500 SERIES COMBINED TELEPHONE SETS
TRANSMISSION PERFORMANCE
C AND D SERIES

CONTENTS PAGE

1. GENERAL

1.01 This section is reissued to include actual test data on the overall transmission, crosstalk, noise, and sidetone performances of the C and D series sets.

1.02 This section describes the electrical characteristics and transmission performance of the 500 and 501 C and D series of combined telephone sets. In these sets equalization is effected by means of varistors rather than by the filament-thermistor combination used in the A and B sets. Discussion of crosstalk and sidetone considerations and of the effect of longitudinal noise and set unbalances is also included. The information contained herein will, in general, apply to subsequently coded sets which utilize the same varistor type of equalization.

2. FIELD OF USE

2.01 The C and D series of 500-type sets are modifications of the earlier A and B series. They contain a newly designed transmission network which includes the equalizing elements as integral parts, thus eliminating the separate equalizer unit. The C and D series sets may be used interchangeably with A and B sets on all common battery loops out to the loop resistance limit of the office. The use of long line equipment may permit extension of the loop to a resistance at which the particular type of equipment will provide a minimum loop current of 23 mA as discussed in Section AB43.535. With commonly used types this may be as much as 1800 ohms. In addition, due to their lower resistance on short loops, the C and D series sets may be used on certain PBX applications from which the A and B sets were restricted, as described in the 502 Division of the Plant Series.

3. CIRCUIT DESCRIPTION

3.01 Figure 1 shows the circuit diagram of the 500D set, which includes a 7A dial. Its manual counterpart, the 500C set, is provided with an apparatus blank in place of the dial. As in the case of the A and B series, the 500C and D sets are adaptable by changes in set and line connections for all services except 4-party full selective and 8-party semiselective. Details of the connections for the different classes of service may be found in the 502 Division of the Plant Series.

3.02 The 501C and D sets, which contain a 426A in place of the C2A ringer, are for use on 4-party full selective and 8-party semiselective services, but are otherwise identical to the 500C and D sets. As described in the 502 Division of the Plant Series, 501-type sets also may be used at 2-party flat rate and divided code ringing stations to provide mitigation in cases of high inductive noise.

3.03 The transmission network of the C and D series sets is coded 425B and differs from the 425A network in that it contains a different sidetone balancing network and two equalizer

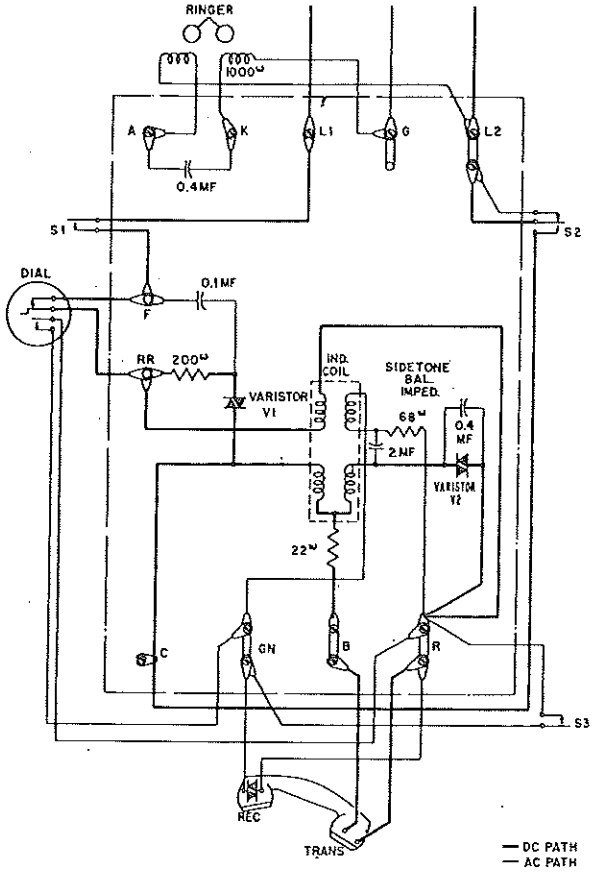


Fig. 1—Circuit Diagram of 500D Set

elements in the form of silicon carbide varistors (Fig. 1a).

3.04 Referring to Fig. 1, varistor V1 is bridged across the set in series with a 200-ohm resistor which also serves as an element of the dial filter. The resistance (both ac and dc) of varistor V1 varies inversely with the current through the set. The ac resistance is about 3/10 of the dc resistance and introduces between the impedance of the line and the impedance of the set a shunt loss which provides the major portion of the equalization feature. Since the dc resistance of the shunt is large compared with that of the set, varistor V1 has a negligible part in control of the transmitter current.

3.05 Varistor V2 is bridged across the receiver, one winding of the induction coil secondary and the 2-μF capacitor and serves two functions, that of maintaining the sidetone balance and that of providing a dc shunt path for the transmitter.

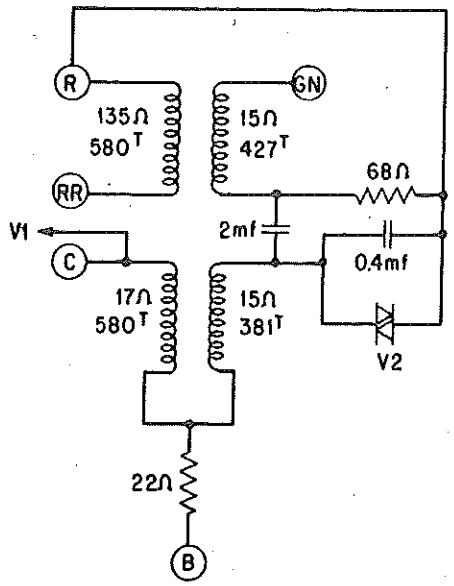


Fig. 1a—Induction Coil Circuit of 425B Network

3.06 On long loops the resistances of both V1 and V2 are very high and have no effect on the performance of the circuit. Under this condition, the resistor and capacitor elements of the balancing network provide adequate balance for the line facility. As the loop is shortened the ac and dc resistances of varistor V1 decrease, lowering the impedance of the line as seen from the set and making it more nearly resistive. Correspondingly, the resistance of varistor V2 also decreases, reducing the impedance of the balancing network and making it also more nearly resistive. Thus, the impedance relationship between the line and the network is maintained and adequate sidetone balance is obtained for all values of loop current.

