

DIAL TELETYPEWRITER EXCHANGE SYSTEM GENERAL DESCRIPTIVE INFORMATION

CONTENTS	PAGE	CONTENTS	PAGE
1. INTRODUCTION	2	C. Subscriber Line Facilities	10
2. GENERAL PLAN OF THE DIAL TWX SYSTEM	2	General	10
A. General	2	Divided Access Line Circuit	10
B. Station Equipment Changes from the Standpoint of the Customer	3	Loop Extension Facilities	10
C. Station Equipment Changes to Adapt Teletypewriter Machines to the Telephone Network	3	Line Concentrator No. 1A and Concentrator MF Signaling Circuit	12
D. Central Office Switching and Message Accounting Arrangements	3	D. Interoffice Trunk Facilities	13
E. Assistance Switchboards for TWX Traffic	4	Echo Suppressor Disabler	13
F. Other Positions for TWX Traffic	4	Elimination of 2000-Cycle SF Signaling	13
G. Changes in Interoffice Trunk Facilities	5	E. Assistance Switchboards	13
Echo Suppressor Disabler	5	General	13
SF Signaling Modification	5	TWX Switchboard Positions	14
H. New or Modified Subscriber Line Facilities	5	TWX Switchboard Circuits	14
Divided Access Line Circuit	5	Auxiliary Switchboard Facilities	15
Loop Extension Facilities	5	F. Other Dial TWX Switchboard Units	16
MF Signaling Circuit for Line Concentrator No. 1A	6	Information Desk	16
I. Maintenance and Testing Arrangements	6	Service Observing Desk	16
3. DESCRIPTION OF NEW OR MODIFIED EQUIPMENT FOR DIAL TWX SERVICE	7	G. Maintenance and Testing Equipment	17
A. General	7	Automatic Test Line	17
B. Station Equipment	7	Portable Station Test Meter	17
Teletypewriter Equipment	7	Telegraph Test Center	17
Subscriber Set	8	4. METHOD OF OPERATION	17
Data Set 101A	8	A. General	17
		B. Customer-Dialed Calls to Another TWX Station	18
		Attended Stations — Keyboard Sending	18
		Unattended Terminating Station	19
		Tape Sending Station	19
		C. Local and Test Operation of TWX Stations	19
		D. TWX Calls via the Assistance Switchboard	20
		E. Variations on Calls via the Assistance Switchboard	21

MISSING P. 15/16

Figures	PAGE
1 — Manual TWX Operation	23
2 — General Concept of Manual TWX— Trunking Plan	23
3 — General Plan of the Dial TWX System .	24
4 — Basic Maintenance Arrangements for Dial TWX Stations	25
5 — Data Set 101A and Subscriber Set 689A Mounted on 28 KSR Teletypewriter	26
5A — Data Set 101A and Subscriber Set 691A3 Associated With 15-Type Teletypewriter	26
6 — Data Set 101A, Principle of Operation	27
7 — Representative Arrangements of Subscriber Line Facilities	28
8 — Switchboard Connection into the Network	29
9 — Physical Layout of 6A Switchboard .	29
10 — Block Diagram of Switchboard Circuits	30
11 — Plan View of the Switchboard Keyshef	30
12 — Sample Copy Obtained from Use of the Automatic Test Line	31
13 — Flow Diagram of a TWX Connection Between Attended Stations	32

1. INTRODUCTION

1.01 This section describes in general terms the dial teletypewriter exchange (TWX) system. This system has been developed to improve the manual TWX system which was introduced as a new service in 1931.

1.02 Manual TWX service makes use of manually operated switchboards, equipped with 14-type (tape-printing) teletypewriters and interconnected by a separate network of telegraph-grade trunks. In recent years the number of manual switchboard locations has increased to about 115. None of these switchboards has trunks to all of the others, and most of them have trunks to less than ten others; thus, a good deal of multilink switching has been required. TWX stations

are served by dc loops and, where appropriate, dc TWX line concentrators are used. Switching is performed and supervisory signals are given by teletypewriter (TTY) characters received at and sent from the TTY at the operator position.

1.03 Fig. 1, attached, is a simple diagram showing how manual TWX connections are established using the manual TWX switchboards. Fig. 2 indicates the general concept of the existing manual TWX trunking plan.

1.04 The conversion of TWX service to dial operation will be accomplished by making use of the existing telephone switching and transmission network. This obviates the need for developing and installing an entirely new system of automatic switching centers and permits the use of the extensive and efficient telephone inter-office network, with only a relatively small increase in facilities to accommodate the added TWX traffic.

1.05 Since TWX service, now and in the future after dial conversion, is limited to communication by TTY code, certain additions and modifications are required in TWX station equipment and in portions of the telephone plant which will be used. The description of the dial TWX system contained in this section is limited to the new or modified equipment required.

2. GENERAL PLAN OF THE DIAL TWX SYSTEM

A. General

2.01 Conversion of TWX to dial operation will be accomplished by transferring all TWX stations to a completely separate system (the exchange telephone and DDD network system) which is already operating on a fully automatic basis in nearly all areas of the country. This solution avoids the very substantial problem of developing and installing new switching equipment in over 100 centers and placing it into service on a nationwide, flash-cutover basis. On the other hand, it does require that certain new and modified equipment be provided in order that TWX service will be compatible with the telephone system. The purpose of this part is to review the areas where compatibility does not already exist between the two systems and to

indicate in general terms the new or modified equipment which is required to achieve compatibility. Fig. 3 is a simple diagram which shows the general plan of the dial TWX system. A general description of the new or modified equipment units required is presented in Part 3.

B. Station Equipment Changes from the Standpoint of the Customer

2.02 After conversion to dial operation, TWX customers will originate messages by dialing 7- and 10-digit numbers into the exchange and DDD telephone network, and thus it will be necessary to equip each TWX station with a dial, or its equivalent.

2.03 Since there will be no conventional telephone station associated with TWX service, some means must be provided for generating the originate, answer, and disconnect supervisory signals which in the telephone system are generated by the receiver switchhook. In dial TWX service a separate button, with associated lamp, will be provided for each of these functions, and, because it is necessary to operate the TTY machine off-line (for practice or for preparing a perforated message tape), an additional button will be provided for local operation.

2.04 The establishment of a TWX connection will require monitoring of the supervisory tones (dial tone, ringing, busy tones, etc) which are sent back to the station to report the progress of the call. For this purpose a receive-only handset is required.

2.05 The foregoing requirements for customer use of the DDD network will be met by the addition of a new unit, a subscriber set, which will be added to each TWX station.

C. Station Equipment Changes to Adapt Teletypewriter Machines to the Telephone Network

2.06 The dc pulse output of TTY machines cannot be transmitted over the carrier and other facilities found in the telephone interoffice plant. Therefore the dc TTY output must be converted into ac tones for outward transmission, and incoming signals received in the forms of ac tones must be converted to dc pulses before being sent to the receiving TTY. The functions

of converting dc pulses to and from ac frequency tones will be performed by a data set which will be added to each TWX station.

2.07 In addition to its primary function of modulating and demodulating TTY signals, the data set will also perform the following functions:

- (a) Control the establishment and termination of a call in response to signals received from the subscriber set and from the central office.
- (b) Turn the TTY motor on and off as required for transmission of the message.
- (c) Monitor the incoming ac signal from the distant TTY station to make sure that the connection is held throughout the message.
- (d) Provide a break signal for interrupting transmission from the distant station.
- (e) At unattended stations, provide for sending an automatic answerback (either a single character or a 21-character, discrete response) at the start of each incoming call.

D. Central Office Switching and Message Accounting Arrangements

2.08 In general, TWX stations will be served from central offices as if they were a special class of telephone stations. Each TWX station will be assigned a 10-digit DDD number consisting of the numbering plan area (NPA) code, a 3-digit office code, and a 4-digit line number.

2.09 TWX calls will continue to be billed on an individual message basis and therefore AMA recording will be required for all customer-dialed calls. Since there will be no outward voice communication from TWX stations, operator identification of the calling station will not be possible. This means that, for originating traffic, all TWX stations must be served from offices with local AMA or from CAMA offices equipped for automatic number identification (ANI). (In addition, TWX stations will not be served from panel offices, even though equipped for ANI, because the impulse noise which occurs in panel offices would result in errors in TWX transmission.)

2.10 For purposes of incoming traffic, TWX stations can be served by any office equipped for inward DDD dialing (except panel offices). Where the normal serving (ie, wire center) office for a TWX station meets this requirement, it will be desirable to serve the TWX station from its normal serving office in order that the central office code assigned to it, which may be the code assigned to telephone stations in the same rate area, will uniquely identify its location for rating purposes. If TWX stations in several adjoining rate areas are connected to a single, remote central office for inward traffic, it may not be possible to assign a different office code for each rate area. This will require the use of one or more digits of the line number to identify the rate area involved, a solution which will complicate the work of rating messages to those stations.

2.11 Where the normal serving office for a TWX station meets the terminating office requirements but not the originating office requirements, it will generally be desirable to assign separate offices for originating and terminating traffic. If this is done, the office code portion of the directory number, which is used for switching inward calls to the station and which will therefore be recorded on AMA tape at the originating office, will uniquely identify the rate area of the called station. The assignment of different originating and terminating offices will be accomplished by use of a new development, the divided access line circuit, which will give appropriate supervisory signals to one of the two offices while the other is being used for a call in progress.

E. Assistance Switchboards for TWX Traffic

2.12 TWX assistance traffic (eg, collect calls and conference calls), which cannot be dialed directly by the customer, cannot be handled at the existing telephone dial service assistance (DSA) switchboards because 2-way voice communication will not be possible from TWX stations. An assistance switchboard of a new design will therefore be employed. This switchboard will be equipped with teletypewriters and data sets for both inward and outward directions of calling, and will also be arranged for establishing connections on a telephone basis for deal-

ing with telephone-equipped positions such as intercept and information.

2.13 Because the total traffic to be handled at these TWX assistance switchboards will be relatively small as compared to total telephone assistance traffic, only 16 TWX switchboards will be installed to serve the entire country. These switchboards will be located at important switching points and will be reached by dialing a 7-digit number, or possibly by dialing some standard 1- or 3-digit code which can be identified by the serving central office. Since some TWX stations will be located in a different NPA area than their serving assistance switchboards, special routing arrangements, based on the TWX class of service and the ABX or standard 3-digit code assigned to the switchboard, will be made for routing switchboard calls to the proper NPA even though the NPA code prefix is omitted. It should be noted in this connection that, since TWX assistance switchboards will be reached by routing over the regular telephone network (instead of over a separate group of "dial O" no-charge trunks), supervision will be returned when the initial connection to the switchboard is established. This will result in a recording of the call on AMA tape except where the TWX serving office is equipped with local AMA, in which case the marker can be arranged to omit the AMA recorder from the connection. Special arrangements will therefore be made by the accounting centers to eliminate charging for calls to switchboards and to charge only for the message connection established by the assistance operator. Elimination of charge data in the accounting centers will also be required for similar calls over the regular telephone network to information and test locations, as described below.

F. Other Positions for TWX Traffic

2.14 Although it would be desirable to provide special TTY-equipped intercept positions to handle calls to TWX directory numbers which have been changed or discontinued, it will not be practicable to do this initially. Therefore, when a TWX station dials a discontinued TWX number and reaches the regular telephone intercept position, the inability to communicate by voice will make it necessary to release the connection and to dial the TWX switchboard for

assistance. AMA charge supervision will not be returned from the telephone intercept position.

2.15 Also because of the inability for voice communication, information service for TWX customers will have to be furnished from information positions equipped for 2-way communication by TTY. Because of the limited number of TWX stations (less than 70,000 in the entire country at cutover), a single information center for TWX will be used, located approximately in the geographical center of the country. This center will be reached from all TWX stations by dialing a single, specially assigned, 7-digit number; the need for an NPA prefix will be avoided by using a unique 3-digit office code which, in conjunction with recognition of the TWX class of service at the originating central office, will result in DDD routing to the information center.

2.16 Service observing on TWX subscriber lines is another function which cannot be performed with regular telephone equipment. To meet this need, new TWX service-observing circuits have been developed and will be installed at various locations throughout the country.

G. Changes in Interoffice Trunk Facilities

2.17 In general, the DDD interoffice network will meet the requirements for handling TWX calls after certain trunk groups have been enlarged slightly to accommodate the additional load. In addition, two elements of interoffice trunking equipment will have to be modified, as described in the following three paragraphs.

