

BELL TELEPHONE LABORATORIES, INC.

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TOLL SYSTEMS
"K2" CARRIER TELEPHONE
KEY SHEET

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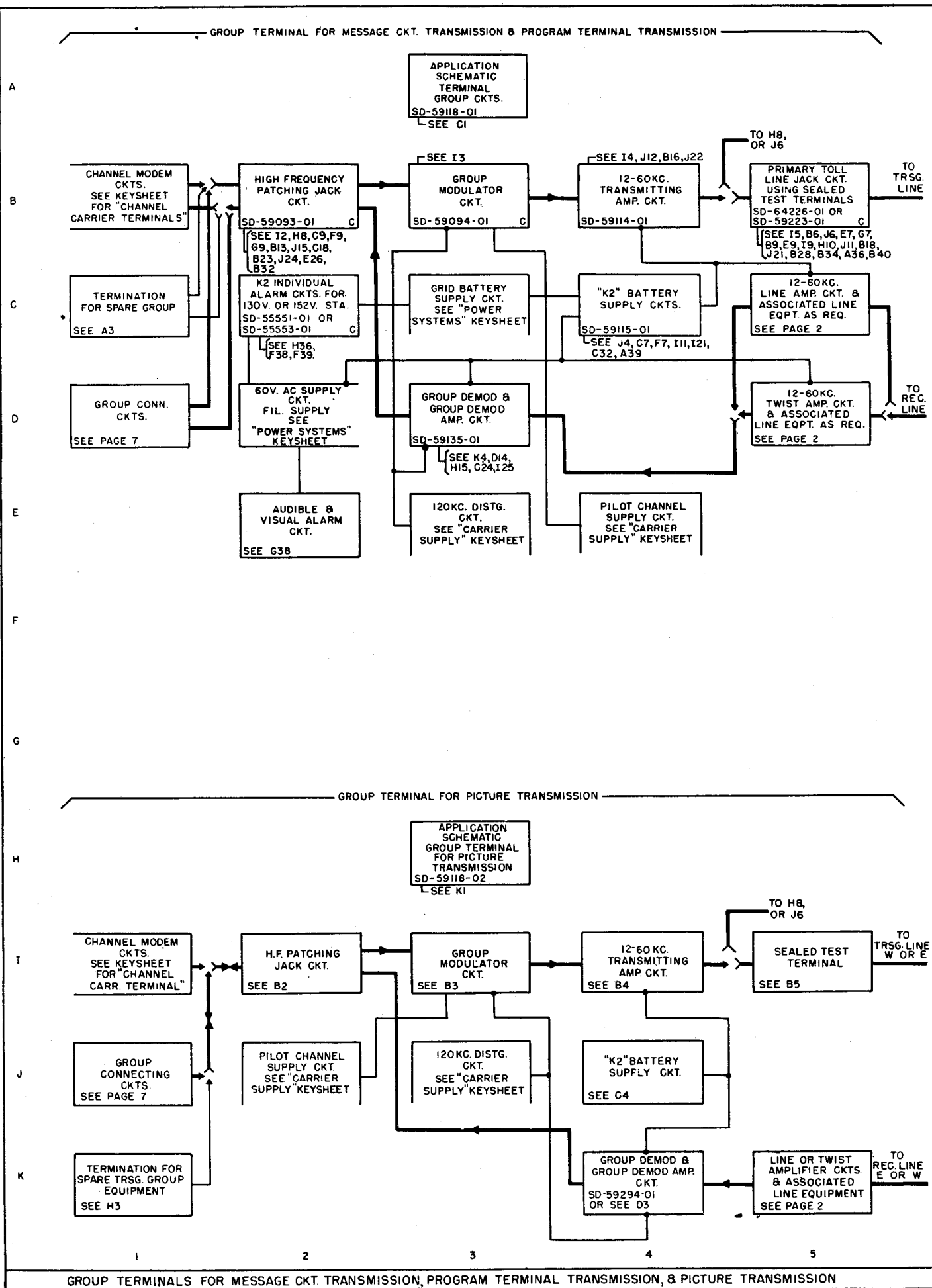
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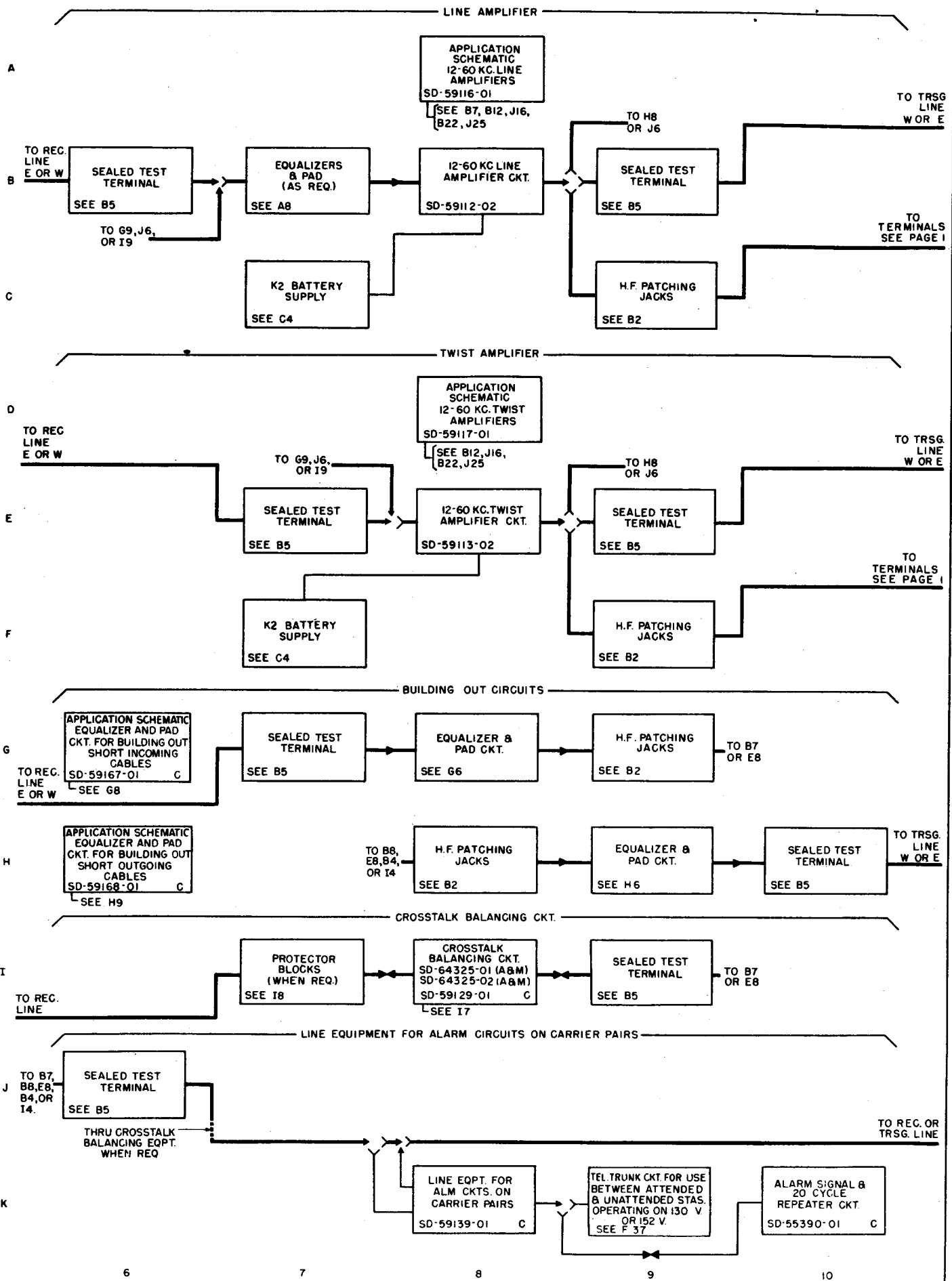
AT&TCO
STANDARD

