CENTREX DATA LOOP AND CONSOLE CONTROL

DESCRIPTION

2-WIRE NO. 1 ELECTRONIC SWITCHING SYSTEM

1. GENERAL

1.01 This section describes the Centrex data loop and the console control system used in conjunction with the 2-wire No. 1 Electronic Switching System (ESS) equipped to provide Centrex-CO and PBX-CO service. For a general description of Centrex-CO and PBX-CO service designed for the 2-wire No. 1 ESS, refer to Section 966-102-100.

1.02 The information in this section was previously given in Section 231-202-101.

1.03 Centrex-CO and PBX-CO service may be provided as follows:

(a) With 1B- and 2B-Type attendant consoles (requiring Centrex data link hardware)

(b) With 121-, 131-, and 151-Type 50A-CPS attendant consoles (not requiring Centrex data link hardware)

(c) Without attendant consoles (using call director, keyset, or simple telephone as attendant position).

1.04 This section describes the Centrex data loop and console control system operation when providing Centrex-CO and PBX-CO service with the 1B- and 2B-Type consoles.

1.05 The operation of the Centrex data loop and console control system for Centrex-CO and PBX-CO service is basically the same. The primary difference is the modification of Centrex-CO translations to simulate PBX-CO service.

Note: For convenience of reference in this document, Centrex-CO and PBX-CO customer service are referred to as Centrex service.

1.06 This Centrex service utilizes the data handling capabilities and switching facilities of a 2-wire No. 1 ESS central office. All Centrex operations are under the control of the central control or the signal processor in the ESS office to which the customer group is connected.

1.07 In order to control the states of the lamps and to receive key signals from the remote Centrex attendant telephone consoles, a data loop and a console control system is employed. Fig. 1 is a block diagram of a typical Centrex customer group. Only one console is shown although as many as four may be controlled by a single data loop and console control system.

1.08 The central office end of a Centrex data loop terminates in a Centrex data link circuit mounted on a Centrex data link frame in the ESS central office. The data link is a peripheral unit which provides the interface between the data loop and the ESS central office control equipment.

1.09 The remote end of a data loop terminates in a console control circuit contained in the Centrex console control cabinet at the Centrex location. The console control circuit provides the interface between the data loop and the attendant telephone consoles.

2. CENTREX DATA LOOP AND DATA LOOP SIGNAL TRANSMISSION

CENTREX DATA LOOP

2.01 Console lamp state changes and key signals are transmitted as data between the remote Centrex location and the central office by means of the data loop. Fig. 2, a block diagram of Centrex service, illustrates this data loop.

2.02 The Centrex data loop consists of two separate 2-wire unidirectional data links. These data links are interconnected at the central office end and at the remote Centrex end by means of transmitting and receiving circuitry in such a way that the two links form a complete loop.

2.03 Lamp data used to control the states of the lamps on the consoles is transmitted from the central office to the attendant consoles, and key signal data is transmitted from the Centrex location to the central office by means of this data loop. Voice frequencies are used for transmission. A synchronous form of transmission is employed, therefore, the receiving end of a data loop is always in synchronism with the transmitting end.

2.04 Data is transmitted serially in the form of a 26-bit data word which contains 24 information bits plus two leading control bits. The two leading control bits are used to indicate to the data receiver circuit at the remote end of the data loop that transmission has started. Furthermore, these bits are used to properly synchronize the

CENTREX
CONSOLE
CONTROL
CABINET

DATA LOOP

(TWO PAIRS)

CENTREX
DATA
LINK

NO. I ESS
CENTRAL
PROCESSOR

ATTENDANT CONSOLE

ATTENDANT
TRUNK CIRCUIT

(TALKING PATH)

SUBSCRIBER
LINES

ATND
TRUNK
AND
LOOP
CIRCUITS

TIE
TRUNKS
AND
FOREIGN
EXCHANGE
TRUNKS
TO OTHER
SWITCHING
SYSTEMS

CENTREX STATIONS

CUSTOMER
PREMISES

LINE
LINK
NETWORK

TRUNK
LINK
NETWORK

ESS SWITCHING
FRAMES

NON-CENTREX
SUBSCRIBER

CENTREX CUSTOMER GROUP

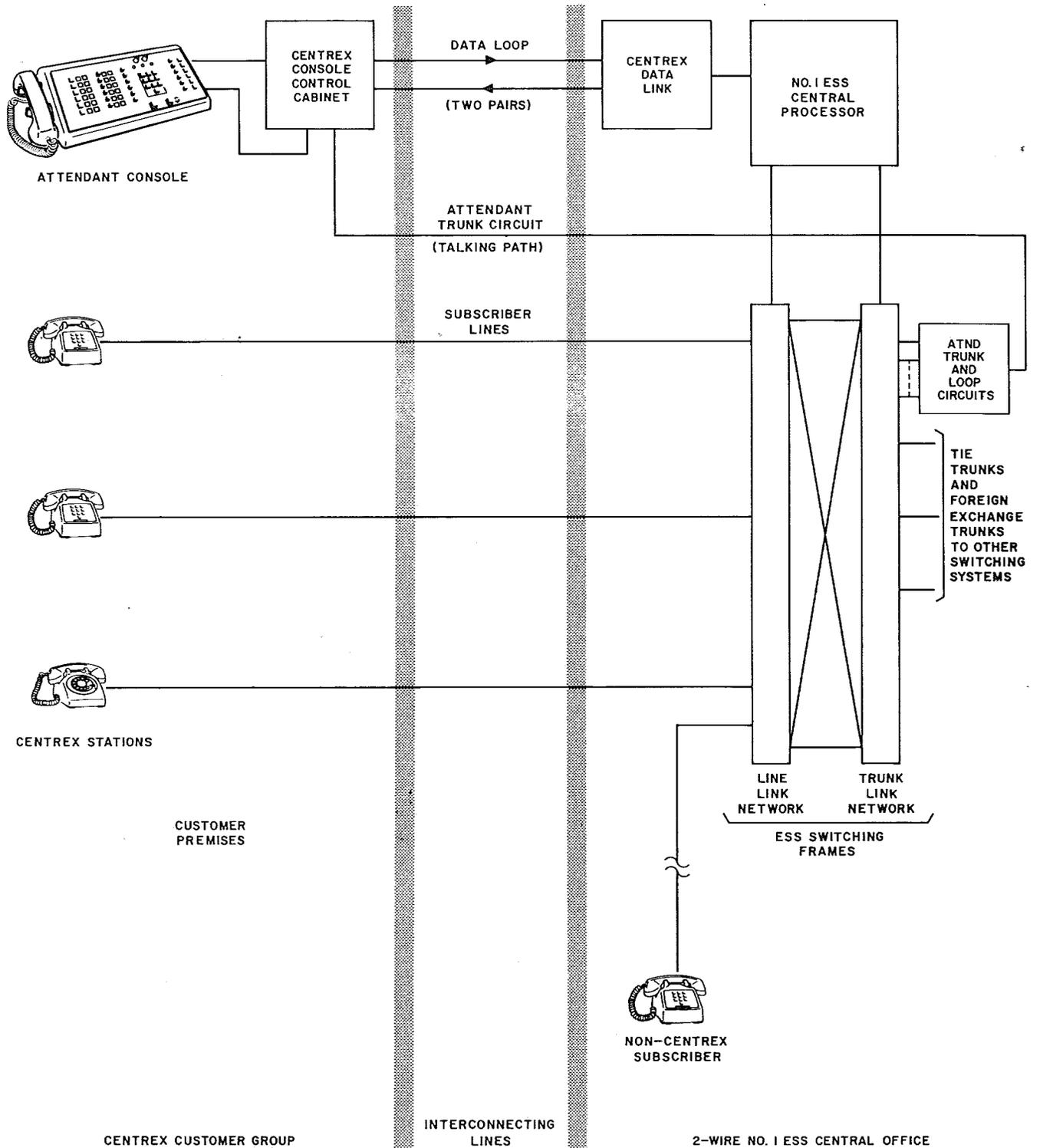INTERCONNECTING
LINES

2-WIRE NO. I ESS CENTRAL OFFICE

Fig. 1—Basic 2-Wire No. 1 ESS Centrex System

start of transmission on both links of the data loop.

A. Data Shift Registers

2.05 A 26-bit shift register is located at both the central office end and the remote Centrex end of the data loop. These shift registers provide the means for parallel-to-serial and serial-to-parallel conversion of the transmitted and the received data.

2.06 The data shift register located at the central office end of a data loop accepts the 24 bits of data from the peripheral unit bus and temporarily stores it before the data is transmitted as lamp data to the remote Centrex end of the data loop. In addition, this register is also used to receive and temporarily store key signal data originating from the remote end. The central control (or signal processor) at the central office can read out the contents of this register via scan points when key signal data is received.

