WIDE AREA DATA SERVICE AND 4-ROW TELETYPEWRITER EXCHANGE SERVICE GENERAL DESCRIPTIVE INFORMATION

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1. INTRODUCTION

1.01 This section presents a general description of the system which will be used to furnish a new service offering, Wide Area Data Service (WADS), and to provide an improved version of the existing Teletypewriter Exchange (TWX) service.

1.02 WADS will be a line-switched service in which connections between originating and terminating teletypewriter (TTY) machines will be established by a central office switching and interoffice trunking system similar to that used for interconnecting dial TWX service.

1.03 While WADS and TWX equipment perform in the same basic fashion, there will be certain important features introduced with WADS which substantially increase the speed of TTY communication while at the same time reducing the cost of the service for medium and large users.

1.04 Speed improvement will be achieved in two areas. TTY stations will transmit at the rate of 100 words per minute (wpm) in contrast to the 60 wpm operation of the existing TWX service, and the time required for establishing TTY connections will be reduced through use of a switching plan which will require no more than three interoffice trunk links for any connection to a WADS station dialed by a WADS customer. (As in the case of TWX service, there will be assistance switchboards to handle special types of calls, such as conference and collect calls, and these may involve more than three interoffice links.)

1.05 The limitation of three interoffice links (or a maximum of four switching offices) involved in any call switched via the WADS switching plan will be accomplished by providing a 2-level hierarchy of central offices through which WADS connections will be established. Approximately 80 central offices, of which 12 will be primary switching centers and the remainder will be secondaries, will be used as WADS Switching Centers. Each primary office will have a direct trunk group to every other primary, and each secondary will have direct trunks to the primary office upon which it homes as well as direct trunks to other WADS offices where the volume of direct traffic warrants them. This restricted WADS switching plan (ie, restricted by comparison with the telephone DDD plan which is based on a 5-level hierarchy of switching offices) results in relatively large trunk groups between switching offices and in longer average length of trunk groups, both of which permit economies to be achieved in the interoffice trunking plant used for WADS.

1.06 Since TTY communication requires only a narrow band frequency channel which is only a fraction of the bandwidth required for voice service, economies can be made by introducing special trunk terminal equipment which permits one voice path to be subdivided into several channels for TTY communication. These economies are significant, however, only on large trunk groups or on trunk groups which extend for relatively long distances. Thus the large trunk groups which will exist in the 2-level WADS switching plan will provide the means for achieving substantial economies in the WADS trunking facilities.

1.07 Charges for WADS messages to WADS service areas will be based upon total accumulated message transmission time used per month and thus will avoid the necessity for recording the detailed elapsed time and distance information as required for individually billed messages. This bulk billing of message charges will permit more economical performance of the accounting and billing operations. This is another factor, in addition to efficient switching and trunking arrangements, which makes it possible to offer WADS rates which will be attractive to TTY customers.

1.08 Because many WADS customers, particularly those who have previously communicated over private line TTY systems, will originate a relatively large volume of messages from each WADS originating station, there will be a need for varying degrees of automatic operation in the sending and receiving of WADS messages. Accordingly, the station equipment provided for WADS will include a new line of TTY machines which will not only send and receive at the 100 wpm rate but, when combined with auxiliary control equipment, will provide virtually complete automatic operation of the call originating and message transmitting functions.

1.09 As an additional improvement, the new TTY machines to be used for WADS will be equipped with 4-row keyboards very similar to those used on office typewriters. In addition to the obvious advantage of facilitating alternate operation of typewriters and TTY machines, the 4-row keyboard speeds typing performance and reduces the likelihood of error by eliminating the need for depressing FIGURES and LETTERS shift keys as required on 3-row machines when interspersed numerals and alphabetic characters are to be transmitted.

1.10 While messages sent between WADS stations will be routed via a restricted switching plan, for reasons cited previously, it will be necessary to provide for interconnection between WADS stations and TWX stations. This will use the same equipment to perform speed and TTY code translation between the 4-row, 100 wpm WADS machines and the 3-row, 60 wpm TWX machines as is used for connections between 4-row and 3-row TWX machines. It will also require a means of establishing connections through the translation equipment between the WADS switching plan and the telephone DDD switching plan which serves dial TWX stations.

1.11 These translation and interconnecting facilities are required because it is not practicable to convert TWX service to 4-row, 100 wpm operation on a flash cutover basis. However, the Bell System plan includes provision for gradual conversion of TWX to 4-row, 100 wpm operation and for serving a large majority of these converted TWX stations from WADS serving offices.

1.12 The foregoing paragraphs have outlined the highlight features of the new WADS and briefly explained the reasons for them. In the next part the general switching plan for the WADS system is described.

1.13 Since it is the purpose of the section to describe only the overall WADS system and the interrelationship between its various parts, no attempt is made to present detailed descriptions of the operation of the system components. Such information can be obtained from the sections listed in 4, following. In particular, this section has been prepared on the assumption that the reader is familiar with the equipment and operation of the dial TWX system as described in Section 972-100-100.

2. SWITCHING PLAN FOR THE WADS SYSTEM

A. General

2.01 Before entering into a discussion of the function and operation of the various equipment components which will be used in the WADS system, it is desirable to describe the overall switching plan for interconnecting WADS and TWX stations. This description will not only indicate the purpose of the component parts in the total WADS system but will also facilitate the understanding of the operation of these components, as described in 3.

2.02 The fundamental plan for providing WADS service is to make use of a portion of the switching network which is presently used to provide direct distance dialing (DDD) telephone service. In this respect the fundamental plan for WADS is the same as for dial TWX service.

2.03 The manner in which WADS connections will be established within the existing switching network will, however, be somewhat different from that which applies to telephone service. This difference is necessitated by the average duration of message characteristic of WADS traffic which does not apply to telephone traffic or to the bulk of TWX traffic.

B. WADS Switching Plan

2.04 The average duration time of WADS messages will be substantially less than that of telephone and TWX messages. Some WADS messages, involving routine queries or reports, will take 10 seconds or less to transmit. The nature of other WADS messages is such that, at the new 100 wpm teletypewriter speed, most of them can be transmitted in less than one minute. As a result, the average duration of WADS messages will be in the range from 30 to 45 seconds, in contrast to an average duration of over 3 minutes for telephone messages.

2.05 With such short duration times for WADS messages, it is necessary to reduce the setup (ie, connection) time for WADS calls in order to achieve efficient utilization of switching, interoffice, and station facilities. To accomplish this objective, the WADS switching plan limits the number of interoffice links in a dialed connection to a maximum of three and the number of switching offices to a maximum of four. In this respect WADS switching will differ from telephone DDD switching, in which a maximum of nine interoffice links (ten switching offices) may be used in establishing a connection.

2.06 Two classes of switching offices will be employed in the WADS switching plan, namely, primary and secondary. There will be 12 primary offices and about 75 secondary offices, each of which will be associated with (ie, homed on) one of the primary offices. Each primary office will have direct trunk connections to every other primary office and to each secondary office which it serves. In addition to this backbone structure of primary and secondary trunk groups, direct high usage trunks will be provided between secondary offices and between secondary offices and other than their home primary offices where warranted by the volume of traffic involved. The basic structure of this primary-secondary system is illustrated schematically in Fig. 1. Fig. 2 shows the planned location of primary and secondary offices expected to be in service in the country by the end of 1963 and indicates the secondary offices which are homed on each primary office.

2.07 A majority of the WADS stations will be located in the same cities in which WADS primary and secondary offices will be located, thus permitting them to be served by local loops. However, WADS stations in outlying areas will be connected to the nearest WADS primary or secondary office by means of RX and long haul concentrator facilities in addition to local station loops.

2.08 The offices selected to serve as WADS primaries and secondaries are all No. 5 crossbar offices and, since most of them will be arranged to serve combined telephone and teletypewriter traffic, they are designated herein as 5C (No. 5 combined) offices. The reason for selecting No. 5 crossbar offices is that they provide 6-digit translation and other capabilities needed for efficient routing and for proper charging for WADS traffic.

C. Numbering Plan and Traffic Routing - WADS Only

2.09 WADS stations will be assigned 10-digit directory numbers which will consist of a special area code (SAC), a numerical central office code (NNX type), and a 4-digit line number. Three SAC's (710, 810, and 910) will be used for the WADS switching plan, and they will each serve approximately the same number of rate centers in each of three east-to-west geographical areas (see Fig. 3).

2.10 With the current maximum limit of 640 central office (NNX) codes per area code, the three SAC's enable distinctive designation of 1,920 central offices, each having a capacity of 10,000 4-digit line numbers. Since the WADS switching plan contemplates the use of only 80-odd serving central offices, this quantity of potential designations is more than sufficient for switching and routing purposes.

2.11 In addition to the routing function, however, the 6-digit (SAC+NNX) codes will be used to designate terminating rate centers for charging purposes. As discussed under 3B., somewhat more than 4000 terminating rate centers must be provided for, and therefore special billing procedures will be required.

2.12 All calls between WADS stations, including intraoffice calls, will require dialing of the complete 10-digit directory number. This requirement in turn makes it necessary to provide 6-digit translation equipment for the three SAC's in all WADS offices in order to permit efficient routing of traffic. The 6-digit translation equipment will also be required for determination of the in-band and out-of-band status of calls as discussed under 3B.

Operator Assistance

2.13 Operator assistance will be provided to WADS stations through use of existing and new 6A switchboard positions modified for operation with the 4-row, 100 wpm TTY machines which will be introduced with WADS. These positions will be provided in each of the 16 locations where 3-row, 60 wpm switchboards will already have been installed to serve dial TWX stations and, in general, the 3-row and 4-row positions will be in the same switchboard line.

2.14 Each of the 16, 4-row switchboard installations will handle assistance traffic originating in those WADS offices located within an assigned geographic service area. There will be no overlap of switchboard service areas and no alternate routing of assistance traffic from one switchboard to another.

2.15 WADS customers will reach the particular 6A switchboard which serves them by dialing a universal 7-digit TTY operator assistance code, 954-1212. The digits 954 are an NNX code which will control routing to the switchboard and the 4-line number digits are added to satisfy certain switching requirements.

2.16 Twelve of the 6A switchboards will be in the same cities as the 12 WADS primary offices. Each of the four remaining assistance switchboards will be in a city in which a WADS secondary office is located. Special routing arrangements will be required in some of these cases to insure that connection is established to the proper 6A switchboard.

D. Arrangement for Interconnecting WADS and 3-Row TWX Stations

2.17 When WADS service is introduced, most TWX stations will be equipped with 3-row, 60 wpm teletypewriters operating on a 5-level (ie, 5 bit) code and they will be served by regular telephone (not necessarily 5C) offices over the DDD network. (Some few of the TWX stations will have been converted to 4-row, 100 wpm operation.) WADS stations will be equipped with 4-row, 100 wpm machines operating on an 8-level code (seven information bits plus one unused bit) and they will be served by 5C offices with normal WADS-to-WADS connections being established over separate trunk groups in a primary-secondary network. In order to provide intercommunication between WADS and 3-row TWX stations, it will therefore be necessary to use the TTY speed and code conversion equipment provided for TWX modernization and to provide traffic routing through this equipment as required.

2.18 As discussed in 2 E, the ultimate plan is to convert all TWX stations to 4-row, 100 wpm operation and this will be accomplished in most cases by transferring TWX stations to 5C central offices, where they will be routed and numbered in accordance with the WADS switching plan. Since TTY speed and code conversion will be required only on calls which originate or terminate in the DDD switching plan and since the conversion equipment (called 3-4 row converters and described in 3 C., following) will be relatively complex and expensive, it was decided that 3-4 row converters will be provided on a centralized basis in selected 4A and 4M toll crossbar offices in the DDD switching plan. Specifically, the 4A, or 4M, equipment in the regional centers (Class 1 offices) of the DDD switching plan will have 3-4 row converters and, in addition, converters will also be provided in ten sectional center switching machines, for a total of 19 converter locations.

2.19 For discussion purposes at this point, it may be assumed that each 4A or 4M office equipment with converters (ie, a 4AC office) will have two outgoing appearances for connection to each converter and one incoming appearance for a return connection from the converter. One outgoing appearance will be employed for 3R-4R traffic and the other for 4R-3R traffic. A converter call incoming to the 4AC office will be forwarded to the converter via the appropriate outgoing appearance and will re-enter the 4AC office as a new incoming call via the converter incoming appearance.

Routing Plan for Calls Between WADS and 3-Row TWX Stations

2.20 While the 3-4 row converters will provide the proper TTY speed and code translation on calls which are presented to them, it will be necessary to arrange special routing procedures in both the WADS and DDD switching plans so that converters will be included in the connections, as required, without changing the dialing procedures normally observed by WADS and TWX customers. The manner in which this will be accomplished can be best explained by describing the routing operations performed in each of three types of calls: dialed connections in the 3-4 row direction, dialed connections in the 4-3 row direction, and calls between 3-row and 4-row stations which are routed via the 6A switchboard. Fig. 4 presents a schematic diagram of these routing arrangements.

3-Row TWX to 4-Row WADS Dialed Connections

2.21 A call from a 3-row TWX to a 4-row WADS station will require routing through a converter in the 3R-4R direction. Within the DDD switching plan, the SAC of the 10-digit WADS directory number dialed by the 3-row TWX station will be recognized as a code which requires routing to a 3R-4R converter, ie, to a 4AC office. Connection to the 4AC office will be accomplished via the DDD switching plan and generally in accordance with the regular DDD alternate routing (high usage and final trunk group) plan.

2.22 Upon receipt of this call, the 4AC office will recognize the SAC digits as an indication that 3R to 4R conversion is required, since this will be the only reason why a SAC call will reach a 4AC office. The 4AC office will therefore forward the call through the 3R-4R outgoing appearance of a converter. At the same time it will convert the SAC code to an associated XXX arbitrary routing code. (The arbitrary routing codes associated with the 710, 810, and 910 SAC's will be 017, 018, and 019, respectively.) This code conversion is necessary so that, when the call re-enters the 4AC office via the incoming appearance of the converter, it will not result in a second seizure of a 3R-4R converter.

2.23 When the call re-enters the 4AC office, the XXX arbitrary code will cause selection of a direct, data-only trunk to a WADS primary office. At the same time the XXX code will be converted back to the original SAC so that the WADS system will receive a normal 10-digit directory number for use in completing the connection.

Note: Calls thus routed from 4AC offices to the WADS switching plan must go to a WADS primary office in all cases in order to insure that no more than two WADS interoffice links will be in tandem with a DDD connection. See 3 C.

4-Row WADS to 3-Row TWX Dialed Connections

2.24 On a call from a WADS to a 3-row TWX station, the originating 5C office will select a trunk to the DDD switching plan and will prefix the 10-digit address (NPA+NNX+XXXX) with the numeral "0". Since the first digit of an NPA code is always a number from 2 to 9 and the second digit is either a "0" or a "1", this prefixing operation results in the first three digits of the address being one of 16 arbitrary codes (8 in the form 0/2-9/0 and 8 in the form 0/2-9/1).

2.25 The first and subsequent offices reached in the DDD switching plan will recognize any of the 16 arbitrary codes as a request for a routing to a 4AC office. The routing from the WADS originating office to the 4AC office will be via the DDD switching plan and generally in accordance with the regular DDD alternate routing plan.

Note: Codes of the 0XX type, which include the 16 arbitrary codes described above, have been used throughout the DDD switching plan as toll center codes for operator dialing. Prior to the introduction of WADS, all toll center codes in the 0/2-9/0-1 range will be changed in order to avoid conflict with WADS originated messages requiring 4R-3R conversion.

2.26 When the call reaches the 4AC office, the 0X0 or 0X1 code will result in selection of a 4R-3R outgoing appearance of a converter. When the call is forwarded through the converter, the prefixed digit "0" will be deleted so that, upon re-entering the 4AC office via the converter incoming appearance, the call carries its original 10-digit address (NPA+NNX+XXXX) and will be completed from the 4AC office in accordance with the normal DDD routing pattern.

Connections Between 3-Row and 4-Row Stations via 6A Switchboards

2.27 A WADS customer desiring a connection to a 3-row TWX station via the assistance switchboard will dial the standard 954-1212 code for operator assistance. The first three digits of this code together with the WADS class of service indication of the calling station in the originating 5C office will cause routing of the call to a 4-row position of the 6A switchboard.

2.28 The operator at the 4-row position will select a direct trunk to the associated WADS 5C office and will outpulse the NPA+NNX+XXXX address of the desired terminating station. Since the switchboard trunk appears as a regular 4-row WADS originating station to the 5C office, the call will be routed through a converter and through the DDD switching plan as described in 2.24 to 2.26.

2.29 In similar fashion, calls received from 3-row TWX stations at 3-row positions of a 6A switchboard for completion to 4-row WADS stations will be routed over a direct trunk group from the switchboard to the associated sectional or regional 4AC office. Since the 3-row switchboard appears as a 3-row TWX originating station to the 4AC office, the call will be routed through a converter and then to and via the WADS switching plan as described in 2.20 to 2.23.

