TROUBLE LOCATION TESTS
USING VOICE-FREQUENCY SWEEP TEST SETS
DETAILED ANALYSES

CONTENTS PAGE

1. GENERAL

1.01 This section describes the procedures for location of transmission irregularities using voice-frequency sweep test sets. These tests may be applied to subscriber cable pairs when transmission troubles are suspected. They are designed to locate and identify these troubles primarily by testing from the Central Office end of the pair.

1.02 The general theory of trouble location using sweep test sets is discussed in Section 330-450-100. Application to subscriber loops is discussed in Section 330-450-102. Procedures and equipment for seizing cable pairs and testing from various test locations are described in Sections 330-450-501 through 330-450-506. This section covers the analysis of sweep traces to identify and locate specific transmission irregularities.

1.03 These tests may be applied to subscriber cable pairs. They may also be applied to cable pairs for special services on an out-of-service basis. When the distant end is terminated in equipment other than a telephone instrument, it may be necessary to arrange for the distant equipment to be temporarily disconnected. The analyses are based primarily on open-circuit tests. When testing circuits which are normally open, little or no assistance is required at the distant end. When it is necessary to disconnect equipment at the distant end, special test equipment is not required.

1.04 Pairs bridged at the Central Office must be tested at the main frame or on test shoes if they are equipped with bridge lifters. Each pair should be tested individually. If not equipped with bridge lifters, each bridged pair can be tested individually by removing the heat coils for the other pair.

1.05 Schematic records should be available for the pair or pairs under test. In addition, the assignment information should also be available.

2. IDENTIFICATION OF PAIR TYPE

2.01 When the pair is in the test condition, operate the TEST PAIR key of the accessory arrangement as furnished per Section 330-450-102, Fig. 1-3. The pair is then connected to the sweep test set. With the set arranged for impedance measurement, examine the shape of the impedance curve. If it is similar to those shown in Fig. 1, the pair is nonloaded. The impedance magnitude will decrease as the length of the pair plus bridged tap increases.

2.02 If the cable pair is loaded, the impedance curve will show peaks and dips. A typical curve for a 22H88 loaded pair with four loading coils is shown in Fig. 2. Note that the peaks and dips tend to rise smoothly from low to high frequency. The height of the right-hand peak is dependent on the amount of cable beyond the last load. With a short far-end section, the last peak will be shorter than the previous one. With a long far-end section, the last peak will be higher than the rest.

2.03 Because of possible irregularities in the cable pair, it cannot be assumed that the number of peaks in the impedance curve is always equal to the number of loading points. It is not always true for H88 loading, and other loading plans may have completely different patterns, because the display does not extend above the cutoff frequency.

2.04 Nontypical impedance curve shapes are an indication of a possible irregularity. Analysis of these curves is discussed further in Parts 3 and 4.

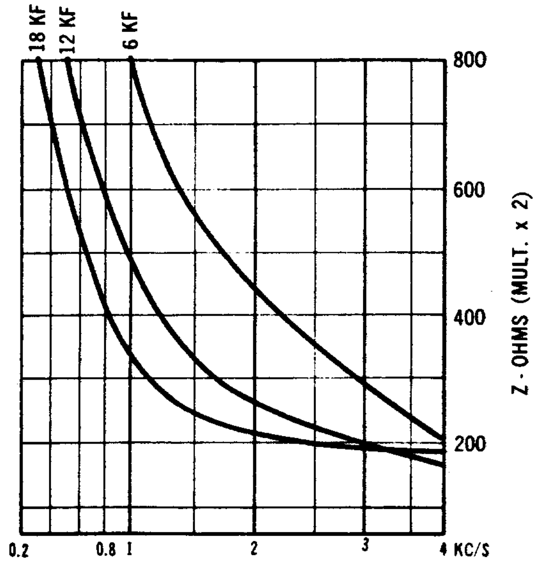


Fig. 1 – Open-Circuit Impedance Curves for Various Nonloaded Pairs

3. IDENTIFICATION OF PAIR FAULTS

(A) Short Circuits

3.01 Faults normally found by DC tests will sometimes be encountered. These should be identified and corrected before proceeding with further tests.

3.02 Fig. 3 shows the effect of a short circuit at the distant end of the pairs shown in Fig. 1. Notice that the impedance approaches the DC resistance of the loop between the Central Office and the short at low frequency.

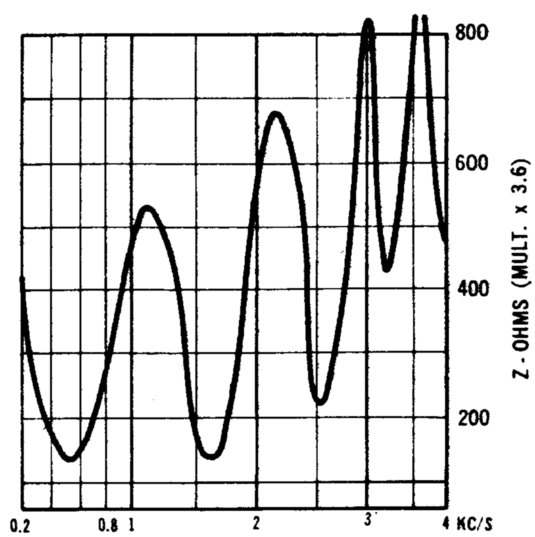


Fig. 2 – Typical Open-Circuit Impedance Curve for Loaded Cable Pair

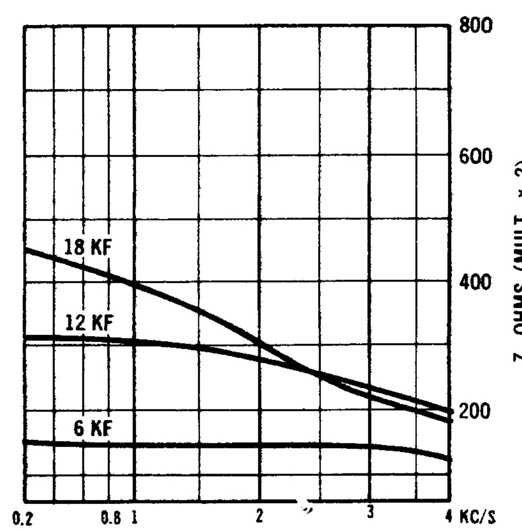


Fig. 3 – Short-Circuit Impedance Curves for Various Nonloaded Pairs

3.03 Fig. 4 shows the effect of a short at the distant end of the H88 loaded pair of Fig. 2. Note that the impedance curve is similar to that of Fig. 2, but the peaks and dips are turned over.

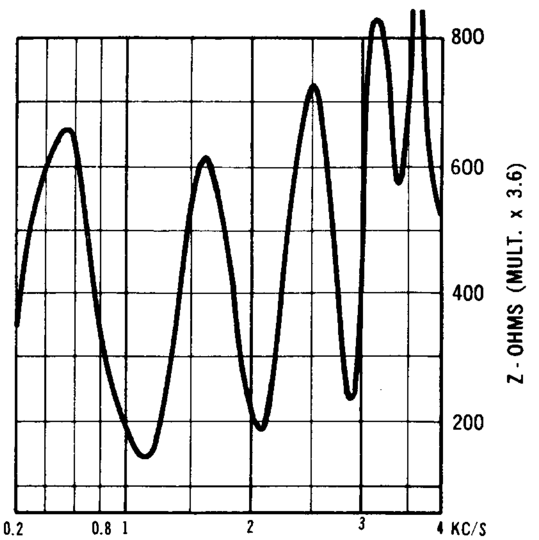


Fig. 4 – Short-Circuit Impedance Curve for H88 Loaded Cable Pair

(B) Effect of Terminations

3.04 Terminations will sometimes be encountered during testing. Fig. 5 shows two types that may be found on nonloaded cable pairs. Curve A illustrates the effect on a 15 KF loop if a 500-type telephone set is encountered in the off-hook condition. Curve B shows the effect of a 120-type repeating coil at the far end with a resistive termination and equipped with capacitors across the center taps.

3.05 Fig. 6 shows the effects of terminations on an H88 loaded cable pair with four loading points and 6 KF of cable in the far-end section. Curve A is for an off-hook 500-type telephone set, and Curve B is for the 120-type repeating coil termination described in 3.04.

3.06 When terminations are encountered, it may be necessary to disconnect the termination to complete the analysis of the sweep traces. When the termination consists of a resistive short circuit, the fault should be located and corrected before proceeding further.

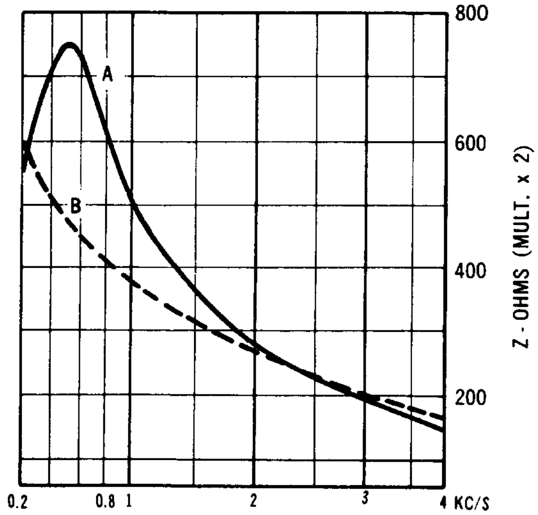


Fig. 5 – Terminated Impedance Curves for a Nonloaded Cable Pair

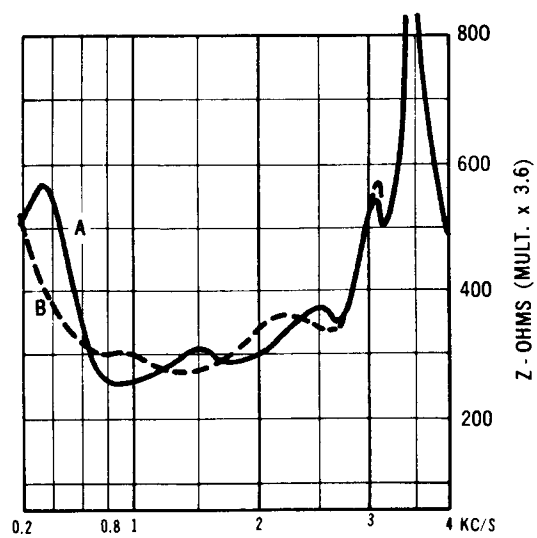


Fig. 6 – Terminated Circuit Impedance Curves for an H88 Loaded Cable Pair

(C) Unbalance

3.07 An unbalanced cable pair will often be encountered. It will usually be indicated by a widening of the trace due to noise. A typical display for a 15 KF nonloaded cable pair is shown in Fig. 7. In this case, an unbalance exists 9 KF from the Central Office.

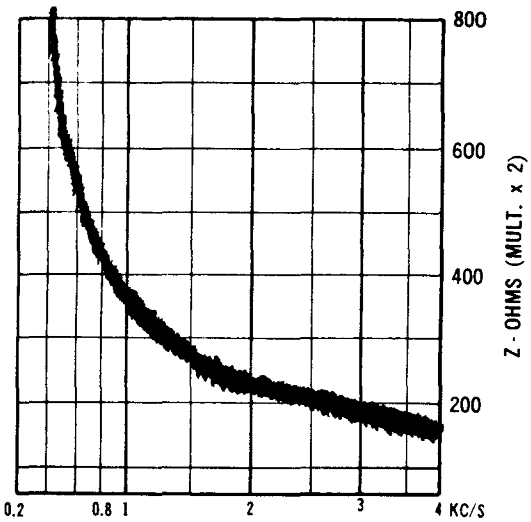


Fig. 7 – Noise on Open-Circuit Impedance Curve for a Nonloaded Cable Pair

3.08 To test for unbalance, operate the TEST RING key on the accessory arrangement and observe the impedance trace, then operate the TEST TIP key and observe the impedance trace. Notable differences in the curves are due to structural differences between the two sides of the pair and they may also be caused by lack of balance in the station equipment.

3.09 Fig. 8 shows some typical displays for a 15 KF nonloaded pair with a fault on the ring side 9 KF from the office. When the ring side is open, its impedance is higher than the tip side. When the ring side is grounded, its impedance is much lower.

3.10 Unbalance may be due to excessive resistance or capacitance in one side of the line, such as may occur in a corroded splice. This may cause only a small difference between the tip-ground and ring-ground impedance curves. If the unbalance disappears when dc voltage is applied to the pair, it may not affect transmission except for special services using key circuits. DC voltage should not be applied to the pair when the sweep test set is connected, unless the set is equipped with a dc blocking capacitor.

3.11 Unbalanced loaded cable pairs may be detected in the same manner as nonloaded pairs, with one exception. When an open or ground occurs in one side of the pair, the peaks and dips in the impedance curves for the two sides of the pair will be substantially different.

3.12 Erratic traces may be encountered. This condition is usually due to intermittent opens, sometimes caused by faulty test connector switches in the testing train.

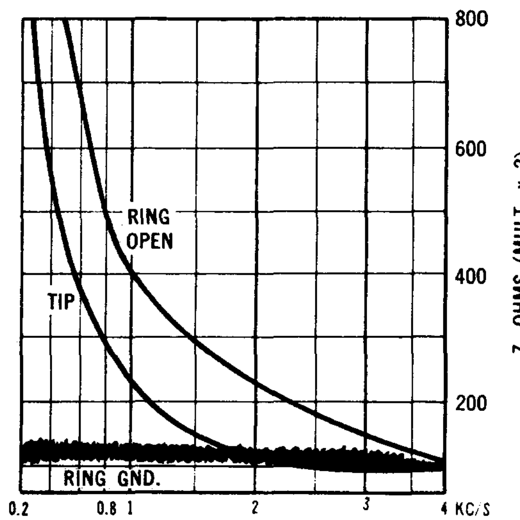


Fig. 8 – Tip and Ring Impedance Curves for a Nonloaded Cable Pair with Fault in Ring Side

4. ANALYSIS OF IMPEDANCE MEASUREMENTS

(A) General

4.01 Some troubles can be identified and located by inspection of the open-circuit impedance curves as displayed by the sweep set. The analysis can be done after any faults have been located and cleared as discussed in Part 3.

4.02 When apparent irregularities cannot be located and identified by inspection, an artificial cable kit may be used. An artificial cable pair is assembled from the kit and made to look like a model of the real pair. Various irregularities may then be inserted in the artificial pair until the curve for the artificial pair is identical to the curve for the real pair. The troubles in the artificial pair then simulate the troubles in the real pair.

4.03 The discussion here is based primarily on tests of nonloaded pairs and pairs with H88 loading. When other loading plans are en-

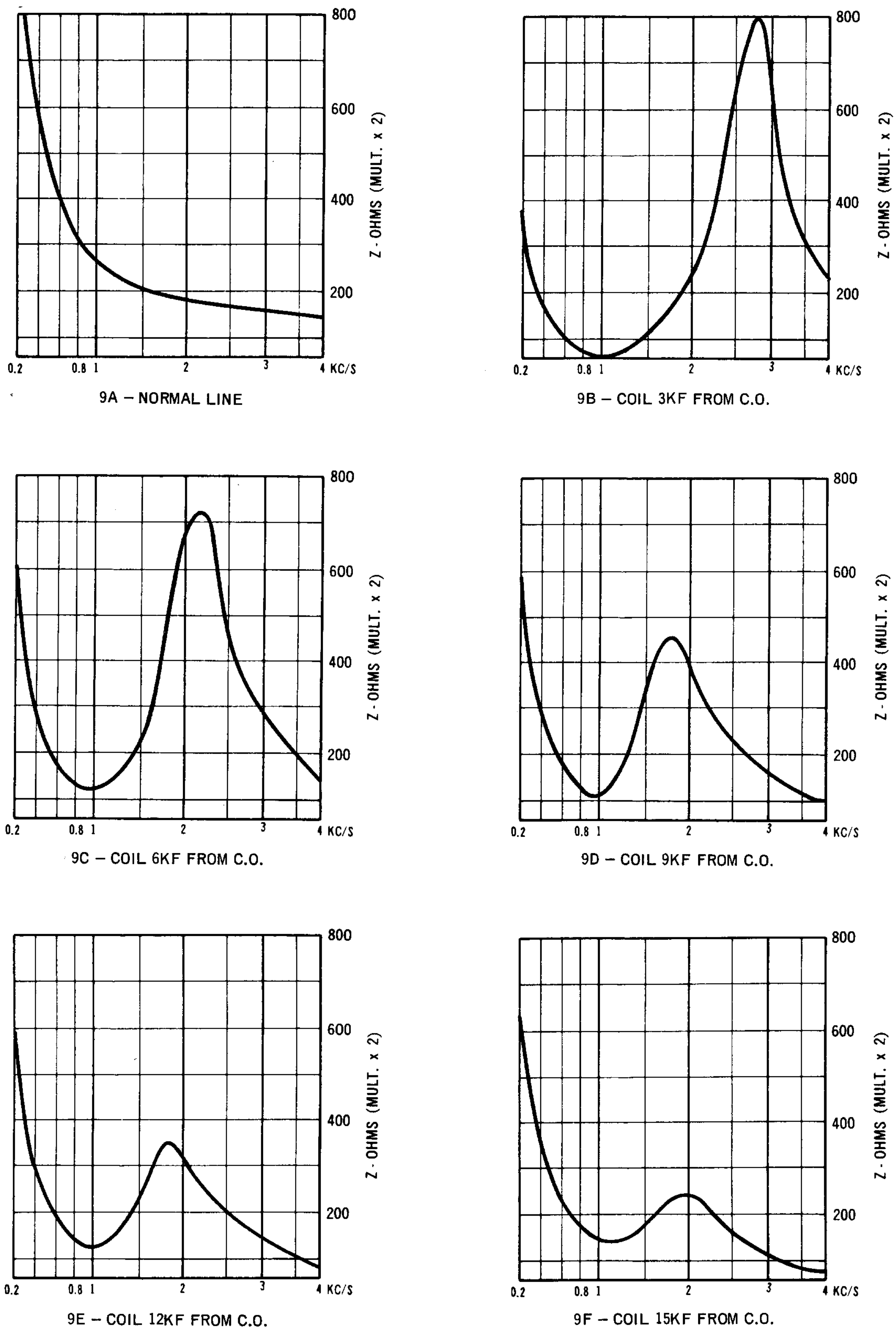


Fig. 9 – Effect of Incorrectly Placed Loading Coil on Open-Circuit Impedance of Nonloaded Cable Pair

countered, or when more precise analysis is necessary, return loss tests may be used as discussed in Part 5.

(B) Analysis of Impedance Curves

4.04 Open-circuit impedance curves for nonloaded cable pairs should look like those in Fig. 1. When an irregularity exists, such as an incorrectly placed loading coil, the curve will be irregular. Some examples are shown in Fig. 9 for a pair 15 KF long.

4.05 An exception will be found on nonloaded pairs terminated at 155G coin telephone sets. An example is shown in Fig. 10. The low impedance at low frequency is caused by the subset. These stations are being replaced.

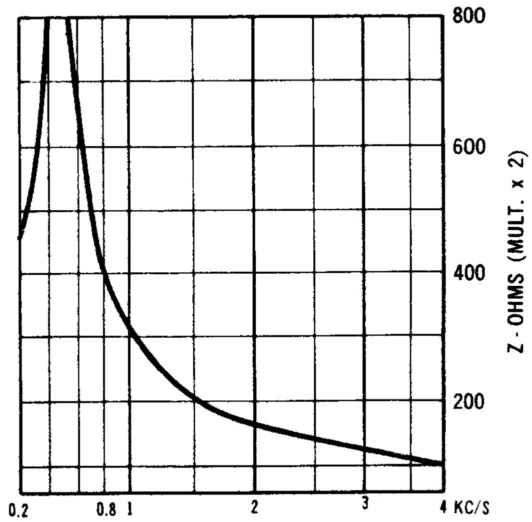


Fig. 10 – Open-Circuit Impedance Curve for Nonloaded Cable Pair Terminated at 155G Coin Telephone Set

4.06 Improper bridged tap on nonloaded pairs cannot be detected by looking at the impedance curve, unless there is bridged tap containing one or more loading coils. It will only make the pair appear to be longer. The curve will then appear similar to one of those in Fig. 9. If there are no coils present, excessive bridged tap can be detected by the pair length tests of Part 6.

4.07 When testing loaded cable pairs with properly spaced 88 mh loading coils, the high-frequency end of the curve will be affected by the total length of cable pair plus bridged tap in the far-end section. Some examples of 22H88 loaded cables with four properly spaced loads are shown in Fig. 11. Note that the last peak disappears when the far-end section is very short. The effect of the last loading coil will appear if the pair is short-circuited at the far end. Its presence can also be detected by the return loss tests of Part 5.

4.08 The length of the Central Office end section has an effect on the open-circuit impedance curves of loaded cable pairs. Fig. 12 shows impedance curves for a 22H88 load pair with four properly spaced loads, a 6 KF far-end section and various C.O. end sections. These types of curves may be found when there is bridged tap in the C.O. end section or when the first loading coil is missing.

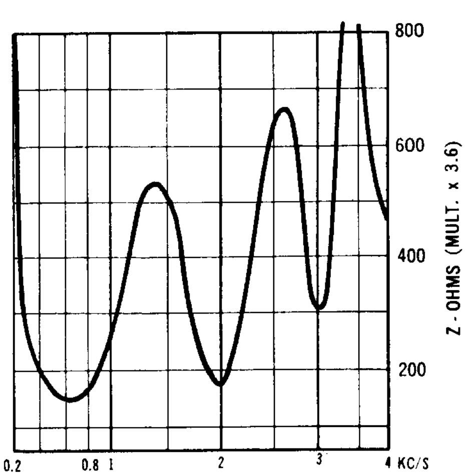
4.09 The effects of other irregularities may be observed. Some of these are missing coils, doubled coils, half coils, reversed sides, improperly spaced coils and bridged tap between coils. Many irregularities have been investigated, and some of the resulting displays for H88 loaded cable pairs are illustrated in Appendix A.

4.10 A few exchanges are engineered for H44 loading. Since H44 loaded cable pairs have a frequency cutoff just above 4000 cps, the open-circuit impedance curves are substantially different. Other loading plans, such as B or D spacings, also produce different patterns. A few open-circuit impedance curves for H44 loaded cable pairs have been investigated. Some typical examples are shown in Appendix B.

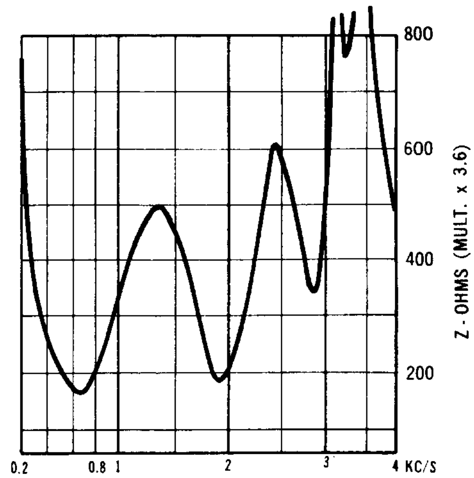
4.11 Many irregularities cannot be identified and located by inspection of the open-circuit impedance curve, although the effect may be seen. When this occurs, or when unusual loading schemes are encountered, the techniques of Part 4(C) or 5 should be used.

(C) Use of Artificial Cable Kit

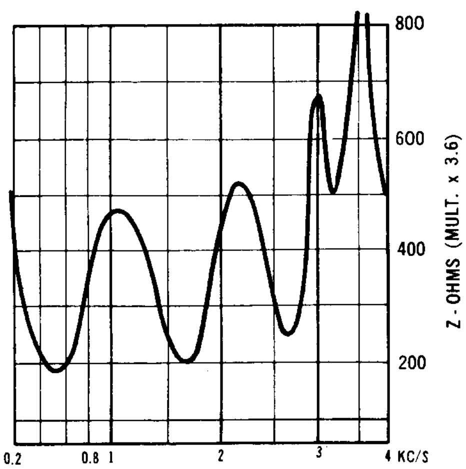
4.12 The Western Electric Company 1A Artificial Cable Kit, or equivalent, may be helpful to identify and locate irregularities when



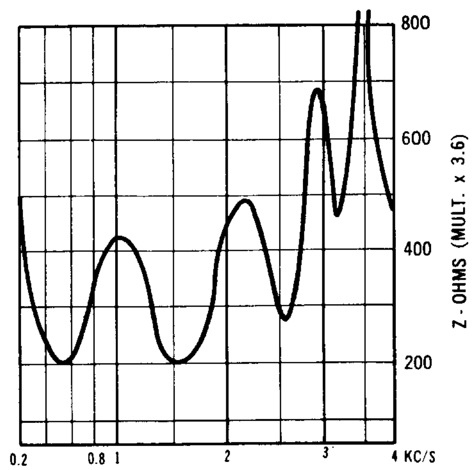
11A – 1.5KF FAR END SECTION



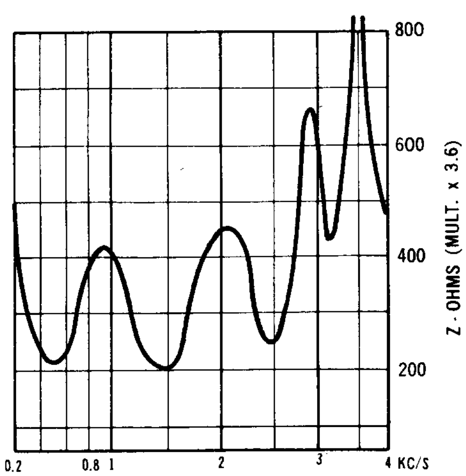
11B – 3KF FAR END SECTION



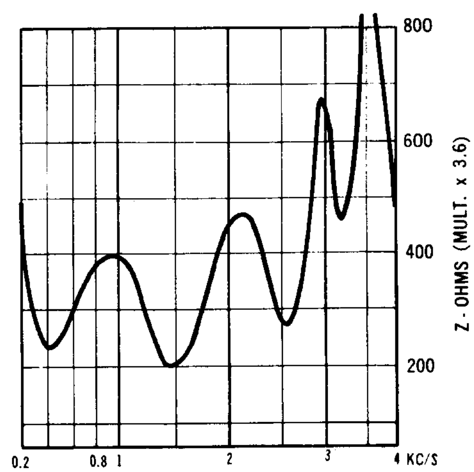
11C – 6KF FAR END SECTION



11D – 9KF FAR END SECTION

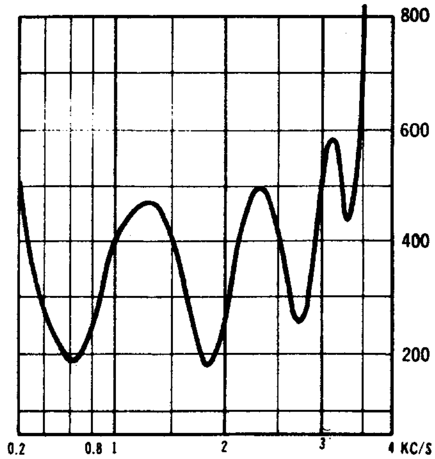


11E – 12KF FAR END SECTION

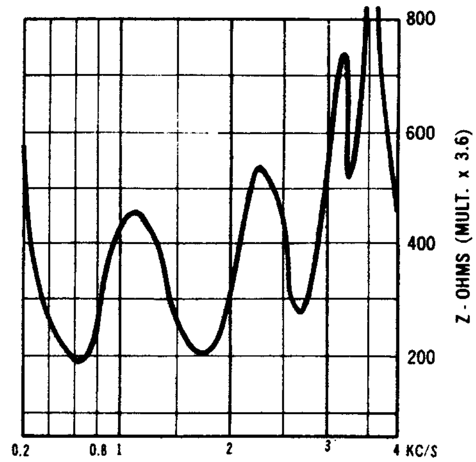


11F – 15KF FAR END SECTION

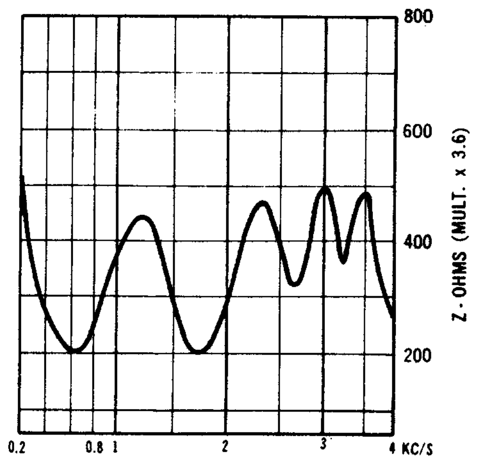
Fig. 11 – Effect of Far-End Section Length on Open-Circuit Impedance of a 22H88 Loaded Cable Pair



