PRIVATE LINE SERVICE
INSTALLATION AND MAINTENANCE
PROGRAM CIRCUITS

Contents

1. GENERAL

1.01 This section provides requirements and procedures used in placing program circuits in service. The following classes of circuits are covered:

(a) Program pick-up loops, e.g., circuits from remote program pick-up points to:

(1) The broadcast company's studio or other control point.

(2) The nearest toll office on a network.

(3) The customers' transmitter.

(b) Network loops, e.g., circuits between the broadcast company's studio or other control point and the toll office at the point of connection to a network.

(c) Studio-to-transmitter circuits (STL), e.g., circuits between the broadcast company's studio or other control point and their associated radio transmitter.

(d) Tie circuits between two studios or other control points within the same local area.

1.02 Information helpful in clearing complaints and some common types of reported trouble with their possible causes are included.

1.03 A sufficient amount of theory pertaining to program transmission and to the functioning of testing equipment used is included to enable the operating forces to do their work.

1.04 The description calibration and operation of test equipment are covered in other A and C Sections of Bell System Practices.

2. SCHEDULES OF PROGRAM SERVICE

Table 1 lists the transmission characteristics of all program service schedules.

2.01 The service order will show the schedule of service to be provided.

TABLE 1

Schedule Designation	Frequency Bandwidth Cycles	Allowable Deviation From 1KC Equal. Loss-db	Service Period Occasional or Temporary	Perm.
AAA	40-15000	±1.0		X
BBB	40-15000	±1.0	X	
AA	50-8000	±1.0		X
BB	50-8000	±1.0	X	
A	100-5000	±1.0 *±2.5		X
B	100-5000	±1.0 *±2.5	X	
C	200-3500	See Para. 2.03		X
D	200-3500	See Para. 2.03	X	
E	Feed Back Tel. Grade	-	X	
**F	As Specified	-	X	X

*The ±2.5 db deviation pertains to a multisection loop containing three amplifiers or more. This deviation pertains to the over-all circuit measurement and generally should not be exceeded in any individual section. In all cases optimum adjustments should be attained.

**All intraexchange circuits are schedule F services. Information indicating whether equalized or nonequalized, and the bandwidth where equalized, must be specified on the service order. When equalization is required, the appropriate schedule deviation applies. All other schedules of service are interexchange circuits.

2.02 Schedules AAA through B are high quality circuits and schedules C and D are medium quality circuits. These schedules all require equalized facilities.

2.03 Schedule C and D services should meet the deviations from the 1000-cycle tone (1KC) reference point as shown in Table 2.

TABLE 2

Frequency	Deviation-db
200	-3.0 to -10.0
300	-2.0 to -8.0
500	+0.5 to -4.5
1000	0
2000	+1.5 to -1.5
3000	+1.0 to -4.0
3500	0 to -8.0

NOTE: Deviations in this table are on a "level basis," e.g., plus (+) signs indicate less loss than at 1KC and minus (-) signs indicate more loss than at 1KC.

2.04 Schedule E services require nonequalized facilities and are primarily used as feedback circuits. Use repeating coils when required for noise reasons to isolate customer's equipment from telephone facilities. The coil impedance ratio should be 1:1 (600-ohms to 600-ohms). See Part 7 on repeating coils for strapping arrangement.

3. PRELIMINARY TESTS

3.01 After completion of the installation work, the installer assists the deskman (control office, local or toll) in making preliminary DC tests. These tests general-

ly consist of a loop measurement, ballistic test, insulation tests, and a grounded varley test as covered in "F" series Bell System Practices.

3.02 On request of the deskman, place a short and ground at the end of the circuit for the loop and varley measurements. The end of a circuit is the point of customer connection.

3.03 Make certain a good solid ground connection is established. The grounded varley measurement should not exceed four (4) ohms per section. Where this value is exceeded, or meter reading varies, make an effort to obtain a better cable facility.

3.04 Place binding post insulators or terminal binding posts, multipling terminals, and central office main and trunk frames.

3.05 Upon completion of the preliminary tests, verify that test shoes have been removed.

3.06 If it is ascertained by the installer that the equalization time (field due date) cannot be met, forward a status report to the control office informing them of the approximate time the circuit will be ready to equalize.

4. BARE LOOP TESTS

4.01 Make a bare loop test consisting of a 1KC loss measurement on the cable facilities as shown below:

(a) On multisection loops.

(1) From pick-up to the only or first line amplifier.

(2) Between line amplifiers.

(3) From the only or last line amplifier to the receiving end termination.

(b) Single section loop (no amplifiers).

(1) From pick-up to receiving end termination.

4.02 Make bare loop measurements on multisection loops as follows:

(a) Send a 1KC from pick-up point and measure at the bare line appearance of the first amplifier point.

(b) After the first section is equalized and the amplifier gain set, make a bare loop measurement in the second amplifier section by sending a 1KC from the pick-up point and measuring at the bare line appearance at the second amplifier point, and so on to the receiving end.

4.03 Make bare loop measurements in single section loops as follows:

(a) Send a 1KC from pick-up point and measure at the bare line appearance at receiving end termination.

4.04 The measured 1KC loss should not exceed ±1.5 db from the computed loss indicated on the service order for each section measured.

4.05 The computed bare loop 1KC loss shown on the service order for overall circuits or between amplifiers generally will not exceed 12 db for all schedules of program service except AAA and BBB, which generally will not exceed 10 db.

4.06 Make a bare loop frequency run when trouble is experienced in equalizing to detect defective cable facilities, excessive bridged taps, and whether cable facilities are loaded or nonloaded. Nonloaded cable facilities can be recognized by the gradual sloping loss as the frequency is increased. The measured 5KC loss of a good nonloaded cable pair will be approximately 2-1/2 times the measured 1KC loss. For loaded cable facilities, except H44, B22, and B7-1/2, the measured loss will have a fairly flat frequency response in the range between 200 and 3000 cycles and a sharp cutoff at frequencies above about 3KC. H44, B22, and B7-1/2 loaded cable facilities will usually have a fairly flat frequency response up to about 5KC, 8KC and 15KC, respectively.

4.07 The test frequencies used for bare loop measurements are shown in Table 3.

TABLE 3

Schedule Designation	Test Frequencies
AA, BB, A, B, and F	100 cycles, 500 cycles, 1KC, 2KC, 3KC, 5KC, and 8KC
AAA, BBB, and F	100 cycles, 500 cycles, 1KC, 3KC, 5KC, 8KC, 10KC, 15KC
C and D	200 cycles, 1KC, 2KC, 3.5KC

5. PURPOSE OF EQUALIZATION

5.01 Equalization of program facilities is made to correct the frequency response of the circuit so that all the required frequencies are received at approximately the same level, without loss of program quality.

5.02 Nonloaded cable facilities are generally used for program services. These facilities have a gradual increasing loss with an increase in frequency and require equalization to restore the flat frequency response. With no equalization, the received program would sound "tubby," e.g., the low frequencies would predominate. Equalization is accomplished with the use of an equalizer which, when adjusted, has a frequency response opposite to that of the nonloaded cable facility. The equalized circuit loss generally will not exceed 2-1/2 times the 1KC bare loop loss. The maximum equalized loss should not exceed approximately 32 db.

5.03 Some types of loaded cable facilities can be used for program services. These facilities may not require equalization but are limited to certain service schedules.

5.04 A graph shows the frequency response characteristic of a typical nonloaded cable pair, an adjusted equalizer, and the resultant equalized pair (see Figure 1).

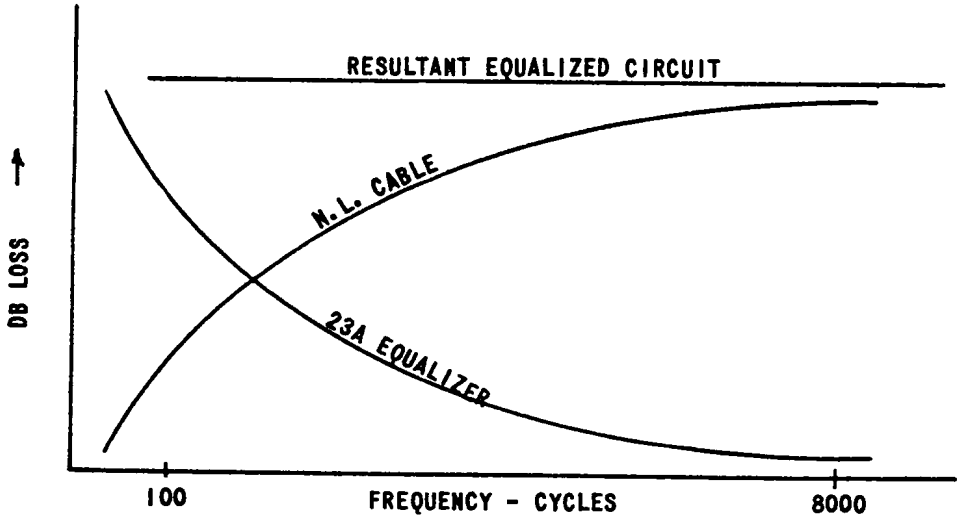


FIGURE 1

6. DESCRIPTION OF 23A AND 15KC EQUALIZERS

23A Equalizer

6.01 The 23A equalizer is a shunt-type equalizer resonating at approximately 9.4KC and is capable of equalizing circuits up to 8KC.

6.02 The equalizer components consist of fixed values of capacitance and inductance in parallel, connected in series with a variable resistance. The equalizer is bridged across the circuit at each amplifier point and at the receiving end. The equalizer is placed on the receiving end of the circuit, rather than the sending end, in order to obtain a maximum signal-to-noise ratio. Two terminals are provided on the equalizer (Terminals 1 and 2) for connection to the circuit. Equalization is accomplished by the proper adjustment of the series resistance.

6.03 The equalizer action for restoring a flat frequency response of a non-loaded cable facility is as follows: At low frequencies the reactance of the inductor is small so that the equalizer acts substantially as a resistor shunted across the circuit. Therefore, the equalizer introduces relatively large loss, the amount being controlled by the value of resistance used in the equalizer. As the frequency is increased, the reactance becomes greater, both because of the increased reactance of the inductor and because of the approach toward resonance between the inductance and capacitance. Therefore, the loss introduced by the equalizer bridged across the circuit decreases as the frequency increases, becoming negligible at resonance. The resonant frequency is arranged to be above the highest frequency for which equalization is desired. Above the resonant frequency the effect of the equalizer is to add to the loss of the circuit.

6.04 The amount of resistance used in the equalizer is mainly dependent on the length and gauge of the cable pairs. The longer the circuit, the less resistance used.

6.05 A repeating coil is always used with an equalizer.

6.06 The schematic of the 23A equalizer is shown in Figure 2.

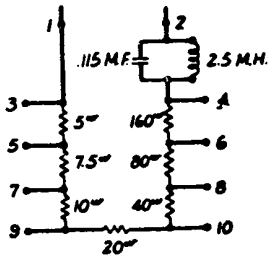


FIG. 2

NOTE: To remove all resistance from equalizer, strap from Terminals 3-5-7-9-10-8-6-4. Cut straps as necessary for obtaining desired value.

