ENVELOPE DELAY CHARACTERISTICS OF 384- AND 385-TYPE EQUALIZERS DESCRIPTION

CONTENTS PAGE

1. GENERAL

1.01 This section describes the 384- and 385-type plug-in equalizers used to provide envelope delay and attenuation equalization on voice-frequency facilities (300-3000 Hz) which are used for 2400 bits-per-second data transmission over the switched network. The equalizers can also be used for equalization on private line data circuits. Amplitude and delay distortion imperceptible in voice communication can cause errors in medium-speed (voiceband) data transmission. It is for this reason that amplitude and delay ***equalization*** must be provided on voice-frequency circuits used for data transmission. For further information on transmission problems encountered, refer to Section 855-310-101. The J99292C equalizer mounting shelf, which is used to mount the equalizers and a 227C amplifier, is also described herein. Curves and tables are included in the section which describe both relative and absolute delay characteristics, and attenuation/frequency characteristics of the equalizers and the amplifier.

1.02 This section is reissued:

- To add information on the 384H, J, K, L, M, and N equalizers
- To indicate that the 384A and B equalizers have been rated manufacture discontinued.

Since the 384A and B equalizers are still used in the field, information on these equalizers is retained. Due to extensive changes throughout the section, arrows ordinarily used to indicate changes have been omitted.

2. DESCRIPTION OF EQUALIZER MOUNTING SHELF AND CIRCUIT

2.01 The J99292C equalizer mounting shelf accepts four 384- or 385-type delay equalizers, two 359-type amplitude equalizers, a 227-type amplifier, an optional 1C pad, and 89-type resistors as required (Fig. 1, 2, and 3). All of these items are equipped to plug into the mounting shelf, which also provides access jacks. The sockets for the equalizers are wired in series; therefore, if a full complement of equalizers is not required, dummy plugs must be used to complete the circuit. The dummy plug for the 384- and 385-type equalizers is the 433A plug; the dummy plug for the 359G equalizer is the 359E; the dummy plug for the 359H equalizer is the 359C.

2.02 One equipped mounting shelf provides delay and attenuation equalization for one direction of transmission, as shown in Fig. 4. The opposite direction of transmission can be equipped with a 1C pad and 89-type resistors for level adjustment on an optional basis.

2.03 The equalizer mounting shelf is 5 inches high and is designed for rack mounting in a 23-inch bay. A J98617A bay accomodates 20 equalizer mounting shelves, providing equalization in both directions of transmission for 10 circuits. A J98617B bay accommodates 17 equalizer mounting shelves, providing one-way equalization for 17 circuits. Optional wiring permits cross-connection to echo suppressors or other transmission equipment.

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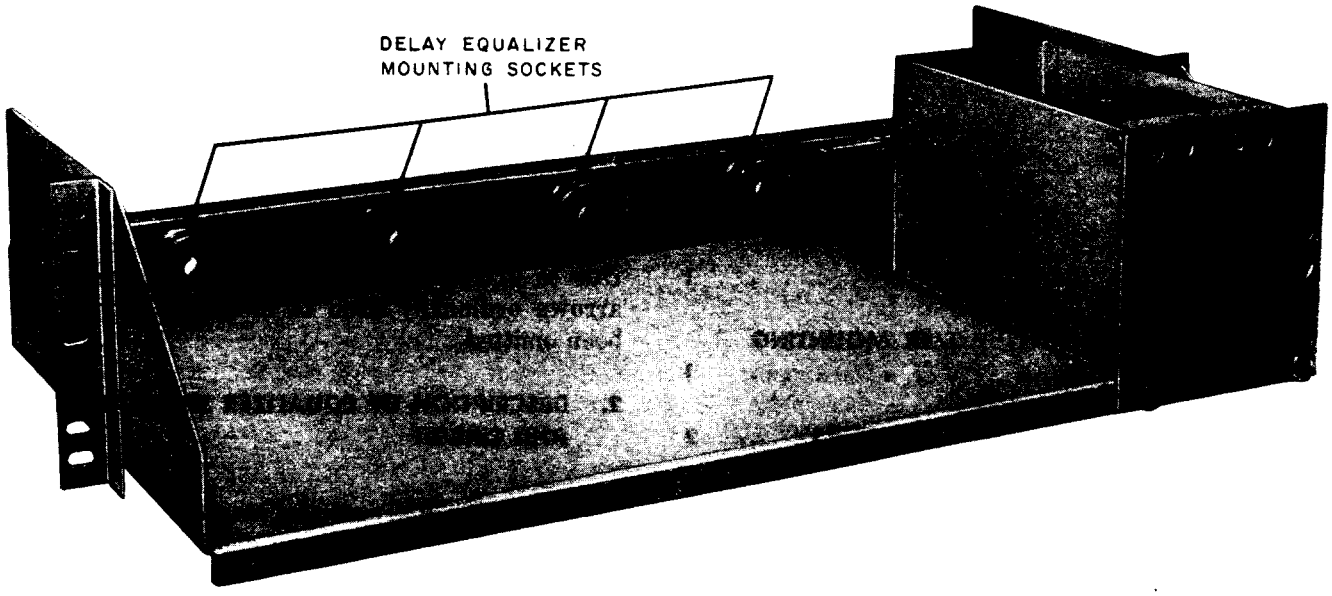

