

BELL SYSTEM PRACTICES
Outside Plant Construction
and Maintenance

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AT&T Co Standard

CABLE TESTING

FAR-END CROSSTALK MEASUREMENTS IN TOLL ENTRANCE AND INTERMEDIATE CABLES AT TYPE C CARRIER FRE- QUENCIES, AND APPLICATION OF LOCALIZED BALANCING FOR CROSSTALK REDUCTION

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1. GENERAL

1.01 This section describes a method for making far-end pair-to-pair (or side-to-side) crosstalk coupling measurements at type C frequencies between pairs, in entrance and intermediate cables. Included also is a method for the application of localized condenser balancing for the reduction of high frequency far-end crosstalk coupling.

**LOCALIZED CROSSTALK
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ENTRANCE CABLES**

1.02 The method of crosstalk measurement is applicable between any combination of C facilities. The localized balancing method, however, is generally applicable only between combinations of C loaded pairs, or combinations of non-loaded pairs. Balancing between different types of facilities (such as non-loaded and C loaded pairs) will generally provide little crosstalk coupling improvement. There is also some chance under these circumstances that the coupling might be increased at some frequency different from that at which balancing is performed.

2. FAR-END PAIR-TO-PAIR CROSSTALK MEASUREMENTS

2.01 Far-end high frequency crosstalk tests should in general be made in accordance with the following standard instructions:

- E40.317—6010-B Oscillator and 29-A Amplifier
- E40.414—51-A Crosstalk Set
- E40.316—8-A Oscillator
- E40.601—1-A Detector-Amplifier

2.02 For the making of far-end coupling measurements alone, the testing apparatus should be connected as indicated in Fig. 1 for loaded pairs and Fig. 2 for non-loaded pairs, with the exception that the modified capacity unbalance set and spare cable pair will not be required for crosstalk measurements alone. All connections between different pieces of apparatus and between such apparatus and cable conductors should be as short as possible.

ARRANGEMENT FOR MEASUREMENT OF FAR-END CARRIER FREQUENCY CROSSTALK IN ENTRANCE AND INTERMEDIATE CABLES AND ITS REDUCTION BY MEANS OF LOCALIZED CROSSTALK BALANCING LOADED TO LOADED PAIRS

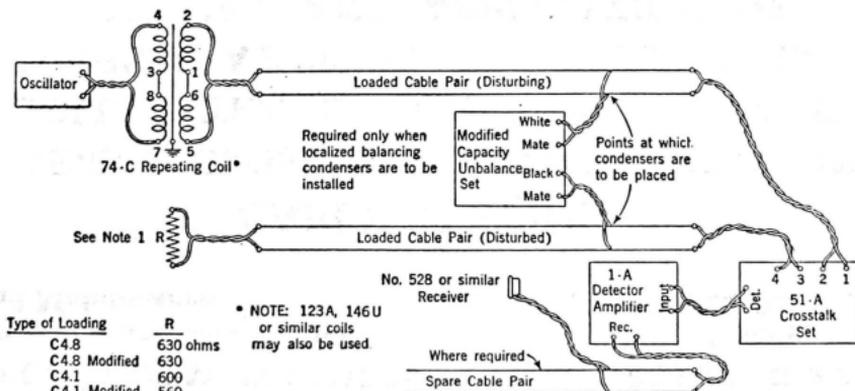


Fig. 1

ARRANGEMENT FOR REDUCTION OF FAR-END CARRIER FREQUENCY CROSSTALK
BETWEEN NON LOADED PAIRS IN ENTRANCE AND INTERMEDIATE CABLES

