359R EQUALIZER

DESCRIPTION

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1. GENERAL

1.01 This section describes the 359R equalizer, which is a plug-in apparatus unit designed for use in V4 telephone repeater applications.

1.02 The 359R equalizer is intended for use with a 227-type amplifier to provide equalization for L5 order wire circuits. Independently adjustable low- and high-frequency equalizing sections provide the necessary equalization to obtain a substantially flat frequency response over the range of 250 to 3000 Hz. The 359R equalizer is designed to equalize up to 75 miles of 16- and 19-gauge Q44 cable having a capacity range from 0.062 μF to 0.083 μF per mile. Q44 cable has a nominal spacing of 1 mile between 44-mH load coils and has full end sections terminated in 22-mH load coils. The 1000-Hz insertion loss varies between 6.2 dB and 21 dB as equalization is adjusted.

2. EQUIPMENT DESCRIPTION

2.01 The 359R equalizer (see Fig. 1) is a plug-in unit equipped with a 20-pin connector plug and is designed to be plugged directly into the equalizer connector socket of the repeater mounting shelf.

2.02 The 359R equalizer consists of 13 resistors, 1 capacitor, and 1 inductor mounted on a printed wiring-board and housed in a metal can approximately 1-3/4 inches high by 1-3/4 inches wide by 7 inches long. Tabs are provided on the front of the can to facilitate removal of the equalizer from the repeater mounting shelf with the use of a 602D tool.

2.03 Ten screw-type switches are mounted on the equalizer faceplate. These switches permit the indicated component values to be added to or removed from the circuit, as required, when adjusting equalization.

3. CIRCUIT DESCRIPTION

3.01 The simplified circuit configuration of the 359R equalizer is illustrated in Fig. 2. The circuit consists of three parts:

(a) A low-frequency section made up of resistors R_{LF}; R10,000; and capacitor C1

(b) A high-frequency section made up of resistors R_{HF} and inductor L1

(c) A 6.2-dB pad made up of resistors R7, R8, and R9, which reduces interaction between the low- and high-frequency sections.

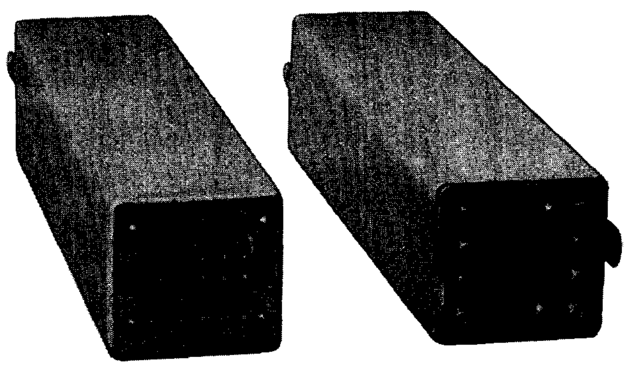

Fig. 1—359R Equalizer

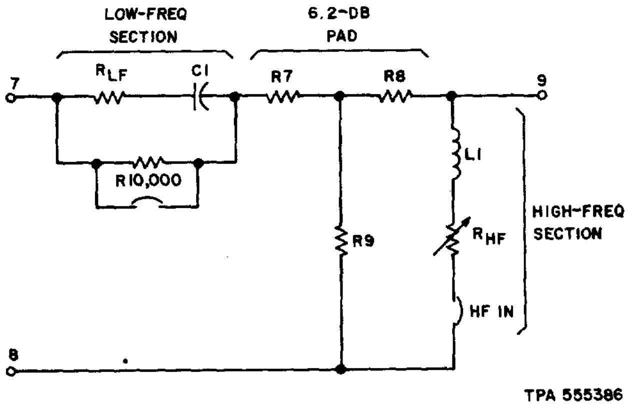

Fig. 2—359R Equalizer—Simplified Circuit Configuration

3.02 Both the low- and high-frequency sections are independently adjustable by means of the faceplate screw-type switches. A detailed schematic of the circuit is shown in Fig. 3. The resistors in both the low- and high-frequency sections are bypassed when the associated screw-type switches are closed (turned in) and are placed in the circuit when the switches are opened (turned out). The entire low-frequency section is added to the circuit when the R10,000 screw-type switch is opened and is removed when the switch is closed. The entire high-frequency section is added to the circuit when the HF IN screw-switch is closed and is removed from the circuit when the switch is opened.

3.03 Figure 3 also illustrates typical circuit connections when plugged into the equalizer socket of a 44V4 repeater. The transmitting side of the 359R equalizer provides no equalization, but does provide connections to the AMPL OUT and MON jacks, and thus connects the 1200-ohm transmitting amplifier output to the Q44 loaded 4-wire line.