E. Arrangements for Conversion of TWX Service to 4-Row, 100 WPM Operation

2.30 Starting immediately after the introduction of WADS, it is planned to gradually convert TWX stations from 3-row, 60 wpm operation to 4-row, 100 wpm operation and to complete the conversion over a period of about 5 years. It has been estimated that about 80 per cent of the TWX stations will be in locations where it will be economically feasible to serve them on a 4-row basis from WADS 5C offices and thus to take advantage of the WADS switching plan. Upon conversion to 4-row operation these stations will be assigned regular WADS directory numbers and traffic involving these stations will be routed in the same manner as WADS station traffic, including interconnections with 3-row TWX stations.

2.31 The 20 per cent of 4-row TWX stations which will remain in the DDD system will also require a directory number change at the time of conversion to 4-row operation. Ten-digit directory numbers will be employed, consisting of an arbitrary area code (AAC), a central office code (NNX), and four line number digits (XXXX). Since it is expected that not more than 640 central offices will be needed to care for all 4-row TWX stations terminated in the DDD switching plan, only one arbitrary code will be required. The specific assignment of this arbitrary area code will be 510 and the related arbitrary routing code (YYY) required to indicate that a call to a 4-row TWX station on the DDD switching plan does not require conversion will be 015.

2.32 The routing arrangements for interconnection of 4-row TWX stations in the DDD switching plan with 3-row TWX and 4-row WADS stations, as well as with other 4-row TWX stations served on the DDD switching plan, are described in the following paragraphs. Fig. 5 summarizes these arrangements in diagram form. This figure, together with Fig. 4, shows the arrangements for interconnection of all WADS and TWX stations during the period of TWX conversion from 3-row to 4-row operation.

3-Row DDD to 4-Row DDD Connections

2.33 On a call from a 3-row TWX station to a 4-row TWX station in the DDD switching plan, the arbitrary area code (AAC) in the dialed directory number will be recognized by the DDD system as a code which requires routing to the 3R-4R outgoing appearance of a converter in a 4AC office. When the call reaches a 4AC office, the 3R-4R outgoing appearance of a converter is seized and the AAC digits are converted to a new code, YYY, which prevents selection of a second converter when the call re-enters the 4AC office. Six-digit translation of the YYY+NNX codes will be required within the DDD system to determine the geographic location of the terminating 4-row TWX station, since the arbitrary routing code, YYY, covers the entire country. The YYY code is not converted back to the AAC code at any point in the establishment of a connection.

4-Row DDD to 4-Row DDD Connections

2.34 On a call between two 4-row TWX stations, both of which are in the DDD switching plan, the AAC in the dialed address must be converted to the YYY arbitrary routing code at an early stage in the establishment of the connection in order to prevent routing through a 3R-4R converter. Where a No. 5 crossbar originating office is involved, the code conversion will normally be accomplished at that point. Otherwise the AAC digits will be converted to YYY at the common control toll switching office to which the originating office routes the call. In this latter case, a segregated trunk group will be required from the originating to the code converting office for the 4-row TWX originating traffic. The incoming class mark of the segregated trunk group will cause the code conversion to be accomplished, while the class mark of incoming trunks handling traffic originating from 3-row TWX stations will result in the AAC code being passed through the code converting office as dialed. Upon conversion of AAC to YYY, the call is routed through the DDD system on a 6-digit translation basis to the called station.

4-Row WADS to 4-Row DDD Connections

2.35 Calls from WADS stations to 4-row TWX stations in the DDD switching plan will be treated similarly to calls between 4-row TWX stations in the DDD system. At the originating 5C office, the AAC will cause selection of a trunk to the DDD system and also will cause the AAC digits in the called station number to be converted to YYY in order that converter equipment will be bypassed. The call will then be forwarded through the DDD switching plan on a 6-digit translation basis (YYY+NNX) to the terminating 4-row TWX station without routing through a converter.

2.36 In the WADS originating office, 6-digit translation of the AAC+NNX digits will be required to determine the in-band or out-of-band status of each call to a 4-row TWX station for charging purposes, as discussed in 3 A.

4-Row DDD to 4-Row WADS Connections

2.37 A call to a WADS station from a 4-row TWX station in the DDD system will require code conversion of the SAC digits of the dialed address to the associated XXX arbitrary routing code at an early stage in the establishment of the connection in order to avoid routing the call through a converter. This is so because, in the case of calls from 3-row TWX stations, the SAC code in the dialed address will be used to indicate to the DDD system that 3-row to 4-row conversion is required (see 2.21). In these latter cases, after the required converter connection is established, the SAC code in the dialed address is converted to the XXX arbitrary routing code to prevent a second connection to a 3-row to 4-row converter. Since on 4-row DDD to 4-row WADS connections no speed and code conversion is called for, the SAC to XXX arbitrary code conversion must be made at the start of the call forwarding operation.

2.38 The SAC to XXX code conversion will be accomplished at the originating office if it is a No. 5 crossbar type and equipped for this function. Otherwise the conversion will be accomplished at the common control toll office to which the originating office will route the call. In the latter case, a segregated trunk group from the originating to the toll office must be used for 4-row TWX originating traffic as discussed in 2.34.

2.39 From the code conversion location the call will generally be routed in accordance with the DDD high usage and final trunk group alternate routing plan to a WADS primary office, subject to the limitation that not more than four links (one toll connecting, two intertoll, and one DDD-to-WADS) will be introduced in the connection.

2.40 Upon selection of a direct trunk to a WADS primary office by the last DDD office encountered, the XXX code (having served its purpose) will be converted back to the original SAC digits so that the WADS switching plan will receive a regular WADS address (SAC+NNX+XXXX). After entering the WADS system, the call will be completed in the usual manner.

4-Row DDD to 3-Row DDD Connections

2.41 A call to a 3-row TWX station served by a DDD office will be handled similarly to calls from WADS to 3-row TWX stations. Prefixing of the numeral "0" to the dialed address (NPA+NNX+XXXX) will generate the required 4-row to 3-row converter routing code (OXO or OX1) as discussed in 2.24 to 2.26. This prefixing will be accomplished in the originating office, or in the first common control toll office reached by a segregated trunk group as discussed in 2.34.

2.42 The 0X0 or 0X1 code thus developed will cause routing of the call to a 4AC office and selection of a 4-row to 3-row appearance of a converter. The "0" will be deleted as the call is forwarded through the converter so that the 4AC office will receive a normal DDD address when the call re-enters the office from the converter. Routing of the call to the terminating 3-row TWX station will then be accomplished in the normal manner.

Connections From 4-Row DDD Stations Via 6A Switchboards

2.43 Operator assistance will be provided to 4-row TWX stations in DDD offices in a manner similar to assistance for WADS stations. The customer will dial the universal 7-digit TTY assistance operator code, 954-1212. In this case, however, the NNX (954) digits of the code will be converted to an arbitrary counterpart, N'N'X' (expected to be 014) in order to cause routing through the DDD switching plan to a 4-row switchboard position, instead of causing the "954" routing to a 3-row position. This conversion will be accomplished either at the originating office or at a directly connected common control toll office, as previously discussed.

2.44 Completion of traffic from 4-row switchboards to all types of TWX and WADS stations will be accomplished in the same manner as the same calls dialed directly by a WADS customer, since the direct trunks from the 4-row switchboard to the associated WADS office which will be used by the operator in completing the calls will appear to the WADS office as regular WADS customer lines.

2.45 Calls from 3-row switchboards to 4-row TWX stations in the DDD network will be routed via a direct trunk group to a 4AC office, where they will appear as 3-row TWX originated calls. Completion from this point will be the same as described in 2.33.

F. Numbering Plan After Conversion of All TTY Stations to 4-Row Operation

2.46 When all TWX stations have been converted to 4-row operation, there will be no further need for 3-row to 4-row converters. Consequently there will no longer be any need for the special code prefixing and conversion operations which were designed to effect routings via converters, namely, the prefixing, and subsequent deleting, of the digit "0" on NPA codes and the code conversion of the special and arbitrary area codes (SAC's and AAC) to their XXX and YYY counterparts, respectively. As a result, after complete conversion to 4-row operation, the use of prefixing and code conversion facilities for TTY traffic will be abandoned. Thereafter, calls within the DDD switching plan, within the WADS switching plan, and between these plans will be routed entirely by means of the codes in the directory numbers of the called stations.

2.47 With respect to reaching 4-row TWX stations in the DDD system, 6-digit translation of the arbitrary area code (AAC) together with its associated NNX codes will be required in place of the previous translation of the YYY + NNX codes. However, after all TWX stations served on the DDD system are converted to 4-row operation, there will be no need to assign these stations to an AAC and they can share the regular NPA code assignments used for telephone service. The conversion from AAC to NPA codes in the directory numbers of these TWX stations can be accomplished on a flash cut basis or on a gradual basis in conjunction with normal inward and outward station movement.

G. Miscellaneous Considerations in the WADS Switching Plan

Information Service

2.48 The Long Lines Department of the AT&TCo will establish a TWX-WADS information desk in St. Louis, Missouri. This desk will be available for service at the cutover of TWX service to dial operation and will be equipped initially for 3-row, 60 wpm operation. Coincidentally with the introduction of WADS, the information positions will be flash cut to 4-row, 100 wpm operation.

2.49 A 10-digit directory number will be dialed by all TWX and WADS customers to reach the information desk. It will consist of the SAC of the area in which

St. Louis is located, 910, plus the NNX code 555 and the line number 1212.

2.50 After dial conversion of TWX and before WADS is introduced, only 3-row TWX stations will have need for information service and calls to the information desk will be routed via the DDD switching plan.

2.51 Upon the introduction of WADS, the 910 code will be indicative to the DDD switching plan of a WADS address. Also at that time, traffic routing to the information desk will change and the desk will be converted to 4-row, 100 wpm operation. Information traffic originating in DDD local offices (3-row and 4-row TWX) will be directed to the WADS switching plan in the manner described for calls to WADS stations. In the WADS system, the information calls thus received from DDD offices will be combined with WADS-originated information calls. The 6-digit translation of the 910 + 555 codes will cause this traffic to be routed to the WADS primary in St. Louis and from there to the information desk via a direct trunk group.

Connections Between 6A Switchboards

2.52 Operators at 3-row and 4-row switchboards will need to reach, respectively, 3-row and 4-row positions at other than their own locations. As an example, operators at two or more locations may be required in setting up conference calls.

2.53 To provide for establishing connections between 3-row switchboards and between 4-row switchboards, two switchboard codes will be required: code 130 for 3-row and code 140 for 4-row. To reach a distant switchboard, an operator will dial the NPA code of the area in which the distant switchboard is located plus the code 130 or 140 as appropriate. Customer usage of these codes will be denied.

2.54 Calls between switchboards will be routed entirely via the DDD switching plan. Therefore, in addition to the normal outgoing group to a WADS office, each 4-row switchboard will require outgoing trunks to the associated DDD regional or sectional center toll switching office. At 3-row switchboards, no special trunking arrangements will be required, since the normal outgoing trunk group connects directly to the associated DDD toll switching office.

3. DESCRIPTION AND FUNCTION OF WADS SYSTEM COMPONENTS

A. General

3.01 As discussed in 1. INTRODUCTION, WADS is a new form of teletypewriter and data communications service which will offer improved operation and other advantages when compared with TWX and private line TTY services.

3.02 One of these advantages will consist of the shorter time required for establishing connections between WADS stations. This will be achieved, in large part, by creating a special switching plan to serve WADS stations, so that no more than 3 interoffice trunk links will be required in any WADS dialed connection. The manner in which calls will be handled within the WADS switching plan, and to points in the DDD Switching plan as required for interconnections with TWX stations, has been described in 2.

3.03 Two other improvements which will be introduced with WADS have to do with (1) a new rate structure and charging method and (2) new teletypewriter machines which will transmit at 100 wpm and will use a new, 8-level code to replace the 5-level Baudot code. Before describing the system components required to accommodate these improvements it is necessary to define these improvements briefly.

WADS Rate Structure

3.04 Three classes of WADS will be offered: full time, measured time, and receiving only. The basic monthly charge for each class will include the basic TTY machine (keyboard sending and receiving or receiving-only) required for the class, a data set, and an access line to the serving (5C) central office. WADS customers may also subscribe to optional station equipment, at additional charges, which will provide varying degrees of automatic operation in the transmission of messages.

3.05 With full time service, the WADS customer is charged a flat monthly rate and he may make an unlimited number of calls, within the capacity of his access line, to other compatible teletypewriters, both TWX and WADS, located within the service area to which he subscribes.

3.06 Measured time service is like the full time service except that the basic monthly rate includes 10 hours of originating message transmitting time and hourly charges apply for additional use in excess of 10 hours per month.

3.07 Incoming calls may also be received over both full and measured time access lines. There is no tariff limitation on the number of incoming calls that can be received under the basic monthly rates, although the use required of an access line for outgoing messages places a practical limitation on incoming calls.

3.08 Receiving-only service, the third class of WADS, is furnished by means of an incoming access line that is equipped with TTY station apparatus designed only for receiving messages. The rate for this service is a flat monthly charge which bears no relationship to service areas or geographical location. Receiving-only service is furnished to permit WADS customers to accept incoming messages without interfering with their capability for originating calls over full or measured time access lines.

3.09 The service area applicable to each full time or measured time WADS line may be any one of six progressively larger areas, the largest of which includes the entire continental United States, with the exception of Alaska. These service areas are, in effect, WADS calling areas because calls originated to points within the subscribed for service area are charged on the basis of WADS rates, either full time or measured time, and calls to points beyond the service area are charged at rates the same as for TWX calls.

3.10 A separate set of six service areas has been defined for each state or portion thereof for which WADS rates are filed. (In general, WADS rates for each class of service are the same for all customers throughout an entire state. In the case of seven states, however, where size or teletypewriter density made it desirable to split the state, each subdivision is treated as if it were a separate state.) The six service areas for each state or subdivision were determined on the basis of "interstate service availability" as measured by square mile area and number of teletypewriters, weighted equally. The first area in each case included the home state, all contiguous states, and other states added in the order of their distance from the home state, if necessary, to bring the interstate service availability up to 10 per cent of the total interstate service availability for the originating area. The second area was formed by adding states in order of distance until the service availability reached 20 per cent of the total. The third, fourth, and fifth areas had additional states added to provide 40 per cent, 60 per cent, and 80 per cent, respectively, of interstate service availability, and the sixth area in all cases included all the states in the continental United States, except Alaska, and thus provided 100 per cent service availability. The map of the United States in Fig. 6 indicates the six service areas for WADS customers in the state of Indiana. Shown also are the subdivisions of states, such as Ohio, Texas, and New York, which are used for WADS originating areas since the total state is too large, either geographically or from the standpoint of teletypewriter density, to be treated as a single unit.

3.11 Because WADS rates are designed on an area-to-area basis, rather than a point-to-point basis as in the case of TWX service, and because different charging methods are required depending upon whether a call from a WADS station is "in-band", ie, is within the subscribed for service area, or is "out-of-band", certain requirements are placed upon the central offices from which WADS stations will be served. One of these is the ability to examine the SAC and NNX codes of a called number (6-digit translation) to determine whether it is an in-band or out-of-band point. Another is the ability to apply metered clock timing to in-band calls originated by measured time customers. Also, of course, it is necessary for the central office to recognize many different classes of service in order to identify the class of service (measured or full time) and the particular one of six possible service areas which applies to each WADS station served. These capabilities are discussed in 3. B.

New TTY Code and 4-Row Keyboard

3.12 The new TTY code to be introduced with WADS, called the Data Interchange Code, will bring additional improvements in TTY communication. In the paragraphs which follow, the major features of the Data Interchange Code are briefly described. Reference should be made to another section for a detailed description of the Data Interchange Code (see 4).

3.13 A complete character transmitted by a WADS station will consist of eleven code elements, or bits. Each bit may be marking or spacing; for example, in terms of the frequency sent from an originating station, each bit may be f_1 mark (1270 cps) or f_1 space (1070 cps). See Section 972-100-100 for complete description of f_1 and f_2 marking and spacing signals. Characters are transmitted at the rate of ten per second, which is therefore equivalent to a bit rate of 110 bits per second. Ten characters per second is 600 characters per minute and, with the conventional factor of six characters per word, this results in the 100 WPM transmitting speed adopted for WADS.

3.14 The first bit in each character is used as a start pulse to identify the start of a new character and it is always spacing. The last two bits in each character are used as a stop pulse and are always marking. These start and stop pulses are used to keep the sending and receiving machines in synchronism and do not transmit message information.

3.15 The remaining eight bits transmitted for each character are available for information purposes but only seven of these are used for the Data Interchange Code. The eighth information bit has been added to permit the transmission of 8-hole paper tapes frequently used as inputs and outputs for automatic data processing machines. When the Data Interchange Code is used, the eighth bit will always be marking and will not be significant.

3.16 The seven bits used in the Data Interchange Code permit 128 combinations. Sixty-four of these are assigned to graphic (ie, printable) characters and the remaining 64 combinations are available for use as control characters, which do not print but which can be used to cause certain actions to take place, such as carriage return and line feed.

