

81D1 TELETYPEWRITER SWITCHING SYSTEM

		DESCRIPTION	
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1. GENERAL

1.01 The 81DL system is an automatic teletypewriter message switching system designed to provide efficient and rapid handling of messages between the various stations on an extensive private line teletypewriter network involving several lines and a multiplicity of stations. Both long distance lines and short or local lines may be included. Provision is made for operating the long lines on a duplex basis with several stations on each line if desired. Local lines may also be operated on this basis but provision is made for simpler connections to local lines terminating in a single station.

1.02 All lines terminate in a switching office (Fig. 1). There may be several switching offices in a system, in which case the switching offices are interconnected by trunks. These switching offices contain the switching equipment for guiding messages to their destination and include machines for handling messages to and from the office as well as machines for storing messages briefly while switching operations are performed. Arrangements are provided at each switching office for general supervision and control of traffic flow on the network.

1.03 The entire system functions in such a manner that a message may be sent from any sending teletypewriter and recorded on any desired receiving teletypewriter or group of teletypewriters in the network without requiring manual handling other than the original perforation of tape at the sending station and the removal of the typed message from the receiving machine or machines to which it was directed. The switching operations are entirely automatic and are under the control of directing characters punched in the original transmitting tape at the head of each message and end-of-message characters punched at the end of each message.

1.04 Safeguards are provided to prevent loss of messages in case of trouble. Trouble conditions are quickly called to attention by various alarms throughout the system. These alarms indicate to operating and maintenance personnel the existence and location of trouble and other irregularities which might otherwise cause loss of messages.

1.05 One of the early applications planned for the 81DL system is a nationwide network for American Airlines. As planned this system involves three switching offices, located at New York, Chicago and Euless, Texas, and serving stations at about 126 locations

throughout the United States. A layout of its system is shown in Fig. 2.

(A) Improved Features of 81DL System

1.06 The 81DL system represents an expansion and improvement of the 81CL system now in service for five large private line teletypewriter customers. The 81CL system provided for the rapid handling of messages but without provision for the special handling of urgent messages. It provided for handling a limited amount of multiple address traffic and the switching office was arranged for a maximum of 30 input and 60 output paths on a standard basis, although two larger offices were installed on a specially engineered basis.

1.07 The 81DL system provides new and improved features as follows:

- (a) A switching office with a maximum of 60 input and 100 output paths.
- (b) The pickup and delivery of urgent messages on an expedited basis.
- (c) The handling of relatively large volumes of multiple address traffic.
- (d) Means on multi-station lines for a constant checking of the line facilities as well as the operation of station control arrangements on these lines.
- (e) Means for preventing the loss of messages bearing invalid codes on multi-station outgoing lines.
- (f) Automatic address arrangements for outlying stations.
- (g) Multiple trunks between switching offices.
- (h) Speeded-up switching functions at the switching office and a more equitable distribution, to all inputs, of access to common switching apparatus. Also more uniform distribution of load over an outgoing group of trunks or local outlet circuits.
- (i) Improved cross-office transmission and cross-office monitoring arrangements, made possible by electronic hub circuit cross-office transmission.
- (j) Improved maintenance arrangements.
- (k) Greater intercept capacity.
- (l) Improved power plant.

(B) Fields of Application

1.08 Automatic switching systems are advantageous for use for heavy duty services involving long distance lines where at least several different line circuits are included and there is a need for passing a considerable volume of traffic between circuits. In earlier arrangements, this relaying of traffic has been done either by manual recopying of the messages or by the manual handling of perforated tapes. In some later arrangements messages received in perforated tape form are relayed by operators who read the address and push a button to direct the message to the proper circuit.

1.09 The automatic switching of messages, as done in the 81C1 and 81D1 systems, has the following advantages as compared with such manual relay methods:

- (a) It eliminates much operating labor at relay offices.
- (b) It provides faster and more uniform speed of service.
- (c) It permits efficient use of long multi-point duplex circuits up to a point approaching their full capacity.
- (d) It can accommodate wide variations in load through a relay center within its capacity, and also temporary overloads, without changes in operating personnel.
- (e) Automatic operation is less susceptible to errors in handling traffic. To this end the 81D1 system is reinforced by automatic supervisory features, message interception means, and alarms to avoid difficulties from machine or circuit troubles or from operator errors.
- (f) The automatic handling of multiple address and group code messages greatly expedites them and saves much labor.
- (g) Each message is delivered only to the station or stations to which it is directed, even on multi-point circuits.
- (h) It provides efficient and economical means for local delivery of messages from switching offices or station selectors to machines located in nearby buildings or offices where such messages are ultimately used.
- (i) It provides for full control and supervision of the traffic flow from switching offices, including means for automatically intercepting and later transmitting messages

for stations which may be temporarily closed or out of service for any reasons.

1.10 In applications of 81C1 systems made to date, the average message length has been between 15 and 60 words. For messages of such length automatic switching has been found very desirable. The shorter the message length the greater is the advantage of automatic switching.

1.11 The indications are that the 81D1 system will find application for large industrial concerns, merchandising houses, manufacturing and distribution organizations, air lines, and others who have offices in widely separated cities with a need for mutual interchange of messages among their various offices on a rapid and efficient basis.

1.12 The first cost installed of the common equipment, including power supply, required for a switching office is quite appreciable, so that in general, this kind of switching system will find its main fields of application in networks involving more than 5 multi-point lines connected to one switching office and in extensive networks involving more than one switching office.

(C) General Features of System

1.13 Some of the more important features of the 81D1 system are as follows:

- (a) It may involve one or more switching offices. Where there is more than one such office they are connected by direct trunks which do not have way stations.
- (b) A total of 400 directing codes is available for assignment in any one network. Accordingly, a network might include up to 400 stations identified by individual two-character codes, or somewhat fewer stations if some codes are used for multiple address and group codes. A maximum of 200 individually coded stations can be served by one switching office, only ten first characters being available for these stations.
- (c) Any multi-point line may have connected to it up to a maximum of 10 sending and 10 receiving stations in addition to the switching office. Such lines must be operated on a full duplex basis and are limited to using only 6 first code characters and 16 codes in all.
- (d) The limit on the number of multi-point lines that can be served from one switching office is usually determined by the number of cross-office transmission paths

that can be provided and by their apportionment, 60 paths being the maximum. These paths represent inputs to the regular link circuit and are assigned to the horizontals of the crossbar switches. One such path is required for each line, but since one path is also required for each incoming trunk, each originating station and each willful intercept, the line capacity is governed by the needs for paths for the latter purposes and usually is taken at about 35 lines.

(e) In some cases, however, the line capacity of a switching office may be controlled by the maximum number of outlets available from the link circuits, rather than by the maximum number or assignment of cross-office transmission paths. These outlets are assigned to the verticals of the crossbar switches, and the maximum number of verticals in either the regular link circuit or the multiple address link circuit is 100. In the regular link circuit two to six verticals are needed for a multiple address position. In addition, one vertical is required for each local outlet station, multi-channel trunk path, willful intercept machine or miscellaneous intercept machine, and two are required for each outgoing line or single trunk. Similarly, in the case of the multiple address link circuit, one vertical is required for each local outlet station, multi-channel trunk path, and multiple address intercept machine, and two verticals are required for each outgoing line or single trunk except when urgent message arrangements are provided, in which case three are needed.

(f) Any line may be operated at either 60 or 75 words per minute. All cross-office transmission, transmission from switching office sending positions, and transmission to local outlets and multiple trunks is at 75 words per minute.

(g) All sending on the system must be on an automatic basis from perforated tape. No provision is made for direct keyboard sending.

(h) The sending from the various stations on a multi-point line is under the control of the switching office. Sending from any station on the line will be automatically started in its rotation sequence.

(i) Messages that are received from lines are recorded in perforated tape form by reperfocator-transmitters at the switching office, then transmitted through a crossbar switching system to similar machines associated with outgoing line or single trunk circuits where they are again recorded in

perforated tape form for retransmission on the required circuit when it is available. This double storage system permits the lines to operate at either of two speeds as previously mentioned but the same principle does not apply to the local outlets or multiple trunks which are directly connected to the switching unit and, accordingly, must operate at 75 words per minute.

(j) Provision is made for the handling of both single address and multiple address messages. This includes assigning each receiving station an individual two-letter code which must be used as a directing code preceding single address messages for this station.

(k) All multiple address messages are preceded by a common multiple address code and may then include as many individual station codes as desired or a group code or any combination of these. The multiple address code will carry the message to separate machinery in the switching office which takes care of its proper distribution to the various lines that are involved.

(l) Message intercepting means are provided at the switching office:

(1) To intercept automatically and record in perforated tape for manual handling any messages having codes not valid in the system.

(2) To intercept willfully all single address messages for any station or group of stations and record them in a perforated tape for automatic retransmission when it is desired to release them. This feature is controlled by keys located in the control board.

(3) To intercept willfully all multiple address and group code messages for any station or group of stations and record them in a perforated tape for manual handling and retransmission when it is desired to release them. This feature is controlled by the same keys as in (2) above.

(m) The minimum time required for a character to pass through the switching office when circuits are available is less than one second so that under favorable conditions a message may be completely delivered at its destination a few seconds after it has been sent. Except under bad overload conditions or possibly in the case of multiple address messages the messages would normally be delayed not more than a few minutes in transmission through the switching office.

- (n) Optional arrangements are available to pick up certain messages in outlying station transmitters on a priority basis before regular (non-priority) traffic is picked up.
- (o) Optional arrangements are available to handle urgent messages across the office to outgoing lines and single outgoing trunks on an expedited basis. These messages, which carry a special urgent message code ahead of their regular code or codes, are handled through the multiple address position to an additional reperforator-transmitter on heavily loaded outgoing lines or single trunks. These reperforator-transmitters are given greater opportunity to transmit their urgent messages to the lines or trunks to which they are assigned than are the two regular machines.
- (p) Arrangements can be made so that messages having certain directing codes are handled on a controlled basis so as to be transmitted through switching offices in such a way as to minimize delay of uncontrolled messages.
- (q) Automatic address arrangements are available whereby messages can be addressed automatically at outlying stations by the operation of keys.
- (r) The continuity of the multi-station lines and the operation of the station control arrangements are automatically checked after each incoming transmission and any failure alarmed at the switching office.
- (s) One receiver at each station control point can be optionally arranged to receive messages with non-valid codes for its line as well as its own messages.
- (t) Arrangements known as supplementary multiple address equipment, are available for automatically breaking down 2, 3 and 4-address messages received at a switching office into 2 messages, 3 messages or 4 messages each carrying a single code for further switching.
- (u) Testing and maintenance arrangements are provided, including means for monitoring lines and loops as well as all inputs and outputs of cross-office paths.
- (v) All circuits in the switching office except the alarm circuit are plug-connected, using multi-point plugs, so that in case of circuit or equipment trouble spares can be quickly substituted to restore service.

#### (D) Security Against Loss of Messages

- 1.14 Assurance against the loss of messages is of vital importance to the users of switching systems. Automatic switching systems are less subject than manual systems to one of the greatest sources of message loss which is human error, but they are not immune to the possibilities of human error. They are also open to possible message loss due to line failures, machine failures and switching equipment failures.
- 1.15 While proper design of machinery and circuits, good maintenance, especially of the preventive type, and adequate operator training and supervision may reduce to a minimum the probability of message loss on a system, troubles and errors will occur and messages will be lost unless some means is provided for discovering that a message is in trouble. It is of great importance also that when such conditions exist they be brought to the attention of the operating personnel forcibly and as quickly as possible so that they can be corrected and the message continued on its way to proper ultimate delivery with a minimum of lost time. This time factor is of extreme importance in the case of air lines where a delay of even a very few minutes sometimes can not be tolerated.
- 1.16 Several methods of message checking are used today on switching systems and in commercial telegraph practice. These methods are based on numbering the messages and checking their delivery from the numbers. Message numbering also provides a means of message identification and is very useful from this point of view. Further, it provides a ready means of counting messages for traffic studies and accounting purposes.
- 1.17 Two general types of message numbering are being widely used. These are point-to-point numbering, wherein a message carries its original number all the way to its destination, and channel numbering, wherein a message has a new sequential number added each time it is transmitted over a communication channel. Both of these methods require considerable clerical time for keeping records and excessive usage of line and switching apparatus time for periodic checks or number transmissions. Neither provides a quick means of discovering the loss of a message, and it may be many minutes or even hours before the operating personnel knows that a message is lost.
- 1.18 In view of the seriousness of message loss and the necessity for rapid discovery of trouble conditions, the 81D1 system

has been designed to reduce greatly the probability of message loss and also to alarm trouble conditions to a degree far beyond that

provided for in the 81C1 system. The security provisions in the 81D1 system are summarized below:

<u>Condition That Might Cause Message Loss or Serious Delay</u>	<u>Indication or Automatic Action</u>
(a) Substitution by originating operator of a different valid code for the proper code in a message.	(a) Delivery of message at wrong station. (It is the responsibility of the receiver of such a misdirected message to take appropriate action.)
(b) Presence of an invalid code in a message, caused either by error on the part of originating operator or by garbling between point of origin and switching office.	(b) Message appears on miscellaneous or multiple address intercept, with visual and audible alarm at switching office.
(c) Failure to use end-of-transmission signal.	(c) Automatic end-of-transmission after 45 seconds.
(d) Incoming line or trunk goes open.	(d) Visual and audible "Line Trouble" alarm at switching office.
(e) Incoming multi-station line closes down.	(e) Visual and audible "No Response" alarm at switching office on next transmitter start attempt.
(f) Incoming line reperforator-transmitter (or 15 R0 machine when used) not responding to signals.	(f) Visual and audible "Machine Trouble" alarm at switching office.
(g) Tape not feeding through punch blocks on incoming reperforator-transmitter.	(g) Visual and audible "Machine Trouble" alarm at switching office.
(h) Low tape supply on incoming reperforator-transmitter.	(h) Visual and audible "Tape Out" alarm at switching office.
(i) Torn tape at transmitter of incoming reperforator-transmitter.	(i) Visual and audible "Tape Out" and "Director Tie-up" alarms at switching office.
(j) Failure of switching office operator to provide sufficient tape at originating station to feed end-of-message signal through transmitter.	(j) Visual and audible "Director Tie-up" alarm at switching office after 30 seconds.
(k) Torn tape during transmission of message from originating station.	(k) Visual and audible "Director Tie-up" alarm at switching office.
(l) Failure of end-of-message signal to appear on multi-station incoming line, no tape available to send in incoming reperforator-transmitter and no incoming signals for 45 seconds.	(l) Automatic generation and transmission of end-of-message signal across office. (This is to clear the tie-up of the cross-office path which may involve a number of outlets.)
(m) Failure of a director to complete its connecting function.	(m) Visual and audible "Director Tie-up" alarm at switching office.

<u>Condition That Might Cause Message Loss or Serious Delay</u>	<u>Indication or Automatic Action</u>
(n) Failure of sequence circuit to complete its functions in 3 seconds.	(n) Visual and audible "Director Common" alarm at switching office.
(o) Attempt by director to make a double connection across office.	(o) Visual and audible "Director Tie-up" alarm at switching office.
(p) A cross-office path has been established to a reperforator-transmitter and it fails to respond to signals or the tape fails to feed through the punch blocks.	(p) Visual and audible "Director Tie-up" and "Tape Out" or "Machine Trouble" alarms at the switching office.
(q) A cross office path has been established to an intercept typing reperforator or to a 15 RO or typing reperforator of a local outlet equipped with machine alarm and the machine fails to respond to signals.	(q) Visual and audible "Director Tie-up" and "Machine Trouble" alarms at the switching office.
(r) Low tape supply in reperforator-transmitters and typing reperforators reached across office.	(r) Visual and audible "Tape Out" alarm at the switching office and automatic busy placed on path at end of the message.
(s) Supplementary multiple address equipment fails to complete its functions.	(s) Visual and audible "Sequence" alarm at switching office.
(t) Torn tape at transmitter of any reperforator-transmitter reached across office.	(t) Visual and audible "Tape Out" alarm at switching office.
(u) If any character other than "Letters" follows a "Figs. H" in transmission to an outgoing line or single channel trunk.	(u) Visual and audible "Tape Out" alarm at the switching office.
(v) Power failure at a local outlet station not equipped with machine alarm.	(v) Station made busy automatically.
(w) Open outgoing multi-station line.	(w) Visual and audible alarm at all stations to which the line is open. (See also (z).)
(x) Open single station line or line to local outlet.	(x) Receiver runs open.
(y) Open outgoing trunk.	(y) Visual and audible "Line Trouble" alarm at switching office at receiving end of trunk.
(z) Closed down multi-station outgoing line or failure of SOTUS unit to operate or sending station to send when tape is available.	(z) Visual and audible "No Response" alarm at switching office on next transmitter start attempt.
(aa) Code mutilated after being switched to multi-station line.	(aa) Visual and audible alarm and message printed at all master stations on line if option is used.

<u>Condition That Might Cause Message Loss or Serious Delay</u>	<u>Indication or Automatic Action</u>
(ab) Sending station has been stopped by an emergency stop.	(ab) Visual and audible "Emergency Stop" alarm at station stopped or at last station to have sent.
(ac) Attempt to turn off station control power when SOTUS is in deactivated condition.	(ac) Power will not turn off until end-of-message signal is received.
<u>2. GENERAL OPERATION OF SYSTEM</u>	
<u>(A) Operating Principles</u>	
2.01 The general operation of the system is based on the use of one or more two-letter directing codes (hereinafter referred to as directing codes) at the beginning of each message to direct it automatically through the system to its ultimate destination. Release of the switching path is effected by the use of a second, two-character, end-of-message code at the end of each message. The general scheme of operation will be explained with reference to the system diagram for American Airlines (Fig. 2), following the course of four typical messages: first, a single address regular message; second, a regular multiple address message; third, a regular group code message; and finally, an urgent message.	2.03 Assuming there is no accumulation of perforated tape in the reperforator-transmitter at New York, the transmitter will read the directing code characters and, through the action of relay and crossbar switching equipment, will set up a transmission path across the New York office to an available one of two similar reperforator-transmitters associated with the outgoing line serving Roanoke. The directing code, message and end-of-message signals will then be transmitted across the office to the outgoing line reperforator-transmitter. The end-of-message code will cause the cross-office connection to be released.
<u>(B) Regular Single Address Message</u>	2.04 The message is now in the outgoing line reperforator-transmitter, ready for transmission as soon as any messages that have preceded it and are likewise waiting for transmission have been cleared. At this time, the directing code and message will be sent on the Roanoke line and through the action of a station selector unit located in the Roanoke office the directing code will cause the Roanoke receiving teletypewriter to be connected and to record the message. The "Line Feed" signal which normally follows the single address code serves as an end-of-address code and prevents further station selection.
2.02 Assume Providence has a message to send to Roanoke. The Providence operator perforates a tape including, first, the Roanoke directing code at the start, then the message, and, finally, the end-of-message code. This tape is inserted in the Providence transmitter and when the transmitter is started in response to control signals from the New York switching office, the message will be transmitted to New York, where it will be received on a reperforator-transmitter.	2.05 At other stations on the Roanoke line, similar station selectors are in action but, the directing code being for the Roanoke station only, these other station selectors keep the other stations in a non-printing condition. At the end of the message the end-of-message code will disconnect the Roanoke teletypewriter and restore it to a normal non-printing condition.
<u>Note:</u> The reperforator-transmitter (see Fig. 3) is a key instrument in the switching office and consists of a typing reperforator, as a receiving element, closely associated with a pivoted type transmitter for resending the received signals from the perforated tape. The resending may be delayed and tape may accumulate between the transmitter and reperforator but the transmitter can, through its pivoting action, creep up the tape and send out the last code combination which has been perforated so that nothing is left stored in the machine.	<u>(C) Multiple Address Message</u>
	2.06 Assume that Providence wishes to send the same message to Roanoke, Peoria, and Los Angeles. The message is first perforated in tape by the Providence operator as previously described except for the directing code. In this case the directing codes will consist

of (1) a two-character code to indicate that it is a multiple address message, followed by the directing codes for (2) Roanoke, (3) Peoria, and (4) Los Angeles and the "Carriage Return" and "Line Feed" signals to start the message.

2.07 The message is transmitted to New York and received there on a reperforator-transmitter as before. In this case, however, when the transmitter reads the first two characters indicating a multiple address message, it will establish a cross-office path to a reperforator-transmitter in the multiple address equipment. All directing codes and the message are then sent across office to this multiple address equipment and recorded there.

2.08 The multiple address equipment has its own directing circuits with separate paths to the outgoing line reperforator-transmitters. Thus, when it reads the directing codes of this message a path is first established to a reperforator-transmitter for the Roanoke outgoing line and the Roanoke directing code recorded on it. This path is held but blinded while a path is established to an outgoing trunk reperforator-transmitter for Chicago. A multiple address code is then automatically sent on this path followed by the Peoria code. This path is then also held and blinded while a path is established to an outgoing trunk reperforator-transmitter for Eules. A multiple address code is then automatically sent on this trunk followed by the Los Angeles code. The "Carriage Return" signal then serves as an end-of-address indication for the multiple address equipment, and the reperforator-transmitters to the Roanoke line, the Chicago trunk and the Eules trunk are unblinded and made responsive so as to record the "Carriage Return," the message and the end-of-message signals. The end-of-message signal causes disconnection of the cross-office paths in the New York office.

2.09 The message is then sent to Roanoke as before and separately to the Chicago and Eules switching offices where it is again recorded on reperforator-transmitters. As in the New York switching office, there is also multiple address equipment in the Chicago and Eules offices to which this message will be directed in a similar manner and whence it will be retransmitted to reperforator-transmitters for the outgoing lines to Peoria and Los Angeles. From these units, it will be sent on these lines and recorded at the stations at Peoria and Los Angeles, each of which has a station selector, similar to the one described for Roanoke, to direct the message to the desired teletypewriter.

#### (D) Group Code Message

2.10 Assume there is a considerable volume of messages from Providence to the same three stations in Roanoke, Peoria and Los Angeles as described for the multiple address message. This group of stations might then be assigned a single two-character group code, for example, "CL." In perforating the original tape in Providence, the operator would use the two-character multiple address code previously mentioned, followed by the group code "CL" which, when received in New York, would direct the message to the multiple address position whence it would be automatically directed to the Roanoke line, the Chicago trunk and the Eules trunk. The station selector at Roanoke would also be arranged to cut on its receiving machine on reception of the "CL" code as would the station selectors at Peoria and Los Angeles. When the message was received in Chicago and Eules, it would likewise be directed to multiple address positions and from them to the Peoria and Los Angeles outgoing lines, so that from this one group code address it would automatically flow through the system and be recorded at the three ultimate destinations which had been preassigned to be reached by any message carrying the directing code "CL."

2.11 In similar manner, messages may flow from any one point in the system to another point or points as determined by the directing codes preceding the messages.

#### (E) Urgent Message

2.12 Assume Providence wishes to send an urgent message to Roanoke. The Providence operator perforates a tape including, first, a two-character urgent message code, followed by the Roanoke directing code, the message and the end-of-message code. Since Providence has a requirement for sending urgency messages the transmitting station is equipped with a priority key. The Providence operator inserts the tape in the transmitter and operates the priority key. The transmitter will be started by control signals from the New York switching office before any other transmitter on the line with regular messages is started and the message will be transmitted to New York where it will be received on a reperforator-transmitter as before. In this case when the transmitter in the New York switching office reads the urgent message code, it will establish a connection to one of a group of reperforator-transmitters assigned to urgent messages in the multiple address equipment.

2.13 The multiple address director will service this message ahead of regular messages waiting in other reperforator-transmitters of the multiple address equipment. If the Roanoke line is a heavily loaded line a third outgoing reperforator-transmitter for urgent messages only will be provided on that line. The multiple address arrangements will establish a connection to this third reperforator-transmitter and send the Roanoke code, the message and the end-of-message code to it. The third reperforator-transmitter is accorded greater opportunity to transmit to the line than the two used for regular messages and will transmit the message to Roanoke as before.

2.14 Urgent multiple address messages are handled in the same way except that several outgoing lines or trunks are selected as described under (C). When an urgent message is sent to a trunk it is preceded by an urgent message code to identify it as an urgent message at the next switching office.