6.07 Resistance values from 5 ohms to 322.5 ohms in steps of 2.5 ohms may be obtained by removing the straps which short out the values required.

EXAMPLE: 77.5 ohms are required to equalize circuit. Remove straps 8-10, 9-10, 7-9, 5-7.

6.08 A 23A equalizer and repeating coil arrangement is shown in Figure 3.

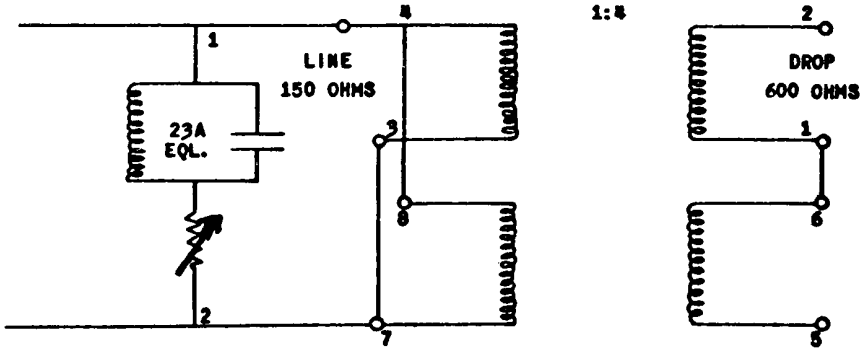


FIGURE 3

6.09 The 15KC equalizer may be used in lieu of a 23A equalizer by selecting similar values of inductance and capacitance as shown for the 23A equalizer. (See Figure 2.)

15KC Equalizer

6.10 The 15KC equalizer is a shunt-type equalizer capable of equalizing a circuit up to 15KC.

6.11 The equalizer consists of resistance in series with a combination of inductance and capacitance in parallel. All the components have been made adjustable to obtain equalization over the required bandwidth where various lengths and gauges of nonloaded cable facilities are used. The equalizer is bridged across the circuit at each amplifier point and at the receiving end. The equalizer is placed on the receiving end of the circuit, rather than the sending end, in order to obtain the maximum signal-to-noise ratio. Equalization is accomplished by the proper adjustment of all the components.

6.12 The action of the 15KC equalizer is similar to that of the 23A equalizer (see Paragraphs 6.03 and 6.04).

6.13 The resonant frequency of the 15KC equalizer is controlled by varying the values of capacitance and inductance.

6.14 The components of the equalizer are a 251A inductor, a 187A capacitor and 19-type resistors. The inductance and associated input repeating coil are contained in special shields to reduce noise pick-up. The 15KC equalizer is shown in drawing ED-55503-01, Figure D, for central office use, and DE-69010-01 for field use.

6.15 The 251A inductor has eight terminals. Make the connection to two (and only two) of the terminals to give the proper amount of inductance.

6.16 The 187A capacitor has ten capacitor units, each having its own separate terminal. The value, in microfarads, of the capacitor units is stamped below each terminal. The C terminal is common to all the units. Since capacitances in parallel add, terminal A may be strapped to one or more of the units to obtain the desired value.

EXAMPLE: .016 mf is needed. Strap from Terminal A to .012 and to .004 resulting in the needed .016 mf.

6.17 To obtain the desired resistance value, strap out portions of the 19-type resistors not required.

6.18 The 15KC equalizer may be used for all schedules of program service requiring equalization. However, it was primarily designed for use on 15KC circuits where variable inductance, capacitance, and resistance components are necessary.

6.19 The equalizer is always used with a repeating coil and is connected to the drop side of the coil.

6.20 The schematic of the 15KC equalizers is shown in Figure 4.

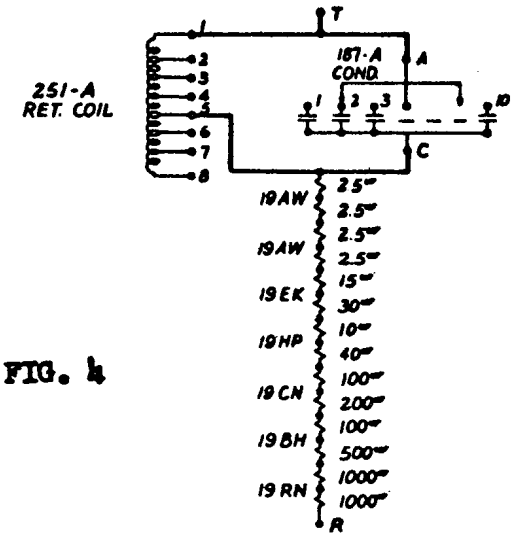


FIG. 4

6.21 A 15KC equalizer and repeating coil arrangement is shown in Figure 5.

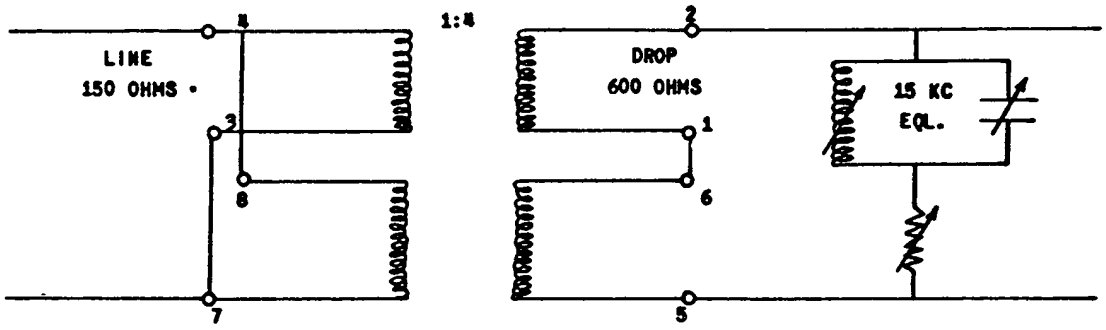


FIGURE 5

6.22 A series resonant shunt-type equalizer may be necessary to "mop-up" equalization where a number of sections of cable facilities and intermediate amplifiers are used and additional loss is required over a relatively small frequency band.

6.23 The mop-up or auxiliary equalizer is not always a standard piece of equipment. It can be made up locally using elements similar to those found in the 15KC standard equalizer. Due to its larger values of inductance, a 251B, rather than a 251A inductor is generally used. The larger values of inductance are necessary where a "hump" as high as 2 db must be corrected. The inductance, capacitance and resistance are all connected in series.

6.24 To obtain the proper values of the capacitive and inductive components for the frequency correction desired, see Chart 1.

6.25 The value of resistance to be used depends largely on the amount of loss required, e.g., the higher the correcting loss needed, the less resistance required. A variable resistance (resistance decade box) may be used to obtain the correct resistance value.

6.26 As there may be interaction between the mop-up equalizer and the standard 15KC equalizer, place the mop-up equalizer at the output of an amplifier or the sending end of a circuit, usually at a 600-ohm impedance point.

6.27 The schematic of a mop-up or auxiliary equalizer is shown in Figure 6.

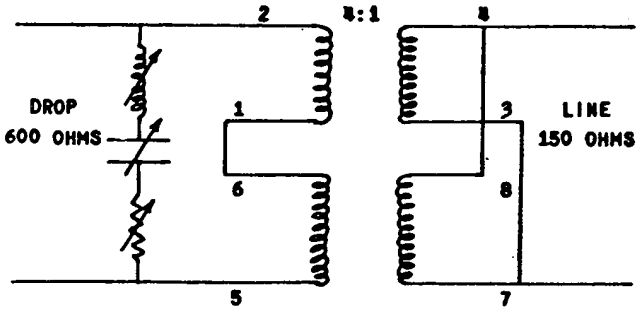
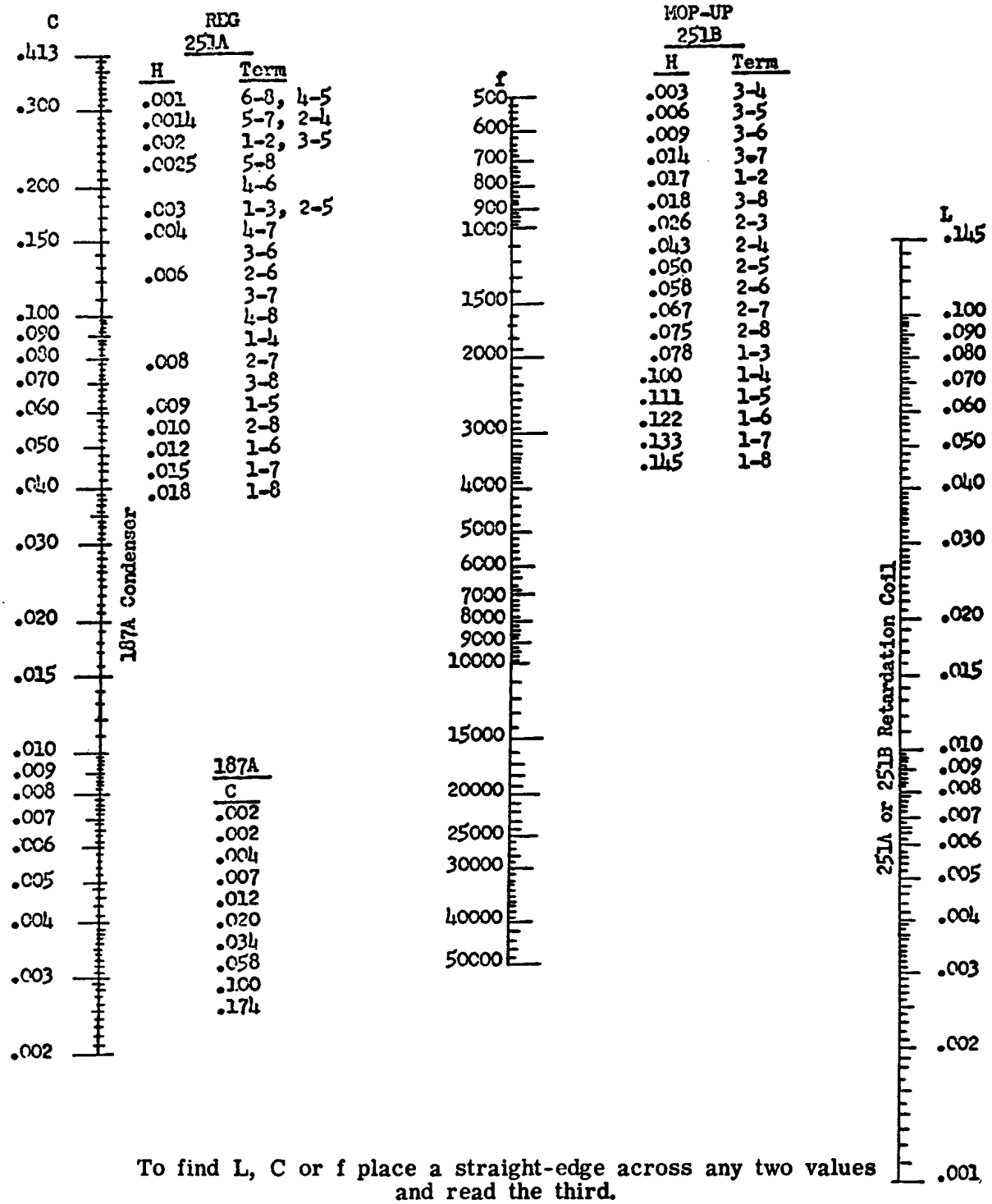


FIGURE 6

CAPACITY AND INDUCTANCE VALUES FOR SHUNT OR SERIES EQUALIZERS FOR VARIOUS RESONANT FREQUENCIES

CHART 1



To find L, C or f place a straight-edge across any two values and read the third.