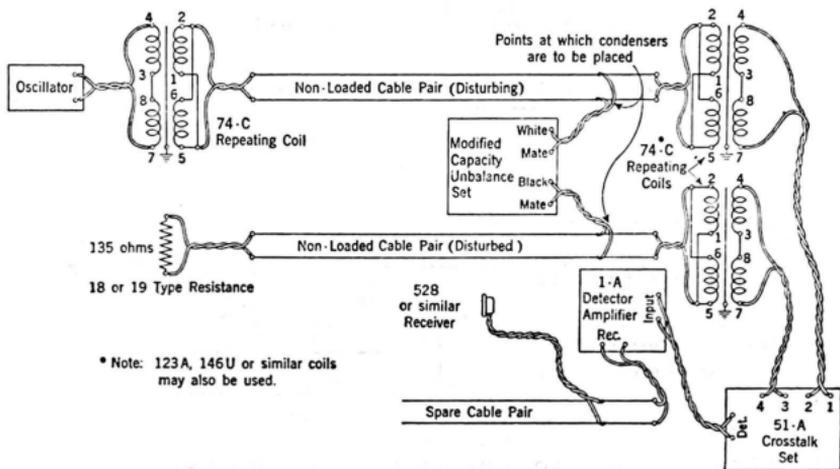


Fig. 2

Check of Wiring and Apparatus for Possible Trouble

2.03 Adjust the oscillator for the desired frequency (25 kc if condenser balancing is to be performed) and make far-end crosstalk coupling measurements in the usual manner. (Key 3 operated to "600".) Record the result. Make tip-ring turnovers, at one end of each lead connecting the testing apparatus to the cable pairs, at the sending end and receiving end of the cable, noting the coupling after each change and restoring the connections to normal each time before making the next turnover. If no testing tone is being picked up in the apparatus or wiring, all of the measurements should be approximately of the same magnitude. If this is not the case the wiring and apparatus should be investigated for trouble.

Measurement of Crosstalk

2.04 With the connections restored to their normal position, far-end crosstalk coupling tests should be made and recorded (at 25 kc if the necessity of condenser balancing is being investigated) for each pair combination under consideration. If balancing is contemplated the measurements should also be made with the disturbed and disturbing pairs interchanged, (that is, measure "A to B" and "B to A" coupling).

3. LOCALIZED CROSSTALK BALANCING

3.01 In the event that results of preliminary far-end pair-to-pair unbalance tests indicate that a reduction of such crosstalk coupling is desirable, (usually based on limiting objec-

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tives furnished with specifications) localized condenser balancing may be utilized as covered in the following procedure:

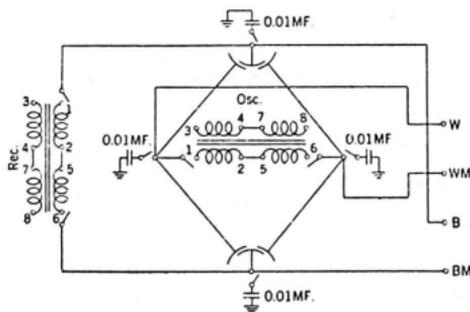
Location of Balancing Condensers

3.02 In order to facilitate observations of far-end coupling during the balancing operation it is desirable to install balancing condensers near one end of the cable rather than at some intermediate point. In the case of toll entrance cables there is a slight advantage from the standpoint of near-end crosstalk in locating the condensers near the open wire terminal. It may be more convenient however to locate them in a splice near the office and this may be done under such circumstances.

3.03 Where only a small number of cable pairs is involved it may be found feasible to install the necessary balancing condensers at a splice in the main cable. In the event that the number of condensers required makes it impracticable to install them in the main cable splice, the condensers may be housed in an auxiliary sleeve connected to the main cable by means of a stub of an appropriate makeup.

Preparation for Tests

3.04 Make the necessary arrangements to have the cable sheath or sleeve opened at the point where the balancing condensers are to be connected to the conductors. Obtain a 3-A or 4-A capacity unbalance measuring set described in Section G72.230 and modify it as a differential condenser as shown in Figs. 3, 4 and 5. Connecting the crosstalk coupling measuring apparatus as shown in Fig. 1 for loaded pairs or Fig. 2 for non-loaded pairs, a pair combination should be selected which is known from the earlier measurements to have not more than about 200 units of measured far-end crosstalk coupling at 25 kc.



SCHEMATIC OF CAPACITY UNBALANCE SET
MODIFIED FOR PAIR TO PAIR UNBALANCE MEASUREMENTS AT TYPE C FREQUENCIES
(Key D operated to "S" to "S" position)

Set should be equipped with leads as indicated in other instructions covering the use of the 3-A and 4-A unbalance sets.