2.07 The data shift register located at the remote Centrex end of the data loop accepts and temporarily stores 24 bits of data originating from keys being depressed on the console. (This data, is transmitted as key signal data to the central office end of the data loop.) In addition, this register receives and temporarily stores the lamp data, which is used for controlling the console lamps transmitted from the central office end.

2.08 Transmission on the data loop is controlled by the circuitry located in the central office. However, a request to transmit the contents of a register may be initiated by either the central control (or the signal processor) at the central office or by the attendant console circuitry at the customer's premises.

2.09 When a data loop is in an idle state (that is, no data is being transmitted in either direction), spaces (binary 0's) are, in effect, being transmitted continuously in both directions. Upon receiving a request to transmit, the transmitting circuitry at the central office applies the contents of the shift register to the line in serial form. The first pulse transmitted is always a mark (a binary 1). The receipt of an initial mark changes the state of the receiver at the remote end from idle to active and causes the receiving shift register to shift in synchronism with the received line signal.

2.10 When either the central control or the console circuitry requests transmission of a data word, the two registers interchange their contents. Since normally only one of these registers contains any information when a data transmission occurs, a blank word containing all 0's (spaces) is usually transmitted in one direction. If the central office end of the loop requests to transmit, the register at the remote end usually transmits all 0's. If the remote end of the loop requests to transmit, the register at the central office end of the loop usually transmits all 0's. In some instances, however, both registers will contain information. Data is transmitted at a rate of 1400 bits per second in both directions.

B. Lamp Data Transmission

2.11 Service requests and other supervisory signals are sent as lamp data from the ESS central office to the remote Centrex location by means of the data loop. Lamp data is sent from the central control or the signal processor over the peripheral bus to the common control equipment in a Centrex data link frame. The common control equipment selects the proper lamp data transmitter, which is enabled by the central pulse distributor. From here, the data is loaded into a register and transmitted serially as binary coded signals by means of a data link to a data receiver at the Centrex customer location. The lamp control circuit decodes the message and stores it in a lamp state memory unit. The lamp state memory then operates the selected console lamps to the desired state.

C. Key Signal Transmission

2.12 Key signals are generated when an attendant operates a console key. These signals are encoded by an associated key signal translator in the console control cabinet at the customer's premises. The encoded data is inserted into the local shift register as a binary number when the register is found to be empty. From there this data is transmitted in serial form to the No. 1 ESS central office where it is received by a receiver. The receiver stores the data in the data shift register. The contents of the register are read out by means of the key scan program which is entered from the central control executive control program at regular interrupt intervals.

2-WIRE NO. I ESS OFFICE ARRANGED WITH CENTREX SERVICE

CUSTOMER PREMISES

MISC TRUNK FRAME

LOOP CKT

LOOP CKT

ATND TRK CKT

TO CENTREX OPERATOR VIA TRANSMISSION FACILITIES

LINE LINK NETWORK

TRUNK LINK NETWORK

LINES TO CUSTOMER STATIONS

CENTREX CUSTOMER STATION

CENTRAL CONTROL

PERIPH UN BUS

CENTREX DATA LINK FRAME

TO MAXIMUM OF 7 OTHER DATA LINKS (SAME FRAME)

TRMTR

DATA LOOP

CENTREX CONSOLE CONTROL CABINET

RCVR

CONSOLE CONTROL

CABLE RECEIVER AND BUFFER REGISTER

DATA LINK CONTROLLER

SHIFT REGISTER

DATA LOOP TRANSFER CKT

CONSOLE KEY TRANSLATOR CKT

SHIFT REGISTER

LAMP CONTROL CKT

3

TEL CONSOLE 3

2

TEL CONSOLE 2

I

TEL CONSOLE I

O

CENTRAL PULSE DISTRIBUTOR

RCVR

TRMTR

SIGNAL DISTRIBUTOR
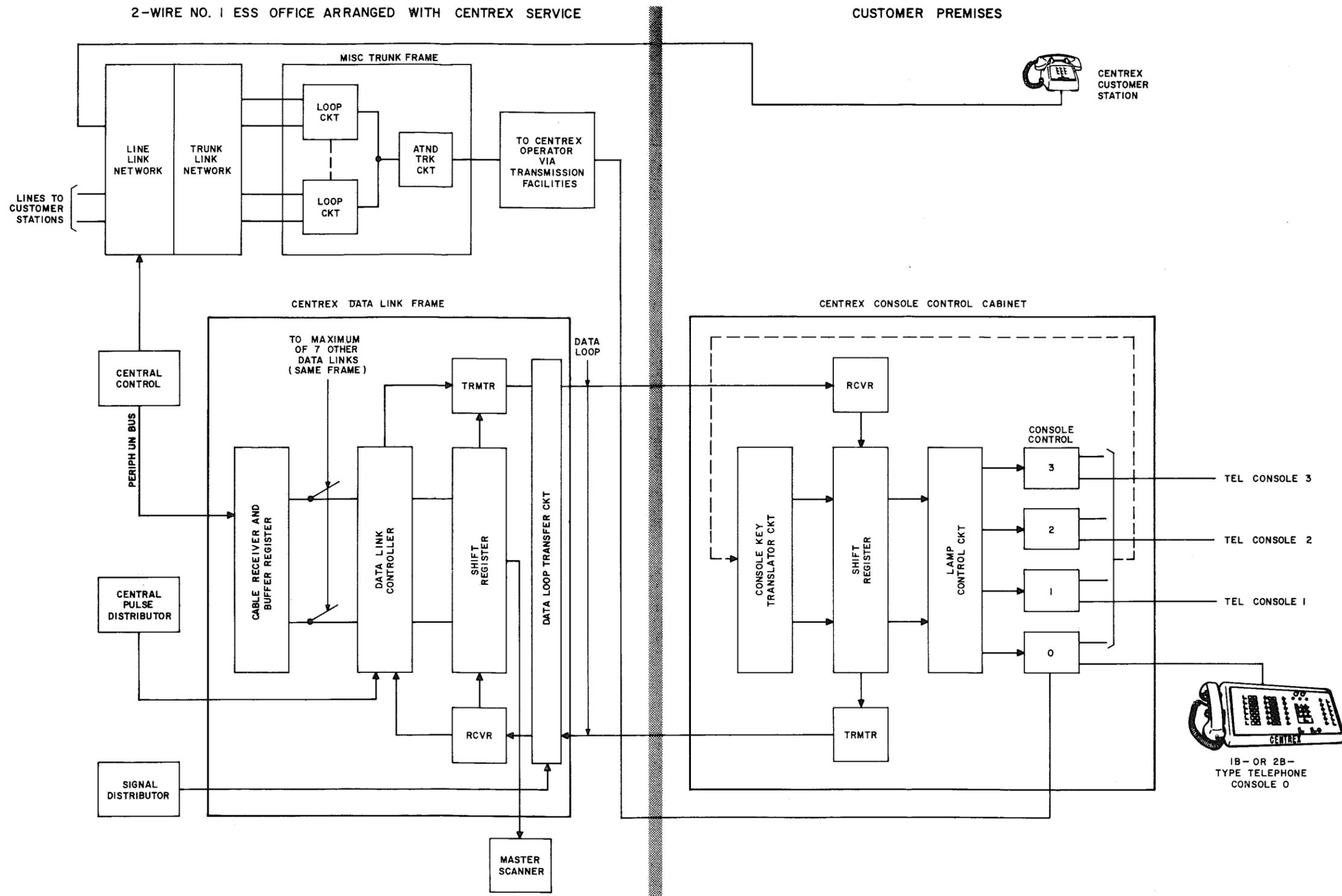
IB- OR 2B- TYPE TELEPHONE CONSOLE O

MASTER SCANNER

Fig. 2 — Centrex-CO or PBX-CO Service—Block Diagram

D. Key Scan Program

2.13 A 100-millisecond (in CC generics) or a 60-millisecond (in SP generics) key scan program scans the Centrex data units at the central office for the presence of key signals received from the remote attendant consoles. When a key signal is received by the data unit, a key signal present scan point is saturated. The key scan program then generates a hopper entry containing the key signal. After the key signals have been read, this same program sends any lamp data that has been awaiting transmission back to the console location. The Centrex key scan program is entered from the executive control program on an interrupt basis at intervals of 100- or 60-milliseconds.

2.14 Several scan points are provided to inform the system about the state of the data link circuit—that is, whether or not the data link circuit is in the process of transmitting or receiving data and/or whether or not there is any information present in its register waiting to be read by the central control. These scan points must be checked before lamp data is loaded into the register for transmission to the remote end of the data loop.

2.15 The Centrex key scan function can be performed either by a central control or by the signal processor program (whichever is used for input-output functions).

DATA LOOP LINE SIGNAL TRANSMISSION

2.16 When key signals or lamp data is to be transmitted via a data loop, it must be converted into audio-frequency signals and must be applied to the transmission facility. Basically, the method of generating and receiving the line signal is the same for both directions. The data to be transmitted is temporarily stored in the shift register at the transmitting end of the data loop prior to transmission. The contents of the shift register are then read out serially and are converted into audio frequencies for transmission to the opposite end of the data loop. A synchronous form of transmission is employed whereby the receiving circuitry operates in synchronism with the transmitting circuitry.