Fig. 1—Equalizer Mounting Shelf With Four Open Positions

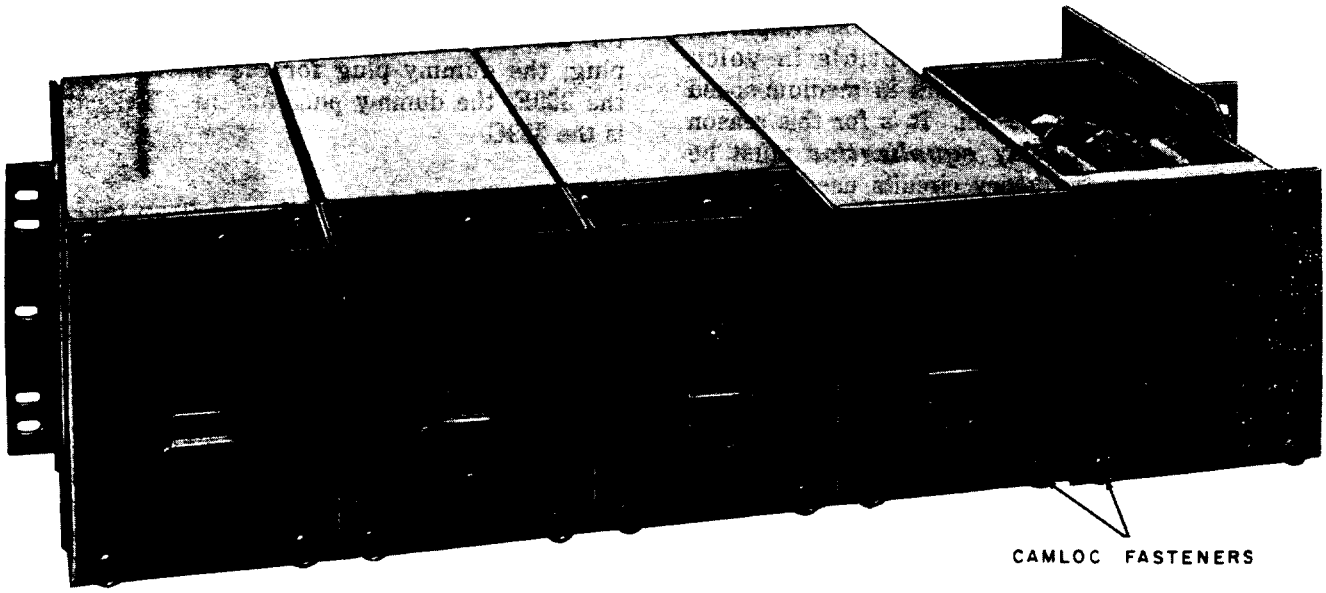

Fig. 2—Equalizer Mounting Shelf Equipped With Plug-In Equalizers and 433A Plug

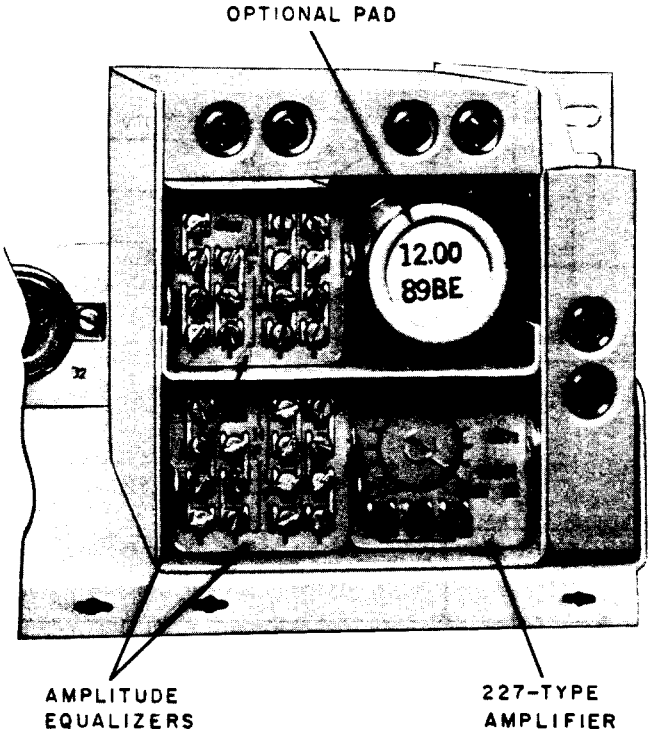

Fig. 3—359-Type Equalizers, 227-Type Amplifier, and Fixed Pad

2.04 Since the equalizer circuit contains a 227-type amplifier which has envelope delay characteristics, this delay must be included in calculating envelope delay equalization. The 227C amplifier has been rated MD and is replaced by the 227D. Envelope delay information on both of these amplifiers is given in Table A. For further information on the 227C and D amplifiers, refer to Section 024-140-103.

2.05 Electrically, part of the 227-type amplifier provides a 600-ohm impedance input transformer to the unbalanced (grounded) equalizers (Fig. 4). A following fixed pad improves the termination presented to the incoming line and to the equalizers. After equalization, the 227-type amplifier compensates for losses in the transformer, the fixed pad, and the equalizers, and provides a balanced output. The amplifier is adjustable over three ranges to provide up to 36 dB gain over the voice-frequency band.

3. DESCRIPTION OF DELAY EQUALIZERS

3.01 Equalizers described in this section and their applications are presented in abbreviated form in Table B.

