizes the XCO (cross check cut-off) relay,

which disconnects the XDRL (cross check on DRL lead) relay and the XCA (cross check on CA leads) relay from the DRL and CA leads respectively (OS 160-1).

DC Relay Functions

5.11 As shown on OS 124-1, the operation of the DC relay connects ground to the winding of the decoder 3D (3-digit signal from sender) relay, causing it to operate. On this call the 6D and 6DA relays remain normal. As shown on OS 160-1, the operated DC relay connects ground to the winding of the NRO (no reorder signal from sender) relay, causing it to operate. The RO (reorder signal from sender) relay and the STI (start trouble indicator request from sender) relay remain normal.

5.12 The operation of the DC relay also closes through the CK1, PF, 5BD, TSA, TSB, TSC, TR2, and CFM leads to the decoder. The continuity of these leads is checked by the integrity check described later.

5.13 The operated DC relay closes through the A_2 to F_2 leads from the register

relays in the sender to the contacts of the CC- (code cut-in) relays in the decoder (OS 162-1, Tables A and B). Since the CC-relays are normal, the leads are open at this point.

5.14 The operated DC relay also closes through the SMI and SMC leads from the incoming trunk to the windings of the SMI, SMC, SM11 and SM11 (incoming trunk) relays (OS 168-1). The operation and use of these relays are discussed in connection with marker selection in Part 6 of this section.

DC1 Relay Functions

5.15 As discussed in Part 4, the operation of the DC1 relay in the decoder connector grounds the BD lead to the decoder, causing the operation of the CBR-CBW (connector busy) relays (OS 155-1). The operation of the CBR-CBW relays places a ground on all CB leads associated with this decoder, causing operation of the CB relays associated with this decoder in all decoder connectors except the connector handling the call. The CB relay in this decoder connector is prevented from operating by a ground on both sides of its primary winding. The operated CB relays of the other connectors advance their start leads to succeeding decoders which, in effect, makes this decoder busy.

5.16 The grounding of the BD lead by the DC1 relay operates the OAT (over-all timing) relay (OS 179-1). This starts the over-all timing period which checks against

failure of the work timer. Decoder timing is discussed in detail in Section A828.121.15.

(C) Integrity Check of Sender-Decoder Leads

5.17 As indicated above, the operated DP relay operates the CKG1 relay. The CKG1 relay causes the operation of the CK2 (integrity check of sender-decoder leads) relay and grounds the CK1 lead to the sender (OS 160-1). The grounded CK1 lead and the CK2 relay are used to make an integrity check, which involves testing the continuity of the TR1, 6DA, 5BD, TSA, TSB, TSC, and CFM leads, and also involves checking to determine that the leads in this group that are not already grounded by the sender or decoder connector are free of false grounds and crosses.

5.18 Note on OS 160-1 that the CK1 lead is cut off from those leads that are already grounded in order to transmit information from the sender or the decoder connector. On this call assume that only the TSB lead is grounded by the sender. The TSB lead causes the TSB relay (traffic separation B) relay in the decoder to operate and remain operated regardless of the grounded CK1 lead used in the integrity check.

5.19 As shown on OS 160-1, the ground that is present on the CK1 lead places ground on those leads that are not already grounded, causing the corresponding decoder relays to operate. When the CFM (card failure memory), TSA, TSB, and TSC (traffic separation A, B & C), 6D (6 digits) or 6DA (6 digits available), PF (preference relay for even/odd trunk block connector), TR2A (decoder indicates second trial) and 5BD (No. 5 board signal from sender) relays are all operated, indicating continuity of all the leads, the CK1 relay operates. This removes the ground that was placed on the CK1 lead and if there are no false grounds on the CK1 lead the CK2 relay and all the above mentioned relays that were operated from the ground on the CK1 lead release. Release of the CK2 relay will cause the CK3 relay to operate and lock as an indication that the integrity check was satisfactorily completed.

5.20 If the CK2 relay is held operated by a false ground on the CK1 lead, the decoder will be blocked by failure of the CK3 relay to operate. The call will be blocked because the CK3 make contacts must be used to operate certain relays that aid in reading the card (OS 163-1). When a call is blocked in this way, the work timer operates the SW11 (work time elapsed) relay after 330 milliseconds, causing the decoder to seize the trouble recorder in order to make a trouble record.

(D) Connecting Decoder to Home Translator

5.21 During the time the integrity check is being made, other relay operations cause the home card translator to be connected to the decoder. The decoder upon each seizure always connects to its home card translator.

5.22 As previously mentioned, operation of the DP relay in the decoder connector completes the closure of ground from the SC relay via the CKG lead to the decoder to operate the CKG, CKG1 and CKG2 relays (OS 155-1). The operation of the CKG1 relay causes the HTR (home translator connector) relay to operate (OS 160-1) which in turn energizes the HC1-16 (home connector) relays (OS 161-1).

5.23 The HC1-10 relays connect the 102 output leads of the home card translator to the decoder. The information punched on the translator card is transmitted to the decoder by these leads. The HC11-16 relays connect the 38 leads for positioning the code bars and the 16 control leads from the decoder to the home card translator. The HTR (home translator check) relay operates when the HC- relays operate, and prevents the decoder from connecting to another translator until all the HC- relays have released.

5.24 The operation of the HC14 relay grounds the CON lead to the card translator to operate the CON (connector off-normal) ground relay (OS 161-1). The operated CON relay operates the PD (pull-down) relay which energizes the eight pull-down magnets and also operates the PDS1-8 (pull-down slave) relays. The contacts of the PDS1-8 relays are used later to check that all the pull-down magnets are energized.

5.25 The operation of the HTR relay also provides a ground which operates the PU1 and PU2 (pull-up) relays in the card translator (OS 161-1). These two relays energize the eight pull-up magnets. These magnets are much stronger than the pull-down magnets. The HTR relay also operates the CSL (card support lift) relay. The CSL relay energizes the CSL1 and CSL2 (card support lift) magnets, causing the card support bars to lift slightly (RM 3-6). It should be noted that the card support bars do not have notches that can be engaged by the latches as do the code bars. Thus, the card support bars movement is independent of the latches. The lifting action of the card support bars, together with the lifting action of the pull-up magnets, raise the translator cards up so that their weight is no longer supported by the code bars.

5.26 Battery for operating the eight pull-up magnets is furnished through

the PUS1-8 (pull-up slave) relays so that they operate at the same time the eight pull-up magnets operate. With the PUS1-8 relays operated, a path is completed to operate the LCH (latch) relay. The operation of the LCH relay energizes four latch operating magnets, designated L1, L2, L3 and L4, causing them to disengage the code bars so that the code bars will be free to move. Each latch operates three sets of contacts as follows:

- (a) A set of four contacts in parallel to furnish a holding ground for the PU1 and PU2 relays.
- (b) A set of four contacts in parallel closes ground to hold the CSL relay operated.
- (c) A set of four contacts, connected in series, closes a circuit from ground on a back contact of the ARC relay to the decoder via the CC lead through make contacts of the NRO (no reorder) and 3D relays, to operate the CC1 and CC2 (code cut-in) relays in the decoder. The CC2 relay operates the CC5 relay.

5.27 With the pull-up and the pull-down magnets energized, the cards are magnetically polarized and have a mutual repulsion to each other, thus reducing any tendency the card might have toward hanging up an adjacent card because of a burr. The home card translator is now conditioned for positioning the code bars from information available in the incoming sender and the decoder. As shown on OS 162-1 the operation of the CC1 and CC2 relays in the decoder connects the A_2^2 , B_2^2 , C_2^2 and VO and NVO leads from the incoming sender to the windings of the associated code bar magnets in the card translator through make contacts on the HC11 and HC12 relays. On this call the AO, A2, BO, B2, C1, C3 and NVO leads are grounded. A ground on the make contacts of the CC2 relay is connected to the windings of the CG1 and CG4 code bars through the HC15 relay. The CG1 and CG4 leads are grounded to indicate that a 3D card is to be dropped. The term 3D card applies to the first card dropped under the control of the first 3 digits registered in the sender.

5.28 The above grounded leads, indicating input information to the card translator, energize the associated code bar magnets and pull the associated code bars down. On this call the AO, A2, BO, B2, C1, C2, CG1, CG4 and the NVO code bars are pulled down.

5.29 The positioning of the code bars causes the operation of corresponding code bar slave relays in the home card translator by means of off-normal contacts associated with each code bar. These code

bar slave relays are used to check the operation of the proper combination of code bars. If the CG1 and CG4 code bars, the NVO code bar and two each of the A, B and C code bars are pulled down, and no others, the CBK (code bar check) relay will operate.

5.30 If more than two code bars are pulled down for any code digit, the ORF (over register failure) relay will operate and block the call. The decoder then causes a trouble recorder to take a trouble record and then causes the call to be routed to reorder.

5.31 The operated CBK relay closes a path to operate the CS1 and CS2 (card support bar magnet) relays (OS 162-1). These relays energize the CS1 and CS2 card support bar magnets which are used to pull down the card support bars. However, these magnets are not nearly as strong as the card support lift magnets which are energized to lift the card support bars. Thus, the card support bar magnets cannot pull down the card support bars at this time.

(E) Dropping Card in Home Translator

5.32 The card with tabs corresponding to the depressed code bars cannot be dropped until:

- (a) the proper combination of code bars has been pulled down, as indicated by operation of the CBK relay;
- (b) the pull-down magnets are all energized, as indicated by operation of the PDS1-8 relays;
- (c) the card support bars have been pulled down, as indicated by the operation of the SCS1 and SCS2 (code support bar slave) relays;
- (d) the pull-up magnets are deenergized, as indicated by the release of the PUS1-8 relays.

Thus far the description has covered items (a) and (b) and we are now ready to drop the card by performing operations (c) and (d).

5.33 In order to position the code bars it was necessary to unblock them by operation of the latches. Now that the code bars have been positioned and the CBK relay has been operated as a check of the proper combination of code bars, the LCH relay releases (OS 161-1). This releases the four latch magnets L1-L4, locking the selected code bars in the operated position. The release of the four latch magnets and the operation of the CBK relay release the CSL relay, which deenergizes the card support lift magnets. Since the card support bar magnets are energized the

the card support bars are pulled down (OS 162-1). With these bars pulled down a path is closed to operate the SCS1 and SCS2 (card support bar slave) relays.

5.34 The operated SCS1 and SCS2 relays and the normal L1-4 latch magnets open the operating path to the PU1 and PU2 relays, allowing them to release. The PU1 and PU2 relays deenergize the eight pull-up magnets and release the PUS1-8 pull-up slave relays. This allows the cards that had been held by the pull-up magnets and the card support bars to drop down on the code bars which are now locked by the latches.

5.35 The card that has tabs that correspond to the depressed code bars drops down about 3/16" below the other cards. The 3D card which is dropped is shown on Fig. 15 and it is like the card indicated by exhibit 4 on both RM 3-4 and RM 3-5. The dropped card has the AO, A2, B0, B2, C1, C2, CG1 and CG2 tabs on its bottom edge. Note that the card does not have an NVO tab to correspond to the depressed NVO code bar. The NVO tab is taken off because there is only one class of trunks to the Wildwood office. These trunks are common grade trunks and it is necessary for the 223-3D card to be dropped when either the VO or the NVO code bar is depressed. Section A828.121.4 describes the use of the VO and NVO tabs when there are two classes of trunks to the call destination.

5.36 With the 3D card dropped, the input information, represented by the tabs, can be translated into output information by reading the output channels associated with the enlarged punches or holes on the translator card. There are 116 punches on the card which are associated with output channels. Two additional punches represent index channels. The index channel punches are never enlarged. The operations involved in using the index channels to indicate that a card has dropped and then in using the output channels to read the card information are explained in (F) of this part.

(F) Reading The 3D Card

General

5.37 As shown on RM 3-6, the card translator has a source of modulated light at one end of the deck of cards and a bank of phototransistors at the other end of the deck. The light source is a pre-focused projection type lamp called an exciter lamp. The light beam is modulated by spinning a perforated disc, called the chopper, in between the lamp and the deck of cards. The bank of phototransistors contains one phototransistor for each of the 116 output channels and one for each of the two index channels. The phototransistors, which are shown on OS 185-1, conduct current when light from the exciter lamp is falling on them. They become nonconducting when a dropped card cuts off

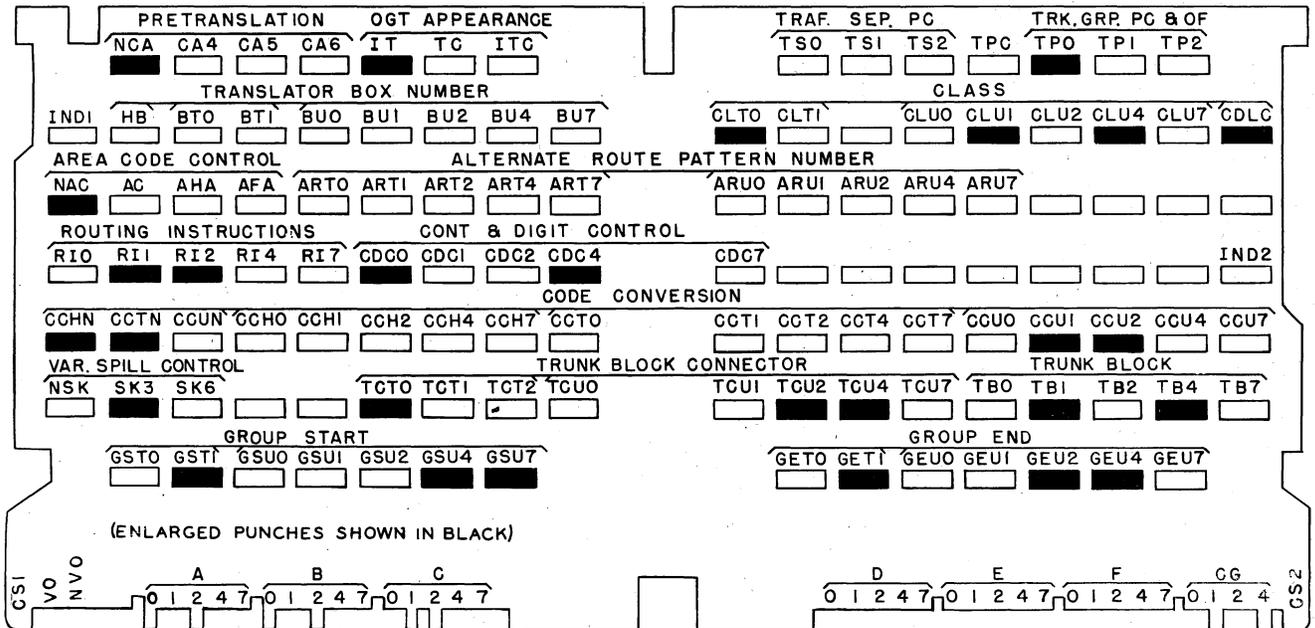


FIG. 15 - CARD LAYOUT FOR NEWARK-WILDWOOD INTERTOLL TRUNK GROUP CODE 223-3D VIEWED FROM LIGHT SOURCE

the light source. The phototransistors used in the index channel circuits are the same type as those in the output channel circuits.

5.38 When all cards are in their normal position, light from the exciter lamp passes through all of the cards and falls on all of the phototransistors. The current flow through the output channel phototransistors does not perform any useful function at this time. The current flow through the index channel phototransistors is used to indicate that all the cards are in their normal position and that the light system is operating properly. When the 223-3D card is dropped, the light through the index channels, as well as the light through all output channels whose punches on the 223-3D card are not enlarged, is cut off. The light through the output channels associated with enlarged punches is allowed to fall on the corresponding phototransistors.

5.39 The operations of the output channel circuits and the index channel circuits are discussed in the following order:

- (a) Output channel circuit operations before 223-3D card is dropped.
- (b) Index channel circuit operations before and after 223-3D card is dropped.
- (c) Reading card by firing tubes in channel output circuits.
- (d) Registering 223-3D card information in the decoder.

Output Channel Circuit Operations Before 3D Card Is Dropped

5.40 The modulated light beam passing through an enlarged punch on the 223-3D card strikes the phototransistor and causes an alternating voltage to be superimposed on the 24-volt d-c circuit associated with the phototransistor. The a-c component may vary from about 2.2 to 6 volts RMS (root mean square).

5.41 As shown on OS 185-1, the signal is applied to a channel output amplifier unit through a 20,000 ohm:600-ohm step-down transformer. The impedance of the phototransistor varies over a wide range but its average value is approximately 20,000 ohms. The input impedance of the amplifier unit averages about 600 ohms. Thus, the transformer matches the impedance of the phototransistor with the impedance of the amplifier unit.

5.42 The channel amplifier unit utilizes the transistor as the amplifying element. The transistor used is slightly

less than 1/4" in diameter and slightly less than 1/2" in length. It consists of a small wafer of germanium crystal, approximately 1/8" square and 0.020" thick. This crystal is mounted on a conducting plate, called a base, in one end of a metal cylinder as shown on Fig. 16. The other end of the cylinder is closed with a piece of ceramic material in which are mounted two small rod terminals. Short pieces of fine tungsten wire are attached to each of these rods so that they touch germanium crystal at points which are about 0.002" apart. One of these point-type contacts is called the collector, while the other one is called the emitter.

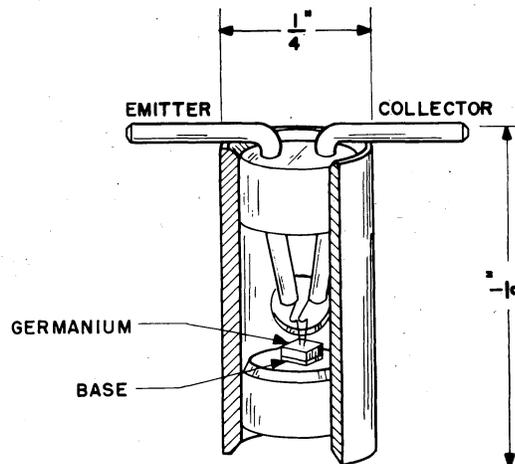


FIG. 16- TRANSISTOR

5.43 The transistor's action is similar to that of an electron tube in its amplifying action. The current, due to the modulated light beam striking the phototransistor, flows between the emitter (E) and base (B) of the transistor and causes changes in the current flowing between the base (B) and collector (C). This current, flowing through the high resistance between the collector and ground, causes a voltage change which is up to 100 times the input voltage. This amplified output voltage is further stepped up to a peak of about 45 volts by the transformer (turn ratio 1:8.7) in the channel output detector unit and is then applied to the control anode of the 376B cold-cathode tube.

5.44 This tube requires 80 volts across the starter gap (cathode to control anode) to get reliable firing. The cathode has a fixed bias of -48 volts; therefore at least +32 peak volts must be applied to the control anode before the tube can fire.

At this time the RD relay is normal and -24 volts is applied to terminal 4 of the detector unit, thus reducing the positive peak voltage on the control anode to a value below +32 volts. Thus, this tube and the other tubes associated with illuminated output channels cannot fire at this time.

Index Channel Circuit Operations Before and After 3D Card Is Dropped

5.45 When all the cards are normal the modulated light passing through the IND1 punch falls on the associated photo-transistor and causes the generation of an a-c signal. As shown on OS 185-1 this signal is applied to the grid of the first triode section of the IND1 (index) electron tube through the coupling capacitor C1. This section of the electron tube is operated as a class A1 amplifier. Class A1 operation means that the grid is always negative with respect to the cathode with normal input signal levels. Bias is provided by the voltage drop across the 1500-ohm cathode resistor K1.

5.46 The amplified output voltage of the first half of the IND1 electron tube is applied to a half-wave varistor rectifier by means of coupling capacitor C1. The varistors are of the germanium type and are connected in the circuit in such a manner that the current during the positive half cycle is shunted directly to ground, while the current during the negative half cycle flows through the 0.47-megohm resistor GR1 to ground. This current flow causes a voltage drop in resistor GR1 which is used to bias the second triode section of the IND1 electron tube to cut-off while the modulated light beam is striking the photo-detector. Capacitor GR1 and resistor GR1 have a time constant which maintains sufficient negative bias voltage on the grid of the electron tube during the positive half cycle, so that the plate current flowing while the modulated light beam strikes the phototransistor is insufficient to operate the IND1 relay. Cutting off the light striking the photo-detector (by a dropped card) removes the a-c component of the voltage. Then the bias on the triode second half of the electron tube becomes zero. With the tube bias reduced to zero, plate current flows, operating the IND1 relay. Similar operation in the other index channel circuit causes the operation of the IND2 relay.

5.47 Failure of an index channel while the card translator is idle (CON relay released) will cause the operation of the ALM (alarm) relay, thus providing protection against failure of the index channel circuit as well as failure of the exciter lamp and the chopper.

5.48 When the 3D card drops, it interrupts the light beams through the

index channels and causes the operation of the IND1 and IND2 relays as previously described. Ground from the operated IND1 and IND2 relays is transmitted through the operated contacts of the PDS1-8 relays in the card translator to the decoder over the IND1 and IND2 leads (OS 164-1). All of the pull-down magnets thus must be energized before the decoder is allowed to proceed.

5.49 The IND1 and/or IND2 relay operates the RD (read) relay in the card translator to remove the 24-volt battery and place ground on the control anode of the 376B cold-cathode tube. This 24-volt battery is connected to the control anode while the translator is idle to guarantee that the tube is extinguished between cards, and to reduce the sensitivity of the detector during idle periods, thus increasing the margin against false operation.

Reading Card by Firing Channel Output Tubes After 3D Card Is Dropped

5.50 When the decoder receives a ground on the IND1 and IND2 leads both the COP1 and COP2 (card operated indication) relays operate (OS 163-1). Work timing is recycled by the operation of the COP2 relay. The COP1 and COP2 relays cause the operation of the CA (come again), FAT (foreign area translator), RI (routing instruction), MKR (marker selection), and CCM (code conversion) battery supply relays. These relays in operating connect positive 130-volt battery to the main anodes of the output channel tubes shown on OS 164-1. The battery is connected to the tubes through make contacts of the OC1-10 (output control of card items) relays (OS 165-1). The OC1-10 relays are operated by the OC (output control) relay which operated from the CKG2 relay when the decoder was seized (OS 163-1).

5.51 In the channel output circuits associated with enlarged punches on the 223-3D card there will be at least 80 volts between the cathodes and the control anodes, in order to fire the associated 376B tubes, since the minus 24-volt bias was removed by the operation of the RD relay. Thus when the CA, FAT, RI, MKR and CCM relays operate, +130 volts is connected to the main anodes of certain channel detector tubes, and those tubes associated with enlarged punches on the 223-3D card will conduct current.

Registering Card Information in the Decoder

5.52 When the channel detector tubes fire and when +130 volts is connected to the main anodes the main gap current operates the corresponding channel relays in the decoder (OS 164-1 and 185-1). These relays lock to ground on their make contacts. This ground extinguishes the main

gap of the tubes that have fired, thus lengthening the life of the tubes. However, the starter gaps remain fired during the time the card remains in the dropped position.

5.53 The following channel relays in the decoder are operated for this call:

(a) The NCA (no come again) relay operates to indicate that the call can be completed from this card and that 6-digit translation will not be required.

(b) The IT (intertoll marker) relay operates to indicate that the outgoing trunk is on the intertoll train and that the outgoing trunks indicated on the card are located on the intertoll train.

(c) The NAC (no area code) relay operates to indicate that the code used to drop the card is not an area code.

(d) The RI1 and RI2 (follow-with-overflow routing instruction) relays operate to indicate that, if the call cannot be completed in the normal manner, the incoming trunk should be connected to an overflow trunk.

(e) The CCHN (code conversion hundreds none), CCTN (code conversion tens none), CCUL and CCU2 (code conversion units 1 and 2) relays operate to indicate code conversion information. This information is later sent to the marker and from the marker it is sent to the sender to instruct the sender to out-pulse a 3 in place of the Cape May 3 national office code, 223. The digit 3 must be used to drive an intertoll selector of the intertoll train in the Wildwood office in order to seize a trunk to the Cape May 3 office.