3.04 The receiving side of the equalizer contains the actual equalizing elements and selects the proper secondary tap of the receiving amplifier input transformer to make the primary side look like approximately 1200 ohms. Received transmission signals from the 4-wire line at terminals 2 and 4 are connected through to the 1200-ohm receiving amplifier input circuit at terminals 1 and 3. Terminals 7, 8, and 9 connect the high- and low-frequency equalizing sections into the receiving amplifier circuit.

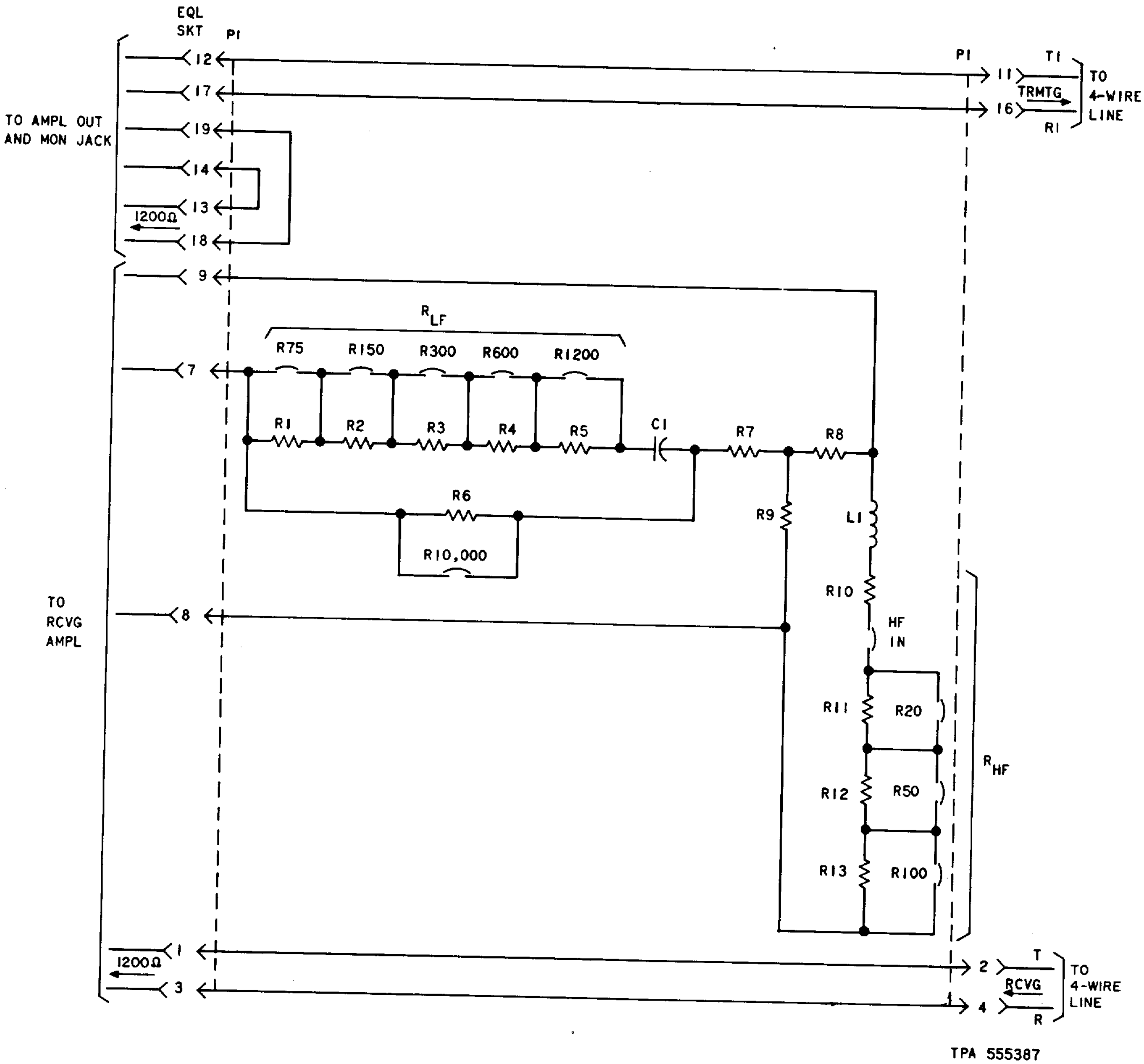

Fig. 3—359R Equalizer—Schematic

4. ADJUSTMENT PROCEDURE

4.01 The adjustment procedure consists of four basic steps:

STEP	PROCEDURE
1	Determine the desired value of R_{LF} from Fig. 4.
2	Determine the actual value for R_{LF} and the positions of the LF screw switches from Table A.
3	Determine the desired value of R_{HF} from Fig. 5.
4	Determine the actual value and the positions of the HF screw switches from Table B.