7. REPEATING COILS

7.01 The 111C, 119C, and 119E repeating coils are similar electrically and are used for:

(a) Isolation, for noise reasons, of telephone facilities from a possible unbalanced customer termination.

(b) Impedance matching where cable pairs of different impedances are interconnected; for example, B22 loaded and nonloaded facilities.

(c) Aid in equalizing.

7.02 Coils are strapped for 1:1 or 1:4 impedance ratio depending upon requirements. The 1:1 ratio is used where isolation only is needed. The 1:4 ratio is used for impedance matching purposes and to aid equalization.

7.03 Repeating coils used at the sending end aid in the equalization of Schedule A, B, and F circuits.

7.04 Repeating coils must be used at the sending end of Schedules AAA, BBB, AA, and BB circuits; and of Schedule F circuits, 40 cycles to 15KC and 50 cycles to 8KC.

7.05 Repeating coil arrangements for 1:1 ratio and 1:4 ratio are shown in Figure 7.

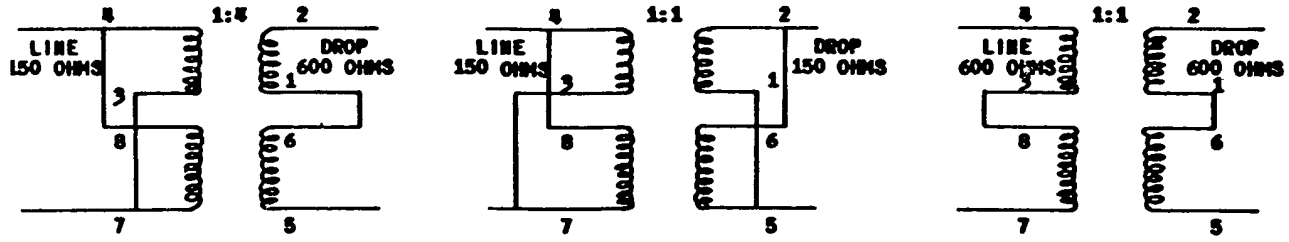


FIGURE 7

8. AMPLIFIERS AND THEIR USE ON PROGRAM SERVICE

8.01 Amplifiers are usually employed where the 1KC bare loop loss exceeds 12 db (10 db for 15KC circuits). The gain is generally set at a value equal to the loss of the preceding equalized sections. This restores the signal to the level applied at the sending end.

8.02 The type of amplifier used depends on the schedule of service to be provided. The amplifiers currently used are 12C, 14C, and Altec S17.

8.03 The 12C and 14C amplifiers are substantially flat from 100 cycles to 8KC and from 40 to 15KC, respectively. External equalizers, and repeating coils for equalizing, generally are associated with the amplifier.

8.04 The Altec S17 amplifier is substantially flat from 20 cycles to 20KC. An equalizer similar to the 23A equalizer is contained in the amplifier cabinet. Input and output impedances of either 150-ohms or 600-ohms are selected by the position of the plugs, thus eliminating the need for external repeating coils. For 15KC service an external 15KC equalizer panel is required.

8.05 Amplifiers are substantially flat over the frequency range used, and therefore have no appreciable effect on the equalization of the circuit.

8.06 Description, circuits, jack arrangements, and maintenance of amplifiers are covered in the A200, E37 and E47 Sections of Bell System Practices.

9. EQUALIZATION PROCEDURES - GENERAL

9.01 Equalization measurements are made by transmitting frequencies over the circuit in the prescribed direction as indicated on the service order. The equalizer is always placed on the receiving end of the section unless otherwise specified. In equalizing circuits consisting of more than one line section (e.g., those with intermediate amplifiers) each section requires equalization. First, equalize the section adjacent to transmitting (pick-up) point making the measurements at the output of the first amplifier. Then equalize the second section in tandem with the first and so on to the end of the circuit, always sending from the transmitting (pick-up) point.

9.02 Where equalization is performed at amplifier points, or other specified points such as a junction of nonloaded and B22 loaded cable facilities, all data required for preparing Form PF-422, "Program Circuit Record," are given verbally to the sending end for transmittal to the receiving end terminal. The receiving end terminal forwards this data, as well as his own, to the control plant service center.

9.03 Form PF-422 is a plant form equivalent to the subscriber line card and is a permanent record of each program circuit. This form is used for trouble investigating purposes and is the only equalization record of the circuit. Therefore, all data must be recorded accurately and contain all information called for on the form. The data required:

(a) The 1KC equalized loss and the deviations from the 1KC equalized loss at the other frequencies. The frequency measurements required are based on the schedule of service provided and are covered in Table 1.

EXAMPLE: 1KC equalized loss as read (measured) on transmission measuring set (TMS) 20.4.

Frequency in Cycles	Equalized Loss	Deviations
100	20.6	-.2
500	20.7	-.3
2000	19.9	+.5
5000	20.2	+.2
8000	20.4	0

NOTE: See note Table 2.

(b) The amplifier type, e.g., Altec S17.

(c) The amplifier number.

(d) The amplifier gain.

(e) The 1KC nonequalized bare loop loss, e.g., 10.3 db.

(f) The exact location of the termination at the sending end, e.g., "on temporary pole, 50 feet north of service entrance."

(g) The exact location of the termination at the receiving end, such as, "master control," "jack number," or "studio (number) stage right by power panel."

(h) The resistance value of a 23A equalizer or the measured resistance value of the equalizer associated with an S17 amplifier.

(i) The resistance, capacitance, and inductance values where a 15KC equalizer is used.

(j) The repeating coil impedance ratio (1:1 or 1:4).

9.04 Some locally assembled portable equalizer test sets are in use. These sets generally contain the equalizer elements and a repeating coil, arranged for equalization of all schedules of service. Where this test set is used, the permanent equalizer is temporarily replaced by this set and equalization is made using the portable set. The permanent equalizer elements and repeating coil are then strapped for the same values as set up on the portable set. Make a recheck at each frequency shown on Form PF-422 to assure proper equalization. The use of this set eliminates the need for a resistance decade box for determining the resistance value.

9.05 Repeating coils at the sending and/or receiving end may be necessary on nonequalized circuits and Schedule C and D circuits where the customer equipment is unbalanced. Usually when repeating coils are required for this purpose, they are wired 1:1 impedance ratio (600-ohms to 600-ohms) as shown in Figure 7.

9.06 The 15KC equalizer (DE-69010-01 LI) also may be used for equalizing Schedules AA, BB, A, B, and F circuits. To start the process of equalization, adjust the

tuned circuits of the equalizer by selecting similar values of inductance and capacitance shown for the 23A equalizer (see Figure 2). When the 15KC equalizer is used for Schedule A and B circuits, make a frequency measurement at 8KC to assure that a high level of more than 4 db is not present. Where a high level at 8KC is measured, a change in the inductance and capacitance will be required. Use Chart 1 to maintain 9.4KC resonance.

9.07 Where difficulty is experienced in equalization and the facilities are as specified on the service order, e.g., non-loaded or loaded cable, and a bare loop frequency run (see Table 3) does not indicate trouble, use some of the following accepted methods as an aid in meeting requirements:

(a) Place a repeating coil wired 1:4 or 1:1 ratio at a junction of trunk and exchange cables to correct for impedance irregularities between different types and gauges of cable, such as, 19 and 26. Where a 1:4 ratio is used, the high impedance side should connect to the finer gauge cable.

(b) On some 5KC circuits a capacitor of 0.235 microfarads connected across lugs 2 and 4 of the 23A equalizer may improve equalization by lowering the resonant frequency of the 23A equalizer from about 9.4KC to about 5.4KC. This also lowers the over-all equalized loss of the circuit.

9.08 The impedance of transmission test equipment used in equalizing program service is 600-ohms. Where customer equipment is arranged for 150-ohm impedance, an additional repeating coil for test purposes wired 1:4 ratio should be used to match the test equipment. If measurements were made with 600-ohm test equipment on a 150-ohm line, without the matching coil, the result obtained would be incorrect.

9.09 When a program channel is to be used in both directions of transmission, the order will specify equalization in both directions. Place a repeating coil and equalizer at both ends of the circuit. Equalization measurements are made in both directions using the equalizer provided at the receiving end with the equalizer at the sending end removed. To remove the equalizer from the sending end and connect the equalizer at the receiving end, a switching arrangement at each end is necessary. Some of the methods of switching are:

(a) Jack arrangements - separate transmitting and receiving jacks with equalizer wired through normal contacts of transmitting jacks.

(b) Key arrangements (6017 or 552-type) to connect or remove the equalizers as required.

(c) Type 1 reversal equipment - provided by equipment engineering when indicated on service order.

9.10 When equalization is completed, inspect all work to assure that soldered and terminal connection are solid.

10. EQUALIZATION - SCHEDULES A, B, AA, BB, AND F

Sending End

10.01 Equipment needed:

(a) Oscillator, 19C or 21A TMS.

(b) Repeating coil, 111C, 119C, or 119E.

(c) Magneto telephone set (331-type) (if coordinating private line terminated on "block in lieu").

10.02 Procedures:

(a) Connect oscillator to line. (Make sure oscillator is calibrated accurately.)

(b) For the 21A TMS, set both oscillator output controls to 0 in the black range.

(c) For the 19C oscillator, adjust output knob to 0 db on the meter at 1KC with a 600-ohm resistance across output terminals with line disconnected. If no 600-ohm resistance is available, connect the oscillator to the line and adjust the level. If the line connection is used for level adjustment, the other end of the circuit must be terminated in 600-ohms.

NOTE: Do not readjust output level at other frequencies even though the meter may vary from 0.

(d) Remove the 600-ohm resistance from the 19C oscillator output, if used.

(e) Establish a talking path with nearest equalization point, each succeeding equalization point, and receiving end, as required.

(f) Send frequency requested by equalization points for bare loop measurement.

(g) After completion of the initial bare loop measurement, connect a repeating coil to the line, if required. The repeating coil is not removed for bare loop measurements made in succeeding amplifier sections.

