

GENERAL DESCRIPTION

INTERTOLL TRUNK CONCENTRATING EQUIPMENT

TOLL SYSTEMS

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1. INTRODUCTION

1.01 Intertoll trunk concentrating equipment switches one-way traffic between two specific metropolitan areas. In the originating area, a concentrator receives this traffic from a number of outward toll and DSA switchboards and switches it to a group of multifrequency intertoll trunks. In the distant area, all the intertoll trunks in this group terminate in the same office which may be of the No. 4-type (No. 4, No. A4A,

No. 4A, or No. 4M) or of the crossbar tandem type. Figure 1 shows typical examples of the use of concentrators.

1.02 The concentrating method of handling traffic has several advantages. First, it permits the sharing of a group of intertoll trunks by a number of switchboards. Second, where the volume of traffic to a particular city is heavy enough to justify concentration, it is more economical than routing the traffic through No. 4-type or crossbar tandem offices. Third, it permits dispersing some of the toll traffic from the main toll center.

1.03 Depending upon traffic requirements, concentrators of various sizes may be provided. The largest concentrator receives traffic from 100 incoming tandem trunks and switches this traffic to 40 outgoing intertoll trunks. If there is more traffic to a given distant area than can be switched by one concentrator, two or more may be provided. However, each concentrator has access only to its own outgoing trunks. The outgoing intertoll trunks from a concentrator can be seized only by the concentrator. They cannot be seized at any of the switchboards nor can they be seized by any other toll switching system, such as a No. 4A system, which might be in the same originating area.

1.04 Briefly, the sequence of operations in establishing a call via a concentrator from a subscriber in New York to a subscriber in Pittsburgh for example, is as follows. When a New York outward toll operator or DSA operator has such a call, she selects a tandem trunk to the New York-to-Pittsburgh concentrator. Automatically, the concentrator connects this tandem trunk to an idle outgoing intertoll trunk. This connection through the concentrator is established without requiring the operator to key any routing digits. Routing digits are not required because all the traffic through a concentrator is switched to the same distant toll office.

1.05 After the connection is made, the concentrator sends a signal to the Pittsburgh No. 4-type switching system which, upon receiving this signal, connects a multifrequency incoming sender to the intertoll trunk. After a sender is connected, a signal is sent back to the operator telling her that she may start keying.

1.06 She then keys the called subscriber's telephone number. This number,

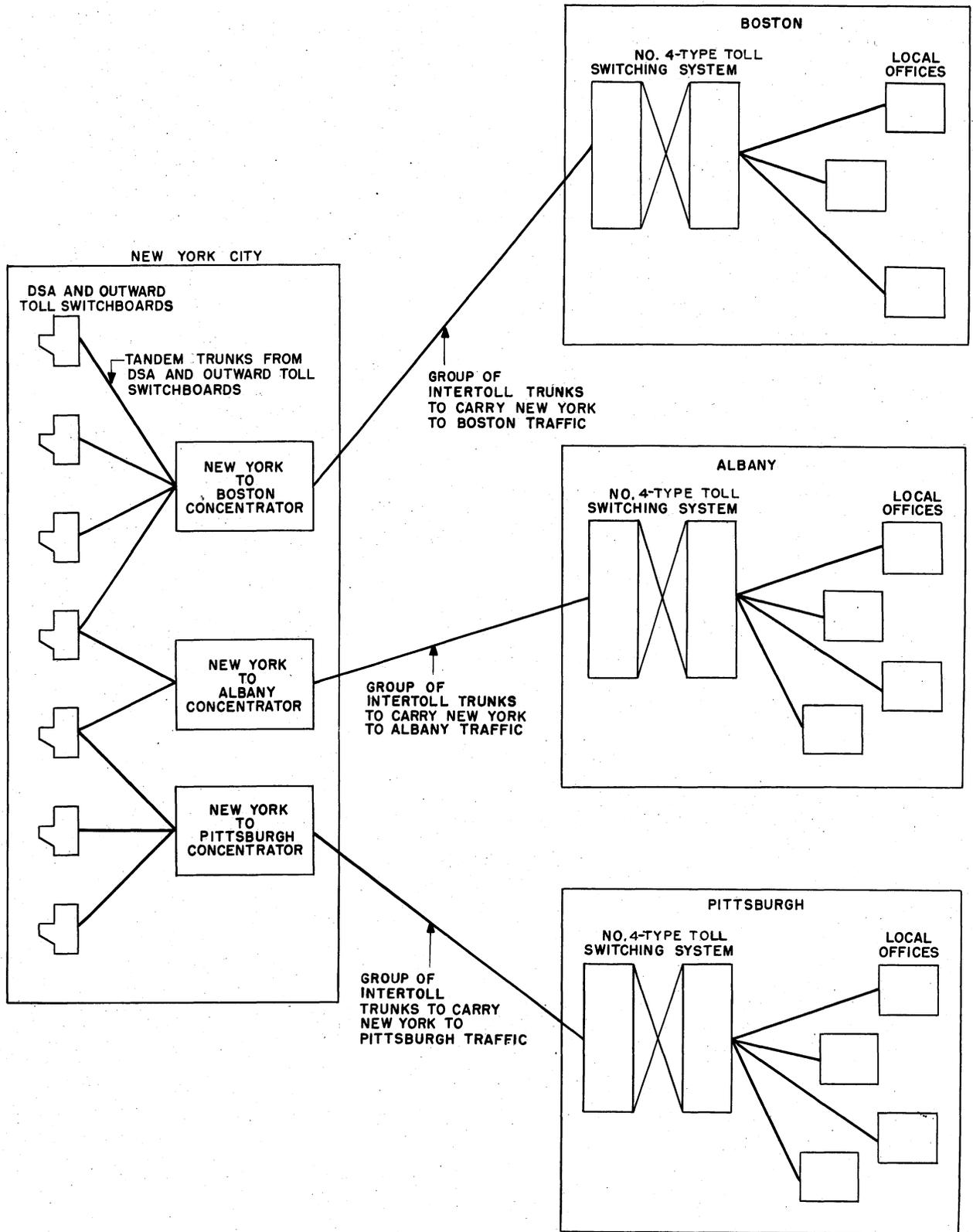


FIG.1-EXAMPLES OF USE OF CONCENTRATORS

transmitted by MF pulses, is sent through the connection established by the concentrator to the incoming sender at Pittsburgh. At Pittsburgh the number is used to route the call through the No. 4-type system to the called local office and the called subscriber.

1.07 Concentrating equipment may be located in the same metropolitan area as a No. 4-type toll switching system. When this is the case the concentrating equipment can be used to relieve the traffic load on the No. 4-type system. A No. 4-type system switches inward, outward and through traffic. By routing some of the outward traffic to concentrators instead of to the No. 4-type system, the total volume of traffic the No. 4-type system has to switch is reduced. Figure 2 shows a typical example of the routing of traffic from switchboards which have trunks to both a concentrator and a No. 4-type switching system.

1.08 As pointed out, a concentrator does not require the operator to set up routing digits for it. In contrast to

this, on a similar call through the New York No. 4-type system, the operator has to key routing digits in addition to the called subscriber's telephone number. These additional digits are required by the system before it can select a trunk to Pittsburgh from among the trunks to all the cities which can be reached through the system. Thus, it can be seen that in addition to relieving the traffic load on No. 4-type switching systems, concentrators reduce operator time and effort.

1.09 In addition to tandem trunks to a concentrator and tandem trunks to No. 4-type equipment, some of the switchboards also have direct trunks to the distant city because the volume of traffic justifies them. These direct trunks appear in the same switchboard multiple as the tandem trunks to the concentrator. Since these trunks appear in the same multiple, the operator need not know when she is selecting a direct trunk or a tandem trunk to the concentrator. She need not know because both the direct trunks and the concentrator tandem trunks require her to set up identical routing information. However, idle indicating

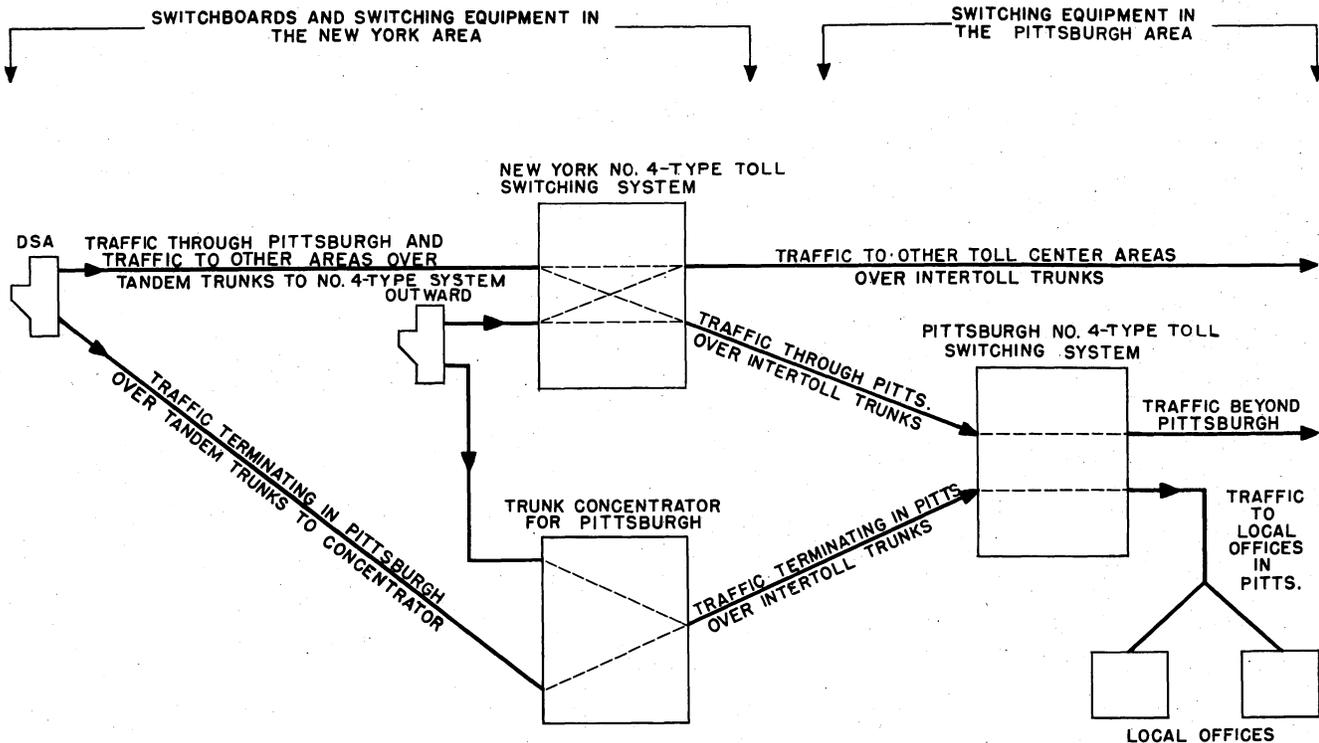


FIG. 2 - ROUTING OF TRAFFIC FROM SWITCHBOARDS WITH TRUNKS TO A CONCENTRATOR AND TO A NO. 4-TYPE SWITCHING SYSTEM

lamps associated with these trunks give preference to the direct trunks when there are idle trunks of both types.

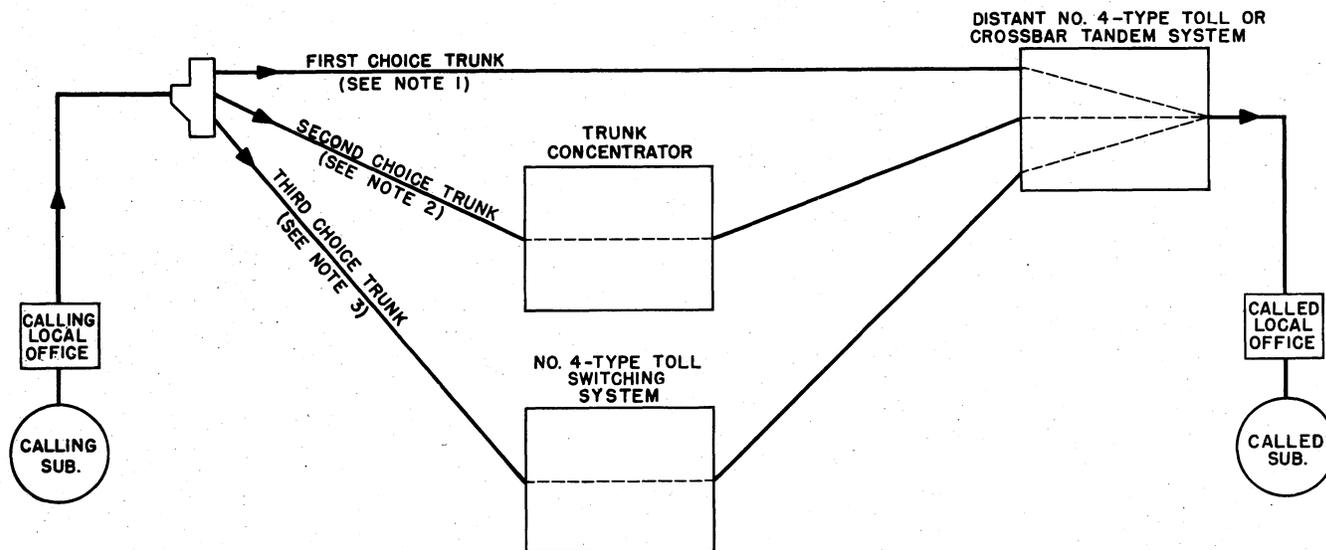
1.10 Figure 3 shows a switchboard which has direct trunks, tandem trunks to a concentrator, and tandem trunks to a No. 4-type equipment. When an operator has a call for the distant city, she uses a direct or concentrator tandem trunk and sets up the called number. However, if all the direct and concentrator tandem trunks are busy, the operator selects a tandem trunk to the No. 4-type equipment and sets up three routing digits in addition to the seven or eight required on direct or concentrator trunks. The designation strip on the direct and concentrator jacks may show the routing digits to be used when overflowing to the No. 4-type equipment and thus reduce bulletin reference work.

1.11 Concentrating equipment can play a part in maintaining the flow of toll traffic during national or other emergencies if a metropolitan area is unable to reach the toll network through the usual toll switching system, such as a No. 4-type. Normally concentrators

are used to switch traffic to specific distant metropolitan areas. In an emergency, however, they can be used to switch traffic to the toll network via the toll switching systems in the distant metropolitan areas.

1.12 For example, in the New York area there are (or will be) concentrators to several major cities and these concentrators will normally be used for traffic terminating in the respective cities. However, if during an emergency the New York No. 4-type toll switching system cannot handle the traffic, part of it will be routed to the various concentrators. This traffic will then have outlets to the toll network through the switching systems in the various cities. To route a call beyond these distant systems, the operators will key whatever routing digits are required.

1.13 Concentrating equipment uses cross-bar switches to connect incoming trunks to outgoing trunks. The transmission path through the switches is on a 4-wire basis; two wires are used for each direction of transmission. Certain control circuits determine which



NOTES:

1. DIRECT TRUNK-OPERATOR SETS UP CALLED NUMBER.
2. TANDEM TRUNK TO CONCENTRATOR-OPERATOR SETS UP CALLED NUMBER.
3. TANDEM TRUNK TO NO. 4 TYPE-OPERATOR SETS UP THREE ROUTING DIGITS PLUS CALLED NUMBER.

FIG. 3-SWITCHBOARD WITH DIRECT TRUNKS, TANDEM TRUNKS TO A CONCENTRATOR, AND TANDEM TRUNKS TO A NO. 4-TYPE SYSTEM

incoming trunks are requesting service and then perform the operations necessary to connect them to idle outgoing trunks.

