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BELL TELEPHONE LABORATORIES, INC.

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TOLL SYSTEMS

BROADBAND CARRIER TELEPHONE CHANNEL CARRIER TERMINAL CKTS. KEY SHEET

INDEX

FOR EXPLANATION OF CONVENTIONS, SEE MASTER KEY SHEET SD-90250-01.

FOR BROADBAND CARRIER SUPPLY KEY SHEET, SEE SD-63394-05.

FOR TRANS. MEAS. KEY SHEET, SEE SD-95021-01.

PARTIALLY REPLACING SD-63394-01

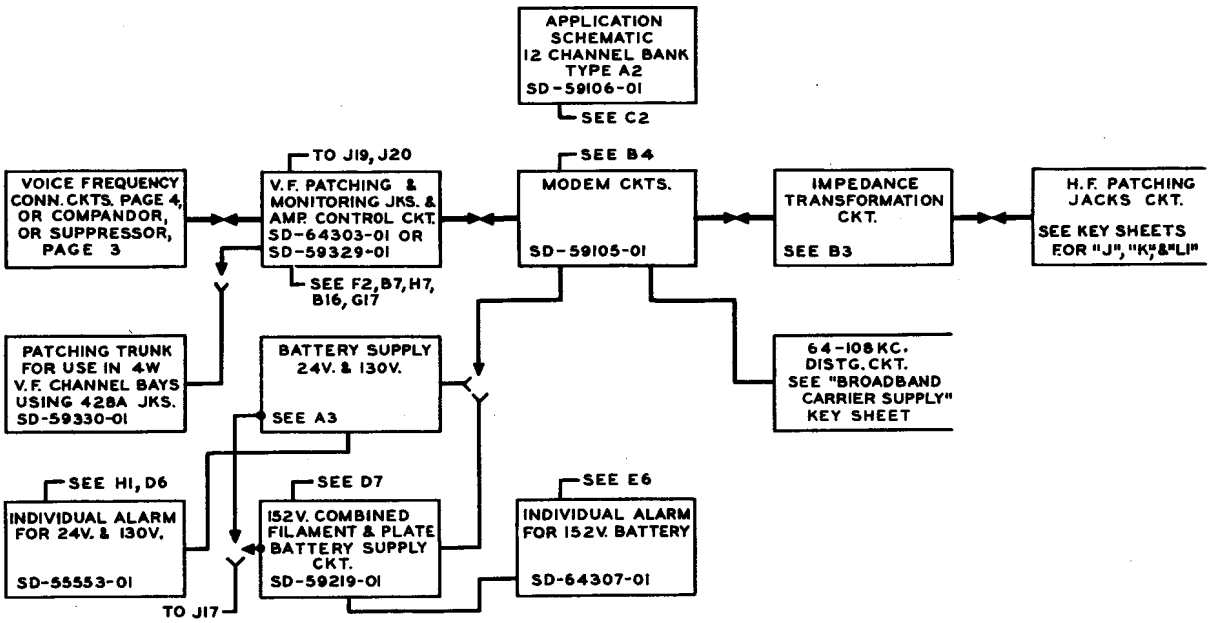
PRINTED IN U.S.A.