REQUIRED MODIFICATIONS:

1. Remove the connections to terminals 1 and 6 of the two repeating coils in the receiver and oscillator circuits
2. Disconnect the 0.01MF condensers from the circuit of the unbalance set.
3. Tape the ends of the disconnected wires to prevent the possibility of contacts with other apparatus

Fig. 3

MODIFIED 3 - A CAPACITY UNBALANCE SET
WIRING DIAGRAM
INDICATING POINTS AT WHICH MODIFICATIONS ARE MADE

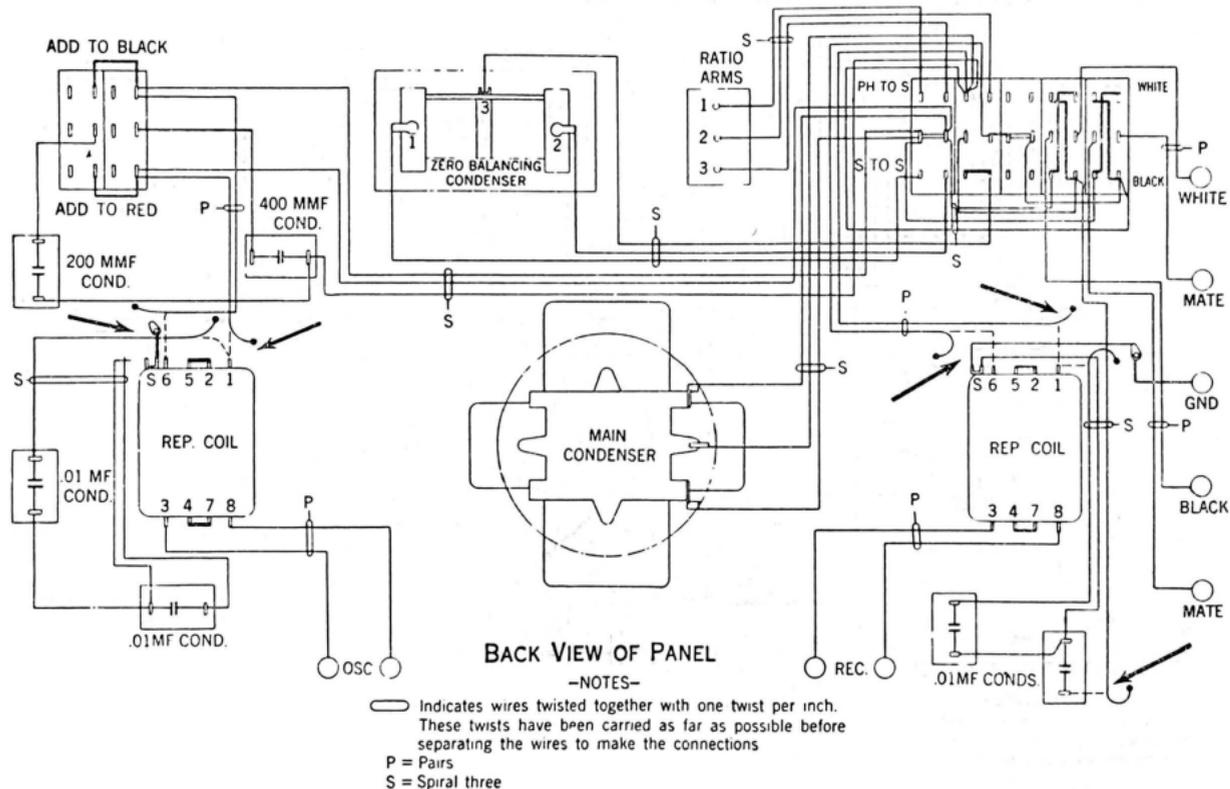
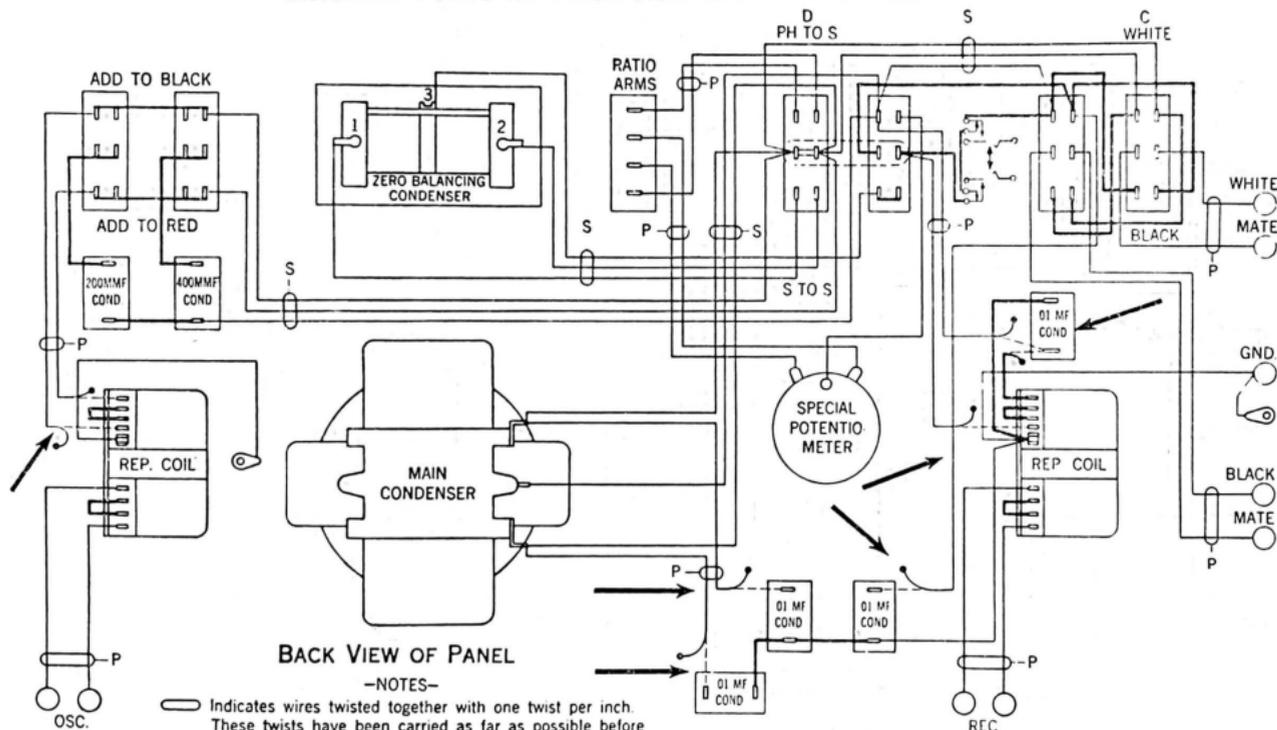