#### (F) Typical Facilities Used

2.15 Typical facilities used to accomplish these purposes in a switching office and on its connected lines are shown in block diagram form in Fig. 4. This diagram shows a multi-point line, a single station line, a single channel trunk and a multi-channel trunk, all connected to a switching office which has an originating station machine, local outlets, intercept machines, a multiple address position, including group code equipment, and supplementary multiple address equipment. The heart of the switching office is the crossbar switch (designated "LINK" on the figure) which serves to connect incoming line or originating station positions to the proper outgoing line, local outlet, intercept or multiple address positions.

2.16 The specific functions of the various circuits and equipment shown on this diagram will be explained later. In general, however, messages received from incoming lines are recorded in perforated tape by the reperforator-transmitter. The transmitter section of this unit is connected to a director which reads and interprets the directing codes and, when given permission to act by the sequence circuit, establishes a connection through the link to the called-for outlet or multiple address position, and causes transmission of the message. The reading of the end-of-message code by the director causes the link connection to be broken down. The multiple address position also includes a director and circuits for making multiple connections directly to any desired group of outgoing line, trunk or local

outlet machines as required for proper delivery of the message to its various addresses.

#### (G) Directing and Other Codes

2.17 Directing Codes: Of the 32 available teletypewriter selections, 20 have been set aside for use in two-character directing codes as follows: A B C D E F G I J K L N P Q R S U W X Y (all letters except H M O T V Z). Only letters of the alphabet are used for directing codes, selections such as "Carriage Return," "Line Feed," and other functions having been considered unsuitable for the purpose. The letters T O M and V are not used because they are subject to accidental production in the system due to a hit on an idle line, and the characters H and Z are used for other directing functions on incoming lines to a switching office equipped with a receiving teletypewriter to record terminating messages.

2.18 Z is used as a second character (to follow any first character chosen from the above group of 20 to represent the switching office) and serves to connect the incoming line to the receiving teletypewriter for recording the message, and to blind the incoming line reperforator-transmitter so it will not record the message. H is used as a second character (to follow the same first character chosen above to represent the switching office) and serves to make both the receiving teletypewriter and the reperforator-transmitter effective to record the incoming message so that it may also go to the other addresses through the switching equipment.

2.19 End-of-Message Code: The end-of-message code which has been previously mentioned is made up of the three characters, FIGSH LTRS. This reacts throughout the system to release switching paths which have been established and to alert them for resetting in accordance with the directing code which will precede the next message.

2.20 End-of-Transmission Code: For efficient operation of multi-point lines, it is desirable to have a signal received at the switching office immediately upon completion of the transmission of messages from one station so that, without delay, signals may be sent to start the transmitter of another station on the line. To accomplish this, it is necessary for the operator at the outlying point to perforate a special end-of-transmission code in the tape containing the messages to go in one transmission and then to tear off the tape eight LTRS characters after it. The transmitter is equipped with a tape out pin to detect when the tape has run out and to stop the transmitter so

that following the sending of this end-of-transmission signal about two LTRS characters will be sent and the transmitter then stopped. The end-of-transmission code consists of the two characters H LTRS (immediately after FIGS H LTRS at the end of the last message) and should be followed by eight more LTRS signals on the tape.

### 2.21 Desirable Start-of-Transmission Signals:

While not technically necessary, it is desirable to start each new transmission from an outlying station with an end-of-message code FIGS H LTRS, preceding the first directing code for a message. This is to insure the automatic clearing of all switching paths ahead of a new transmission in case there has been any line hit or other interruption or irregularity during an idle period.

## 3. TYPICAL MESSAGE TAPES

3.01 In the following examples covering the preparation of message tapes the directing code for a given station or group of stations is inserted only once at the head of a message. Any mutilation of this code due to transmission or machine errors will deliver the message either (a) to the wrong station, if the code has been changed to another assigned code, (b) to an intercept machine at some switching office, if it has been changed to an unassigned code, or, in the case where the mutilation takes place during transmission on a multi-station outgoing line, (c) to one or more master stations on the line as desired.

### (A) Message Tapes Prepared at Outlying Stations on Multi-Point Lines

3.02 Typical sections of message tapes as prepared by an operator at an outlying station on a multi-point line are described below giving first the composition of a typical tape for one transmission, comprising three single address messages, and then typical tape sections for multiple address and urgent messages.

3.03 In all of these tapes the signals CAR RET, LINE FEED, LTRS, have been shown as following the address codes and preceding the message. These are the signals usually recommended for starting a message in the operation of all types of teletypewriter service, to assure that the machine receiving the message will be in the proper condition to record it. In the 81DL system, however, the CAR RET and LINE FEED signals are necessary also for switching purposes, to serve as an end-of-address code.

3.04 A typical tape for one transmission, comprising three single address regular messages for stations AA, AC and CD, respectively, is as follows:

```
AHVAAV<≡V(MESSAGE)AHVACV<≡V(MESSAGE)AHVCDV<≡V(MESSAGE)AHVHVVVVVVVVVVV
```

▲ indicates FIGS character ) Used generally  
▼ indicates LTRS character ) in following  
< indicates CAR RET character ) tape descrip-  
≡ indicates LINE FEED character) tions.

3.05 A typical section of tape for a regular multiple address message for these same stations would be as follows:

```
BCVAAVACVCDV<≡V(MESSAGE)AHV
```

In this example the BC directing code is typical of one that might be assigned to indicate that the message is a regular, multiple address message. If the two-character combination BC were chosen for this purpose, it would be used universally by all operators throughout the system. Following this code any number of directing codes including a group address code might have been added, if desired.

3.06 A typical section of tape for a regular group code message for these same three stations, assuming they were assigned the group code CL, would be as follows:

```
BCVCLV<≡V(MESSAGE)AHV
```

If desired, other addresses involving individual station codes such as FE and LD might have been added to the group, giving a section of tape as follows:

```
BCVCLVFEVLDV<≡V(MESSAGE)AHV
```

The directing codes that follow the multiple address code BC in the tape may be placed in any order desired, and, in addition, the code pattern may consist of any combination of group codes and individual station codes desired.

3.07 A typical section of tape for an urgent single address message would be as follows:

```
PCVAAV<≡V(MESSAGE)AHV
```

In this example the PC directing code is typical of one that might be assigned to indicate that the message is an urgent message. If the two-character combination PC were chosen for this purpose it would be used throughout the system by all operators who were permitted to send urgent messages.

3.08 Urgent multiple address and group code messages are prepared in the same manner as regular multiple address and group code messages except that the urgent message code PC is substituted for the regular multiple address code BC.

3.09 Typical tapes for messages to be handled by supplementary multiple address equipment, when such equipment is provided, are as follows:

(a) Two address

**EAVAACV < ≡ V(MESSAGE)AHV**

Where EA is the directing code assigned to two address messages to be handled by supplementary multiple address. This code would be used universally throughout the system for this type of message.

(b) Three address

**EBVAACVCDV < ≡ V(MESSAGE)AHV**

Where EB is the directing code assigned to three address messages to be handled by supplementary multiple address.

(c) Four address

**ECVAACVCDVDCV < ≡ V(MESSAGE)AHV**

Where EC is the directing code assigned to four address messages to be handled by supplementary multiple address.

(B) Message Tapes Prepared at Outlying Stations on Single Station Lines

3.10 At outlying stations on single station lines the tape preparation procedures are the same as those for stations on multi-point lines except that the end-of-transmission code may be omitted.

(C) Message Tapes Prepared at Originating Stations in Switching Offices

3.11 Tape preparation procedures at originating station positions in switching offices are the same as those previously described except that the tapes are usually continuous and they do not contain start-of-transmission or end-of-transmission codes. At these positions, sufficient tape should be kept perforated ahead so that the tape stop lever on the transmitter will not be operated for more than 30 seconds at a time during the sending of a message as this will cause an alarm condition. When there are no more messages to be perforated, sufficient LTRS characters should be perforated in the tape to insure that the last message will be fed completely through the transmitter.

(D) Message Tapes Prepared at Outlying Stations on Lines Equipped with a Receiving Teletypewriter at the Switching Office

3.12 Typical sections of tape, each illustrating one message, as prepared at such stations to include recording on the receiving teletypewriter associated with the incoming line circuit at the switching office, are given below:

(a) Typical tape section for a regular or urgent message to be recorded on the incoming line Receiving Only Teletypewriter:

**GZV < ≡ V(MESSAGE)AHV**

In this case, G has been chosen as a first character to represent the switching office (cf. Par. 2.18).

(b) Typical tape section for a regular message to be recorded on the incoming line Receiving Only Teletypewriter and at one other station in the system (cf. Par. 2.18):

**GHVAACV < ≡ V(MESSAGE)AHV**

(c) Typical tape section for an urgent message to be recorded on the incoming line Receiving Only Teletypewriter and at one other station on the system:

**GHVPCVAACV < ≡ V(MESSAGE)AHV**

In this case PC is taken as the typical urgent message code.

(d) Typical tape section for a regular message to be recorded on the incoming line Receiving Only Teletypewriter and to have additional multiple addresses:

**GHVBCVAACVCDV < ≡ V(MESSAGE)AHV**

In this case, BC is taken as the typical multiple address code and AA, AC and CD are individual station codes. One or more group codes could also be included, if desired, following the BC code.

(e) Typical tape section for an urgent message to be recorded on the incoming line Receiving Only Teletypewriter and to have additional multiple addresses:

**GHVPCVAACVCDV < ≡ V(MESSAGE)AHV**

In this case, PC is taken as the typical urgent message code. One or more group codes could also be included, if desired, following the PC code.

4. STATION ARRANGEMENTS AND EQUIPMENT(A) Outlying Stations

4.01 Outlying stations consist of Receiving Only Teletypewriters or Typing Reperforators for receiving purposes and No. 19 Teletypewriters or Automatic Address Arrangements for sending purposes.

(B) Automatic Address Arrangements

4.02 Automatic address arrangements are available for outlying sending stations on either multi-point or single station lines. With these arrangements messages may be automatically addressed and introduced into the 81D1 system. The addressing of the messages as well as the automatic addition of end-of-message codes is accomplished by push button keys, a control circuit and a double reperforator-transmitter.

Note: The double reperforator-transmitter is a teletypewriter machine consisting of two reperforator-transmitters individually controlled but mounted on a single base and driven by a single motor. Each of these reperforator-transmitter units is similar in function to the reperforator-transmitter used in the switching offices except that it does not print on the tape.

4.03 The double reperforator-transmitter along with the tape storage and handling arrangements, a double reel motor driven tape winder, the control circuit, alarm lamps, control keys, power switches and rectifiers are mounted in a steel cabinet 78" high, 27" wide and 24" deep (Fig. 5). This cabinet, which is furnished with a gray-green wrinkle finish, is arranged with sliding shelves to provide for easy access to the machines and circuits for maintenance and installation purposes. The address keys and certain other control keys and control lamps are provided separately in a panel locally engineered to fit the mounting and housing requirements of the particular installation where they are used.

4.04 The automatic address arrangements can be used where a limited number of message address patterns is required and where speed and accuracy of coding are demanded to such a degree as to justify the increased cost of such a station as compared to that of an ordinary sending station consisting of a 19-type set. These arrangements may be provided in several different ways to meet different requirements for introducing traffic into the 81D1 system. The present automatic address arrangements are designed to answer the need for a specific type of service used primarily by the air lines.

4.05 At certain control points on air lines systems radio operators, who are in communication with airplanes by means of VHF radio-telephone, receive operations reports that must be sent to distant points on the system as rapidly and with as little extra effort as possible. The automatic address arrangements are used to provide this type of service. The radio operator types the message or report on a 15-type keyboard teletypewriter as he receives it and a perforated tape copy is simultaneously made in one of the reperforator-transmitters of the double unit. This tape copy serves as a temporary storage to which address and end-of-message codes can be added later for 81D1 system transmission.

4.06 The automatic address control circuit consists of 46 U and Y-type relays, two 255A polar relays, one 209-type selector and 7 vacuum tubes. Its functions are as follows:

- (a) To cause perforation of a message sent from a 15-type teletypewriter keyboard on the first unit of a double reperforator-transmitter.
- (b) To produce a page copy of the message on the 15-type machine.
- (c) To provide for automatically introducing the end-of-message code (FIGS H LTRS) at the end of each message in the first unit of a double reperforator-transmitter.
- (d) To provide for introducing from one to five directing codes automatically at the head of a message by the operation of a push button address key which causes these codes to be perforated in tape on the second unit of a double reperforator-transmitter.
- (e) To provide for automatically perforating the CAR RET, LINE FEED, LTRS signals following the address codes in the tape of the second unit of the double reperforator-transmitter.
- (f) To provide for transmitting the message and end-of-message signal from the first unit to the second unit of the double reperforator-transmitter so that a complete message tape with all switching characters appears on the tape of the second unit.
- (g) To provide normally for ten of the address keys but not limit the number that may be used. (Each additional address key will require the addition of a relay in the control circuit.)
- (h) To provide for automatically sending an end-of-transmission signal (H, LTRS)

when all the tape in the second unit of the double reperforator-transmitter has been sent to the line and no messages are being processed. This feature is used only when these arrangements are employed on multi-point lines.

(i) To provide for sending a message which has been copied on the 15-type machine and perforated on the first unit of the double reperforator-transmitter over a local circuit to a local receiving machine. This is accomplished by the operation of a push button LCL key. This operation introduces the end-of-message signal at the end of the message in the first unit and transmits CAR RET, LINE FEED, LTRS to the local circuit before transmitting the message.

(j) To provide a means for addressing messages manually from the 15-type teletypewriter keyboard. This is done by the operation of a locking twist key designated MA which permits the keyboard to send codes to the second unit of the double reperforator-transmitter. The restoration of this key first introduces the end-of-message signal at the end of the message in the first unit of the double reperforator-transmitter, then introduces CAR RET, LINE FEED, LTRS following the codes in the second unit, and finally causes the message and end-of-message signal that has been perforated in the first unit to be transmitted to the second unit, all automatically.

(k) To provide a means of cancelling a message that has been perforated on the first unit of the double reperforator-transmitter. This is done by the operation of a push button type CAN key, which causes the first unit of the double reperforator-transmitter to step the tape through its transmitter without transmitting it anywhere.

(l) To provide means of preventing improper operation of either the 15-type teletypewriter keyboard or the control keys from interfering with the operation of the circuit and also to prevent the keyboard from sending a FIGS H.

(m) To provide for making a copy of a message on the 15-type teletypewriter only. This is done by means of a locking twist key designated COPY and it overrides any alarms that would otherwise disable the keyboard. Thus, messages can be typed even under conditions of trouble in the automatic address equipment.

(n) To light a lamp designated W on the key control panel while the circuit is in the process of addressing a message to indicate that another address or control key should not be operated.

(o) To light a lamp designated T on the key control panel while the manual address key is operated.

(p) To light a lamp designated C on the key control panel when the key for copy on the 15-type teletypewriter only is operated.

(q) To recognize a low tape supply condition for either unit of the double reperforator-transmitter, light a TAPE REEL OUT lamp at the machine cabinet and a BSY lamp at the key control panel, sound an audible alarm and disable the 15-type teletypewriter keyboard.

(r) To recognize a torn tape condition between the punch block and the transmitter of either unit of the double reperforator-transmitter, stop the transmitter of that unit, light a TAPE OUT lamp associated with that unit at the machine cabinet, sound an audible alarm, light a BSY lamp at the key control panel and disable the 15-type teletypewriter keyboard and the address keys.

(s) To provide an alarm in case either unit of the double reperforator-transmitter is not receiving signals when it should or in case the feed holes in the tape on either unit are torn, light a MCH lamp at the machine cabinet associated with the unit in trouble, stop the transmitter of the unit in trouble, sound the audible alarm, light the BSY lamp at the key control panel and disable the 15-type teletypewriter keyboard and the address keys.

(t) To provide TRANS STOP keys at the machine cabinet for manually stopping the transmitter of either unit of the double reperforator-transmitter.

(u) To provide a MAKE BUSY key at the machine cabinet for making the circuit busy. This key also lights the BSY lamp on the key control panel and disables the 15-type teletypewriter keyboard and the address keys.

(v) To provide an alarm in case a fuse blows in the control circuit, light a FUSE ALM lamp at the machine cabinet, sound the audible alarm, light the BSY lamp at the key control panel and disable the 15-type teletypewriter keyboard and the address keys.

- (w) To provide an AUD ALM SUP key at the machine cabinet for suppressing the audible alarm.
- (x) To provide an ALM RLS key at the machine cabinet for releasing alarm indications.
- (y) To cooperate with the station control circuit in starting and stopping transmission to the line.

(C) Stations on Single Station Lines

4.07 No control arrangements are required on single station lines and the Receiving Only Teletypewriter may consist of a No. 15-type machine mounted on a standard teletypewriter table. This machine may operate either directly on its holding magnet or with a line relay. The sending side of the station consists of either an Automatic Address Arrangement or a standard No. 19 teletypewriter, with the receiving machine of the No. 19 set so arranged that a home copy can be made either when transmitting on the line or when perforating the tape. Transmission may take place from this station at any time as determined by the operator.

(D) Stations on Multi-Station Lines

4.08 Station Arrangements: On multi-station lines additional station equipment must be furnished to control operation of the receiving and sending machines. The receiving station consists of a No. 15 Receiving Only Teletypewriter or a No. 14 Typing Reperforator. These machines must be equipped with a line relay. When a Typing Reperforator is used, it must also be equipped with a tape feedout magnet. The sending station consists of either an Automatic Address Arrangement as previously described or a No. 19 Teletypewriter.

4.09 The No. 19 Teletypewriter is equipped with a transmitter-distributor having special wiring and a tape out contact. A line relay is required in this set, also. It is so arranged that copy may be made either when transmitting or when perforating tape. The machine may have either a 60-cycle a-c synchronous motor or a d-c shunt motor. The transmitter-distributor and exposed parts of the apparatus mounted on the 19-type table are normally finished in a dark brown wrinkle finish. The station is equipped when desired with a priority key which, when momentarily operated after a tape has been inserted in the transmitter-distributor, marks the message for priority pickup. Stations may be wired for priority pickup at all times if desired.

4.10 Station Control Equipment: The station control equipment consists of a SOTUS Unit (see Par. 4.15), a rectifier for furnishing direct current, a basic station control circuit and, on an optional basis, a tape feedout circuit and a line release delay circuit.

4.11 The station control equipment is mounted in a sheet metal cabinet 52" high, 26-1/2" wide and 17" deep (see Fig. 6). This cabinet is finished in either a dark brown wrinkle finish or a gray-green wrinkle finish. All normal adjustment and maintenance work can be done from the front by opening a hinged door. Installation and wiring maintenance must, however, be done from the rear through a removable back door.

4.12 The basic control circuit consists of lamps, keys, jacks, resistors, receptacles for plugs, 24 U and Y-type relays, two 255A polar relays, a power relay and a buzzer. Its functions are as follows:

- (a) To receive teletypewriter signals from the switching office.
- (b) To repeat the received signals to the selector magnet of the SOTUS Unit.
- (c) To repeat the received signals to the receiving machines when they are cut on.
- (d) To cooperate with the SOTUS Unit to cut on either or both of two receivers in response to individual station codes or group codes.
- (e) To cooperate with the SOTUS Unit to disconnect the receivers, if they have been cut on, when the end-of-message code is received.
- (f) To cooperate with the SOTUS Unit to cut off temporarily any receiver during the period when a transmitter start pattern is being sent over the line.
- (g) To cooperate with the SOTUS Unit to start a transmitter, if it has traffic to send, in response to the transmitter start pattern.
- (h) To stop a transmitter when the tape is exhausted.
- (i) To recognize whether traffic to be sent is for priority pickup or regular pickup and start the transmitter accordingly.
- (j) To recognize that a sending station has no traffic to transmit and cause the SOTUS Unit to signify this fact by sending

an H over the line to the switching office when the start pattern tests the station.

- (k) To control two sending stations
- (l) To recognize, in cooperation with the SOTUS Unit, all valid address codes for the line on which it is operating and optionally do one of the following if no valid code appears ahead of a message:

Option 1 - Ignore the conditions.

Option 2 - Provide for typing all codes, whether valid or not, on one of the two receivers it controls and when a valid code appears disconnecting the receiver (unless it is called for by the message codes) but if no valid code appears continuing the connection to the receiver for the entire message and alarming that condition by sounding an audible alarm and lighting an alarm lamp.

Option 3 - Provide for connecting one of the two receivers it controls at the start of a message, if no valid codes for the line appear, and alarming the condition by sounding an audible alarm and lighting an alarm lamp. In this case the message but not the invalid code will be typed on the receiver.

- (m) To cooperate with the SOTUS Unit to stop a sending station when an emergency stop pattern is received from the switching office.
- (n) To sound an audible alarm and light an alarm lamp associated with a sending station if it has been stopped by an emergency stop pattern or if it was the last station to have sent before the emergency stop pattern was received.
- (o) To sound an audible alarm and light an alarm lamp if the line from the switching office goes open for more than about 1/2 second.
- (p) To provide a means of suppressing the audible alarm.
- (q) To provide a means of cutting off the alarm arrangements.
- (r) To provide a means of manually connecting both receivers to the line for emergency service in case of trouble.
- (s) To provide a means of manually starting a sending station for emergency service in case of trouble.

4.13 The tape feedout circuit, which can be provided on an optional basis, consists of three U and Y-type relays, one polar relay and one vacuum tube. It is used when one of the receiving stations is a typing reperforator and provides for automatically feeding out tape perforated with "letters" signals after each message.

4.14 The line release delay circuit, which can be provided on an optional basis, consists of one polar relay and a vacuum tube. It is used where it is desired to delay releasing the circuit for a given interval (20 seconds) after the tape of a sending station runs out and the tape out contact operates. This permits inserting another tape without releasing the line to other senders.

4.15 The SOTUS Unit: The SOTUS Unit (see Fig. 7) is the basic selecting device for stations on multi-point lines. (The name is derived from the initial letters of "Sequentially Operated Teletypewriter Universal Selector".) It is a motor-driven, mechanically operated, selecting mechanism which operates continuously on all line signals sent from the switching office. It recognizes two-character directing codes and in cooperation with the control circuit connects stations represented by the codes to the line for recording messages. It also recognizes the end-of-address code in a message and prevents further connections on any two-character combinations occurring in the message text that might otherwise form valid codes. At the completion of a message it recognizes the end-of-message code and in cooperation with the control circuit disconnects any station previously connected and activates the circuit again for further code reading.

4.16 The SOTUS Unit reads the transmitter start patterns and in cooperation with the control circuit disconnects any machine receiving from the line at the time and starts the local transmitter if the pattern calls for it and there is traffic to send. It sends an H back to the switching office if no traffic is available when the pattern is received for one of the transmitters it controls.

4.17 The SOTUS Unit is so arranged that the codes used for controlling the receiving machines and starting the transmitters can be readily changed by the manual insertion of code levers. The unit comes equipped with the basic parts required for any control point, but the code bars or levers required to make it function properly at a specific station must be ordered separately. Each unit is capable of closing 16 contacts in response to 16 two-

character address codes, which are limited in their make-up to the use of any 6 first characters that may be employed for codes. The unit is mechanically so arranged that it has 6 first-character positions, four of which control three second-character positions each and the remaining two of which control two second-character positions each. These contacts may be allocated to cut on receiving machines in response to single address and group codes depending on the number of receiving machines being controlled. When the full assurance features are used and non-valid codes cut on one of the receivers, each valid code used on the line must be represented at the SOTUS Unit by a cut-on contact. When a SOTUS Unit controls two receiving machines a group code that connects them both requires only one contact.

4.18 Four transmitter start contact positions are provided in each unit to control two sending stations, there being one regular and one priority pick-up position for each station.

4.19 Each SOTUS Unit is furnished with an RY test feature which permits taking orientation ranges on the unit and testing its general over-all operation.

4.20 Loops to Machines and to Telegraph Office:

The station control circuit has been designed to be mounted at the customer's premises and a receiving loop and a sending loop from the telegraph office are all that are required, regardless of the number of the machines controlled. A single loop is required from the station control unit to each receiving only 15-type machine and four wires are required for each typing reperforator. Five wires are required for each sending station controlled if it is used for regular messages only or urgent messages only; six wires are required if used for both regular and urgent messages.

