

VACUUM TUBE HEATER CIRCUIT

METHOD OF ADJUSTMENT FOR 9 VOLT OPERATION

1. GENERAL

1.01 This section describes methods for making a readjustment of the strapping on the heater circuit resistances in certain carrier telephone system amplifiers to provide for the operation of 310A and 311A vacuum tubes with nominally 9 volts instead of 10 volts per tube applied to the heaters. The objective is to extend the useful service life of tubes. After all tests of this section are completed, the usual routine tests covered in the E sections shall apply.

1.02 This section is reissued to incorporate material from the addendum in its proper location. In this process marginal arrows have been omitted.

1.03 Procedures are given for adjusting K1 carrier telephone Line, Twist, Test, Transmitting, Auxiliary Receiving and Auxiliary Switching amplifiers and also for 12 Channel Bank Types A1 and A2 Modem units when used with any type carrier system. Where 9-volt operation is authorized for other circuits, the resistance strapping required will be found on the circuit drawings, and the vacuum tube testing requirements will be found in the appropriate sections of Bell System Practices. Nine-volt operation should not be employed unless covered in this section or on the circuit drawing.

1.04 The readjustment of heater circuits is accomplished in the case of main stations, which have separate filament and plate voltage supply, by first determining the mean or "REFERENCE" heater voltage for the fuse panel supplying the equipment bays of the units to be converted to 9-volt heater operation. The building out resistances of each amplifier heater circuit are then restrapped in accordance with TABLE I, II, III, IV or V of this section, depending on the particular "REFERENCE" heater fuse panel voltage.

1.05 In the case of amplifiers located in auxiliary stations, a similar procedure is employed. The procedure is identical for all such stations because of the constant voltage supply from the 152-volt battery plant and a uniform heater supply arrangement for all circuits.

1.06 After each amplifier heater circuit readjustment is made for 9-volt operation, grid current, cathode activity and space millivolt measurements should be made on the existing tubes for the amplifier using the 1R or 1AC Tube Test Set, to determine their suitability for 9-volt heater operation, applying for this purpose the requirements given in TABLES VI and VII of this section.

1.07 It is necessary to open the heater circuit before removing a tube from or placing a tube in its socket. The heater circuit should not be opened except when the equipment is out of service. In order to prevent possible damage to the tubes in the amplifier the input to the amplifier (carrier leak, pilot channel energy or test tone) should be removed, wherever practicable, before the heater circuit is opened and no input should be applied to the amplifier until after all tubes have been energized for at least 3 minutes. In connection with the transmitting amplifier, arrangements for preventing amplifier input are not readily available.

Caution: If plate and filament fuses are not removed when working on the amplifier, care shall be exercised to not touch exposed terminals to avoid shock hazard.

2. APPARATUS

2.01 1R or 1AC Tube Test Set.

2.02 Weston Model 1 or Model 45 voltmeter, scale 0-30 with 150 scale divisions, or equivalent. This meter is required only at main stations.

Note 1: If a Model 1 meter is used in testing, the meter shall be kept at least 6 inches from other metal such as the frames of the relay rack bays, power boards, etc. If a Model 45 meter is used, this precaution is not necessary.

2.03 258C plug (open).

2.04 Soldering copper.

2.05 Strap wire.

2.06 Pliers.

Note: If tool handles are not insulated, both plate and filament fuses should be removed at fuse panel in power supply of amplifier being converted, to avoid shock hazard.

3. PROCEDURE(A) Main Stations

3.01 Determine the "REFERENCE" or mean fuse panel voltage using the 0-30 volt range voltmeter connected through a 1-1/3 ampere fuse to the bus bar terminals of the fuse panel located at the top of the bay containing the equipment to be converted to 9-volt heater operation. Where a diverter pole generator power plant is provided, the voltage measured at the bus bar terminals is the "REFERENCE" voltage. Where this power plant is not provided, the procedure for determining the "REFERENCE" voltage is as follows:

3.02 Have the power attendant adjust the battery voltage to obtain as precisely as possible the high limit as determined by the operation of the voltage alarm or the automatic equipment in automatically regulated power plants. In this procedure the exact voltage alarm point should not be over-run. Accurately observe and record the voltmeter reading of the amplifier bay.