(f) The TCTO, TCU2 and TCU4 (trunk block connector tens and units) relays operate to indicate that the outgoing trunks to the Wildwood office are terminated on trunk block connector No. 6.

(g) The TB1 and TB4 (trunk block) relays operate to indicate that the outgoing trunks to the Wildwood office are terminated on trunk block No. 5 of the trunk block connector.

5.54 The operation of the NCA relay as described in (a) above closes a path to operate the RCC (battery supply for alternate route pattern) relay (OS 163-1). This relay connects +130 volts to the windings of the alternate route pattern number tubes and the continuity and digit control tubes in the translator. (See RM 3-7.)

The operation of the RCC relay fires the main gap of those tubes that are associated with enlarged punches on the 223-3D card. On this call the alternate route pattern number punches are not enlarged. (See Fig. 15.) Since the CDCO and CDC4 continuity and digit control punches are enlarged, the CDCO and CDC4 tubes fire.

5.55 When the CDCO and CDC4 tubes fire the corresponding channel relays operate in the decoder (OS 164-1). These relays lock to a ground which extinguishes the tubes. The CDCO and CDC4 relays are used to indicate both continuity information and sender digit control information to the marker. The purpose of this information is discussed under Marker Operations in Part 7 of this section.

5.56 The variable spill control, class, group start, group end and trunk group peg count information on the card is read by the marker. The leads carrying this information are extended from the translator to the marker via the operated OC-relays in the decoder and the marker connector. Thus, the next operation on this call involves seizure of a marker connector and a marker, and is described in the following part.

6. CONNECTING TO IDLE MARKER THROUGH A MARKER CONNECTOR (SC 113-1)

(A) General

6.01 The decoder has now read the information available to it from the card. No come again instruction indicates that the decoder should be connected to the proper type of marker at this time. In this description it is assumed that the call originates at an outward toll switchboard at Newark and that the toll tandem trunk from the switchboard appears on only the intertoll train of the 2-train 4A office at Newark. The outgoing trunk to Cape May appears only on the intertoll train, so it is necessary to select an intertoll marker, i.e., one which has access to the intertoll train.

6.02 The connection between the decoder and the marker is made by a marker connector. There are a maximum of 109 leads to be cut through from the decoder to the marker. In addition, there are 52 leads to be connected between the marker and the decoder connector. Forty-three of these 52 leads are extended by the decoder connector into the incoming sender, and nine are used between the decoder connector and marker.

6.03 There is one marker connector for each decoder and no other decoder has access to it. Each marker connector has access to all markers, both intertoll and toll completing. A marker connector

is composed of one 60-contact MCA relay, one 30-contact MCB relay and from one to three MC- U-type relays for each marker in the 4A office. The number of U-type relays per marker depends on the number of trunk block connectors installed in the 4A office. In a 2-train office, two double-transfer lockout preference circuits are also provided in each marker connector to control the selection of a marker by a decoder. One preference circuit is used for preferring an intertoll marker while the other is used for preferring a toll completing marker (OS 188-1).

6.04 Each preference circuit is arranged so that each decoder has access to all markers in the group and prefers a particular marker. If the preferred marker is engaged or plugged busy, the preference circuit transfers the request to the next available marker in the chain. Where the number of decoders are more than the markers in an IT or TC group, the preference assignment made gives each marker as nearly an even loading as possible. Thus each decoder has access to any marker and the connections between the marker and the decoder are completed by the operation of the appropriate multicontact and U-type cut-in relays.

6.05 Figs. 13 and 14 show in simplified form how the decoder connector, decoder, marker connector and marker are interconnected. The leads which cause the operation of the proper marker cut-in relays in the decoder connector are not shown.

(B) Seizing an Intertoll Marker in a 2-Train Office

6.06 On this call both the toll tandem trunk and the outgoing intertoll trunk are terminated on the intertoll train; therefore an intertoll marker must be used. In order to indicate that the incoming trunk is located on the intertoll train, the trunk circuit is so wired that low resistance ground is placed on the SMI lead and high resistance ground is placed on the SMC lead. As shown on OS 168-1 these leads are extended from the trunk circuit through the sender link and connector, and the decoder connector, to the decoder. These grounded leads operate the SMI and SM11 (select magnet intertoll train) relays. The SMI relay operates the SMI2 (select magnet intertoll train) relay. With the SMI2 relay operated the decoder has registered that the incoming trunk is terminated on the intertoll train.

6.07 As shown on Fig. 15 the IT punch is enlarged on the 223-3D card to indicate that the outgoing trunks are located on the intertoll train. The operated IT relay is matched with the SMI2 relay to operate the IT1 relay, as shown on OS 168-1.

The operation of the IT1 relay indicates that an intertoll marker is required.

6.08 The matching circuit is arranged so that it can recognize a mismatch in order to route the call to reorder. A mismatch results from an operator's error in the following way. The toll tandem trunks to a 2-train office are terminated on only one train. Most of these tandem trunks are designated intertoll and are terminated on the intertoll train. The other tandem trunks, designated toll completing, are terminated on the toll completing train. If by mistake the operator seizes a toll completing tandem trunk on this call, the SMC2 relay operates in the decoder. When the IT relay operates after the decoder reads the card, the matching circuit indicates a mismatch by operating the ROTC relay. The ROTC relay then operates the TC1 relay to indicate that a TC marker is to be used to seize a reorder trunk as discussed in Section A828.121.18.

6.09 The matching circuit on OS 168-1 is also used by the decoder to select the type of marker to be used when an incoming trunk, such as a common grade trunk, is terminated on both trains. With this type of trunk both the SMI2 and SMC2 relays operated in the decoder. When the IT relay operates from the card, the IT1 relay operates to indicate that an intertoll marker is required.

6.10 If the incoming and the outgoing trunks are terminated on both frames, the call could be completed by selecting either types of marker. With this condition the ITC relay is operated after the card is read and the SMC2 and SMI2 relays are operated from the incoming trunk. The matching circuit is arranged to operate the TC1 relay to indicate that a toll completing marker should be selected. (See Table 2, OS 168-1.)

6.11 When the IT1 relay is operated on the call being described, a circuit is closed to operate the SMCO (select magnet cut-off) relay in order to open the SMI and SMC leads and release the SMI and SM11 relays. At the time the card is read by the decoder, the NCA (no come again) relay is operated. The operation of this relay and the non-operation of the CA4, CA5 or CA6 (come again 4, 5, or 6) relay is checked on a one-only basis by the CAK (come again check) relay (OS 166-1). The operation of the NCA, the CAK, IT1 and the SMCO relays complete the path for operating the IT2 (intertoll marker auxiliary) relay (OS 168-1).

6.12 The operation of the IT2 relay indicates that the decoder has now progressed to a point where it is ready to select an intertoll marker with the assistance of a marker connector. In a 2-train

office the SIT lead between the decoder and the marker connector is used to select an intertoll marker (OS 188-1). The SIT lead passes through a chain set of contacts on the CB relays starting with the preferred intertoll marker. The back contact of each CB relay is wired to the winding of the MP relay for that marker, while the front contact is wired to the SIT lead that connects to the MP relay for the next marker in the chain, and so on through the preference circuit associated with the intertoll marker.

6.13 The MP relay in the marker connector is arranged in a double-transfer lockout circuit which extends from an MP relay in one connector through the MP relays associated with the same marker in other connectors. The functional ground associated with this chain extends through all connectors, and starts with a different connector for each marker. Several MP relays associated with a particular marker may operate and lock simultaneously, but only one of them will be successful in operating the MC- relays to connect the marker to the decoder.

6.14 Operation of the IT2 relay connects battery to the SIT lead in the marker connector, which causes the operation of the preferred MP relay in the marker connector if the preferred marker is not engaged or plugged busy on the trouble recorder frame. If the preferred marker is busy, the operated CB relay will advance the circuit to operate the next idle MP relay which causes the operation of the marker cut-in multicontact relays MCA, MCB and U-type relays, MC1, MC2 and MC3. The operation of the MCA relay in the marker connector places a ground on the ITK (intertoll marker check) lead to the decoder to operate the ME (marker engaged) relay (OS 168-1). The operation of the ME relay indicates to the decoder that a marker is attached and restarts the decoder work timer which was stopped during marker selection. This timing feature is covered in detail in Section A828.121.15.

6.15 The MCA relay operates the CBR (connector busy) relay in the marker which in turn operates the CB (connector busy) relays belonging to that marker in all other marker connectors (OS 188-1). The CB relay in the connector that has the MCA relay operated is kept normal by having its winding short-circuited. This arrangement is necessary because the SIT (or STC) lead that is holding the MP relay operated is wired through normal contacts on the CB relay. Each operated CB relay advances the start lead to the CB relay of the next choice marker in the same connector.

6.16 As long as the IT2 decoder relay is operated, the operated CB relays in the connector are held operated by their

locking windings (OS 188-1). However, the locking circuit is broken when all CB relays in the connector are operated in order to prevent their being held permanently. The reason for locking them is to prevent a connector that has started to seize a marker other than its first choice from abandoning that marker and reverting to an earlier choice marker if one becomes idle.

6.17 The 52 leads between the selected marker and the decoder connector used for transmitting information from the marker to the decoder connector and incoming sender must be closed through. This is done by operating the MC (marker cut-in) relay for the selected marker in the decoder connector. The operation of the MP relay in the marker connector places a ground on the IT- lead between the marker connector and the decoder connector (OS 188-1). The DC1 relay in the decoder connector associated with the decoder in use on this call is operated, and the DC1 relays associated with this decoder in all other decoder connectors are not operated. Thus the ground from the MP relay in the marker connector causes the operation of the proper MC relay in the decoder connector that is handling this call.

6.18 A marker of the proper type has now been selected and connected to the decoder and the decoder connector. The equipment is now prepared for the marker to perform its functions which are described in Part 8 of this section.

(C) Seizing Marker in a Combined Train Office

6.19 In an office having a combined train, all trunks are on the same train so there is no need for using different types of markers. The SIT leads between the decoders and the marker connectors are used for marker selection.

6.20 When the decoder in a combined train office has read the 3D card, operation of the NCA and CAK relays indicates that 3-digit translation is to be made. The operation of the NCA and CAK relays completes the circuit for operating the IT2 relay (OS 168-1). The operated IT2 relay places battery on the SIT lead to the marker connector (OS 188-2). The action of the marker connector in selecting and cutting through the leads between the marker and the decoder and decoder connector is the same as described under 2-train office operation.

7. MARKER OPERATION (SC 122-1)

(A) General

7.01 At this time the call has progressed to the point where the decoder has received the 3-digit code from the incoming

sender, has connected to the card translator, and from the 223-3D card has received the information necessary to select and seize an intertoll marker via a marker connector. The marker now receives information from the decoder and the 223-3D card, and uses it to establish a connection between the incoming trunk originating the call and an idle outgoing trunk toward the called point.

7.02 The marker must perform the following operations in order to establish the connection between the incoming and outgoing trunk:

- (a) Register some information from the translator card through the decoder and some directly from the decoder.
- (b) Check to determine that sufficient information has been received, and signal the decoder to release.
- (c) Seize the trunk block connector and the trunk block containing the test leads for the desired group of outgoing trunks.
- (d) Test the trunk group and seize an idle outgoing trunk.
- (e) Identify and seize the outgoing frame on which the seized outgoing trunk is located.
- (f) Identify and seize the incoming frame on which the originating incoming trunk is located.
- (g) Test the channels and seize an idle one between the incoming trunk and the selected outgoing trunk.
- (h) Operate the select and hold magnets associated with the seized channel connecting the desired trunks.
- (i) Make a continuity test to insure that the 4-wire talking connection has been set up from the incoming trunk to the outgoing trunk.
- (j) Transfer to the incoming sender all the control information required by the sender to complete the connection to the called office.
- (k) Transfer control of the connection to the incoming sender and send a marker release signal to the sender. When the sender receives the marker release signal, it releases the decoder connector which releases the marker.

(B) Equipment Layout

7.03 To gain access to the frames and circuits necessary to perform the

above operations, the marker makes use of the following connectors.

Marker Connector

7.04 A marker connector is used by the decoder to establish the connections between the decoder and the marker. There is one marker connector for each decoder, and each marker connector has access to every marker. This is accomplished by a group of marker cut-in relays (one for each marker) in every marker connector. (See Fig. 14.)

Decoder Connector

7.05 A decoder connector is used first to establish a connection between the sender and a decoder, when the marker connector has seized a marker, the decoder connector then establishes a connection between the sender and the marker. This connection between the incoming sender and the marker via the decoder connector is maintained after the decoder and the marker connector have released. The decoder connector operation is described in Part 4 of this section and is shown on Figs. 13 and 14.

Trunk Block Connector

7.06 The trunk block connector is used by the marker to gain access to the test leads of the outgoing trunks. The general trunk block connector arrangement is shown on Fig. 17. The outgoing trunks in any particular trunk group are distributed over as many outgoing frames as possible. The trunk block connector is used to concentrate the test leads of these trunks for connection to a marker.

7.07 The test leads from each trunk connected to the marker by the trunk block connector are the MS (marker sleeve) and SM (select magnet) leads. The MS lead indicates whether the trunk is busy, and also provides a path for making it busy. The SM lead carries a multifrequency indication that identifies the number of the outgoing frame on which the associated trunk appears. This lead is also used to operate the select magnet.

7.08 In a 2-train office, the intertoll marker group has access to only those trunk block connectors associated with the intertoll train. Likewise, the toll completing marker group has access to only those trunk block connectors associated with the toll completing train. Each train of a 2-train office can be equipped with a maximum of 30 trunk block connectors each having the test leads for 400 outgoing trunks.

7.09 The connector arrangement allows any one of ten markers (maximum) to gain

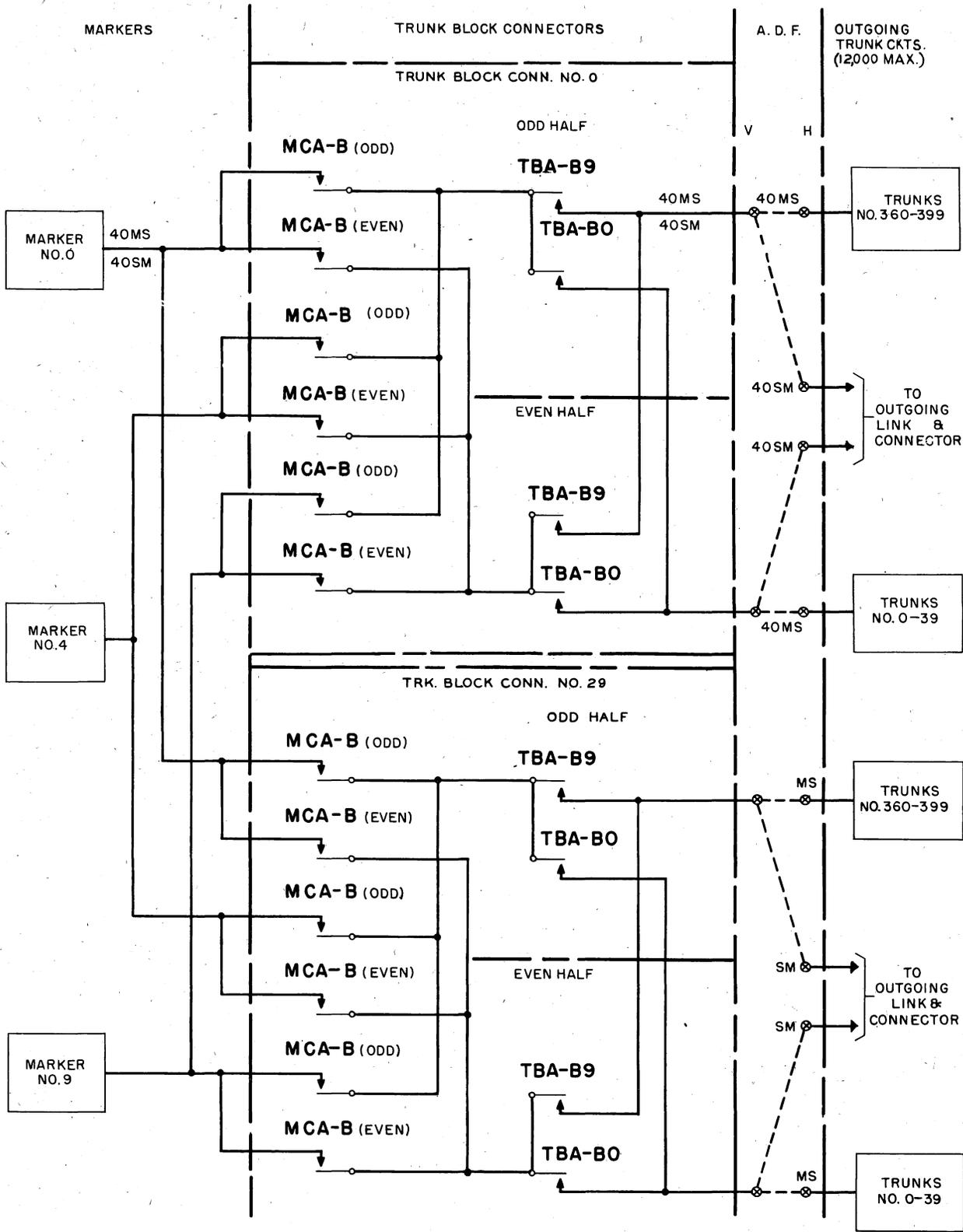


FIG. 17 - TRUNK BLOCK CONNECTOR ARRANGEMENT

access to any one of the 30 trunk block connectors (maximum), and then to any one of the ten blocks within one trunk block connector.

7.10 Each trunk block connector consists of an even and an odd half-connector. A marker can connect to either half depending upon a preference arrangement. Using the trunk block number from the translator card the marker can connect to a trunk block and test as many as 40 trunks.

7.11 Each half-connector contains:

- (a) An MCA- and an MCB- (marker cut-in) multicontact relay for each marker in the group.
- (b) A TBA- and a TBB- (trunk block) multicontact relay for each of the ten trunk blocks.
- (c) A set of double-transfer lockout marker preference relays.

7.12 The test leads for 400 trunks are multiplied so that each half-connector has access to all 400 trunks. These 400 outgoing trunks are subdivided into two groups of 200 trunks each and, as described later in this part, provision is made to enable one marker to test in the lower group (trks. 0-199) of the even half-connector while another marker tests in the upper group (trks. 200-399) of the odd half-connector, or vice versa. This arrangement reduces the marker holding time, by allowing two markers to test in the same 400 trunks at the same time, provided of course, that each marker is in a different subgroup of 200 trunks and a different half-connector. This arrangement also insures access to the group of 400 trunks on a trunk block connector even though one of the two half-connectors may be out of service.

Incoming Frame Connector

7.13 An incoming frame connector is used by the marker to gain access to either of a pair of incoming link frames. One incoming frame connector is mounted on each incoming link frame. As shown on Fig. 18, each incoming frame connector contains a home connector and a mate connector. On the even numbered frame of the pair, the home connector provides access to the trunks on the frame where the incoming frame connector is located. The mate connector provides access to the trunks located on the odd numbered frame of the pair. On the odd numbered frame, the home connector provides access to the trunks on the odd numbered frame where the frame connector is located, while the mate connector provides access to the even numbered frame. With this arrangement two paths are provided between the marker and

each frame. If the incoming frame connector on an even numbered frame is out of service, the marker can still be connected to that frame through the mate connector of the incoming frame connector on the odd numbered frame.

7.14 For convenience, where the frames are paired for junctor distribution, the same frames are associated in pairs for the home and mate connector operation. There is, however, no circuit reason for arranging the frames in the same pairs for both features.

7.15 A complete incoming frame connector consists of the previously mentioned home and mate connectors, a group of MC- (marker cut-in) relays consisting of one MC relay for each marker, and a preference circuit that determines which marker is to gain access to the frame. The components of an incoming frame connector, except the preference circuit, are shown on Fig. 19, attached.

7.16 A home connector consists of ten link cut-in relays LCHO-9 (link cut-in home), ten secondary home cut-in relays SHO-9 (secondary home), and an FCH (frame cut-in home) relay.

7.17 A mate connector consists of apparatus elements that duplicate those of the home connector. These elements are ten link cut-in mate relays LCMO-9 (link cut-in mate), ten secondary mate relays SMO-9 (secondary mate), and an FCM (frame cut-in mate) relay.

Outgoing Frame Connector

7.18 A complete outgoing frame connector consists of a home connector and a mate connector, a group of MC- relays consisting of one MC- relay for each marker, and a preference circuit that determines which marker is to gain access to the frame. The outgoing frame connector contains all the relays installed in an incoming frame connector. In addition, the home connector of an outgoing frame connector contains ten JCH- (junctor cut-in home) relays and the mate connector contains ten JCM- (junctor cut-in mate) relays. The components of an outgoing frame connector, except the preference circuit, are shown on Fig. 20, attached.

(C) Seizure

7.19 When the marker is seized by the decoder through the marker connector, as explained in Part 6 of this section, the first action in the marker circuit is the operation of a group of off-normal relays (OS 190-1) and the release of the DA1, DA2, and DA3 (preference chain alarm) relays. When the marker is idle, the DA1, DA2, and DA3 relays are operated from grounds

PAIR OF INCOMING LINK FRAMES

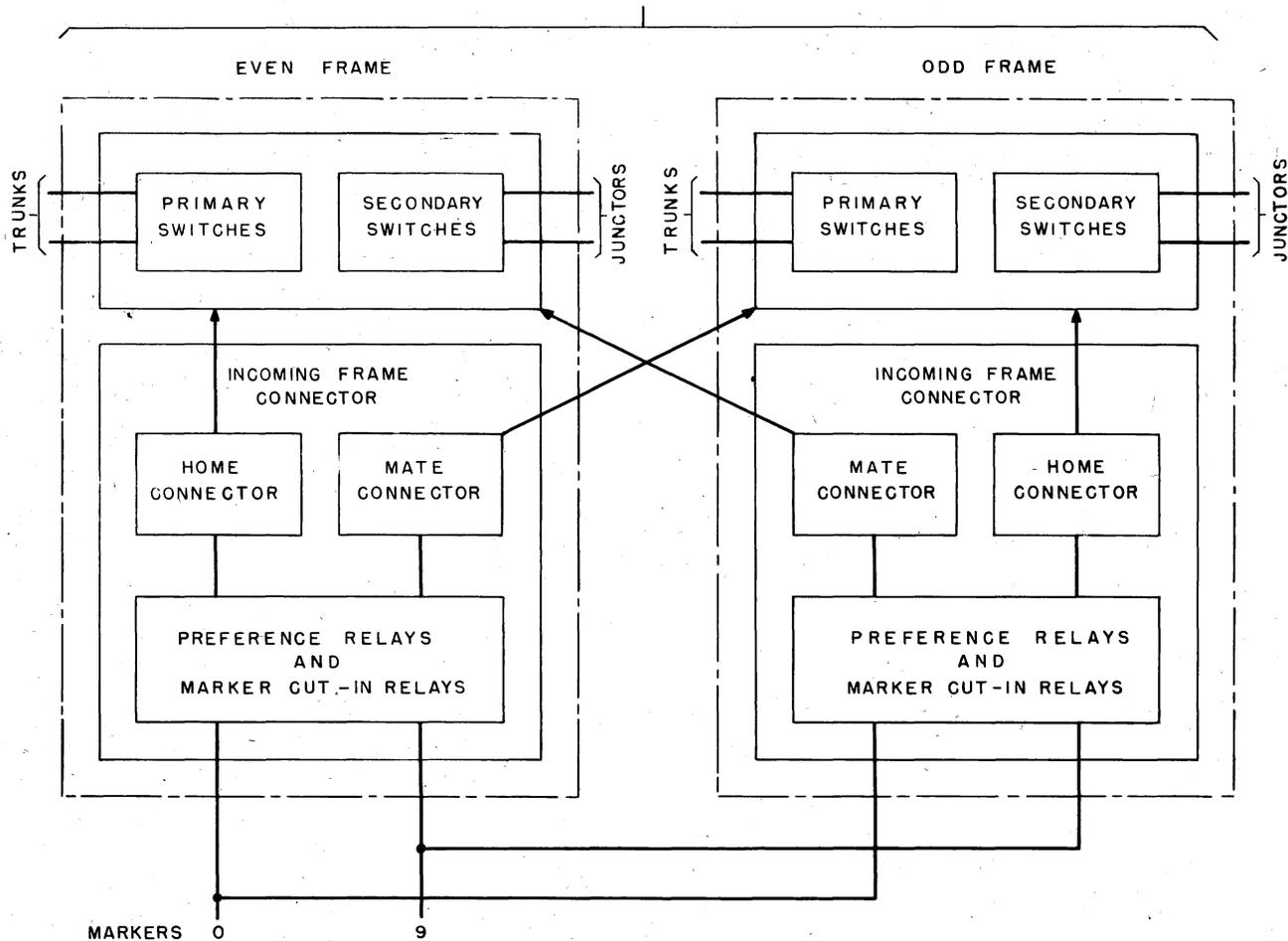


FIG. 18 - INCOMING FRAME CONNECTOR

supplied through the back contacts of each MP relay associated with the particular marker (OS 188-1). If any of these contacts are opened due to a trouble condition while the marker is idle, one of the DA-relays releases and closes the circuit to the OAT (over-all timing) circuit of the marker, as explained in Part 8 of Section A828.121.15. The normal DA1 relay also lights the DMB (decoder marker busy) lamp or the MB (marker busy) lamp in the miscellaneous circuit for the trouble recorder frame, indicating that the marker is busy either with or without a decoder attached.

