COMMON SYSTEMS
"N1" CARRIER TELEPHONE
LOW GROUP TRANSMITTING CKT.

CHANGES

B. CHANGES IN APPARATUS

B.1 In Fig. 2 Superseded	In Fig. 2 Superseded By
1 - Cap. (C55), KS-14141, L2 .01µf	1 - Cap. (C55), KS-14142, L2 .01µf

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Options "P" and "R" are added to cover B.1 above. "P" option only was previously shown and not rated "Mfr. Disc."

All other headings, no change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 2210-JBE-PGE-AJ

COMMON SYSTEMS
"N1" CARRIER TELEPHONE
LOW GROUP TRANSMITTING CKT.

CHANGES

B. CHANGES IN APPARATUS

B.1

Superseded	Superseded By
1 - Crystal (Y40), 27DB, 304 kc	1 - Crystal (Y40), 33DA, 304 kc
1 - Cap. (C54), KS-14081, L2, 1µf	1 - Cap. (C54), 508A, 1µf
1 - Cap. (C56), KS-14081, L2, 1µf	1 - Cap. (C56), 508A, 1µf

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Options "H", "J", "M" and "N" are added to cover B.1 above. Options "H" and "M" only was previously shown and not rated "Mfr. Disc."

All other headings, No change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 2210-JBE-PGE-CG

COMMON SYSTEMS
"N1" CARRIER TELEPHONE
LOW GROUP TRANSMITTING CKT.

CHANGES

B. CHANGES IN APPARATUS

B.1

Superseded	Superseded By
Option E	Option F
1 - Capacitor (C9), .01 mfd KS-14141, L2	1 - Capacitor (C9) .01 mfd KS-14142, L2

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Option "E" and "F" were added to cover B.1 above. Option "E" only was previously shown and not rated "Mfr. Disc."

All other headings, no change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 2210-HWH-PGE-CP

COMMON SYSTEMS
"N1" CARRIER TELEPHONE
LOW GROUP TRANSMITTING CKT.

CHANGES

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Rating was changed from "AT&TCo. Provisional" to "AT&TCo. Standard".

All other headings under "Changes," no change.

1. PURPOSE OF CIRCUIT

1.1 This circuit provides modulation of the high group band of channel frequencies (164-260 kc) to place it in the low group band (44-140 kc). This low group is then amplified for transmission on the cable. A controllable amount of noise is added to the signal to provide proper masking of intelligible system crosstalk. A 3700-cycle oscillator to supply the signal tone for the channel units is included in the same unit.

2. WORKING LIMITS

2.1 None.

3. FUNCTIONS

3.1 Inverts the frequencies received from the channel units as the high group band (164-260 kc) to the low group band (44-140 kc) by modulating the received high group with the 304-kc carrier oscillator.

3.2 Generates the 304-kc carrier required for the modulation process described in paragraph 3.1.

3.3 Amplifies the modulated signals in the 44-140-kc band.

3.4 Generates and introduces a masking noise into the transmitting path.

3.5 Introduces a fixed amount of pre-equalization (+7 db).

3.6 Provides means of obtaining a 6 db excess gain in the amplifier when required.

3.7 Provides means of supplying positive voltage to an adjacent repeater station when required. The negative voltage is supplied through the associated high group receiving circuit.

3.8 Provides means for making filament activity tests and for measuring the space currents.

3.9 Generates a 3700-cycle tone required for the signaling circuit of the channel units.

4. CONNECTING CIRCUITS

4.1 Channel Unit Circuit - SD-95118-01.

4.2 Application Schematic for Terminal-SD-95121-01.

4.3 High Group Receiving Circuit - SD-95130-01.

DESCRIPTION OF OPERATION

5. GENERAL

The low group transmitting circuit is made up of two subunits. One subunit of this circuit contains the noise generator, equalizer, modulator, band-pass filter and amplifier. The second subunit contains the 304-kc carrier oscillator and the 3700-cycle signal tone oscillator. The complete unit when associated with a high group receiving circuit constitutes the terminal group equipment.