4.21 Normal Operation for Sending: Sending from Automatic Address stations has previously been described in some detail. Sending from normal sending stations using No. 19 teletypewriters will now be considered. Messages to be sent are first perforated in tape at the No. 19 teletypewriter using the start-of-transmission, directing, end-of-message and end-of-transmission codes previously described. The allowable number of messages that may be included in one continuous tape is generally dictated by speed of service requirements but usually does not exceed five. The tape is then torn off and inserted in the transmitter-distributor. If the station is equipped to send urgent messages, the urgent message or

priority key may now be operated if the message or messages require urgent handling. On receipt of the "start" signal from the switching office, transmission will start and proceed until the end of the tape passes the tape out pin in the transmitter when it will automatically stop. Meanwhile, additional messages may be perforated to prepare further similar tapes for transmission on later transmission turns.

4.22 At stations equipped with the line release delay feature the line will not be released immediately but will be held for a period of 20 seconds after the end of a tape passes through the transmitter. This is to allow time for the insertion of another tape and continuation of transmission from the station, a feature intended for use where there may be need for sending short pieces of tape such as might be received on typing reperforators connected to other circuits. The operating procedures at a station of this kind require that the last piece of tape to be so transmitted either contain the end-of-transmission code or be followed by a short piece of tape carrying that code. The former condition can usually be attained by sending first any tapes containing the messages to be relayed from other circuits and following these by the tape prepared for the messages to be originated locally.

4.23 The teletypewriter of the No. 19 set is arranged to record the messages, either as they are transmitted on the line or while they are being perforated.

4.24 Normal Operation for Receiving: A No. 15 Receiving Only machine is normally used for receiving. It records only messages having directing codes that call for it unless it has been arranged as a "Master Station" to receive messages having non-valid codes, in which case it will also record those messages. It may or may not record the directing codes themselves if it has been arranged as a "Master Station." If not arranged as a "Master Station" it does not record the directing code that caused it to be connected but, in the case of multiple address messages, will record all succeeding directing codes sent to connect other stations on the same line. (Note: Directing codes for stations on other lines are automatically withheld from being sent on this line at the switching office.) Accordingly, messages directed to this station will normally appear one following another on the receiving teletypewriter and merely have to be torn off, checked and delivered.

4.25 When transmitter start or stop signals are sent on the line while a message is being recorded, there will be a brief

interruption in the recording during the interval when such signals are being transmitted, following which recording will be resumed. The teletypewriter is temporarily blinded from recording during that interval.

4.26 At stations where a typing reperforator is used as the receiving instrument, the operation is similar except that the preliminary "blank" signal of the transmitter start pattern is recorded on the typing reperforator when transmitter control signals are sent during the recording of a message. The tape feed-out features take over following the receipt of each message on the typing reperforator by perforating LTRS signals for a length of about 7" of tape or until the reperforator is again connected for recording another message. This is to provide for easy removal of the tape. About six such LTRS signals will be recorded even if one message follows another immediately. When the feedout is thus interrupted by the receipt of another message, there is no interference with the signals of the new message.

4.27 Emergency Operation: In case the SOTUS Unit must be taken out of service for routine or trouble maintenance, the station may be continued in service by the use of manual keys. Keys are provided for permanently connecting receiving machines to record all messages transmitted on the circuit and for manually starting transmitters. Manual control of the transmitter would, of course, require special operating procedures at the switching office and would ordinarily be used only under emergency conditions, when the message was particularly urgent or when the out-of-service time was expected to be long.

#### (E) Local Outlet Stations

4.28 Local outlet stations receive their transmission directly from incoming line reperforator-transmitters, originating stations, the multiple address positions or willful intercepts without storage on the outgoing side of the switching office. These stations are provided with receiving only page teletypewriters or typing reperforators, the latter being required at locations where it is desired to relay messages from the 81D1 system to TWX, radio or other systems. These stations may also be used for terminal business at the switching office, and when all the incoming lines are not equipped with incoming line teletypewriters or when incoming trunks are used, a local outlet station must be provided to receive the messages addressed to the switching office.

4.29 A local outlet station may consist of from one to ten receiving machines, all of which are assigned the same two-character directing code. The number of machines provided is dependent upon the traffic load the station will be required to handle. In general, a single machine will be satisfactory for a station where this load does not exceed about 16 per cent of the full load capacity of one 75-speed receiving teletypewriter, two machines will be satisfactory where the load does not exceed about 80 per cent of the full load capacity of one 75-speed receiving teletypewriter, and additional machines will be needed for stations with greater loads. The allowable load per machine increases somewhat as the number of machines increases, because of the teaming effect that comes into play.

4.30 Local outlet stations that are near enough to the switching center so that it is economically practical to furnish circuit facilities in excess of a single loop between the switching center and the machine can be provided with machine alarm, tape out alarm, and feed-out features. Machines thus located and equipped, whether receiving only teletypewriters or typing reperforators, are mounted on 115-type tables. These are steel tables 24-1/4" high, 17" deep, and 17-1/2" wide containing a recessed lamp and key panel which mounts on the upper front portion, and equipped with power and line terminal strips and receptacles on the inside. Where typing reperforators or page machines using roll paper are used, a flat rear door is provided. Where fanfold paper is used, a shelf in the bottom of the table carries paper supply and a rear door containing a hinged chute is used to carry the paper up to the point where it enters the teletypewriter cover. These tables are furnished in a gray-green wrinkle finish. When typing reperforators are used, an adapter is required on the top of the table to mount the reperforator, and the reperforator is equipped with a feedout magnet. Both page and tape copy can be made at these stations if this feature is desired; however, in this case the alarms are provided only for the typing reperforator.

4.31 Local outlet stations that are too far from the switching center to make feasible the furnishing of circuit facilities in excess of a single loop are provided without machine alarm, tape out alarm or feedout features and may require the installation of a loop repeater in the circuit. With such a repeater, loops may be as long as about 30 miles. At these stations, any of the standard 15-type teletypewriter or typing reperforator station arrangements may be used with the

exception that a power relay must be added. The function of the power relay is to make the station appear busy to the switching office circuits if its power is not turned on, thus preventing messages from being sent to a machine that is not running. The availability of this feature also makes it desirable to turn off the power when changing ribbons, paper or tape, or when the machine is being given maintenance attention.

## 5. SWITCHING OFFICE CIRCUITS

### (A) Circuit Arrangements and Features

5.01 The 8LDM switching system has been designed to be installed as either a large or a small system and provision has been made for further growth after installation. To achieve these ends, the various circuit arrangements have been designed in the form of individual circuit units which can be provided in different combinations and quantities for a variety of switching office requirements. Certain of the circuit units are common, regardless of the size of a switching office, while others are provided in different quantities, depending upon the size of the office.

5.02 Fig. 4 shows the general interrelation of most of the circuits in the switching office and should be referred to when reading the following. One or two of the circuits are not shown in the figure as they are not significant to an understanding of the switching process.

### (B) Incoming Line and Trunk Circuit

5.03 The incoming line circuit works with the receiving (reperforating and typing) portion of a reperforator-transmitter and may also operate with a receiving only teletypewriter, when one is provided. It consists of 22 relays of the U and Y types, two 280-type relays, one 255A relay, one B-type relay and one vacuum tube. This circuit provides for the incoming termination of a line or trunk and its functions are as follows:

- (a) To receiving incoming messages.
- (b) To switch messages intended for the switching office to the receiving only teletypewriter associated with it, when one is provided.
- (c) To reperforate messages for points other than the switching office in tape, for cross-office transmission, as well as to reperforate messages for the switching office when incoming receiving only teletypewriters are not provided.

(d) To switch messages intended for both the switching office and another station to both the receiving only teletypewriter, when one is provided, and to the reperforator-transmitter.

(e) To recognize the no-traffic response signal from a station without traffic that the transmitter start circuit has attempted to start and notify the transmitter start circuit to try to start another station.

(f) To recognize the end-of-transmission signal and notify the transmitter start circuit to start another station.

(g) To recognize a start of transmission and prevent the transmitter start circuit from making further station start attempts.

(h) To recognize that incoming signals have stopped for a 45-second period without an end-of-transmission signal and notify the start circuit to start another station.

(i) To provide alarms in case of improper operation.

(j) To provide, by the operation of a key, means for receiving all messages on the receiving only teletypewriter, when one is provided, or on the reperforator-transmitter.

(k) To indicate to a director circuit that no end-of-message code has been received, that there is no tape to transmit in the reperforator-transmitter and that no incoming signals have been received for a period of 45 seconds.

(l) To provide, by the operation of a key, for connecting a tape-changing machine to a single station incoming line or trunk when a receiving only teletypewriter is not provided.

### (C) Originating Station Circuit

5.04 The originating station circuit operates with the originating station No. 19 teletypewriter and provides the means of introducing messages into the system at a switching office. It consists of 13 relays of the U and Y types, two 280-type relays, two 255A relays, one B-type relay and one vacuum tube. This circuit has the following functions:

- (a) To provide the means for messages that originate at a switching office to enter the switching system.

- (b) To recognize the end-of-message code in the tape as it is being sent so that further switching can be stopped at the end of a message in progress (see h).
- (c) To recognize certain other signals such as LTRS, BLANK, Z, etc., during the director search period in order to discard them.
- (d) To present to the director circuit the code impulses of the switching characters in the tape.
- (e) To provide means for getting a home copy of messages, either during transmission or while perforating, as desired.
- (f) To recognize that the transmitter has stopped for a period of about 30 seconds without an end-of-message signal, because of taut or torn tape, and to provide a director tie-up alarm for the condition.
- (g) To provide, by the operation of a key, a means of stopping transmission at any time.
- (h) To provide, by the operation of a key, a means of stopping further switching or transmission at the end of a message in progress.
- (i) To provide a means of sending an end-of-message code by the operation of a key.
- (j) To provide means for manually routing a message that is waiting to find a free outlet directly to a willful intercept.
- (c) To read the switching codes at the start of each relayed or originating message and by cooperating with the sequence circuit and controlling the crossbar switches to direct that message to the proper outlet or to the multiple address position.
- (d) To store the switching code of a directed message and repeat it to the outlet connected.
- (e) To test an outlet to determine if it is busy, and, if it is busy, to wait until it is free before making a connection to it.
- (f) To test whether a message is to be intercepted and, if so, to send it to an intercept.
- (g) To bring in alarms and drop control of the circuits involved under abnormal or trouble conditions.
- (h) To disconnect from an outlet at an end of a message.
- (i) To discard the characters FIGS, H, LTRS, BLANK and Z when they appear singly in the coding portion of a message, and to discard any two-character combination consisting of one of these as a second character combined with any other first character, under the same conditions.
- (j) To route messages bearing unassigned codes to a miscellaneous intercept.
- (k) To provide a means of stopping further switching after the completion of any message in progress by the operation of a key.

#### (D) Director Circuit

5.05 A director circuit is used with each incoming line, originating station or willful intercept machine and with each supplementary multiple address receiver. This circuit is provided in two parts, of which the director relay unit consists of 55 relays of the U and Y types, two S-type relays, one 280-type relay and one B-type relay, and the final code relay unit consists of 20 U-type relays. This circuit has the following functions:

- (a) To provide a means of recognizing 200 two-character address codes using any 10 of the 20 usable first characters.
- (b) To provide a means of recognizing the remaining 10 first characters for switching exclusively to trunks.
- (l) To provide a means of stopping cross-office transmission at any time by the operation of a key.
- (m) To provide for creating an end-of-message code in response to the operation of keys.
- (n) To provide a means of manually routing a message waiting to find a free outlet directly to intercept in response to the operation of keys.
- (o) To create an end-of-message code automatically and disconnect from any outlet to which it is connected if signals cease for 45 seconds on a multi-station incoming line, when no end-of-message signal has been received and there is no tape to transmit in the reperforator-transmitter. (See Par. 5.03(k))

- (p) To provide means for its being tested without interfering with traffic in the office.

(E) Sequence Circuit

5.06 The sequence circuit, by allowing only one director at a time to use a link horizontal, prevents two or more directors from otherwise simultaneously establishing cross-office connections to the same outlet machine. Access to the link is allotted by it to the directors on a rotary basis. The sequence circuit consists of two circuit units, one of which is a common unit that must always be provided regardless of the size of the switching office. This unit, which includes both a regular and a spare, consists of 9 U-type relays, one B-type relay, one 275-type mercury relay and one vacuum tube. The other unit, which must be provided on the basis of one for each 10 directors in the office, consists of 21 U-type relays. The functions of the circuit are as follows:

- (a) To operate the proper link select magnets when a director makes a bid for switch action.
- (b) To insure that only one director at a time makes a successful bid.
- (c) If more than one director places a bid at substantially the same time to give preference on a rotary basis to those directors.
- (d) To provide an alarm in case of trouble in the circuit.
- (e) To revoke a bid from a director which has not completed building up its cross-office connection within 4 seconds, to bring in the alarm condition in that director, and to free itself for serving other directors.

(F) Link Circuit

5.07 The link circuit, comprising from 6 to 60 ten-by-ten crossbar switches, provides a means for connecting any director to any outlet. The number of crossbar switches is determined by the size of the switching office. The functions of the circuit are as follows:

- (a) To connect leads from any director to any outlet under control of that director.
- (b) To enable many such connections to exist simultaneously from different directors.

(G) Intercept Key Circuit

5.08 The intercept key circuit provides the keys used for the various willful interception requirements. These keys are located on the control board. The functions of the circuit are as follows:

- (a) To provide one or two intercept keys for each station served by a switching office to permit the interception of all messages carrying the individual station code of that station.
- (b) To provide keys to permit intercepting messages to trunk circuits.
- (c) To provide keys for directing certain messages to "orders intercept," an arrangement which permits sidetracking certain messages to allow others to pass them.
- (d) To provide keys to permit intercepting entire multiple address messages in willful intercept before they reach the multiple address position.

(H) Outgoing Line or Single Trunk Circuit

5.09 The outgoing line or single trunk circuit is arranged to receive messages for all stations on a given line or for all stations reached over a single channel trunk from any director or from the multiple address position. It is provided with either two or three reperforator-transmitters depending on whether there are urgency messages to be handled and the magnitude of the traffic load on the line or trunk. With no urgency messages, or with both regular and urgency messages and light loads, only two reperforator-transmitters are used. With heavy traffic loads and urgency messages, the third reperforator-transmitter is used to handle the urgency messages only.

5.10 When two reperforator-transmitters are used the circuit consists of 67 U and Y-type relays, one 280-type relay, and 4 vacuum tubes. The addition of the third reperforator-transmitter requires an applique circuit consisting of 15 U-type relays and 2 vacuum tubes. The functions of the circuit are as follows:

- (a) To receive regular messages from directors on either of the two regular reperforator-transmitters and reperforate them in tape.
- (b) To enable each of the two regular reperforator-transmitters separately to participate with a calling director in closing the proper crosspoints on the link.

- (c) To insure that current is neither made nor broken by the crosspoints on the link.
- (d) To maintain the closure of crosspoints in the link until the director informs it that an end-of-message code has been transmitted cross-office.
- (e) To receive regular messages from the multiple address position on the two regular reperforator-transmitters and reperforate them in tape.
- (f) To receive urgent messages from the multiple address position on the two regular reperforator-transmitters, if the urgent message reperforator-transmitter is not provided, and reperforate them in tape.
- (g) To receive urgent messages from the multiple address position on the urgent message reperforator-transmitter if one is provided.
- (h) To prevent simultaneous seizure of one of the two regular reperforator-transmitters by both a regular director and the multiple address position.
- (i) To participate with the multiple address circuit in closing the proper crosspoints on the multiple address link.
- (j) To provide a holding path on each reperforator-transmitter for the selector magnet after a code has been received from the multiple address position until another code is to be received or the message is transmitted.
- (k) To indicate to the multiple address position that it is being used either as an outgoing line or as a single trunk circuit.
- (l) To indicate to the multiple address position, if it is being used for trunk, that the office code has already been sent to it and need not be repeated.
- (m) To provide for making a reperforator-transmitter appear busy while it is engaged in receiving a message cross-office and thus prevent its being seized by another director or the multiple address position.
- (n) To cause a reperforator-transmitter to assume the busy condition when its tape supply is low and to alarm the condition.
- (o) To provide a means for making a reperforator-transmitter appear busy by the operation of a BUSY key.
- (p) To provide a means whereby if the urgency machine is manually made busy, urgent messages will be transmitted to the regular reperforator-transmitters.
- (q) When only two reperforator-transmitters are used, to transmit messages from them alternately if they both have tape or from whichever one has messages to transmit.
- (r) To transmit all messages in the urgent message machine, when provided, after the completion of transmission of a message from the second of the regular reperforator-transmitters, or after transmission of a message from the first regular reperforator-transmitter if there are no messages in the second, or whenever there are no messages available in either of the regular machines.
- (s) To provide a means for preventing, by the operation of a key, further transmission from each machine after any message in progress has been completed.
- (t) To provide a means for stopping transmission from each machine at any time by the operation of a key.
- (u) To stop each transmitter automatically and alarm the condition if the tape is torn.
- (v) To make the distributor contacts of either of the two regular reperforator-transmitters available to the transmitter start circuit upon request from that circuit, except during the transmission of an address code, and except immediately following a FIGS character.
- (w) To recognize a machine trouble in the reperforator-transmitters and give an alarm.
- (x) To provide a means of manually releasing an outgoing line which has been seized, and automatically sending to the line an end-of-message code.

#### (I) Transmitter Start Circuit

5.11 The transmitter start circuit consists of 42 relays of the U and Y types, three 209-type selectors, one B-type relay and one vacuum tube. Its functions are as follows:

- (a) To code the distributor of an outgoing line reperforator-transmitter for sending transmitter start pattern characters.
- (b) To provide the proper time intervals between these characters.

(c) To generate automatically and in rotation the proper pattern for starting each of a maximum of ten transmitters on the line either on a priority pickup or regular basis.

(d) To try first all stations in rotation for priority traffic, up to and including the last station to have sent priority traffic, and then if there is no priority traffic try all stations in rotation for regular traffic, up to and including the last station to have sent regular traffic.

(e) To suspend operation for an optional waiting period of one or two minutes if no traffic has been picked up, after which to begin a new round of trials.

(f) To cause a no-response alarm if after sending the start pattern for a station neither traffic nor a no-traffic response (H) is received within five seconds.

(g) To withhold sending further start patterns, when an attempt to start a station results in the receipt of traffic, until after the end-of-transmission code is received from that station or until informed by the incoming line circuit that incoming transmission has ceased for at least 45 seconds.

(h) To provide a manual means for sending a transmitter stop pattern, by the operation of an EMERG STOP key.

(i) To suspend transmission from the outgoing line reperforator-transmitters while start patterns are being sent.

(j) To provide a means of skipping both priority and regular pickup of a station by the operation of a SKIP TRANS key.

(k) To provide a means of indicating which transmitter has been started by lighting a TRANS lamp.

(l) To provide a means of indicating whether a transmitter which has been started was started on a priority pattern, by lighting a PRIORITY lamp.

5.12 The transmitter start pattern codes that are available for assignment to station transmitters, listed in the order in which they are sent, are as follows:

Station	1	2	3	4	5	6	7	8	9	10
Priority Code	U	F	C	B	J	P	Y	W	M	G
Regular Code	A	S	I	D	R	H	Z	L	N	O

#### (J) Local Outlet Circuit

5.13 The local outlet circuit enables any director or multiple address position to connect directly to receiving machines without reperforation or storage on the outgoing side of the switching office. It is used to provide local receiving stations as described in 4(E) and to provide the various types of intercepts used in a switching office. There may be from one to ten receiving machines per outlet and they are reached on a rotary basis so that they share the load equally. The machines for receiving stations may be 15-type page receiving only teletypewriters, typing reperforators or both. The machines for intercepts may be typing reperforators or reperforator-transmitters.

5.14 The circuit is provided in two parts.

There is a common group of apparatus consisting of 2 U-type relays and a 209-type selector which must be provided for each group of station machines responding to a given code or for each group of intercept machines. A second group of apparatus must be provided for each of the individual machines of an intercept or local outlet station. This individual circuit consists of 16 relays of the U and Y types, one B-type relay, three 280-type relays and three vacuum tubes.

5.15 The functions of the circuit are as follows:

(a) To participate with a calling director in closing the proper crosspoints on the link.

(b) To participate with the multiple address position in closing the proper crosspoints of the multiple address link.

(c) To prevent the simultaneous seizure of a given local outlet or intercept machine by both a regular director and the multiple address position.

(d) To insure that current is neither made nor broken by the crosspoints on the link.

(e) To provide a holding path for its associated machine during an idle condition and to release it when a cross-office connection has been established.

(f) To blind the machine after a code has been sent to it from the multiple address position and to unblind it, either to receive another code for that outlet or to receive the message.

- (g) To maintain the closure of the crosspoint in the link until the director informs it that an end-of-message code has been transmitted.
- (h) To provide a busy condition which prevents any new call from being established when no outlets are idle.
- (i) To provide a manual means for making each outlet busy, by the operation of a BUSY key either at the outlet or the control board.
- (j) To assume the busy condition and give an alarm upon recognition of any machine trouble, in cases where the machine alarm feature is used.
- (k) To assume the busy condition and give an alarm in the case where a typing reperforator is used and the tape supply is running low.
- (l) To cause messages to be sent to the outlet machines on a rotational basis.
- (m) To provide for feeding out a given amount of tape after each message when a typing reperforator is used.
- (n) To assume a busy condition, if the station is not equipped with the machine alarm feature, if the power at the station is not turned on.
- (o) When used as miscellaneous intercept or multiple address intercept, to cooperate with the alarm circuit and sound the alarm chime when a message is being received.

#### (K) Multi-Channel Trunk Circuit

5.16 The multi-channel trunk circuit enables a director or the multiple address position to connect directly to any one of a group of from three to ten trunks to another switching office, without storage on the outgoing side of the local switching office. The trunks are selected on a rotational basis and the circuit is used when the traffic loads to another switching office are too great to be handled by one or two outgoing line and single channel trunk circuits. Typing reperforators are provided on each trunk to make a record of the traffic it handles.

5.17 The circuit is provided in two parts.

There is a common group of apparatus consisting of four U-type relays and one 209-type selector which must be provided for each group of trunks. A second group of apparatus must be provided for each individual trunk. This individual circuit consists of 8 U-type relays,

one 280-type relay, one 255A polar relay and two vacuum tubes. The functions of the circuit are as follows:

- (a) To participate with a calling director in closing the proper crosspoints on the link.
- (b) To participate with the multiple address position in closing the proper crosspoints of the multiple address link.
- (c) To prevent the simultaneous seizure of a given trunk by both a regular director and the multiple address position.
- (d) To insure that current is neither made nor broken by the crosspoints on the link.
- (e) To provide a holding path for its associated trunk during an idle condition and to release it when a cross-office connection has been established.
- (f) To blind the trunk after a code has been sent to it from the multiple address position and to unblind it, either to receive another code for the trunk or to receive the message.
- (g) To inform the multiple address director that one connection has already been made to it and, in case another code is to be sent, that the office code need not be transmitted again.
- (h) To maintain the closure of the crosspoint in the link until the director informs it that an end-of-message code has been transmitted.
- (i) To provide a busy condition which prevents any new call from being established when no trunks are idle.
- (j) To provide a manual means for making each trunk busy, by the operation of a BUSY key at the control board.
- (k) To cause messages to be sent to the trunks on a rotational basis.

#### (L) Multiple Address Circuit

5.18 The multiple address circuit is arranged to receive multiple address, group code and urgent messages from any director in the office on from one to six reperforator-transmitters associated with its receiving side. These machines are used in rotation. All of the above types of messages may be received on

these machines indiscriminately or, if desired, the receivers may be divided into any two groups one of which receives only urgent messages and the other non-urgent messages. The circuit is arranged to read the directing codes of the messages one at a time and make connections to the outlets required.