AT&TCO STANDARD

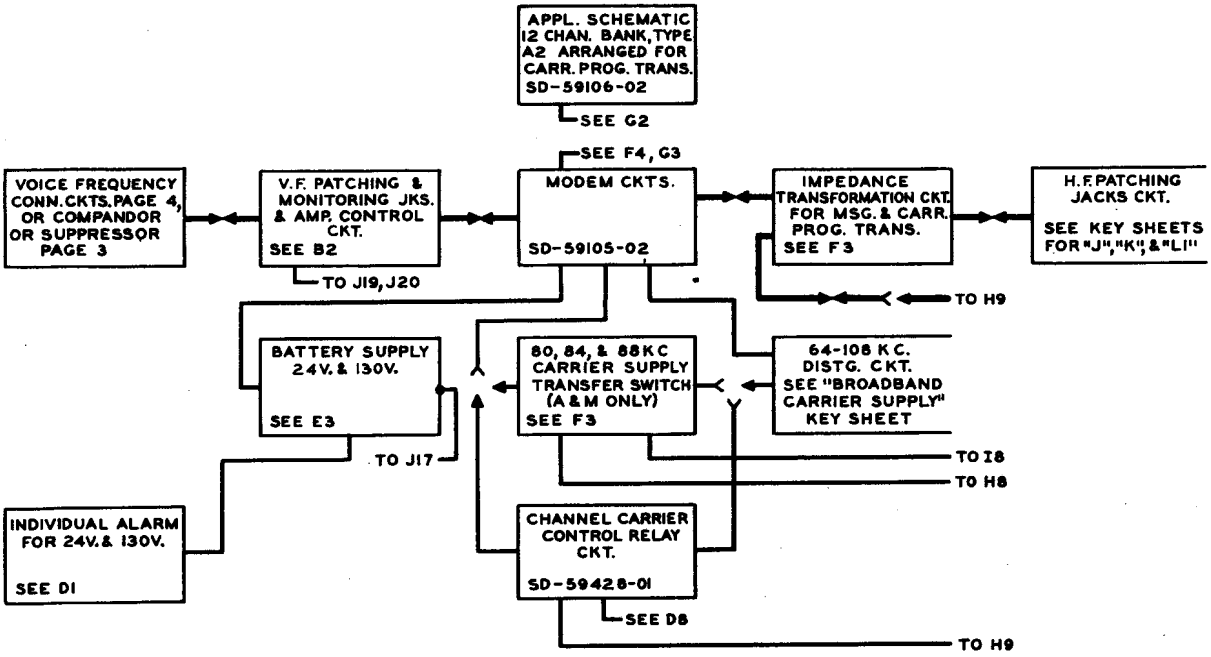
SD-63394-06

J. J. DAMOUR

12 CHANNEL BANK, TYPE A2



12 CHANNEL BANK, TYPE A2, ARRANGED FOR CARRIER PROGRAM TRANSMISSION