3.03 Then have the power attendant adjust the battery voltage to obtain as precisely as possible the low limit as determined by the operation of the voltage alarm or the automatic equipment in automatically regulated power plants. The exact voltage alarm point should not be over-run. Accurately observe and record the voltmeter reading again. Then have the power attendant adjust the battery voltage back to normal.

3.04 Determine the average of the high and low voltage readings recorded in 3.02 and 3.03. This average is the "REFERENCE VOLTAGE" for the particular fuse panel.

3.05 Refer to TABLES I to V, depending on the equipment to be adjusted, and obtain the required total building-out resistance for 9-volt operation corresponding to the value of "REFERENCE VOLTAGE" determined in 3.01 or 3.04. The following procedure applies to every amplifier to be readjusted and the same value of building-out resistance is used for all similar units fed from any one fuse panel.

3.06 Remove the amplifier for service (see 1.07). Open the heater circuit by inserting a 258C plug in the FIL jack. If pliers with insulated handles are not available, remove the plate and filament supply fuses for the amplifier at the fuse panel on the amplifier bay to avoid danger of electrical shock when performing the following procedures.

Caution: Inserting the plug in the FIL jack of a channel demodulator amplifier opens the heater circuit of two channel demodulator amplifiers.

3.07 Remove the vacuum tubes from the amplifier to be converted. Identify tubes so they can be restored to the same socket.

3.08 Restrap building-out resistances to provide the required value of total resistance selected in 3.05.

3.09 Restore the original tubes to their respective sockets. Remove the 258C plug from the FIL jack. Replace fuses if they have been removed and allow a heating up interval sufficient to stabilize the new heater current, as observed on the 1R or 1AC Tube Test Set filament milliammeter. The heater current will ordinarily stabilize in about 3 minutes.

3.10 Make GRID current, CATH ACT and SP-MV tests with the heater current range specified for the lower heater voltage operation using the 1R or 1AC Tube test Set. Use test limits given in TABLES VI and VII. In connection with the CATH ACT test, allow the usual interval for the reduced heater current to become stabilized.

3.11 Tubes which do not meet the 9-volt operating limits given in TABLES VI and VII should be replaced with tubes which meet these requirements. Used tubes which do not meet the 9-volt operating limits should be reserved for 10-volt operation.

3.12 Any new tubes which do not meet 9 volt operating limits should be aged or soaked on 9 volts for a period of approximately 48 hours. A retest at the end of the 48 hours may show that the tubes have become satisfactory for 9 volt operation. Those tubes which do not meet the 9 volt operating limits shall be reserved for 10 volt operation.

3.13 Restore the amplifier to service (see 1.07).

(B) Auxiliary Stations

- 3.14 Amplifiers selected for 9-volt operation in auxiliary stations must be converted in groups of seven, i.e., #1 to 7, 8 to 14, etc., so that in any case all seven amplifiers of any group bridged across the 152V battery are either completely on a 9-volt or 10-volt basis.
- 3.15 To provide an equal load on all seven sections of the battery where less than seven repeaters are converted to 9-volt heater operation, each of the associated (DF) resistances (44 type) in the dummy heater load group shall be increased 1 ohm to 17 ohms, as covered in SD-64330-011. In addition, the corresponding out-of-service heater load resistances shall be modified to provide 17 ohms for the REP plug and 34 ohms for the AMPL plug, as indicated on SD-64330-012. These are the EBY 97A-515 type 4-prong plugs having suitable dummy resistance load wired to the filament terminals for use in the appropriate socket of the CSL EBY 12A socket bank. These are required whenever a complete repeater or individual amplifier is temporarily removed from service.
- 3.16 Remove the amplifier from service (see 1.07). Open the heater circuit by inserting a 258C plug in the FIL jack. If pliers with insulated handles are not available, remove the plate and filament supply fuses for the amplifier at the fuse panel on the amplifier bay to avoid danger of electrical shock when performing the following procedures.
- 3.17 Remove the vacuum tubes from the amplifier to be converted. Identify tubes so they can be restored to the same socket.
- 3.18 For amplifiers equipped with 14 ohms resistance (adjustable in 1 ohm steps) for heater circuit adjustment (19DR and 19LW resistances), restrap the resistances of each amplifier to provide a total resistance as given in TABLE VIII.
- 3.19 For amplifiers equipped with 9 ohms resistance (adjustable in 0.6 ohm steps) for heater circuit adjustment (19TG and 19TH resistances), restrap the resistances of each amplifier to provide a total resistance as given in TABLE IX.
- 3.20 Restore the original tubes to their respective sockets. Remove the 258C plug from the FIL jack. Replace fuses if they have been removed and allow a heating up interval sufficient to stabilize the new heater current, as observed in the 1R or LAC Tube Test Set filament milliammeter. The heater current will ordinarily stabilize in about 3 minutes.