Fig. 4

**LOCALIZED CROSSTALK
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 ENTRANCE CABLES**

MODIFIED 4 - A CAPACITY UNBALANCE SET
WIRING DIAGRAM
 INDICATING POINTS AT WHICH MODIFICATIONS ARE MADE



BACK VIEW OF PANEL

-NOTES-

- Indicates wires twisted together with one twist per inch. These twists have been carried as far as possible before separating the wires to make the connections
- P = Pairs
- S = Spiral three-

Fig. 8

3.05 Set the oscillator to a frequency of 25 kc and operate key 2 of the 51-A crosstalk measuring set to "LINE," key 6 to "FAR END," key 7 to "XT" and key 3 to "600." Listen to the crosstalk tone at the receiver output of the 1-A Detector-Amplifier and adjust the dial of the capacity unbalance set for minimum tone. Note the unbalance reading in magnitude and sign. Next reverse at one end only, one pair of the leads to the capacity unbalance set and again adjust for minimum crosstalk. If the set is properly balanced the last measurement will be of the same magnitude as the first but of opposite sign. If the readings differ in magnitude the "S to S Zero" dial should be adjusted until readings of equal magnitude but of opposite sign are obtained upon reversal of one pair of leads.

3.06 Next disconnect the leads of the capacity unbalance set from the cable pairs and check the apparatus and wiring involved in the crosstalk measuring connections both at the sending and measuring ends of the cable pairs as outlined in Paragraph 2.03. Any errors found should be located before balancing is attempted.

Adjustment and Installation of Condensers

3.07 Connect the crosstalk coupling measuring equipment and capacity unbalance set to the pair combination having the worst far-end coupling as determined from the preliminary measurements, and with the oscillator set at 25 kc, adjust the capacity unbalance set until the tone at the receiver output of the 1-A Detector-Amplifier is a minimum. The reading of the capacity unbalance set both in magnitude and sign should be recorded. (In this test, the "worst" direction—i.e., "A to B" or "B to A"—should be used.)