3.17 The use of 64 graphic codes permits all frequently used characters (alphabetics, numerals, and a few punctuation marks and symbols) to be included on a keyboard of four rows of keys, as on standard typewriters, and avoids the need for shifting in order to alternate between numerals and alphabetics, as required on 3-row keyboards. The 4-row arrangement of the new keyboard is illustrated in Fig. 7.

3.18 The characters, both graphic and control, appearing on the 4-row keyboard may be described in five separate groups based on the way they are generated for transmission and the results produced.

3.19 Basic Graphics are generated by depressing a single key. They include the 26 letters of the alphabet, the ten numerals (0-9), and the following symbols and marks:

: - ; , . /

3.20 Shift Graphics are generated by simultaneously depressing the shift key and any other key having a symbol or punctuation mark in the upper half of its printed keytop. The marks and symbols generated in this way are:

! " # $ % & ' ( ) * =

← @ + ↑ < > ?

Only a few of these are available on the 3-row keyboard used with the Baudot code.

3.21 Basic Controls are generated by depressing a single key, so arranged because they are so frequently used. Operation of these keys will cause no printing but will cause a control function to be performed, as defined below:

- Line Feed - causes the platen to advance to the next following printing line.

- Return - causes the printing carriage to return to the proper position for starting a new line.

- Rub-Out - causes all seven information bits of the code to be generated as marking pulses. Since all-bits-marking has been assigned as a nonprinting, nonspacing character, this rub-out character may be used to delete, in effect, any other character previously punched in tape.

- Space - in Fig. 7 this is not a key but is the bar centered below the four rows of keys; it has the same function as the space bar on a typewriter.

3.22 Dual-Key Controls are generated by simultaneously depressing the control (CTRL) key at the left of the second row of keys and any key having one of the following control characters printed in the upper half of its keytop:

- WRU - This character, Who Are You, will cause the receiving station to send an automatic identification answer-back by operating its answer-back drum. If the WRU character is sent from tape rather than from a keyboard, it will cause the sending transmitter to stop until the WRU response has been received from the distant station.

- TAPE and $\overline{\text{TAPE}}$ - These characters are sent to a distant receiving station to turn on (TAPE) and to turn off ($\overline{\text{TAPE}}$) a receiving-only typing reperforator (ROTR) at the distant station. Use of a ROTR results in the message being received in perforated tape form (for retransmission or for direct input to a business machine), in addition to the printed copy.

- TAB - In the case of stations properly equipped, this character operates as a horizontal tab and will cause both the sending and receiving TTY machines to perform a right shift to the next tab point. Since the tab settings must be the same on both machines, use of TAB requires prearranged agreement between the communicating parties.

- SOM - This stands for Start of Message. It is used only for messages on tapes where the message is to be sent automatically. See EOA.

- X OFF - This stands for Transmitter Off. Since any WADS transmitter which reads this character will turn itself off, this character is perforated on tape at any point where it is intended to reverse the direction of message transmission.

- EOT - This is the End of Transmission control character. When this character is sent from either keyboard or perforated tape, both the sending station and the receiving station will initiate the disconnect sequence simultaneously. This will provide a more rapid disconnection than depressing the clear key on the attendant set, which requires the receiving station to recognize a clear (spacing frequency) signal for a timed interval before going on-hook.

- RU - This character is used to make the Are You? request of terminating stations which are arranged to respond with a confirmation type answer-back. The RU character is followed by from two to four graphic characters which are unique to the called customer (and which appear as a part of his listing in the directory). The confirmation answer-back is described in 3. F.

- BELL - This control character causes a bell in the TTY machine to ring at both the sending and receiving stations.

- VT - This is a Vertical Tab control character which will result in skipping lines in a vertical direction in a fashion similar to the horizontal skipping of spaces caused by the TAB control character. Vertical tab operation is normally provided only when preprinted TTY forms are used, and the sending and receiving machines must be arranged for tab stops at the same level of the form.

- FORM - This control character will cause a form feed-out operation at both sending and receiving machines, ie, will advance preprinted copy to the start of the next form. TTY machines equipped to respond to the FORM control character will also execute the form feed-out upon disconnecting.

- EOM - This stands for End of Message and may be used to separate individual messages which are sent in sequence on a single transmission between two stations.

- EOA - This stands for End of Address. This character, together with SOM, will be used to define the section of perforated tape in which the directory number of the addressee is contained. These characters will be used only at the more complex WADS stations which are arranged for completely automatic sending of messages. These characters are not a part of the message and are not transmitted.

3.23 An Alternate Mode control character will be provided at the extreme left of the third row on the keyboard to permit an increase in the control operations which can be initiated from a 4-row keyboard. The most frequently used control operations can be implemented by the control characters previously described. Additional controls can be achieved by sending the ALT MODE character followed by any graphic character on the keyboard. Use of ALT MODE as the first character in the pair will result in nonprinting of the following character, thus producing a 2-character control code. Specific meanings will be assigned for uniform use by all WADS and 4-row TWX customers for approximately 20 ALT MODE control code pairs, consisting of ALT MODE followed by any alphabetic character A through T. ALT MODE pairs formed with the six remaining alphabetic letters will be available for arbitrary assignment to meet the additional needs of individual customers. In addition, individual customers may use any of a large group of ALT MODE sequence codes consisting of (1) the ALT MODE character, (2) from one to ten decimal digits (0-9), and (3) any graphic character. A typical example of such a sequence might be: ALT MODE 1 3 2 C. This type of control can be used where some control function, indicated by the letter C, is to be performed only if a predetermined numerical sequence(132 in this case) has been received. This will prevent use of the control by calling stations which are not authorized, ie, have not been given the "secret" numerical sequence required as part of the total control code. All characters in an ALT MODE control group, whether the 2-character alphabetic type (eg, ALT MODE R) or the sequence type (eg, ALT MODE 634R) will normally be nonprinting. If desired, printing of the characters following the ALT MODE character may be provided on an optional basis. (Printing of the ALT MODE character itself will not be provided in any case, since it has no graphic representation.)

3.24 There are two additional control characters, X ON and CNFM (for confirmation), which are used to turn on the transmitter at the distant end of a WADS connection. It will be possible to generate the X ON control character from the keyboard (by simultaneously depressing the CONTROL and Q keys), but X ON will not appear on the Q key top because it will not normally be generated by this means. It will not be possible to generate the CNFM control character from the keyboard. Both X ON and CNFM will be generated by the answer-back drum and they will serve the purpose of turning on a sending transmitter after a receiving station has transmitted its answer-back response. As described in 3. F, two kinds of answer-back responses, identification and confirmation, will be used. The X ON control character will be used in the identification answer-back and the CNFM control character will be used in the confirmation answer-back. The reason for using CNFM instead of X ON to start the distant transmitter after a confirmation type answer-back has been sent is to permit the originating station to distinguish automatically between the two types of answer-back responses, a requirement which is explained in 3. F.

B. Switching and Charging Facilities

3.25 The WADS switching plan (described in 2) requires that WADS serving central offices be equipped with the following features:

(a) liberal availability of classes of service,

(b) code conversion,

(c) digit prefixing of called address digits,

(d) 6-digit translation and

(e) local AMA (LAMA) charge recording.

In addition, all WADS primary offices and some secondary offices must be arranged for through as well as terminal switching. As only the No. 5 crossbar switching system includes all of the foregoing capabilities, this system will be used exclusively for WADS serving offices.

3.26 The following is a discussion of the primary needs for the foregoing features.

3.27 Classes of Service - WADS switching offices will be combined (5C) offices in that they will serve numerous telephone classes of service as well as WADS, 4-row TWX and 3-row TWX stations. In addition, these offices will serve, as required, other classes of subscribers such as 3-row TWX and WATS. Class of service treatment for trunks is also required to enable treating traffic received over WADS trunks in a different manner from calls received over other trunks (routing to WADS call progress tones, etc). With respect to WADS originating lines, a maximum of six subscriber classes of service are required per originating rate area to permit the in-band vs out-of-band status of calls to be determined in accordance with the six zones of completion to which WADS customers may subscribe. As a WADS office may serve more than one WADS originating rate area, the number of WADS classes of service required in an office can be substantial. No. 5 crossbar offices are arranged to handle a maximum of 100 classes of service, whereas the maximum for the best of other switching systems is 24.

3.28 Code Conversion and Digit Prefixing - These features are required in WADS originating offices to enable modification of dialed addresses so that traffic can be controlled to by-pass or route through 3-4 row converters as necessary.

3.29 6-Digit Translation - This feature is required for both switching and charging purposes. With regard to switching, 6-digit translation will enable WADS offices to select high usage direct routes to other WADS offices. Where charging is concerned, this features provides the means for determining the in-band or out-of-band status of calls dialed from WADS stations.

3.30 LAMA Recording - Local AMA recording is required for WADS out-of-band and for 4-row TWX calls to enable recording these calls as dialed on direct, high usage routes to other WADS offices. Since centralized recording (CAMA) would preclude employment of direct trunks between WADS end offices, it will not be used in the WADS switching plan.

3.31 The code conversion and digit prefixing features mentioned heretofore will also be required for traffic originated by 4- row TWX stations served by regular DDD local offices. However, since the need for direct trunks to other end offices is negligible and since TWX originated traffic does not require out-of-band determinations, there will be no controlling need for 6-digit translation or LAMA recording facilities in the serving office. Therefore, although No. 5 crossbar is preferred, other types of local switching offices may be used. Where other than a No. 5 crossbar office (including a No. 5 crossbar without LAMA equipment) is employed, the 4-row TWX class of service must cause routing of associated traffic via a segregated trunk group directly to a connecting office arranged for code conversion, digit prefixing, and CAMA recording. The class mark of the segregated incoming trunk group at the connecting office will cause these features to be applied to 4-row TWX originated traffic as necessary.

C. Converters for 3-4 Row Translation

General

3.32 As discussed in 2 , 3-4 row converters will be required in all connections between 3-row and 4-row TTY stations in order to provide the requisite code translation and speed conversion. These converters will be installed in No. 4A and 4M toll offices at 19 locations throughout the country.

3.33 In order to provide access to each 3-4 row converter and also to provide the telephone supervisory features that are needed for the data converter to function with the No. 4 office, a junctor trunk circuit is required. This junctor trunk circuit together with the 3-4 row converter itself, comprise a Data Converter Junctor Trunk (DCJT). In effect, the DCJT consists of an outgoing trunk tied directly to an incoming trunk in the same office.

3.34 In its role as an outgoing trunk, the DCJT has two appearances: one for a call originated by a 3-row, 60 wpm station and the other for a call originated by a 4-row, 100 wpm station. The decision as to which appearance is seized is governed by the area code of the directory number dialed at the originating station in conjunction with the class of service of the originating station.

3.35 In its role as an incoming trunk, the DCJT has only one appearance and this is available for connection to a regular outgoing trunk of the No. 4 office. In the process of going through the DCJT, the area code of the directory number address of a call is changed to an alternate form (eg, SAC to XXX, and ONPA to NPA, as described in 2. D. and 2. E.) in order to prevent a second seizure of a DCJT.

Data Converter Junctor Trunk (DCJT)

3.36 The function of the DCJT can be best explained by describing what happens on a call which requires data conversion. Assuming a call from a 4-row WADS station to a 3-row TWX station, the number dialed will be in the form NPA+NNX+XXXX, but the serving WADS 5C office will prefix the numeral 0 in order that the call will be routed to a converter. The resultant 0X0 or 0X1 digits which thus appear as the area code of the called number will cause a routing to the 100 wpm appearance of a DCJT in a No. 4 office. (The SAC digits 710, 810, or 910, which would be dialed by a 3-row TWX station to reach a 4-row WADS station, would cause a routing to the 60 wpm appearance of a DCJT.) In passing through the DCJT the numeral prefix 0 will be deleted so that, from the appearance of the DCJT which is incoming to the No. 4 office, a connection will be established to a regular outgoing trunk from which subsequent routing will establish a connection in the normal DDD manner to the central office serving the 3-row TWX station. The connection through the No. 4 office is illustrated in block diagram form in Fig. 8.

3.37 The outpulsing of the directory number will pass directly through the junctor trunk circuit shown in Fig. 8, but, as soon as the outpulsing is completed, the transmission path from the calling (4-row) station will be connected to the demodulator of Modem A, in order to permit recognition of the f_1 mark signal which the calling station will send out after it has received f_2 mark from the called station. Also at this time, the modulator of Modem B will be connected to the transmission path toward the called station in preparation for passing f_1 mark to the called station at the appropriate time. In the reverse (called to calling) direction, however, the transmission path remains in the telephone mode so that call progress indications, such as busy tone and reorder tone, can be passed back to the calling station.

3.38 When the called station off-hook indication reaches the No. 4 office, the called-to-calling station transmission path through the junctor trunk circuit will be broken for a timed period of 675 milliseconds (ms) in order to prevent the f_2 mark signal transmitted from the called station from proceeding beyond the junctor trunk and interfering with the propagation of the SF off-hook signal to the serving office of the calling station. After this 675-ms guard interval, the called-to-calling station direction of the transmission path is restored, to permit the f_2 mark tone from the called station reach the calling station.

3.39 When the calling station detects this f_2 mark tone for the proper timed interval, it will return f_1 mark. This will be detected by Modem A for the appropriate time interval, after which Modem B will send f_1 mark toward the called station. At the same time the junctor trunk circuit will shift the called-to-calling station transmission path from the telephone mode to the data mode through Modems B and A, respectively, and the f_2 mark signal will thereafter be sent to the calling station from Modem A.

3.40 At this point the DCJT will be completely in the data mode. Data signals transmitted by either station will be demodulated, fed through the converter translator, and modulated for transmission to the other station. Note that, although the DCJT is seized for either 4-row to 3-row or 3-row to 4-row conversion, it will provide two-way data transmission on either type of connection and thus will be capable of both directions of conversion on every connection. The two separate outgoing appearances of the DCJT do not, therefore, specify the direction of conversion (since this may be in both directions on each connection), but they are required so that Modems A and B, which serve the originating and terminating stations, respectively, will be connected to the proper "sides" (4-row receive or 3-row receive) of the converter translator (see Fig. 8.) as required by the type of station originating the call.

Data Supervision Circuitry

3.41 The data supervision block shown in Fig. 8 includes circuitry which will serve a number of functions. It will provide safeguard features for releasing the DCJT under abnormal conditions, such as when a calling station fails to send f_1 mark after it has received f_2 mark from the called station. In addition, through the entire progress of the call this circuitry will monitor continuously for a communication break from either station. Since the 3-row and 4-row stations will operate with different break timing intervals (as described in 3. F.), the data supervision circuitry will be arranged to intercept the break signal from a 3-row station and then to generate and send out a differently timed break signal to the 4-row station, and vice versa.

3.42 The data supervision circuitry will also monitor for a clear signal (indicating a disconnect) from either station. If a clear signal is received from the 3-row station, the DCJT will generate and pass to the 4-row station a reverse slash character (\) followed by an end-of-transmission (EOT) character. Conversely, if an EOT character is received from the 4-row station, the DCJT will forward an appropriately timed clear signal to the 3-row station.

Converter Translator

3.43 The converter translator part of the DCJT will perform the logical functions necessary to translate the 7-element, 4-row TTY characters into 5-element, 3-row TTY characters, and vice versa. It will also provide the speed conversion between 100 wpm and 60 wpm. The major elements of the converter translator used for 4- to 3-row conversion are illustrated in block diagram form in Fig. 9A and those for 3- to 4-row conversion are shown in Fig. 9B.

Conversion on Calls from 4-Row to 3-Row Machines

3.44 Let it be assumed for this discussion that the originating station on a converter connection is 4-row; this will mean that the 100 wpm outgoing appearance of the DCJT has been seized (see Fig. 8) and that the 4-row, 7-element characters will be received from Modem A and will be sent out, after translation, through Modem B. The first character of a message, after demodulation in Modem A, will be received in the form of serial dc 100 wpm signals. The serial to parallel converter will convert the signals to parallel form for input to the 7-to-5 translator (Fig. 9A), which will be a magnetic core device. Here the translation will take place and a 5-element character will be fed into stage 20 of the buffer store. From that point it will immediately be shifted down to the lowest unoccupied stage of the buffer store (which in this case will be the first stage) for read-out to the parallel to serial converter which will, in turn, key the modulator of Modem B to send the character to the 3-row station in the form of serial, 60 wpm signals. During this process a second 4-row character will have been received, translated, and fed into the buffer store, where it will await completion of transmission of the first character. The purpose of the buffer store is now readily apparent: it is to permit characters to be received at the rate of ten per second (equivalent to 100 words per minute) while disposing of them at the rate of about six per second (equivalent to the 60 wpm speed of 3-row TWX machines). However, since the four character per second differential (actually somewhat greater, as will become apparent later) would result in filling the 20-character buffer store in approximately 5 seconds, a restraining arrangement must be provided.