A. Data Loop Line Signal

2.17 The data loop line signal is constructed by a discontinuous frequency-shift keying method

(Fig. 3). The line signal is generated by switching between two oscillators, one operating at 700 Hz and the other operating at 2100 Hz.
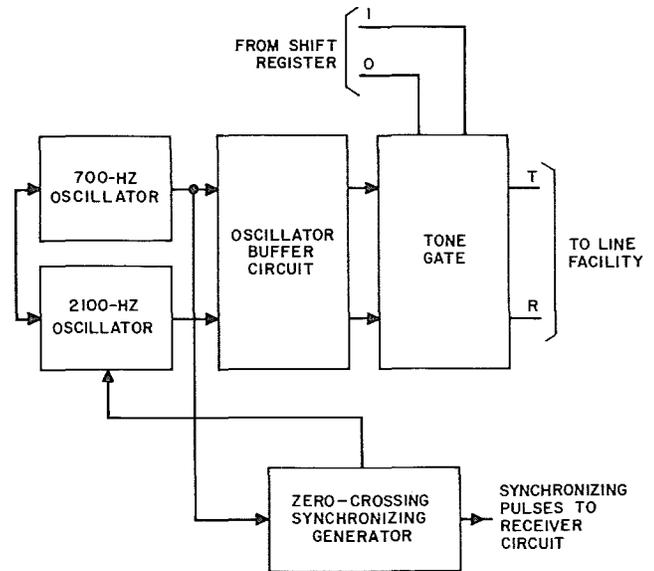
Fig. 3—Basic Data Transmitter

2.18 *Tone Gate:* Switching between the two oscillators is accomplished by the use of a tone gate. The tone gate applies the output of either of the two oscillators to the line, depending on the contents of the shift register. When the first bit in the shift register is a 1 (mark), the tone gate applies the output of the 2100-Hz oscillator to the line. When the first bit is a zero (space), the tone gate applies the output of the 700-Hz oscillator to the line. Each of the succeeding bits causes the output of either the 700-Hz or 2100-Hz oscillator to be applied to the line in a similar manner.

2.19 *Oscillator Buffer Circuit:* The oscillator buffer circuit isolates the oscillator from the tone gate.

2.20 *Zero-Crossing Synchronizing Generator:* This circuit is used to ensure that the shifting of the register is synchronized with the phase of the audio signal oscillators. Each zero crossing of the 700-Hz signal occurs at the same time and has the same polarity slope as the 2100-Hz signal. This is accomplished by stopping both oscillators momentarily and restarting them again in proper

phase relation. This phase-correcting function is performed by the zero-crossing synchronizing generator. Fig. 4 illustrates the output of the two oscillators and the points at which they are stopped and restarted in phase.
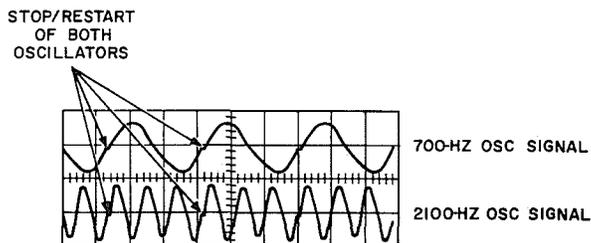
STOP/RESTART
OF BOTH
OSCILLATORS

700-HZ OSC SIGNAL

2100-HZ OSC SIGNAL

Fig. 4—Transmitter Oscillator Waveforms

2.21 Fig. 5 illustrates a dc binary signal applied to a tone gate and the resulting line signal which is transmitted. (Only a few of the bits are shown in this illustration.) A binary 0 or space signal is represented by a half cycle of the 700-Hz signal. A binary 1 or mark signal is represented by three half cycles of the 2100-Hz signal. The presence of a mark will therefore cause a phase reversal during the center of a bit interval as opposed to the presence of a space.
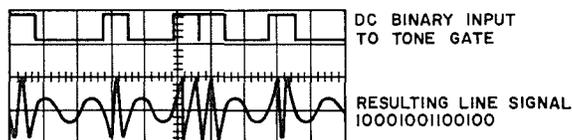
DC BINARY INPUT
TO TONE GATE

RESULTING LINE SIGNAL
1000100100100100

Fig. 5—DC Binary Signal and Resulting Line Signal

2.22 When key data or lamp data is not being transmitted, the data loop idles with a steady 700-Hz tone applied to the line. This tone is equivalent to a continuous stream of spaces. The steady idling tone keeps the receiver circuit at the receiving end of a data loop in synchronism with the transmitter. This continuous idling tone also serves as a guard against impulse noise on the line causing false starts of the shift registers at the receiving end of the data loop.

B. Line Signal Data Recovery

2.23 Data recovery from the line signal is accomplished by sampling the received signal at the center of each bit interval. A phase reversal during the center of a bit interval caused by the presence of the 2100-Hz signal is interpreted by the receiving equipment as a mark.

2.24 The data receivers (Fig. 2) at both ends of the data loop are in either an idle or an active mode similar to the transmitters. The receivers must be switched to the active state prior to the reception of the data. The data receiver circuit at the central office end of the data loop is switched from an idle to an active mode as the associated transmitter changes from idle to active. The data receiver at the remote end is switched from an idle to an active mode by the receipt of the initial mark.

2.25 After switching to an active mode, the shift registers shift in synchronization with the line signal. The receivers interpret each following bit slot as data and temporarily store the received data in the shift registers.

2.26 The oscillators in each data receiver are kept in synchronism and in phase with the incoming line signal by proper oscillator-to-line signal coupling. This permits synchronizing pulses and sampling pulses to be generated at the receiver. The synchronizing pulses are used to time the shifting of the receiving shift registers and to generate the sampling pulses used in sampling the center of each bit interval. Furthermore, word synchronism and bit synchronism permit the receiving circuitry to determine the end of a word. This is done by means of a bit counter which counts to 26, returns the receiver to an idle mode, and stops the shifting.

2.27 The central office end of a Centrex data loop is equipped with one pair of oscillators for transmission and another pair for data recovery, whereas the remote end of a data loop is equipped with only one set of oscillators which performs both transmitting and receiving functions. The data transmitter and receiver at the remote end of the data loop is basically a data repeater.

2.28 Fig. 6 is a block diagram of a simplified data receiver. The tone gate which ensures that data is transmitted in synchronism with the received data is included.

2.29 The line amplifier in the data receiver amplifies the received line signal and provides the coupling to synchronize the 700-Hz oscillator signal with the line signal.

2.30 The oscillator buffer circuit amplifies the two local oscillator signals and furnishes the sampling pulses for the line signal sampler.

2.31 When a mark signal is received from the line amplifier, the line signal sampler sets the mark-space (MS) flip-flop. At the end of each bit interval a synchronizing pulse from the zero-crossing sync generator interrogates the state of the mark-space flip-flop. Each received mark

and space signal is converted into a zero or a 1 and is inserted into the lowest numbered cell of the shift register at the receiving end of the data loop.

2.32 The end of a received data word is determined by the bit counter which counts the number of bits received. When the bit count indicates that a complete word has been received, the receiver and the transmitter return to an idle mode. Similar bit counters are located at both the central office end and the remote end of the data loop.