FOR EXPLANATION OF CONVENTIONS SEE MASTER
KEYSHEET SD-90250-01.
FOR BROADBAND CARRIER SUPPLY KEYSHEET SEE
SD-63394-05.
FOR CHANNEL CARRIER TERMINAL KEYSHEET SEE
SD-63394-06.
FOR TRANS. MEAS. KEYSHEET SEE SD-95021-01.

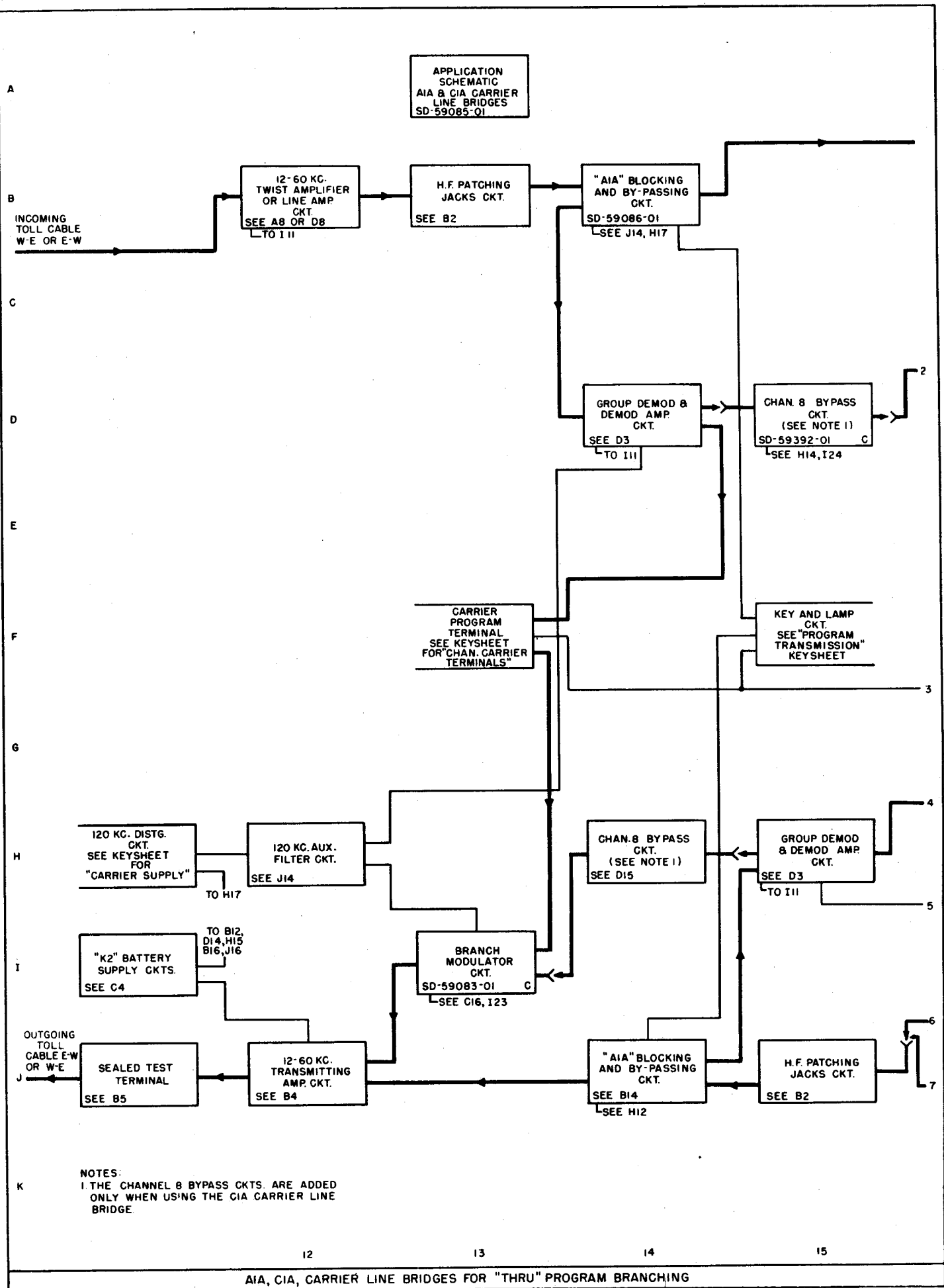
SD-63394-03

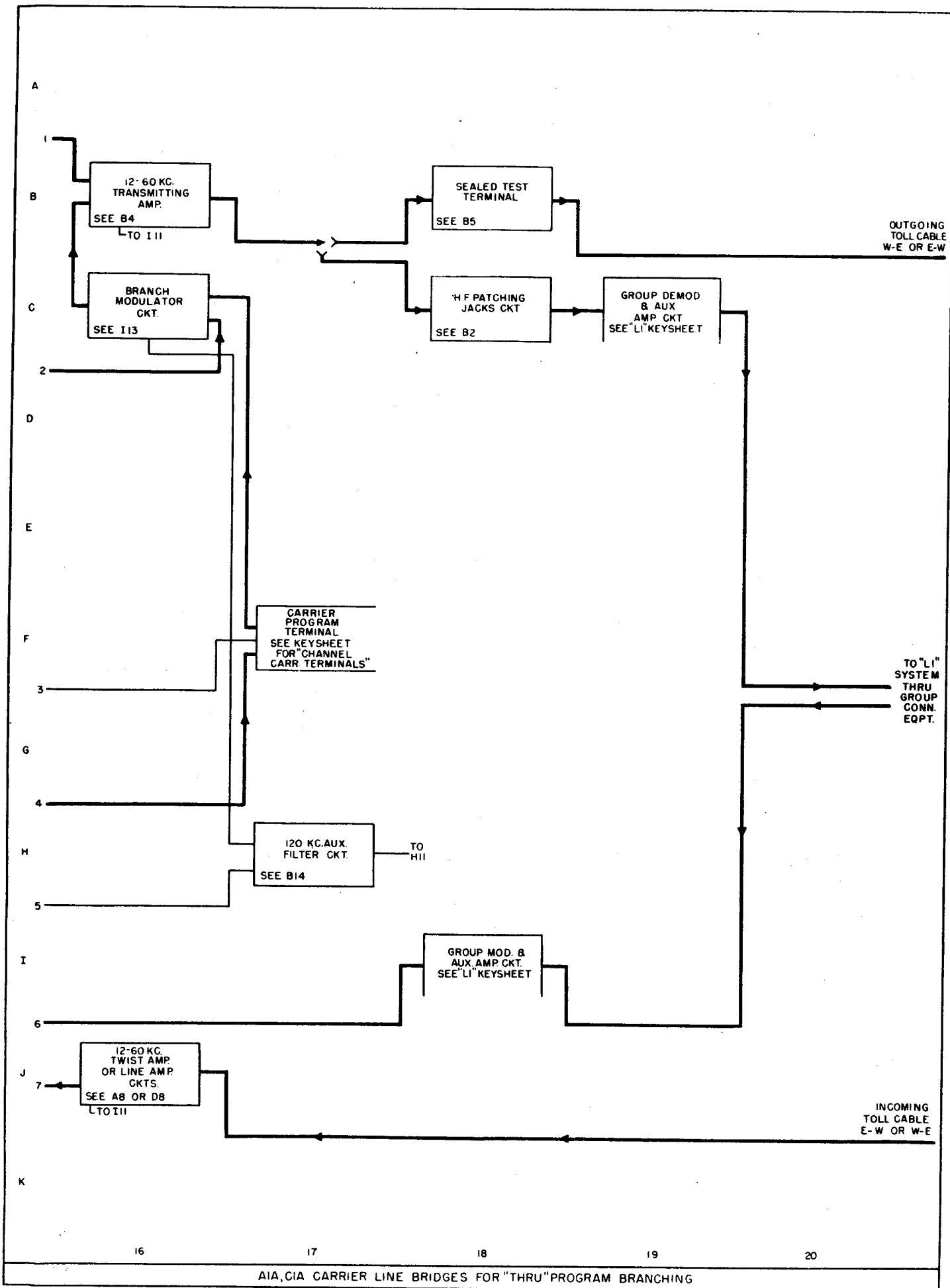
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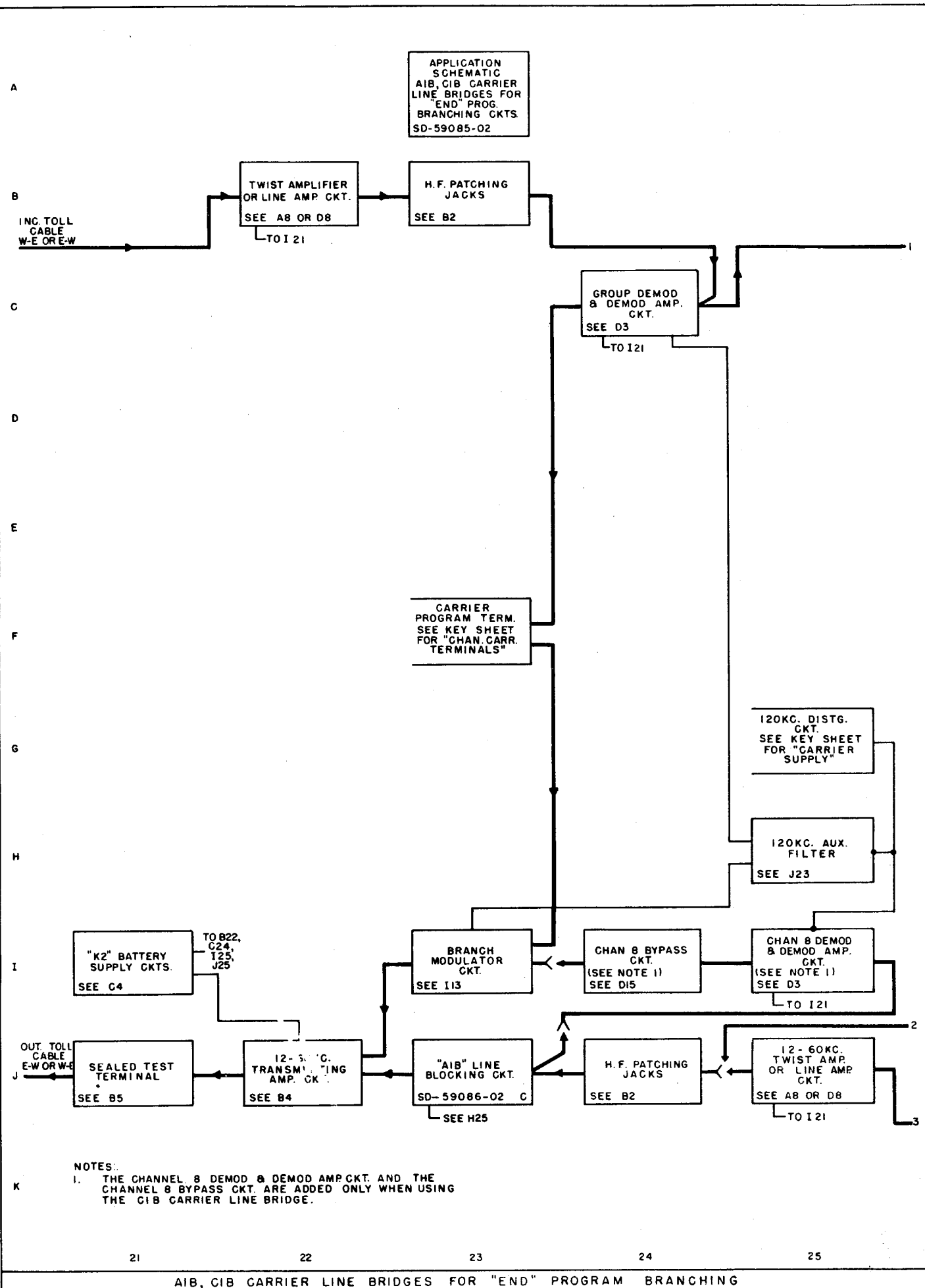