3.07 The second function of varistor V2 is that of providing a dc shunt path for the transmitter. On long loops the resistance of this varistor is high enough so that it has no significant effect on the current in the transmitter branch. As the loop shortens, the resistance of varistor V2 drops until on very short loops its resistance approaches that of the transmitter branch. Thus, varistor V2 carries a substantial portion of the loop current and limits the current through the transmitter. Since transmitters vary somewhat from the nominal 50-ohm resistance, a stabilizing series resistance of 22 ohms has been placed in the transmitter branch of the circuit.

3.08 It will be noted that the 2-μF capacitor has been located in the circuit so that it not only blocks dc current flow through the receiver but also serves as an element of the sidetone balancing network.

3.09 Figure 2 is a photograph of a 500D-3 set with the cover removed to show the arrangement of components.

4. TRANSMISSION PERFORMANCE

4.01 The transmission data given in Section 852-220-101 for the 500A and B series sets is, in general, considered applicable to the C and D series, with the exception that on short and medium length loops the latter sets are slightly higher in transmitting and receiving volumes. On long loops the performances are practically identical. For this reason the loop loss data for 500 series sets contained in the AB43 Sections of the practices may be applied also to C and D series sets. Although the data do not apply strictly on short and medium length loops, the performance is never poorer than that shown by the curves.

5. CROSSTALK

5.01 As in the case of other 500 series sets, the C and D series on long loops are comparable in crosstalk performance to 300 series local battery talking sets with HC5 receivers. On short loops, due to slightly less equalization than that attained in the A and B sets, the crosstalk performance of the C and D sets is expected to be a little poorer. However, except where crosstalk couplings are marginal with 300-type sets, no crosstalk problems sufficiently serious to require remedial measures in outside plant are anticipated. Further information on the crosstalk aspects of station sets will be found in the AB61 Series of the practices.

6. SIDETONE

6.01 As described in Part 2, the sidetone balance is maintained by the simultaneous change

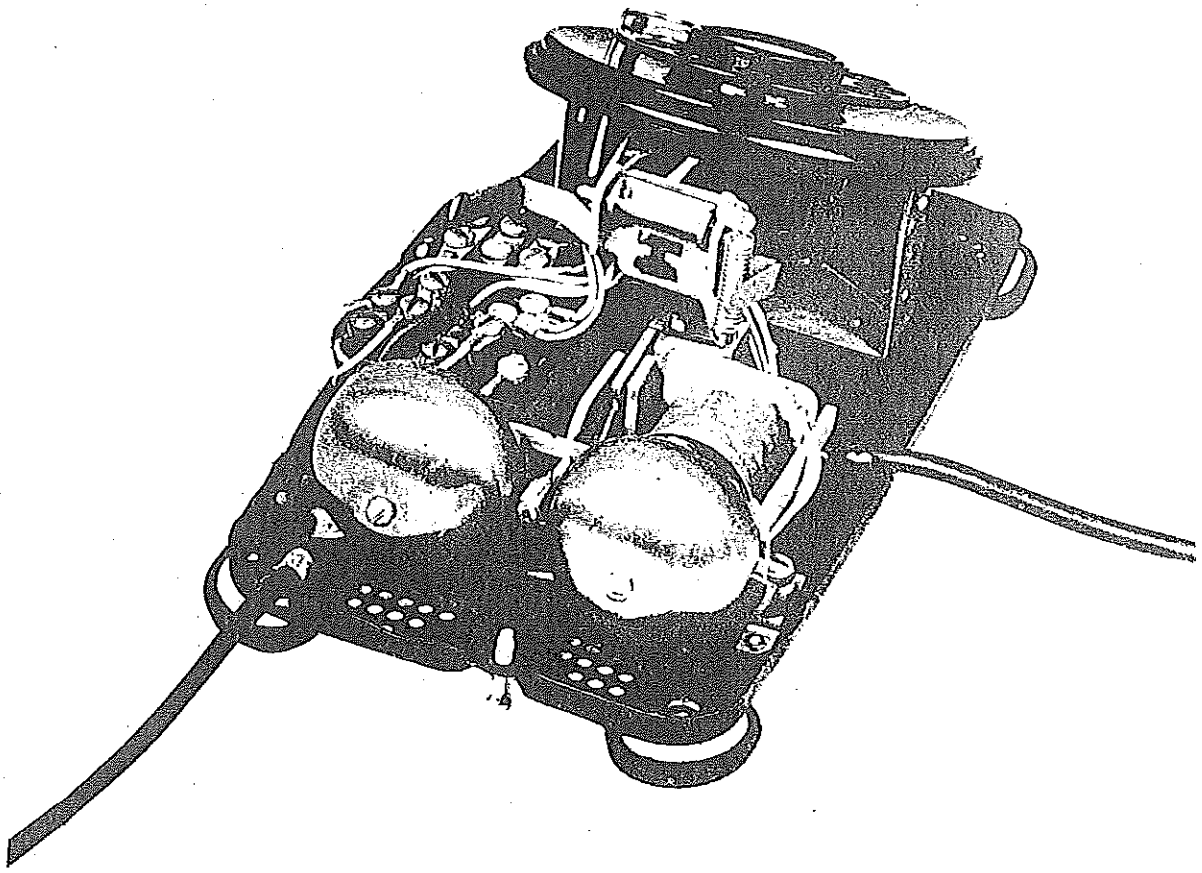


Fig. 2—500D-3 Telephone Set

of both the bridged impedance and the network impedance. The degree of balance attained will be dependent also upon the impedance of the line, or on very short loops upon the impedance of the trunk to which the line is connected. On short and medium length loops the sidetone levels of the C and D series sets may be expected to be slightly, but not significantly, higher than those of the A and B series sets which are approximately the same as that of the 302 set.