(h) A repeating coil connected 1:4 ratio, low impedance side to the line, is required on the sending end of a circuit when:

(1) Service is permanent.

(2) Schedule is AA, or BB, or F (8KC).

(i) The use of a repeating coil is optional on the sending end of a Schedule A, B, or F (5KC) circuit when no difficulty in equalization is encountered and the customer equipment has a balanced output.

(j) Connect the oscillator to the drop (600-ohm) side of the repeating coil when used, and send frequencies requested by equalization points for equalizing.

(k) When intermediate equalization points are involved, accumulate data for transmittal to receiving end terminal. (See Paragraph 9.02.)

Receiving End

10.03 Equipment needed:

(a) 13A or 21A TMS.

(b) Repeating coil, 111C, 119C, or 119E.

(c) 23A equalizer.

(d) Resistance decade box (variable resistance).

10.04 Procedures:

(a) Connect TMS to line. (Make sure TMS is calibrated accurately.)

(b) Make a 1KC bare loop measurement. The 1KC loss should be within the allowable tolerance (+1.5 db) of the computed loss shown on the service order. Normally, a bare line frequency run is not necessary unless trouble is encountered in equalizing. Use the bare loop test frequencies listed in Table 3.

(c) Record the 1KC reading on Form PF-422.

(d) Remove TMS from line and connect equalizer and resistance decade box as shown in Figure 9. Make certain that the equalizer resistances are strapped out and the repeating coil is strapped 1:4 ratio, low impedance side toward the line.

(e) Request highest frequency to be used (5KC or 8KC) be sent and note the measured loss.

(f) Request lowest frequency to be used during equalization (100 cycles on 5KC circuits or 1KC on 8KC circuits). Adjust resistance decade box until measured loss is approximately the same value as the highest frequency loss.

(g) Again request the highest frequency and note the measured loss.

(h) Again request the lowest frequency and readjust resistance decade box until the measured loss is as near as possible to the highest frequency loss.

(i) If necessary, continue this procedure until the highest and lowest frequency losses are the same.

(j) Make complete frequency run as indicated on Form PF-422 from 100 cycles to 5KC for 5KC circuits and from 40 cycles to 8KC for 8KC circuits.

(k) Make minor resistance adjustments to obtain the flattest frequency response possible.

(l) Note the resistance value used in resistance decade box.

(m) Remove resistance decade box from the equalizer circuit.

(n) Connect same resistance value in the equalizer as indicated in the resistance decade box by cutting the appropriate straps. If exact value cannot be obtained, use the nearest possible value.

(o) Recheck the measured loss at each frequency used in (j). If the requirement is not met, make a slight readjustment in resistance value as needed to meet the requirement.

(p) Prepare Form PF-422 as covered in Paragraph 9.03.

(q) Where a 150-ohm customer equipment connection is required, strap the receiving repeating coil for 150-ohms (windings in parallel) on both line and drop sides. Use an additional repeating coil for making equalization tests wired 1:4 ratio to match the 600-ohm TMS as shown in Figure 8.

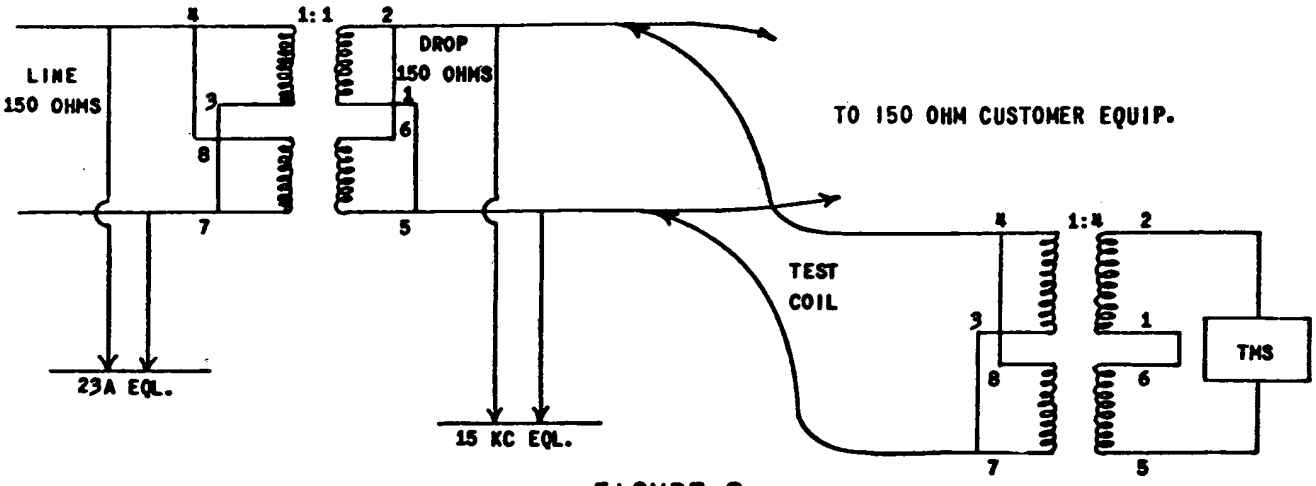


FIGURE 8

10.05 Where extremely short circuits are encountered, in the neighborhood of 2 db bare loop loss at 1KC, equalization may be obtained without an equalizer. Repeating coils wired 1:4 ratio on both sending and receiving ends provide adequate equalization.

10.06 A typical equalization layout with resistance decade box is shown in Figure 9.

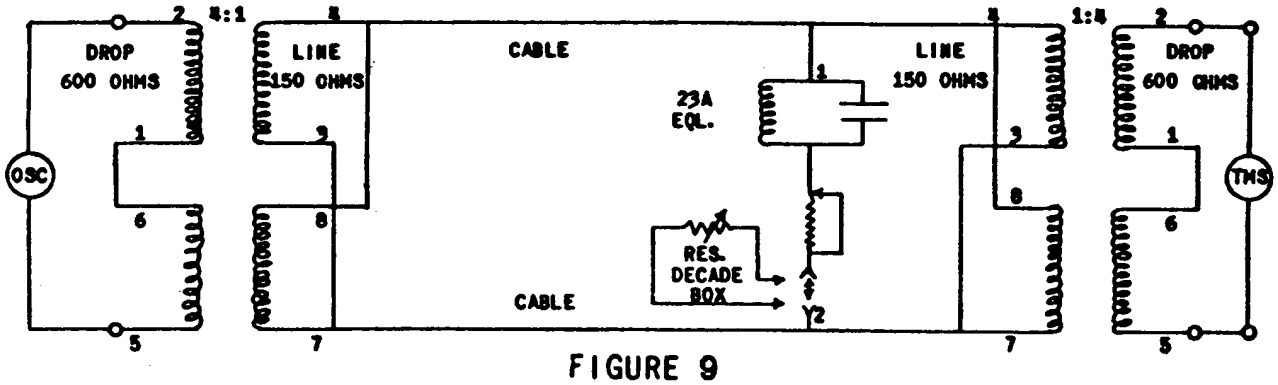


FIGURE 9

10.07 When a 42A connecting block is used, make certain that terminals are strapped to terminals directly opposite the line termination. If 11A or 12-type connecting block is used, the terminals are strapped within the block.

Amplifier Points

10.08 Equipment needed:

(a) Resistance decade box.

(b) Volume indicator (VI) or TMS, 13A or 21A.

(c) Cord with 241A plug and two spade tips.

(d) Magneto telephone set (331-type) for use when coordinating private line routes through the office.

10.09 Procedures:

(a) Make a 1KC bare loop measurement at bare loop jack appearance (TRSG LP or LOOP IN) with either a TMS or VI. (Make sure TMS is calibrated accurately.)

NOTE: Make certain VI switch is in 600-ohm position. Set attenuator on + 10.

(b) The 1KC loss should be within the allowable tolerance (±1.5 db) of the computed loss shown on service order.

(c) Record the 1KC reading on Form PF-422.

(d) Remove the TMS or VI from the bare line jack appearance and patch to amplifier out jacks.

(e) Check to see that the input repeating coils on 12C and 14C amplifiers are wired 1:4 impedance ratio (see Figure 7).

(f) For 12C and 14C amplifiers, connect the resistance decade box in the equalizer circuit by means of the patch cord. Insert plug vertically in equalizer jacks, as follows:

12C amplifier - "Eql.In" and "LP Eql."
14C amplifier - "NLC Eql. In" and "Eql. Conn."

This method of connection puts the resistance decade box in series with the components of the equalizer.

(g) Strap out all the resistances of the 23A equalizer or the 19-type resistors in the 15KC equalizer.

(h) For the Altec S17 amplifier, no resistance decade box is needed since the resistance in the equalizer contained in the amplifier is variable. To obtain, for record purposes, the value of resistance used in the S17 equalizer, after equalization, remove one of the leads and measure the resistance by connecting an ohmmeter across the equalizer.

(i) The impedance matching arrangements are contained in the S17 amplifier and should be set in the following positions, as required:

(1) Place the input matching plug in the 150-ohm position when equalizing nonloaded cable facilities or in the 600-ohm position for loaded cable facilities.

(2) Place the output pad in the 600-ohm position when equalizing and setting output levels.

(3) After equalization is completed and output level is set, place the output pad in the 150-ohm position when amplifier feeds into nonloaded cable facilities or in the 600-ohm position when amplifier feeds into loaded facilities.

(j) Request that the highest frequency (5KC or 8KC) be sent from the pick-up point and adjust amplifier gain until 0 (VU or dbm) is read on TMS or VI.

(k) Proceed with the equalization as described in Paragraph 10.04, (e) through (o).

(l) Recheck to make certain amplifier output level is 0 as read on the TMS or VI at 1KC.

(m) Make certain that impedance matching plugs in Altec amplifiers are in proper position as described in (i) above.

(n) Remove all patch cords.

(o) Record all data on Form PF-422 as covered in Paragraph 9.03. Transmit verbally to the sending end.

(p) Where difficulty is encountered in equalizing a circuit, make a bare loop frequency run to determine whether cable facility assignments are correct as follows:

(1) Where a TMS is used, measure at bare loop jack appearance.

(2) Where a VI is used, patch from bare loop appearance to "amplifier in," and from "amplifier out" to the VI. This removes the equalizer from the circuit under test and provides suitable gain to permit the use of a VI.

NOTE: Where a 12C amplifier is used, the equalizer must be patched out by means of a 165-type or a 258-type phenol plastic dummy plug. On the 12C and the Altec S17 amplifiers, the repeating coil or input coil, respectively, cannot be removed but will not cause any appreciable change in the cable facility characteristics.

(3) Adjust the amplifier gain until 0 (VU) at 1KC is read on the VI.

(4) Measure the test frequencies as listed in Table 3.

(q) Characteristics of cable facilities are described in Paragraph 4.06.

11. EQUALIZATION - SCHEDULES AAA, BBB, AND F

Sending End

11.01 Equipment needed:

(a) Oscillator, 19C or 21A TMS.

(b) Repeating coil, 111C, 119C, or 119E.