5.19 The over-all multiple address circuit consists of four individual circuit units which, together with the multiple address link circuit, comprise the regular multiple address arrangements of the switching office. One of these, a level sequence circuit unit, is always provided and it determines to which of the multiple address reperforator-transmitter units a message will be sent. It consists of two U-type relays and two 209-type selectors. From one to six level circuit units are also provided, depending on the number of cross-office paths and multiple address reperforator-transmitters required. Each level circuit unit consists of 31 U-type relays, two 275-type relays and 2 vacuum tubes. In addition, one director selector circuit unit is provided to attach the director to the outputs of the level circuit units one at a time. This circuit unit consists of 2 U-type relays and two 209-type selectors. Finally, one director circuit is provided to read the address and make the connections through the multiple address link. It consists of 41 U-type relays, two 275-type relays, one 280-type relay, 1 vacuum tube and 2 crossbar switches.

5.20 The functions of the over-all multiple address circuit are as follows:

- (a) To receive messages from directors on the receiving level reperforator-transmitters in rotation, with the receivers arranged either as a single group or in two groups if special urgent message levels are required.
- (b) To enable each of the receiving levels separately to participate with a calling director in closing the proper crosspoint on the link.
- (c) To insure that current is neither made nor broken by the crosspoint on the link.
- (d) To provide a holding path for each of its reperforator elements during an idle condition and to release it when a cross-office path has been established to the machine.
- (e) To maintain the closure of a crosspoint in the link until the director informs it that an end-of-message code has been transmitted.

- (f) To provide for making a reperforator-transmitter appear busy while it is engaged in receiving a message cross-office and thus prevent its being seized by another director.
- (g) To cause a reperforator-transmitter to assume the busy condition when its tape supply is low and to alarm the condition.
- (h) To provide a manual means for making its reperforator-transmitters appear busy, by the operation of a BUSY key.
- (i) To recognize a machine trouble in any of the reperforator-transmitters of the receiving levels and give an alarm.
- (j) To make connections from the transmitting levels one at a time to outlets one at a time, in cooperation with the multiple address link, the director leaving the transmitting level as soon as the connections for a message are completed and before transmission of the message itself takes place.
- (k) To cause its director to service the transmitting levels in rotation, always servicing the urgent message group first.
- (l) To determine if the message is an urgent message and route it to urgency levels of outlets when such levels are provided.
- (m) To read the address codes at the start of each message and to seize outlets represented by them.
- (n) To store and repeat each address code to the outlet connected by it.
- (o) To test an outlet to determine if it is busy and, if it is busy, to wait until it is idle before making a connection to it.
- (p) To connect multiple address intercept for receiving a copy of the message whenever an intercept key is operated for a station represented by one of the address codes in the message.
- (q) To test for abnormal or trouble conditions and to bring in alarms.
- (r) To send unassigned codes to multiple address intercept, along with a copy of the message.
- (s) To recognize that the end-of-address code of the message has been reached and all the outlets required have been seized and then to transmit the message simultaneously to all these outlets.

(t) To discard the multiple address and urgent message codes appearing at the head of a multiple address or urgent message.

(u) To generate and send an office regular multiple address code or an office urgent message code ahead of any message directed to a trunk, for the purpose of insuring regular multiple address or urgent message handling at the distant switching office and of informing the multiple address position at that office of the source of the message so that it can determine what further trunking, if any, is required. To accord the same treatment to a message involving a group code, when an 81DL system involves more than one switching office, on the possibility that the group code may include stations served by another switching office.

(v) To disconnect from an outlet at an end-of-message code.

(w) To provide a means of stopping cross-office transmission at any time by the operation of a key.

(x) To provide a means of stopping further switching at the completion of a message by the operation of a key.

(y) To provide for creating an end-of-message code in response to the operation of keys.

(z) To provide a means of manually routing directly to intercept a message waiting to find an idle outlet.

#### (M) Multiple Address Link Circuit

5.21 The multiple address link circuit, comprising from one to 10 ten-by-ten crossbar switches, provides a means for connecting from any of the six possible multiple address levels to any of the outlets, in cooperation with the multiple address director. The number of crossbar switches is determined by the number of outlets to be reached. The functions of the circuit are as follows:

(a) To connect leads from any multiple address level to any desired outlet or group of outlets under control of the multiple address director.

(b) To enable many such connections to exist simultaneously from different multiple address levels.

#### (N) Group Code Circuit

5.22 The group code circuit, in cooperation with the multiple address circuit, provides a means of making a multiple connection to a number of outlets on a single two-character switching code. The circuit consists of common equipment, which is provided regardless of the number of group codes used, trunking relay equipment and, in addition, individual relay equipment for each group code used. The common equipment is furnished in units capable of handling four outlets and consists of 10 U-type relays. The number of these units provided depends on the total number of outlets to be reached by group codes. The trunking relay equipment, which consists of 15 U-type relays, must be provided when trunks between switching offices are used. For each group code used in the office an individual circuit consisting of four U-type relays must be provided.

5.23 The functions of the group code circuit are as follows:

(a) To respond to the multiple address circuit when a group code is read.

(b) To test simultaneously all outlets represented by a given group code.

(c) To inform the multiple address circuit when all outlets contained in a group code have been seized.

(d) To get an indication from the multiple address circuit as to whether a group code message has been received over a trunk and, if so, to avoid trunking it back to the office from which it came.

(e) To inform the multiple address circuit, when an 81DL system involves more than one switching office, that the office code must be sent ahead of the group code. This is necessary to care for the possibility that the group code may include stations served by another switching office.

(f) To add the multiple address intercept to a connection if the group code includes any station for which an intercept key is operated.

#### (O) Supplementary Multiple Address Circuit

5.24 The supplementary multiple address circuit provides a means of handling two, three and four-address messages on the basis of breaking them down at the switching office into two messages, three messages, or four messages, each carrying only one of the address codes. These

messages are then automatically switched on a single address basis to the proper outlets for delivery. The inclusion of a special two-character supplementary multiple address code ahead of the address codes themselves, in the preparation of the message at the point of origin, enables the switching office equipment to determine whether the message contains two, three or four addresses. A maximum of five cross-office paths may be assigned for access to this circuit and a maximum of ten reperforator-transmitters may be provided for perforating the individual messages, thus permitting the handling at one time of up to five separate messages containing a total of ten codes, in any combinations of messages and codes. The cross-office paths are chosen by directors on a cascade basis, with messages always going to the lowest numbered path that is not busy. The reperforator-transmitters are used on a rotary basis, with the load divided about equally among them. A director circuit must be provided with each of the reperforator-transmitters to handle the switching of each of the resulting single address messages to its proper outlet.

5.25 The supplementary multiple address circuit consists of a group of common apparatus made up of 20 U-type relays, one B-type relay, six 280-type relays, one 209-type selector, one vacuum tube and one ten-by-ten crossbar switch if three or fewer cross-office paths and six or fewer reperforator-transmitters are used, or two ten-by-ten crossbar switches if a greater number of cross-office paths and reperforator-transmitters are used. For each cross-office path used, equipment consisting of 37 U-type relays and two vacuum tubes is provided. For each receiver circuit used (for a reperforator-transmitter) additional equipment consisting of six U-type relays and two vacuum tubes must be provided.

5.26 The functions of the circuit are as follows:

- (a) To participate with a calling director in closing the proper crosspoints on the link.
- (b) To insure that current is neither made nor broken by the crosspoints on the link.
- (c) To maintain closure of the crosspoint in the link until the director informs it that an end-of-message code has been transmitted.
- (d) To provide a busy condition which prevents any new call from being established when no cross-office paths are idle.

- (e) To provide a manual means of making each cross-office path busy by the operation of a BUSY key at the control board.
- (f) To transfer the test leads to the lowest numbered cross-office circuit that is idle.
- (g) To ascertain from the director whether the message is a two, three, or four-address message.
- (h) To seize two, three or four reperforator-transmitters as required by the number of addresses.
- (i) To prevent code and message transmission from the director until the necessary reperforator-transmitters have been seized.
- (j) To distribute the codes to the seized reperforator-transmitters so that each receives only one.
- (k) To transmit the message simultaneously then to all seized machines.
- (l) To disconnect the seized machines when the end-of-message code has been transmitted to them.

#### (P) Alarm Circuit

5.27 One alarm circuit is provided for the switching office. It consists of 14 relays of the U and Y types, three B-type relays, one vacuum tube and a tone-bar chime. Its functions are as follows:

- (a) To provide alarms which are common to more than one circuit or are common to the switching office.
- (b) To light a TAPE OUT pilot lamp when a tape out alarm appears in the office.
- (c) To light a DIR COM (Director Common) alarm lamp to indicate trouble in the sequence circuit.
- (d) To light a D-C POWER alarm lamp to indicate a blown fuse on either the 115-volt or 48-volt fuse panel.
- (e) To operate a major PILOT alarm lamp when any of the above mentioned alarms is encountered as well as whenever there is a Director Tie-Up alarm, Machine Trouble alarm, Line Trouble alarm or Supplementary Multiple Address alarm in the office.

- (f) To operate the chime at about 60 IPM whenever an alarm appears in the office.
- (g) To provide a means of silencing the alarm chime by the operation of a SUPPRESS key at the control board.
- (h) To provide a means of permanently turning off the alarm chime by means of a key at the control board.
- (i) To provide a means of lighting a lamp and operating a buzzer at the testing position for calling the maintenanceman, by the operation of a key at the control board.

#### (Q) Patching Circuit

5.28 The patching circuit provides the wiring and equipment for separable plug and cord assemblies to enable removing individual circuit units from service and replacing them with spare units. It consists of 50-conductor receptacles and plugs. Its functions are as follows:

- (a) To provide a means of patching the following circuits: Incoming Line and Trunk, Originating Station, Director, Outgoing Line and Single Trunk, Transmitter Start, Sequence, Local Outlet, Multiple Address, Group Code, Multi-Channel Trunk and Supplementary Multiple Address.
- (b) To provide means of trunking the individual leads from a given circuit to the test position for testing purposes.

#### (R) Line Jack and Patching Cord Circuit

5.29 This circuit consists of jack and patching cord circuit arrangements each consisting of three jacks, two of which are looping jacks and one of which is a set jack. Miscellaneous jacks are also provided. Its functions are as follows:

- (a) To provide a means of patching incoming and outgoing loops.
- (b) To provide a means of inserting monitoring and test equipment in the incoming and outgoing loops.
- (c) To provide a means of trunking the input and output of incoming and outgoing lines to the test position.

#### (S) Machine Test Circuit

5.30 The machine test circuit provides at the switching office maintenance position a means of testing the various types of

teletypewriter machines used and of monitoring transmission into, out of, or across the office. It consists of a test bench, a test cabinet and a machine cabinet which are used in cooperation with a number of teletypewriter test machines. There are also two 255A relays and a polar relay test set in the circuit. Its functions are as follows:

- (a) To provide for testing all the various types of teletypewriter machines used in the office.
- (b) To provide for testing certain other types of standard teletypewriter machines such as those used on TWX and pony wire services.
- (c) To provide for testing and adjusting 255A relays.
- (d) To provide monitoring equipment and arrangements to monitor transmission on all horizontal (input) and vertical (outlet) paths of both the regular and multiple address links.
- (e) To provide monitoring arrangements for all inputs and outputs of the switching office itself.
- (f) To cooperate with the unit test circuit for circuit testing.

#### (T) Unit Test Circuit

5.31 The unit test circuit provides a means of testing all relay circuit units in the switching office except the alarm circuit without interfering with the normal operation of the office. It consists of a cabinet of equipment containing lamps, keys and patching arrangements and 72 U-type relays, two 280-type relays, three B-type relays and one S-type relay. Its functions are as follows:

- (a) To provide a means of testing all of the relay circuit units in the switching office except the alarm circuit.
- (b) To test these circuits when they are patched out of use without interfering with normal switching office operation.
- (c) To test these circuits independently, on an individual circuit basis, by means of keys and lamps.
- (d) To cooperate with the machine test circuit when making tests.

6. SWITCHING OFFICE POWER SUPPLY

6.01 A power plant operating from a primary power source of "Wye" connected 120/208-volt, 3-phase, 4-wire, regulated 60 cycle a-c is provided for each switching office. This plant distributes a-c power to the teletypewriter machines and generates both 48-volt d-c and 130-volt d-c power for relay circuit operation and transmission purposes.

(A) A-C Power Arrangements

6.02 A-C Distribution: The primary power is connected to the power plant at an a-c distribution cabinet. This cabinet is similar to the other equipment cabinets in the office and contains fusing, a starting contactor, an On and Off switch and 49 distribution switches. These distribution switches are individually fused and five are assigned for test position control while the remaining 44 are for controlling the teletypewriter machines used in the office. A-c is provided from this cabinet to the 48-volt and 130-volt d-c plants. The five switches for the test position and the a-c distribution to the d-c plants are not under control of the On and Off switch or the contactor. The contactor automatically releases on a no-voltage condition and is under control of the On and Off switch.

6.03 Each of the distribution switches is capable of controlling the power to one machine cabinet, to one originating station or to not more than four teletypewriter motors. Because of the high starting current required by the synchronous motors of the teletypewriter apparatus the full starting load for the office should not be applied at one time. Therefore, after the office has been shut down or after a power failure has released the contactor, the individual distribution switches should be operated to OFF, and after power has again been turned on by the contactor, these switches should be individually operated to ON.

6.04 Supplementary A-C Distribution: For large offices requiring more distribution switches than are available in the initial distribution cabinet a supplementary a-c distribution cabinet is provided. This supplementary cabinet contains eight distribution switches for test or other purposes and 52 for controlling teletypewriter apparatus. A contactor similar to the one in the initial cabinet is also provided and supplies power to the 52 switches. This contactor is under control of the On and Off switch in the initial cabinet.

6.05 Power Factor Correction: When large numbers of teletypewriter synchronous motors are operated on a single power source,

power factor correction is required. In the 81C1 system this correction was supplied as common equipment and was always present regardless of the number of motors turned on. In the 81D1 system power factor correction is provided with each machine cabinet in the office as part of the cabinet equipment. The correction thus provided is sufficient to take care of the other motors in the office, such as those on originating stations, intercept machines, local outlet machines and receiving only machines, for which power factor correction equipment is not specifically provided. This treatment of power factor correction eliminates the danger of overcorrection because the proper amount is applied as the machines are turned on.

(B) 48-Volt D-C Plant

6.06 This plant provides 48-volt d-c power for the operation of the relay circuits, crossbar switches, machine magnets, etc., of the switching office. It has a capacity of from 5 to 100 amperes at its normal voltage limits of 47 to 51 volts and it consists of a 24-cell battery floated by 30-ampere regulated metallic rectifiers. This plant is fully automatic; it switches rectifiers in and out with the load. From one to five 30-ampere charging rectifiers may be provided as required. In general enough rectifiers should be provided so that one can be employed as a spare for use in case of the failure of an operating rectifier or for purposes of recharging the battery after an a-c power failure. The maximum of five rectifiers, plus the necessary control and distribution equipment, requires three cabinets for mounting purposes. These cabinets are the same as the equipment cabinets used for mounting the relay equipment in the switching office. The initial cabinet contains common plant control, distribution and control fuses and one rectifier. The other two cabinets may contain either one or two rectifiers, as required, each with its associated relay control equipment.

6.07 The batteries for the 48-volt d-c plant will be mounted on standard open-type battery stands according to arrangements specified on a job basis.

(C) 130-Volt D-C Plant

6.08 This plant provides 123-volt d-c power for the operation of relays and vacuum tubes and for transmission purposes at the switching office. It has a capacity of from 0.5 to 20 amperes at its normal voltage limits of 121.5 to 124.5 volts at the load fuse panel and it consists of a 61-cell battery floated by means of 8-ampere regulated tube rectifiers. The plant is designed to supply power at  $131 \pm 1$  volts at the battery, and counter cells

are provided to maintain the normal load voltage at 123 volts. From one to four rectifiers, which are automatically switched in and out with the load, may be provided as required. As in the case of the 48-volt d-c plant, enough rectifiers should be provided so that one can be employed as a spare for use in case of the failure of an operating rectifier or for purposes of recharging the battery after an a-c power failure. The maximum of four rectifiers, plus the necessary control and distribution equipment, requires two cabinets for mounting purposes. These cabinets are the same as the equipment cabinets used for mounting the relay equipment in the switching office. The initial cabinet mounts common control equipment, distribution fuses and two rectifiers. The second cabinet mounts either one or two additional rectifiers, as required, with their associated control equipment.

6.09 The batteries for the 130-volt d-c plant will be mounted on standard open-type battery stands according to arrangements specified on a job basis.

## 7. SWITCHING OFFICE EQUIPMENT ARRANGEMENTS

7.01 In the design of the switching office equipment and its arrangements, consideration was given to the following factors:

- (a) Appearance.
- (b) Adaptability to various sizes of office.
- (c) Provision for growth.
- (d) Simplified installation.
- (e) Capability of being manufactured and stocked in units.

7.02 In order to meet these objectives the relay switching equipment, the power plant and the testing circuits are mounted in fully enclosed steel cabinets 7' tall and finished in a gray-green wrinkle enamel. The teletypewriter apparatus is mounted in steel cabinets or on steel tables similarly finished (Figs. 8, 9 and 12) and a control board (Figs. 13 and 14) which harmonizes in appearance with the apparatus cabinets is also provided. The packaging of the equipment thus in cabinets makes it possible to provide it in the proper quantities needed for the different sizes of switching offices encountered and to arrange it in the most suitable layout for the space in which it is to be installed. A typical switching office layout is shown in Fig. 15.

7.03 Certain of the relay cabinets may be considered as common equipment which must always be provided regardless of the size of the office being installed. Other equipment cabinets are provided in the quantities required to fit the particular office. Details as to the make-up of these cabinets are given in the paragraphs that follow.

### (A) Fuse and Loop Cabinet

7.04 This cabinet is one of those that may be considered as a common equipment cabinet for at least one is always required for each installation. The cabinet contains the following:

- (a) Mountings for 180 fuses for +130-volt distribution.
- (b) Mountings for 240 fuses for -48-volt distribution.
- (c) Sixty sets of jacks for patching purposes, each set consisting of two looping and one set jack.
- (d) Sixty miscellaneous jacks for patching and trunking purposes.
- (e) The alarm circuit for the switching office.
- (f) Space for 30 resistance wave shaping networks.
- (g) Space for 30 inductive wave shaping networks.

7.05 For large switching offices more than one of these cabinets may be required in order to provide more fuses and loop board positions. When a second cabinet is required it can be obtained without the alarm circuit, and the extra space may be used for mounting miscellaneous equipment.

### (B) Sequence Cabinet

7.06 One sequence cabinet is required per switching office regardless of its size. The circuit units supplied in the cabinet, however, are provided on the basis of the number required. This cabinet contains the following:

- (a) Final code point cross-connection field for regular director code assignments.
- (b) A sequence control relay unit that contains both the regular and spare common equipment of the sequence circuit.

(c) From two to seven sequence circuit units.

Each of these units is capable of handling ten directors and is patchable as a unit. One spare unit of ten should always be provided; thus, the full number provides for 60 directors and includes the spare unit.

(d) A patching unit that provides the facilities for patching in the spare relay units in place of the operating units.

(C) Director Cabinet and Director Final Code Relay Cabinet

7.07 Two types of cabinet are used to house the director circuits since these circuits are provided in two parts to simplify installation and reduce the amount of cabling required. One of these parts is the director unit itself and from one to six such units can be provided in a cabinet. The other part consists of the 20 final code relays required per director and these are provided in units of six, capable of handling six directors each. Three of these final code relay units can be mounted in a cabinet making a full cabinet capable of handling 18 directors.

7.08 These two types of cabinets and their circuit units are provided as required for the size of office being installed.

(D) Link Switch Cabinet

7.09 The link switch cabinet provides mounting arrangements for the crossbar switches comprising the regular link of the switching office. Each cabinet can mount 6 ten-by-ten crossbar switches and a total of ten cabinets mounting 60 switches are required for the maximum size office. The cabinets are available equipped with either six switches or four switches as required. Two additional switches may be ordered to add to the four switch cabinet if required for growth. Local wiring is provided in each cabinet so that it represents 30 horizontals and 20 verticals of the link.

(E) Originating Station Cabinet

7.10 The originating station cabinet is capable of housing up to ten originating station circuits. Space not used for these circuits may be used for mounting miscellaneous equipment when required.

(F) Incoming Line Cabinet

7.11 The incoming line cabinet is capable of housing eight incoming line or incoming trunk units. No local cabling is provided in this cabinet.

(G) Outgoing Line Cabinets

7.12 Two types of outgoing line cabinets are provided for the switching office. One type mounts four outgoing line relay units for the regular outgoing line levels one and two. The other mounts ten outgoing line relay units for urgent level three. These cabinets may be provided in any combination as required by the size of the office. No local cabling is provided in them.

(H) Transmitter Start Cabinet

7.13 The transmitter start cabinet is capable of mounting five transmitter start relay units. As many of these cabinets and units as required may be ordered. No local cabling is provided in this cabinet.

(I) Local Outlet Cabinets

7.14 Two types of local outlet cabinets are provided, an originating local outlet cabinet and a supplementary local outlet cabinet. The originating local outlet cabinet contains a relay unit which provides common circuit unit equipment for five local outlet or intercept circuits, and, in addition, the cabinet contains five individual circuit relay units, each of which provides for one local outlet station or intercept machine, and either one or two distributing frame units. The distributing frame units provide a cross-connection field for easy installation and change of the local outlet arrangements and each frame includes cross-connection facilities for ten local outlet sequence or common circuits and 20 local outlet individual circuits.

7.15 The supplementary local outlet cabinet can mount another relay unit of five common circuits, and also ten individual circuit relay units, thus providing the necessary relay equipment for up to five more local outlet or intercept circuits and up to ten local outlet or intercept machines. If required, the tenth individual circuit relay unit may be omitted and one or two local outlet loop repeater units, each comprising three loop repeaters, substituted for it.

(J) Multi-Channel Trunk Cabinet

7.16 The multi-channel trunk circuit is provided as two relay units. Four common circuits comprise one unit and each second unit provides for an individual trunk. The multi-channel trunk cabinet can accommodate one of the common units and ten of the individual units.

(K) Multiple Address Cabinets

7.17 The multiple address arrangements mount in three types of cabinets. A maximum of four cabinets will mount the maximum size multiple address arrangements for the maximum size office.

7.18 One of these, known as the multiple address level cabinet, mounts five multiple address level circuits. Four of these circuits are for operation and the fifth is a spare. Patching arrangements for these circuits are also provided in this cabinet. This cabinet must always be provided.

7.19 A second cabinet, which is always provided, known as the multiple address director cabinet, houses the following:

- (a) A regular and a spare multiple address level sequence circuit.
- (b) Two multiple address level circuits. These are optional and bring up to seven the total number of these circuits provided for the maximum size multiple address position (six working and one spare).
- (c) A regular and a spare director selector circuit.
- (d) A regular and a spare multiple address director circuit.
- (e) Patching arrangements for these circuits.

7.20 The third type of cabinet required for the multiple address arrangements is known as the multiple address link switch cabinet. One or two of these cabinets are provided depending on the size of the office. The first of them, which must always be provided, contains two crossbar switches that are used as first and second fan circuits, four crossbar switches that supply 40 verticals of the multiple address link and a cross-connection field for the multiple address director code assignments. When a second multiple address link switch cabinet is used it mounts up to six crossbar switches which provide the remaining 60 verticals required for the maximum size office.

(L) Group Code Cabinets

7.21 Two types of group code cabinets are provided, an originating group code cabinet, which must always be provided when group codes are used, and a supplementary group code cabinet, which is used when more than eight group codes are desired.

7.22 The originating group code cabinet mounts the following:

- (a) Regular and spare group code trunk relay units.
- (b) Up to 11 regular and one spare group code outlet relay units, each of which can handle four outlets, thereby providing for a maximum of 44 outlets.
- (c) One group code relay unit, which will provide for eight group codes and a spare.
- (d) Three patching units to patch the above relay units.

7.23 The supplementary group code cabinet, a number of which can be provided depending on the number of group codes required, mounts three group code relay units, each providing for eight group codes and a spare, and patching arrangements for these units. Each of these cabinets therefore provides for a total of 24 group codes.

