

**GENERAL  
NO. 4A OFFICE  
ENGINEERING INFORMATION  
NO. 4 TYPE TOLL SWITCHING SYSTEMS**

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1. GENERAL

A. Scope

1.01 This practice provides engineering information on No. 4A toll crossbar system equipment.

B. Reference Material

1.02 A general description of No. 4A operation is given in Section 964-110-100. Western Electric Company Questionnaire Form E-8022 covers ordering information for the Nos. 4, A4A, and 4A systems. Key sheet SD-68400-01 lists the circuits for the No. 4A system.

C. Capacity

1.03 In order to meet a variety of office sizes and conditions, the No. 4A toll switching system possesses considerable flexibility both with regard to quantities and arrangements of equipment.

1.04 There are two general arrangements of equipment, namely:

(a) A single combined train for the smaller offices which will have no more than 40 incoming and 40 outgoing frames of approximately 3200 intertoll trunk capacity in the ultimate.

(b) A 2-combined train arrangement (separate train combined operation) for large offices. All incoming trunks will multiple to both trains. A group of outgoing trunks whose routings are given on one card will terminate on either train, but not on both. No outgoing trunk will multiple to both trains. Each train will have an ultimate theoretical capacity of 40 incoming and 40 outgoing frames. The intertoll trunk capacity of the office will be about 6400 by using 400 terminations per incoming frame and 300 for the outgoing. The maximum capacity varies, depending upon the amount of through switching.

1.05 The maximum amounts of common control equipments are:

	<u>2-train Office</u>	<u>Single-train Office</u>
Senders (Incoming)	378*	300
Decoders	18	10
Markers	20	10
Foreign Area Translators	19	19

\*No more than 300 of the 378 may be one type of incoming sender.

1.06 The maximum frame arrangements for each train for the various available junctor distribution plans are as shown on Table A.

D. General Equipment Setup of a No. 4A Office

1.07 Fig. 1 (attached) is an equipment schematic of a typical No. 4A office.

2. TRAFFIC FRAMES

A. General

2.01 The traffic frames consist of the incoming and outgoing link frames and the junctor grouping frame. Incoming intertoll trunks, the incoming appearances of 2-way intertoll trunks, and the toll tandem trunks terminate on horizontals on the primary bays of the incoming frames. The outgoing intertoll trunks, the outgoing appearances of 2-way intertoll trunks, and the outgoing toll connecting trunks terminate on horizontals on the secondary bays of the outgoing link frames.

2.02 In establishing talking connections, crosspoint closures extend the incoming trunks through the "A" links of the incoming frame, through the junctors ("B" links) between incoming and outgoing frames, and through the "C" links of the outgoing frames to the outgoing trunks. Fig. 2 (attached) illustrates this.

2.03 An incoming primary extension frame and an outgoing secondary extension frame are always furnished, and one or two additional extension bays may be furnished for the incoming link frames and one for the out-

TABLE A

Juncture Distributing Plan	Incoming			Outgoing		
	Frames	Groups*	Juncture Cap. per Fr. or Gp.	Frames	Groups*	Juncture Cap. per Fr. or Gp.
TA	10	-	200	10	-	200
TB	20	10	400	20	-	200
TC	40	20	400	40	20	400
TAB**			TA initially, arranged to convert to TB			
TBC**			TB initially, arranged to convert to TC			
TLB***	24	12	400	24	-	200

\*An incoming or outgoing group comprises two frames (0 and 1, 2 and 3, etc.) using 400 junctors in common. Thus, when both frame and group quantities are given in the table, the junctor capacity is on a per group basis.

\*\*Due to costs, administrative difficulties, and maintenance problems, the use of the convertible plans should be considered only for cases where the conversion will probably never be made but where forecasts are so uncertain that some protection against exceeding the foreseeable ultimate size is deemed necessary.

\*\*\*Distributing plans used in 2-train offices, where there is a possibility of growth beyond twenty frames, will usually have four incoming link primary bays and three outgoing link secondary bays. These distributing plans are:

- (a) The TLB plan which involves starting with the LB plan, previously a standard plan (with a 20-group ultimate) for the toll completing train, and growing with a hybrid plan employing TB junctor distribution and LB junctor grouping.
- (b) The TC plan which requires a build-out at the outgoing primaries.

going link frames to accommodate additional trunks when required. Two-train offices with combined operation will usually be equipped with four incoming primary bays per incoming frame, to accommodate the multiple appearances of all the incoming trunks and all the incoming appearances of the 2-way trunks, and three outgoing secondary bays per outgoing frame, to accommodate the outgoing trunks and outgoing appearances of 2-way trunks.

2.04 A maximum of forty incoming frames (twenty incoming groups of two frames each) and forty outgoing frames may be furnished. The number of actual frames required is determined by the terminations and by the CCS's (hundred call seconds of traffic) required. Whichever

basis indicates need for the greater number of frames is the controlling one.

2.05 Home and mate connectors are furnished for each incoming and outgoing frame to provide duplicate channels for marker access. This feature requires the frames to be furnished in pairs and that the frames of a pair be located near each other. Provision can be made for mounting the duplicate connector on a special frame when the ultimate requirements result in an odd number of frames.

B. Incoming Link Frames

2.06 The capacity of the incoming frames is:

	Trunks	"A" Links	Junctors	Markers
Primary Bay	100			
First Primary Extension	100			
Second Primary Extension	100			
Third Primary Extension	100			
Secondary Bay			200	
Secondary Extension Bay*			200	
Maximum	400	200	400	10

\*Used when there are more than ten incoming frames and the junctors of frames 0 and 1, 2 and 3, etc., are grouped.

C. Outgoing Link Frames

2.07 The capacity of the outgoing frames is:

	<u>Junctors</u>	<u>"C" Links</u>	<u>Trunks</u>	<u>Markers</u>
Primary Bay	200			
Primary Extension Bay*	200			
Secondary Bay			100	
First Secondary Extension			100	
Second Secondary Extension			100	
	400	200	300	10

\*Furnished where the number of outgoing frames exceeds twenty and the frames are grouped.

D. Junctor Grouping Frame

2.08 The first subgroup junctors of the initial installation must remain fixed to become the ultimate junctor group. The remaining junctors of the total junctor group are run to a junctor grouping frame which is a single-sided distributing frame. This permits the necessary rearrangements of junctors incident to growth without recabling and with a minimum of service reaction.

senders through the sender link frames. The controller connector is called in to select an idle controller by the sender link frame on which the originating trunk appears. Each sender link frame has a choice of one of two controller connectors which in turn have access to the same group of controllers, providing, in effect, a duplicate means for selecting a controller in the group from any sender link frame.

3. COMMON CONTROL EQUIPMENTA. Senders

3.01 In the No. 4A system, the following types of senders are available:

<u>Type</u>	<u>Inpulsing</u>	<u>Outpulsing</u>
Incoming MF	MF	DP, MF, or DCKP
Incoming DP	DP	DP, MF, or DCKP
Outgoing, Revertive - PCI	DCKP	RP or PCI

3.02 There may be a maximum of 378 incoming senders. The maximum per type, either dial pulse or multifrequency, is 300. When 378 incoming senders are provided, the maximum number of outgoing senders is 36. By reducing the maximum number of incoming senders, 18 at a time, it is possible to add additional outgoing senders up to a maximum of 80. Three incoming MF or DP senders mount on one incoming sender frame.

3.03 Incoming senders can receive from 3 to 11 digits and send from 0 to 14, and they are arranged for code conversion. By prefixing three digits on an 11-digit call, it is possible to send 14 digits. This can be used to switch calls through a No. 4 office which does not have the spill forward feature. The outgoing sender is arranged to outpulse four digits on a revertive basis and four or five digits on a panel call indicator basis. Three incoming senders of one type mount on one incoming sender frame. Three revertive - PCI senders mount on one outgoing sender frame.

B. Link Controllers and Connectors

3.04 The function of the link controllers and connectors is to establish connections between the various types of trunks and the

3.05 The link controller and connector frame mounts two controllers and two connectors, each of the latter having access to a maximum of six controllers. Link controllers and connectors are usually furnished in groups of six. Controllers and connectors should, if possible, be assigned on the frames so that no two connectors and controllers in the same group appear on the same frame. When the limit of six controllers and six connectors is reached, the sender link frames are subgrouped and each subgroup provided with access to certain controllers and connectors. The maximum number of sender link frames served by one group of six controllers is 32.

3.06 Since each sender link frame has access to two connectors and odd and even connectors are fused separately, each pair of connectors must consist of an odd and an even so that failure of a main distributing fuse will not disable both connectors serving a link frame. An odd number of connectors would result in an uneven distribution of load within the group. Therefore, either four or six connectors should be furnished. As a rule, six connectors will be furnished in each link controller and connector group because of the difficulty of adding connectors in an established group. Where it can be definitely determined that four connectors will meet the ultimate requirements of the group, it is permissible to provide only this number.

C. Decoders, Card Translators, and MarkersGeneral

3.07 In the No. 4A system, the decoder, card translator, and marker collectively perform the functions of decoding information ob-

tained from an incoming sender and translating it into other information which enables this control equipment to complete a call through the switches and to points beyond.

3.08 The complexity of 6-digit translation has made it economically desirable to separate the decoding, translating, and marking functions into separate entities, to be used only when needed instead of providing only one entity embracing all functions. Fig. 3 (attached) shows their relationship.

#### Decoders

3.09 The decoder, in conjunction with the card translator, translates the code received from the sender into the specific information required by the marker for the completion of a call through a No. 4A toll switching system. This translator is new with the No. 4A system and is quite different from the conventional relay-type translators used in the Nos. 4 and A4A systems.

3.10 On alternate routes, the decoder may with the use of route relays, there being a maximum of 100 route relays in up to six ground supplies in a decoder, cause one or more cards for an alternate route to be dropped.

3.11 In 2-train offices, there may be a maximum of eighteen decoders used in common; in single-train offices, a maximum of ten.

3.12 The decoders in an office are arranged to function with the following maximum quantities of equipment:

Alternate route traffic control frames	2
Marker connectors (one per decoder)	18
Markers per train	10
Decoder connectors	76
Home translators (one per decoder)	18
Decoder foreign translators (one per decoder)	18
Emergency translator connector	1
Emergency translator	1
Foreign translator connectors	19
Foreign translators	19
Incoming sender test frame	1
Trouble recorder frame	1

#### Card Translators

3.13 The card translator shown in Fig. 4 (attached) is an electromechanical device for receiving a code, translating it by dropping a card corresponding to the code, reading the information contained on the card, and passing this information to the decoder and the marker for completion of the call.

3.14 Each translator has a capacity of 1140 cards. A sample card is shown in Figs. 5A and 5B (attached). In order to prevent the cards from sticking, twelve compartments, each with a maximum capacity of 95 cards, are provided.

3.15 The four classifications of card translators and the maximum number which can be provided are:

	<u>2-train Offices</u>	<u>Single-train Offices</u>
Home translators	18 (one per decoder)	10 (one per decoder)
Decoder foreign translators	18 (one per decoder when provided)	10 (one per decoder when provided)
Foreign translators	19	19
Emergency translator	1	1

3.16 The home translator contains all the cards necessary for completing calls in the home area of the CSP (Control Switching Point) plus an area code card for each foreign area plus cards for operator codes and alternate route cards. These cards are all 3-digit cards, but, where space is available and traffic considerations permit, this translator may contain some 6-digit cards. Cards for TX operators are generally in the home box.

3.17 A foreign translator contains all the 6-digit cards required for completion of calls to one or more particular foreign areas. For cases where a CSP cannot route to a foreign area via a principal city route, duplicate cards for that area must be located in each of two paired foreign translators.

3.18 The decoder foreign translator contains all the 6-digit cards for one or more foreign areas for which there are such high calling rates that excessive delays would be incurred if the cards were located in a foreign area translator.

3.19 The emergency translator is arranged to be a substitute for any home, foreign area, or decoder foreign translator.

#### Auxiliary Equipment

3.20 Certain maintenance and auxiliary equipment used in connection with the card translators require manufacturing intervals of such length that they should be included in the original order for the No. 4A switching equipment. These items are as follows:

- 200A blanks
- 616A card coding tool
- Bulk card handling tool
- Portable selector elevating table
- Single-card handling tool
- Template tab coding tool
- Template punch board tool
- Card stack gauge
- Spare set of dies

Markers

3.21 In the standard No. 4A system, there is only one type of marker although the three discriminating names, TC, IT, and combined, are retained from earlier practice.