6. FILTER, EQUALIZER AND NOISE GENERATOR (Fig. 1)

Signals received from the channel units, are fed through low-pass filter (FL1). This filter suppresses unwanted frequencies lying above the high group band. The wide band noise generated in vacuum tube (V1) is introduced into the transmitting path at the output of transformer (T2). This noise is used to raise the over-all system noise as required to mask intelligible crosstalk. The channel signals combined with the noise pass through an equalizer (EQ1) and (EQ2). This equalizer inserts a fixed amount of predistortion which preequalizes approximately one-half of the slope in a repeater section so that the maximum level difference between the highest and lowest channel frequencies is about halved. From the equalizer the signals pass to the primary winding of the modulator input coil (T1).

Thermal noise generated in grid leak resistance (R7), plus the internal noise of vacuum tube (V1) is amplified by the tube and applied at the primary of input transformer (T2) from the plate of tube (V1). The plate and screen supply for tube (V1) is received through resistances (R23) and (R24) with condenser (C3) providing filtering to ground and plate circuit by-pass to cathode. The plate is fed through the primary of transformer (T2) and the screen through the (NOISE) potentiometer. This potentiometer controls the noise output of the tube. Condenser (C1) provides screen-to-cathode by-pass. Resistance (R8) by-passed by condenser (C4) provides cathode bias for tube (V1). The space current for tube (V1) can be measured between test jack (FIL ACT 3 and 6).

7. MODULATOR AND LOW-PASS FILTER (Fig.1)

The signals coming from the equalizer (EQ1) and (EQ2) enter the modulator circuit at terminals 6 and 4 or repeating coil (T1). Signals during one-half cycle of the carrier frequency flow directly to repeating coil (T5) through 1-2 and 5-4 of the varistor unit, while in the alternate half cycle of the carrier the poling is reversed in that the signals flow through 6-5 and 2-3 of the varistor unit and in an opposite direction through repeating coil (T5). This poling reversal at carrier frequency produces lower and upper sidebands which flow out of the (T5) repeating coil. The carrier, which is generated in the 304-kc oscillator (described in paragraph 9), is introduced at the mid-points of the (T1) and (T5) repeating coils facing the varistor unit. With this modulator configuration the input signal is, to the degree of modulator balance realized, excluded from the output branch, the modulated signal excluded from the input branch and the carrier is excluded from both the input and output branch, being balanced out in the local path through repeating coils (T1) and (T5) and the varistor unit. Of the modulation products produced by the varistor, the lower sideband (44-140 kc) is selected by the low-pass filter (FL2) and (FL3) which is inserted between the repeat coil (T5) and the input transformer (T3) of the amplifier. Condenser (C2) is bridged across the low winding of the (T3) input coil to improve its impedance.

8. AMPLIFIER CIRCUIT (Fig. 1)

The amplifier circuit is generally similar to that of the high-low repeater. The signal received from the output filter of the modulator is stepped up by the input transformer (T3). Resistances (R10), (R11) and (R12) make up an input feedback bridge which provides a suitable termination for the input transformer. The secondary winding of the transformer is connected to the control grid of tube (V2) and through the feedback bridge and resistance (R13) to the cathode. Resistance (R13) by-passed by condenser (C6) is the cathode bias resistance. The first stage, tube (V2), is impedance coupled to the second amplifier tube (V3) by means of retardation coil (L1), condenser (C8) and grid leak resistance (R15). Resistance (R16) is the cathode bias resistance for tube (V3). The plate of the second tube delivers the amplified signal to the line through the output transformer (T4). The midpoint of the transformer low winding is used to transmit or receive power over the line, when desired, longitudinal voltages being suppressed by retardation coil (L3). Condenser (C10) is bridged across the low winding of the transformer to improve the impedance facing the line. The hybrid coil arrangement of the output transformer (T4), together with resistance (R21) forms the output feedback bridge which is connected to the input feedback bridge through the "Beta" circuit. Condensers (C7) and (C9) are provided for d-c insulation. The "Beta" circuit consists of resistances (R22), (R20), (R19) and (R17). Proper strapping of resistances (R20) and (R19) is used for manufacturing adjustments of amplifier gain.