(c) Magneto telephone set (331-type) (if coordinating private line terminated on "block in lieu").

11.02 Procedures:

(a) Connect oscillator to line. (Make sure oscillator is calibrated accurately.)

(b) For the 21A TMS, set both oscillator output controls to 0 in the black range.

(c) For the 19C oscillator, adjust output knob to 0 db on the meter at 1KC with a 600-ohm resistance across output terminals with line disconnected. If no 600-ohm resistance is available, connect the oscillator to the line and adjust the level. If the line connection is used for level adjustment, terminate the other end of the circuit in 600-ohms.

NOTE: Do not readjust output level at other frequencies even though the meter may vary from 0.

(d) Remove the 600-ohm resistance from the 19C oscillator output, if used.

(e) Establish a talking path with nearest equalization point, each succeeding equalization point, and receiving end, as required.

(f) Send frequency requested by equalization points for bare loop measurement.

(g) After bare loop measurements have been made to first equalization point, or to receiving end if no intermediate amplifiers are used, connect repeating coil to line. Connect repeating coil for 1:4 ratio with low impedance side to line.

(h) Connect oscillator to drop (600-ohm) side of repeating coil and send frequencies requested by equalization points for equalizing.

(i) When intermediate equalization points are involved, accumulate data for transmittal to receiving end terminal. (See Paragraph 9.02.)

Receiving End

11.03 Equipment needed:

(a) 13A or 21A TMS.

(b) Panel, equalizer, FM DE-69010-01, List 1.

(c) Resistance decade box.

11.04 Procedures:

(a) Connect TMS to line. (Make sure TMS is calibrated accurately.)

(b) Make a 1KC bare loop measurement. The 1KC loss should be within the allowable tolerance (+1.5 db) of the computed loss shown on the service order. Normally, a bare line frequency run is not necessary unless trouble is encountered in equalizing. Use the bare loop test frequencies listed in Table 3.

(c) Record the 1KC reading on Form PF-422.

(d) Remove TMS from line and connect 15KC equalizer panel to line. Repeating coil should be 1:4 ratio, low impedance side toward the line.

(e) Insert resistance decade box in series with the elements of the 15KC equalizer. Strap out all resistances.

(f) Connect the TMS to the drop side of the repeating coil.

(g) To start the process of equalization, adjust the tuned circuit of the equalizer with a resonant frequency in the neighborhood of 17 to 19KC using .004 henries inductance and .020 mf. capacitance.

(h) The values of capacitance and inductance for 18KC resonance are listed in Table 4. The capacitance and inductance values for any resonant frequency are listed in Chart 1.

TABLE 4

251A Ind. Terminals	Inductance Henries	Cap. for 18KC Resonance Microfarads
1-8	.018	.004
1-7	.015	.005
1-6	.012	.007
2-8	.010	.008
1-5	.009	.009
2-7 or 3-8	.008	.010
1-4,2-6,3-7, or 4-8	.006	.013
3-6 or 4-7	.004	.020
1-3 or 2-5	.003	.026
4-6 or 5-8	.0025	.031
1-2 or 3-5	.002	.039
2-4 or 5-7	.0014	.056
4-5 or 6-8	.001	.079

(i) Request highest frequency to be used (15KC) be sent and note the measured loss.

(j) Request 1KC and adjust resistance decade box until measured loss is approximately the same value as the highest frequency loss.

(k) Again request 15KC and note the measured loss.

(l) Request 1KC again and readjust resistance decade box until the measured loss is as near as possible to the 15KC loss.

(m) If necessary, continue this procedure until the 1KC and 15KC losses are the same.

(n) Make complete frequency run as indicated on Form PF-422 from 40 cycles to 15KC.

(o) Make minor resistance adjustments to obtain the flattest frequency response possible.

(p) If requirements cannot be met (see Table 1) readjust the equalizer elements resonating at 18KC (see Table 4) and repeat equalizing procedure. If requirements still cannot be met, a change in the resonant frequency is made, generally higher.

(q) In connection with the readjustment of the equalizer elements, after the initial trial setting, the following discussion should be helpful in determining what changes should be made. The modifications suggested change the characteristics at 1KC and 15KC, provided the resistance in the equalizer is changed to keep the loss at 1KC and 15KC the same.

(1) Change in ratio of inductance (L) to capacitance (C) - for the same resonant frequency (LxC - constant), the ratio of L/C will affect the over-all loss at the frequencies intermediate between 1KC and 15KC, particularly at frequencies in the range of 8KC to 10KC. In general, the larger the value of L the less the loss at the intermediate frequencies.

(2) Change in resonant frequency - The resonant circuit of the equalizer may be tuned to a higher frequency by using a smaller value of inductance or capacity, or both. The effect of this change will, in general, give less loss at the intermediate frequencies, particularly in the range from 8KC to 13KC. This change will also introduce more loss in the equalizer at 15KC.

(r) After requirements are met, make final frequency run.

(s) Note resistance value used in resistance decade box.

(t) Remove resistance decade box from the equalizer circuit.

(u) Connect same resistance value in the equalizer as indicated in the resistance decade box by using appropriate 19-type resistors.

(v) Recheck the measured loss at each frequency as indicated on Form PF-422. If requirements are not met, a slight readjustment of resistance may be necessary.

(w) Prepare Form PF-422 as covered in Paragraph 9.03.

11.05 Where a 150-ohm customer equipment connection is required, strap the receiving repeating coil for 150-ohms (windings in parallel) on both line and drop sides. Use an additional repeating coil for making equalization tests wired 1:4 ratio to match the 600-ohm TMS. (See Figure 8.)

11.06 A typical equalization layout with resistance decade box is shown in Figure 10.

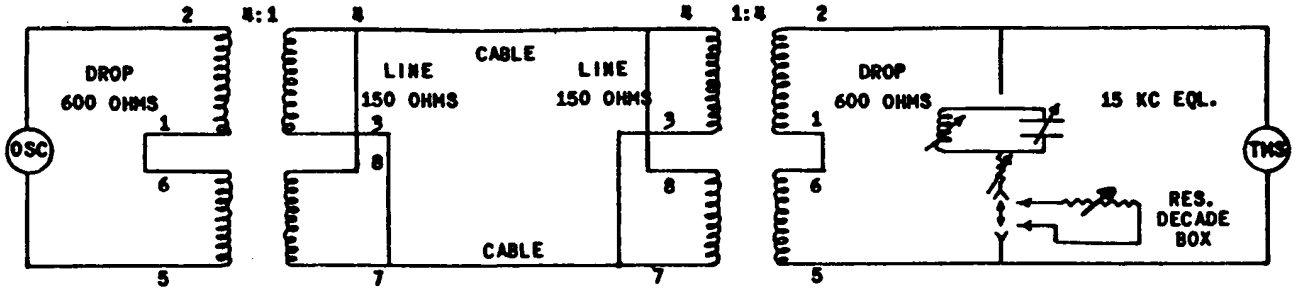


FIGURE 10

Amplifier Points

11.07 Equipment needed:

(a) Resistance decade box.

(b) Volume indicator (VI) or TMS, 13A, or 21A.

(c) Cord with 241A plug and two spade tips.

(d) Magneto telephone set (331-type) for use when coordinating private line routes through the office.

11.08 Procedures:

(a) Make a 1KC bare loop measurement at bare loop jack appearance (TRSG LP) with either a TMS or a VI. (Make sure TMS or VI is calibrated accurately.)

NOTE: Make certain VI switch is in 600-ohm position. Set attenuator on + 10.

(b) The 1KC loss should be within the allowable tolerance (+1.5 db) of the computed loss shown on the service order.

(c) Record the 1KC reading on Form PF-422.

(d) Remove the TMS or VI from the bare line jack appearance and patch to amplifier out jacks.

(e) For 14C amplifiers, connect the resistance decade box in the equalizer circuit by means of the patch cord. Insert plug vertically in the equalizer jacks as follows: "NLC Eql. In" and "Eql. Conn." This method of connection puts the resistance decade box in series with the components of the equalizer. Check to see that the input repeating coil is wired 1:4 ratio, low impedance side toward the line.

(f) For Altec S17 amplifiers, use separate 15KC equalizer panel connected as follows:

(1) Remove 23A equalizer leads from equalizer punchings on terminal strip associated with amplifier to be used.

(2) Place leads from these punchings to the line side of the 15KC equalizer repeating coil.

(3) Wire 15KC equalizer repeating coil for 1:4 ratio low impedance side toward the line. The S17 input impedance matching plug should be in the 150-ohm position. With this arrangement all the jacks associated with the S17 can still be used.

(4) Place the output pad in the 600-ohm position when equalizing and setting output level.

(5) After equalization is completed and output level is set, place the output pad in the 150-ohm position when the amplifier feeds nonloaded cable facilities or in the 600-ohm position when the amplifier feeds loaded facilities.

(6) The connections for the 15KC equalizer associated with the S17 Altec amplifiers as shown in Figure 11.

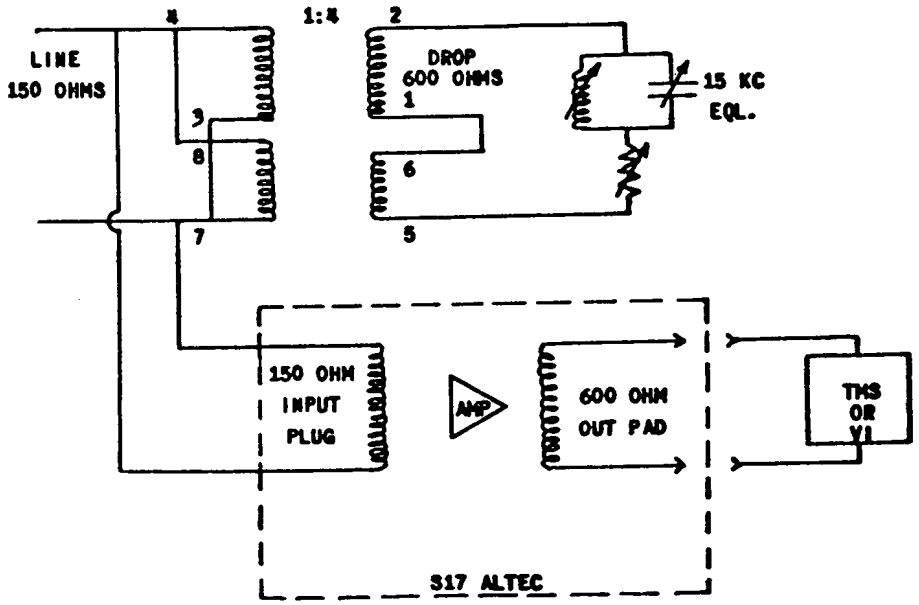


FIGURE 11

(g) Strap out 19-type resistances in 15KC equalizer.

(h) Request that the highest frequency (15KC) be sent from the pick-up point and adjust amplifier gain until 0 is read on TMS or VI.