7.20 The operation of the MCA (marker cut-in) relay in the marker connector operates the CBR (marker busy) relay in the marker. The CBR relay places ground on the CB leads from this marker into all marker connectors, operating the associated CB relays in each marker connector

except the marker connector that has seized the marker. The winding of the associated CB relay in the marker connector that seized the marker is short-circuited and this CB relay cannot operate. The operated CB relays transfer the preference to the next idle marker, thus preventing other decoders from attempting to seize the busy marker (OS 188-1).

7.21 The CKG relay operated by the marker connector MP (marker preference) relay is one of the principal control relays in the marker, and is operated through the normal contacts of the TR (trouble release), RL (release), OCO (outgoing frame cut-in), and ICO (incoming frame cut-in) relays to insure that these relays have released from a previous call before starting seizure of this marker (OS 190-1).

7.22 The CKG relay operates the CKGA (check ground supply auxiliary) relay, the

ONB (off-normal battery) relay, and the ONG (off-normal ground) relay, which in turn operates the ONG1 (off-normal ground auxiliary) relay. These relays close off-normal battery and ground paths to operate the following relays for use in subsequent marker operations.

Relay	Functional Meaning	OS
TKE	Trunk end	201-1
CHE	Channel end	212-1
HMT1	Hold magnet timing aux.	216-1
TMR	Time measured release	218-1
ID	Incoming frame detector	205-1

The functions of these relays are explained in the proper order later in this part.

7.23 The CKGA relay operated and DA2 relay released cause the operation of the XCOA, XCOB, XCOC, XCO, and XCO1 (cross cut-off auxiliary) relays (OS 190-1). These relays cut off the various idle marker standing test conditions in the marker.

7.24 The DE (decoder engaged) relay operates on seizure directly from the MCA relay in the marker connector and remains operated as long as the decoder is attached. The operation of the DE relay at this time operates the SPT (stop timing) relay, which blocks the TM timer until a check of the card information registered in the marker has been made (OS 218-1).

7.25 Each time a marker is seized the leads from the decoder indicate whether the call is a first or second trial call (OS 190-1). This fact is registered by the operation of either the TR1 (first trial call) relay or the TR2 (second trial call) relay. On the call being considered, the TR1 relay is operated by ground from the decoder over the TR1 lead. The TR1 relay locks to the CKGA ground and is used to control the marker operations on a first trial basis for the entire operation of the marker. Second trial calls are explained in detail in Section A828.121.17.

7.26 Odd or even preference is also registered in the marker on seizure. This preference is used to equalize the flow of traffic through the trunk block connectors and the incoming and outgoing link connectors which are arranged for dual access operation. The incoming sender controls the preference and registers it in the decoder, which, in turn, grounds either the CNO or CNE lead to the marker, operating the corresponding CNE (connector even) relay or the CNO (connector odd) relay. Since this call is considered to be completed on a first trial basis, whatever connector preference the sender originally requested is registered in the marker. However, on a second trial call, the

preference is reversed by the operation of the TR2A relay in the decoder shown on OS 190-1.

(D) Recording Card Information in the Marker

Signaling Marker to Read Card

7.27 When the decoder reads the 223-3D card shown on Fig. 15, the decoder RI1 and RI2 relays, and the decoder TCTO, TCU2, and TCU4 relays are operated. The RI1 and RI2 relays indicate that the decoder is to allow the marker to now read the card. The TCTO, TCU2, and TCU4 relays indicate that the sleeve leads for the trunks identified by the 223-3D card are terminated on the No. 06 trunk block connector. Ground through the make contacts of the RI1, TCTO, TCU2, and TCU4 relays operates the marker RCD (read card) and the marker TC6 (trunk block connector) relays in series (OS 191-1). By operating the TC6 relay at this time, the marker registers the trunk block connector number before registering the remainder of the translator card information. This allows the marker to start the seizure of a trunk block connector as soon as possible after marker seizure.

7.28 The RCD relay operates the RCD1 and RCD2 (read card auxiliary) relays. With the RCD, RCD1, and RCD2 relays operated, minus 48- and plus 130-volt battery is connected to the windings of marker register relays. The marker thus registers the remainder of the information from the decoder and from the translator card.

Registering Information from the Decoder

7.29 The operated RCD relay also closes paths to register in the marker the trunk block number, the routing instruction, the code conversion information and the sender digit control information from the decoder, as described in the following paragraphs.

Trunk Block Number

7.30 When the decoder reads the 223-3D card, it registers the trunk block number by operating the decoder TB1 and TB4 relays. These relays ground the TB1 and TB4 leads to the marker. The operation of the RCD relay closes these leads, causing the marker TB1 and TB4 relays to operate and lock (OS 192-1). These relays indicate that the trunks identified by the card are located on trunk block No. 5.

Routing Instruction

7.31 As pointed out above, the decoder RI1 and RI2 relays are operated. These relays operate the FOF decoder relay. Ground through the operated FOF and NVO

relays in the decoder is connected to the winding of the FOF (follow with overflow) relay in the marker. The FOF relay operates when the RCD relay places 48-volt battery on the other side of its winding. Follow-with-overflow routing instruction indicates to the marker that if all the trunks identified by the 223-3D card are busy, the marker should attempt to connect the incoming toll tandem trunk to an overflow trunk in order that an overflow signal can be sent to the operator originating the call.

Code Conversion Information

7.32 The code conversion relays in the marker (OS 195-1) provide facilities for registering one, two, or three code conversion digits, and for sending these converted digits to the sender for outpulsing in place of certain digits recorded by the register relays in the sender. There are three groups of marker code conversion relays:

- (a) CCH $\frac{2}{5}$ (code conversion hundreds)
CCHN (no code conversion hundreds)
- (b) CCT $\frac{2}{5}$ (code conversion tens)
CCTN (no code conversion tens)
- (c) CCU $\frac{2}{5}$ (code conversion units)
CCUN (no code conversion units)

7.33 Referring to Fig. 15, the 223-3D card has the CCHN, CCTN, CCU1 and CCU2 punches enlarged. The decoder reads this information from the card and operates the decoder CCHN, CCTN, CCU1, and CCU2 relays. These relays ground the corresponding leads to the marker (OS 195-1), and when the marker RCD relay operates the corresponding relays are operated to indicate the following:

<u>Relay Operated</u>	<u>Indicating</u>
CCHN	No digit to be substituted for the hundreds code digit.
CCTN	No digit to be substituted for the tens code digit.
CCU1 and CCU2	Digit 3 to be substituted for the units code digit.

Sender Digit Control Information

7.34 Sender digit control information is registered by the operation of one-out-of-four marker relays. The relays are the NDG, ODG, 4DG and 5DG. Referring to Fig. 15, the 223-3D card has the CDCO and CDC4 punches enlarged. The decoder reads this information and operates the decoder CDCO and CDC4 relays, which grounds the 4DG

lead to the marker. When the RCD relay operates, the marker 4DG relay is operated (OS 176-1). The digit control information is later transmitted by the marker to the sender, indicating that there are four digits (other than code digits) to be outpulsed.

Continuity Test Control Information

7.35 Continuity test control information is also indicated by the enlarged continuity and digit control punches (CDC $\frac{2}{5}$). The CDC $\frac{2}{5}$ relays, which operate in the decoder, place ground on either the MLCT (make loop continuity test) or the CLCT (cancel loop continuity test) lead, as shown on OS 176-1. Continuity test control information is used only when the trunks identified by the translator card are toll switching trunks of the loop dial type. Therefore, MLCT and CLCT relays are provided only in toll completing markers. This information is not used on this call since an intertoll marker is being used to seize an outgoing intertoll trunk requiring SX dialing.

Information Registered Directly from 223-3D Card

7.36 The operated RCD1 relay connects +130-volt battery to the windings of the marker relays that register variable spill information, class information, and trunk group peg count and overflow information. The +130-volt battery is connected through the register relay windings, through the decoder OC- and HC- relay contacts, to the home translator, in order to cause the cold cathode tubes associated with enlarged punches in the 223-3D card to fire. With the tubes fired, the associated register relays operate in the marker. In the same way, the operated RCD2 relay connects +130-volt battery to the windings of the relays that register group start and group end information. These relays operate when the associated tubes fire in the home translator. The information registered by the operation of the RCD1 and RCD2 relays is described in the following paragraphs.

Variable Spill Information

7.37 When the RCD1 relay operates, the marker registers the variable spill information from the card by operating the SK3 (skip three) relay (OS 176-1). The skip 3 variable spill information is later sent to the sender, instructing it to skip the first three digits A, B and C impulsed to the sender.

Class Information

7.38 Class information is registered and stored in the marker by the CLT0 and CLT1 (class tens) relays, which operate on

a one-out-of-two basis, and the CLU_2^2 (class units) and the CDLC (cancel delay loop closure) relays (OS 164-1). The card (see Fig. 15) for this call shows the CLTO, CLU1, CLU4, and the CDLC punches enlarged. When the RCD1 relay operates, the corresponding tubes fire and operate the CLTO, CLU1, CLU4 and the CDLC relays in the marker. The combination of the CLTO, CLU1, and CLU4 relays operates the CL5 (class) relay, indicating that the outgoing inter-toll trunk requires simplex dialing from the incoming sender (OS 193-1). The CDLC relay is operated to cancel delayed loop closure. This information is later transmitted to the sender.

Trunk Group Peg Count and Overflow Information

7.39 When the RCD1 relay operates, trunk group peg count and overflow peg count information is registered by the operation of the TPO, TP1, and TP2 (trunk peg count) relays. These relays operate over the corresponding leads energized by the translator (OS 164-1). The combination of TP- relays operated determines which PC- and OF- leads will be energized. A particular PC register is operated on each call to the trunks in the trunk group, and an OFL register operates each time all trunks are found busy in the group. The card (Fig. 15) for the call under consideration shows the TPO punch enlarged. This energizes the TPO lead and, in turn, operates the TPO relay to the 130-volt battery from contacts of the operated RCD1 relay. The TPO in operating places ground on the PCO lead and prepares the OFO lead to the traffic registers for registering the overflow if all trunks are found busy (OS 196-1).

Group Start and Group End Information

7.40 Test leads for forty trunks appear on a trunk block. The trunk group, indicated by group start and group end on the card, may be of any size from two to forty trunks. When a trunk group is larger than 40 trunks, it is divided into subgroups of 40 or less trunks. A translator card is provided for each subgroup. A trunk group (or subgroup) must start with an even-numbered trunk and end with an odd-numbered trunk. Therefore each trunk group (or subgroup) requires an even number of terminals. If a trunk group (or subgroup) has an odd number of trunks the extra terminal is made busy. To cover all possibilities, there must be twenty even-numbered starting points and twenty odd-numbered ending points, which can be registered by the GS0-38 and GE1-39 marker relays. Only even-numbered GS- relays are provided, and only odd-numbered GE- relays are provided.

7.41 By using the above arrangement, it is unnecessary to indicate the actual number of the group start and group position on the translator card. This would be undesirable because of the large number of punches that would be required. Therefore, the translator card is arranged so that any one of 20 numbers (0-19) can be indicated for group start, and any one of 20 numbers (0-19) can be indicated for group end. When the RCD2 relay operates, the group start and group end numbers are registered by the operation of the following relays:

GSTO or GST1 (group start tens)

GSU_2^2 (group start units)

GETO or GET1 (group end tens)

GEU_2^2 (group end units)

7.42 Combinations of the above operated relays operate one of the twenty even-numbered GSO to GS38 (group start) relays and one of the twenty odd-numbered GE1 to GE39 (group end) relays, as shown on the table on OS 192-1. Note that the number of the operated GS- relay is always twice the number indicated by the GST- and GSU- relay combination. Also, the number of the operated GE- relay is always twice the number indicated by the operated GET- and GEU- relays, plus one.

7.43 The card as shown on Fig. 15 has the GST1, GSU4 and GSU7 punches enlarged. The GST1, GSU4 and GSU7 marker relays operate and lock from the 130-volt battery on the operated RCD2 relay (OS 164-1). This combination of relays operates the GS20 relay, indicating to the marker that the trunk group starts on terminal 20 of the trunk block (OS 192-1).

7.44 Again referring to Fig. 15, the card has the GET1, GEU2 and GEU7 punches enlarged. The marker reads these and registers the information in the same manner as for group start, but now operates the GET1, GEU2, and GEU7 relays (OS 164-1). With this combination the GE39 relay operates, indicating that the trunk group ends on terminal 39 of the trunk block.

(E) Register Checking Circuit

7.45 When all the information from the decoder and the card is properly registered in the marker, a path is closed to operate the RCK (register check) relay (OS 197-1).

7.46 The operating path for the RCK relay is a series circuit through the make contacts of all of the registered

information relays except the trunk group peg count and overflow peg count register control relays. These relays are not included in the check as there is no definite number of these relays

operated. The following list indicates the relays that are checked operated and the information that they have registered, starting at the RCK relay winding.

<u>Information Registered</u>	<u>Relays Available for Registering Information</u>	<u>Relay Combination Required for Register Check</u>	<u>Relays Operated on This Call</u>
Route Control	FOF, FMB, MB, FRO, RO, FST, STI, HLD	One-out-of-eight operated.	FOF
Trunk Group End	GE1-39 (Only odd-numbered GE- relays are supplied)	One-out-of-twenty operated.	GE39
Trunk Group Start	GSO-40 (Only even-numbered GS- relays are supplied)	One-out-of-twenty operated.	GS20
Class	CLO-2, CL5-14	One-out-of-thirteen operated.	CL5
Cancel Delay Loop Closure	CDLC	Operated only with CL1, CL5, CL6, CL7, and CL14.	CDLC
Class Units	CLUO,1,2,4,7	Two-out-of-five operated.	CLU1,4
Continuity Test	MLCT,CLCT	One-out-of-two operated. (Combined markers and toll completing markers only)	-
Sender Digit Control	5DG,4DG,ODG, and NDG	One-out-of-four operated.	4DG
Sender Variable Spill Control	NSK,SK3,SK6	One-out-of-three operated.	SK3
No Code Conversion Units	CCUN	Operated if code conversion units is not used.	-
Code Conversion Units	CCUO,1,2,4,7	Two-out-of-five operated if CCUN is normal.	CCU1,2
Code Conversion Tens	CCTO,1,2,4,7	Two-out-of-five operated if CCTN is normal.	-
No Code Conversion Tens	CCTN	Operated if code conversion tens is not used.	CCTN
No Code Conversion Hundreds	CCHN	Operated if code conversion hundreds is not used.	CCHN
Code Conversion Hundreds	CCHO,1,2,4,7	Two-out-of-five operated if CCHN is normal.	-
Trunk Group End Units	GEUO,1,2,4,7	Two-out-of-five operated.	GEU2,7
Trunk Group Start Units	GSUO,1,2,4,7	Two-out-of-five operated.	GSU4,7
Trunk Block Number Checked	TB2K	Operated.	TB2K

<u>Information Registered</u>	<u>Relays Available for Registering Information</u>	<u>Relay Combination Required for Register Check</u>	<u>Relays Operated on This Call</u>
Trunk Block Connector Number	TCO-29	One-out-of-thirty operated.	TC6
First or Second Trial	TR1,2	One-out-of-two operated.	TR1
Odd or Even Connector Preference	CNE,CNO	One-out-of-two operated.	CNE or CNO

The ground is supplied through contacts of the operated MC relay in the decoder connector. If a successful check is made, the RCK relay operates.

(F) Decoder Release

7.47 The completion of the RCK check satisfies the marker that all the necessary information for completing this call is registered. With follow-with-overflow routing instruction indicated, no additional trunks are available for testing on this call, therefore the decoder can be released to serve another call (SC 113-1).

7.48 The marker grounds the RCK lead to the decoder, which operates the RCD (restore card and disconnect) relay in the decoder through the operated FOF decoder relay (OS 167-1). The RCD relay operates and locks to the CKG relay ground, releases the OC (output control) relay in the decoder, and operates the ARC (automatic restore of card) relay in the card translator (OS 166-1), which locks to the operated code bar SLAVE relays. The OC relay releases the OC-relays which disconnects the output leads of the card translator from the decoder (OS 163-1).

7.49 The operation of the ARC relay:

- (a) Disconnects the input information leads to the card translator by releasing the operated CC-relays (OS 161-1).
- (b) Releases the CON relay (OS 161-1).
- (c) Releases the PD relay which, in turn, deenergizes the eight pull-down magnets and the PDS-relays (OS 161-1).
- (d) Operates the CSL (card support lift) relay which, in turn, energizes the two card support lift magnets (OS 161-1). The magnets overpower the card support bar magnets and cause the two card support bars to rise, restoring the dropped card. The two card support bars also lift all the cards slightly.

(e) Operates the PU1 and PU2 relays which, in turn, energize the eight pull-up magnets and the PUS-relays. These magnets, with the aid of the card support bars, lift and hold the cards off the code bars (OS 161-1).

(f) Releases the CS1 and CS2 relays which, in turn, release the CS1 and CS2 magnets to release the card support bars and the SCS1 and SCS2 relays.

(g) Operates the RLT (release after translation) relay which starts the release of the decoder and part of the decoder connector (OS 177-1).

7.50 The release of the CON relay:

(a) Releases the RD relay (OS 163-1), which, in turn, removes the ground and places a minus 24-volt bias on the control anode of the cold cathode tubes in the channel detectors. This makes certain that the tubes have been extinguished, and also reduces their sensitivity during standby periods (OS 185-1).

(b) Releases the COP1 and COP2 relays in the decoder (OS 163-1).

7.51 The operation of all the PUS-relays closes the circuit to operate the LCH relay which, in turn, energizes the latch magnets L1-L4 (OS 161-1). This withdraws the latches from engagement with the code bars and permits them to restore to normal under the influence of their springs. When any one of the code bars has restored and its slave relay has released, the CBK relay releases (OS 162-1). When all code bars and code bar slave relays are released, the ARC relay releases (OS 166-1).

7.52 The normal ARC relay opens the path from the SR (slow release) relay (OS 162-1), which releases after a delay of approximately 350 milliseconds. Release of the SR relay releases the LCH relay (OS 161-1) which, in turn, opens the circuit to the latch magnets L1-L4. The latches

now restore under the influence of spring tension and lock all code bars in normal position. When all four latches are in position, the parallel path through the latch auxiliary contacts is open, releasing the PU1 and PU2 relays and the CSL relay (OS 161-1).

7.53 The release of the PU- relays opens the operating path of the pull-up magnets and the normal CSL relay opens the operating path of the code support magnets. With these magnets released, all the weight of the cards in the translator is supported by the code bars and code support bars.

7.54 The operated RLT relay releases the CKG, CKG1, and CKG2 relays in the decoder (OS 155-1), and grounds the RLT lead to the decoder connector, operating the RLT (release decoder and transfer) relay in the decoder connector (OS 177-1).

7.55 The RLT relay in the decoder connector closes a holding path for the MC (marker cut-in) relay in the decoder connector through the winding of the CHK (check) relay in the decoder connector (OS 177-1), and releases the DC1 (decoder cut-in auxiliary) relay in the decoder connector (OS 155-1). The normal DC1 relay releases the CBR-W relays, which releases the CB relays operated in other decoder connectors. One of the other decoder connectors can now operate the DP relay associated with the decoder. It may or may not be able to operate its DC relay depending on its place in the chain circuit.

7.56 The release of the DC1 relay opens the operating path of the MC relay (OS 177-1). When the operating path of the MC relay is opened, the ground shunt is removed from the CHK relay, causing it to operate and hold in series with the MC relay.

7.57 The CHK relay closes a path to operate the RLT1 in series with the secondary winding of the RLT (OS 177-1), and removes ground from the MCS (marker connector start) lead to the decoder releasing the IT2 relay (OS 168-1). This, in turn, releases the MP relay in the marker connector which releases the MC-, MCA and MCB relays in the marker connector, thus releasing the marker connector (OS 186-1). This breaks all contact between the marker and the decoder.

7.58 Operation of the RLT1 relay in the decoder connector releases the DP (decoder preference) relay which, in turn, releases the DC relay in the decoder connector (OS 155-1).

7.59 The release of the DC relay in the decoder connector breaks the last contact between the sender and the decoder. As shown on OS 155-1, another decoder connector trying to seize the decoder can now

operate its DC relay if it is not already operated because of its place in the relay chain. However, the decoder is not free to handle another call until the CAK and RLT relays have released to close the path to operate the CKG, CKG1, and CKG2 relays.

7.60 The decoder connector used for this call remains in use to maintain the connections between the sender and the marker until the marker has completed its functions.

(G) Trunk Block Connector Operation

7.61 As pointed out previously, the marker prefers either the even or odd half of the required trunk block connector, depending upon the condition of the CNE and CNO preference relays, in order to ensure an even spread of traffic between both half-connectors. The CNE and CNO preference relays (OS 198-1) are primarily under control of the PF (connector preference) relay in the decoder. This relay, in turn, is under control of the sender involved on a particular call (OS 160-1).

7.62 The PF lead is wired to ground in all alternate-numbered senders of a sender test group, in the order of their association with the sender test frame beginning with the first sender. When one of the senders with a grounded PF lead connects to the decoder, the PF relay in the decoder operates. When the decoder connects to a marker, the PF relay operates the CNO (connector odd) relay on first trials and the CNE (connector even) relay on second trials (OS 198-1). When a sender with an ungrounded PF lead connects to a marker, the PF relay in the decoder does not operate. This causes the CNE relay to operate on first trials and the CNO relay on second trials. With this arrangement, traffic through both connectors should be evenly distributed.

7.63 With the TC6 relay operated and the associated trunk block connector idle, battery through the SB resistance lamp is placed on the STO6 lead with the CNO relay operated, or on the STE6 lead with the CNE relay operated, through make contacts of the TC6 relay to operate the MP (marker preference) relay in the preferred trunk block connector circuit (OS 198-1). However, if the half of the trunk block connector to which the marker has been directed is busy at the time the CNE or CNO relay operates, either by the operation of the CB (connector busy) relay on a service call or by the operation of a make busy key, there will be a 226-ohm battery present on the associated CBO6 or CBE6 lead. This battery operates the marker TCBA (trunk block connector busy auxiliary) relay, and the ground on the make contacts of the TCBA relay operates the TCB (trunk block connector busy) relay.

This switches the ST- leads, causing seizure of the other (other than the preferred) half of the trunk block connector.

7.64 When an MP relay is operated in the trunk block connector, a ground is connected to the marker to operate the TCK (trunk block connector check) relay and to lock operated the TCB relay. With the TCB relay locked operated, the established start lead path is prevented from being broken if the CB relay or the make busy key should be released during the time the marker is establishing the connection.