3.22 The markers are arranged to function with the following maximum quantities of connecting equipment:

	<u>2-train Offices</u>	<u>Single-train Offices</u>
	<u>Per Train</u>	
Incoming frames	40	40
Outgoing frames	40	40
Trunk block connectors	30	30
Block relay frames	15	15
	<u>Per Office</u>	
Decoders	18	10
Decoder connectors	76	60
Marker connectors	18	10
Trouble recorder frame	1	1
Incoming sender test frame	1	1

3.23 In 2-train offices, there may be a maximum of ten markers per train (each train being equipped with the same number of markers); in single-train offices, a maximum of ten per office.

D. Connectors

Decoder Connectors

3.24 A decoder connector cuts through to an idle decoder upon receipt of a signal from an incoming sender. Connection to a marker is not effected until the decoder has selected an idle marker through the marker connector. The connections between the decoder connector and marker connector insure that the sender connects to the same marker as the decoder. The decoder is dismissed after it gives final instructions to the marker, but the sender marker connection is retained until the marker function is completed.

3.25 Three decoder connector frames and two supplementary decoder connector frames are available to provide five different decoder and marker capacities as follows:

<u>Type of Office</u>	<u>Decoders</u>	<u>Markers</u>
Single train	6	10
	10	10
Two train	10	18
	14	18
	18	20

The capacities of the individual frames, there being three different capacities for the decoder frames and two for the supplementary frames, are:

	<u>Decoder Connector Frames</u>			<u>Supplementary Frames</u>	
Connectors per frame	3	3	3	6	3
Senders per connector	5	5	5	-	-
Senders per frame	15	15	15	-	-
Decoders	6	10	10	4	8
Markers (nominal)					
Intertoll or combined	10	10	10	-	-
Toll completing	-	-	8	-	2

Marker Connectors

3.26 One marker connector is provided per decoder. The marker connector cuts through upon receipt of a signal from the decoder. Each connector can handle one call at a time and is held only as long as the decoder is required to be connected to the marker. Each connector prefers markers in a fixed order which differs between connectors for the purpose of distributing calls as evenly as possible over the markers.

3.27 The marker connector frame is available in two sizes, one for 2-train offices and the other for single-train offices.

Marker Connector Frame for Use

	<u>With Two Trains</u>	<u>With Single Train</u>
Connectors per frame	2	2
Decoders per connector	1	1
Decoders per frame	2	2
Markers - total	20	10

Foreign Translator Connectors

3.28 Cut through is effected by the connector upon receipt of a signal from a decoder, provided the translator is idle. Each connector can handle one call at a time and is held only as long as the decoder is required to be connected to a foreign translator.

3.29 The foreign translator connector frame is available in one size: one frame is furnished for single-train offices and two frames in combination for 2-train offices.

Foreign Translator Connector Frame

Connectors per frame	2
Foreign translators per connector	1
Foreign translators per frame	2
Decoders per frame	10

Emergency Translator Connector

3.30 The emergency translator connector provides facilities for substituting the emergency translator for any home, decoder foreign, or foreign translator.

3.31 One emergency translator connector frame is provided. In single-train offices, its capacity is:

Emergency Translator Connector Frame

Emergency translator connector	1
Decoders per frame	10
FIF (frame identification frequency) control	1

3.32 The frame identification frequency control equipment is mounted on the emergency translator connector frame in single-train offices because the space is available. However, in 2-train offices, the frame identification frequency control equipment is located on a different frame and the capacities of each of these frames are:

Emergency Translator Connector Frame

Emergency translator connector	1
Decoders per frame	18

FIF Control Frame

FIF Control	1
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E. Associated FramesBlock Relay Frames

3.33 The block relay frame mounts the block relays through which the marker reaches the busy test terminals of the outgoing and 2-way trunks. These relays together with marker connector relays, also mounted on the block relay frame, make up a trunk block connector which is a dual access arrangement by which the marker can reach the trunk block and perform the busy tests on trunks. Each connector consists of an odd and even half which have identical sets of marker connector relays multiplied on the marker side and trunk block relays multiplied on the trunk side. Senders are arranged so that calls from half of the senders cause the marker to prefer the odd-half connector, and calls from the other senders cause preference of the even-half in order to provide equitable load distribution. On second trials, this preference is reversed.

3.34 Trunks are tested in groups of up to and including forty at a time, and the capacity of the block relay frame is:

Markers	10*
Trunk block connectors	2
Trunks per block connector	400
Trunks per frame	800

\*There may be fifteen block relay frames per marker group.

3.35 In order to facilitate the cabling from the assignment distributing frame to the trunk test connector frames, the trunk block relays in each train are assigned to intertoll

trunks in bottom-up order; that is, 0, 1, 2, etc., and to toll completing trunks in top-down order; that is, 9, 8, 7, etc.

Overflow Trunk Frame

3.36 The overflow trunk frame mounts the group-busy relays for outgoing intertoll trunk groups and all groups to crossbar tandem, the overflow trunks, and their associated control circuits.

3.37 The nominal capacity of the overflow trunk frame is:

Group-busy relays	104
Overflow trunks*	90
Control circuits**	22-45

\*The use of these trunks as overflow trunks has been discontinued. However, they may be used for other purposes such as for delay pronouncements. Studies are currently underway to determine their ultimate use, if any. The future arrangements may obviate the use of control circuits.

\*\*The number of control circuits depends on the number of C2 and C4 units provided. The C2 unit is a single-plate unit consisting of a control circuit and one or two overflow trunks. The C4 unit is a 2-plate unit consisting of a control circuit and from one to four overflow trunks.

MF Current Supply Frame

3.38 This frame mounts the oscillator units which generate the MF current for MF pulsing. A minimum of two supply frames are furnished in each office to assure continuity of service.

MF Pulsing Receiving Frame

3.39 The receiving units on this frame, one for each MF sender, detect MF pulsing signals. These signals are then transmitted to the sender on a d-c basis.

3.40 An MF receiving frame has a maximum capacity of twelve receiving units.

Frame Identification Frequency Supply Frame

3.41 This frame mounts the oscillators, amplifiers, and mixing resistances which supply the frequencies for frame identification during marker operation. Two of these frames, a regular and an alternate, are furnished per office to assure continuity of service.

Alternate Route Traffic Control Frame

3.42 The alternate route traffic control frame provides centralized facilities for interconnecting the alternate route relays of each decoder in accordance with the basic switching plan. Associated with each decoder route relay is a route transfer relay which can be used to prevent the alternate routing of traffic over a trunk group to a CSP that has

become congested. The route transfer relays are controlled by the operation of traffic control keys located with their associated guard lamps on the traffic supervisory rack.

3.43 Traffic which is denied access to a trunk group as an alternate route is automatically routed to an NC circuit. This type of operation applies only to alternate route traffic as direct traffic over the trunk group is not affected by the alternate route traffic control keys.

3.44 The capacity of an alternate route traffic control frame is:

Decoders 10\*  
Alternate route transfer relays 100

\*The alternate route traffic control frame is also arranged for use as a supplementary frame to be provided in offices having more than ten decoders.

3.45 There is one transfer relay for each trunk group between the CSP and any other CSP it reaches. There is one traffic control key and one lamp per route transfer relay.

Sender Traffic Control Circuit

3.46 The sender traffic control circuit regulates the time an incoming sender will wait for a sender ahead during periods of heavy traffic. Whenever all senders of a type in one key frame group become busy, the timing is shortened in all incoming senders of the same type. This reduced timing is maintained for a few seconds after one or more senders are available in each group for that type of sender.

3.47 The sender traffic control circuit holds back calls on a sender link frame when all the associated senders are busy. This permits other sender link frames, which do have available senders, to gain access to link controllers so that calls may be served with a minimum of delay. The lockout feature is still effective so that a frame which has just been served cannot be served again until all link frames in the connector which have waiting calls and available senders are handled.

3.48 This circuit provides a lamp indication at the maintenance center and traffic control panel for each type of sender that has reduced timing, and for each sender link key frame group of senders that are all busy.

3.49 One circuit is furnished per office. Two sizes are available, namely:

	Small Offices	Maximum Size Offices
Groups of senders (80 max.)	3	6
Groups of senders (40 max.)	1	1
Controller connector groups	4	6

Office Interrupter Frame

3.50 This frame is arranged to mount reciprocating bar-type interrupters which function to supply interrupted battery or ground to the various circuits in the toll switching office and for other uses. Each frame has a capacity of 24 interrupters. Nevertheless, a minimum of four frames is provided for each office so as to divide the load approximately evenly and minimize service reaction in event of the temporary failure of the motor or drive mechanism of a frame.

4. TRUNKS

GENERAL

4.01 The No. 4A trunks, which are similar to the Nos. 4 and A4A trunks and in many cases identical, are designed for 4-wire operation, separate paths being provided for each direction of transmission. Some trunks have incoming only appearances, some have outgoing only, and some are two way; that is, they have both incoming and outgoing link frame appearances.

4.02 These trunks, intertoll and toll connecting, may pass multifrequency or dial pulsing (in or out) and may be ringdown or "automatic start of ringing" - manual (out). Ringdown intertoll trunks remain in manual switchboards as at present, but calls from dial intertoll trunks or toll tandem trunks can reach them through the switches. In general, outward switchboards in the same building with the No. 4A system will reach ringdown intertoll trunks in the manual multiple, while decentralized outward boards will reach them through the dial equipment if transmission limitations permit. Ringdown to dial is trunked from the through switchboard through the switches. Calls may be completed to the usual service operators for delayed outward, inward, information, rate and route, toll station, mobile, and circuit request traffic.

4.03 At the toll crossbar office, the No. 4A trunks terminate in circuits which provide the necessary signaling and control functions for the operation of the system.

4.04 Incoming trunks and the incoming appearances of 2-way trunks to the No. 4A system furnish class indications, wired in by the installer, to the sender to indicate the type of trunk; that is, loop or E and M, transmission grade, and traffic separation mark.

4.05 The trunk circuits associated with trunks having a single appearance on an incoming or outgoing link frame in a single-train office may be cabled directly to the switch levels of these frames or cabled to the trunk distributing frame (TDF) and there cross-connected to the switch levels. All other trunks should be cabled to the TDF. A small percentage of the outgoing trunks in a separate train combined operation office may be cabled directly if it

appears that they will not interfere with the transfer of trunks in subsequent frame additions or for load balancing. Trunk relay equipments for trunks requiring senders are cabled directly to the sender link frames. Fig. 6 (attached) shows the direct cabling and cross connections of the outgoing trunks to the outgoing link frames, block relay frames, and distributing frames.

**TRANSMISSION CONSIDERATIONS**

4.06 From a transmission standpoint, the toll switching system, as developed for the Nos. 4, A4A, and 4A systems, differs from previous Bell System dial switching systems in that all connections are carried through the switches on a 4-wire rather than a 2-wire basis. Two-wire circuits are made to appear as 4-wire circuits by omitting the drop side hybrid coil or resistance hybrid on 4-wire repeated circuits or by adding a hybrid coil on nonrepeated circuits or 2-wire repeated circuits.

4.07 A system of switching pads is used to adjust transmission losses on the various types of connections. In general, the system makes use of switching pads in intertoll trunk circuits. These switching pads, usually referred to as the "A" pads, have the same value (4, 5, 6, or 7 db) for all intertoll trunks in a given office. The No. 4A toll switching system has split "A" pads which consist of a 2 db part and an A-2 part. The whole "A" pad remains in on dial intertoll connections and is switched out in a connection to a high loss trunk of any kind or to a 2-wire ringdown trunk. On "low-loss terminal connections," only the 2 db pad is switched out.

4.08 The incoming trunk has two possible class marks for indicating the transmission grade of the incoming trunk. This, with information concerning the destination of the call, enables the No. 4A system to set up the connection to an outgoing trunk of the proper grade of transmission. Table B (below) illustrates this.

**TERMINATIONS ON INCOMING, OUTGOING, AND SENDER LINK FRAMES**

4.09 With the two standard No. 4A arrangements, single combined train operation and separate train combined operation, the possible incoming and outgoing link frame connections are shown in Fig. 7.