7. NOISE

7.01 For classes of service employing grounded ringing, the C and D series sets on long loops, like the A, B, J, and K series, have a higher susceptiveness to longitudinal noise above 250 Hz than the 300 series sets. On short and medium length loops the C and D sets may be expected to have a somewhat higher susceptiveness than the A and B sets due to the lesser degree of equalization attained. In Fig. 1 it will be noted that the primary winding of the induction coil has been divided between the two sides of the line. In addition, the point of connection of the grounded ringer winding for tip party dial measured and automatic ticketing services has been placed at terminal "B" between the transmitter and the stabilizing resistor. This point is nearer the electrical center of the circuit and these two features result in better balance to ground with a lower susceptiveness than attained in the 500B and K sets for these classes of service.

7.02 Unless longitudinal noise is high enough to be marginal with 300 series sets, it is not expected that the higher susceptiveness of the 500C and D sets will alone be sufficient to require any corrective measures in outside plant. Further information on the susceptiveness of these sets under various set, loop, and battery supply conditions will be found in the AB63 Series of the practices.

8. TEST DATA

8.01 Actual test data on the overall transmission, impedance, and sidetone performances of typical C and D series sets are included in Fig. 3 through 11. Transmitting, receiving, and sidetone response over the frequency range at various loop currents for typical sets is shown in Fig. 3 through 5. The arrangements used to determine the data are shown under each set of curves. Figures 6 through 8 show the impedance characteristics of the C and D sets measured at various terminals, and Fig. 9 shows the line impedance at which minimum sidetone levels are obtained. Finally, Fig. 10 and 11 show loop and transmitter current variations under various conditions.