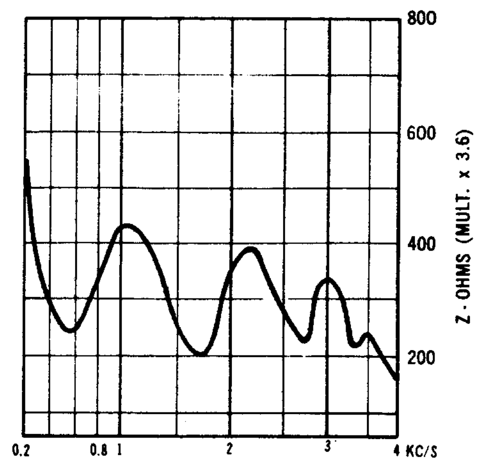
12A – 1.5KF C.O. END SECTION



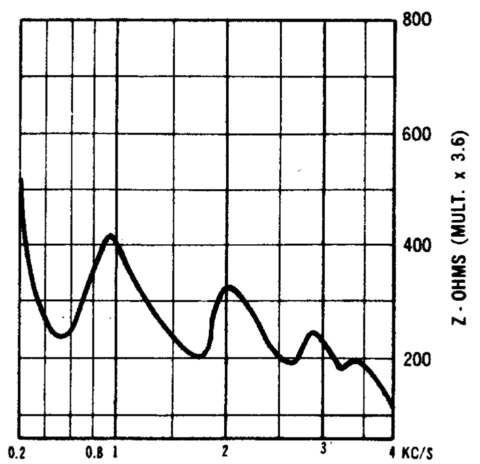
12B – 3KF C.O. END SECTION



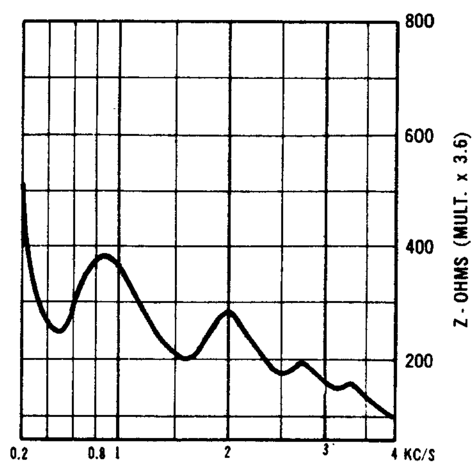
12C – 4.5KF C.O. END SECTION



12D – 6KF C.O. END SECTION



12F – 9KF C.O. END SECTION



12E – 7.5KF C.O. END SECTION

Fig. 12 – Effect of C.O. End Section Length on Open-Circuit Impedance of a 22H88 Loaded Cable Pair

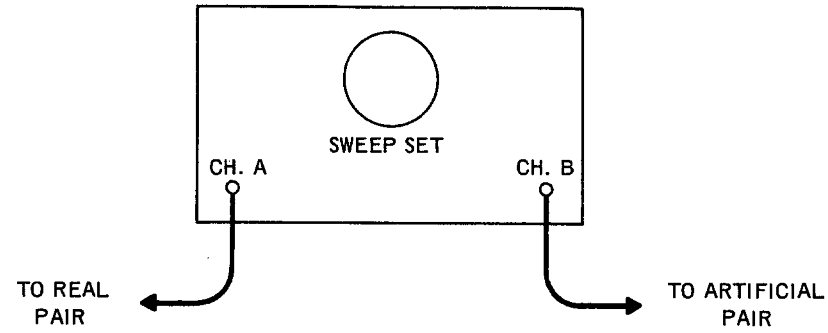


Fig. 13 – Connection of Dual Channel Sweep Set for Impedance Comparison

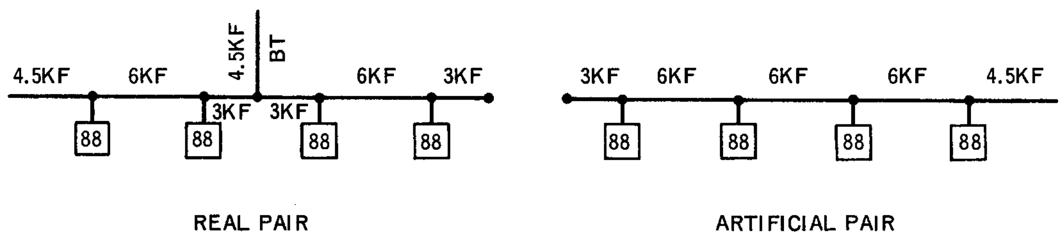


Fig. 14 – An Arrangement for an Impedance Comparison Test

inspection of the open-circuit impedance curve fails. A model of the real pair is constructed from the artificial cable kit. The impedance curve of the real pair is compared with the impedance curve of the artificial pair. Irregularities are introduced into the artificial pair until one is found which results in matching of the curves.

4.13 When the sweep set is arranged for dual channel operation, practically all transmission-affecting irregularities are easily identified. The connections may be made as shown in Fig. 13.

4.14 Fig. 14 illustrates an arrangement that might be found in actual practice. The real pair has an irregularity, and the artificial pair is constructed in accordance with the cable record. Most irregularities, such as missing or doubled loading coils, can be identified by impedance matching.

4.15 Fig. 15 shows the results of the test above. The two impedance curves have been displaced vertically for easier comparison. Inspection shows that the irregularity is not due to a missing coil, because the peaks occur at the same frequencies. The impedance curves can be made to match by introducing bridged tap in the second loading section of the artificial pair or by lengthening the section. The correct interpretation can be selected by inspection of the cable schematic or by measuring loop resistance to any terminal beyond the irregularity. Most irregularities, such as missing or doubled loading coils, can be positively identified.

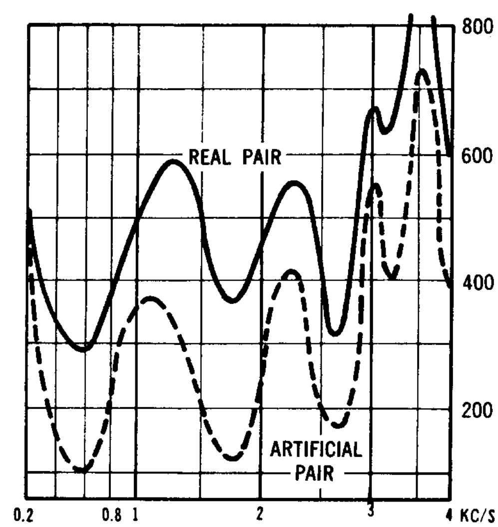


Fig. 15 – Comparison of Impedance of Irregular Pair with Impedance of Correct Artificial Pair

4.16 When a more precise location of irregularities and their magnitudes is desired, the tests of Part 5 should be used.

5. ANALYSIS OF RETURN LOSS MEASUREMENTS

5.01 Return loss measurements can be used for location of transmission irregularities. They are generally more precise than impedance measurements but may require more testing time. The troubles cannot be identified by inspection of the shape of the sweep trace.

5.02 The internal hybrid of the sweep set is used, if provided, or an external resistance hybrid may be used. A simple one suitable for the purpose is described in Section 330-450-101. The pair under test is connected as the line, and a model of the real pair is assembled from the artificial cable kit and connected as the network.

5.03 In this test arrangement, the hybrid functions like a wheatstone bridge. The real pair is compared with the artificial pair. As the artificial pair is made more like the real pair, the balance of the circuit is improved, and the apparent return loss increases.

5.04 The impedance comparisons of Part 4(C) involved impedance magnitudes only. The return loss tests require matching of both the magnitudes and phase angles of the compared pairs. Therefore, the return loss tests can be quite sensitive to small differences.

5.05 Fig. 16 shows the effect of some typical irregularities on return loss curves. Fig. 16A illustrates the effect of unsuspected bridged tap on a nonloaded cable pair. The various curves show the effect of adding various amounts of additional bridged tap to the artificial pair.

5.06 It should be noted here that, when testing nonloaded pairs, it is not possible to determine whether the pair has unknown bridged tap or is longer than the records indicate. Both situations produce about the same effect. This can be resolved by making tests with a short circuit at the known distant end terminals and by comparison with the cable schematic. When the distant end is short-circuited, the artificial pair must have a short circuit at the same location for best return loss.

5.07 Fig. 16B, C and D show some results of tests with H88 loaded cable pairs. Similar results are obtained with other loading plans.

5.08 The amount of cable plus bridged tap in the distant end section can be determined with reasonable accuracy, but the amount of each cannot be readily determined. This can be resolved by testing with a short circuit at the known distant terminals in the same manner as in 5.06.

5.09 It may be difficult to detect the presence or location of the most distant loading coil when the distant end section is less than 3 KF. The coil can be readily located when testing with a short at the distant end.

5.10 When stations are connected on short bridged tap between loading points, they are not readily detected by open-circuit tests. The fact that they are located between loading points can be readily detected when a short circuit is put on at the station location.

6. MEASUREMENT OF PAIR LENGTH

6.01 Total pair length, both loaded and nonloaded, plus bridged tap can be measured with reasonable accuracy by measuring the apparent shunt capacitance of the cable pair under open-circuit conditions. This is easily done with the accessory arrangement described in Section 330-450-102.

6.02 To measure shunt capacitance, operate the sweep set with the oscillator fixed at about 200 cps. Note the indicated impedance, then operate the CAL key on the accessory arrangement. This connects the decade capacitor to the sweep set in place of the cable pair. Adjust the decade capacitor for the setting which reproduces the open-circuit impedance measurement of the pair.

6.03 Measured shunt capacitance of nonloaded high capacitance cable pairs can be converted to pair length using the curves of Fig. 17. For loaded high capacitance cable pairs, use Fig. 18. If older low capacitance cables are en-

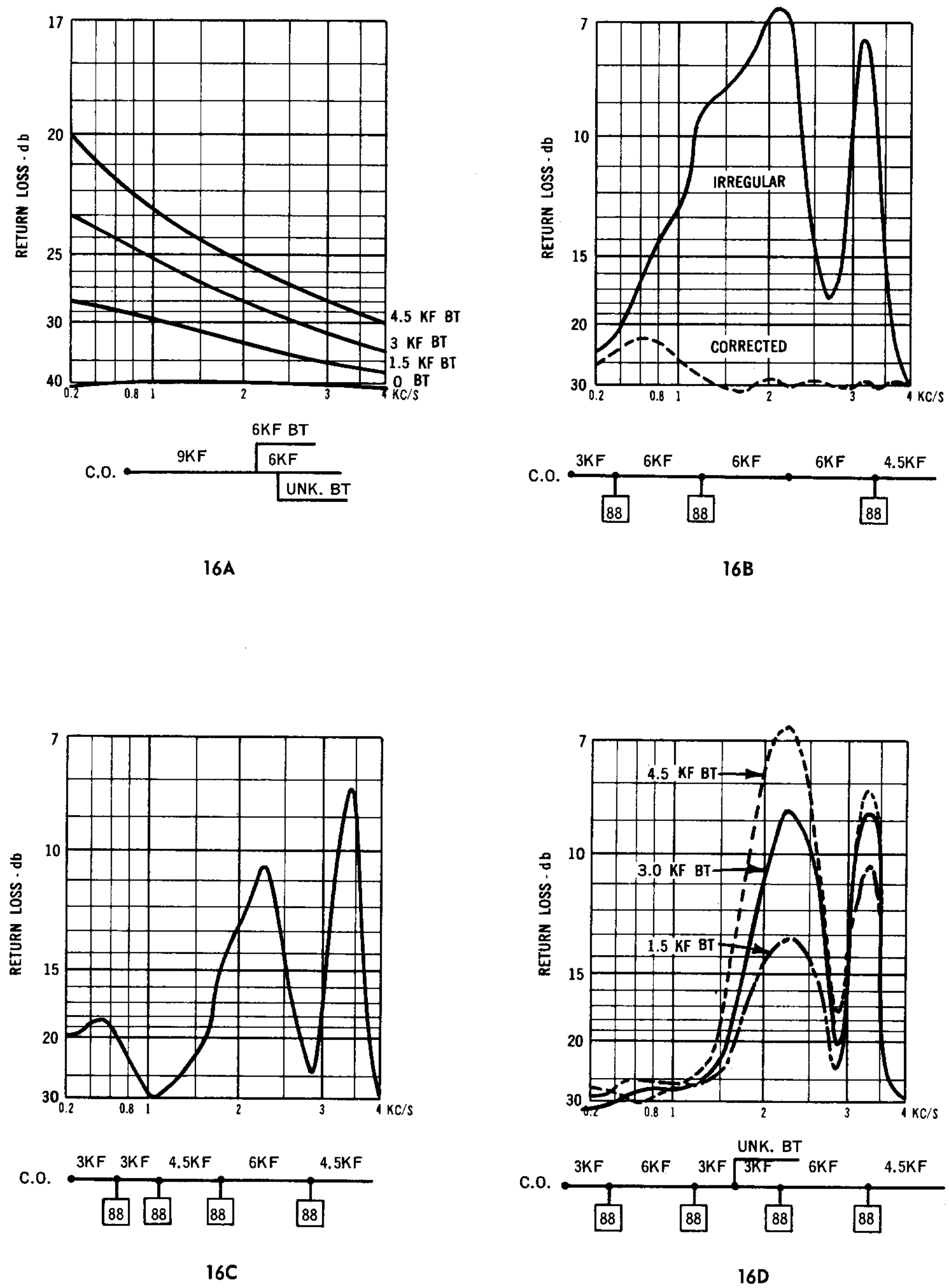


Fig. 16 – Effect on Return Loss Curves of Some Transmission Irregularities

countered, Fig. 17 and 18 are not applicable, and the return loss technique should be used. At some test locations, it may be necessary to subtract the office wiring. This can be determined as described in Part 7.

6.04 Tests of H88 loaded cable pairs can be used to estimate the amount of cable plus bridged tap in the distant end section, if the open-circuit impedance curves are normal. Fig. 19 may be used for this purpose. It is applicable only for high capacitance cable and only for H88 loading. Other arrangements do not produce one peak in the impedance curve for each loading coil.

6.05 Pair length can be simulated by constructing a model from the artificial cable kit which best matches the real pair on return loss tests. This method gives the greatest accuracy in

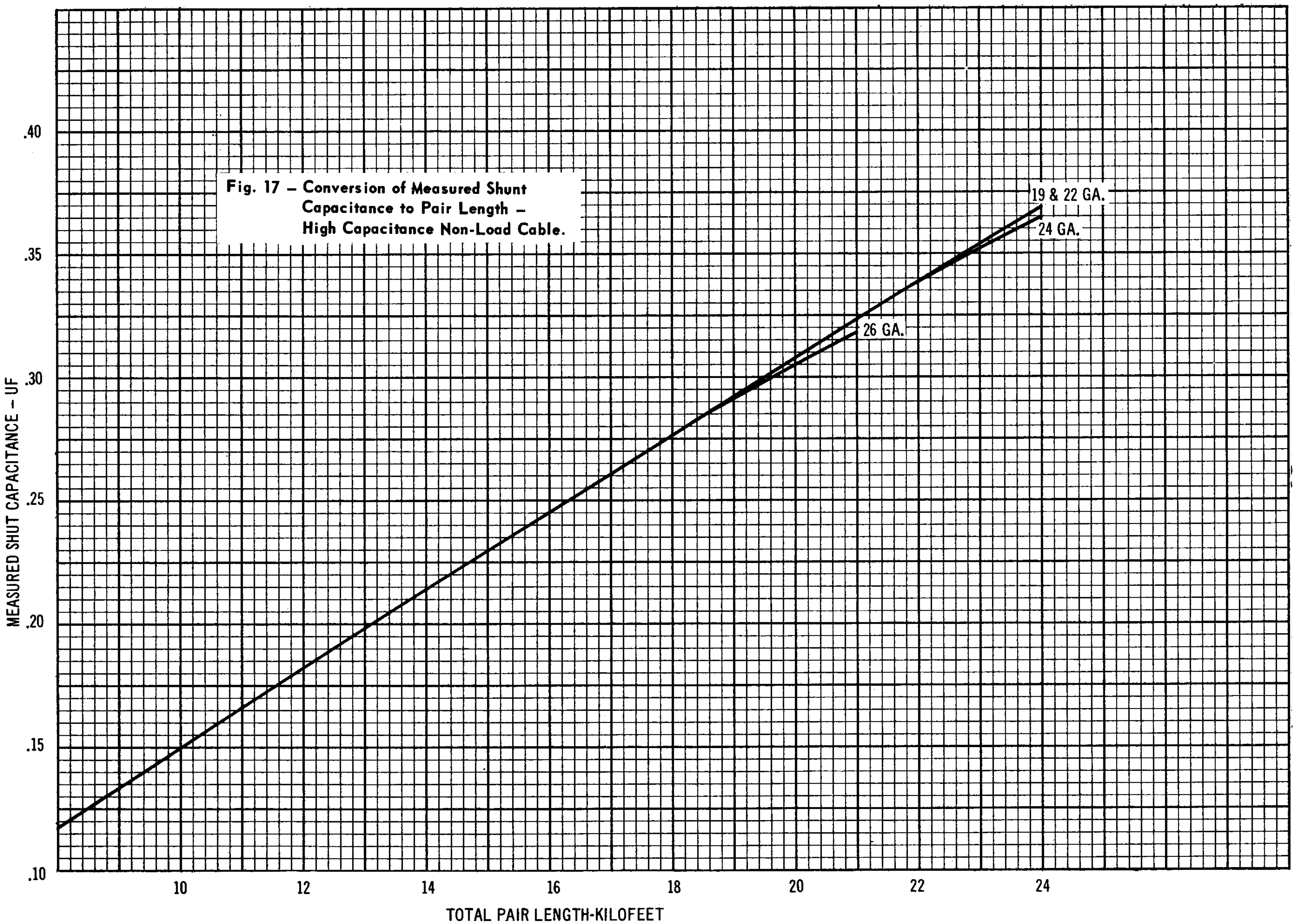


Fig. 17 – Conversion of Measured Shunt Capacitance to Pair Length – High Capacitance Non-Load Cable.

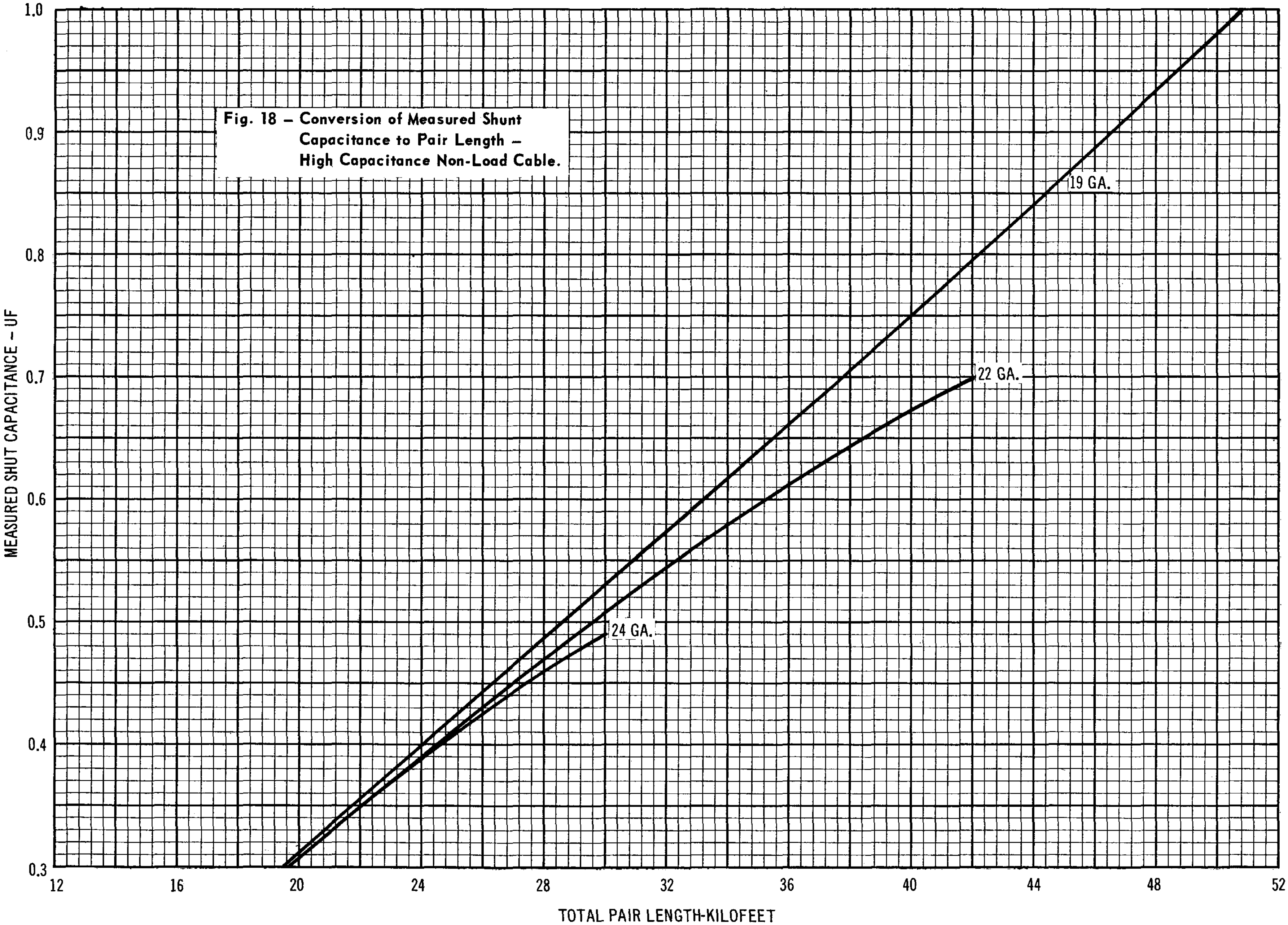


Fig. 18 – Conversion of Measured Shunt Capacitance to Pair Length – High Capacitance Non-Load Cable.

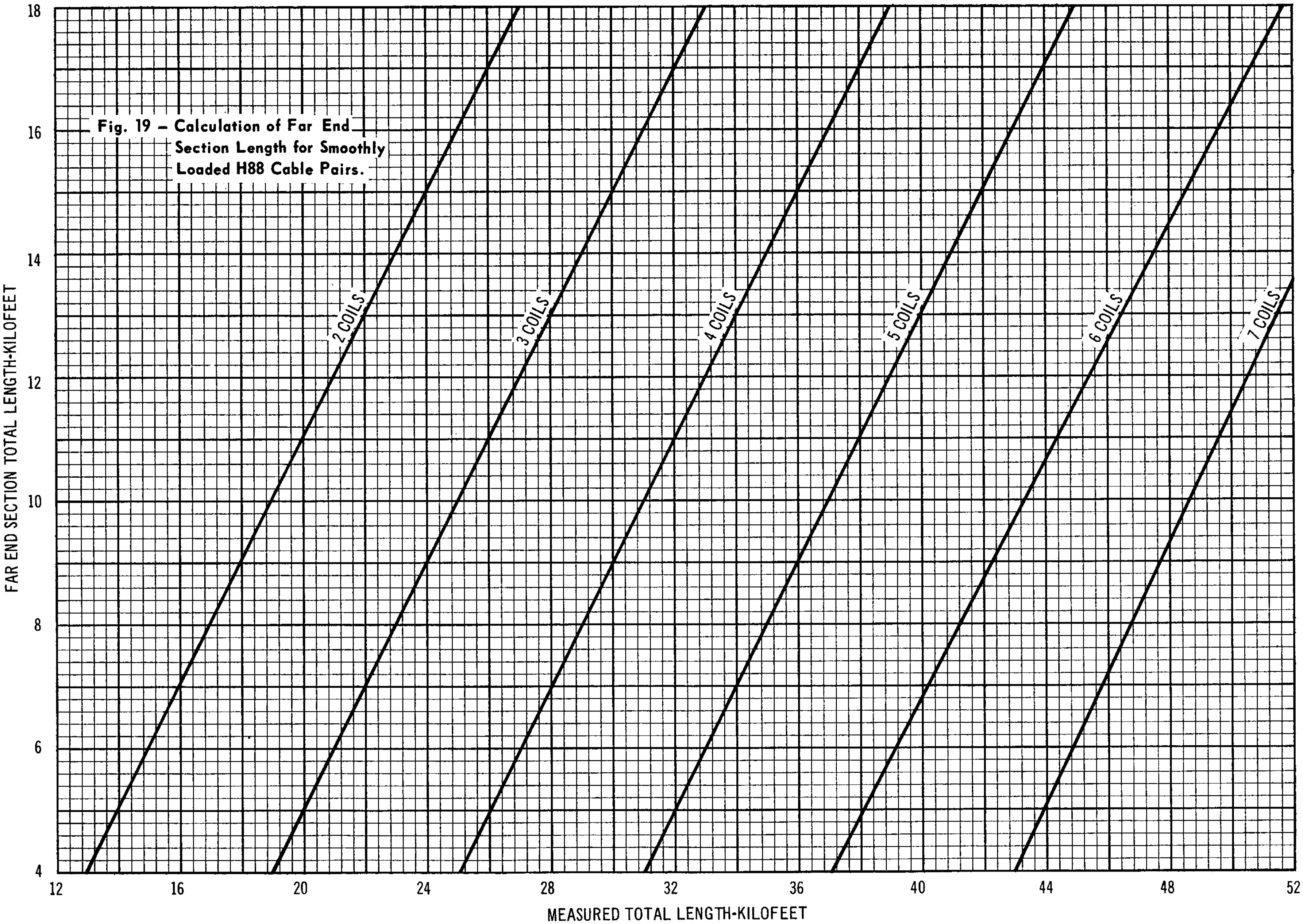


Fig. 19 – Calculation of Far End Section Length for Smoothly Loaded H88 Cable Pairs.

checking far end sections of loaded cable pairs. It may also be used to check improper spacing of loading coils and bridged tap between coils.

6.06 Bridged tap between loading coils has the same effect as an excessively long loading section. The difference between the two irregularities can generally be detected by comparison of the results with the cable schematic.

6.07 Return loss measurements and comparisons are convenient for determining the length of very short cable lengths. The open-circuit impedance may be too high for convenient impedance measurement.

7. EFFECT OF OFFICE WIRING

7.01 When trouble location tests are made at points in the office other than the main distributing frame, it is desirable to know if the office wiring is sufficient to affect measurements. Excessive office wiring may occur due to cross-connection of the test circuit through an intermediate distributing frame, multiplying test positions through an intermediate distributing frame, the presence of unknown jumpers at the main frame and Central Office bridges.

7.02 The average length of office wiring can be determined by seizing pairs for testing at scattered locations at the main frame and removing the heat coils. The office wiring length is then measured by the procedures described in Part 6. The average length of office wiring should be used to adjust pair length measurements if it exceeds about 500 feet.

7.03 If the average office wiring is substantially greater, it is desirable to locate and eliminate the cause of the excess wire or to test at a different location, such as the main frame.