3. CONSOLE LAMP CONTROL AND KEY SIGNALING

CONSOLE LAMP CONTROL

3.01 The states of the attendant telephone console lamps are controlled by a Centrex console lamp control circuit located in the Centrex console
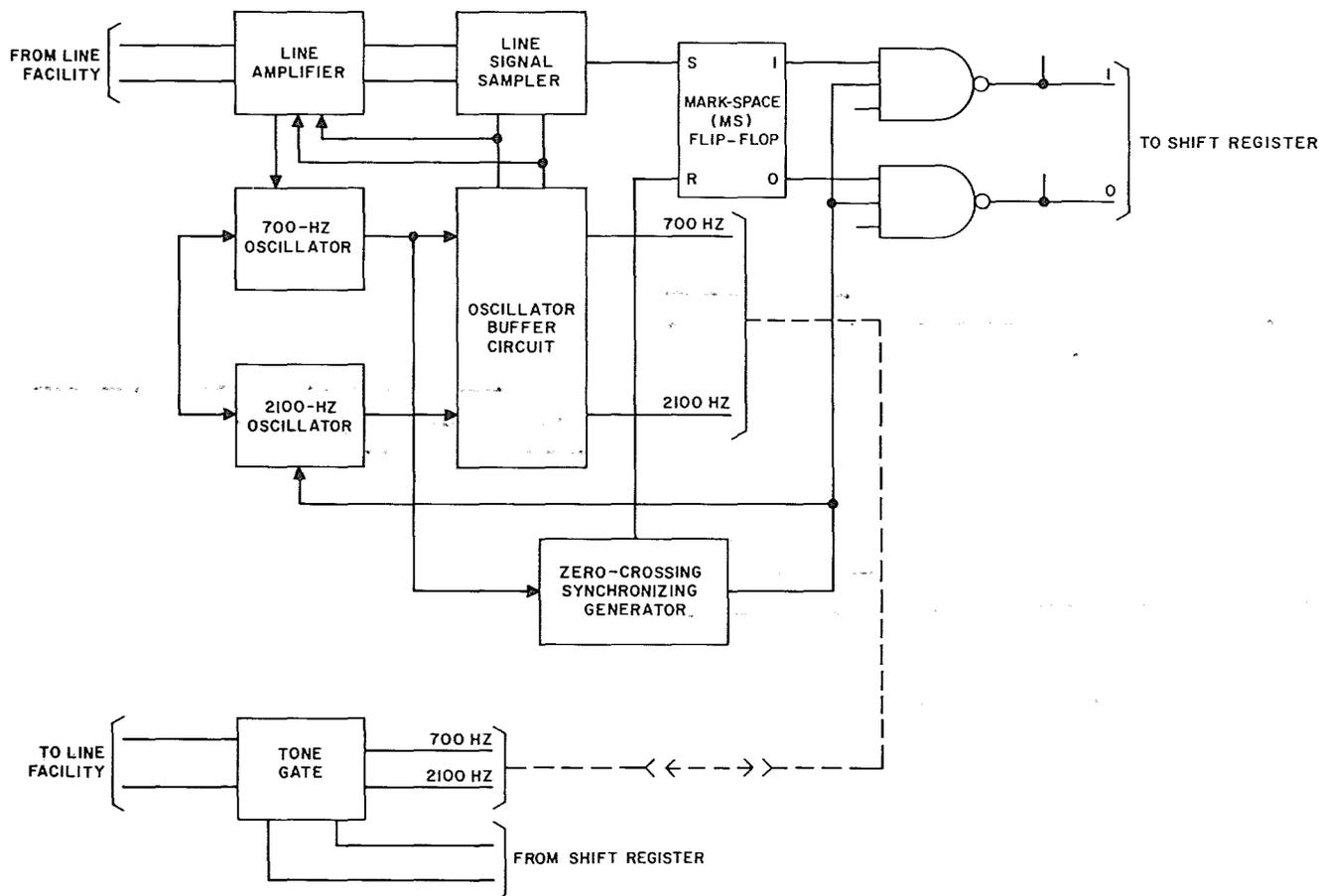

Fig. 6—Basic Data Receiver—Block Diagram

control cabinet. The controlling lamp data is received from the data loop by means of the lamp data receiver circuit and is temporarily stored in the data shift register. The received data is decoded and is applied to operate bipolar ferreed switches in lamp state memory units. The ferreed switches connect the selected lamp to ground for steady or to a lamp interrupter for the various flashing rates.

3.02 Console lamps are arranged into eight groups for control purposes. When a lamp data word is transmitted to a Centrex location, it is addressed to one of these lamp groups and to a particular console.

3.03 The data word received consists of the two leading control bits plus a 24-bit lamp data word. The following two leading control bits only perform administrative functions and are not considered part of the data portion of the word.

(a) Bit 25 is the start (ST) bit which causes the receiver circuit to switch from an idle to an active mode.

(b) Bit 24 is primarily used in synchronizing the start of the two words that are present simultaneously on the two lines of the data loop. This bit absorbs the signal propagation time delay that exists between the central office and the remote end of the data loop. This bit is set to a 1 only when a transmission is initiated from the remote end.

CONSOLE LAMP CONTROL CODE FORMATS

3.04 The code formats for the 24-bit data portion of the word used to control the states of lamps on the Centrex attendant consoles are shown in Fig. 7. The code is composed of a 7-bit lamp control prefix and a 17-bit lamp state code format. The code shown is used to control the 1B-type consoles and is modified somewhat to control the 2B-type consoles (3.18 and 3.19).

A. Lamp Control Prefix

3.05 The seven most significant bits of the code make up the lamp control prefix, which performs the following functions.

(a) Bit 22 is a signal present (SP) bit, or flag, which indicates to console control circuitry

that the word being transmitted is a valid word. If bit 22 is not a 1, the word may be a maintenance order. (See 3.28.)

(b) Bits 20 and 21 form the console select code. This selects the particular one of the four possible consoles to which the lamp order is to be directed. (See CONSOLE SELECT CODE TABLE on Fig. 7.)

(c) Bits 17, 18, and 19 form the lamp group select code. These bits determine which group of lamps on the selected console is to be controlled. (See LAMP GROUP SELECT CODE TABLE on Fig. 7.)

3.06 The eight groups of lamps on the attendant consoles are controlled by three different lamp state code formats. These formats are shown in Fig. 7. FORMAT A is used to control the six groups of loop lamps (key, SRC, and DEST lamps), the RLS lamp, the audible signal, and the optional call indicator lamps. FORMAT B is used to control the common lamps and some of the trunk busy lamps. FORMAT C is used to control other trunk group busy lamps.

B. Lamp State Code Formats

3.07 A single bit in the lamp state code format is provided for each allowable active lamp state. The selected lamp is operated to the chosen active state by the presence of a 1 in the proper bit slot. An exception to this is the operation of the optional call indicator lamps, which is explained in 3.15 through 3.17.

3.08 A zero in a particular lamp code position will cause that lamp to be extinguished when that code word is received at the remote Centrex installation.

Loop Lamp Format

3.09 If the lamp group select code (table on Fig. 7) is between 000 and 101 (binary code), a corresponding loop lamp group (decimal 0 through 5) is selected, and the loop lamp format (FORMAT A) is transmitted to control the lamps in this group. Any bit position which contains a 1 in a word transmitted to the consoles will operate the selected console lamp to the chosen state. For example, if bit 9 is a mark and a loop lamp group is specified,

LAMP CONTROL PREFIX | **LAMP STATE CODE FORMAT**

BIT NO.	23	22	21	20	19	18	17
	PARITY	SIGNAL PRESENT (SP)	CONSOLE SELECT CODE 1/4		LAMP GROUP SELECT CODE 1/8		

LAMP GROUP SELECT CODE TABLE

CONTROL BIT NUMBER			LAMP GROUP SELECTED
19	18	17	
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7

LAMP GROUP 0-5 LOOP LAMPS AND OPTIONAL CALL INDICATOR LAMPS

LAMP GROUP 6 COMMON LAMPS

LAMP GROUP 7 TRUNK GROUP BUSY LAMPS

FORMAT A (LOOP LAMPS)

BIT NO.	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
LAMP	RLS	AUD	KEY		SOURCE				DESTINATION				CALL INDICATOR				
STATE	S	S	W	S	120	60	W	S	120	60	W	S	HOR. SELECT CODE 1/4		VERTICAL SELECT CODE 1/8		

FORMAT B (COMMON LAMPS)

SPARE	BUSY VER		TRUNK GROUP BUSY			NITE	EXCL SRC	EXCL DEST	POS BSY	CW		SPARE	CONFERENCE 1		
	W	S	11	10	9					W	S				

FORMAT C (TRUNK GROUP BUSY LAMPS)

SPARE	TRUNK GROUP BUSY									SPARE	CONFERENCE 2
	8	7	6	5	4	3	2	1	0		

CONSOLE SELECT CODE TABLE

CONTROL BIT NUMBER		CONSOLE SELECTED
21	20	
0	0	0
0	1	1
1	0	2
1	1	3

LEGEND:
S — STEADY
W — WINK
60 — ONE FLASH PER SECOND
120 — TWO FLASHES PER SECOND

Fig. 7—Centrex Lamp Control Code Formats

the SRC lamp of the specified loop lamp group is operated to the steady (S) state.

3.10 The RLS lamp, the audible signal, and the optional call indicator lamps may be operated by data addressed to either of the six groups of loop lamps.

3.11 As shown in Fig. 7, some lamps may be operated to only one active state while others may be operated to one of several selected states. If no bit slots for a particular lamp contain a 1, the lamp is placed in the dark or inactive state.

Common Lamp Format

3.12 When the lamp group select code is binary 110 (lamp group 6), the common lamp format is specified. A selected lamp here is also operated to the chosen active state by the presence of a 1 in the proper bit slot. This format controls three of the trunk busy lamps in addition to the common lamps.

Trunk Group Busy Lamp Format

3.13 When the group select code is binary 111 (lamp group 7), the trunk group busy lamp format is specified. This format controls a field of nine additional trunk group busy lamps, A 1 in the proper bit slot here will also operate the selected lamp to the active state.

