PUB 42301

PRELIMINARY

Bell System Voice Communications
TECHNICAL REFERENCE

Voice Connecting Arrangement 2A

Interface Specification

February 1969

ENGINEERING DIRECTOR - CUSTOMER TELEPHONE SYSTEMS

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PRELIMINARY

NOTICE

This Technical Reference is specifically intended for the developers and designers of telephone voice communication systems and equipment which interface with the Bell System telecommunication network and for technical consultants to use in designing communications systems and arrangements requiring connections to the Bell System telecommunications network. The right to revise this Technical Reference for any reason, including conformity with USASI, EIA, CCITT or other standards, to utilize new advances in the state of the technical arts, or to reflect changes in the design of the equipment and/or service described herein is expressly reserved. Liability for difficulties arising from technical limitations is disclaimed.

If further information is required, please contact:

Engineering Director - Customer Telephone Systems
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195 Broadway
New York, New York 10007

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PRELIMINARY

PREFACE

The material in this Technical Reference is intended for use by designers and manufacturers of telephone equipment who expect to connect their communication equipment to the Bell System telecommunication network. This material covers guides which, if followed, should permit the transmission and reception of voice signals without interference to other Telephone Company services.

The responsibility of the Bell System with respect to the use of customer-provided equipment is as set forth in the appropriate tariff regulations.

In furnishing this material, the Bell System Telephone Companies makes no claims or representations and assume no responsibility, beyond that set forth in the tariff regulations, for the suitability of the transmission path or the performance of the telecommunications system. The Bell System is in no way responsible for the design, performance, installation, operation or maintenance of the communications systems or equipment provided by others which are connected to the telecommunication network and does not endorse or approve any such system or equipment. The material in this Technical Reference is furnished in the interest of preventing interference to other Telephone Company services and users, and is not furnished with the intent to provide complete design specifications or parameters, or to assure the quality or performance of customer-provided telephone systems and equipment.

1. GENERAL

The Bell System intrastate and interstate tariff regulations provide for the connection of customer-provided voice transmitting and receiving terminal equipment and communications systems. These Tariffs provide for direct electrical connections of such equipment to the Bell System telecommunication network through a voice connecting arrangement furnished, installed, and maintained by the Telephone Company; they also provide for the indirect, acoustic or inductive, connection of such equipment or systems.

In addition, the Bell System retains responsibility for network control signaling; this includes the switchhook, dialing and control functions, as well as for the protective function of voice signal limiting and isolation of Central Office battery from the customer-provided equipment.

For new or additional service, contact your local Telephone Company business office or marketing representative. For ready identification, the Telephone Company describes this service as Voice Connecting Arrangement 2A.

2. SYSTEM DESIGN CONSIDERATIONS

2.1 Voice Connecting Arrangement 2A

The Voice Connecting Arrangement 2A provides a means for manually connecting a customer-provided dial intercom or dial communication system that furnishes answer supervision to the Bell System telecommunication network through a Bell System Manual PBX cord switchboard. It is arranged to handle voice calls in either direction. This arrangement is terminated at the manual PBX cord switchboard as a manual station line for calls originated by the communication system station user and uses an auxiliary dial jack to initiate calls by the PBX attendant to a communication system station user. This arrangement provides voice frequency coupling only, between the PBX and

the communication system for transmission purposes. A dc circuit is established between the PBX switchboard and the communication system voice TRANSMISSION leads, a pair of conductors, for holding and dialing the station users. SERVICE REQUEST leads, a separate pair of conductors between the arrangement and the communication system, provide the means for the customer to supply answer supervision for incoming calls and to initiate outgoing calls.

2.2 Service and Maintenance Considerations

2.21 Responsibility of the Customer

The Tariffs permitting direct electrical connection of customer-provided communication systems state:

> Where message telecommunications service is available under this tariff for use in connection with customer-provided equipment, the operating charactertistics of such equipment 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 customer-provided equipment does not endanger the safety of Telephone Company employees or the public; damage, require change in or alteration of, the equipment or other facilities of the Telephone Company; interfere with the proper functioning of such equipment or facilities; impair the operation of the telecommunications system or otherwise injure the public in its use of the Telephone Company's services. Upon notice from the Telephone Company that the customer-provided equipment is causing or is likely

to cause such hazard or interference the customer shall make such change as shall be necessary to remove or prevent such hazard or interference.

2.22 Responsibility of the Telephone Company

The Tariffs permittting direct electrical connection of customer-provided communication system state:

The Telephone Company shall not be responsible for the installation, operation or maintenance of any customer-provided terminal equipment. Message telecommunications service is not represented as adapted to the use of customer-provided equipment and where such equipment is connected to Telephone Company facilities the responsibility of the Telephone Company shall be limited to the furnishing of facilities suitable for message telecommunications service and to the maintenance and operation of such facilities in a manner proper for such telecommunications service; subject to the responsibility the Telephone Company shall not be responsible for (i) the through transmission of signals generated by the customer-provided equipment or for the quality of, or defect in, such transmission, or (ii) the reception of signals by customer-provided equipment.

The Telephone Company shall not be responsible to the customer or otherwise if changes in the criteria contained in the Tariffs

and Section 5 of this Technical Reference, or in any of the facilities, operations or procedures of the Telephone Company render any customer-provided equipment obsolete or require modification or alteration of such equipment or otherwise affect its use or performance.

