PUB 42211

PRELIMINARY

Bell System Voice Communications
TECHNICAL REFERENCE

Voice Connecting Arrangement

CEZ

Interface Specification

November 1971

ENGINEERING DIRECTOR - CUSTOMER TELEPHONE SYSTEMS

NOTICE

This Technical Reference is published by American Telephone and Telegraph Company as a guide for the designers, manufacturers, and consultants of customer-provided systems and equipment which connect with Bell System communications systems or equipment. American Telephone and Telegraph Company reserves the right to revise this Technical Reference for any reason, including, but not limited to, conformity with standards promulgated by ANSI, EIA, CCITT, or similar agencies; utilization of new advances in the state of the technical arts; or to reflect changes in the design of equipment or services described therein. The limits of responsibility and liability of the Bell System with respect to the use of customer-provided systems and equipment are set forth in the appropriate tariff regulations.

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TECHNICAL REFERENCE

VOICE CONNECTING ARRANGEMENT CEZ

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VOICE CONNECTING ARRANGEMENT CEZ

1. GENERAL

1.1 Introduction

F.C.C. Tariffs and corresponding intrastate tariffs filed by the Bell System provide for the direct electrical connection of customer-provided voice transmitting and receiving terminal equipment and communications systems to Bell System telecommunications network. The tariffs also provide for the indirect (acoustic or inductive) connection of such equipment or systems. Both methods require compliance with network protection criteria given in the tariffs.

Direct electrical connection is made through a voice connecting arrangement and associated network control signaling unit furnished, installed, and maintained by the Telephone Company.

1.2 Application

Voice Connecting Arrangement CEZ provides the means for manually connecting customer-provided equipment (typically used for call conferencing) to a Central Office or PBX station line terminated on a Telephone Company-provided Key Telephone System six button key telephone set. The arrangement is designed to be connected to incoming or outgoing calls. It is intended for the coupling of speech signals only and for use with customer-provided equipment designed to automatically disconnect whenever a momentary open condition of the line is provided.

This arrangement provides local battery on a pair of leads used for transmission and supervision and repeats opens and reversals on the line to the customer-provided equipment as opens of the local battery. A second pair of leads is provided for the control of the Key Telephone System line circuit by the customer-provided equipment.

1.3 Ordering and Identification

The connection service described in this Technical Reference is identified by the Bell System as Voice Connecting Arrangement CEZ. One voice connecting arrangement should be ordered for each station line which is to be connected to the customer-provided equipment, for up to five lines. The local Telephone Company business office or Marketing representative will provide information regarding availability and rates for this service.

2. DESCRIPTION

2.1 Functions

The major functions of this voice connecting arrangement are:

(a) To protect Telephone Company personnel and facilities from hazardous voltages which may be applied to the voice connecting arrangements.

(b) To provide isolation from longitudinal imbalance.

(c) To limit abnormally high speech signal levels to the telecommunications network.

(d) To provide speech transmission to and from the telecommunications network.

(e) To provide Key Telephone System line circuit control to the customer-provided equipment.

(f) To repeat Central Office line conditions to the customer-provided equipment.

2.2 Physical

Voice Connecting Arrangement CEZ consists of a printed circuit board housed in an apparatus box measuring approximately 8 inches square and 4 inches deep and is intended for wall mounting (Fig. 1), typically in the kneewell of a desk. The arrangement weighs approximately 4 to 9 pounds depending on the number of lines equipped. The housing has a steel base and a molded plastic cover with a light olive-gray finish.

The arrangement is powered from the Key Telephone System dc power supply. A plug ended cable (6 feet long) is provided for connection to the key telephone equipment and a receptacle is provided for connection to the key telephone set connecting cable (Fig. 2). The customer-provided equipment must be supplied with a 50-pin male connector (Amphenol Manufacturing Company No. 57-10500-7 or Cinch Manufacturing Company No. 222-32-50-023 or equivalent) that mates with the female connector of the interface connecting cable (18 inches long). This cable will accommodate up to five lines, each equipped with a Voice Connecting Arrangement CEZ (see Fig. 4 for connector pin assignments).

2.3 Interface Leads

Voice Connecting Arrangement CEZ provides two pairs of interface leads. Leads CT and CR provide a two-way speech transmission

path between the customer-provided equipment and the telecommunications network. Local battery from the arrangement is supplied to the customer-provided equipment over these leads to simulate Central Office or PBX line battery. After seizure momentary opens or reversals on the line to the Central Office or PBX are repeated as momentary opens toward the customer-provided equipment on these leads. The customer-provided equipment must either automatically disconnect upon detection of an open or the use of the equipment must supervise the connection and disconnect manually at the completion of the call.