(M) Patching Cabinet

7.24 The patching cabinet is similar to the cabinets used to mount the relay equipment except that it is somewhat wider and has double front and rear doors. This cabinet mounts six patching units, each of which contains eleven 50-point patch plugs and receptacles. These patching cabinets are used to supply patching facilities for the following:

- (a) Incoming Line or Trunk Circuits.
- (b) Director Circuits.
- (c) Transmitter Start Circuits.
- (d) Outgoing Line or Single Outgoing Trunk Circuits.
- (e) Local Outlet Circuits.
- (f) Multi-Channel Trunk Circuits.
- (g) Originating Station Circuits.

(N) Testing Arrangements

7.25 The testing arrangements for the switching center must always be provided. These arrangements consist of the following:

- (a) A test bench for making machine tests. This bench has two testing positions each equipped to make tests of the various types of teletypewriter apparatus.

(b) A machine test cabinet which is similar to the cabinets used for mounting the relay equipment except that it has no front door. This cabinet mounts a monitoring jack panel for monitoring cross-office paths, a jack field for setting up tests, a 14-type monitoring teletypewriter, a relay test panel for testing and adjusting 255A relays, and miscellaneous fuses, resistances and relays.

(c) A unit test cabinet which mounts the testing arrangements for the circuit tests. This cabinet is also similar to the relay equipment cabinets except that it has no front door.

(d) A 100-type apparatus cabinet which mounts two reperforator-transmitters for test purposes.

(e) One or two 15-type monitoring teletype-writers for general monitoring purposes.

(f) Miscellaneous testing apparatus such as 1A teletypewriter test sets, transmitter-distributors, a vacuum tube test set, etc.

#### (O) Apparatus Cabinets

7.26 The reperforator-transmitters are housed in 100-type apparatus cabinets (Figs. 8 and 9). The design of these cabinets is such that they can be installed in a row without space between them, and end sections are provided for each row to give a finished appearance. A cable turning section, which has the appearance of a narrow cabinet, is generally used in each cabinet line-up to bring cables into the line-up from overhead racks, inter-cabinet cabling being laid in space provided within the cabinets. Each cabinet is divided into three compartments and equipped with front and rear doors for access to them. Ventilating arrangements with air filters cool the machinery and keep out dirt, and soundproofing material and resilient mounting arrangements minimize noise. The front doors of the various compartments are arranged with windows through which the operation of the equipment can be observed, and fluorescent lighting is provided to light the compartments. Power factor correction equipment for the machines is also contained in these cabinets.

7.27 The functions and arrangements of the compartments are as follows:

(a) The top compartment houses one reperforator-transmitter and two tape reels for the supply of perforator tape. A key and lamp panel for this machine is also located here.

(b) The middle compartment is also arranged to house one reperforator-transmitter and its key and lamp panel. In addition, it contains a tape chute with a motor-driven belt to carry the tape that accumulates between the reperforator and the transmitter portions of the top compartment machine into the tape storage bin in the bottom compartment.

(c) The bottom compartment houses a removable, two-compartment tape storage bin for separate storage of the tape accumulating between the reperforator and transmitter portions of the two machines in the compartments above. The walls of the bin are transparent to permit observation of the tape, and the partition separating the two compartments is transparent and colored to provide a means for distinguishing between the tape from the two machines. The storage capacity of each bin compartment is approximately 75 feet of tape, corresponding to about 1500 words. The bottom compartment of the cabinet also houses a double-reel, motor-driven tape winder, each reel of which winds the tape from one of the machines after it has been transmitted. The reels are removable for disposing of the wound tape and each will accommodate approximately 1000 feet of tape.

#### (P) Control Board and Supplementary Control Arrangements

7.28 The control board (Figs. 13 and 14) is provided in sections each of which can mount five control panels. One common section is always provided. This section contains an alarm and intercept panel which mounts the common alarm lamps and keys, the originating station director tie-up lamps and the intercept lamps. Control panels for the regular and supplementary multiple address arrangements, the trunks, and the local outlets are also contained in the common section. Besides the common section, line sections each containing five control panels are provided. These panels are line control panels and may be multi-station line panels, each handling one line, or single station line panels, each capable of handling four single station lines. Blank panels may be used for spaces where neither of the above types is required. The control board is designed to mount either in line with the apparatus cabinets or by itself. Certain additional control arrangements are provided in the form of key and lamp panels at the apparatus cabinets and at the teletypewriter tables rather than in the control board. These are illustrated in Figs. 10 and 11.

(Q) Equipment Dimensions

7.29 The sizes of the various switching office equipment units are listed in the following table, which also indicates the recommended minimum aisle space at the front and rear of these units:

<u>Unit</u>	<u>Size</u>			<u>Recommended Minimum Aisle Space</u>	
	<u>Height</u>	<u>Width</u>	<u>Depth</u>	<u>Front</u>	<u>Rear</u>
Test Cabinets and all Relay Cabinets	7'	26-1/4"	17"	3'	3'
Patching Cabinets	7'	33-3/4"	17"	3'	3'
Test Bench	34" (Working Surface)	7'	3'-2"	5'	None
Apparatus Cabinets	54"	25-7/16"	22-5/8"	4'	3'
Cable Turning Section (To bring overhead cable into apparatus cabinets)	54"	10-5/8"	22-5/8"	4'	3'
End Panels (Used on each end of apparatus cabinet line-up)	54"	2"	22-5/8"	-	-
115-Type Table	24-1/4"	17-1/2"	17"	3'	3'
119-Type Table	26-1/8"	45"	23"	4'	2'
Control Board Section	51-1/2"	15"	24-5/8"	4'	2'
Control Board End Panels	54"	2-1/2"	22-5/8"	-	-

(R) Floor Loads

7.30 Estimated weights of equipment for use in determining floor loads are listed in the following table:

<u>Unit</u>	<u>Weight - Lbs.</u>
Apparatus Cabinet (fully equipped)	400
Typing Reperforator and 115-Type Table	75
15RO Teletypewriter and 115-Type Table	150
Originating Station No. 19 Teletypewriter	300
Control Board - Per Section	250
Cabinets of Relay, Test and Patching Equipment	650
115V Rectifier Cabinet (2 rectifiers)	1110
48V Rectifier Cabinet	770
Power Service Cabinet	540
Auxiliary Power Service Cabinet	440
Test Bench (with machines)	500

7.31 The weight of the battery racks depends on the type of battery cells used, which is determined on a job basis.

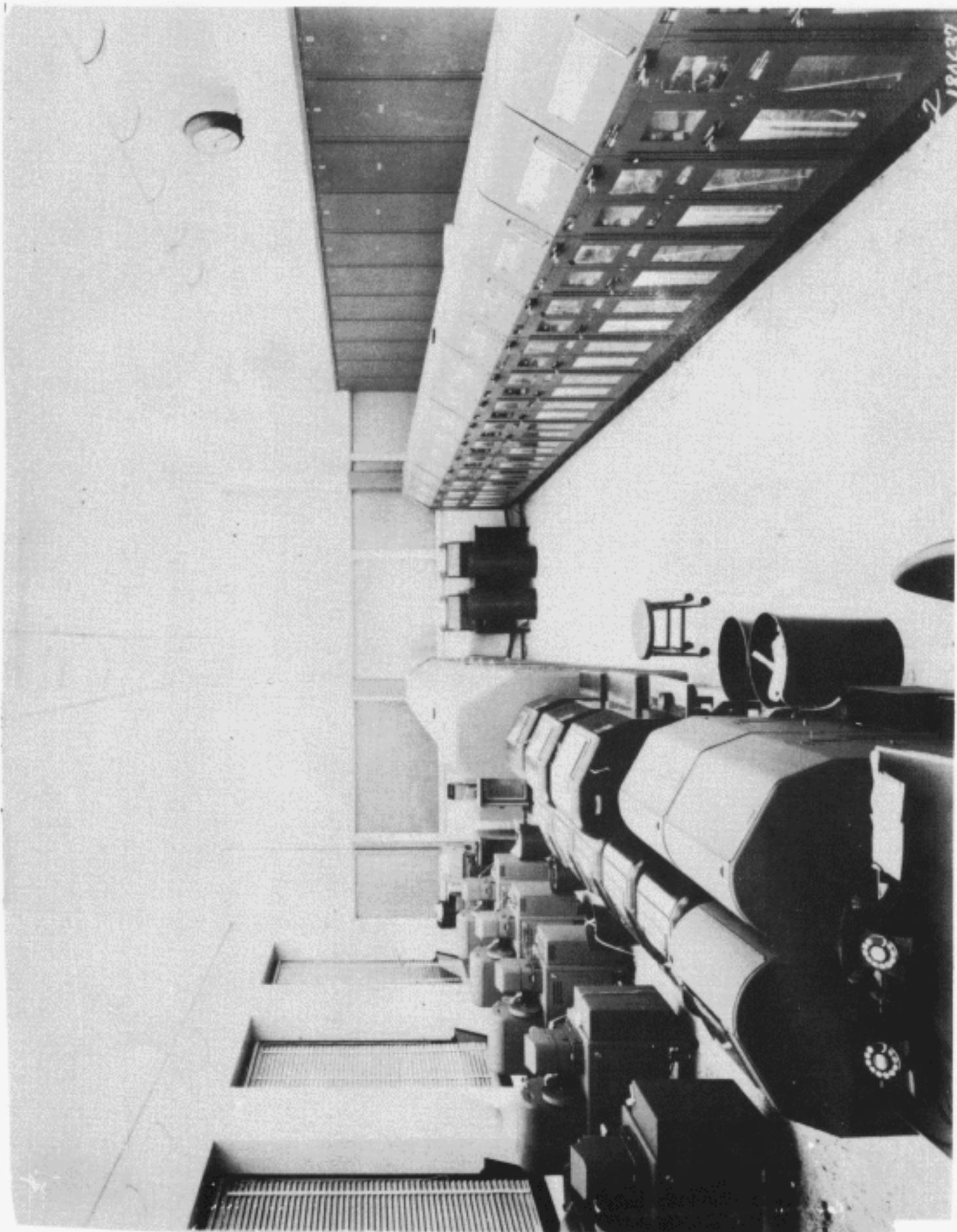


Fig. 1 - General Motors Corporation Switching Office



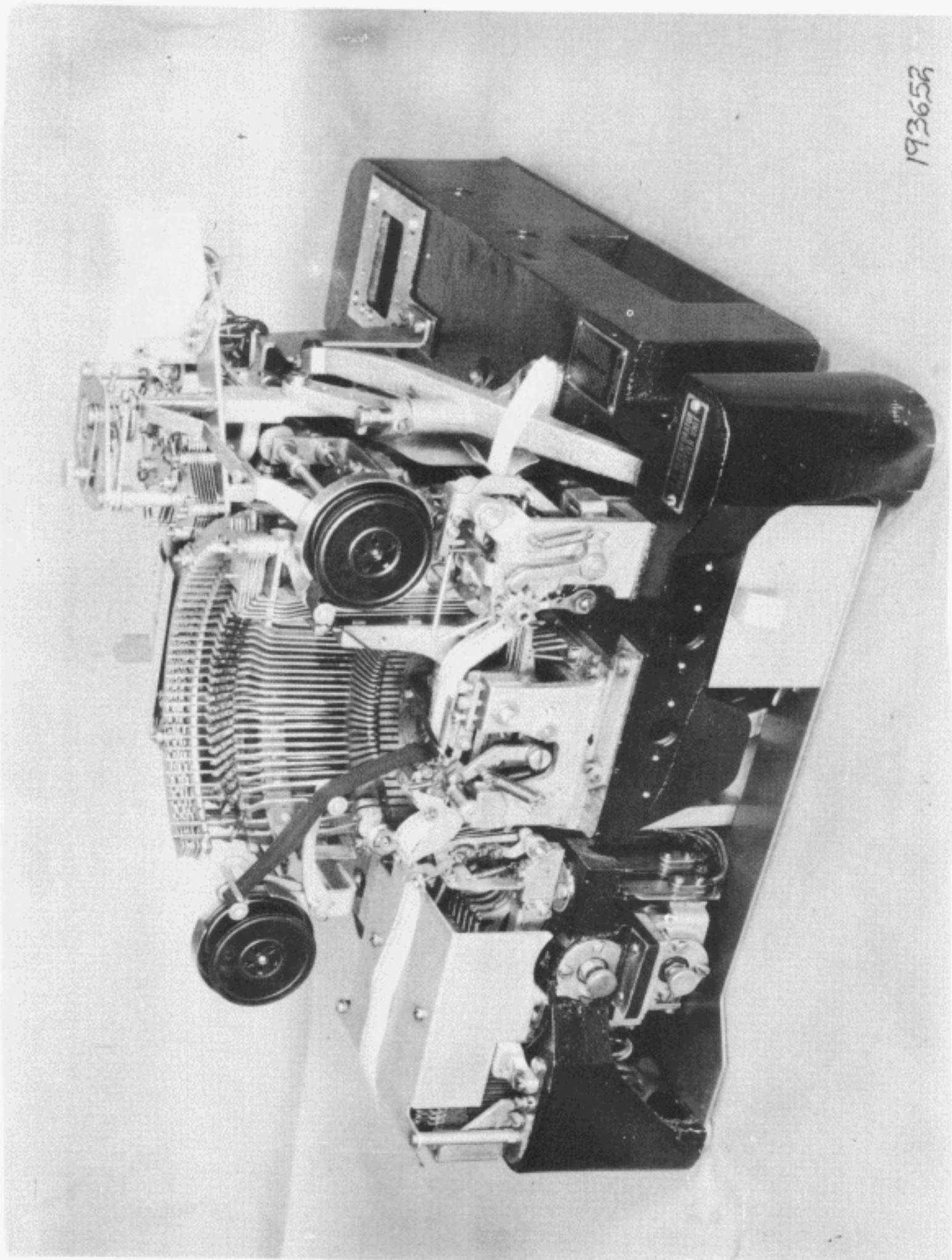
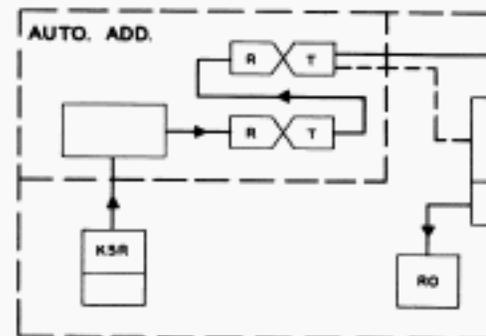
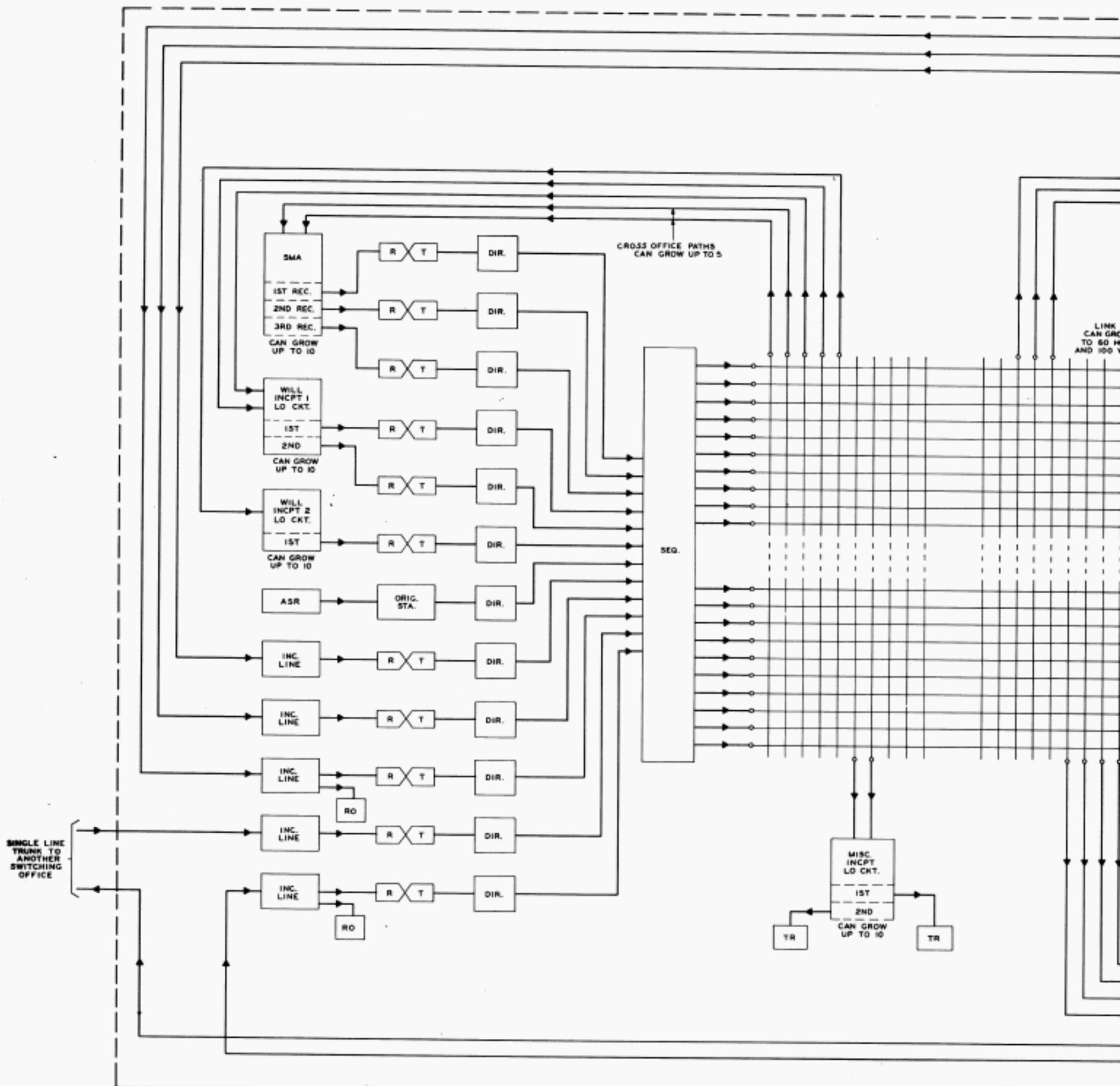
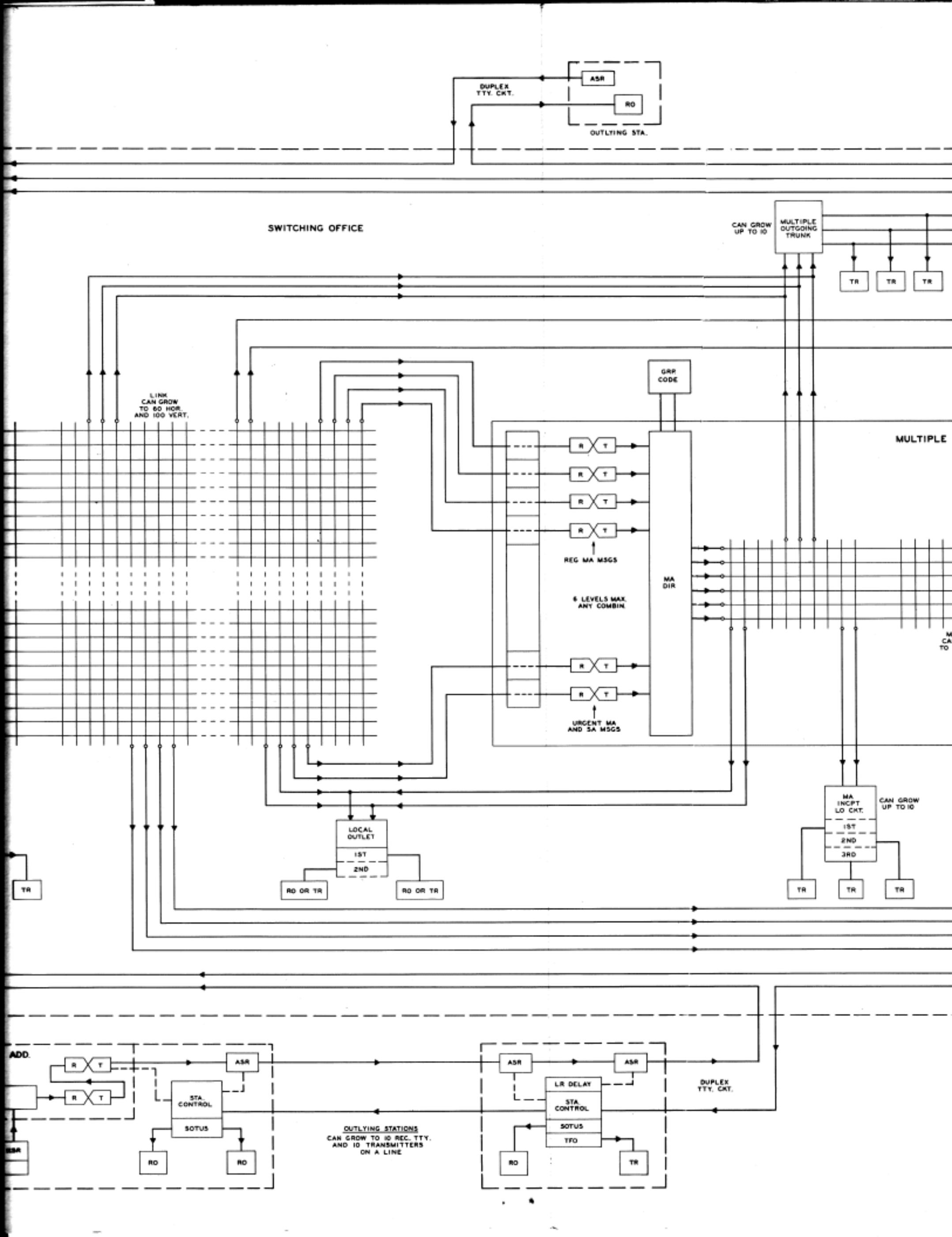