2. SWITCHING PRINCIPLES

(A) General

2.01 The switching problem for trunk concentration is to give all the incoming trunks access to all the outgoing trunks. The switching principles used to solve this problem are discussed here.

2.02 A concentrator consists of groups of crossbar switches and a relay-type controller. The incoming trunks appear on the verticals of the crossbar switches and the outgoing trunks on the horizontals. The controller's job is to operate a particular switch and connect an incoming trunk to an outgoing trunk. (A description of the crossbar switch and how it operates is given in Section A828.101, No. 4A Toll Switching System.)

(B) The Crossbar Switch As Used for Intertoll Trunk Concentration

2.03 Intertoll trunk concentrating equipment uses 200-point crossbar switches to connect incoming tandem trunks to outgoing intertoll trunks. A switch has space for 20 incoming and 10 outgoing trunks. Each of the 20 incoming trunks can reach any one of the 10 outgoing trunks.

2.04 To handle more incoming or outgoing trunks more switches are added and multiplied. For example, four switches are required to give 40 incoming trunks access to 20 outgoing trunks (see Fig. 4). The first twenty incoming trunks (0 to 19) appear on the verticals of both switches 0 and 1. These trunks obtain access to outgoing trunks 0 to 9 through switch 0 and to outgoing trunks 10 to 19 through switch 1. The second twenty incoming trunks (20 to 39) appear on switches 2 and 3. They obtain access to outgoing trunks 0 to 9 through switch 2 and to outgoing trunks 10 to 19 through switch 3.

2.05 This method of multiplying makes it possible to obtain different sizes of concentrators. This is important because different sizes of concentrators will be used in various areas according to traffic requirements.

2.06 Concentrators are 4-wire switching devices and therefore the 200-point crossbar switches used are of the 5-wire type. That is, five wires are connected when a crosspoint closes (see Fig. 5). Two of these wires carry voice and signals from the incoming trunk circuit to the outgoing trunk circuit; in the direction, that is, from the originating office to the terminating office. The other two wires carry voice and signals in the opposite direction, that is, from the terminating office to the originating office. The fifth wire is grounded when the crosspoint closes. This ground tells the outgoing trunk circuit to busy itself to the controller.

(C) Concentrator Sizes

2.07 The size of a concentrator depends upon traffic requirements. In some cases twenty outgoing trunks are enough to carry the traffic received over one hundred incoming trunks. In other cases more outgoing trunks are required because of greater traffic loads over the same number of incoming trunks. Therefore, in order to meet these different traffic requirements concentrators are provided in various sizes. The most usual concentrator sizes provide access to 20, 30 or 40 outgoing trunks for a maximum of 100 incoming trunks. There are other optional arrangements for fewer incoming trunks but regardless of the size of the concentrator, there are always more incoming trunks than outgoing trunks. The equipment arrangements for the different size concentrators are discussed in Part 6.

2.08 Basically all concentrators work in the same manner regardless of size. They all use the same simple switching principle of connecting an incoming trunk to an outgoing trunk by closing a single crosspoint on a crossbar switch. They each have one controller which performs this function.

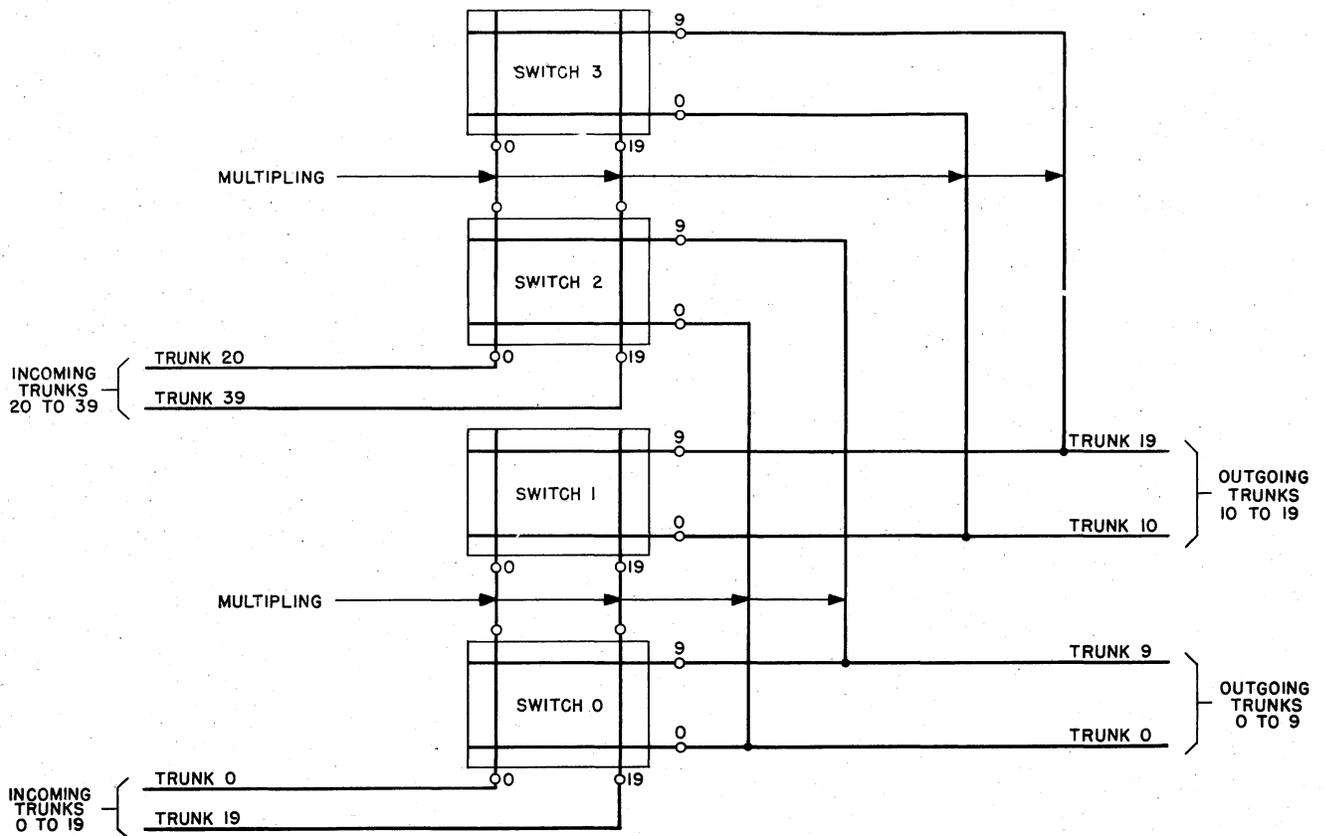


FIG. 4 - CROSSBAR SWITCH AS USED FOR INTERTOLL TRUNK CONCENTRATION

(D) Controller

2.09 The controller's job is to connect an incoming trunk to an outgoing trunk. It does this by closing the crosspoint on the switch on which these trunks appear.

2.10 When an incoming trunk indicates that it has a call, the controller selects an outgoing trunk to complete the call. In order to establish the connection the controller must find the crossbar switch on which both these trunks appear. Then it locates the vertical on which the incoming trunk appears and the horizontal on which the outgoing trunk appears and closes this crosspoint.

2.11 How the controller performs this and other functions, such as

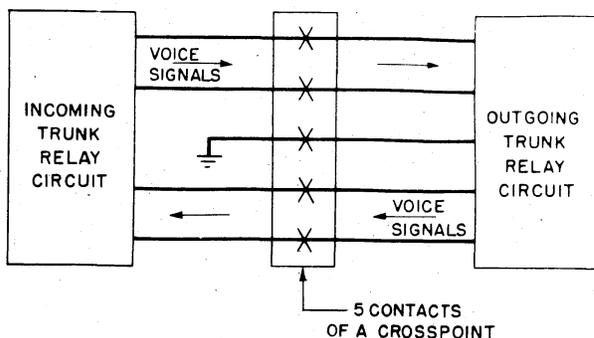


FIG. 5 - USE OF FIVE CONTACTS OF A CROSSPOINT

serving the trunks according to a certain order, is discussed in Part 3.

3. FUNCTIONS OF PRINCIPAL EQUIPMENT ELEMENTS

(A) General

3.01 Major equipment elements used for intertoll trunk concentration are the controller and the trunk relay equipment. The relationship of these elements is shown on Fig. 6. The talking and signaling path of a call is through an incoming trunk relay equipment, a crosspoint of a crossbar switch, and an outgoing trunk relay equipment.

3.02 Incoming trunk relay equipment passes supervisory signals from the switchboard to the controller and, after the crosspoint is closed, to the outgoing trunk relay equipment. It also passes supervisory signals in the reverse direction, that is, from the outgoing trunk relay equipment to the switchboard.

3.03 Outgoing trunk relay equipment passes supervisory signals on to the distant switching equipment and also receives signals from that equipment. These latter signals are passed back through the crossbar switches to the incoming trunk relay equipment.

3.04 The controller is common to all the incoming and outgoing trunks of a concentrator and is responsible

for setting up connections between the incoming and outgoing trunks. It knows which incoming trunks want service and which outgoing trunks are idle.

3.05 There are other equipment elements such as idle trunk indicating equipment, test equipment and traffic registers. The functions of all these elements are described in more detail in the following paragraphs.

(B) Controller

General

3.06 The controller is the brain of the concentrator. It is used on every call; it takes charge from the time a call is received and directs operations until the call is disposed of.

3.07 Although the controller establishes only one connection at a time, it can accept requests for service from many incoming trunks. After accepting the requests, the controller identifies and serves each trunk according to a definite sequence. When it has served the last trunk it repeats the process of accepting, identifying, and serving and continues to do so as long as there are requests.

3.08 A definite sequence is also used in selecting idle outgoing trunks. After each connection is established, the controller advances to the next idle outgoing trunk, identifies it, and selects it for the next connection.

3.09 After the controller identifies the incoming tandem and the outgoing

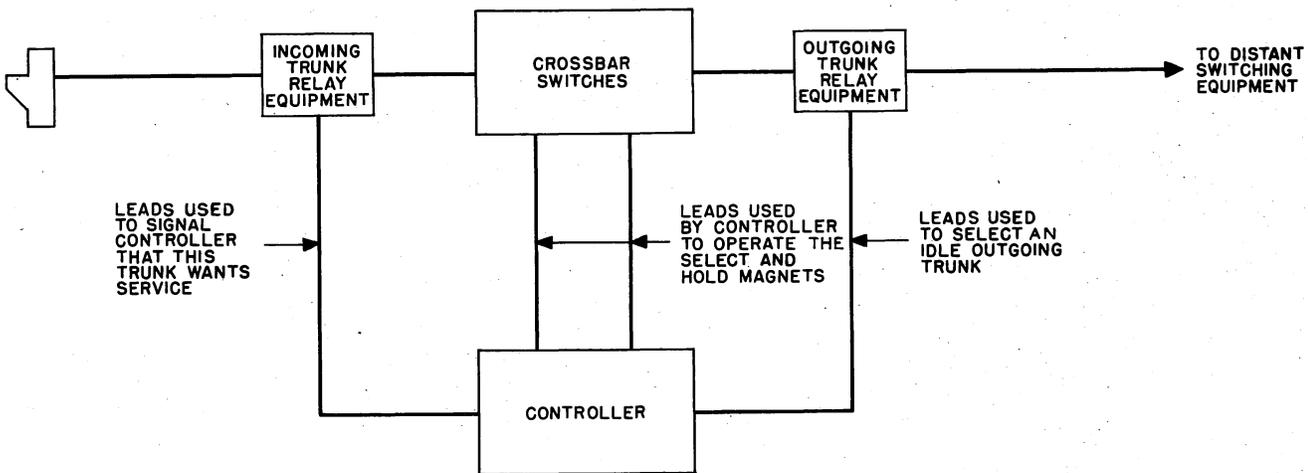


FIG. 6 - BLOCK DIAGRAM SHOWING RELATIONSHIP OF MAJOR EQUIPMENT ELEMENTS

intertoll trunks which are to be connected, their locations on the crossbar switches are determined. Then the controller operates the select and hold magnets and thus closes the single crosspoint which connects the trunks. When the connection is completed, the controller's job for this call is finished and it proceeds to the next call.

3.10 The controller normally connects an incoming trunk to an outgoing trunk in less than one second. Because the controller is used on every call and may handle as many as 400 to 800 calls during the busy hour, it is important that a trouble condition encountered on any one call should not delay other calls. Therefore if the controller fails to establish a connection within the allotted time interval, it either makes another attempt or goes on to another call depending on the type of trouble condition.

3.11 The following paragraphs describe how the controller:

- (1) Makes incoming trunk identification and selection.
- (2) Makes outgoing trunk identification and selection.
- (3) Connects an incoming trunk to an outgoing trunk.
- (4) Operates under trouble conditions.

Incoming Trunk Identification and Selection

3.12 The incoming trunks are divided into groups of ten which are numbered consecutively starting at zero. (A 100 to 20 concentrator has ten such groups numbered 0 to 9.) The ten trunks within each group are also numbered 0 to 9. The controller, during each serving cycle, goes from group to group and from trunk to trunk within each group identifying and serving in a definite sequence those trunks which made requests for service.

3.13 A gate circuit opens and accepts all requests from trunk groups with calls waiting and then closes, locking out late requests from other trunk groups. Once the controller starts its serving cycle, preference chains tell it which trunk group and trunk it should serve first, second and so on.

3.14 These gate and chain functions are more easily visualized by describing a typical serving cycle using trunk numbers. Figure 7, attached, shows the relationship of ten groups of incoming trunks, the gate circuits, and preference chains. The figure also shows how the controller serves requests from three trunk groups during a typical serving cycle.

3.15 While the controller is idle, the "tens" gate is open to requests from all trunk groups. As soon as a trunk wants service, it sends a signal through the open tens gate to its associated tens relay which operates. Its operation tells the controller that this tens group wants service. Then the controller starts to close the tens gate so that it can begin its serving cycle. Before closing it completely however, the controller allows a short interval of time (30 to 100 milliseconds) during which other trunk groups may also signify by operating their associated tens relays that they want service. Thus, in Fig. 7, three tens relays (2, 5, and 8) are shown operated because trunks in their associated groups signaled that they wanted service before the tens gate closed.

3.16 After the tens gate closes, a preference chain circuit associated with the ten tens relays takes over and directs the controller to the trunk group to be served first. There are two preference chain circuits associated with these tens relays; one tells the controller to serve from the lowest to the highest numbered trunk group (low to high selection), the other tells the controller to serve from the highest to the lowest numbered trunk group (high to low selection). The direction of selection remains fixed for a particular serving cycle.

3.17 The preference chain for the typical case chosen is set for low to high direction of selection and therefore the controller goes first to trunk group 2.

3.18 When the controller examines trunk group 2, it opens the "units gate" to this group only and permits all the trunks within the group that want service to signal this information to the controller. Each trunk requesting service signals this information by operating an associated units relay. There are ten of these relays, (common to all groups) one for each trunk within a group. In this example, three units relays (2, 6, and 8) are operated in tens group 2. This indicates to the controller that incoming trunks 22, 26, and 28 want service.

3.19 After the units relays operate, the controller closes the units gate and locks out any late arriving calls in trunk group 2. During this serving cycle, the controller serves only the three trunks which have their units relays operated; it does not permit any other trunks within the same trunk group to operate their associated units relays.

