R1 TRANSPOSITION SYSTEM

Purpose: The purpose of this addendum is to expand the original issue of Section 462 on the use of carrier on the R1 system as determined from recent measurements of an R1 system at carrier frequencies.

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CURVE I	-	Comparison of the Insertion Loss data between R1 and REA-1.

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3. Conclusions from Data.
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2. Application and Discussion of Data

2.01 In applying carrier to the R1 system two important losses must be considered, namely absorption losses and crosstalk losses. Absorption losses are the losses measured above the theoretical attenuation losses at various frequencies and are discussed in TE & CM-407 "How to Make Insertion Loss Measurements" paragraph 7.08. Crosstalk losses are the coupling losses between wire pairs on a pole lead which, if low enough, will cause crosstalk from one pair into the other, especially at carrier frequencies. Table I presents the minimum equal level far end crosstalk losses as measured for the R1 system. Table III presents the insertion loss measurements for the various pair combinations. The differences between the calculated attenuation loss in the last column of Table III and the values shown in the other columns are considered absorption losses.

2.02 The absorption losses as determined from the insertion loss measurements of Table III show that the measured losses are fairly close to the theoretical calculated losses up to 220 kc. Therefore, for all practical purposes it can be stated that the R1 system is satisfactory from an absorption loss standpoint up to 220 kc. Of course this is based on

2.05 No particular coordination with power line transpositions is required when the R1 or R2 system is used.

2.06 Transpositions in the R1 and R2 systems are made by brackets, such as tandem or point type, or by two pin crossarms on the sides of poles. Drop type transpositions may impair the effectiveness of the system, particularly at carrier frequencies, and their use is not recommended.

2.07 Although there is no established limitation on deviations in pole spacing or sag, all practicable means should be used to minimize these.

2.08 Branch circuits should be transposed independently of the progress of the transposition system in the main circuit. That is, the first pole in the branch lead should correspond to pole No. 1 of the transposition diagram.

2.09 Subject to the frequency limitations discussed in Paragraphs 3.04 and 4.022 a single carrier system can usually be routed over a pair on an R1 or R2 transposed line. If more than one carrier system is desired it is advisable to make crosstalk loss measurements over a range of carrier frequencies between one or more combinations of pairs. Such measurements indicate which type of carrier system is suitable and the number of channels which may be employed. Two compandored carrier systems up to about 100 kc have been used successfully on pairs 1/2 and 7/8 or 3/4 and 9/10 on R1 transposed lines. For R2 transposed lines the corresponding top frequency is about 50 kc.

2.10 Where a number of up to 8 carrier systems on a line are desired and a new line is to be built, the REA-1 transposition system (REA-TE & CM-463) may be suitable. When an R1 transposed line exists, four pairs on the top arm may be made suitable for carrier by making minor transposition changes as discussed in (REA-TE & CM-466) entitled REA-3 Transposition System.

3. THE R1 TRANSPOSITION SYSTEM

3.01 Physical Features

3.011 The R1 system essentially transposes each pair at every other pole. For crosstalk control, however, horizontally or vertically adjacent

pairs are transposed at different poles as can be seen from Figure 1, of this section. This results in transpositions in half of the pairs at all even numbered poles and transpositions in the other half of the pairs at all odd numbered poles in a line.

3.012 To provide additional crosstalk control, transpositions are omitted on certain pairs at certain specific intervals. These omissions are made on the 25th, 50th, 75th and 100th pole as shown in Figure 1 of this section. The pattern is then repeated for the 125th, 150th, 175th and 200th pole. This pattern is carried through to the end of the line.

3.02 Application Features

3.021 The R1 system should be used with tandem transposition brackets in non-windy areas for all joint use plant and for non-joint construction involving span lengths averaging 300 feet or greater for all voice frequency applications.