3.21 Make GRID current, CATH ACT and SP-MV tests with the heater current range specified for the lower heater voltage operation using the 1R or LAC tube Test Set. Use test limits given in TABLES VI and VII. In connection with the CATH ACT test, allow the usual interval for the reduced heater current to become stabilized.

3.22 Tubes which do not meet the 9-volt operating limits given in TABLES VI and VII should be replaced with tubes which meet these requirements. Used tubes which do not meet the 9-volt operating limits should be reserved for 10-volt operation.

3.23 Any new tubes which do not meet 9 volt operating limits should be aged or soaked on 9 volts for a period of approximately 48 hours. A retest at the end of the 48 hours may show that the tubes have become satisfactory for 9 volt operation. Those tubes which do not meet the 9 volt operating limits shall be reserved for 10 volt operation.

3.24 Restore the amplifier to service (see 1.07).

4. FINAL ADJUSTMENT TEST - CONVERSION

4.01 All tubes should be retested after 3 to 5 weeks operation and should meet the tube test requirements given in TABLE VI and VII. Tubes which fail to meet their requirements after this operating interval should be removed and reserved for 10-volt operating circuits.

5. FINAL ADJUSTMENT TEST - NEW INSTALLATIONS

5.01 Where amplifiers are adjusted for 9-volt heater operation and are equipped with new tubes, the tubes should meet the requirements given in TABLES VI and VII. Tubes which do not meet these requirements should be reserved for 10-volt operation.

5.02 Wherever practicable, tubes should not be rejected for 9 volt operation before they have been operated in a 9 volt circuit for at least 48 hours, but if the installer is leaving the station in less than 48 hours this interval may be shortened or omitted. (In most cases this will not occur except for tubes used to replace others found unsuitable for 9 volt operation).

TABLE I

K1 LINE, TWIST, TRANSMITTING, TEST AND
AUXILIARY SWITCHING AMPLIFIERS

Total Building Out Resistance in Heater Circuit vs REFERENCE
Fuse Panel Voltage
Amplifiers Equipped with 19 TG and 19TH Resistances

<u>REFERENCE Fuse Panel Voltage</u>	<u>Total Building Out Resistance Ohms</u>	<u>REFERENCE Fuse Panel Voltage</u>	<u>Total Building Out Resistance Ohms</u>
26.5	12.6 (Note 3)	23.3	7.8
26.4	12.6 "	23.2	7.8
26.3	12.6 "	23.1	7.8
26.2	12.6 "	23.0	7.2
26.1	12.6 "	22.9	7.2
26.0	12.6 "	22.8	7.2
25.9	12.0 "	22.7	7.2
25.8	12.0 "	22.6	6.6
25.7	12.0 "	22.5	6.6
25.6	12.0 "	22.4	6.6
25.5	11.4 "	22.3	6.6
25.4	11.4 "	22.2	6.0
25.3	11.4 "	22.1	6.0
25.2	10.8 "	22.0	6.0
25.1	10.8 "	21.9	5.4
25.0	10.8 "	21.8	5.4
24.9	10.8 "	21.7	5.4
24.8	10.2 "	21.6	5.4
24.7	10.2 "	21.5	4.8
24.6	10.2 (Note 1)	21.4	4.8
24.5	10.2 "	21.3	4.8
24.4	9.6 (Note 2)	21.2	4.2
24.3	9.6 "	21.1	4.2
24.2	9.6 "	21.0	4.2
24.1	9.0	20.9	4.2
24.0	9.0	20.8	3.6
23.9	9.0	20.7	3.6
23.8	9.0	20.6	3.6
23.7	8.4	20.5	3.6
23.6	8.4	20.4	3.0
23.5	8.4	20.3	3.0
23.4	8.4	20.2	3.0

Note 1: This value of resistance cannot be obtained with the resistances (19TG and 19TH) furnished with the amplifier. The 19DR, 19LW or 19UC resistance should be substituted for the 19TG resistance.

