KS-16816,L1 EQUALIZER —

DESCRIPTION

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1. GENERAL

1.01 This section describes the KS-16816,L1 Equalizer for use on 5, 8 and 15 KC local program circuits. The unit is designed to equalize nonloaded cable pairs and can be mounted in the central office or at the customer's premises.

1.02 The equalizer is portable (10 lbs.) and has the following equipment features:

(1) A 111C repeating coil which can be strapped for 150 or 600 ohms on the line side.

(2) A 251A inductor (tapped) and six fixed capacitors.

(3) A rotary switch for selecting suitable L/C ratios: one ratio for 5 KC and 8 KC and four for 15 KC.

(4) A 1000 ohm slide wire resistor calibrated for use as the resistive element.

(5) A series-resonant circuit which is provided for use on an optional basis. It can be used to introduce a large transmission loss at about 8 KC when the rotary switch is set at 5 KC.

(6) Provision for mounting on the wall at the customer's premises or on standard mounting rails on relay racks in a central office.

(7) An apparatus box 9-9/16″ high, 7-3/32″ wide and 4-9/16″ deep which houses the assembly. The box is finished in beige-gray wrinkle enamel.

(8) Screw terminals which are provided for making external connections to the equalizer.

1.03 Fig. 1 shows a view of the equalizer with the cover in place. Fig. 2 is a view with the cover removed. Connecting information and the schematic for the equalizer is provided on SD-95285-01.

Fig. 1 — Equalizer with Cover in Place

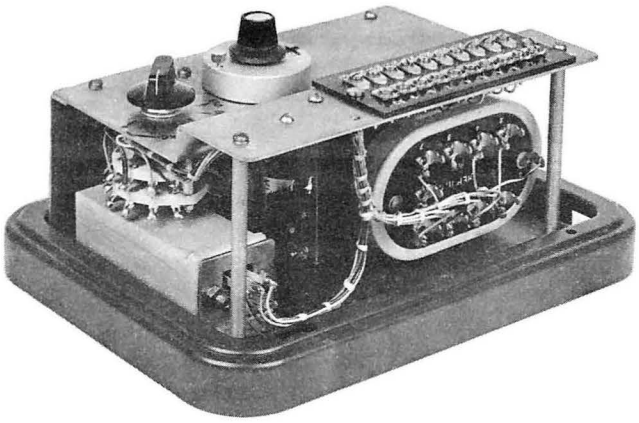

Fig. 2 — Equalizer with Cover Removed

2. DESCRIPTION

2.01 The KS-16816,L1 Equalizer is designed for use at the customer's premises or in the central office. It is housed in an apparatus box and can be screwed to mounting rails spaced 6-3/8" apart in the bay or it can be screwed to a wall board at the customer's premises.

2.02 Line connections and straps are made to screw-type terminals mounted under the cover of the unit. The connections are brought into the equalizer through cutouts provided in the base. The unit is normally provided with a strap between terminals 17 and 18. The strap is removed when it is desired to add external resistance to provide additional equalization. This feature is discussed in more detail later.

2.03 The KS-16816,L1 Equalizer is equipped with a 10-turn, continuously adjustable 1000 ohm precision resistor and a dial which reads directly in ohms. The resistance is used in series with the fixed parallel combinations of inductance and capacitance to equalize 5, 8 or 15 KC local program circuits. This determines the low frequency loss. The adjustable arm is gold plated to minimize noise which may otherwise result when the equalizer is in use for long periods of time without resetting the resistance.

2.04 The equalizer is an anti-resonant device. Below the resonant frequency the reactance is capacitive and, hence, the equalized loss increases as the frequency decreases. Since the equalizer acts like a resistance shunted across the cable pair, it introduces more loss at the low frequencies than it does at the high frequencies. Also, the lower the resistance introduced the greater the equalization.

2.05 As the frequency increases, the inductive reactance increases. Therefore, the resistance has less equalizing effect as the inductance and capacitance approach resonance. Hence, the equalizer introduces less loss at the higher frequencies. In general, the loss of the cable pair increases with frequency while the loss of the equalizer decreases with frequency. The resonant frequency of the equalizer is designed to be sufficiently above the highest equalized frequency for each band so as not to degrade the circuit. Table I below shows the various resonant frequencies for the selector switch.