2.23 Trouble Reporting Procedure

Even though there is an adequate maintenance operation for this service, there will be occasions when trouble is experienced with this service. When this occurs the customer should perform the necessary testing to sectionalize the difficulty, i.e., determine whether the service impairment is located in the customer-provided equipment or tests towards the Telephone Company. If the tests indicate the trouble is in the Telephone Company-provided equipment, it should be promptly reported to the Telephone Company. Trouble reports should be called to the listed "Repair Service" number, which can be found in the front of the telephone directory. The repair attendant should be given:

1. Customer name.
2. Customer address.
3. Listed Telephone number.
4. Description of the trouble.
5. Customer contact for additional information.

2.3 Surge Voltage Protection

Where telephone lines are exposed to lightning, power circuit contact, or induction there are protective devices located at the Central Office and on the subscriber premises that will provide a path to ground for foreign

voltages that exceed 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 longitudinal lightning surge by transformer isolation. The maximum surge between conductors CT and CR (see Fig. 4) due to foreign potential that the customer's equipment will encounter is 30 volts. The surge potentials on the other conductors of the voice connecting arrangement will not exceed about 600 volts peak.

The customer is responsible for providing protection, internal to his equipment and facilities, against surge and hazardous voltages from his equipment and facilities being applied to the voice connecting arrangement. The surge potential on the conductors CT and CR is expected to be limited to 30 volts. The surge potential on conductors CS and CG is expected to be limited to about 600 volts peak between conductors or from one conductor to ground.

2.4 Hazardous Voltages

For the purpose of providing adequate protection to personnel and plant facilities, unless otherwise specified in Section 4.2 and 4.3 of this Technical Reference, steady-state voltages applied to conductors connected to the Voice Connecting Arrangement 2A should be limited to the following:

	dc	ac (RMS)
Maximum voltage, any conductor to ground	135	50
Maximum voltage, conductor to conductor	135 270*	50 100*

* Permitted only if voltage source is center-tapped to ground.

The power supplies and wiring methods used in the customer-provided equipment should meet the provisions of the National Electric Code, Article 725, for Class 2 remote control and signal circuits.

3. DESCRIPTION OF VOICE CONNECTING ARRANGEMENT 2A

3.1 Physical

The Voice Connecting Arrangement 2A is assembled on a 2 inch by 23 inch mounting plate which provides for one connecting circuit. It weighs approximately 7 pounds. This arrangement will be mounted by the Telephone Company in an appropriate mounting. This arrangement will function satisfactorily within a temperature range of 0° to 55° C and a humidity range from 5 to 95 percent. Each arrangement dissipates approximately 20 watts of heat. Leads from this arrangement are terminated on a Telephone Company provided interface connecting block conveniently located to permit testing, maintenance, trouble isolation, and ease of connection to the customer's equipment. The interface connecting block (see Fig. 2) must be located within 25 feet of the Voice Connecting Arrangement. The Voice Connecting Arrangement is shown in Figure 1.

3.2 Functions

The major functions of this voice connecting arrangement and its associated Bell System PBX switchboard are:

a. To provide voice frequency access to and from the telecommunication network.

b. To provide network control signaling to the network.

c. To limit abnormally high voice signal voltages.

d. To isolate hazardous voltages and currents.

e. To provide for dialing into the customer-provided equipment.

f. To provide for accepting supervisory signals from the customer-provided equipment.

3.3 Originating and Receiving a Call

3.31 Incoming Call From the Central Office

A call received at the Bell System Manual PBX, either from the telecommunication network or from a manual station, is to be connected to a station of the customer-provided communications system. When the voice connecting arrangement is seized by a PBX attendant plugging into the TALK jack, an off-hook signal (closure) is transmitted to the customer-provided equipment over the TRANSMISSION leads (CT and CR), to seize it in preparation for dialing. If the PBX is a multiple switchboard, the busy lamps for this circuit will light and if the PBX furnishes machine ringing, it will be tripped. When the attendant plugs into the DIAL jack, the customer's line will be transferred from the TALK jack to the DIAL jack for dialing purposes. Dial tone, from the customer-provided equipment, if present, will be heard by the attendant who will dial the desired customer's station number and then disconnect from the DIAL jack. The customer's line will then be transferred back to the TALK jack. When the station is answered, the customer-provided equipment closes a contact that connects the SERVICE REQUEST leads (CS and CG) together which operate the supervisory relay of this circuit. This relay initiates cut-through of the transmission path via the voice coupler portion of this circuit from the TALK jack to the customer's line. As soon as the circuit has cut-through the attendant will receive answer supervision in the form of a lamp signal on her cord. If the station user wishes to recall the attendant, he may do so by slow (minimum 1/2 second open) switchhook flashing. When the station is placed on-hook (open on the CS-CG leads), the attendant will receive disconnect supervision in the form of a lighted

lamp signal and will release the connection. This circuit will then return to its idle condition. See Figure 4.