Leads CA and CA1 provide the means for the customer-provided equipment to hold the Key Telephone System line circuit busy after the associated key telephone set goes on-hook.

3. OPERATION

3.1 Connection

An incoming or outgoing call on a Central Office or PBX station line is handled in the normal manner for a Key Telephone Set. The station user may then operate the customer-provided equipment to connect it to that line. The customer-provided equipment shall provide a dc connection across the CT and CR leads in order to cause the arrangement to bridge on the station line (Fig. 3). The customer-provided equipment shall also provide a closure on the CA and CA1 leads in order to hold the Key Telephone System line circuit operated to busy

out the appearance of the line when the Key Telephone Set leaves the connection (Use of the Key Telephone System "HOLD" feature is not required).

The station user may activate two or more Voice Connecting Arrangements CEZ to provide a bridged connection for up to five lines on the six button Key Telephone Set, typically for setting up a conference connection. The station user may leave the connection by placing the telephone handset on-hook or by operating another pickup key to answer or originate another call.

3.2 Disconnection

When a distant party on a conferenced line hangs up, the local Central Office or PBX may momentarily open or reverse the line toward the station. Voice Connecting Arrangement CEZ will recognize these conditions and will provide a momentary open of approximately 25 milliseconds duration on the CT and CR leads in response to either an open or a reversal. The customer-provided equipment must recognize this momentary open as a signal to disconnect and must remove the closures across leads CT-CR and CA-CA1 to restore the arrangement and line to the idle condition.

Not all C.O.'s provide an open or a battery reversal when the distant party disconnects, and some C.O.'s or PBX's provide an open for other reasons. In the absence of a disconnect signal from the arrangement, the user customer-provided equipment shall manually initiate the removal of the closures to prevent a permanent signal condition from occurring on the line.

It should be noted that when multiple arrangements are used by the customer-provided equipment to conference two lines, a nominal 2 dB loss is inserted in the path between the two distant parties. This, of course, is in addition to the loss present in the customer-provided equipment and in the end-to-end connection of the two lines. When three or more parties are connected, bridging loss must also be considered to determine the transmission quality of the connection. No voice signal amplification is provided by the voice connecting arrangement.

4. SPECIFIC DESIGN CONSIDERATIONS

4.1 Transmission Path

4.11 Insertion Loss

The insertion loss of Voice Connecting Arrangement CEZ through leads CT and CR is a nominal 1 dB over the voice-frequency range of 300 to 3000 Hz.

4.12 Impedance

Voice Connecting Arrangement CEZ provides about a one-to-one impedance transformation on the CT and CR leads. The impedance is a function of the voice connecting arrangement impedance and the impedance of the loop to the Central Office. For design purposes, the input impedance of this arrangement should be considered to be 600 ohms and, therefore, the impedance of the customer-provided equipment should be 600 ohms for optimum voice signal power transfer across the interface.

4.13 Bandwidth

The nominal voice-frequency bandwidth of the telecommunications network extends from about 300 to 3000 Hz. In general, an end-to-end connection may be expected to have a loss characteristic which increases on either side of this band. The voice connecting arrangement does not limit this bandwidth.

4.14 Voice Signal Power Level

The tariffs state that the average power (in any 3-second interval) delivered at the Central Office should not exceed -12 dBm in order to prevent excessive noise and crosstalk from interfering with other services. The maximum available power from a customer-provided 600 ohm source when averaged over any 3-second interval and measured at the CT and CR leads should not exceed -8 dBm. This limit has been set so that when the average loss in the Bell System are considered (including the insertion loss of the voice connecting arrangement), the limit of -12 dBm at the local Central Office will be met.

Using measuring Method A (see Paragraph 4.15), in almost all cases, the speech power averaged over any 3-second interval, will not exceed -8 dBm if the maximum meter swing does not exceed 85 dBrn. With the additional damping of measuring Method B, the power averaged over any 3-second interval will not exceed -8 dBm if the maximum meter swing does not exceed 83 dBrn.

When these arrangements are used on foreign exchange or private line service, the local Telephone Company may specify lower levels.