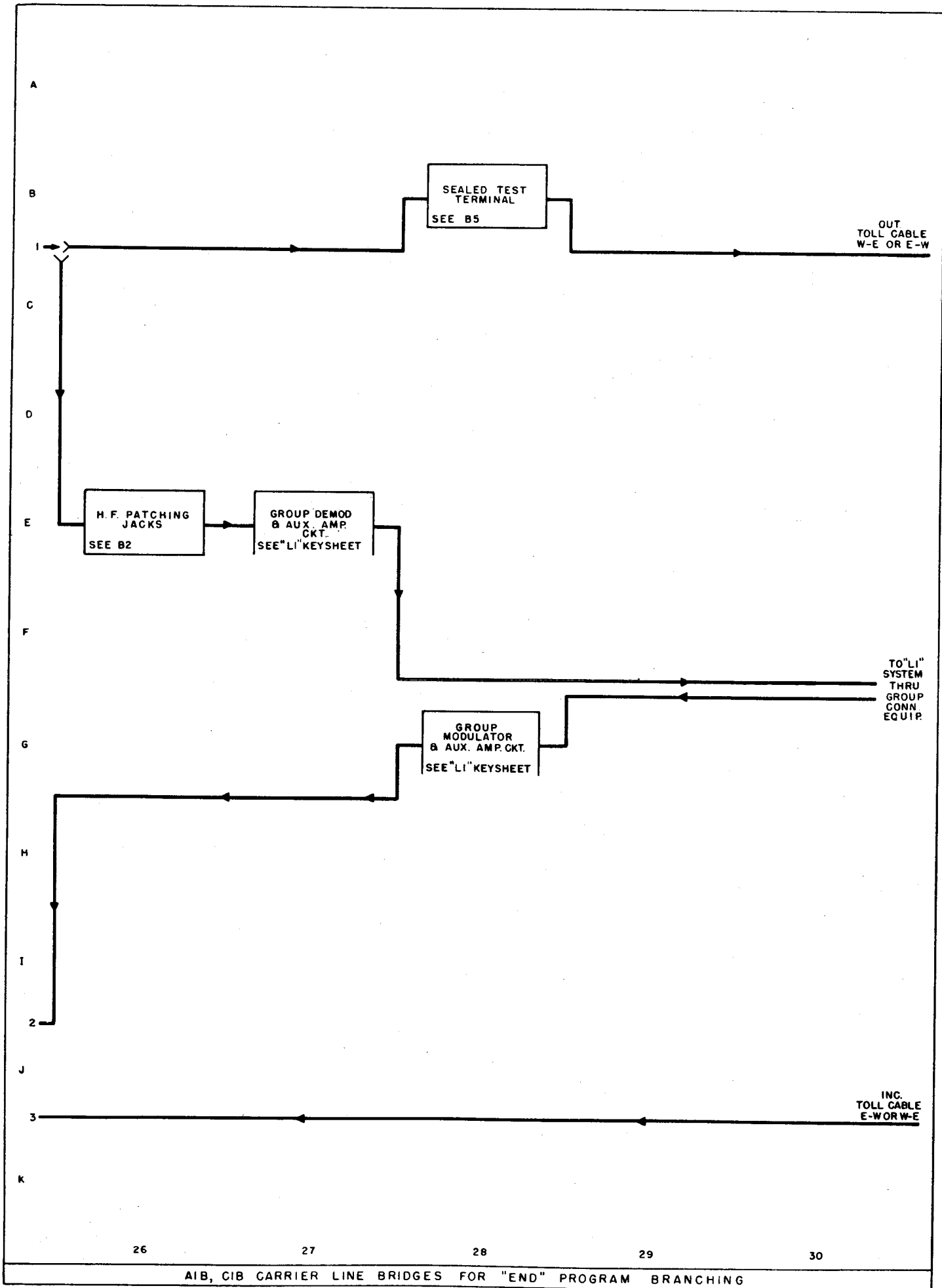


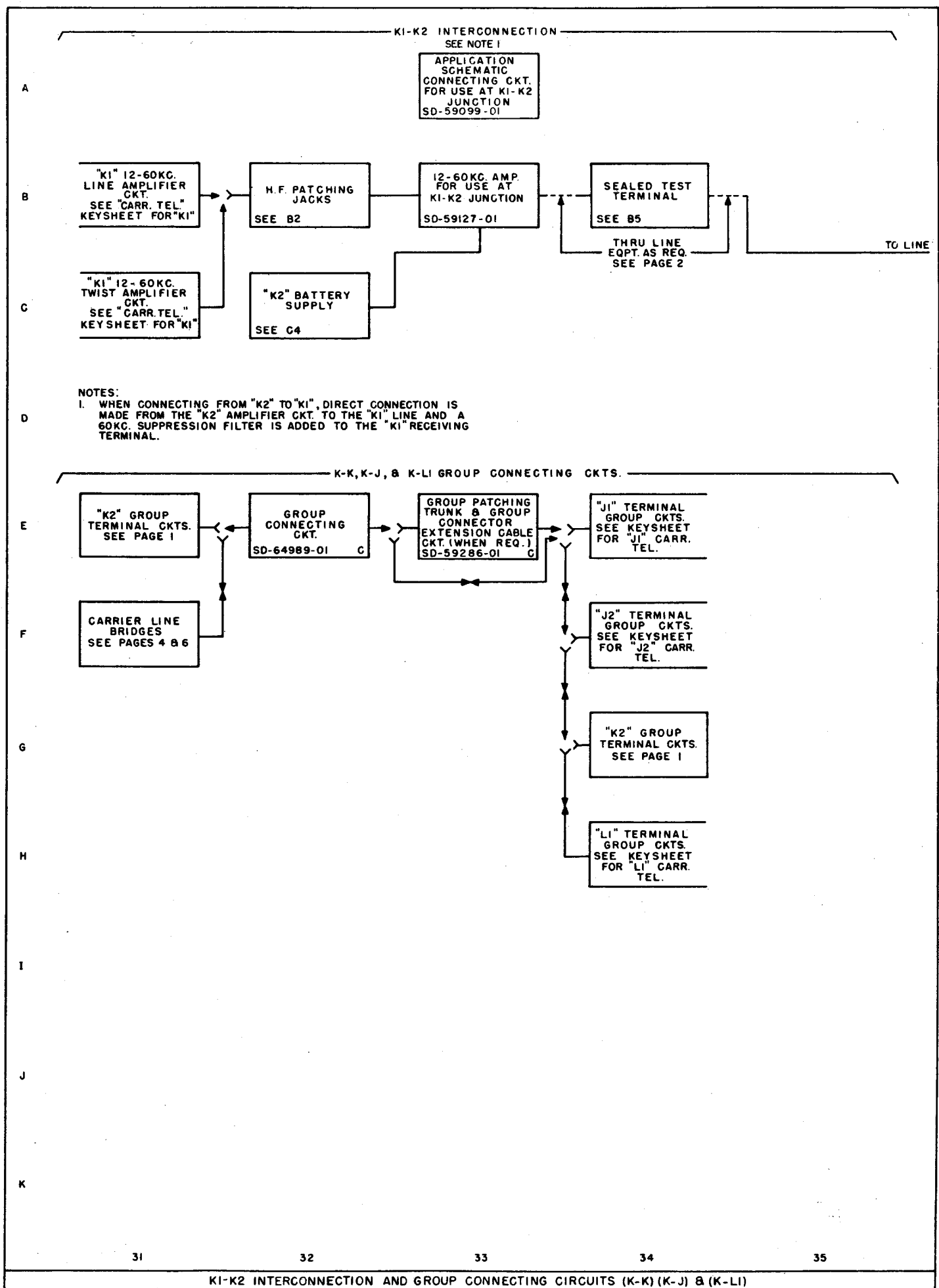
LINE EQPT., INCLUDING AMPLIFIERS, EQUALIZERS, CROSSTALK BALANCING CKTS., ETC



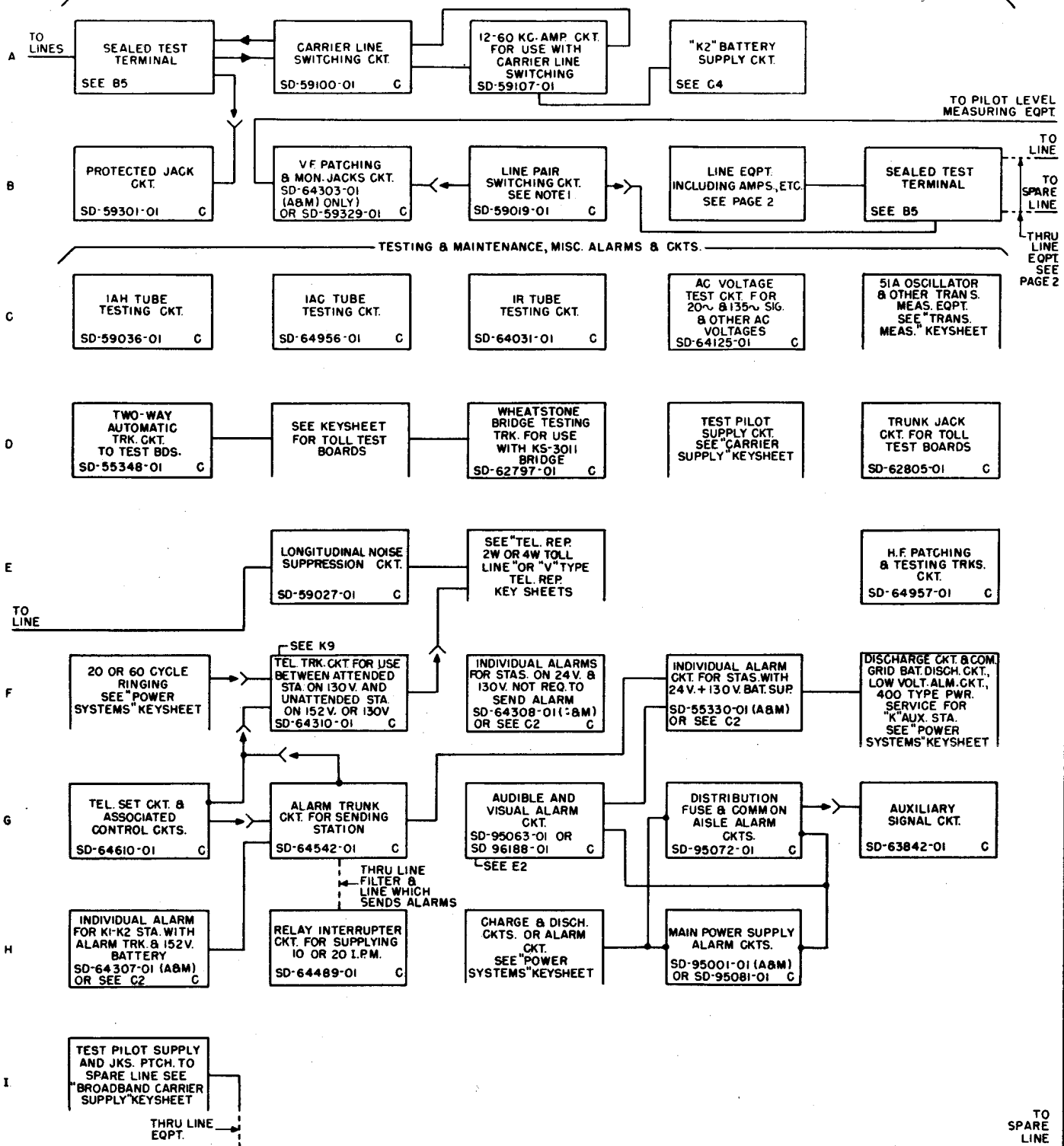








CARRIER LINE SWITCHING



NOTES:

1. THIS CIRCUIT IS USED ONLY TO SWITCH LINES BETWEEN ADJACENT STATIONS.

[illegible]

9. DRAINS FOR "GRP. DEMOD. & AUX. AMP. CKT." AND "GRP. MOD. & AUX. AMP. CKT." (USED WHEN BRANCHING TO "LI"), AND FOR LINE OR TWIST AMPS. MUST BE ADDED TO THESE DATA AS REQ.