C. Lamp State Memory

3.14 A bipolar fereed is associated with each active lamp state. These fereeds are mounted in 241C 1 by 8 switches. Ten of these switches comprise a lamp state memory unit in which the active lamp states of an attendant telephone console are stored. Fig. 8 is a block diagram of a lamp state memory unit used to store the states of the console lamps. One lamp state memory is provided for each console. The operation of a fereed in a lamp state memory actuates the corresponding active state by connecting the selected lamp either to ground for steady or to the appropriate lamp interrupter for wink, 60 interruptions per minute, or 120 interruptions per minute. Three additional 241C 1 by 8 switches are used as a separate lamp state memory for the optional call indicator lamps.

D. Lamp State Changes

3.15 Each change of state of a lamp on a console requires the complete updating of the whole lamp group of which the lamp is a part. Updating is accomplished when another data word is received. The updating operation requires two steps. First, all ferreeds in the selected lamp group are released, thus erasing the previous lamp states; then, for each 1 in the lamp state code of the new data word received, the corresponding ferreed in the selected lamp group is operated. An all-zero code in a particular lamp code position causes that lamp to be extinguished when that particular code word is received at the remote Centrex location.

E. Call Indicator Lamp Control

3.16 The optional call indicator lamp field is also controlled by the loop lamp format (FORMAT A on Fig. 7). Bits 0 through 4 are assigned to their control. A maximum of 24 call indicator lamps per console can be controlled by these bits.

3.17 Call indicator lamps indicate to the console attendant information concerning the origin of the call currently being processed; therefore, only one lamp in the call indicator group is illuminated at one time. The indication remains on the console as long as the attendant is connected to the loop.

3.18 A separate memory unit (Fig. 9), consisting of three 1 by 8 ferreed switches, is provided for call indicator lamps. This memory unit has the capacity to store the states of up to 24 call indicator lamps. Ferreeds in the call indicator memory are controlled in four groups of six lamps each. Bits 0 through 2 of the loop lamp code format are arranged in a 1-out-of-8 vertical select code; bits 3 and 4, in a 1-out-of-4 horizontal select code in order to select the desired lamp. Binary codes 001 through 110 are used for the 1-out-of-8 vertical selection, and binary codes 00 through 11 are used for the 1-out-of-4 horizontal selection. For example, to select call indicator lamp 5, the vertical select code would be 010 and the horizontal select code would be 01. Each instruction to the call indicator memory requires a 2-step updating sequence. First, all six ferreeds in the selected call indicator group are released, then all ferreeds specified in the incoming code are operated. Binary code 111 (bits 0, 1, and 2) in the vertical select code is used to reset all ferreeds and therefore turn off all lamps in the group selected by bits 3
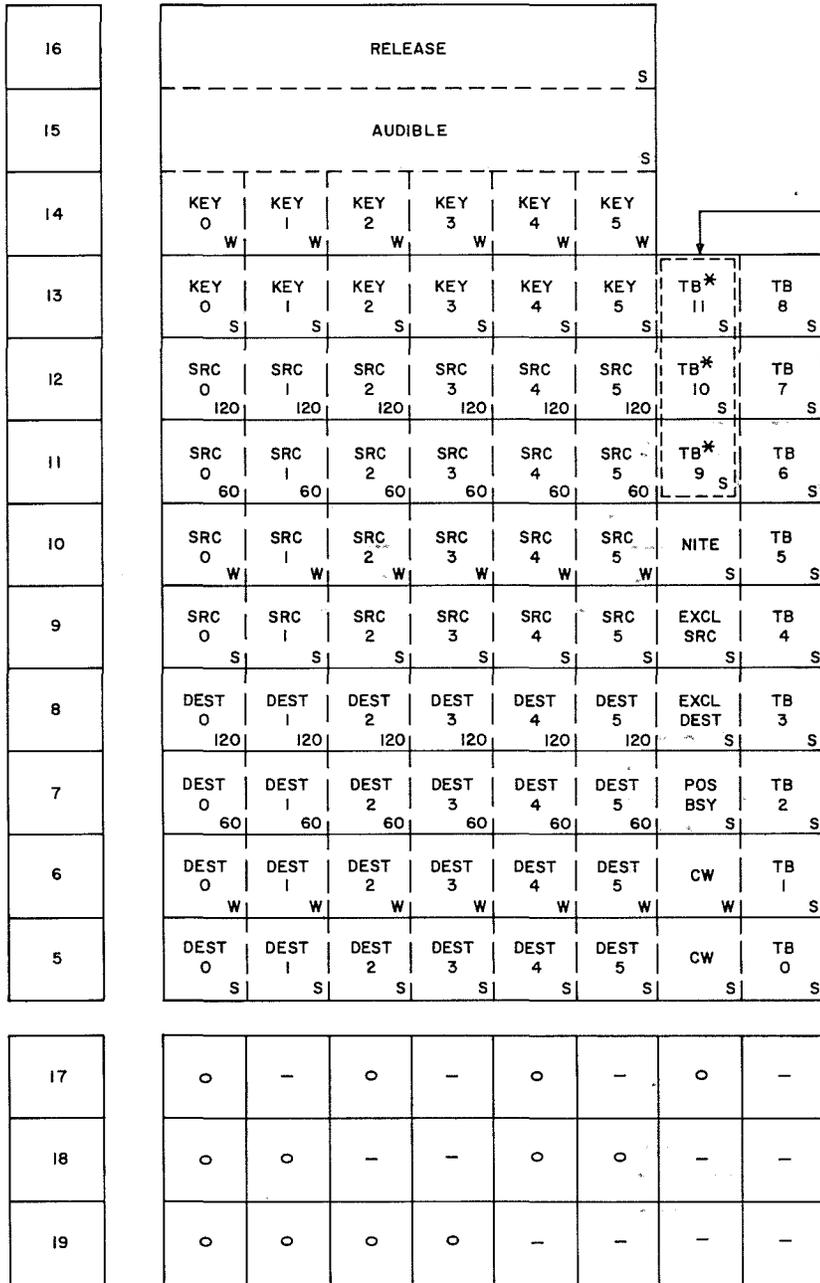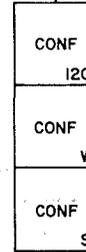
CONTROL
BIT
NUMBER

LEGEND:

S – STEADY
W – WINK
D – DARK
60 – ONE FLASH PER SECOND
120 – TWO FLASHES PER SECOND

Control Bit Number								
16	RELEASE						S	
15	AUDIBLE						S	
14	KEY 0 W	KEY 1 W	KEY 2 W	KEY 3 W	KEY 4 W	KEY 5 W		
13	KEY 0 S	KEY 1 S	KEY 2 S	KEY 3 S	KEY 4 S	KEY 5 S	TB* 11 S	TB 8 S
12	SRC 0 120	SRC 1 120	SRC 2 120	SRC 3 120	SRC 4 120	SRC 5 120	TB* 10 S	TB 7 S
11	SRC 0 60	SRC 1 60	SRC 2 60	SRC 3 60	SRC 4 60	SRC 5 60	TB* 9 S	TB 6 S
10	SRC 0 W	SRC 1 W	SRC 2 W	SRC 3 W	SRC 4 W	SRC 5 W	NITE S	TB 5 S
9	SRC 0 S	SRC 1 S	SRC 2 S	SRC 3 S	SRC 4 S	SRC 5 S	EXCL SRC S	TB 4 S
8	DEST 0 120	DEST 1 120	DEST 2 120	DEST 3 120	DEST 4 120	DEST 5 120	EXCL DEST S	TB 3 S
7	DEST 0 60	DEST 1 60	DEST 2 60	DEST 3 60	DEST 4 60	DEST 5 60	POS BSY S	TB 2 S
6	DEST 0 W	DEST 1 W	DEST 2 W	DEST 3 W	DEST 4 W	DEST 5 W	CW W	TB 1 S
5	DEST 0 S	DEST 1 S	DEST 2 S	DEST 3 S	DEST 4 S	DEST 5 S	CW S	TB 0 S

CONF 120								
CONF W								
CONF S								

* THESE THREE FERREEDS MAY BE
OPTIONALLY ASSIGNED TO CONTROL
CONFERENCE LAMPS.

