

DETAILED CIRCUIT OPERATION  
CALL FROM AN OUTWARD SWITCHBOARD TO A MANUAL TOLL  
OFFICE IN THE SAME NUMBERING PLAN AREA - SWITCHED  
VIA A CSP IN A FOREIGN AREA - PREFIXING  
NO. 4A TOLL SWITCHING OFFICES

<u>CONTENTS</u>	<u>Page</u>
1. GENERAL	1
2. DECODER OPERATIONS	2
(A) Routing Via a Foreign Area from an AR Card (Case A)	2
(B) Routing to a Foreign Area from a 3D Card (Case B)	5
3. MARKER OPERATIONS (Cases A and B)	6
4. INCOMING SENDER OPERATIONS (Cases A and B)	6

Figures

1 - Call Between Offices in the Same Numbering Plan Area - Switched Via a Foreign Area	3
2 - Case A - Card Layout for Newark-Lambertville Trunk Group (Code 526)	4
3 - Case A - Card Layout for Newark-Philadelphia Alter- nate Trunk Group	4
4 - Case B - Card Layout for Newark-Philadelphia Trunk Group (Lambertville Code 526)	5
5 - Case A or B - Card Layout for 201 3D Area Card at Philadelphia	7
6 - Case A or B - Card Layout for Philadelphia- Lambertville Trunk Group (Code 201-526)	7

1. GENERAL

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 4A Toll Switching System.

1.02 This description covers the various operations necessary for completing a call from an outward switchboard to a manual switchboard in the same numbering plan area by routing the call via a 4A office in a foreign area.

1.03 For such calls the home area code must be prefixed to the national office code before it is sent forward to the foreign area 4A office. The prefixed home area code serves two purposes in the foreign area office:

(a) Enables the foreign area 4A to route the call back into the home area.

(b) Prevents conflicts with identical national office codes existing in the foreign area.

1.04 Since the outward operator does not key an area code on calls to points in the home area, the prefixing of the area code is carried out on an automatic basis in the 4A office which routes the call into the foreign area. Prefixing is carried out by the incoming sender from information received via the marker from the decoder. Only the home area code can be prefixed.

1.05 The steps involved in prefixing an area code are as follows:

(a) The decoder determines that prefixing is required, and causes a no skip signal and three code conversion digits representing the home area code to be sent to the marker.

(b) The marker, after seizing an outgoing trunk, transmits the no skip signal and the code conversion digits to the sender.

(c) At the proper time, the sender outpulses the three code conversion digits followed by those digits which were originally inpulsed.

1.06 The following description covers operations occurring in a 4A office when handling a call to a manual toll office

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in the home area via a 4A office in an adjacent area. Only functions peculiar to the prefixing feature are described in detail; other operations are covered elsewhere in the A828.121 sections.

1.07 For purposes of description it is assumed that a call for a subscriber in Lambertville, N.J. originates in Morristown, N.J. Both of these locations are in the New Jersey numbering plan area (201). The call is handled over a DP intertoll trunk from the Morristown manual toll office to the Newark 4A office. In order to illustrate the two prefixing methods used in the 4A system, the call is first described under case A assuming that trunks are provided between Newark and Lambertville but that they are busy. (See Fig. 1.) Under case B the call is described assuming that no direct trunks are provided between Newark and Lambertville. In either case, the Newark 4A office routes the call to the foreign area 4A office (Philadelphia) which, in turn, switches the call to a Philadelphia-Lambertville intertoll trunk. In case A, the route via the Philadelphia office is an alternate route. Since it is assumed that the direct Newark-Lambertville trunks are busy, a trunk to Philadelphia is selected from information on an alternate route (AR) translator card. In case B, direct trunks are not provided between Newark and Lambertville and the route via the Philadelphia office is the preferred (or only) route. The call is handled from information on the 3-digit (3D) card having code tabs corresponding to the Lambertville national office code.

1.08 In either case, the Newark 4A office routes the call to the Philadelphia office which, in turn, switches the call to a Philadelphia-Lambertville intertoll trunk. Newark must spill forward to Philadelphia the Newark home area code prefixed to the Lambertville national office code. Differences in the method of handling the two cases lie in the manner in which the decoder determines that prefix digits are required.

1.09 The decoder determines the need for prefixing as follows.

In Case (A):

(1) No-area-code information is registered in the sender (meaning the call is to a point in the home area). This information is obtained from the enlarged NAC (no-area-code) punch on the first card (3D) dropped.