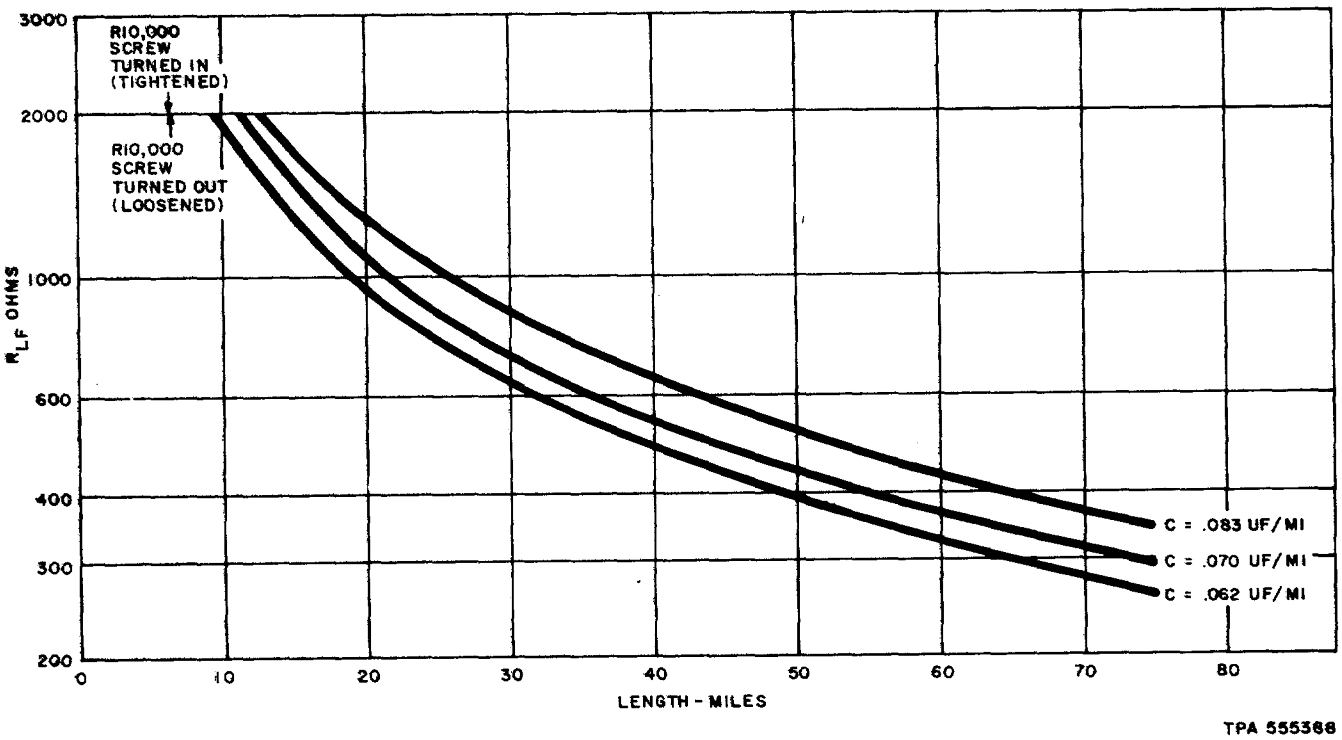

Fig. 4—359R Equalizer—Desired R_{LF} Versus Length for 19-Gauge Q44 Cable

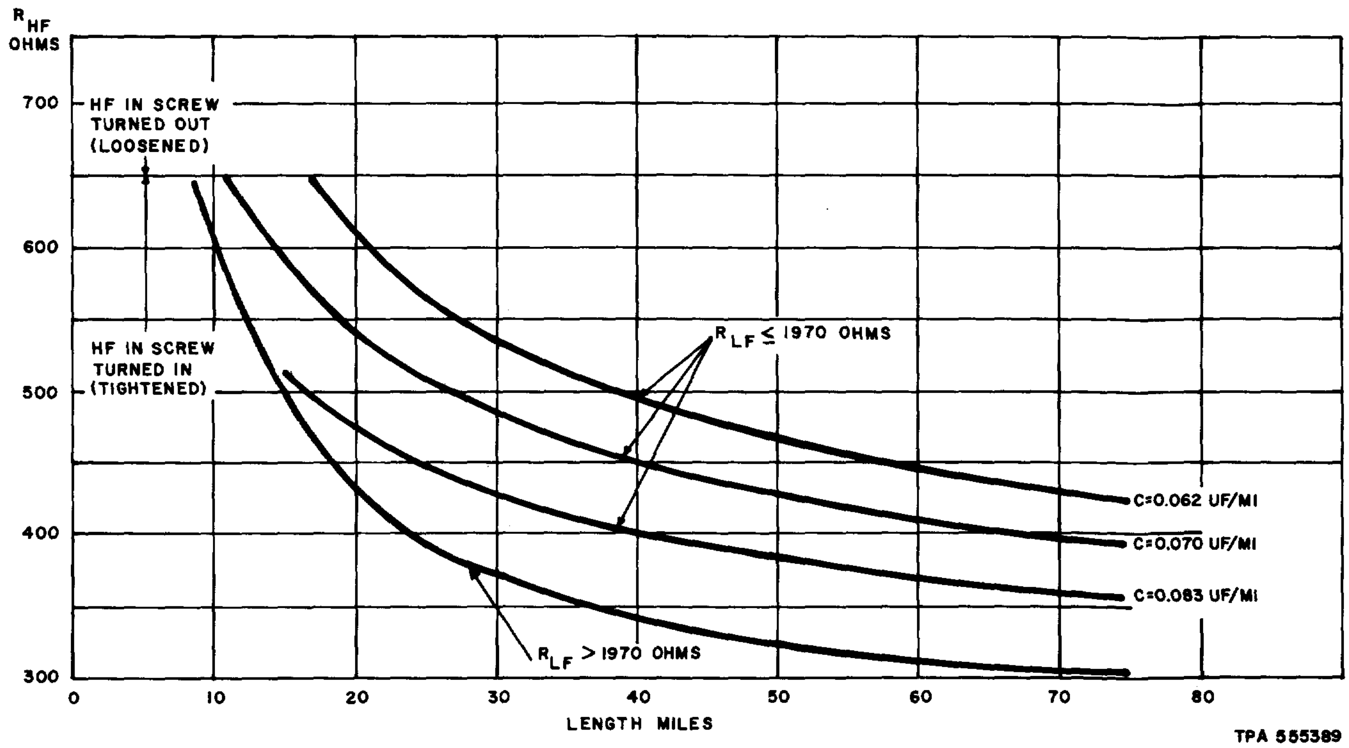

Fig. 5—359R Equalizer—Desired R_{HF} Versus Length

TABLE A

Note: Tighten (turn in) all low-frequency (LF) screws on the front plate, except as indicated in the table.

Desired LF Resistance (Ohms)	Actual Value R_{LF} (Ohms)		LF Screws Loosened (Turned Out)	Loss of LF Section at 1000 Hz (dB)
0 – 25	0	R10,000		0.95
26 – 100	75		R75	1.44
101 – 185	147		R150	1.90
186 – 270	222		R75, R150	2.34
271 – 354	316		R300	2.86
355 – 427	391		R75, R300	3.26
428 – 500	463		R150, R300	3.62
501 – 570	558		R75, R150, R300	3.98
571 – 638	600		R600	4.26
639 – 711	675		R75, R600	4.59
712 – 785	747		R150, R600	4.89
786 – 870	822		R75, R150, R600	5.19
871 – 990	916		R300, R600	5.54
991 – 1135	1063		R150, R300, R600	6.06
1136 – 1283	1210		R1200	6.55
1284 – 1442	1357		R150, R1200	6.99
1443 – 1600	1526		R300, R1200	7.46
1601 – 1740	1673		R150, R300, R1200	7.85
1741 – 1970	1810		R600, R1200	8.18
1971 or Greater – R10,000 Screw Tightened (Turned In)		None		

TABLE B

Note: Tighten (turn in) all high-frequency (HF) screws on the front plate, except as indicated in the table.

Desired HF Resistance (Ohms)	Actual Value R_{HF} (Ohms)	HF Screws Loosened (Turned Out)	Loss of HF Section at 1000 Hz (dB)
0 – 298	287	None	5.65
299 – 321	308.5	R20	5.41
322 – 344	333.4	R50	5.16
345 – 371	354.9	R20, R50	4.96
372 – 398	387	R100	4.69
399 – 421	408.5	R20, R100	4.52
422 – 444	433.4	R50, R100	4.34
445 – 649	454.9	R20, R50, R100	4.20
650 or Greater – Open HF IN Screw		HF IN	0

4.02 For 16-gauge cable, the low-frequency section should be removed from the circuit by tightening the R10,000 screw. To find the desired value of R_{LF} for a circuit that contains both 19- and 16-gauge sections, use the following procedure:

STEP	PROCEDURE
1	Find the desired value of R_{LF} for a 19-gauge circuit of the same ***total length*** from Fig. 4. Call this value R_{19}.
2	Using 86 ohms per mile as the resistance of the 19-gauge section and 43 ohms per mile as the resistance of the 16-gauge section, compute the R_{AV}, the average resistance per mile of the entire circuit from the following formula: $$R_{AV} = \frac{(86 \times L_{19}) + (43 \times L_{16})}{L_{19} + L_{16}}$$ L_{19} = length in miles of 19-gauge section L_{16} = length in miles of 16-gauge section.
3	The desired value for R_{LF} would then be given by $R_{LF} = R_{19}\ (86/R_{AV})^3$. Whenever the desired value of R_{LF} is greater than 1970 ohms, the low-frequency section should be removed. ***Example:*** Assume a 50-mile section contains 35 miles of 19-gauge 0.062 μF cable and 15 miles of 16-gauge 0.062 μF cable. From Fig. 4, 50 miles of 19-gauge cable = 390 ohms; $$R_{AV} = \frac{(86 \times 35) + (43 \times 15)}{50} = 73.1$$ $$R_{LF} = 390\ (86/73.1)^3 = 635 \text{ ohms.}$$

From Table A, the actual value would be 600 ohms (screw switch R600 turned out). Whenever the desired value of R_{LF} is greater than 1970 ohms, the low-frequency section should be removed.

4.03 The top three curves of Fig. 5 show the desired value for R_{HF} is less than or equal to 1970 ohms. The bottom curve shows the desired R_{HF} when the low-frequency section is not in the circuit. Whenever the desired value of R_{HF} is greater than 650 ohms, the high-frequency section should be removed from the circuit by loosening the HF IN screw switch.

4.04 The 1000-Hz loss of the low-frequency section (R_{LF}) is shown in Table A, and the 1000-Hz loss of the high-frequency section is shown in Table B. The loss of the entire equalizer at 1000 Hz is the sum of these two values plus 6.2 dB, the loss of the pad.

5. TRANSMISSION PERFORMANCE

5.01 The series arm low-frequency components R_{LF}; R10,000; and C1 provide compensation for amplitude distortion in the 4-wire line facilities at frequencies up to approximately 1000 Hz. Figure 6 illustrates typical equalization losses that may be obtained by various combinations of R_{LF} with R_{HF} equal to 333 ohms.

5.02 The shunt arm high-frequency components provide amplitude equalization for Q44 and are trimmer equalizers. Relatively small changes of loss are accomplished with the high-frequency section, which can be seen in Fig. 7. Varying resistor R_{HF} adjusts the amount of high-frequency equalization for various lengths and gauges of facilities.

5.03 While the series arm low-frequency components R_{LF}; R10,000; and C1 provide compensation for amplitude distortion, they introduce delay distortion at the same time. Figure 8 illustrates typical delay-frequency characteristics obtained by various combinations of R_{LF} with a nominal R_{HF} equal to 333 ohms.

5.04 While the shunt arm high-frequency components provide compensation for amplitude distortion, they introduce delay distortion at the same time. Figure 9 illustrates typical delay-frequency characteristics obtained by varying R_{HF}.