Echo Suppressor Disabler

2.18 Echo suppressors have been installed on many long distance telephone trunks to prevent the voice signal which is being transmitted in one direction from being reflected, or echoed, in the other direction. Echo suppressors accomplish their purpose by inserting a high loss in the direction opposite to that from which they receive energy. When energy is received in both directions, the echo suppressor will favor the stronger signal, thus eliminating the echo.

2.19 Although desirable on telephone connections, echo suppressors would nullify the circuit assurance feature which has been de-

signed for TWX connections over the telephone network. As indicated in 2.07(c), circuit assurance will be accomplished by having each TWX station monitor an ac signal which originates from the station at the opposite end of the connection. In order to permit this 2-way simultaneous transmission on TWX connections, an echo suppressor disabler circuit has been developed which will have negligible effect on telephone calls but which will disable the echo suppressor for the duration of any call which starts out with the particular frequency emitted by TWX terminating stations. All echo suppressors in the DDD network must be equipped with disablers.

SF Signaling Modification

2.20 At the present time, some signaling over trunks between central offices is performed by signaling units which make use of a single 2000-cycle tone. This frequency is so close to one of the frequencies assigned for TWX transmission that interference would exist between supervisory signals and TWX coded signals. This conflict will be avoided by modifying the existing single-frequency (SF) signaling units to operate at 2600 cycles and, in some cases, by replacing the existing units with a new transistorized unit.

H. New or Modified Subscriber Line Facilities

Divided Access Line Circuit

2.21 As indicated in 2.11, the divided access line circuit (DALC) is a new development for dial TWX service to permit a TWX station to originate messages to other stations via one central office and to receive its incoming messages via a different central office. The DALC has been designed to present a busy appearance toward the terminating central office while an outgoing call is being made via the originating central office. Conversely, when an incoming call is being received via the terminating office, the DALC will present an on-hook circuit appearance to the originating office.

Loop Extension Facilities

2.22 Some TWX subscriber loops will be substantially longer than normal telephone subscriber loops, since the stations will be con-

nected to other than the normal serving (ie, wire center) office. In most of these cases the TWX loop will consist of one section extending from the station to the wire center office and one or more additional sections of interoffice exchange or toll facilities. These sections must be designed to meet the return loss requirements and also to permit supervisory signaling between the serving office and the TWX station. Depending upon the circumstances, one or some combination of the following devices, developed for dial TWX service, will be used:

(a) **Modified Dial Long Line Circuit.** Circuits of this type are placed in regular telephone loops to extend the dc signaling range beyond the normal central office limit. For use on a TWX loop, the coil in the circuit must be replaced with another which is designed to keep the return loss within allowable limits.

(b) **Line Impedance Compensators.** Two passive network devices, one for loaded lines and the other for lines without loading, are available for improving the return loss on TWX subscriber lines.

(c) **Repeaters.** A repeater is an active device which can be used to reduce transmission loss and, in conjunction with an appropriate network, to improve return loss. A new repeater, E7, has been designed for use on non-loaded subscriber lines; the existing E6 repeater, which was designed for interoffice circuits, can be used to reduce transmission loss on loaded sections of subscriber lines.

(d) **SF Signaling Circuits.** In certain interoffice sections of TWX subscriber lines it will be economical to use carrier facilities. However, although carrier facilities will transmit the SF signals normally used on interoffice trunks, they will not transmit the dc signals sent over a loop to a TWX or telephone station. Thus two SF signaling circuits, one for each end of the carrier system, have been developed to convert dc loop signals to SF tones for transmission over the carrier.

MF Signaling Circuit for Line Concentrator No. 1A

2.23 In areas where a group of TWX stations are at a substantial distance from the central office which is to serve them, economies

will be achieved by using line concentrators in the subscriber lines. The existing No. 1A line concentrator used for telephone service may be used when the TWX stations are within the dc range limit from a central office, and a concentrator modification is available for the use of dial long line circuits on concentrator trunks to extend this range slightly. However, in some instances it will be desirable to use carrier facilities for the concentrator trunks. This will place the remote unit of the concentrator beyond the dc signaling range of the control unit. To meet this situation a new multifrequency (MF) signaling circuit has been developed for the No. 1A line concentrator. The MF signaling circuit converts the dc signals of the concentrator signaling leads to voice-frequency tones for transmission over the voice facilities. SF signaling circuits will usually be employed on the concentrator trunks when the MF signaling circuit is used.

1. Maintenance and Testing Arrangements

2.24 With manual TWX service, when a customer wishes to report a trouble condition, he is instructed to place a call by telephone to the local telephone repair service desk (in most areas by dialing 611). The same procedure will apply after conversion to dial operation but, because the TWX station equipment and subscriber line facilities involve substantially more circuit elements, additional and modified testing facilities will be required, as described in the following paragraphs. Fig. 4 illustrates how typical TWX stations will gain access to the test and trouble-reporting locations via the DDD network.

2.25 **Portable station test meters** will be used by the station maintenance personnel for testing at the customer's premises. The principal test instrument is a multipurpose meter which will be used for making test point and output level readings on station equipment and for making loop loss measurements. Occasionally additional specialized items of plant test equipment will be required for more detailed tests.

2.26 Automatic test lines will be provided at some of the TWX originating central offices to permit one-man testing of the over-all operation of a TWX station. Access to an automatic test line, which is a new development for dial TWX service, will be available to all TWX stations by dialing a specially assigned 7-digit number. An AMA entry will be recorded on the call, but no charge will be billed, as in the case of calls to TWX assistance switchboards. After the connection is established, the test line will automatically send standard test signals several times under various conditions, including transmission at reduced level and with increased distortion. Results of the test line transmission will be obtained by observing the printed copy of the teletypewriter. The station attendant is also requested to transmit test characters; the results of this test transmission are automatically measured by the automatic test line and reported by automatic TTY transmission to the station being tested.

2.27 TWX test centers are in use at present to serve manual TWX stations as well as private line TTY stations. A new telegraph test board is being developed for use in areas where additional test center coverage is desired. The following new test equipment items are being developed for use at both the existing and the new telegraph test board locations in making tests on TWX stations and lines:

(a) **Two-way station test line circuits** will be provided at manned backup test centers. They will be reached on a dialed basis and will be used in those cases where the tests available from the automatic test line are insufficient to clear unusual or difficult troubles. They will also be used in testing "terminate-only" stations and stations using the divided access line circuit with long, remote exchange facilities.

(b) **Monitoring circuits** will be available at TWX test centers to permit monitoring a customer's line without interfering with his communications. The necessity for monitoring TWX service is expected to be limited. However, an intermittent trouble condition may be difficult to locate and monitoring of the customer's line may be helpful in such cases.

3. DESCRIPTION OF NEW OR MODIFIED EQUIPMENT FOR DIAL TWX SERVICE

A. General

3.01 The functions and physical arrangement of the new or modified equipment required to furnish dial operation of TWX service over the telephone switching and transmission network are briefly described in this part. In the case of equipment items required for TWX subscriber lines, for interoffice trunks, and for maintenance and testing, a brief explanation of how the equipment operates is also included. The method of operation of the TWX station equipment and of the assistance switchboard is described for various types of TWX calls in Part 4.

B. Station Equipment

Teletypewriter Equipment

3.02 Basically, the teletypewriter (TTY) machines used for dial TWX service will be the same as those presently in use for manual service. The existing 14-, 15-, 19-, and 28-type machines will be converted for dial operation by making relatively minor changes, the more significant of which are described in the following paragraphs. The 26-type machine is considered obsolete and, if used for dial TWX service, will be cared for on a locally engineered basis. At cutover all machines will operate at 60 words per minute and will use the existing 5-level code and the 3-row keyboard. It is planned ultimately to eliminate the 14-, 15-, and 19-type machines and to use only the 28-type and a new 30-type machine which will be available after cutover.

3.03 Automatic answering will be available as an option with TWX service after cutover. All automatic answering stations will be equipped with an automatic answerback feature. In the case of the 28 KSR machines, a drum answerback unit will be added. This drum consists essentially of 21 slots containing code plates which code a set of sending contacts sequentially when the answerback unit is operated. In the case of the 28 ASR machines, a multicontact distributor will be used to generate the answerback characters. The 21-character answerback will consist of a specific set of three initial TTY codes, a specific set of four final TTY codes, and a num-

ber of intervening characters which the customer may specify for his station identification. The drum answerback will not be used on the 14-, 15-, and 19-type machines; instead, the data set will be arranged to send out a single character, V, as an indication that an automatic answering TWX station has been reached. (Further reference is made to the V answerback under the description of the data set in 3.09 through 3.15.)

3.04 All TTY machines will be equipped with a motor control relay which will be operated automatically by the data set. This relay replaces the motor on-off switch which, in manual TWX service, is operated by the attendant. (In the case of 19-type machines, because of heavy power requirements, a manual switch will be provided for the transmitter-distributor motor.)

Subscriber Set

3.05 A subscriber set will be provided at each TWX station for use by the attendant in setting up and controlling the progress of calls. Actually, the data set, which is the major new item of dial TWX station equipment, will perform most of the control functions automatically, but the subscriber set provides the means for translating the station attendant's call requests into signals which the data set can act upon. For this reason a brief description of the subscriber set is appropriate as an introduction to the description of the data set.

3.06 Two types of subscriber sets will be used: a 689A set for 28-type machines and a 691A3 set for 14-, 15-, and 19-type machines. The difference between the two types results from the fact that the 689A unit has been designed to fit the contour of the 28-type TTY cabinet, whereas this was not feasible to do with the other three types of TTY machines, since it is planned to replace them within a period of several years after cutover. The 691A3 set is a modified key-in-base telephone set; the 689A set consists of a new design but with the same functions (see Fig. 5 and 5A). The 689A subscriber set will be mounted on the right side of the TTY and at the keyboard level; the 691A3 set will be mounted on the left side of the TTY machine.

3.07 The subscriber set contains a regular telephone dial for placing calls over the DDD network and a receive-only handset for monitoring audible signals which report the progress of a call. A ringer is also included to provide an audible indication of incoming calls. Subsequent to the conversion to dial operation, a card repertory dialer and a loudspeaker to supplement the receive-only handset will be made available on an optional basis.

Control Buttons

3.08 The subscriber set also contains a 6-button unit; one of the buttons will not be used but the remaining buttons are used for the following purposes:

- (a) An ORIGINATE button and an ANSWER button are provided to signal that the data set should place the station in the off-hook condition. Two separate buttons are provided because different actions are required of the data set depending on whether a call is being originated or received.
- (b) A CLEAR button is provided to signal that the data set should begin the disconnect procedure and then place the station in the on-hook condition. Operation of this button cancels the conditions which are set up by the operation of the other four buttons.
- (c) A LOCAL button is provided to signal the data set to arrange the station for off-line operation. This is required for practice typing and, in the case of tape-sending machines, for off-line preparation of perforated tape.
- (d) A TEST button is provided to signal the data set to arrange the station so that TTY signals received from the line will be "looped back" onto the line in addition to being typed on the printer. This test mode is used in connection with certain tests performed by a telegraph test center.

Data Set 101A

3.09 The data set 101A is basically a converter. It converts the dc signals from the sending teletypewriter into frequency-shifted tones for transmission over the telephone network. It also converts tone signals received from the net-

work into dc pulses to operate the receiving teletypewriter. When a message is being transmitted, the sending station sends mark tones with interspersed space tones as required to represent the mark and space code elements of the characters being sent, and the receiving station sends a continuous mark tone. If the received signal at either station shifts to the space tone for more than about 1 second (which is much longer than the maximum space tone required for any TTY character), or if the received signal is totally lost for that same period, the data set will cause the station to be disconnected. In this way the data set provides assurance that the connection to the other data set is maintained throughout the period of message transmission. To accommodate the simultaneous transmission in both directions, different frequencies are used for transmission in the two directions. The station which originates a call transmits a 1270-cycle mark signal (F_1 mark) and shifts this down to 1070 cycles for a space signal (F_1 space). The station at which the call is terminated sends a 2225-cycle signal for a mark (F_2 mark) and a 2025-cycle signal for space (F_2 space). These mark and space frequencies are assigned by the data set based upon which station has originated the call and are not changed by the fact that both stations may send and receive TTY characters at alternate periods during the connection. This general transmission principle is illustrated in Fig. 6.

3.10 This principle of transmission permits a space signal which is appreciably longer than required for transmission of the TTY code to be used for the "break" signal required in regular TWX communication. The operation of the break key at a receiving TTY machine causes the data set to change its marking tone output to spacing for a period of approximately 575 milliseconds, and this is recognized by the sending station as the signal to interrupt transmission. In addition, two break signals sent at approximately a 1-second interval will be used to recall the operator on connections established via the TWX assistance switchboard, as described in Part 4.