4.15 Measuring Maximum Available Inband Power

The measuring methods described below are satisfactory for estimating the maximum power averaged over a 3-second interval to determine that the inband criteria specified in Paragraph 4.14 is being met.

Method A

Operate the customer-provided equipment into a 600 ohm load, (this assumes that the customer-provided equipment has a 600 ohm source impedance), bridged by a Hewlett-Packard Transmission and Noise Measuring Set - Model 3555B, or a Western Electric 3-Type Noise Measuring Set, or the equivalent.* To insure a proper measurement technique, the control settings on these meters should be as follows.

Western Electric 3-Type Noise Measuring Set		Hewlett-Packard Transmission and Noise Measuring Set Model 3555B	
Control	Setting	Control	Setting
FUNCTION (Switch)	BRDG	INPUT (Switch)	NOISE/BRDG
NORM/DAMP (Switch)	DAMP	FUNCTION (Pushbutton)	VF/Nm-600 BAL
WTG (Plug-in Network)	3KcFLAT	Noise WTG (Switch)	3kHz FLAT
		NORM/DAMP (Switch)	DAMP

Method B

The accuracy of Method A can be somewhat improved by increasing the size of the damping capacitance in the Western Electric 3-Type Noise Meter by 150 microfarads. To do this, connect the negative lead

* These meters do not have a 3-second averaging time but, when used on speech, they give a reliable estimate of a 3-second average. The use of meters with shorter time constants, such as VU meters or standard voltmeters, is not recommended.

of a 150 microfarad capacitor to either terminal of the NORM/DAMP switch and connect the positive lead to ground. This allows the meter to more nearly approximate a 3-second averaging meter. (NOTE: This modification does not necessarily hold for the Model 3555B or noise meters other than the Western Electric 3-Type.)

4.16 Signal Power Distribution

The telecommunications network incorporates tone signaling devices that are used for network control functions. These devices, which are connected at all times to the telephone circuit, are designed to be sensitive to a single-frequency tone at 2600 Hz. They are, however, relatively insensitive to energy at this frequency if sufficient energy is present at the same time at other frequencies in the voiceband.

In order to prevent the interruption or disconnection of a call, or interference with network control signaling, it is necessary that the signal applied by the customer-provided equipment to the voice connecting arrangement at no time have energy solely in the 2450 to 2750 Hz band. If signal power is in the 2450 to 2750 Hz band, it must not exceed the power present at the same time in the 800 to 2450 Hz band.

4.17 Out-of-Band Signal Power Limits

To protect other services, it is necessary that the signal which is applied by the customer-provided equipment to the Telephone Company interface, located on the customer's premises, meet the following limits:

(a) The power in the band from 3995 Hz to 4005 Hz shall be at least 26 dB below one milliwatt (18 dB below the level specified in Paragraph 4.14).

(b) The power in the band from 4000 Hz to 10,000 Hz shall not exceed 16 dB below one milliwatt.

(c) The power in the band from 10,000 Hz to 25,000 Hz shall not exceed 24 dB below one milliwatt.

(d) The power in the band from 25,000 Hz to 40,000 Hz shall not exceed 36 dB below one milliwatt.

(e) The power in the band above 40,000 Hz shall not exceed 50 dB below one milliwatt.

4.18 Signal Limiting

A voice signal limiter is incorporated in the transmission path (lead CT and CR) to protect the Bell System telecommunications network from applications of abnormally high signal levels. This has no effect on normal voice signal levels. This limiter does not abrogate the customer's responsibility to meet the network protection criteria contained in the tariffs and in Section 4 of this Technical Reference.

4.2 DC Signaling Paths

4.21 Transmission and Loop Signaling Leads

Leads CT and CR provide an isolated contact opening of approximately 25 milliseconds duration whenever an open or a battery reversal is detected on the telephone line. This interrupts the local battery supplied to the customer-provided equipment over these leads. This local battery will provide 26 volts dc maximum open circuit voltage. The customer-provided closure shall provide 100,000 ohms minimum open circuit resistance and shall limit the closed circuit load current on these leads to .080 amperes.

4.22 Control Leads

Leads CA and CA1 provide the means to extend Key Telephone System line circuit control to the customer-provided equipment. The customer-provided closure shall have 100,000 ohms minimum open circuit resistance and 50 ohms maximum closed circuit resistance including customer-provided connecting cable resistance. The closure shall be capable of handling a maximum dc load of 30 milli-amperes through a relay coil equipped with diode suppression. The maximum open circuit voltage is 26 volts. To insure proper operation of the line circuit, the customer-provided closure must be isolated from any other circuit.