7.04 If tests are made at a test desk and the Central Office end of a loaded cable pair appears to be too long, the pair can be retested over a direct MDF trunk of known length. This may reveal unknown jumpers or Central Office bridges.

7.05 When tests are made at the main frame, it may be desirable to make tests with and without the heat coils in place. This will also reveal the presence of unknown jumpers or Central Office bridges. A DC blocking capacitor is necessary in the test set.

8. NOISE INDICATIONS

8.01 Noise will sometimes be indicated by widening of the sweep trace. The noise signal level necessary to produce this condition is well above normal noise levels, but the noise may be at a frequency which will not affect transmission. Noise measurements should be made only with the 3A Noise Measuring Set equipped with a C-497A network. The cable pair can be easily transferred to a 3A NMS for noise measurement, if desired, by operating the NMS key on the accessory station arrangement.

8.02 Noise displays may be due to faults or unbalanced conditions in the cable pair. These conditions may be detected as discussed in Part 3.

8.03 If no faults are found as discussed above, the noise display may be caused by 60 cps voltage induced on the cable pair. This may be verified by making noise measurements with the 3A NMS, first with C MSG weighting and then with 3 KC FLAT weighting. If the flat weighted noise is 15 db or more higher than the C MSG weighted noise, the display is probably due to 60 cps voltage. The message weighted noise reading should be used to decide whether the noise level will affect service.

8.04 Widening of the trace due to 60 cps longitudinal voltages can be remedied by connecting a repeating coil in the line at the sweep test set. Other tests should be made to determine the source of the 60 cps voltage.

ANALYSIS OF OPEN-CIRCUIT IMPEDANCE CURVES WITH VOICE-FREQUENCY SWEEP TEST SETS H88 LOADING PLAN

1. This appendix illustrates some of the open-circuit impedance curves found during analysis of troubles in subscriber cable pairs equipped with 88 mh loading coils and using H spacing. The curves are typical of the types obtained with a voice-frequency sweep set covering the frequency range 200-4000 cps. The impedances shown are absolute magnitudes. The phase angles are unknown.

2. There are many arrangements of cable pairs not shown here which represent irregularities. Some of the illustrations do not represent irregularities. For example, a pair equipped with only two loading coils may be serving a PBX. The examples are chosen to aid in field analysis and suggest some types of troubles that should be checked.

3. All illustrations involve 22- or 24-gauge high capacitance cable. Since the wire resistance has little effect on open-circuit impedance, other gauges of high capacitance cable will produce substantially the same results.

4. Caution should be used if low capacitance cable is encountered. A loading section composed of low capacitance cable will appear to be somewhat shorter than a section of high capacitance cable of the same physical length.

5. The figures are grouped on the basis of the number of peaks in the impedance curve. The groups are:

Number of Peaks	Figures
1	1-5
2	6-16
3	17-32
4	33-55
5	56-78
6	79-91
7	92-93

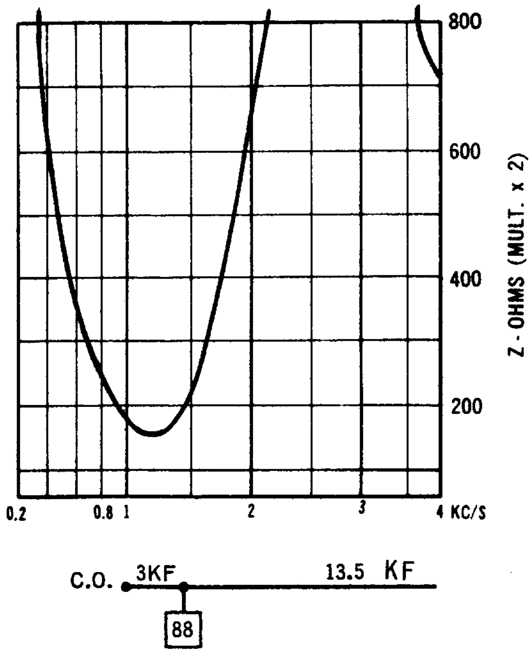


Fig. 1

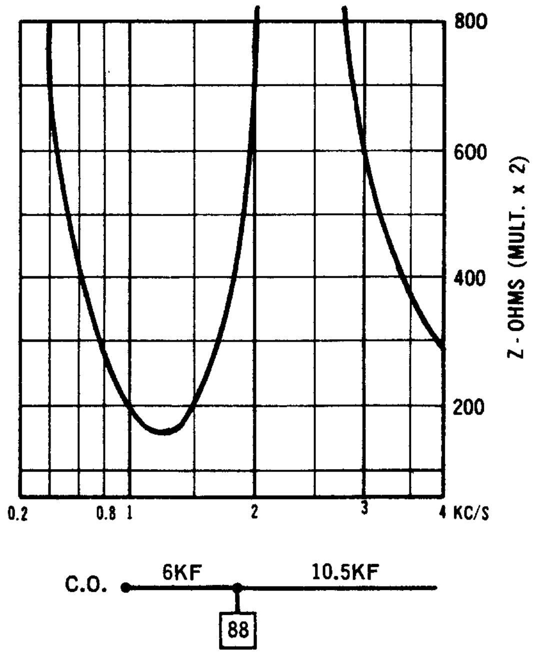


Fig. 2

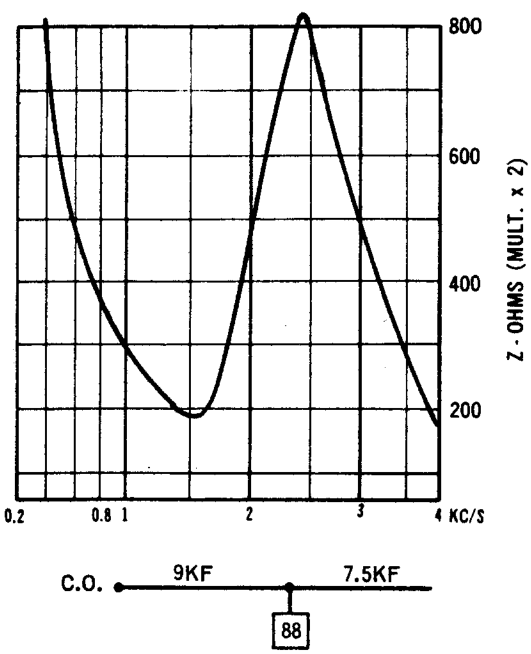


Fig. 3

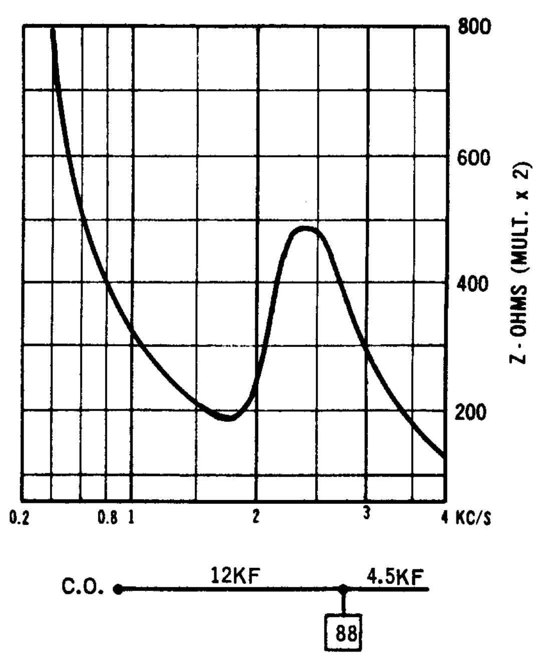


Fig. 4

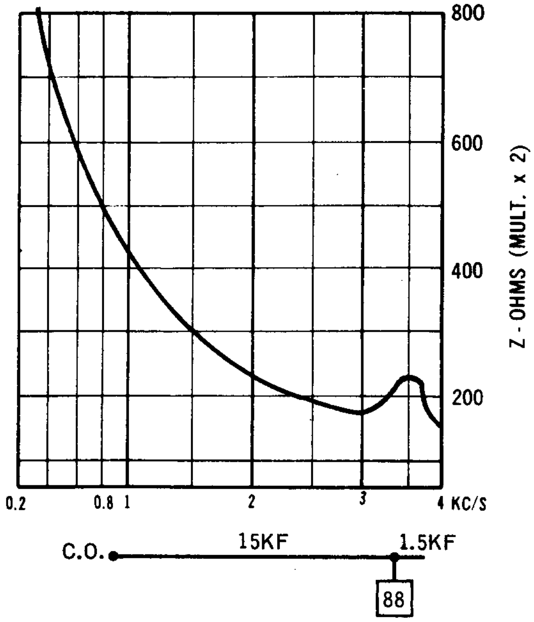


Fig. 5

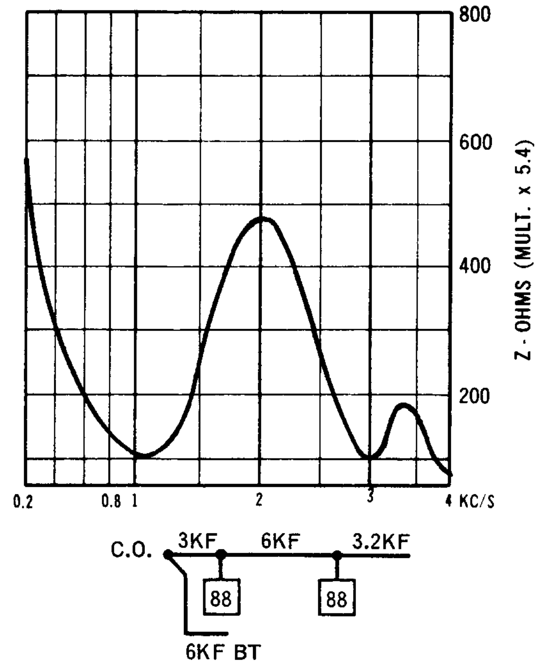


Fig. 6

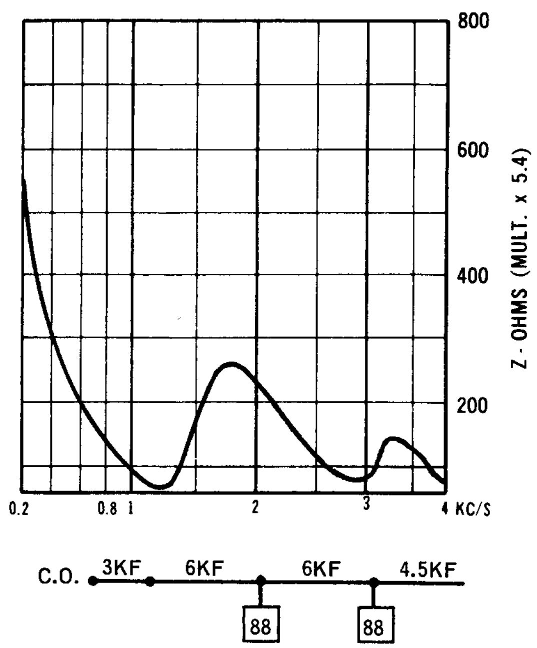


Fig. 7

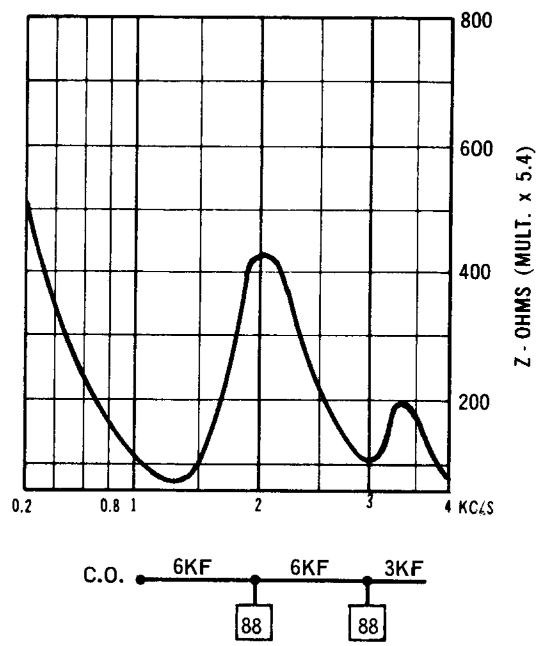


Fig. 8

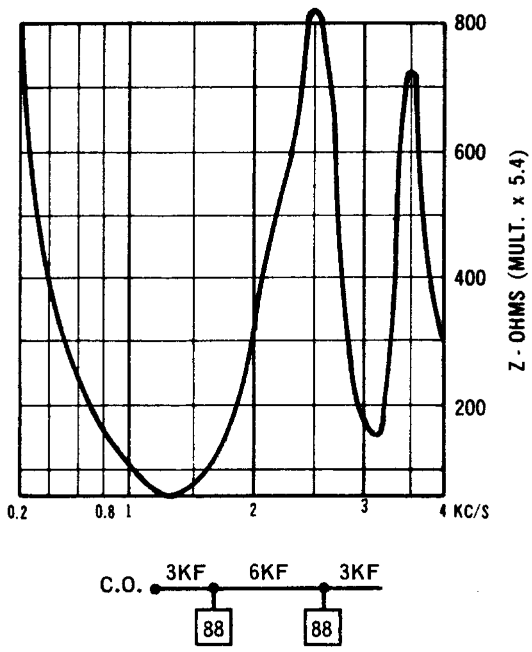


Fig. 9

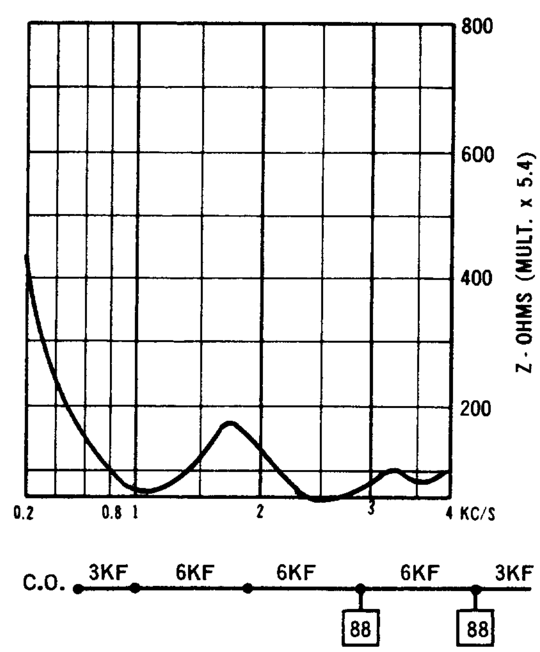


Fig. 10

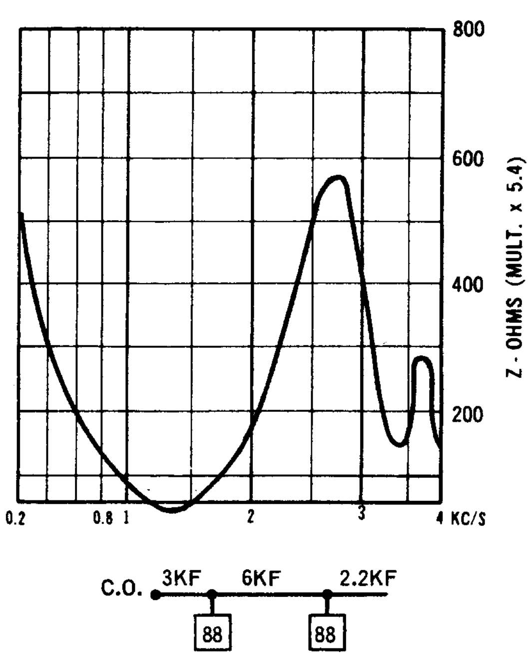


Fig. 11

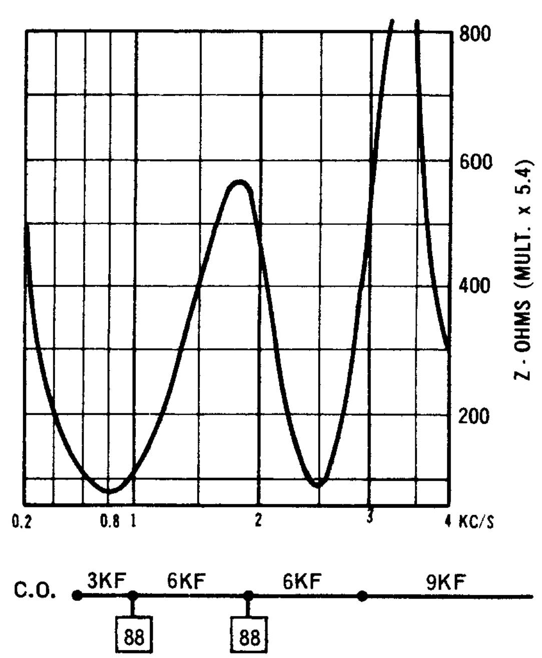


Fig. 12

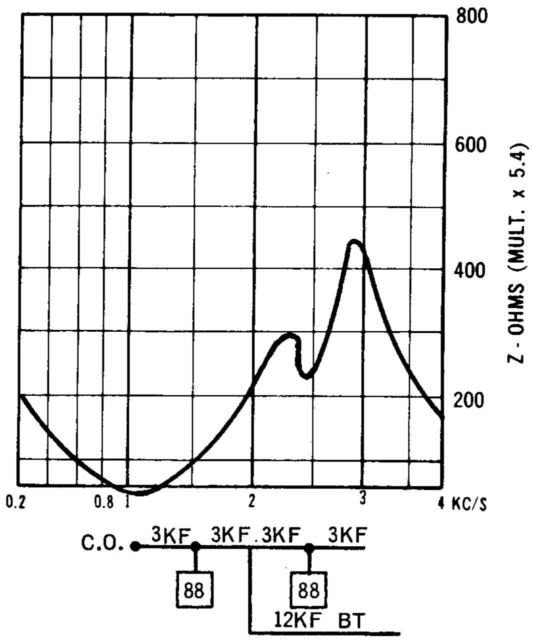


Fig. 13

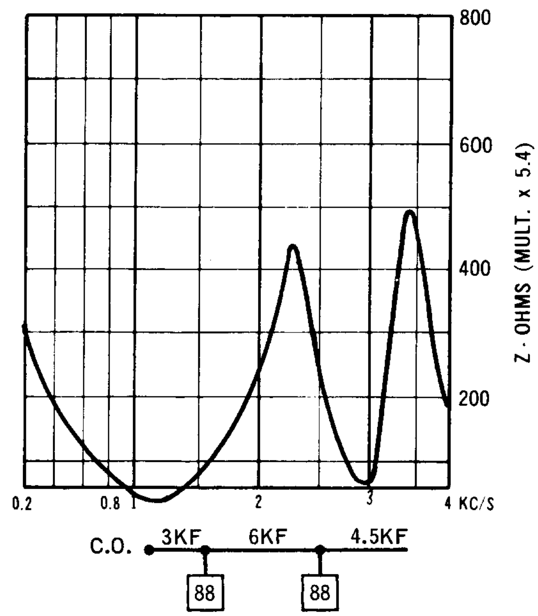


Fig. 14

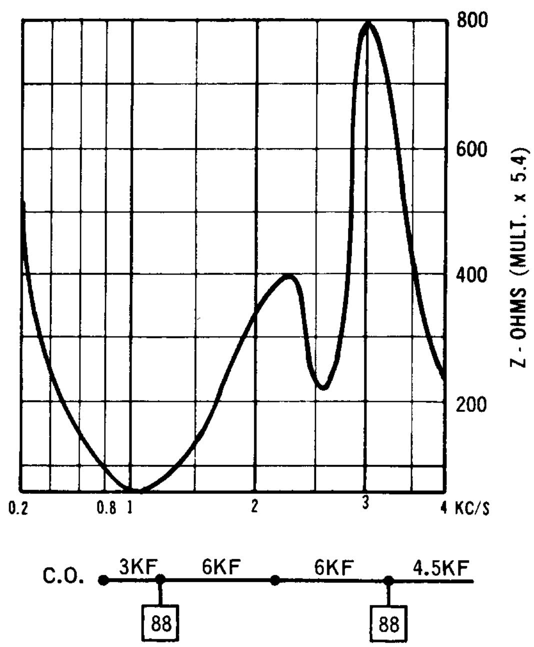


Fig. 15

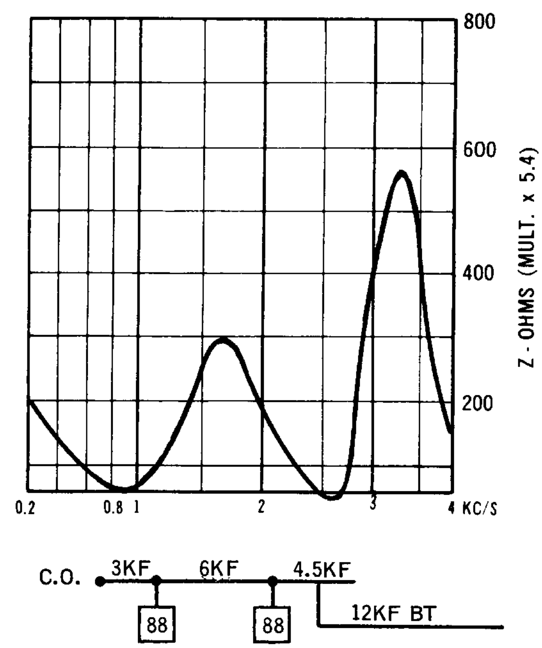


Fig. 16

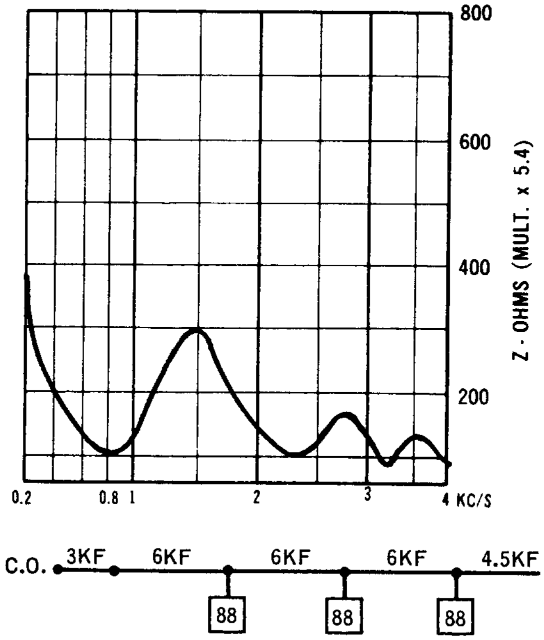


Fig. 17

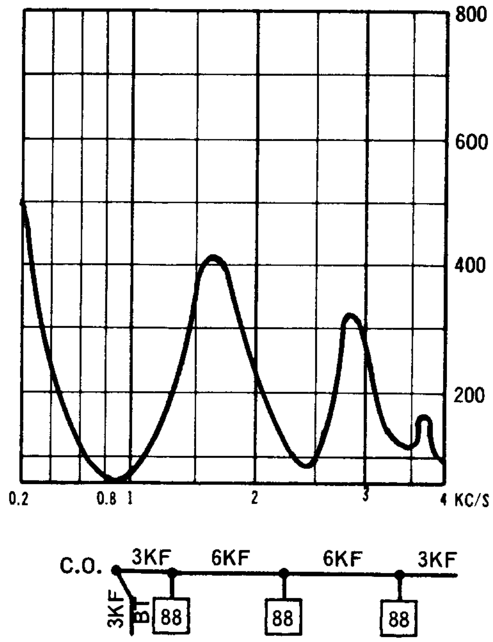


Fig. 18

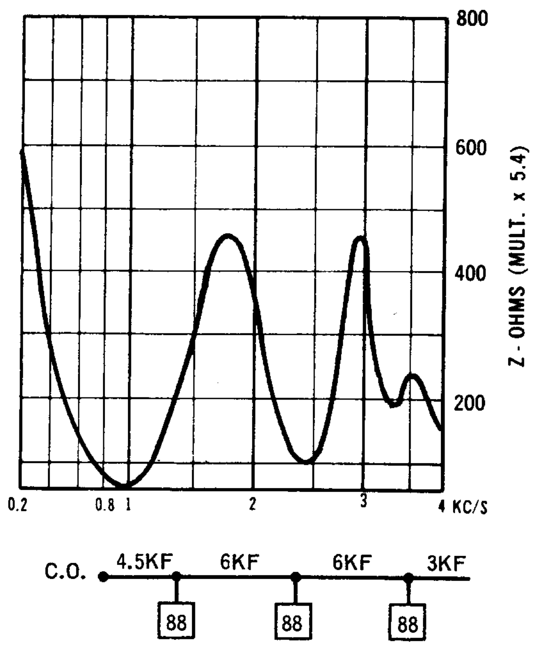


Fig. 19

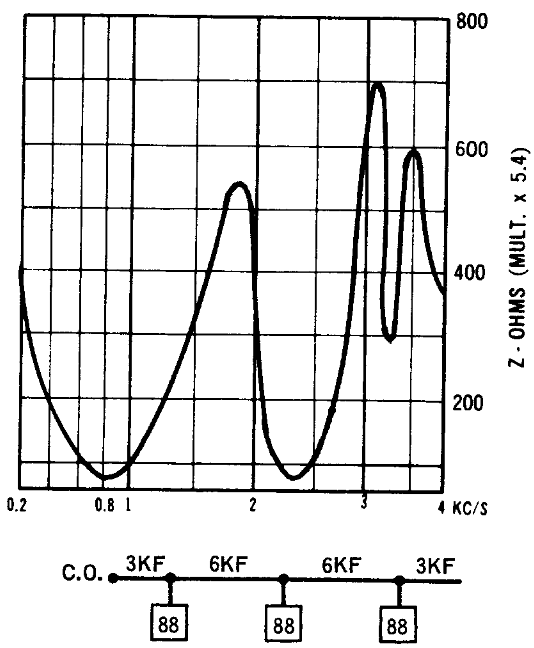


Fig. 20

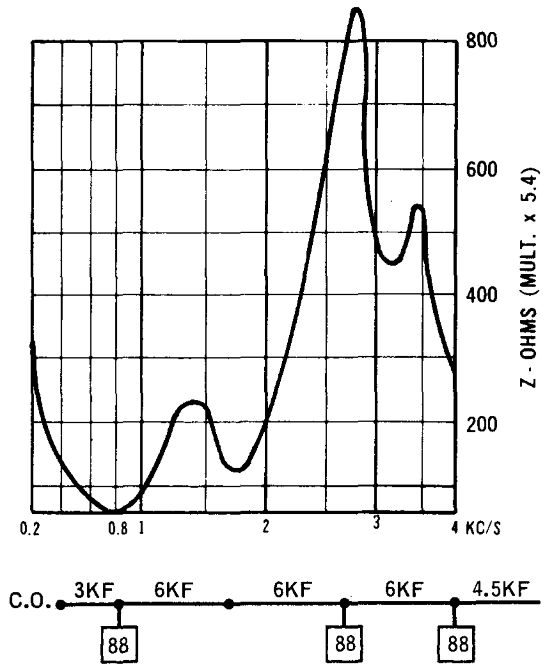


Fig. 21

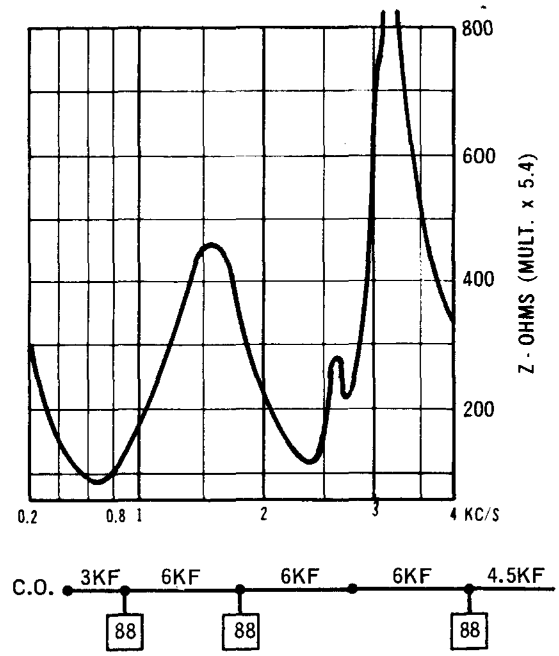


Fig. 22

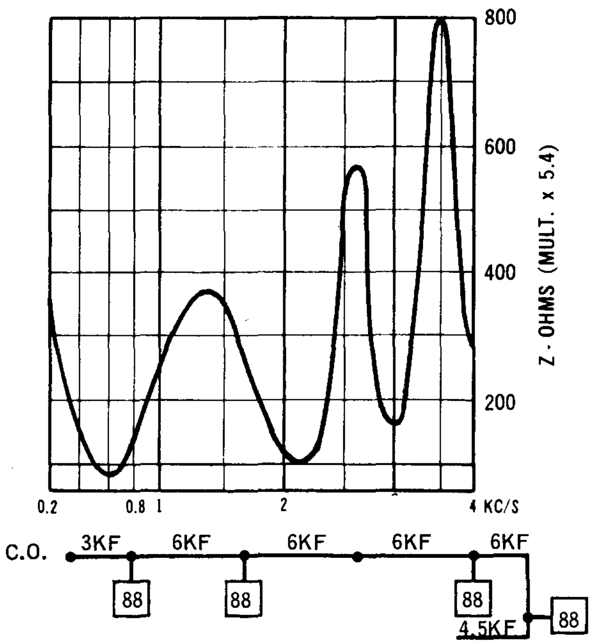
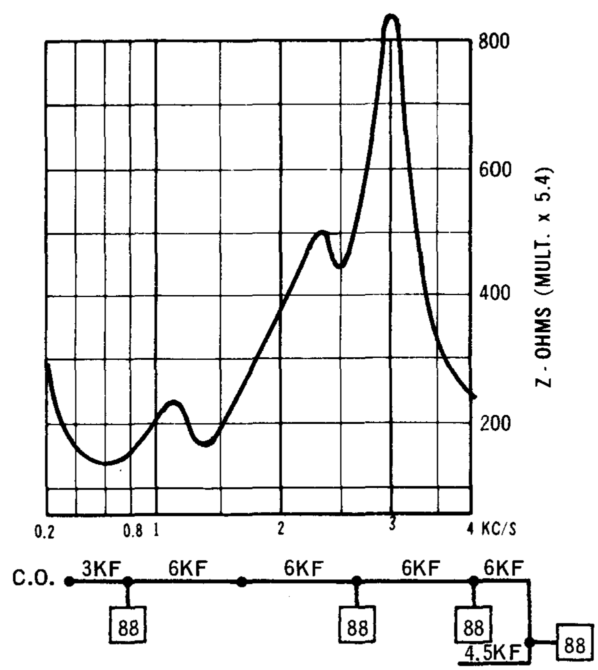