7.65 As previously mentioned, all markers of a particular train have access to the outgoing trunk test leads in that train by means of the trunk block connectors. The MP relay referred to in the preceding paragraph is wired, along with the MP relays of other markers, on a double-transfer lockout basis to prevent more than one marker from being connected to the same trunk block connector circuit at any given time.

7.66 When the MP relay operates it connects ground to the MC lead for operating the MCA relay which, in turn, operates the MCB relay. As mentioned above, the operated MP relay connects ground over the MCK lead to the marker, operating the TCK relay. This indicates to the marker that the trunk block connector has been seized to the exclusion of all other markers. The operation of the MCA relay connects the windings of the TBA0-9 relays through to the marker (OS 199-1).

7.67 At the time the marker receives information from the decoder, the marker registers the trunk block number by operating the TB1 and TB4 relays. The operation of these TB₂⁵ relays connects

52.5-ohm battery to the TB5 lead to the trunk block connector in series with the polar relay XTB (crossed trunk block) relay, operating the TBA5 relay in the trunk block connector. The XTB relay operates only when the TB- leads of the trunk block connector are crossed or falsely grounded.

7.68 The operation of the TBA5 relay:

(a) Operates the associated TBB5 (trunk block) relay (OS 199-1) which closes through the SM 15-39 leads that are used for making outgoing frame identification, as described later (OS 204-1).

(b) Grounds the TBK lead into the marker (OS 199-1).

(c) Closes through the MSO-39 leads into the marker for test (OS 203-1).

(d) Closes through the SMO-14 leads that are used by the marker for making outgoing frame identification as described later (OS 204-1).

7.69 The ground that is placed on the TBK lead operates the TBK (trunk block relay check) relay in the marker as a signal that a trunk block relay has operated (OS 199-1). This ground is connected through both the 4 and the 5 contacts of the TBA5 relay as a check that both halves of the multicontact relay have operated, since the 4 contact is closed by the lower magnet and the 5 contact is closed by the action of the upper magnet. This is a check circuit arrangement which is common in many crossbar circuits and may be encountered elsewhere.

7.70 There is a GCO and a GC1 (group cut-off) relay in each half-connector (OS 200-1). These relays provide the means for locking out the other half-connector from serving trunks in the same subgroup of 200 trunks until an idle trunk is seized and the GCO or GC1 relay is released by the marker. The operation of the desired TBA- relay closes through a ground from the marker to operate the GCO or GC1 relay. The operation of the GCO relay associated with a subgroup of 200 trunks on the even half-connector opens the operating circuit for the GCO relay associated with the same subgroup of trunks on the odd half-connector, thus locking out traffic to this group in the odd half-connector. The GC1 relay performs the same function for the other subgroup of 200 trunks.

7.71 The operation of the GCO relay in the even half-connector, which prevents the operation of the GCO relay in the odd half-connector, grounds the GCK lead into the marker operating the GCK (trunk group cut-off check) relay. This relay must be operated to complete the circuit for selecting an idle outgoing trunk. If another marker has seized the odd half of the trunk block connector and desires to test the same 200 trunks, the GCO relay in the odd half cannot be operated. Therefore the GCK relay in this marker cannot be operated and this marker is locked out. If this lockout feature were not provided, two markers of the same type, in attempting to complete a call to the same destination, might seize the same trunk. As explained later, when an outgoing trunk appears on both trains of a 2-train office, the possibility of a double connection is further checked by a sleeve guard feature.

(H) Selecting an Idle Trunk

Operation of a K- Relay in the Marker

7.72 When the marker receives information from the 223-3D card, the group start and group end information is registered by

the operation of the GS20 and GE39 relays. This indicates that the last 20 trunks on the trunk block of 40 trunks are to be tested.

7.73 The T- relays, numbered from T0 to T39, are used by the marker to identify busy trunks (OS 203-1). When the TBA- and MCA relays operate, all T- relays that are associated with busy trunks within the entire block of 40 trunks cut in by the trunk block connector are operated. However, as the following paragraphs show, only one of the K20 to K39 relays (the one corresponding to the selected trunk) operates to indicate the selection of an idle trunk.

7.74 The TKE (trunk end) relay operates upon marker seizure through make contacts on the ONG relay and through the back contacts of all K- relays. This checks that all K- relays are normal prior to trunk selection on this call.

7.75 When the TBK (trunk block check) relay operates as an indication that the trunk block connector has closed through the MS and SM leads of the block of 40 trunks for test, ground is removed from the secondary winding of the TKT (trunk relay timing) relay. This ground was holding the polarized TKT relay in a non-operate position and at the same time maintaining a shunt around the TKT capacitor. When this shunt is removed the TKT relay does not operate immediately because current continues to flow in the same direction through the secondary winding to charge the TKT capacitor. As the capacitor becomes charged, the current in the secondary winding decreases. When the current through the primary winding is more effective than the current through secondary winding, the TKT relay operates. Thus an interval of time (approximately .015 second) elapses and permits any of the T- relays that are associated with trunks that have just been made busy to operate (OS 203-1).

7.76 The TKT relay in operating completes a path from ground through the contacts of the first normal T- relay to the winding of the K- relay (OS 201-1) that corresponds to the first idle trunk in the group. The operated K- relay locks to ground on the make contacts of the ONG relay. The operation of the K- relay transfers the MS- lead of the outgoing trunk from the T- relay winding to the ground on the make contacts of the ONG relay (OS 203-1). This operates the OS (out seizure) relay in the outgoing trunk circuit, making the selected trunk busy. The operation of a K- relay also releases the TKE relay which shunts the TKT capacitor by grounding both sides (OS 201-1). This energizes the secondary winding of the TKT relay causing it to go to its back contact.

7.77 The released TKE relay opens the operating paths of the K- relays, thus preventing the possible operation of another K- relay if one of the more preferred busy trunks becomes idle after the trunk is seized.

7.78 On first trials the TR2A relay is normal and the TR1A relay is operated, thus starting the selection of a trunk at the point indicated by the operated GS20 relay (OS 201-1). On second trials the TR2A is operated and the TR1A relay is normal, which connects the trunk selecting ground to the GE39 relay; thus reversing the order of trunk preference.

7.79 When the TKE relay releases following the operation of a K- relay, a path is completed from ground on the back contact of the TKE relay (OS 202-1), through the operated K- relay, through the 300-ohm winding of the TSA (trunk selected check) relay, through the make contacts of the TKS (trunk selected) relay that operated when the TKE relay released, through the back contacts of the SDT1 (sender test cut-in auxiliary) relay, and through the decoder connector to battery on the winding of the TKS relay in the sender. Both the TKS relay in the sender and the TSA (trunk selected check) relay in the marker operate in series.

7.80 The make contacts of the TSA relay are in the operating path of the SRL (start release) relay (OS 217-1) to insure that the TKS lead is continuous and free from a false ground before the marker gives the sender a release signal. The TKS relay in the sender causes the RTT or DLC timing interval to start even though the marker has not completed all its functions. This circuit action is more fully described in Part 8 of this section.

Sleeve Guard Test

7.81 This discussion assumes that an inter-toll marker has seized an outgoing trunk by operating a K- relay. The K- relay closes the MS lead from the trunk circuit to a ground path through the SG (sleeve guard) and the SCT (sleeve guard continuity test) polarized relays (OS 203-1). This causes the SCT relay to operate from battery on the MS lead in the trunk circuit, showing that the MS lead is continuous to the trunk circuit. The operated SCT relay operates the SCT1 relay, which is checked operated later when the hold magnets are operated.

7.82 The SG relay is poled opposite to the SCT relay and operates in case the trunk is seized by another marker and a ground is connected to the MS lead by that marker. When trunks appear on only one train as in this example, there is little chance of such a double seizure and the SG relay could operate only when a trouble

condition exists in one or both of the markers. When outgoing trunks, principally test trunks, appear on both the intertoll and toll completing trains, there is a possibility that an IT and a TC marker may simultaneously seize the same trunk. As shown on OS 203-1, the sleeve guard circuit in a toll completing marker insures that the toll completing marker has preference in case of a simultaneous trunk seizure. When a trunk is seized by a toll completing marker, a direct ground is placed on the MS lead to operate the SG relay in the intertoll marker; however the SG relay in the toll completing marker cannot operate since its winding is shunted. The toll completing marker keeps control of the trunk. The intertoll marker must seize another trunk.

7.83 When the SG relay operates, a path is closed to operate the SGA (sleeve guard auxiliary) relay through the operated HMT1 relay. The SGA relay is used to release the K- relay in order that another trunk can be selected as indicated on the sequence chart of OS 203-1. Later, the HMT1 relay is released to operate the hold magnets; thus a double connection can be recognized in an intertoll marker from the time the K- relay operates until the time the HMT1 relay releases. In a toll completing marker the operation of the AK relay opens the shunt path around the SG and SCT relays. Thus, a double connection can be recognized in a toll completing marker from the time the AK relay operates until the time the HMT1 relay releases.

(I) Incoming and Outgoing Frame Identification

General

7.84 While the outgoing trunk is being seized as described above, the marker identifies the incoming frame on which the incoming trunk is located. By the time the marker has seized the outgoing trunk the incoming frame identification should be completed, the marker thus proceeds with outgoing frame identification.

7.85 The marker is able to identify the frame on which the selected incoming and outgoing trunks appear by receiving multifrequency signals which are transmitted by the select magnet leads from the primary switches on the incoming frames and the select magnet leads of the secondary switches on the outgoing frames. Since the incoming trunk seizure started the entire chain of events, the frame on which the trunk is located can be identified soon after the marker is seized.

Incoming Frame Identification

7.86 When the CKG relay operates on seizure, it closes a circuit from ground through the normal contacts of the frame

identification test relays to operate the ID (incoming detection) relay (OS 204-1). The ID relay connects the SMI or SMC (incoming select magnet) lead associated with the incoming trunk to the IP (input) transformer (OS 215-1) of the frame identification detector circuit. This call, which is being set up on the intertoll train, uses an intertoll marker. Although both the SMI and SMC leads are closed through by the sender link and the decoder connector, only the SMI lead is used for identification because of the wiring arrangement in the intertoll marker.

7.87 The ID relay in operating closes a path to operate the ICO (incoming frame cut-in) relay (OS 205-1). The ICO relay operates the IC1 and IC2 (incoming frame cut-in auxiliary) relays. These relays connect the windings of the 20 I- (incoming frame register) relays, the IEV (incoming frame even) relay and IOD (incoming frame odd) relay to the contacts of the frame detector relays, FA2 to FH2 (OS 204-1).

7.88 The frame identification signal on the SMI lead connected to the marker at this time, consists of a group of three out of a possible eight frequencies. The same signal is present on all select magnets of a given incoming or outgoing frame. A table of multifrequency combinations can be found on OS 204-1.

7.89 The frame identification signal is passed through the IP (input) transformer to the AM (amplifier) tube, where it is amplified and then passed through the OP (output) transformer to the detector units. There are eight sets of detector units, each unit consisting of a filter and a detector tube. The tubes are held at cut-off, or in a nonconducting condition, when a signal is not present by the application of -26 volts to the control grid. Three of these filters (designated A to H) respond to the frequencies received and feed these frequencies to the associated detector tubes (also designated A to H). The incoming signal, by reducing the grid bias, causes the tubes to conduct, thereby operating three of the associated FA to FH (frequency) relays in their plate circuits.

7.90 Three associated FA1 to FH1 (frequency auxiliary) relays then operate, and in turn operate corresponding FA2 to FH2 (frequency auxiliary) relays. This action closes a circuit through the make contacts of the IC1 and IC2 relays to operate one of the I- relays that indicates the pair of incoming frames involved (OS 205-1). Two of the three FA2 to FH2 relays that are operated provide a ground to operate either the IEV (incoming frame even) or the IOD (incoming frame odd) relay. The I- relay number, together with

the odd or even registration, indicates to the marker the particular incoming frame on which the incoming trunk is located.

- 7.91 If less than three of the FA2 to FH2 relays operate, no I- relay can operate. This will cause the marker to block and time-out on first trial calls.
- 7.92 If more than three FA1 to FH1 relays are operated, the DFP (detector false pulse) relay will operate (OS 204-1), preventing the operation of the I- relay and the IEV or IOD relay (OS 205-1). When more than three FA1 to FH1 relays operate this may have been caused by receiving three regular frequencies plus a transient frequency produced by the operation of a select magnet on the same frame. This may be possible since one marker may be identifying the frame even though it has already been seized by another marker. A retard coil C, shown on OS 215-1, is provided in the select magnet operating circuits to minimize the effect of transients on incoming frame identification. A retard coil D is provided for this purpose in the operating path of the select magnets on the outgoing frame. The operation of the DFP relay operates the SPT (stop primary timer) relay to stop the TM timer. When the extraneous frequency disappears the DFP and SPT relays release to restart the TM timer (OS 218-1). The extra FA- relay is released and an I- relay is operated in the normal manner.
- 7.93 If two of the I- relays operate due to a trouble condition, the XI (crossed I relay) relay operates, and in turn operates the XIA (crossed I auxiliary) relay, and calls in a trouble recorder. The above operations are described in more detail in Section A828.121.15.
- 7.94 With an I- relay and either one of the IEV or IOD relays operated, the IL (incoming lock) relay operates and locks; it then locks the I- relay to ground on the make contacts of the CKGA relay (OS 205-1). The IL relay operates the ILA (incoming lock auxiliary) relay and releases the ID relay (OS 204-1), thereby opening the incoming frame identification lead to the detecting circuit. The ILA relay releases the IC- relays (OS 205-1), which opens the operating path of all the I- relays. This prevents any other I- relays from operating. With the ID relay released, the signal path of the SMI lead is opened and all FA- to FH- relays release. The marker has now completed the identification of the incoming frame. If the outgoing trunk has been seized, the marker can start outgoing frame identification without delay.
- the OD (outgoing detector) relay operates (OS 204-1). The OD relay connects the select magnet lead from the outgoing frame through the operated K- relay associated with the chosen trunk to the IP transformer (OS 215-1). The OD relay also operates the OCO (outgoing frame cut-in) relay which, in turn, operates the OC1 and OC2 (outgoing frame cut-in auxiliary) relays (OS 205-1). With these relays operated, the windings of the O- (outgoing frame) relays and OEV (outgoing frame even) and OOD (outgoing frame odd) relays are connected to the contacts of the FA2 to FH2 frequency detection relays.
- 7.96 The frame identification signal which is presented to the marker when the OD relay operates consists of a group of three out of a possible eight frequencies in the combinations like those used for the incoming frame identification. (See table on OS 204-1.) The combination of three frequencies that is present on the SM lead is passed through the IP transformer to the AM tube where it is amplified and then passed through the OP transformer to the detector units. The circuit action from this point to the operation of the three desired FA2 to FH2 relays is the same as that described for incoming frame identification.
- 7.97 A combination of three FA2 to FH2 relays closes a circuit through make contacts of the OC1 and OC2 relays to operate one of the O- relays that indicates the pair of outgoing frames involved. Two of the FA2 to FH2 relays that are operated provide a ground to operate either the OOD or OEV relays (OS 205-1). The O- relay number, together with the odd or even registration, indicates the outgoing frame on which the selected outgoing trunk is located. On outgoing trunk identification the DFP and XO (crossed O relay) relays are used in the same manner as explained for incoming frame identification.
- 7.98 The operated O- relay operates the OL (outgoing frame lock) relay through an operated OEV or OOD relay. The OL relay operates the OLA (outgoing frame lock auxiliary) relay and both lock to the ground on the make contacts of the CKGA relay. The OL relay in operating opens the path for receiving the outgoing frame identification signal by releasing the OD relay (OS 204-1). With no signal present on the detecting units all operated, FA- to FH- relays are released. The OC- relays remain locked operated for the duration of the call.
- Operation of the Marker Junctor Cut-In and Junctor Pattern Relays
- 7.99 When the identification of the incoming and outgoing frames is completed, the marker uses the frame numbers to determine information about the junctor group

Outgoing Frame Identification

- 7.95 With all the FA1 to FH1 relays released and the ILA relay operated,

between the particular incoming and outgoing frames. The marker can test one subgroup of 20 junctors at a time in selecting a B link between the incoming and outgoing frame. A group of junctors between any incoming frame and any outgoing frame may contain as many as 80 junctors, depending upon the size of the 4A office. By means of a walking circuit, the marker can be arranged to make four successive subgroup tests to find an idle channel. The junctor walking circuit also allows the marker to vary the first choice junctor subgroup on each successive call. As shown on OS 213-1, one of the RT'- relays operates when the marker is seized, to indicate the junctor subgroup preference to the marker.

7.100 Assume for the purposes of this description that the incoming trunk is located on the No. 0 incoming frame and that the outgoing frame is located on the No. 1 frame. Also assume that the RTA' relay is operated in the junctor walking circuit. With these assumptions the RTA', IEV, IO, OOD1 relays are operated after frame identification and a path is closed to operate the marker JC10 (junctor cut-in) relay (OS 209-1). This JC- relay is later used to operate one of ten JCH (junctor cut-in home) or ten JCM (junctor cut-in mate) relays on the outgoing frame, thereby indicating the first subgroup of 20 or less junctors to be tested in selecting a path between the incoming and outgoing frames.

7.101 As shown on OS 209-1, the number of the JC- relay operated in the marker is determined by the outgoing and incoming frame numbers, the particular RT'- relay operated in the junctor walking circuit, and the cross-connections between the JC- and N- punchings. The cross-connections between the JC- and N- punchings and the cross-connections within the junctor walking circuit (OS 213-1) depend on the number of incoming and outgoing frames in the 4A office. It should be noted that OS 209-1, 210-1, and 213-1 show arrangements which apply to an office with six incoming and six outgoing frames.

7.102 All junctor subgroups may not contain 20 junctors. It is necessary to make busy the junctor positions that are not used before the marker tests for an idle channel. This is controlled by the JP- (junctor pattern) relays shown on OS 210-1. As pointed out above, OS 210-1 applies to an office with six incoming and six outgoing frames. For this type office, each incoming frame is connected to each outgoing frame by one full subgroup of 20 junctors and one subgroup with 10 junctors.

7.103 With the RTD' relay operated in the junctor walking circuit, the JPO or JPI relay operates when the OOD or OEV relay operates during outgoing frame identification. The operated JPO or JPI relay places ground on ten BL- terminals. The

BL- terminals are cross-connected to the JP- terminals shown on OS 210-1, in order to operate certain CPL- (C link left) relays and CPR (C link right) relays so that the channels that are not used will appear busy when the marker tests the subgroup with less than 20 junctors.

7.104 With the RTA', RTB' or RTC' relay operated in the junctor walking circuit, the JPN (normal junctor pattern) relay operates when the OLA relay operates after outgoing frame identification. The JPN relay is operated when the subgroup contains 20 junctors. In this case, no JP- relays need be operated to make certain junctors appear busy. The purpose of operating the JPN relay is to close the checking path between the BK and BK1 terminals instead of checking for an operated JP- relay.

(J) Outgoing and Incoming Frame Seizure and Lockout

General

7.105 With the location of the incoming and outgoing trunks registered by the operated I-, IEV or IOD relays and the O-, OEV or OOD relays, the next operation of the marker is the seizure of the desired outgoing frame. The outgoing frame rather than the incoming frame is seized first, because the choice of the outgoing trunk can be changed in the course of a call while the choice of an incoming trunk cannot. A different outgoing trunk may be selected because of action resulting from an unsuccessful sleeve guard test, or because trouble may be encountered at the outgoing frame that serves the selected outgoing trunk causing the marker to time-out and make a second trial.

7.106 As long as these possibilities exist, the seizure of the incoming frame is delayed until an outgoing trunk has been seized and some progress has been made in the seizure of the desired outgoing frame. This prevents the incoming frame from being held busy while a recycle or a time-out is taking place, since other markers handling calls and desiring access to the same incoming frame would be locked out, resulting in traffic delay.

7.107 Two paths through the incoming and outgoing frame connectors are available through which a marker can seize and connect to a particular incoming or outgoing frame. (See Figs. 19 and 20.) On this call, assume that the sender that is being used has an ungrounded PF lead, resulting in a normal PF relay in the decoder and an operated CNE relay in the marker (OS 190-1). Also assume that the incoming trunk is located on the No. 0 incoming frame which is the even frame of

the pair associated with the operated IO relay and that the selected outgoing trunk is located on the No. 1 outgoing frame which is the odd frame of the pair associated with the operated OO relay.

7.108 Under these conditions the marker prefers to seize the outgoing frame connector circuit on the even frame of the pair represented by the operated OO relay and the incoming frame connector circuit on the even frame of the pair represented by the operated IO relay. If the marker is successful in seizing the preferred frame connectors, the mate connector on the even outgoing frame must be used to connect to the selected odd outgoing frame. The home connector on the even incoming frame must be used to connect to the selected even incoming frame.

Outgoing Frame Seizure

Operation with Frames Not Paired for Junction Distribution

7.109 The operation of the OO relay completes a circuit for placing battery on the STE lead under control of the operated CNE relay and the normal OCB (outgoing connector busy) relay (OS 207-1). This battery operates the MP (marker preference) relay on the even outgoing frame. The MP relay is in a double-transfer and lockout arrangement with MP relays of all other markers that have access to this frame. The operated MP relay operates the multi-contact MCA- and MCB- (marker cut-in) relays to connect the marker leads to the outgoing connector circuit.

7.110 The MCA- relay grounds the MCK lead into the marker, operating the OCK (outgoing connector check) relay and indicating to the marker that the outgoing frame has been seized. The OCK relay places battery on the KK lead through the winding of the XTOF (crossed to outgoing frame) marginal relay to operate the CB (connector busy) relay. The XTOF relay does not operate unless the KK lead is closed through two operated MCA relays to two operated CB relays in parallel; this condition would indicate that two MP relays are operated as a result of a cross between the STE and STO start leads. The operation of the XTOF relay causes the trouble recorder to be seized.

7.111 The CB relay in operating makes this connector appear busy to other markers seeking the No. 1 outgoing frame by changing the potential on the CB- lead from ground to battery. This battery operates the OCB (outgoing connector busy) relay in any other marker desiring to use this particular connector. The marker OCB relay in operating transfers the path of the start lead to the connector of the mate frame.

7.112 At the time frame identification is made the OOD relay operates to indicate that the outgoing trunk is located on the odd frame of the pair represented by the operated OO relay (OS 205-1). With the OOD relay operated, a 90-ohm battery on the FO lead is closed through the operated contacts of the MP relay to the winding of the FLM (frame lockout mate) relay in the even frame connector (OS 207-1). This FLM relay operates to a ground on the normal contacts of the FLH (frame lockout home) relay in the frame connector on the odd frame. If another marker has previously seized the odd frame connector and has operated the FLH relay, the marker seizing the even frame cannot operate its FLM relay until the odd frame connector releases.

7.113 With the FLM relay operated in the even outgoing frame connector, the following operations take place in the marker and on the outgoing frame:

(a) The LWM (link wanted - mate) relay operates in the odd outgoing connector circuit (OS 207-1).

(b) The FCM (frame cut-in mate) relay operates in the even outgoing connector (OS 208-1). The operated FCM relay places a ground on the FKL lead and battery on the FK lead into the marker (OS 207-1) to operate the OFK (outgoing frame check) relay, indicating that the marker has access to the crossbar switches on the proper outgoing frame. The operation of the OFK relay also serves as a check that either the FCH or FCM relay is operated but not both. If both were operated, there would be a ground on both sides of the OFK relay, preventing its operation.

(c) A JCMO (junctur cut-in mate) relay operates on the odd outgoing frame. As shown on OS 209-1, each outgoing frame has ten JCM- relays and ten JCH- relays. The number of the JCM- or JCH- relay is determined by the operated JC- relay in the marker as well as the operated FLM relay. Battery on the make contacts of the FLM relay on the even frame through the operated MCA- relay on the even frame, the normal marker JC19 to JC11 relays, the operated marker JC10 relay, the operated MCA- relay on the even frame operates the JCMO relay on the odd frame. The operation of the JCMO relay closes 20 leads designated JSOL to JS9L and JSOR to JS9R through the operated FCM and the MCB relays to the channel test relays in the marker (OS 212-1). The JCMO relay also closes a path to operate the BK (B link check) relay to indicate that the junctur sleeve leads have been connected to the marker (OS 210-1).