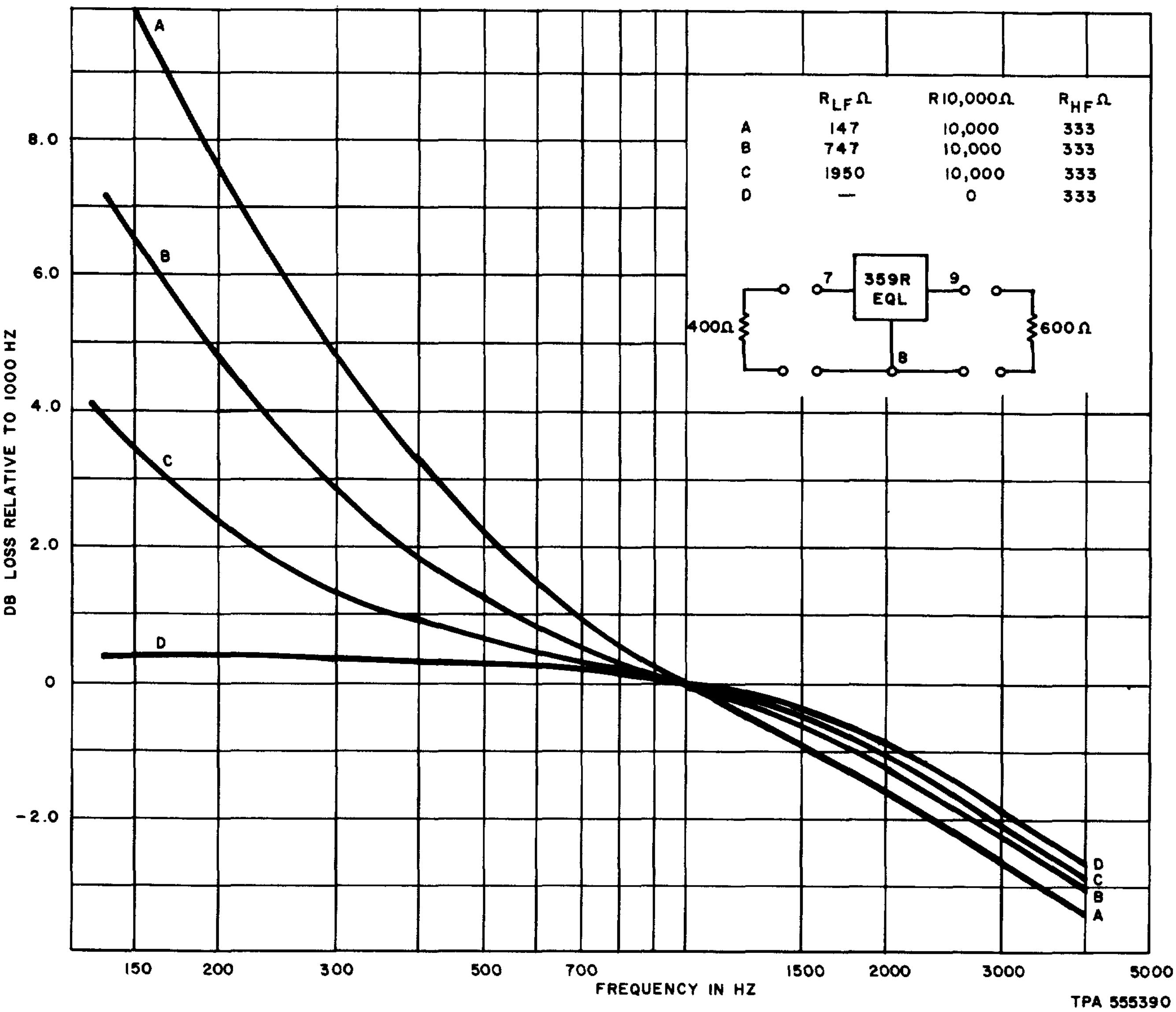

Fig. 6—359R Equalizer—Loss-Frequency Characteristic

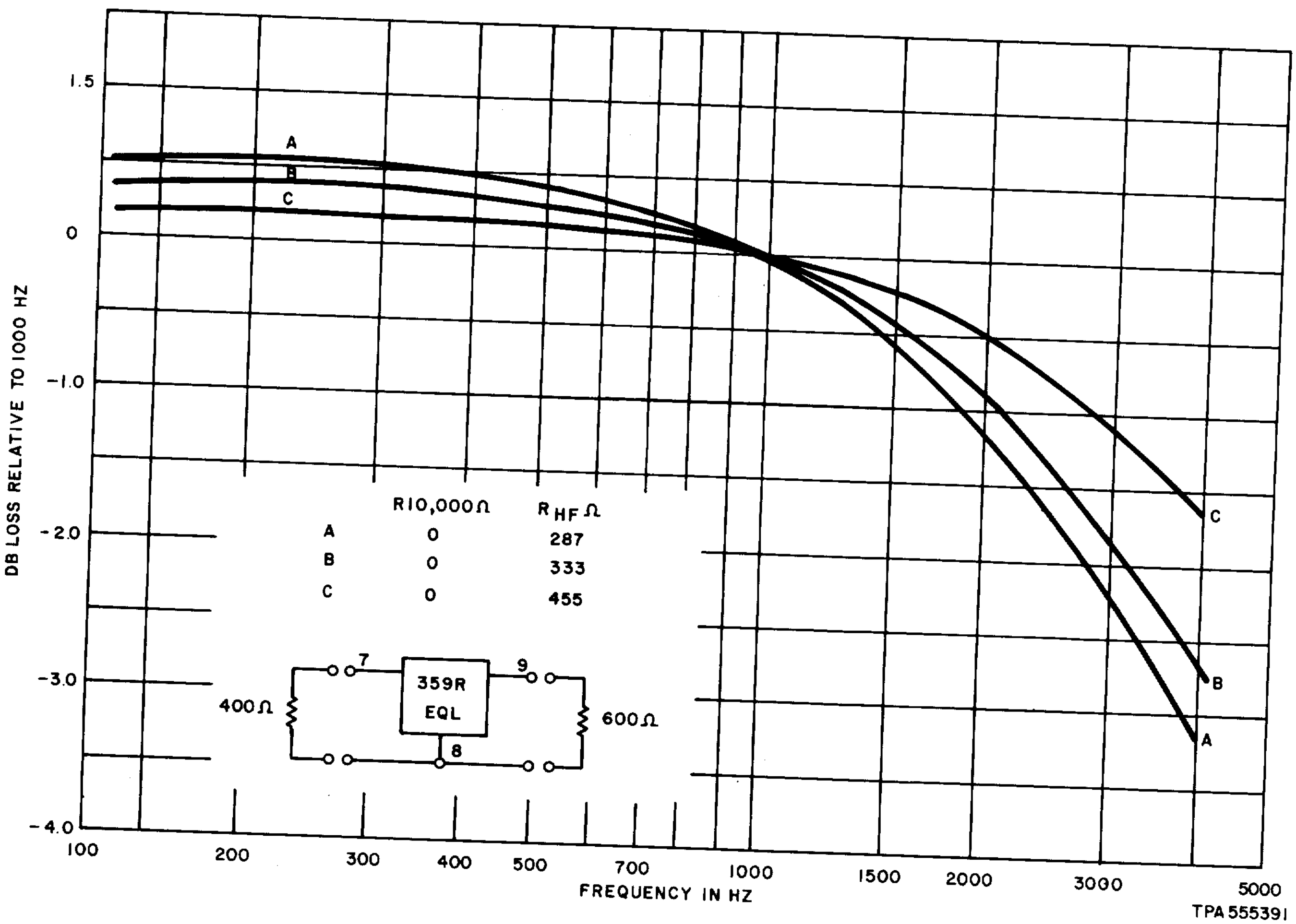