Fig. 23



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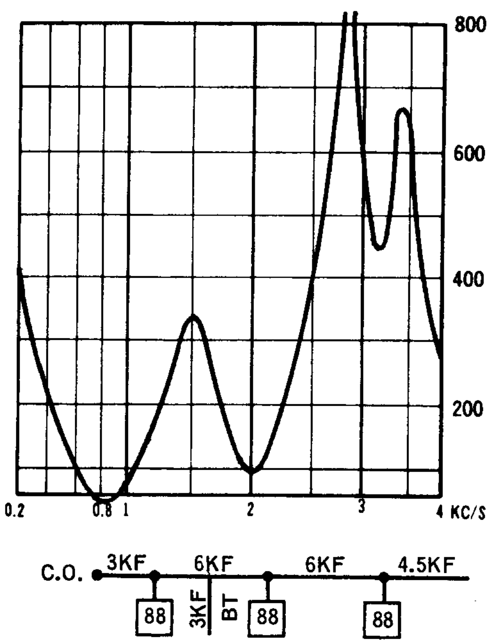

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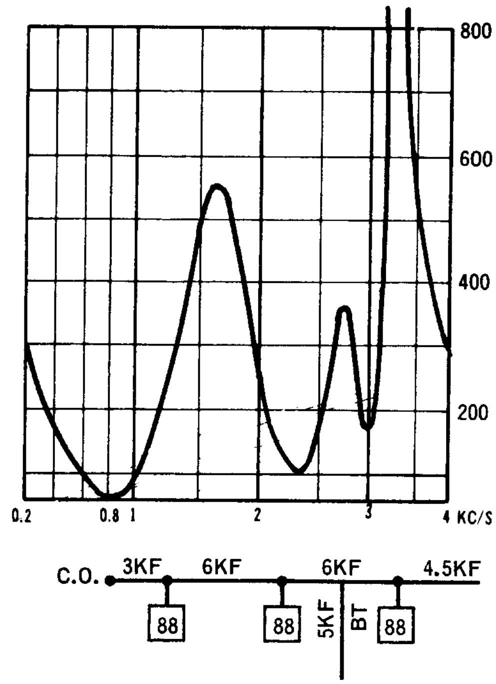

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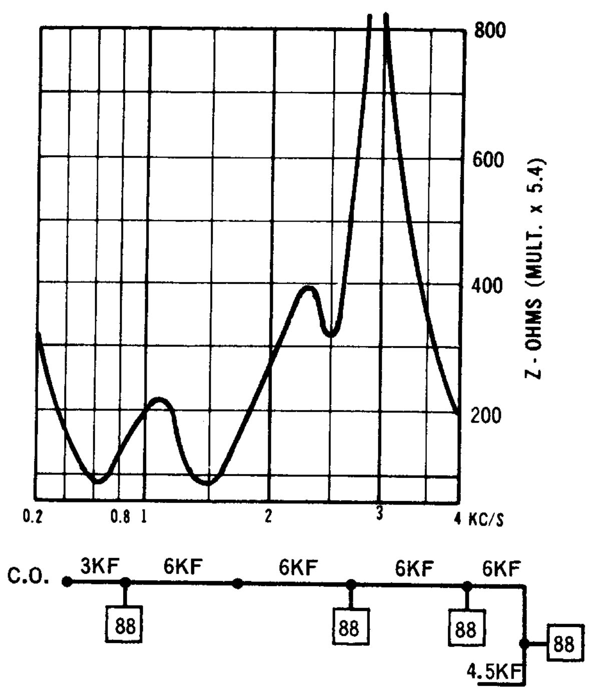
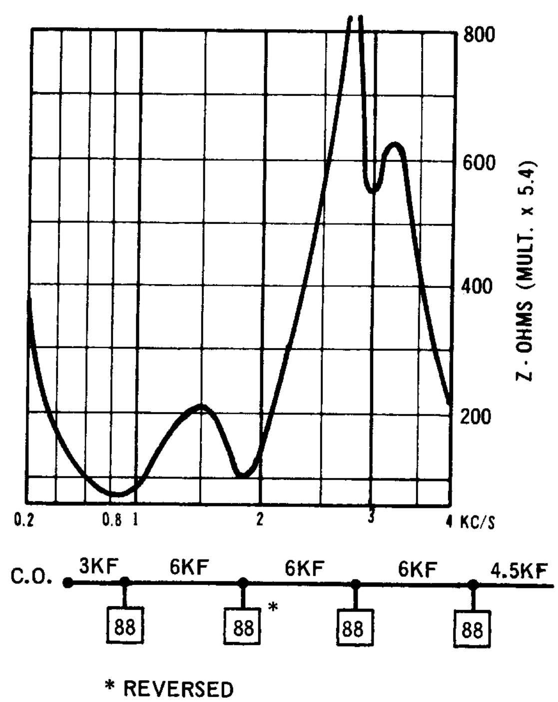


Fig. 27



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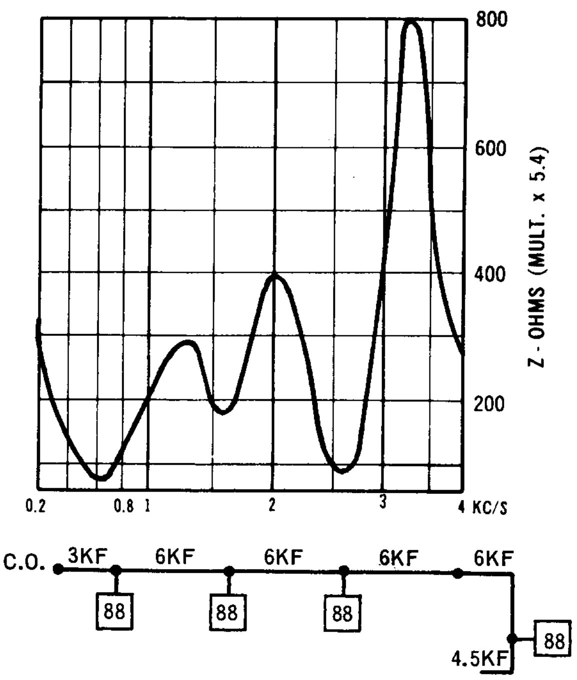

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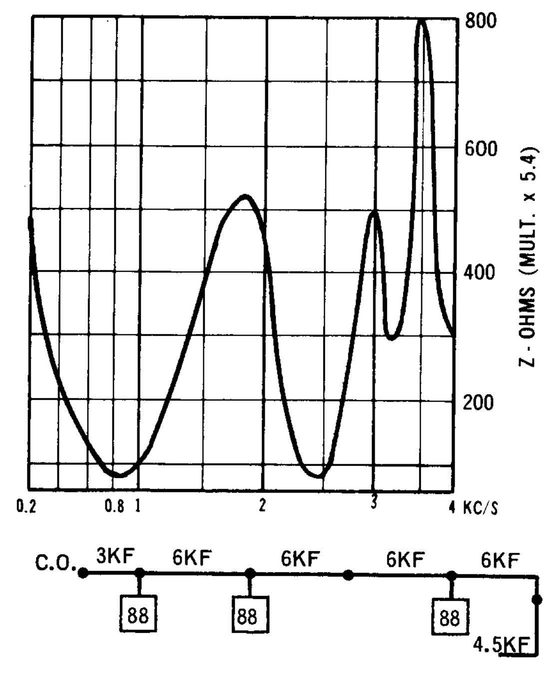

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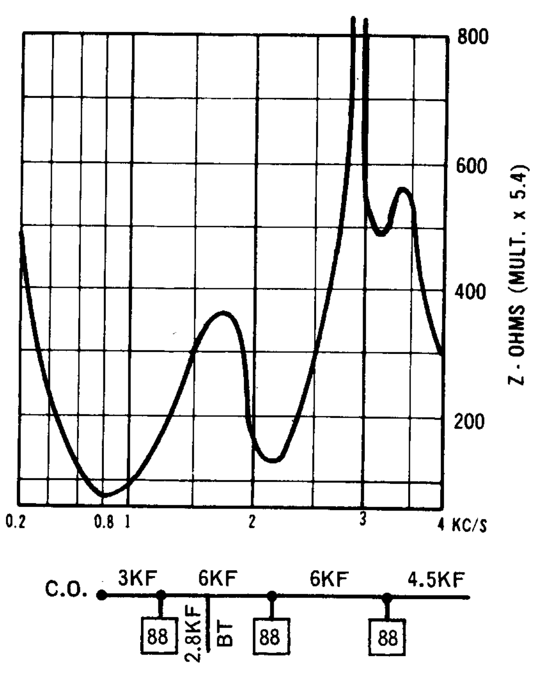
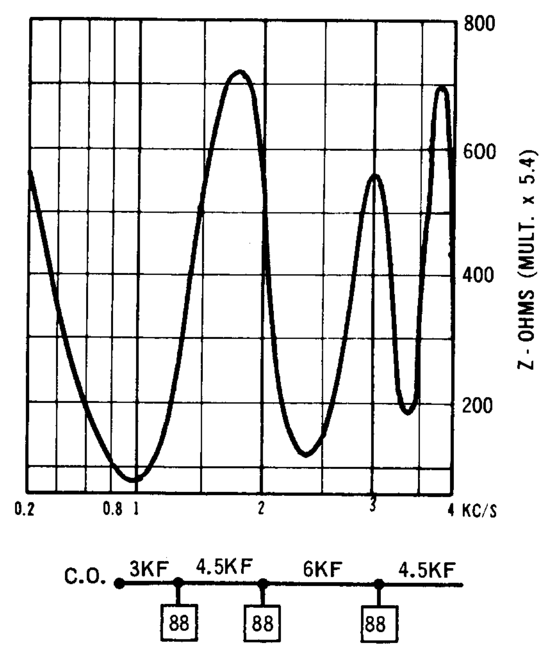


Fig. 31



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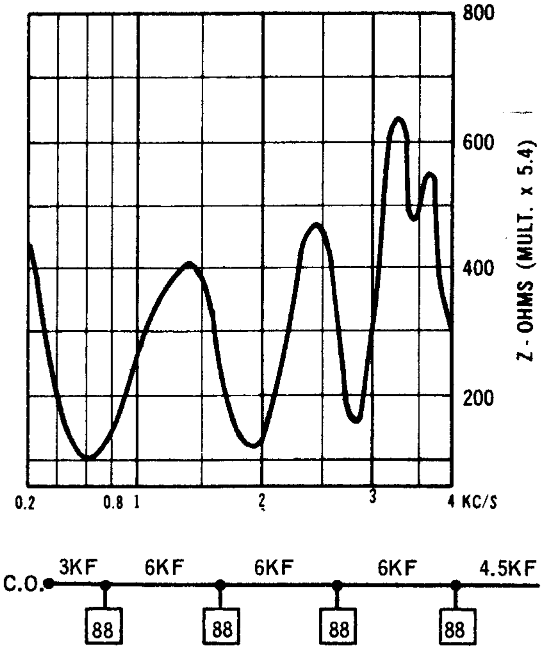

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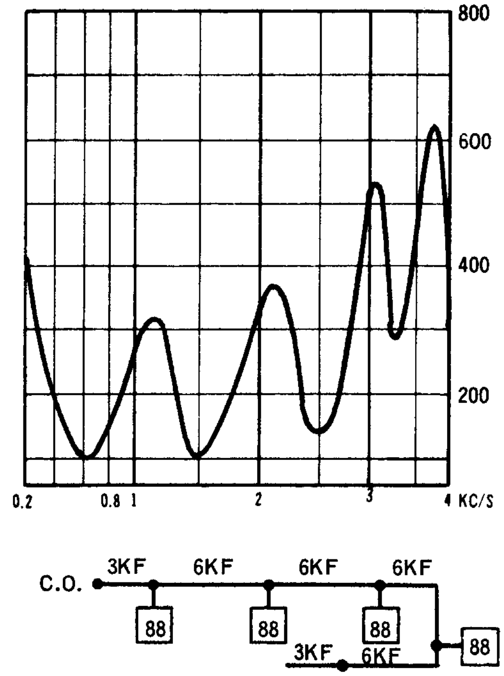

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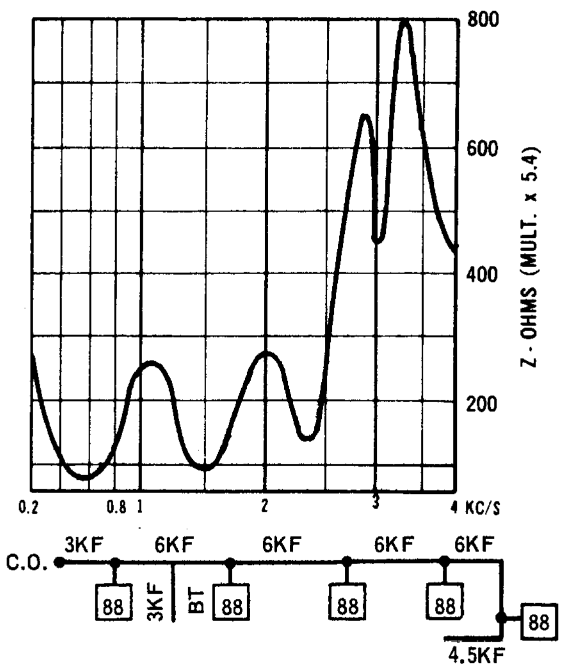


Fig. 35

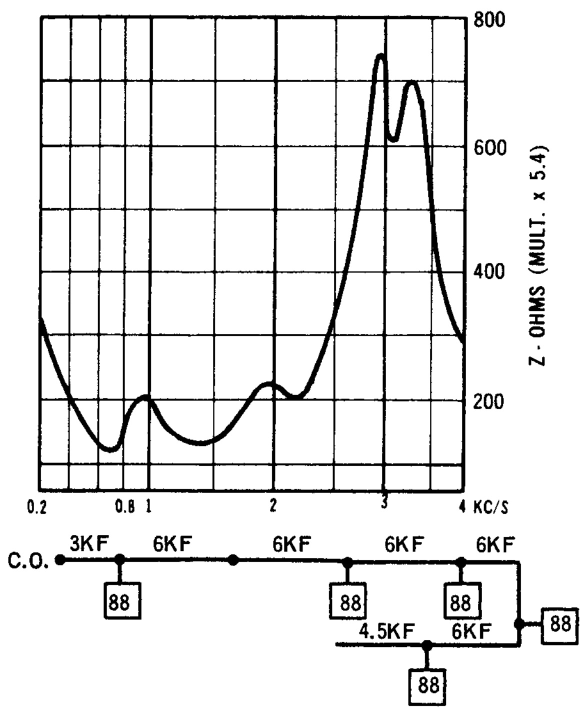


Fig. 36

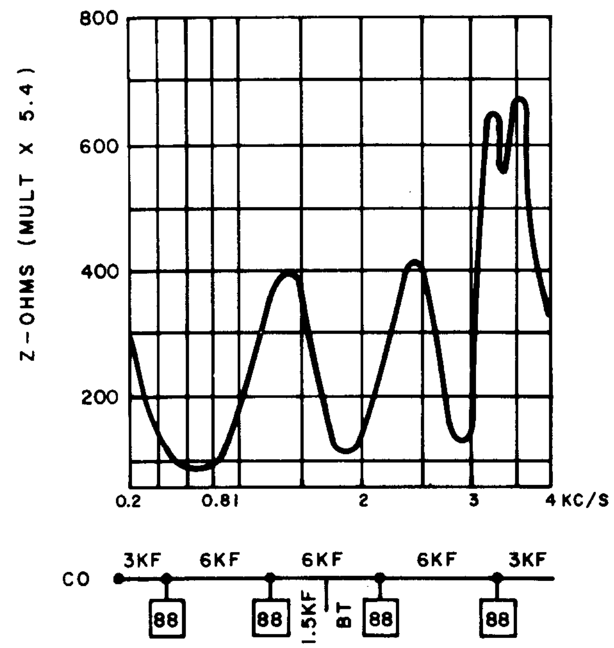


Fig. 37

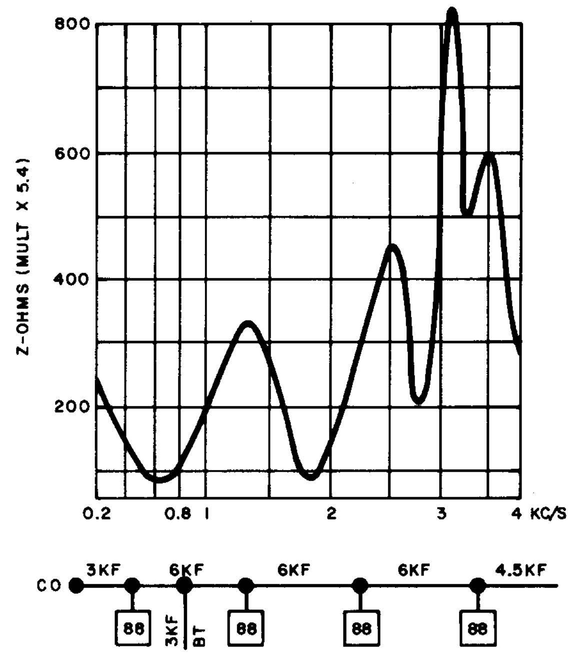
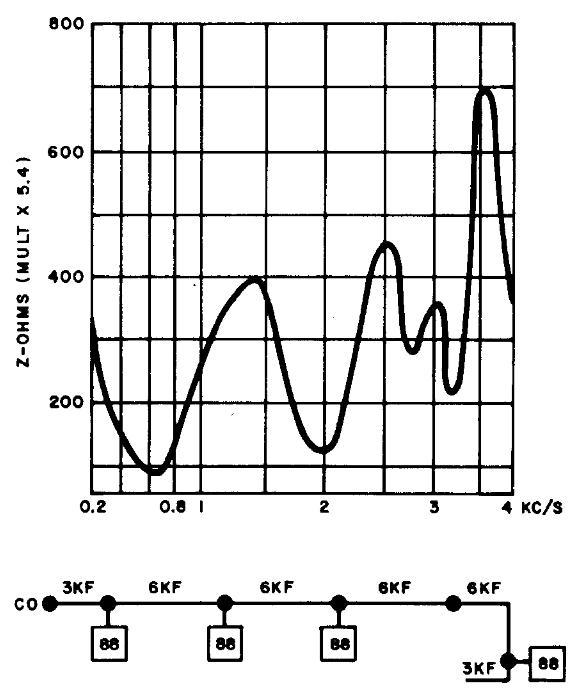


Fig. 38



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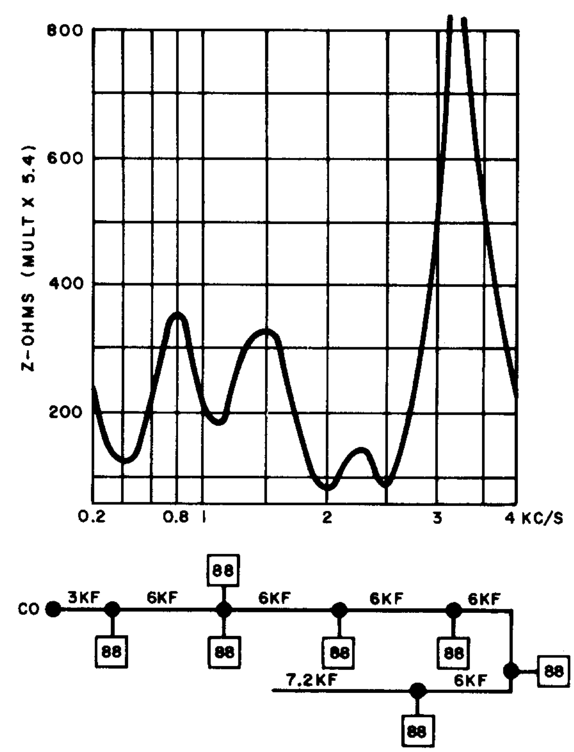
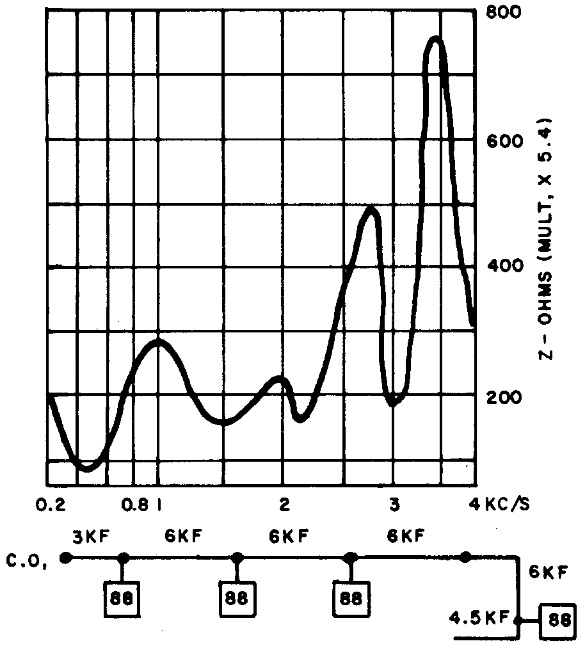


Fig. 40



◆Fig. 41◆

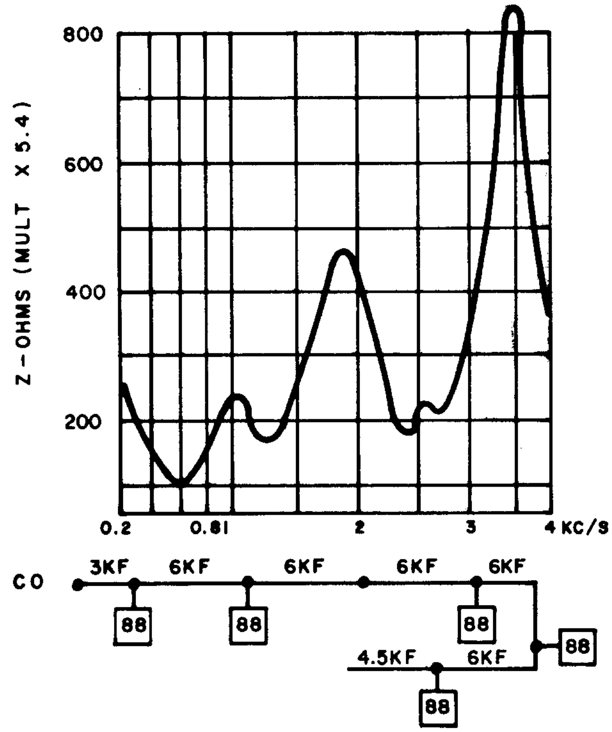


Fig. 42

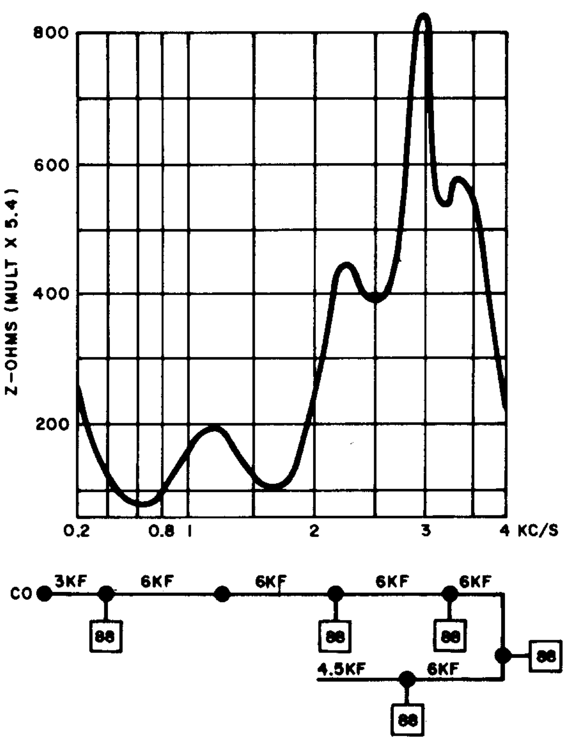
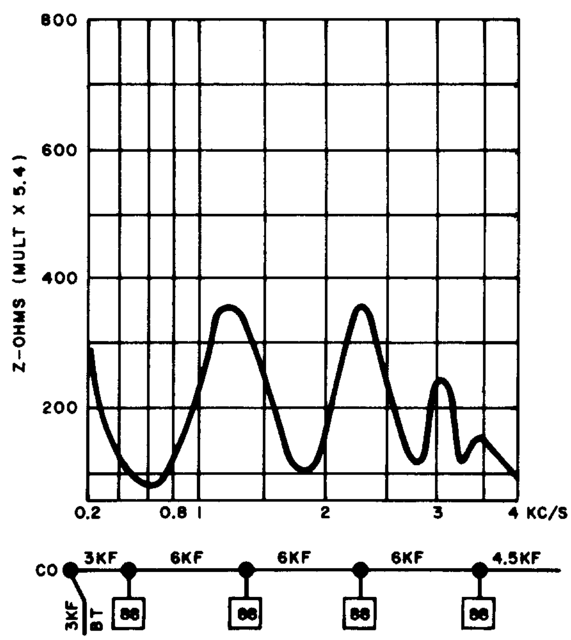