TABLE I

SWITCH POSITION	RESONANT FREQUENCY (KC)
5 KC	6.0
8 KC	9.6
15 KC-1	17.6
15 KC-2	18.2
15 KC-3	21.3
15 KC-4	23.7

2.06 A separate series-resonant circuit is provided in the equalizer assembly to introduce a large loss at 8 KC when the rotary switch is set at 5 KC. This limits the user of the program circuit to a 5 KC channel when the switch is in this position. The circuit may be used on an optional basis and, when employed, should be connected to the drop side of the repeating coil in the following manner: Terminal 20 should be connected to terminal 10 and terminal 19 should be connected to terminal 9.

2.07 One of the advantages of the KS-16816,L1 Equalizer is its flexibility. It is arranged so that nonloaded cable sections can be equalized quickly and easily. It should equalize the same

length of single or mixed gauges of cable handled by the 23A Equalizer and an equalizer assembled locally per SD-55503-01.

2.08 The maximum length (bare-pair loss) of nonloaded cable which can be amplitude equalized to either 5 KC or 8 KC is about 12.5 db at 1000 cycles. For 19 gauge cable with this limiting loss, the circuit can be equalized to within ±1 db of its 1000 cycle value. If mixed gauges smaller than 19 gauge are used, this characteristic may depart by as much as ±2 db from the 1000 cycle value. For 5 KC circuits, the rotary selector switch should be set to the 5 KC position and the equalizer should be connected to the line side of the 111C repeating coil.

2.09 Table II below shows the approximate length of nonloaded cable, consisting entirely of one gauge, which can be equalized to 8 KC. The equalized loss of the section is also shown for deviations of ±1 or ±2 db. The rotary selector switch should be operated to the 8 KC position and the slide-wire resistance adjusted, until the losses at 1 KC and 8 KC are the same. The equalizer should be connected to the line side of the 111C repeating coil.

TABLE II

	Max. Deviation ±1 db		Max. Deviation ±2 db	
Gauge	Length Miles	Equalized Loss (db)	Length Miles	Equalized Loss (db)
16	21.5	30.5	25.0	34.0
19	10.0	29.0	11.5	32.0
22	6.5	30.0	7.0	32.0
24	5.0	29.0	5.5	32.0
26	4.2	29.0	4.8	32.0

2.10 When it is desired to equalize a section consisting of mixed gauges, more difficulty will be experienced due to junction losses, variations in capacitance, etc. The limiting length for mixed gauges will be somewhat less than that shown in Table II. The over-all length will be dependent on the amounts of the various gauges used to make up the section.

2.11 When a circuit is to be equalized to 15 KC, the rotary selector switch should be set to one of the four positions for 15 KC. Each position selects a fixed tuned circuit which resonates at one of the frequencies shown in Table I. A switch position should be selected which permits the circuit to be equalized to within ±1 db over the frequency band. The slidewire will also require adjustment. The equalizer should be connected to the drop side of the 111C repeating coil.

2.12 The length of section (bare-pair) that can be equalized to 15 KC is about 10 db at 1000 cycles. This is equivalent to about 13 miles of 16 gauge nonloaded cable and about 9 miles of 19 gauge cable. Mixed gauges can be equalized provided the combined 1000 cycle loss does not exceed 10 db. If the circuit exceeds 10 db, it will be necessary to break it up into sections which can be equalized.

2.13 In most cases, it is more difficult to equalize a section made up of mixed gauges. Provision is made in the KS-16816,L1 Equalizer to insert an external resistance in series with the 251A inductor or in parallel with the drop side of the 111C repeating coil. These resistances may be helpful in providing flatter equalization with existing equalizer resistance and tuned circuits.

2.14 The resistance in series with the inductor should be in the order of 50 ohms and will provide additional flattening between 10 and 12 KC. The resistance should be connected to terminals 17 and 18 on the terminal strip after removing the strap normally provided on these terminals. In some situations additional flattening may be required between 3 and 8 KC. This can be accomplished by strapping a resistance having a value of 2000 ohms or slightly less, depending on the amount of flattening required, across terminals 7 and 8 or 9 and 10. When either of these resistances is added, the over-all equalized loss will be increased with the result that it may be more difficult to meet the noise requirements for the program circuit. Both these resistances can be used in the same setup, if needed, provided the resulting equalized loss can be tolerated.