(2) The group of trunks over which the call is alternate routed terminates in a foreign area. This information is obtained from the enlarged AFA (alternate foreign area) punch on the AR card.

In Case (B):

(1) The 3D card routing the call via the foreign area provides appropriate variable spill and code conversion information directly.

## 2. DECODER OPERATIONS

### (A) Routing Via a Foreign Area From an AR Card (Case A)

#### Dropping 3D Card

2.01 In this example, the Lambertville national office code (526) dialed by the outward operator at Morristown is registered in the Newark 4A office by operation of the appropriate A, B and C digit register relays in an incoming DP sender. An idle decoder is seized, and the operated register relays serve to drop corresponding A, B and C digit code bars in the home translator, selecting a 3D card in the normal manner.

2.02 The selected card (526-3D) has the NAC (no-area-code) punch enlarged since the three digits used in its selection are a national office code. (See Fig. 2.) When the decoder reads the card, the enlarged NAC punch results in the operation of the NAC relay from the FAT (foreign area translator battery supply) battery (OS 164-1). The FAT and NAC relays remain operated, regardless of any subsequent cards which may be read, until the decoder is released (OS 163-1). Other items required by the decoder in handling the call are also read (OS 164-1).

#### Dropping AR Card

2.03 Case A assumes that the 526-3D card contains the card-to-relay routing instruction. With this condition, a marker is seized in the manner shown in Fig. 2 on SC 118-1, and the outgoing trunks presented by the card are tested by the marker. It is assumed that this group of direct Newark-Lambertville trunks is found busy by the marker, but that the decoder in testing in the relay tree (OS 173-1) finds an alternate route group with idle trunks (Fig. 4 on SC 118-1). The 3D card is restored in the translator and an AR card is read (Fig. 5 on SC 119-1). The AR card is selected by its A and B digit tabs which correspond to the number of the R- (route) relay, and its C digit tabs corresponding to the G- (subgroup chain test) relay (OS 162-1) of the subgroup in which an idle trunk is available. Cards selected in this manner also have the CGO and CG2 tabs attached to indicate AR. Alternate route card selection is described in Section A828.121.3.