The plate power supply is introduced through resistance (R23) with condenser (C11) for filtering. The plate and screen of the first tube are supplied through resistance (R14), filtering condenser (C5) acting at the same time as screen-to-cathode by-pass. The plate is fed through retardation coil (L1). For the second stage the supply passes through retardation coil (L2), the screen being supplied through resistance (R21), which is part of the outer feedback bridge, with condenser (C7) providing screen-to-cathode by-pass. The plate is fed through the high winding of output transformer (T4). Retardation coil (L2) prevents an a-c short of the "Beta" circuit through condenser (C11). The space current of the tubes can be measured between test jacks (FIL ACT 1 and 2) for the first stage, and between jacks (5 and 4) for the second stage.

9. OSCILLATOR CIRCUIT (Fig. 2)

The 304-kc carrier supply oscillator is a crystal controlled oscillator. The oscillating circuit utilizes the grid, screen and cathode of tube (V40) as a triode oscillator. The screen grid of tube (V40) is coupled back to the control grid through condenser (C40), crystal (Y40) and resistance (R45), the latter preventing unwanted high frequency oscillations. The resistance (R40) and condenser (C42) parallel combination, together with condenser (C40) provide voltage division determining the amount of feedback to the control grid. The output of the oscillator is delivered from the plate of the tube to the primary winding of output transformer (T40) which is tuned to 304 kc by condenser (C47) to provide harmonic discrimination. The oscillator output is fed from the secondary of the transformer to the harmonic suppression filter, retard coil (L40), condensers (C49) and (C41), hence to the mid-points of the repeating coils (T1) and (T5) in Fig. 1.

The plate is supplied through resistance (R44) with condenser (C48) filtering and also acting as by-pass to ground of the plate circuit. The plate is fed through the primary of repeating coil (T40). The screen is supplied through resistances (R42) and (R43) which with condenser (C46) provide filtering. Condenser (C45) provides screen-to-cathode by-pass. The cathode of the tube is a-c grounded through condenser (C44). Space current for tube (V40) can be determined by measuring the voltage across resistance (R41) between test jacks (FIL ACT 1 and 2).

10. 3700 CYCLE OSCILLATOR CIRCUIT (Fig2)

10.01 This circuit is a Wien bridge oscillator. One arm of the bridge is composed of condensers (C51), (C52) and (C53) in parallel with resistances (R51) and (R59). (R51) is returned through a 4 µf condenser external to this circuit (C8 of SD-95121-011, "Application Schematic for Terminal"). Condenser (C53) is the variable frequency tuning element. The second arm of the bridge consists of condenser (C50) in series with resistance (R50). The frequency of oscillation is determined mainly by these two arms. The third arm of the bridge is the thermistor (RT40), and the fourth arm consists of the series combination of resistances (R53) and (R54) shunted by the series combination of resistance (R56) and condensers (C56) and (C58).

10.02 The output terminals of the bridge are connected to the grid and cathode of the first section (V41A) of double triode (V41). The cathode and plate of the second section (V41B) of the double triode are coupled back to the input terminals of the bridge, so that the bridge is included in the feedback circuit. The bridge is always operated slightly unbalanced.

10.03 Thermistor (RT40) limits the amplitude of oscillation to the linear portions of the double triode characteristics by adjusting the bridge balance as oscillations initially build up. This provides a signal with low harmonic content. The thermistor (RT40) also stabilizes the output voltage amplitude against variations in load impedance and supply voltages by automatically adjusting bridge balance to maintain constant output voltage.