5. GENERAL DESIGN CONSIDERATIONS

5.1 Foreign and Surge Voltage Protection

Where telephone lines are exposed to foreign voltages by direct contact or induction (e.g., power line crosses or lightning), protective devices are installed at the Central Office and on the customer's premises that will provide a path to ground for foreign voltages that exceed about 600 volts peak. Since the customer's equipment is connected to the telephone line through the voice connecting arrangement, the customer's equipment is protected from metallic and longitudinal surges.

The customer is responsible for providing protection, internal to his equipment and facilities, against foreign and hazardous voltages from his equipment and facilities being applied to the voice connecting arrangement.

5.2 Telecommunications Network Characteristics

5.21 End-to-End Electrical Loss

The end-to-end electrical loss of a connection is a function of the impedances of both end terminations, and the losses of the inter-office trunks, the serving Central Offices and the facilities to the serving offices. The information found in the REFERENCES in Appendix B may be used to determine statistical loss distributions for different types of calling patterns on the telephone network.

5.22 Nonlinearities

Nonlinearities such as compression, clipping, and harmonic distortion can exist on the telecommunications network. Normally, these are insignificant for speech transmission. It is expected that harmonic distortions caused by the network will result in single tones which are no greater than about 5% of the fundamental.

6. SERVICE AND MAINTENANCE CONSIDERATIONS

6.1 Responsibility of the Customer

The tariffs permitting connection of customer-provided terminal equipment or communications systems state that where telecommunications service is available under these tariffs for use in connection with terminal equipment or communications systems, provided by a customer, the operating characteristics of such equipment or systems shall be such as not to interfere with any of the services offered by the Telephone Company. Such use is subject to the further provisions that the equipment or systems provided by a customer does not endanger the safety of Telephone

Company employees or the public; damage, require change in or alteration of, the equipment or systems or other facilities of the Telephone Company, interfere with the proper functioning of such equipment or systems or facilities, impair the operation of the telecommunications system of facilities or otherwise injure the public in its use of the Telephone Company's services. Upon notice from the Telephone Company that the equipment or system provided by a customer is causing or is likely to cause such hazard or interference, the customer shall take such steps or make such change as shall be necessary to remove or prevent such hazard or interference.

6.2 Responsibilty of the Telephone Company

The tariffs permitting connection of terminal equipment and communications systems, provided by a customer, state that the Telephone Company shall not be responsible for the installation, operation or maintenance of said terminal equipment or communications systems. Telecommunications service is not represented as adapted to the use of customer-provided equipment or systems and where such equipment or systems are connected to Telephone Company facilities, the responsibility of the Telephone Company shall be limited to the furnishing of facilities, including the protective connecting arrangements and network control signaling units, suitable for telecommunications service and to the maintenance and operation of such facilities in a manner proper for such services. Subject to this responsibility the Telephone Company shall not be responsible for (i) the through transmission of signals generated by the customer-provided equipment or systems or for the quality of, or defects in, such transmission, or (ii) the reception of signals by customer-provided equipment or systems, or (iii) address signaling where such

signaling is performed by customer-provided tone-type signaling equipment. The Telephone Company shall not be responsible to the customer if changes in minimum network protection criteria contained in the tariffs (and in this Technical Reference) or in any of the facilities, operations or procedures of the Telephone Company render any customer-provided facilities obsolete or require modification or alteration of such equipment or systems or otherwise affect its use or performance.

6.3 Trouble Reporting Procedure

When trouble is experienced with this service, the customer should perform the necessary testing at the interface to sectionalize the difficulty, i.e., determine whether the service impairment is located in the customer-provided equipment or in the equipment provided by the Telephone Company. If the tests indicate that the trouble is in the Telephone Company-Provided equipment, it should be promptly reported to the Telephone Company. Trouble reports should be called into the listed "Repair Service" number which can be found in the front of the telephone directory. The repair attendant should be given:

(a) Customer's name

(b) Customer's address

(c) Listed telephone number

(d) Description of the trouble

(e) Customer's contact for additional information

If a Telephone Company service call results in the location of the trouble in the customer-provided equipment, the customer is liable to be charged for the service call.