2.04 Enlarged punches on the AR card (see Fig. 3) provide information which enables the marker to test and select a

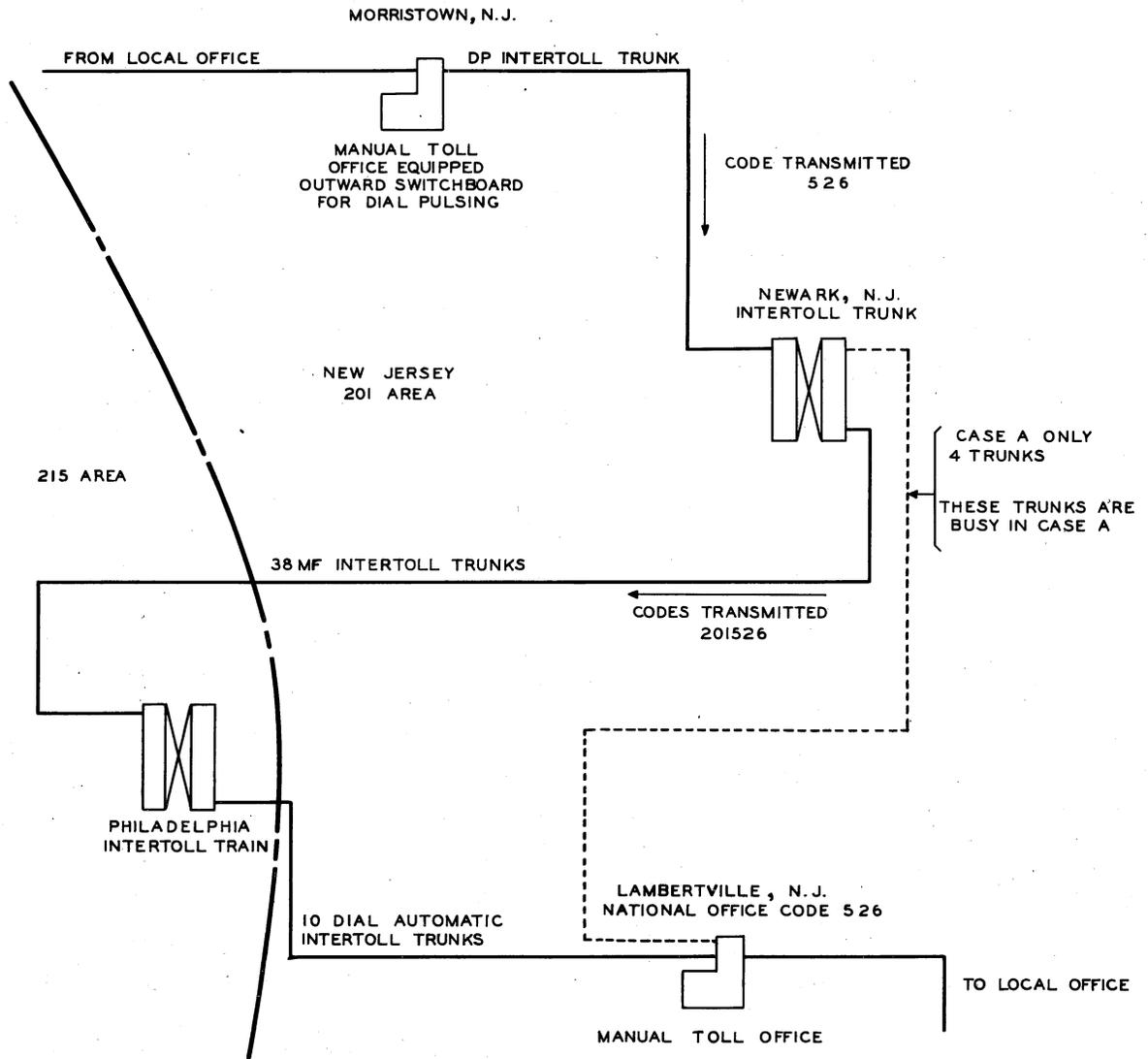


FIG. 1- CALL BETWEEN OFFICES IN THE SAME NUMBERING PLAN AREA SWITCHED VIA A FOREIGN AREA.

PRETRANSLATION				OGT APPEARANCE			TRAF. SEP. PC				TRK. GRP PC & OF						
NCA	CA4	CA5	CA6	IT	TC	ITC	TS0	TS1	TS2	TPC	TP0	TPI	TP2				
TRANSLATOR BOX NUMBER								CLASS									
INDI	HB	BT0	BT1	BU0	BUI	BU2	BU4	BU7	CLT0	CLT1	CLU0	CLU1	CLU2	CLU4	CLU7	CDLC	
AREA CODE CONTROL				ALTERNATE ROUTE PATTERN NUMBER													
NAC	AC	AHA	AFA	ART0	ART1	ART2	ART4	ART7	ARU0	ARU1	ARU2	ARU4	ARU7				
ROUTING INSTRUCTIONS				CONT. & DIGIT CONTROL													
RIO	RII	RI2	RI4	RI7	CDC0	CDC1	CDC2	CDC4	CDC7							IND2	
CODE CONVERSION																	
CCHN	CCTN	CCUN	CCH0	CCH1	CCH2	CCH4	CCH7	CCT0	CCT1	CCT2	CCT4	CCT7	CCU0	CCU1	CCU2	CCU4	CCU7
VAR. SPILL CONTROL				TRUNK BLOCK CONNECTOR						TRUNK BLOCK							
NSK	SK3	SK6							TCU1	TCU2	TCU4	TCU7	TB0	TB1	TB2	TB4	TB7
GROUP START								GROUP END									
GST0	GST1	GSU0	GSU1	GSU2	GSU4	GSU7		GET0	GET1	GEU0	GEU1	GEU2	GEU4	GEU7			