3.0211 For windy areas, point type brackets should be used. Refer to REA-TE & CM-615 for additional information on transposition brackets to use under various conditions. These may cause a signficant increase in overall pole line cost. Where increased cost due to the employment of point type brackets is excessive, it is considered good engineering practice to employ the R2 system (Par. 4) for multi-circuit leads and the REA-V1 system (REA-TE & CM-465) for single circuit leads for all subscriber lines on a system wide basis regardless of span length or joint use. This may be done only if little or no carrier frequency capability is needed. Special study may have to be given to those circuits which may require additional transpositions in order to effectively reduce excessive noise. In this connection, however, experience has shown that serious noise usually results from other causes (C.O. unbalances, ringer unbalances, etc.; refer to REA-TE & CM-455) and no retransposition to reduce noise should be considered until there is a certainty that the more common causes have been eliminated.

3.0212 For salt spray areas, point type brackets, insulated line wire or both may have to be employed. These cases should be given special study by the engineer.

3.03 Additions, extensions and branches to existing lines already transposed to another voice frequency system may be applied by means of the R1 system without regard to the transposition intervals of the existing system. If carrier frequencies are to be superimposed on one or more pairs of such a line, special study must be given by the engineer.

3.04 Performance at Carrier Frequencies

3.041 Unless line insertion loss at carrier frequencies is measured in advance, it is not recommended that carrier systems in the region 220-450 KC be applied to the R1 system because of absorption peaks. Below this frequency range, carrier may be applied to any one pair of the R1 system provided that the total of attenuation and miscellaneous losses are within the manufacturers' recommendations.

4. THE R2 TRANSPOSITION SYSTEM

4.01 Physical Features

4.011 The R2 system involves transposing each pair every four spans. As in the R1 system, horizontally or vertically adjacent pairs are transposed on different poles. With the transpositions made on the even numbered poles, this results in half the pairs being transposed on poles whose numbers when divided by four result in a whole number. The other half of the pairs are transposed on even numbered poles whose numbers when divided by four do not result in a whole number.

4.012 Certain transpositions are omitted to provide additional crosstalk control. These omissions are made on the 26th, 52nd, 78th and 100th pole as shown in the diagram on this system. The pattern is then repeated for the 126th, 152nd, 178th and 200th pole and so on to the end of the line.

4.02 Application Features

4.021 The R2 system normally should be used with tandem transposition brackets for non-joint use construction involving span lengths averaging less than 300 feet for all voice frequency applications, provided that the application is not in a windy or salt-spray area. For windy or salt-spray areas, where point brackets are required (below), and it is necessary to hold line construction costs to a minimum, the R2 system can be used for multi-circuit leads even with average span lengths over 300 feet.

4.0211 For windy areas, tandem brackets should not be used where the average span lengths are over 200 feet. In these cases, point type brackets should be employed. For single circuit leads in windy areas, the REA-V1 transposition system (REA-TE & CM-465) should be employed if little or no carrier frequency capability is needed.

4.0212 Salt-spray areas may require point type transpositions or insulated line wire or both and should be given special study by the engineer.

4.0213 Refer to REA-TE & CM-615 for more information on transposition bracket applications.

4.022 Performance at Carrier Frequencies

4.0221 Unless line insertion loss at carrier frequencies is measured in advance, it is not recommended that carrier systems in the region 115-225 KC be employed because of absorption peaks. The absorption peaks depend on span lengths as follows:

Average Span Length in Feet	Frequency Range in KC Where Excessive Absorption Peak Effects are Apt to Occur in the R2 Transposition System
300	175-225
325	165-215
350	150-200
375	140-180
400	130-170
425	120-160
450	115-155

4.0222 Outside of the region of excessive absorption peaks, carrier may be applied to any one pair of the H2 system provided that the total of line attenuation and miscellaneous losses are within the manufacturers' recommendations.