Fig. 43



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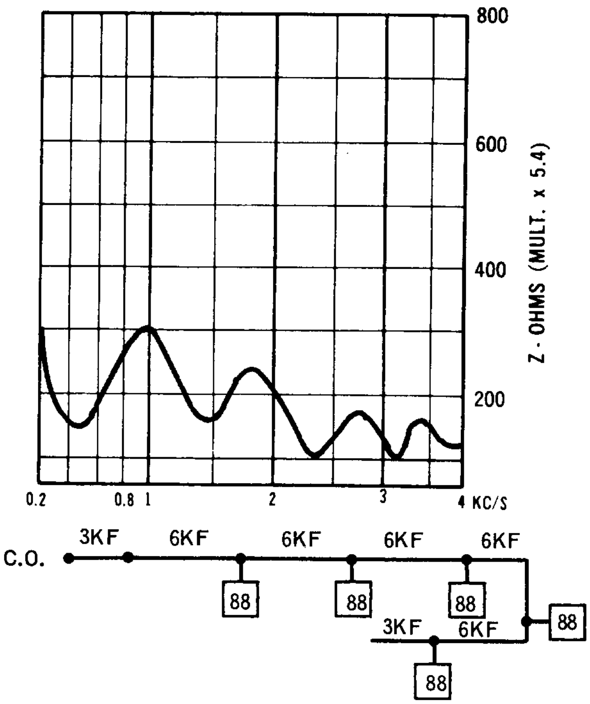