4.10 In separate train combined offices, all incoming trunks appear on both trains, and intertrain balancing is done on the out frames. Therefore, outgoing trunk groups will be assigned to either train in accordance with traffic requirements. Outgoing trunk groups should not be split between trains if possible, and no outgoing trunks should be multipled to both trains.

4.11 A sender link frame provides 100 trunks requiring a given type of sender with access to 40 senders of that type. Senders of a type, either MF or dial pulse incoming or revertive - PCI outgoing, are connected to the sender link frames in groups of 80 maximum on a "key" frame basis. The "key" frames are the first four sender link frames and are interconnected with a slip multiple which is arranged so that, when there are 40 or less senders, all senders appear on all link frames. When the number exceeds 40, the additional senders are introduced into the slip multiple in such a way that when the maximum of 80 are provided each sender has appearances on two key frames. When the number is between 40 and 80, some senders appear on two key frames and others on four key frames. Thus, each frame always has access to 40 senders when 40 or more senders per type are provided. However, the combinations of 40 senders vary. When more than four sender link frames per type of sender are required, the additional ones are introduced as nonkey frames. The frames 4, 8, etc., have the same senders on the same horizontals as frame 0; 5, 9, etc., as frame 1; etc.

**TYPES OF TRUNKS**

**A. General**

4.12 The trunks of the No. 4A system may be classified as:

- 1. Intertoll
- 2. Toll connecting
  - a. Toll tandem
  - b. Toll completing
    - (1) Toll switching
    - (2) Operator trunks

- TX trunks
- 121 (inward assistance)
- Information trunks
- Rate and route
- Delayed through position trunks

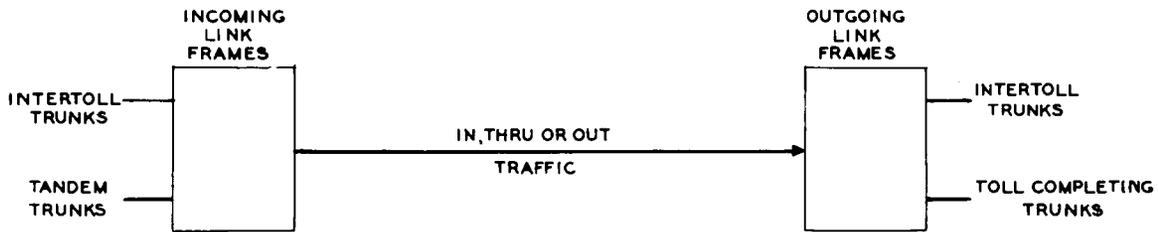
TABLE B

<u>Class Mark on Incoming Trunk</u>	<u>Type of Incoming Trunk</u>	<u>Transmission Grade of Outgoing Intertoll Trunk</u>
VO (via only)	Intertoll or toll tandem from delayed through board	VO
NVO (non via only)	All other toll tandem	Trunks with the NVO mark can connect to trunks of either the via (VO) or terminal grade (NVO) depending on the codes.

VO: if switched in the distant city.

NVO: if the call involves only one intertoll trunk.

FOR SINGLE TRAIN OFFICES - COMBINED OPERATION:



FOR SEPARATE TRAIN OFFICES - COMBINED OPERATION:

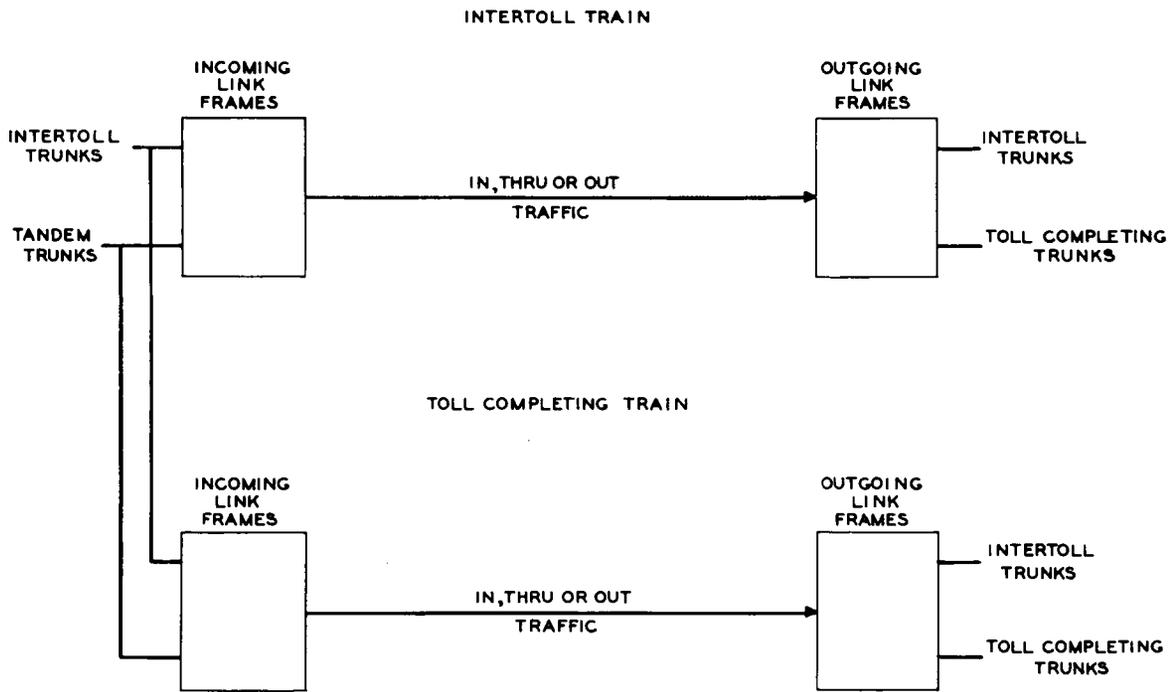


FIG. 7 - TRUNK APPEARANCES ON INCOMING AND OUTGOING LINK FRAMES

### 3. Miscellaneous

- a. Overflow
- b. Combined NC-operator
- c. Reorder
- d. Digit absorbing
- e. Test trunks

#### B. Intertoll Trunks

4.13 These trunks, which are used to establish connections to other toll points and which have an appearance at a No. 17C toll test board, are similar to those used in the No. A4A system. The types are:

1. Incoming dial pulse
2. Incoming multifrequency
3. Two way, incoming dial pulse, outgoing multifrequency, dial pulse, or automatic
4. Two way, incoming multifrequency, outgoing multifrequency, dial pulse, or automatic
5. Outgoing multifrequency, dial pulse, or automatic
6. Outgoing ringdown intertoll
7. Outgoing ringdown intertoll appliques

#### C. Ringdown Intertoll Appliques

4.14 When ringdown intertoll circuits are to be multiplied on the outgoing frames, the existing ringdown intertoll trunks and their appearances in the manual switchboard are left intact, and the applique circuits are provided, so that, with proper ringing control and with exchange of busy with the manual switchboard, the No. 4A can pick up a ringdown intertoll circuit in the outgoing condition.

4.15 The ringdown intertoll applique circuits are provided with two alternate build-out pad conditions. One option provides for a fixed "S" pad and the other for switchable pad arrangements. The latter option may be employed where it is planned to route locally originated calls to the ringdown intertoll trunks via the No. 4A switches if transmission conditions permit.

#### D. Toll Connecting Trunks

4.16 Trunks which connect a No. 4A toll office with local offices or switchboards are called toll connecting trunks. Incoming to the No. 4A they are called toll tandem; outgoing they are toll completing. These trunks are similar to the corresponding trunks employed in the No. A4A system.

#### Toll Tandem

4.17 The No. 4A toll tandem trunks are designed to connect through the switching frames with intertoll trunks or toll connecting trunks. They are one way and may be high loss or low loss from a transmission standpoint. Tandem trunks from manual through boards, as well as certain conference and overseas positions, are through-type trunks equipped with pad control. Tandem trunks are

provided for three wire, E and M, or loop signaling. Loop signaling may use high-low or reverse battery arrangements. Ringing may be either loop 20-cycle ringing or E and M pulsed ring.

4.18 The different types are:

1. Dial pulse, two wire (regular)
2. Dial pulse, three wire (regular)
3. Dial pulse, three wire (through)
4. Multifrequency, two wire (regular)
5. Multifrequency, three wire (regular)
6. Multifrequency, three wire (through)
7. Multifrequency, four wire (regular)
8. Multifrequency, four wire (through)
9. Multifrequency, from delayed through positions
10. Multifrequency, from No. 17C test board

#### Toll Completing

##### Toll Switching Trunks

4.19 These are one way, may be high loss or low loss from a transmission standpoint, and may be provided with wet-dry, reverse battery, or high-low supervision.

4.20 The No. 4A system has two types of dial toll switching trunks. One is used for MF or DP outpulsing or for straightforward operation; and the other for offices in cities where revertive pulsing or PCI is employed.

4.21 Switching trunks to repeated dialing toll trains and to some community dial offices, however, have more complicated functions and must employ more complex trunks.

4.22 Appliques for operator office trunks are toll completing trunks which secure access to existing operator office trunks to community dial offices. Outward traffic is handled at switchboard positions and the appliques complete inward traffic from the No. 4A. When they are to be multiplied on the outgoing frames, the existing toll switching trunks and their appearances at the switchboards are left intact, and applique circuits are provided in order that, with exchange of busy with the switchboards, the No. 4A can select one of these circuits in the outgoing condition.

##### Operator Trunks

4.23 These consist of:

- (a) TX Trunks: Automatic trunks are provided to outward toll boards for extending connections through the toll crossbar system to TX (outward delayed) positions. In the case of No. 1 and No. 3 type toll switchboards, 2- and 3-wire circuits are available. For DSA switchboards, 2-wire circuits are provided. If connection is to be made to one of several TX teams in a distant building over a common trunk group, toll switching trunks capable of passing ringing are used at the No. 4A end and one or more DP digits sent into selectors at the distant end.

- (b) Inward Operator Trunks (Code 121): Inward operator trunks from the outgoing link frames are provided so that inward (No. 5, No. 3 type, or No. 1) toll operators may be reached in response to the code 121 dialed or keyed over dial trunks for assistance. The trunk operates essentially as a ringdown intertoll trunk; that is, supervision from the originating end is received in the trunk and recalls the inward operator.
- (c) Information Trunks (Code 131): Automatic 2- or 3-wire trunk circuits with audible ring are used for trunks to information desks. After the information operator has released from a connection, a flashing signal is automatically sent toward the originating end.
- (d) Rate and Route Trunks (Code 141): Automatic trunk circuits are provided for trunks key-ended at rate and route desks. The originating operator uses them to reach the rate and route desk operators to obtain information pertinent to the call not covered in her bulletin.
- (e) Delayed Through Position Trunks
- (1) Circuit Request Traffic: During periods of heavy traffic, trunk groups may become overloaded and operators trying to reach these groups through the No. 4A system encounter delays. In case the outward operator desires to leave a circuit request, she dials the code "121" and is connected to delayed through positions which are provided to handle such calls during busy hours, or if this office is equipped with combined NC-operator trunks, the originating operator may in the future signal the delayed through position operator by ringing forward. The ring disconnects the flashes and switches to the delayed through operator.
- (2) At smaller installations or at those handling a relatively small amount of through traffic, the No. 3 type or No. 1 switchboard may be used for 121 traffic with some transmission reactions.
- (3) Interposition Trunks: Interposition trunks are provided to permit communication between operators. Each delayed through position is provided with access to every other. The outgoing ends of these trunks are multiplied through the board (each appearance having a busy or idle indicating lamp), and the answering ends terminate on the individual positions in answering jacks and lamps.
- (4) Where delayed through and through positions appear in the same switchboard, which may be the case for No. 1 and No. 3 type switchboards, interposition trunks are provided to connect these positions.
- (5) Interposition trunks may also connect the No. 5 board, when provided, and the through positions of toll switchboards No. 1, and No. 3, 3C, or 3CL. These trunks are used to facilitate the handling of delayed through calls which involve the through operators in each of the toll offices.
- (6) Tandem Trunks: Tandem trunks from the delayed through positions to the incoming link frames are provided, and circuit requests are usually completed over these 4-wire trunks which have test and make-busy jacks.
- (7) Monitoring Trunks from the No. 17C Toll Test Board: A circuit is available which permits delayed through position operators to monitor on busy intertoll trunks that they wish to secure under emergency conditions. A monitoring trunk is patched to an intertoll trunk at the test board upon request of the operator.
- (8) With this arrangement, the operator not only determines when the intertoll trunk becomes idle, but, if necessary, is able to cut in and request the release of the trunk if it is being held by an operator.
- (9) When the trunk becomes idle, she secures it in the normal manner by keying over a tandem trunk. Having secured the trunk, she instructs the test board to remove the monitoring patch.
- (10) Delay Quotation Trunks: Under present arrangements, in the event that an outward trunk group with overflow trunks is busy and is put on a "posted delay" by means of patching at the traffic supervisory panel, any call for this group is automatically routed over a delay quotation trunk to an operator, or in some installations, to a recorded quotation of the posted delay. Modifications of these arrangements are under study.
- (11) When signaled that an incoming call has reached delay quote, the operator alternates delay announcements and flashes until the overflow circuits are released.
- (12) If the call is routed to a recording machine, flashes and a maximum of six independent delay quotations can be passed from the machine to overflow trunk circuits. There is provision for an operator to record delay quotations on the machine, check the recording, and announce and flash in case of trouble or a change in announcement.
- (13) Operators who receive a delay quote will hold the ticket and reattempt to place the call after the quoted time has elapsed.