Note 2: This value of resistance cannot be obtained with the resistances (19TG and 19TH) furnished with the amplifier. The 19TH or 18AY resistance should be substituted for the 19TG resistance.

Note 3: Resistance values specified for fuse panel voltages over 24.6V cannot be obtained with resistances (19TG and 19TH) furnished with amplifier. The 19UW should be substituted for the 19TH resistance. This substitution can also be applied in lieu of resistances specified in Notes 1 and 2.

TABLE II

K1 LINE, TWIST, TRANSMITTING, TEST AND
AUXILIARY SWITCHING AMPLIFIERS

Total Building Out Resistance In Heater Circuit vs REFERENCE
Fuse Panel Voltage
Amplifiers Equipped with 19DR and 19LW Resistances

<u>REFERENCE</u> <u>Fuse</u> <u>Panel</u> <u>Voltage</u>	<u>Total</u> <u>Building Out</u> <u>Resistance</u> <u>Ohms</u>	<u>REFERENCE</u> <u>Fuse</u> <u>Panel</u> <u>Voltage</u>	<u>Total</u> <u>Building Out</u> <u>Resistance</u> <u>Ohms</u>
26.5	13.0	23.3	8.0
26.4	13.0	23.2	8.0
26.3	13.0	23.1	8.0
26.2	13.0	23.0	7.0 (Note 1)
26.1	13.0	22.9	7.0 "
26.0	12.0	22.8	7.0 "
25.9	12.0	22.7	7.0 "
25.8	12.0	22.6	7.0 "
25.7	12.0	22.5	7.0 "
25.6	12.0	22.4	6.0 "
25.5	12.0	22.3	6.0 "
25.4	11.0	22.2	6.0 "
25.3	11.0	22.1	6.0
25.2	11.0	22.0	6.0
25.1	11.0	21.9	6.0
25.0	11.0	21.8	5.0
24.9	11.0	21.7	5.0
24.8	10.0	21.6	5.0
24.7	10.0	21.5	5.0
24.6	10.0	21.4	5.0
24.5	10.0	21.3	5.0
24.4	10.0	21.2	4.0
24.3	10.0	21.1	4.0
24.2	9.0	21.0	4.0
24.1	9.0	20.9	4.0
24.0	9.0	20.8	4.0
23.9	9.0	20.7	4.0
23.8	9.0	20.6	3.0
23.7	9.0	20.5	3.0
23.6	8.0	20.4	3.0
23.5	8.0	20.3	3.0
23.4	8.0	20.2	3.0

Note 1: This value of resistance cannot be obtained with the resistances (19DR and 19LW) furnished with the amplifier. The 19KU resistance should be substituted for the 19LW resistance.

TABLE III

K1 AUXILIARY RECEIVING AMPLIFIER

Total Building Out Resistance vs
REFERENCE Fuse Panel Voltage

<u>REFERENCE Fuse Panel Voltage</u>	<u>Total Building Out Resistance Ohms</u>	<u>REFERENCE Fuse Panel Voltage</u>	<u>Total Building Out Resistance Ohms</u>
26.5	25.5 (Note 1)	23.3	16.0
26.4	25.5 "	23.2	16.0
26.3	25.5 "	23.1	15.5
26.2	25.5 "	23.0	15.0
26.1	25.5 "	22.9	15.0
26.0	25.0 "	22.8	14.5
25.9	25.0 "	22.7	14.0
25.8	24.5 "	22.6	14.0
25.7	24.0 "	22.5	13.5
25.6	24.0 "	22.4	13.5
25.5	23.5 "	22.3	13.0
25.4	23.0 "	22.2	12.5
25.3	23.0 "	22.1	12.5
25.2	22.5 "	22.0	12.0
25.1	22.0 "	21.9	11.5
25.0	22.0 "	21.8	11.5
24.9	21.5 "	21.7	11.0
24.8	21.0 "	21.6	10.5
24.7	21.0 "	21.5	10.5
24.6	20.5 "	21.4	10.0
24.5	20.0	21.3	9.5
24.4	20.0	21.2	9.5
24.3	19.5	21.1	9.0
24.2	19.0	21.0	8.5
24.1	19.0	20.9	8.5
24.0	18.5	20.8	8.0
23.9	18.0	20.7	7.5
23.8	18.0	20.6	7.5
23.7	17.5	20.5	7.0
23.6	17.0	20.4	6.5
23.5	17.0	20.3	6.5
23.4	16.5	20.2	6.0

Note 1: Resistance values specified for F.P. voltages over 24.6V cannot be obtained with resistances (19N, 19KU and 19KW) furnished with amplifier. The 19PA should be substituted for the 19N resistance.