Fig. 3 - Reperforator-Transmitter





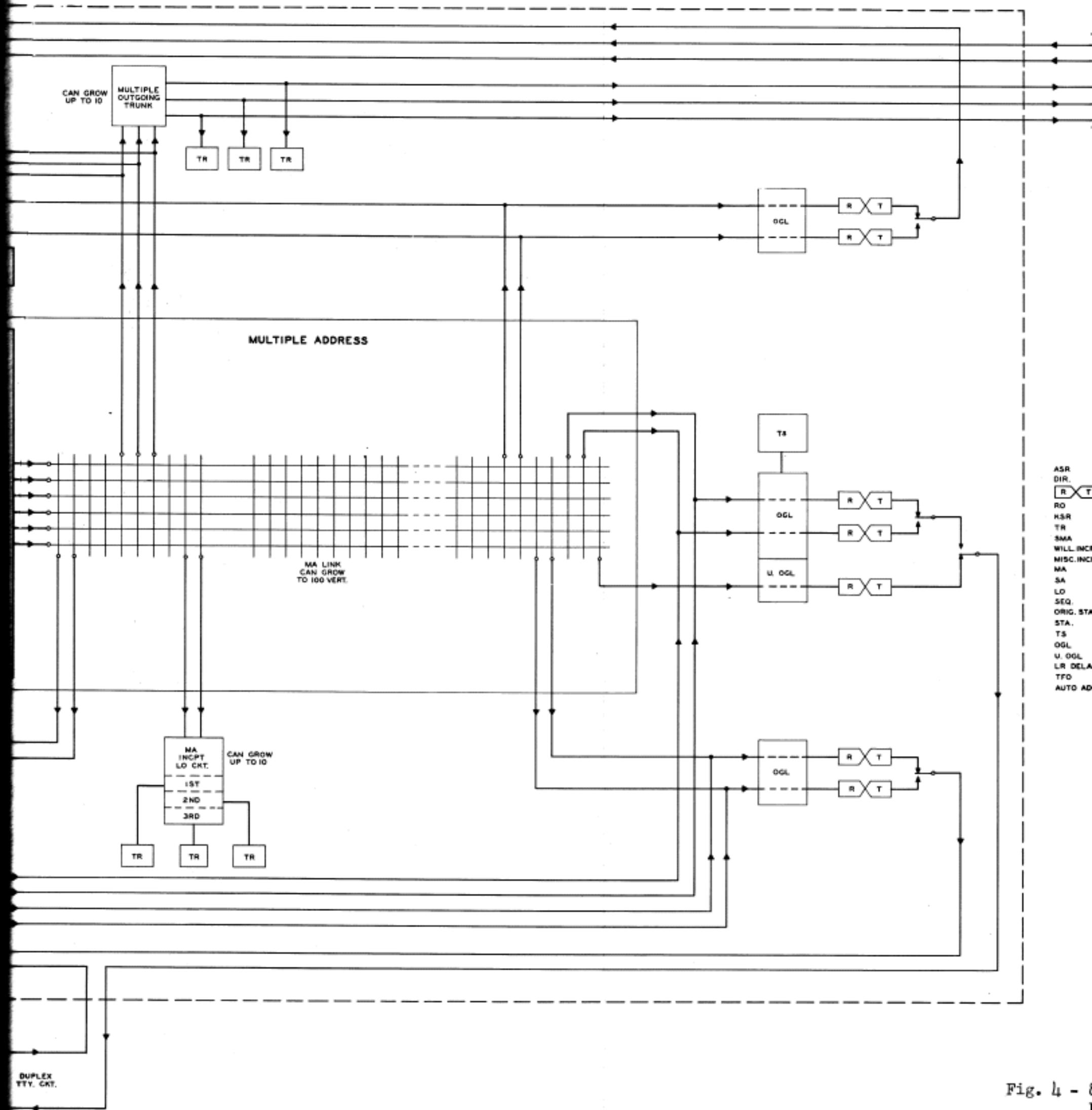


Fig. 4 -

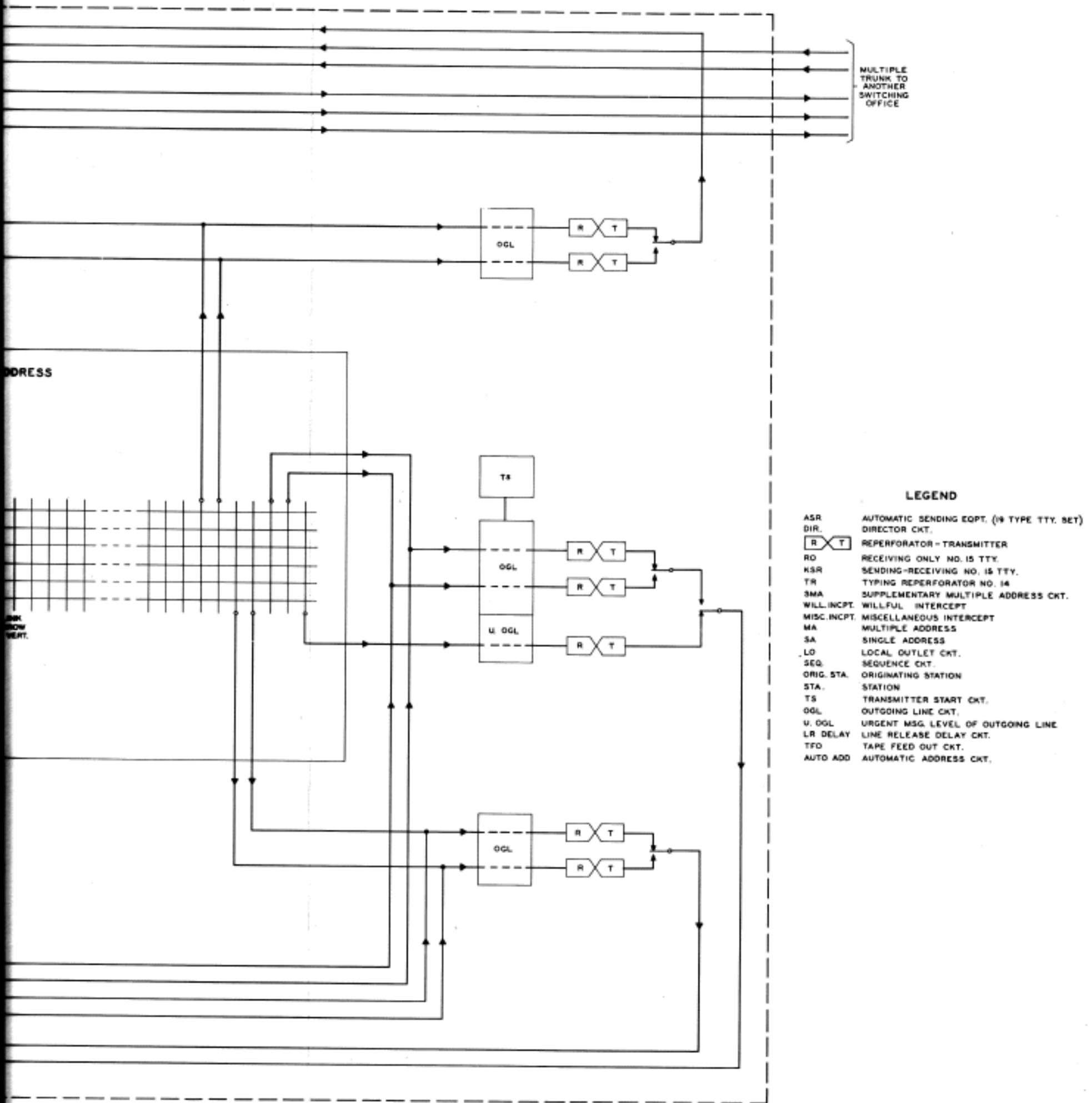


Fig. 4 - 81D1 Switching System - Block Diagram

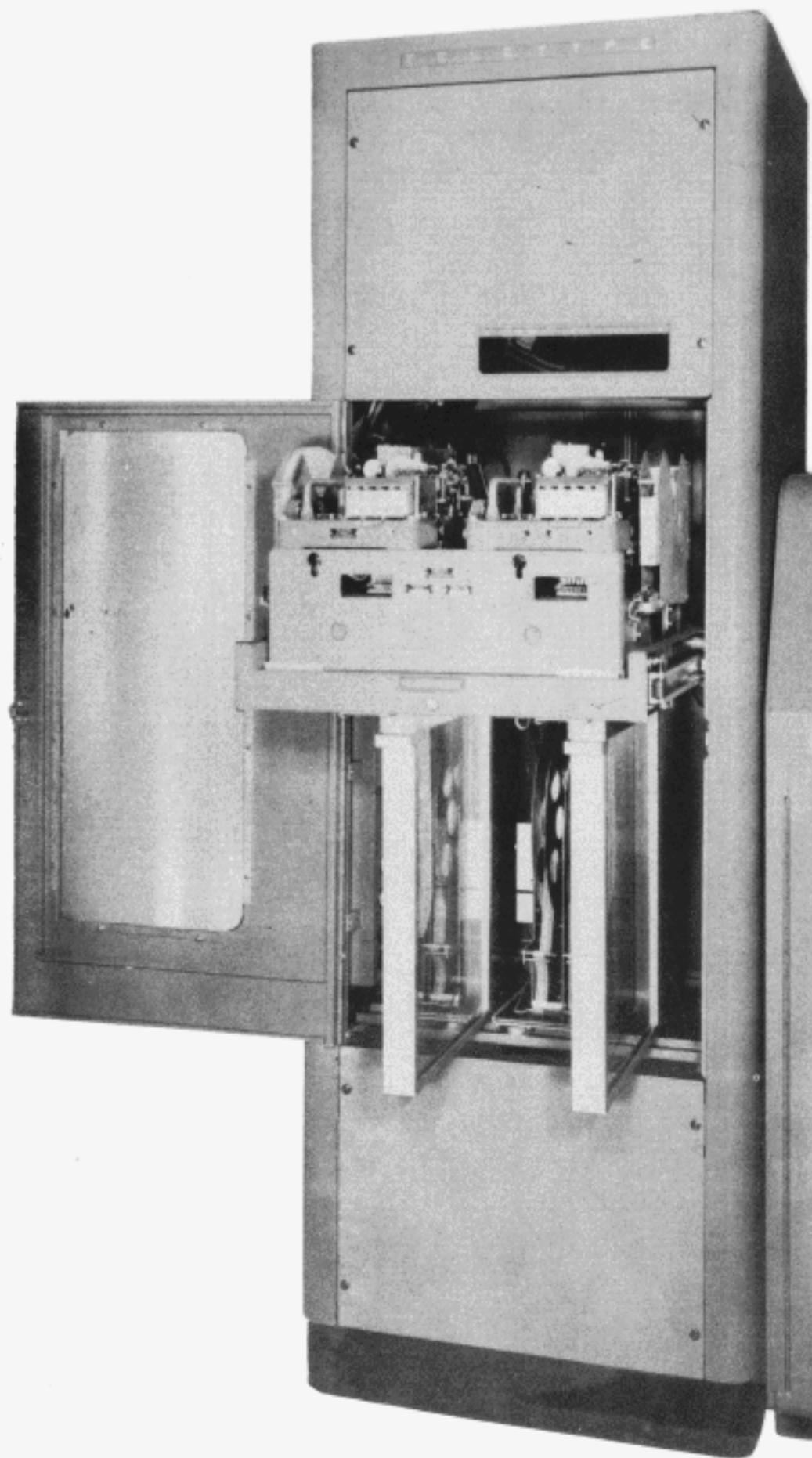


Fig. 5 - Automatic Address Cabinet

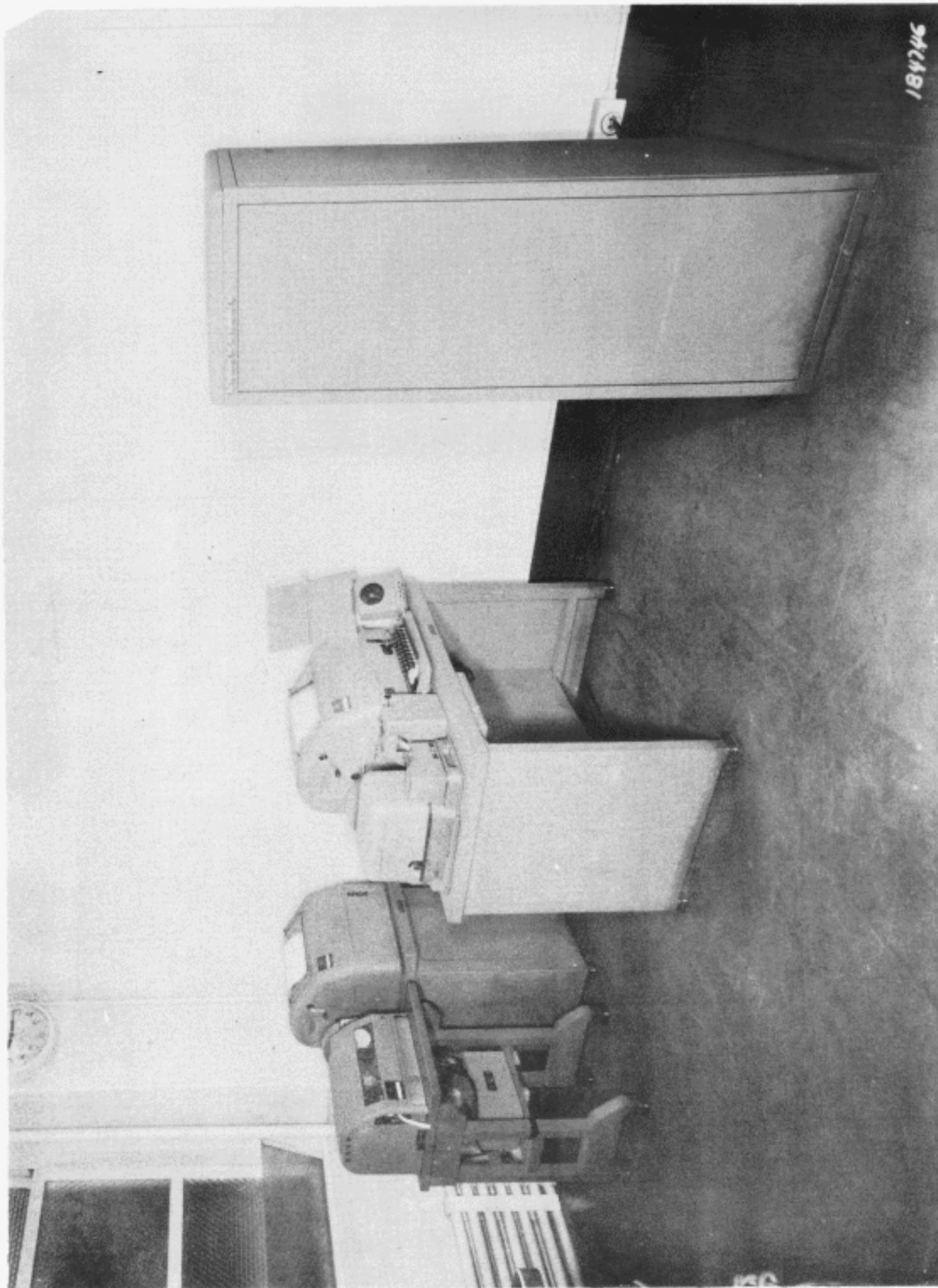


Fig. 6 - A Typical Station on a Multi-Station Line

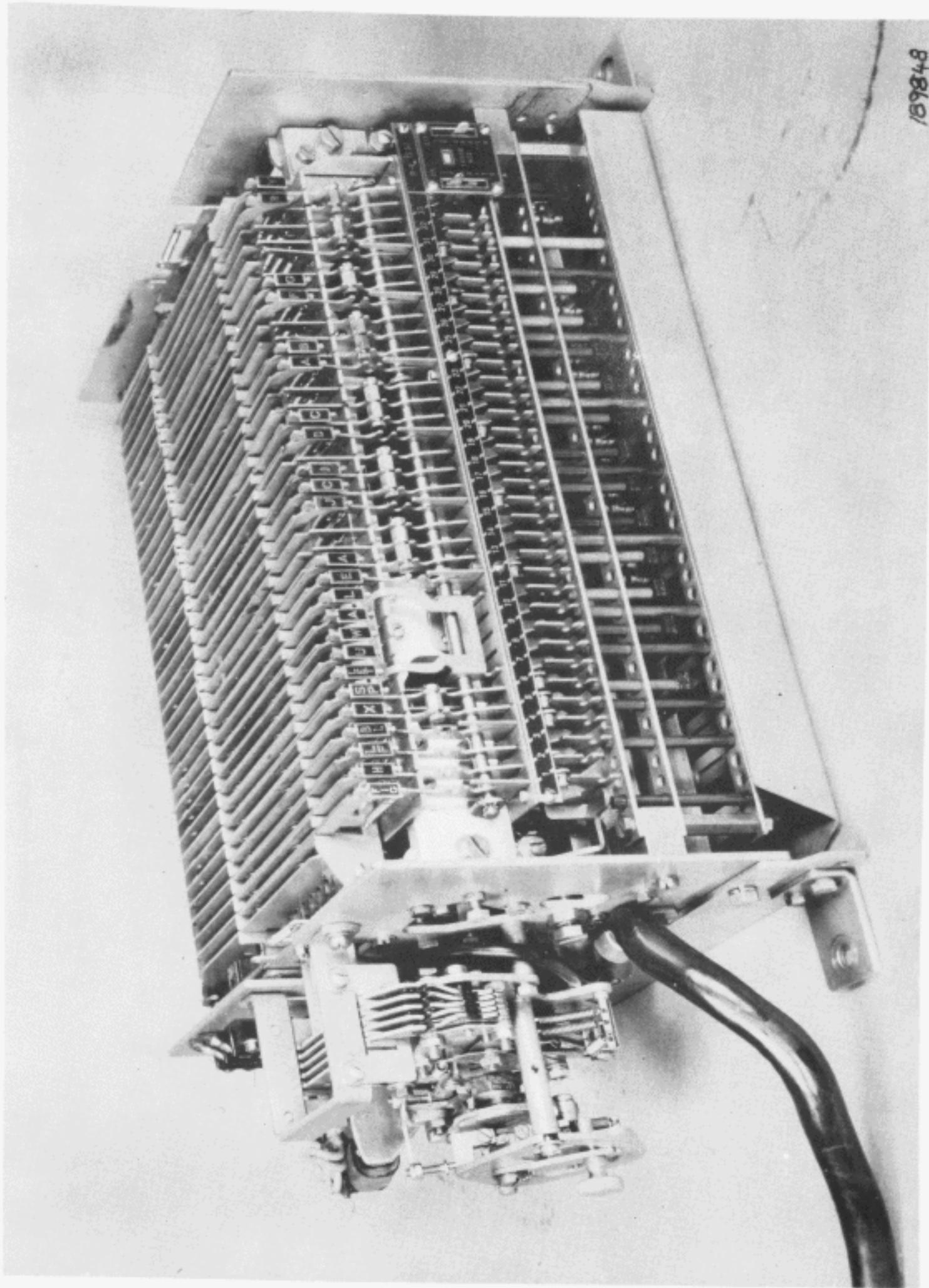


Fig. 7 - SOTUS Unit

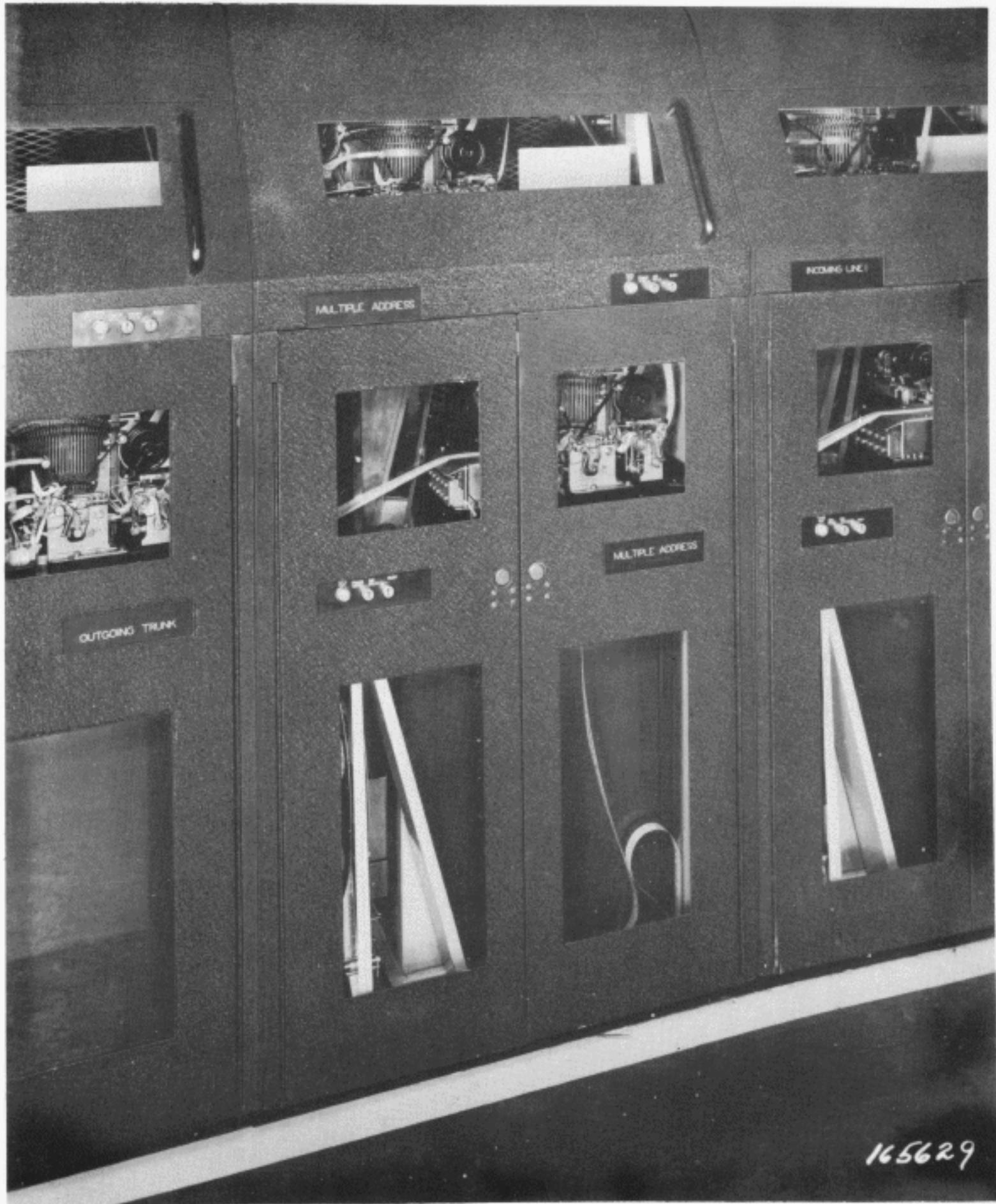


Fig. 8 - 100-Type Apparatus Cabinets

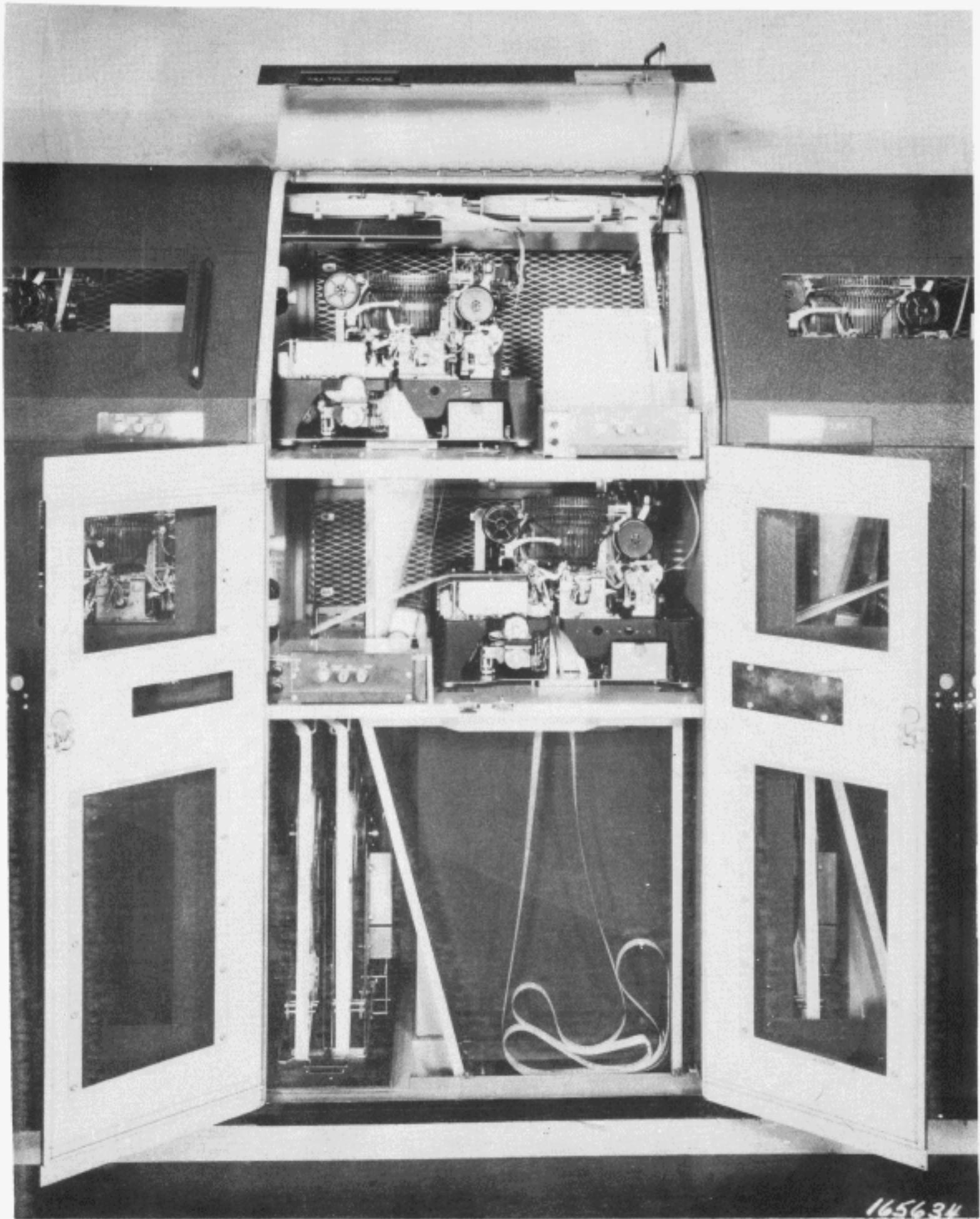
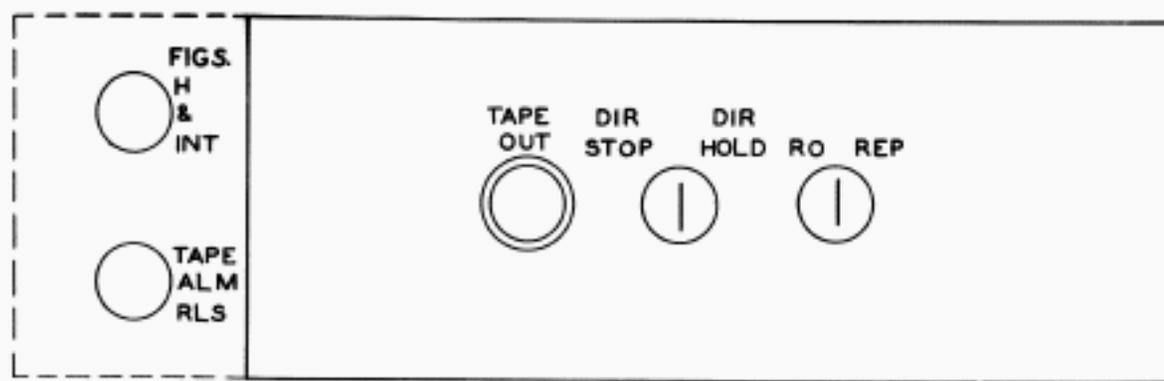
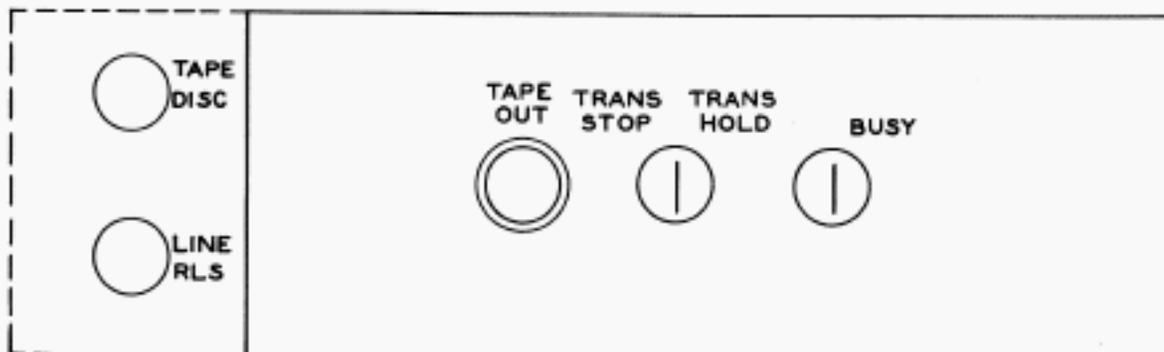