Restraint and Break Logic

3.45 When the number of characters in the buffer store reaches 12, the restraint and break logic circuitry (Fig. 9A) will cause the transmission of a restraint signal to be sent toward the 4-row station. This restraint signal will be a 50-cycle shift from the normal marking tone at a 50 cycle per second (cps) rate (ie, alternating between 2225 and 2175 cycles for f_2 mark in the case where the originating station is 4-row, and alternating between 1270 and 1220 cycles at a 50 cps rate for f_1 mark when the terminating station is 4-row).

3.46 Receipt of the restraint signal by the 4-row sending (but not necessarily originating) station will cause a restraint (REST) lamp to light on the 4-row machine, as an indication that the converter storage is being filled too rapidly. If the message is being sent from a transmitter-distributor (T-D) in the case of an ASR sending station, receipt of the restraint signal will interrupt the operation of the T-D. The restraint lamp (REST) will indicate to a keyboard typist that the keying rate should be reduced and to an ASR station attendant that the T-D has stopped momentarily to avoid overflow of the converter storage. Normally, the transmission of the restraint signal will result in the number of characters in storage being reduced. When the number of stored characters falls below two, the restraint signal will be removed, and normal transmission from the 4-row station will be resumed (including automatic restarting of the T-D at an ASR station).

3.47 If the keyboard operator disregards the restraint lamp (REST) or if the T-D at an ASR sending station has failed to stop, a break signal will be generated and sent to the 4-row sending station when the number of characters in buffer store reaches 19. This will blind the keyboard so that it cannot be used for sending and will turn off any sending T-D (not merely interrupt its operation). The DCJT will continue to send characters from buffer store to the 3-row receiving machine after this break, and thus the buffer will be quickly emptied. However, the restraint lamp (REST) will have been locked in the on condition by the receipt of the break signal and this, in combination with the BREAK lamp being on, will provide the sending station attendant with an adequate explanation of the reason for the break.

3.48 If trouble exists and the 19-character break signal does not take effect, a disconnect signal will be generated by the DCJT whenever the stored characters reach the buffer capacity of 20. This will also cause the buffer store to be cleared, as will also be the case when either station sends a communication break.

Case Memory

3.49 The 3-row TTY requires a shift character, FIGURES or LETTERS, to be transmitted whenever a shift is made from alpha to numeric characters or from numeric to alpha characters, respectively; however, no such shift is required for transmission from 4-row machines. To take care of this difference it will be necessary to insert FIGURES or LETTERS characters to the 3-row machine whenever a shift is called for. To meet this requirement, the case memory circuitry will be provided in the DCJT (Fig. 9A) to keep track of the state of the case (figures or letters) of the last character translated and to compare it with the case of the next character to be translated. When the new character represents a change in case, the character generator (Fig. 9A) will enter the appropriate shift character (FIGURES or LETTERS) into the buffer store in stage 19, just ahead of (and at the same time as) the newly translated character. Thus the appropriate shift character will precede the translated character upon read-out.

Conversions on Calls from 3-Row to 4-Row Machines

3.50 The operation of the DCJT in the 3-row to 4-row direction is essentially the same as described above for 4-row to 3-row translation, but there are certain differences which should be noted.

3.51 Assuming a call from a 3-row TWX station to a 4-row WADS station, the directory number dialed will be in the form of SAC+NNX+XXXX. The SAC digits will cause a routing to the 60 wpm appearance of a DCJT in a No. 4 office. In passing through the DCJT, the SAC will be converted to XXX (as discussed in 2.22) so that, on progressing from the incoming appearance of the DCJT, the call will be recognized as one for which translation is not required.

3.52 Since the 60 wpm outgoing appearance of the DCJT will be used in this case, the calling-to-called station path through the DCJT will proceed through the demodulator of Modem A, the 3-row to 4-row path in the converter translator (Fig. 9B), and the modulator of Modem B to the incoming appearances of the DCJT in the No. 4 office. Conversely, the called-to-calling station path will proceed through the demodulator of Modem B, the 4-row to 3-row path in the converter translator (Fig. 9A), and the modulator of Modem A to the 60 wpm appearance of the DCJT. In this case the buffer storage and restraint action of the converter translator will not be brought into action until and unless the terminating (4-row) station sends information to the originating (3-row) station.

3.53 When 5-to-7 element translation is performed (Fig. 9B), case memory will also be required but in this instance its output will be fed to the 5-to-7 translator because it is needed for the proper interpretation of each character received. Also in this direction of translation, there will be no need for buffer storage and restraint action, so that the outputs of the 5-to-7 translator and of the character generator will be connected directly to the parallel to serial converter.

No-Such-Character Translation

3.54 Whenever a 4-row sending station transmits a graphic character which is not available on the 3-row machine, for example the per cent (%) symbol, the translator will enter a no-such-character symbol into the buffer store, and this will print as a reverse slant (\) on the 3-row machine. The same character will also be substituted whenever the input logic to the DCJT determines that the received character is not valid, as will be the case, for example, when a start pulse is not followed by the 2-element stop pulse in the expected interval. Since a communication break (as contrasted to the restraint break described above) from a 4-row station will simulate this condition, a reverse slant will always be sent to a 3-row machine as an accompaniment of a communication break.

3.55 In the 3-row to 4-row direction there are also some characters which will not be available in the 4-row machine (eg, $\frac{1}{4}$ and $\frac{3}{8}$); in these instances the translator will insert the no-such-character symbol (\). The characters for which the no-such-character symbol will be substituted, in both directions of translation, are shown in the upper portion of Fig. 10.

Special Translations

3.56 A number of special translations will be required in connection with characters which are used for control. One example of this is the EOT character, which will cause a disconnection to be initiated automatically when received by a 4-row station but for which there is no counterpart in a 3-row machine. To meet this discrepancy, when EOT is received from a 4-row machine, the translator will call in circuitry which will generate the clearing sequence toward the 3-row station after the buffer store has been emptied. In the reverse direction, receipt of the clearing sequence from a 3-row machine will cause the converter translator to send the no-such-character symbol (\), to generate an EOT character, and to place it in the parallel to serial converter (Fig. 9B).

3.57 As another example, the EOM 4-row control character is represented by the sequence FIGURES H in 3-row machines used in private line applications. In order that this control may be transmitted, the converter translator will be arranged to make the required 2 for 1 and 1 for 2 character substitutions. Other special translations of this type which will be required are shown in the lower portion of Fig. 10.

D. Narrow Band Trunk Facilities

3.58 The majority of WADS trunk facilities will be provided by B1 data carrier trunks. These trunks are derived by the channelizing of standard voice grade facilities. The B1 data carrier system divides the voice band frequency range into seven narrow band channels. Six of these are used for the transmission of WADS data signals. The seventh narrow band is used to transmit the control signals needed to supervise the calls which are established over the six data channels. Control signals are used in conjunction with senders and registers during the establishment of a call and, also, indicate whether a calling or called station is off-hook (active) or on-hook (idle).

3.59 Application of the B1 data carrier system to a voice grade facility will increase the utilization of the toll line facility, in general, by approximately 500 per cent. This will result in considerable savings, particularly where long distances are involved. In general, B1 data carrier facilities will be used on all trunk groups except those where short length of haul or the small number of trunks involved makes it economical to use voice grade trunks.

3.60 In addition to the control signals, which will be transmitted over a separate (seventh) narrow band channel, there are three types of signals which will be transmitted over each of the six narrow band data channels, as described in 3.61 to 3.63.

3.61 Address Signals. These signals transmit the called number to the distant office. They have to be arranged for operation within the narrow band which the B1 data carrier system provides. New senders and registers, which transmit and receive address signals by a frequency shift pulsing (FSP) method, will be employed for sending and receiving address signals over B1 data trunks. These FSP senders and registers have two significant advantages over those of earlier design, namely, faster operation and increased reliability. FSP senders and registers can transmit the called number information about three times faster than present MF senders. Greater reliability is provided by the fact that, if an FSP register receives an incomplete or faulty address, it will cause the distant sender to repeat its transmission automatically.

3.62 Call Progress Signals. These are signals that convey to the calling customer the status of his call, eg, audible ringing and the busy signal. These signals, which must also be arranged to pass through the B1 data narrow band trunks, are discussed in 3. E.

3.63 Data Signals. WADS and 4-row TWX stations will send and receive frequency shift data signals centered around 1170 cps (for f_1) and 2125 cps (for f_2). These signals will be shifted by the B1 data carrier terminal to fit into the narrow frequency band allocated to the particular channel over which a call is established. Fig. 11 illustrates the principle used to shift the data frequencies into a particular channel. The data signals from the sending station are fed into the modulator, where they are mixed with a carrier frequency. As a result, the signals are frequency shifted into one of the narrow bands as shown. At the distant (receiving) terminal the data signals are restored to their original frequencies.

E. Call Progress Signals

3.64 The WADS narrow-band trunks will not pass the normal telephone call progress signals, such as busy tone and audible ring. Therefore, new call progress signals will be required to provide compatibility with the narrowband trunking facilities.

3.65 These signals will be designed for recognition by automatic machines as well as by station attendants. Since a calling station receives information with signals centered at 2125 cps, the new call progress signals will lie in this frequency band. The tone for WADS call progress signals will consist of a frequency shift tone centered at 2125 cps and shifting between 2025 and 2225 cps at a 20 cps rate. This frequency shift tone will be interrupted at suitable rates to identify four different call progress reports: audible ring, busy, reorder, and intercept. The first three will employ interruption rates similar to those used in the DDD switching plan. The fourth interruption sequence will be unique to the WADS switching plan. The interruption patterns are given in Fig. 12.

3.66 Machine recognition will depend on the different lengths of silent interval for each signal. Recognition by attendants will depend on the distinctive interruption rates.

3.67 Generally, audible ring will last for only a short period of time and will indicate that the switching equipment has fulfilled its function. Prolonged audible ring will be possible when the called station is in a condition in which it cannot answer automatically (eg, trouble condition or station in local mode), when the called station is a switchboard location, or when the called station is served by a line concentrator that is unable either to complete the connection or to return a reorder signal.

3.68 Busy tone will be an indication that the called party's line is busy.

3.69 Reorder tone will generally indicate that an all-paths-busy condition has been encountered by the switching equipment. This signal may also indicate a common equipment circuit failure, a glare condition caused by both ends of a trunking facility being seized simultaneously, possibly a vacant code, or a condition of overflow of busy tone trunks.

3.70 The intercept tone will be used in the WADS switching plan to indicate those conditions which, in the DDD switching plan, are handled by an intercepting operator, eg, the called station has been disconnected or has had a number change. This tone may also be used in certain instances to indicate a vacant, ie, nonworking, central office code.

3.71 In addition to the four foregoing call progress tones, a new tone will be provided for handling WADS permanent signals. This tone will consist of 3 seconds of f_2 mark (2225 cps) alternating with 3 seconds of f_2 space (2025 cps). This signal will normally cause any station in the originating mode to go on-hook.

F. Station Equipment

General

3.72 The station equipment to be provided for WADS and for 4-row TWX service will be similar in fundamental principle to that which has been designed for 3-row dial TWX service. The differences between WADS and 3-row TWX station represent areas of improvement with respect to speed of operation, automatic operation, and refinements which result in greater reliability and flexibility of operation. It is the purpose of this part to outline the nature of these differences. For a more complete description of WADS and 4-row TWX station equipment, reference should be made to Section 972-200-102.

WADS Data Sets

3.73 As in the case of 3-row dial TWX service, a data set will be associated with each 4-row WADS station to convert the dc output of the TTY machine into ac tones for transmission and, also, to convert the received ac signals to dc pulses for input to the receiving TTY machine. The originating station sending frequencies (f_1 mark and space) and the terminating station sending frequencies (f_2 mark and space) used for 3-row dial TWX service will be used for WADS, thus achieving compatibility from the standpoint of transmission frequencies. (For an explanation of how connections are established by interchange of f_1 and f_2 tones and how circuit assurance is achieved during message transmission, reference should be made to Section 972-100-100.

3.74 Two data sets, 101C and 105A, will be used for WADS. The difference between the two lies in the fact that data set 105A will be arranged to operate with an additional unit, called a controller, which will permit various phases of the message transmitting function to be performed automatically. Both of the WADS data sets differ from the data set 101A used for 3-row TWX service by the addition of the following features.

- Restraint circuitry--to prevent overflowing the buffer storage of the converter translator used in connections between 4-row, 100 wpm WADS stations and 3-row, 60 wpm TWX stations.
- Break detector--provides for generating a communication break and for recognition of a received break signal by timing circuitry in the data set instead of using two BLANK characters as in the case of 3-row TWX stations.
- Low paper alarm--to prevent automatic station answering where there is danger that a receiving machine will run out of paper.
- Shorter timing intervals for monitoring mark and space signals.

In all other respects, the WADS data sets will function the same as the data set 101A. Data set 101B, also used for 3-row dial TWX service, operates exactly the same as data set 101A but it has been wired and equipped so as to facilitate subsequent conversion to a data set 101C.

3.75 The function of the restraint circuit has been described in 3.43 to 3.46.

3.76 By incorporating the generation and detection of the break signal in the 101C and 105A data sets, it will be possible to reduce the length of the spacing frequency tone used for the break signal. This, in turn, will permit reduction in the spacing (ie, clear) signal used for disconnect and reduction in the timed recognition of f_1 and f_2 marking tones when connections are established. All of these changes will permit faster connections and result in more efficient utilization of the switched network and of the station equipment.

3.77 All WADS and 4-row TWX stations will be arranged for automatic answering (which is called unattended service for 3-row TWX stations). This is an important feature which will make WADS both faster and more automatic, but it will necessitate provision of means for preventing automatic answer when there is insufficient paper remaining on the receiving machine to insure that the next message may be completely received. The low paper feature will cause a receiving machine to give a "don't answer" response to incoming calls when the paper supply has reached a critical point. It will also turn on an alarm to call the condition to the attention of the station attendant. A similar feature, the out-of-service key, will also be provided for manual operation by the attendant to give a "don't answer" response to incoming calls when for some other reason the WADS station is not capable of receiving calls. This will create a condition similar to that caused by operation of the local key on 3-row TWX machines, except that the station ringer will not operate in the out-of-service mode. Both the low paper and the out-of-service features will result in a central office line busy condition when used at receive-only stations in a terminal hunting group, as described in 3.93 below.

New TTY Machines for WADS

3.78 Two new models of TTY machines, the 33- and 35-type, will be used for WADS and 4-row TWX. In addition to providing for the 4-row keyboard and generating the 11-bit codes, these machines will be of an improved, more efficient design with the lamps and keys of the attendant set incorporated as part of the TTY console. The 11-bit code will consist of seven information bits plus a neutral eighth bit plus one bit for start pulse and two bits for stop pulse. The neutral eighth bit (not used for the codes of this system) is provided so that eight level customer tapes can be transmitted. Normally the eighth bit will always be marking. Both machines will be equipped with a stunt box feature to recognize the end-of-transmission (EOT) character and to initiate the disconnect sequence automatically when EOT is received.

3.79 Both machines will be available in keyboard send-receive (KSR) and automatic send-receive (ASR) models, the latter having a perforator and transmitter - distributor (T-D) for sending messages from perforated tape. The 35-type will be a heavy duty machine very similar in overall capability to the 28-type machines presently in use. The 33-type machines will be used for receiving-only stations (where the traffic is one way and divided evenly over several machines at a single location) and for originate and terminate stations where the originated load is less than 40 hours per month.

3.80 There will be important differences between the 33- and 35-type machines with respect to the features and functions which they provide. The 35 machine, in combination with its data set, will be capable of performing a wide range of control functions and automatic operations, many of which will not be possible with the 33 machine. These functions are described in detail in Section 972-200-102, but the following partial list of 35-type capabilities, either standard or optional, which will not be available with the 33-type, gives an indication of the differences between the two WADS TTY machines:

- Call progress lamps.
- WRU (request answer-back) from tape.
- Request or respond to confirmation (RU) request.
- ON ASR models, perforate tape blind (no local copy) while receiving an incoming message on page copy.
- Respond to T-D on and off control characters.
- Horizontal and vertical tabulation (as used with preprinted forms and sprocket feed).

Automatic Answer-Back Responses - Terminating Machines

3.81 An automatic response from terminating stations would be a desirable feature for identification purposes in any case, but with universal automatic answering, the automatic response is a virtual necessity. Two types of response, one for identification and the other for automatic confirmation, will be generated by means of an answer-back drum in each WADS station which may terminate messages. The answer-back drum, similar to the one provided for unattended type 28 machines in 3-row TWX service, will be able to send out up to 21 characters of response, automatically at the start of each incoming call or in response to a Who Are You (WRU) or Are You (RU) request received during a message.