APPENDIX A

GLOSSARY

COMMUNICATIONS SYSTEM - denotes channels and other facilities which are capable, when not connected to the Long Distance Message Telecommunications service, of communications between customer-provided terminal equipment or Telephone Company stations.

CONNECTING ARRANGEMENT - equipment provided by the Telephone Company to accomplish the electrical connection of customer-provided equipment and the Telecommunications Network.

CUSTOMER - the term "Customer" denotes the person, firm or corporation which orders service and is responsible for the payment of charges and compliance with Telephone Company regulations.

CUSTOMER-PROVIDED TERMINAL EQUIPMENT - denotes devices or apparatus and their associated wiring, provided by a customer, which do not constitute a communications system and which, when connected to the communications path of the telecommunications system, are so connected either electrically, acoustically, or inductively.

INTERFACE CONNECTING CABLE - the Telephone Company-provided connecting point to which the customer brings and connects the mating plug and cable of his equipment to the voice connecting arrangement.

NETWORK CONTROL SIGNALING - denotes the transmission of signals used in the telecommunications system which perform functions such as supervision (control, status, and charging signals), address signaling (dialing), calling and called number identification, audible tone signals (call progress signals indicating reorder or busy conditions, alerting, coin denominations, coin collect and coin return tones) to control the operation of switching machines in the telecommunications system.

NETWORK CONTROL SIGNALING UNIT - denotes the terminal equipment furnished, installed, and maintained by the Telephone Company for the performance of network control signaling.

OFF-HOOK SUPERVISION - the conditioning of the SERVICE REQUEST leads by the customer-provided equipment which indicates that the customer's telephone is answering or originating a call.

ON-HOOK SUPERVISION - the conditioning of the SERVICE REQUEST leads by the customer-provided equipment which indicates that the customer's telephone has disconnected or that the equipment is idle.

SUPERVISORY SIGNALS - signals used to initiate a request for service by the calling party (off-hook); to notify the called party that he is being called (ringing); to indicate an answered call (off-hook); to indicate a disconnect (on-hook); and to recall an operator or distant party to a connection (switchhook flash).

TELECOMMUNICATIONS NETWORK - the Bell System voice switching equipment, associated interconnecting facilities, and station equipment which provide Long Distance Message Telecommunications service or private line service.

TELEPHONE COMPANY - denotes the American Telephone and Telegraph Company, the Long Lines Department, its concurring carriers, and its connecting carriers, either individually or collectively.

VOICE COUPLER - the part of the voice connecting arrangement which connects the transmission path from the customer-provided equipment to the telecommunications network.

VOICE CONNECTING ARRANGEMENT - a protective connecting arrangement designed to transmit speech signals as contrasted to one designed to transmit data signals.

VOICE CONNECTING UNIT - that portion of the voice connecting arrangement including the voice coupler that provides the interconnection function between the customer-provided equipment and the Telephone Company facilities.

NOTE: Under the tariff regulations, the terms "connecting arrangement" and "network control signaling unit" are separate and distinct from each other, however, the term "connecting arrangement" is generally used to include the functions of network control signaling.

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APPENDIX B

REFERENCES

Some references describing various transmission characteristics of the telecommunications network are listed below:

(a) McAdoo, K. L., "Speech Volumes on Bell System Message Circuits - 1960 Survey," Bell System Technical Journal (BSTJ), Vol. 42, No. 5 (September 1963), p. 1999.

(b) Nasell, I., "The 1962 Survey of Noise and Loss on Toll Connections," BSTJ, Vol. 43, No. 2 (March 1964), p. 697.

(c) Nasell, I., "Some Transmission Characteristics of Bell System Toll Connections," BSTJ, Vol. 47, No. 6 (July-August 1968), p. 1001.

(d) Nasell, I., Ellison, C. R., and Homstrom, R., "The Transmission Performance of Bell System Intertoll Trunks," BSTJ, Vol. 47, No. 8 (October 1968), p. 1561.

(e) Gresh, P. A., "Physical and Transmission Characteristics of Customer Loop Plant", BSTJ, Vol. 48, No. 10 (December 1969), p. 3337.

(f) Bell System Technical Reference PUB 41007, "1969-70 Switched Telecommunications Network Connection Survey (Reprints of Bell System Technical Journal Articles") - April 1971.

(g) Breen, C., and Dahlbom, C. A., "Signaling Systems for the Control of Telephone Switching," BSTJ, Vol. 39, No. 6 (November 1960), p. 1381.