3.02 The 384- and 385-type equalizers measure 3-7/8 inches wide by 4-7/8 inches high by 10-3/4 inches deep. Their weights vary from 1-3/4 pounds for the 433A plug to 6-1/4 pounds for the 384M equalizer. Each equalizer is provided with two Cam-Loc* fasteners to hold the equalizer in the mounting shelf.

*Registered trademark of Westmoreland Plastics

3.03 The following paragraphs provide a brief description and suggested application of the various 384-type equalizers. Curves showing the envelope delay with respect to frequency are shown in Fig. 5 through 13.

(a) ***384A Delay Equalizer (MD):*** The 384A equalizer provides delay equalization for an average pair of A-type channel banks. Typical carrier systems are J, K, and L. The 384A is rated manufacture discontinued, and is replaced by the 384M.

(b) ***384B Delay Equalizer (MD):*** The 384B equalizer provides delay equalization for 3/4 of an average pair of A-type channel banks. It is used in conjunction with 385A and 385B adjustable equalizers or where delay measurements on a particular pair of A-type channel banks indicate. The 384B is rated manufacture discontinued, and is replaced by the 384N.

(c) ***384C Delay Equalizer:*** The 384C equalizer provides delay equalization for an average pair of N2 carrier terminals. It can also be used with T1 carrier equipped with E and M channel units.

(d) ***384D Delay Equalizer:*** The 384D equalizer provides delay equalization for an average LMX-1 channel 1 L-to-L group connector.