3.20 However, this is not true of late arriving calls in other trunk groups which have already signified their requests for service, groups 5 and 8 in this example. Because the units gate has not yet been

opened to these other trunk groups, the controller can still accept calls within these groups. All that the controller knows at this time is that some trunk or trunks in these other groups want service. The controller does not find out which individual trunks until it is ready to serve the particular trunk group.

3.21 After the units gate closes on trunk group 2, a units preference chain tells the controller to serve trunks 22, 26, and 28 in that order, low to high selection. There are two units preference chains which can tell the controller in which order to serve the individual trunks within a group. The one units preference chain in use during a particular cycle is always set for the same direction of preference as the tens preference chain.

3.22 After an incoming trunk is served, it is locked out from this serving cycle. This is done so that the trunk will not be served again during this same serving cycle if it is released by the operator and reselected by the same or another operator.

3.23 After the controller serves trunks 22, 26, and 28 in trunk group 2, it moves on to the next higher trunk group requesting service, trunk group 5. Then the controller opens the units gate to trunk group 5 and, using the same units relays, records the identity of the individual trunks within group 5 that want service. It then closes the units gate on group 5 and serves trunks 51 and 56.

3.24 In this manner, the controller goes from trunk group to trunk group serving the groups from the lowest numbered to the highest numbered.

3.25 After trunk groups 2, 5, and 8 are served, the controller starts another serving cycle by opening the tens gate to all ten trunk groups. With the gate open, any trunk group can then request service. Then the controller repeats the process of going from trunk group to trunk group and from trunk to trunk within each group.

Outgoing Trunk Identification and Selection

3.26 Although the controller has no influence on which incoming trunks are selected by operators, it does have control over the outgoing trunks. It exercises this control to see that insofar as practicable each trunk gets an equal share of the outgoing traffic.

3.27 The outgoing trunks are also divided into groups of ten and for each group there is an associated group relay within the controller. The controller learns whether a trunk group contains idle outgoing trunks by the condition (operated or

released) of the associated group relay; this relay is operated when there is at least one idle outgoing trunk within the group.

3.28 The operation and release of a group relay depends upon the condition (operated or released) of ten trunk relays which are associated with the individual trunks within a group. When there are no idle outgoing trunks within a group, all the trunk relays are operated and the associated group relay is released; when there is at least one idle trunk within a group, its associated trunk relay is released and the group relay is operated.

3.29 At the start of a serving cycle the controller goes to a group which has an associated group relay operated (indicating at least one idle trunk) and selects those trunks which have their associated trunk relays released (indicating that these trunks are idle). Then the controller goes to the next group which has an associated group relay operated and selects the idle trunks within this group, and so on.

3.30 As soon as a trunk is selected, its associated trunk relay is operated and locked. While so locked, the trunk appears busy even though it becomes idle during the serving cycle. Thus, as the controller advances from trunk to trunk, the individual trunk relays are operated until all are operated. This releases the associated group relay and the controller goes to the next group which has its associated group relay operated.

3.31 Like incoming trunk selection, outgoing trunk selection is made under control of preference chains. There are two preference chains associated with the group relays and two preference chains associated with the individual trunk relays. During a serving cycle the controller uses one preference chain associated with group selection and one with trunk selection. Both chains are always set for the same direction of selection either low to high or high to low.

3.32 After the controller has gone through the outgoing trunks to the last trunk group and the last trunk within that group as directed by the preference chain, the controller checks to see if any outgoing trunks have become idle. If any have, the controller changes to the other preference chain so that the direction of selection of outgoing trunks is reversed; if trunks have not become idle, the controller waits until one becomes idle and then makes the reversal. This reversal is made for both trunk groups and individual trunks.

3.33 When the controller reverses the direction of selection of outgoing trunks, it also reverses the direction of

selection of incoming trunks providing that there are no incoming trunks requesting service. If trunks are requesting service, the controller serves them and then reverses the direction of selection. This reversal is also made for both trunk groups and individual trunks.

Connection of an Incoming Trunk to an Outgoing Trunk

3.34 After identifying and selecting the incoming trunk and the outgoing trunk it is to connect, the controller must close the proper crosspoint on a crossbar switch. As described in Part 2, Switching Principles, each incoming an outgoing trunk appears on several switches. For example, in the arrangement shown on Fig. 8, incoming trunk number 21 (in a 100 to 40 concentrator) appears on switches 2, 2', 3 and 3' and outgoing trunk number 38 appears on switches 1', 3', 5', 7' and 9'. Only switch 3' has appearances of both incoming trunk 21 and outgoing trunk 38. To connect these two trunks the controller must close a crosspoint on switch 3' and only on switch 3'. The following paragraphs describe how this is done.

3.35 When the controller has progressed to the stage of closing the crosspoint, the first thing it does is to operate the five select magnets on switches 1', 3', 5', 7' and 9', associated with outgoing trunk 38. Of course, not all of these select magnets are needed to establish a connection; only one is used. However, to operate one and only one select magnet would require additional selection circuits within the controller. Since the controller makes only one connection at a time, it is satisfactory to momentarily operate all the associated select magnets.

3.36 Now the controller must operate a hold magnet to hold the proper selecting finger in place. Incoming trunk 21 appears on four switches (2, 2', 3 and 3') and is therefore associated with four hold magnets. Like the select magnets, the controller operates all four hold magnets. However, only the one on switch 3' is effective. This magnet holds the selecting finger on level 8 in place and causes crosspoint closure.

3.37 Once the crosspoint is closed, the controller releases all the select magnets but keeps the four hold magnets operated. The release of the select magnets frees the selecting bars so that they can be used again on another connection. That is, any connection associated with outgoing trunk 39 since these selecting bars are common to the pair of outgoing trunks 38 and 39. The four hold magnets are left operated; this action has no adverse effect on traffic because these bars are not associated with any other incoming trunk.

3.38 Similar procedures are used for connecting other incoming and outgoing trunks. Select magnets operate on each of the switches on which the outgoing trunk appears; hold magnets operate on each of the switches on which the incoming trunk appears. The crosspoint which closes is on the switch that has both a hold magnet and a select magnet operated.

Operation of the Controller Under Trouble Conditions

3.39 Because the controller is common to all incoming and outgoing trunks, a trouble condition encountered while setting up any one connection must not be permitted to delay the setting up of other connections. The controller recognizes certain types of trouble conditions and, when it encounters such a trouble, takes action which tends to prevent this trouble from affecting subsequent calls. The type of action taken depends upon the type of trouble condition and can consist of one or more of the following operations:

- (1) Reversing the selection of incoming trunks.
- (2) Reversing the selection of outgoing trunks.
- (3) Advancing to the next idle outgoing trunk.
- (4) Opening the tens gate to accept new requests for service.

3.40 Timing circuits within the controller enable it to determine when a trouble condition exists. One timing circuit (short time-out) starts a timing period (approximately 3 seconds) whenever the controller attempts to set up a connection. The timing is stopped when a connection has been established and then it is restarted to time the interval for the next connection, and so on. Normally a connection is established in approximately 0.6 of a second. If the connection is not established within the short time-out period the controller knows that trouble condition was encountered.

3.41 When the controller times out on a short time-out it seizes the trouble indicator; gives it the number of the incoming trunk, the number of the outgoing trunk, etc.; then releases. (This subject is discussed further in Part 5, Testing and Maintenance.)

3.42 After the controller releases, it attempts to serve either the same or another incoming trunk depending upon the type of trouble that was encountered. To do this the controller performs one or more of the operations mentioned in Par. 3.39 so

100 TO 40 CONCENTRATOR

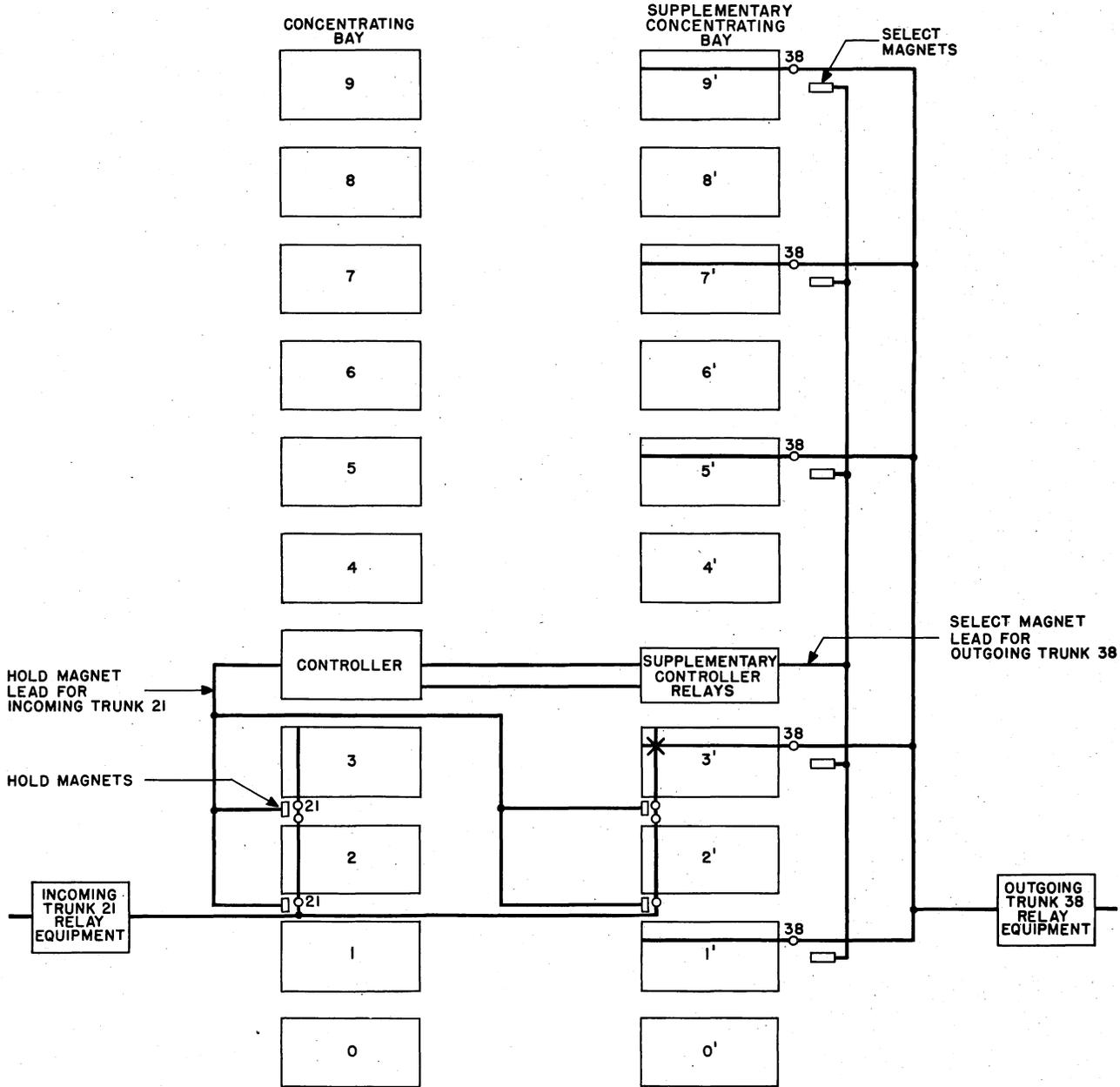


FIG. 8 - EXAMPLE OF CONNECTING AN INCOMING TRUNK TO AN OUTGOING TRUNK IN A 100 TO 40 CONCENTRATOR

that the trouble condition that was encountered while the controller was attempting to set up the first connection will not be encountered while setting up other connections.

3.43 In addition to the short time-out circuit, the controller has a long time-out circuit (approximately 11 seconds) which starts timing at the same instant as the short time-out circuit. The long time-out circuit like the short time-out circuit is also stopped and restarted as each connection is established. However, if the controller cannot establish any connection within the long time-out interval, a major alarm is sounded. Upon completion of a long time-out, the controller reverses the direction of selection of incoming and outgoing trunks in an attempt to get traffic through.

(C) Trunks and Trunk Relay Equipment

General

3.44 Incoming trunks to concentrators originate at various types of toll or DSA switchboards, (see Fig. 9, attached). These trunks have trunk relay equipment associated with them at the concentrator for receiving and forwarding supervisory signals and for performing certain transmission functions such as converting 2-wire trunks to 4-wire trunks. There are different types of this equipment depending on:

- (a) the type of switchboard at which the trunk originates,
- (b) the supervisory and ringing features used by the switchboard,
- (c) the location of the switchboard with respect to the concentrator.

3.45 When a switchboard is located outside the building in which the concentrator is housed, then outgoing trunk relay equipment is required at the switchboard. That is, at the outgoing end (switchboard end) of the incoming trunk to the concentrator.

3.46 There is also outgoing trunk relay equipment for trunks outgoing from the concentrator. Unlike incoming trunk relay equipment, there is only one type of outgoing trunk relay equipment because all of the outgoing trunks from concentrators are of the same type.

3.47 As mentioned in Part 1, some switchboards have direct trunks which bypass a concentrator and go to the same distant crossbar tandem or No. 4-type toll office as the concentrator trunks. Although the direct trunks do not go through concentrating equipment, they are closely

associated traffic wise with both the tandem trunks to the concentrator and the outgoing intertoll trunks leaving the concentrator. For this reason they are also discussed here.

3.48 Figure 9 shows a concentrator, switchboards, trunks, and the trunk relay equipment. Although several types of switchboards and trunk relay equipment are shown for diagrammatic purposes, it does not necessarily mean that all will be used at a particular concentrator location.

Incoming Trunks and Associated Trunk Relay Equipment

General

3.49 The incoming trunk relay equipment associated with a particular trunk passes signals received from a switchboard to a controller and to outgoing trunk relay equipment. It also receives signals from outgoing trunk relay equipment and passes them to the switchboard.

3.50 There are six types of incoming trunk relay equipment provided for use with trunk concentrators. Four of these types are used with switchboards located in the same building as the concentrating equipment; the fifth type is used with switchboards that are outside the building, but within loop-type signaling range (a radius of about 25 miles); the sixth type is used with switchboards located beyond loop-type signaling range).

Trunks From Switchboards in Same Building as Concentrator

3.51 Toll switchboards of the No. 1, No. 3, No. 3C, and No. 3CL types can be in the same building as a concentrator. Four of the six types of incoming trunk relay equipment are used with these switchboards. Two types are used with No. 1 toll switchboards depending on the kind of supervision as shown on Fig. 9. The third type is used with No. 3 toll switchboards. It is also used when No. 3 and No. 3C or No. 3CL switchboards use trunks in common. The fourth type is used with No. 3C or 3CL switchboards. However, all four of these equipments perform the same functions. Therefore, no distinction is made between them in the following discussion.

3.52 This equipment converts the 2-wire transmission path from the switchboard to a 4-wire path at the concentrator. (The trunks from these switchboards to the incoming trunk relay equipment are 3-wire trunks: two wires are used for transmission and one for signaling.)

3.53 The incoming trunk relay equipment receives supervisory signals from

the outgoing trunk relay equipment on a simplex basis through the concentrator switches. Then it passes these signals on to the switchboard by either sleeve or wet-dry supervisory methods.

3.54 Re-ringing signals by the originating operator are sent from the switchboard to the incoming trunk relay equipment either on a d-c or a-c basis depending upon the type of switchboard. The incoming trunk relay equipment passes the re-ringing signal on to the outgoing trunk relay equipment on a d-c basis, over a simplex. A re-ringing signal is transmitted as long as the operator holds the ringing key operated, but is converted to a short pulse by the outgoing trunk equipment to insure that the circuit at the distant end does not disconnect.