2.15 In the majority of cases, the L/C ratios and resonant frequencies provided will be adequate to equalize the cable section within the

required limits. However, in some unusual situations for 15 KC sections, it may be necessary to provide external capacitance to effect adequate over-all equalization. The L/C ratios can be reduced by strapping an external capacitor between terminals 16 and 18 on the terminal strip. This places the external capacitor in parallel with the internal capacitor used in the equalizer circuit for a given setting of switch S1A. See the schematic shown in Fig. 3. If external capacitors are used, they should be high grade paper capacitors or equivalent.

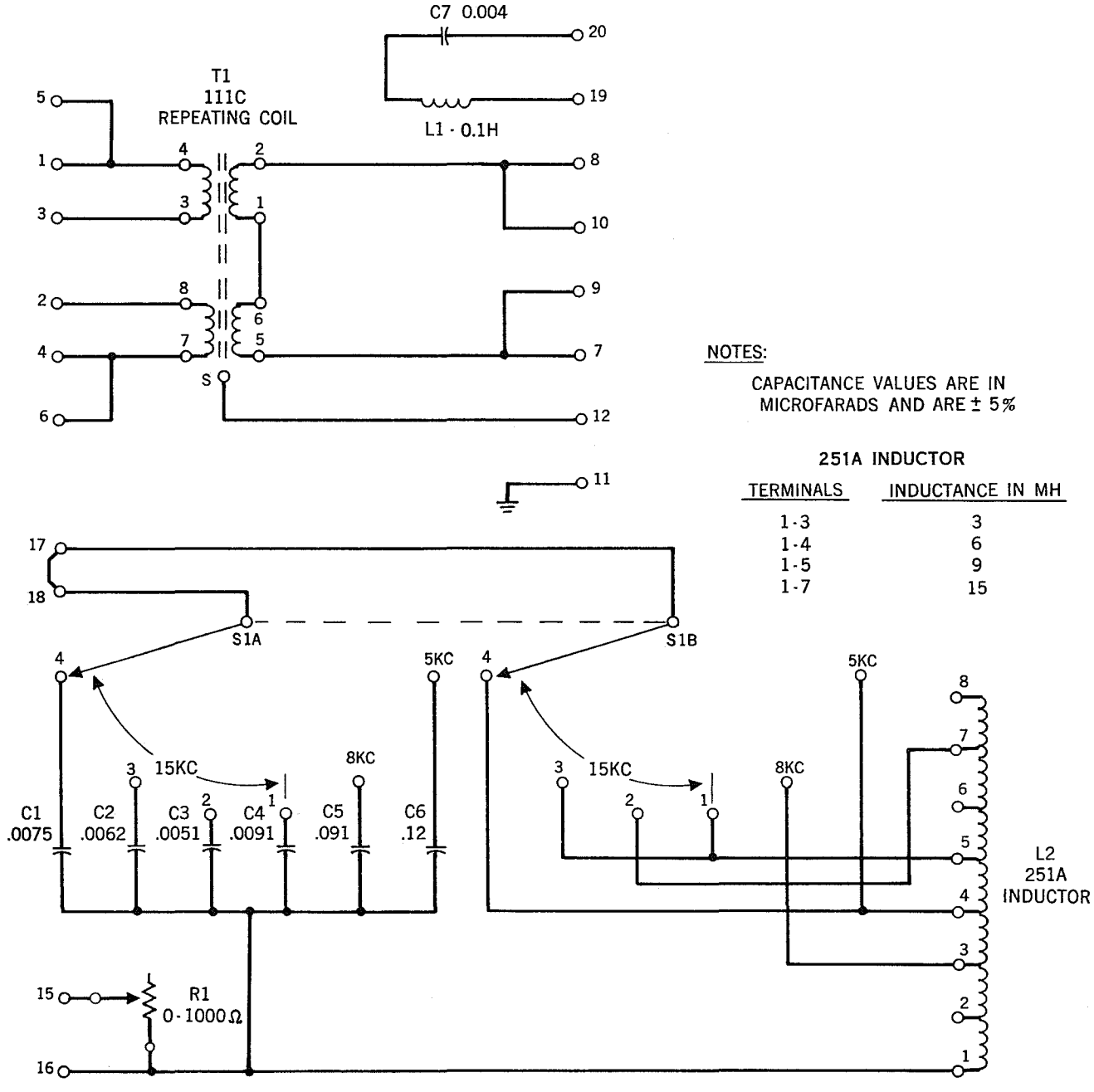

Fig. 3 — Schematic of Equalizer

3. APPLICATION OF EQUALIZER

3.01 The KS-16816,L1 Equalizer is designed as a shunt device to be connected across the line or drop side of the 111C repeating coil included with the unit. It is primarily designed for use on nonloaded cable pairs. However, it can be used on 16 gauge cable pairs with B22 loading and will equalize these circuits up to 8 KC. When used on short lengths of these facilities (1-2 db at 1000 cycles) the coil should be strapped for a 1:1 impedance ratio (600 ohms).

3.02 In most situations the repeating coil will be strapped for a 4:1 impedance ratio as shown in Fig. 4. This figure shows a simplified schematic of the circuit arrangement for 5 KC or 8 KC circuits.

3.03 Fig. 5 shows a simplified schematic for a 15 KC program circuit. In this arrangement, the equalizer is connected to the drop side of the 111C repeating coil provided with the unit. The equalizer will provide more uniform equalization when connected in this manner.