3.08 Select a 209 type adjustable balancing condenser with a nominal capacity value a little greater than indicated by the reading of the capacity unbalance set, and prepare it for installation as outlined in Section G72.226. Connect the condenser between a wire of one pair and the proper wire of the other pair determined as follows:

3.09 **If the dial setting of the unbalance set is positive, the balancing condenser should be connected between white and black or between white mate and black mate.**

3.10 **If the reading of the set is negative the condenser should be connected between white and black mate or between white mate and black.**

3.11 With the condenser connected, balance again for minimum crosstalk. The unbalance should be reduced in magnitude and should be of opposite sign. Carefully adjust the 209 type condenser until a reading of zero unbalance on the capacity unbalance set gives minimum crosstalk tone. Record

the final value of crosstalk coupling "A to B" and "B to A" thus obtained.

Order in Which Combinations Should be Balanced

3.12 The above procedures should be followed for all the remaining pair combinations to be balanced, if practicable, in the order of previously measured far-end crosstalk coupling starting with the pair combination exhibiting the highest value of coupling.

Final Tests

3.13 If the condensers have been placed in a splice, far-end crosstalk coupling measurements should be made at 25 kc after the balancing condensers have been permanently installed and the splice wrapped up preparatory to wiping on the sleeve. These tests should be made with the disturbed and disturbing pairs in both a normal and interchanged position and the results should be checked with previous measurements for the combinations involved in order to establish that no trouble has been introduced in the wrapping operation. The above tests should also be repeated after the splice is closed, without interchanging the disturbing and disturbed pairs, to ensure that no trouble has been introduced by the closing operation.

Representative Results

3.14 Indicated in Table 1 are representative values of maximum far-end crosstalk coupling which will only rarely be exceeded after the installation of balancing condensers.

Table 1

Representative values of maximum far-end crosstalk coupling at 25 kc which will only rarely be exceeded after the installation of balancing condensers.

<u>Cable Length</u>	<u>Far-End Equal-Level Crosstalk Units</u>
1 mile or less	200
2 miles	250
5 "	350
10 "	500

4. LOCALIZED CROSSTALK BALANCING DATA SHEET

4.01 A copy of a suggested data sheet for use in recording the results of measurements made in connection with localized crosstalk balancing in toll entrance or intermediate cables is given in Fig. 6. Indicated thereon are sample test data which illustrate the use of the form.

4.02 In view of the expected relatively small demand for data sheets it is suggested that forms similar to that of Fig. 6 be made up locally.

LOCALIZED CROSSTALK BALANCING ON TOLL ENTRANCE
OR INTERMEDIATE CABLES

CABLE White Sulphur Springs MEASURING POINT Palw 8843
 LINES SERVED Palmer Run - Gallowaytown
 LENGTH OF CABLE 1.7 miles OSCILLATOR LOCATED AT Palw 8774
 TESTER T. J. T. CONDENSERS LOCATED AT Palw 8843

"A"		"B"		Length Miles	Freq. kc	Coupling Without Balancing Condenser cu		Min. Coupling after Balancing With Cap. Unbal. Set for Worst Direction	Max for Min. Coupling	Type Bal. Cond. Installed	Crosstalk Coupling After Installation of Balancing Condenser - 25 kc				
Pr. No.	Type Ldg.	Pr. No.	Type Ldg.			A-B B-A					Splice Open		Splice Wrapped		Splice Closed
						A-B	B-A				A-B	B-A	A - B		
1	CH1	7	CH1	1.7	25	400	400	15	-32	209D	25	25	50	50	50
2	"	8	"	"	"	650	700	75	+60	209D	100	75	100	75	100
7	"	21	"	"	"	350	375	200	-20	209D	250	200	275	250	275
7	"	22	"	"	"	500	450	100	+40	209D	100	125	125	150	150
9	"	21	"	"	"	400	475	100	+33	209D	125	100	150	125	150
9	"	22	"	"	"	100	125	-	-	none					
1	CH1	31	CH1	1.7	25	400	450	100	+60	209D	75	50	100	75	100
1	"	32	"	"	"	300	225	50	-30	209D	50	25	75	50	100
7	"	31	"	"	"	400	350	200	+55	209D	200	225	250	300	275

Fig. 6