Control Bit Number								
17	o	–	o	–	o	–	o	–
18	o	o	–	–	o	o	–	–
19	o	o	o	o	–	–	–	–

LAMP GROUP NUMBER	0	1	2	3	4	5	6	7

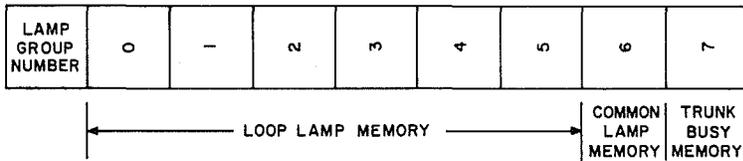←————— LOOP LAMP MEMORY ——————→ COMMON LAMP MEMORY | TRUNK BUSY MEMORY

Fig. 8—Lamp State Memory—Block Diagram

and 4. Binary code 000 in the vertical select code is used if the ferreeds in the call indicator memory are to be left unchanged.
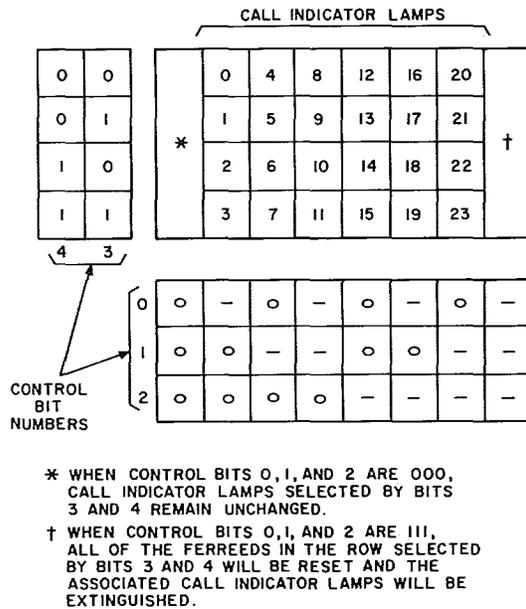

Fig. 9—Call Indicator Lamp Memory

* WHEN CONTROL BITS 0,1,AND 2 ARE 000, CALL INDICATOR LAMPS SELECTED BY BITS 3 AND 4 REMAIN UNCHANGED.

† WHEN CONTROL BITS 0,1, AND 2 ARE 111, ALL OF THE FERREEDS IN THE ROW SELECTED BY BITS 3 AND 4 WILL BE RESET AND THE ASSOCIATED CALL INDICATOR LAMPS WILL BE EXTINGUISHED.

Fig. 10—Optional Trunk Busy Memory

F. Trunk Busy Memory

3.19 The control of 2B-type consoles requires additional trunk busy memory beyond that available in the basic lamp state memory units. This is provided by a special trunk busy memory (Fig. 10) which replaces one of the basic lamp state memory units in a console lamp control circuit.

3.20 The special trunk busy memory consists of three additional 1 by 8 ferreed switches equipped in memory unit position 1 of the first lamp control circuit associated with a 2B-type console customer.

3.21 Fig. 11 is a block diagram of the acceptable combinations of basic lamp state memory units and trunk busy memory units which may be controlled by a single data loop circuit.

CONSOLE KEY FORMAT

3.22 Key information from the remote Centrex attendant consoles is transmitted to the central office as binary coded signals. These key signals are interpreted as requests for specific actions concerning calls that are associated with the consoles. Key signals from a single console require 5-bit spaces for encoding, therefore, the data register located in the console control cabinet has sufficient capacity to encode as many as four consoles. The contents of the register are read out serially as a 24-bit word during data transmission.

3.23 Fig. 12 shows the key signal bit assignments for each of the four possible consoles. Four groups of five bits (0 through 19) are assigned for the key signals from each console; one bit (20) is a flag or signal present bit to indicate to the central control the presence of a valid key signal word; two bits (21 and 22) must be 0 when a key signal is to be transmitted, and bit 23 is a parity check bit.

3.24 The 31 possible codes which may be derived from a group of five bits are shown in Table A; 20 codes are presently used and 11 are
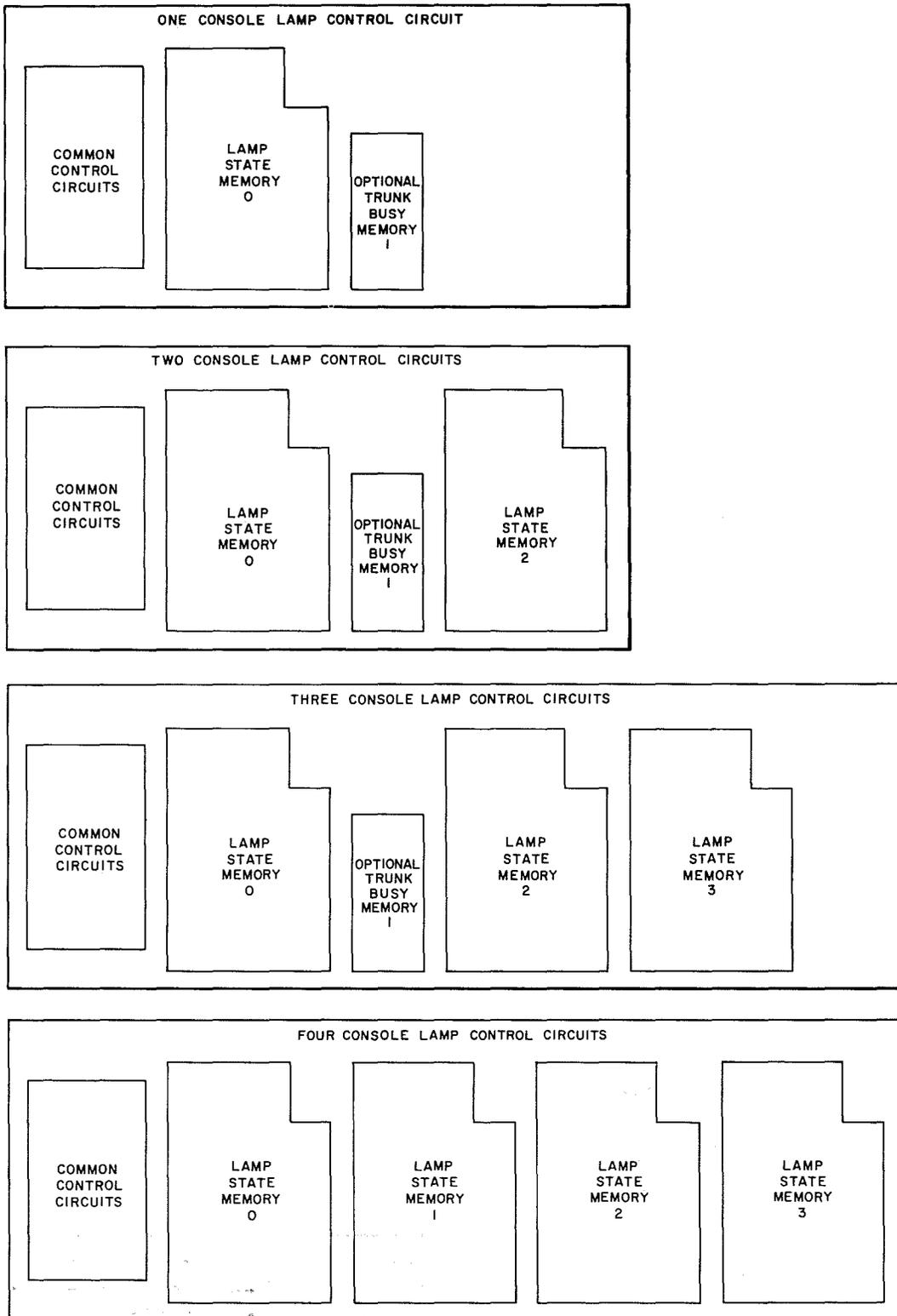
ONE CONSOLE LAMP CONTROL CIRCUIT

COMMON CONTROL CIRCUITS

LAMP STATE MEMORY 0

OPTIONAL TRUNK BUSY MEMORY I

TWO CONSOLE LAMP CONTROL CIRCUITS

COMMON CONTROL CIRCUITS

LAMP STATE MEMORY 0

OPTIONAL TRUNK BUSY MEMORY I

LAMP STATE MEMORY 2

THREE CONSOLE LAMP CONTROL CIRCUITS

COMMON CONTROL CIRCUITS

LAMP STATE MEMORY 0

OPTIONAL TRUNK BUSY MEMORY I

LAMP STATE MEMORY 2

LAMP STATE MEMORY 3

FOUR CONSOLE LAMP CONTROL CIRCUITS

COMMON CONTROL CIRCUITS

LAMP STATE MEMORY 0

LAMP STATE MEMORY I

LAMP STATE MEMORY 2

LAMP STATE MEMORY 3

Fig. 11—Use of Optional Trunk Busy Memory

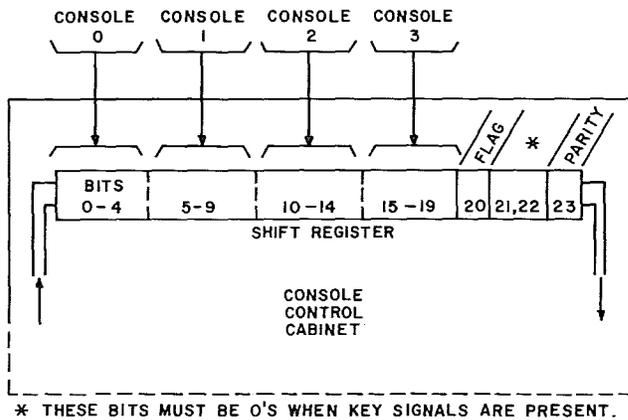* THESE BITS MUST BE 0'S WHEN KEY SIGNALS ARE PRESENT.