Fig. 7—359R Equalizer—High-Frequency Section—Loss-Frequency Characteristic

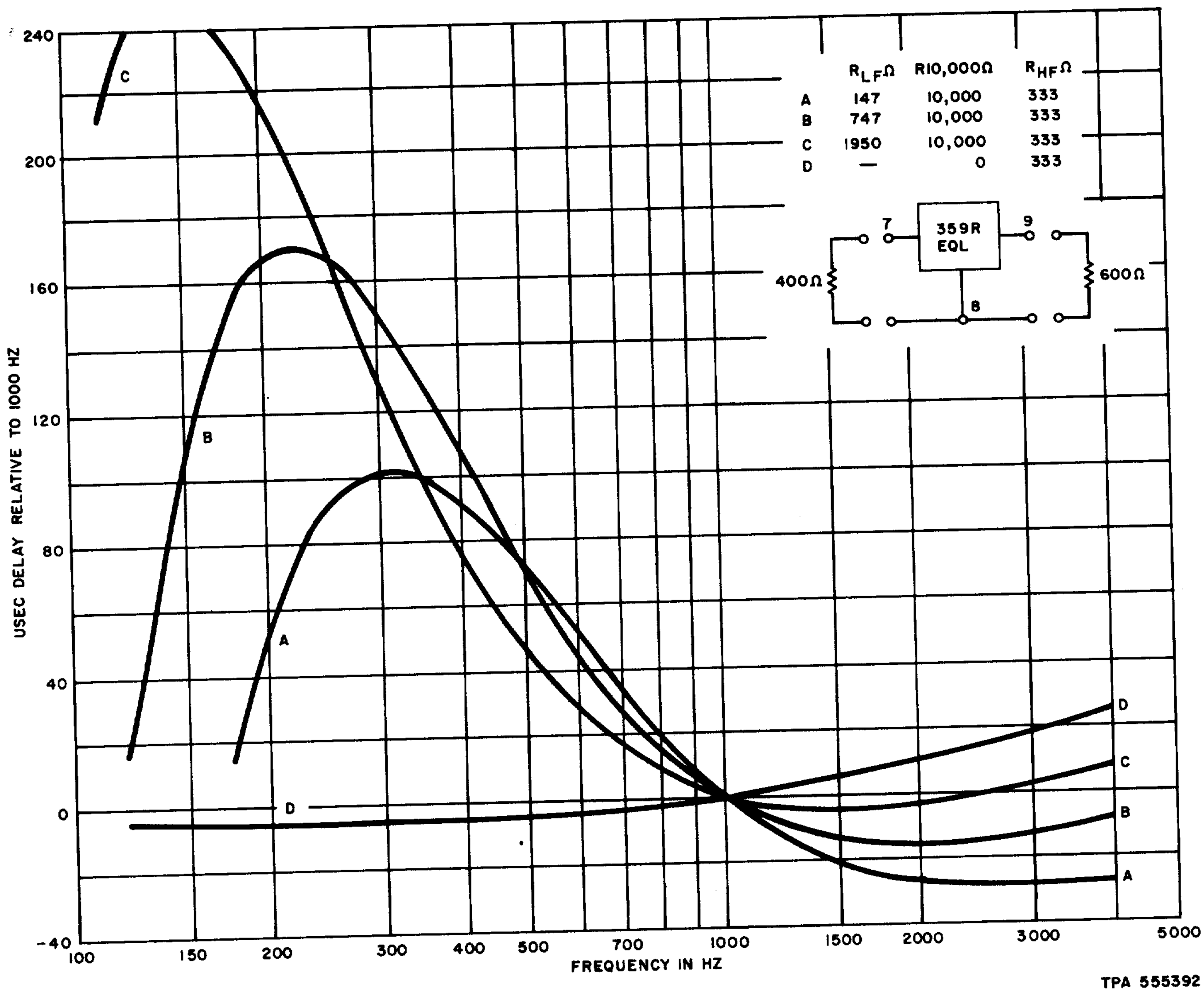

Fig. 8—359R Equalizer—Delay-Frequency