3.82 The Identification Answer-Back makes use of the full drum capacity of 21 characters, seven of which are used for form positioning, control and timing purposes, leaving 14 positions for graphic characters to identify the terminating customer. For directory listing reasons, the number of characters actually used for customer identification will be limited to a maximum of 12. The printed portion of the identification answer-back for each WADS or 4-row TWX customer will appear as part of the customer's listing in the WADS-TWX directory, so that it can be determined in advance at the time that the terminating directory number of a call is obtained. Receipt of this 12-character answer-back upon establishing the connection permits the calling station attendant to identify the terminating station manually. The identification answer-back will be fired automatically when the terminating station has received a timed f_1 mark at the start of the call. The final character in the identification answer-back will be the X ON control character, which can be used for automatically starting the originating station T-D where this feature is desired on an optional basis. It is important to note that this type of answer-back (which prints but does not get a stunt box check) provides terminating station identification only. To insure that the correct station has answered, the identification answer-back must be verified by human means, either when the message is originated or subsequently.

3.83 The Confirmation Answer-Back has been designed to permit verification that the desired station has been reached and to accomplish this automatically. For this feature an identification code, usually of from two to four characters, will be included as part of the terminating station's directory listing. Terminating WADS stations equipped for confirmation answer-back will have their answer-back drums coded to transmit a response of which the following are essential:

CAR RET LINE FEED CNFM
RUB OUT

The reverse slant is a graphic character which will print, the next two characters are control characters for positioning the form, CNFM is a control character which will start the distant T-D, and rub out is used for timing purposes. This response will be sent automatically when the f_1 mark signal has been recognized at the start of a call. The originating station will then send:

RU (2 to 4 char identity) X OFF RUB OUT

The RU plus the two to four identifying characters, obtained from the terminating station's directory listing, will be checked as a sequence by the terminating station stunt box and, if the sequence is correct, the terminating station will again send the confirmation answer-back. The originating station T-D, if one were used, would stop after sending the RU request (by reason of the X OFF control character) and would be started again automatically to send its message, only when the second confirmation answer-back response is received. If the transmitted RU sequence did not match the particular terminating station reached, the confirmation response would not be given and message transmission would not take place. The same operations could be followed with a message sent from a keyboard but then, of course, the confirmation would necessarily be partly manual. Note that a successful completion of the confirmation procedure will result in sending station page copy consisting of a reverse slant (\) character printed on the first line and the confirmation characters plus a reverse slant (\) character printed on the second line. Also, if the originating station is an ASR type sending from tape, it can be arranged with optional logic (type D stations) so that it will start automatically the second time only if it receives the CNFM control character; it will not restart in response to X ON, which it might receive if it had reached an identification type answer-back station by mistake. An equivalent arrangement will be provided as a standard feature of type E and F stations (see 3.87 and 3.88).

Types of Originating Station Arrangements

3.84 The variety of station equipment available to WADS customers will include not only a choice between light and heavy duty TTY machines (#33- or #35-types) and a choice between keyboard or perforated tape sending (KSR or ASR), but it will also provide for varying degrees of automatic operation and control in the sending of messages from perforated tape. It is presently planned to provide several groups of station arrangements; the first two of these, which are called arrangements C and D and are described in detail in Section 972-200-102, will be available for the initial WADS in January, 1963; more completely automatic station arrangements will be made available somewhat later. The basic differences between the four groups of station arrangements are outlined in the following paragraphs.

3.85 Arrangement C will provide all of the basic features required for proper use of WADS or 4-row TWX service. It will require an attendant to handle the dialing of the called number and to monitor the progress of the call. The only alarms provided will be the low paper and paper-out alarm. Thus station arrangement C will include: a loudspeaker for monitoring call progress signals; a low paper switch and lamp to prevent automatic answering when there is an insufficient paper supply; a restraint recognizing circuit to permit operation with the 3-4 row converter; the keys and lamps on the attendant set required for manually originating a call; an answer-back drum for automatically sending the identification or confirmation answer-back as required for automatic answering; and the ability to disconnect upon receipt of the EOT control character also required because of the automatic answering feature which will apply to all 4-row TWX and WADS stations. In all these respects, the 4-row TWX station and WADS station arrangement C are alike. However, all WADS stations (and thus the 5C offices which serve them) will be equipped for TOUCH-TONE dialing using the 10-button keyset instead of the rotary dial. TOUCH-TONE dialing will be available to 4-row TWX stations on an optional basis where the central office from which they are served is equipped for it.

3.86 Arrangement D will provide additional features for more automatic monitoring of the progress of the call and for alarming when trouble conditions are encountered. The most significant of these will be:

- An automatic time-out alarm if no connection results within one minute after a dialed attempt.
- Optional call progress tone detection to terminate a dialing attempt when a condition is encountered that prohibits completion of the call. Visual indications will be provided to indicate the nature of the condition resulting in the unsuccessful attempt.
- The ability to alarm if no response to an answer-back request is received within 5 seconds.
- An automatic indication if transmission ceases for a period of 20 seconds for any of a number of reasons (taut tape, power failure, sending machine ceases to send but has not transmitted an EOT character, etc).

By the addition of these features, it will be possible for attendants at D stations to place a perforated tape in the transmitter, key pulse the directory number of the desired station, and then leave the station knowing that (1) the message will be sent automatically and the call will be disconnected automatically at the end of the message, or (2) an alarm will be given indicating that the message could not be sent. These automatic features will permit the attendant to begin preparation of a subsequent message or to attend to other work while the first message is in progress.

3.87 An intermediate station arrangement will provide an additional degree of automatism by means of automatic outpulsing of called directory numbers perforated as an address in tape preceding the message to be delivered. The format of the entire message will be:

- Start of message (SOM) control character
- 10-digit directory number
- End of address (EOA) control character
- Message text
- End of transmission (EOT) control character

The transmitter and related control circuitry will cause a tape to advance until SOM is recognized. The tape will then stop and the station will go off-hook. When dial tone is received, the tape will advance, the ten digits of the directory will be outpulsed, and the tape will be stopped on the EOA character. When an answer-back is received, the tape will be started, the message will be transmitted, and the station will go on-hook after EOT has been recognized. If at this point there is additional tape in the transmitter, the tape will be advanced to the SOM character of the next message. Automatic detection of call progress signals will also be included so that appropriate action will be taken (including in some cases the sounding of an alarm) if a connection is not established. If a busy signal is received, an automatic retry will be made, consisting of a dial tone request and a redialing of the directory number, and an alarm will be given after a specified number of such unsuccessful attempts.

3.88 A fully automatic station arrangement will include all the features of the intermediate arrangement plus two additional features: (a) the ability to send a message to more than one address where multiple addresses and a specified address coding arrangement are perforated on tape preceding the message text, and (b) the ability to dispose of messages on which a specified number of unsuccessful attempts have been made by sending them to some centralized point for special handling.

Receive-Only Stations

3.89 Prior to this point, the description of station equipment has dealt with stations which can both send and receive messages. In many situations WADS customers will want the send and receive functions combined in a single machine, but there are two fundamental reasons why it will be desirable to provide separate stations to perform the sending and receiving functions:

(a) During periods when large volumes of messages are being originated from a WADS station, messages being sent to the station will very frequently encounter a busy signal and will not be transmitted. This would be undesirable for the calling customer, because it means that many subsequent reattempts will be required or that the message will be delayed, or both. It would also be undesirable from the standpoint of the WADS switching plan, because unsuccessful call attempts constitute unproductive use of the switching and trunk facilities.

(b) The use of WADS originating access lines and station equipment for the receipt of incoming messages would constitute inefficient and wasteful use of the automatic originating equipment, which is not needed for receiving messages, and wasteful use of the access line which, if not interrupted by incoming messages, is capable of originating 30 to 40 outgoing messages per hour (depending on the average length of message and other factors). To subscribe for additional originating access lines and automatic sending station equipment in order to receive messages would be uneconomic from the standpoint of the WADS user.

3.90 To meet the requirement for handling significant volumes of incoming messages, a receive-only station and WADS access line will be provided. Since these stations will originate no outgoing messages, a relatively low, full time monthly charge can be made for the access line and station equipment. Additional saving will be achieved by reason of the fact that these stations will be unable to send messages to distant stations which have called them, ie, messages will be one-way incoming and there will be no need for a keyboard for sending to the distant station which has originated the call. (The only response sent out by a receive-only station will be the identification or confirmation responses and these will be transmitted from an answer-back drum.)

3.91 Where large volumes of messages will be received, there may be two or more receive-only stations. As a matter of fact, WADS customers will be urged to subscribe for sufficient receive-only stations to insure that, during the busy hour, not more than 10 per cent of the incoming calls will encounter all stations busy. Of course, where there are two or more receiving stations, terminal hunting will be provided by the central office equipment so that, although only the first station will be listed in the directory, calls will be routed to any of the idle stations in the hunting group.

3.92 Terminal hunting will result in a connection, if any of the stations in the group is idle, but it will tend to deliver most of the incoming messages, particularly during the off-peak hours, to the first few stations in the group and to deliver relatively few of the total messages to the last few stations in the group. This is satisfactory in the case of telephone service but, in the case of WADS, it will be desirable from a maintenance standpoint to provide for a more even distribution of incoming messages over all stations in the terminal hunting group. To meet this need, a call gating circuit will be provided in the central office for each WADS receive-only hunting group. This circuit will, in effect, hold each station busy after it has received a call until all stations in the group have received a call. When the last station in the group has thus become busy, the held-busy stations will be released and connections will again be made to the first stations in the group. This will result in 1/n of the load being handled by each of n stations in a terminal hunting group. In most cases, because of the relationship between busy hour and total day message volumes, 1/n of the total load is small enough so that it can be handled satisfactorily by the light-duty #33 TTY machine, thus permitting further economy in the provision of receive-only service.

3.93 One additional feature is required in connection with the central office call gating circuit and that is a means of making a receive-only station appear busy when, for some reason, it is unable to accept calls. Inability to receive incoming calls may result from a low paper condition, loss of ac power, or operation of the out-of-service key. To meet this need, the central office call gating circuit will include a make-busy feature which will operate as follows. Let it be assumed that the second station in a 3-station hunting group has had its out-of-service key thrown to the out-of-service position. Then, if the first station is receiving a call and a second call is received, the call will be connected to the second station line and audible ring will be returned to the calling station. After approximately 27 seconds a time-out will occur in the central office and this will cause the second station to be made busy and a reorder signal to be sent to the calling station. The next call to the 3-station group will be connected to the third and last station in the group and, as soon as the third station becomes busy (as the result of answering the incoming call), all of the held-busy lines will be released, but the made-busy line will remain busy. In the assumed case, the first station's busy condition will be released (if it has disconnected from the call which made it busy in the first place) but the second station's busy condition (a made-busy rather than a held-busy condition) will not be released until the station attendant operates the out-of-service key to the restore position. This action will be recognized by the central office circuitry and will result in cancelling the made-busy condition.

G. Maintenance Equipment

Toll Testboard No. 20A

3.94 The 20A WADS toll testboard will be used for testing WADS intertoll trunks which employ voice band facilities either with or without B1 terminal equipment. It will be located in No. 5 crossbar offices serving WADS or in the same building where it will have access to the trunk circuit under test by means of test lines or trunks which will be connected to the trunk to be tested via the crossbar switching equipment. The principal tests performed by the board are intended to detect the presence of trouble by means of over-all tests and to locate troubles observed on over-all tests by means of sectionalizing tests. Sectionalizing tests determine whether trouble is in the line facility or in the terminal equipment at one end or the other.

3.95 The types of tests performed by the testboard are as follows:

- Data Distortion
- Transmission Loss
- Frequency Offset
- Steady State Noise and Impulse Noise.

3.96 Initially, tests will be made on a 2-man basis between testboards. At this time, one-man tests also will be made on a limited basis by means of loop-around facilities. Loop-around tests will require the use of a wide band return trunk having known loss and distortion. Later, when a far-end test line is made available for WADS trunk testing, it will be possible to make tests on a one-man basis from the testboard without using a return trunk. Eventually, it is expected that the testboard will be relieved of all routine testing. This will be accomplished by developing automatic testing equipment which will be designed to make over-all trunk tests to a far-end test line.

Automatic Data Test Line (No. 5A)

3.97 The automatic data test line (ADTL) will provide automatic and semi-automatic transmission testing facilities for WADS and 4-row TWX stations. Two types of test trunks are available in the ADTL: (a) programmed and (b) break-controlled test trunks. The programmed test trunk is for the use of installers, repairmen, and station attendants to give an over-all performance test of the station. The break-controlled test trunk, which is intended primarily for the use of maintenance forces, will provide a 3-step sequential transmission test under control of break signals sent from the station being tested.

3.98 Upon accepting a call, the programmed test trunk, in conjunction with the station being tested, will automatically apply a series of transmission tests. The various steps of the test program, generally referred to as phases, are arranged to test both the sending and the receiving qualities of the station. The test trunk will transmit an 8-level code test sentence and will accept for distortion measurement a random series of characters from the station. Specifically, upon answering a call from a station, the programmed test trunk will initiate and perform the following phases of testing:

Phase 1. Two lines of a standard test sentence, with no distortion, will be sent to the station. Each such line will be suffixed with the notation UNDIST.

Phase 2. Two lines of test sentence will be sent containing a predetermined amount of switched combination distortion and each line will end with the notation SW-DIS.

Phase 3. Two lines of test sentence containing switched combination distortion will be sent at a reduced level and each line will be suffixed with the notation DISPAD.

Phase 4. The programmed trunk will start this phase by sending the instruction GA SEND (go ahead send). In response, the attendant or repairman at the station will send a series of characters (from the keyboard, the transmitter, or the answer-back drum) until stopped by a restraint signal, followed by a break signal, from the trunk. After the break signal, the trunk will send back a reply consisting of 5%, 10%, 15%, 20%, or 20%+, depending on the distortion peak measured in the sample transmitted from the station.

Phase 5. After the result of the percent-distortion measurement has been sent to the station, the trunk will transmit the instruction FLIP. This is a request to the station attendant to operate certain keys on the attendant unit to accomplish an interchange of the directions of the f_1 and f_2 transmitting frequencies, ie, to change the station from the originating to the terminating mode. When the FLIP cycle has been started at the station, the programmed trunk will cooperate in completing the mode conversion and will then repeat phases 1 through 4 for the station in the terminating mode. At the conclusion of this second round of phase 4, the trunk will terminate the test by sending the instruction END.

A representation of the copy which will be received by the station is shown in Fig. 13.

3.99 The break-controlled trunk will provide a 3-step sequential transmission test completely controlled by break signals sent from the station. Upon accepting a call, a break-controlled trunk will immediately start to transmit repeated lines of test sentence without distortion. The first break signal received from the station will cause the trunk to add a fixed amount of switched bias distortion to the test sentence signal which it is transmitting. These signals will continue until the next break signal is received from the station, at which time the distortion in the test signal will be changed from switched bias to switched combination distortion. When a third break signal is received from the station, the trunk will terminate the test by disconnecting.

10B Telegraph Testboard

3.100 The 10B telegraph testboard will be similar to the 10A telegraph testboard designed for 3-row dial TWX service. It will include the features necessary for testing TTY stations using the 4-row keyboard, 8-level code and operating at the 100 wpm rate. Test centers equipped with the 10B testboard will ultimately be provided in each office serving WADS, but they may not be provided initially in some secondary offices which serve only a small number of WADS stations. In these cases, access to a 10B testboard in a primary office serving WADS will be provided via a full band width facility. The characteristics of this facility must be known to assure accurate test results. The 10B test positions will be used when there is need for a more complete test than can be performed with the ADTL.

Portable Equipment for Station Testing

3.101 The principal test equipments that a station repairman will have available for use at the customer's location are the TTS-28 portable station test meter (previously used for 3-row dial TWX service), a new carrying case to accommodate spare electronic plug-in units for the teletypewriter and data set 105A, and a portable station test set (907A).

3.102 In addition to the basic test functions provided by the maintenance test unit card used with 101A-type data sets (eg, data set sensitivity and bias measurements), the 907A test set includes a timing test circuit satisfactory for testing the data set timing intervals. Also included is a restraint signal generator for testing the response of WADS data sets to such a signal.

3.103 By means of an extender card and a connecting cable, the 907A test set may be connected to either 101- or 105-type data sets. A function selector switch on the test set is used to establish the appropriate conditions for the various tests with either a 101- or 105-type data set. The function selector switch permits establishing the necessary test conditions without gaining access to the specific components under test.

3.104 To permit distortion measurements, a modified transmission distortion measuring set, the 164C4, may be connected to the teletypewriter station by using the 907A test set. The 164C4 set has been arranged to operate with the new 8-element code at 100 words-per-minute.

H. Miscellaneous Other WADS Facilities

Subscriber Line Facilities

3.105 Because of the limited number of proposed WADS central offices, there will be many stations located in areas remote from their serving central office. The subscriber line facilities needed to provide the necessary range extension for WADS subscriber loops will be essentially the same as those used for 3-row dial TWX service. Certain differences will exist, however, and these are briefly described in the following paragraphs.

3.106 Dial long line circuits (DLLC) will be used for WADS, in the same manner as for 3-row TWX service, to extend the normal central office loop range. A modification, introduced for WADS, will provide for the immediate tripping of ringing during either the silent or active phase of the ringing cycle.