3.11 In order to measure the duration of space tones and to time break signals, the data set contains timing circuits and logic to control them. These circuits are also used for other tim-

ing functions which are required for the establishment and termination of TWX connections, as described in Part 4.

3.12 Automatic answering for unattended stations is also provided by the data set on an optional basis. For this option the data set circuitry is arranged to recognize an incoming call, to initiate the answer sequence automatically, and to cause the coded answerback signal to be sent after the connection has been established. As described in 3.03, the answerback will be supplied by a drum in the case of 28-type TTY machines, but the operation of the drum will be triggered by the data set. For 14-, 15-, and 19-type machines, the data set itself will generate the code of the single-letter V answerback.

3.13 The data set also includes logic and control circuits for other functions which are more easily explained in Part 4. The circuitry is a combination of transistors and wire-spring relays which are housed in a cabinet. In the case of 28-type TTY machines, the data set is mounted on the side of the TTY cabinet, beneath the subscriber set (see Fig. 5). The data set cabinet also contains a power supply.

3.14 The electronic circuitry of the data set is packaged on separate printed circuit boards, or cards, which are of the plug-in type for easy removal for maintenance purposes. Seven plug-in cards are provided to serve the functions indicated below:

- (a) A *modulator* card converts dc TTY pulses to frequency-shift tones for transmission over the telephone network.
- (b) Three cards, a *limiter*, a *demodulator*, and a *keyer*, convert the incoming frequency-shift tones into dc signals and transmit them to the TTY.
- (c) A *timer* card supplies the various timed intervals required for the proper sequencing steps performed by the data set and for the recognition of various signals, such as the disconnect signal.
- (d) An *answerback* card, of one of two types, is used to trigger the operation of the drum answerback unit on a 28-type TTY or to emit the V answerback for the 14-, 15-, and 19-type machines.

(e) A *hybrid* card provides the proper termination for connecting the data set to the subscriber line.

3.15 The relays in the data set perform a number of functions among the more important of which are:

- Detection of ringing for automatic answering
- Conditioning the oscillator to produce the proper sending frequency
- Connecting the proper filters for the transmitting and receiving frequencies
- Controlling the TTY motor and answer-back function
- Conditioning the timing circuit
- Lighting lamps in the subscriber set
- Restoring the data set to normal after disconnection of a call.

C. Subscriber Line Facilities

General

3.16 Because the general plan for dial TWX service places limitations on the central offices from which TWX stations can be served, there will be numerous instances where subscriber lines (ie, loops) for TWX stations must extend beyond the normal serving (ie, wire center) office to a remote central office. The various new or modified items of equipment which have been developed for use in remote exchange loops are briefly described in the following paragraphs. Fig. 7 shows representative arrangements of these items as they may be used in TWX subscriber lines.

Divided Access Line Circuit

3.17 A divided access line circuit (DALC) permits serving a dial TWX station from one central office for originating traffic and from another central office for terminating traffic. The DALC is designed to work with No. 5 crossbar, No. 1 crossbar, and step-by-step central offices. It is a plug-in type unit similar to E-type signaling units and is designed to be mounted in the terminating central office. The same mounting equipment used for E-type signaling units will be used for mounting the DALC.

3.18 Incoming calls to the TWX station will be routed in the normal manner to the terminating office serving the TWX station. If the line is idle, a sleeve relay will be operated in the DALC which opens the circuit toward the distant office used for originating calls and establishes a metallic path from the terminating central office to the station. If the line is busy, busy tone will be returned to the calling customer in the normal manner. The DALC introduces no additional resistance in the loop from the terminating central office to the TWX station.

3.19 Calls originating from the TWX station will route through the DALC in the local terminating office. When the originating station goes off-hook, current in the subscriber loop operates a line relay in the DALC. The operated relay makes the appearance used for terminating calls busy to incoming traffic, while permitting normal dc supervisory signals to pass through the DALC toward the serving central office. When the DALC is employed in No. 5 or No. 1 crossbar offices, operation of the terminating line make-busy feature requires utilization of the PBX hunting feature in the number group frame. The same station range limitations and features prevail as for regular telephone loops except that an additional resistance of approximately 10 ohms is introduced in the originating loop by the DALC. Therefore, regular range extension arrangements can be employed towards the station.

3.20 A portable case is provided for holding two DALC units. It is intended for use at the main frame or other temporary locations so that new service may be established promptly by means of cross connections. A 48-volt PBX or other similar power feed available at the distributing frame may be used for the portable arrangement.

Loop Extension Facilities

Dial Long Line Circuits

3.21 Dial long line circuits (DLLC) are employed in telephone subscriber loops to extend the normal central office loop range. A DLLC detects dc loop signals (supervisory and dial pulsing) from the customer end and repeats

them towards the central office. A DLLC does not alter the voice transmission characteristics appreciably. On terminating calls DLLCs are arranged to detect ringing from the central office and either bypass or relay the ringing to the customer.

3.22 Certain loop-type DLLCs that have been modified to replace the 94-type coil with a 120-type coil may be used for range extension of dial TWX subscriber loops. Modified DLLCs may also be used in concentrator trunks to extend the loop range. Replacement of the 94-type coil is necessary to ensure meeting the return loss objectives. However, it should be noted that modification of a DLLC reduces its signaling range extension capabilities.

Line Impedance Compensators

3.23 Two passive devices are available for improving the return loss of customer loops. The 1613A inductor is an impedance compensator designed for use on nonloaded customer loops. The 837A network is an adjustable impedance compensator for use on loaded facilities.

E7 Repeater

3.24 The E7 repeater is an active device designed for application to nonloaded subscriber loops at the central office. Use of the E7 repeater will reduce transmission loss, improve poor frequency response of nonloaded cable, and improve the return loss of customer loop when balanced against a 900-ohm and 2-microfarad impedance at the central office. It is designed to be stable under all normal terminations encountered on customer loops. The repeater has adjustable networks so that the over-all loop loss across the bandwidth can be adjusted to the required range for dial TWX loops. The E7 repeater does not repeat ringing or dial pulses, and it may be necessary to use additional circuits in conjunction with the E7 repeater to provide adequate signaling. The package for the E7 repeater has the same mechanical structure as that for the E6 repeater, and it is mounted in the same frame.

Subscriber Line SF Signaling Circuits

3.25 A pair of E-type transistorized signaling units (E1L and E1S) are available for use where a portion of a customer loop must be provided over 4-wire cable or carrier facilities. The subscriber line SF signaling circuits permit an extended signaling range by using the voice band for signaling purposes prior to and after completion of message transmission. These units are intended for foreign exchange telephone as well as for dial TWX use. They are plug-in units having the same dimensions and mounting details as the E1C and E1D E-type signaling units. A built-in, coil-type hybrid is used together with a compromise network designed for balancing a 900-ohm plus 2-microfarad termination.

3.26 The E1L and E1S units are designed to work in pairs. The E1L unit at the serving central office must be paired with an E1S unit at the office from which the TWX station receives dc supervision and 20-cycle ringing. Battery is supplied to the 2-wire loop from the E1S unit. In the idle condition, the E1L unit will be receiving 2600-cycle tone from the E1S unit as an indication that the station is on-hook. An off-hook condition at the station will cause the E1S unit to remove the 2600-cycle tone from the line. The E1L unit will detect the absence of tone and present an off-hook signal to the serving central office subscriber line circuit. The E1L and E1S combination is designed to accept dc loop pulses at a nominal 10 pulses-per-second dial speed.

3.27 The E1L unit is designed to accept 20-cycle ringing from the serving central office over tip and ring and convert this to a 2600-cycle tone in the transmit path towards the distant E1S unit. The E1S unit is designed to detect an incoming 2600-cycle tone and apply locally supplied 20-cycle ringing (between tip and ring) to the station. When the customer answers, the off-hook indication is returned to the central office and ringing is tripped. Upon completion of signaling over the facility, the entire voice band is available for the transmission and receipt of F_1 and F_2 tones.

Line Concentrator No. 1A and Concentrator MF Signaling Circuit

3.28 The line concentrator No. 1A consists of two major units, a control unit and a remote unit. When used for dial TWX service, both units will be mounted in a central office. The system uses a dc signaling path between the control and remote units and provides individual line terminal appearances at each end. An unmodified line concentrator No. 1A (as used for telephone service) may be used for concentrating TWX loops whenever the stations are within the dc range limitations of the central office and the No. 1A line concentrator. Concentrator wiring modifications are available which will enable use of DLLCs in the concentrator trunks. These changes alter the power feed arrangements to the remote unit battery. Range extension facilities between the station and its line appearance at the remote unit do not affect the concentrator arrangement required.

3.29 In addition to the above, many of the TWX applications will require that the concentrator operate over carrier facilities. To extend the range of the concentrator signaling system, a concentrator MF signaling circuit has been developed for use with the four control leads between the concentrator control and remote units. The concentrator MF signaling circuit converts the dc signals on the control leads to MF tones for transmission over voice-frequency facilities. The MF signaling arrangement uses a standard MF receiver and a standard transistorized MF supply in addition to other control relays. Interconnection of these concentrator signaling applique circuits requires the use of one 4-wire voice channel.

3.30 The signaling circuit is arranged to work with both the 50-line and 100-line remote concentrator units and with the concentrator control unit. The concentrator MF signaling circuit adds an additional delay of approximately 1-1/3 seconds to the normal 1/2-second average setup time of the concentrator.

3.31 In addition to the present arrangement for pole and wall mounting of the concentrator remote unit when dc signaling is used, ar-

rangements will be available for frame-mounting this unit in a central office building, as required in cases where MF signaling is used. Although the concentrator MF signaling units will normally be mounted in the same office as the concentrator units, it is possible to mount them remotely, up to the maximum dc signaling limits of the concentrator.

3.32 For operation over carrier facilities, the concentrator modifications will include both apparatus and wiring changes. The changes will provide for the following:

- (a) Arrangements for charging the remote unit battery when it is located in a central office building.
- (b) Arrangements for terminating remote unit alarms in the same central office which supplies power to the remote unit.
- (c) Arrangements for testing the concentrator from the control unit location.

Concentrator modifications for both carrier facilities and DLLCs have been arranged so that the concentrator may be reused for normal telephone service with a minimum of inconvenience.

Method of Operation

3.33 A line relay is operated in the remote unit in response to an off-hook signal from an originating customer. Operation of this relay commences a signaling sequence which sets up one of ten trunks between the customer line appearances at the remote unit and at the control unit. When the concentrator completes the connection at the control unit, the connection is the same as though the customer were connected directly to his line appearance in the central office. The control unit recognizes a terminating call by receiving a ground on a sleeve lead associated with the customer line appearance in the control unit. The control unit responds by connecting the customer's remote unit line appearance to his control unit line appearance over one of the available trunks. When the connection is completed, ringing from the terminating central office is passed directly to the customer.

D. Interoffice Trunk Facilities

Echo Suppressor Disabler

3.34 As was pointed out in Part 2G, certain DDD trunks are equipped with echo suppressors. More specifically, most regional center to regional center (RC-RC) trunks will contain the equivalent of an echo suppressor. Some multiswitched connections will contain the equivalent of two echo suppressors. Echo suppressors are also used in certain long distance high-usage trunks between offices in different regional centers. In order to reduce the length of time that echo transmission is impaired following cessation of speech in a given direction, echo suppressors may be employed at each end of the longer RC-RC and interregional high-usage trunks. Each such echo suppressor controls the insertion loss in only one direction of transmission.

3.35 Echo suppressors are located in the 4-wire part of the voice facility. They have the property of inserting a high loss in the direction of transmission opposite to that from which energy is being received. If energy is received from both directions, the echo suppressor will favor the stronger signal. Although echo suppressors are required for voice communication, they cannot be permitted on dial TWX connections because they nullify the TWX circuit assurance feature, which requires that frequency tones be transmitted in both directions simultaneously during a TWX call. In order to prevent the echo suppressor from inserting loss in either side of the line when the circuit is used on a dial TWX call, a disabler will be installed on every echo suppressor that may be encountered by a TWX call.