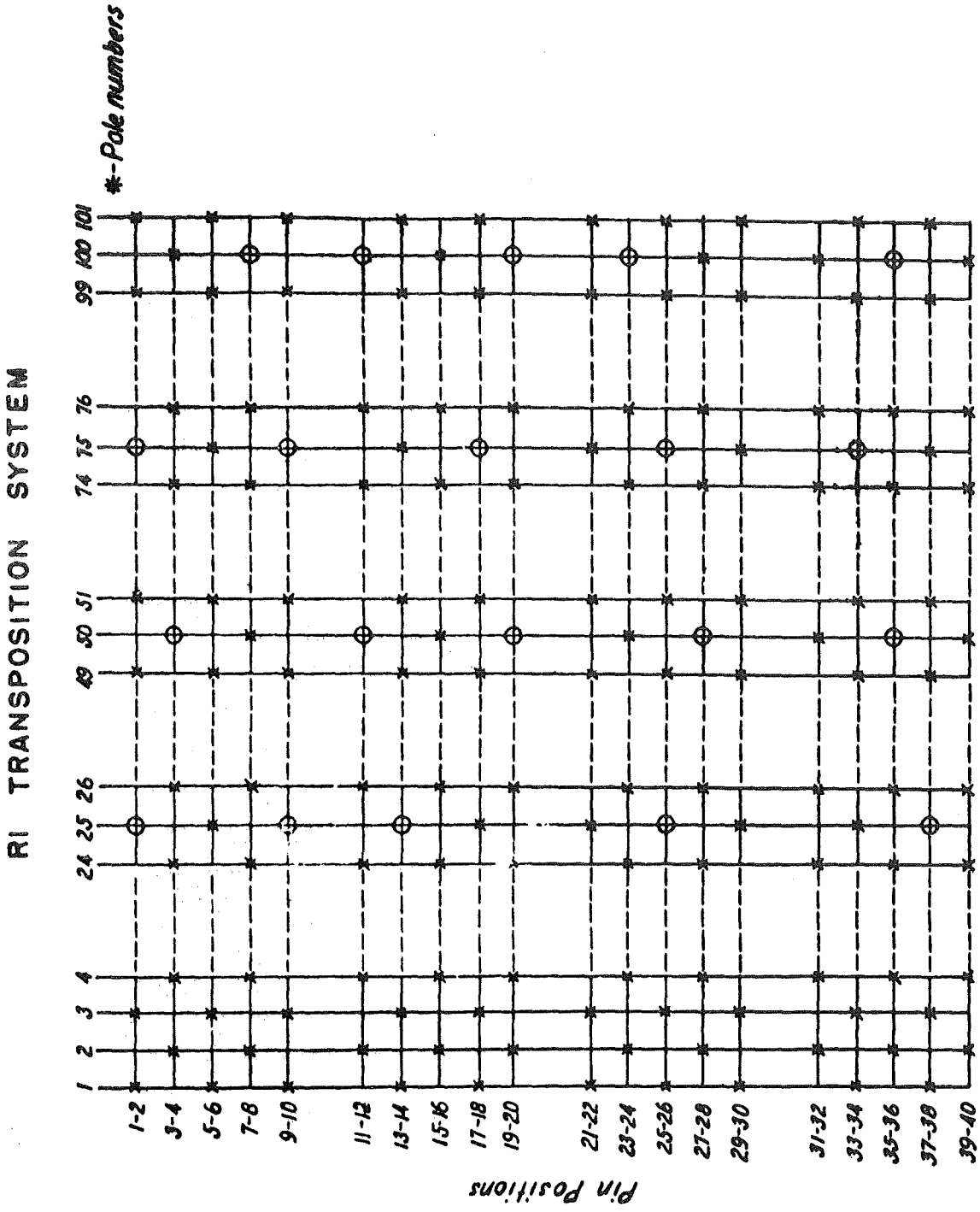

Figure 1

- Indicates transposition omitted from normal pattern - See paragraph 3.012 in text. For lines longer than 100 poles, pattern is repeated.