CSI VO NVO

A 0 1 2 4 7

B 0 1 2 4 7

C 0 1 2 4 7

D 0 1 2 4 7

E 0 1 2 4 7

F 0 1 2 4 7

CG 0 1 2 4

CS2

-3D-

NOTES:  
 1. VIEWED FROM LIGHT SOURCE  
 2. ENLARGED PUNCHES SHOWN IN BLACK

FIG. 2-CASE A: 526-3D CARD FOR NEWARK-LAMBERTVILLE TRUNK GROUP

PRETRANSLATION				OGT APPEARANCE			TRAF. SEP. PC				TRK. GRP PC & OF						
NCA	CA4	CA5	CA6	IT	TC	ITC	TS0	TS1	TS2	TPC	TP0	TPI	TP2				
TRANSLATOR BOX NUMBER								CLASS									
INDI	HB	BT0	BT1	BU0	BUI	BU2	BU4	BU7	CLT0	CLT1	CLU0	CLU1	CLU2	CLU4	CLU7	CDLC	
AREA CODE CONTROL				ALTERNATE ROUTE PATTERN NUMBER													
NAC	AC	AHA	AFA	ART0	ART1	ART2	ART4	ART7	ARU0	ARU1	ARU2	ARU4	ARU7				
ROUTING INSTRUCTIONS				CONT. & DIGIT CONTROL													
RIO	RII	RI2	RI4	RI7	CDC0	CDC1	CDC2	CDC4	CDC7							IND2	
CODE CONVERSION																	
CCHN	CCTN	CCUN	CCH0	CCH1	CCH2	CCH4	CCH7	CCT0	CCT1	CCT2	CCT4	CCT7	CCU0	CCU1	CCU2	CCU4	CCU7
VAR. SPILL CONTROL				TRUNK BLOCK CONNECTOR						TRUNK BLOCK							
NSK	SK3	SK6							TCU1	TCU2	TCU4	TCU7	TB0	TB1	TB2	TB4	TB7
GROUP START								GROUP END									
GST0	GST1	GSU0	GSU1	GSU2	GSU4	GSU7		GET0	GET1	GEU0	GEU1	GEU2	GEU4	GEU7			

CSI VO NVO

A 0 1 2 4 7

B 0 1 2 4 7

C 0 1 2 4 7

D 0 1 2 4 7

E 0 1 2 4 7

F 0 1 2 4 7

CG 0 1 2 4

CS2

-AR-

NOTES:  
 1. VIEWED FROM LIGHT SOURCE  
 2. ENLARGED PUNCHES SHOWN IN BLACK

FIG. 3-CASE A: 180-AR CARD FOR NEWARK-PHILADELPHIA ALTERNATE TRUNK GROUP

trunk in this subgroup of alternate route trunks to Philadelphia. Routing instruction, class and other required information are included.

AFA Relay Function

2.05 The AFA (alternate foreign area) punch is enlarged on the AR card signifying that the trunks presented by the card terminate in a foreign area. The AFA relay operates from the FAT battery when the card is read (OS 164-1).

2.06 Operation of the AFA relay, in addition to the NAC relay which was operated from the 3D card, results in operation of the NSK (no skip) relay in the decoder (OS 176-1). Thus, when the decoder information is read by the marker, its NSK relay is operated. Variable spill items (NSK, SK3, or SK6) are not enlarged on AR cards, in order to prevent any conflicts. Cross-connections from the AFA relay contacts (OS 195-1) are arranged so that, when the marker reads the decoder, the operated AFA and NAC relays operate marker code conversion relays corresponding to the home area code (201 for New Jersey).

2.07 The code conversion punches on the AR card are not read by the decoder on this call since operation of both the NAC and ARB (alternate route code bar operated) relays prevents operation of the CCM relay