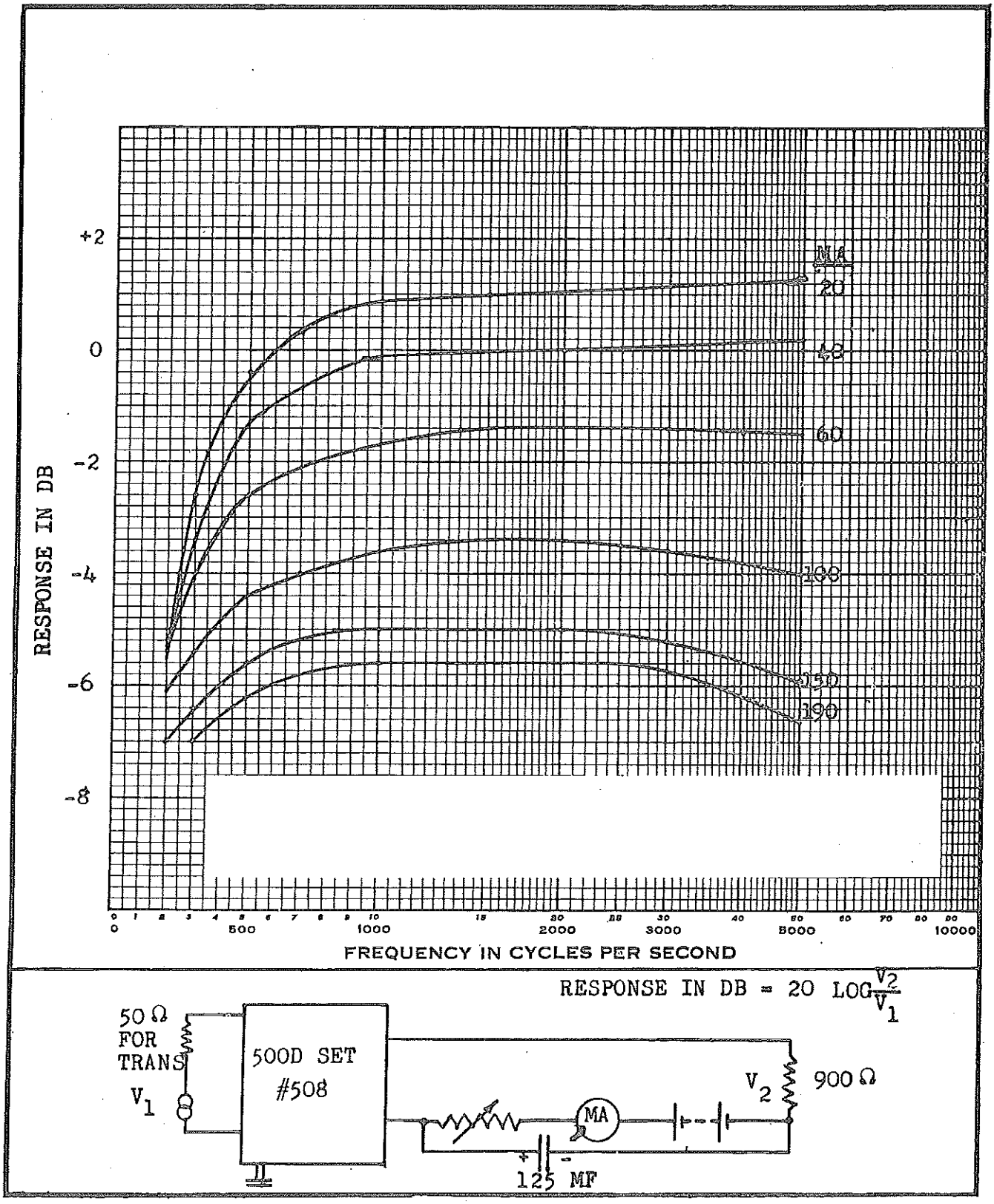


Fig. 3—500C and D Telephone Sets—Transmitting Response

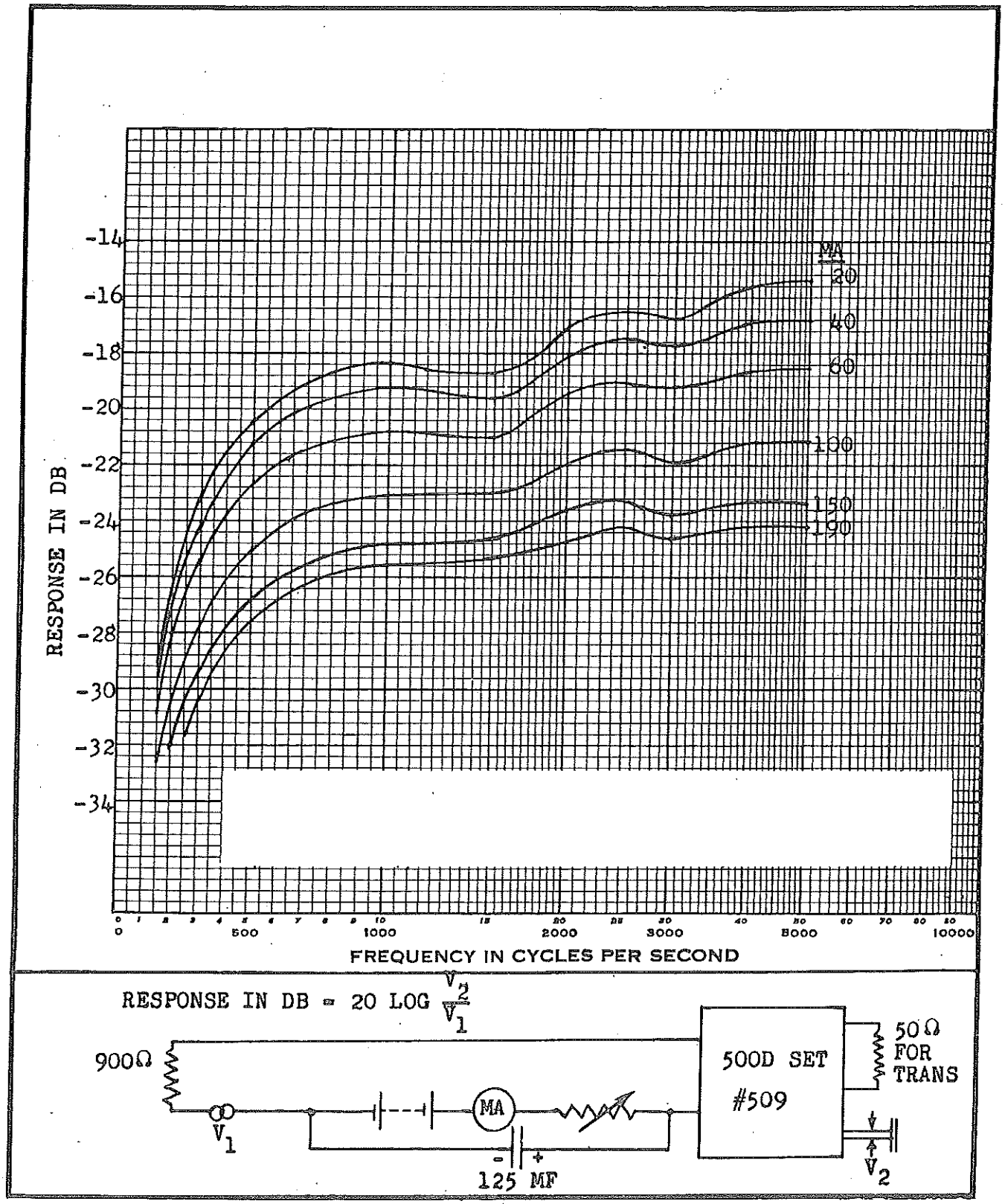


Fig. 4—500C and D Telephone Sets—Receiving Response