Fig. 45

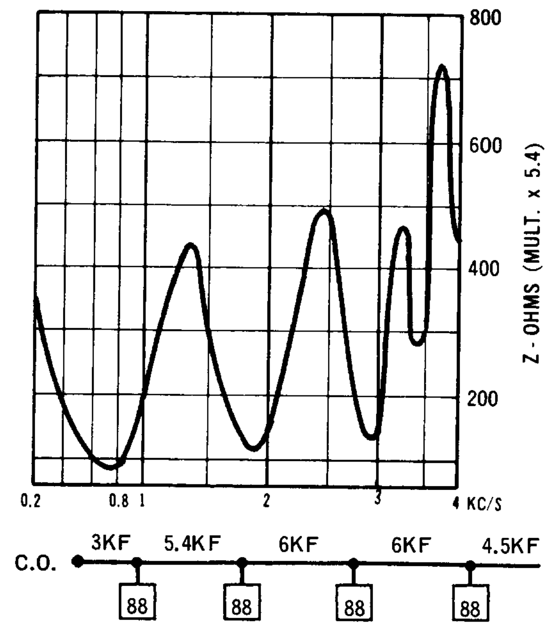


Fig. 46

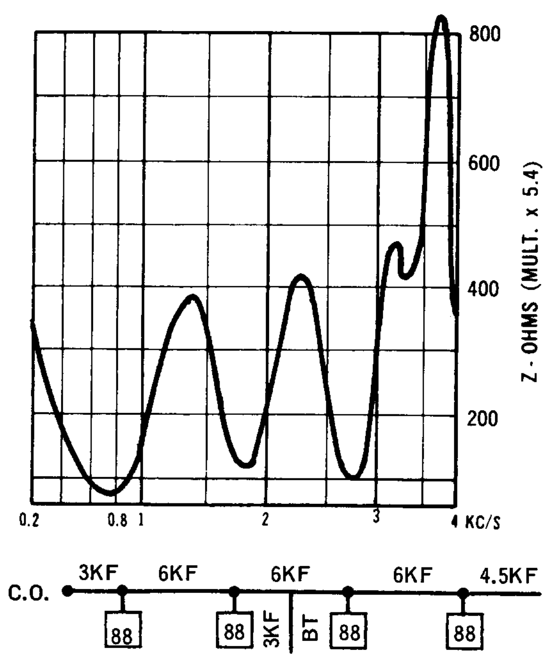


Fig. 47

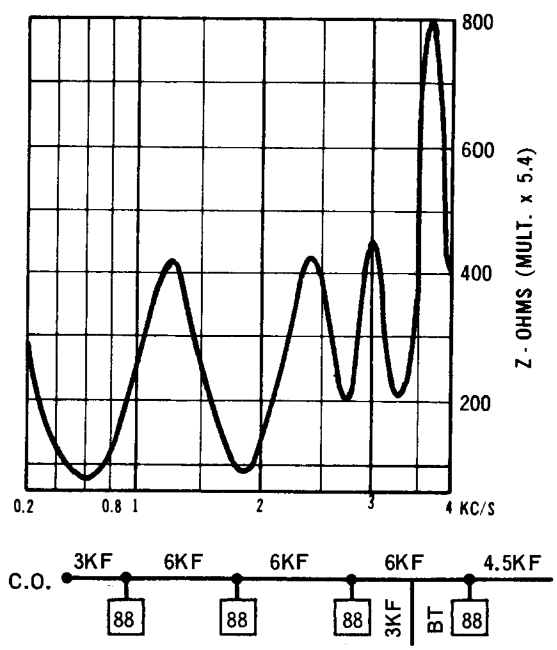


Fig. 48

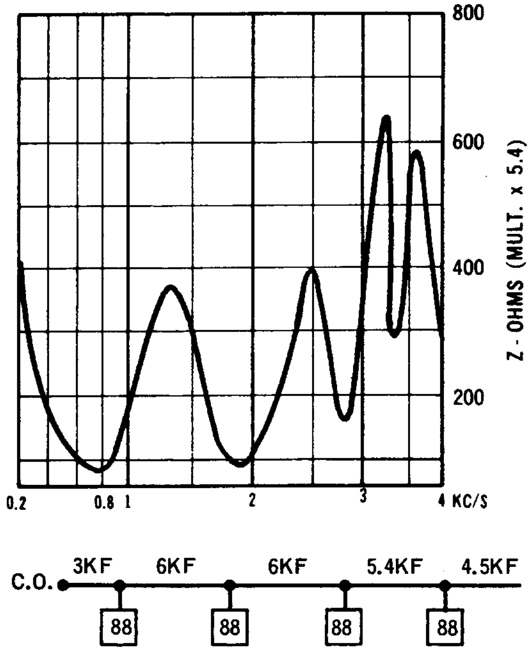


Fig. 49

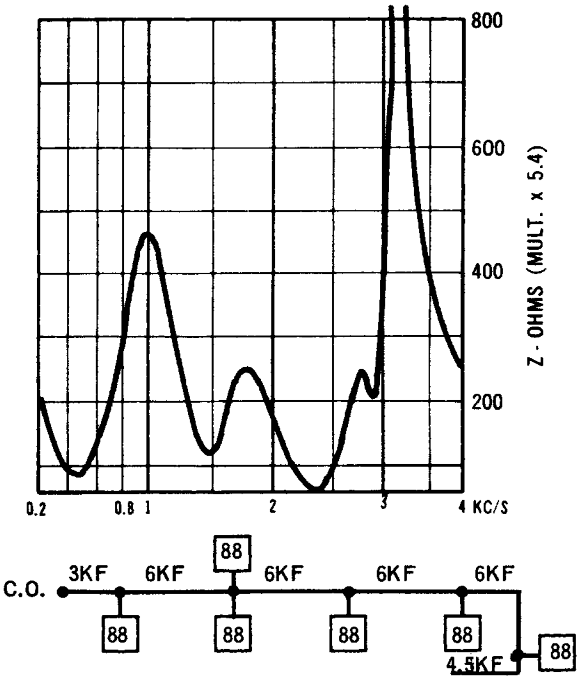


Fig. 50

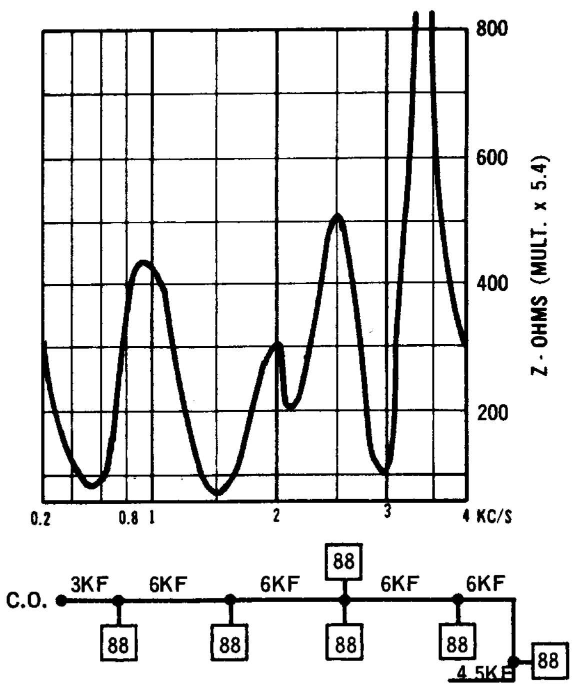


Fig. 51

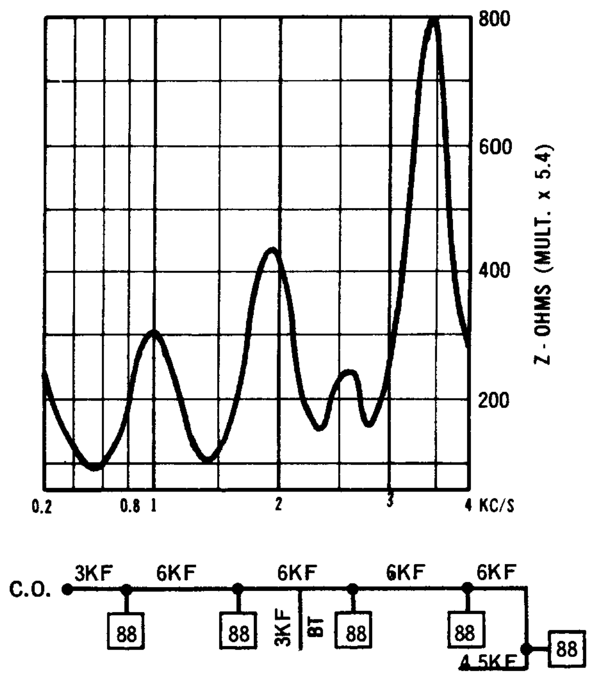


Fig. 52

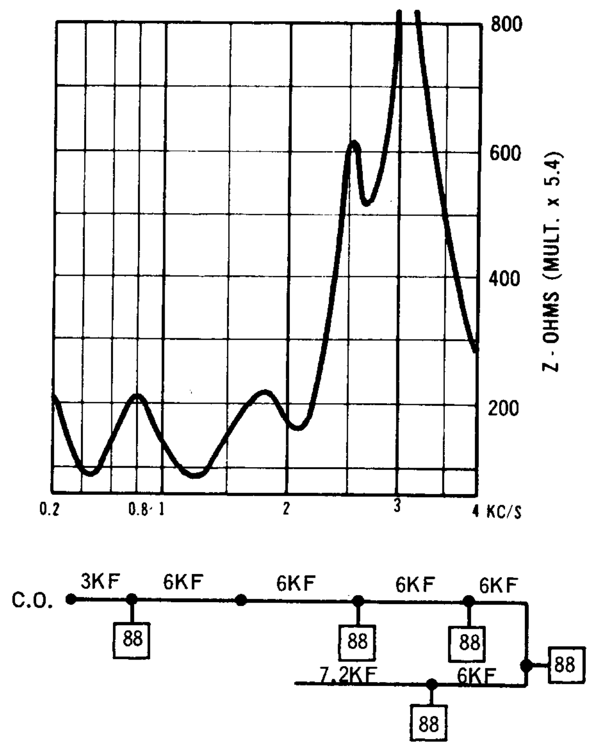


Fig. 53

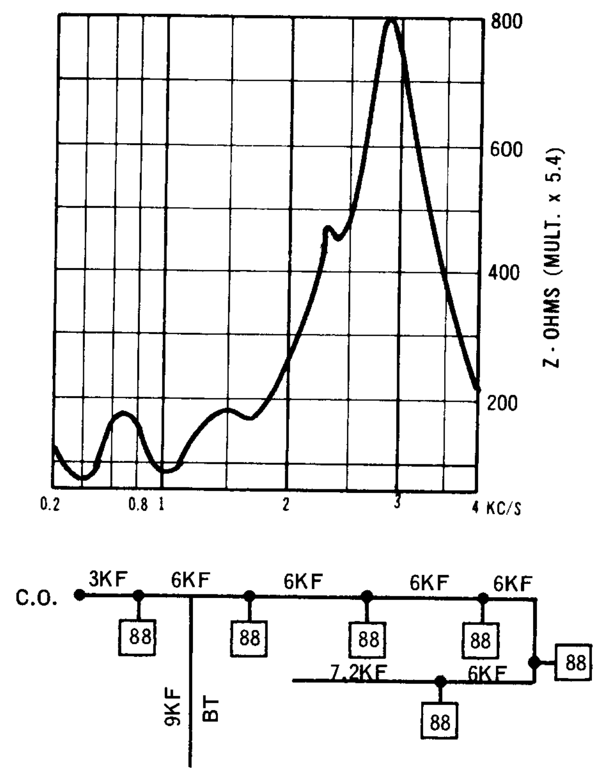


Fig. 54

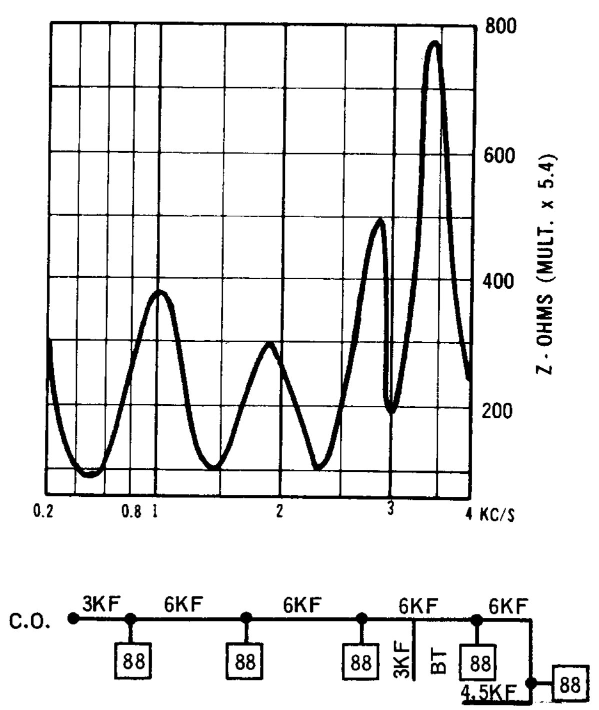


Fig. 55

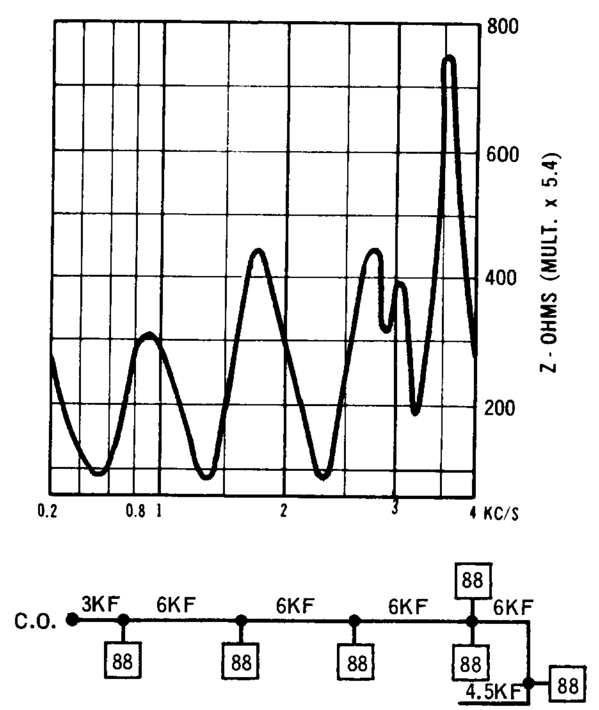


Fig. 56

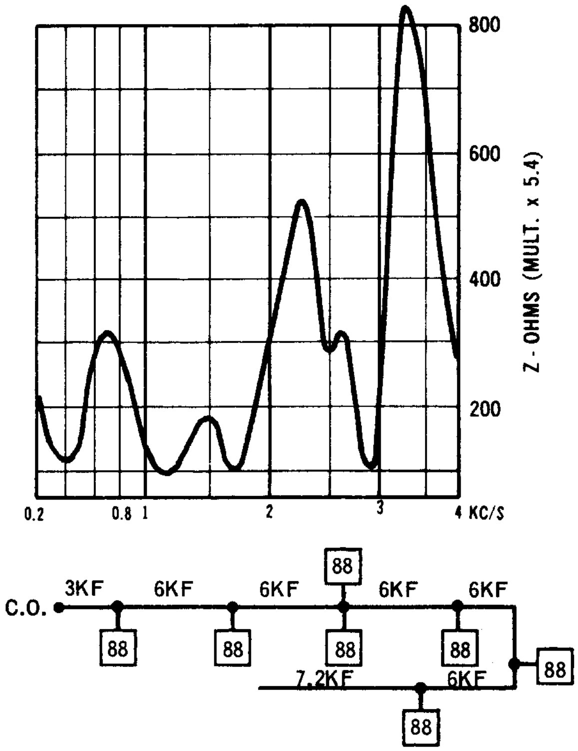


Fig. 57

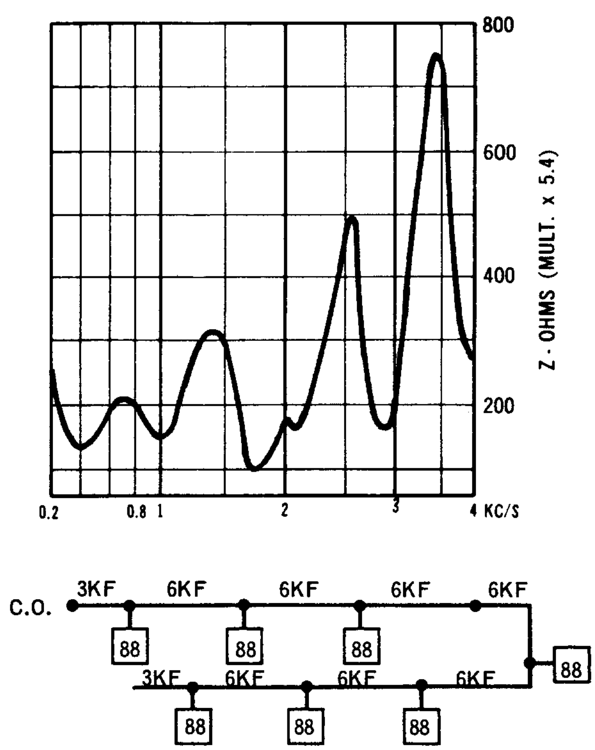


Fig. 58

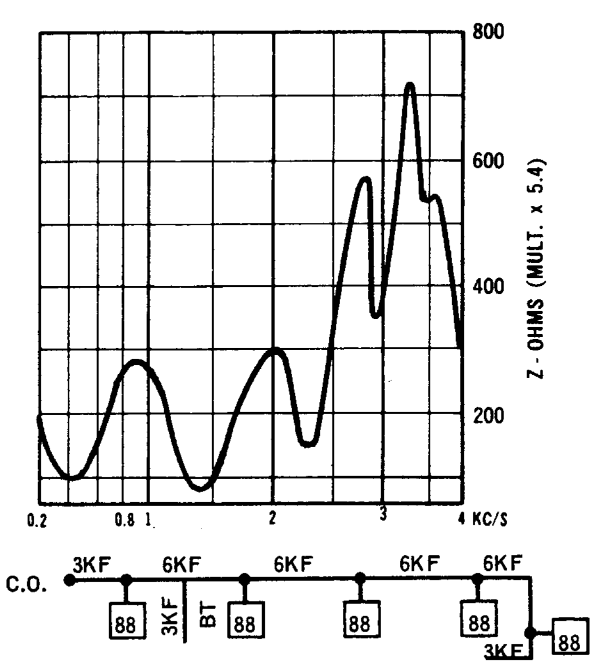


Fig. 59

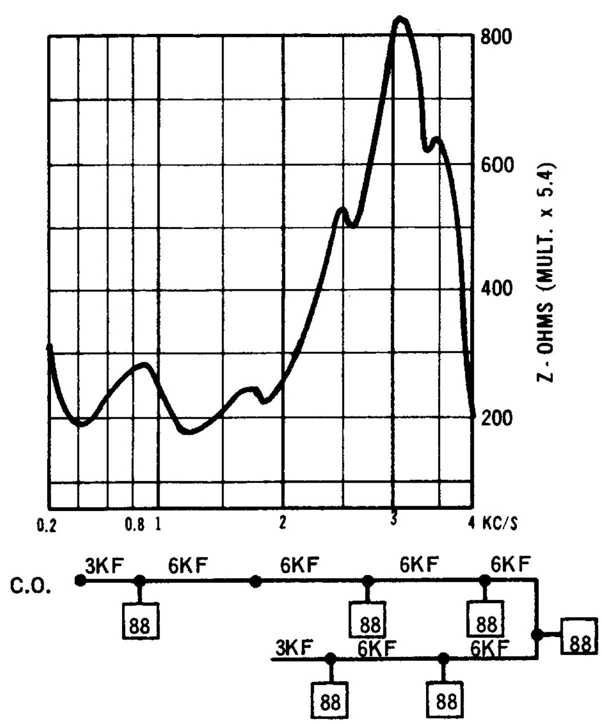


Fig. 60

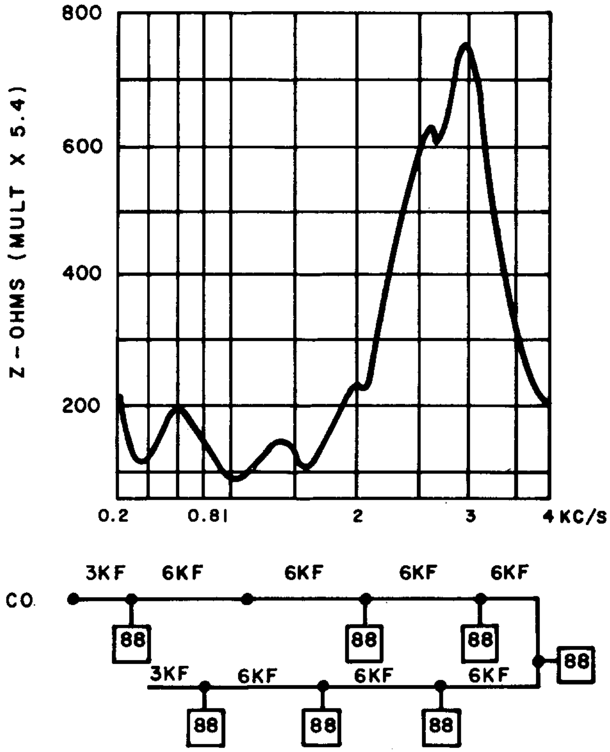


Fig. 61

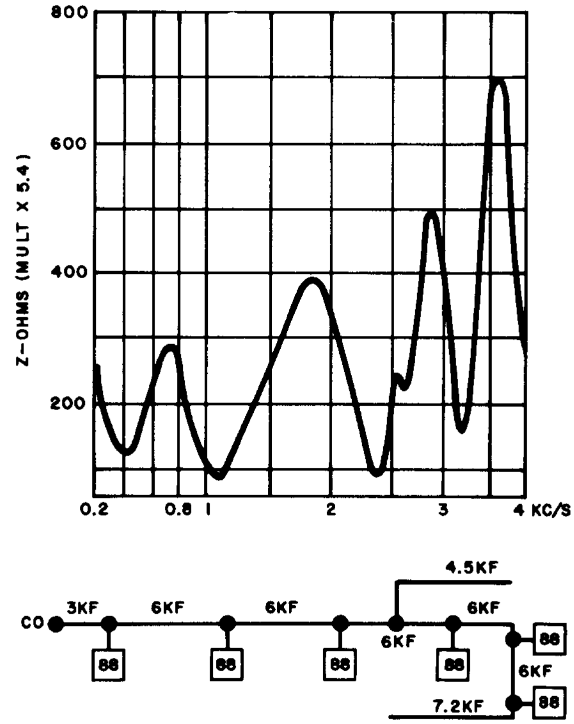


Fig. 62

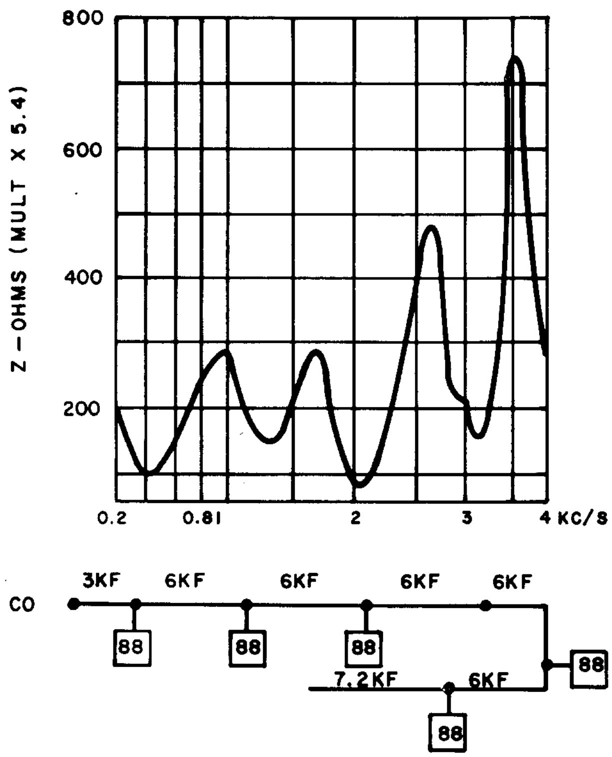


Fig. 63

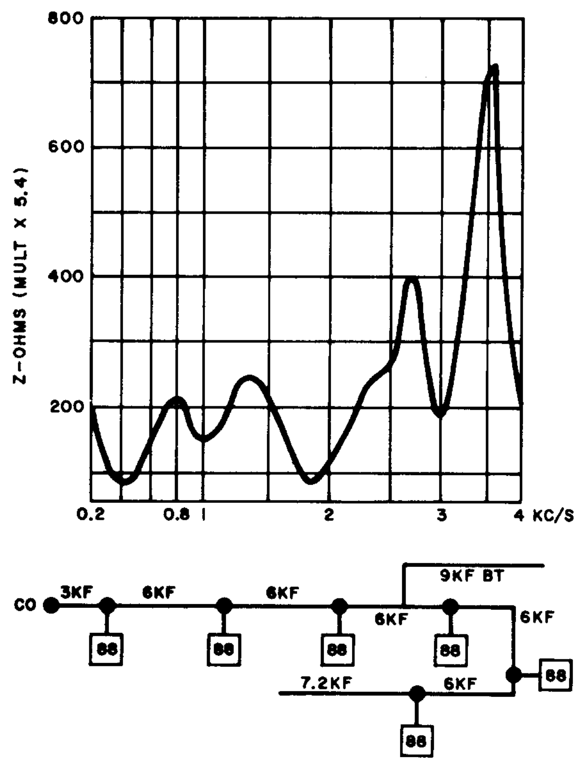


Fig. 64

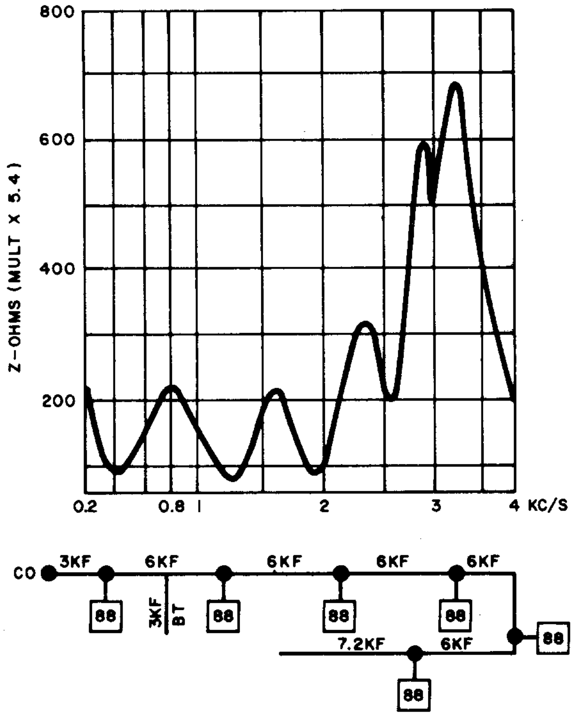


Fig. 65

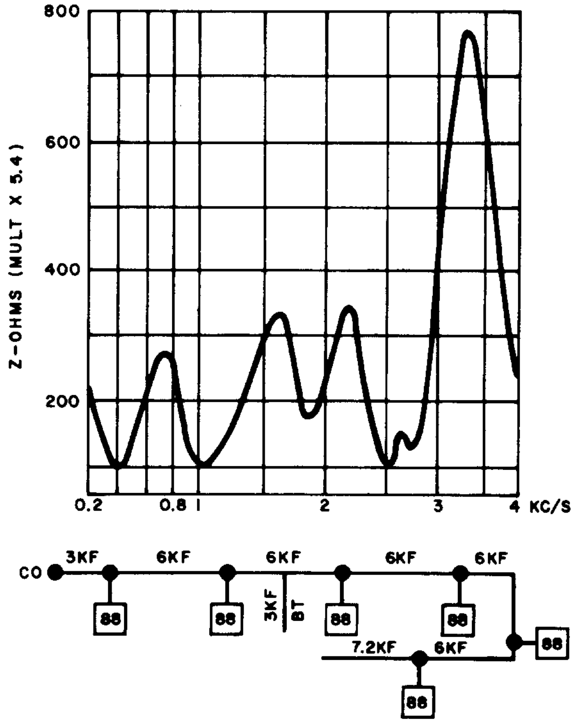


Fig. 66

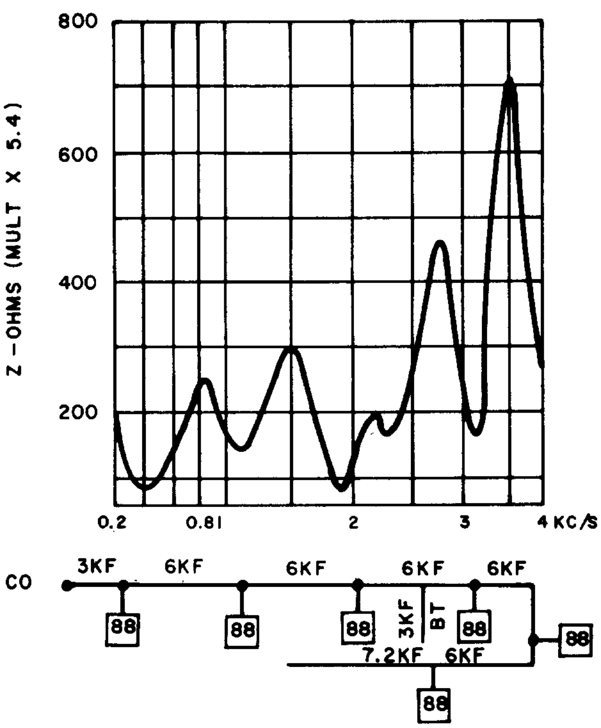


Fig. 67

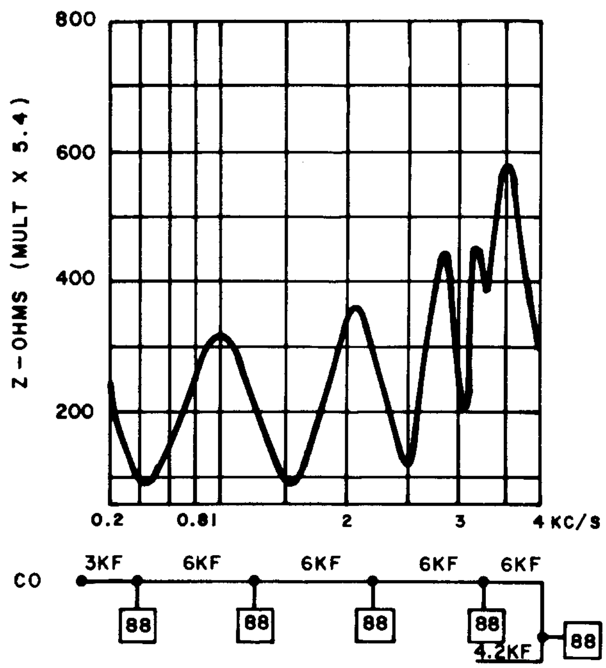
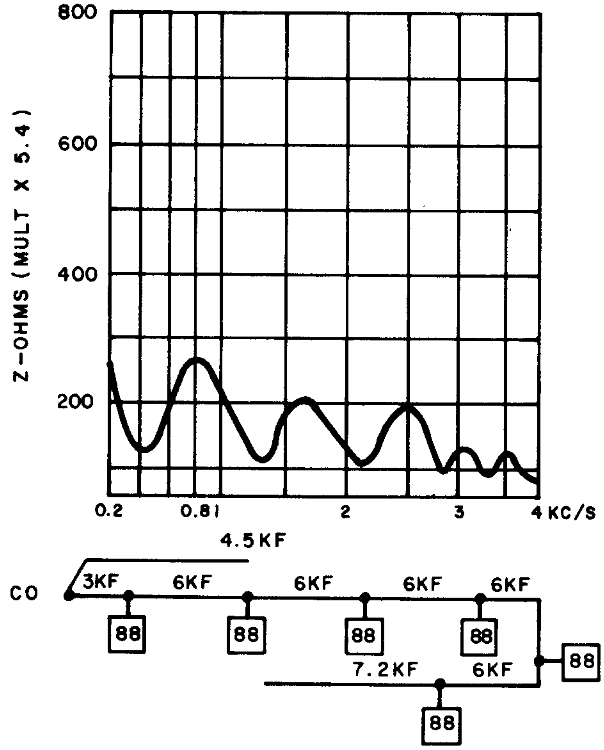


Fig. 68



➧ Fig. 69 ➧

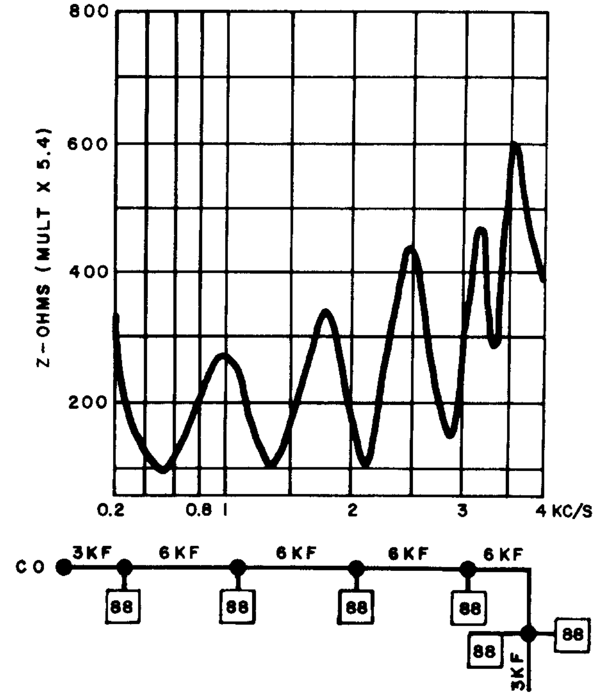


Fig. 70

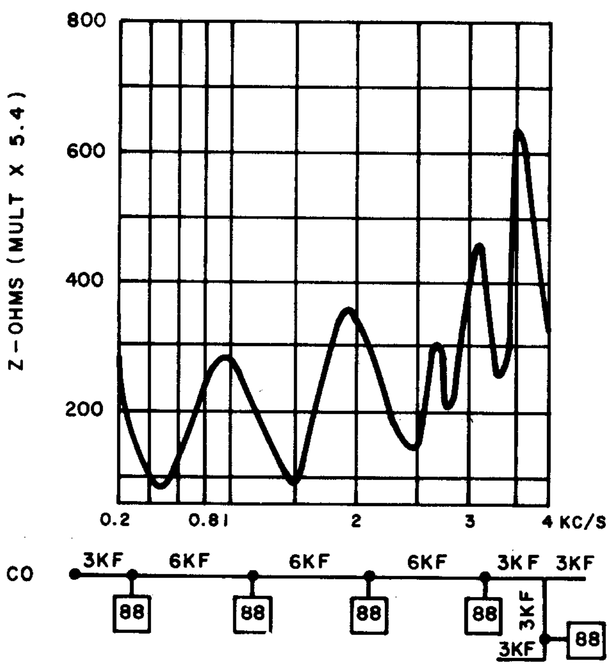
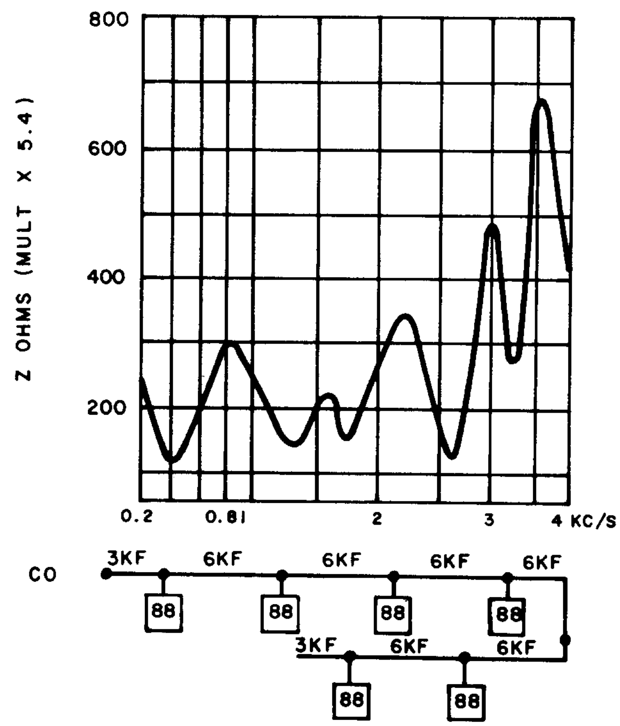


Fig. 71



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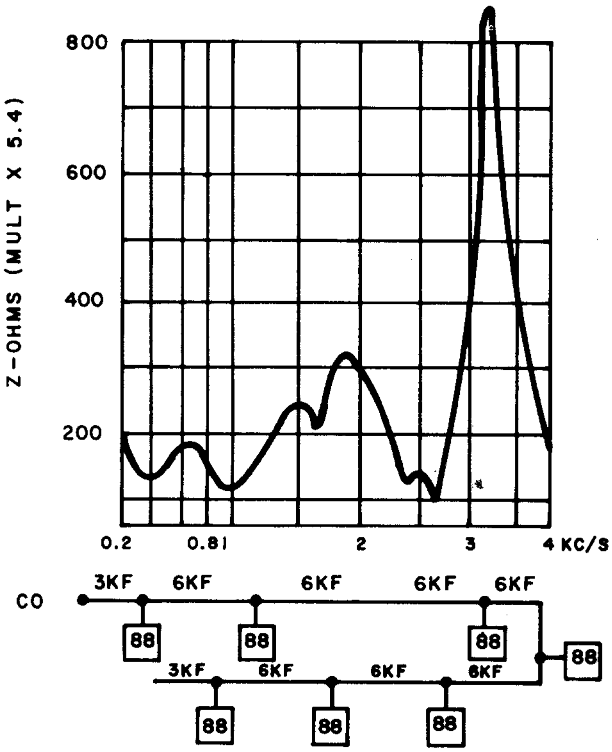

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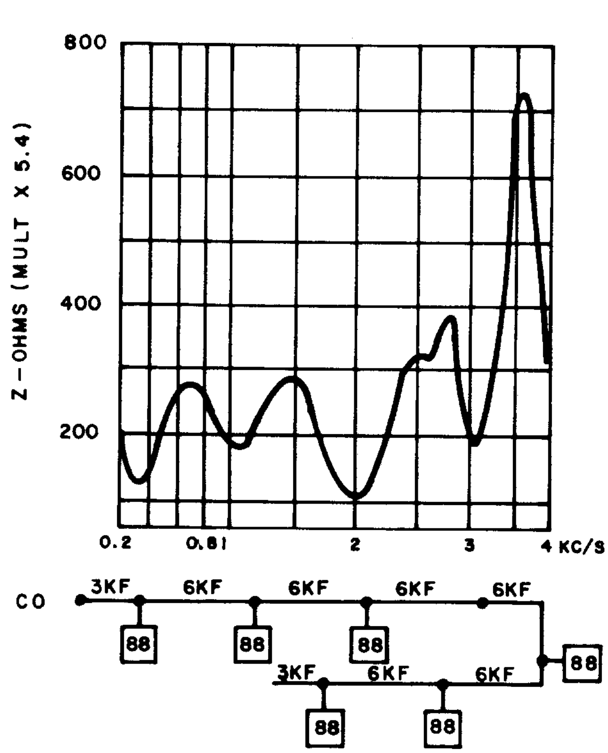

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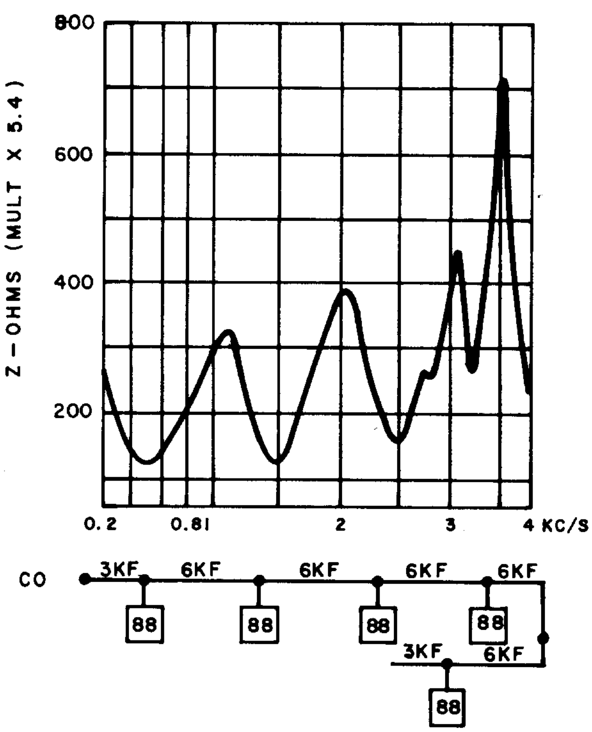

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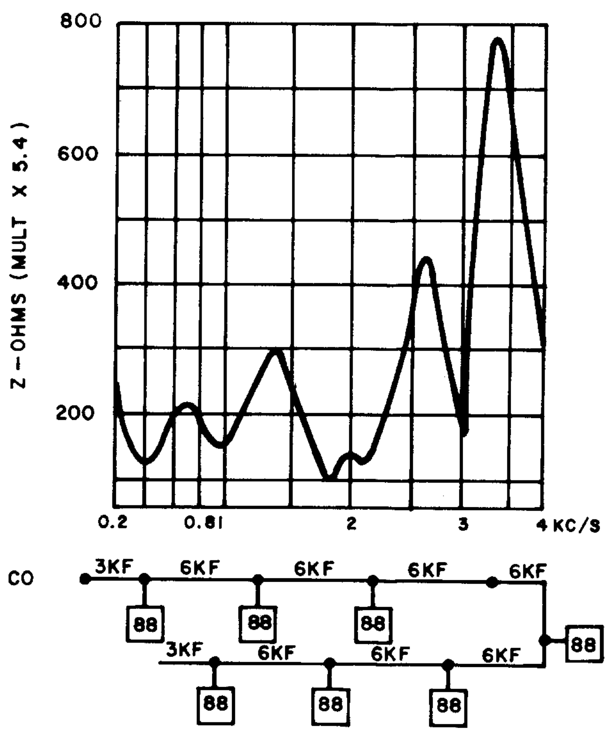

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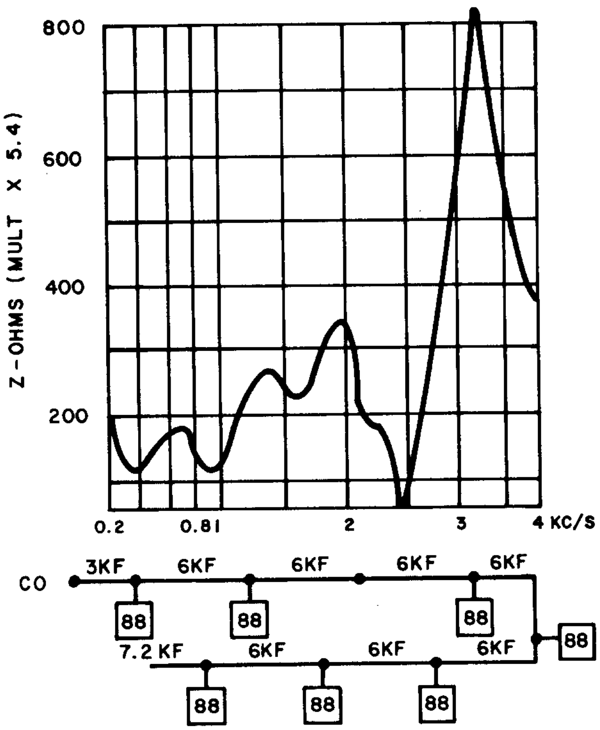

Fig. 77

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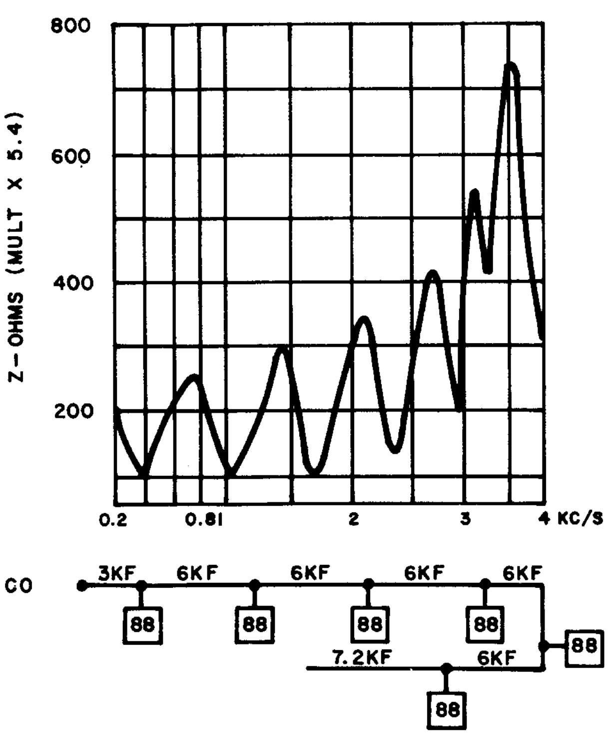

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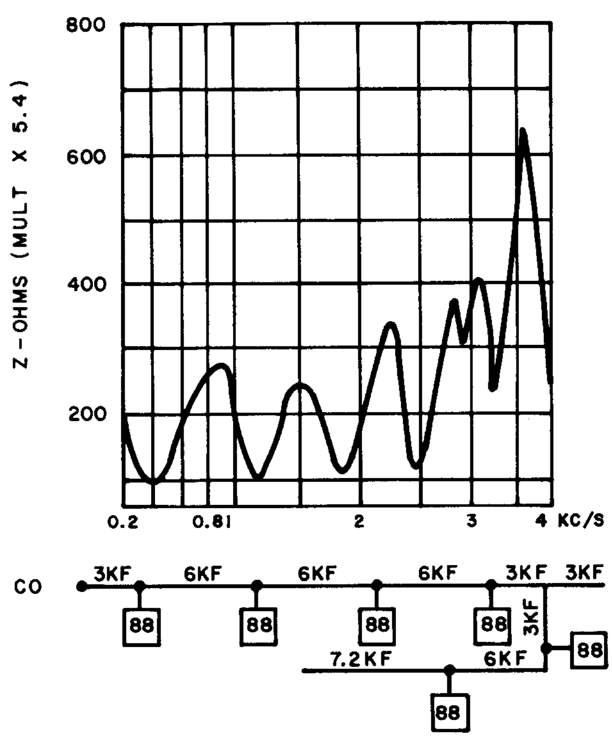

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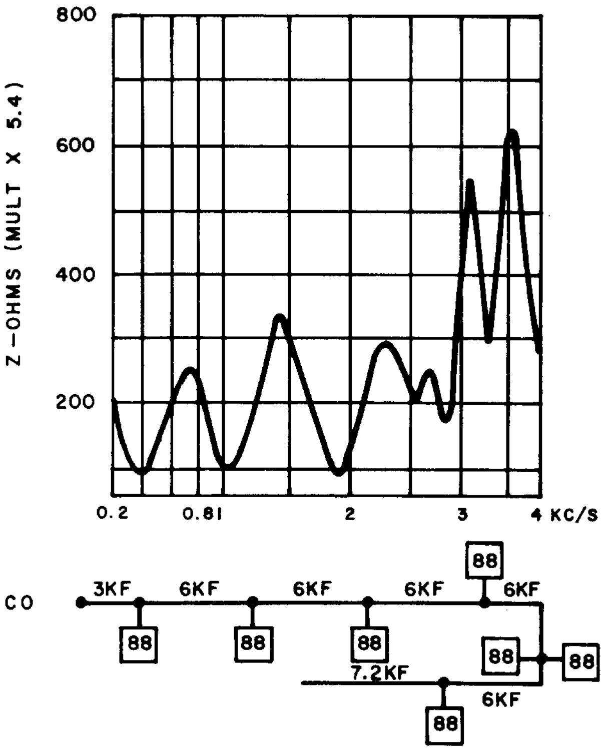
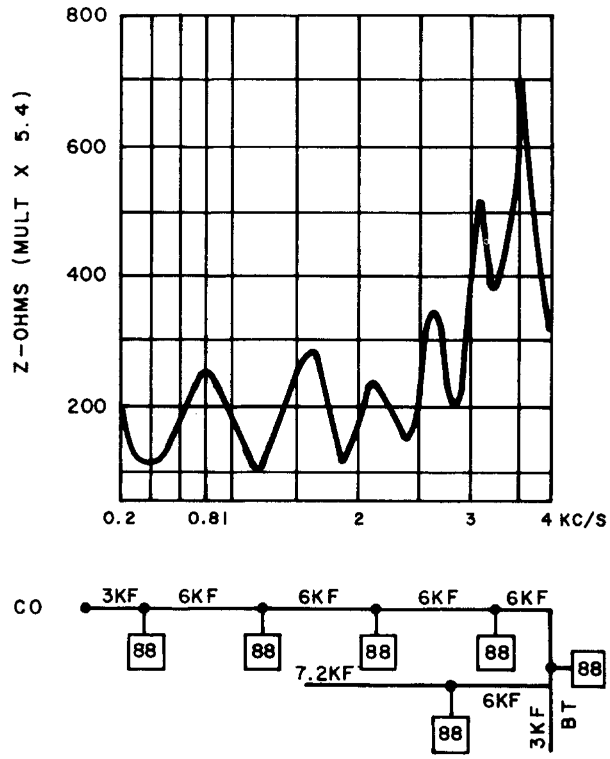


Fig. 81



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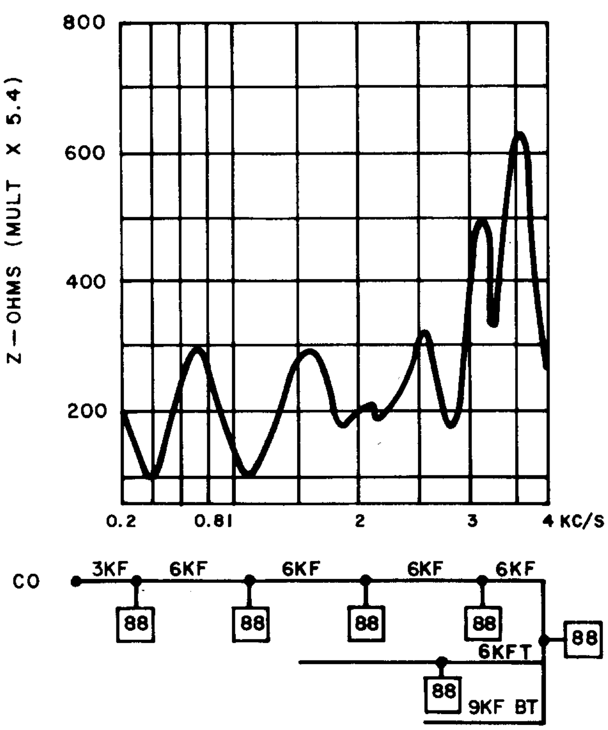

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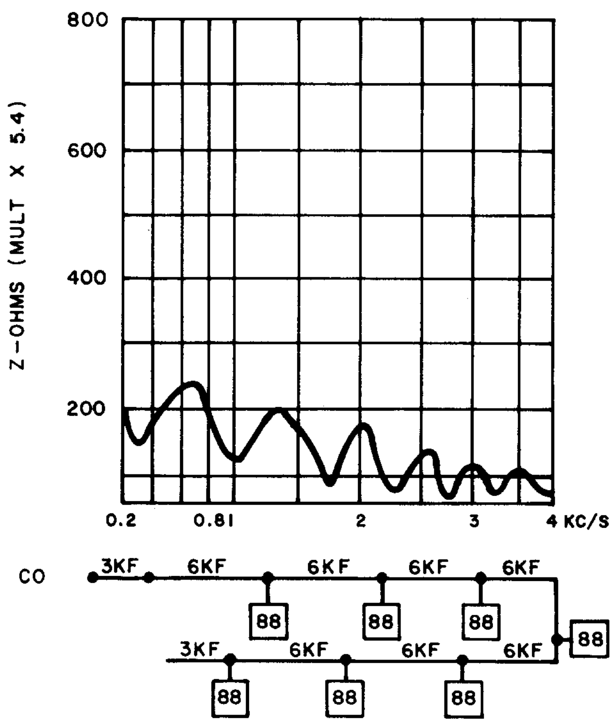

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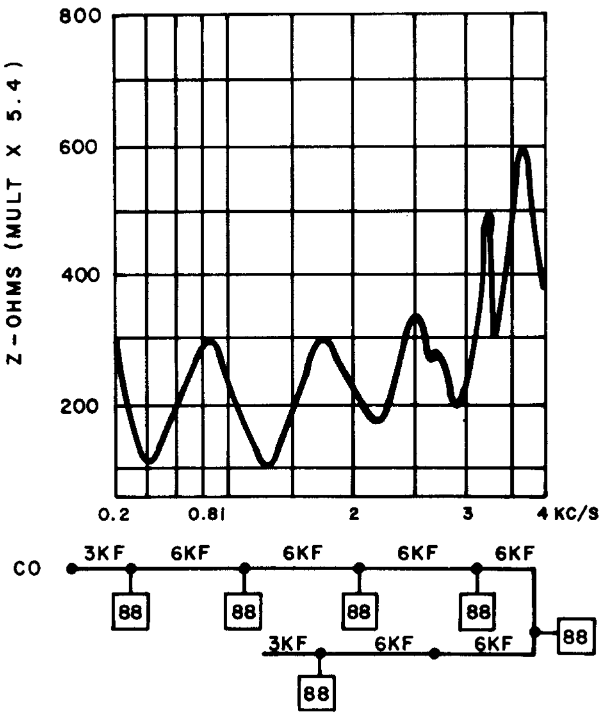