3.32 Outgoing Call Towards the Central Office

When the customer's station user dials the proper code to connect to this circuit, the customer-provided equipment closes a contact that connects the SERVICE REQUEST leads (CS and CG) together which operates the supervisory relay of this circuit causing the PBX station line lamp to light. If the customer's equipment furnishes machine ringing, it will be tripped when his equipment cuts-through to the TRANSMISSION leads (CT and CR). When the PBX attendant plugs into the TALK jack associated with the lighted line lamp, the lamp will be extinguished and the transmission path will be cut-through, via the voice coupler portion of the circuit, to the customer's station. The attendant will receive off-hook supervision (dark lamp) on her cord, and will establish the desired connection for the station user. If the desired connection requires dialing, the attendant will dial the number in the usual manner. This circuit prevents through dialing by the customer-provided station. If the station user wishes to recall the attendant, he may do so by slow (minimum 1/2 second open) switchhook flashing. When the station is placed on-hook, the attendant will receive disconnect supervision and will release the connection. This circuit will then return to its idle condition.

3.4 Interface Leads

Four interface leads per circuit are provided from the Voice Connecting Arrangement 2A to an interface terminal block (see Fig. 2) for the customers' use. Technical information pertaining to these leads is discussed in Section 4.

The first pair, designated CT and CR, provides the two-way voice transmission path from the voice connecting arrangement. The second pair, designated CS and CG, provides for the function of request for service of an outgoing call and the answer of an incoming call.

The customer must provide and install the conductors from the customer-provided communication system to the interface connecting block. This block will accept leads up to 18 gauge.

3.5 Method of Connection

The leads from the Voice Connecting Arrangement 2A will be terminated by the Telephone Company in a terminal box equipped with the interface connecting block (Fig. 2). The customer or his representative will make the necessary connections to associate his equipment with the voice connecting arrangement at this terminal box. The leads from the voice connecting arrangement will be terminated by the Telephone Company on studs under washers secured by nuts on an interface connecting block mounted in the box. Separate nuts and washers on the same studs will be provided for the customer's connections. These will be designated as follows:

EARLIER DESIGNATION*	CURRENT DESIGNATION	FUNCTION
1T2	1CT	(voice transmission
1R2	1CR	(pair
S2	CS	(service request
S3	CG	(pair
2	2	(designates (second (circuit

* A small quantity of initially provided units will have this designation.

EARLIER DESIGNATION	CURRENT DESIGNATION	FUNCTION
3	3	(designates (third (circuit

4. ELECTRICAL CHARACTERISTICS

4.1 General

The Bell System Manual PBX will generate dial pulses over the interface leads CT and CR towards the customer-provided equipment at the rate of 8 to 11 pulses per second with a percent break of 58 to 64 percent. The 600 ohm insertion loss of the Voice Connecting Arrangement 2A is approximately one (1) dB over the voice frequency range of 300 to 3,000 Hertz. The customer's equipment must furnish its own talk and signal battery. No voice signal amplification is provided by this arrangement.

4.2 Transmission Path - Leads designated CT and CR

4.21 Voice Signal Limiter

A voice signal limiter is incorporated in the transmission path to protect the Bell System telecommunication network from applications of abnormally high signal levels. This has no effect on normal voice signal levels.

This limiter does not remove the customer's responsibility to meet the network protection criteria as prescribed in the Tariffs and as outlined in Section 5 of this Technical Reference.

4.22 Transmission Parameters

The Voice Connecting Arrangement 2A provides about one to one impedance transformation. The impedance is a function of the manual PBX Switchboard

and the design of the connection between the switchboard and the central office. For design purposes, the impedance of the customer-provided equipment should be 600 ohms. The voice signal levels must comply with the applicable Tariffs. The Tariffs permitting electrical connection of customer-provided communications systems state: "To prevent excessive noise and cross-talk in the network, it is necessary that the power of the signal at the central office not exceed 12 dB below one milliwatt when averaged over any three second interval. To insure that this limit is not exceeded the power of the signal which may be applied by the customer-provided equipment to the Telephone Company interface located on the customer's premises will be specified for each type of connecting arrangement, but in no case shall it exceed one milliwatt."

For the Voice Connecting Arrangement 2A the maximum permissible voice signal power at the interface connecting block is -9 dBm when averaged over any 3-second interval.

4.23 Signaling Parameters

The minimum current which the customer-provided equipment shall supply over the CT and CR leads for dialing shall be 0.025 ampere through a series resistance of 350 ohms, mimimum. This insures that the 180 ohm relay in series with the dial circuit will operate to permit dialing by the PBX attendant. The maximum dc voltage across terminals CT and CR or from ground to CT or CR, measured at the interface connecting block, shall be as follows:

a. In the talking mode, 12 volts dc. This insures that the 200 ohm inductor of the holding bridge across CT and CR does not saturate and cause excessive transmission loss.

b. In the idle mode, 55 volts dc. This insures that the ring tripping electron tube, when connected, will not fire falsely.

When the customer-provided equipment furnishes machine ringing, the machine ringing circuit must be capable of supplying 85 volts ac, minimum, superimposed on 44 volts dc, minimum. The ringing generator current must flow into the loop CT-CR, when applied, so that the ringing can be tripped on a loop basis in this arrangement. The customer's tripping circuit shall be capable of limiting the peak current through the voice connecting arrangement ring tripping electron tube to 0.035 ampere dc, maximum. The ringing voltage supply shall be grounded. See Section 4.4 Grounding. The voice connecting arrangement does not supply battery or ground over the CT or CR leads.