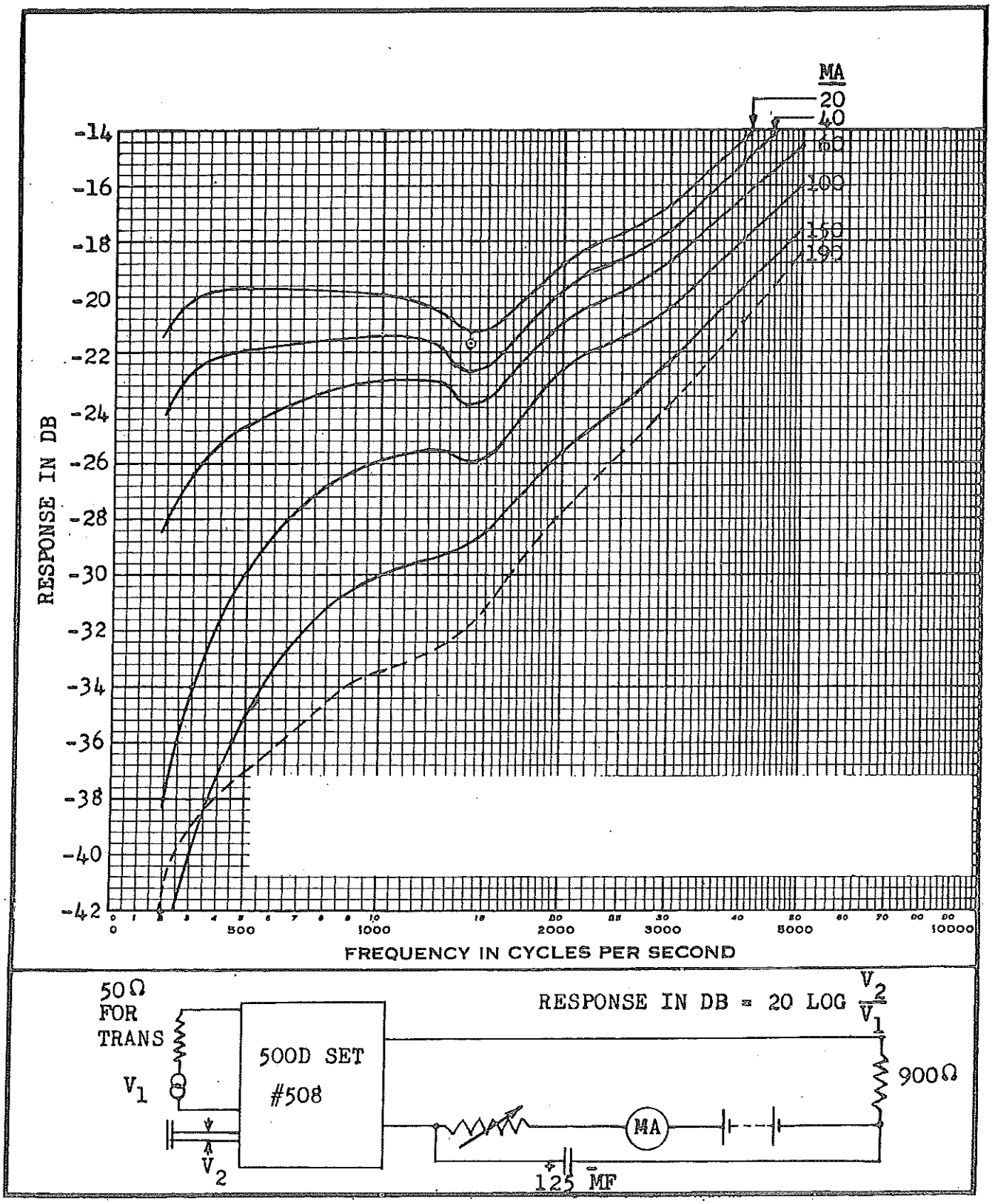
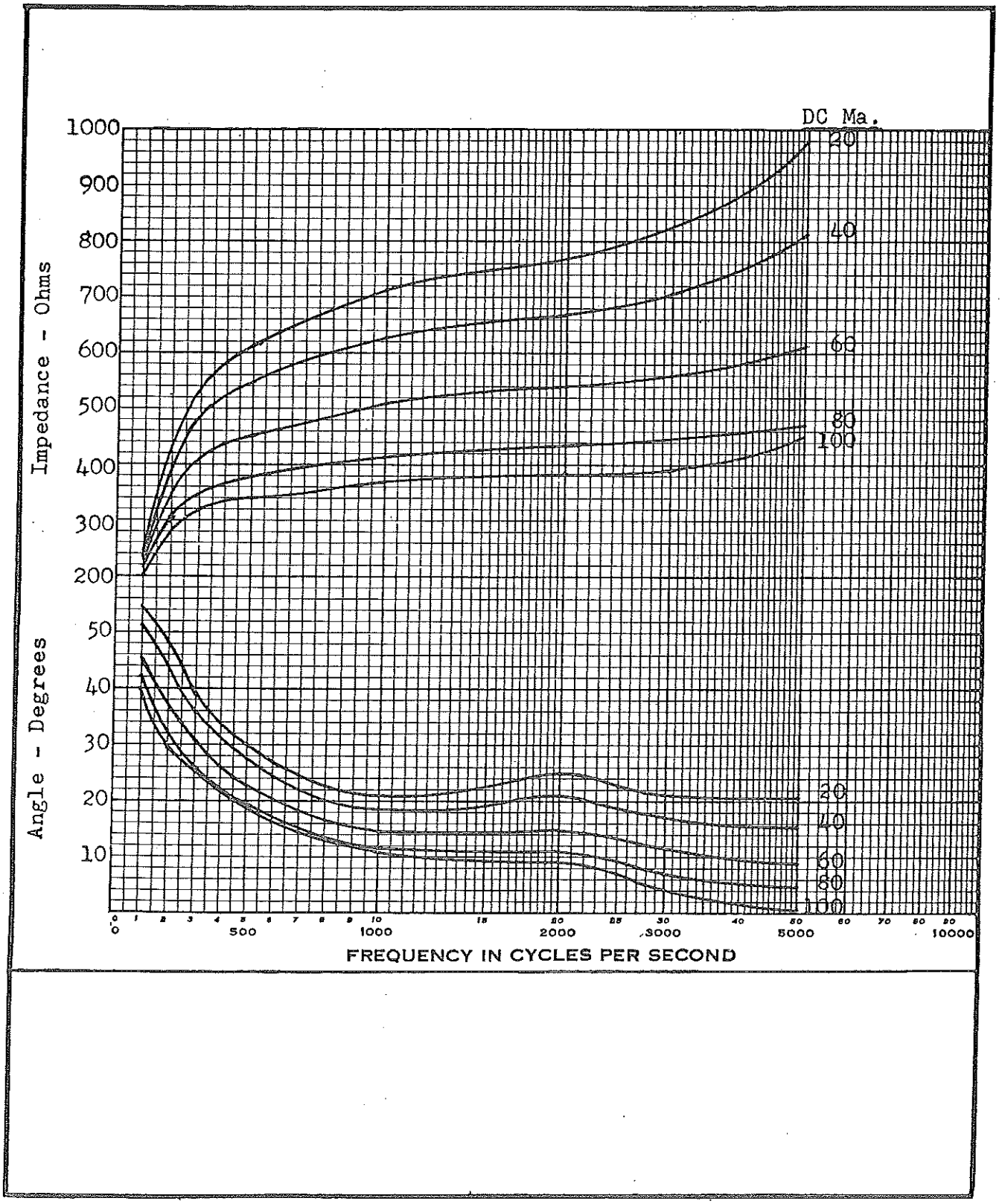


Fig. 5—500C and D Telephone Sets—Sidetone Response



The above impedances were measured with 50 ohms substituted for the transmitter.