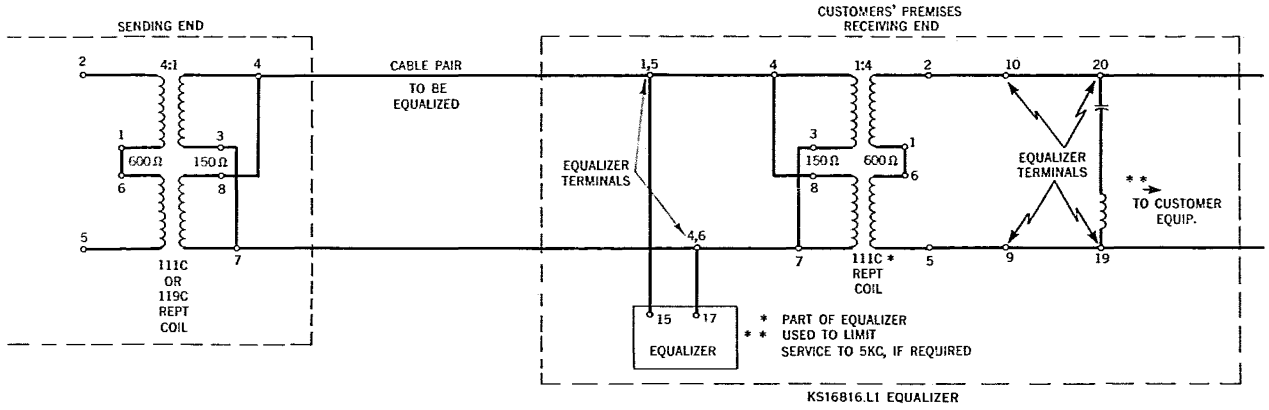

Fig. 4 — Simplified Application Schematic for 5 KC or 8 KC Program Circuits

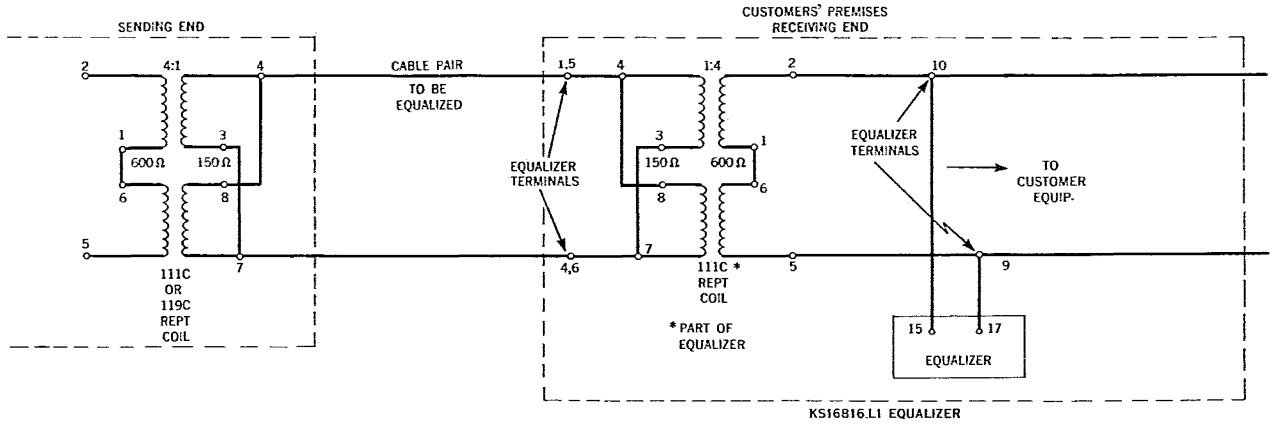

Fig. 5 — Simplified Application Schematic for 15 KC Program Circuits

4. TYPICAL ELECTRICAL CHARACTERISTICS

4.01 Shown in Figs. 6 and 7 are some typical curves for equalized facilities using the KS-16816,L1 Equalizer. The section measured was made up of 10,266 ft., 26 gauge cable. The data for each curve were obtained on a looped basis using a 21A Transmission Measuring Set. The time required to obtain data for each curve was about five minutes, which included setup time for the equalizer. Fig. 7 shows the effect of series resistance on the over-all equalization for a 15 KC bandwidth.