4.3 Service Request Path - Leads designated CS and CG

This pair of leads provides the means of answering an incoming call and initiating an outgoing call from the customer's communication system. The customer's equipment must provide a closure to answer an incoming call, continue that closure throughout the duration of the call, open these leads when the customer's equipment disconnects at the completion of the call, and maintain the open until the next call is handled. When a call is initiated, the customer's equipment is expected to provide and maintain a closure throughout the duration of the call, open these leads at the completion of the call, and maintain the open unitl the next call is handled. The transmission path will be cut through a closure of the SERVICE REQUEST leads

(CS and CG) and the transmission path will remain connected until the SERVICE REQUEST leads are opened. The CS lead of the SERVICE REQUEST pair has a maximum of -52 volts dc through 2,000 ohms. The CG lead is grounded at the voice connecting arrangement. See Section 4.4 Grounding. The SERVICE REQUEST pair will load the customer's supervisory contact with 0.030 ampere, maximum, inductive load. The minimum open circuit insulation resistance between the CS lead and the CG lead, and from either lead to ground, will be 100,000 ohms. The maximum external loop resistance from the CS lead to the CG lead measured at the interface connecting block towards the customer is shown in the table.

DC Supply Voltage	Maximum Resistance CS to CG at Interface
20-26	200 Ohms
26-32	900 Ohms
32-44	1600 Ohms
44-52	3000 Ohms

The selection of the value of the supply voltage is at the option of the Telephone Company and will vary with each installation. The installer will inform the customer of that value at the time of installation.

4.4 Grounding

In general, it is desirable that circuits in the customer's equipment which connect to the voice connecting arrangement have some path to ground. A direct or resistive ground on one side of the power supply would be an example of such a path. This practice avoids the possibility of the entire circuit involved being at an indeterminate potential with respect to ground.

Such a potential, perhaps as a result of electrostatic induction, could result in an insulation breakdown in the arrangement. It is expected that the customer's equipment, if powered from commercial power, will be grounded in accordance with applicable electrical codes (NEC). Self-powered or passive customer's equipment need not be grounded. One side of the customer's ringing generator supply, when provided, should be grounded.

The Bell System switchboard and the Voice Connecting Arrangement 2A are provided with a common signal ground (a cold water pipe or other ground approved by the N.E.C.) which is always bonded to the electric power ground and telephone protector ground where present. The CG lead of the SERVICE REQUEST pair is grounded at the unit. If necessary, this SERVICE REQUEST ground lead may be connected to the frame ground of the customer's equipment. It is not permitted to derive the main ground for the customer's equipment through this lead from the voice connecting arrangement.

As an example, a good ground may be obtained with a proper connection to a metal cold water pipe, using a single #6 AWG conductor. The other end should be connected to the ground return terminal of the customer's equipment. Proper attention should be given to providing the lowest possible resistance connection at each end of the circuit. It is imperative that this ground be connected at the same location to the water piping system as the telephone protector or signal ground. A preferable connecting point is the grounding terminal of the telephone protector where present. This lead shall not be fused.

5. POWER AND IMPEDANCE CONSIDERATION FOR CUSTOMER-PROVIDED EQUIPMENT

5.1 Average Power at the Central Office

The average power (in any 3-second interval) delivered to a 900-ohm resistive load at the Central Office should not exceed - 12 dBm. The limitations described in 5.2 and 5.3 below, on power at the customer's location have been set so that when all PBX loops and manual PBX Switchboards in the Bell System are considered, the limit of -12 dBm will be met.

5.2 Maximum Available Power

The central office power criterion, in 5.1 above, can be satisfied by limiting the maximum available power* from a customer-provided 600 ohm source to -9 dBm when averaged over any 3 second interval. The customer-provided communication system should be so designed that the average power over any 3-second interval applied to the interface block associated with a Voice Connecting Arrangement 2A does not exceed -9 dBm. The recommended procedure for estimating the power is given in Section 6.

5.3 Signaling Considerations

The telecommunication network incorporates tone signaling devices that are used for network control functions. These devices, connected at all times to the telephone circuit, are designed to be sensitive to single frequency tones 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.

* The available power of a source is the maximum power that the source can deliver to a load. Maximum power transfer occurs when the load and source impedance are matched.

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.

5.4 Out of Band 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 3,995 Hertz to 4,005 Hertz shall be at least 18db below the power of the signal as specified in Section 5.2 above.

b. The power in the band from 4,000 Hertz to 10,000 Hertz shall not exceed 16db below one milliwatt.

c. The power in the band from 10,000 Hertz to 25,000 Hertz shall not exceed 24db below one milliwatt.

d. The power in the band from 25,000 Hertz to 40,000 Hertz shall not exceed 36db below one milliwatt.

e. The power in the band above 40,000 Hertz shall not exceed 50db below one milliwatt.

5.5 Internal Impedance

The internal impedance of the customer's equipment should be approximately 600 ohms.