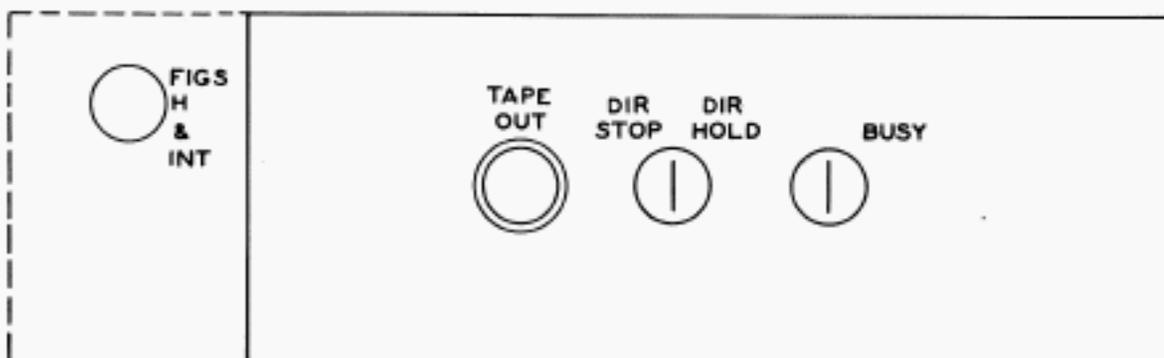
Fig. 9 - 100 Type Apparatus Cabinets - Doors Open



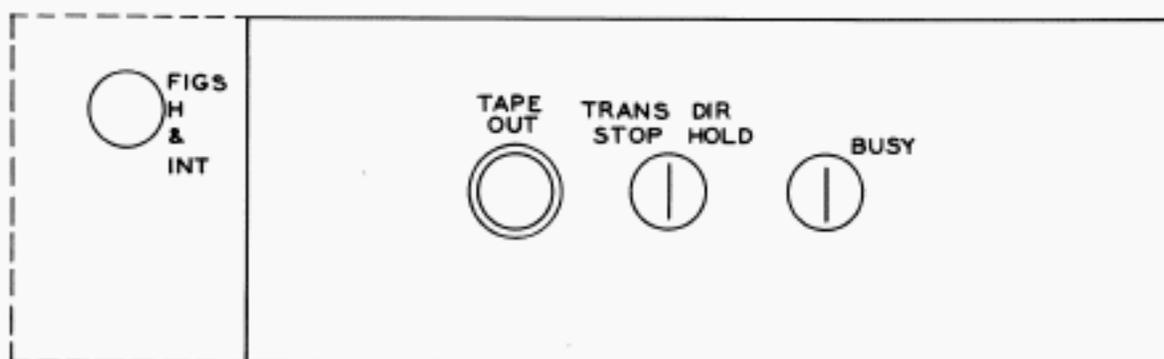
INCOMING LINE



OUTGOING LINE



WILLFUL INTERCEPT



MULTI F ADDRESS

LEGEND



Fig. 10 - Apparatus Cabinet Key and Lamp Panels

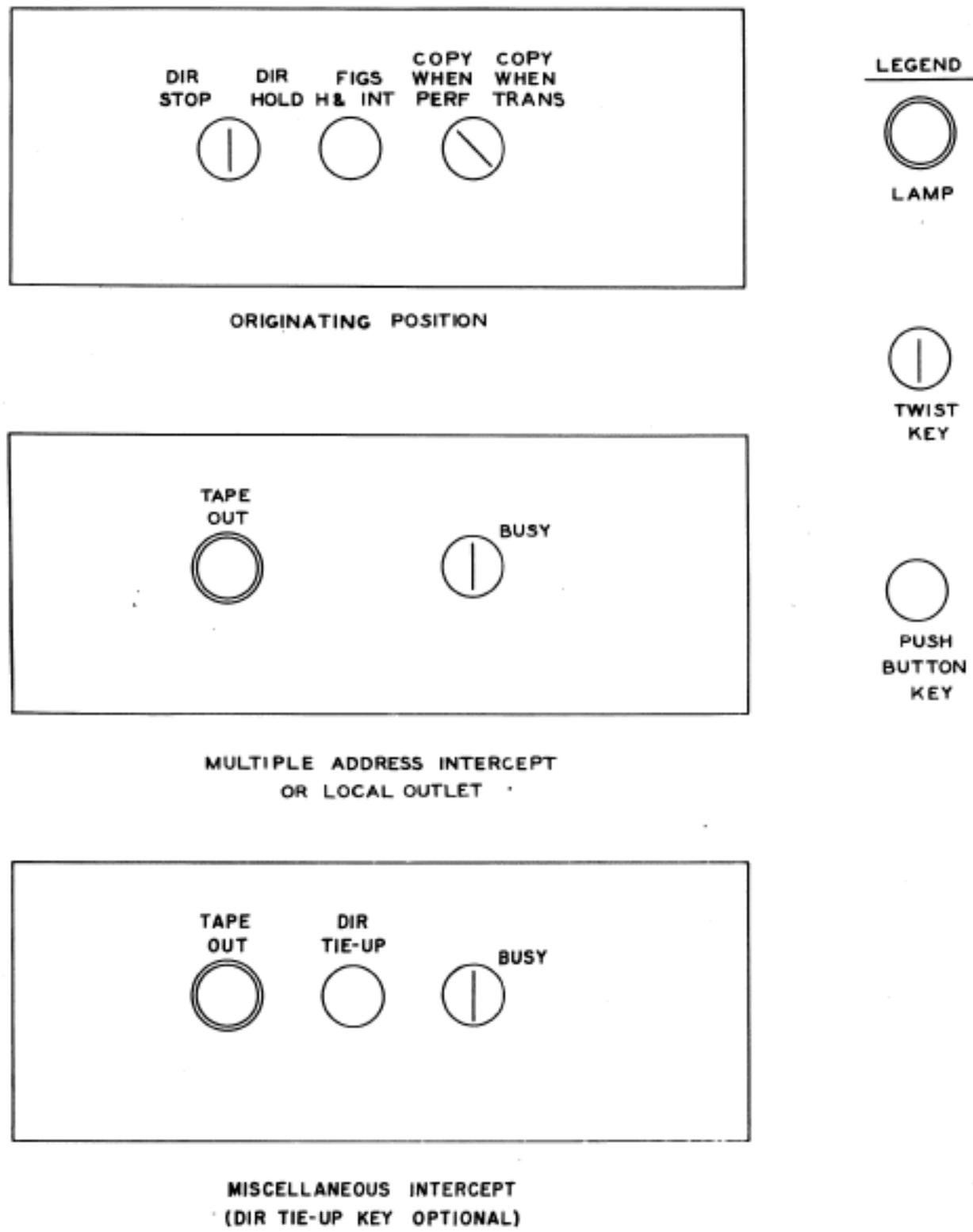


Fig. 11 - Teletypewriter Table Key and Lamp Panels

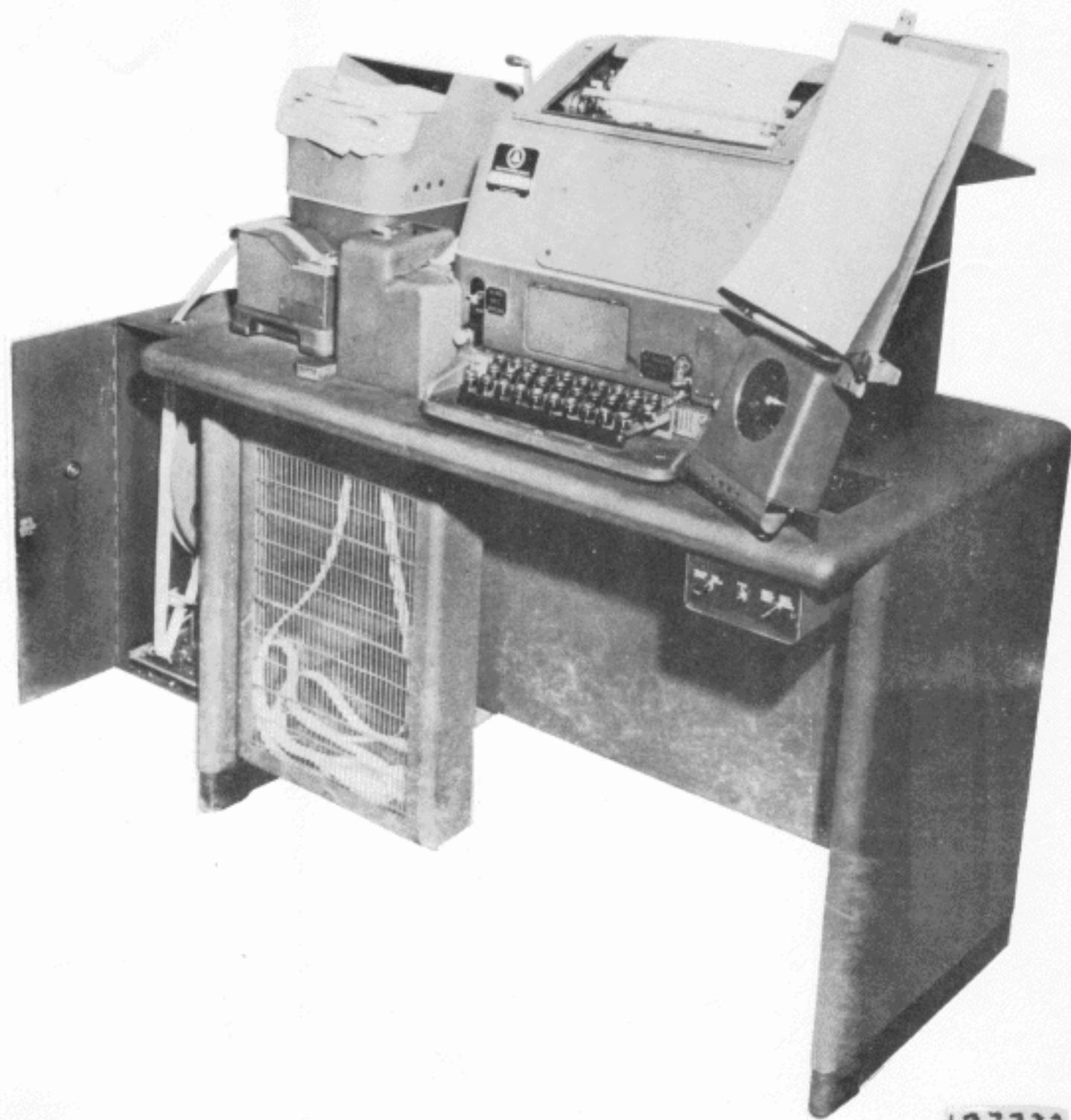


Fig. 12 - Originating Station

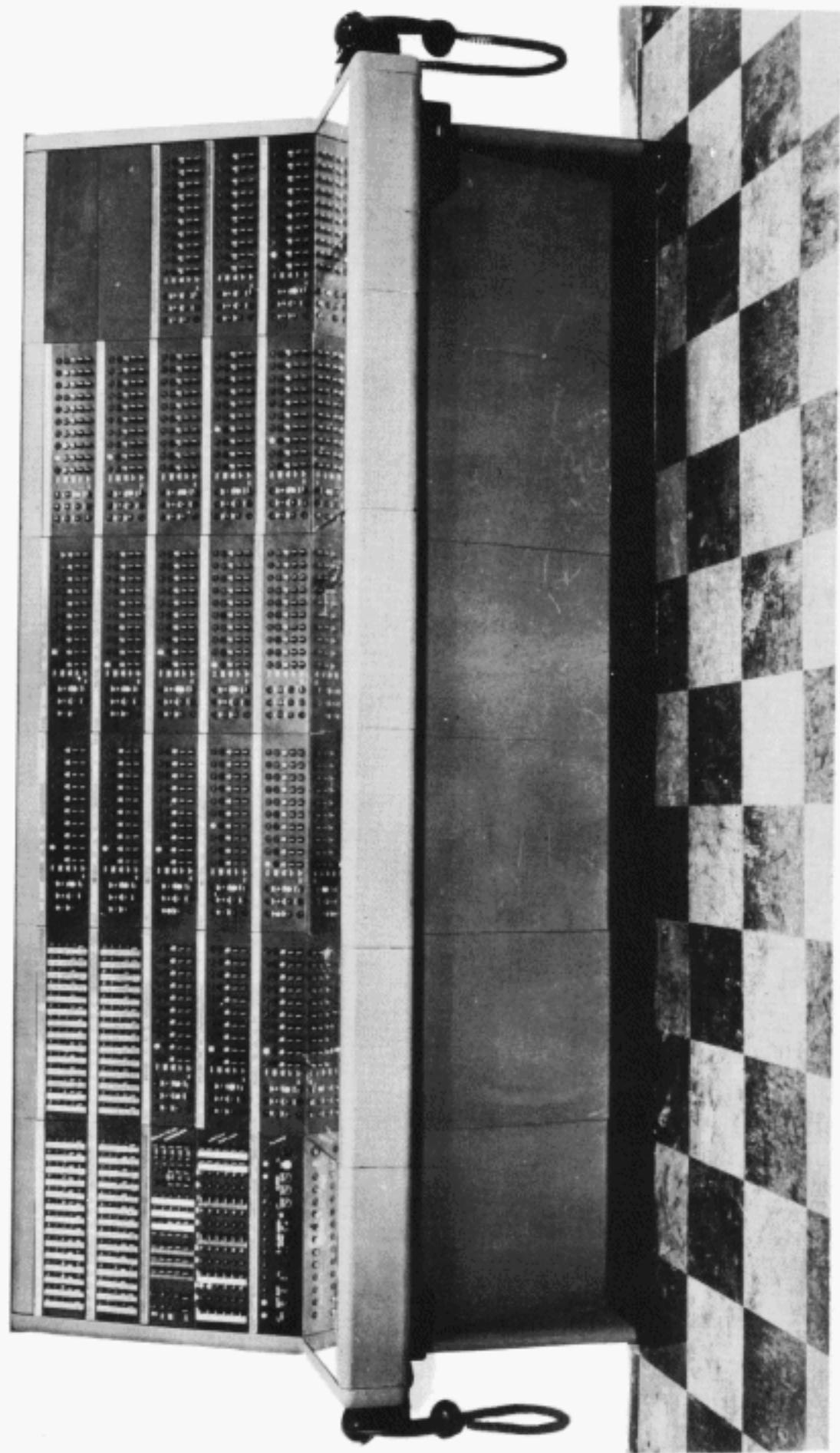
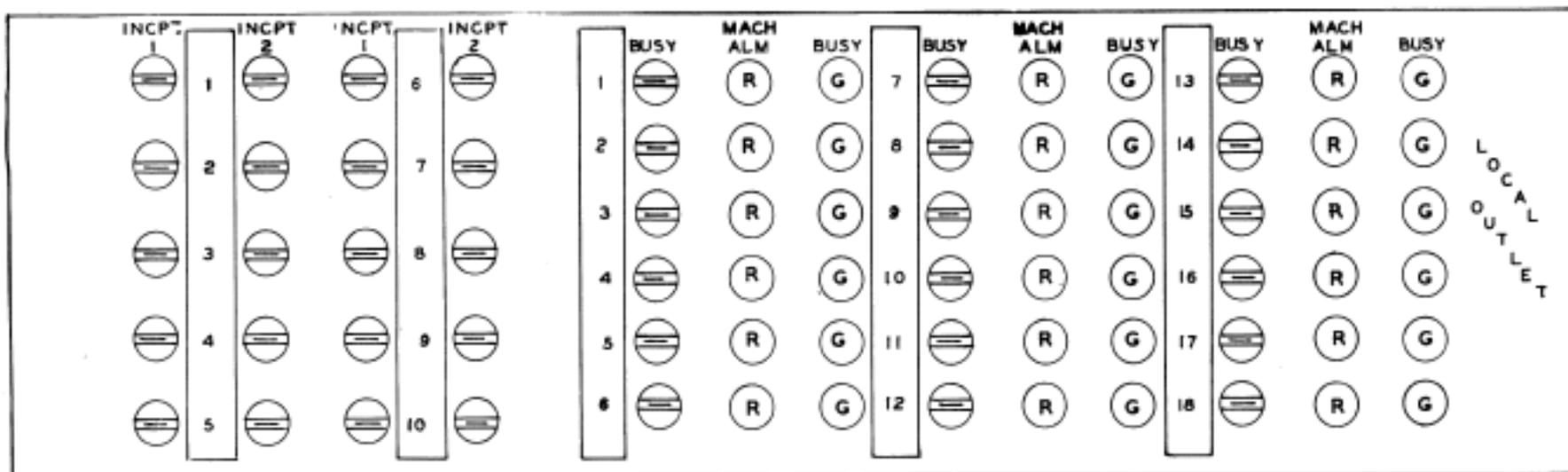
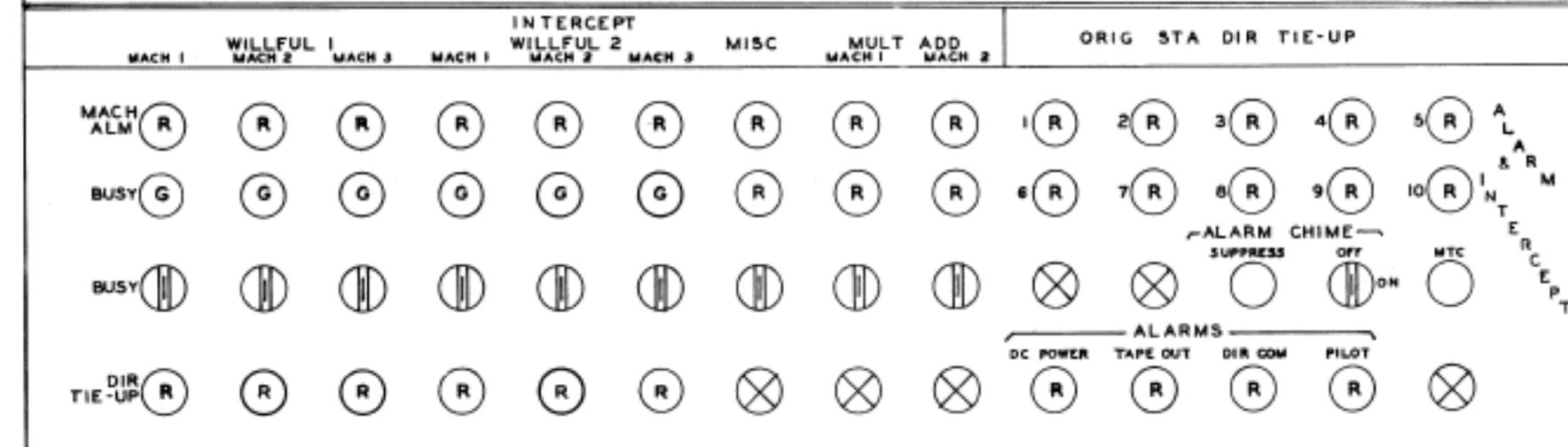
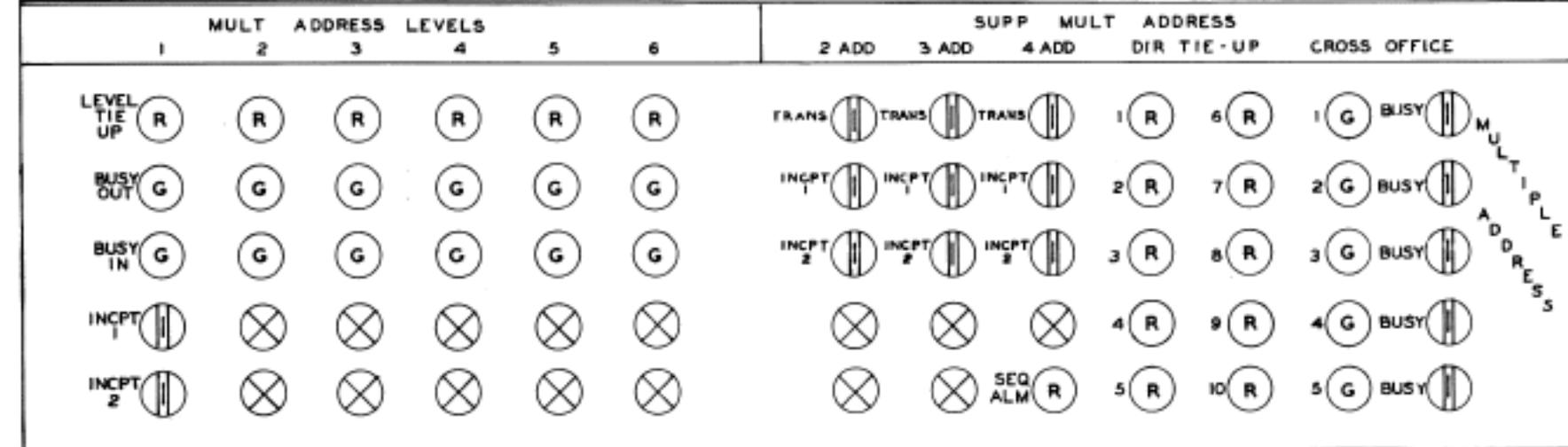
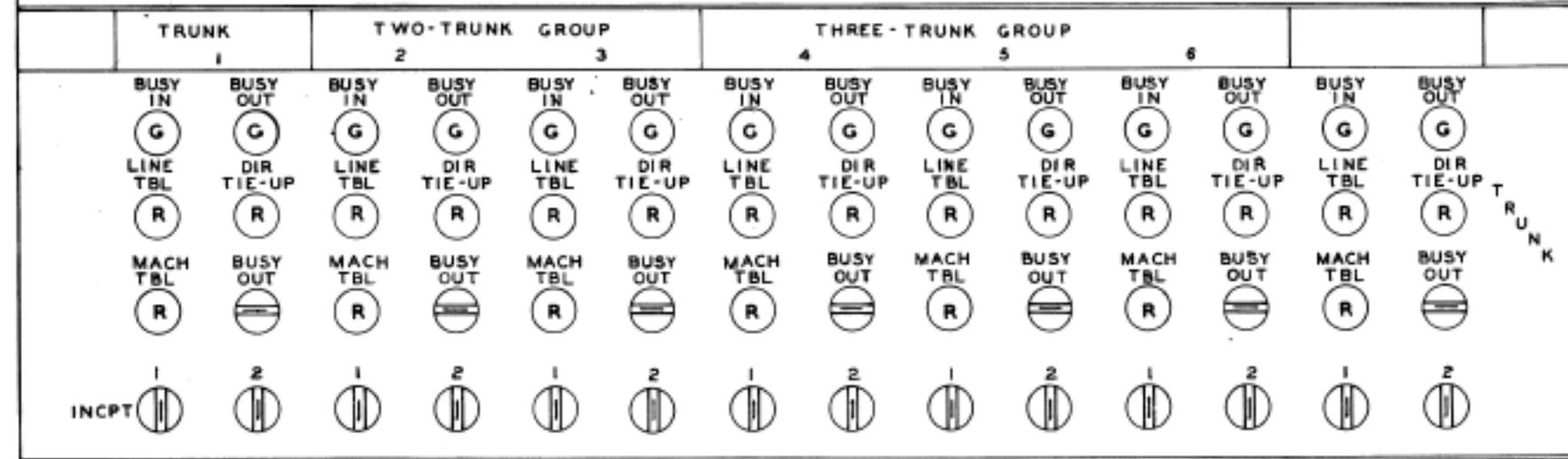