Trunks From Switchboards Outside the Concentrator Building But Within Loop Signaling Range

3.55 These switchboards, which can be either the toll or DSA type, are too far away to use sleeve signaling methods. Therefore, 2-wire trunks employing loop signaling methods are used between the switchboard and concentrator locations.

3.56 At the concentrator these trunks require the fifth type of incoming trunk relay equipment. Only one type of incoming trunk relay equipment is required at the concentrator, because the trunks from all the switchboards use one type of signaling, reverse battery loop signaling.

3.57 This fifth type converts a 2-wire transmission path to a 4-wire transmission path by means of a hybrid coil and a compromise balancing network. However, if a better balance is required, an external precision balancing network can be used.

3.58 This equipment also has options to meet the various ringing requirements. Re-ringing signals are passed on a d-c simplex basis to the outgoing trunk relay equipment for the duration of the ringing period. A simplex is also used to pass supervisory signals between the outgoing trunk relay equipment and the incoming trunk relay equipment.

3.59 In addition to the incoming trunk relay equipment at the concentrator, these switchboards require outgoing trunk relay equipment at the switchboard location. This outgoing trunk relay equipment meets the supervisory and ringing requirements for a particular switchboard. As already pointed out, all this outgoing trunk relay equipment uses the reverse battery loop signaling between the switchboard and the concentrator.

Trunks From Switchboards Beyond Loop Signaling Range

3.60 The sixth type of incoming trunk relay equipment is provided when the

switchboard is located beyond loop signaling range. This equipment uses composite (CX) or single frequency (SF) signaling methods between the concentrator location and the switchboard location. (Composite signaling is a method of d-c signaling; SF signaling is a method of a-c signaling using tones within the voice band.)

3.61 Unlike the other incoming trunk relay equipment type used with switchboards outside the building but within loop signaling range, this equipment does not contain a hybrid coil and balancing network. The reason for this is that the conversion from 2 to 4-wire usually has been made external to the trunk relay equipment for reasons other than for switching purposes. For example, a conversion is required when the incoming trunk is equipped with terminal voice repeaters or when a carrier channel is used for the trunk. A similar conversion is required when SF signaling (see Fig. 9) is used.

3.62 However, if the trunk does not use any of these facilities then it is necessary to make the conversion for switching purposes only. For example, if CX signaling is used between the distant switchboard and the incoming trunk relay equipment, the conversion must be made for switching purposes only (see Fig. 9).

3.63 Supervisory signals from the outgoing trunk relay equipment at the concentrator are brought through the concentrator on a simplex basis to the incoming trunk relay equipment. They are then passed back to the originating switchboard location by either CX or SF signaling methods under control of d-c signals applied by the incoming trunk relay equipment to the M lead. At the originating switchboard location, the CX or SF signaling circuit passes the signals to the outgoing trunk relay equipment via the E lead.

3.64 Signals, including re-ringing signals, are sent from the outgoing trunk relay equipment at the switchboard location via the M lead to the CX or SF signaling system. Ringing between the switchboard location and the concentrator location is on a pulse basis and is not controlled by the duration of the ringing signal from the switchboard. Actually, the ringing pulse is not sent until the operator restores her ringing key.

Outgoing Trunks and Associated Trunk Relay Equipment

3.65 All the outgoing trunks from the concentrator are 4-wire trunks and use only one type of outgoing trunk relay equipment.

3.66 The outgoing trunk relay equipment uses E and M leads to exchange signals

between the trunk relay equipment and the signaling facilities provided on the outgoing trunks. Either CX or SF signaling facilities can be used.

3.67 Supervisory signals between outgoing trunk relay equipment and incoming trunk relay equipment are exchanged on a simplex basis through the established connection of the crossbar switches.

Direct Trunks and Associated Trunk Relay Equipment

3.68 Some switchboards have direct trunks to the distant switching equipment in addition to having trunks through a concentrator. Figure 9 shows the equipment necessary for the case where the switchboard is within the same building as the concentrator and for the case where the switchboard is located outside the building.

3.69 When the switchboard is located within the same building as the concentrator, the direct trunks, which are in the same idle indicating chain as the trunks to the concentrator, are equipped with the same outgoing trunk relay equipment they would normally use even if there were no concentrator. However, the trunks are brought through the circuit patching bay on a 4-wire basis, so that they will be similar to the outgoing trunks from the concentrator. A 4-wire terminating set is used to convert the 2-wire transmission path to a 4-wire transmission path.

3.70 The outgoing trunk relay equipment contains options to meet the supervisory and ringing requirements of the switchboards. E and M leads are extended from the trunk relay equipment to either CX or SF signaling systems. Supervisory and ringing signals are passed over these leads between the outgoing trunk relay equipment and the signaling circuit.

3.71 When the switchboard is located outside the building, outgoing trunk relay equipment is supplied at the switchboard location. In addition, an intermediate trunk relay equipment is provided at the concentrator location.

3.72 At the switchboard location the outgoing trunk relay equipment conforms with the supervisory and ringing requirements of the switchboard. Between the outgoing trunk relay equipment and the intermediate trunk relay equipment, a 2-wire trunk with reverse battery loop signaling is used. Options within the intermediate trunk relay equipment are used to meet the various ringing requirements.

3.73 Another function of the intermediate trunk relay equipment is to convert the 2-wire transmission path to a 4-wire

transmission path. A hybrid coil and balancing network are part of this equipment. However, an external balancing network can be used if required.

Transmission Arrangements

3.74 Incoming tandem trunks to concentrating equipment are of the high loss type. These high loss trunks are similar to high loss toll connecting trunks used in the No. 4-type systems. This similarity is of value, especially during emergencies, when it may be desirable to interchange intertoll trunks among concentrator routes, No. 4 routes, and direct routes at the patching bay.

3.75 Outgoing intertoll trunks from a concentrator have the same transmission level at the circuit patch bay as No. 4-type intertoll trunks. The "P" pads on the line side of the circuit patch bay are adjusted to obtain this transmission level for both the trunks from a concentrator and trunks from No. 4-type equipment.

3.76 The direct trunks also have a similar transmission layout. The "P" pads for these trunks are adjusted to obtain the same transmission level as the trunks from a concentrator. The layout then is such that the over-all transmission loss on a connection established via a direct trunk is the same as on a connection (from the same switchboard) established through a concentrator.

(D) Idle Trunk Indicating Equipment

3.77 Idle trunk indicating equipment is provided at the switchboard locations to:

(a) Eliminate the necessity for making busy tests.

(b) Insure that when direct trunks to the same distant office are provided these are used first thereby reducing the load on the concentrator.

3.78 At the switchboard locations, an idle indicating lamp is associated with each of the tandem trunks to a concentrator and with each of the direct trunks to the same distant office. Idle trunks are indicated by lighted lamps. However, only the idle trunk next to be used is lighted; the other idle trunks and the busy trunks have dark lamps. The lamps are in a chain under control of relays which determine which idle trunk is to be used next. When the trunk with the lighted lamp is selected by an operator, the relays extinguish this lamp and light the lamp associated with the idle trunk next to be used.

3.79 To reduce the probability of seizure of the same trunk by several operators, the trunks are divided for idle indicating purposes into subgroups. Figure 10 shows a typical subgrouping arrangement of idle indicating lamps above direct (D) and concentrator (C) tandem trunk jacks. The trunks and associated lamps are divided into three subgroups; each subgroup has its own chain of idle indicating relays and in each subgroup the direct trunks are made first choice. With the arrangement shown on Fig. 10 three lamps can be lighted simultaneously thus providing an operator with three choices. All three subgroups appear in a different panel at the various positions along the switchboard and when more than one lamp is lighted each operator tends to select the nearest trunk.

3.80 Because of this subgrouping, an operator might select a tandem trunk to the concentrator when a direct trunk is available in another subgroup. However, the effect of this is not expected to be serious during the busy hour and is of no importance during light load periods.

3.81 Subgrouping is also done when a switchboard has tandem trunks to two or more concentrators which have outgoing trunks to the same distant office. Figure 11 shows a typical subgrouping arrangement at a switchboard which has tandem trunks to three such

concentrators (C1, C2, C3). The number of subgroups and their sizes are entirely flexible. By proper assignment of trunks to the subgroups, equalization of traffic flow to each concentrator can be obtained.

3.82 When all the outgoing trunks from a concentrator are busy, the lamps above the tandem trunk jacks associated with this concentrator are extinguished by an indicator control circuit. This circuit gets its information about the all-trunks-busy condition over a lead from the controller. Separate indicator control circuits must be provided for each concentrator.

3.83 For example, three would be provided for the lamps shown on Fig. 11. When the outgoing trunks from concentrator C2 are all busy, the associated indicator control circuit extinguishes any lighted lamps above C2 tandem trunk jacks. As long as the all-trunks-busy condition exists, the idle indication cannot be given to any C2 tandem trunks but it passes to the C3 tandem trunks.

(E) Traffic Registers

3.84 Registers are provided at the switchboard and concentrator locations to indicate to the traffic forces the load on the tandem trunks, the direct trunks, the controller, and the outgoing trunks.

3.85 At each of the switchboard locations, an all-trunks-busy (ATB) register is provided to count the number of times an all trunks busy condition occurs on the tandem trunks to a concentrator.

3.86 If a switchboard has direct trunks to the same distant office as the concentrator, the direct trunks are grouped for all-trunks-busy registrations with the tandem trunks to the concentrator.

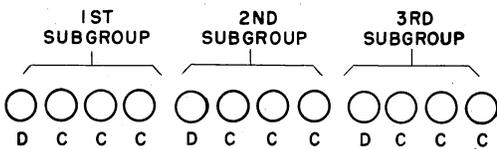


FIG. 10- TYPICAL SUBGROUPING ARRANGEMENT OF IDLE INDICATING LAMPS ASSOCIATED WITH ONE CONCENTRATOR

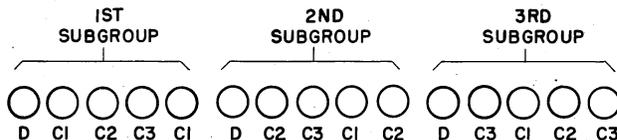


FIG. II- TYPICAL SUBGROUPING ARRANGEMENT OF IDLE INDICATING LAMPS ASSOCIATED WITH THREE CONCENTRATORS

3.87 At the concentrator location, a peg count register associated with the controller is provided to count the number of calls it handles.

3.88 A group busy time register associated with the outgoing intertoll trunks is also provided at the concentrator location. This register is connected at six second intervals to a lead from the trunk group and is scored if the group is found busy.

4. METHOD OF OPERATION ON A TYPICAL CALL

(A) General

4.01 This part traces a typical call through a concentrator from start to completion. During the description of the call, the functions of the various equipment elements are discussed in the sequence in which they are performed. Not all the functions are discussed; only the main functions are highlighted as the call progresses.

4.02 For this call shown on Fig. 12, attached, the following assumptions are made:

- (1) The calling subscriber reaches an outward toll operator through a dial local office.
- (2) The outward operator is in the same building as the concentrator.
- (3) This is the only call through the concentrator at this time.
- (4) No trouble conditions exist.
- (5) The distant toll office is of the No. 4-type.
- (6) SF signaling is used between the concentrator and the No. 4-type office.
- (7) The called local office is a dial office.

(B) Description of Operation

4.03 To place the call, the calling subscriber dials 211. The local office switching equipment routes the call to the outward toll switchboard. When the outward toll operator answers, the calling subscriber gives her the name of the called city and the called subscriber's telephone number.

4.04 The outward operator selects a tandem trunk to the concentrator by inserting

a cord into a trunk jack over which an idle indicating lamp is lighted. As the cord is inserted, the idle indication is removed from this trunk and advanced to the next idle trunk. Insertion of the cord also causes a signal to be sent, via the sleeve conductor, to the associated incoming trunk relay equipment.

4.05 The incoming trunk relay equipment recognizes the signal as a seizure signal. This equipment then sends a signal to the controller indicating that a connection to an outgoing trunk is wanted. This signal operates the tens group relay associated with the group containing the incoming trunk. Then the controller closes the tens gate.

4.06 After the tens gate is closed, the controller, directed by the preference chain, associates the units relays with the group requesting service. Now the units relay corresponding to the number of the incoming trunk operates and identifies the incoming trunk that wants service. Then the units gate closes.

4.07 Now that the controller has identified the incoming trunk to be served and has closed the gate on any others, it proceeds to select an idle outgoing trunk. Actually the preferred idle outgoing trunk is predetermined by the preference chain circuits associated with the outgoing trunk group relays and individual trunk relays. These chain circuits had advanced the preference to the next idle outgoing trunk after the previous call. Therefore, when the controller knows that an outgoing trunk is wanted, it operates all the select magnets associated with this predetermined idle outgoing trunk.

4.08 Next, the controller operates all the hold magnets associated with the incoming trunk being served. One crosspoint closes: the one on the switch containing an appearance of both the incoming trunk and the outgoing trunk. After the crosspoint closes, the controller releases all the select magnets but continues to hold all the hold magnets operated.

4.09 When the crosspoint closes, the outgoing trunk relay equipment receives a signal and in turn sends a seizure signal toward the No. 4-type equipment in the distant area. This signal is sent from the outgoing trunk relay equipment to the SF signaling equipment by a d-c signal over the M lead. The seizure signal is forwarded by the SF signaling equipment at the concentrator location to the SF signaling equipment at the No. 4-type office. There a d-c signal is sent via the E lead to the incoming trunk relay equipment.

4.10 While this equipment is waiting for a sender, a delay dial signal is returned to the outward operator. This signal tells her to wait before keying the information until a sender is attached to the trunk. (She receives another signal later when a sender is attached.) The delay dial signal is returned from the No. 4-type equipment to the concentrator via the SF signaling system. There the incoming trunk relay equipment passes the delay dial signal to the switchboard over the sleeve conductor.

4.11 Now the incoming trunk relay equipment takes over from the controller and keeps the hold magnets operated for the remainder of the call. A signal is sent to the controller notifying it of this change. This signal (a continuity check signal) indicates to the controller that the connection is complete to the distant office. The controller then releases. (This is only a partial continuity check because individual tip or ring failures through the crossbar switches and certain signaling and transmission failures are not detected.)

4.12 No other signals are sent until the No. 4-type equipment attaches an MF sender to the trunk. When it has attached a sender, a start dial signal is sent to the operator. She then keys the called subscriber's telephone number.

4.13 The No. 4-type office, using the called local office code, routes the call to the called local office. In turn the local office, using the numerals, routes the call to the called subscriber.

4.14 When the called subscriber answers, an off-hook signal is transmitted from the called station all the way back to the outward operator. She recognizes this signal as the start of the talking period and then starts timing the call for charging purposes.

4.15 At the end of the talking period, the operator receives on-hook signals from both the calling and called subscribers. She then notes the time again and pulls down the cords. When she pulls down the calling cord, the incoming trunk relay equipment at the concentrator gets a disconnect signal. Upon receiving the disconnect signal the incoming trunk relay equipment releases the hold magnets and thus opens the crosspoint.

4.16 When the crosspoint opens, a disconnect signal is given to the outgoing trunk relay equipment. The signal is then

forwarded, via the SF signaling system, to the No. 4-type office. The No. 4-type equipment and the equipment in the called local office then release.

5. TESTING AND MAINTENANCE

(A) General

5.01 This part briefly describes the principal features of the concentrating equipment that require testing. It also describes the test equipment used and the general testing procedures for some typical tests. These procedures are described for familiarization purposes only and are not to be used for making the actual tests. Detailed procedures for testing and maintenance are given in other sections.

5.02 The central office maintenance forces make tests of incoming trunk relay circuits and of controllers. To make these tests, each office is provided with a portable test set, a test line circuit, and miscellaneous test facilities.