Disabler Operation

3.36 By means of hybrid coils the disabler monitors each side of the 4-wire facility. The disabler looks for signal energy in each direction of transmission in two bands: the conditioning band (2000 to 2250 cps) and the guard band (the voice band outside of the conditioning band). The energy in the guard band is sampled and used to oppose the energy in the conditioning band (2000 to 2250 cps). The conditioning band has been chosen so that it brackets the range of F_2 tones which will be transmitted from data sets at dial TWX terminating sta-

tions. Whenever sufficient net unopposed energy in the conditioning band is present for at least 300 milliseconds, the echo suppressor will be disabled. [If sufficient energy outside of the F_2 band (2000 to 2250 cps) is present, it will prevent the echo suppressor from being disabled.] A loss of signal for about 100 milliseconds will permit the echo suppressor to return to normal operation. Energy in the guard band is used to prevent normal voice communications from disabling an echo suppressor.

Physical Layout

3.37 The echo suppressor disabler circuit is assembled on a printed wiring board supported by a die-cast aluminum frame that is hinge-mounted on the wiring side of the echo suppressor. This hinge-mounting permits access to the echo suppressor panel and to the printed circuitry of the disabler. All operating adjustments and tests on the disabler can be made from the front of the echo suppressor bay. The existing 1A echo suppressor test set can be used for normal maintenance of the tone disabler.

Elimination of 2000-Cycle SF Signaling

3.38 The present DDD network uses 1600- and 2000-cycle and 2400- and 2600-cycle signaling systems to transmit supervisory signals and dial pulses over telephone trunks. As pointed out in Part 3B, the F_2 spacing frequency for the dial TWX data set is 2025 cps. The presence of this tone would interfere with the proper operation of the 2000-cycle SF signaling units. Therefore, all 2000-cycle SF signaling units used with trunks to which dial TWX calls will have access will be either changed to 2600-cycle operation or replaced with new 2600-cycle SF signaling units.

E. Assistance Switchboards

General

3.39 For dial TWX service, just as for telephone service, there are several types of assistance calls that cannot be directly dialed from the station. These include calls of the following types: collect, conference, time and charge, delayed, and number verification. In ad-

dition, provision must be made for calls for information service; the switchboard equipment for handling information calls is described under Part 3F.

3.40 A new teletypewriter switchboard, No. 6A, has been developed for handling dial TWX assistance calls. These switchboards will serve only dial TWX stations, and there will be no sharing with telephone service. Fig. 8 shows how a connection will be established from a calling station to this switchboard and from the switchboard to a called station. The calling customer will dial the 7-digit telephone number of his serving switchboard (as described in 2.13), and the connection will be established over the DDD network. The switchboard operator will answer the call and will receive the customer's request for service by means of a teletypewriter located at her position. The operator will complete the call to the called station by connecting to the DDD network and keypulsing the called number. Since the path of the connection is through the switchboard, the operator will have the ability to monitor, to cut in, and to control the call.

TWX Switchboard Positions

3.41 The physical layout of the switchboard is shown in Fig. 9. A 28-type tape-printing TTY machine is located in the center of each position. A calculagraph message timer is located on the horizontal shelf in alternate spaces between the TTY machines (ie, a calculagraph is shared by two positions). Five cords and associated plugs, keys, and lamps are mounted on each side of the TTY, on a sloping shelf, making a total of ten cords per position. This results in there being ten cords between each position TTY, five being normally associated with the position to the left and five with the position to the right. The jacks and lamps associated with the incoming and outgoing trunks are located above the sloping shelf on the vertical panels.

3.42 Jacks are provided for plugging in a regular operator telephone headset, and space is provided for holding the mark sense tickets on which the charging details of calls will be recorded. Each position is equipped with an MF keypulsing set.

TWX Switchboard Circuits

3.43 Fig. 10 shows a functional block diagram of the major switchboard circuits.

3.44 An incoming trunk circuit and an outgoing trunk circuit have been developed for interconnecting the switchboard with the DDD network. These trunks will work with the following types of central office equipment: No. 1 and No. 5 crossbar, crossbar tandem, and No. 4A and No. 4M toll crossbar. Routing to and from the switchboard will be on a trunk basis. At the telephone office, trunks to the switchboard will be treated as interoffice trunks; the trunks from the switchboard will be treated as operator tandem trunks.

3.45 The 6A switchboard will operate in either of two modes: the TTY mode or the telephone mode. Transfer circuits are provided which will connect either the TTY mode circuits or the telephone mode circuits at the proper time.

3.46 The TTY circuits associated with each switchboard position include:

- The incoming and the outgoing modulator-demodulator units and the associated coupling circuits
- The regenerative repeater circuit
- The TTY control circuit
- The TTY machine.

3.47 The telephone circuits associated with each switchboard position include:

- The telephone control circuit
- The operator telephone set
- The MF keypulsing set.

3.48 A control circuit (shown at the bottom of Fig. 10) is provided to switch automatically from one mode to the other in order that the operator is not required to do this as a separate action. This function is explained below in connection with the description of the cord circuits.

3.49 Fig. 11 shows a plan view of the sloping shelf containing the cord equipment and some of the position equipment, and it also shows

G. Maintenance and Testing Equipment

Automatic Test Line

3.62 Customer trouble conditions will be reported by telephone to the local telephone repair service bureau. The deskman at the bureau will analyze the report and determine what course of action is required. The deskman may, under certain circumstances, request the customer to call the automatic test line (ATL) and under the deskman's direction use the capabilities of the ATL to determine the trouble by discussing the copy obtained. If it is necessary to dispatch a repairman, the ATL will also serve as an important field test instrument for the repairman to use in clearing trouble conditions.

3.63 The ATL, which is a new development for dial TWX, is expected to permit a station repairman to locate the majority of station troubles without test center assistance. The repairman, by dialing a connection to the ATL, will cause the equipment to automatically transmit a programmed group of test sentences. The transmission of these test sentences is programmed to send normal, low level, and distorted signals. The ATL also requests the station to transmit a series of characters. The ATL monitors this transmission, measures the received signals, and replies by TTY characters whether the transmission was acceptable or out of limits. The programmed sequence indicates to the station attendant when to change from the originating to the terminating mode. Additional test sentences are transmitted permitting the station to be tested in the terminating as well as the originating mode. (See Fig. 12 for a sample of the copy received at the TWX station.) From examination of the copy received from the programmed portion of the ATL, a repairman will in most cases be able to determine the nature of the station equipment trouble. The ATL transmission may also be interrupted to obtain continuous signals as an aid in locating trouble.

Portable Station Test Meter

3.64 The station repairman will also have available a portable station test meter and a carrying case containing spare electronic plug-in units (cards) for data set 101A. Functionally, the portable station test meter will be a multimeter

with sufficient sensitivity to measure the loss on subscriber loops. With the knowledge gained from a test call to the ATL, a station repairman should be able to clear most troubles by using the portable station test meter for test-point measurements to isolate the trouble and by substituting spare cards for defective cards. Troubles involving the TTY machine will be cleared in accordance with procedures previously followed for TWX service (with relatively minor additions to cover dial TWX components), and troubles occurring in the subscriber line equipment will generally be referred to the telegraph test center for clearance.

Telegraph Test Center

3.65 A manned test center has been provided for those cases where it is necessary to perform tests beyond the combined capabilities of the ATL and the portable station test meter. Additional assistance may also be required when the trouble is located in the subscriber loop. For this purpose 2-way station test line circuits are available on a dialed basis to give access to the manned test centers for performing additional tests. It is in connection with these test lines that the TEST button in the TWX subscriber set will be used [see 3.08(d)].

3.66 Monitoring circuits are available at the test centers for monitoring subscriber lines suspected of intermittent troubles. These circuits may be connected to the monitoring equipment in the serving dial TWX office over full-time facilities, over "engineered facilities" to be turned down on request, or over dialed connections. Connections between the monitoring equipment and the desired TWX lines will be made by clips on the horizontal side of the main distributing frame.

4. METHOD OF OPERATION

A. General

4.01 This part describes the operation of the TWX station equipment during the connecting, communicating, and disconnecting phases of a customer-dialed call to another TWX station, including variations for different types of TWX stations. The operation of the TWX

switchboard for a variety of conditions commonly encountered in completing assistance calls is also described.

4.02 This part does not include the operation of the originating and terminating central offices involved in TWX calls because this is similar to the operation for telephone calls and is described in other publications. The operation of the various equipment units which have been developed for TWX subscriber line facilities is also omitted, because this is the same for all types of TWX calls and because it has been covered in general terms in the description of these units.

B. Customer-Dialed Calls to Another TWX Station

Attended Stations — Keyboard Sending

4.03 The sequence of operations for initiating a call, establishing the connection, transmitting the message, and terminating the call is described below. Numbers in parentheses refer to the numbered steps in the flow diagram presented in Fig. 13.

(a) The attendant at the originating station depresses the ORIGINATE button (1), which is located in the subscriber set, and the light under this button turns on and remains on until the call is finished.

- Operation of the ORIGINATE button causes the data set to present an off-hook condition to the central office (2) and to connect its F_1 sending circuit and its F_2 receiving circuit to the loop through the hybrid coil. However, no F_1 signal is transmitted at this time. If other than an ac synchronous motor is used in the TTY machine, the TTY motor is turned on at this time.

(b) The attendant listens for dial tone in the receive-only handset and, when it is received (3), dials the 7- or 10-digit number of the terminating station (4).

(c) The switching links are then set up through the DDD network. If a busy tone or an intercept report is received (5), the originating station attendant will cancel the call by depressing the CLEAR button (6). This

will cause the data set to go on-hook (7). If audible ringing is received (8) but the called station does not answer, the attendant would cancel the call as in the case of the busy tone.

(d) At the terminating station the station bell is operated on the normal ringing cycle (generally, 2 seconds on and 4 seconds off) (9), and the light under the ANSWER button flashes on during the ringing periods. The attendant depresses the ANSWER button to respond to the incoming call (10).

- This causes the data set to send an off-hook signal to the terminating office (11) and to trip ringing. This off-hook signal is sent back to the originating office, where an AMA initial timing entry is recorded. The data set also connects its F_2 sending circuit and F_1 receiving circuit to the loop through the hybrid coil.

(e) The data set introduces a timing delay of approximately 1.4 seconds after going off-hook (12) and then begins to send F_2 mark (13). The delay in sending the F_2 signal ensures that it will not interfere with the transmission of the supervisory answer signal back to the originating office over in-band frequency signaling systems. If any echo suppressors are involved in the switchboard connection, they detect F_2 and are disabled as long as F_2 is present.

(f) Upon receipt of F_2 mark (14), the originating station applies a timed delay of approximately 1.0 second (15), to be sure that any echo suppressor has had time to become disabled and to ensure receipt of a steady F_2 mark (rather than an imitation created by circuit noise). The data set at the originating station then sends F_1 mark (16) and turns on its TTY motor (17).

(g) The terminating station data set receives F_1 mark (18) and then starts a timing delay of approximately 1.0 second (19). After this delay the data set turns on the TTY motor (20).

(h) The turning on of the terminating station TTY motor is the signal to the attendant to type her station identification (21) and then await the transmission of the message.

(i) The originating station attendant recognizes the terminating station identification (22) and then proceeds to type the message (23). Responses from the terminating station can be interspersed, as desired, in the same manner as with manual TWX service: the station which is sending can transmit the bell signal to call in the other station, and the receiving station can interrupt transmission at any time by using the BREAK key on the TTY.

(j) At the conclusion of transmission, the originating or the terminating attendant (or both) may depress the CLEAR button (24) to disconnect both stations.

- The operation of the CLEAR button causes the data set at the station involved to remove the TTY from the data set, generate a one-second spacing signal, and go on-hook (25). The one-second spacing signal ensures the disconnection of the distant station (26) if the CLEAR button at the distant station is not depressed after the completion of the call.

Unattended Terminating Station

4.04 If the terminating station is arranged for unattended operation, the answering of the call and the sending of terminating station identification are performed automatically, as described in the following paragraphs.

4.05 When ringing current is applied to the unattended terminating station, a ringing relay in the data set is operated, and this causes the sequence of operations which follow the depression of the ANSWER button in an attended station to be performed automatically. If the terminating TTY is of the 28-type equipped with the drum answerback mechanism, the TTY motor will be started at this point instead of after incoming F_1 mark has been received.

4.06 At the point when F_1 mark has been received by the terminating station for a period of 1 second, the terminating data set triggers the operation of the drum answerback in the case of a 28-type machine. If the terminating station is a 14-, 15-, or 19-type, which is not equipped with the drum answerback, the data set shifts its F_2 output to space for a timed interval

so that the character V is sent as an answerback code, and then the TTY motor is turned on.

4.07 The automatic answer feature of an unattended station is disabled by the operation of the LOCAL button on the subscriber set (see Part 4C). If the station is called while in the local condition, the bell will ring and the ANSWER lamp will flash during the "on" portion of each ringing cycle. If at this point the ANSWER button is depressed, the data set will proceed automatically with the remaining sequences of the call-answering operation.