TABLE IV

12 CHAN BANK TYPE A1 MODEM UNITS

Total Building Out Resistance vs
REFERENCE Fuse Panel Voltage

<u>REFERENCE</u> <u>Fuse</u> <u>Panel</u> <u>Voltage</u>	<u>Total</u> <u>Building Out</u> <u>Resistance</u> <u>Ohms</u>	<u>REFERENCE</u> <u>Fuse</u> <u>Panel</u> <u>Voltage</u>	<u>Total</u> <u>Building Out</u> <u>Resistance</u> <u>Ohms</u>
26.5	27.0	23.3	16.0
26.4	27.0	23.2	16.0
26.3	26.0	23.1	16.0
26.2	26.0	23.0	16.0
26.1	26.0	22.9	15.0
26.0	25.0	22.8	15.0
25.9	25.0	22.7	15.0
25.8	25.0	22.6	14.0
25.7	24.0	22.5	14.0
25.6	24.0	22.4	14.0
25.5	24.0	22.3	13.0
25.4	23.0	22.2	13.0
25.3	23.0	22.1	13.0
25.2	23.0	22.0	12.0
25.1	22.0	21.9	12.0
25.0	22.0	21.8	12.0
24.9	22.0	21.7	11.0
24.8	21.0	21.6	11.0
24.7	21.0	21.5	11.0
24.6	21.0	21.4	10.0
24.5	20.0	21.3	10.0
24.4	20.0	21.2	10.0
24.3	20.0	21.1	9.0
24.2	19.0	21.0	9.0
24.1	19.0	20.9	9.0
24.0	19.0	20.8	8.0
23.9	18.0	20.7	8.0
23.8	18.0	20.6	8.0
23.7	18.0	20.5	7.0
23.6	17.0	20.4	7.0
23.5	17.0	20.3	7.0
23.4	17.0	20.2	6.0
		20.1	6.0

TABLE V

12 CHAN. BANK TYPE A2 MODEM UNITS

Total Building Out Resistance vs. REFERENCE Fuse Panel Voltage
 19UW + 19TH + KS-8512 List 3B 12 ohm Resistances (see Note 1)

<u>REFERENCE Fuse Panel Voltage</u>	<u>Total Building Out Resistance Ohms</u>	<u>REFERENCE Fuse Panel Voltage</u>	<u>Total Building Out Resistance Ohms</u>
26.5	26.4	23.2	15.6
26.4	26.4	23.1	15.6
26.3	26.4	23.0	15.6
26.2	26.4	22.9	15.6
26.1	25.2	22.8	14.4
26.0	25.2	22.7	14.4
25.9	25.2	22.6	14.4
25.8	25.2	22.5	13.2
25.7	24.0	22.4	13.2
25.6	24.0	22.3	13.2
25.5	24.0	22.2	13.2
25.4	22.8	22.1	12.0
25.3	22.8	22.0	12.0
25.2	22.8	21.9	12.0
25.1	22.8	21.8	12.0
25.0	21.6	21.7	10.8
24.9	21.6	21.6	10.8
24.8	21.6	21.5	10.8
24.7	21.6	21.4	9.6
24.6	20.4	21.3	9.6
24.5	20.4	21.2	9.6
24.4	20.4	21.1	9.6
24.3	19.2	21.0	8.4
24.2	19.2	20.9	8.4
24.1	19.2	20.8	8.4
24.0	19.2	20.7	8.4
23.9	18.0 (Note 1)	20.6	7.2
23.8	18.0	20.5	7.2
23.7	18.0	20.4	7.2
23.6	16.8	20.3	6.0
23.5	16.8	20.2	6.0
23.4	16.8	20.1	6.0
23.3	16.8	20.0	6.0