Characteristic

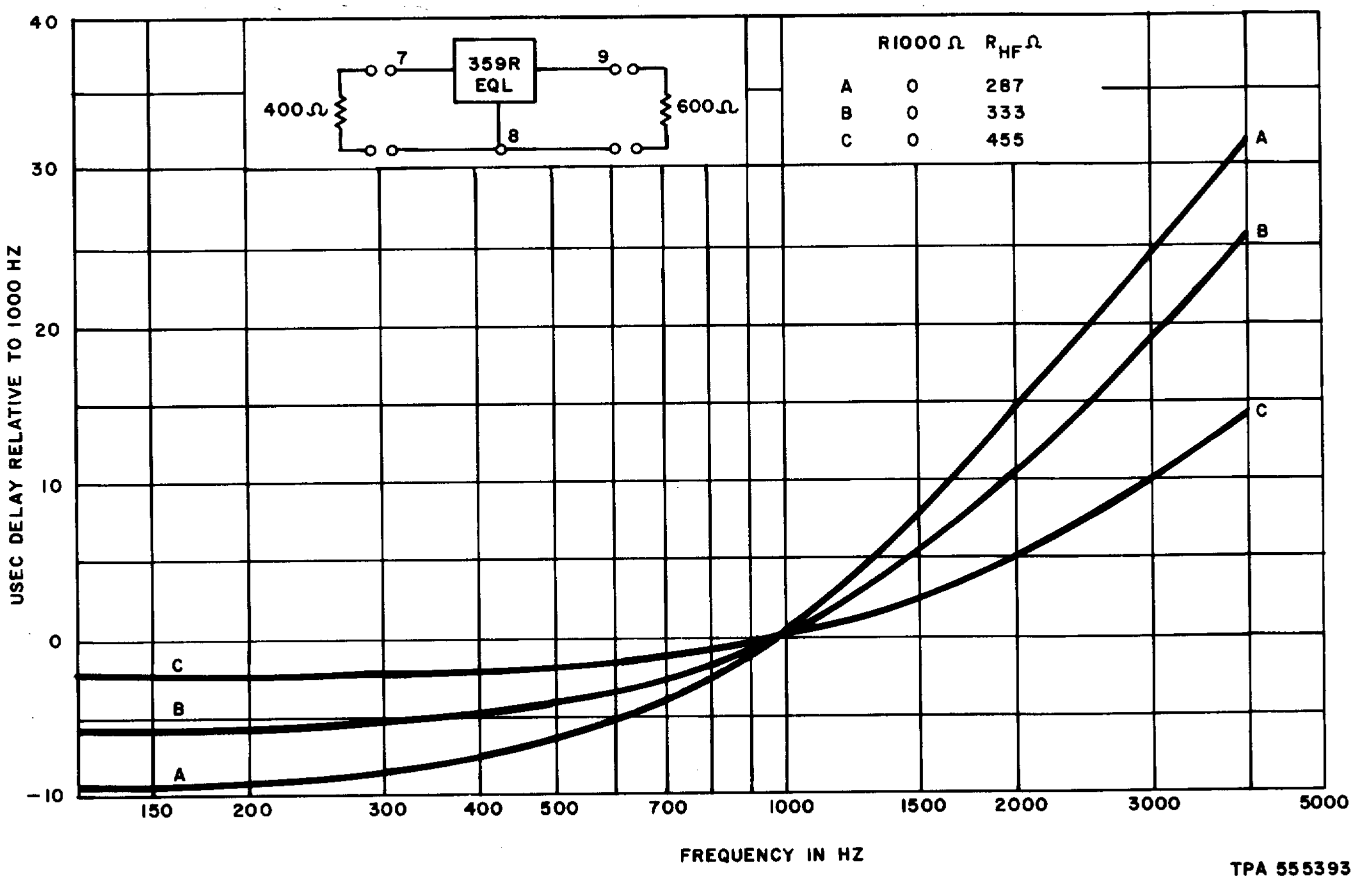

Fig. 9—359R Equalizer—High-Frequency Section—Delay-Frequency Characteristic