* - Pole numbers shown are not necessarily the pole numbers in the line. These numbers are shown only to illustrate the progress of the transposition pattern.

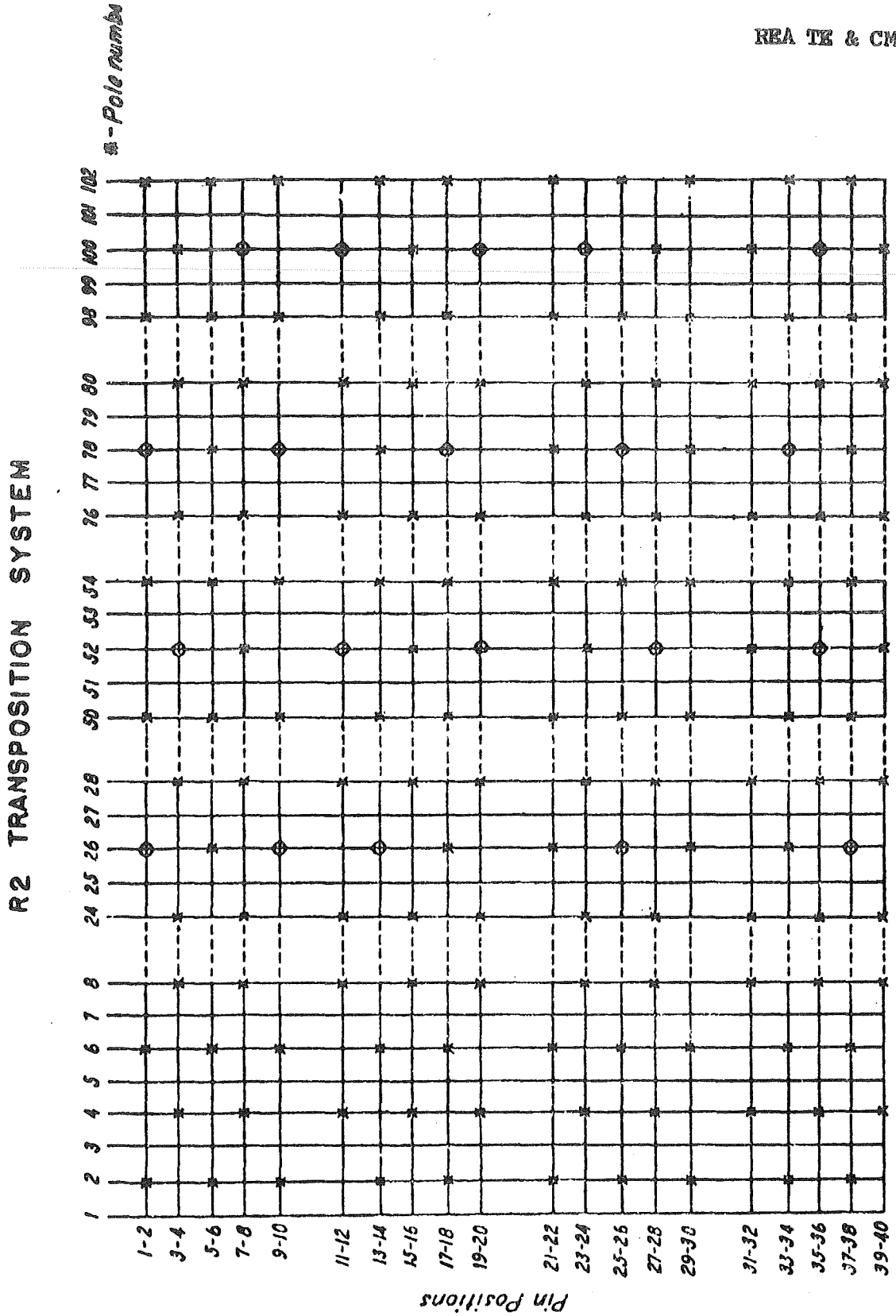

Figure 2