6. TESTING AND MEASURING METHODS

6.1 General

Studies of measuring techniques for measuring maximum available power are being made and should result in refinement to the methods given below. It is expected that refinements in or alterations to the recommended measuring procedure will be available in a forthcoming technical reference. In addition, information related to the philosophy and techniques of measuring transmission parameters as applied to voice connecting arrangements will be discussed in this forthcoming technical reference expected to be available from:

Engineering Director - Customer Telephone Systems
American Telephone and Telegraph Company
195 Broadway
New York, New York 10007

6.2 Measuring Maximum Available Power

The following measuring method is satisfactory for estimating the maximum power averaged over a 3-second interval to determine that the inband criterion is being met:

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 Telephone Test Meter 3555A, a Western Electric 3C (3A) Noise Measuring Set, or the equivalent.* The meter FUNCTION switch should be in the BRIDGE position, the slide switch marked DAMP-NORM in the DAMP position, and 3kHz flat weighting should be used. In almost all cases

* 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 speech power averaged over any 3-second interval will not exceed -9 dBm if the maximum meter swing does not exceed 84 dBrn.

The accuracy of this method can be somewhat improved by increasing the size of the damping capacitance in the Western Electric 3C or 3A Noise Meter by 150 micro-farads. To do this connect the minus side of a 150 micro-farad capacitor to either terminal of the NORM/DAMP switch and connect the plus side to ground. This allows the meter to more nearly approximate a 3-second averaging meter. (NOTE: This modification does not necessarily hold for noise meters other than the Western Electric 3C and 3A.) With the additional damping the power averaged over any 3-second interval will not exceed -9 dBm if the maximum meter swing does not exceed 82 dBrn. The use of meters with shorter time constants, such as a VU meter or a standard voltmeter, is not recommended.

7. TELECOMMUNICATIONS NETWORK CHARACTERISTICS

7.1 Transmission Parameters

Information describing the component parts and operating characteristics of the Bell System telecommunication network has been published. Various articles have discussed statistical information on talker volumes (a), end-office losses and noise (b-d), loop characteristics (e), and other characteristics (f-h); these articles are listed in Section 8. In addition, five general information texts are listed.

The 1000 Hz insertion loss for this voice connecting arrangement (with a customer's communication device having a 600 ohm source impedance) and its associated loop will average about 3 dB with a standard deviation of about 1 dB.

7.2 End-to-End Electrical Loss

The end-to-end electrical loss of a connection is a function of the impedances of both end terminations, the losses of the loops at both ends, and the end-office loss. The information given in the references may be used to determine statistical loss distributions for different types of calling patterns on the telephone network.

7.3 Bandwidth and Frequency Response

The nominal voice frequency bandwidth of the telecommunications network is about 3000 Hz. In general, an end-to-end connection may be expected to have a loss characteristic which increases with increasing frequency. This voice connecting arrangement does not limit this bandwidth.

7.4 Nonlinearities

Nonlinearities such as compression, clipping, and harmonic distortion can exist on the telecommunications network. Normally, these are low enough to be ignored. It is expected that total harmonic distortions no greater than about 5 per cent of the fundamental will normally be encountered.

8. REFERENCES

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

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

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

c. Nasell, I., "Some Transmission Characteristics of Bell System Toll Connections", BSTJ, 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, 47, No. 8 (October 1968), p. 1561.

e. Hinderliter, R. G., "Transmission Characteristics of Bell System Subscriber Loop Plant", IEEE Transactions, Communications and Electronics, September 1963, p. 464.

f. Alexander, A. A., Gryb, R. M., and Nast, D. N., "Capabilities of the Telephone Network for Data Transmission", BSTJ, 39, No. 3 (May 1960), p. 431.

g. Breen, C., and Dahlbom, C. A., "Signaling Systems for the Control of Telephone Switching", BSTJ, 39, N. 6 (November 1960) p. 1381.

h. Bodle, D. W. and Gresh, P. A., "Lightning Surges in Paired Telephone Cable Facilities", BSTJ, 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. Notes on Distance Dialing - 1968 by American Telephone and Telegraph Company, New York, New York.

* m. Transmission Systems for Communications by Bell Telephone Laboratories.

* Available through Graybar Electric Company.

9. GLOSSARY OF TERMS AS USED IN THIS TECHNICAL REFERENCE *

COMMUNICATION SYSTEMS - denotes channels and other facilities which are capable when not connected to the telecommunication network, of two-way communication between customer-provided terminal equipment.

CONTROL FUNCTION - see network control.

CONNECTING ARRANGEMENT - the Voice Connecting Arrangement 2A provided by the Telephone Company to accomplish the direct electrical connection of customer-provided facilities with the facilities of the Telephone Company and to connect the transmission path from the customer-provided equipment to the telecommunications system.

CUSTOMER-PROVIDED TERMINAL EQUIPMENT - devices, apparatus, and their associated wiring, provided by a customer, which do not constitute communications systems.

END-OFFICE - the last serving Central Office in the switching hierarchy of the telecommunication network.

INTERCOM - the general category of equipment which is used to provide internal communication between stations of a customer.

INTERFACE CONNECTING BLOCK - the Telephone Company furnished connecting point to which the customer brings and connects the leads of his equipment.

* May differ in letter from exact wording as used in the Tariffs.