Note 1: KS-8512 resistance required only
 for values above 23.9 volts

TABLE VI

TUBE TEST REQUIREMENTS - 9 VOLT OPERATION
TRANSMITTING AND AUXILIARY RECEIVING AMPLIFIERS
AND TYPES A1 AND A2 MODEM UNITS

TEST		Transmitting Amplifier			Auxiliary Receiving Amplifier		A1, A2 Modem Units		
		Tube	1	2	3	1	2	1	2
		Type	310A	310A	311A	310A	310A	310A	310A
Heater Current in Amperes	Min. Max.	← .56 → ← .66 →			← .28 → ← .33 →		← .28 → ← .33 →		
Grid Current	Switch on 1R or LAC set Max. Grid current in Microamps. Max. Grid current Read on Millivolt Scale		G2 *1.0	G3 250	G1 5.0	G2 5.0			
Space Current SP-MV	Switch on 1R or LAC set Min. Max. SP-MV	P1 240 420	P2 240 420	P3 350 #1000	P1 330 490	P2 400 640	P1 300** 440	P2 300** 440	
Cathode Activity CATH.ACT	Switch on 1R or LAC set Decrease Heater Current in Amperes Max. % Cath. Act	P1 ← .03 → 20	P2 ← .03 → 20	P3 ← .03 → 25	P1 ← .015 → 20	P2 ← .015 → 20	P1 ← .015 → 20	P2 ← .015 → 20	

*A tube in position 2 which fails to meet this requirement may meet the requirements in other sockets and should be reused where possible.

#This is read as 100 with the SHUNT KEY of the 1R or LAC Set in the ON (non-operated) position.

**With gain control in extreme clockwise position.

TABLE VII

TUBE TEST REQUIREMENTS - 9 VOLT OPERATION
LINE, TWIST, TEST AND AUXILIARY SWITCHING AMPLIFIERS

TEST	Tube	Line Amplifier				Twist, Test and Auxiliary Switching Amplifier		
		1	2	†3	+3	1	2	3
		310A	310A	311A	311A	310A	310A	311A
Heater Current in Amperes	Min.	← .56 →				← .56 →		
	Max.	← .66 →				← .66 →		
Grid Current	Switch on 1R or 1AC set	G1	G2	G3	G3		G2	G3
	Max. Grid current in Microamps.	*.5	5.0				*1.0	
	Max. Grid current Read on Millivolt Scale			250	250			250
Space Current SP-MV	Switch on 1R or 1AC set	P1	P2	P3	P3	P1	P2	P3
	Min.	350	350	350	450	240	240	350
	Max.	750	750	#1000	750	420	420	#1000
Cathode Activity CATH.ACT	Switch on 1R or 1AC set	P1	P2	P3	P3	P1	P2	P3
	Decrease Heater Current in Amperes	← .03 →				← .03 →		
	Max. % Cath. Act	20	20	25	20	20	20	25

*A tube in this position which fails to meet this requirement may meet the requirements in other sockets and should be reused where possible.

#This is read as 100 with the SHUNT KEY of the 1R or 1AC set in the ON (non-operated) position

†"Z" lead on terminal 6 or 8.

+ "Z" lead on terminal 10.

TABLE VIII

Total Resistance Values
For Amplifiers Equipped With
14 ohms Resistance
(See Paragraph 3.18)

Amplifier No.	Total No. of Repeaters in Station				
	1-28 Res. Ohms	29-42 Res. Ohms	43-70 Res. Ohms	71-84 Res. Ohms	85-105 Res. Ohms
1,8,15,22	5.0	5.0	5.0	5.0	5.0
7,14,21 28,35,42 49,56	5.0	5.0	4.0	4.0	4.0
64	-	-	5.0	5.0	5.0
63,70,77 84,91,98 105	-	-	5.0	4.0	4.0
All Others	5.0	5.0	5.0	5.0	5.0

TABLE IX

Total Resistance Values
For Amplifiers Equipped With
9 ohms Resistance
(See Paragraph 3.19)

Amplifier No.	Total Res. Ohms
7, 14, 21, 28, 35, 42 49, 56, 63, 70, 77, 84, 91, 98, 105	4.2
All others	4.8