Tape Sending Station

4.08 Calls from TWX machines which are equipped for transmitting messages from perforated tape (ie, 19 and 28 ASR machines) will be handled as described above except that, after identification has been received from the terminating station, the originating station attendant will start message transmission by operating the transmitter start switch. When all of the taped message has been transmitted, the transmitter will no longer be operating and the originating data set will transmit F_1 mark until a CLEAR button is depressed at one of the two stations.

C. Local and Test Operation of TWX Stations

4.09 A LOCAL (locking-type) button is provided in the TWX subscriber set so that the TTY may be placed in an off-line condition for preparation of perforated tape and for practice purposes. When the LOCAL button is depressed, the data set turns on the TTY machine, and its transmitting contacts and selector are tied together and supplied with local battery. Operation of the CLEAR button is the normal way of placing the TTY back in the normal on-hook condition. However, if an incoming call is received while the station is in the local mode, the ANSWER button should be depressed; this will cancel the local condition and cause the station to assume a normal off-hook condition.

4.10 A TEST button is provided in the subscriber set to permit a received signal to be "looped back" through the modulator of the data set when this button is depressed. This arrangement is provided so that a telegraph test

center can transmit a signal to a station under test and receive the signal back after being re-modulated at the station. This test mode is accomplished by tying together the modulator and demodulator units of the data set; in this mode the TTY of the station being tested will still record the incoming message. The station is restored to the normal on-hook condition by operation of the CLEAR button.

D. TWX Calls via the Assistance Switchboard

4.11 The most common situation encountered by an operator is to answer an incoming call with the answer cord and then to establish a connection using the calling cord. This sequence is assumed for the operations described in the following paragraphs. Variations required for other calling situations are described in Part 4E.

4.12 When an incoming trunk signal is received, the operator operates the answer (ANS) key of an idle cord to the TYPE position and inserts the answer cord into the trunk multiple jack which has the waiting call. This results in the following:

- (a) The answer lamp corresponding to the waiting call goes out.
- (b) The cord circuit modulator and demodulator are connected to the line facility.
- (c) The modulator sends F_2 mark into the line after a delay to allow answer supervision to be propagated back through the connection.
- (d) The demodulator waits for F_1 mark from the TWX station, and the space-hold feature of the demodulator holds the loop side of the demodulator in the space condition until marking carrier is received. The operator position circuit is held spacing, and the position TTY runs open until F_1 mark has been received for the timed interval, in order to prevent the operator from announcing before the calling station is fully connected. Then the demodulator output is connected to the position circuit; this places the position TTY in the marking condition, and the operator announces by typing OPR.

4.13 After receiving the necessary information, the operator operates the calling (CLG) key to the TYPE position (the ANS key may be restored, if desired) and inserts the calling cord into the multiple jack of an idle outgoing trunk.

4.14 The operator presses the KP key on the keypulse set. This will connect the MF keypulse set to the cord circuit (via the position telephone circuit) and light the KP lamp. The operator waits for the S lamp in the keypulse set to light, indicating that the cord circuit has received the register (sender) ready signal from the trunk. This signal also lights the calling cord supervisory lamp. After the S lamp lights, the operator pulses the digits of the called number and then presses the ST key. Pressing the ST key releases the keypulse set; the KP and S lamps go out, but the cord supervisory lamp stays on.

4.15 Assuming that the desired station is reached, the operator will hear the audible ring on her telephone set if the CLG key is still in the TYPE position. When the called station answers and off-hook supervision is returned to the calling cord via the trunk, the cord transfer circuit responds by bridging the demodulator to the line. After receiving F_2 mark for the timed interval, the cord circuit will:

- (a) Transfer the calling cord from the telephone mode to the TTY mode.
- (b) Cause the supervisory lamp on the calling cord to go out.
- (c) Connect the calling and answer cords together.
- (d) Connect the calling cord modulator to the line with F_1 mark turned on.

If either cord key is operated to TYPE at this point, the operator will receive a copy of the called station announcement on her TTY as it passes through the cord pair to the calling station, and she will be able to communicate with the TWX stations by TTY if desired.

4.16 When the calling TWX station disconnects by operating the station CLEAR button, the disconnect signal, consisting of a timed interval of F_1 space, is sent out by the data set before the station on-hook signal appears. The originating station disconnect signal

passes through the cord circuit to the terminating station and starts it on the disconnect cycle used for direct-dialed calls. The cord supervisory lamps light when the station on-hook signals are received from their respective stations. On calls to unattended stations it is necessary that the originating disconnect signal pass through to the terminating data set so that it may recognize the end-of-message condition and go on-hook.

4.17 The terminating station disconnect signal does not pass through the cord circuit to the originating station. Instead, all space signals received from the station on the calling side of the cord pair are timed, and, when spacing has been received for an interval equal to the break signal, the answer side of the cord is clamped in the marking state. This clamp is held until the calling cord is taken down, or until the signal received from the calling cord station returns to the marking state. This arrangement allows the operator to receive a disconnect signal from the called station and still have the originating side of the connection held intact until the originating station CLEAR button is operated.

E. Variations on Calls via the Assistance Switchboard

4.18 In setting up a call, the operator may encounter a busy condition at the called station. If the operator has left the CLG key in the TYPE position after completion of keypulsing, she will hear the busy tone in her telephone headset. Upon hearing this tone the operator will type the report to the calling station, since transmission of the busy tone from the called office stops at the cord circuit in the switchboard. "No-circuit" signals behave in the same manner and are treated in the same way as busy signals.

4.19 After a call has been keypulsed and the operator has checked the start of ringing, the cord key will generally be restored to normal. If the supervisory lamp does not go out after a reasonable length of time, the cord key is reoperated to TYPE to check the status of the call. If audible ringing is still heard, the operator releases the outgoing trunk and types a don't-answer report to the calling party.

4.20 After a TWX connection has been set up and the operator has restored the cord cir-

cuit keys to normal, the operator will be recalled by either station if the attendant sends two break signals in succession with about a one-second interval between. The cord circuit detects this break signal and causes the cord supervisory lamp (the ANS or the CLG lamp, depending on which party initiated the recall) to flash at a rate of 120 impulses per minute. This flashing signal is extinguished when the respective cord key is operated to the TYPE position.

4.21 It is possible for the operator to reach a telephone station when completing a call, either because the calling TWX station passed a wrong number or because of a keypulsing error. When the called telephone station goes off-hook, answer supervision is returned, but not F_2 mark. The cord circuit stays in the telephone mode and the supervisory lamp stays lighted. If the CLG key is operated to TYPE, the operator can hear the telephone station answer; however, in order to talk with the telephone subscriber, the operator must change the CLG key from the TYPE to the TALK position.

4.22 When a telephone intercept operator or intercept trunk is reached, neither answer supervision nor F_2 mark will be returned, and the cord circuit used for the outward call remains in the telephone mode with the supervisory lamp lighted. The operator can hear intercept announcements while the CLG key is in the TYPE position, but the key must be operated to TALK in order to permit 2-way voice communication with an intercept operator.

4.23 In the normal course of handling calls, the operator answers an incoming call with the answer cord and completes the connection by using the calling cord. However, when setting up a delayed call, and in certain other instances, it will be necessary to call both parties from the switchboard. One of the parties (the calling party) will therefore be called by using the answer cord. For this reason the answer cord circuit has been arranged so that it will send F_1 and receive F_2 (as required for originating a TWX call) whenever the answer cord is inserted into an outgoing trunk.

4.24 Conference connections are set up by using one cord pair for each station to be bridged or for each leg to a distant TWX switch-

board where additional stations are bridged at that point. (The latter alternative permits the use of one interoffice trunk instead of several.) For each terminal station involved, the answer cord is inserted in a jack of the conference bridge and the calling cord is used for the connection to the station. This could also apply to the calling station if this station is recalled after the conference grouping has been set up; if the

calling station remains connected to the switchboard while the conference call is being set up, its connection to the conference bridge would be by the calling cord. If more than five stations are to be bridged at the switchboard, the operator will use jack No. 5 for the first cord inserted in the conference bridge, and this automatically ties the two groups of five outlets into one group of ten.

Attached:

Fig. 1 through 13

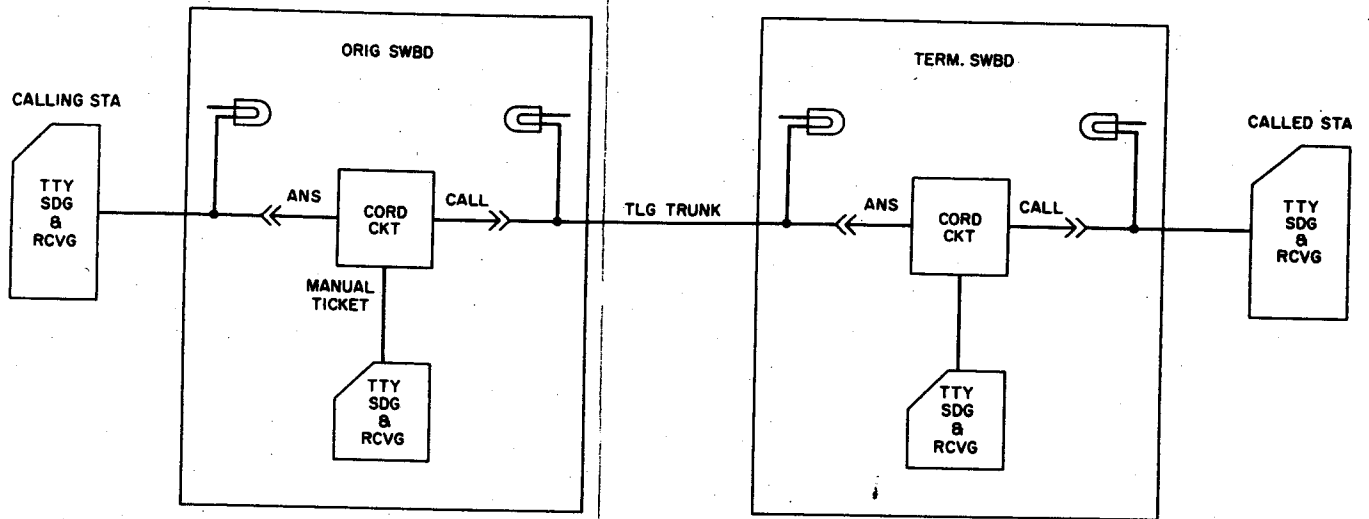


Fig. 1 - Manual TWX Operation

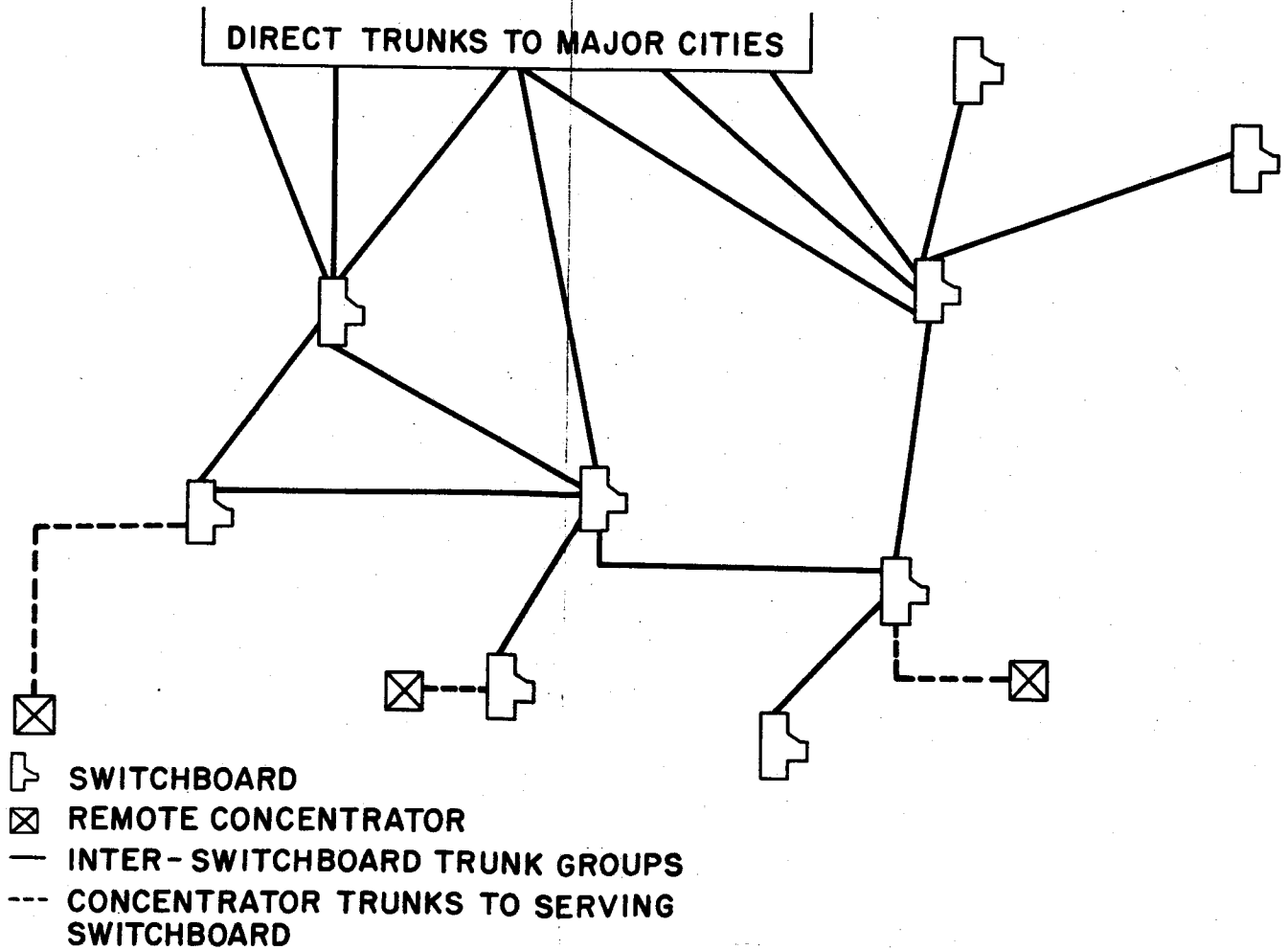


Fig. 2 - General Concept of Manual TWX Trunking Plan

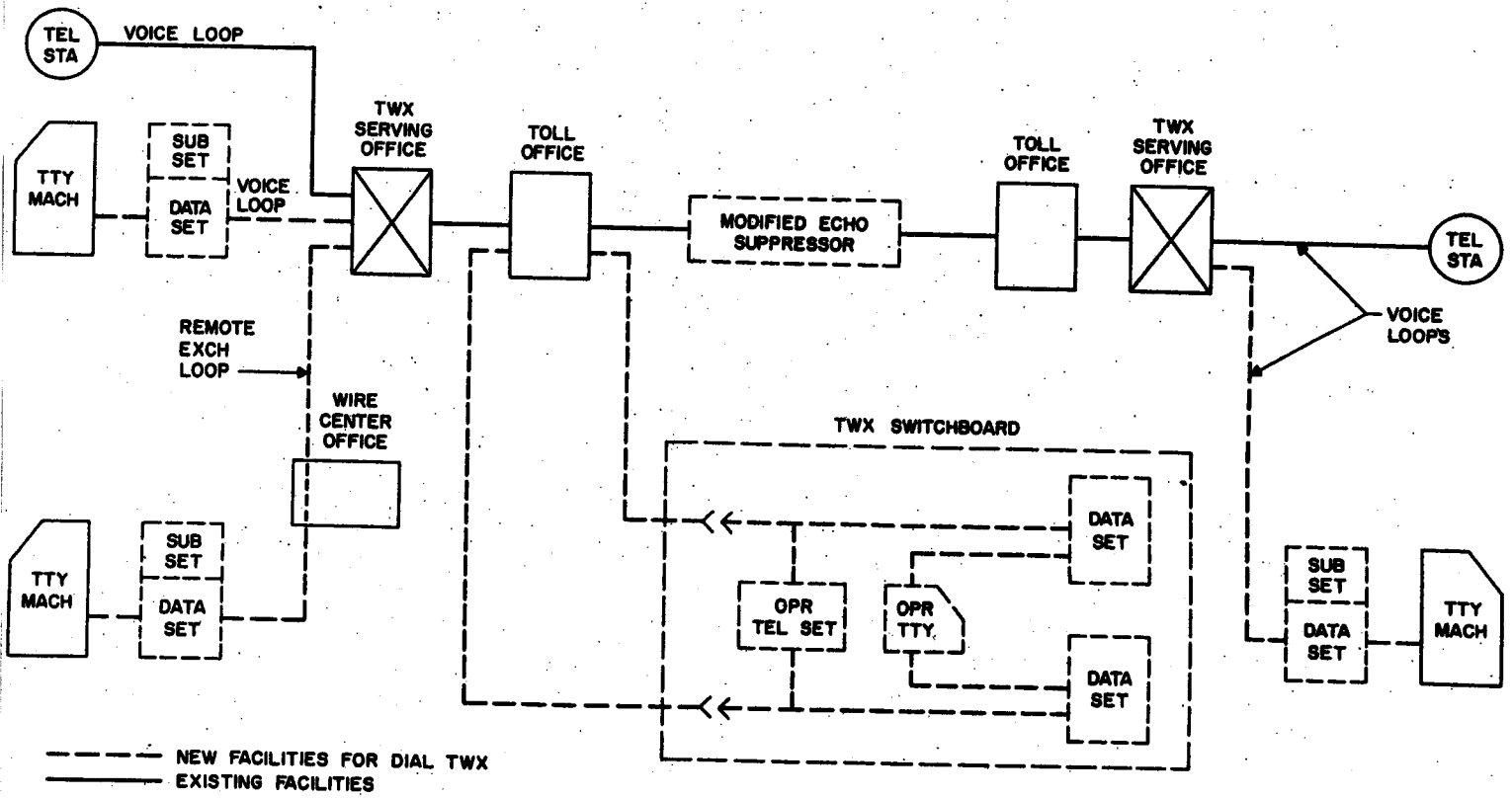


Fig. 3 - General Plan of the Dial TWX System

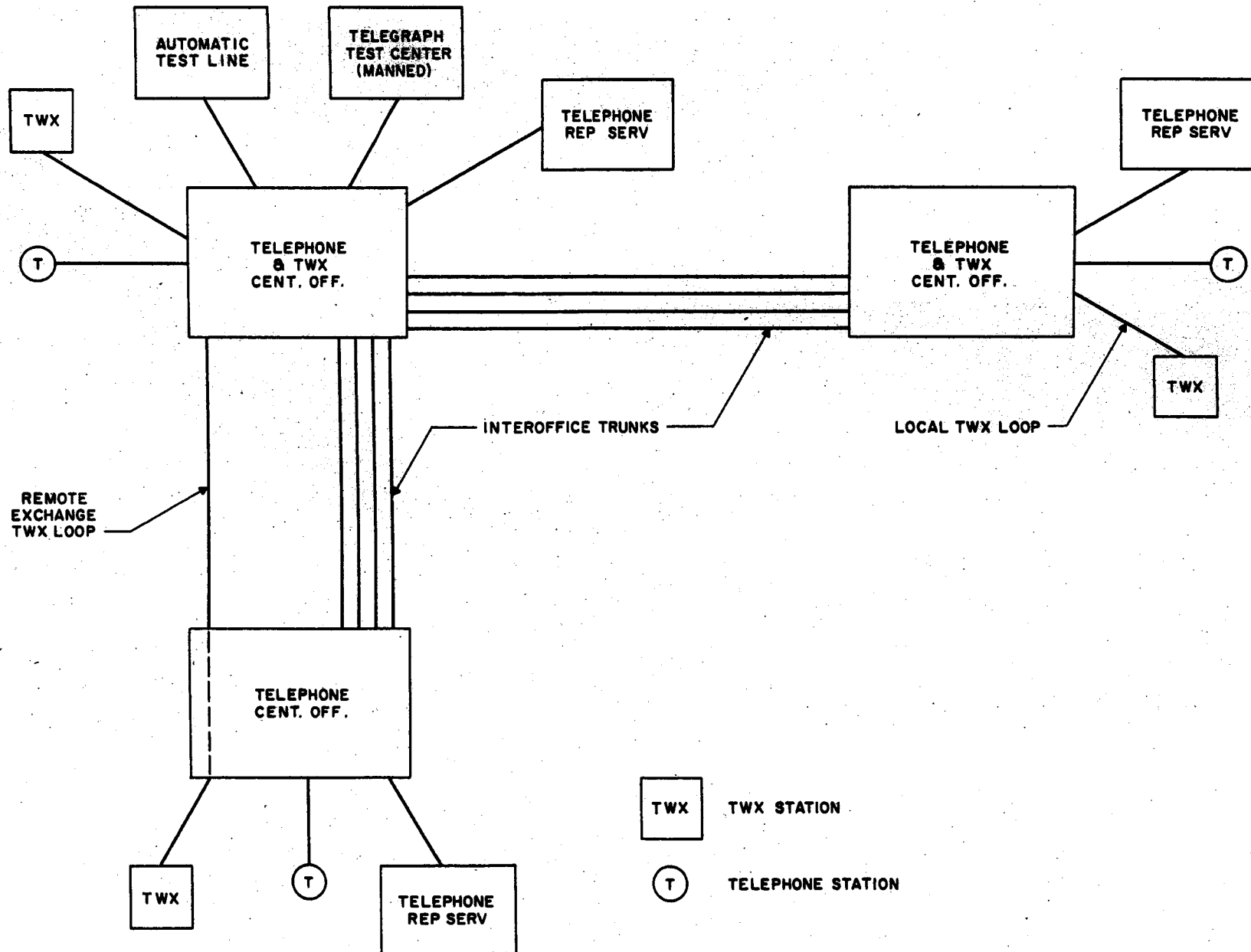
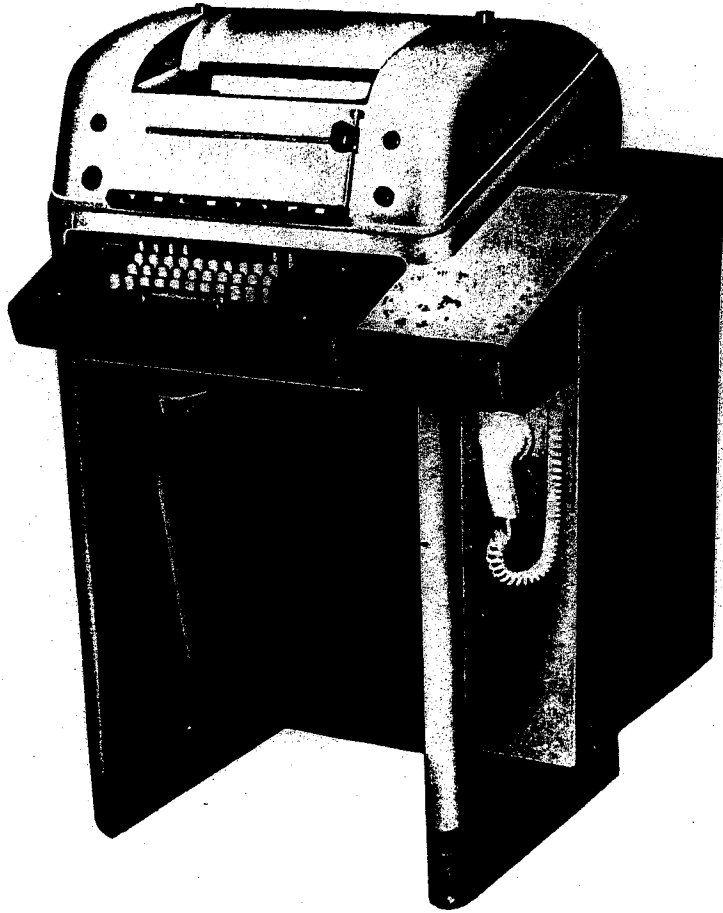
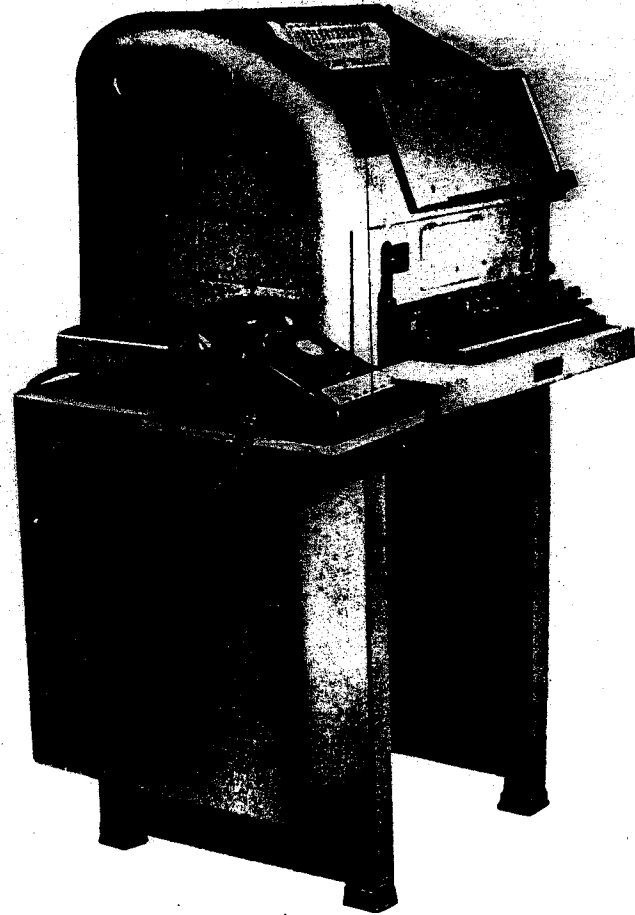