NETWORK CONTROL SIGNALING - the transmission of signals used in the telecommunication 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 re-order or busy condition, alerting, coin denominations, coin collect and coin return tones) to control the operation of switching machines in the telecommunication system.

NETWORK CONTROL SIGNALING UNIT - the Bell System Manual PBX Switchboard furnished, installed and maintained by the Telephone Company for the provision of network control signaling used with the Voice Connecting Arrangement 2A.

OFF-HOOK SUPERVISION - the conditioning of the SERVICE REQUEST leads by the customer-provided equipment which indicates a customers' 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 customers' telephone has disconnected, or theequipment is idle.

SERVICE REQUEST - the designation of the leads or function which accepts supervision from the customer's equipment.

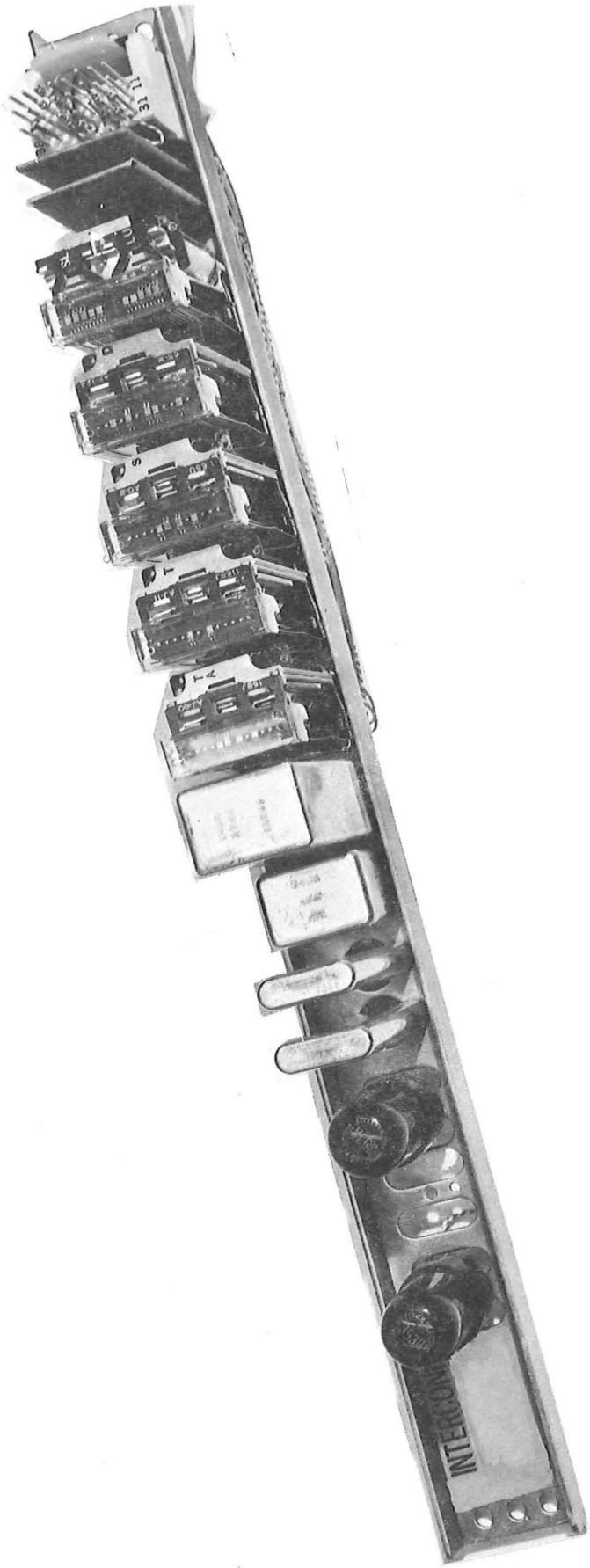
SUPERVISORY SIGNALS - see off-hook and on-hook supervision.

TELECOMMUNICATION NETWORK - the Bell System voice switching equipment, associated interconnecting facilities and station equipment which connects its subscribers together.