3.107 Divided access line circuits, developed for 3-row dial TWX stations which are served by two different central offices for their originating and terminating traffic, will not be required for WADS or 4-row TWX stations, since these stations will in all cases be furnished both originating and terminating service from the same central office. Where a portion of a subscriber loop will be served over 4-wire facilities, WADS loops will use the same E1L and E1S signalling units which were developed for 3-row TWX stations. Also, where improvement is needed in the transmission capabilities of WADS loops, the active repeaters and line impedance compensators used for 3-row dial TWX will be used for WADS.

3.108 In areas where a substantial number of WADS stations require loop connection to a remote serving office, concentrator facilities will be used. Initially the 1A line concentrator, which was modified for 3-row dial TWX service, will be used for WADS. Later on, a new line concentrator, the 2A, will be introduced. The 2A line concentrator will concentrate 80 lines to 16 trunks and will be arranged to generate an overflow tone, when all trunks are busy, which can be recognized by WADS stations with automatic transmitting features. A new method of signalling between the control and remote units of the 2A concentrator will provide for a reduced average set-up time and disconnect time. The 2A concentrator will be designed so that 15 of its 16 trunks remain connected, in each case, to the last loop served, while one additional trunk will be preselected to serve the next call not involving one of the 15 stations for which the trunk connections have been retained. The heavy user WADS stations served by a concentrator will generally be those for which trunk connections have been retained and thus they will seldom experience a concentrator delay when they originate calls.

Assistance Switchboards

3.109 The assistance switchboards which will be provided to serve WADS and 4-row TWX customers will be the teletypewriter switchboard No. 6A arranged for operation with the 8-level code, 100 wpm transmitting rate, and the restraint signal which will be sent out from 3-4 converters. The same switchboard locations will be used to serve both 3-row and 4-row TTY stations, but separate switchboard positions, usually in the same line of switchboard, will be required for assistance to 4- row stations. At the inception of WADS, two or more positions of the 4-row variety will be furnished at each of the 16 switchboard locations; as the requirement for additional 4-row positions increases, additional positions will be provided by conversion of 3-row positions to 4-row operation in the same line of switchboard.

3.110 Basically, the changes required to convert a 6A switchboard position from 3-row to 4-row operation consist of the following:

(a) The model 28 tape-type TTY machine at each position must be replaced with a teletypewriter arranged for 100 wpm, 8-level 4-row keyboard operation.

(b) New timing intervals are required in the cord circuits to be compatible with the new data sets to be used for WADS.

(c) The regenerative repeaters used in the conference and cord circuits must be arranged for handling the 8-level, 100 wpm code.

(d) Circuitry to recognize and pass the 3-4 row converter restraint signal must be added to the cord circuits.

(e) A new timing interval is required in the position circuit for the break signal.

The foregoing modifications will also be required in the supervisor or service assistant desk and in the position monitoring equipment.

Service Observing Arrangements

3.111 Line service observing equipment installed in No. 12 service observing desks for 3-row dial TWX service will be modified for observing on WADS calls by adding a new page-type receive-only #35 TTY machine and an auxiliary transfer unit, under control of the loop identification circuit, to transfer the output of the data line monitoring unit to either the 3-row or 4-row receiving equipment.

4. REFERENCE LIST OF BELL SYSTEM PRACTICES

4.01 The following sections will provide additional information concerning the equipment and facilities used in the WADS system:

972-100-100 Dial Teletypewriter Exchange System - General Descriptive Information.

972-200-102 Wide Area Data Service and 4-Row Teletypewriter Exchange Service - Station Arrangements C and D - General Descriptive Information.

570-011-101 Data Interchange Code and Related 4-Row Keyboard (to be issued).

574-100-100 #32 and #33 Type Teletypewriters - Descriptive Information.

574-2XX-100 Descriptive Information for #35 Type Teletypewriter:

574-200-100 #35 RO

574-201-100 #35 KSR

574-202-100 #35 ASR

574-203-100 #35 ROTR

314-016-150 B1 Data Carrier Terminal - Description and Operating Principles

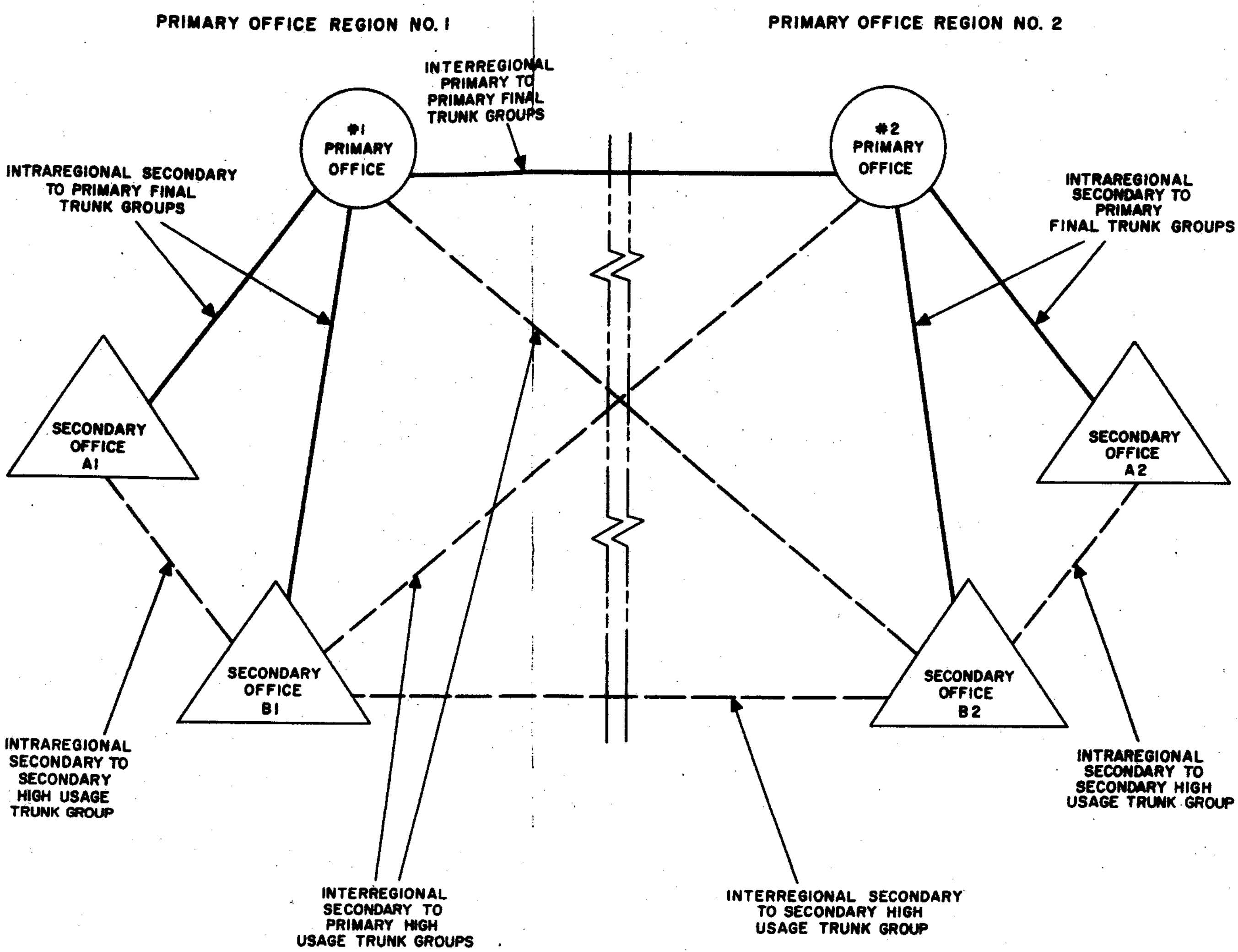
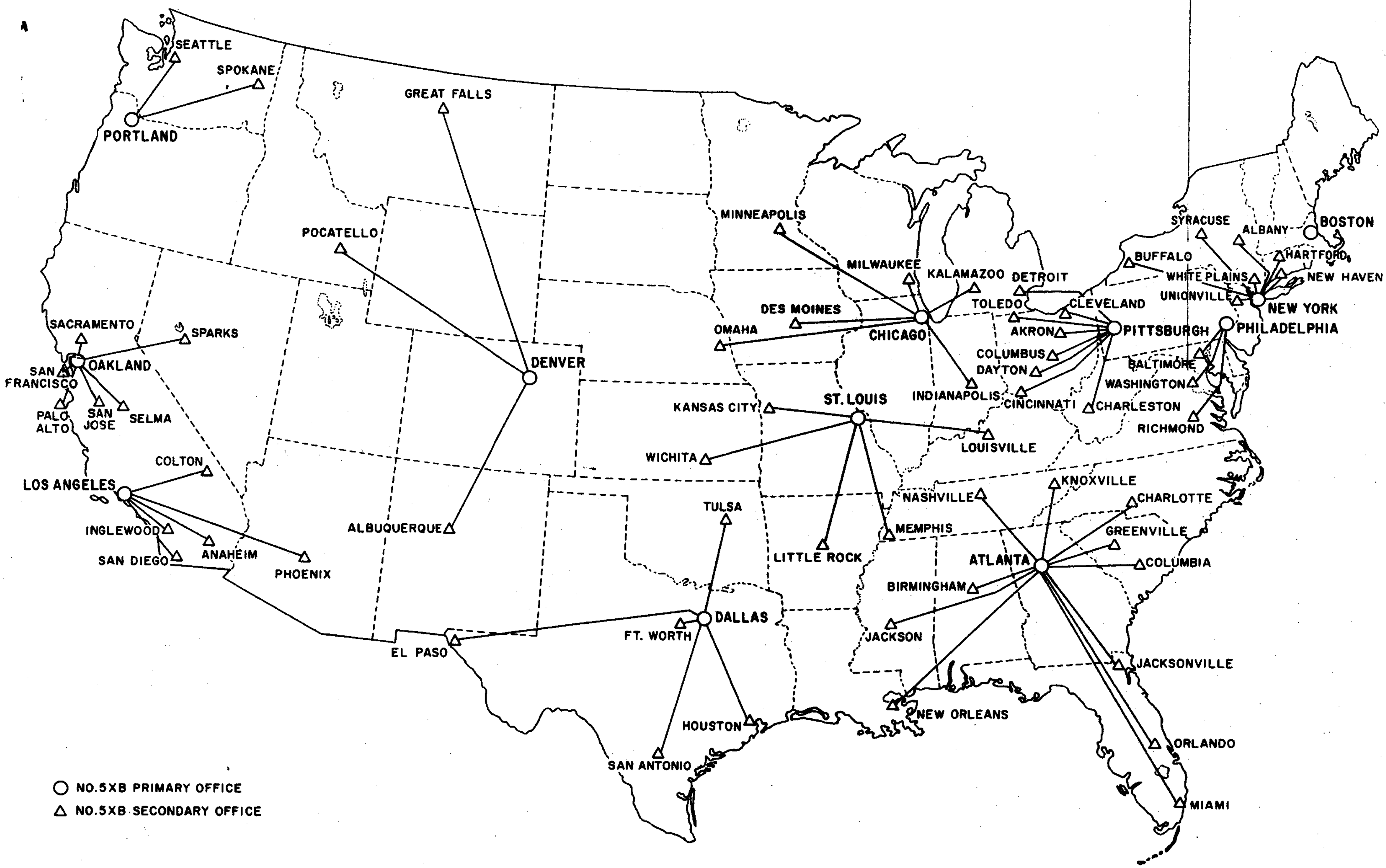


Fig. 1 - WADS Switching Plan - Typical Routing Pattern



NOTE: AT ATLANTA, DALLAS AND NEW YORK TWO NO.5XB MACHINES WILL BE USED.

Fig. 2 - WADS Switching Plan - Location of Primary and Secondary No. 5 Crossbar Offices