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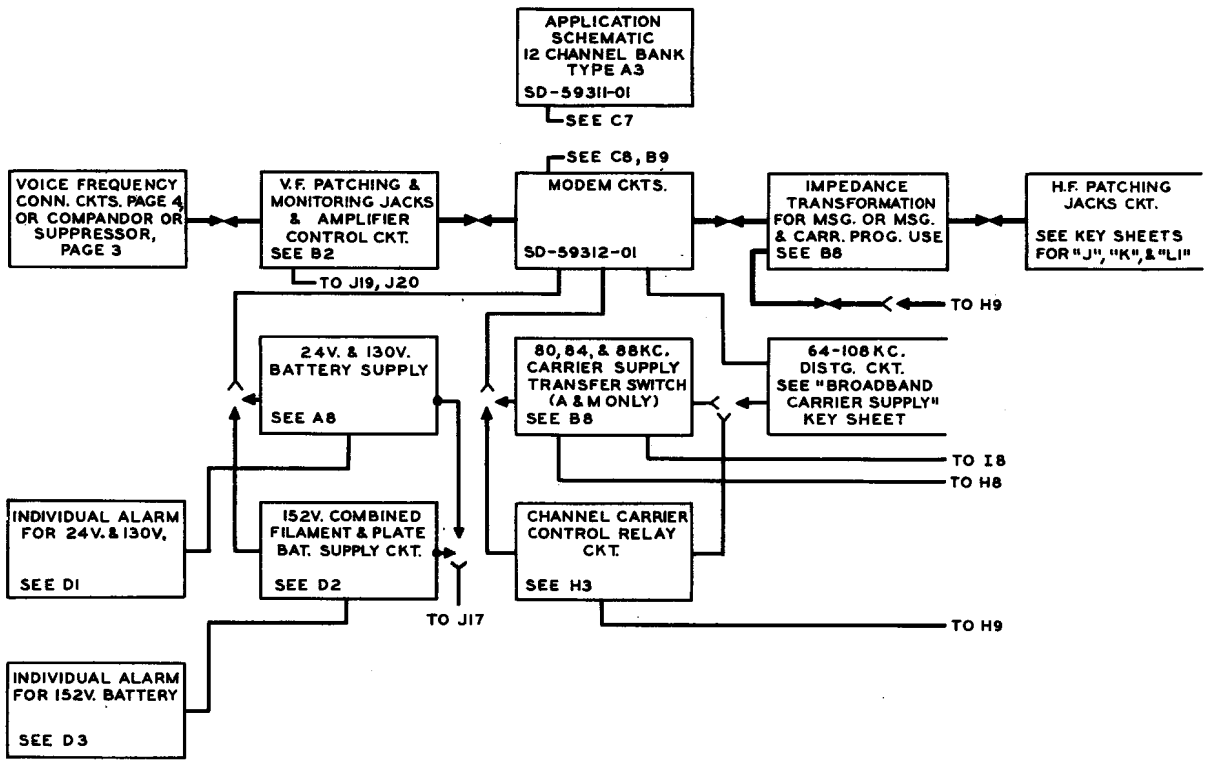
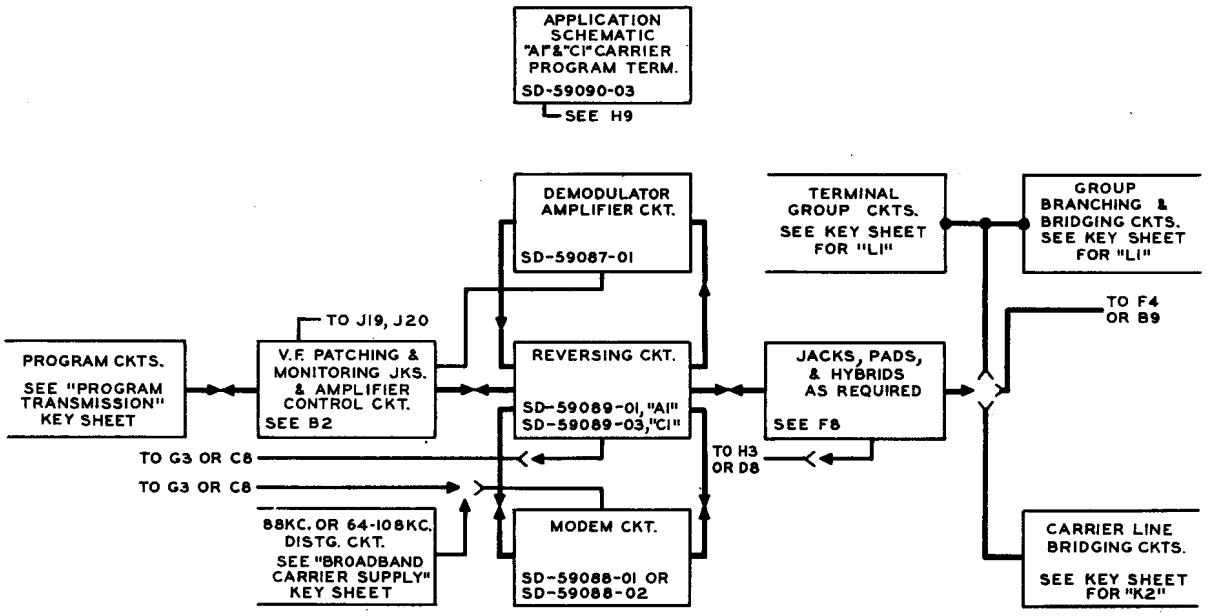
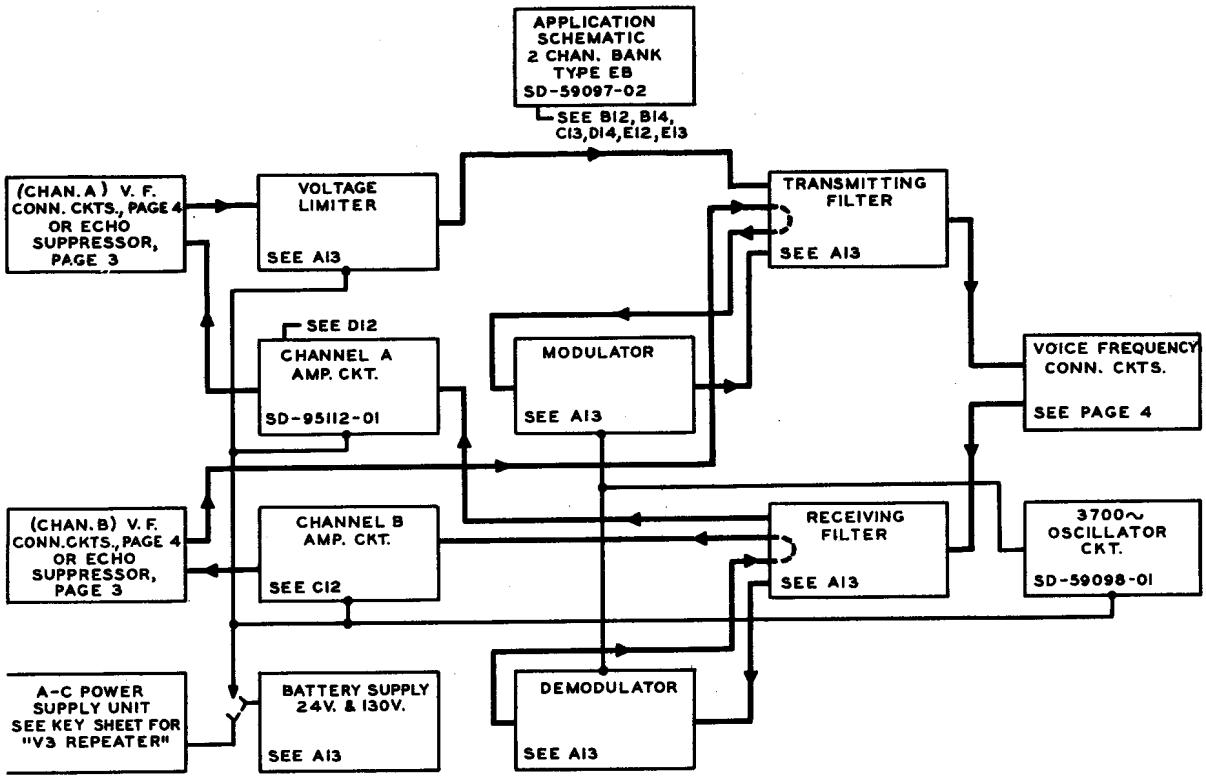