Fig. 85

▶Fig. 86 deleted◀

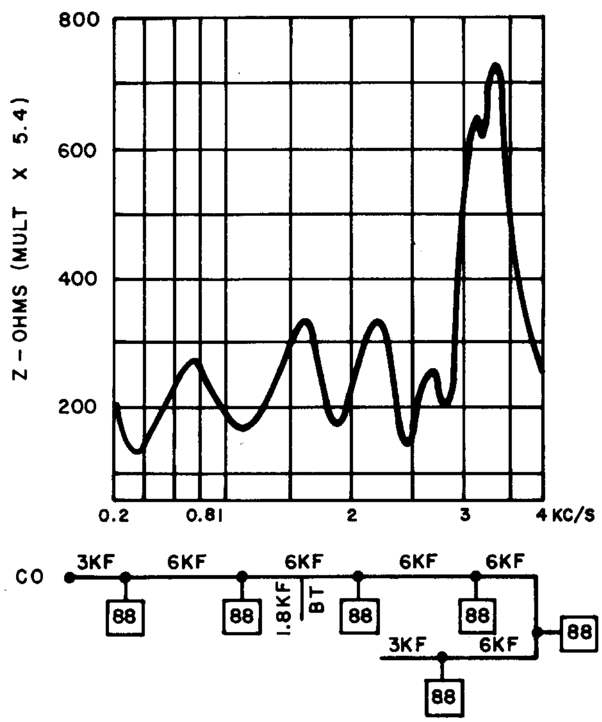


Fig. 87

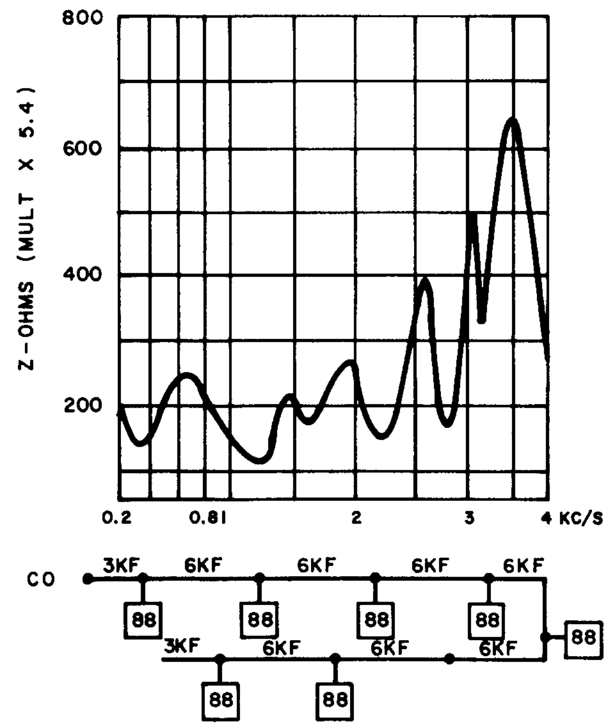


Fig. 88

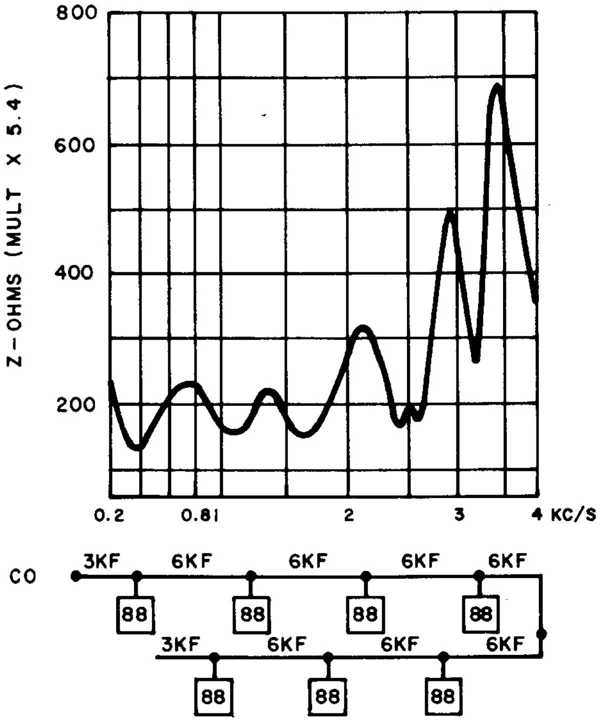
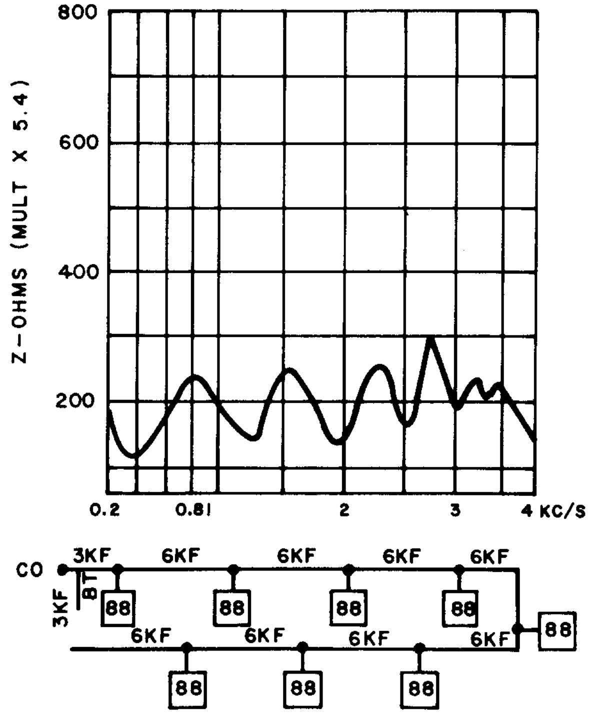


Fig. 89



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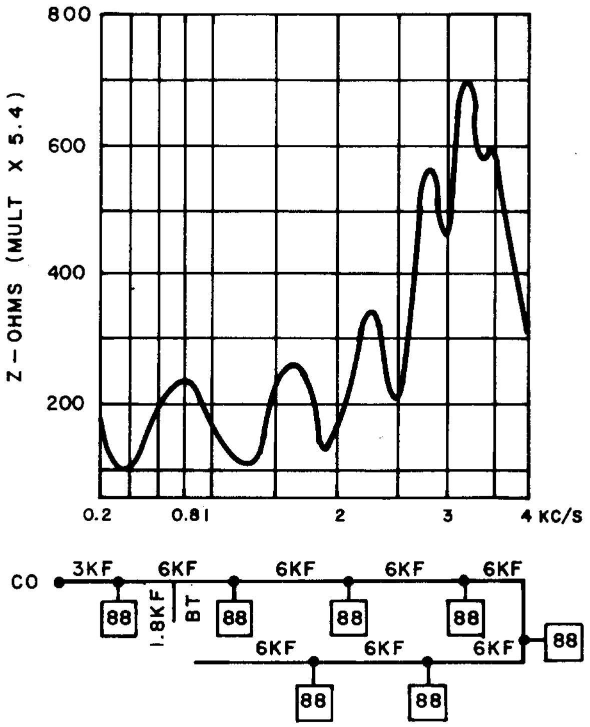

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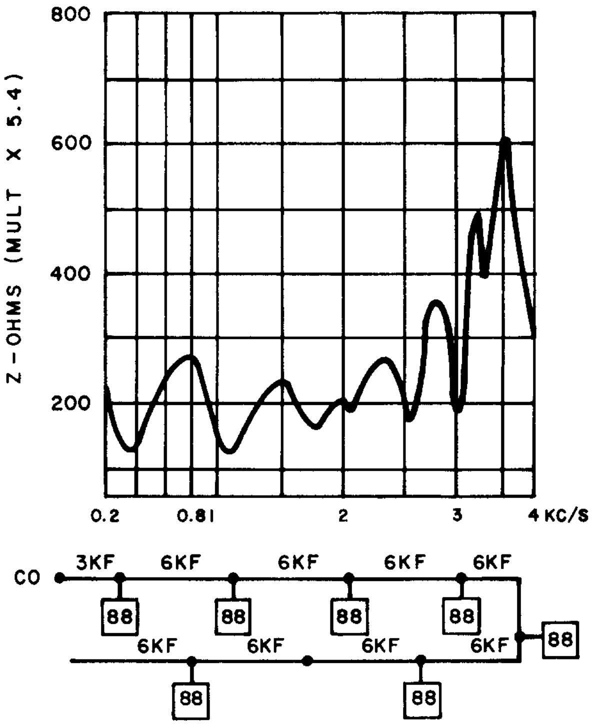
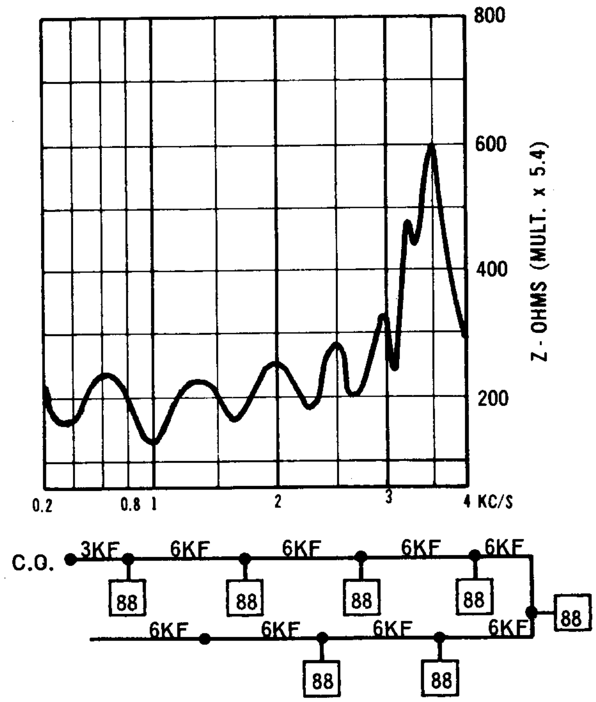


Fig. 92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Z - OHMS (MULT. x 5.4)
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4 KC/S
C.O.
3KF
6KF
6KF
6KF
6KF
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6KF
6KF
6KF
6KF
88
88

FIG. 93

ANALYSIS OF OPEN-CIRCUIT IMPEDANCE CURVES WITH VOICE-FREQUENCY SWEEP TEST SETS H44 LOADING PLAN

1. This appendix illustrates some of the open-circuit impedance curves found during analysis of troubles in subscriber cable pairs equipped with 44 mh loading coils and using H spacing. The curves are typical of the types found with a voice-frequency sweep test set covering the frequency range 200-4000 cps. The impedances shown are absolute magnitudes. The phase angles are unknown.

2. H44 loaded cable pairs do not have as high impedances as similar H88 loaded pairs. Since the cutoff frequency of H44 loaded pairs is normally above 4000 cps, the sweep set does not show all the characteristics of the open-circuit impedance curves, and the curves cannot be analyzed in the same manner as for H88 loaded pairs.

3. There are many arrangements of cable pairs not shown here which represent irregularities. Some of the illustrations do not represent irregularities. The examples are chosen to aid in field analysis and suggest some types of troubles that should be checked in an exchange where H44 loading is employed.

4. All illustrations involve 22- or 24-gauge high capacitance cable. Since the wire resistance has little effect on open-circuit impedance, other gauges of high capacitance cable will produce substantially the same results.

5. Caution should be used if low-capacitance cable is encountered. A loading section composed of low capacitance cable will appear to be somewhat shorter than a section of high capacitance cable of the same physical length.

6. The figures are grouped on the basis of the number of peaks in the impedance curve. The groups are:

Number of Peaks	Figures
1	1-10
2	11-19
3	20-30
4	31-34

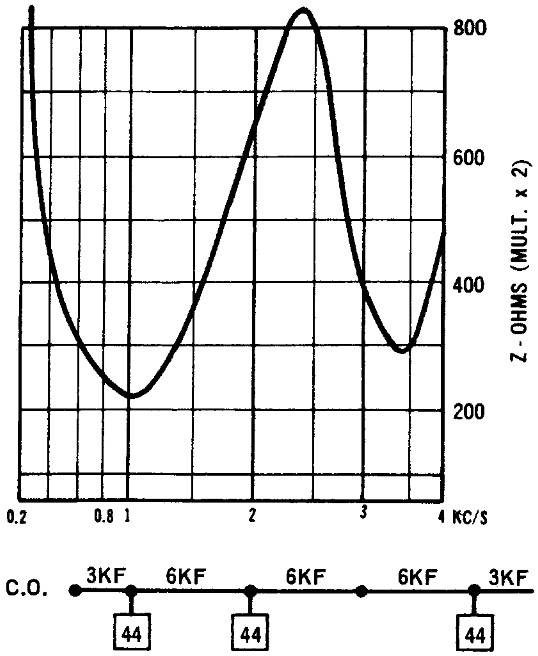


Fig. 1

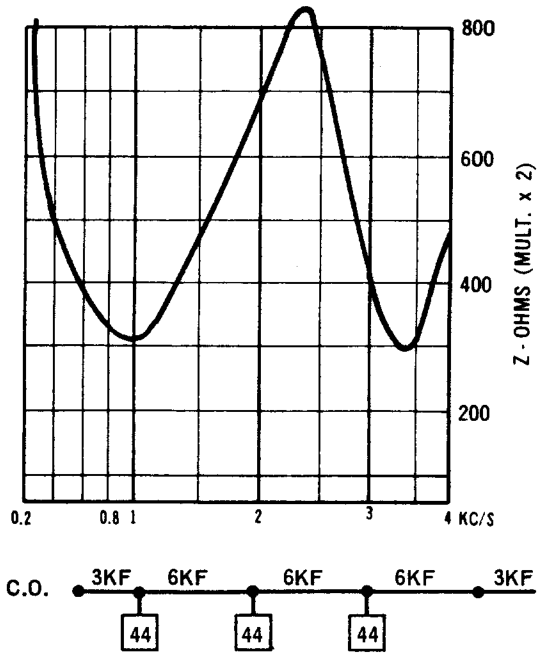


Fig. 2

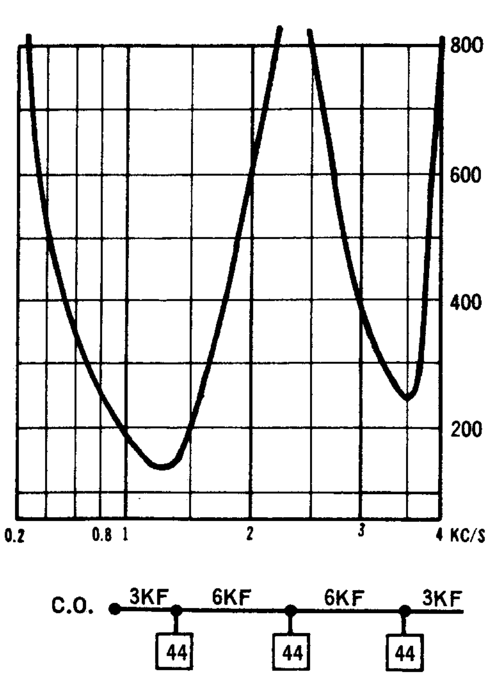


Fig. 3

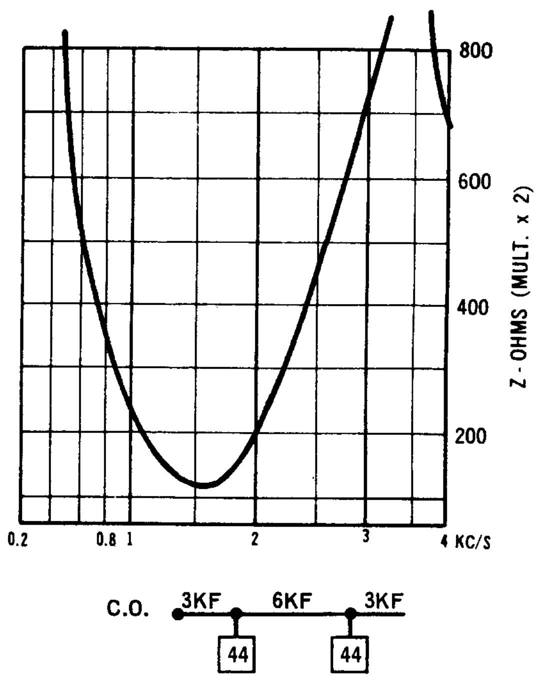


Fig. 4

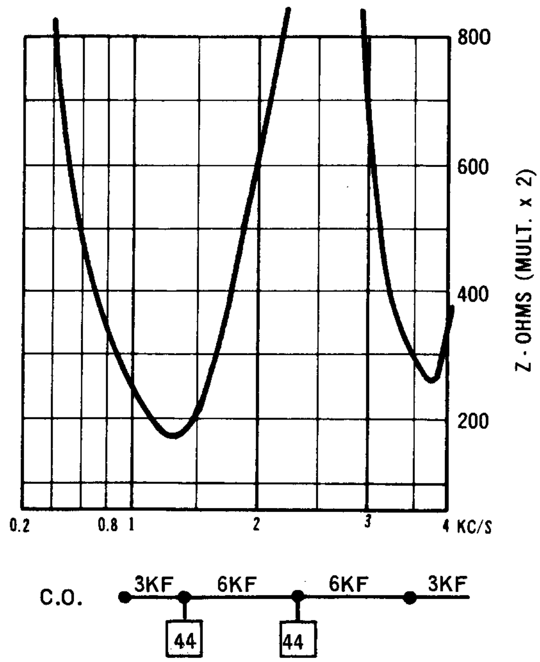
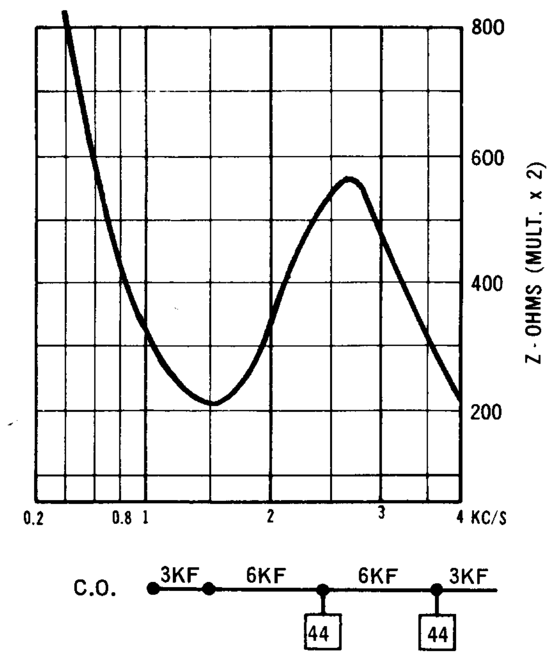


Fig. 5



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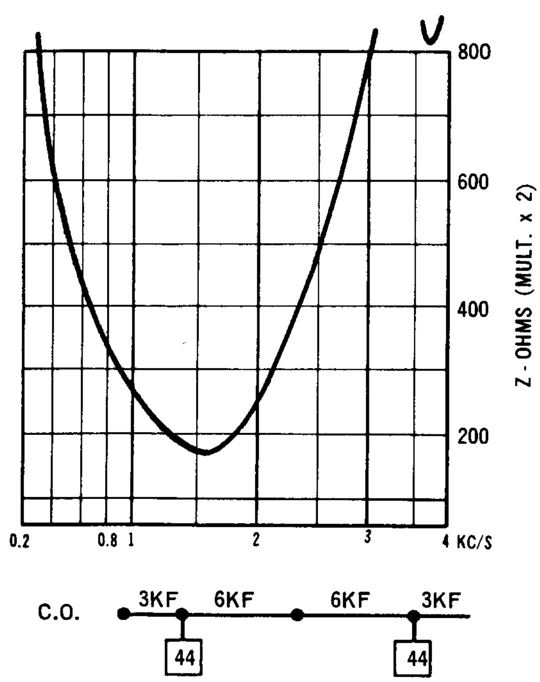

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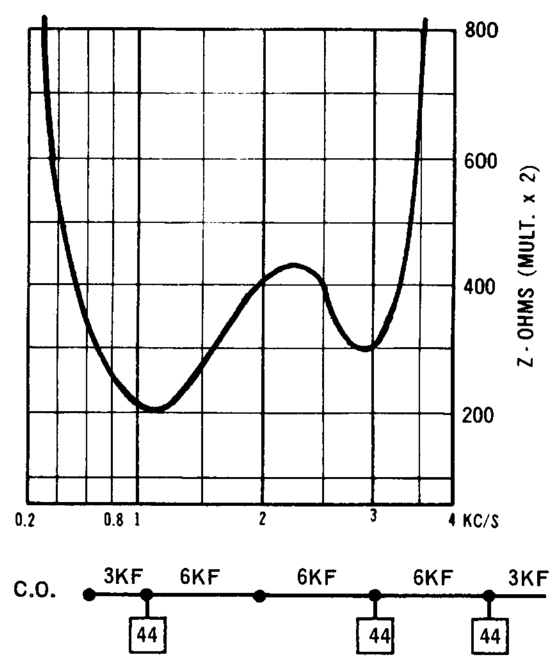