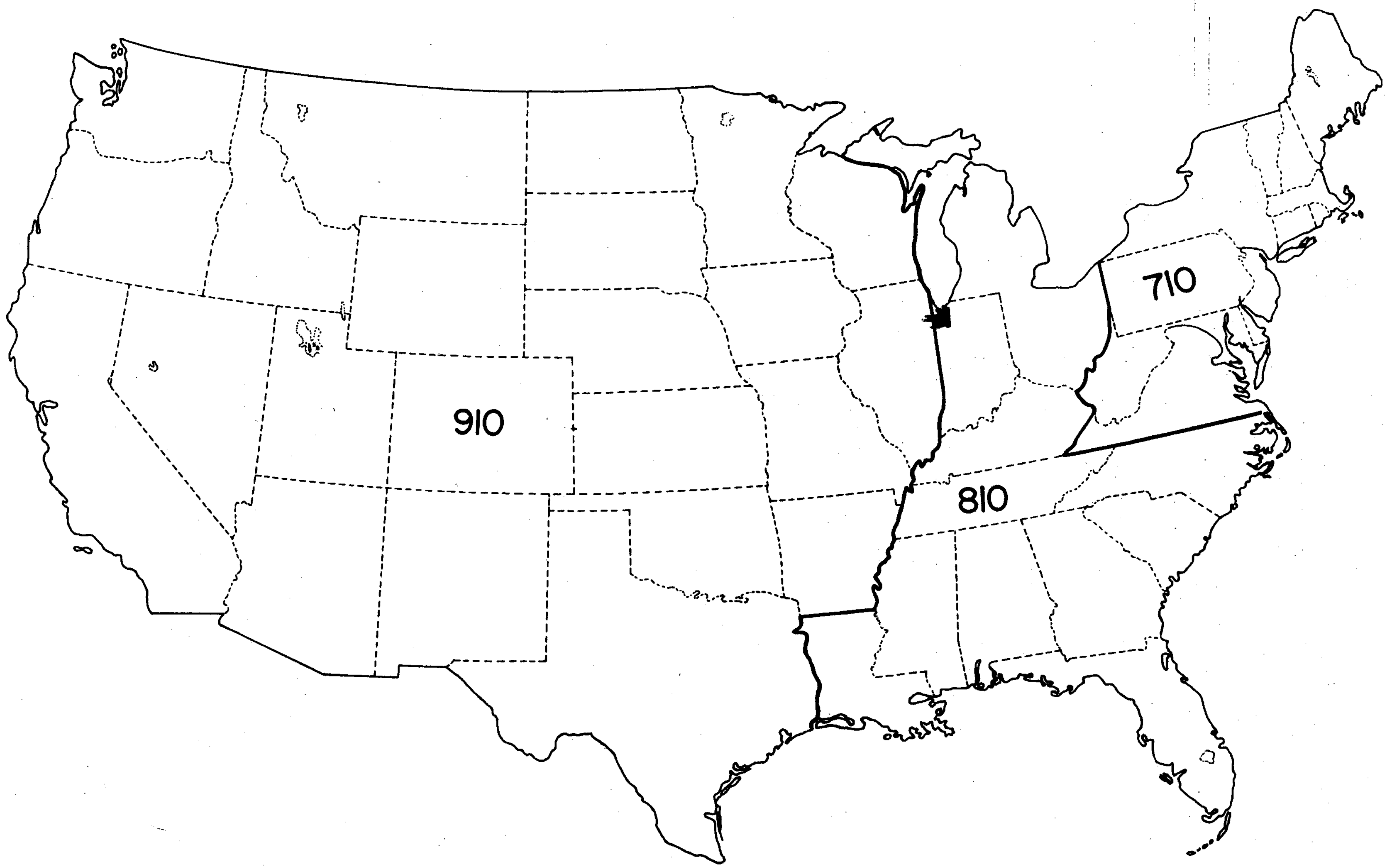


Fig. 3 - Special Numbering Plan Areas

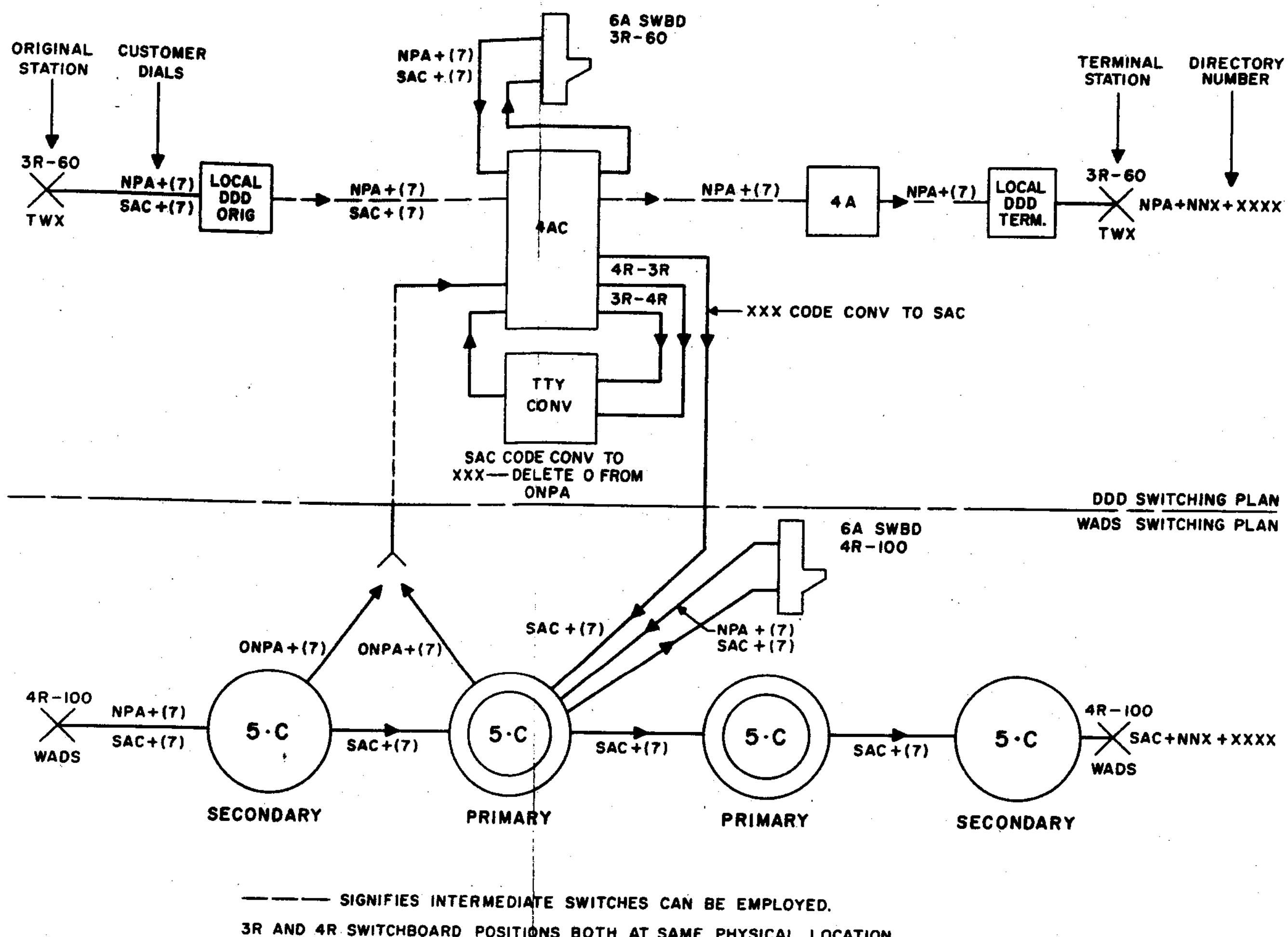
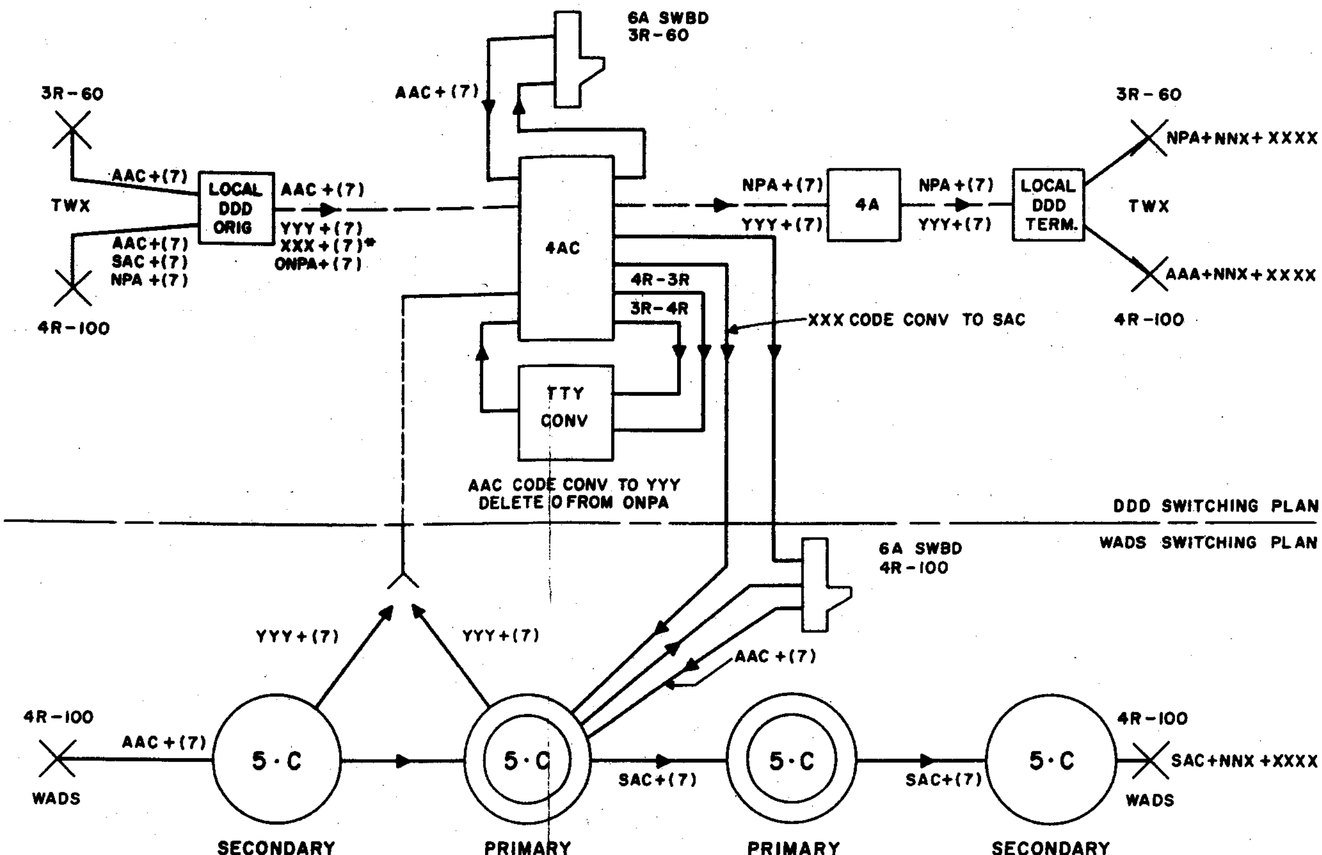


Fig. 4 - WADS and Dial TWX Interconnection at Introduction of WADS



NOTES:
1. ——— SIGNIFIES INTERMEDIATE SWITCHES MAY BE EMPLOYED.
2. 3R AND 4R SWITCHBOARD POSITIONS BOTH AT SAME PHYSICAL LOCATION.
3. * MAXIMUM OF 3 LINKS (1 TOLL CONNECTING AND 2 INTERTOLL) BETWEEN ORIGINATING OFFICE AND LAST TOLL OFFICE ENCOUNTERED BEFORE ENTERING WADS SWITCHING PLAN.

Fig. 5 - Interconnection of 4-Row TWX Stations in DDD Switching Plan with 3-Row TWX and WADS Stations

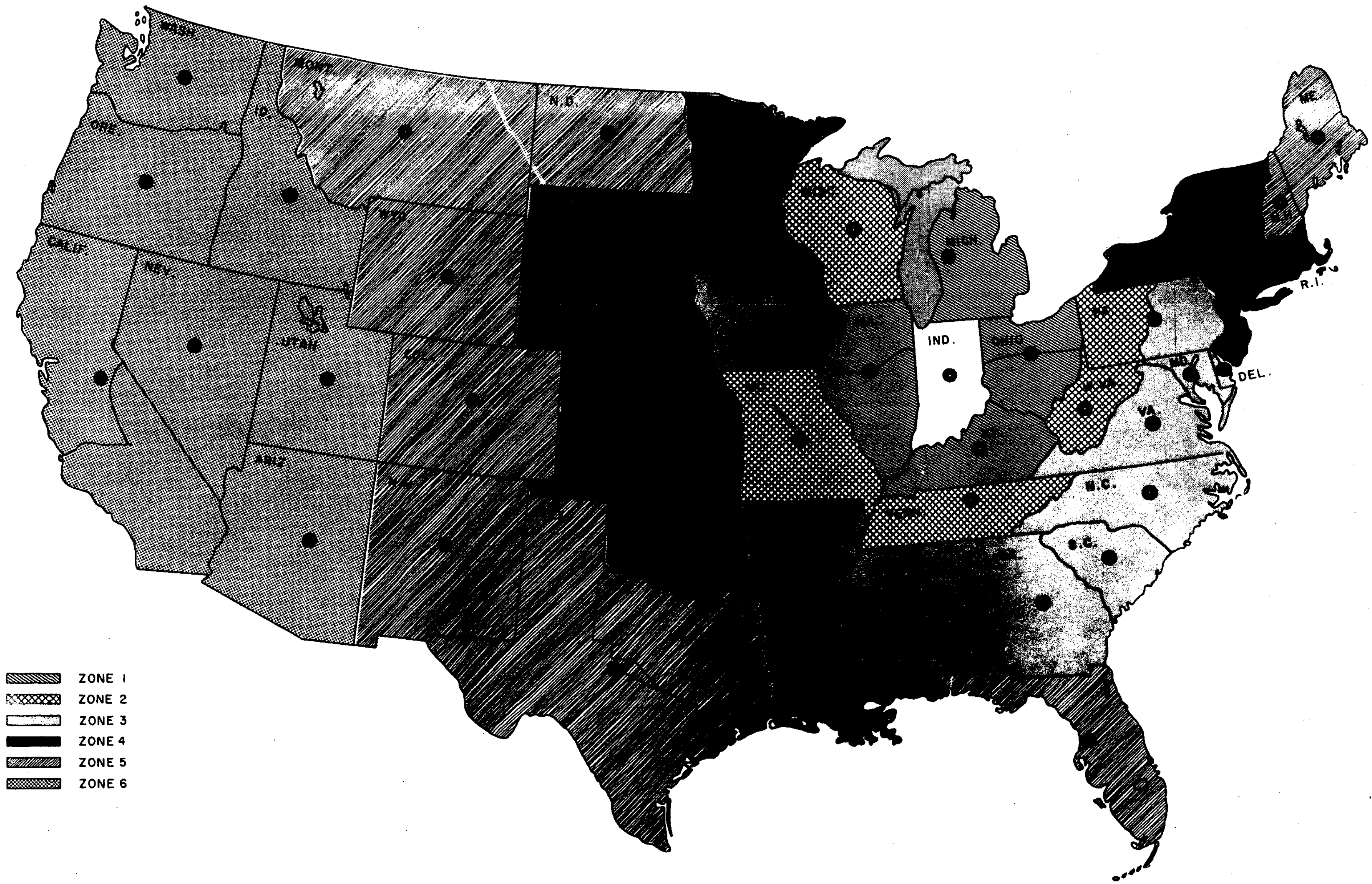
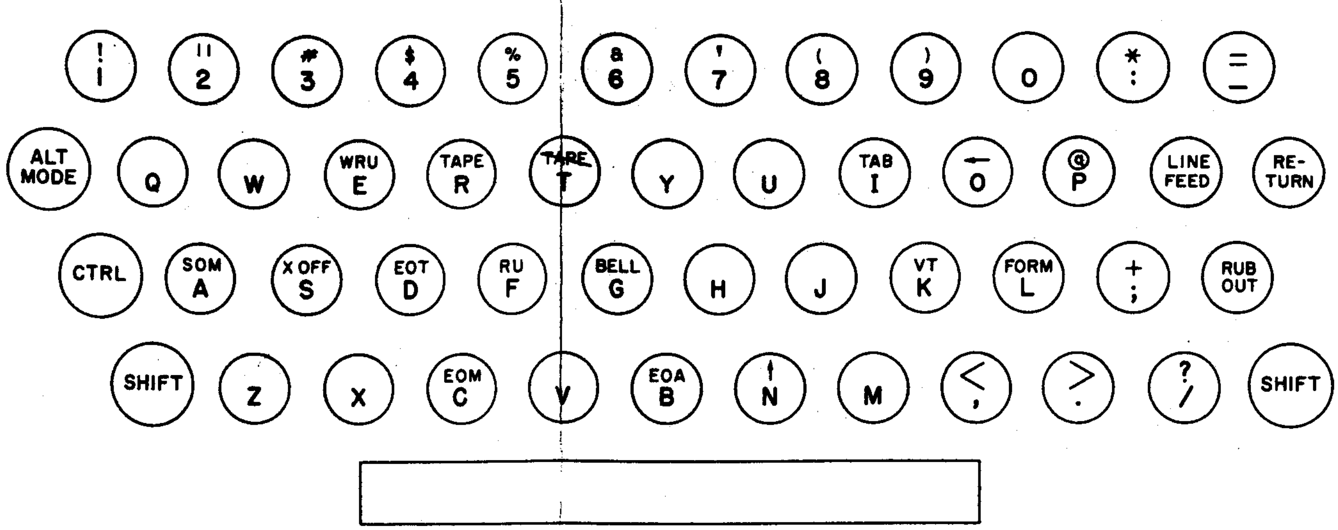


Fig. 6 - Calling Areas



NOTE: THIS KEYBOARD SHOWS THE MAXIMUM KEYTOP LETTERING. EXCEPT WHERE SPECIFICALLY REQUIRED, THE UPPER KEYTOP CONTROL CHARACTERS WILL NOT APPEAR ON THE KEYS FOR A, C, AND B (ie, THE CONTROL CHARACTERS SOM, EOM, AND EOA WILL BE OMITTED).