5.03 Tests of an incoming trunk relay circuit are made by patching the portable test set to the test access jack of the trunk and to the miscellaneous test facilities. With these patches made, the controller establishes a connection to the test line circuit which returns visual and audible signals to the test set via the incoming trunk relay circuit. These signals indicate the results of the tests.

5.04 Tests of a controller are also made using the test set, the miscellaneous test facilities, and an incoming trunk relay circuit. A controller is tested by permitting it to establish a connection from an incoming trunk to an outgoing trunk as on a normal service call. The outgoing trunk returns a signal to the test set via the incoming trunk relay circuit when the connection is successfully completed.

5.05 Tests of outgoing trunk relay circuits are made at the 17C toll test board. These tests do not require the use of the test set or the test line circuit. The test facilities used, namely, toll test board, trouble tracing selector, transmission measuring equipment, etc., are similar to those used to test other types of inter-toll trunks.

5.06 Certain maintenance equipment which records information but is not used to make tests is also provided in each office. A lamp-type trouble indicator which can serve a maximum of 40 controllers is provided to aid the maintenance forces in locating and analyzing trouble conditions. Maintenance registers which provide information relative to the number of times a particular controller is in trouble

or the number of times a particular type of trouble occurs, are also furnished.

(B) Testing and Maintenance Equipment

Incoming Trunk Test Set

5.07 The incoming trunk test set (see Fig. 13) is used to test incoming trunk relay circuits and controllers. The test set is of the portable box type and can be carried to the incoming trunk relay rack bays, the switch frames, or the trouble indicator where tests are made. It is expected that only one test set will be required for an installation of concentrators. For this reason only one test line circuit and one tie line circuit are necessary. However, should cases arise where it is desired to make use of more test sets, it will be necessary to provide additional test line and tie line circuits.

5.08 Jacks are provided on the test set so that patches can be made to the trunk relay circuit under test, to a controller, to sources of 48 volts, +130 volts, and 20 cycles.

5.09 Three keys are provided on the test set for presetting signaling and ringing conditions required by the various types of incoming trunks. Four other keys permit the insertion of different values of resistance so that various conditions can be set up to simulate the different types of incoming trunks.

5.10 Results of the tests are indicated by visual or audible signals returned to the test set. Two lamps provide for observation of the visual signals; a headset patched to jacks on the test set permits listening to the audible signals.

Test Line Circuit

5.11 The test line circuit permits supervisory, ringing, and transmission tests to be made on an incoming trunk relay circuit. To make these tests, the incoming trunk test set is used to set up a test circuit from the incoming trunk relay circuit to the test line circuit through the crossbar switches of a concentrator.

5.12 As explained in par. 5.07, test line circuits are provided on the basis

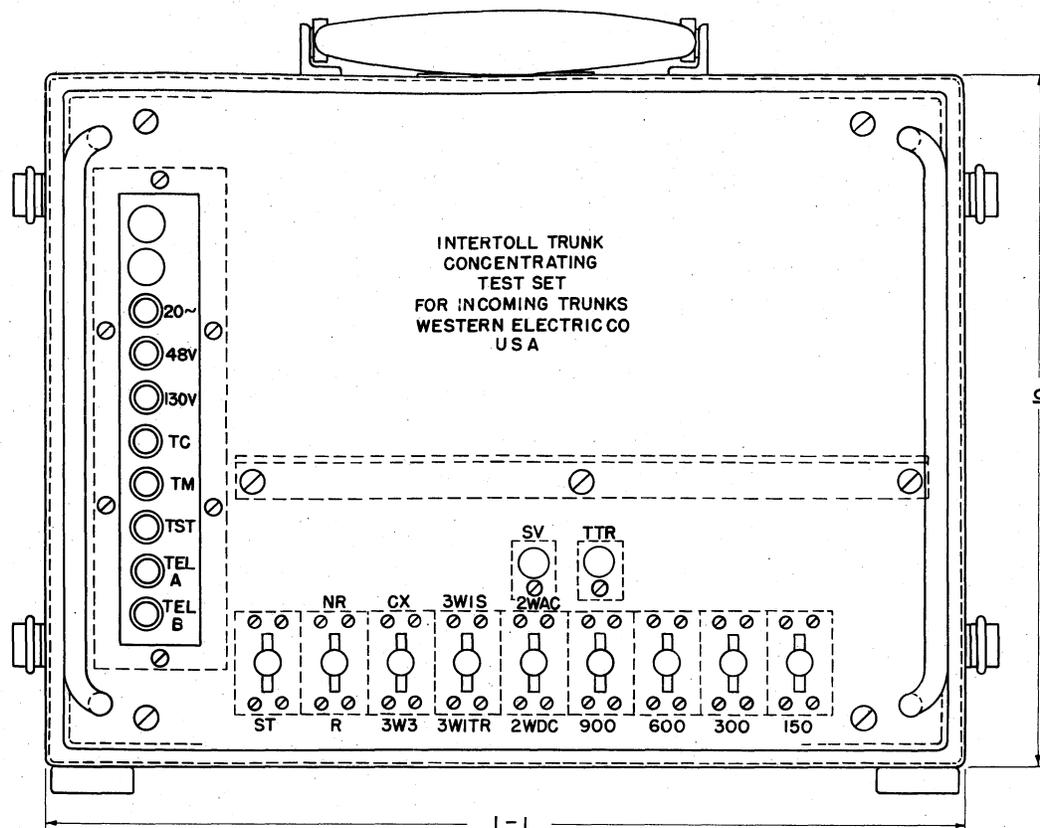


FIG. 13 - INCOMING TRUNK TEST SET

of one per test set. If one test set and one test line circuit are provided, all the concentrators in the office share the same test line circuit; if more than one test set and test line circuit are provided, the concentrators are divided into groups with each group having access to an associated test line circuit.

5.13 A test line circuit is reached through a No. 0 outgoing trunk appearance. Leads from this appearance are terminated on the contacts of a controller relay. (Each controller has one of these relays.) This relay can connect these leads either to No. 0 outgoing trunk relay equipment or to the test line circuit. When a connection to the test line is wanted, the controller first determines whether the No. 0 outgoing trunk appearance is busy or idle. If it is busy, a busy indication is given via the test set. When the outgoing trunk is idle, the leads from the switches are transferred from the outgoing trunk relay equipment to the test line circuit and an indication is given via the test set that the supervisory and ringing tests may be made. These tests are described further in pars. 5.34 to 5.36.

5.14 Transmission tests of the incoming trunk relay circuits can also be made using the test line circuit which contains three jacks for this purpose. Two of these jacks permit access to the incoming trunk relay circuit, the third jack permits access to a source of 1000-cycle tone. Transmission measurements can be made by patching this tone to the incoming trunk relay circuit and from there to transmission measuring equipment.

Miscellaneous Test Facilities

5.15 Tests of incoming trunk relay circuits and of controllers can be made from several locations within an office. To permit this, certain miscellaneous test facilities are provided at these locations. These are jack-ended test facilities and jack-ended connecting facilities.

5.16 The jack-ended test facilities are:

- (1) 48 volt supply jacks (A)-power for operation of the test set.
- (2) 130 volt supply jacks (D)-for test of d-c ringing features of incoming trunks.
- (3) 20-cycle supply jack (C)-for test of a-c ringing features of incoming trunks.

5.17 The jack-ended connecting facilities are:

- (1) Tie line circuit jacks (E)- for patching from one bay to another.
- (2) Frame talking line jacks (TEL) - for talking between locations.
- (3) Controller jacks (TL)-to signal a controller for a test line circuit connection.
- (4) Spare jacks to I.D.F. (B)-for use as required.

5.18 All of these facilities are provided (with the exception of the controller jacks) on every third incoming trunk relay rack bay starting with the second in a lineup. Each of the controller jacks (there can be a maximum of 40) has only one appearance in an office. All the controller jacks are at one central location, usually on one of the incoming trunk relay rack bays along with the other miscellaneous test facilities (see Fig. 14).

5.19 Figure 15 shows the miscellaneous test facilities provided on alternate switch frames. Only some of the miscellaneous test facilities are provided at these locations, as the figure shows, because the 130-volt, 20-cycle, and controller jacks (which are not provided) are needed only at the incoming trunk relay rack locations to test incoming trunk relay circuits.

5.20 The facilities shown on Fig. 15 are also provided at the trouble indicator so that tests of a controller can be made from that location and the results observed as successive tests are made.

5.21 A few of the facilities are also provided at outgoing trunk relay rack bay locations (see Fig. 16). The test set is not used at these locations; only miscellaneous testing (with headset and "pick") is done at these bays. These facilities appear on every third outgoing trunk relay rack bay starting with the second in a lineup.

Trouble Indicator

5.22 A lamp-type trouble indicator that serves a maximum of 40 concentrators is provided in each office to aid in locating trouble conditions. The trouble indicator is seized whenever a controller times out due to a trouble. (An exception is made when the time-out is due to failure to receive a continuity check signal. Seizure of the trouble indicator for this type of time-out is under key control as discussed later in par. 5.29.) The type of information given to the trouble indicator by a controller is as follows:

- (1) The number of the controller.

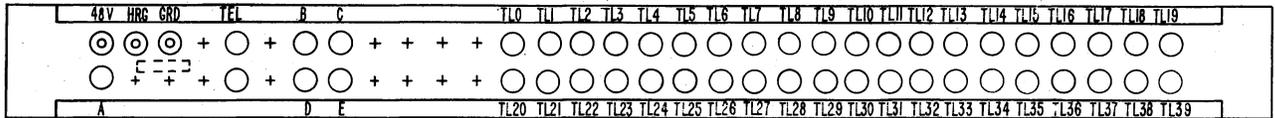


FIG.14- MISCELLANEOUS TEST FACILITIES AT INCOMING TRUNK RELAY BAY LOCATIONS



FIG. 15 - MISCELLANEOUS TEST FACILITIES AT SWITCH FRAMES

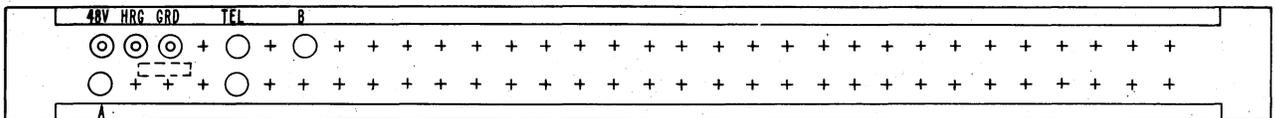


FIG. 16- MISCELLANEOUS TEST FACILITIES AT OUTGOING TRUNK RELAY BAY LOCATIONS

- (2) The number of the incoming trunk.
- (3) The number of the outgoing trunk.
- (4) The stage of the call before trouble was encountered.
- (5) In some cases, the nature of the trouble.

5.23 The trouble indicator is mounted on a bay (see Fig. 17) together with the miscellaneous test facilities already described and the maintenance registers described later in this text (par. 5.28).

5.24 Briefly, this is how a trouble indicator records trouble conditions. When a controller encounters trouble while serving a call it times out and seizes the trouble indicator. The controller then passes on to the trouble indicator the information pertinent to the call. This information is stored in the trouble indicator and the controller releases so that it may serve other calls.

5.25 When the trouble indicator is seized, a minor alarm sounds. When the alarm is answered, a key is operated which causes the lamps corresponding to the

information stored in the trouble indicator to light. After recording this information, another key is operated which restores the trouble indicator to normal. The recorded information is used to locate and analyze the trouble.

5.26 While the trouble indicator is busy recording a trouble, other controllers may encounter trouble and wish to record information. These controllers light display lost lamps and thus leave records of the fact that they attempted to seize the trouble indicator.

5.27 By operation of keys, the trouble indicator can be taken out of service or made busy to one or more controllers. The make-busy keys are intended for use where it is desired to limit the indications to particular controllers and to prevent unproductive indications from others when certain types of maintenance work is being done.

Maintenance Registers

5.28 Peg count registers are provided on the basis of one per concentrator to count the number of times each controller

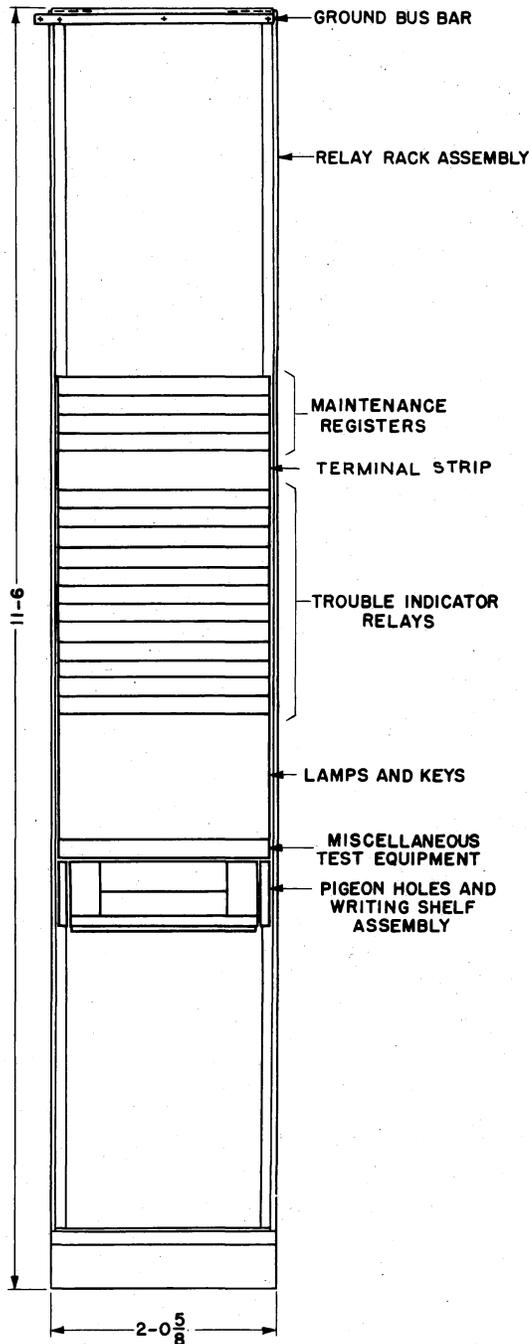


FIG. 17- TROUBLE INDICATOR AND MAINTENANCE REGISTER BAY

fails to complete its operations within the short time-out interval. These registers do not count the number of time-outs due to continuity test failures; other registers, described below, perform this function.

5.29 To count continuity test failures, peg count registers are provided as follows:

- (a) For one concentrator - one register.
- (b) For two to twenty concentrators - two registers.
- (c) For twenty-one to thirty concentrators - three registers.
- (d) For thirty-one to forty concentrators - four registers.

These registers can be cross-connected, at terminals on the trouble indicator, to the various controllers as desired. If a register shows that a particular controller has had a large number of such failures, trouble indicator displays from this controller may be desired. To obtain these displays, an associated controller key is operated which permits the controller to seize the trouble indicator when continuity test failures occur. These keys, one per controller, are located on the trouble indicator frame.

(C) Typical Tests

General

5.30 No attempt is made here to describe all the tests, or to give all the details of those tests which are described. The purpose is to give a general picture of several typical tests and the general procedures followed. As mentioned earlier, the detailed procedures are covered in other Sections.

Tests of Incoming Trunk Relay Circuits

5.31 The supervisory and ringing features of incoming trunk relay circuits are tested (after permission is obtained to take the trunks out of service) by setting up patches similar to those shown in Fig. 18.