(f) Toll Station Operator (Code 181): Trunks may be provided to permit operators at distant dial points to reach a manual toll position where connections are completed to toll stations.

(g) Transfer to CLR Board (Code 191): Trunks may be provided for the use of dial tributary operators in reaching CLR operators in the No. 4A toll center area.

#### E. Miscellaneous Trunks

##### Group-busy Facilities

4.24 Trunk groups may be equipped with group-busy circuits. Group-busy circuits associated with route relays indicate to the decoders the first subgroup with idle trunks, or that all trunks in the group are busy, thus causing the decoder to route calls to the first subgroup with idle trunks, to an alternate route, to the overflow trunks of this group, to NC, or to reorder.

4.25 Group-busy circuits may be associated with jacks at the delayed through positions. When an operator plugs into the jack associated with a group-busy circuit of a given trunk group, the supervisory lamp of the cord remains dark when all trunks are busy, and flashes at 120 ipm when one or more trunks are available.

##### Combined NC-operator

4.26 If all the outgoing trunks in a group are busy and all the overflow trunks (if provided) are also busy and no alternate route is available, a call for this group is routed to a combined NC-operator trunk which sends a 30-ipm signal back to the operator. In the future if the originating operator desires to leave a circuit request, she may signal the delayed through position operator by ringing forward. The ring disconnects the flash and switches to the delayed through operator.

##### Reorder Trunks

4.27 Reorder trunks producing 120-ipm flashes are provided. If the trunk is not released within 120 to 240 seconds, a time alarm register is scored, and visual and audible alarm signals function.

4.28 A second type of reorder trunk permits monitoring from delayed through positions. When used for monitoring, its automatic flashing and timing functions are disabled.

##### Digit Absorbing Trunks

4.29 These trunks are used in No. 4A toll offices to complete incoming calls when more than six digits are required for transmission, as in the case where a 4- or 5-digit TX code is preceded by the home TC code. The use of the digit absorbing trunk permits deletion of the first three digits by routing the call through the system twice.

##### Test Trunks

Test Line for Noise and Balance Measurement (Code 100)

4.30 This test line enables a testman at a distant office to dial into this office and reach this line in order to make balance and noise tests on the intertoll trunks used to set up the connection. Basically this circuit consists of a 600-ohm resistance and a condenser. It may be selected by the outgoing trunk test circuit to determine whether it functions satisfactorily.

Trunk to No. 17C Test Board (Code 101)

4.31 This trunk provides means for establishing a connection through the outgoing link frame to the toll test board for communication with the toll testman. Two jacks per trunk are provided at each appearance at the test board since transmission over these trunks is on a 4-wire basis.

##### Tandem Trunks from No. 17C Test Board

4.32 These MF trunks provide access to all the outgoing trunk groups. They terminate on the incoming link frames and are arranged to connect to incoming senders through sender link frames. Two jacks per trunk are provided as above.

Milliwatt Supply (Code 102 and 959)

4.33 This circuit permits a connection to be established through the incoming and outgoing link frames to a source of 1000-cycle testing power for transmission measurements. It provides a 2 db loss between the supply and the intertoll trunk.

Test Line Circuit (Code 103)

4.34 This circuit is used to terminate a test call from a distant office and to indicate, by supervisory signals, the cut through of switches and the correct functioning of the ringing feature.

Automatic Intertoll Trunk Transmission Test Line Circuit (Code 104)

4.35 This circuit permits the connection of intertoll trunks to a source of transmission testing power at the terminating office.

Trunk to No. 20 or 21 Key Cabinet (Code 958)

4.36 Provision is made for trunks from a toll or local office to reach a No. 20 or 21 key cabinet at a switchman's desk or at a telephone with multiple keys and lamps at the maintenance frames. In conjunction with outgoing

trunks from the telephone, key, and lamp circuits at the distant offices, this circuit is used as a means for direct verbal communication between the maintenance men in the two offices. It is an aid to the maintenance men in providing and obtaining information that will be helpful in the location of troubles.

Trunk from No. 20 or 21 Key Cabinet

4.37 This is the outgoing counterpart of the above circuit.

5. DELAYED THROUGH TOLL SWITCHBOARD POSITIONS

5.01 The No. 5 toll switchboard is a 5' 4" high, 92-jack, double-plug, cord-type switchboard located in the same building with the No. 4A switching equipment. It provides the necessary flexibility for access to and from intertoll and toll connecting trunks. The basic features are similar to the No. 3CL switchboard but the cord and trunk circuits are designed to establish connections on a 4-wire basis. The primary purpose of this switchboard is to complete delayed through traffic in response to circuit requests placed by toll operators.

5.02 The capacity of the switchboard is:

Panels per position	3
Cords per position	
Connecting cords (double plugs)	8
Overflow cords (single plugs)	3

5.03 There is space for multiple appearance on a 7-panel basis of 140 incoming trunks, 210 outgoing trunks, and 420 overflow trunks. In addition, space is available below the multiple for ticket boxes and additional answering jacks and in the multiple for ten tandem trunks, individual to each two positions, to the combined train or trains in a given office.

5.04 At many installations No. 3 type or No. 1 toll switchboard positions may be used in place of the No. 5 for handling delayed through traffic.

6. OPERATING AND SWITCHING ROOM DESK EQUIPMENT

A. No. 20 Key Cabinet

6.01 The No. 20 key cabinet contains key and lamp equipment for trunks and tie lines required for traffic and maintenance desks. The cabinet is equipped with eight key and lamp circuits providing for the termination of a total of eight trunks or tie lines to other key cabinets, desks, switchboards, and switching equipment. A ninth key unit is used for transferring trunks and tie lines to another location and for controlling the audible and visual signals.

6.02 The equipment located at a traffic or maintenance desk consists of the key cabinet, which may be mounted on either side, associated handset or desk stand, telephone jacks when required to permit the use of an operator's telephone set, and a bell or buzzer located in the knee well of the desk. Provision is made to substitute a lamp indicator for the audible signal. Monitoring jacks may also be located at the desk when required for monitoring on operators.

B. No. 21 Key Cabinet

6.03 The No. 21 key cabinet contains key and lamp equipment for trunks and tie lines required for maintenance desks. Its capacity is:

28 key and lamp circuits for the termination of 28 trunk or tie line circuits
1 transfer and auxiliary signal circuit
1 telephone circuit
1 call bell circuit

6.04 When a No. 21 key cabinet is provided, a night alarm key and telephone jacks, which permit transfer of incoming signals to the alarm system, are also provided at the maintenance desk.

7. TRAFFIC MEASURING AND ADMINISTRATIVE FACILITIES

A. Traffic Supervisory Rack Equipment

7.01 The traffic supervisory rack is used in the operating room to assist the chief operator in estimating the delay expected to be encountered in handling calls on any trunk group during heavy traffic periods, to provide means of putting that group on a specific "delay quotation" basis, and to provide means of denying access to trunk groups for alternate route traffic. The jack, lamp, and key fields required for these functions are mounted on a 6' 2" floor-supported rack, the same as that used for the traffic register rack. The traffic supervisory rack is generally located adjacent to bay 0 of the register rack and has a capacity of:

Sender group-busy lamps	24
All decoders-busy lamp	1
All markers-busy lamps	2
Sender overload lamps	2
Overflow lamps	600
Delay quotation jacks for overflow trunks	280
Delay quotation trunk patching jacks (20 per trunk)	120
Alternate route traffic control keys and lamps (each)	100

B. Traffic Register Rack Equipment

7.02 The traffic register rack in conjunction with the traffic register relay rack and traffic register distributing frame provides

facilities for obtaining overflow, peg count, delay, group busy, traffic usage, answering time, and load distribution data on the various circuits in the office.

7.03 The traffic register racks mount the registers, meters, and miscellaneous control keys and patching jacks, and are located in the operating room. The associated register relays and ampere-minute meters are mounted on the traffic register relay rack located in the switchroom. The traffic register distributing frame provides flexibility between the register relays and the circuits requiring registration, and between the register relays and the registers.

7.04 The traffic register rack has a capacity of:

14-type message registers per bay 320\*

\*Eight magnetic counters occupy the same space as 30 message registers. A maximum of 38 magnetic counters, one per decoder and one per marker, plus one per decoder connector per type of sender, will be required.

7.05 The first bay of the register rack line-up mounts the various ammeters and associated patching jack equipment. Consequently, it is known as the power patch bay.

7.06 The second bay mounts the register patching jacks, and when space is available, the magnetic counters. It is known as the register patch bay.

7.07 The remaining bays mount the 14-type register and the magnetic counters as required.

7.08 Requirements for some of the various registers and meters are as follows:

(a) Overflow } Three of each per trunk block  
(b) Peg Count } (forty trunks) plus two of each per trunk block connector. Overflow and peg count registers are also operated from the alternate route relays in the decoder.

(c) Delay

- (1) All Sender Busy: A maximum of one per key frame group.
- (2) Sender Link Frame: One register per sender link key frame group.
- (3) Reorder Trunk - Time Alarm: One per office.

(d) Group Busy: One per incoming toll tandem trunk group.

(e) Answering Time Recorder: Two per office, located in the first panel of the delayed through toll switchboard positions.

(f) Traffic Usage Recorder

(1) A recorder for measuring usage on all trunks, links, and senders is under development. The trunks and links require one usage lead and the senders two. The capacity of one recorder is 3600 terminations. More units may be employed when this capacity is exceeded. The circuits cabled to this recorder shall be those recommended by the local Traffic Department. This equipment will be mounted on a 4' 1-1/4" frame. The associated registers will be mounted on the traffic register rack.

(2) A second type of traffic usage recorder with a much faster scanning rate to measure usage of markers, controllers, decoders, and foreign translators is under consideration.

(g) Load Meters

- (1) Ampere-minute Meters: Maximum of twenty per office.
- (2) Instantaneous Ammeter: One per office.
- (3) Recording Ammeter: One per office.
- (4) Total Train Load: One per switching train.

## 8. ALARM EQUIPMENT

### A. Emergency Alarm Frame

8.01 The emergency alarm frame, located in the maintenance center, houses the equipment associated with automatic fire detection, which functions with fuseable fire detection wire installed on top of the skinners and on the surface of the local cables. Alarms are sounded when any break occurs in the series circuit setup. The alarms may be arranged with or without code signaling as required.

### B. Floor Alarm Frame

8.02 The floor alarm frame provides mounting facilities for the alarm equipment for a variable number of frames, aisles, and main aisles of toll crossbar equipment distributed over a maximum of three switching floors and for the power and operating rooms. This equipment furnishes simultaneous audible and visual signals directing the maintenance force to the particular frame or fuse bay in trouble. Power failure and major and minor troubles have distinctive signals. Provision is made for switching the switchroom alarms from one floor to another or to the operating room when required by the distribution of the maintenance forces.

## 9. TESTING AND MAINTENANCE EQUIPMENT

### A. General

9.01 The maintenance of a toll crossbar system requires close co-ordination of inter-toll trunk maintenance with maintenance of the switching equipment. Intertoll trunk

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maintenance facilities are located in the toll test and terminal room. Switching maintenance equipment is concentrated in a section of the No. 4A switchroom called the "maintenance center." To permit co-ordination of activities between the two areas, intercommunicating trunks are provided.