Fig. 12—Console Key Signal Bit Assignments

spares. The code is divided into three logical groups. This logical grouping facilitates the decoding of these key signals by the control program. The three groups are:

- Loop keys

- Console state keys

- Call processing keys.

3.25 *Loop Keys:* Decimal codes 1 through 7 are used to encode the loop keys on the consoles. There is one spare code available in this group.

3.26 *Console State Keys:* Decimal codes 8 through 15 are used to encode those keys which affect the overall state of the console or which have other certain specialized functions. There are three spare codes available in this group.

3.27 *Call Processing Keys:* Decimal codes 16 through 31 are used to encode those keys which are used in the processing of a particular call. There are seven spare codes available in this group. Decimal code 0 in any console key signal slot is used to indicate that no key signal was transmitted from that particular console.

MAINTENANCE ORDERS

3.28 Data can be encoded and transmitted to the shift registers in console control cabinets to perform maintenance functions. When data is transmitted to the control cabinet shift registers and bit 22 is a zero, the order is interpreted as a

maintenance order. Bits 20 and 21 are then used to specify the maintenance function to be performed.

3.29 When bit 22 is a zero and bits 21 and 20 are both 1's, the order is used to perform a loop-around test. This test checks the overall ability of the data loop to properly transmit and receive data. This order contains data which is transmitted to the shift register in the console control cabinet. A second transmission initiated from the central office causes the data to be transmitted back to the central office.

3.30 When bit 22 is a zero, bit 21 is a 1, and bit 20 is a zero, the order is an interrogate order. This order is transmitted to a console control cabinet to determine the status of the POS BSY and the NITE lamps on each of the consoles controlled by the console control cabinet. This order also determines whether or not the customer's equipment is on emergency power.

3.31 As a response to the interrogate order, data is entered into the shift register in the console control cabinet and is transmitted back to the central office. This data contains bits which may be set to indicate the states of the NITE and POS BSY lamps of the consoles and the emergency power status of the console control cabinet. The bits which may be set and their indications are as follows:

(a) Bit number 0—Console 0 NITE lamp lighted

(b) Bit number 1—Console control cabinet is on emergency power

(c) Bit number 4—Console 0 POS BSY lamp lighted

(d) Bit number 5—Console 1 NITE lamp lighted

(e) Bit number 9—Console 1 POS BSY lamp lighted

(f) Bit number 10—Console 2 NITE lamp lighted

(g) Bit number 14—Console 2 POS BSY lamp lighted

(h) Bit number 15—Console 3 NITE lamp lighted

(i) Bit number 19—Console 3 POS BSY lamp lighted.

TABLE A

CENTREX CONSOLE KEY CODES

KEY GROUPS	DECIMAL NUMBER	CONSOLE KEY OPERATED	BINARY CODE TRANSMITTED
LOOP KEYS	0	NONE	00000
	1	LOOP 0	00001
	2	LOOP 1	00010
	3	LOOP 2	00011
	4	LOOP 3	00100
	5	LOOP 4	00101
	6	LOOP 5	00110
	7	SPARE	00111
CONSOLE STATE KEYS	8	POS BUSY	01000
	9	NITE	01001
	10	SPARE	01010
	11	BUSY VER	01011
	12	CONF. 1	01100
	13	CONF. 2	01101
	14	SPARE	01110
	15	SPARE	01111
CALL PROCESSING KEYS	16	RLS	10000
	17	RLS SRC	10001
	18	RLS DEST	10010
	19	START	10011
	20	SIG SRC	10100
	21	SIG DEST	10101
	22	HOLD	10110
	23	EXCL SRC	10111
	24	EXCL DEST	11000
	25	SPARE	11001
	26	SPARE	11010
	27	SPARE	11011
	28	SPARE	11100
	29	SPARE	11101
	30	SPARE	11110
	31	SPARE	11111

3.32 When bits 22, 21, and 20 are either 0, 0, and 0 or 0, 0, and 1 respectively, the order is a no-operation order. Bits 0 through 19 will be set to 0. These orders are used to clear the shift register in the console control cabinet of data and to prepare the register for the reception of the key signals of a new order.

4. CENTREX EQUIPMENT DESCRIPTION

4.01 In addition to attendant consoles and station telephones, two other specialized equipment units are required for Centrex operation. These are the Centrex data link frame (Fig. 13) located in the ESS central office and a Centrex console control cabinet (Fig. 14) located at the customer's premises. The Centrex data link frame provides the interface between the ESS central office equipment and the data loop. The Centrex console control cabinet provides the interface between the consoles and the data loop.
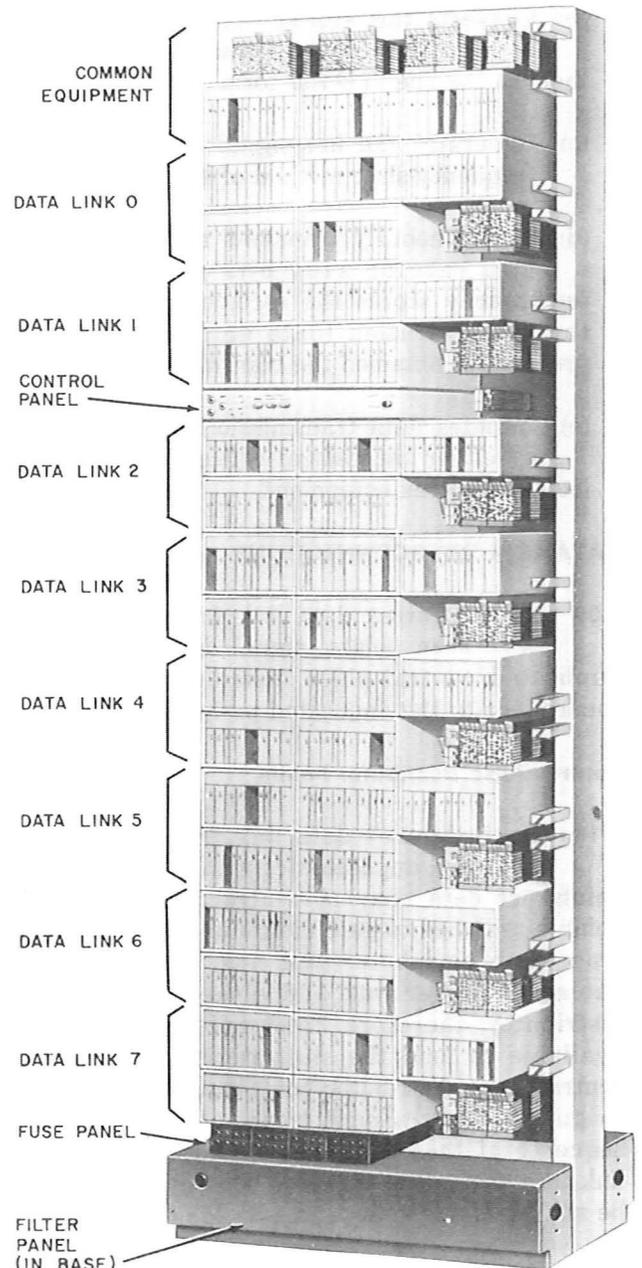
CENTREX DATA LINK FRAME

4.02 A Centrex data link frame (Fig. 13) is a standard 7-foot frame which can house a maximum of eight data links and the associated common equipment. The frame may be partially equipped but link 0 must always be installed.

4.03 The common equipment includes facilities for reading peripheral bus information and facilities for receiving enable signals from the central pulse distributors. The common circuitry also includes the data link address bus and the dynamic buffer registers.

4.04 Each data link circuit contains a data link controller and a scanner buffer circuit in addition to the data transmitter, receiver, and shift register.

4.05 The data link controller accepts the enable signals from the common equipment and selects the peripheral bus containing the desired data. The controller also provides timing functions and sequencing of events necessary to initiate the reading of the peripheral bus data and to transmit the received data word.

4.06 The scanner buffer circuit contains buffer circuits necessary to supply the current to drive scan points.

COMMON EQUIPMENT
DATA LINK 0
DATA LINK 1
CONTROL PANEL
DATA LINK 2
DATA LINK 3
DATA LINK 4
DATA LINK 5
DATA LINK 6
DATA LINK 7
FUSE PANEL
FILTER PANEL (IN BASE)

Fig. 13—No. 1 ESS Centrex Data Link Frame

4.07 Each data link also contains a bit counter used to determine the end of transmission by counting the number of bits transmitted.

4.08 A Centrex data link circuit performs the following functions:

(a) Accepts and temporarily stores a 24-bit word from either of the two peripheral buses

(b) Converts this stored word into a sequence of mark and space signals and transmits them to the line in serial form

(c) Generates the line-signal intelligence by a frequency-shift method of signaling

(d) Simultaneously transmits and receives data at a rate of 1400 bits per second and temporarily stores the received information in the same location (data shift register) that previously contained the transmitted word

(e) Initiates data transmission when requested by either the central office or the remotely located Centrex equipment.