(d) A 52.5-ohm battery is placed on the SSO lead to the marker (OS 215-1). In this example the SSO lead is closed through the operated OOD relay, through the operated K-relay where it is connected to the SM- lead, through the trunk block connector to the No. 1 outgoing frame. The 52.5-ohm battery operates the secondary select magnet associated with the seized outgoing trunk.

(e) Battery is connected to the MPB lead to the marker as a signal that the outgoing frame has been seized and to start incoming frame seizure (OS 208-1).

Operation with Frames Paired for Junctor Distribution

7.114 When the outgoing frames are paired for junctor distribution, primary extension bays are provided for each frame of the pair. Also, the junctors are common to each outgoing frame of the pair. Before a marker can proceed with operations in one frame of a pair, a test must be made to insure that the common junctors are not connected to a marker that has seized the other frame of the pair.

7.115 The JLH and JLM (junctor lockout) relays are provided in the connector on each frame of the pair in order to make the above test (OS 211-1). When the FLM relay operates on the even frame, the JLM relay operates on the even frame through the normal contacts of the JLM relay on the odd frame. The JLM relay on the odd frame is normal when the odd frame connector is not being used for mate operation. The FLM relay in operation has already checked that the FLH relay on the odd frame is normal, indicating that the odd frame connector is not being used for home operation. Thus, when the JLM relay operates on the even frame the marker has control of both frames of the pair and can proceed. The operated JLM relay operates the FCM and the JCM relays as shown on OS 211-1. Also the operated JLM relay closes the MPB lead to the marker to start incoming frame seizure (OS 208-1). The outgoing secondary select magnet and the LWM relay in the odd frame connector circuit are operated by the operated FLM relay as described in Par. 7.113.

Operation of the LC- and SM- Relays on the Outgoing Frame

7.116 As indicated in Par. 7.113, the FLM relay operates the LWM relay in the odd frame connector. With the secondary select magnet operated and the LWM relay operated, a path is closed to operate one of the ten LCM- (link cut-in) relays and one of the ten SM- relays on the odd outgoing frame (OS 215-1). The number of the

LCM- and the SM- relay is the same as the number of the switch on which the operated secondary select magnet is located, and a cut-off arrangement on the contacts of the SM- relays prevents more than one link cut-in relay from operating at a time. At this point an LCM-, the FCM, and an MCB- relays are operated on the outgoing frame connector and the C links are connected to the channel test relays in the marker (OS 212-1). The operated SM- relay connects the PS-leads from the primary select magnets to the marker (OS 215-1).

7.117 With the LCM- relay and the FCM relay operated, a path is closed to operate the marker CK (C link check) relay to indicate that the C links have been connected to the marker (OS 215-1).

Incoming Frame Seizure

Operation with Frames Not Paired for Junctor Distribution

7.118 When the FLM relay operates in the outgoing link and connector circuit, it places a resistance battery on the MPB lead into the marker (OS 208-1). This battery is extended through the operated CNE relay, the normal ICB (incoming connector busy) relay, and the operated IA- (incoming frame auxiliary) relay, to operate the MP relay in the desired incoming link and connector circuit.

7.119 This MP relay is in a double-transfer and lockout arrangement with MP relays of all other markers that have access to this frame. The MP relay, in operating, operates the MC- (marker cut-in) relay, to connect the marker leads to the incoming link and connector circuit and to connect the windings of the FLH and the FLM relays into the marker via the FE and FO leads respectively.

7.120 Since one assumption made was that the incoming trunk is located on frame No. 0, which is an even frame of a pair, the IEV relay is operated when frame identification is made. With the IEV relay operated, a circuit is completed on the FE lead to a 90-ohm battery which operates the FLH relay in the incoming link and connector circuit. This relay operates to a ground on the normal contacts of the FLM relay that is located on and associated with the connector for the odd frame. As was the case on the outgoing frame, this arrangement checks that the connector on the odd frame is not in use.

7.121 With the FLH relay operated on the even incoming frame connector, the following operations take place in the marker and on the outgoing frame:

(a) The LWH (link wanted home) relay is operated in the even connector circuit (OS 208-1).

(b) A 52.5-ohm battery is placed on the PSE lead to the marker (OS 215-1). The PSE lead is closed through the operated IEV relay, through the normal ID relay where it becomes the SM- lead. The SM- lead operates the select magnets associated with the incoming trunk on the primary switch of the incoming frame.

(c) The FCH (frame cut-in home) relay is operated in the even connector circuit (OS 207-1).

7.122 The FCH multicontact relay in operating connects the AK (OS 215-1), SK (OS 214-1), FK and FK1 (OS 208-1) leads to the marker. Ground and battery on the FK and the FK1 leads, respectively, operate the IFK (incoming frame check) relay, indicating that the marker has access to the switches on the proper incoming frame and checking that either the FCH or FCM relay is operated but not both.

Operation with Frames Paired for Junctor Distribution

7.123 When the incoming frames are provided with secondary extension bays, the junctors between a pair of incoming frames are shared. With this arrangement it is necessary to prevent the operation of the incoming secondary select magnets on the frame on which the call is not being set up. This is accomplished by a select magnet lockout feature using the SK lead (OS 214-1).

7.124 When the FLH relay operates on the even frame, it places a 226-ohm battery on the winding of the SLH (select magnet lockout home) relay which operates to ground on the normal contacts of the SLH relay located on the odd frame. The SLH relay of the even incoming frame is in a lockout arrangement with the SLH on the even incoming frame. It is therefore possible to operate only one SLH relay. The operated SLH relay operates the SK (select magnet lockout check) relay in the marker by placing battery on the SK lead. A make contact on the SK relay is in the circuit for operating a CH- (channel) relay (OS 212-1).

7.125 The CH- relay operates the incoming secondary select magnets. Since it is not possible to operate the SK relays in two markers, each of which is connected to an incoming frame of a pair, it follows that only one select magnet can be operated on the secondary switches of either of these two frames at one time. This prevents double connections.

Operation of the LC- and SM- Relays on the Incoming Frame

7.126 When the primary select magnet on the incoming link and connector

frame operates, it grounds one of the LCO-9 leads (OS 215-1). The LC- lead that is grounded has the same number as the primary switch on which the incoming trunk is located. This ground operates like-numbered LCH- (home link connector cut-in) and SH- (select magnet home) relays in parallel to a 52.5-ohm battery furnished by the previously operated LWH relay (OS 215-1), provided no other primary select magnet on the same frame is operated at the same time.

7.127 A cut-off arrangement on the contacts of the SH- relay prevents more than one link cut-in relay from operating at a time. The SH- relay connects the secondary select magnets (one from each secondary switch corresponding in number to the operated SH- relay) to the marker. The LCH- relay connects the LSOL to LS9L and the LSOR to LS9R (link sleeve) leads to the marker channel test relays (OS 212-1).

7.128 With the LCH- relay operated in the incoming connector circuit, and with the BK and CK relays operated as described under Seizure of the Outgoing Frame, a circuit is completed for operating the AK (A link check) relay (OS 215-1). By wiring the operating path of the AK relay through the make contacts of the BK and CK relays, the operation of the AK relay is used to tell the marker that all the necessary components needed to select an idle channel have been cut through.

(K) Selection of an Idle Channel

Operation of AB-- and CP-- Channel Test Relays

7.129 At this point the three sets of leads associated with the A, B and C links have been connected by the multicontact relays on the incoming and outgoing frame connectors to the channel test relays in the marker (OS 212-1). Also, a set of JP- leads may have been connected to the channel test circuit if the JPO or JP1 relay is operated (OS 210-1). The 20 AB-- (A and B link number) relays and the 20 CP-- (C link number) relays shown on OS 212-1 are the channel test relays used to test the A, B and C links for a busy condition.

7.130 Each AB-- relay and each CP-- relay has two windings. The windings of these relays are connected in the following way to the four sets of leads mentioned above:

(a) The primary windings of the CP-- relays are connected through the normal contacts of the associated CH-- relay to the LS-- (C link) leads in the outgoing frame. A ground on any of these leads indicates a busy

C link and operates the CP-- relay through battery on the make contacts of the XCO relay.

(b) The secondary windings of the CP-- relays are connected to the JP- terminals which are used in connection with the JP- relays shown on OS 210-1 in order to make busy those junctors or B links that are not in use. Ground on the make contacts of a JP- relay, when used, operates the proper CP-- relays through battery on the make contacts of the operated XCO relay.

(c) The primary windings of the AB-- relays are connected through the normal contacts of the associated CH-- relays to the 20 JS-- (B link) leads in the outgoing frame. Ground on any one of the JS-- leads indicates a busy B link and operates the associated AB-- relay through battery on the make contacts of the XCO relay.

(d) The secondary windings of the AB-- relays are connected through the normal contacts of the associated CH-- relays to the LS-- (A link) leads in the incoming frame. Ground on any one of the LS-- (A link) leads indicates a busy A link and operates the associated AB-- relay through battery on the contacts of the operated XCO relay.

7.131 If both the AB-- and CP-- relays associated with the A, B and C links of a channel are normal, this indicates that the channel is idle. The following paragraphs explain the channel test, which allows the marker to seize a channel by operating a CH-- (channel number) relay associated with the first set of idle AB-- and CP-- relays.

7.132 When all of the channels are busy, indicating that at least one of the AB-- or CP-- relays is operated on each of the 20 channels, the CHB (all channels busy) relay is operated in order to advance the junctor walking circuit and to test the next junctor subgroup, as indicated on the sequence chart of OS 213-1. When all channels are busy in the last junctor subgroup, the marker releases so that the decoder connector can make a second trial call. The operations for an all channels busy condition are explained in Section A828.121.11.

Channel Selection and Select Magnet Operation

7.133 Before a path is closed to allow one of the CH-- relays to operate and thereby select a channel, the marker waits 15 milliseconds to insure that the AB-- and CP-- relays have time to operate, to indicate those channels which are busy.

This interval is timed by the CHT (channel timing) circuit and begins when the AK relay operates.

7.134 The operation of the AK relay (OS 215-1) and the BK relay (OS 210-1) removes a ground which, by energizing the secondary 2600-ohm winding, has been holding the polarized CHT (channel timing) relay in a non-operate position (OS 212-1). The primary 200-ohm winding is energized in the direction to operate the CHT relay but it is not in sufficient strength to overcome the stronger secondary winding.

7.135 This same ground was also holding a shunt around the CHT capacitor, and its removal now allows the capacitor to charge in series with the secondary winding of the CHT relay. Current continues to flow, which holds the CHT relay non-operated until the capacitor becomes sufficiently charged; then the primary winding is more effective and the CHT relay operates. In this manner an interval of time, approximately 15 milliseconds, is measured to permit the operation in response to a busy link of the slowest AB-- or CP-- relay. When the CHT relay operates, it completes a circuit that operates the CH-- (channel) relay associated with the first set of AB-- and CP-- relays, which are found normal.

7.136 The complete path for this channel selecting circuit goes through contacts of various relays which, depending on their operated or non-operated condition, check that essential functions have taken place. The relays and the action that they have checked (OS 212-1) are as follows:

<u>Relay</u>	<u>Condition</u>	<u>Operation Checked</u>
TKE	(released)	Trunk has been selected.
TCK	(operated)	Trunk block connector checked in.
CHT	(operated)	Cut-in relays operated on incoming and outgoing frames.
CHTK	(operated)	CHT relay is on back contact before channel test started.
CHB	(released)	Channels are not all busy.
CHE	(operated)	All CH- relays normal.
HMT1	(operated)	Hold magnet timing circuit is functioning properly.

Relay	Condition	Operation Checked
AC1	(operated)	Hold magnet test circuit is functioning properly.
IFK	(operated)	Incoming frame connected.
OFK	(operated)	Outgoing frame connected.
STI	(released)	Trouble recorder not called.
TR1A TR2A	(operated) (released)	First trial.
TR1A TR2A	(released) (operated)	Second trial.
SGA	(released)	No double connection exists on outgoing trunks.
SK	(operated)	Incoming secondary select magnet block-out completed or unwanted frame of pair.

7.137 The CH-- relay that operates corresponds to the number of the channel that will be used for connecting the incoming trunk to the selected outgoing trunk. At this time these various parts may be identified as the channel number, since the number of the vertical on both the incoming primary switch and the outgoing secondary switch, the incoming secondary switch number and the outgoing primary switch number to be used on this call are the same as the number of the operated CH-- relay. For example, if the number of the CH-- relay is CHL9, then the channel number is L9.

7.138 The select magnets associated with the incoming and outgoing trunks located on the incoming primary and outgoing secondary switches, were operated as described under outgoing and incoming frame seizure.

7.139 The operation of a CH-- relay now completes a circuit for operating an incoming secondary and an outgoing primary select magnets (OS 215-1). Battery through the winding of the XSMI (crossed incoming select magnet) relay is placed on the SS-lead that corresponds in number to the operated CH-- relay, into the incoming link and connector circuit. This operates a secondary select magnet on this frame that corresponds in number to the operated SH-relay, but on a switch whose number is the same as the operated CH-- relay. The operation of the SH- relay is described in the Outgoing and Incoming Frame Seizure of this part. Note that the number of the operated SH- relay corresponds to the incoming primary switch number.

7.140 A battery is also placed through the winding of the XSMO (crossed outgoing select magnet) relay on a PS-lead, that corresponds in number to the operated CH-- relay, into the outgoing link and connector circuit. This operates a primary select magnet on this frame that corresponds in number to the operated SM-relay, but on a switch that is numbered the same as the operated CH-- relay. Crosses in the incoming secondary and outgoing primary select magnet leads are detected by the polarized XSMI and XSMO relays, which operate if two or more select magnets are connected to the same lead.

(L) Outpulsing Information Sent to Sender

General

7.141 The marker has now progressed to the point where completion of the connection between the incoming trunk and outgoing trunk is assured. It has selected an outgoing trunk, identified and seized the frames on which the incoming and outgoing trunks are located, and selected a channel to connect the incoming trunk to the outgoing trunk. Therefore the marker now proceeds to give the information for this call to the sender.

7.142 With the CH-- relay operated, the CHE relay releases. The normal CHE relay closes ground from the make contacts of the ICK relay through the make contacts of various register relays to the sender in order to indicate the following types of information:

- (a) Class information (OS 193-1).
- (b) Variable spill information (OS 194-1).
- (c) Digit control information (OS 194-1).
- (d) Code conversion information (OS 195-1).

Class Information

7.143 With the CL5 and CDLC class relays operated, this ground is closed through the winding of the CLA (class check) relay, make contacts of the CL5, through the decoder connector and operates the SXD (simplex dial) relay in the sender and the CLA relay in the marker (OS 193-1). The CDLC relay operated, prevents grounding the DLC lead to the sender. The DLC (delayed loop closure) relay in the sender does not operate and the sender therefore cancels delay loop closure timing.

Variable Spill Information

7.144 The variable spill SK3 relay, also operated on card registration, directs the ground (OS 194-1) through the

winding of the SKA (skip check) relay to the SK3 lead via the decoder connector to the sender SK3 (skip 3) relay winding, operating the SK3 relay in the sender and the SKA relay in the marker.

Digit Control Information

7.145 The same ground is also closed through the winding of the DGA (digit control check) relay, the make contacts of the 4DG relay operated on card registration, to the 4DG lead through the decoder connector, to operate the HPS (H position start) relay in the sender and the DGA relay in the marker (OS 194-1).

Code Conversion Information

7.146 Code conversion relays CCU1 and CCU2 operated, direct the same ground through the winding of the CUA (code conversion units check) relay and the make contacts of the CCU1 relay through the decoder connector to the sender CU1 relay, operating this relay in the sender and the CUA relay in the marker (OS 195-1). In a similar manner the CCU2 operates the sender CU2 relay and the marker CCUB (code conversion units check) relay.

7.147 The SXD relay operated in the sender, prepares the sender to out-pulse on a simplex basis. The SK3 relay operated in the sender, drops the A, B and C digits originally registered, and the operated CU1 and CU2 relays in the sender substitute a 3 for the C digit. The operated HPS relay in the sender signals the sender to stop pulsing after the G digit has been outpulsed.

7.148 The operated check relays CLA, SKA, DGA, CUA and CCUB indicate to the marker that the corresponding information is registered in the sender. The make contacts are used in the operating path of the SRL (sender release) relay to prevent the release of the marker until this information is registered in the sender (OS 217-1).

(M) Operations Prior to Hold Magnet Operation

Test of A and C Hold Magnet Leads

7.149 When the channel test is completed and the desired CH-- relay is operated, the A and C link hold magnet leads close to the grids of the AC (A and C link test) tube (OS 216-1). This starts a test to insure that these leads are closed to battery through the hold magnets and are free from a ground condition.

7.150 The AC tube is arranged so that when the marker is idle and the leads to the grids are open, a slight negative grid bias of approximately one volt exists (between the cathodes and grids) and

current flows in the plate circuit. This holds the AC (A and C link test) relay operated. If either or both of the A or C hold magnet leads are grounded, the grid or the grids of the AC tube are positive with respect to ground, and plate current continues to flow. When negative 48-volt potential is applied to both halves of the AC tube, the tube is biased to cut-off. This is the normal condition and it occurs when both A and C hold magnet leads provide a negative 48-volt potential on both grids from the windings of the A and C link hold magnets. This reduces the plate current to zero, and the AC relay releases. With the AC relay released, the locking path for the HMT1 relay is open, which permits the HMT1 relay to release as soon as a hold magnet timing interval is completed.

Timing for Release of Hold Magnets After Previous Call

7.151 The selected channel may be one which has just been freed by another call. The channel tests idle to the marker, but there has not been sufficient time to allow the associated hold magnets to release and their select fingers to unlatch. If the hold magnets were energized at this time, a double connection may be set up. To prevent failures of this type, a hold magnet timing feature in the marker delays the operation of the hold magnets.

7.152 The operation of a CH-- relay, as explained previously, operates the incoming and outgoing link select magnets, and closes the A and C link hold magnets to the AC tube for the hold magnet test. It also releases the CHE (channel end) relay (OS 212-1) which removes ground from the secondary winding of the HMT (hold magnet timing) relay and permits the HMT capacitor to charge in series with it (OS 216-1). Current continues to flow, thus preventing the HMT relay from operating. However, after an interval of approximately 25 milliseconds, the current flow reduces to a point where the primary winding of the HMT relay takes control and operates the HMT relay. With the hold magnet test complete and the hold magnet timing complete the HMT1 relay releases. In this manner an interval is measured by the operate time of the HMT relay and the releasing of the HMT1 relay which is sufficient to permit a previously operated hold magnet to release and its select finger to unlatch.

(N) Operation of Hold Magnets

7.153 The release of the HMT1 relay closes the CKG ground through the CH-- relay to operate the A, B and C link hold magnets (OS 216-1). When the hold magnets have operated and both sets of tip and ring leads have been closed, a crosspoint continuity test is made to check that the A, B and C

link hold magnets have operated and closed through the switches from the incoming trunk to the outgoing trunk. This feature is explained in detail later in this part.

7.154 A successful continuity test results in the operation of the CON1 (continuity check auxiliary) relay, which removes the shunt from the primary winding of the B (B link continuity and false ground test) relay connected to the junctor sleeve (OS 216-1). If there is no double connection, as indicated by the absence of ground on the junctor sleeve, the B relay operates in series with the hold magnets, at the same time holding them operated. If, however, there is a double connection, there will be ground present on the sleeve which prevents the operation of the B relay, blocking the next step in the progress of the marker and causing it to time-out and call in the trouble recorder.

7.155 Assuming that no double connection exists on the A, B or C links and a successful continuity test has been made, the CON1 and B relays complete a circuit for operating the CON3 (continuity check) relay, which locks and removes ground from the MT lead to the sender via the decoder connector (OS 216-1). This results in the release of the MT (marker transfer) relay in the sender, which applies a holding ground to the incoming and outgoing frame hold magnets through the incoming trunk. At this point, therefore, the incoming sender takes over the control of the established channel. The holding ground from the MT relay is connected to the marker over the junctor sleeve and shunts the winding of the B relay, causing it to release.

7.156 When the secondary hold magnet on the outgoing frame operates, it connects ground to the MS lead into the marker via the trunk relay circuit, which operates the SG (sleeve guard) relay and releases the SCT relay in the marker (OS 216-1). The SG relay operated indicates that the outgoing trunk circuit is held busy from the ground through the crosspoints of the operated C link switch.

(O) Crosspoint Continuity Test and Release

7.157 The crosspoint continuity test referred to in Par. 7.149 is a test of the tip and ring leads, and it is made by the marker on every call to verify that all the hold magnets have operated to close all the crosspoints on the selected channel. This test is made by two general methods, simplex type for classes CLO to CL7 and CL14, and loop type for classes CL8 to CL13.

7.158 The simplex type of continuity test is generally used for outgoing trunks of the intertoll type where simplex consisting of retard coils and relay

windings appear in both transmission paths as they leave the outgoing frame (OS 216-1). These simplexes provide d-c paths for the operation of the CONA and CONB (continuity test) relays when the nongrounded d-c potential is applied through the crosspoints. As shown in Note 1 of OS 216-1, there are certain conditions under which the marker may cancel the continuity test. Cancellation of this type of crosspoint continuity test does not mean that the entire test is cancelled, but that it is made in a different manner. Cancellation, for the reasons shown in Note 1 on OS 216-1, causes the CONA relay circuit to revert to battery and ground operation on that portion of the circuit only. This test still checks for crosspoint closure, but only on the OT and OR leads of the transmission circuit.

7.159 The loop type of continuity test is used for outgoing trunks of the toll switching type where half of the transmission path consists of a retard coil and relay simplex, and the other half consists of a metallic loop to the office ahead. The CONA relay operates as described above when continuity test is applied. However, the operated LPD relay, which indicates loop dial class, transfers the KT1 and KR1 leads from the CONB relay operating path to the LCON (loop continuity) relay operating path. The LCON relay is dependent for its operation upon battery and ground received from the office ahead. The varistor bridge LCON maintains the polarity shown whether the battery and ground from the office ahead are straight or reversed. Generally, the loop continuity test is only canceled due to the conditions shown in Note 1 on OS 216-1, or when there is a probability that the continuity test on the metallic loop will operate relays falsely in the office ahead.

7.160 The call that is described in this part uses an intertoll outgoing trunk that is now connected to the toll tandem trunk (OS 216-1). The CL5 relay is operated in the marker as explained in Par. 7.38 by the class punches shown on Fig. 15. The CL5 registration indicates that the type of outpulsing is to be simplex dial. The LPD relay is normal. The KT and KR leads are connected to the CONA relay and the KT1 and KR1 leads are connected to the CONB relay.

7.161 The make contacts of the CKGA relay complete a circuit from a continuous ringing current supply to the primaries of transformers CONA and CONB. These transformers reduce the voltage to the rectifiers CONA and CONB to approximately 48 volts. When rectified, this voltage serves as a nongrounded d-c potential for making the crosspoint continuity test. A nongrounded potential is necessary for this test because it reduces the

probability of false relay operations in the outgoing trunk relay circuit when the continuity test is applied. It also prevents a false continuity indication when foreign battery or ground appears on the transmission leads. The latter condition would be recognized by the incoming sender at the time that the outgoing trunk is connected to the sender for outpulsing or sleeve check.

7.162 On this call, when all the cross-points have closed, a direct current circuit in the outgoing trunk completes a path to operate the CONA and CONB relays (OS 216-1). The operation of these relays indicates that the continuity test is successful and completes a circuit for operating the CON1 relay. The CON1 relay removes the shunt around the primary winding of the B relay, permitting the marker to proceed as described previously, and opens the operating path for the incoming primary and the outgoing secondary select magnets (OS 215-1). The release of these select magnets causes the associated LCH- or LCM- relays to release, which opens the AK and CK leads. The removal of ground on the AK and CK leads releases the AK and CK relays in the marker, thus preparing a path for the operation of the RL (release) relay. However, the SRL (start release) relay must operate before the RL relay can operate.