9.02 The maintenance components are:

### Maintenance Center Equipment

Test Frames Located in Maintenance Center

- (a) Trouble recorder frame
- (b) Incoming sender test frame
- (c) Outgoing sender test frame
- (d) Sender make-busy frame
- (e) Automatic outgoing toll connecting trunk test frame
- (f) Manual outgoing toll connecting trunk test frame

### Intertoll Trunk Maintenance Equipment

Equipment Located In Toll Test and Terminal Room

- (a) No. 17C toll test board
- (b) Patching bays
- (c) Automatic outgoing intertoll trunk test frame

### Miscellaneous Test Equipment

Switching Maintenance

- (a) Incoming and outgoing intertoll trunk test set
- (b) Frame identification frequency test set
- (c) No. 100A test set
- (d) Trouble tracing selector
- (e) No. 5 toll switchboard position control test set
- (f) Card translator test set (under development)

Intertoll Trunk Maintenance

- (g) Test line circuit for making balance and noise tests (code 100)
- (h) Trunk to No. 17C test board (code 101)
- (i) Test line circuit to milliwatt distributing circuit (code 102)
- (j) Incoming trunk test line (code 103)
- (k) Automatic intertoll trunk transmission test line circuit (code 104)

## B. Maintenance Center Frames

### Trouble Recorder Frame

9.03 The trouble recorder frame consists of a trouble recorder, a decoder marker test circuit, a link controller test circuit, and a translator conditioning circuit which pre-

pares any translator for the addition or removal of cards or for the removal of the selector unit of the translator. All of these units function more or less independently. This frame is also a central location for circuit-busy indicating lamps, make-busy jacks, alarm lamps and keys, and jacks to put the emergency translator in service in place of any other translator. One frame is provided in each No. 4A installation.

### Incoming Sender Test Frame

9.04 The incoming sender test frame provides a means for the routine testing of incoming senders on an automatic basis. Also, individual senders may be tested as required. The capacity of the sender test frame is:

MF (or DP) incoming senders	306*
DP (or MF) incoming senders	72*
Total incoming senders	378

\*The capacity of the smaller group may be increased in multiples of 18 up to 180 senders with a corresponding decrease in the larger group. The number of incoming senders of one type in an office is limited to 300 by the trouble recorder card capacity.

### Outgoing Sender Test Frame

9.05 The outgoing sender test frame provides a means for the routine testing of outgoing senders on an automatic basis. Individual senders may be tested as required. The frame is arranged to test 90 outgoing revertive - PCI senders.

### Sender Make-busy Frame

9.06 This frame provides jacks to permit removing any sender from service, group-busy lamps for each group of senders, link frame lamps to indicate the sender connection, and registers for stuck senders and link controller trouble records. The capacity of the frame, there being two arrangements, is:

#### Make-busy Jacks, Keys, and Lamps and Registers for:

Revertive-PCI outgoing senders	80	36
MF (or DP) incoming senders	216	306
DP (or MF) incoming senders	108	108

The total number of incoming senders and the maximum number of one type are limited by the sender test frame and trouble recorder frame capacities to 378 and 300 respectively.

### Automatic Outgoing Toll Connecting Trunk Test Frame

9.07 The automatic outgoing toll connecting trunk test frame is used to make over-all circuit tests of toll switching trunks to local offices, trunks to TX operators, and miscellaneous trunks such as overflow, reorder, holding, etc. The tests are made through the regular switching train and are

performed automatically if it is possible to reach an automatic test line without going through an operator. Lamps are provided to indicate the progress of the tests and the failure of any particular trunk.

9.08 Access to the trunks is obtained through crossbar switches on the associated test connector frames and through the incoming and outgoing link frames.

9.09 The capacities of the test frame and test connector frame are:

Automatic outgoing toll connecting trunk test frame	8000 trunks
Outgoing toll connecting trunk test connector frame	5 connector units 200 trunks per connector unit

Manual Outgoing Toll Connecting Trunk Test Frame

9.10 In addition to the automatic test frame described in the foregoing, a manual outgoing toll connecting trunk test frame is provided to test outgoing trunks independently of the outgoing trunk relay equipment. Test jacks are bridged across the cable side of the trunk circuit.

9.11 Test facilities at this frame include a voltmeter test circuit and sender and supervisory circuits for testing the incoming trunk and selector equipment at the local terminating office. The test jacks are grouped with trunk make-busy jacks in the jack panels of the test and make-busy frames which are located adjacent to the manual test frame.

9.12 The capacity of the test and make-busy frame is 2000 jack circuits. Each 2- or 3-wire trunk requires one jack circuit. Each 4-wire trunk requires two. The assignment of 2-, 3-, or 4-wire trunks is flexible except for the limitation that each type provided be in multiples of twenty to agree with the separate jack strip plan per type of trunk. The jack circuits for the trunks are arranged for cross connection to the outgoing trunks to permit grouping by office designations.

9.13 The usual setup consists of one test frame and one or two adjacent jack frames. In some cases, however, more than one test frame with associated jack frames is desirable.

C. Test and Terminal Room Equipment

No. 17C Toll Test Board

9.14 The No. 17C toll test board is used in No. 4A toll offices for making over-all tests of the intertoll circuits in order to facilitate the location of troubles and to expedite the restoration of service when it has been interrupted. It consists of a lower unit housing testing and control equipment and a jack field with an appearance of the intertoll trunks and miscellaneous trunks.

9.15 The capacity of the No. 17C toll test board is:

<u>Lower Unit (per bay)</u>	
Cord circuits	4
Position and keyset circuit	1
Extension cord circuits	4
<u>Jack Field in Bays with "Test" Jacks</u>	
Panels	2
Jack field opening	36"
Test jacks	480
Answering and outgoing trunk jacks	40
Miscellaneous jacks	40
Monitoring jacks for delayed through switchboard	20

Patching Bays

Circuit Patching Bays

9.16 The circuit patching bays permit re-assignments of intertoll trunk relay equipment with other toll terminal equipment. This permits substitution of spare relay equipment for one on which trouble occurs or the enlargement of a particular trunk group to meet transient increases in traffic. Only temporary reassignments are made at this bay since reassignments of a more permanent nature are made by cross connections at the intermediate or combined distributing frames.

9.17 The capacities of the circuit patching bays are shown in Table C.

TABLE C

	<u>6-wire Patch Jack Ckts.</u>	<u>2-wire Patch Jack Ckts.</u>	<u>Spare Pad Jack Ckts.</u>	<u>"SP" Pad Ckts.</u>	<u>"P" Pad Ckts.</u>	<u>2-way Trks.</u>
Circuit Patch Bay with Telephone Set & Misc. Jacks & Full Period Talk Jacks	240	90				
When no Full Period Talk Jacks are Provided	300					
With Spare Transmission Pads	270		30	30		
Relay Rack Bay					300	6

## Trunk Assignment Patching Bay

9.18 This bay permits reassignment of outgoing intertoll trunks to other trunk blocks. At this bay also, groups of intertoll trunks may be temporarily enlarged to meet increases in traffic. These patches change the test leads of the trunks from one block relay to another, and are usually made in conjunction with a relay equipment patch at the circuit patching bay. Reassignments on a more permanent basis are made at the trunk assignment distributing frame.

9.19 These patching changes need not be accompanied by any card change in the translator if the reassignment or enlargement is made to block relay terminals within the group start and end points of the trunk group. Thus, in order to add to the trunk groups, there must be spare, normally busied terminals on the block relay.

9.20 The trunk assignment patching bay is arranged for 600 assignment patching jack circuits.

Automatic Outgoing Intertoll Trunk Test and Connector Frames

9.21 These frames provide facilities to make routine tests on the intertoll trunks appearing on the outgoing frames, in a manner similar to that described for toll connecting trunks in 9.07.

9.22 The capacities of the test and test connector frames are:

Automatic outgoing intertoll trunk test frame	10,000 trks.
Outgoing intertoll trunk test connector frame	5 connector units
Outgoing intertoll trunk test connector unit	200 trks.

D. Miscellaneous Test EquipmentSwitching Maintenance

## Incoming and Outgoing Intertoll Trunk Test Set

9.23 This semi-portable test equipment consists of a tea-wagon-type test set working in conjunction with a relay rack unit and with patching and test line jack appearances at the trunk relay bays, the toll test and terminal room patch bays, and the No. 17C toll test board.

## Frame Identification Frequency Test Set

9.24 This portable test set (box type) consists of eight filters corresponding to the frame identification frequencies, an amplifier, and a rectifying meter. Keys are provided so that with a given input signal of one or more frequencies the meter may be associated with any one of the filter circuits,

thereby providing an indication of the magnitude of the voltage corresponding to the frequency associated with the depressed key (and frequency components of the input signal).

## No. 100A Test Set

9.25 This portable test set is used to check the output of the phototransistors and the transistor amplifiers in the card translators.

## Trouble Tracing Selector

9.26 This equipment provides a means for tracing trouble on a connection between an incoming tandem trunk and an outgoing intertoll trunk. When trouble is reported on such a connection, only the identity of the incoming trunk is known to the test board operator. The trouble tracing equipment provides step-by-step switch facilities through which he can dial and be connected to the reported incoming tandem trunk. Once this connection is established, testing potential is applied over it to the outgoing intertoll trunk, and the resulting operation of a lockout relay in the trunk lights an associated lamp in the test board.

9.27 The trouble tracing selector frame has a capacity for mounting:

First-selector units (each arranged for 3 first selectors)	3
Second-selector units (each arranged for 2 second selectors)	3
or	
First-selector units	2
Second-selector units	4

9.28 One first selector is required per test board position and one second selector per 300 tandem trunks. A completely equipped frame, therefore, serves nine test board positions and 1800 trunks, or six positions and 2400 trunks. Additional second-selector units may be furnished and mounted on adjacent relay rack bays to provide for a maximum of seventeen second selectors and 5100 trunks.

## No. 5 Toll Switchboard Position Control Test Set

9.29 This equipment consists of a testing unit consisting primarily of relays and resistances arranged to mount on 23" relay racks and a portable (handsize) testing control set. The relay rack unit is jack-ended in the multiple of the No. 5 board, and the tests are made at the switchboard by plugging the cords of the position and patching the control set to these jacks. The control set contains two keys which control the setup of the test circuit for any of nine major tests and two keys which control the setup of subtests of the major tests. Lamps are provided for indicating the subtest condition and for indicating the response of the test to the operation of ringing keys, keyset keys, etc., and a potentiometer for use in making continuity tests.

10. MISCELLANEOUS EQUIPMENTA. Frame Line Talking Circuits

10.01 Jacks for frame line circuits for communication between the various frames and the maintenance center are provided on all frames and every third relay rack bay starting with the second bay in a line-up. Two frame line circuits are provided; one for frames and racks in the even-numbered line-ups and the other for those in the odd-numbered line-ups. Both circuits are connected to all the test frames in the maintenance center.

B. Service Observing

10.02 Service observing of inward traffic on the No. 4A intertoll trunk circuits may be obtained by the provision of the No. 12 service observing desk and the associated toll service observing facilities.

10.03 The desk-end equipment consists of two sections or four operating positions per unit. Provision is made for an additional unit, or portion thereof, if necessary.

10.04 A maximum of thirty service observing multiline intertoll trunks can be associated with each unit of four or less operators, and each of the thirty can handle a maximum of fifty toll incoming loops.

10.05 The association of intertoll trunks with the service observing trunk is affected by patching between the fifty connector sockets and loop sockets for the intertoll trunks. Approximately 10 per cent of the trunks (max. 200) are cabled to the loop sockets, and connector sockets are provided as required by the number of observations required. This patching equipment and the relay equipment associated with the service observing trunks are located on the miscellaneous relay rack.

10.06 The observing circuits connect to any idle observing position on an automatic call distribution basis.

11. DISTRIBUTING FRAMES

11.01 In addition to switching and common control frames, distributing frames are provided for making cross connections between frames where flexibility is required.

11.02 The intermediate distributing frame (IDF) is used to associate:

- (a) Toll terminal equipment with circuit patching bay.
- (b) Intertoll trunk relay equipment with the circuit patching bay.
- (c) Toll connecting trunk relay equipment with trunks to local offices.

(d) Trunk relay equipment with delayed through and other switchboards.