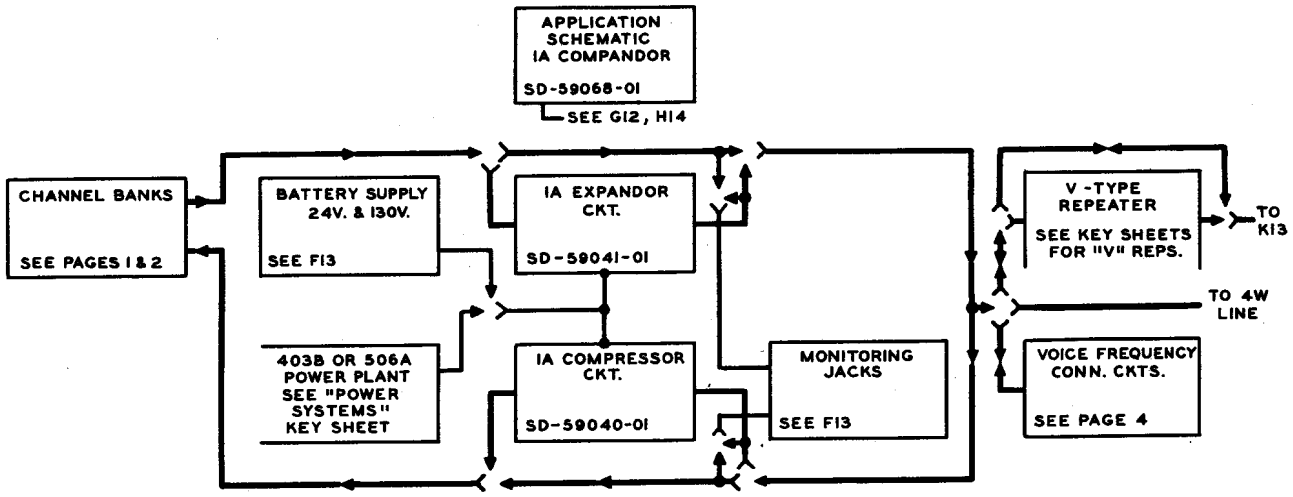
"AI" & "CI" CARRIER PROGRAM TERMINAL



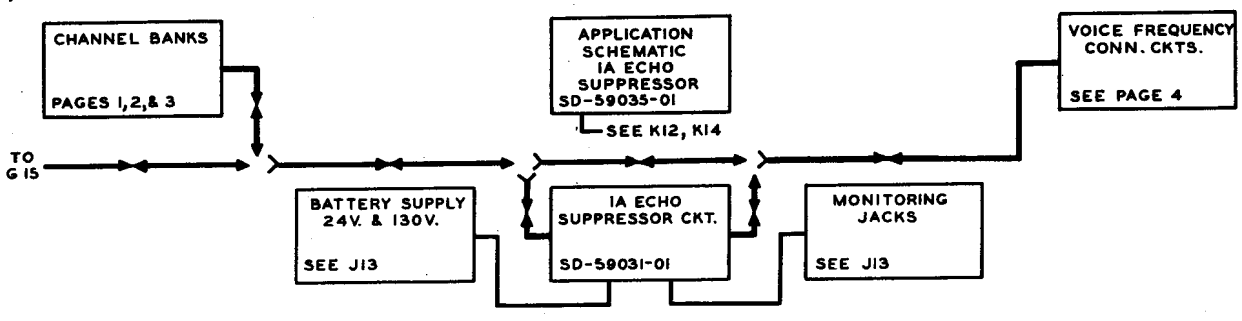
TWO CHANNEL BANK, TYPE EB



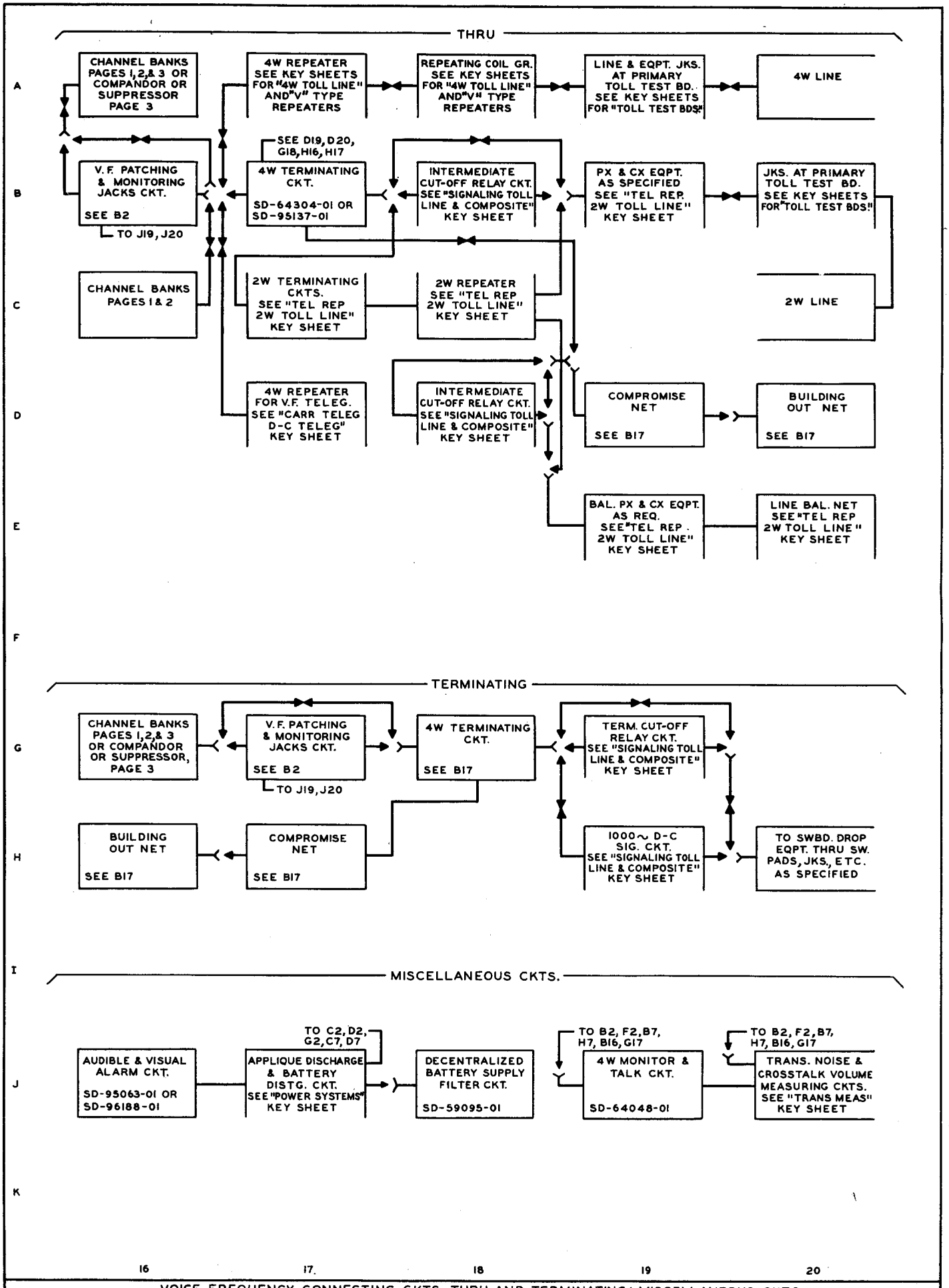
IA COMPANDOR



IA ECHO SUPPRESSOR



TWO CHANNEL BANK, TYPE EB; IA COMPANDOR; IA ECHO SUPPRESSOR



VOICE FREQUENCY CONNECTING CKTS., THRU AND TERMINATING; MISCELLANEOUS CKTS.