7.163 With the B relay released after the channel holding ground has been transferred to the sender, and with the SG relay operated from the crosspoint ground of the outgoing frame secondary hold magnet, a ground is closed to operate the SRL (start release) relay (OS 217-1). The operating path of the SRL relay is through contacts of various relays, either operated or released, to check that all the necessary functions required to connect the incoming trunk to the selected outgoing trunk have taken place. The operation of the SRL relay checks that the sender has been supplied with all the pertinent information needed for completing the call. The relays involved in the SRL operating path and their functions are given in the following table.

<u>Relay</u>	<u>Condition</u>	<u>Operation Checked</u>
ONG1	Operated	Off-normal ground supply.
XSMT	Released	No crossed select magnet leads.
SG	Operated	Outgoing secondary crosspoints operated.
HMT1	Released	Hold magnet timing, and A and C link hold magnet lead tests completed.

<u>Relay</u>	<u>Condition</u>	<u>Operation Checked</u>
AC1	Operated	AC and HMT1 relay continuity test made.
B	Released	Connection under control of the incoming sender.
CON3	Operated	Continuity test completed.
GCHN	Operated	No code conversion hundreds digit.
CCTN	Operated	No code conversion tens digit.
CCUA) CCUB)	Operated	Registration in the sender of a units digit to be outpulsed in place of the original C digit.
SKA	Operated	Variable spill information given to the sender.
DGA	Operated	Digit control information given to the sender.
TSA	Operated	Trunk selected signal given to sender.
RCK	Operated	Register check completed.
CLA	Operated	Class of outgoing trunk given to the sender.
CL5	Operated	Class of outgoing trunk.
CDLC	Operated	Sender to cancel delay loop closure.
TRA	Released	No trouble record made.

The operated SRL relay locks to the ONG1 relay ground, closes ground on the MRL lead through the decoder connector to the incoming sender, and completes the path for the RL (release) relay in the marker (OS 217-1).

7.164 The grounded MRL lead operates the MRL (marker release) relay in the sender, which in turn removes battery from the ST lead to the decoder connector (OS 155-1). This causes the SC and SP relays in the decoder connector to release. The normal SC relay releases the SC1 (OS 155-1) and MC (OS 177-1) relays in the decoder connector, which in turn break all connections between the sender and the marker and fully release the decoder connector.

7.165 The operation of the SRL relay also removes the 48-volt battery from the ST- lead to the trunk block connector, releasing the MP relay in the trunk block connector. The normal MP relay releases the trunk block connector (OS 198-1), disconnecting all leads between the trunk block connector and the marker.

7.166 The operation of the RL relay releases the ONG, ONB and the CKGA relays. These normal relays cause the release of most of the relays still operated in the marker provided the decoder connector has been fully released. The normal ONB relay removes battery from the ST- leads to the incoming and outgoing frames, releasing both frames (OS 207-1 and 208-1).

7.167 When the decoder connector is released by the sender the CBR relay in the marker is released, this in turn releases all the CB relays (associated with this marker) in all the marker connectors, thus permitting this marker to be seized on another call (OS 188-1). However, to insure the release of all the relays in the marker before being seized for another call, the operating path for reoperating the CKG relay is held open until the RL relay is released (OS 190-1).

7.168 With the CKGA relay released, the CKG relay releases (OS 190-1). With all frames released, the OCK and ICK relays release (OS 207-1 and 208-1). With the trunk block connector released, the TCK (OS 198-1) and the GCK relay release (OS 200-1). With these relays all released, the RL relay releases (OS 217-1), and the CKG relay can be reoperated to start another call.

8. DP INCOMING SENDER - OUTPULSING

(A) General

8.01 At this point the sender is connected to the toll tandem trunk through the crosspoints of switches on the sender link frame and is connected to the marker through the decoder connector. The incoming sender has the digits 223-2346 registered in its digit registration circuit as explained in Part 3.

8.02 The operations that prepare the sender to outpulse begin when the marker signals information to the sender as described in Part 7. On this call these operations and other sender operations involved in outpulsing take place in the following sequence:

(a) The sender receives information that an outgoing trunk has been selected by the marker. Later when a channel has been selected by the marker, the sender receives simplex dial class, variable spill, code conversion, and digit control information. The sender

is also signaled when the marker is prepared to release.

(b) The sender starts a condenser-timed circuit, known as the pulse generator, when the trunk selected signal is registered. The pulse generator contains a group of relays which operate for 50 milliseconds, release for 50 milliseconds, then continue the operation and release cycles at the same speed until the pulse generator is stopped.

(c) The sender uses pulse dividing relays and pulse counting relays to count the cycles. This call is a simplex dial class call and the sender is required to count the cycles in order to measure a round trip transit timing (RTT) interval of 375 ms before registering whether the equipment at the distant office is prepared to receive pulses. The RTT interval allows time for the outgoing trunk circuit at the 4A office to send a start signal to the distant end of the trunk and allows time for the distant end to return a stop pulsing signal if the distant office is not prepared to receive pulses.

(d) When the code conversion, variable spill, class and marker release information is received, the sender registers the first digit to be outpulsed in a circuit called the recapture circuit. This operation takes place during the RTT timing interval.

(e) When the RTT timing interval has elapsed, the pulse generator stops and the sender registers whether the Cape May office is prepared to receive pulses. On this type of call the sender normally registers a start pulsing signal, which indicates that the office is ready to receive pulses. This signal is also referred to as an on-hook signal or a go signal.

(f) When the sender has registered that the Cape May office is prepared to receive pulses, and when the first digit to be outpulsed is registered in the recapture circuit, the pulse generator is restarted so that it can be used in outpulsing.

(g) When the pulse generator is operating, its relays operate and release once every 100 milliseconds. The front contacts of one of the relays in the pulse generator circuit intermittently place ground on the common point of two simplex leads to the outgoing trunk circuit so that a train of pulses is outpulsed. The outgoing trunk circuit in turn sends these pulses to a composite set which sends them to the Wildwood office.

(h) The sender registers the number of pulses sent to the outgoing trunk circuit by counting the cycles of the pulse generator. When this count equals the number of the digit registered in the recapture circuit, the path to the simplexed leads is opened so that outpulsing is stopped. On this call the first digit to be outpulsed is 3, therefore, outpulsing of the first digit stops after ground has been intermittently placed on the simplex leads three times.

(i) After the first digit has been outpulsed, the pulse generator continues to operate. The operation and release cycles of its relays are counted so that an effective interdigital interval of 600 ms can be measured. Also, the sender prepares to outpulse the second digit by registering the number of the second digit in the recapture circuit. When the interdigital interval has elapsed, the second digit is outpulsed in the same way as the first digit.

(j) When all of the digits have been outpulsed, the sender signals the outgoing trunk circuit that outpulsing has been completed. The trunk circuit then acknowledges receipt of this signal. This interchange of signals is known as the SL check. When it is completed, the sender releases. In releasing the sender transfers control of the operated hold magnets on the incoming and outgoing frames to the incoming trunk circuit.

8.03 These above operations are shown on SC 104-1 and are described in detail in the following paragraphs.

(B) Registering Information from the Marker

8.04 When the marker has selected an outgoing trunk, the TKS lead to the sender is grounded. This lead operates the sender TKS (trunk selected) relay (OS 202-1). Later, when the marker has selected an idle channel as indicated by the operation of a CH-- relay and by the release of the CHE relay (OS 212-1), the marker closes ground through the normal CHE relay to register class, variable spill, code conversion, and sender digit control information in the sender by operating the following sender relays:

(a) SXD (simplex dial) relay (OS 193-1). The operation of this class relay indicates that the sender should outpulse dial pulses over simplexed leads to the outgoing trunk and that an RTT timing interval of 375 ms should elapse before the sender registers the start dial or stop dial signal. The SXD relay operates the DP (dial pulse)

and the DP1 (dial pulse auxiliary) relays (OS 125-1).

(b) SK3 (skip 3) relay (OS 194-1). The operation of this variable spill relay indicates that the sender should not outpulse the first three digits registered in the sender, i.e., the National Office Code 223.

(c) CHN, CTN, CUL, and CU2 (code conversion) relays (OS 195-1). These relays indicate that no digits should be outpulsed in place of the hundred digit and ten digit of the national office code which is being skipped, and that a 3 should be outpulsed in place of the unit digit of the code. Thus, instead of outpulsing 223-2346 the sender should outpulse 3-2346.

(d) HPS (H position start) relay (OS 194-1). This relay operates from ground on the 4DG lead from the marker. The operation of this relay prevents outpulsing more than four numerical digits following the National Office Code 223. On this 3-digit translation call, the G digit will be the last digit outpulsed. If an H digit is dialed as a result of an operator's error, it cannot be outpulsed. This digit control information also allows the sender to outpulse the G digit and then indicate to the outgoing trunk that outpulsing has been completed without waiting for an interdigital time-out period to elapse.

8.05 When the marker has completed its operations, it grounds the MRL lead to the sender to operate the MRL (marker release) relay (OS 217-1). As described in Part 7, the sender MRL relay opens the start lead to the decoder connector, causing it to release and break all connections between the sender and the marker (OS 155-1). The sender MRL relay operates the MRL1 (marker release auxiliary) relay (OS 217-1). The operated MRL and MRL1 relays provide locking grounds for the above relays which record information from the marker.

(C) RTT Timing

General

8.06 The operation of the SXD relay indicates that an RTT (round trip indirect) timing interval of 375 ms should be used and also that the selected outgoing trunk is a guarded type trunk (RM 3-3). Outgoing trunks may be of the guarded or unguarded type. A guarded type trunk circuit contains a guard relay which holds a busy condition on the sleeve lead for a measured interval after release on the previous call to allow all equipment at both ends to release. An unguarded trunk circuit does not have this feature. All

2-way trunks are guarded. One-way trunks may be either guarded or unguarded. It is assumed that the outgoing trunk selected on this call is a guarded one-way trunk. This assumption has been made in order to conform with the circuit arrangements shown on OS 127-1 and 221-1.

8.07 When a guarded trunk is seized by a marker a signal is immediately sent ahead to the distant end by placing battery on the M lead. As indicated on SC 127-1, the operated K- relay in the marker operates the OS relay in the trunk, which sends the battery signal forward to start equipment seizure at the distant office. When a 2-way trunk is being used, this signal also busies the distant end. As shown on OS 127-1, the E lead to the outgoing intertoll trunk circuit is connected to 48-volt battery. As long as the E lead is open the battery is placed on the OT1 and OR1 leads to the sender through the simplex. This battery acts as a start pulsing signal and indicates that the distant end is ready to receive pulses. However, the start pulsing signal cannot be registered in the sender until the TCA (timing completed) relay operates to indicate that the RTT timing has been completed.

8.08 If the distant end of a 2-way trunk circuit is not ready to receive pulses, it places battery on the M lead in the distant trunk circuit. This signal is transmitted through the composite set to the 4A office where a ground is placed on the E lead. This ground shunts the 48-volt battery in the outgoing trunk circuit and serves as a stop pulsing signal to the sender over the simplex OT1 and OR1 leads. By holding the OT1 and OR1 leads open until the RTT timing has been completed, the distant office is allowed time to send a stop pulsing signal if necessary. A 2-way trunk circuit is equipped to send a stop pulsing signal when both ends of the trunk have been seized simultaneously.

8.09 Note that both OS 127-1 and 221-1 show a one-way IT trunk circuit. This type of circuit is not equipped to send a stop pulsing signal by placing battery on the M lead. However, if the T and R leads are reversed due to a trouble condition, ground on the M lead from the distant office has the same effect as battery on the M lead and a stop pulsing is indicated (OS 221-1).

8.10 There is another important difference between the operation of a guarded trunk as described above and an unguarded trunk. When an unguarded trunk is seized, it is merely made busy. No signal is sent forward until the sender closes the loop consisting of the T and R leads used in outpulsing. Such a loop is used with the toll switching trunk on OS 127-1. No RTT timing is necessary but an interval is

timed before the sender closes the loop by operating the TCA relay. This allows time for the release of any equipment that may have been operated on a previous call. This interval is called delay loop closure timing. This timing is measured like RTT timing since it makes use of the sender pulse generator and the pulse counting relays.

Operating the Pulse Generator

8.11 The pulse generator circuit is shown at the top of Sheet 1, OS 125-1. The operation and release of its relays allows the sender to measure DLC timing; to outpulse DC key pulses, MF pulses or dial pulses at the proper cadence; and to measure the interdigital interval.

8.12 The pulse generator consists of the PG (pulse generating) relay, P (pulsing) and PCK (pulse check) relays, the DP (dial pulsing) and KP (key pulsing) resistance networks, and the PG and PGA capacitors. The PG relay is a polar relay without a biasing spring. During dial outpulsing the DP resistance network and capacitor PG cause the PG relay to operate and release 10 times per second. During MF outpulsing or DC key pulsing the KP resistance network and capacitors PG and PGA in parallel cause the PG relay to operate and release 7.3 times per second.

8.13 Upon sender seizure, off-normal ground is placed on the junction of the primary and secondary windings of the PG relay. With this condition both terminals of capacitor PG are grounded; therefore it is maintained in a discharged condition. The current flow from ground through relays PG, P, and PCK to battery beyond the DP network is in the proper direction to operate the relays P and PCK, but not the PG relay.

8.14 When the sender is connected to an outgoing trunk, the marker operates the TKS (trunk selected) relay in the sender. The TKS relay in turn operates the PA (pulse counting auxiliary) relay, which allows the pulse generator to function. Reference should now be made to Fig. 21 which shows the pulse generator in simplified form.

8.15 The operation of the PA relay opens the path from ground to the PG relay; thereby applying 48 volts through the U resistor to the PG relay. This reverses the current in the primary winding of relay PG, releases relays P and PCK, and allows capacitor PG to charge as shown on the Force-Time chart on Fig. 22. The effect of the capacitor charging current in the secondary winding overcomes the effect of the current in the primary winding and holds the armature of the relay against its back contact for a time determined by the R-C combination of the secondary

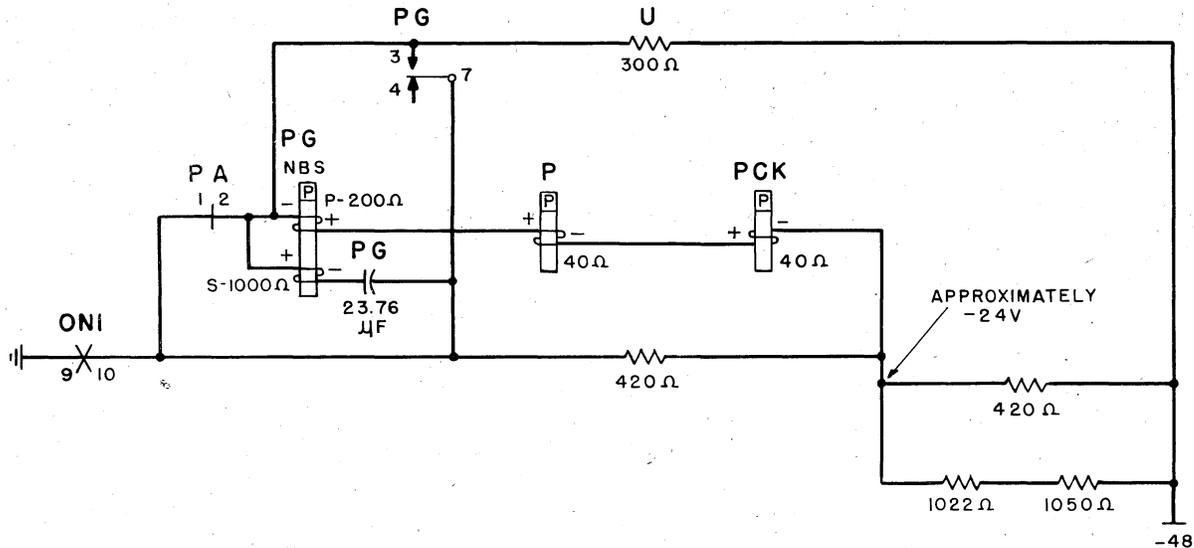


FIG. 21- SIMPLIFIED PULSE GENERATOR

winding. As the current in the secondary winding decreases, the resultant force upon the armature decreases to zero and then reverses. When sufficient force has developed, the armature moves to its front contact (or operates the relay). Operation of the PG relay applies ground to the junction of its primary and secondary windings, which again operates relays P and PCK. This also permits the PG capacitor to discharge through the PG secondary winding. This discharge current, which is in a direction to hold the armature against its front contact, decreases as the capacitor becomes discharged. The rate of discharge is controlled by the R-C combination.

8.16 When the PG relay operates the current through its primary winding reversed, and is in direction to hold the armature against its back contact. As the secondary current decreases, the resultant force on the armature falls to zero and reverses. This action finally causes the armature to move to its back contact (or releases the relay). As long as the PA relay remains operated the foregoing action continues.

8.17 The operation of the pulse generator on this call is shown on SC 104-1 beginning at N102. This sequence chart shows that the PG, the P, and the PCK relays remain operated for 50 ms and then remains released for 50 ms. During the period when these relays are released a pulse can be sent out. Contacts of the PCK relay are used for counting the pulses and measuring timing. Contacts of the P relay are used only when the sender is outpulsing.

Measuring the RTT Timing Interval

8.18 Associated with the pulse generator circuit are the PA, PB, PC, PD, PE (pulse counting auxiliary) relays and the PC1-6 (pulse counting) relays (OS 125-1). The PA, mentioned above, is operated by the TKS relay and is used to start the pulse generator. The PB relay is used in absorbing the first pulse each time the generator is started so that it will not be outpulsed. This is done because this pulse may be longer than subsequent pulses since the PG capacitor is completely discharged when the generator is started. The PC, PD, and PE relays operate as a pulse dividing circuit. The counting relays, PC1-6, are operated by the alternate operation and release of the PE relay. The pulses are counted on the PC-relays as follows:

Condition of PE Relay	PC- Relays Operated	Digit Count	Time Measured
Operated	PC1	1	100 ms
Released	PC2	2	200 ms
Operated	PC3	3	300 ms
Released	PC4	4	400 ms
Operated	PC5	5	500 ms
Released	PC6,PC5	6	600 ms
Operated	PC6,PC1	7	700 ms
Released	PC6,PC2	8	800 ms
Operated	PC6,PC3	9	900 ms
Released	PC6,PC4	10	1000 ms

8.19 When the pulse generator is started, the first pulse cycle is counted. Thus, when the pulse generator is being used to measure time, the operation of the PC1 relay indicates the end of a 100 ms

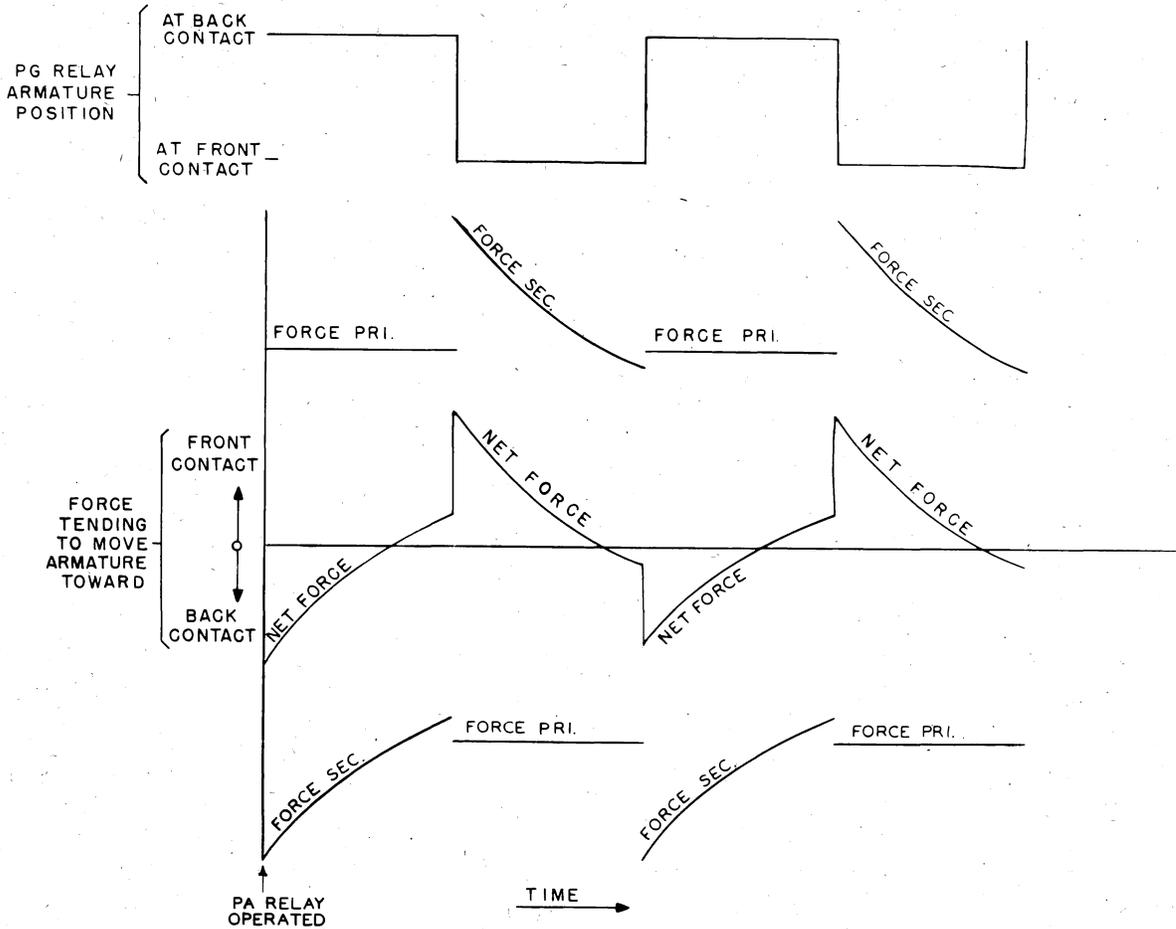


FIG. 22 - PG RELAY TIME - FORCE CHART

interval. When the pulse generator is being used to count the pulses being outputted, the operation of the PC1 relay indicates that the first pulse generated has been absorbed and that the next pulse generated is to be sent out as the first pulse of the digit.

8.20 RTT timing is measured in the following way. When the PCK relay releases at the start of the first pulse, the PB relay operates. When the PCK relay reoperates at the end of the first pulse, the PC relay operates (SC 104-1, J105 and OS 125-1). The next release of the PCK relay operates the PE (pulse counting auxiliary). The operated PE places ground on one of the two leads to the pulse counting relays and operates the PC1 (pulse count one) relay to indicate that 100 ms has elapsed. The reoperation of the PCK relay (second pulse completed) causes the PD (pulse counting auxiliary) relay to operate. The PD relay then releases the PC relay. When the PCK relay releases again the PD and PE relays release. The PE relay,

when released, grounds the other lead to the pulse counting relays and operates the PC2 relay to indicate that 200 ms has elapsed.

8.21 The operated PC2 relay in turn operates the TC3 relay and releases the PC1 relay. The SXD (simplex dial) relay is already operated from class information received from the marker. If the marker has requested release, the MRL relay is operated. The MRL closes ground through the normal DLC relay, the operated SXD relay, the TC3 relay that has just operated, the normal TKS2 relay and the operated PB relay. This ground operates the DE1 (digit end) relay. The operation of this relay indicates that the RTT timing should be continued for 175 ms. The next pulse of the PCK relay operates the TKS1 (trunk selected auxiliary) relay and in turn the DE2 (digit end) relay. The DE2 relay indicates that the 300 ms has elapsed. The DE2 relay releases relays PC2, PA and PB. The next operation of the PCK relay reoperates the PA relay and releases relays DE1 and DE2. At this point 350 ms has

elapsed. The release of the DE1 relay connects off-normal ground to the winding of the PG relay, and thereby stops the pulse generator.

8.22 The released DE2 relay removes the shunt from the winding of the TKS2 relay and allows it to operate. Ground on the contacts of the MRL relay, through the operated TC3, SXD, and TKS2 relays, operates the TCA (timing completed) relay to indicate that the RTT interval of 375 ms has elapsed. The operation of the TCA relay closes the KT1 and KR1 leads from the outgoing trunk circuit so that the sender can register either a start pulsing signal or a stop pulsing signal.