5.32 As the patch between the TL jack and the TC jack is made, the controller gets a signal which tells it that a connection to the test line circuit is wanted by some incoming trunk relay circuit. If outgoing trunk No. 0 is idle, a signal is returned to the test set and lights a lamp there.

5.33 When the lamp lights as an idle indication, a key is operated which

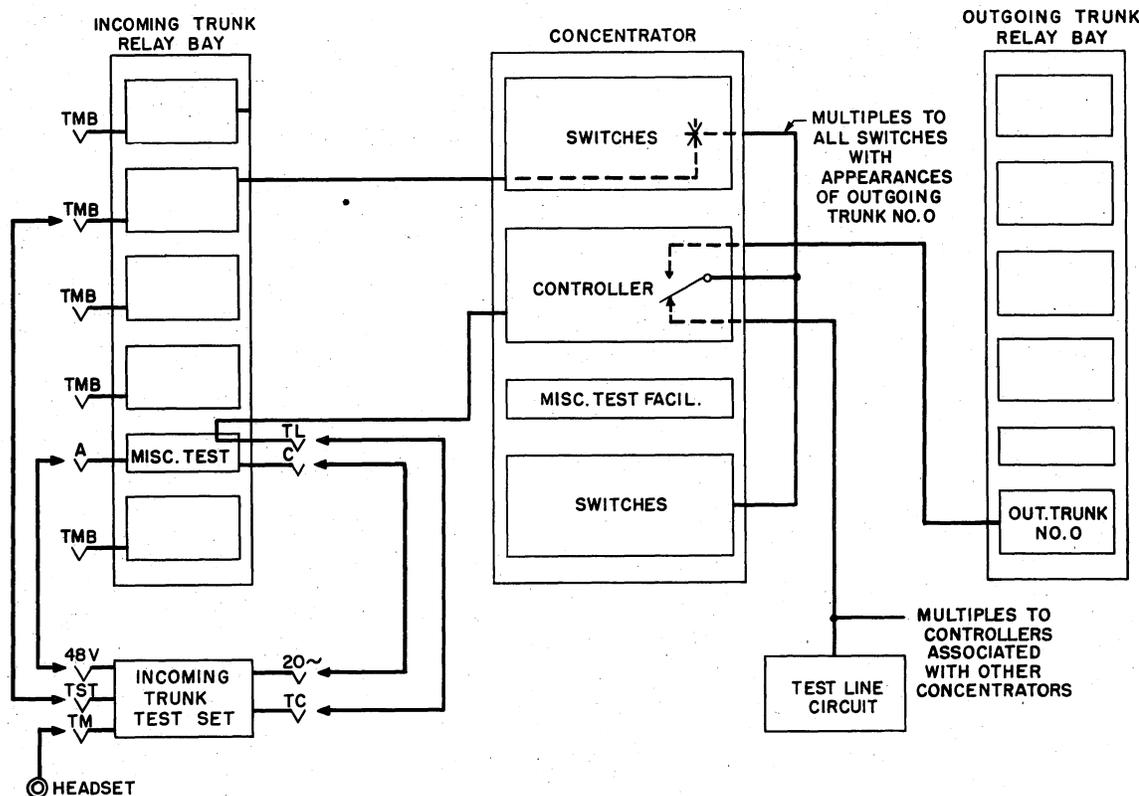


FIG. 18- PATCHING FOR INCOMING TRUNK RELAY CIRCUIT TESTS

causes seizure of the incoming trunk. Seizure of the incoming trunk gives an indication to the controller that this is the trunk requesting a connection to the test line circuit. The controller does not immediately make the connection but handles this request in its regular turn along with the other incoming trunks requesting connections to outgoing trunks.

5.34 After the connection is made, the test line circuit returns supervisory flashes at the rate of 120 IPM to the incoming trunk where they are passed on to the test set causing a lamp to flash. The flashing of this lamp indicates that the incoming trunk relay circuit is passing supervisory signals properly.

5.35 Another key is then operated which causes a ringing signal to be sent from the test set to the incoming trunk relay circuit. Successful transmission of the ringing signal by the incoming trunk is indicated by the return of two signals from the test line circuit. One signal is a 1000-cycle tone; the other signal is a d-c signal causing a lamp on the test set to light steadily.

5.36 The tie line circuit, which has jack appearances on every third incoming

trunk relay rack bay, permits moving the test set from bay to bay and testing all the incoming trunk relay circuits associated with a controller. To do this a patch is made from the controller jack to the tie line circuit jack at the bay on which they both appear. Then at the other bays a patch is made from one of the multiple appearances of the tie line circuit to the test set.

Tests of Controllers

5.37 Controllers can be tested from incoming trunk relay racks, the trouble indicator, and switch frame locations. Figure 19 shows the patches necessary when these tests are made from a switch frame location. These tests are made by setting up successive calls through the concentrator. These test calls are made in order to test the concentrator's ability to set up connections to the outgoing trunks. Because incoming trunk relay equipment is used to make these tests, permission to take the incoming trunk out of service must be obtained before proceeding.

5.38 The incoming trunk used in this test is seized as soon as a key is operated. Then the controller proceeds to connect this trunk in accordance with the

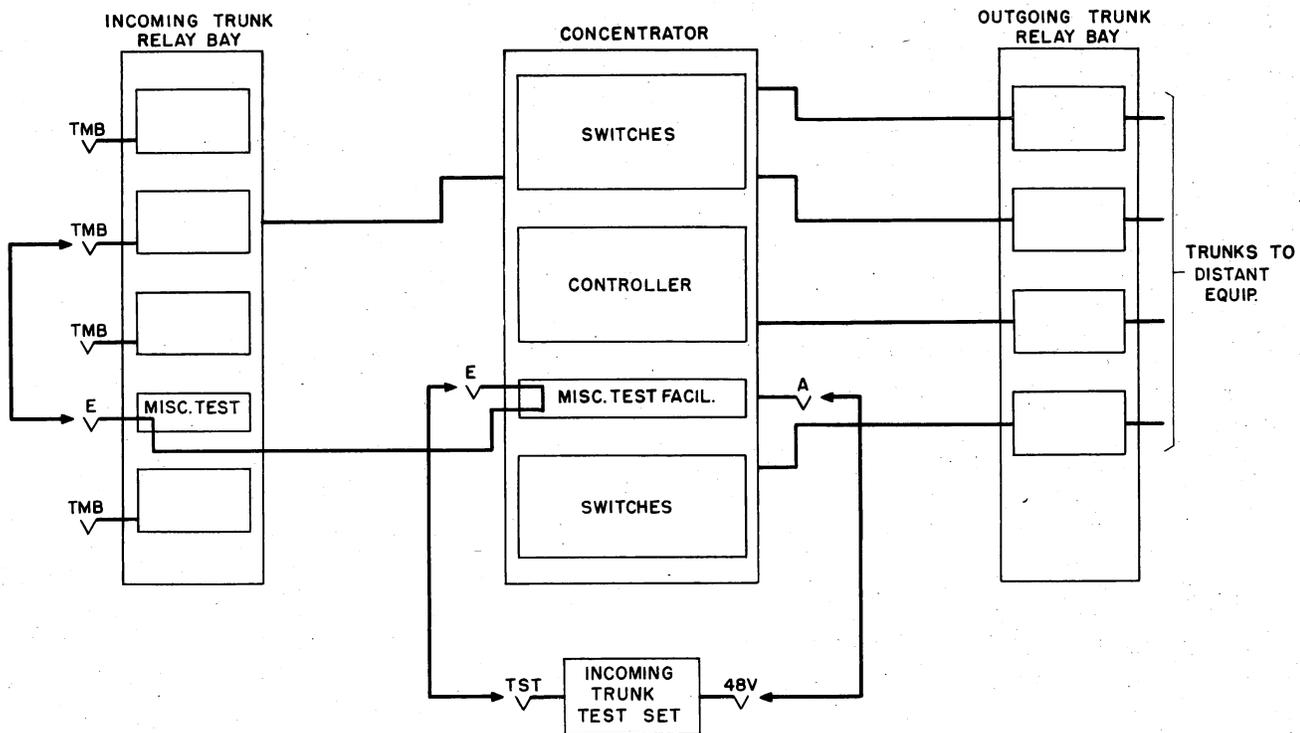


FIG. 19- PATCHING FOR CONTROLLER TESTS

order of selection, to an outgoing trunk. The outgoing trunk sends a seizure signal to the distant office. When the distant office attaches a sender, a signal is returned to the test set and causes a lamp to light. The lighting of this lamp signifies that the test is completed. If the outgoing trunk is held too long on these test calls, the distant sender will time out.

Tests of Outgoing Trunk Relay Circuits

5.39 All of the outgoing trunks have transmitting and receiving jack appearances at a No. 17C toll testboard or its equivalent. The jack field also contains miscellaneous jacks for transmission measuring equipment, noise measuring equipment, and other testing equipment of a specialized nature. These facilities are arranged to permit a testboard man to test for busy trunks, to monitor on the trunk, and to make operational and transmission tests.

6. EQUIPMENT

(A) General

6.01 Basically all concentrators consist of one controller and a varying

number of crossbar switches. The controller relay units and the crossbar switches are mounted on the same bays. The amount of traffic an individual concentrator carries determines how many switches and bays are required. The equipment arrangements for the 100 to 20, the 100 to 30, and the 100 to 40 concentrators are described here. Block diagrams of the multiplying of the switches for these concentrators are shown. Other arrangements are listed for fewer than 100 incoming trunks.

(B) 100 to 20 Concentrator

6.02 A 100 to 20 concentrator (see Fig. 20A, attached) consists of a single bay (concentrating bay) on which a maximum of ten 200-point, 5-wire crossbar switches are mounted. The controller is also mounted on this bay. The controller contains all the relays necessary to identify and serve any of 100 incoming trunks. All the relays necessary to identify and select any one of 20 outgoing trunks are also contained within the controller.

6.03 Figure 20B, attached, shows the location of the incoming and outgoing trunks on the switches in a concentrating bay and also how the switches are multiplied.

A maximum of 100 incoming trunks are distributed over the verticals, one trunk to each of the verticals of the five even numbered switches. The verticals of each even numbered switch are multiplied to the verticals of an odd numbered switch: No. 0 switch to No. 1 switch, No. 2 switch to No. 3 switch, etc.

6.04 A maximum of 20 outgoing trunks are terminated on the horizontals and are distributed as follows: ten of these trunks (numbers 0 to 9) are terminated on the horizontals of all even numbered switches; ten others (numbers 10 to 19) are terminated on the horizontals of all odd numbered switches. Thus each incoming trunk can be connected to any one of the outgoing trunks terminated on the horizontals of the switches.

(C) 100 to 30 Concentrator

6.05 Where more outgoing trunks are required to serve the incoming traffic, a 100 to 30 concentrator may be provided. In this size concentrator another switch is multiplied to each of the five pairs of switches in the concentrating bay.

6.06 The five additional switches are mounted in another bay (supplementary bay) which is the same physical size as the concentrating bay. However, the supplementary bay has space for ten crossbar switches, therefore two 100 to 30 concentrators can share this space (see Fig. 21A, attached). The two concentrators are independent of each other, each having its own incoming and outgoing trunks and individual controller.

6.07 The arrangement of the incoming and outgoing trunks and switch multiplying on the concentrating bay (see Fig. 21B, attached) is the same as that provided on the 100 to 20 concentrator and, like it, provides access from each incoming trunk to all of outgoing trunks 0 to 19. The added ten outgoing trunks (20 to 29) appear on the horizontals of five switches in the supplementary bay. The verticals of each of these five switches are multiplied to the verticals of one of the five pairs of switches in the concentrating bay so that there are five sets of three switches.

Each set provides access from 20 incoming trunks to the same 30 outgoing trunks.

6.08 The controller described in connection with the 100 to 20 concentrator (see par. 6.02) serves a maximum of 100 incoming trunks and 20 outgoing trunks. Additional control relays are added for a 100 to 30 concentrator. These control relays are associated with the ten additional outgoing trunks (trunks 20 to 29). As Fig. 21B, attached, shows, there are two sets of these additional control relays mounted on the supplementary bay. One set is associated with the left controller and concentrator; the other with the right controller and concentrator.

(D) 100 to 40 Concentrator

6.09 For still heavier traffic conditions a 100 to 40 concentrator (see Fig. 22A, attached) is provided. A 100 to 40 size concentrator also uses a concentrating bay and a supplementary bay. Unlike the 100 to 30 concentrator, all ten crossbar switches in the supplementary bay are associated with a single concentrator.

6.10 Figure 22B, attached, shows the arrangement of the incoming and outgoing trunks and switch multiplying. This arrangement is very similar to those already described. In this case there are five sets of four switches and each set provides access from 20 incoming trunks to the same 40 outgoing trunks.

6.11 The controller mounted in the concentrating bay, like those in the other concentrators, also serves a maximum of 100 incoming and 20 outgoing trunks. The twenty additional control relays needed for outgoing trunks 20 to 39 are mounted in the supplementary bay.

(E) Other Concentrator Sizes

6.12 Some installations may have less than 100 incoming trunks. Table A lists the various concentrator sizes and the switches required (for convenience the switches required with 100 incoming trunks are also listed). The various multiplying arrangements are not described; they follow the patterns described for the full size concentrators.

TABLE A

<u>Trunk Arrangement</u>	<u>Switches Required In a Concentrating Bay</u>	<u>Switches Required In a Supplementary Bay</u>
100 to 20	0-9	Bay Not Required
80 to 20	0-7	" " "
60 to 20	0-5	" " "
40 to 20	0-3	" " "
100 to 30	0-9	Left Conc.* 0'L,2'L,4'L,6'L,8'L Right Conc.* 1'R,3'R,5'R,7'R,9'R
80 to 30	0-7	Left Conc.* 0'L,2'L,4'L,6'L Right Conc.* 1'R,3'R,5'R,7'R
60 to 30	0-5	Left Conc.* 0'L, 2'L, 4'L Right Conc.* 1'R, 3'R, 5'R
40 to 30 ⁺	0-3	Left Conc.* 0'L, 2'L Right Conc.* 1'R, 3'R
100 to 40	0-9	0'-9'
80 to 40	0-7	0'-7'
60 to 40 ⁺	0-5	0'-5'

*The left and right concentrators need not agree in size.

⁺These are possible but not likely arrangements.