Fig. 6—500C and D Telephone Sets—Impedance at Line Terminals

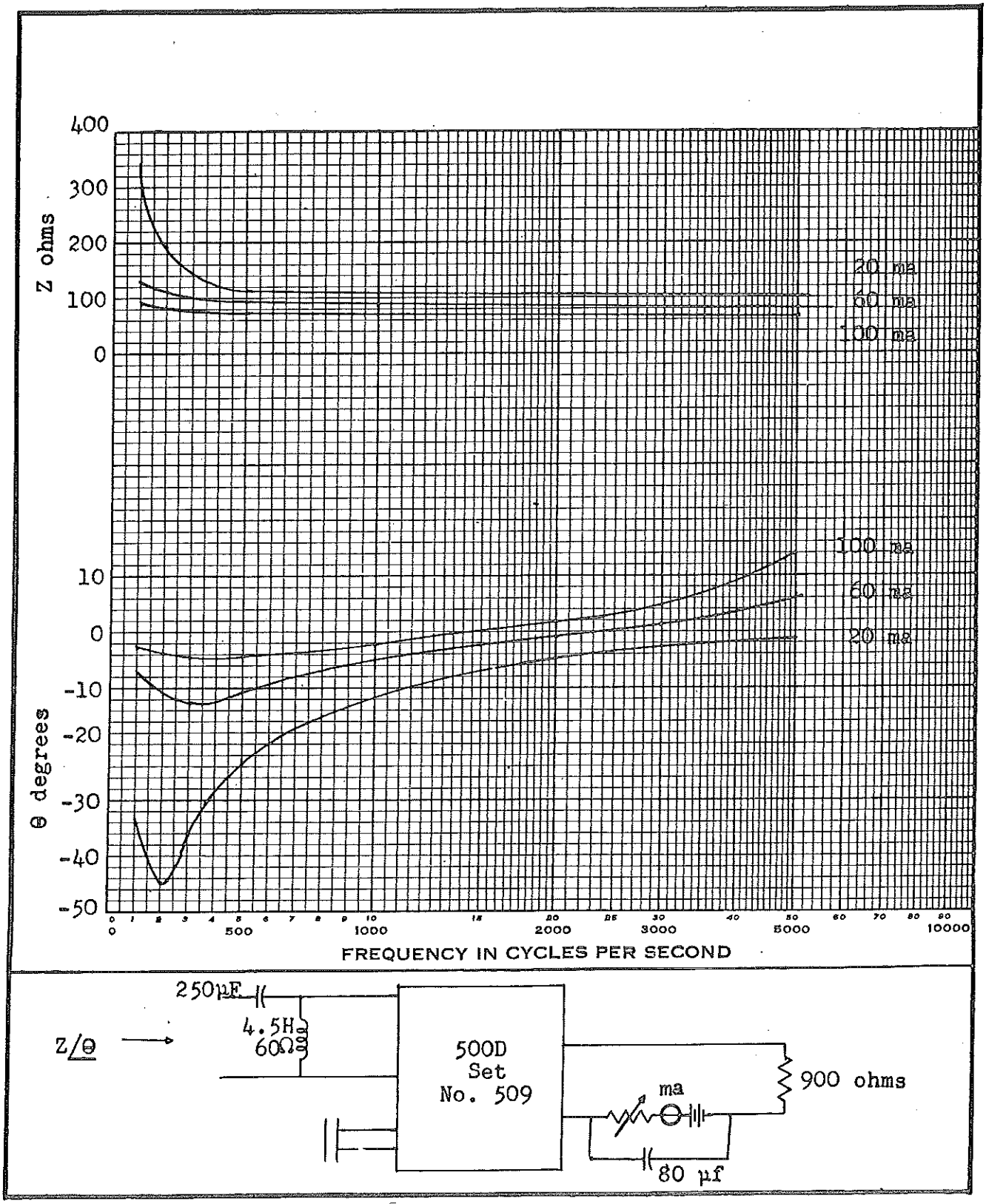


Fig. 7—500C and D Telephone Sets—Impedance at Transmitter Terminals

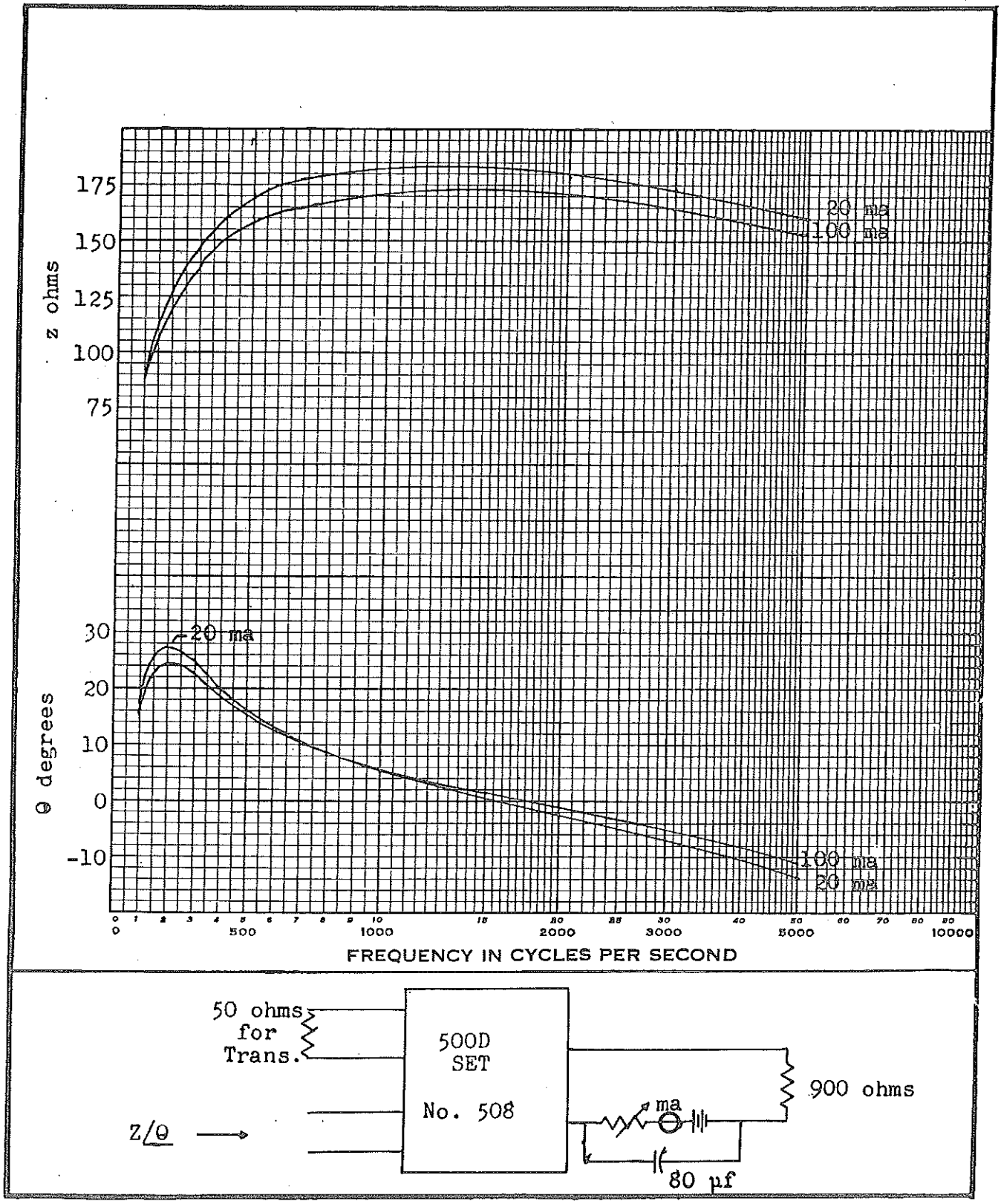