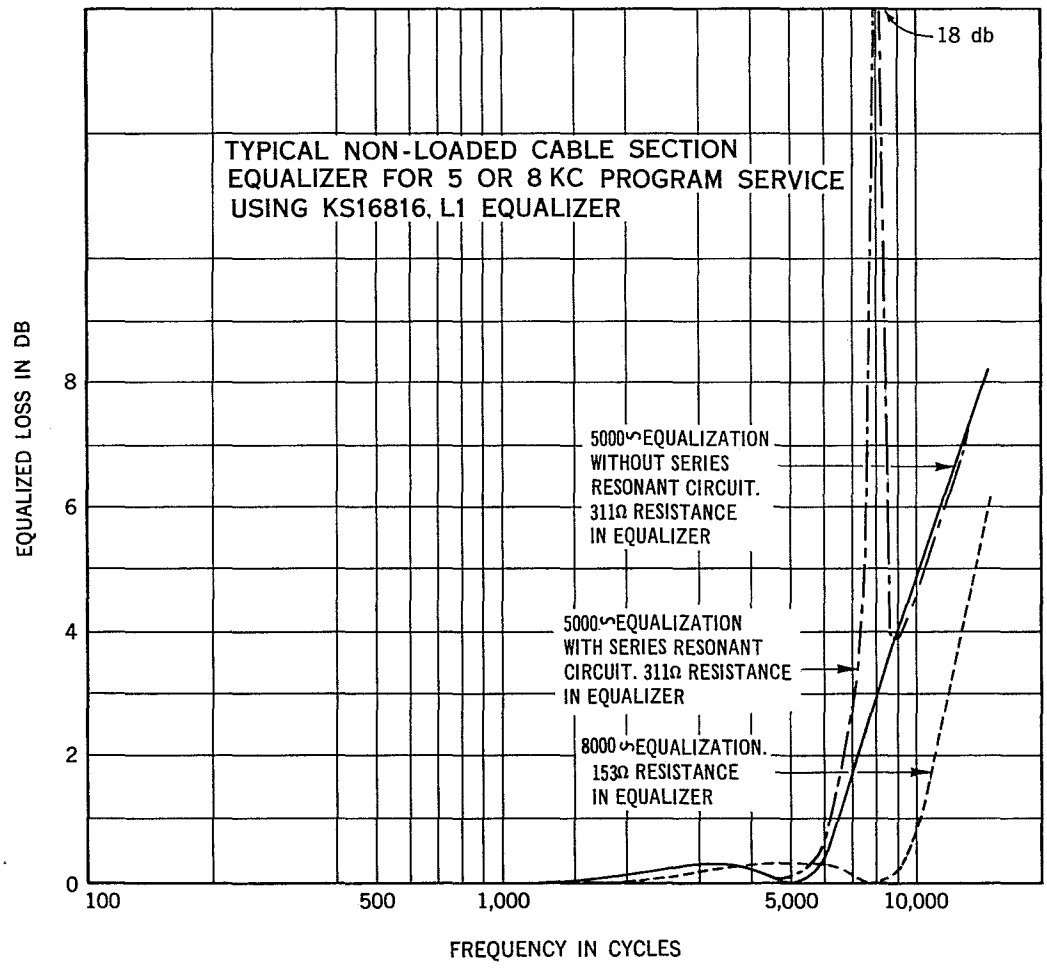

Fig. 6 — Typical Curves for Equalized 5 and 8 KC Cable Section

4.02 The approximate envelope delay distortion of the equalizer when measured between 600 ohm impedances for all 15 KC switch positions is shown in Table III. The delay is shown for 100 ohms and 300 ohms in the potentiometer.