Fig. 7 - Keyboard Arrangement and Lettering for 4-Row WADS Teletypewriters

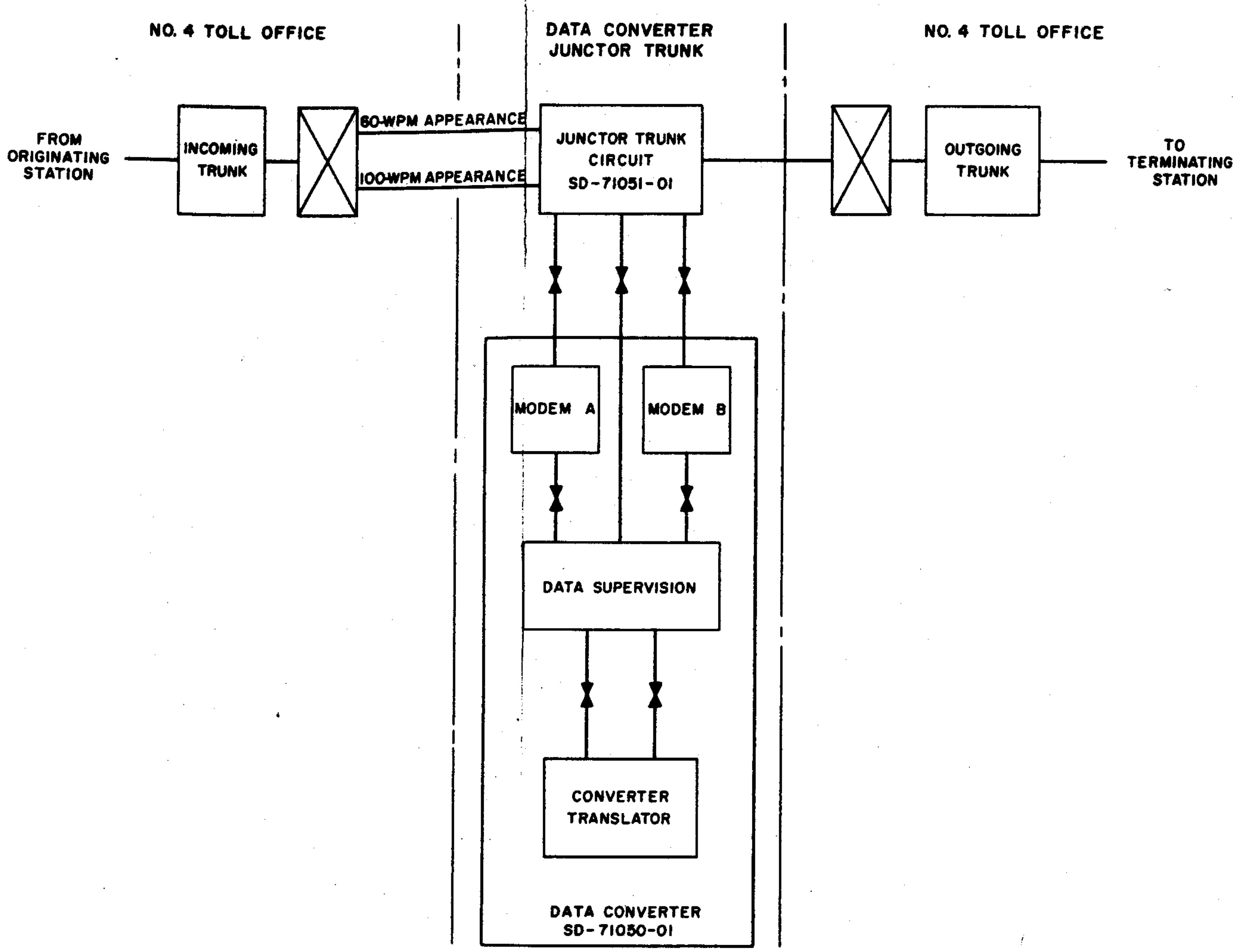


Fig. 8 - Data Converter Junctor Trunk

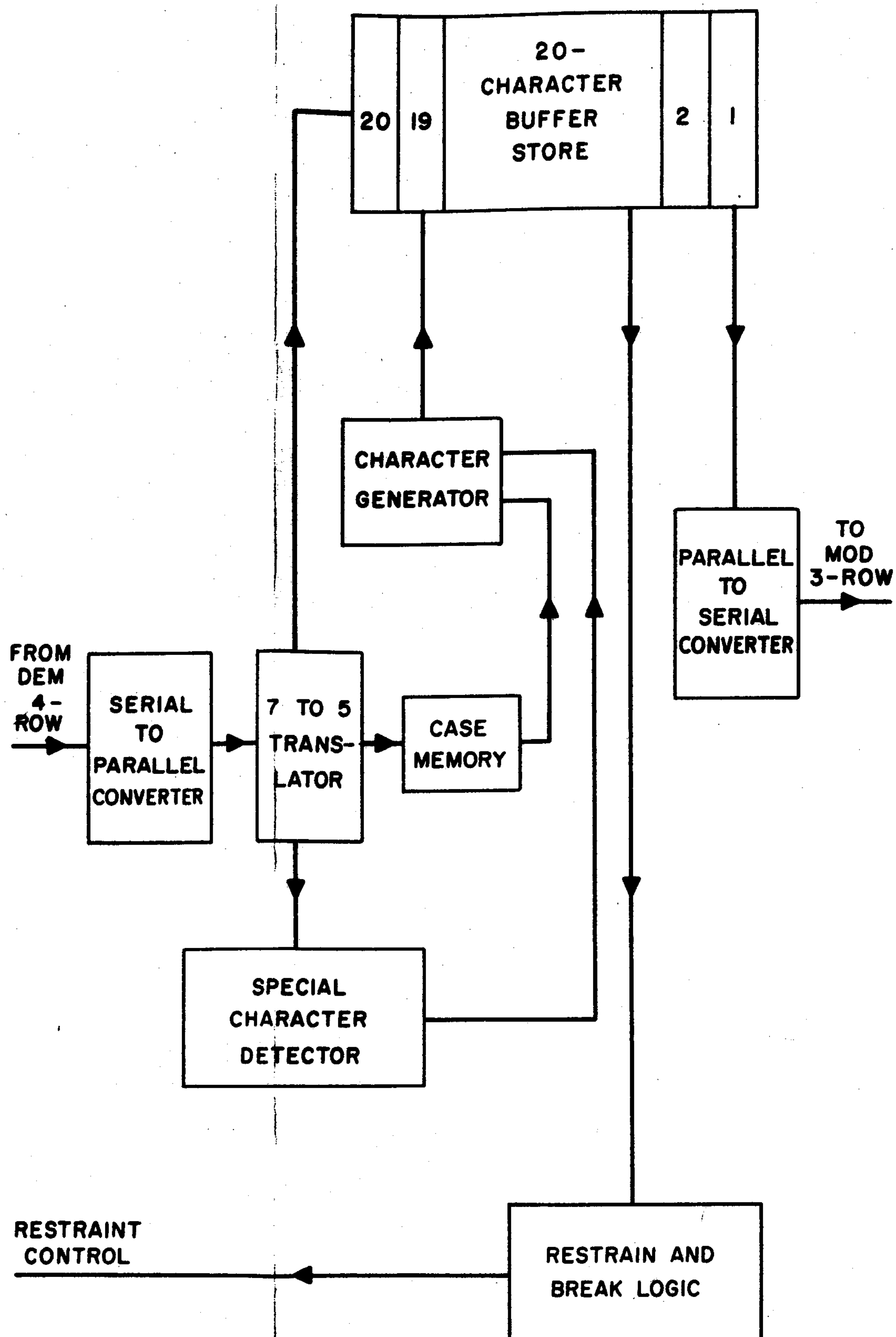


Fig. 9A - Converter Translator Elements for 4-Row to 3-Row Conversion

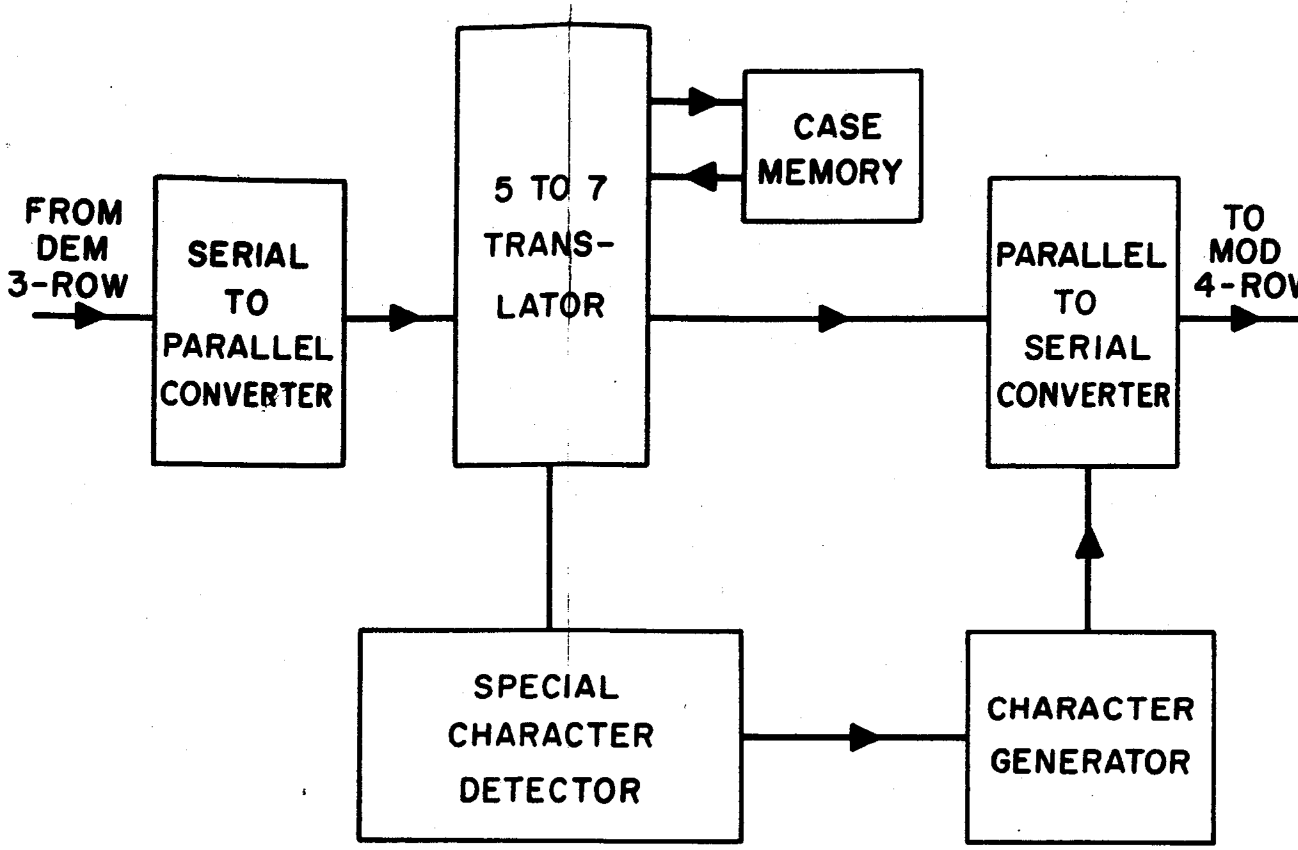


Fig. 9B - Converter Translator Elements
for 3-Row to 4-Row Conversion

Characters without a counterpart in the receiving machine and which will therefore be translated to \.

3-Row to 4-Row Translation

(none)

4-Row to 3-Row Translation

SOM RU TAB VT

FORM TAPE X OFF

~~TAPE~~ CNFM ALT MODE

Characters which will require special translation

3-Row to 4-Row Translation

LINE FEED BLANK LETTERS
will be translated to
LINE FEED NULL X ON

FIGURES H
will be translated to
EOM

The clear signal will be
recognized and sent out as
EOT

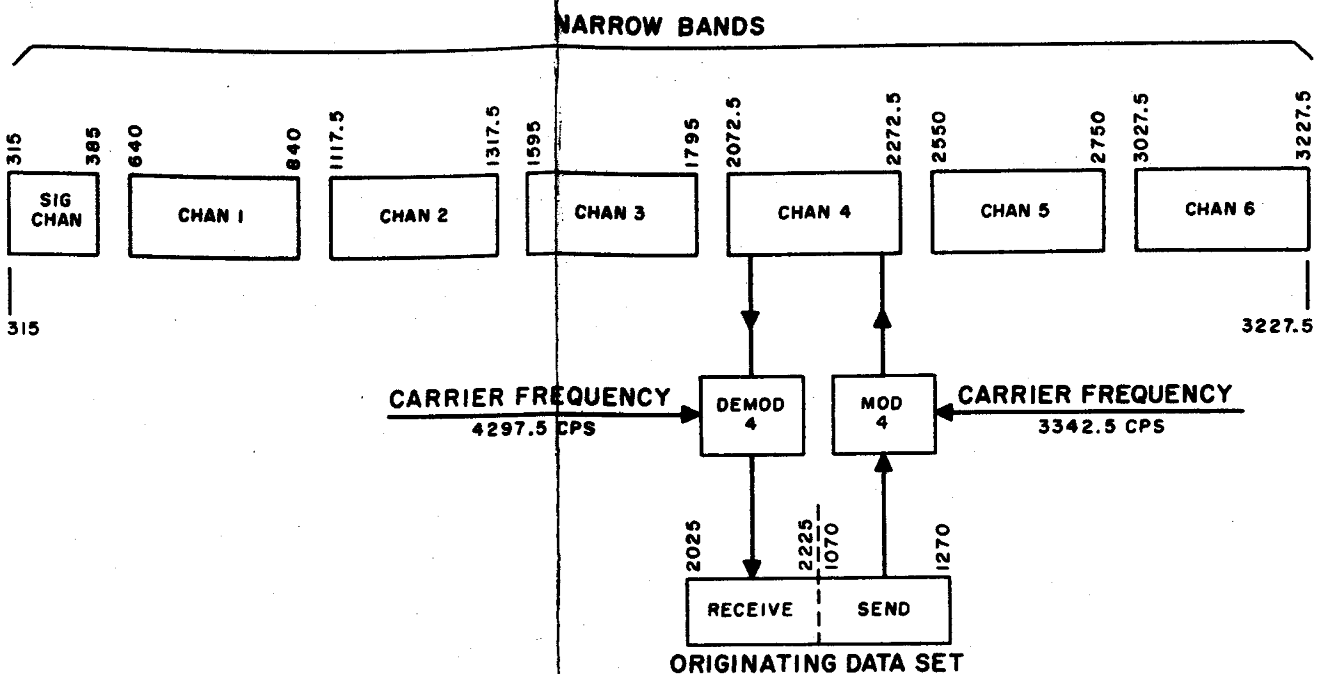
4-Row to 3-Row Translation

EOM will be translated to
FIGURES H

X ON will be translated to
BLANK LETTERS

EOT will be converted to
a clear signal, to be sent
to the 3-row station after
the buffer store has been
emptied.

Fig. 10 - Special Translations Made by the Data Converter Junctor Trunk



FREQUENCY SHIFTING PRINCIPLE

	DEMOD (F_2)		MOD (F_1)	
	SPACING	MARKING	SPACING	MARKING
CARRIER FREQ (CHAN 4)	4297.5	4297.5	3342.5	3342.5
DATA SET FREQUENCIES TO BE SHIFTED	-2025.0	-2225.0	-1070.0	-1270.0
RESULTANT NARROW BAND FREQUENCIES	2272.5	2072.5	2272.5	2072.5

Fig. 11 - Conversion of Data Set Frequencies to Narrow Band Frequencies

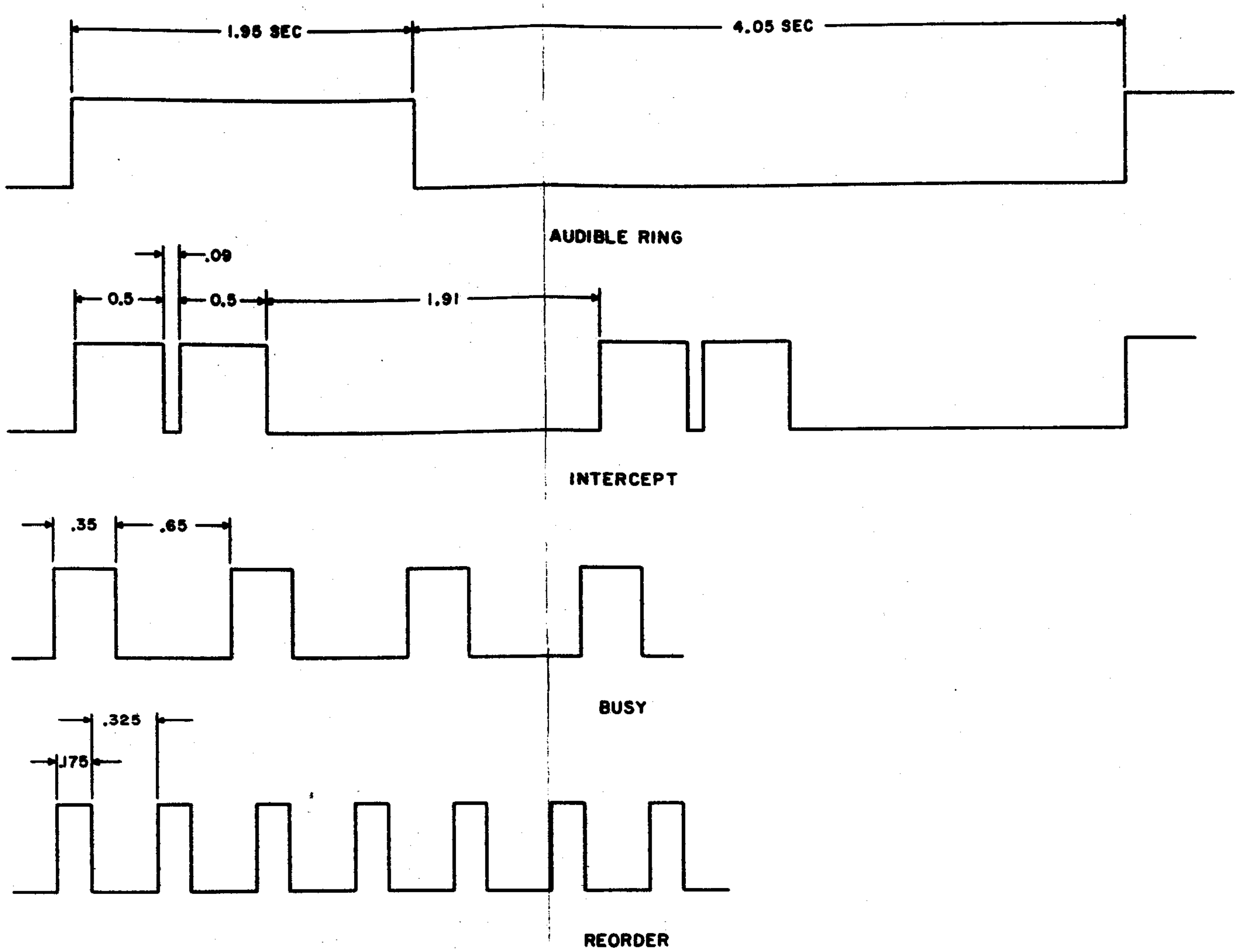


Fig. 12 - Interruption Patterns of Call Progress Signals

Programmed Test Trunk

THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 ## UNDIST
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 ## UNDIST
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 ## SW-DIS
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 ## SW-DIS
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 ## DISPAD
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 ## DISPAD

GA SEND
78IU78IU78IU78IU
10%

FLIP

STATION ANSWERBACK

THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 ## UNDIST
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 ## UNDIST
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 ## SW-DIS
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 ## SW-DIS
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 ## DISPAD
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 ## DISPAD

GA SEND
NOW IS THE TIME FOR ALL
15%

END

Note 1. The following control characters will be transmitted by the ADTL for proper spacing:

Before each test sentence	CR NULL RUBOUT LF
Before GA SEND	CR CR LF LF
After GA SEND	CR LF
Before percent distortion	CR LF
After percent distortion	LF
Before FLIP	CR LF
After FLIP	LF
Before END	CR LF

Note 2. A repeated sequence of the four characters, 78IU, is recommended for sending from the station to accomplish the purpose for which the characters RY have been used in the 5-level code. The 78IU combination will exercise the selecting mechanism and provide a good transmission test. The ADTL will measure any series of characters, however.

Break-Controlled Trunk

The following sentence and special suffix will be transmitted repeatedly by the break-controlled trunk:

THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 ## (&$,.)

Fig. 13 - Copy Received at Station When Tested with an Automatic Data Test Line (ADTL)