Fig. 8—500C and D Telephone Sets—Impedance at Receiver Terminals

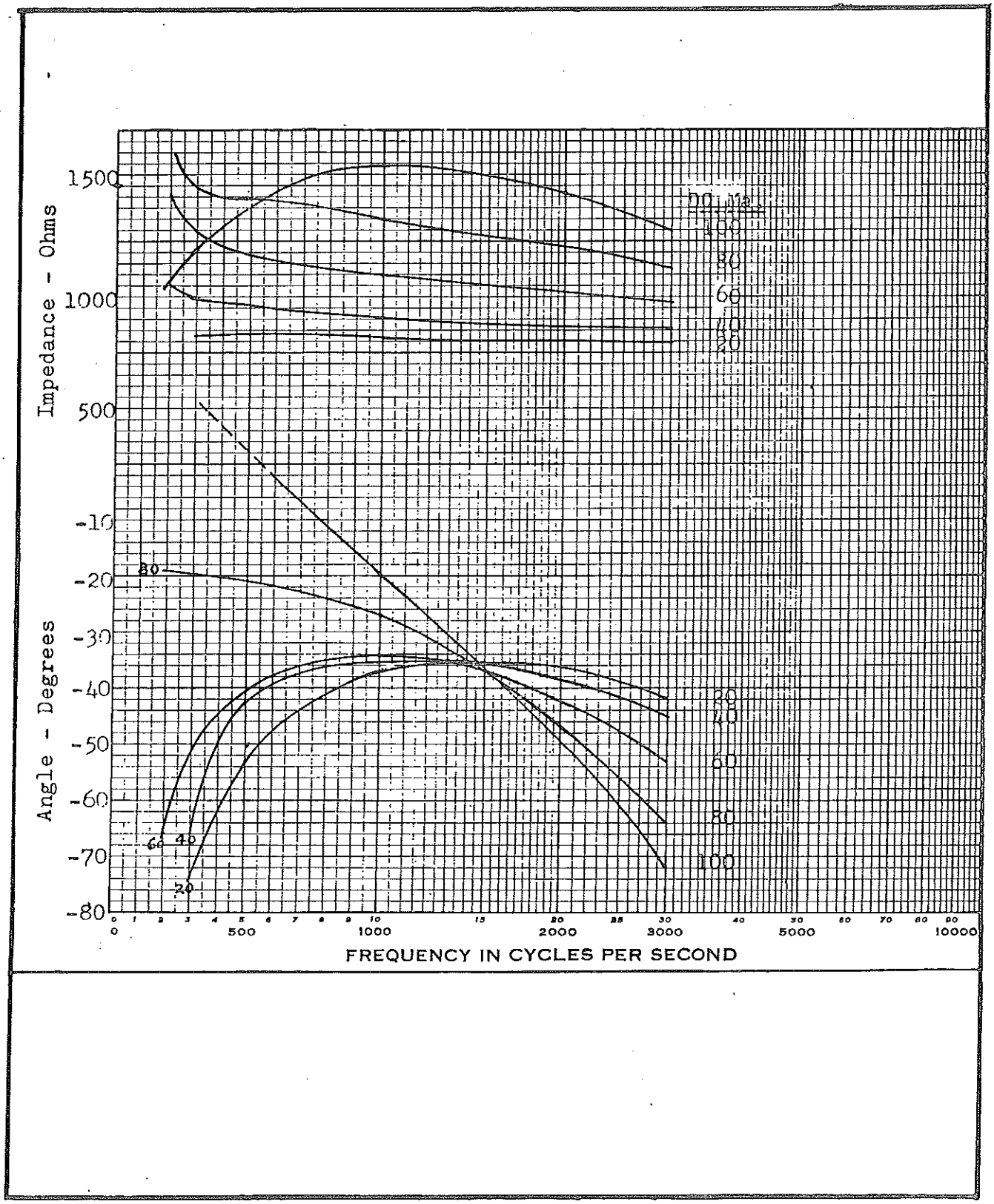


Fig. 9—500C and D Telephone Sets—Line Impedance for Minimum Sidetone