CURRENT DRAIN
AMPERE HOURS PER BUSY HOUR

CIRCUIT DRAWINGS		SEE NOTE NO.	DRAINS LIST 1 AND LIST 2														
			24 VOLTS					152 VOLTS						130 VOLTS			
CIRCUIT TITLE	CIRCUIT NO.		SIG. BAT.	FIL. BAT.	R.R. GRD.	F. BD. GRD.		PLT.	PLT. BAT.	FIL.	F. BD. GRD.					PLT. BAT.	
APPLICATION SCHEMATIC 12 CHAN. BANK, TYPE A2	SD-59106-01																
MODEM CKTS. (SEE ALSO SD-59219-01, BELOW)		2,4		.320		.304										.016	
		3,4		.430		.414										.016	
APPLICATION SCHEMATIC 12 CHAN. BANK, TYPE A2, ARR. FOR MSG. & PROG.	SD-59106-02																
MODEM CKTS.		2,4,5		.320		.304										.016	
		2,4,6		.305		.289										.016	
CHAN. CARR. CONTROL RELAY CKT.		9, 11		C.034		C.034											
		9, 12		C.068		C.068											
		10,12		C.068		C.068											
APPLICATION SCHEMATIC 12 CHAN. BANK, TYPE A3	SD-59311-01																
MODEM CKTS. (SEE ALSO SD-59219-01, BELOW)		2,4,5		.320		.304										.016	
		2,4,6		.305		.289										.016	
		3,4		.430		.414										.016	
CHAN. CARR. CONTROL RELAY CKT.		9, 11		C.034		C.034											
		9,12		C.068		C.068											
		10,12		C.068		C.068											
APPLICATION SCHEMATIC 2 CHAN. BANK, TYPE EB	SD-59097-02	2		.753		.713				.040						.040	
APPLICATION SCHEMATIC AI & CI CARR. PROG. TERM.	SD-59090-03																
DEMOD. AMP. CKT.				.320		.308										.012	
MOD.-DEMOD. CKT.				.320		.314										.006	
REVERSING CKT.		7	C.184	.320	C.184	.308										B.032	
		8	C.088	.320	C.088	.308										.012	
APPLICATION SCHEMATIC IA COMPANDOR	SD-59068-01																
IA COMPRESSOR		1, 2	A.440	.640	A.440	.624										.016	
		1, 3	A.440	.850	A.440	.834										.016	
IA EXPANDOR		1, 2	A.440	.640	A.440	.624										.016	
		1, 3	A.440	.850	A.440	.834										.016	
APPLICATION SCHEMATIC IA ECHO SUPPRESSOR	SD-59035-01	2	.096	.640	.096	.630										.010	
		3	.096	.850	.096	.840										.010	
152V. COMBINED FILAMENT PLATE BATTERY SUPPLY	SD-59219-01	5						D.016		.320	D.336						
		6						D.016		.305	D.321						

NOTES:
1. WHEN FIL. BAT. IS NOT AVAILABLE, FIL. BAT. SHALL BE CONSIDERED AS SIG. BAT.
2. 24V. REGULATED BATTERY.
3. 24V. NON-REGULATED BATTERY.
4. DRAIN PER EACH TWO-CHANNEL UNIT.
5. 10V. FILAMENT OPERATION.
6. 9V. FILAMENT OPERATION.
7. RECEIVING
8. TRANSMITTING
9. 5KC. PROGRAM
10. 8KC. PROGRAM
11. CHANNELS 6 & 7 DISABLED
12. CHANNELS 6, 7, & 8 NOT DISABLED.

A. ADD WHEN OVEN IS HEATED BY 24V. SIG. BAT.

B. ADDITIONAL 20MA PLT. BAT. DRAIN IS SIMPLEXED CONTROL CURRENT AND IS IN AMPERES. (SEE NOTE C)

C. THIS DRAIN IS IN AMPERES. TO OBTAIN AMPERE-HOURS PER BUSY HOUR, MULTIPLY BY PERCENTAGE OF BUSY HOUR CIRCUIT IS IN THIS OPERATING CONDITION.

D. DRAIN FOR TWO-CHANNEL UNIT. ADD .016 AMPERE-HOUR FOR EACH ADDITIONAL TWO-CHANNEL UNIT.

Message Circuit Transmission

Two-wire circuits, after passing through signaling and other two-wire equipment as required, are connected through the I.D.F. to the Four-Wire Terminating Circuit. This circuit provides a hybrid transformer arrangement for properly terminating any derived four-wire carrier telephone channel, a compromise or line network for balancing the connecting two-wire line circuit, pads for adjusting transmission levels, and building-out condensers to build out and balance office cabling. This terminating circuit is again connected through the I.D.F. for connection to the four-wire voice-frequency channel bay which provides jack facilities for centralized patching to the channel banks, monitoring on a four-wire basis for either or both directions of transmission, talking and 1000-20-cycle signaling on a four-wire basis to either or both terminals and making transmission and noise measurements.

Four-wire circuits, either thru or terminating, also connect to these same V.F. Patching and Monitoring Channel Jacks of the I.D.F. through proper pads. After passing through the jacks, the circuits enter the transmitting and receiving circuits of the "A2" or "A3" channel bank on a four-wire basis.