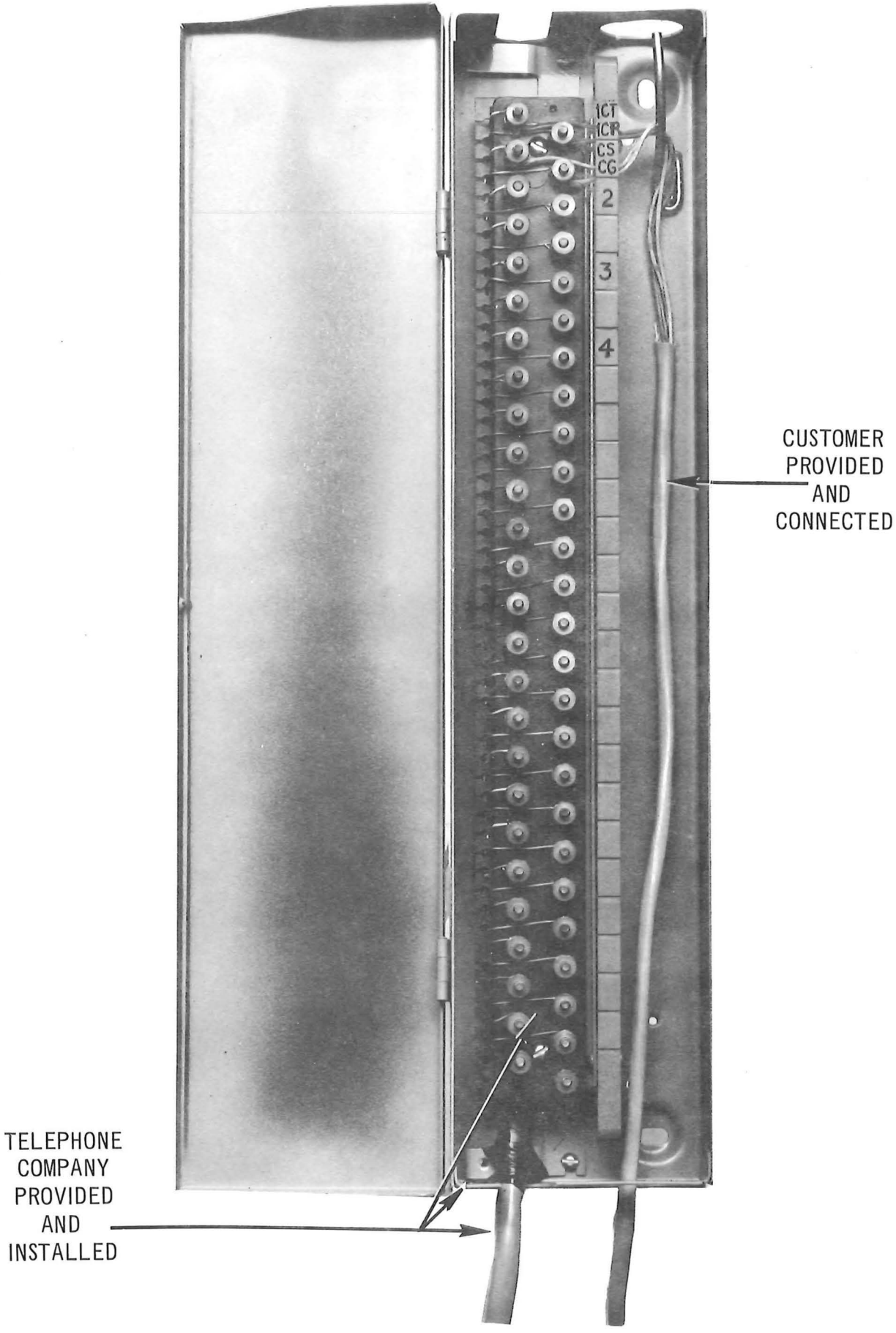
TELEPHONE COMPANY - denotes the American Telephone and Telegraph Company, Long Lines Department, its concurring carriers and its connecting carriers, either individually or collectively.

VOICE COUPLER - the Voice Connecting Arrangement 2A which connects the transmision path from the customer-provided equipment to the telecommunication network.