Fig. 4 - Basic Maintenance Arrangements for Dial TWX Stations



**Fig. 5 – Data Set 101A and Subscriber Set 689A
Mounted on 28 KSR Teletypewriter**



**Fig. 5A – Data Set 101A and Subscriber Set 691A3
Associated with 15-Type Teletypewriter**

Fig. 5 and 5A

DC TTY PULSES AND CORRESPONDING AC FREQUENCIES

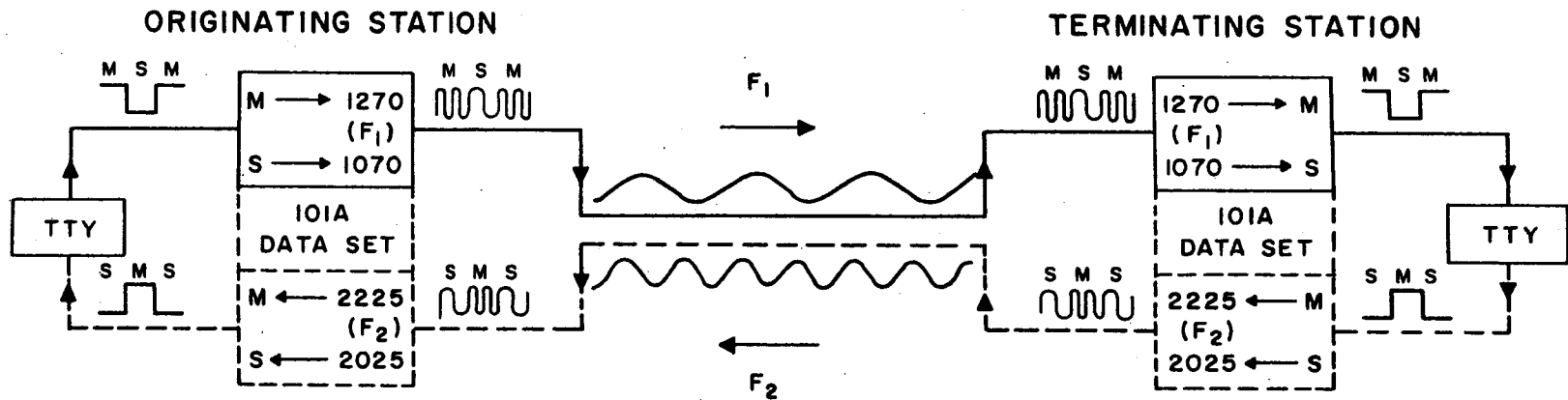
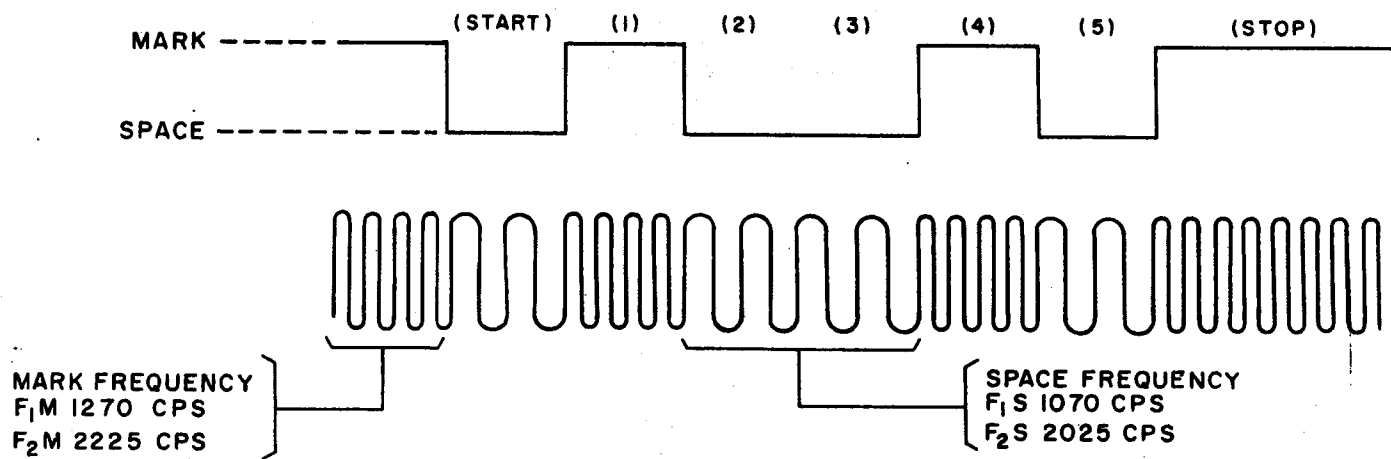