(h) Bodle, D. W., and Gresh, P. A., "Lightning Surges in Paired Telephone Cable Facilities," BSTJ, Vol. 40, No. 2 (March 1961), p. 547.

*(i) "Principles of Electricity Applied to Telephone and Telegraph Work," by American Telephone and Telegraph Company, New York, New York.

*(j) "Switching Systems," by American Telephone and Telegraph Company, New York, New York.

*(k) "Notes on Transmission Engineering," by United States Independent Telephone Association, Washington, D. C.

*(l) "Transmission Systems for Communications," by Bell Telephone Laboratories, Inc.

* Available through Western Electric Company, Inc.
Commercial Relations
P. O. Box 1579
Newark, New Jersey 07102

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APPENDIX C

WHERE TO OBTAIN REFERENCE MATERIAL

1. Bell System Technical References

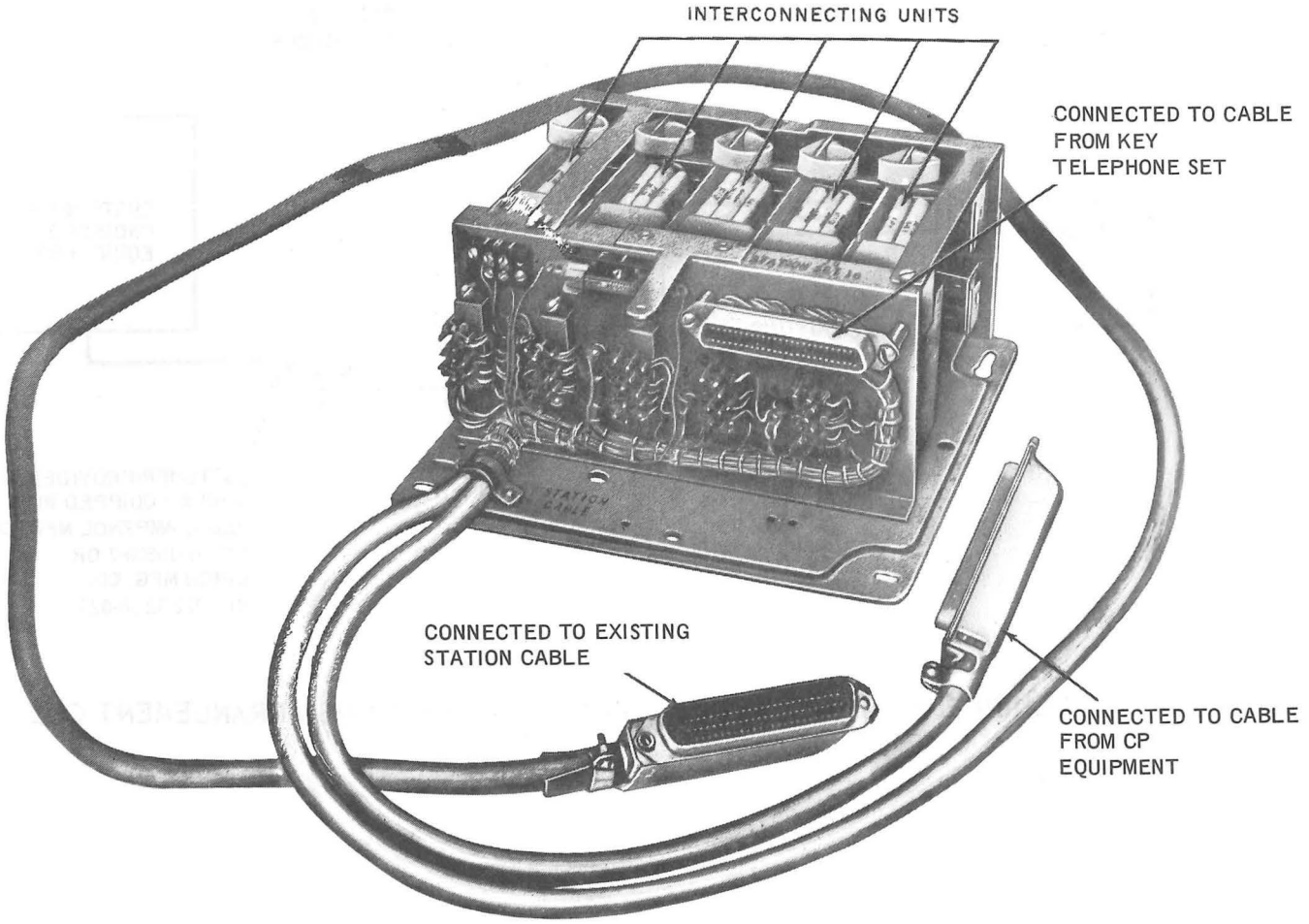
These references may be purchased by writing to:

Western Electric Company, Inc.
Commercial Relations
P. O. Box 1579
Newark, New Jersey 07102

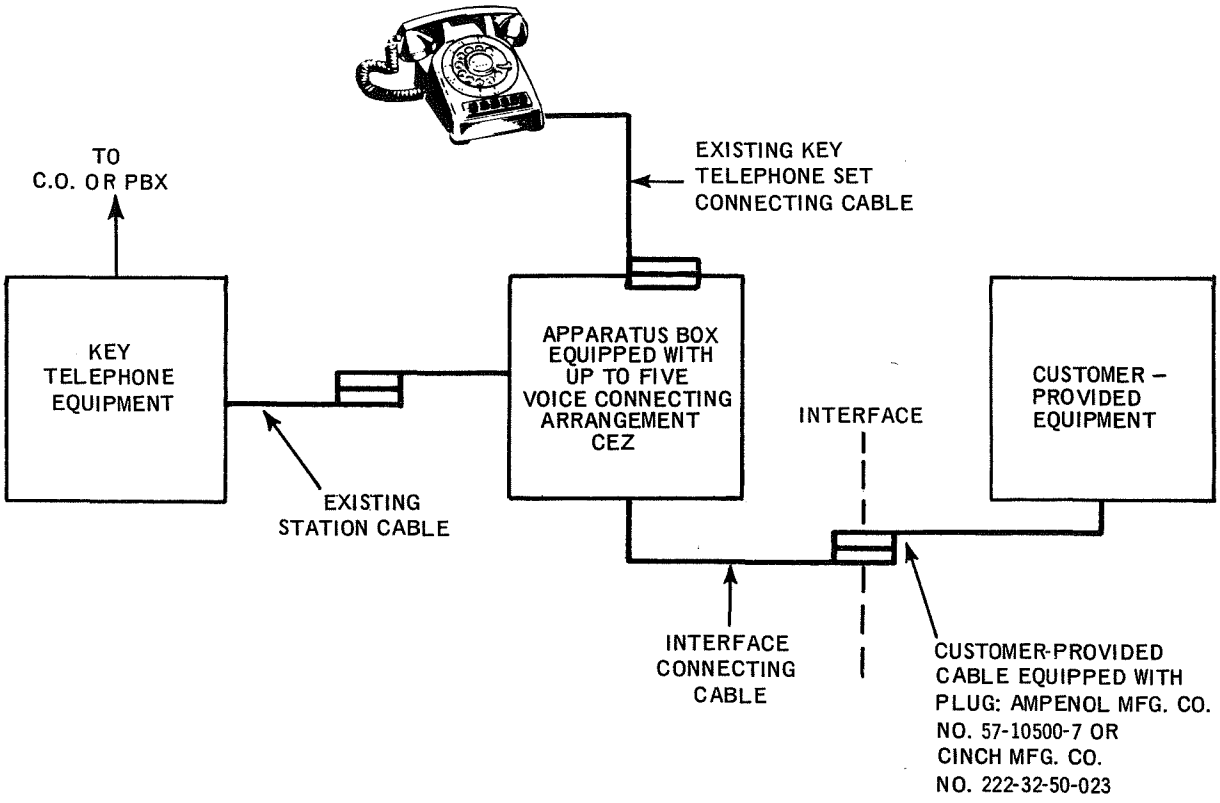
2. Bell System Technical Journals (BSTJ)

These journals may be purchased by writing to:

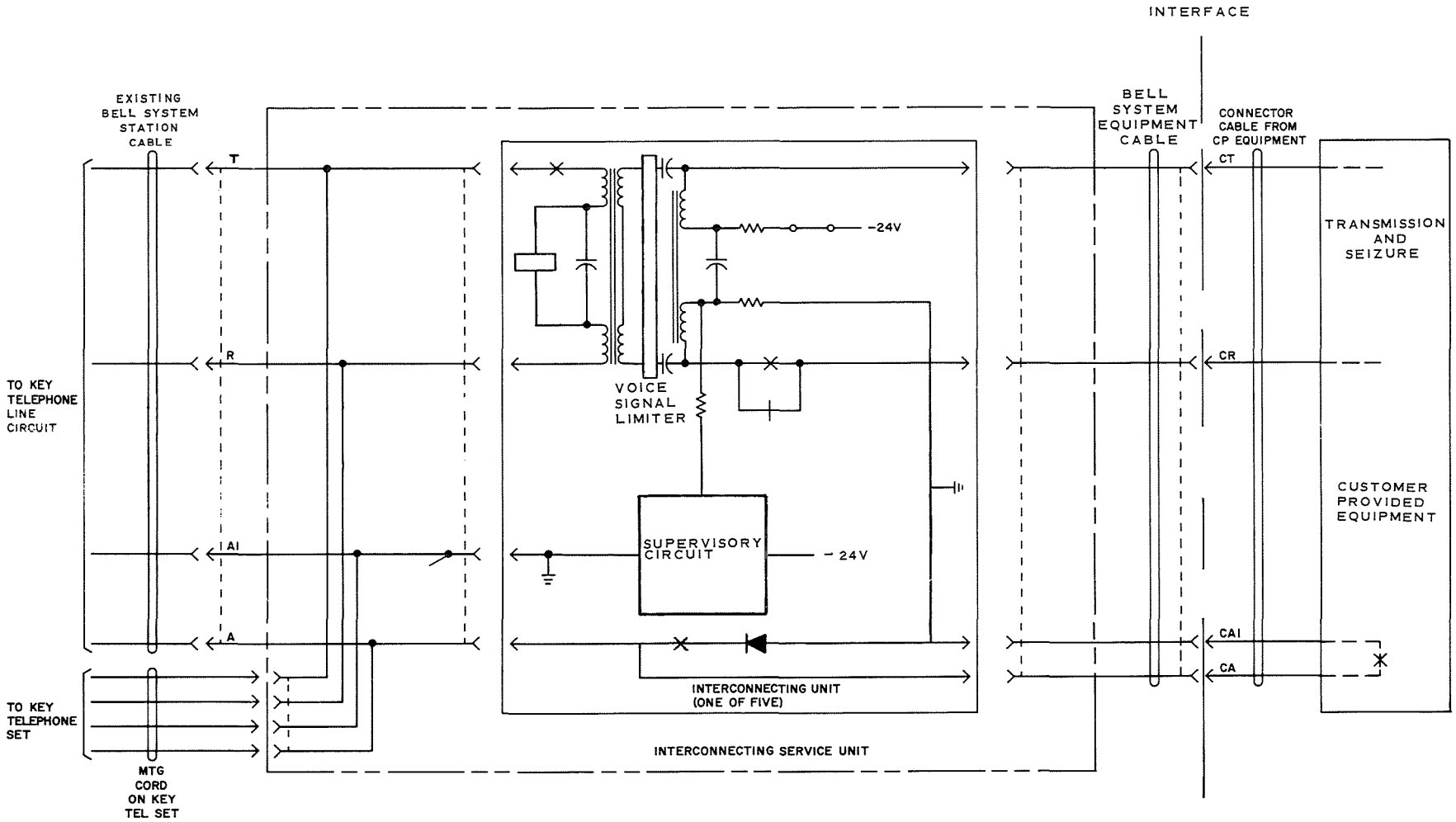
Mr. F. J. Schwetje
Bell Telephone Laboratories, Inc.
Mountain Avenue, Room 3C115
Murray Hill, New Jersey 07974



APPARATUS BOX (COVER OFF) EQUIPPED WITH FIVE VOICE CONNECTING ARRANGEMENTS CEZ
FIG. 1



EQUIPMENT CONFIGURATION FOR VOICE CONNECTING ARRANGEMENT CEZ
FIG.2



SIMPLIFIED SCHEMATIC – VOICE CONNECTING ARRANGEMENT CEZ
FIG. 3

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Circuit No.	Lead Designation	Connector Pin No.
1	CT CR CA CA1	26 1 27 2
2	CT CR CA CA1	29 4 30 5
3	CT CR CA CA1	32 7 33 8
4	CT CR CA CA1	35 10 36 11
5	CT CR CA CA1	38 13 39 14

VOICE CONNECTING ARRANGEMENT CEZ

INTERFACE CONNECTING CABLE CONNECTIONS
FIG. 4