In the channel bank transmitting circuit, the input repeating coil presents a high impedance to carrier frequencies and acts as a low-pass filter to prevent carrier frequencies from passing it in either direction and insures a balanced circuit into the modulator. The signals of each voice channel are modulated with one of the 12 carriers spaced at 4 kc intervals from 64 to 108 kc. The modulator is of the varistor bridge type, balanced so that the carrier appearing at the output is relatively small. The amplitude of the carrier supplied to the modulator is of a value such as to provide some load limiting action. At the output of the modulator a high-pass filter provides a high impedance to voice frequencies, and an adjustable resistance pad permits each channel to be brought to the same level and also provides a good impedance for the modulator band filters. The crystal-type band filter selects only the lower sideband and rejects all other frequencies.

In the transmitting impedance transformation circuit, the 12 sidebands are combined to form a single 60-108 kc broadband channel group. A compensating network, bridged across the common side of the modulator band filter circuits, improves the transmission characteristic of the first and last channels of the groups; a fixed pad adjusts the level of the output and a hybrid repeating coil provides impedance matching and a regular and alternate output. The mid-point of this hybrid provides another connection for carrier program transmission on those banks arranged for program service.

The 12 channels are treated as a unit in subsequent steps of modulation, transmission over the line, and demodulation, up to the point where they enter the receiving circuits of the far-end 12-channel bank.

The receiving impedance transformation circuit provides circuit arrangements similar to those of the transmitting impedance transformation circuit for connecting the Group Demodulator Amplifier to the receiving side of the 12 channels. The demodulator band filters select the individual 4-kc frequency bands for each of the 12 channels from the 60-108-kc range, and each band is transmitted from its respective filter to its associated demodulator circuit. Each band then passes through a resistance pad and a high-pass filter which serve the same purpose as the corresponding units in the modulator circuit. In each demodulator the received sideband is modulated with the locally supplied carrier to produce voice frequency and an upper sideband. The signals enter the demodulator amplifier through a network and an input transformer which provide the necessary amplitude equalization in each channel required to compensate for the distortion introduced by the band filters. Practically all of the unwanted sideband energy, which is above the voice range, is suppressed in the demodulator amplifier circuit. The output of this amplifier, which is a single-tube circuit, connects to the V.F. channel jacks mentioned above. The gain and feedback of the amplifier are controlled simultaneously by means of a rheostat located in the four-wire voice-frequency channel bay together with the V.F. channel jacks.

Carrier Program Transmission

The "A1" and "C1" Carrier Program Terminal provides for an 8-kc or 5-kc program channel by single sideband transmission over "J2", "K", or "L1" carrier telephone facilities. The voice-frequency program material is applied on a two-wire basis to the Reversing Circuit under the control of a simplex signal which is used to condition the Reversing Circuit for transmitting or receiving use, as described below.

When operating in the transmitting direction, the voice signals are sent to a

predistorting network in the case of an "A1" terminal, or through a 5-kc low-pass filter to the network in the "C1" terminal. The voice signals are then applied to the modulator either through a pad or a delay equalizer. The required carrier is obtained from an 88-kc carrier supply bus directly or through a Carrier Supply Transfer Switch (see below), and is applied to a filter in the Modem Circuit either directly or through an impedance adjusting pad. After modulation the signals pass through a pad or delay equalizer and then the lower sideband is selected by a program band filter and, returning to the Reversing Circuit, is connected to the transmitting circuit.

On the receiving end the signals, passing through the Reversing Circuit, are applied to the program band filter which selects only those frequencies in the program range of 79.5 to 88 kc. They then pass through a pad or delay equalizer to the demodulator. After demodulation the program signals pass again through either a pad or delay equalizer, through the Reversing Circuit to a restorer and Demodulator Amplifier, back to the Reversing Circuit and thence through a repeating coil (and a low-pass filter in case of "C1") to the receiving voice frequency program circuits.

A d-c simplex signal received from preceding circuits operates reversing relays which place the Reversing Circuit in the transmitting condition, causing it at the same time to generate a 78-kc signal in the "A1" terminal or 81 kc in the "C1" terminal which, after group modulation, is transmitted over the line for control of the distant terminal. The same transmitting condition can be obtained by plugging into specified test jacks. When the transmitting control is released, and a reversal of the program channel is to be effected, the 78-kc or 81-kc signal received from the distant terminal is amplified, rectified, and operates relays to place the Reversing Circuit in a receiving condition, at the same time furnishing a d-c simplex control voltage for the circuits immediately following the carrier link.