(i) Proceed with the equalization as described in Paragraph 11.04, (g) through (v).

(j) Recheck to make certain amplifier output level is 0 as read on TMS or VI at 1KC.

(k) Make certain that impedance matching plugs in Altec amplifiers are in proper position as described in (f) above.

(l) Remove all patch cords.

(m) Record all data on Form PF-422 as covered in Paragraph 9.03. Transmit verbally to the sending end terminal.

(n) When difficulty is encountered in equalizing a circuit, make a bare loop frequency run to determine whether cable facility assignments are correct. (See Paragraph 10.09 (p) for 5KC and 8KC circuits. Disregard references to 12C amplifier.)

(o) Characteristics of cable facilities are described in Paragraph 4.06.

12. EQUALIZATION - SCHEDULES C AND D

12.01 Where C and D schedules are to be provided the service order will specify schedule C and D interoffice facilities connected to nonequalized local channels. The schedule C and D portion of a circuit applies between the first and last central office only, and usually contains loaded cable facilities. The nonequalized local channels are from the remote pick-up point to the first central office and from the last central office to the receiving terminal.

12.02 Equalization is generally performed between the first and last central office only (office-to-office basis). Since personnel and test equipment are required at both ends of the circuit for an over-all measurement make equalization on an over-all basis (including the nonequalized local channels). If the requirements are met, the need for personnel at the central offices for equalization purposes is eliminated.

12.03 Either equalization procedure is acceptable.

12.04 After equalization measurements are made, a 1KC over-all measurement is required between the sending and the receiving terminals to assure continuity and that the 12 db maximum circuit loss is not exceeded. Furnish the customer with the equalized over-all 1KC loss.

Sending End

12.05 Equipment needed - central office or pick-up point:

(a) Oscillator, 19C or 21A TMS.

(b) Magneto telephone set (331-type) (if coordinating private line terminated on "block in lieu" or where private line routes through the office).

12.06 Procedures - central office or pick-up point:

(a) Connect oscillator to line. If equalization is being done on an office-to-office basis, be sure the nonequalized local channel is disconnected. (Make sure oscillator is calibrated accurately.)

(b) For the 21A TMS, set both oscillator output controls to 0 in the black range.

(c) For the 19C oscillator adjust output knob to 0 db on the meter at 1KC with a 600-ohm resistance across output terminals with line disconnected. If no 600-ohm resistance is available, connect the oscillator to the line and adjust the level. If the line connection is used for level adjustment, the other end of the circuit must be terminated in 600-ohms.

NOTE: Do not readjust output level at other frequencies even though the meter may vary from 0.

(d) Remove the 600-ohm resistance from the 19C oscillator output if used.

(e) Establish a talking path with nearest equalization point, each succeeding equalization point, and receiving end, as required.

(f) Send frequency requested by equalization point for bare loop measurement.

(g) After completion of bare loop measurements, send frequencies requested by the equalization point for equalizing.

(h) Upon completion of equalization, reconnect the nonequalized local channel where equalization is being done on an office-to-office basis.

(i) When intermediate equalization points are involved, accumulate data for transmittal to receiving end office or terminal. (See Paragraph 9.02.)

Receiving End

12.07 Equipment needed - central office or receiving terminal:

(a) 13A or 21A TMS.

(b) Repeating coil, 111C, 119C, or 119E, and 187A capacitor (used at central office only).

12.08 Procedures - central office or receiving terminal:

(a) Connect TMS to line. If equalization is being done on an office-to-office basis, be sure the nonequalized local channel is disconnected.

(b) Make a 1KC bare loop measurement. The 1KC loss should be within the allowable tolerance (+1.5 db) of the computed loss shown on the service order.

(c) Record the 1KC reading on Form PF-422.

(d) Make a frequency run using test frequencies shown in Table 2.

(e) If the requirements as given in Table 2 are met, no equalization is required.

(f) Prepare Form PF-422.

(g) If measurements are made at the last central office, reconnect the local channel.

(h) When requirements are not met and test is being made on an office-to-office basis, use a 111C, 119C, or 119E repeating coil with a 187A capacitor connected to terminals 1 and 6 (drop

side) of the repeating coil. Refer to Figure 12 for repeating coil connections with capacitor.

(i) Request frequencies shown in Table 2 and adjust the 187A capacitor value until the requirements are met. Strapping arrangements for the 187A capacitor are given in Paragraph 6.16.

(j) Prepare Form PF-422 as covered in Paragraph 9.03.

(k) Reconnect the nonequalized local channel where equalization is being done on an office-to-office basis.

(l) When requirements are not met and equalization is made on an over-all basis (including the local channels), proceed as follows:

(1) Request that frequency readings be made at the last central office. Where requirements are met to the last central office no equalization is required. Obtain the results from the last central office and make a final 1KC over-all loss measurement.

(2) Where requirements are not met to the last central office, request the last central office to equalize circuit as described in (h) through (k).

(3) Where requirements still cannot be met, have the circuit equalized on an office-to-office basis as described in (a) through (k). Obtain the results from the last central office and make a final 1KC over-all loss measurement.

(m) Prepare Form PF-422 as covered in Paragraph 9.03.

Amplifier Points

12.09 Equipment needed:

(a) Resistance decade box.

(b) Volume indicator (VI) or TMS, 13A or 21A.

(c) Cord with 241A plug and two spade tips.

(d) Magneto telephone set (331-type) for use when coordinating private line routes through the office.

12.10 Procedures:

(a) Make a 1KC bare loop measurement at bare loop jack appearance with either a TMS or VI. (Make sure TMS or VI is calibrated accurately.)

NOTE: Make certain the VI switch is in the 600-ohm position. Set attenuator on + 10.

(b) The 1KC loss should be within the allowable tolerance (+1.5 db) of the computed loss shown on the service order.

(c) Record the 1KC reading on Form PF-422.

(d) Remove the TMS or VI from bare line jack appearance and patch to amplifier out jacks.

(e) Rewire input repeating coil for 1:1 impedance ratio. On Altec amplifiers, change input plug to 600-ohm position and output pad to 600-ohm position. Disconnect the equalizer.

(f) Measure 1KC loss at amplifier out and adjust amplifier gain in accordance with the following:

(1) If frequencies are being sent from pick-up point, adjust gain to 0 dbm or 0 VU (level).

(2) If frequencies are being sent from first central office, adjust gain to a value in excess of 0 by an amount equal to the computed loss of the sending end local channel. For example, if local channel computes 3.0 db the amplifier out level should be set at + 3.0 db.

(3) Make frequency run using test frequencies shown in Table 2.

(4) If the requirements as given in Table 2 are met, no equalization is required.

(5) Prepare Form PF-422 as covered in Paragraph 9.03.

(g) When requirements as given in Table 2 are not met, equalization is required.

(h) To equalize at an amplifier point, use the equalizer associated with the amplifier.

(i) For 12C and 14C amplifiers, connect the resistance decade box in the equalizer circuit by means of the patch cord. Insert plug vertically in equalizer jacks, as follows:

12C amplifier - "Eql. In" and "LP Eql."

14C amplifier - "NLC Eql. In" and "Eql. Conn."

This method of connection puts the resistance decade box in series with the components of the equalizer.

(j) Strap out all the resistances of the 23A equalizer or the 19-type resistors in the 15KC equalizer.

(k) For the Altec S17 amplifier, no resistance decade box is needed since the resistance in the equalizer contained in the amplifier is variable. To obtain, for record purposes, the value of resistance used in the equalizer after equalization, remove one of the leads and measure the resistance by connecting an ohmmeter across the equalizer.

(l) The impedance matching arrangements are contained in the S17 amplifier. Set in the following positions, as required:

(1) Place the input matching plug in the 150-ohm position when equalizing nonloaded cable facilities or in the 600-chm position for loaded cable facilities.

(2) Place the output pad in the 600-ohm position when equalizing and setting output levels.

(3) After equalization is completed and output level is set, place the output pad in the 150-ohm position when amplifier feeds into nonloaded cable facilities or in the 600-ohm position when amplifier feeds into loaded facilities.

(m) Request that the highest frequency to be used (3.5KC) be sent from the sending end and note the measured loss.

(n) Request the lowest frequency to be used (200 cycles) be sent and adjust resistance decade box until measured loss is approximately the same value as the highest frequency loss.

(o) Again request the highest frequency and note the measured loss.

(p) Again request the lowest frequency and readjust resistance decade box until the measured loss is as near as possible to the highest frequency loss.

(q) If necessary, continue this procedure until the highest and lowest frequency losses are the same.

(r) Make complete frequency run as indicated on Form PF-422 from 200 cycles to 3.5KC.

(s) Make minor resistance adjustments to meet the requirements shown in Table 2.

(t) Note the resistance value used in resistance decade box.

(u) Remove resistance decade box from the equalizer circuit.

(v) Connect same resistance value in the equalizer as indicated in the resistance decade box by cutting the appropriate straps. If exact value cannot be obtained, use the nearest possible value.

(w) Recheck the measured loss at each frequency used in (r).

(x) Recheck to make certain amplifier output level is as specified in (f). Make certain that impedance matching plugs in Altec amplifiers are in the proper positions, as described in (L). Remove all patch cords.

(y) Record all data on Form PF-422 as covered in Paragraph 9.03. Transmit verbally to sending end terminal.

(z) Where difficulty is encountered in equalizing a circuit, make a bare loop frequency run to determine whether cable facility assignments are correct. Proceed as follows:

(1) Where a TMS is used, measure at bare loop jack appearance.

(2) Where a VI is used, patch from bare loop appearance to amplifier in and from amplifier out to the VI. This removes the equalizer from the circuit under test and provides suitable gain to permit the use of a VI.

NOTE: Where a 12C amplifier is used, the equalizer must be patched out by means of a 165-type or a 258-type phenol plastic dummy plug. On the 12C and the Altec S17 amplifiers, the repeating coil or input coil, respectively, cannot be removed but will not cause any appreciable change in the cable facility characteristics.

(3) Adjust the amplifier gain until 0 (VU) at 1KC is read on the VI.

(4) Test frequencies are listed in Table 3. Characteristics of cable facilities are described in Paragraph 4.06.

12.11 The schematic of a coil and capacitor arrangement for Schedule C and D circuits is shown in Figure 12.

13. EQUALIZATION OF COMBINATION B22 LOADED AND NONLOADED FACILITIES

13.01 Metropolitan area program circuits are usually made up of various gauges of nonloaded cable facilities. However, occasionally, B22 loaded trunk cable pairs, when available, may be assigned for 5KC or 8KC circuits in conjunction with the nonloaded facilities. B22 facilities have a lower loss than nonloaded facilities and their use may avoid the necessity of intermediate amplifiers. B22 facilities alone would generally meet frequency response requirements without equalizing, but when used with nonloaded facilities, equalization will usually be necessary. This generally can be accomplished by the use of an additional repeating coil and 23A equalizer at the junction of the B22 and nonloaded facilities. Arrangements and connections of repeating coils and equalizers for equalizing combinations of B22 and nonloaded facilities are shown in Table 5.