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Attached: Figs. 7,9,12,20,21,22

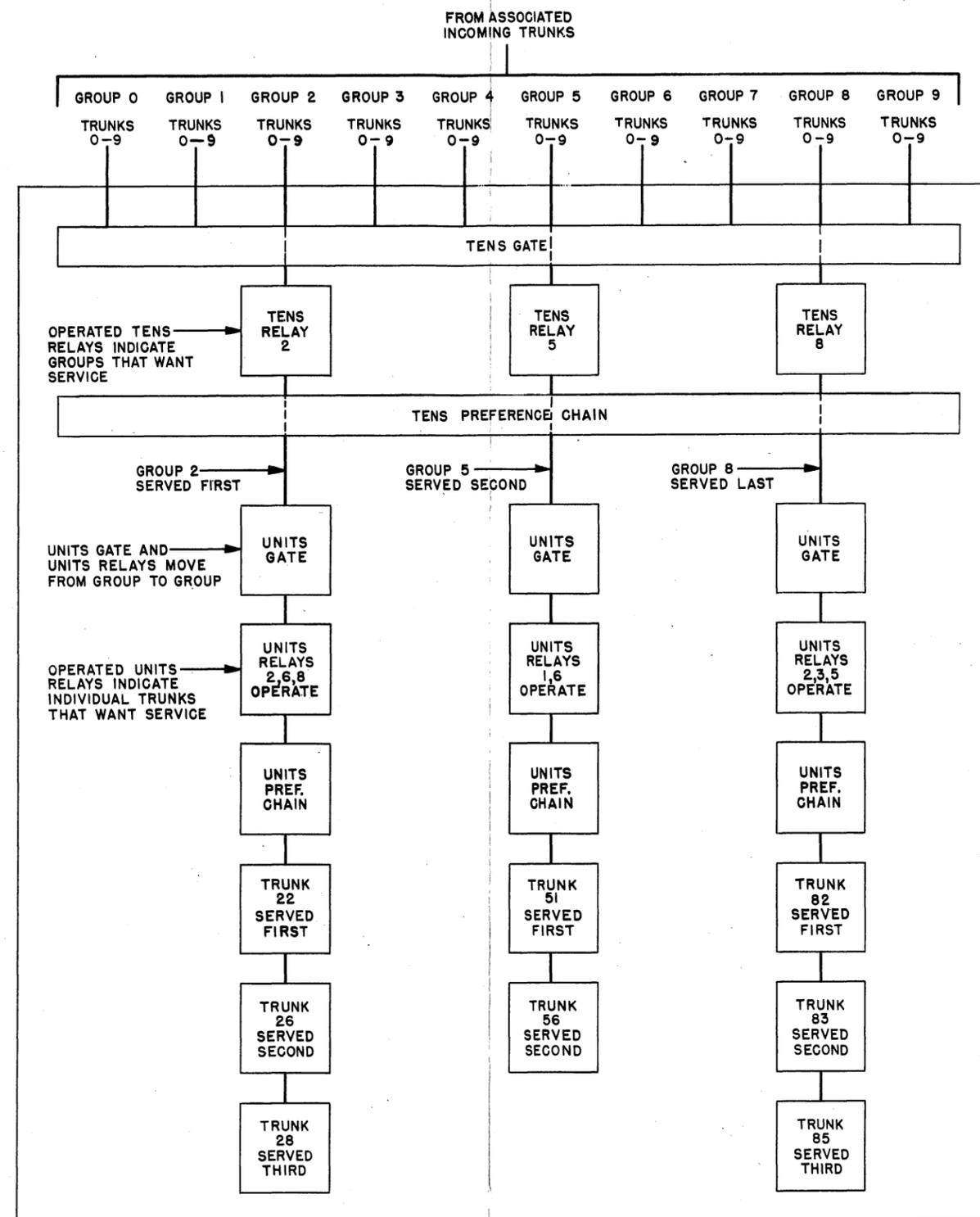


FIG.7-BLOCK DIAGRAM SHOWING INCOMING TRUNK IDENTIFICATION AND SELECTION

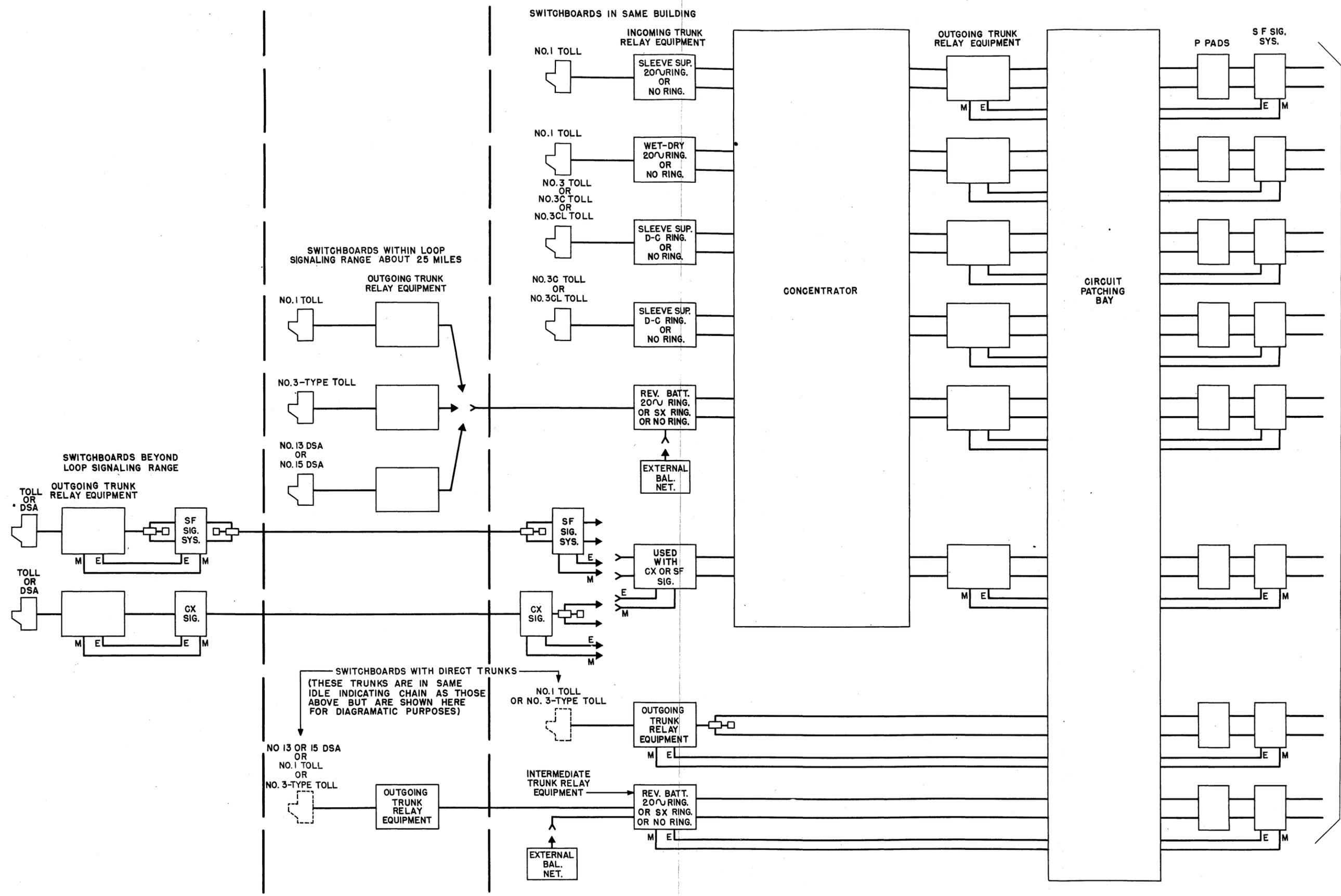


FIG. 9 - TRUNKS AND TRUNK RELAY EQUIPMENT ASSOCIATED WITH INTERTOLL TRUNK CONCENTRATING EQUIPMENT

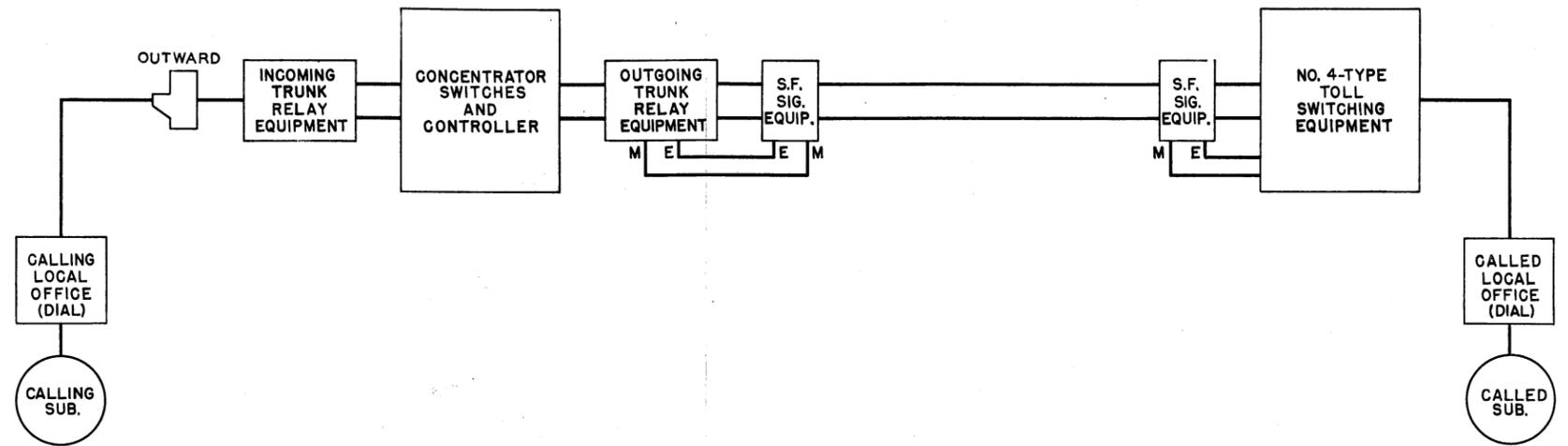


FIG. 12 - TYPICAL CALL THROUGH A CONCENTRATOR

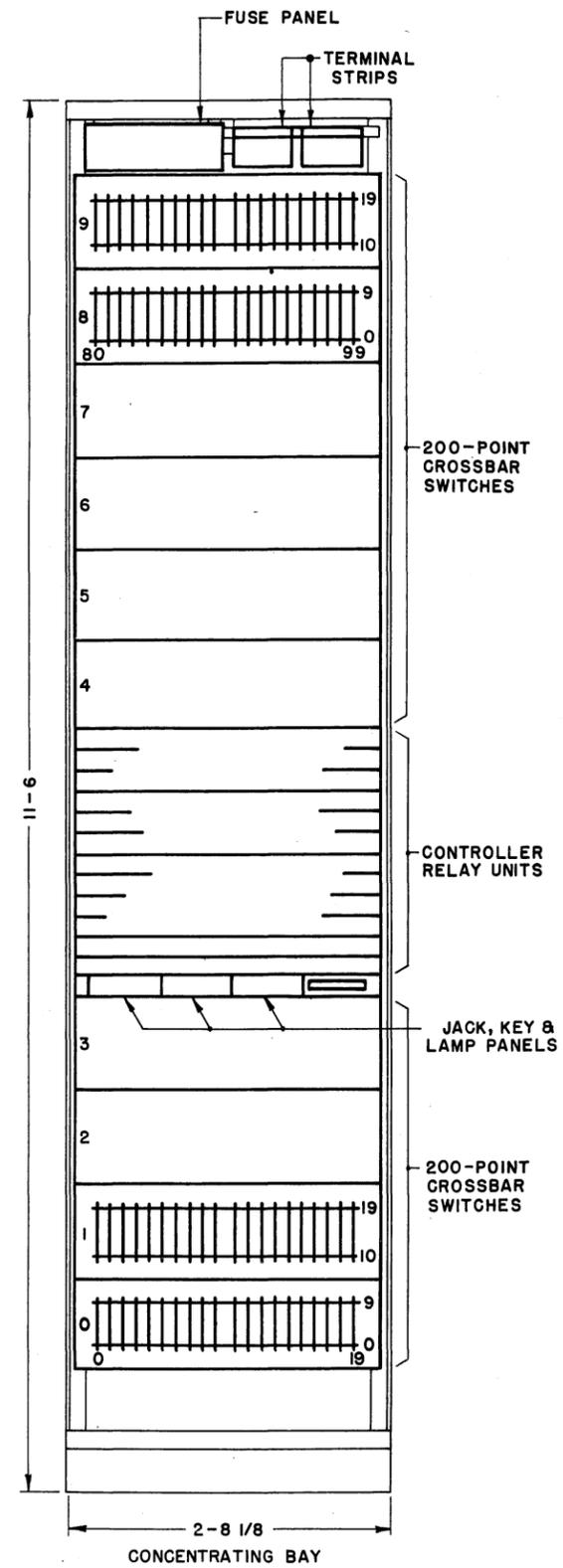