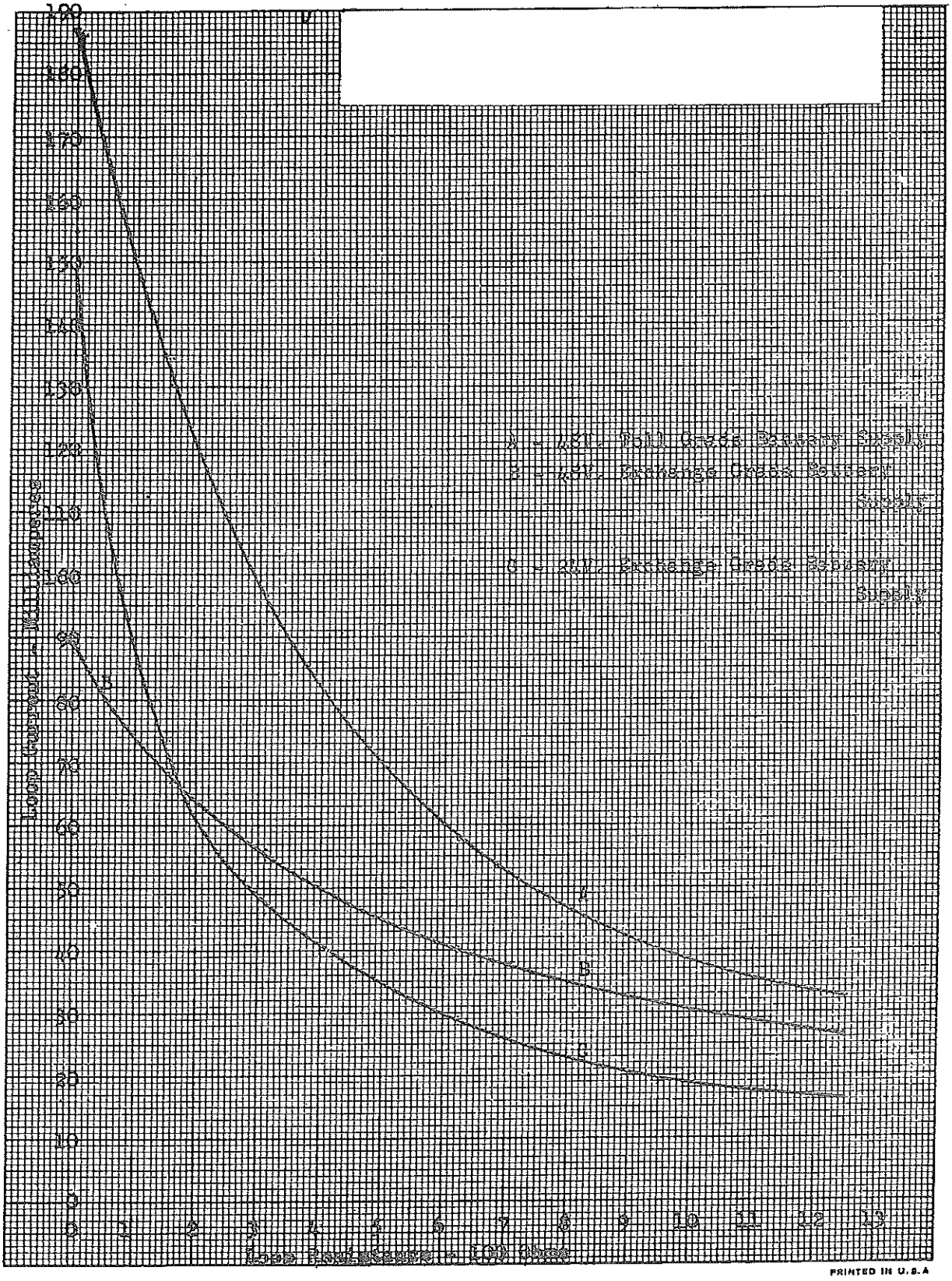


Fig. 10—500C and D Telephone Sets—Loop Current Characteristics

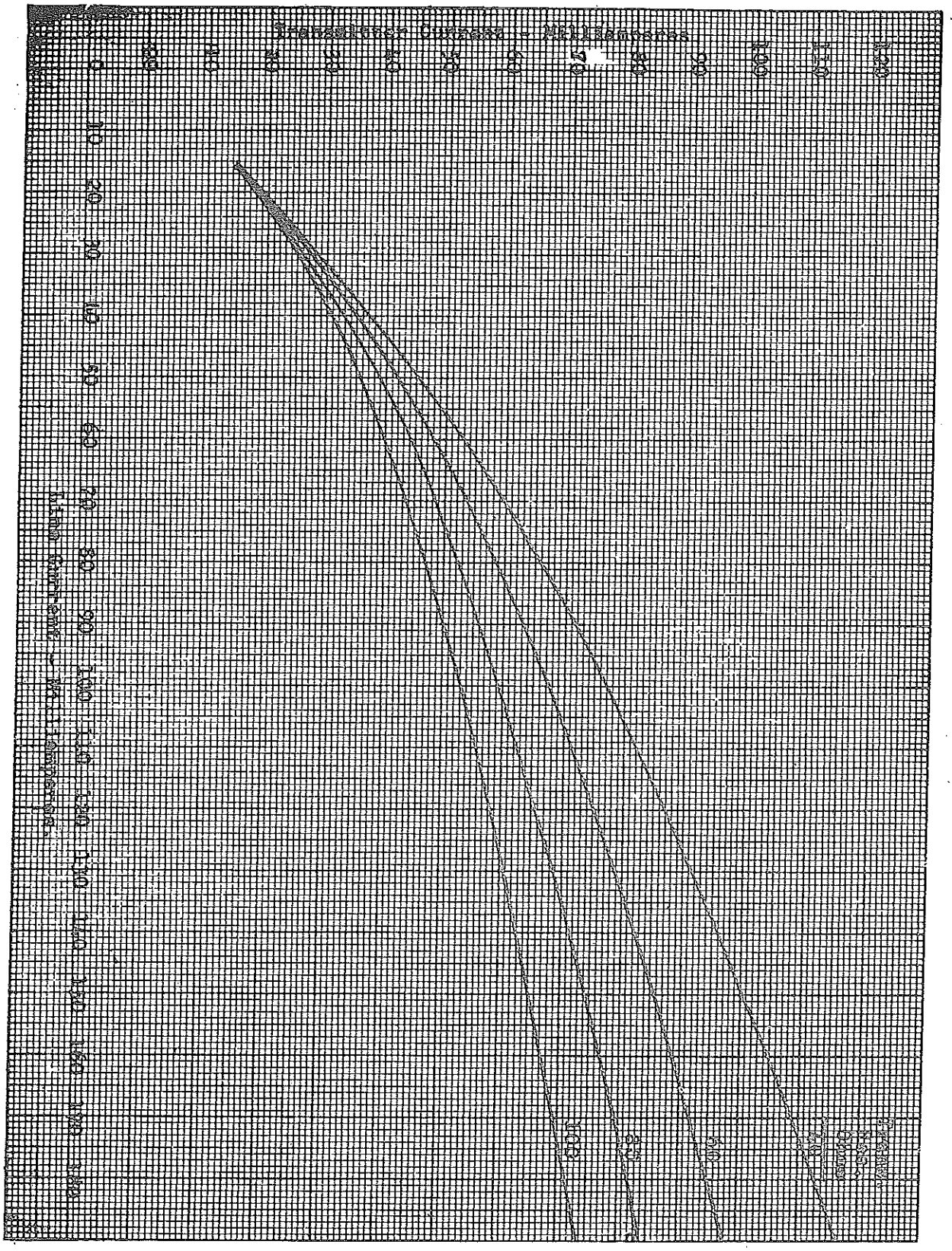


Fig. 11—500C and D Telephone Sets—Transmitter Current Versus Line Current