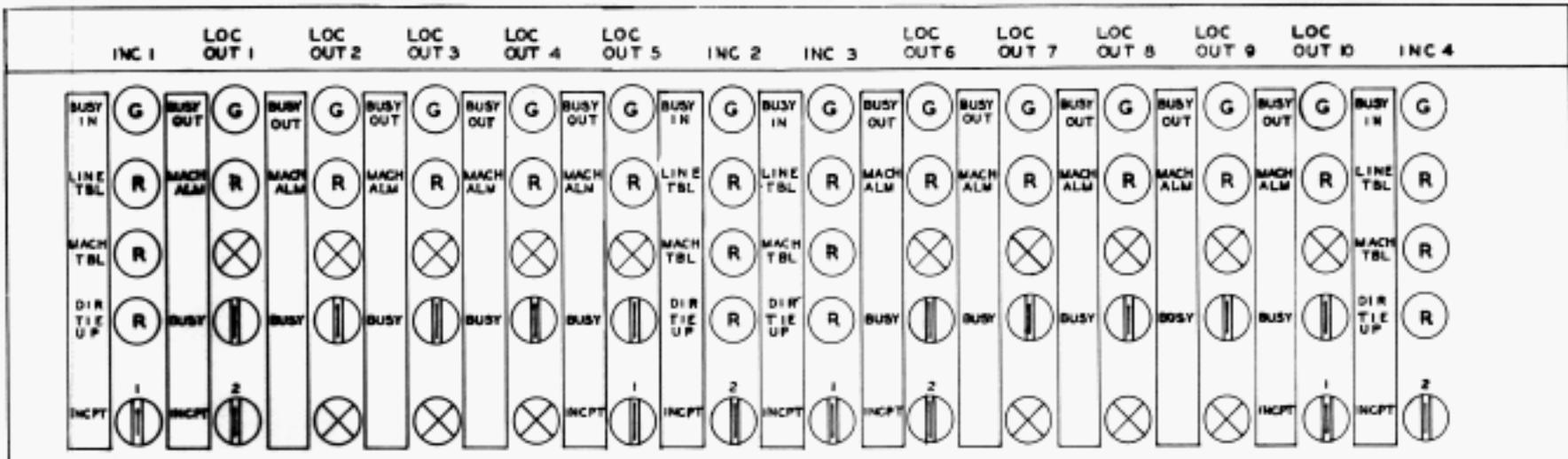
Fig. 13 - Control Board



SECOND TRUNK PANEL OR SECOND LOCAL OUTLET PANEL

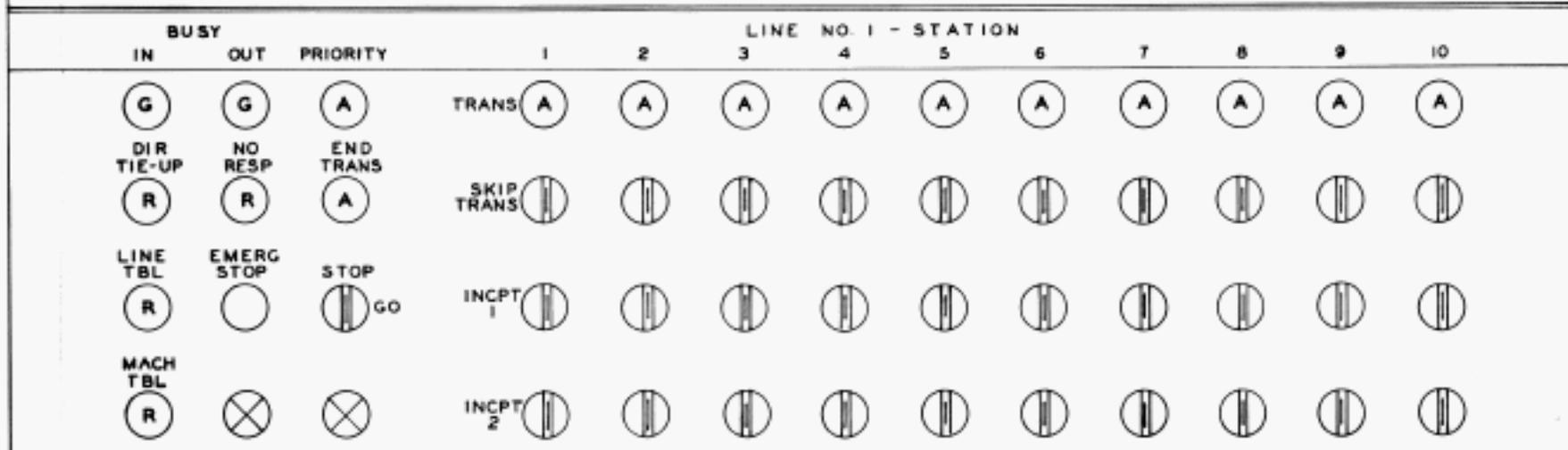
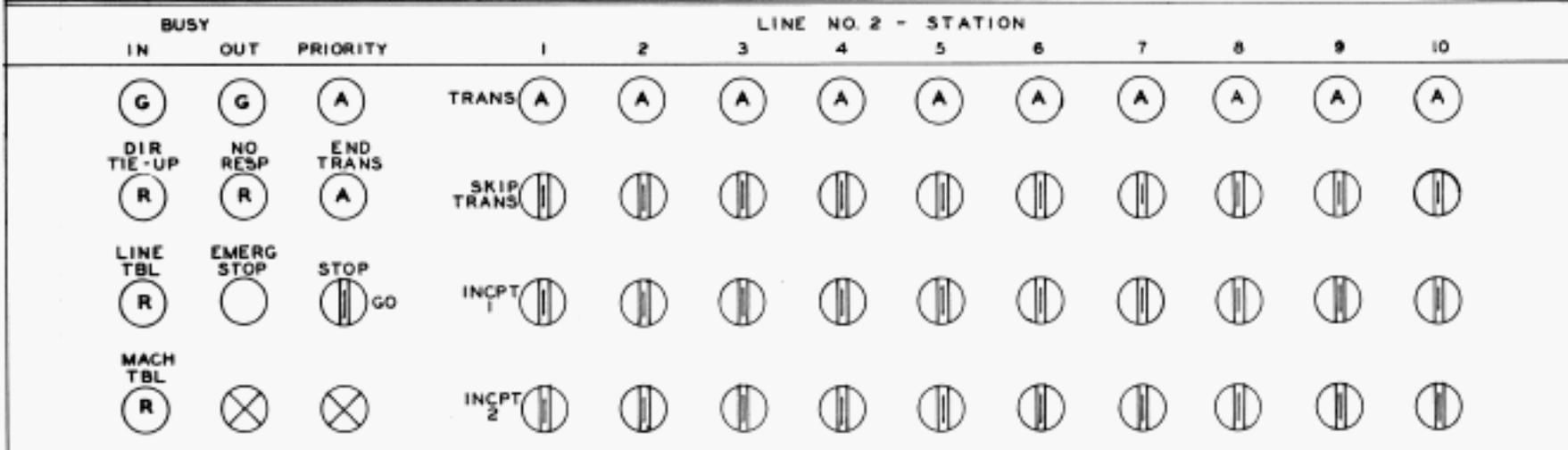
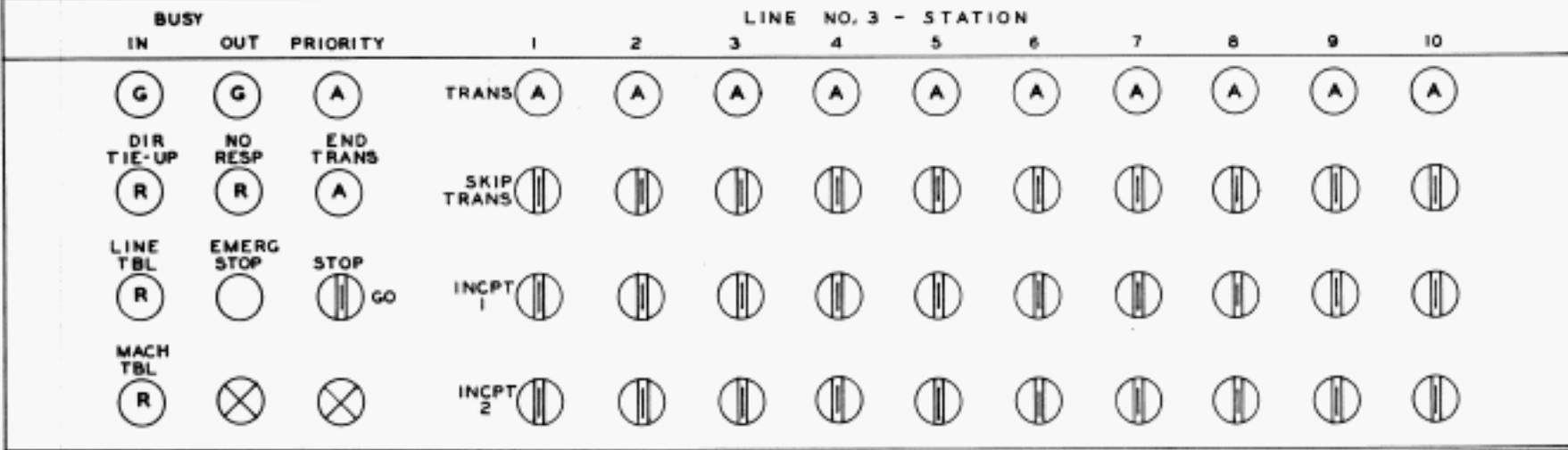


CONTROL BOARD LAYOUT  
TYPICAL COMMON SECTION



← SINGLE STATION (MULTI-STATION IN THIS POSITION)

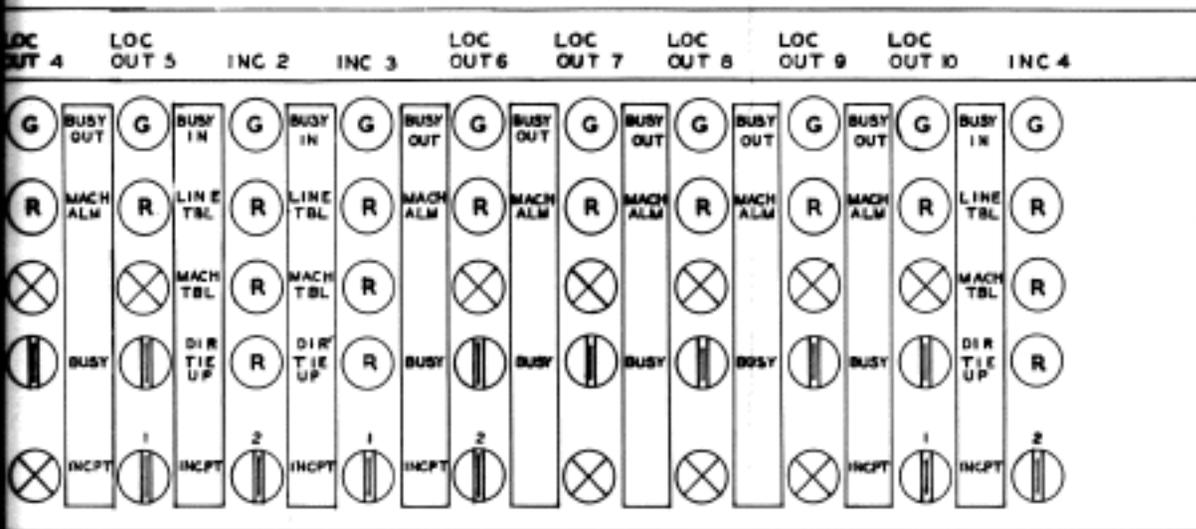
MULTI-STATION LINE PANEL  
OR  
SINGLE STATION LINE & LOCAL OUTLET PANEL



MULTI-STATION

Fi

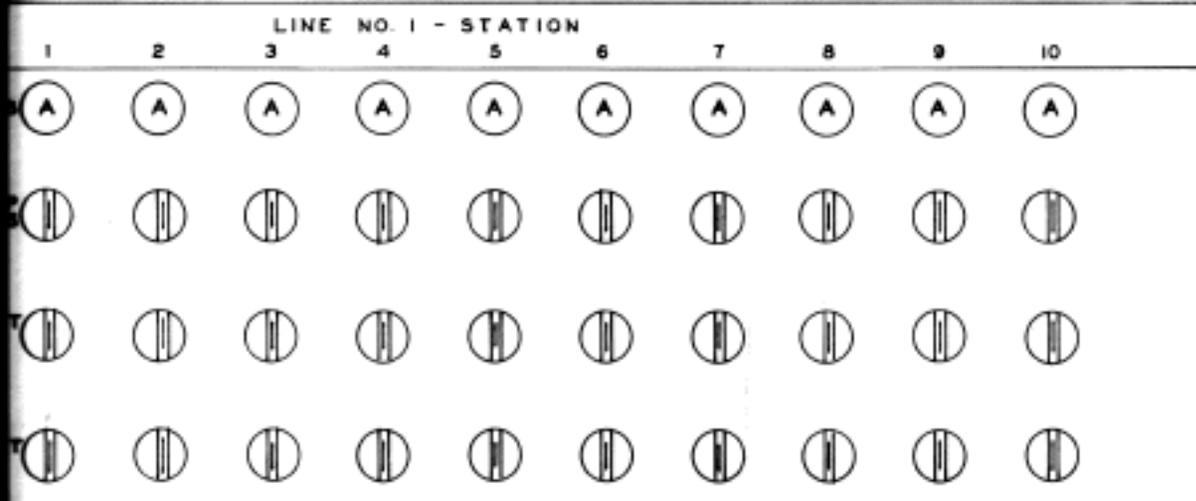
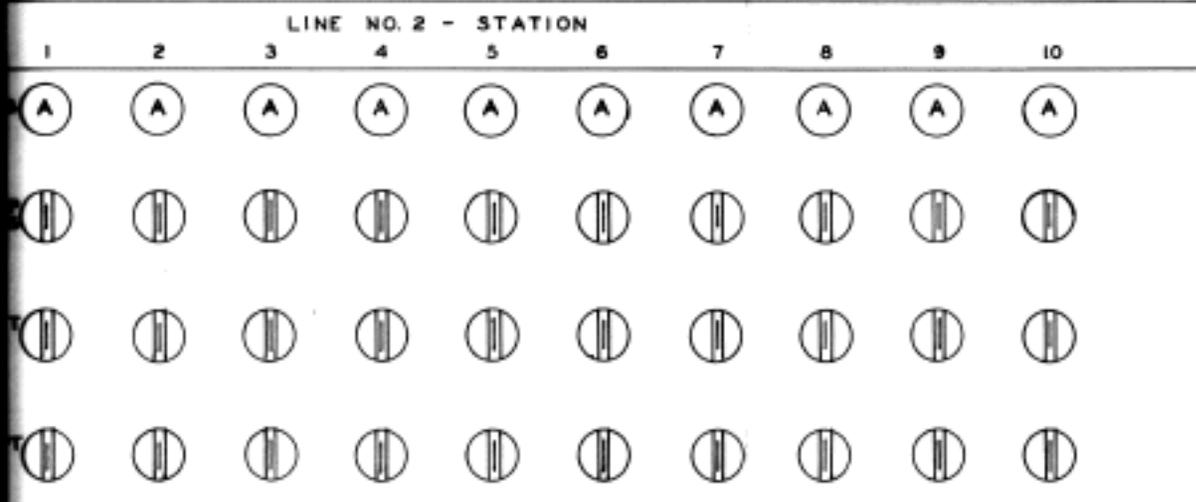
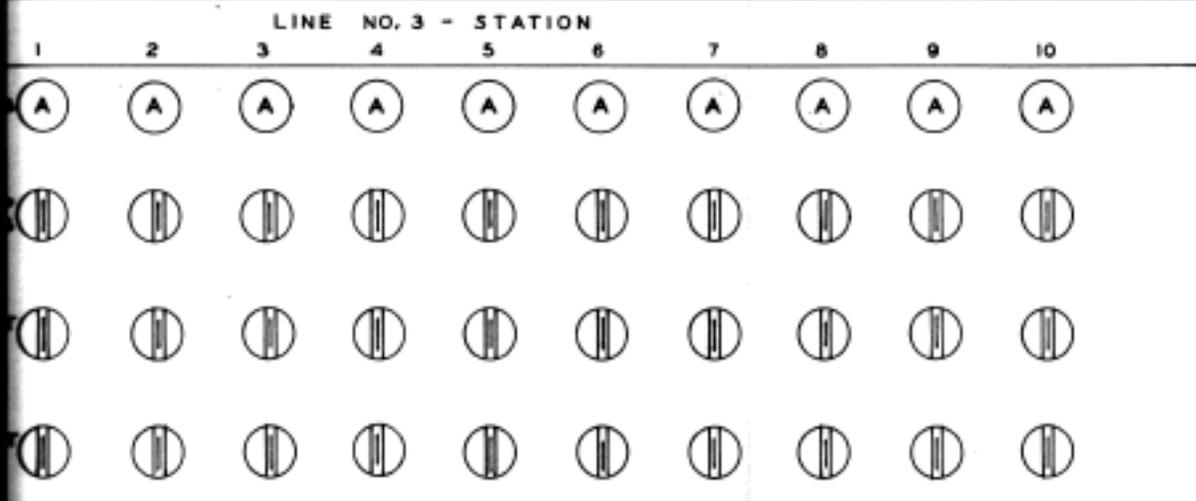
CONTROL BOARD LAYOUT 4  
TYPICAL LINE SECTION



← SINGLE STATION LINE & LOCAL OUTLET PANEL  
(MULTI-STATION LINE PANEL MAY BE USED  
IN THIS POSITION)

LINE PANEL

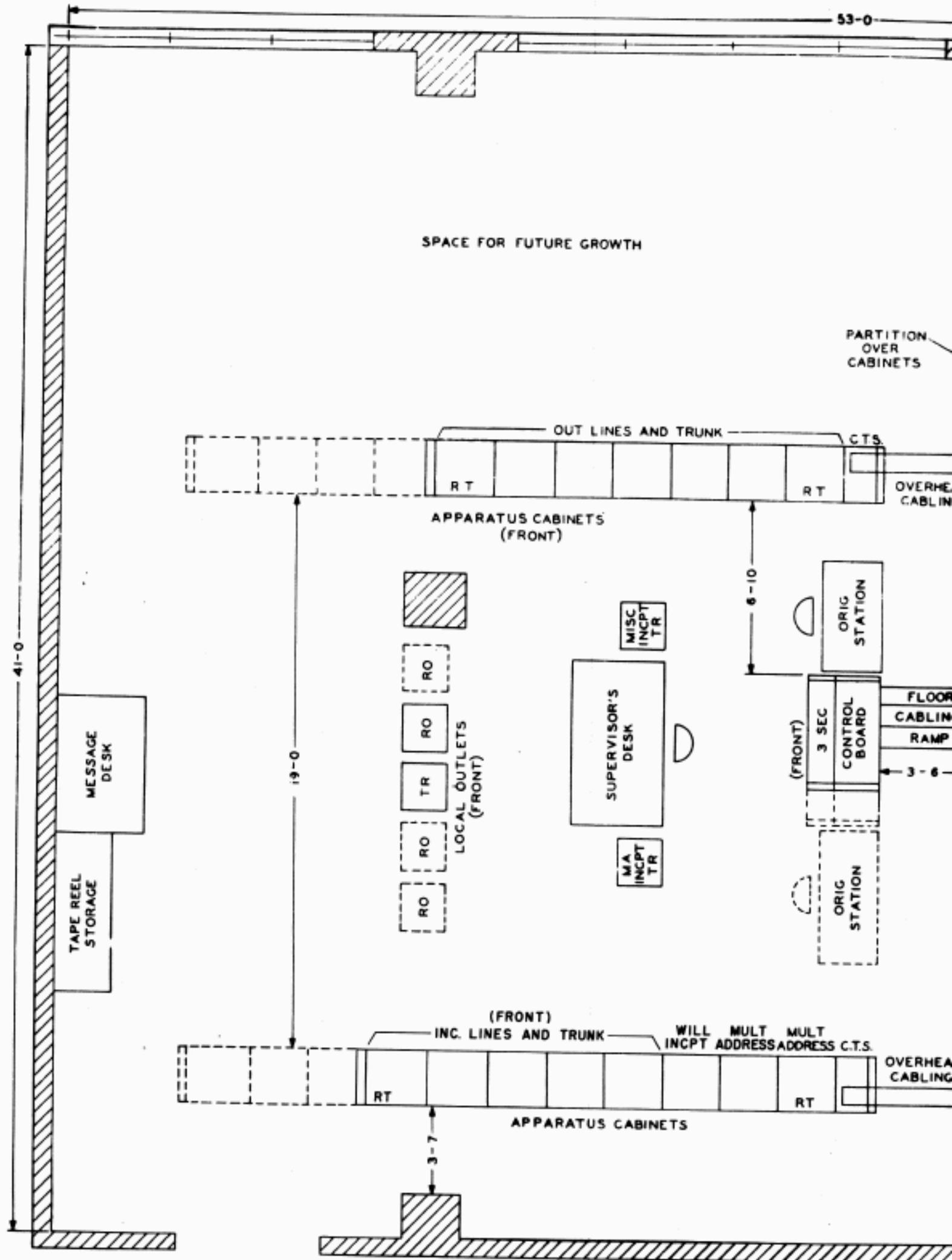
LINE & LOCAL OUTLET PANEL



- LEGEND —
- (R) RED LAMP
  - (G) GREEN LAMP
  - (A) AMBER LAMP
  - (T) TWO POSITION LOCKING TWIST KEY
  - (O) PUSH TYPE NON-LOCKING KEY
  - (X) APPARATUS BLANK

MULTI-STATION LINE PANELS

Fig. 14 - Control Board Layout



NOTES:  
 --- INDICATES PROVISION FOR GROWTH.  
 ——— INDICATES INITIAL INSTALLATION.