FIG. 20A - FRONT VIEW OF A 100 TO 20 CONCENTRATOR

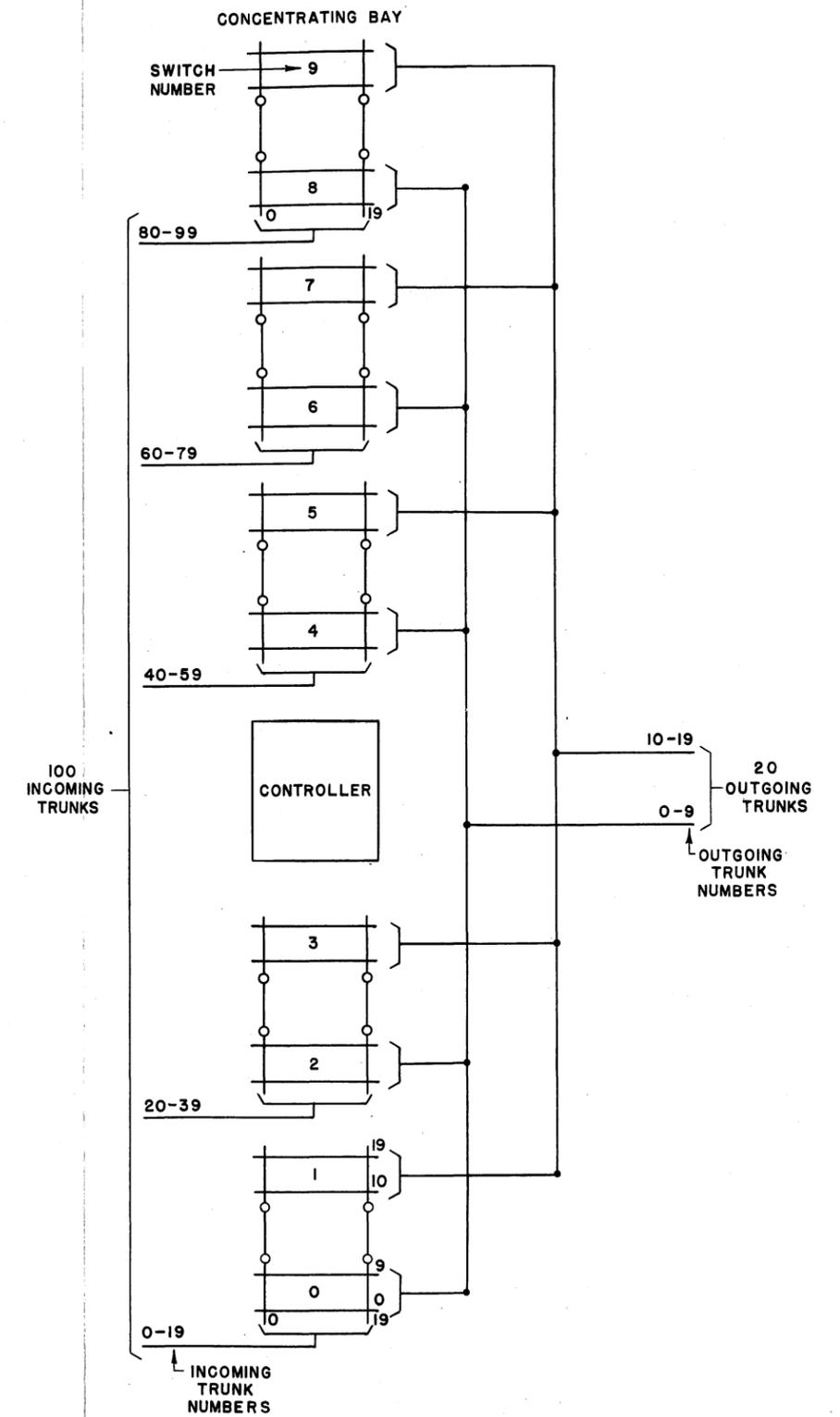


FIG. 20B - MULTIPLYING FOR 100 TO 20 CONCENTRATOR

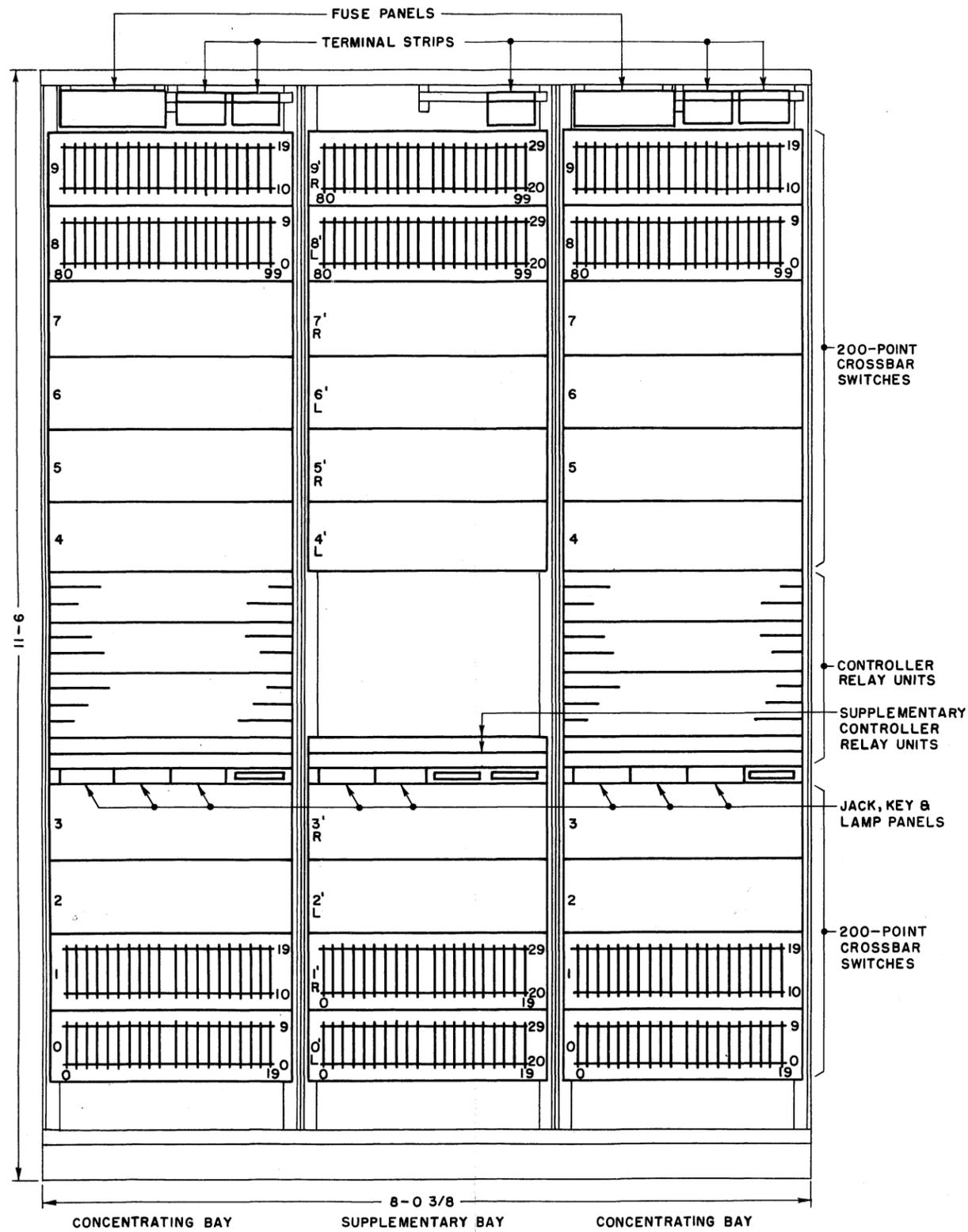


FIG. 21A - FRONT VIEW OF TWO 100 TO 30 CONCENTRATORS

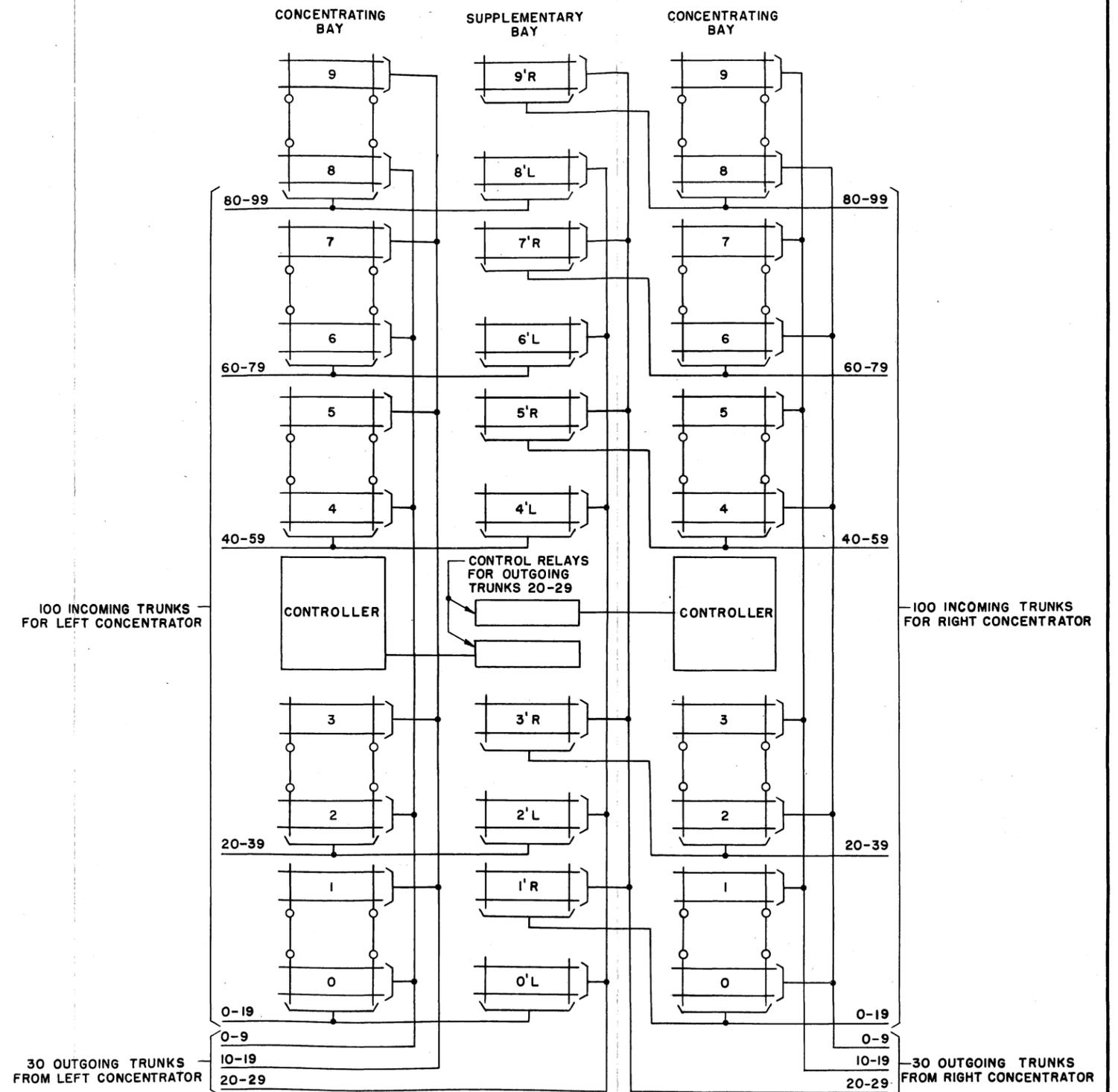


FIG. 21B - MULTIPLYING FOR TWO 100 TO 30 CONCENTRATORS

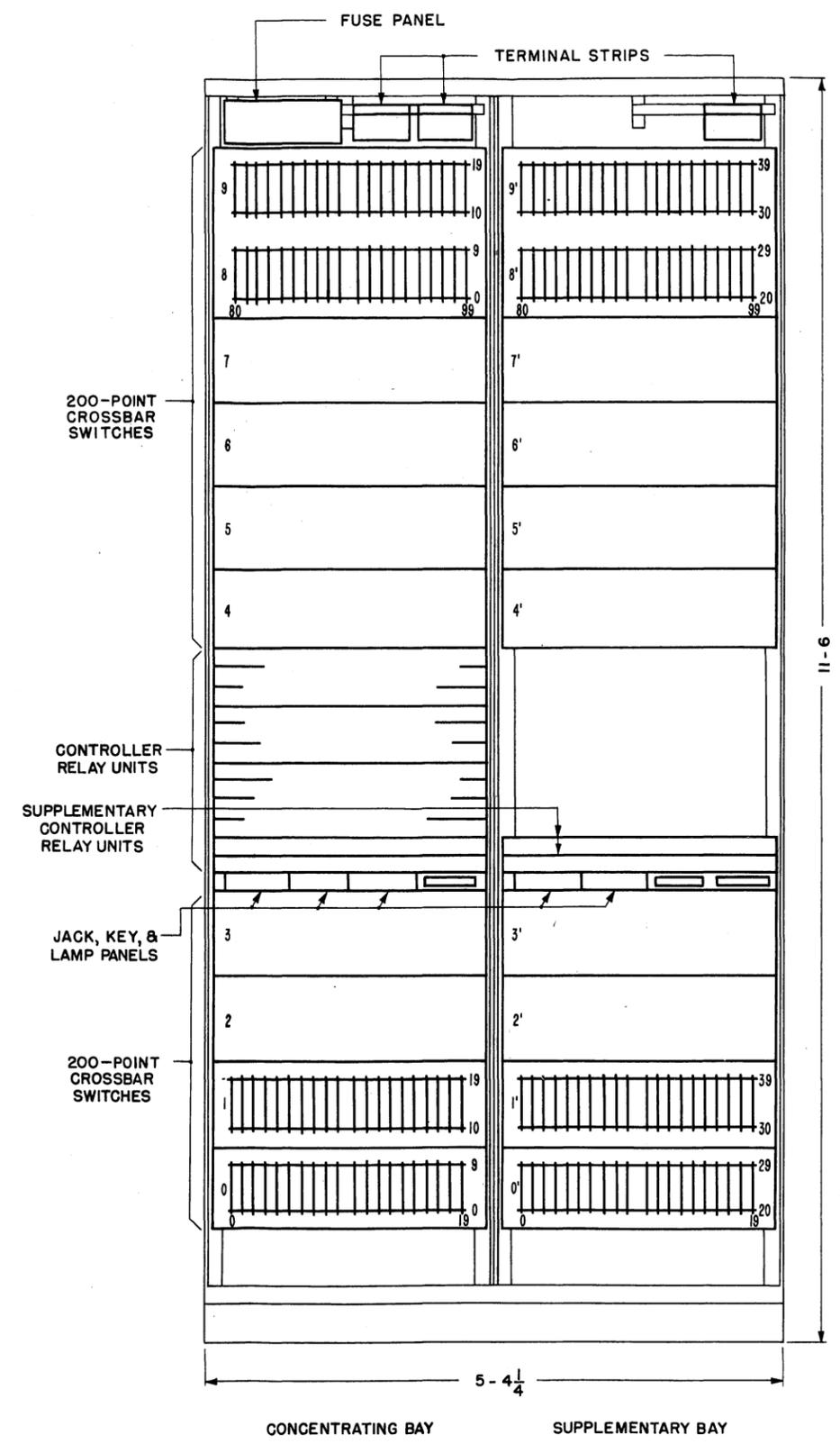


FIG. 22A - FRONT VIEW OF A 100 TO 40 CONCENTRATOR

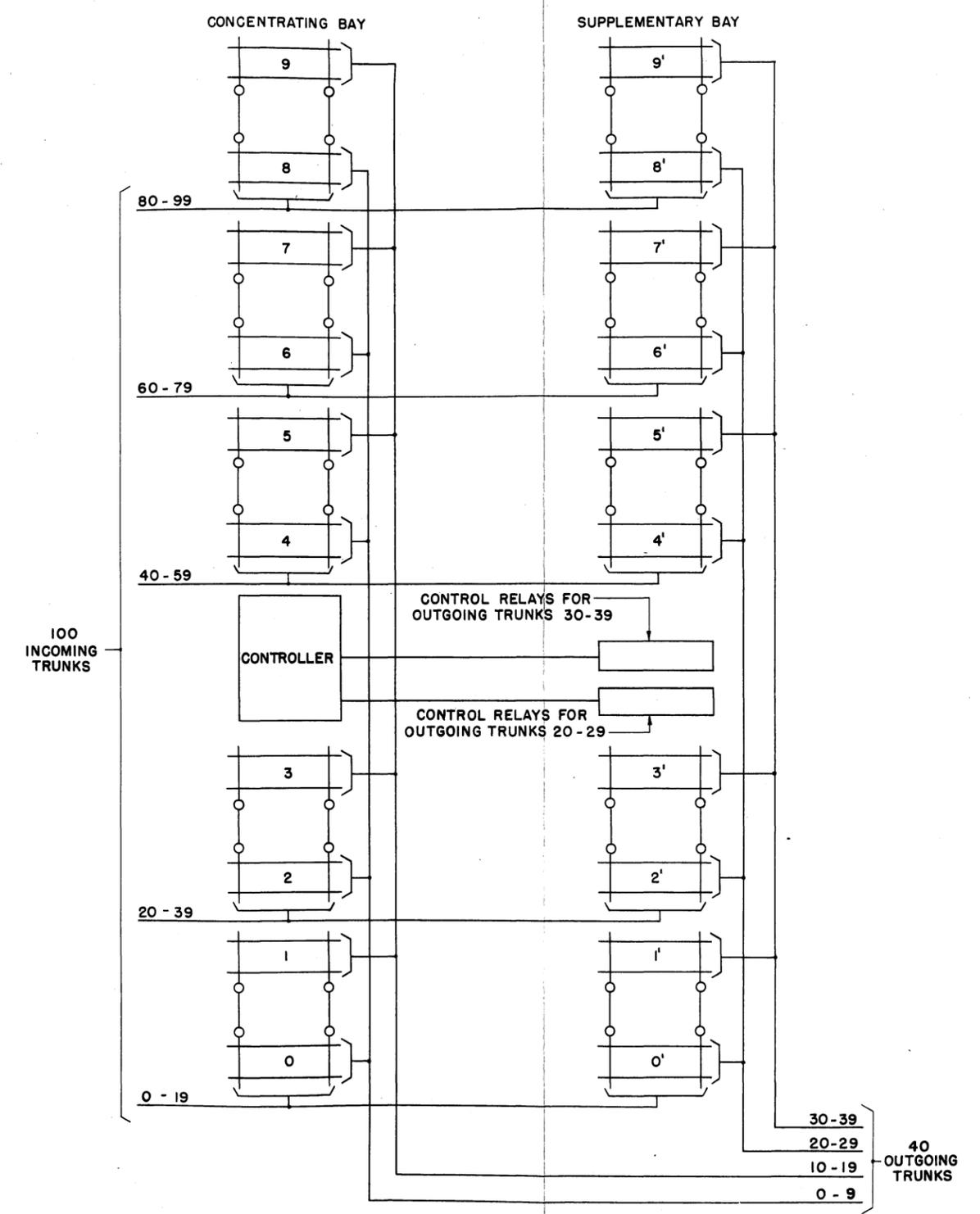


FIG. 22 B - MULTIPLYING FOR 100 TO 40 CONCENTRATOR