Receiving Start Pulsing or Stop Pulsing Signal

8.23 If the distant office is prepared to receive pulses, ground remains on the M lead from that office. This causes the CX relay in the 4A office to remain unoperated, leaving the E lead to the outgoing trunk circuit open (OS 127-1). With the E lead open, battery is connected through the winding of the SVP relay to the KT1 and KR1 leads, through the operated TCA and SXD relays, and through the normal TM6 and FL1 relays to operate the TG (trunk guard) relay. The operation of the TG relay registers a start pulsing signal in the sender. The TG relay operates the TG1 (trunk guard auxiliary) relay (OS 131-1).

8.24 On this call, where a one-way trunk is being used and simplex dialing class has been indicated, the XDD (expect dial delay) relay is normal, and the sender ordinarily receives a start pulsing signal at the conclusion of RTT timing. However, if trunk trouble such as reversed T and R leads is encountered, a stop pulsing signal is received by the sender. Ground on the E lead at the distant office is placed on the R lead instead of the T lead (OS 221-1). This operates the CX relay in the 4A office, which places ground on the E lead. This ground shunts the 48-volt battery in the outgoing trunk circuit. The ground is connected through the winding of the SVP relay, through the KT1 and KR1 leads, to operate the OF (overflow) relay in the sender. If the stop pulsing signal does not change to a start pulsing signal within 30-40 seconds, the sender times out. The use of stop pulsing and start pulsing signals for all classes of calls are shown on RM 3-3.

Preliminary SL Check

8.25 When the TCA relay operates following RTT timing, the sender makes the preliminary part of the SL check mentioned in (j) of Par. 8.02. As shown on OS 127-1, the TCA relay closes a path from ground through the 8700-ohm winding of the SL (sleeve out) relay in the sender via the KT and KR leads to the SL relay in the trunk

circuit. At this time the current flow in this circuit is sufficient to operate the sender SL relay, but it is not sufficient to operate the marginal SL relay in the outgoing trunk. On this simplex dial call, the SL relay in the trunk is not operated until outpulsing is completed. The operation of the sender SL relay constitutes the preliminary SL check. It tests the continuity of the KT and KR leads and prepares the circuit for completing the SL check.

(D) Outsteering and Registering of First Digit in Recapture Circuit

8.26 During the RTT timing interval the sender makes use of the code conversion, variable spill, class, and marker release information to determine which digit should be outpulsed first. The decision is registered by the operation of one of the relays in the outsteering control circuit (OS 126-1). The sender is then able to use information from the code conversion relays or the register relays ($A\frac{2}{5} - L\frac{2}{5}$) to register the number of the first digit to be outpulsed.

8.27 On this call, code conversion of the C digit is required, and this has been indicated to the sender by the operation of the SK3 relay and the operation of the CU1 and CU2 relays. As shown on OS 125-1, these relays close a path to operate the CC (convert C digit) relay. This relay opens the path between the grounded C digit leads from the register circuit. After the marker has requested release, the operation of the MRL1 (marker release auxiliary) relay operates the CC1 (convert C digit auxiliary) relay. These relays are used to operate the CSO (C digit outsteering) relay in the outsteering circuit. As shown on OS 126-1, ground through the operated MRL1 and DP1 relays, the normal OSC, NSK and SK6 relays, the operated SK3 relay, the normal CA1, CA, CB1, and CB relays, the operated CC1 and CC relays to operate the CSO relay. The operated CSO relay indicates that the A and B digits are to be skipped and that a digit in the C position is to be outpulsed first. The operated CSO relay closes a path to operate the ODO (odd outsteering) relay.

8.28 As shown on OS 125-1, the operated CU1 relay closes a path through the operated CC1, CSO and the ODO relays to operate the RT1 (recapture tip) relay and the RR1 (recapture ring) relay. The operated CU2 relay closes a path through the operated CC1, CSO and ODO relays to operate the RT2 and RR2 relays. The operation of these relays registers that the code converted digit 3 is to be outpulsed first. The RT- and RR- relays operate in pairs to provide sufficient contacts. Two-out-of-five pairs of relays are operated for the particular digit. The two-out-of-five operation of these relays closes a path to

operate the OSC (outsteering cock) relay (OS 126-1). The OSC relay prepares the outsteering circuit for advancing to the next outsteering relay by breaking the operating path for the CSO relay. Relay CSO, however, remains operated as it is locked to the ground at the ON1 (off-normal auxiliary) relay through the normal DSO relay.

(E) Outpulsing of First Digit

8.29 At this point, the first digit is registered in the outsteering circuit and the sender has registered a start pulsing signal. With these conditions the sender can begin the outpulsing operations by operating the SY (synchronizing) relay (OS 126-1). The SY relay operates from off-normal ground through the following relays.

- (a) Operated RR- and RT- relays corresponding to any digit. (Two and only two of these relays must be operated to close the SY relay operating path, thus checking for faulty registration.)
- (b) Operated auxiliary pulse class relay or relays. The call represented is dial pulse. The relay operated is thus the DP1.
- (c) The OSC relay must be operated.
- (d) One of the following relays must be operated: SK3, SK6 or NSK (no skip). On this call the SK3 relay is operated.
- (e) The outpulse control relay must be operated, indicating that a start pulsing signal is present from the trunk. For the type of call being described this relay is the TG1 (trunk guard auxiliary) which is operated by the TG relay (OS 131-1).
- (f) The KD (key circuit detector) relay must be normal. (This relay when operated indicates that outpulsing is to be on a DC or MF pulsing basis.)

8.30 Operation of relay SY starts the pulse generator (OS 125-1), by removing off-normal ground from the PG relay windings. As shown on SC 104-1, J205, the P and PCK relays immediately release. After 50 ms the PG, P and PCK relays operate. After another 50 ms, all relays release. These operations are the same as described previously under RTT Timing. In simplex dialing the KT1 and KR1 leads are simplex and connected to a common point through the operated SXD relay. When the BD (between digits) relay is operated, the common point is grounded each time the P relay in the pulse generator circuit returns to its back contacts. Intermittent grounding of the simplex leads sends out the train of pulses necessary for outpulsing

to the outgoing trunk circuit. The SVP relay in the trunk circuit follows these pulses by operating and releasing.

8.31 As shown on SC 104-1, K207, the first release of the P relay performs no function since the BD relay is not allowed to operate until after the first pulse has been absorbed. The first release of the PCK relay allows the PB relay to operate. When the PCK, PG, and P relays operate after 50 ms, the PCK relay operates the PC relay. Then the PC relay operates the BD relay (OS 125-1). When the P relay releases after 50 ms, the ground is closed through the operated BD relay to the simplex KT1 and KR1 leads to operate the SVP relay in the trunk circuit. When the P relay operates after another 50 ms, the SVP relay releases. Note that the operation of the SVP relay places ground on the M lead through the operated OS relay in order to release the CX relay in the composite set (OS 221-1). Release of the SVP relay removes the ground and places battery on the M lead in order to reoperate the CX relay. When the CX relay releases and reoperates, a pulse is sent out to the distant office. The sender continues to send a pulse each time the P relay releases until the simplex path is opened by the release of the BD relay.

8.32 The BD relay is released by the operation of the DE1 (digit end) relay. The DE1 relay operates when the number of the pulses counted by the PC-relay operations equals the digit number registered by the operated RR- recapture relays. Counting of the pulses in order to operate the PC-relays is done while outpulsing is taking place. The counting is done by using the contacts of the PCK relay, the pulse dividing relays PB, PD, and PE, and the pulse counting PC1-6 relays. The method used is the same as described under RTT Timing.

8.33 On this call the first digit outpulsed is a 3. When the PC3 relay operates, a path is closed from ground on the contacts of the operated TCA relay through the normal Z relay, the normal KP relay, the operated RR1 and RR2 relays, the operated DP1 and PC3 relays and the normal PC6 relay, to operate the DE1 relay (OS 125-1). As shown on OS 127-1, the DE1 relay releases the BD relay to stop the outpulsing of the first digit.

(F) Outsteering and Registering of Second Digit in Recapture Circuit

8.34 When the BD relay operated to start the outpulsing of the first digit, the DSO (D outsteering) relay was operated. The release of the BD relay to stop outpulsing releases the CSO outsteering relay, which in turn releases the ODO relay. As shown on SC 104-1, B217, the ODO relay releases the recapture relays and operates

the EVO relay. The normal RR- and RT- relays release the SY relay. The second digit to be outpulsed is then registered in the recapture circuit (OS 125-1). On this call this digit is 2 as indicated by the operated DO and D2 register relays. The DO relay closes ground through the normal CD relay, and the operated DSO and EVO relays to operate the RRO and RTO relays. The D2 relay closes ground through the normal CD relay and the operated DSO and EVO relays, to operate the RT2 and RR2 relays. These operated RR- and RT- relays close the path to reoperate the SY relay to indicate that the second digit is available for outpulsing.

(G) Timing the Interdigital Interval

8.35 Before sending out the second digit, an interval is timed to separate the pulses of the first digit from the second. In order to do this the pulse generator is kept in operation after the outpulsing of the first digit in order that 500 ms interdigital interval can be measured. After this interval, one pulse is absorbed and then the pulses are sent out for the second digit; absorbing one pulse increases the effective interdigital interval to 600 ms.

8.36 In measuring the interdigital interval, the sender makes use of the pulse dividing and pulse counting relays and a W-Z relay combination circuit consisting of the W, Z and WR relays (OS 125-1). When the DEL relay operates at the end of the train of pulses for the first digit, the W relay operates from off-normal ground. The W relay opens the ground path to the PG relay in the pulse generator. Thus, the release of the SY relay, which occurs when the recapture relays release, does not stop the operation of the pulse generator.

8.37 The release and operation cycles of the PCK relay are counted until 500 ms have elapsed as indicated on SC 104-1, J215 to J239.

(H) Outpulsing Succeeding Digits

8.38 The second and succeeding digits are outpulsed in the same way as the first. The OF and TG relay circuit is connected to the trunk circuit after each digit in order to recognize a stop or start pulsing signal.

(I) Use of Sender Digit Control Information

8.39 As pointed out in Par. 8.04, the HPS relay is operated in the sender from a ground on the 4DG lead from the marker. As shown on OS 194-1 the operating path of the HPS relay is through normal contacts of the 6DT relay. The 6DT relay is normal, since this is a 3-digit translation call. The operated HPS relay serves two purposes.

(a) When the digits 2-2346 (i.e., the digits C through G) have been outpulsed, the outsteering HSO relay operates (OS 126-1). The operated HSO relay and the HPS relay close a path to operate the SST (send start) relay (OS 127-1). The SST relay is used to indicate that outpulsing is completed. The HPS and HSO relay arrangement allows the sender to be assured that outpulsing is complete without waiting for an interdigital timing period to end. Interdigital timing must be used when the marker grounds the NDG lead to the sender instead of the ODG, 4DG or 5DG leads. It is used to indicate that the number digits following the code digits may vary for different calls to the same destination.

(b) The operated HPS relay prevents an operator from misdirecting a call by dialing more digits than are required to complete the call. As shown on OS 126-1, the operated HPS relay opens the path of the EVO relay so that it cannot operate after the HSO relay operates. This prevents the H digit, if registered, from being stored in the recapture circuit.

(J) Completion of SL Check and Sender Release

8.40 When the SST relay operates, the sender makes the SL check by an interchange of signals with the outgoing trunk circuit. This check is made to insure that the outgoing trunk has recognized the end of outpulsing and is prepared to transfer the KTL and KRL leads from a signaling to a transmitting condition and to transfer the KT and KR leads from the SL checking to a receiving and supervisory condition.

8.41 On OS 127-1 it is shown that when the SST relay operates, off-normal ground is extended to operate the marginal SL relay in the outgoing trunk. Operation of the SL relay in the outgoing trunk releases the SL relay in the sender. The normal SL relay operates the OP (outpulse) relay through the SL1 relay which is locked operated (OS 128-1). The operated OP relay operates the OP1 relay, which starts sender release (OS 126-1) by operating relay AV (advance). Sender release from the operation of relay AV is shown on SC 104-1. The sender, in releasing to handle other calls, releases the SP relay in the incoming trunk. The released SP relay places ground on the IS lead to hold the connection by placing ground on the hold magnets of the incoming and outgoing frames. At this time the outward operator is cut through to the distant subscriber, and all equipment is disconnected in the Newark 4A office except the hold magnets on the incoming and outgoing frames, which

are now under the control of the CO relay in the incoming trunk circuit.

9. SUPERVISION

(A) Supervision During Ringing Period

9.01 At the conclusion of pulsing the sender releases and, in turn releases the SP relay in the toll tandem trunk since its holding ground is removed on sender release. The tip and ring conductors are disconnected from the sender and extended through the toll tandem trunk to the incoming and outgoing frames of the 4A system and over the 2-wire line facilities to the distant toll office (OS 221-1).

9.02 When the last two digits have been pulsed into the combination connector at the distant office, the K relay operates. This connects automatic ringing to the called subscribers loop. Audible ringing is also induced into the line and carried back to the originating operator telling her that the call has progressed to that stage.

9.03 The cord lamp remains lighted because the LU relay in the toll tandem trunk, which operates during sender seizure, maintains battery of proper polarity to keep the P relay in the cord circuit unoperated. This condition is maintained throughout the ringing period and does not change until the called subscriber answers (SC 127-1).

(B) Called Party Supervision

Off-Hook Signal

9.04 When the called subscriber answers by removing the receiver from the switchhook, the resistance in the path of the secondary winding of the F relay in the combination connector is reduced. The F relay operates, and ringing to the subscriber is tripped (OS 221-1).

9.05 The off-hook signal is now passed on to the originating operator as follows. The F relay operates the Y relay in the toll transmission selector; the Y relay in operating connects ground to operate the AN relay in the intertoll trunk. The AN relay in turn connects battery to its M lead, which operates the CX relay at the 4A office.

9.06 The operated CX relay at the 4A office connects ground through the operated SL relay to a simplex through the LO relay in the outgoing intertoll trunk. This ground is carried over the OT and OR leads through the crosspoints to the IT and IR leads in the toll tandem trunk. The ground is extended over these leads and through the released SP relay to the winding of the SV relay.

9.07 The operation of the SV relay again reverses the loop to the switchboard cord circuit. The battery through the windings of the L relay is correctly poled to operate the P relay in the cord circuit. The CH relay again operates and in so doing extinguishes the cord lamp. This is the off-hook signal to the operator, informing her that the called party has answered.

On-Hook Signal

9.08 When the called subscriber replaces the receiver on the switchhook, an on-hook signal is transmitted with the release of the relays previously operated by the off-hook signal. The release of the Y relay in the toll transmission selector and the AN relay in the intertoll trunk removes battery from the M lead at the distant toll office (OS 221-1, sheet 3).

9.09 Removal of battery from the M lead releases the CX relay at the 4A end. Ground is removed from the simplex over the IT and IR leads to the toll tandem trunk. This breaks the operating path of the SV relay.

9.10 The release of the SV relay again reverses the battery to the tip and ring of the cord circuit. The polarity of the battery is such that the P relay releases and in turn releases the CH relay. The cord lamp relights, giving the operator an on-hook signal and informing her that the called subscriber has hung up and that she may proceed to disconnect.

Operator Disconnect - All Equipment Releases

9.11 When the originating operator receives the on-hook signal, she removes her calling cord. This action releases all equipment from the calling end to the called end.

9.12 The sequence of equipment release is shown on OS 221-1. When the calling cord is removed, ground is removed from the winding of the SC relay causing it to release. The normal SC relay releases the S relay to extinguish the cord lamp.

9.13 In the toll tandem trunk circuit, the L, H, and CO relays which were operated now release. The LU relay then releases since its operation is under the control of the operated CO relay. The hold magnets on the incoming and outgoing frames held operated by ground supplied from the toll tandem trunk through the operated CO relay also release at this time.

9.14 The OS relay in the outgoing intertoll trunk releases when its holding

ground from the operated crosspoint on the outgoing frame is removed. The SVP relay releases at this time because the released OS relay disconnects its holding ground. The released OS relay also disconnects battery from the M lead.

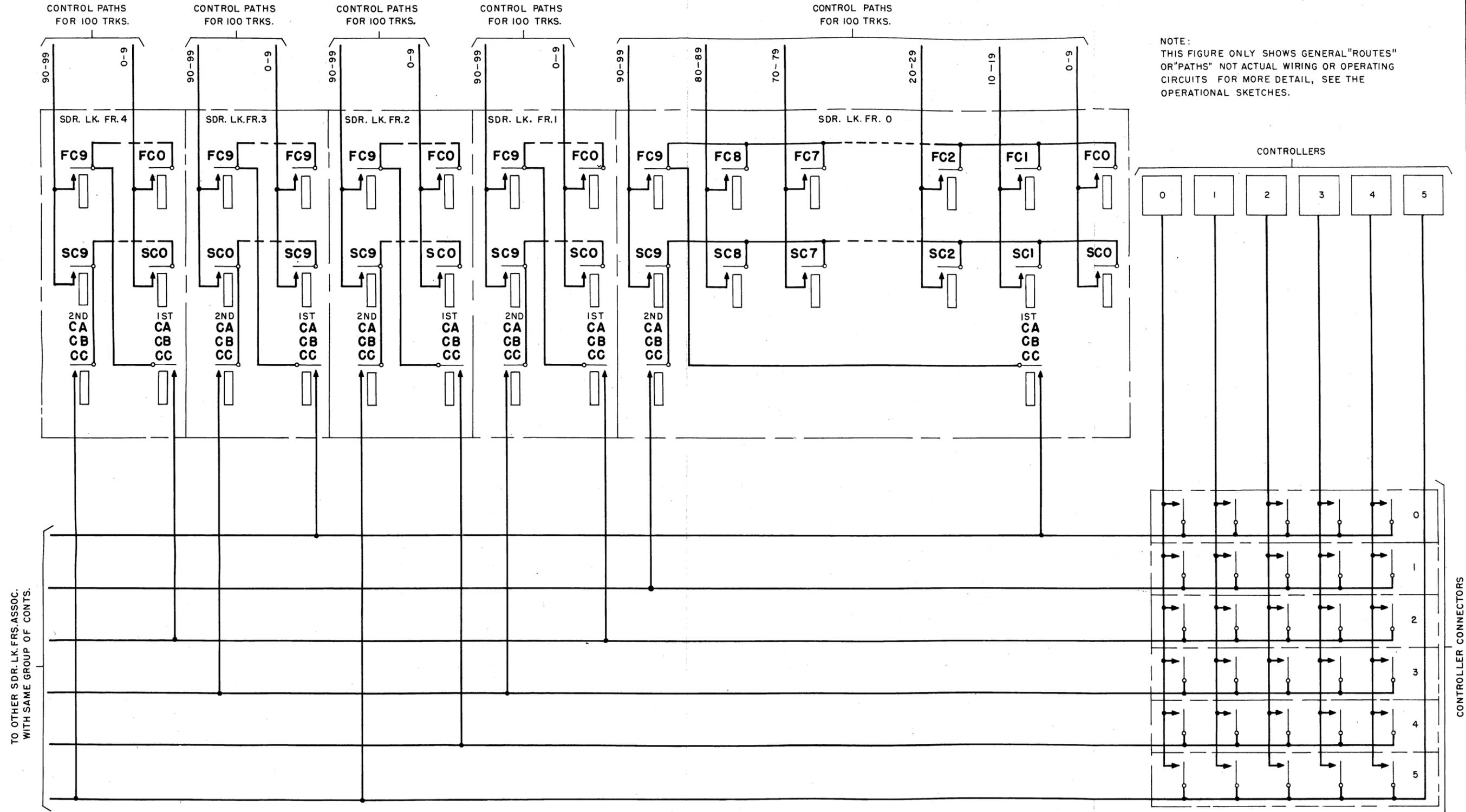
9.15 The removal of this battery causes the CX relay at the distant office

to release and disconnect ground from its E lead. Removal of this ground breaks the operating path for the A relay in the distant intertoll trunk circuit and the A relay in the toll transmission selector. The remaining operated relays now release, and in turn cause the release magnets to operate and restore the selectors and connector to normal.

Bell Telephone Laboratories, Inc.

Attached:

Figs. 2,9A,9B,13,14,19 and 20



NOTE: THIS FIGURE ONLY SHOWS GENERAL "ROUTES" OR "PATHS" NOT ACTUAL WIRING OR OPERATING CIRCUITS FOR MORE DETAIL, SEE THE OPERATIONAL SKETCHES.

TO OTHER SDR. LK. FRs. ASSOC. WITH SAME GROUP OF CONTs.

CONTROLLER CONNECTORS

FIG. 2-CONTROLLER ACCESS FROM SENDER LINK FRAMES SHOWING THE ASSOCIATION OF SENDER LINK FRAMES, CONTROLLER CONNECTORS & CONTROLLERS IN A GROUP HAVING 6 CONTROLLER CONNECTORS & 6 LINK CONTROLLERS.

EACH CONTACT REPRESENTS MULTI CONTACT RELAYS CA1, CBI-2 & CCI-2.

TABLE "A"
PCHGS. ON CHAIN TERM. STRIP J67407C-1 FIG. E PER T-68336-37 SHALL BE WIRED AS FOLLOWS:

LINE	LCC FRAME	CONNECTOR	CONNECT MC WRG. FOR 1ST CHOICE CONT. ON		CONNECT MA WRG. ON		CONNECT MB WRG. ON	
			PCHG. PS	PCHG. CBT	PCHG.	PCHG.	PCHG.	PCHG.
115	0	SDR A0	0	0	0	0	1	1
		SDR A1	1	1	1	1	2	2
		SDR A2	2	2	2	2	3	3
		SDR A3	3	3	3	3	0	0
		SDR A4	0	0	-	-	-	-
		SDR A5	1	1	-	-	-	-
120								
125								
130								
135								
140								
145								
150								

TABLE "B"
ASSIGNMENT OF CONNECTORS TO 1ST CHOICE CONTROLLERS

LINE	FRAME	CONNECTOR	1ST CHOICE CONTROLLER	FRAME
155	0	SDR A0	SDR A0	0
		SDR A1	SDR A1	0
		SDR A2	SDR A2	1
		SDR A3	SDR A3	1
		SDR A4	SDR A0	0
		SDR A5	SDR A1	0
160				
165				
170				
175				
180				
185				
190				

TABLE "C"
STENCILLING OF CONNECTOR, CONTROLLER & FUSE PANEL

LINE	FRAME	CONN. & CONT.			CONN. NBG	CONT. NBG	FUSE PAN.
		POS. NBG	DESIG.	GRP.			
195	0	0	SDR	A	0	0	A
		1			1	1	B
		0			2	2	A
		1			3	3	B
		0			4	-	A
		1			5	-	B
200							
205							
210							
215							
220							
225							
230							

TABLE "D"
WIRING OF THE DA & F LEADS BETWEEN "MISC. O" T.S. FIG. E, J67407B-2 & CHAIN T.S. FIG. E IN J67407C-1 & MB LEADS IN FIG. B, J67407C-1 SHALL BE AS FOLLOWS:

LINE	FRAME	CONNECTOR	CONNECT DA LEADS		CONNECT F LEADS		CONNECT MB LEADS	
			T-68336-41 FROM PCHG.	T-68336-37 TO PCHG.	T-68336-41 FROM PCHG.	T-68336-37 TO PCHG.	T-68336-34 PCHG.	
			FROM	TO	FROM	TO	FROM	TO
235	0	SDR A0	18	0	19	0	21	08
		SDR A1	18	1	19	1	22	19
		SDR A2	18	2	19	2	21	28
		SDR A3	18	3	19	3	22	39
		SDR A4						
		SDR A5						
240								
245								
250								
255								
260								
265								
270								

FRAMEWORK & EQUIPMENT LINK CONTROLLER & CONNECTOR FRAME

LINE	FRAME	FRAME		CONNECTOR						CONTROLLER					
		FR. NO.	"J" DWG.	LIST	DES.	0		1		0		1			
						"J" DWG.	LIST	DES.	"J" DWG.	LIST	DES.	"J" DWG.	LIST		
96	0	J67407C-1	L-1, WB, ZL-5	SDR A0	J67407C-1	L-3,4,6, L-WY, W, WX	SDR A1	J67407C-1	L-3,4,6, L-WY, W, WX	SDR A0	J67407B-2	L-1,2,6, A, C, D, WR	SDR A1	J67407B-2	L-1,2,6, B, C, D, WS
	1		L-1, WA, ZL-5	SDR A2		L-3,4,6, L-WY, W, WX	SDR A3		L-3,4,6, L-WY, W, WX	SDR A2			SDR A3		
	2		L-1, WA, WT, WU	SDR A4		L-3,4,6, L-WX	SDR A5		L-3,4,6, L-WX						
100															
105															
110															
115															

TABLE "E"
ASSIGNMENT OF CONTROLLER CONNECTORS

GROUP A	ASSIGNMENT OF CONTROLLER CONNECTORS															
TYPE SDR. LINK FR.	IKSL							IDSL								
INC. SDR. LINK FR.	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
CONN. (SDR. LINK FR.)	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
LCC FRAME	0	0	1	2	2	0	1	2	2	0	2	1	0	1	2	2
LINK CONT. CONN.	0	1	2	3	4	5	0	3	2	1	4	3	0	1	2	3

TABLE "F"
ASSIGNMENT OF CONTROLLER CONNECTORS

GROUP B	ASSIGNMENT OF CONTROLLER CONNECTORS													
TYPE SDR. LINK FR.														
INC. SDR. LINK FR.														
CONN. (SDR. LINK FR.)														
LCC FRAME														
LINK CONT. CONN.														