DATA LINK INTERCONNECTIONS

4.09 Each Centrex data link frame is equipped with scan points, signal distributor points, duplicated central pulse distributor points, and connections to the duplicated peripheral unit bus.

Central Pulse Distributor Points

4.10 Each Centrex data link frame is provided with two duplicated central pulse distributor points per data link. A central pulse distributor point is assigned to gate data into the shift register from each peripheral unit bus. This permits a choice of either bus and either central pulse distributor; therefore, four different routes are available to load the shift register. The other central pulse distributor point causes the data link to go into the transmit mode. A special reverse sequence of these points is also used to place the link in a test mode in which the shift register can be shifted one step at a time on command.

Signal Distributor Point

4.11 One signal distributor point is assigned per data link to provide a maintenance function. This point is a part of the data loop transfer circuit (Fig. 2). It is used to switch the data loop from a normal loop to a local loop condition to aid in isolating troubles in the data loop circuitry.

4.12 One scan point is assigned per data link frame as a common fuse alarm. This is a supervisory scan point scanned at a 100-millisecond rate. If a data link or the common equipment on a data link frame should develop a power failure

due to a blown fuse, this supervisory scan point is energized, and an indication is displayed on the ESS master control center alarm, display, and control panel.

4.13 The data link frame is also equipped with an alarm retire key which has an associated supervisory scan point. Finally, a set of points (one per data link) is employed to indicate that a valid data loop is present (that is, a 700-cycle tone is present in both directions).

Directed Scan Points

4.14 Two 16-point information scan rows are assigned per data link to provide access to the Centrex data unit shift register. These scan points are assigned in adjacent rows. Twenty-four of the scan points are delegated to read the contents of the shift register; three are assigned to indicate the state of the console for maintenance and checking purposes; and five are spares. These scan points are scanned at a 100-msec (in CC CTX generic offices) or 60-msec (in SP CTX generic offices) rate. The information row scan point assignment has been arranged so that the data link can grow smoothly from a 1-console to a 4-console installation.

Fast Supervisory Scan Points

4.15 Each Centrex data link is equipped with a key signal present scan point. This is a supervisory scan point which is saturated when a key signal is received from an attendant console at the remote Centrex location. Before any lamp data is transmitted from the central office to the remote location, this scan point is examined to determine whether or not there is a key signal stored in the data register. If a key signal is present, lamp data transmission is delayed until the key signal has been read out. Key signal present scan points are scanned at a 100-millisecond (in CC Centrex generic offices) or 60-millisecond (in SP Centrex generic offices) rate. Entire scanner rows of 16 scan points are assigned for the exclusive use of the signal present function. Unused scan points in these rows will not be used for other purposes. If there are more than 8 data links in a central office, the additional scanner rows need not be on adjacent rows in the scanner.

CENTREX CONSOLE CONTROL CABINET

4.16 Each Centrex customer is provided with a Centrex console control cabinet (Fig. 14). This cabinet provides the interface between the data loop and the attendant consoles. One console control cabinet is capable of controlling a maximum of four of the 1B-type attendant telephone consoles. For 2B-type attendant telephone console installations, the first such cabinet can be equipped to handle three 2B-type consoles and one trunk busy memory unit. Additional cabinets belonging to the same customer group can be equipped to handle four 2B-type consoles.

4.17 A Centrex console control cabinet may be shared by different Centrex customer groups under the restrictions covered in Section 966-102-100.

4.18 A Centrex console control cabinet contains equipment common to all consoles controlled by the cabinet and equipment added on a per console basis.

COMMON EQUIPMENT

Common Control Equipment

Power Supply (One Per Slide)

Trunk Busy Memory Unit (For 2B-Type Consoles Only)

ADDED EQUIPMENT PER CONSOLE

Console Control Unit

4.19 The console control cabinet provides the following functions:

(a) Encodes attendant console key signals

(b) Transmits key signals as data to the central office

(c) Receives lamp data from the central office

(d) Decodes lamp data received from the central office

(e) Provides timing

(f) Furnishes local power

(g) Provides the lamp interrupter circuitry

(h) Contains the lamp state memory

(i) Contains a pulser circuit for controlling ferreeds in the lamp state memory.

CONNECTING BLOCKS

SLIDE 2

SLIDE 1

CENTREX CONSOLE
CONTROL UNIT
OR
TRUNK BUSY
MEMORY UNIT
OR
LAMP MULTIPLE UNIT
(CONTROL POSITION 1)

(CONTROL
POSITION 3)

CENTREX CONSOLE
CONTROL UNIT
(CONTROL POSITION 0)

(CONTROL
POSITION 2)

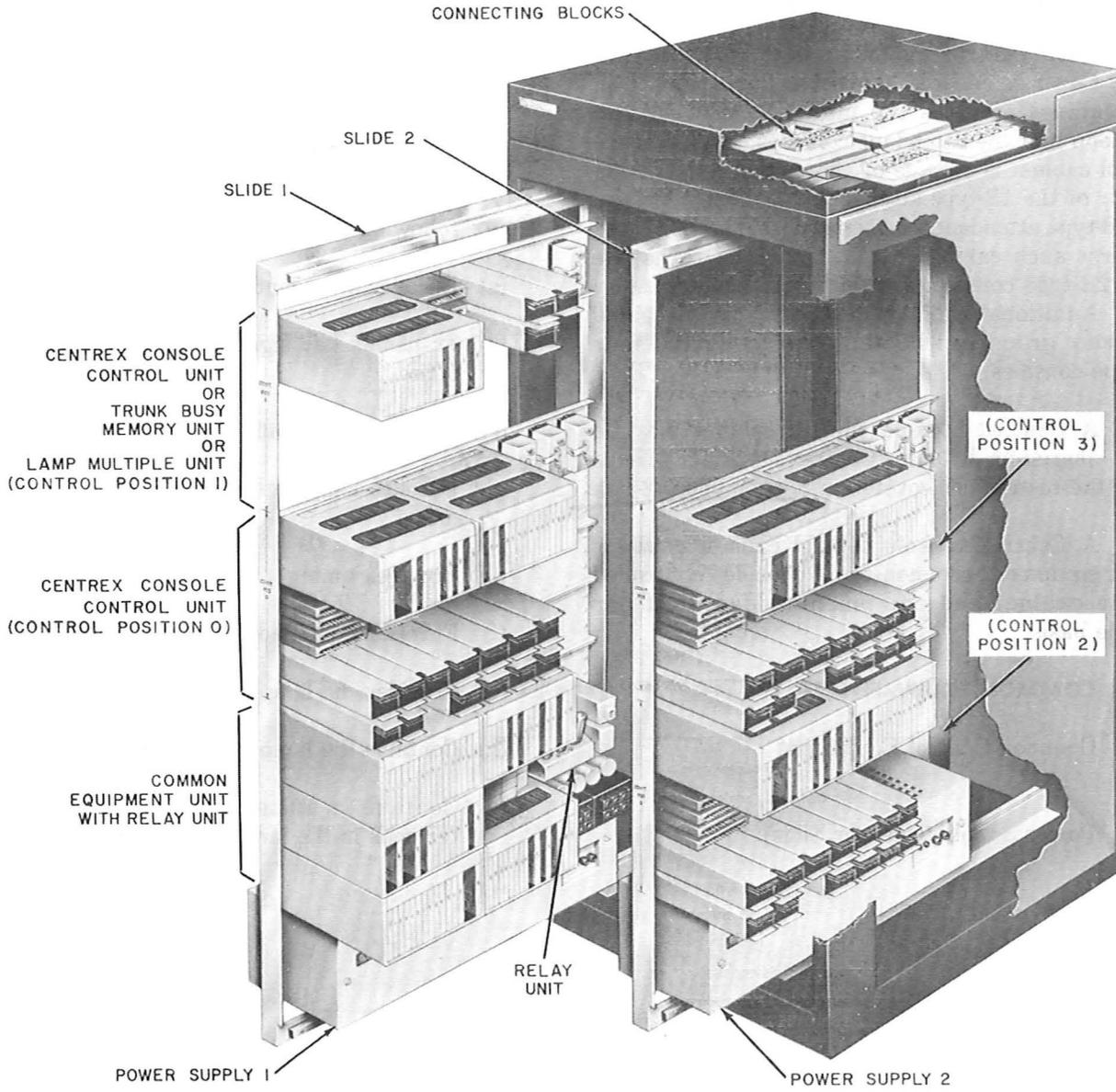COMMON
EQUIPMENT UNIT
WITH RELAY UNIT

RELAY
UNIT

POWER SUPPLY 1

POWER SUPPLY 2

Fig. 14—No. 1 ESS Centrex Console Control Cabinet