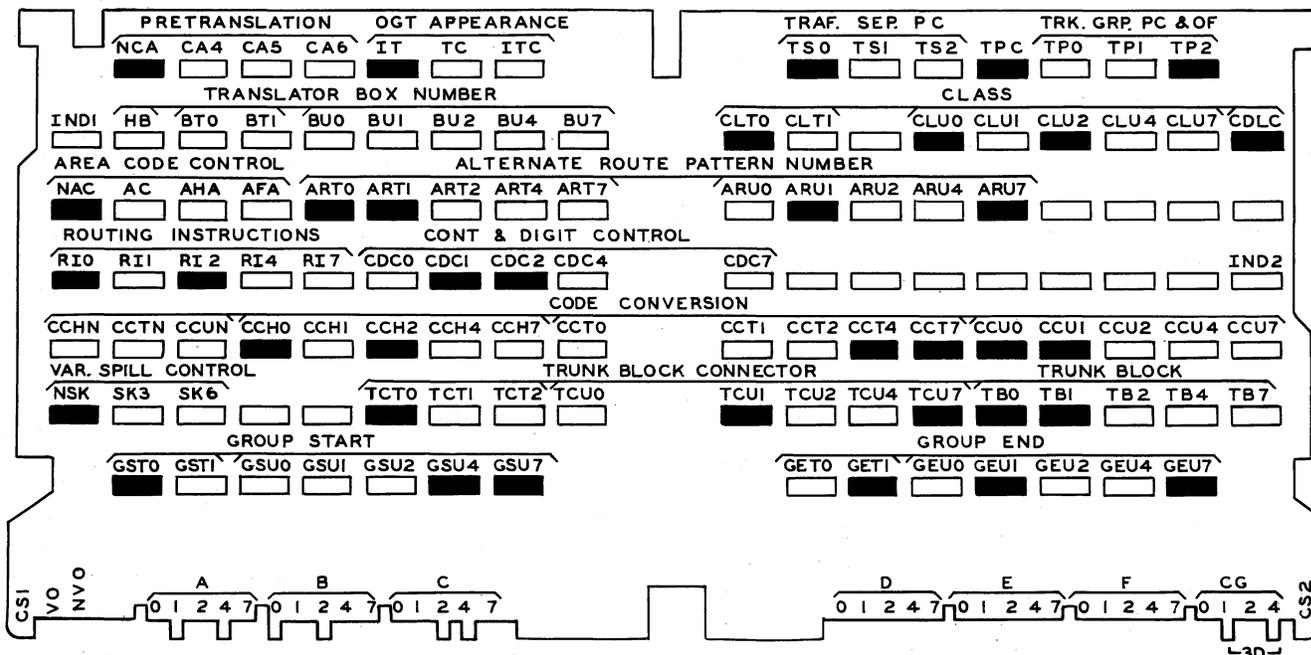
(code conversion relays battery supply) as shown on OS 163-1.

(B) Routing to a Foreign Area from a 3D Card (Case B)

Using Code Conversion and Variable Spill Information on 3D Card

2.08 In case B no direct Newark-Lambertville trunks are provided. When the Lambertville office code (526) is dialed at Morristown, a 526-3D card is dropped at the Newark 4A office. This 3D card, shown in Fig. 4, contains information for routing the call via the Philadelphia office. Since the routing is via a foreign area and always requires prefixing, it is possible to record and obtain the prefix information directly from the card.

2.09 The 3D card dropped in the home translator by the Lambertville national office code contains relay-to-relay routing instruction. This is indicated by the RIO and RI2 enlarged punches on the card. The decoder tests the trunks on the preferred route, and it is assumed that an idle trunk is found in the first subgroup (OS 173-1). In such a case, the information on the 3D card is used in handling the call. Figs. 2 and 3 on SC 119-1 show the decoder operations involved.



NOTES:  
 1. VIEWED FROM LIGHT SOURCE  
 2. ENLARGED PUNCHES SHOWN IN BLACK

FIG.4- CASE B: 526-3D CARD FOR NEWARK-PHILADELPHIA TRUNK GROUP

2.10 In addition to the information required in selecting a trunk and outpulsing, the NSK punch on the 3D card is enlarged; and the code conversion punches are enlarged to indicate the home area code, 201. The code conversion digit information is read by the decoder upon completion of the index channel check by the operation of the CCM relay (OS 163-1). The  $CCH\frac{2}{5}$ ,  $CCT\frac{2}{5}$  and  $CCU\frac{2}{5}$  (code conversion hundreds, tens, and units) tubes are fired in accordance with the enlarged card punches and the corresponding decoder  $CCH\frac{2}{5}$ ,  $CCT\frac{2}{5}$  and  $CCU\frac{2}{5}$  relays are operated (OS 164-1).

2.11 After seizure of a marker, the operation of its RCD, RCD1 and RCD2 (read card) relays indicates that the decoder is ready to pass forward its information (OS 191-1). These marker operations are shown on SC 122-1.

2.12 The enlarged NSK punch on the card is read directly by the marker. Operation of the RCD1 relay in the marker fires the NSK tube in the translator operating the NSK relay in the marker (OS 176-1). At the same time the marker code conversion relays operate on a two-out-of-five basis (OS 195-1) from the operated decoder code conversion relays.

2.13 If all trunks in the first subgroup of trunks tested by the group busy chain relay circuit are busy, an idle trunk may be found in another subgroup or on an alternate route. In that case an AR card would be used. Routing via a foreign area from an alternate route card would be the same as described in Pars. 2.03 to 2.07.

### 3. MARKER OPERATIONS (Cases A and B)

3.01 The NSK and code conversion information is not used in the marker but is registered until an outgoing channel is selected; then it is forwarded to the sender.