Fig. 6 - Data Set 101A, Principle of Operation

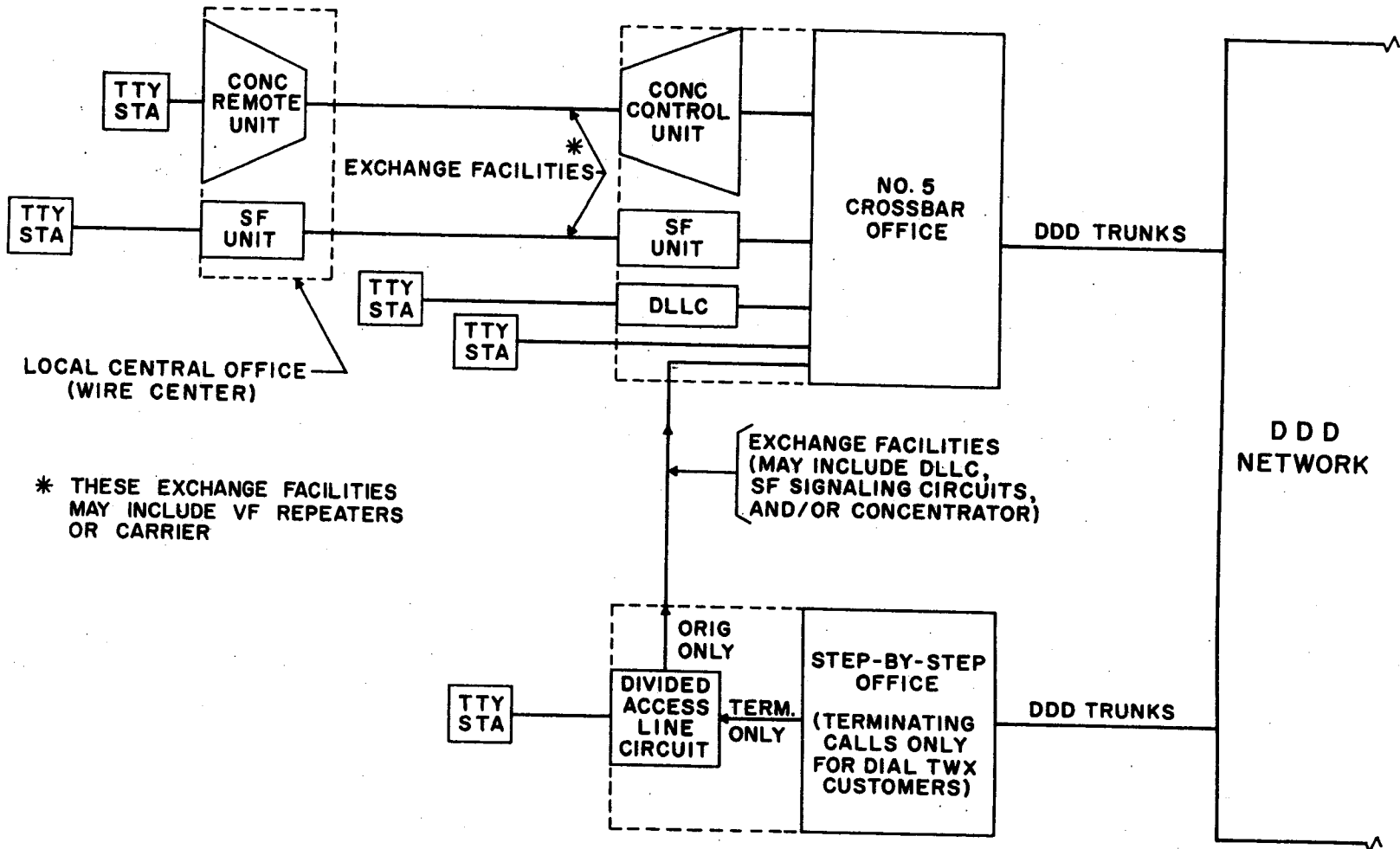


Fig. 7 - Representative Arrangements of Subscriber Line Facilities

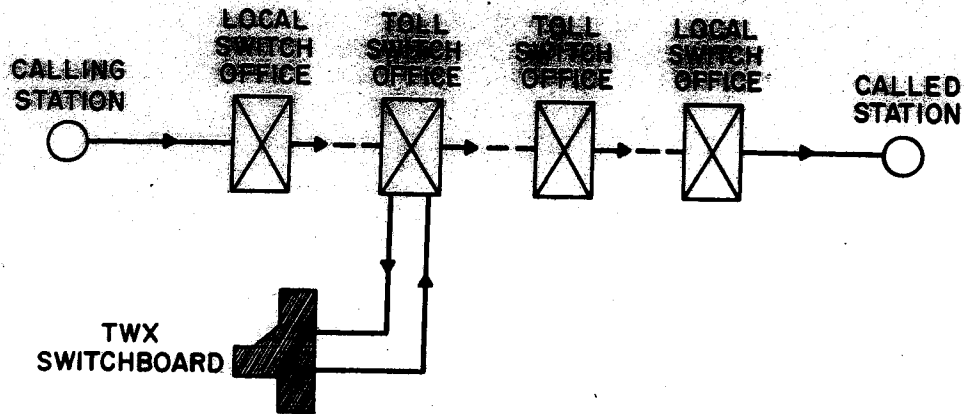


Fig. 8 - Switchboard Connection into the Network

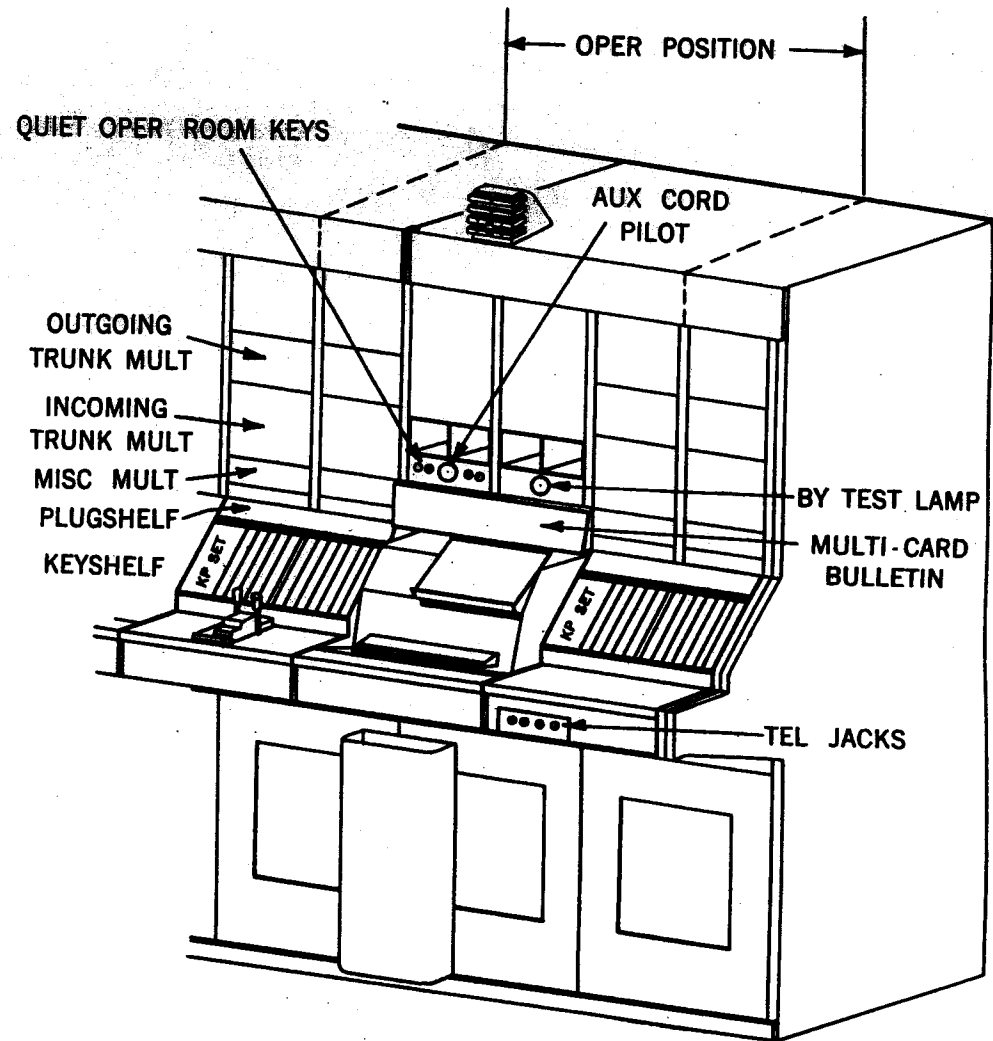


Fig. 9 - Physical Layout of 6A Switchboard

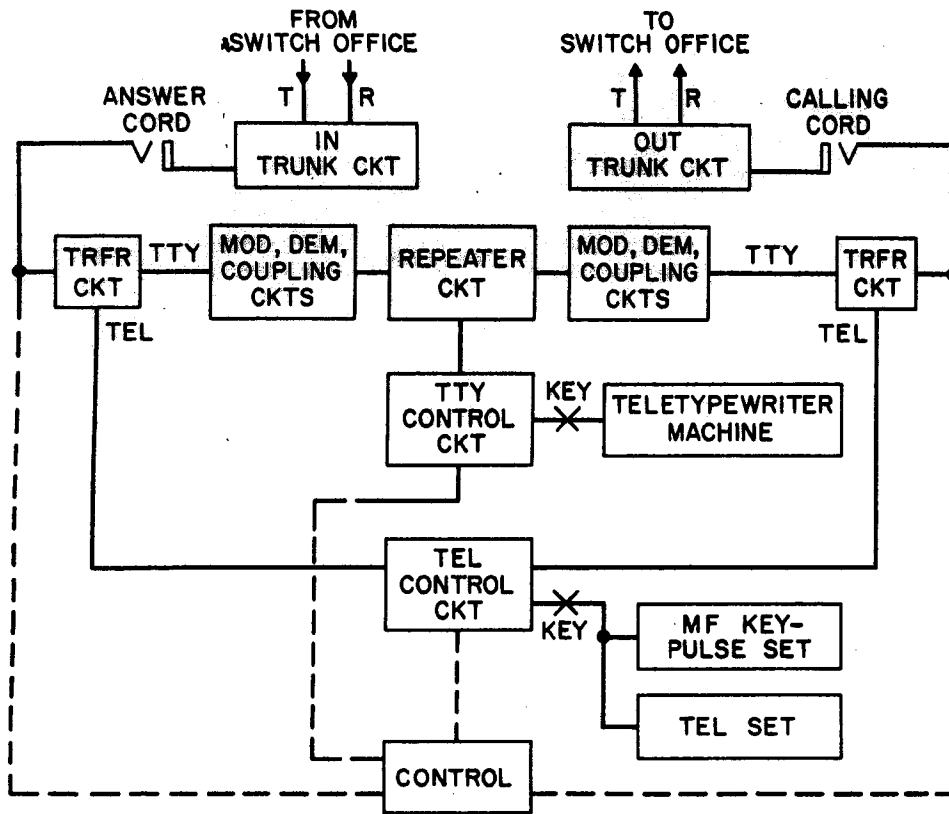


Fig. 10 - Block Diagram of Switchboard Circuits

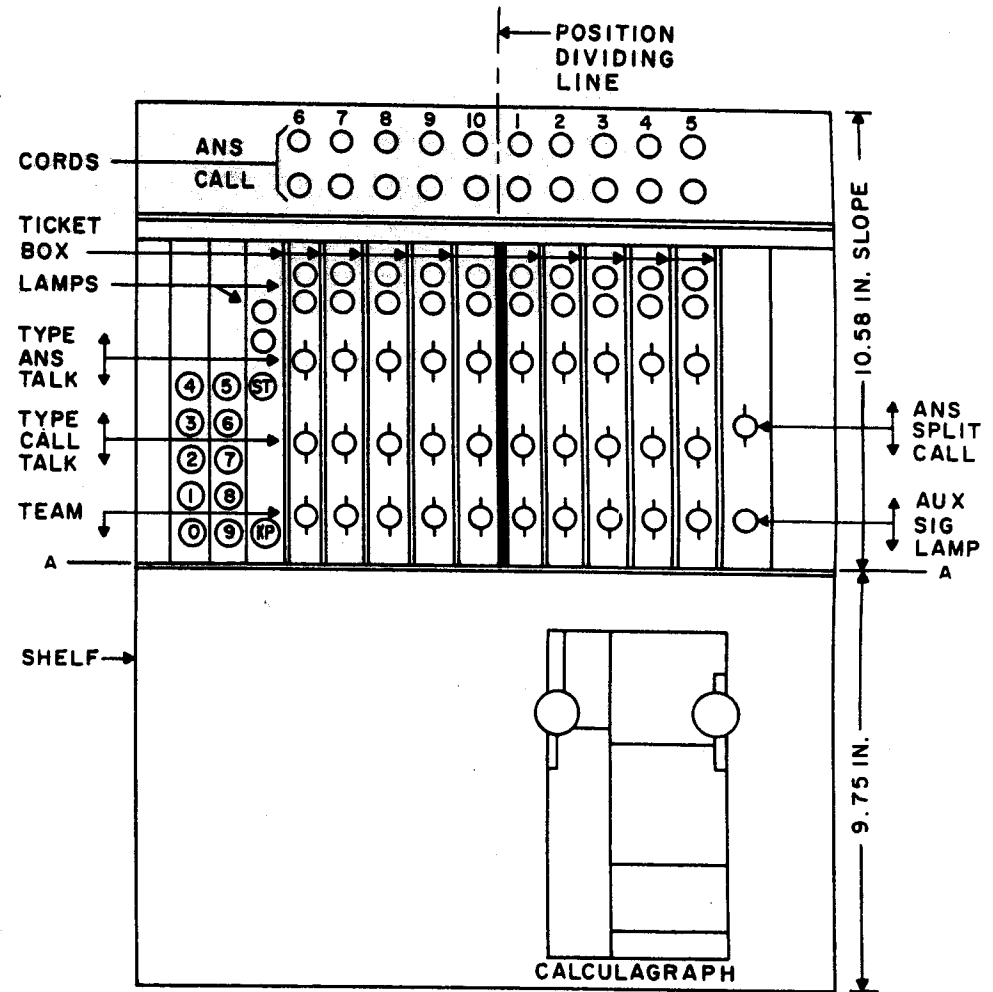


Fig. 11 - Plan View of the Switchboard Keyshelf

UNDIST

THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 (XXX)* SENDING
 THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 (XXX)* SENDING
 DIS 20

THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 (XXX)* SENDING
 THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 (XXX)* SENDING
 DIS PAD

THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 (XXX)* SENDING
 THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 (XXX)* SENDING

GA RY (Bell)

RYRYRYRYRYRYRYRYRYRYRYRYRYRYRYR

TRAN OK† FLIP‡ (2 Bells)

UNDIST

THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 (XXX)* SENDING
 THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 (XXX)* SENDING
 DIS 20

THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 (XXX)* SENDING
 THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 (XXX)* SENDING
 DIS PAD

THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 (XXX)* SENDING
 THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 (XXX)* SENDING

GA RY (Bell)

RYR

TRAN OK†

TNX END

* A 3-letter combination will be used to identify which ATL is being used.

† If the transmission received from the outlying station is out of limits, the wording will be OUT LIM.

‡ FLIP means that the outlying station should change from the originating to the answer mode.

Fig. 12 - Sample Copy Obtained from Use of the Automatic Test Line

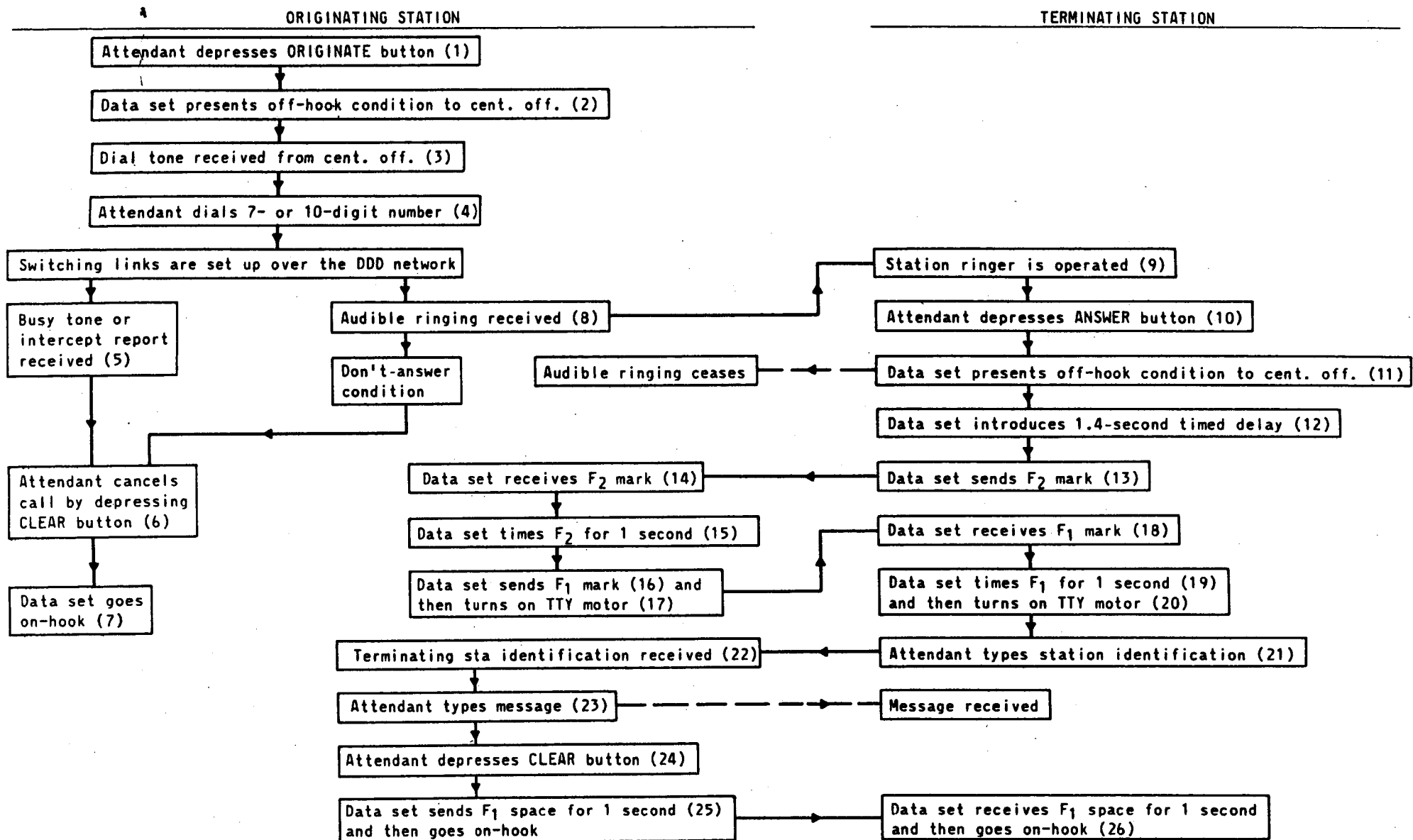


Fig. 13 - Flow Diagram of a TWX Connection Between Attended Stations