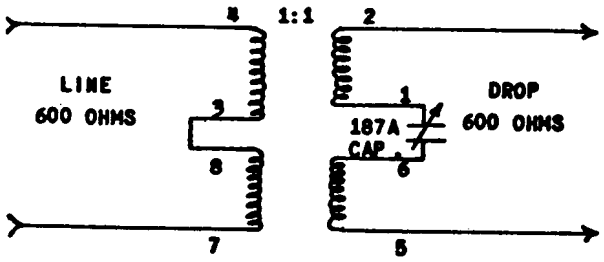


FIGURE 12

GENERAL RULES FOR LAYING OUT AND EQUALIZING COMBINED LOADED AND NONLOADED CABLE PAIRS

TABLE 5

Arrangement No.	Pick Up	Ca. Pr.	C. O.	Ca. Pr.	C. O.	Ca. Pr.	C. O.	Ca. Pr.	Studio
1	-	NL .5 Mi. or less	--	B22	--	B22	--	NL .5 Mi. or less	23A & 1:4 Coil
2	-	NL .5 Mi. or less	--	B22	--	B22	#	NL over .5 Mi.	23A & 1:4 Coil
3	-	NL over .5 Mi.	23A & 1:4 Coil	B22	--	B22	--	NL .5 Mi. or less	1:1 Coil
4	-	NL over .5 Mi.	#	B22	--	B22	#	NL over .5 Mi.	23A & 1:4 Coil
5	-	NL .5 Mi. or less	--	B22	23A & 1:4 Coil IN Amplifier 1:1 Coil OUT	B22	As in 1 or 2 Above	As in 1 or 2 Above	
6	-	NL over .5 Mi.	23A & 1:4 Coil	B22	1:1 Coil IN Amplifier 1:1 Coil OUT	B22	As in 1 or 2 Above	As in 1 or 2 Above	
7	-	NL Any Length	23A & 1:4 Coil IN Amplifier 1:1 Coil OUT	B22	--	B22	As in 1 or 2 Above	As in 1 or 2 Above	
8	-	NL .5 Mi. or less	--	B22	--	B22	23A & 1:4 Coil IN Amplifier 4:1 Coil OUT	NL	23A & 1:4 Coil

= 23A equalizer and 1:4 coil. The high side of the coil connected to the B22 facilities. The resistance in the equalizer adjusted to the highest value that eliminates the reflection.

14. NOISE TESTS

14.01 All program circuits should meet noise requirements at the receiving terminal, e.g., the point where the customer's equipment is connected.

14.02 Noise is measured using a 2B Noise Measuring Set (NMS) as described in the E40 Sections of Bell System Practices. Correct the noise set readings by adding the equalized circuit loss in order to compare with the noise objective which is based on the customer's level as delivered to the line (+ 8VU).

14.03 Noise requirements are not to exceed:

	Noise - dbRN		
	15KC	Sound	
Schedule	Flat Wtg.	Flat Wtg.	Pgm. Wtg.
AAA - BBB	33	33(xx)	(x)
AA to D, Incl.	(x)	46	36
E	(x)	46	36
F	33	46	36

(x) Does not apply.
(xx) When standard 2B NMS is used.

14.04 Where sound flat weighting and program weighting objectives are given (46 and 36 respectively) both values must be met.

14.05 A measurement of 15KC flat noise requires a 2B NMS modified as described in the E40 Section of Bell System Practice. Due to the limited need for this weighting, only a few sets have been modified. Where a noise measurement is required on a 15KC circuit and a modified set is not available, use the standard 2B NMS set with sound flat weighting.

14.06 Where noise requirements are met using sound flat weighting, but the values are marginal and the customer is not satisfied with the noise performance of the circuit, arrange with the supervisor to obtain a 2B NMS modified for 15KC flat weighting.

2B Noise Measuring Set - Program and Sound Flat Weighting

14.07 Primary calibration: (generally about every 6 months)

(a) Turn on battery supply (FIL key out).

(b) Operate K1 key to FIL and adjust FIL RHEO potentiometer to red line on meter. Operate K1 key to PLATE. Meter reading should be above red line. If not, replace plate batteries. Restore K1 key to center position.

(c) Insert dummy plugs in VOL jacks (adds 30 db pad) set DB dial to 55, K3 key to NORMAL and K4 key to 144.

(d) Connect a 1KC 1MW outlet to PROG jacks and adjust CAL ADJ potentiometer until meter reads + 5 db (1KC 1MW = 90 dbRN).

(e) Disconnect tone from PROG jacks and remove dummy plugs from VOL jacks.

(f) Check internal calibration circuit (field calibration) by inserting plug attached to set in CAL jacks, set DB dial to 40, meter should read to red line. If meter does not read to red line, remove cover from potentiometer P2 and adjust until meter reads to red line. Do not disturb the adjustment of CAL ADJ potentiometer.

(g) If adjustment is made as prescribed in (f), repeat (c) through (e).

14.08 Field Calibration:

(a) Turn on battery supply (FIL key out) and wait one minute.

(b) Operate K1 key to FIL and adjust FIL RHEO potentiometer until meter reads to red line.

(c) Operate K1 key to PLATE. Meter reading should be above red line. If not, replace the plate batteries. Restore K1 to center position.

(d) Operate K3 key on NORMAL.

(e) Operate K4 key to 144.

(f) Set DB dial to 40.

(g) Insert plug of set in CAL jacks, all other jacks empty.

(h) Adjust CAL ADJ potentiometer until meter reads to red line.

(i) Remove plug from CAL jacks and set is ready for use.

14.09 Measuring - Program Weighting:

(a) Adjust DB dial to 75.

(b) Connect equalized line to IN binding posts. Insert 2B set plug (289A) in PROG jacks. If circuit under test appears on jacks, a patch cord (241A plugs) may be used. Insert directly into PROG jacks of 2B set, and do not use the 2B set plug.

(c) Adjust DB dial until reading is between 0 and + 5 on meter scale, if possible. (This provides most accurate reading.)

(d) The corrected noise will be the DB dial reading, plus the meter reading above 0, plus the 1KC equalized loss of the circuit. If the meter reading is below 0, the noise will be the DB dial reading minus the meter reading, plus the 1KC equalized loss of the circuit.

14.10 Measuring - Sound Flat Weighting:

(a) Adjust DB dial to 75.

(b) Connect equalized line to IN binding posts. Insert 2B set plug (289A) in PROG jacks. If circuit under test appears on jacks, a patch cord (241A plugs) may be used. Insert directly into PROG jacks of 2B set, and do not use the 2B set plug.

(c) Insert dummy plugs in SOUND jacks.

(d) Operate K3 key to FLAT.

(e) Adjust DB dial until reading is between 0 and + 5 on meter, if possible.

(f) The corrected noise will be the DB dial reading, plus meter reading above 0, plus the 1KC equalized loss of the circuit, minus 16 db. If the meter reading is below 0, the noise will be the DB dial reading, minus the meter reading, plus the equalized loss of the circuit, minus 16 db.

2B Noise Measuring Set - 15KC Flat Weighting

14.11 Calibrating and measuring procedures are mounted in the modified 2B set cover.

15. INSTRUCTIONS PROVIDED TO THE CUSTOMER

15.01 The customer must be provided with a trouble reporting number both during regular 8:00 A.M. to 5:00 P.M. day, and after hours. Proper designation procedures are described in the C37 Series of Bell System Practices.

15.02 The over-all equalized db loss of the circuit should be provided to the customer.

15.03 The customer may wish to set levels on his equipment at the receiving end with our 1KC 0 level test tone being sent from the oscillator at the sending end. The 1KC 0 level is 8 db lower than the customer program level of + 8 VU. Under this test condition the customer's amplifier gain would be adjusted until his VI reads 8 VU lower than his program level.

16. PRIVATE LINES FOR COORDINATING PROGRAM SERVICE

16.01 Preliminary tests of the cable facilities used should be made by the test desk, local or toll office. Talking and ringing tests should be made to the test desk and over-all circuit.

16.02 Where service orders indicate a coordinating private line, and state "block in lieu of instrument," make a talking and ringing test by means of a portable 331-type magneto telephone set. This set may be used on the coordinating private line for talking while the program channel is being established and equalized.

NOTE: Do not leave the portable magneto telephone set on customer's premises.

16.03 The "C" Series of Bell System Practices contains:

(a) descriptions and connections of:

(1) 331-type

(2) F50682

(3) other magneto telephone sets

(b) modifications of:

(1) hand suspension sets

(2) hand telephone sets

Special features, such as lamps, etc., are provided on engineering sketches.

16.04 Loaded cable facilities will generally be used for coordinating private lines. The over-all loss should not exceed 18 db at 1KC. If poor transmission is observed, check the telephone sets including batteries, and if transmission is still poor, measure the 1KC loss of the facilities to assure the 18 db maximum loss is not exceeded.

17. TROUBLE INVESTIGATION

17.01 Before investigating trouble reports, make certain a release of the circuit has been obtained by the control office.

17.02 When investigating reported trouble of improper program level or poor quality, it is generally advisable to first sectionalize the trouble. The customer program material, if available, can be fed at the proper level into the circuit at the sending end. If this is not practicable, an oscillator may be used. A frequency of 1KC will suffice unless the complaint involves poor quality. In this case a frequency run is required.

17.03 With program or tone of proper level fed into the circuit at the sending end, each amplifier output can be checked for proper level or frequency response, and at each central office frame where no amplifier is used, a rough check with a test receiver can be made.

17.04 It should be noted that the customer's level is normally + 8 VU (approximately + 8 dbm) whereas we use 0 dbm for lineup purposes. The customer's + 8 VU program level has sometimes been called "0 level" erroneously.

17.05 When investigating reported complaints of intermittent troubles or varying levels, make a thorough physical inspection of all connections. Include:

(a) Main frame jumpers.

(b) Amplifier connecting blocks.

(c) Repeating coils and equalizer connections.

(d) Cross-connecting terminals.

(e) Drop and inside wiring connections, etc. Where Altec S17 amplifiers are involved, check for proper seating of amplifier in case.

17.06 An investigation of noise is best made by:

(a) Disconnecting the customer equipment.

(b) Terminating the sending end, preferably in 600-ohms, at the point where the customer sending equipment connects, and observe the noise at the receiving end where the customer receiving equipment connects. Sectionalization is made by observing at the receiving end and successively opening and terminating the circuit at AMP IN jacks and at other points toward the receiving end, as necessary, until the facility or equipment responsible is located. With the power turned off, the 21A or 13A TMS or 19C oscillator provides a 600-ohm termination. A 12A TMS in the measure condition also provides a 600-ohm termination.

17.07 Make a thorough investigation to determine the defective component, this will avoid unnecessary replacement of facilities or equipment.