3.02 After the operation of the ICK (incoming connector check) relay indicating seizure of an incoming frame (OS 208-1), and the release of the CHE (channel end) relay indicating that a channel has been selected (OS 212-1), the marker sends forward class, code conversion, variable spill, and digit control information to the sender. The NSK variable spill relay in the marker operates the NSK relay in the sender (OS 194-1). Continuity of the path between marker and sender is checked by the operation of the SKA (skip auxiliary) relay in the marker.

3.03 In a similar manner the three code conversion digits, 201, are transmitted to the sender (OS 195-1) where they operate the  $CH\frac{2}{5}$ ,  $CT\frac{2}{5}$  and  $CU\frac{2}{5}$  (convert

hundreds, tens and units) relays. Continuity of the code conversion paths to the sender is checked by the operation of the CCHA, CCHB, CCTA, CCTB, CCHA, CCUB relays in the marker. One of the two paths used in transmitting the two-out-of-five combination for each digit extends through the A- relay and the second path through the B- relay. These relays operate in series with their associated  $CH\frac{2}{5}$ ,  $CT\frac{2}{5}$  and  $CU\frac{2}{5}$  relays in the sender. Therefore the operation of both the A- and B- check relays indicates that the associated digit has been sent forward. The appropriate continuity check relays must be operated to permit the normal release of the marker and the beginning of sender outpulsing.

### 4. INCOMING SENDER OPERATIONS (Cases A and B)

4.01 In addition to other information normally required, the decoder and marker functions described have resulted in transmitting a no skip signal and three code conversion digits to the sender.

4.02 The sender outsteering circuit may be started at any one of several points depending jointly upon the operated skip (NSK, SK3 or SK6) and code conversion relays. The operated NSK and code conversion relays result in outsteering beginning with the PAO (prefix A digit outsteering) relay with consequent outpulsing of the conversion hundreds, tens and units digits in that order followed by the A, B and C digits. These operations are performed as follows.

4.03 The operated NSK and  $CCU\frac{2}{5}$  relays operate the PFX (prefix) relay and (when the marker completes its functions) the PFX1 (prefix auxiliary) relay (OS 125-1). The PAO relay then operates over a path through the PFX1 and NSK relays to ground at the MRL1 relay (OS 126-1). The sequence of relay operations is shown on SC 105-1.

4.04 The EVO (even outsteering) relay operates (OS 126-1) completing paths from the operated hundreds conversion relays to operate recapture relays on a two-out-of-five basis corresponding to the first digit of the code being prefixed (OS 125-1). Since the digit 2 is registered on the CH- relays, recapture relays 0 and 2 operate at this time. When a start pulsing signal is received from the succeeding (Philadelphia) office outpulsing begins.

4.05 After transmission of the KP pulse (MF outpulsing) and during the outpulsing of the first prefix digit, the outsteering circuit advances by operating relay PBO (prefix B digit outsteering)

PRETRANSLATION										OGT APPEARANCE							TRAF. SEP. PC				TRK. GRP PC & OF						
NCA	CA4	CA5	CA6	IT	TC	ITC	TS0	TS1	TS2	TPC	TP0	TP1	TP2														
TRANSLATOR BOX NUMBER																	CLASS										
INDI	HB	BT0	BT1	BU0	BUI	BU2	BU4	BU7	CLT0	CLT1	CLU0	CLU1	CLU2	CLU4	CLU7	CDLC											
AREA CODE CONTROL										ALTERNATE ROUTE PATTERN NUMBER																	
NAC	AC	AHA	AFA	ART0	ART1	ART2	ART4	ART7	ARU0	ARU1	ARU2	ARU4	ARU7														
ROUTING INSTRUCTIONS										CONT. & DIGIT CONTROL																	
RI0	RI1	RI2	RI4	RI7	CDC0	CDC1	CDC2	CDC4	CDC7	IND2																	
CODE CONVERSION																											
GCHN	CCTN	CCUN	CCH0	CCH1	CCH2	CCH4	CCH7	CCT0	CCT1	CCT2	CCT4	CCT7	CCU0	CCU1	CCU2	CCU4	CCU7										
VAR. SPILL CONTROL										TRUNK BLOCK CONNECTOR							TRUNK BLOCK										
NSK	SK3	SK6	TCT0	TCT1	TCT2	TCU0	TCU1	TCU2	TCU4	TCU7	TB0	TB1	TB2	TB4	TB7												
GROUP START										GROUP END																	
GST0	GST1	GSU0	GSU1	GSU2	GSU4	GSU7	GET0	GET1	GEU0	GEU1	GEU2	GEU4	GEU7														