11.03 The trunk distributing frame (TDF) provides means for cross connecting:

- (a) Trunk relay equipment with incoming and outgoing frames.
- (b) Intertoll trunk relay equipment with the No. 17C test board.
- (c) Incoming toll tandem trunks with second-trouble tracing selectors.

11.04 The trunk assignment distributing frame (TADF) is used to associate:

- (a) Outgoing frames, outgoing trunks, and the outgoing appearances of 2-way trunks with assignment patching jacks and trunk block relays.
- (b) Outgoing trunks and the outgoing appearances of 2-way trunks with assignment patching jacks and overflow trunk circuits.
- (c) Outgoing trunks and the outgoing appearances of 2-way trunks with test and make-busy jacks.

11.05 The junctor grouping frame (JDF) provides means for connecting the links between the incoming and outgoing frames for those junctors that will be regrouped as additions are made to the office.

11.06 The traffic register distributing frame (TRDF) provides means to associate:

- (a) The traffic registers with the traffic register relays and with circuits requiring registration.
- (b) The traffic register relays with the trunks requiring group-busy registrations.

12. FLOOR PLAN LAYOUT

12.01 Larger installations generally will require two floors for switching frames and trunk relays with about 5 square feet per intertoll trunk in the ultimate. A small installation of less than 1000 intertoll trunks ultimately will probably require about 10 per cent more space per line. The general approach to a No. 4A floor plan should have as its primary objective a layout which keeps within the critical conductor length limitation for the runs between the trunk and CX signal equipment as well as those between the switch frames and the lead lengths from switchboards to tandem trunks and TX trunks. The lead limits are given in detail in key sheet SD-68400-01 and in 818-031-150 (J60103).

12.02 The toll testboard and the delayed through switchboard are ordinarily located as dictated by toll terminal placement and traffic department consideration, among other factors.

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12.03 The maintenance center is usually planned with thought given to room entrance and should be located away from windows. In the ultimate, the maintenance center should be surrounded by markers, trunk block connectors, decoders, and translators. Senders are definitely "second row" frames, and should not be located too far from the maintenance center.

### 13. POWER

13.01 The circuits for a No. 4A office require the following regulated supplies:

- (a) -48-volt signal battery
- (b) -24-volt signal battery
- (c) -24-volt filament battery
- (d) +130-volt signal battery
- (e) +130-volt plate battery
- (f) 20-cycle, 105-volt a-c continuous ringing

An additional nonregulated supply (+55 volts 60 cycles), such as No. 420B power plant, is required for marker continuity tests.

13.02 When the No. 4A office is installed in the same building as a local dial office, the existing power plant may be used when applicable. Fuse bay-mounted filters are used to obtain 24-volt filament from the 24-volt signal battery and 130-volt signal from the 130-volt plate. The latter is required where no common filter is provided in the plate discharge circuit. It prevents the introduction of noise on the plate circuits.

13.03 Position clocks in the delayed through switchboard positions are of the motor-driven type requiring 50 or 60 cycles, 22 volts, a-c, such as obtainable from a No. 506A power plant which is arranged for mounting on the miscellaneous relay rack.

### 14. RE-USE OF EXISTING EQUIPMENT

14.01 Since the toll crossbar system employs new automatic trunk and switching facilities for handling inward, through, and tandem traffic, much of the existing inward and through manual switchboard and trunking facilities will be replaced. Outward or CLR boards and associated trunks to local offices may be retained and re-used to function with the toll crossbar system in their usual manner. It will, in general, be economical to modify the positions, for reaching intertoll trunks over tandem trunks, and the delayed outward switching trunks to local dial offices for keypulsing.

14.02 In general, it will be possible to re-use with modifications existing terminal signaling and repeater equipment, although the simplified design of the new units being developed for or paralleling the development of the toll crossbar system may make it desirable to consider replacing certain units of existing equipment. The amount of existing ringdown intertoll signaling equipment that it will be possible to re-use will, of course, be diminished by the extent to which intertoll dialing is employed.

14.03 Where re-use of existing toll terminal equipment is contemplated, it will be noted that the principal modifications required are those necessary to adapt the plant to 4-wire switching.

14.04 Four-wire voice frequency and carrier repeaters will be readily adapted to the toll crossbar system. The use of 4-wire terminating circuits will not be required, but the retention or duplication of the filter associated with the terminating circuit will probably be necessary. Two-wire terminal repeaters will require modification to a 2-wire - 4-wire basis. This modification involves principally the installation of an input transformer and the conversion of the drop side hybrid coil to a one-way output transformer.

14.05 The phantom coils used on terminal repeatered ringdown circuits may be retained. It is necessary to use nonring-through coils on those circuits used for CX dialing.

### 15. REFERENCES

#### A. General

- 818-000-000 - No. 4 Type Toll Switching Systems Index
- AA128.006 - List of General Equipment Requirements Sections
- 818-030-150 (J60101) - Switchboard Power Cable
- 818-011-151 (J67410) - Junctor Distribution
- 818-005-150 (J69202) - Toll Office Equipment (4A)
- 818-031-150 (J60103) - Limiting Conductor Lengths
- 964-110-100 - General Description No. 4A Toll Switching System
- 212-120-101 - 1-type Translator (Card Translator) No. 4A Toll Switching System

#### B. Transmission Path Frames

- 818-210-150 (J67409) - Junctor Grouping Frame
- 818-400-150 (J67439) - Incoming Frame
- 818-201-150 (J67438) - Outgoing Frame

#### C. Common Control Frames

- 818-330-150 (J67402) - Incoming and Outgoing Sender Link Frame
- 818-331-150 (J67407) - Link Controller and Connector Frame
- 818-480-150 (J67408) - Block Relay Frame
- 818-305-150 (J67413) - Outgoing Sender Frame
- 818-300-150 (J67430) - Incoming Sender Frame
- 818-302-150 (J67431) - Incoming Sender Units
- 818-401-150 (J67449) - Decoder Connector Frame
- 818-451-150 (J67446) - Marker Connector Frame
- 818-421-150 (J67445) - Translator Connector - Frame Identification Frequency Control Frames
- 818-041-150 (J67444) - Alternate Route Traffic Control Frame
- 818-046-150 (J67448) - Overflow Trunk Frame
- 818-450-150 (J67440) - Marker Frame
- 818-400-150 (J67439) - Decoder Frame
- 818-420-150 (J67442) - Card Translator Equipment

818-042-150 (J67450) - Sender Traffic Control Frame  
 AA388.082 (J95102) - MF Pulsing Receiving Equipment

D. Maintenance Center Frames

AA247.801 (J28350) - Emergency Alarm Frame  
 818-705-150 (J67418) - Automatic Outgoing Toll Connecting Trunk Test Frame  
 818-761-150 (J67435) - Sender Make-busy Frame  
 818-703-150 (J67436) - Outgoing Sender Test Frame  
 818-701-150 (J67443) - Trouble Recorder Frame  
 818-708-150 (J98501) - Manual Outgoing Toll Connecting Trunk Test Frame

E. Other Frames

818-040-150 (J67422) - Office Interrupter Frame  
 818-043-150 (J67424) - Frame Identification Frequency Supply Frame  
 818-760-150 (J67427) - Trouble Tracing Selector Frame  
 818-780-150 (J67441) - Floor Alarm Frame  
 818-082-151 (J62603) - Traffic Register Equipment  
 AA388.062 (J98609) - MF Current Supply

F. Operating Room Equipment

AA261.443 (J61558) - No. 5 Toll Switchboard - Lower Unit Equipment  
 AA261.444 (J61559) - No. 5 Toll Switchboard - Switchboard Equipment  
 818-083-150 (J62604) - Traffic Supervisory Rack

G. Test and Terminal Room Equipment

818-631-150 (J67421) - Trunk Assignment Patching Bay  
 818-706-150 (J67447) - Automatic Outgoing Intertoll Trunk Test Frame  
 AA262.001 (J68602) - Signaling and Testing Panels and Units  
 AA267.014 (J63519) - No. 17C Toll Test Board  
 AA267.016 (J63524) - Circuit Patching Bay

H. Trunks and Relay Rack Equipment

818-602-150 (J61561) - Intertoll Trunk Units  
 818-603-150 (J61562) - Incoming Trunk Units  
 818-604-150 (J61563) - Outgoing Trunk Units  
 818-081-150 (J61564) - Miscellaneous Relay Rack Units  
 AA268.504 (J64001) - Transmission Measuring Panels and Units  
 AA387.040 (J93017) - Relay Rack Mounted Test Equipment  
 AA387.043 (J94731) - Cold-cathode Tube Test Set  
 AA388.054 (J99227) - 10-ipm Interrupter and Impulse Clock Supply

I. Test Sets

817-723-150 } (J24753) - Test Set for Timing Tests  
 819-731-150 }  
 818-741-150 (J64727) - Frame Identification Frequency Test Set

AA261.439 (J64728) - No. 5 Toll Switchboard Position Control Test Set  
 AA268.207 (J64730) - No. 2B Signaling Test Set  
 AA268.534 (J64072) - No. 72A Frequency Meter  
 AA268.611 (J64722) - Pulse Repeating Test Set  
 AA387.031 (J94723) - Pulse Checking Test Set  
 AA387.032 (J94724) - Contact Closure Test Set  
 AA387.033 (J94725) - Test Set for Nos. 275 and 276 Relays  
 AA387.035 (J94727) - No. 1A Signaling Test Set  
 AA387.042 (J94730) - No. 1A Fault Locator Test Set - Test Set for Locating Crosses and Grounds in Central Office Wiring and Cable

J. Power Plants

AA367.304 (J86434) - No. 302A Plants - 24 and 48 Volts  
 AA367.504 (J86724) - No. 506A Plant - Low-voltage A-c Supply  
 AA367.809 (J86555) - No. 803C Plant - Machine Ringing Equipment

K. Miscellaneous

818-080-150 (J25551) - End Guards Aisle Pilot Lamp, DPTS Supports, and Fuse Record Rook and Holder  
 AA381.129 (J67002) - Distributing Frames  
 AA381.319 (J97025) - Relay Racks - Angle Type - Framework and Cabling  
 AA381.321 (J97033) - Fuse Bay - Angle Relay Rack Type  
 AA381.803 (J90604) - Ladders, Benches, and Stools - Application Practices Type  
 AA381.804 (J90605) - Rolling Ladders - Track Type  
 AA382.018 (J93814) - No. 12 Service Observing Desk  
 AA382.514 (J94907) - No. 20 Key Cabinet  
 AA382.526 (J94909) - No. 21 Key Cabinet  
 AA388.012 (J98302) - Emergency Alarm System - Automatic Fire, Detection Feature  
 AA388.013 (J98303) - Emergency Alarm System without Code Signaling  
 AA388.025 (J95501) - Central Office Lighting Equipment, Appliance Outlets, and Miscellaneous Conduits  
 AA388.026 (J95502) - Emergency Lighting Equipment for Central Offices  
 AA388.046 (J93009) - Audible and Visual Maintenance Alarm Equipment  
 AA388.049 (J95503) - Central Office Lighting - Fluorescent Type  
 Section 10 - Floor Plan Data Sheets

L. Auxiliary Equipment

KS-14545 - Bulk Card Handling Tool  
 KS-14550 - Portable Selector Elevating Table  
 KS-14553 - Single Card Handling Tool  
 KS-14558 - Template Tab Coding Tool  
 KS-14590 - Template Punch Board Tool