Fig. 8

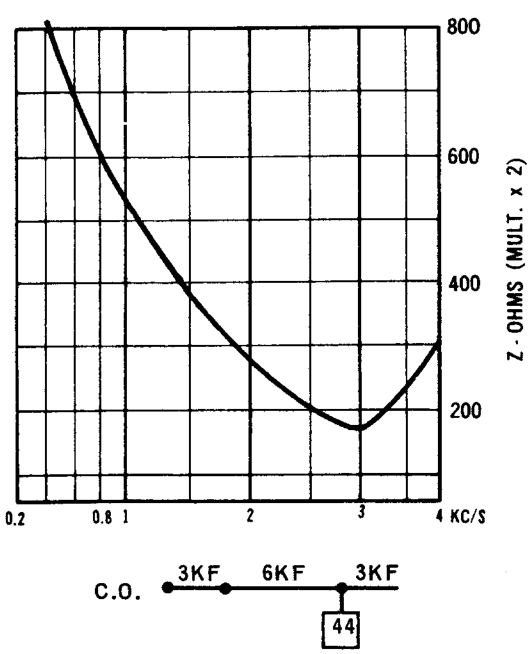


Fig. 9

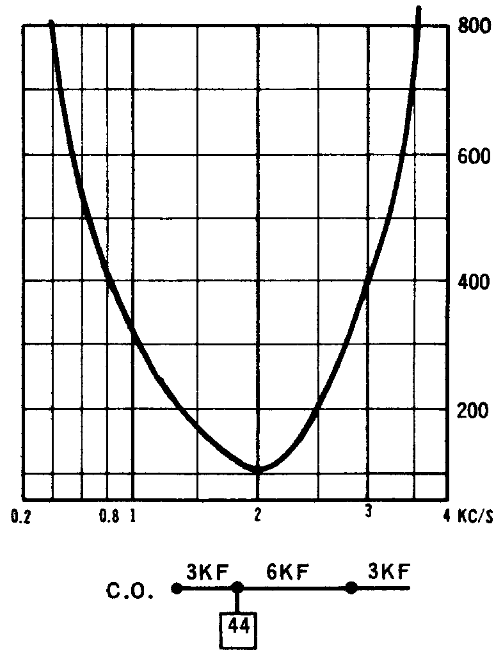


Fig. 10

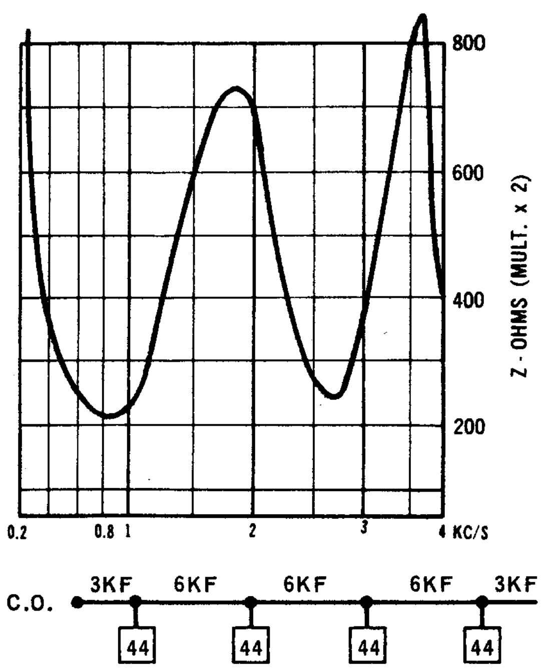


Fig. 11

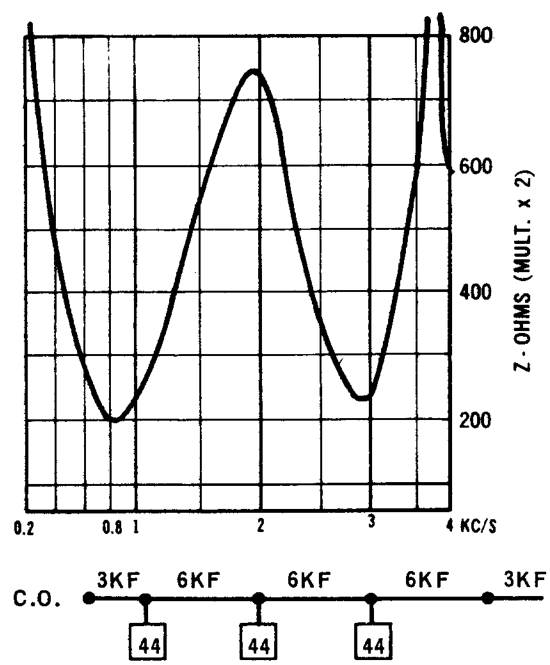


Fig. 12

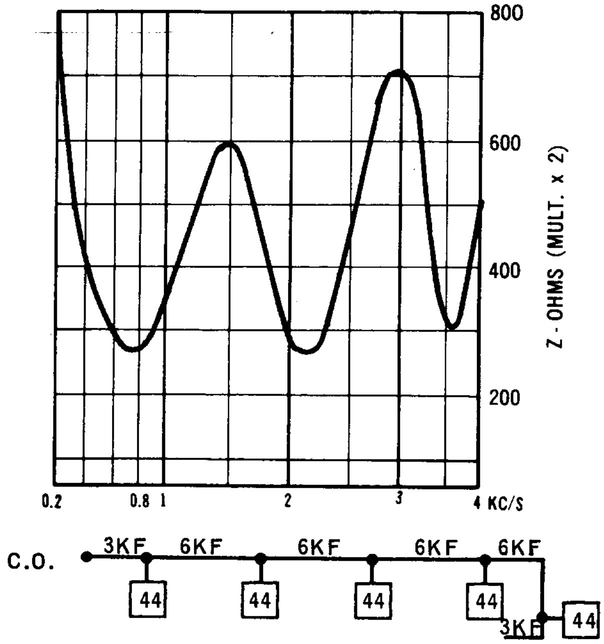


Fig. 13

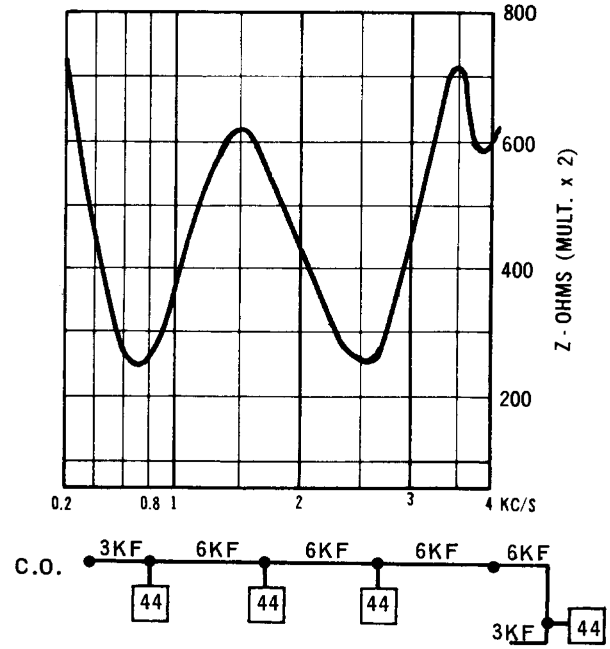


Fig. 14

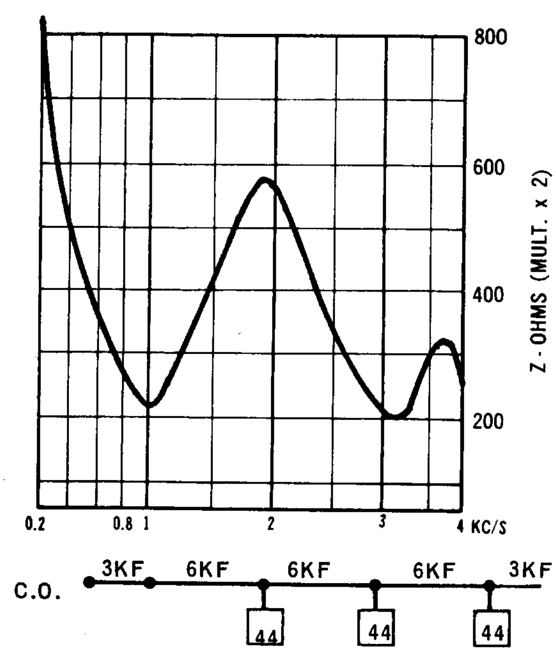


Fig. 15

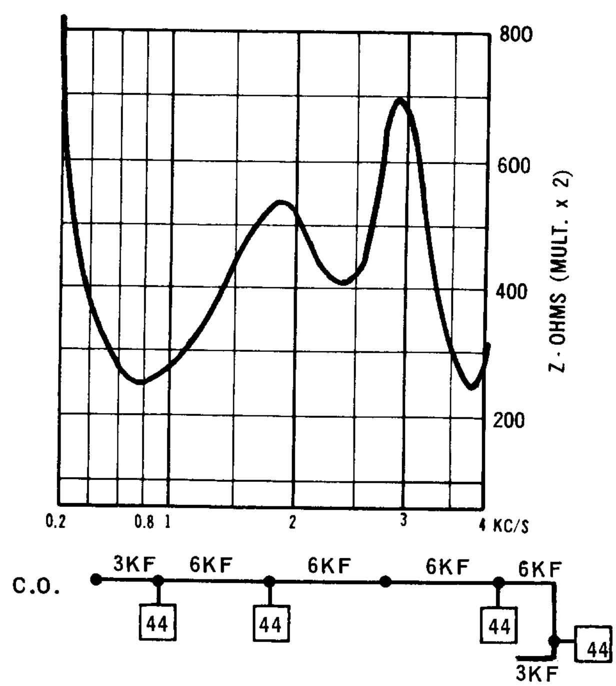


Fig. 16

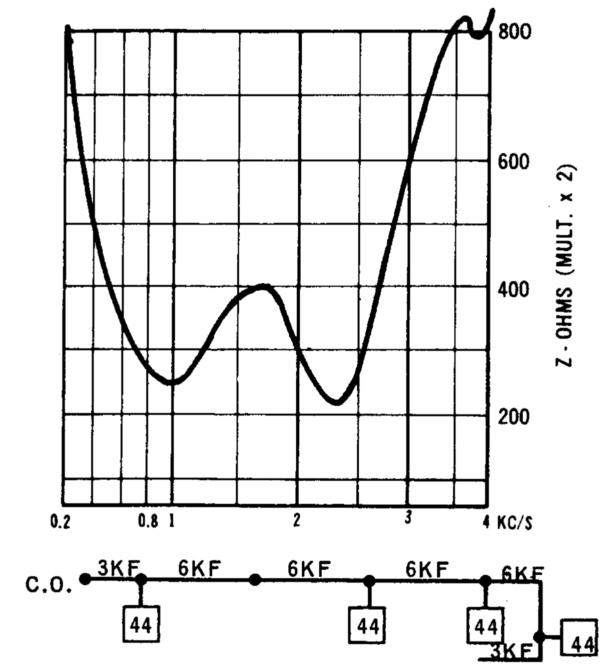


Fig. 17

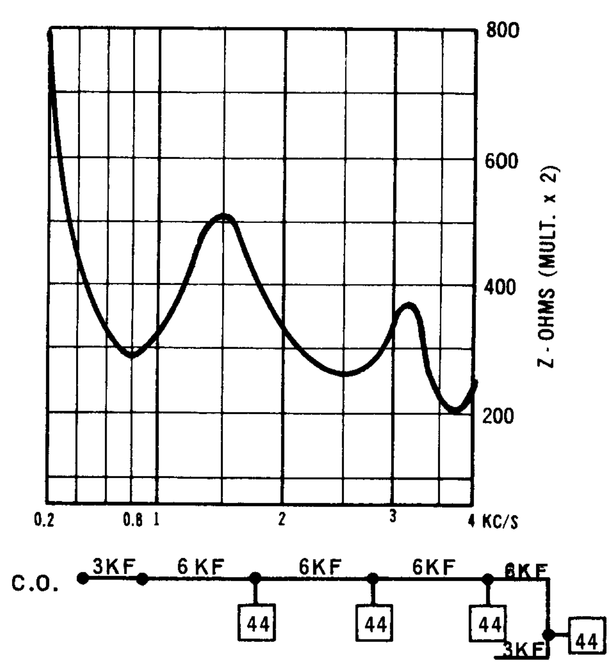
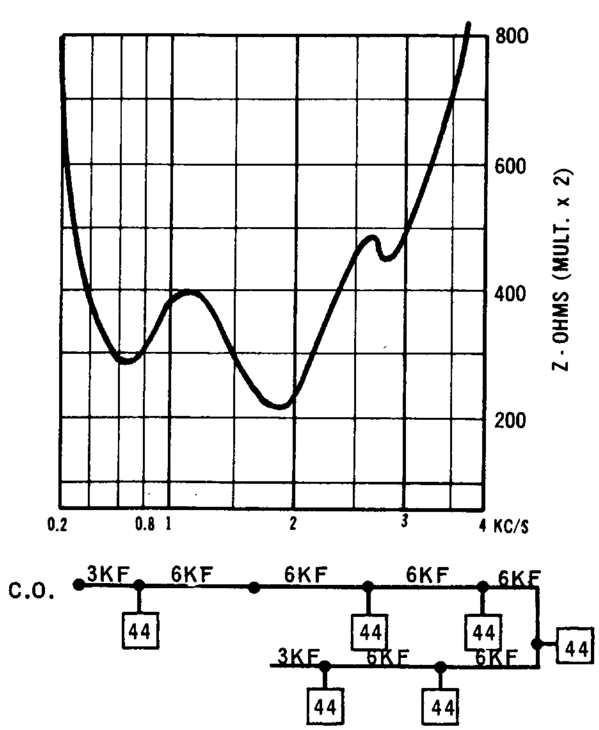


Fig. 18



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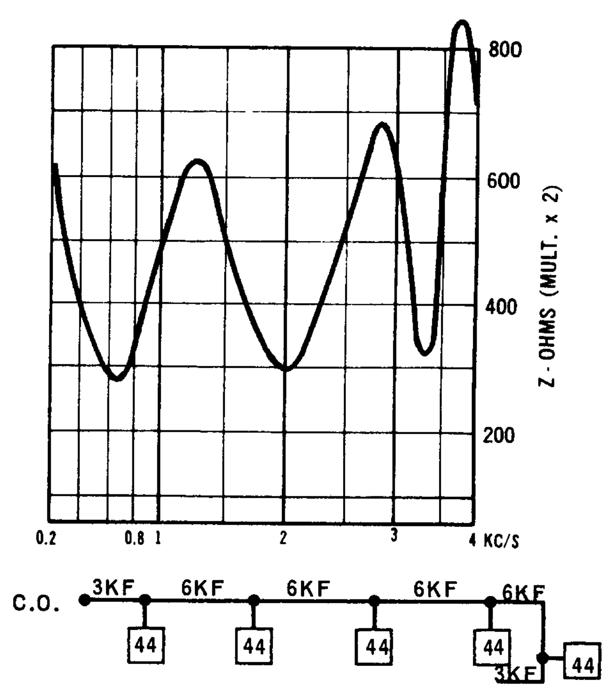
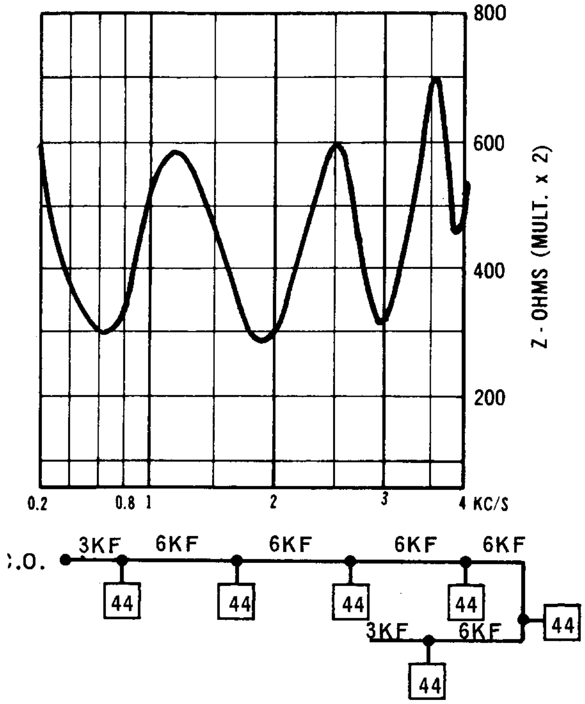


Fig. 20



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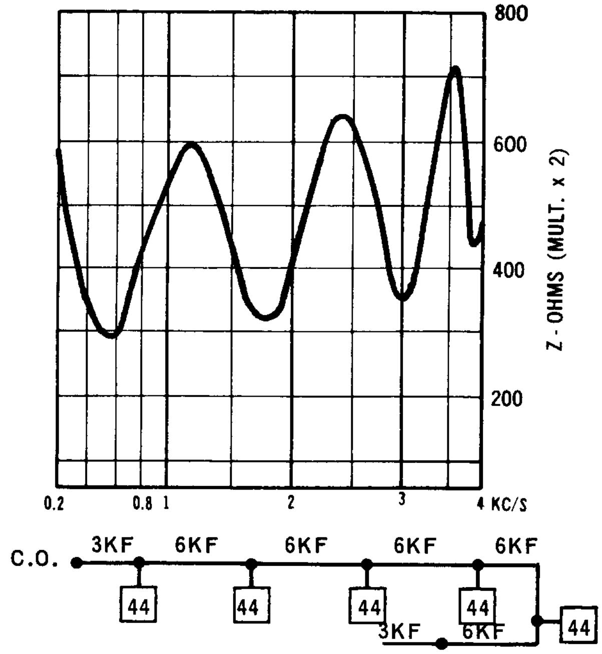

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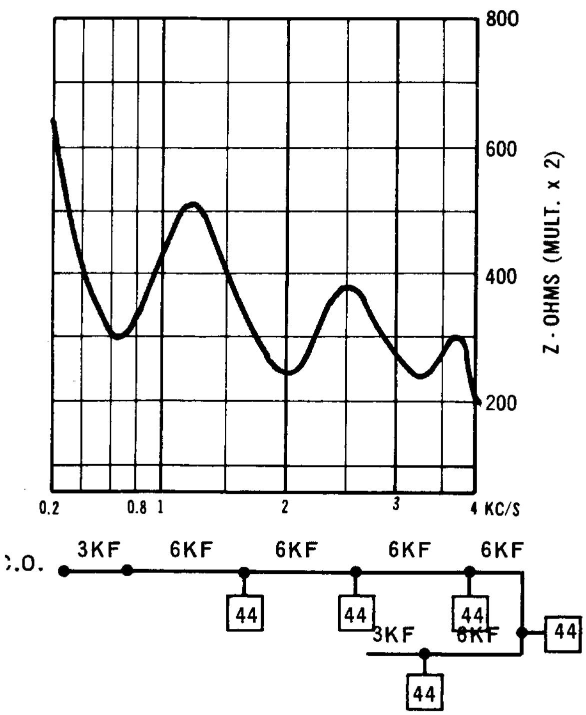
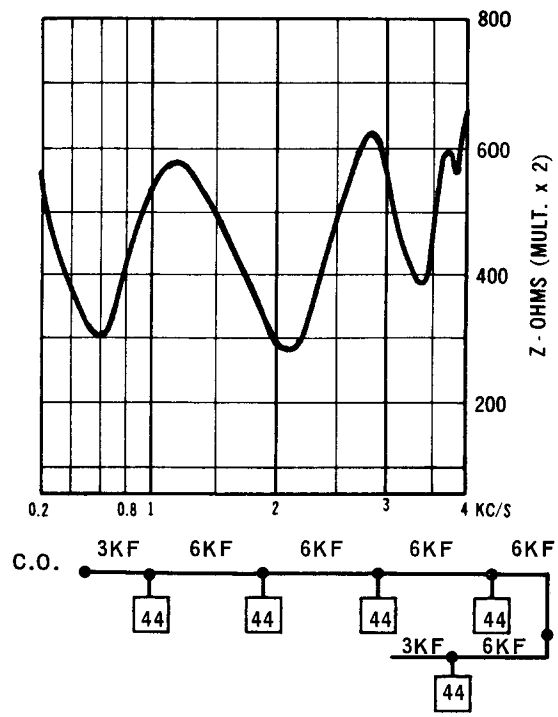


Fig. 23



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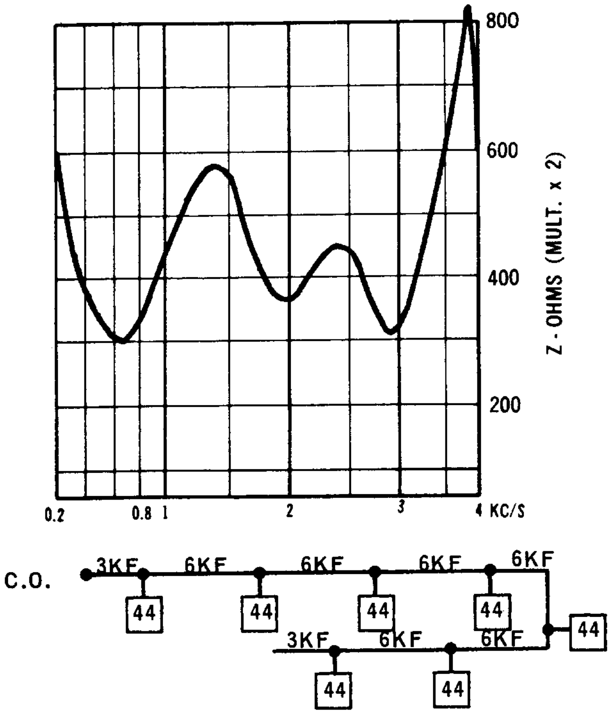
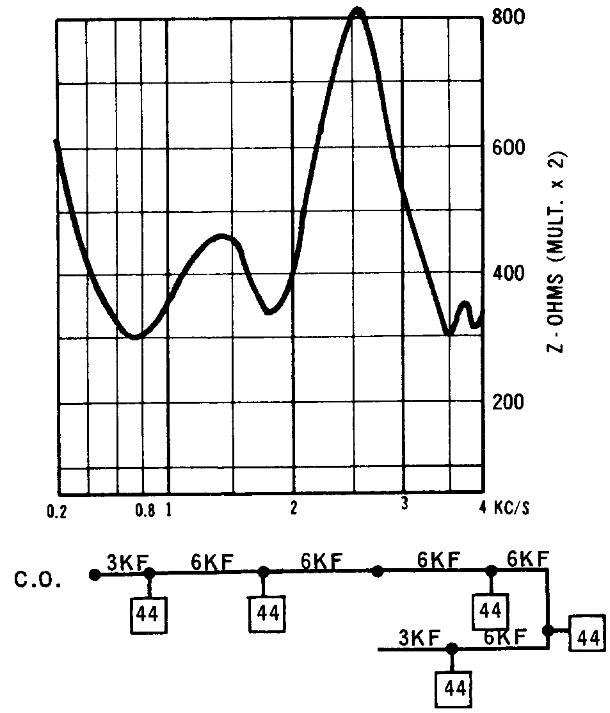


Fig. 25



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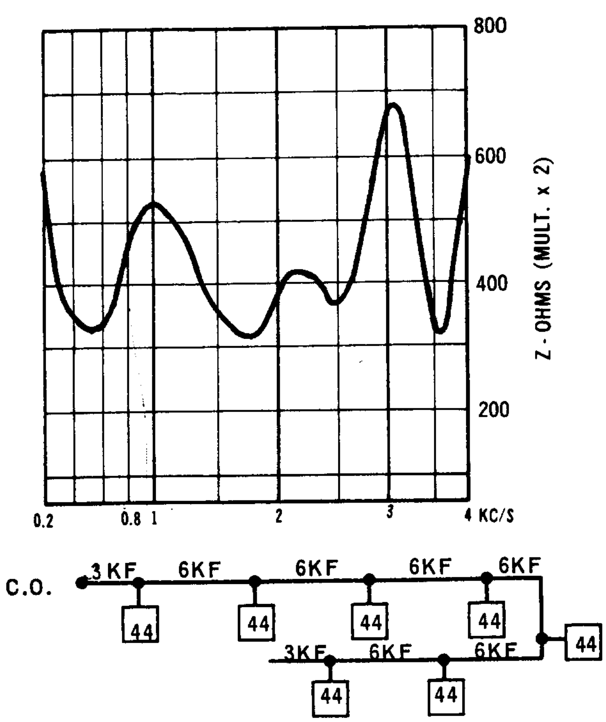

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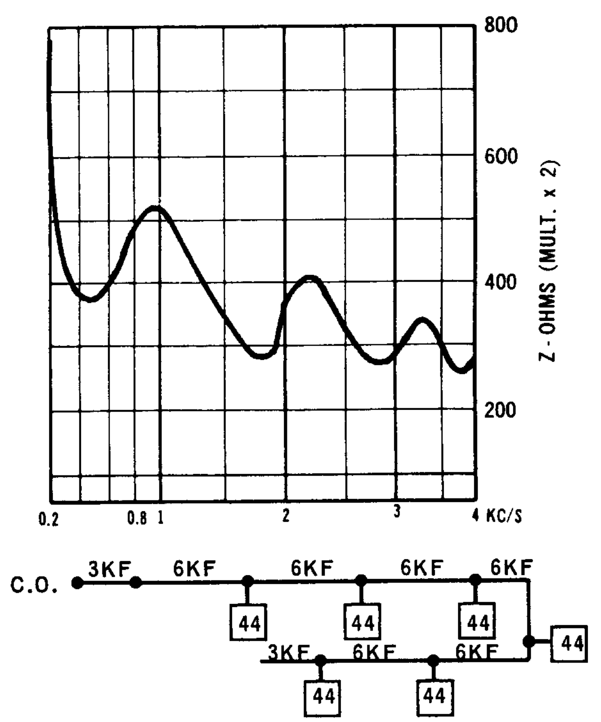

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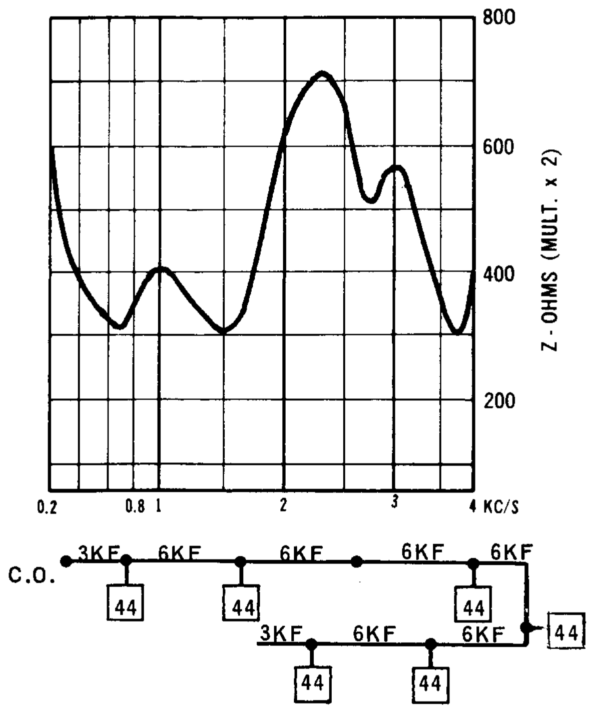

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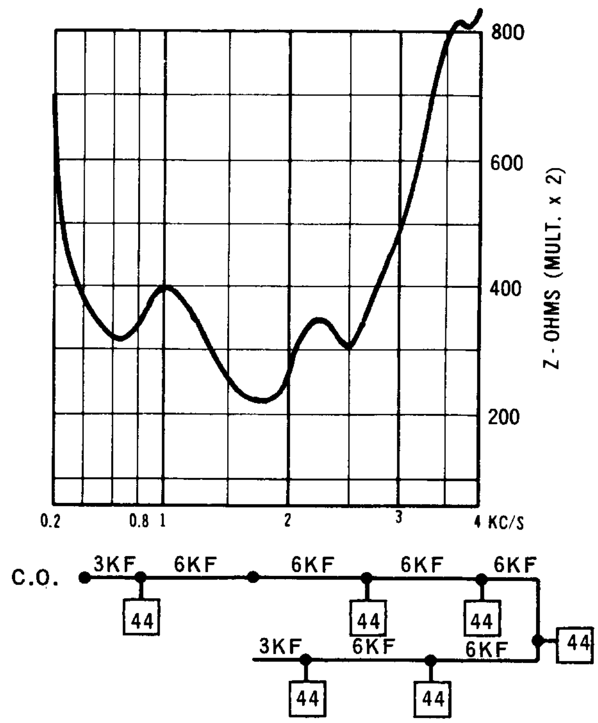

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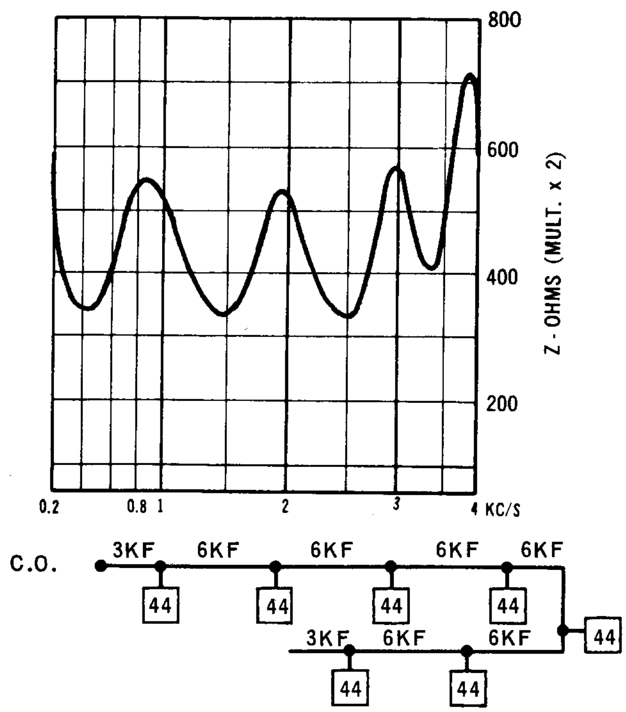
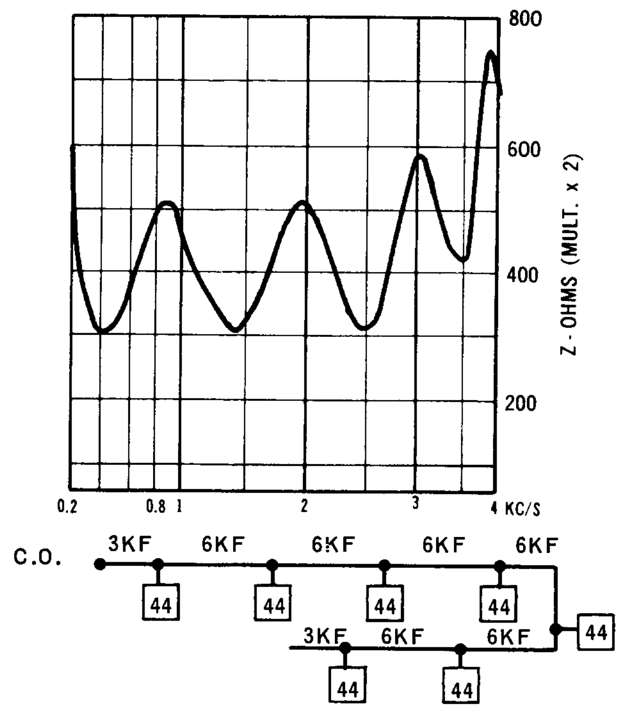


Fig. 31



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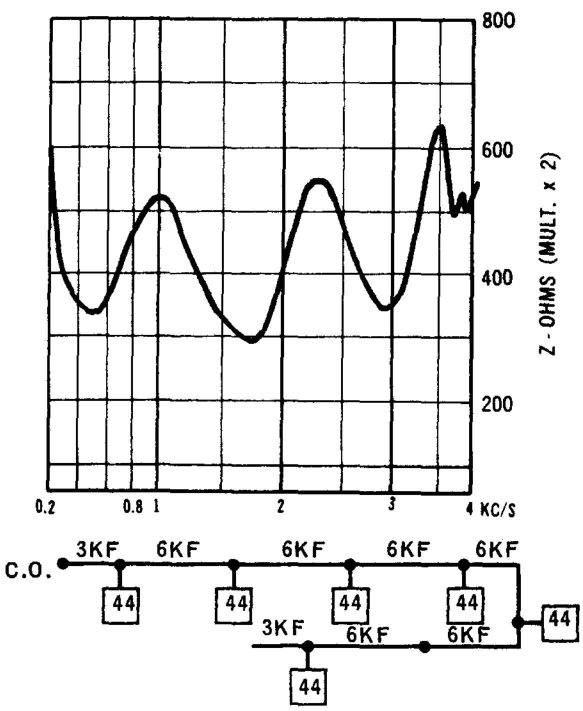
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3KF
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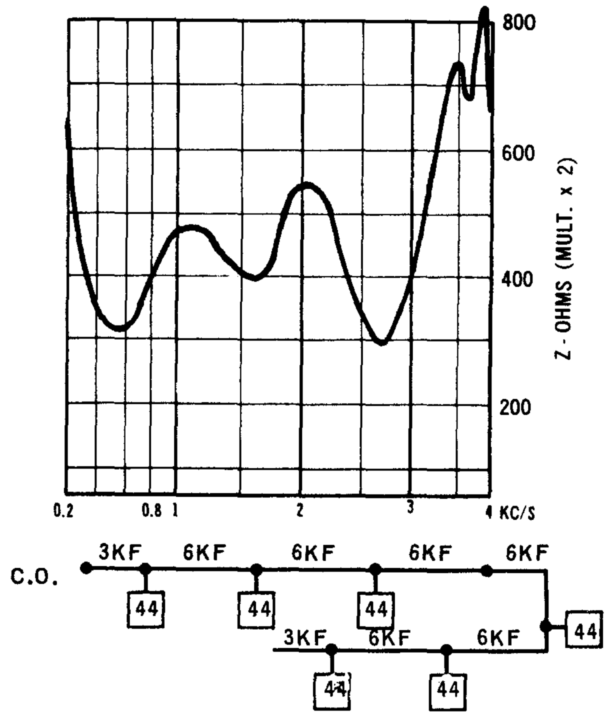
Fig. 33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2
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4 KC/S
C.O.
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44
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Fig. 34