When the program terminal is used with a channel bank on a non-associated basis, the transmitting leads connect through a pad and program high frequency patching jacks to the transmitting hybrid coil of the bank. The program signals, together with the message channel signals, proceed into the transmitting group terminal. The receiving leads are patched to the receiving hybrid coil of the associated bank to which the output of the receiving group terminal is applied. The carrier supply for the Modem Circuit may be obtained directly from an 88-kc bus when the Channel Carrier Control Relay Circuit is used or through the Carrier Supply Transfer Switch. The Channel Carrier Control Relay Circuit is controlled by contacts in the program HF patching jacks and removes or restores carriers from the message channels' modems when these channels are replaced by the program channel or the program channel is removed, respectively. Channels 6, 7 and 8 are used for "A1"; Channels 6 and 7 are used for "C1". The setting of a "5-8 KC Control Key", which is located in either the channel bank or program high frequency patching bay, determines whether two or three channels are switched. The Carrier Supply Transfer Switch, which is manually controlled, disables the replaced channels' modems and transfers the Channel 6 carrier to the program modem, or vice versa, as required. When the message channels are in use, the Switch applies a short circuit to the output of the 78-kc or 81-kc control tone oscillator in the Reversing Circuit to prevent the possible introduction of a 2-kc tone into message channel 8 for "A1", or 3-kc tone into message channel 7 for "C1".

When the program terminal is associated with an "A1"- or "C1"-type "K" Carrier Line Bridge, the transmitting and receiving leads connect to the input of the Branch Modulator Circuit and the output of the Group Demodulator Circuit, respectively. (See "K2" Key Sheet).

When the program terminal is associated with an "L1" Group Circuit without a channel bank, the transmission leads connect to the High-Frequency Patching Jacks through a pad and hybrid. (See Key Sheet for "L1".)

When the program terminal is associated with the "L1" Group Bridging and Branching Circuits, the transmission path is through pads to the relay circuit. (See Key Sheet for "L1".)

Two-Channel Bank, Type EB

This equipment may be used with either four-wire voice-frequency or V.F. channels derived from broad-band carrier telephone systems which transmit frequencies between 250 and 3450 cycles with reasonable fidelity to provide two narrow band width telephone circuits where formerly only one existed. The two new channels are designated channels "A" and "B".

When speech currents enter channel "A", they pass through a voltage limiter which prevents the large speech voltages from producing excessive crosstalk in channel "B". The limiter is essentially a peak clipping device and has no effect on low-volume speech. A pad adjusts the level at the output of the channel "A" transmitting equipment

to be equal, approximately, to the corresponding level at the output of channel "B". A low-pass filter restricts the transmitted speech frequencies to the band below 1700 cycles.

At the receiving end of channel "A" another low-pass filter selects frequencies below 1700 cycles, and an amplifier compensates for the losses introduced by the system.

In the channel "B" transmitting equipment a low-pass filter selects frequencies below 1700 cycles. These speech currents are modulated with a 3700-cycle signal. A band-pass filter selects only the lower sideband, suppressing the upper sideband and carrier. The modulator provides voltage limiting to an extent which is comparable to that introduced by the voltage limiter circuit in channel "A". This, as was the case for channel "A", minimizes the crosstalk between the two channels.

Thus, two bands appear at the output of the "EB" equipment: one, from approximately 200 to about 1700 cycles, and the second from 2000 to about 3500 cycles.

At the channel "B" receiving end, the signals pass successively through a band-pass filter, a pad, a demodulator, and a low-pass filter to an amplifier which compensates for the loss in the equipment of channel "B".

1A Compandor

The "1A" Compandor provides a means of reducing the effect of noise and crosstalk. It operates at the ends of four-wire telephone circuits.

One compandor consists of a compressor at the transmitting end and an expandor at the receiving end on the same side of the circuit which provide, respectively, compression and expansion in a ratio of about 2 to 1 for changes of input which are relatively slow. Either or both sides of the circuit may be equipped with compandors. In the latter case, which is the usual arrangement, cross control may be provided between the expandor and compressor at the same end of the circuit to improve the return loss of the circuit. Monitoring and talking facilities at the compandor bay may be employed by patching between the monitoring jacks and a four-wire monitoring and talking Circuit.

"1A" Echo Suppressor

The "1A" Echo Suppressor was designed for general use in suppressing echoes on four-wire or two-wire voice-frequency circuits, or on carrier channels. This circuit differs from earlier models in several important respects. Among these are the following:

The two sides of the suppressor are differentially interconnected, making its operation dependent upon the difference between the speech levels in the two directions of transmission. This provides protection against false operation by echoes or noise, and also permits the listener to break in more easily on the talker and take control of the toll circuit. The suppressor may be located at circuit terminals as well as at intermediate points. Also, the suppressor is sufficiently sensitive to permit its application at low level points. The above two features permit its use on carrier channels.

The suppressor is in series with the toll circuit instead of being bridged across it. The suppression loss is applied by balancing a hybrid coil inserted in the transmission path.

Current Drain Data

The current drain data is to be used in determining the size of the toll power plant 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 throughout the busy hour for all equipment shown on that circuit.

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*Application Schematic