Attached: Figs. 1 to 6



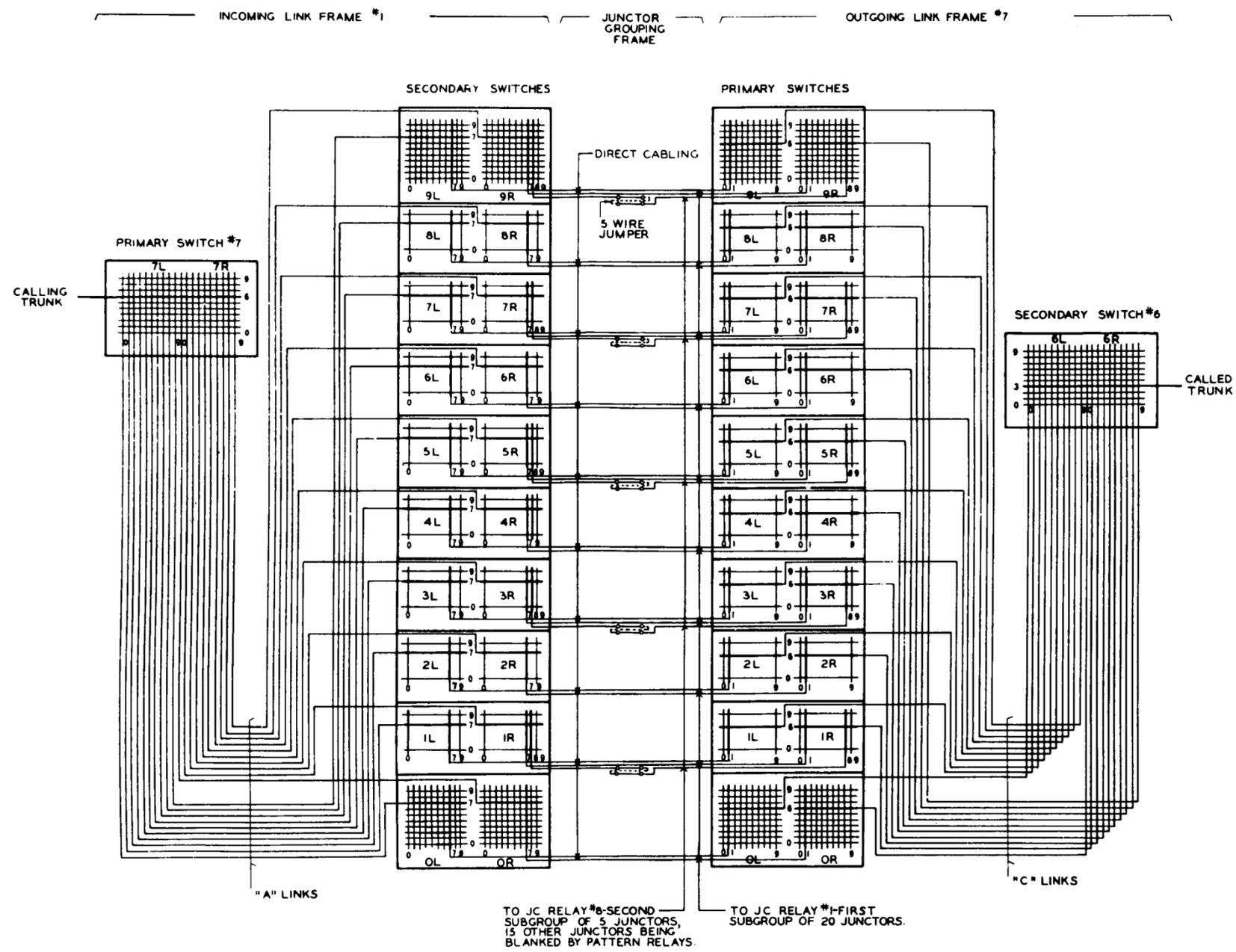


FIG. 2 - TOLL CROSSBAR SYSTEM. SCHEMATIC DIAGRAM OF COMBINED TRAIN CHANNELS

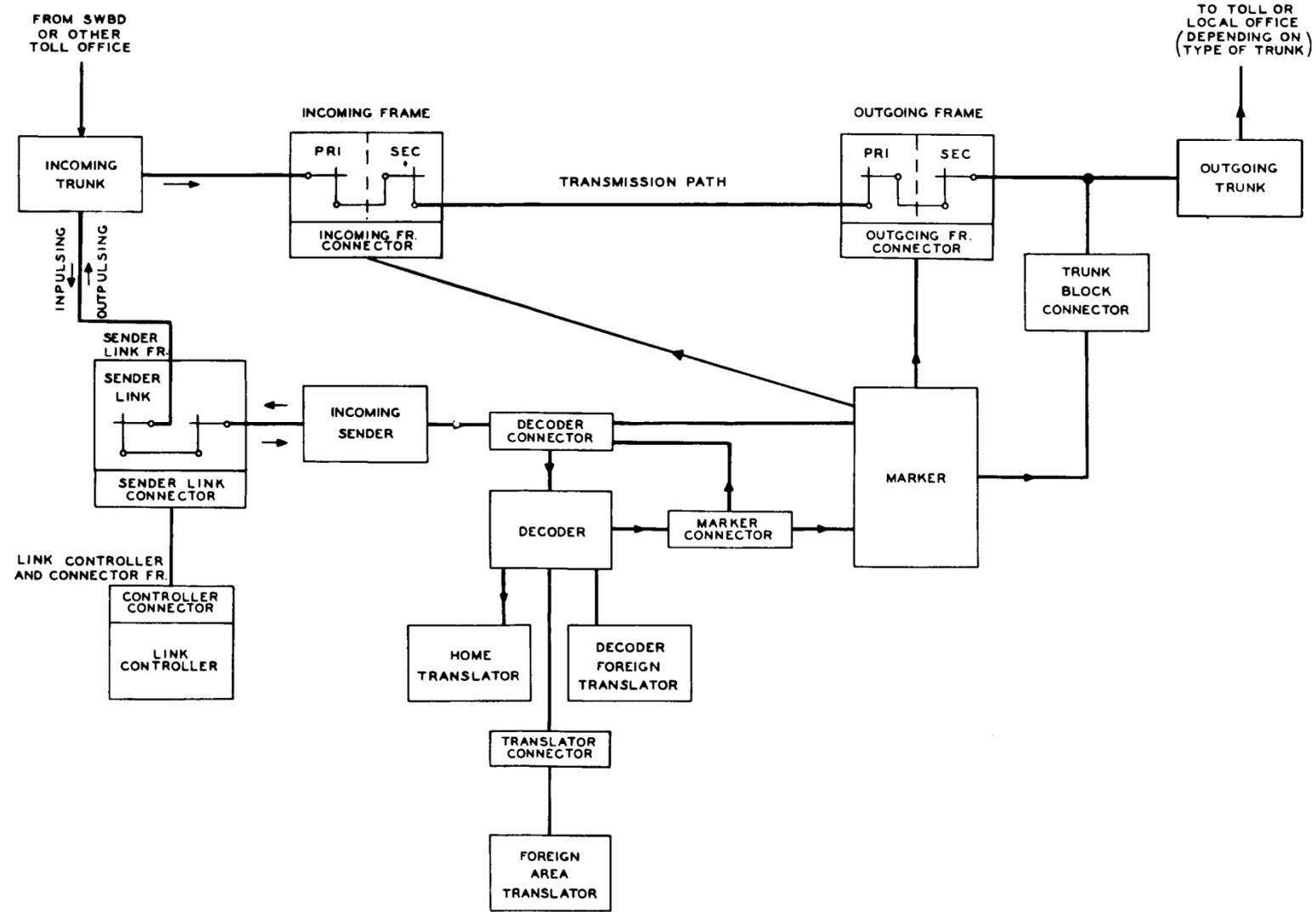


FIG. 3 - RELATIONSHIP BETWEEN COMMON CONTROL EQUIPMENT AND SWITCHING FRAMES

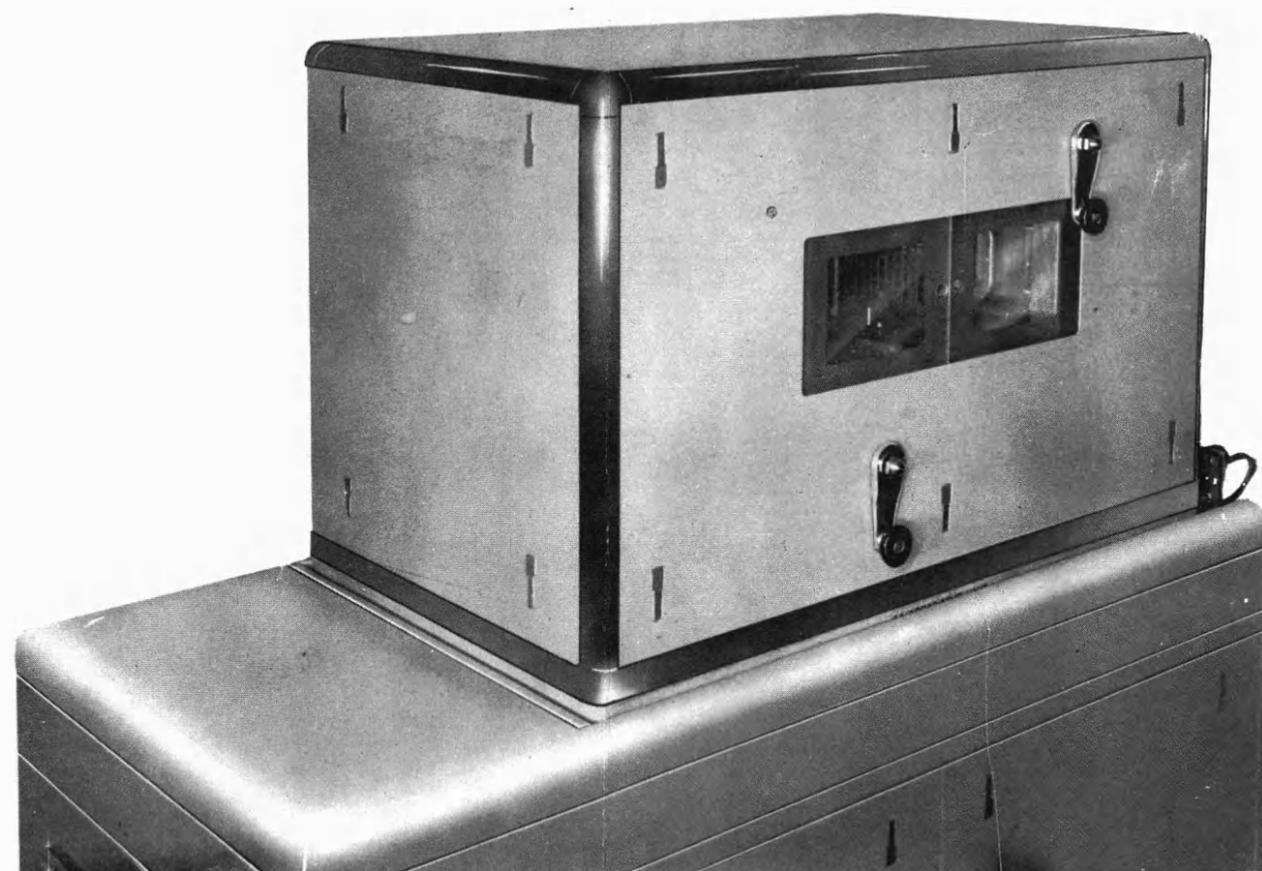


FIG. 4 - CARD TRANSLATOR

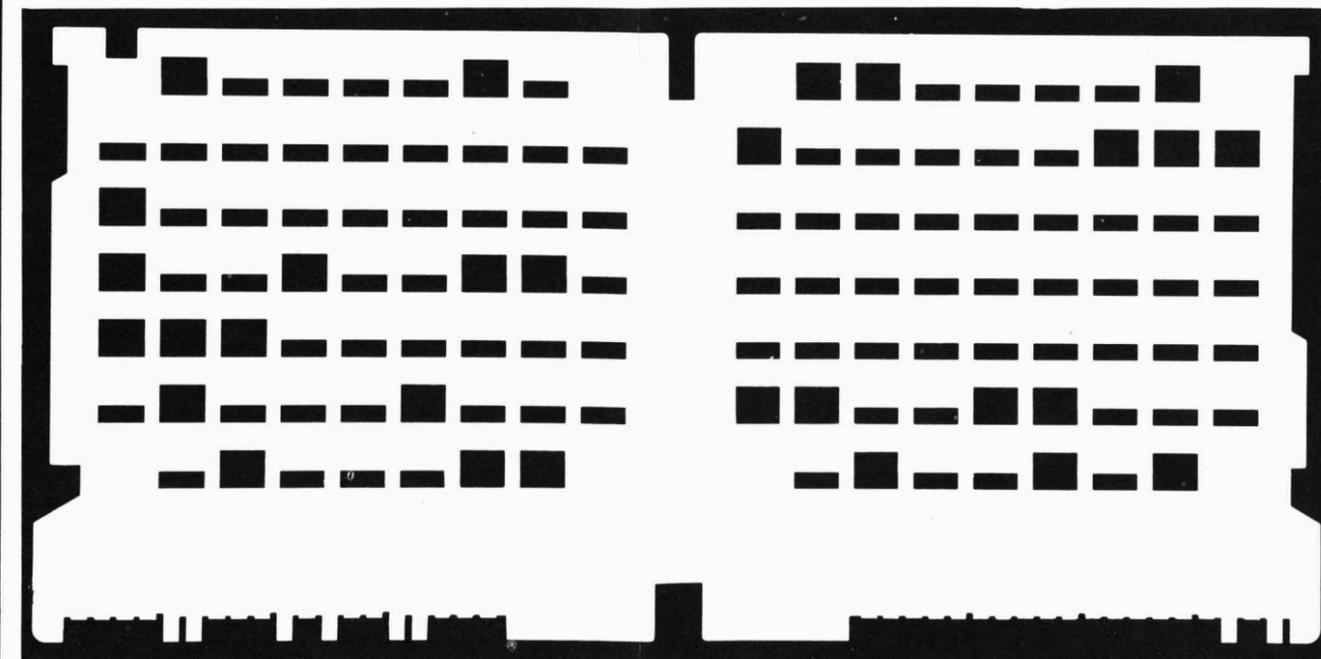


FIG. 5A - CARD FOR USE IN CARD TRANSLATOR