GENERAL DESCRIPTION

Type K2 Carrier System

The Type K2 system provides for 12 communication channels per 19 gauge non-loaded pair in aerial or underground cable. It operates on a four-wire basis and uses a frequency range on the line of 12 to 60 kc in each direction of transmission. Pairs in separate cables are ordinarily employed for each direction of transmission.

A process of double modulation is used in the "K2" terminal equipment in order to realize economies through the use of crystal filters in the channel banks. The first step of modulation, which occurs in the channel bank modulator units, uses the lower sidebands of carriers in the frequency range of 60-108 kc. In the second step of modulation, the 12 carrier channel bands are shifted as a group by modulation with a group carrier frequency of 120 kc to the line frequency range.

At the receiving terminal, the 12 carrier channels (12 to 60 kc) received from the line are modulated with the group carrier frequency of 120 kc in the group demodulator and translated as a group to the 60 to 108 kc range for transmission to the channel demodulator units. The demodulator band filters in the channel modem unit separate the 12 channel bands from each other, and each channel is demodulated with its associated carrier frequency in the channel demodulator to produce 12 communication channels. These channels may be used for voice, carrier telegraph, Class C program and picture transmission. Modifications of group terminal equipment are available for use when transmitting program and picture signals, and the modifications which are necessary in the channel carrier terminal and carrier supply equipment for the transmission of the higher classes of program service are described in the key sheets covering those circuits.

The carrier frequencies mentioned above and the pilot frequencies (used in transmission regulating system) may be obtained from a common "K" carrier supply or from combined carrier supplies which also furnish frequencies used in the "J2" and "L1" systems.

Repeater stations, which are spaced on the average about every 17 miles, are divided into line and twist amplifier points. Twist amplifiers (see below) are normally provided about every 100 miles for aerial cable, every 200 to 250 miles for underground cable, and usually in receiving

circuits at the terminals. Line amplifiers are used at each intermediate repeater station between twist amplifier points.

Equalizers are employed at the input of the line or twist amplifiers to compensate for the attenuation characteristic of the Type K cable pairs which rises with frequency. The effect of these equalizers is to reduce the gain of the amplifiers at the low frequencies so that substantially flat transmission occurs through the cable section and amplifier together for a particular temperature condition.

However, since the rate of change of the attenuation of a cable pair with temperature is not uniform with frequency throughout the Type K range, further equalization is usually necessary. The departure from a flat transmission characteristic which remains after the basic equalization has been completed may, for convenience, be analyzed as follows:

- (1) Flat Loss or flat gain. Independent of frequency.
- (2) Twist. The difference in change of attenuation at various frequencies as the cable temperature varies. Consists of:
 - (a) Slope. The difference between the transmission levels at 12 kc and 60 kc. (The slope is considered positive when the 60 kc level is higher than the 12 kc level, and vice versa).
 - (b) Bulge. The departure in transmission level from a straight line drawn between the levels at 12 and 60 kc. (The component of the deviation which is all above this straight line is called positive bulge, and vice versa). When the slope is zero, the bulge is usually a positive or negative maximum at about 28 kc.

A transmission regulating system employing thermistors provides automatic and continuous compensation for cable loss variations due to temperature by the use of four pilot channel frequencies as follows:

Twist Amplifiers

12 kc for control of slope.
28 kc for control of bulge

Twist Amplifiers

56 kc for control of flat gain.

Line Amplifiers

60 kc for control of flat gain.

The pilot frequencies of 12, 28 and 56 kc are obtained as 108, 92, and 64 kc from the common carrier supply employed at the terminal and modulated in the group equipment to the desired frequencies. The 60 kc pilot frequency is obtained from the terminal transmitting amplifier which is arranged to oscillate at 60 kc as well as to amplify the carrier channels in the 12-60 kc range. The output power of the 60 kc pilot to the line is controlled by the speech input in such a manner that the sum of the talker powers on all channels plus the 60 kc pilot power is held substantially constant at +15 dbm at the transmitting amplifier output.

In the line amplifiers, a thermistor is used in a feedback circuit to provide the flat gain regulation over the working range of amplifier input levels normally encountered in service. (Non-regulating or fixed-gain line amplifiers, in which the thermistors are omitted, are sometimes used in place of certain selected regulating amplifiers on underground cables where temperature variations are small). Since the temperature changes occur slowly, the 60 kc regulation is designed to be slow, requiring a considerable time to stabilize so that instantaneous power peaks will not cause the net loss to change.

In the twist amplifiers, the flat gain regulation holds substantially constant the output power of the 56 kc pilot over the working range of the 56 kc input powers. The 56 kc regulation is designed to be as rapid as possible in order to compensate for rapid changes in net loss such as might be caused by the interaction of ringing currents or test tones on the line amplifier 60 kc regulating circuit. Regulation for slope and bulge is also provided in the twist amplifier in addition to flat gain regulation. The slope and bulge networks are designed so that the shape of the transmission frequency characteristic of the twist amplifier is controlled by one variable resistance associated with each network. The variable resistance employed for this purpose consists of a thermistor, the resistance of which is determined

by the power of the 12 kc or 28 kc pilots at the output of the twist amplifier.

The transmission band width of Type K2 channels is substantially flat between 200 and 3300 cycles. A circuit composed of five type K channels connected in tandem provides a band width of about 3225 cycles with the lower and upper 10 db points falling at about 175 and 3400 cycles, respectively.

Portable and relatively economical testing and maintenance equipment has been developed for use with the "K2" system.