LIST OF FIGURES



VOICE CONNECTING UNIT 2A
Fig. 1



Interface Connecting Block
Fig. 2

BLOCK DIAGRAM – CONNECTING ARRANGEMENT 2A AND NETWORK CONTROL SIGNALING UNIT

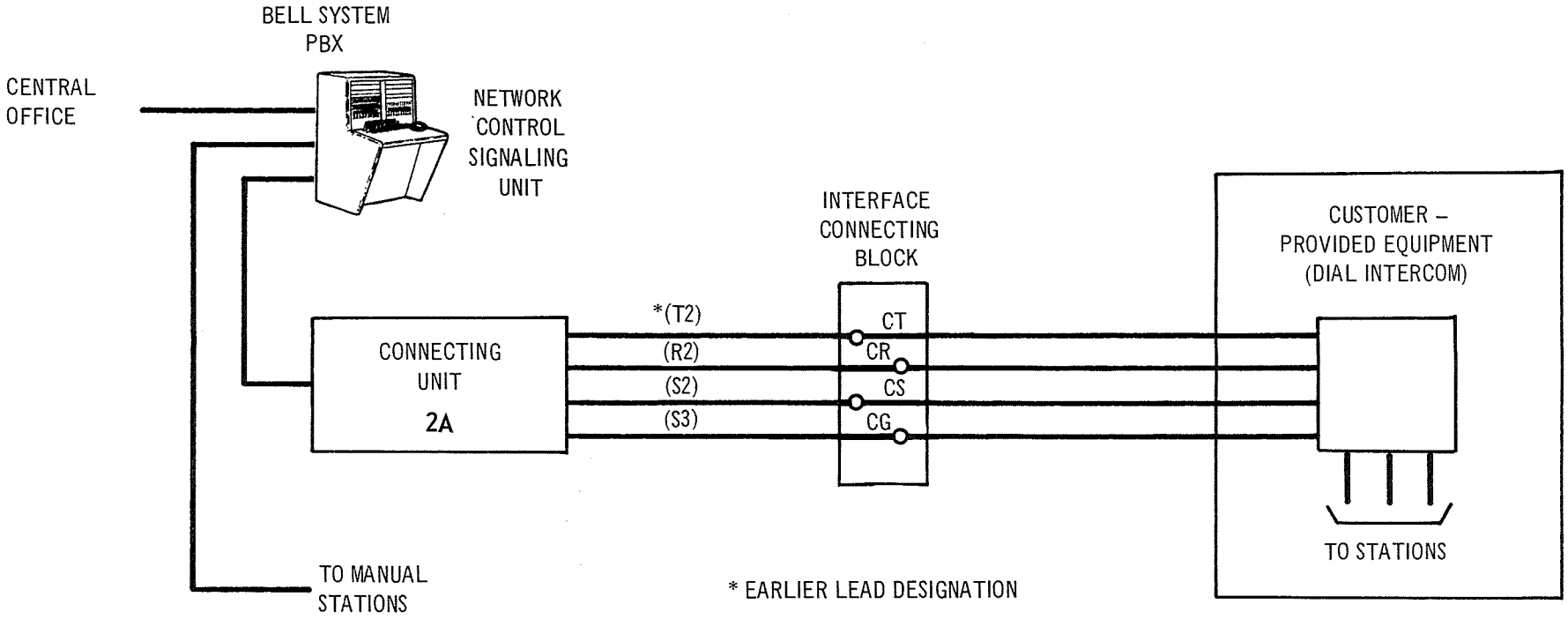


Fig. 3

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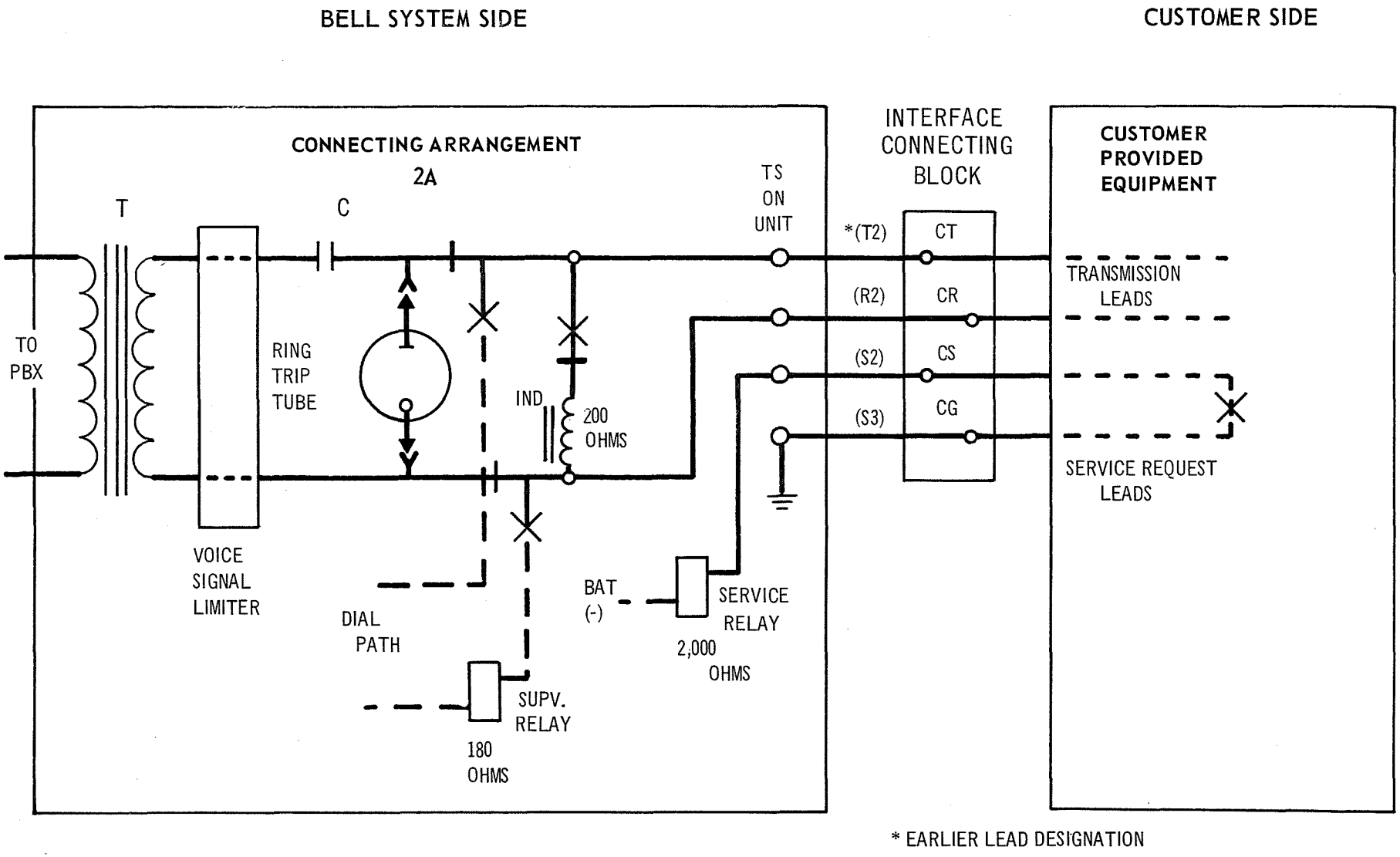

* EARLIER LEAD DESIGNATION

SIMPLIFIED SCHEMATIC – CONNECTING ARRANGEMENT 2A
FIG. 4

PRELIMINARY