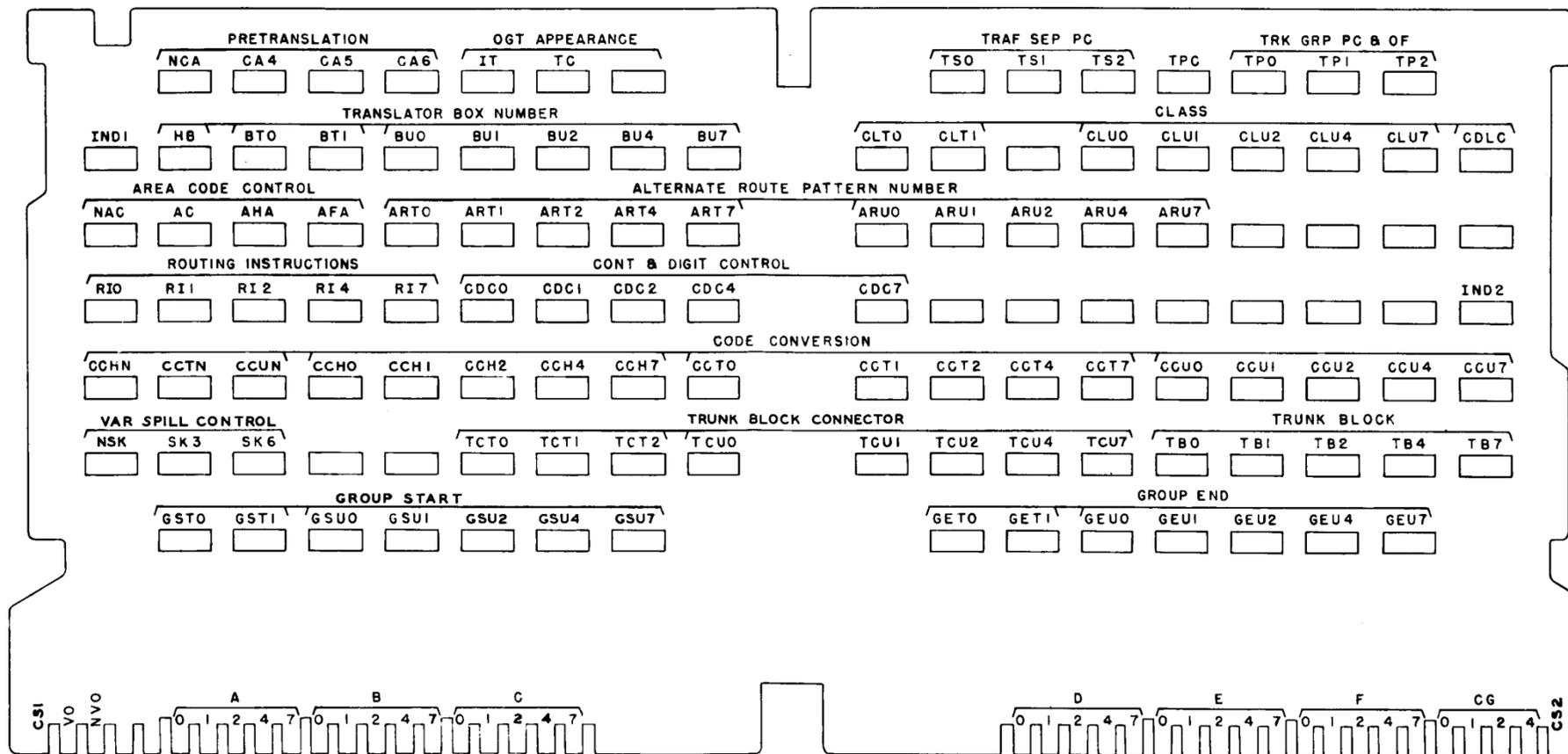
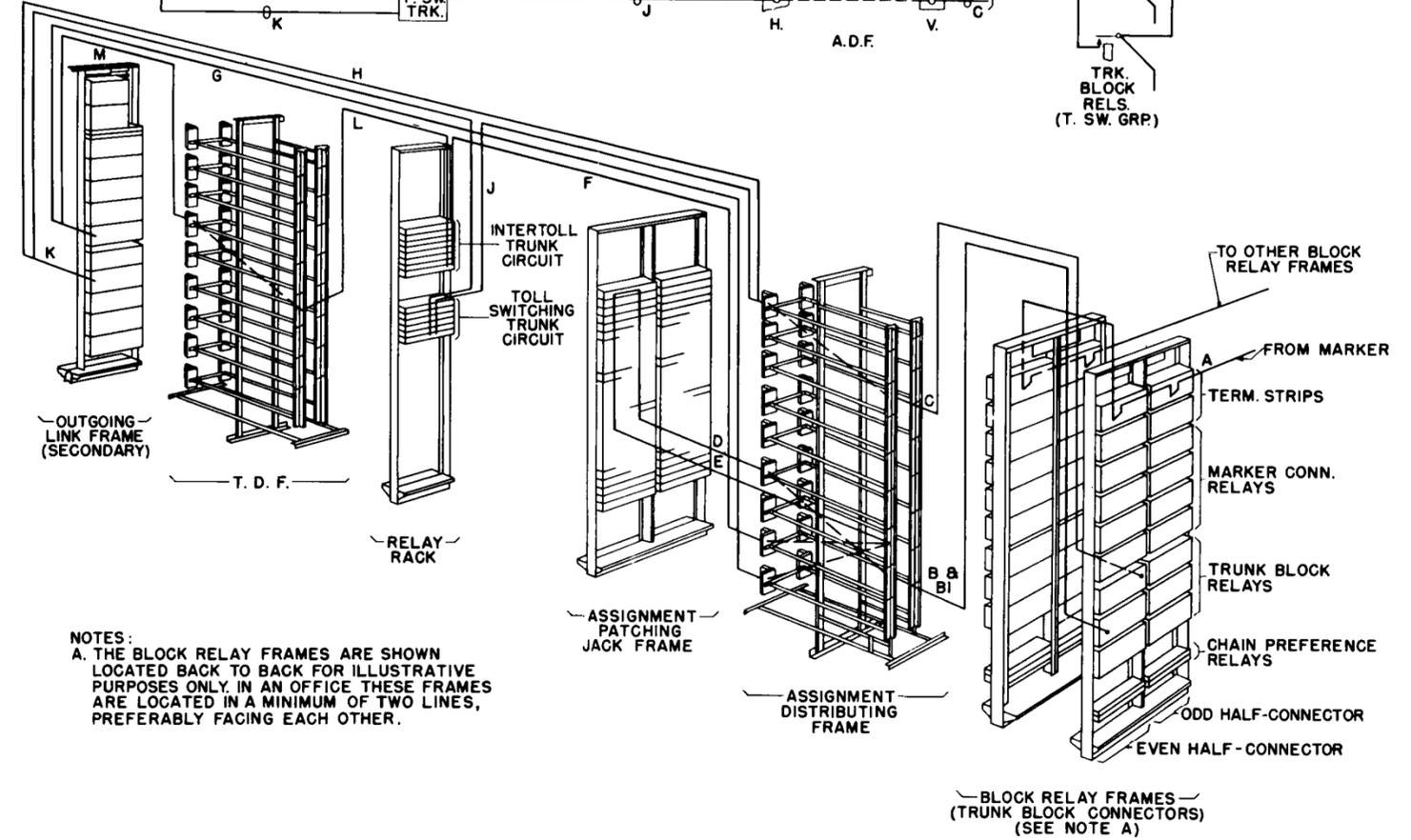
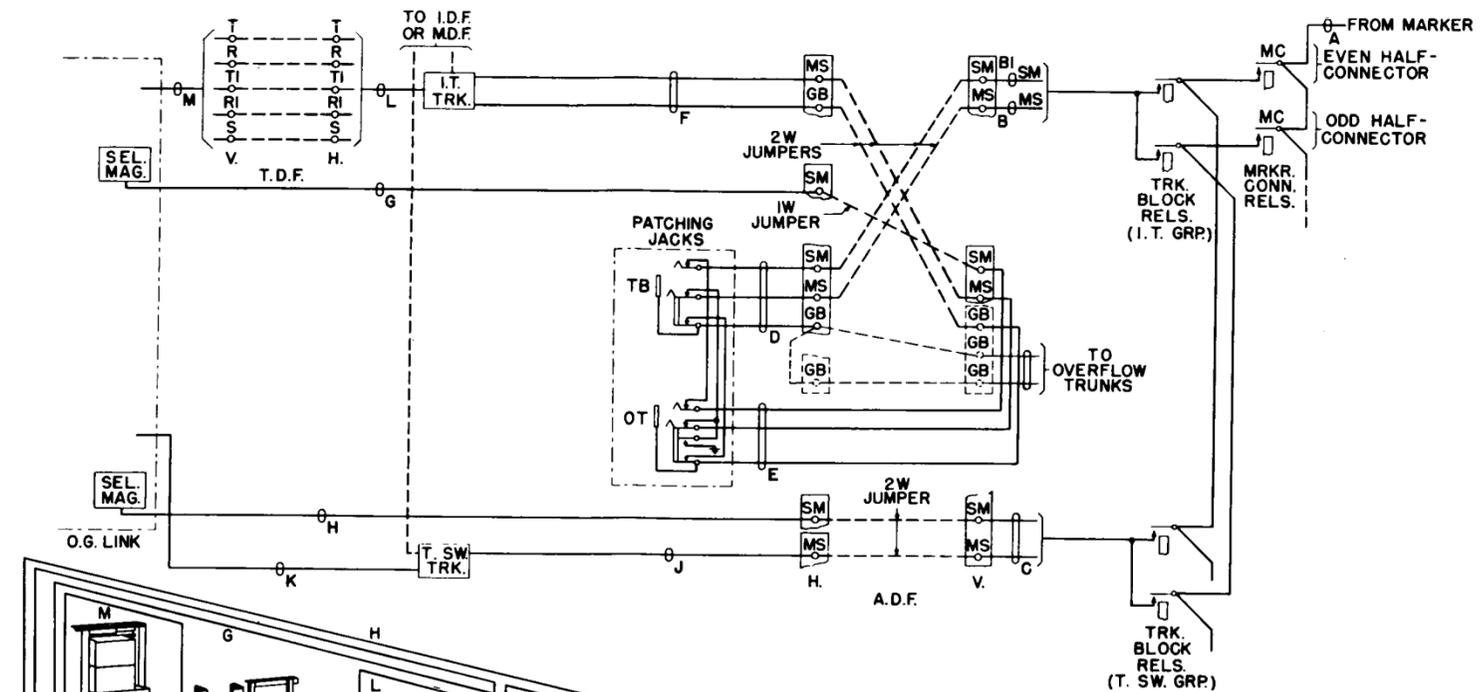


FIG. 5B - TRANSLATOR CARD



NOTES:  
 A. THE BLOCK RELAY FRAMES ARE SHOWN LOCATED BACK TO BACK FOR ILLUSTRATIVE PURPOSES ONLY. IN AN OFFICE THESE FRAMES ARE LOCATED IN A MINIMUM OF TWO LINES, PREFERABLY FACING EACH OTHER.

FIG. 6 - CABLING SCHEMATIC AND PERSPECTIVE VIEW