Provisions are available for interconnection between "K2" and "J1", "J2", "K1", "K2", and "L1" systems, such connections being made in the channel group frequency range of 60-108 kc.

The branching point equipment provides for the connection of a reversible program circuit to a "K" line at an intermediate point between "K" terminals. An end branching point connects to a single program terminal and provides program transmission toward or from one "K" terminal. A two-way (thru) branching point connects to two program terminals and provides program transmission to or from a program terminal toward each "K" terminal. The two high-frequency program circuits thus formed, one extending in each direction from the branching point, may be operated either independently, in which case the through program transmission along the "K" line is blocked, or in tandem, using the branching point equipment for bridging only. When the branching point is used for bridging only, the through transmission does not pass through the program terminals and hence is not subjected to band filter distortion at the branching point.

Current Drain Data

The current drain data provided herein is to be used in determining the size of the toll power plants and the power leads. These data shall be used in all cases except for those deviations specifically authorized by the Bell Telephone Laboratories, Inc. in accordance with the routine procedure covering special practices.

The drain given for each circuit represents the average drain throughout the busy hour for each unit of the given type of equipment.

INDEX OF DRAWINGS

<u>DWG. NO.</u>	<u>DESCRIPTION</u>	<u>LOCA- TION</u>	<u>DWG. No.</u>	<u>DESCRIPTION</u>	<u>LOCA- TION</u>
SD-55330-01	Individual Alarm Ckt.	F39	SD-59167-01*	Bldg.Out Ckt. for In-coming Cables	G6
55348-01	Trk. Ckt.	D36	59168-01*	Bldg.Out Ckt. for Out-going Cables	H6
55390-01	Alm.Sig. & 20 Cycle Rep.	K10	59223-01	Pri.Toll Line Jk. Ckt. Using Sealed Tst. Term.	B5
55551-01	Ind.Alm. (152V) Ckt.	C2	59286-01	Grp. Ptch. Trk. & Conn. Extension Cable Ckt.	E33
55553-01	Ind.Alm. (130V) Ckt.	C2	59294-01	Grp. Dem. & Amp. for Pict. Trans.	K4
59019-01	Line Pair Sw. Ckt.	B38	59301-01	Protector Jack Ckt.	B36
59027-01	Longitudinal Noise Suppression Ckt.	E37	59329-01	VF Ptch. & Mon.Jks. & Amp. Cont. Ckt.	B37
59036-01	1AH Tube Tst. Set	C36	59392-01	Chan. 8 By-pass Ckt.	D15
59083-01	Branch Mod. Ckt.	I13	62797-01	Wheatstone Bridge Tst. Trk.	D38
59085-01*	A1A & C1A Carr. Line Bridging	A13	62805-01	Trk. Jk. Ckt. for Teleg. Test Board	D40
59085-02*	A1B & C1B Carr. Line Bridging	A23	63842-01	Aux. Sig. Ckt.	G40
59086-01	Blocking and By-Passing Ckt.	B14	64031-01	1R Tube Test Ckt.	C38
59086-02	Line Blocking Ckt.	J23	64125-01	A.C. Voltage Test Ckt.	C39
59093-01	HF Patch Jks.	B2	64226-01	Pri. Toll Line Ck. Ckt. Using Sealed Tst. Term.	B5
59094-01	Group Mod. Ckt.	B3	64303-01	VF Ptch. & Mon.Jks. & Amp. Cont. Ckt.	B37
59094-01	Group Mod. Ckt.	B3	64307-01	Individual Alm. Ckt.	H36
59099-01*	K1-K2 Conn. Ckt.	A33	64308-01	Individual Alm. Ckt. for 24 and 130 V	F38
59100-01	Carr. Line Sw. Ckt.	A37	64310-01	Telephone Trk.Ckt.	F37
59107-01	Amp. For Carr.Line Sw.	A38	64325-01	Crosstalk Bal. Ckt.	I8
59112-02	K2-B Line Amp. Ckt.	B8	64325-02	Crosstalk Bal. Ckt.	I8
59113-02	Twist Amp. Ckt.	E8	64489-01	Relay Interrupter Ckt.	H37
59114-01	Trsg. Amp. Ckt.	B4	64542-01	Alarm Trk. Ckt.	G37
59115-01	K2 Bat. Sup. Ckt.	C4	64610-01	Telephone Set Ckt.	G36
59116-01*	Line Amp. Ckt.	A8	64956-01	1AC Tube Tst. Set	C37
59117-01*	Twist Amp. Ckt.	D8	64957-01	HF Ptch. & Tst. Trk.Ckts.	E40
59118-01*	Term. Grp. Ckts.	A3	64989-01	Group Connector Ckt.	E32
59118-02*	Term. Grp. Ckt. for Pict. Trans.	H3	95001-01	Main Pwr.Sup. Alm.Ckts.	H39
59127-01	Amp. For K1-K2 Junction	B33	95063-01	Aud. & Visual Alm.Ckt.	G38
59129-01	Crosstalk Bal. Ckt.	I8	95072-01	Distribution Fuse, Com. Aisle & Misc.Ind.Alm.Ckts.	G39
59135-01	Grp.Dem. & Dem.Amp.Ckt.	D3	95081-01	Pwr. Supply Alm. Ckt.	H39
59139-01	Alm.Ckts. on Carr.Pairs	K8	96188-01	Aud. & Visual Alm.Ckt.	G38

*Application Schematic