CS1 VO NVO A B C D E F CG CS2  
0 1 2 4 7 0 1 2 4 7 0 1 2 4 7 0 1 2 4 7 0 1 2 4 7 0 1 2 4 7 0 1 2 4 7 0 1 2 4 7

NOTES:  
1. VIEWED FROM LIGHT SOURCE  
2. ENLARGED PUNCHES SHOWN IN BLACK

FIG. 5- CASE A OR B: 201-3D AREA CARD AT PHILADELPHIA

PRETRANSLATION										OGT APPEARANCE							TRAF. SEP. PC				TRK. GRP PC & OF						
NCA	CA4	CA5	CA6	IT	TC	ITC	TS0	TS1	TS2	TPC	TP0	TP1	TP2														
TRANSLATOR BOX NUMBER																	CLASS										
INDI	HB	BT0	BT1	BU0	BUI	BU2	BU4	BU7	CLT0	CLT1	CLU0	CLU1	CLU2	CLU4	CLU7	CDLC											
AREA CODE CONTROL										ALTERNATE ROUTE PATTERN NUMBER																	
NAC	AC	AHA	AFA	ART0	ART1	ART2	ART4	ART7	ARU0	ARU1	ARU2	ARU4	ARU7														
ROUTING INSTRUCTIONS										CONT. & DIGIT CONTROL																	
RI0	RI1	RI2	RI4	RI7	CDC0	CDC1	CDC2	CDC4	CDC7	IND2																	
CODE CONVERSION																											
GCHN	CCTN	CCUN	CCH0	CCH1	CCH2	CCH4	CCH7	CCT0	CCT1	CCT2	CCT4	CCT7	CCU0	CCU1	CCU2	CCU4	CCU7										
VAR. SPILL CONTROL										TRUNK BLOCK CONNECTOR							TRUNK BLOCK										
NSK	SK3	SK6	TCT0	TCT1	TCT2	TCU0	TCU1	TCU2	TCU4	TCU7	TB0	TB1	TB2	TB4	TB7												
GROUP START										GROUP END																	
GST0	GST1	GSU0	GSU1	GSU2	GSU4	GSU7	GET0	GET1	GEU0	GEU1	GEU2	GEU4	GEU7														

CS1 VO NVO A B C D E F CG CS2  
0 1 2 4 7 0 1 2 4 7 0 1 2 4 7 0 1 2 4 7 0 1 2 4 7 0 1 2 4 7 0 1 2 4 7 0 1 2 4 7

NOTES:  
1. VIEWED FROM LIGHT SOURCE  
2. ENLARGED PUNCHES SHOWN IN BLACK

FIG. 6- CASE A OR B: 201526-6D CARD FOR PHILADELPHIA-LAMBERTVILLE TRUNK GROUP

(OS 126-1). Relay PAO releases when outpulsing of the first digit is complete. The resulting release of the EVO relay releases the first prefixed digit from the recapture circuit (OS 125-1), while the operation of the ODO (odd outsteering) relay causes the second digit (0) to be transferred from the conversion tens relays to the recapture relays for outpulsing.

4.06 As outpulsing continues, the outsteering control advances permitting the conversion units digit (1), A digit (5), B digit (2), and C digit (6) to be transferred to the recapture circuit and outpulsed in turn. In this manner the Newark office outpulses 201526; that is, the New Jersey area code 201 followed by the Lambertville national office code 526.

4.07 Registration of this code in the Philadelphia 4A office results in a

3D card coded 201 being read. (See Fig. 5.) Since Philadelphia has intertoll trunks to numerous New Jersey points, 6-digit translation is required and therefore the card is punched CA6. When all six digits (201526) are received in Philadelphia, the translator box number on the 3D card directs the decoder to the translator containing the 201526 card. This 6D card is shown on Fig. 6.

4.08 The 6D card contains the necessary information to permit selection of a Philadelphia-Lambertville trunk in the normal manner. Since Lambertville has a manual toll office no outpulsing is required. The variable spill punches are enlarged to skip the six digits registered at Philadelphia, the manual class instruction is provided, and routing instruction denotes follow-with-overflow in the event that the Philadelphia-Lambertville trunks are busy.