17.08 Some types of reported troubles and their probable causes are listed in the following chart:

Reported Trouble	Probable Cause
Program level drops 20 db or more	One side open
No program	Open
Loss of high frequencies	No equalizer Loaded facilities
Noise	Wet cable pairs Protector or cable grounds Loose connections Defective amplifiers Physical or inductive cross Power induction
Loss of low frequencies	Equalizer resistance shorted out
Low level	Defective amplifier Low amplifier gain Equipment or wiring trouble Bridged tap
High level	High amplifier gain Equalizer open Customer feed too high Nonloaded cable replaced by loaded cable in cable rearrangements.

18. SUPPLIES

18.01 Equipment:

BACKBOARD - KS5796 L2 Backboard

Will mount one 105-type apparatus box and two repeating coils

BOX - Apparatus, 105-type or equivalent

Will mount two J-98610B L2 subscriber line terminating equipments (23A equalizers and mounting plates).

COIL - Repeating, 111C, 119C, or 119E

EQUALIZER - J-98610B L2 subscriber line terminating equipment

Consists of the following:

One 23A equalizer mounted on a double-spaced key-telephone-unit mounting plate. This unit is designed to mount in a 105-type apparatus box. Space is available in the box to mount two units.

EQUALIZER - 23A

EQUALIZER - DE-69010-01, List 1

Used for equalizing 15KC program channels. Consists of two 251A inductors, two 187A capacitors, fourteen 19-type resistors, and two 111C repeating coils mounted on a 5-7/32 inch by 19 inch mounting plate.

WIRE - Station, SK (specify brown or ivory as required)

A twisted pair, red and red-green insulated conductors, shielded with a copper wire serving and covered with thermoplastic compound. Used for extending program channels from building terminals to equalizers, connecting blocks, etc.

ADDENDUM A399.006
ADDENDUM C70.904
Issue B, October, 1961
Pacific Tel.-LA

PRIVATE LINE SERVICE INSTALLATION AND MAINTENANCE PROGRAM CIRCUITS

1. GENERAL

1.01 This addendum supplements Section A399.006 and C70.904.

1.02 This addendum is reissued to add to and change Paragraph 9.04, and provide a description of the GB-731 Portable Program Equalizer.

1.03 By standardizing one set, locally assembled sets can be eliminated.

7. REPEATING COILS

The following changes apply to Part 7 of the section:

1. 7.01 - Revised

2. Fig. 7 - Add drawing of 175A repeating coil to the three existing drawings.

7.01 The 111C, 119C, 119E and 175A repeating coils are similar electrically and are used for:

(a) Isolation, for noise reasons, of telephone facilities from a possible unbalanced customer termination.

(b) Impedance matching where cable pairs of different impedances are interconnected; for example, B22 loaded and nonloaded facilities.

(c) Aid in equalizing.

175A

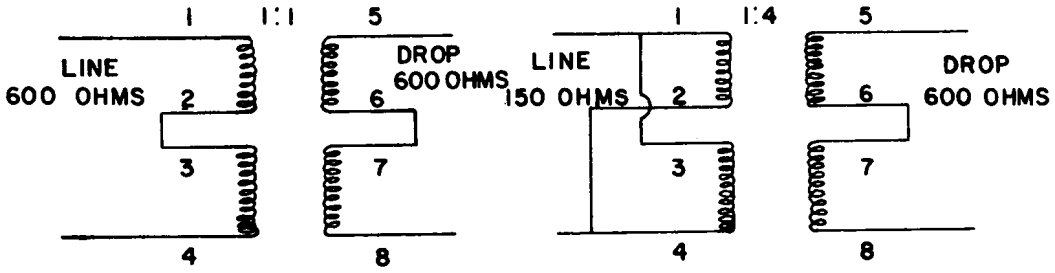


Fig. 7

9. EQUALIZATION PROCEDURES - GENERAL

9.04 The GB-731 Portable Test Equalizer contains all the component parts of a 23A and DE-69010-01 (15 KC) equalizer and is arranged, via switches, to equalize 5, 8 and 15 KC program channels.

The test set temporarily replaces the permanent equalizer during equalization and is connected by use of either the jacks or binding posts.

When equalization is completed, the permanent equalizer and repeating coil are then strapped for the same values as set up on the portable test set. Some minor changes may be required to assure proper equalization on limiting length loops.

This portable test set eliminates the need for decade boxes. It is used at either customer premises or Central Offices.

9.04.1 Design and Switch Functions -

The set is contained in a metal covered case and weighs about ten pounds. There are two input and output connections, jacks and binding posts. The jack takes 241-type plugs.

Connect the test set in the following manner:

(a) To 14-type amplifiers:

1. "In" to "Trsg. Lp." - "Out" to "Amp. In"

(b) To 12-type amplifiers:

1. "In" to "Lp. In" - "Out" to "Amp. In"

(c) S17 System

1. "In" to "Eql. Conn."
2. No connection is made to the "Out" jack.
3. The test set is not required for 5 and 8 KC circuits.

(d) Customer Premises Equipped with Jacks:

1. "In" to bare loop line jack, "Out" to T.M.S.

(e) Customer Premises Not Equipped With Jacks:

1. Connect bare line to "In" - Connect "Out" to T.M.S.

The ratio switch determines the repeat coil impedance, either 1:1 (600:600) or 1:4 (150:600).

The equalizer switch connects the 23A or 15 KC equalizer. Only the 15 KC position connects the capacitance and inductance switches. In either position, the resistance switches are connected.

The capacitance switch provides the same range as the 187A capacitor found on the 15 KC equalizer panel.

The inductance switch provides the inductance value along with the terminal numbers on the 251A retard. For example, .003 henries is terminals 2 and 5 of the 251A inductor.

MEASURING PROCEDURE

9.04.2 15 KC Circuits

To equalize 15 KC circuits, set the equalizer switch to 15 KC and the ratio switch to 1:4. Select capacitance and inductance values in accordance with Paragraph 11.04 (g). Equalize in exactly the same manner as described in the remainder of the paragraph.

When equalizing 15 KC circuits on S17 systems, connect the set to temporarily replace the equalizer as shown, 11.08 (f), Figure 11. The "Out-Measure" jacks are not used. The equalizer is in a bridged position.

9.04.3 5 and 8 KC Circuits

To equalize 5 and 8 KC circuits, set the equalizer switch to 23A, the ratio switch to 1:4, and follow instructions covered in Section 10.

To equalize a 5 or 8 KC circuit, using a 15 KC equalizer (usually associated with a 14C amplifier), set the test set equalizer switch to 15 KC and the ratio switch to 1:4. Set the capacitance and inductance switches to the same values as in a 23A equalizer (Fig. 2). Equalize as covered in Section 10. When equalization is complete, strap the same values of resistance, capitance and inductance in the permanent equalizer as obtained using the test set.

9.04.4 Figure 13 is a simple schematic of the GB-731 Program Equalizer.

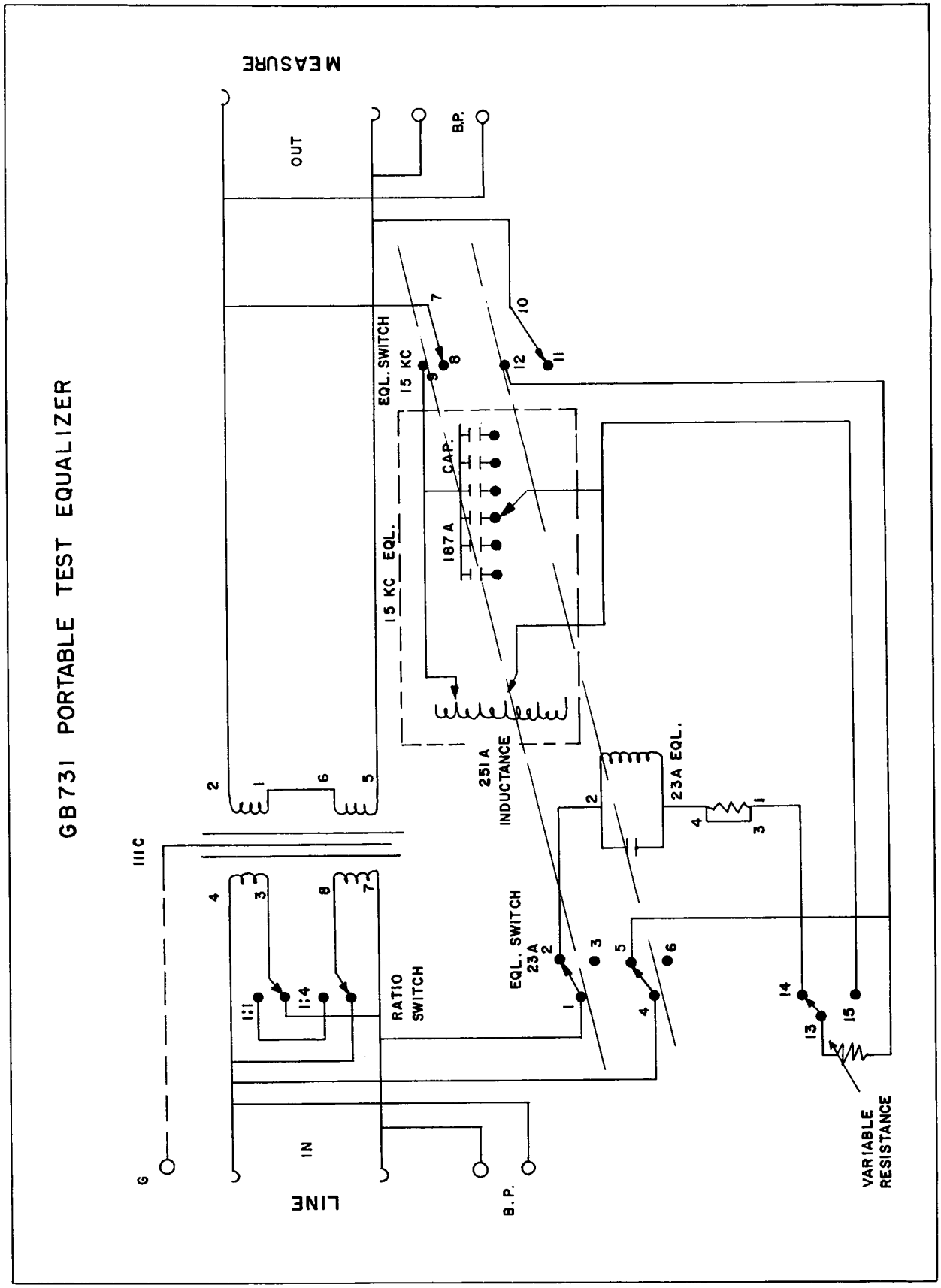


FIG. 13

18. SUPPLIES

The following changes apply to Part 18 of the section.

Delete: Box and J-98610B L2 equalizer descriptions.

Change to read: COIL - Repeating, 111C, 119C, 119E or 175A

Add: J98610B L1 and L2 Subscriber Line terminating equipment consist of the following:

One Repeating Coil 175A
One 23A Equalizer

These units are mounted on Key Telephone Units in a 105A apparatus box.