TABLE III

Frequency Band (cycles)	Resistance Setting (ohms)	Approximate Relative Delay (microseconds)
35 — 500	100	15
500 — 15 KC	100	4
35 — 500	300	2
500 — 15 KC	300	0*

*The absolute delay in this range is 0.5 microseconds.

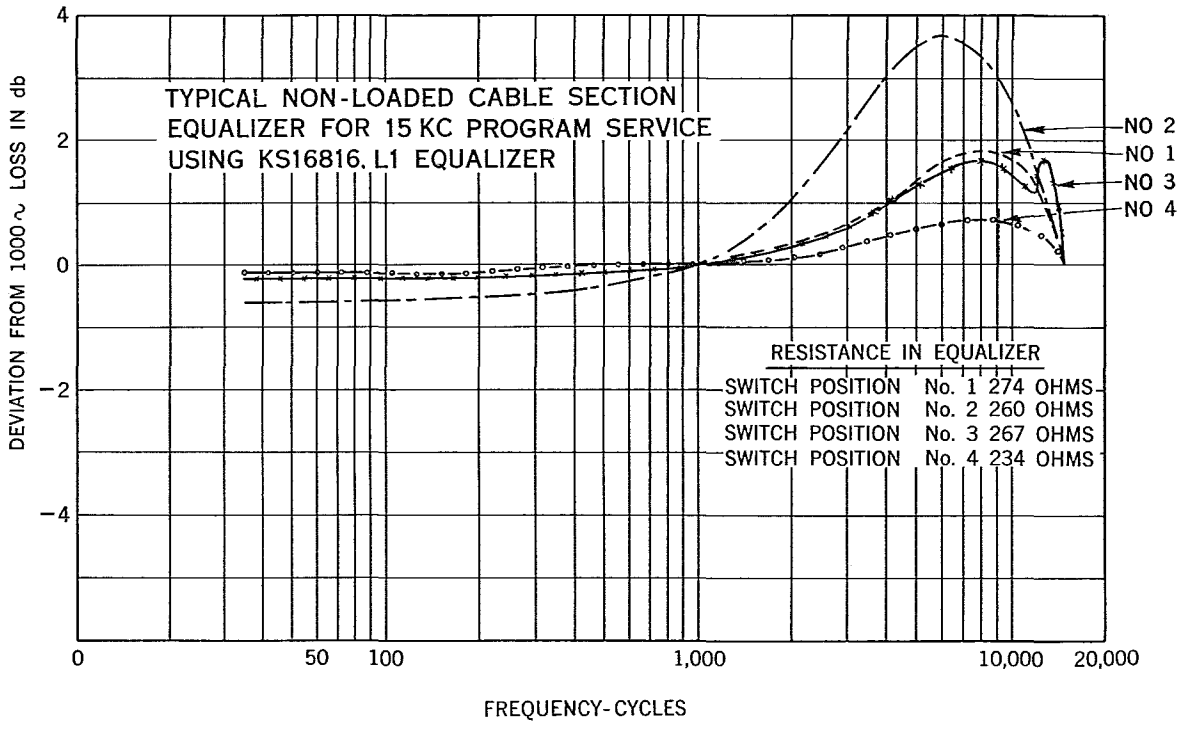

Fig. 7 — Typical Curves for Equalized 15 KC Cable Section