TABLE "G"
ASSIGNMENT OF CONTROLLER CONNECTORS

GROUP C	ASSIGNMENT OF CONTROLLER CONNECTORS													
TYPE SDR. LINK FR.														
INC. SDR. LINK FR.														
CONN. (SDR. LINK FR.)														
LCC FRAME														
LINK CONT. CONN.														

TABLE "H"
ASSIGNMENT OF CONTROLLER CONNECTORS

GROUP D	ASSIGNMENT OF CONTROLLER CONNECTORS													
TYPE SDR. LINK FR.														
O.G. SDR. LINK FR.														
CONN. (SDR. LINK FR.)														
LCC FRAME														
LINK CONT. CONN.														

TABLE "J"
LOCATION OF CB GROUPING T.S. (MTD. UNDER END GUARD)

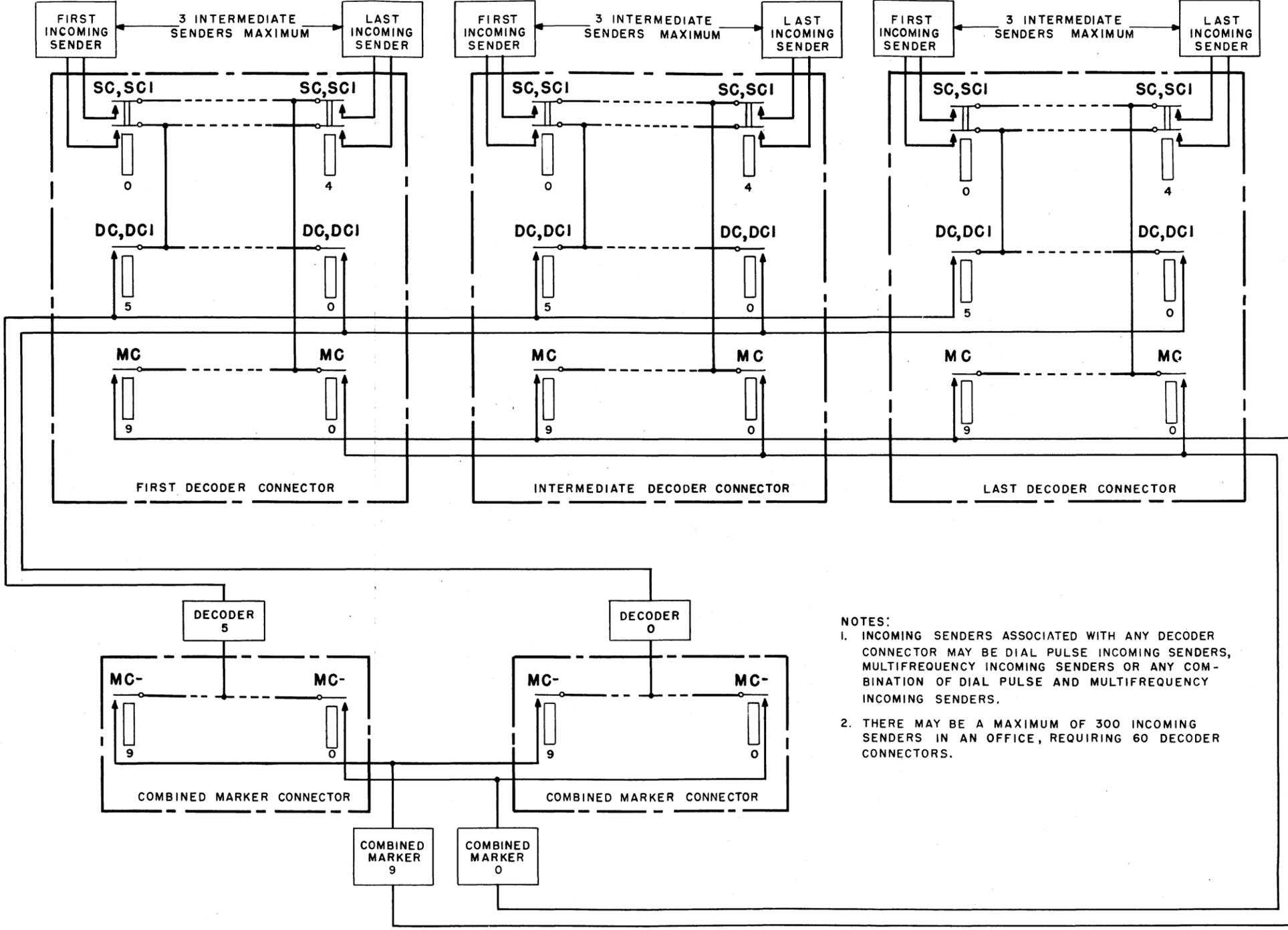
LINE	FOR GRPS.	LOCATION		EQPT. PER	T.S. MTG. POS. ARRANGED TOP DOWN									
		EVEN	ODD		A	B	C	D	E	F	G			
275	SDR A	LCC-2		J67407C-1, FIG. N										
	SDR A		FUT. IKSL-20	J67407C-1, FIG. P										
280														

NOTES:
NOTES NUMBERED ABOVE "50" AND ALL LETTERED NOTES WILL BE FOUND IN THE JOB SPECIFICATION.
FIGS. NOT IN () INDICATE EQPD. CKTS. AND FIGS. IN () INDICATE TOTAL OF EQPD. AND UNEQPD.
1. LEAD "F" IN "T" CABLE PER T-68336-34, FIG. I SHALL NOT BE CONNECTED BETWEEN LCC-0 & LCC-1.

FIG. 9A-TYPICAL WIRING LIST AND EQUIPMENT DRAWING FOR LINK CONTROLLER AND CONNECTOR FRAME

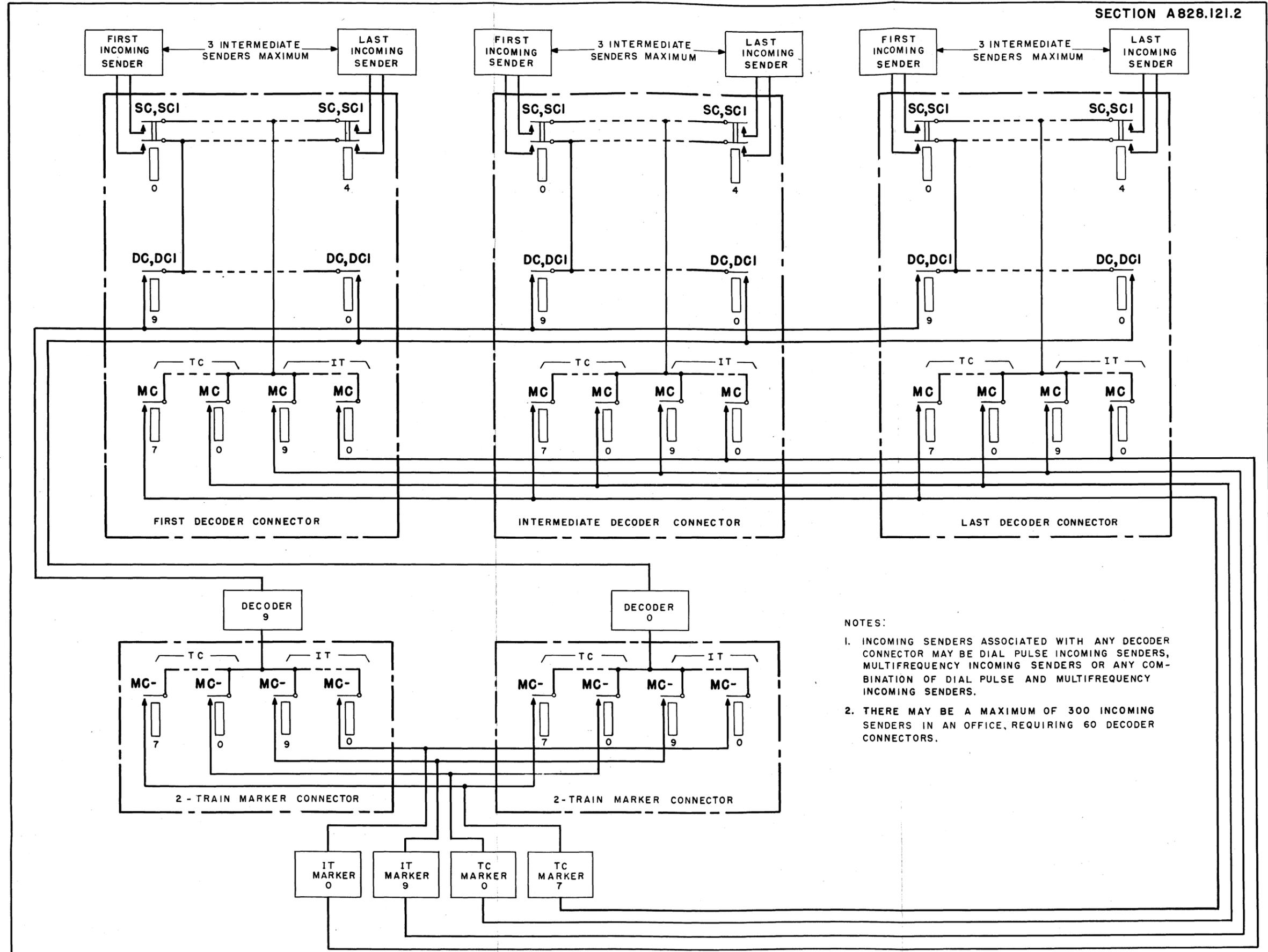
R.R. EQPT. LINE	NAME OF CIRCUIT	LOCAL CABLE & MISC. WIRING						NOTES	REMARKS	EQ. COM. TO LINE UP	CIRCUITS EQPD. PER CONNECTOR & CONTROLLER PER FRAME										EQPD. REF. DWG.
		SCHEMATIC		WIRING DIAGRAM							0	1	2								
		NUMBER	EQUIPPED	NUMBER	FIG.	WIRING	FURN.				CONN.	APP.	0	1	2	0	1	2	3	4	
CONTROLLER CKT.																					
	LC & MISC. CKT. MTG. PLT. T	SD-68028-01	1, 51	T-68028-43	1	Z, ZH	Z, ZH														
5	LC CKT. MTG. PLTS. P, R, S	SD-68028-01	1, 3, 6, H, K	T-68028-44	1	ZF	ZF														
	LC CKT. MTG. PLTS. M & N	SD-68028-01	1, 5	T-68028-45	1	ZF	ZF														
10	LC CKT. MTG. PLTS. K & L	SD-68028-01	1, 3, A, B, D, E	T-68028-46	1	V	V														
	LC CKT. MTG. PLTS. G, H & J	SD-68028-01	1, 3, A	T-68028-47	1	W	W														
	LC CKT. MTG. PLTS. D, E & F	SD-68028-01	1, 3, L, M	T-68028-48	1	ZH	ZH	Z													
	LC CKT. MTG. PLTS. A, B & C	SD-68028-01	1	T-68028-49	1			Z													
CONNECTOR CKT.																					
25	CC & LC CKT. CA1 & CA2 RELS.	SD-68336-01	2	T-68336-31	1																
	CC & LC CKT. CB1 & CB2 RELS.	SD-68336-01	2	T-68336-32	1																
	CC & LC CKT. CC1 & CC2 RELS.	SD-68336-01	2	T-68336-33	1																
30	CC & LC CKT. MTG. PLTS. C, D & E	SD-68336-01	1, 2, A, B, C	T-68336-36	1			T	Z												
FRAME CKT.																					
55	CC, LC & MISC. FUSING CKT.	SD-68028-01		T-68336-30	1																
	CC & LC CKT. MISC. & CONT. & CONN. T.S.	SD-68028-01		T-68336-34	1																
	CONT. & CONN. T.S.	SD-68336-01		T-68336-35	1	W, Z	W, Z														
60	CONN. T.S.	SD-68336-01		T-68336-36	1																
	CHAIN T.S.	SD-68336-01		T-68336-37	1	T	T														
65	CC & LC CKT. MISC. JKS. & LAMPS	SD-68028-01		T-68336-39	1																
		SD-68087-01	1, 2, 3, 4, 5, 6, 8, 10		1																
		SD-68336-01			2																
70					3																
					4																
					5																
					6																
					7																
75	GROUP TERM. STRIPS	SD-68028-01		T-68336-40	1																
		SD-68336-01			2																
	LC & C INTERCONNECTION CKT.	SD-68028-01	1	T-68336-41	1																
		SD-68087-01			2																
		SD-68336-01			1																
80																					
85																					
90																					

FIG. 9B-TYPICAL WIRING LIST AND EQUIPMENT DRAWING FOR LINK CONTROLLER AND CONNECTOR FRAME



- NOTES:
1. INCOMING SENDERS ASSOCIATED WITH ANY DECODER CONNECTOR MAY BE DIAL PULSE INCOMING SENDERS, MULTIFREQUENCY INCOMING SENDERS OR ANY COMBINATION OF DIAL PULSE AND MULTIFREQUENCY INCOMING SENDERS.
 2. THERE MAY BE A MAXIMUM OF 300 INCOMING SENDERS IN AN OFFICE, REQUIRING 60 DECODER CONNECTORS.

FIG.13-ARRANGEMENT OF DECODER AND MARKER CONNECTORS (COMBINED TRAIN 4A OFFICE)



- NOTES:
1. INCOMING SENDERS ASSOCIATED WITH ANY DECODER CONNECTOR MAY BE DIAL PULSE INCOMING SENDERS, MULTIFREQUENCY INCOMING SENDERS OR ANY COMBINATION OF DIAL PULSE AND MULTIFREQUENCY INCOMING SENDERS.
 2. THERE MAY BE A MAXIMUM OF 300 INCOMING SENDERS IN AN OFFICE, REQUIRING 60 DECODER CONNECTORS.

FIG. 14-ARRANGEMENT OF DECODER AND MARKER CONNECTORS (2-TRAIN 4A OFFICE)

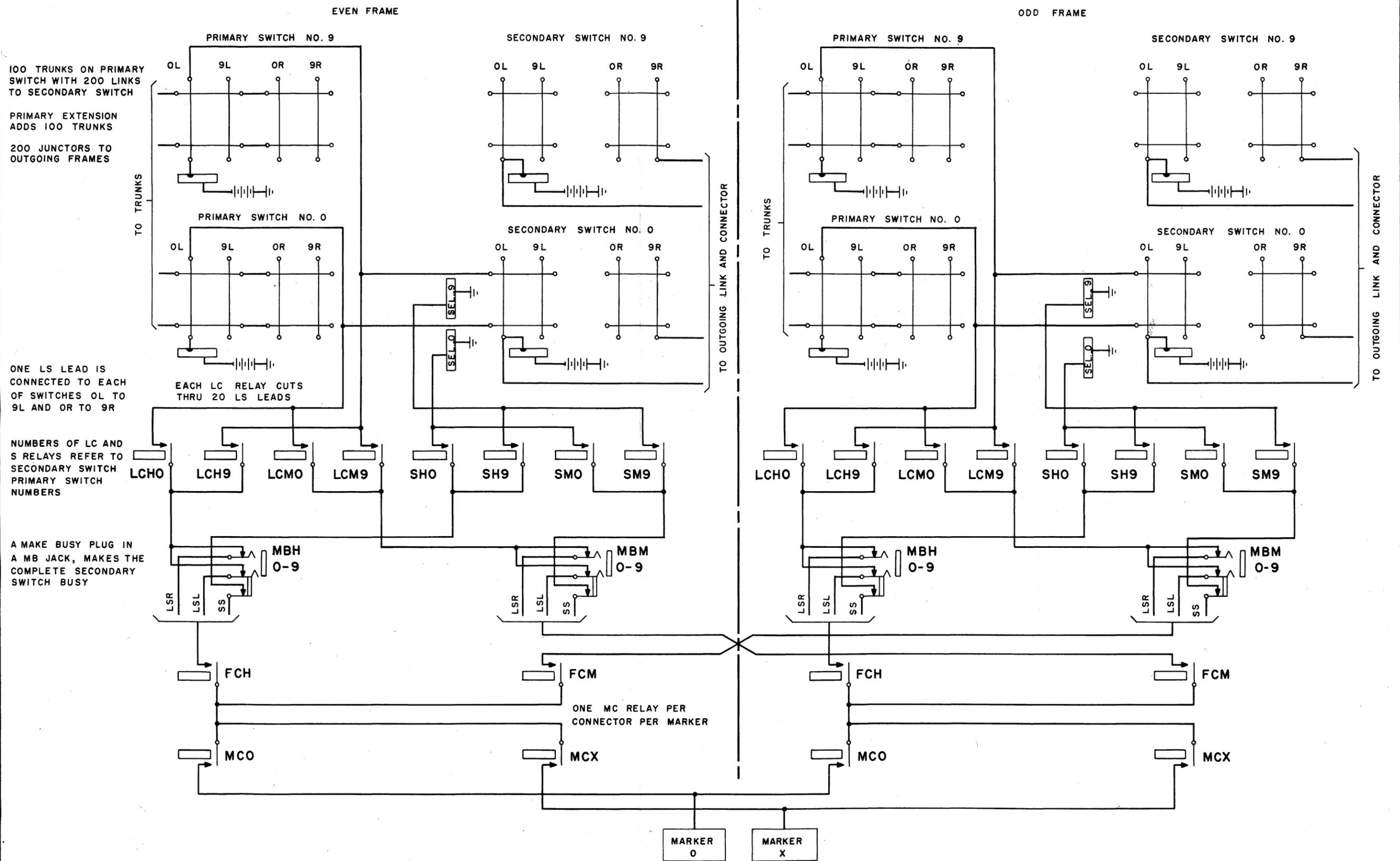


FIG. 19 - INCOMING FRAME CONNECTOR ARRANGEMENT

200 JUNCTORS ON PRIMARY SWITCH FROM INCOMING FRAMES.

100 OUTGOING TRUNKS ON SECONDARY SWITCH CONNECTED BY 200 LINKS FROM PRIMARY SWITCH.

SECONDARY EXTENSION ADDS 100 TRUNKS.

NUMBERS OF JC RELAYS REFER TO PRIMARY SWITCH VERTICALS.

NUMBERS OF LC AND S RELAYS REFER TO PRIMARY SWITCH HORIZONTALS AND SECONDARY SWITCH NUMBERS

EACH LC RELAY CUTS THRU 20 LS LEADS FROM THE ASSOCIATED SECONDARY SWITCH, TWO TO EACH SWITCH.

A MAKE BUSY PLUG IN A MB JACK, MAKES THE COMPLETE PRIMARY SWITCH BUSY.

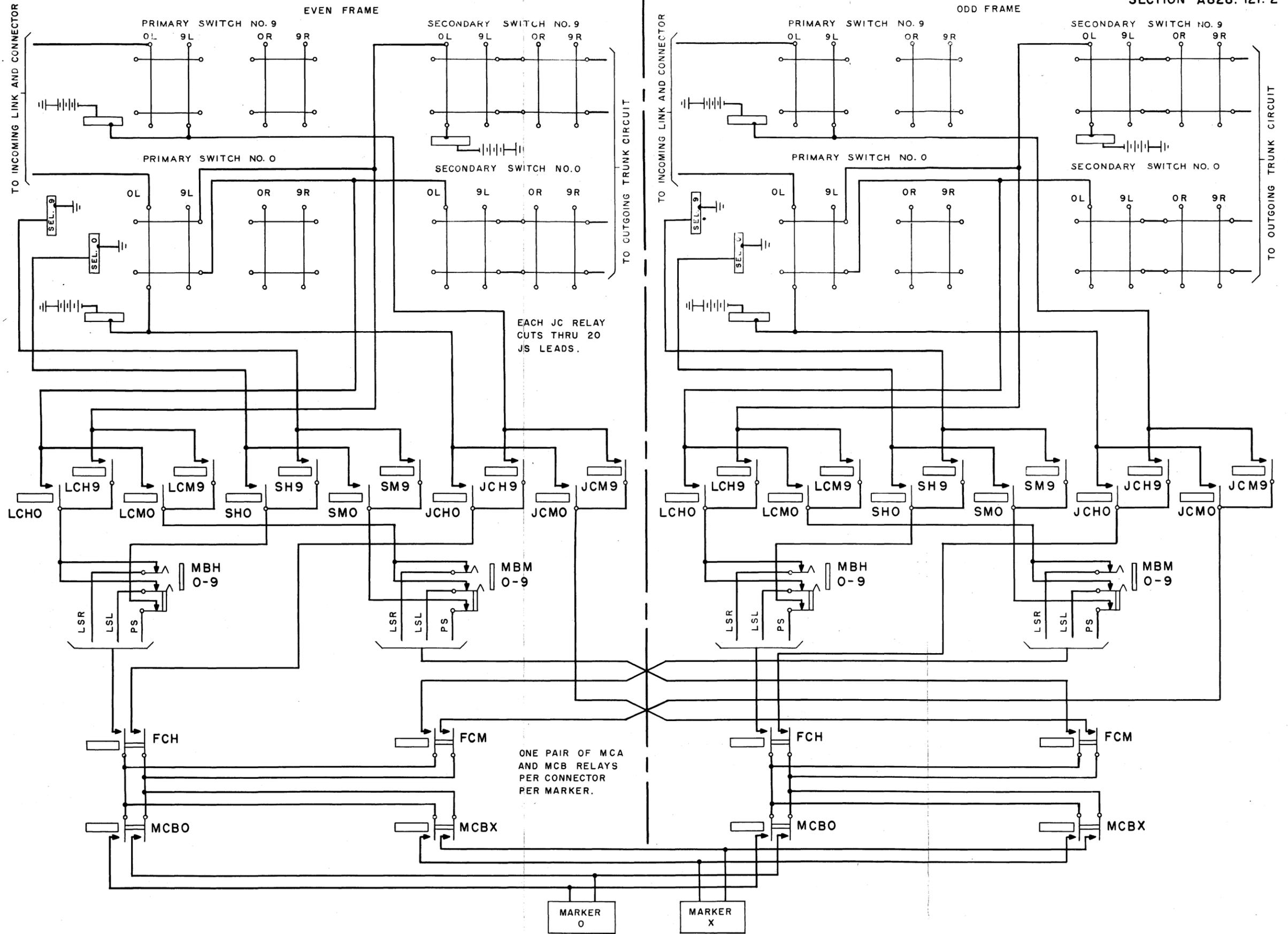


FIG. 20-OUTGOING FRAME CONNECTOR ARRANGEMENT