10.04 The control grid of triode section (V41A) is connected to the junction of the first two bridge arms through resistance (R52) to prevent spurious oscillations. Bias voltage for triode section (V41A) is obtained by a balance between two opposing IR drops. Resistance (R51) and (R59) are in series across the -40 volt battery and hold the grid at -20 volts with respect to ground potential. Resistances (R53) and (R54) pass the cathode current and produce about -17 volts between cathode and ground, thereby placing a net operating bias of about -3 volts on tube section (V41A).

10.05 The amplified bridge output voltage appears across resistance (R62), the plate load resistance of triode section (V41A). Resistance (R62) is returned to the cathode of (V41A) through by-pass condenser (C58). The a-c voltage across (R62) constitutes one component of the voltage applied between grid and cathode of triode section (V41B). The other component is the a-c voltage across the series combination of resistances (R53) and (R54). These two components add in series through by-pass condenser (C58) and the net a-c voltage is applied between the grid and cathode of triode section (V41B).

10.06 The a-c voltage across resistances (R53) and (R54) is of opposite phase to the a-c voltage across resistance (R62), so that the amplitude of the net voltage applied between grid and cathode of triode section (V41B) is the difference between the amplitudes of the two components. The a-c voltage across (R62) is slightly greater than that across (R53) and (R54), so that the net voltage is of proper phase to maintain oscillations. The effect of the bucking voltage across (R53) and (R54) is to increase the percentage variation of the net voltage amplitude for a given change in bridge balance. Thus less change in bridge balance is required to correct for a given change in output voltage, and frequency stability is therefore enhanced.

10.07 Condenser (C55) is the grid-coupling condenser for triode section (V2B). Resistance (R57) is to prevent high frequency spurious oscillation. Resistance (R58) provides a d-c return path for the grid, and cathode resistances (R60) and (R61) develop bias for the output stage. Resistance (R56) in the d-c plate supply path to triode section (V41A) is necessary to prevent an a-c short-circuit across the bridge arm containing (R53) and (R54). This circuit condition results from the grid and cathode of (V41A) and the plate and cathode of (V41B) being coupled to the bridge output and input terminals respectively.

10.08 The feedback of the circuit is obtained by connecting the plate of triode section (V41B) back to the bridge through resistance (R63), potentiometer (R64) and blocking condenser (C54). Resistance (R55), in conjunction with condenser (C56) and condenser (C8) of the terminal application schematic, filters the 130 volt supply and provides isolation from other circuits connected to the 130 volt battery. Condenser (C56) also acts as the plate circuit by-pass for triode section (V41B).

10.09 Oscillator output is taken from the plate circuit of (V41B) through transformer (T41). The balanced secondary of (T41) is connected to plug terminals (PB12) and (PB14) and to varistor rectifier (CR40), which supplies rectified current for operating an external 3700 cycle alarm relay.

10.10 Resistance (R65), in conjunction with the leakage reactance of transformer (T41), attenuates the higher harmonics of 3700 cycles. This resistance also improves transient behavior and reduces changes in frequency with load variations by acting as a minimum load.

10.11 Space current for the two triode sections can be measured between test jacks (Fil. Act 3 and 4) for (V41A) and between jacks (5 and 4) for (V41B).

11. FILAMENT CIRCUIT (Fig. 2)

The filament supply is obtained from an office 48-volt battery through a resistance, external to this circuit, dropping the voltage to approximately 40 volts.

The filaments of tubes (V1), (V2) and (V40) in parallel are in series with the paralleled filaments of tubes (V3) and (V41).

The reduction in filament current for filament activity tests is obtained by bridging a suitable resistance across test jacks (FIL ACT TST 1 and 2) for tubes (V1), (V2) and (V40) and across jacks (FIL ACT TST 2 and 3) for tubes (V3) and (V41). The same test points are used for the associated high group receiving circuit, to the filament circuit of which they are externally connected.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 2210-DNR-PGE-KT