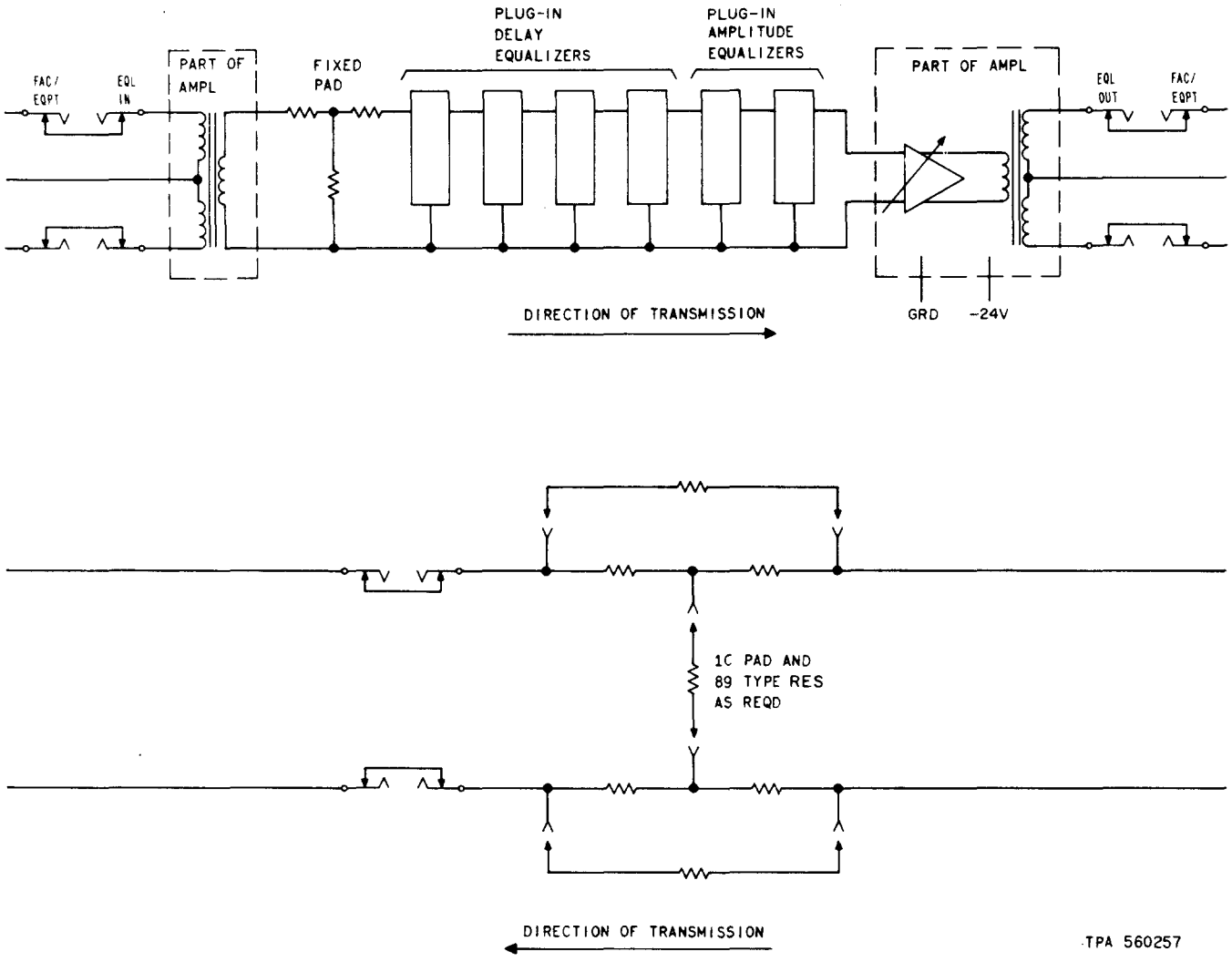

Fig. 4—Block Diagram of Equalizer Mounting Shelf

(e) ***384E Delay Equalizer:*** The 384E equalizer provides delay equalization for an average LMX-1 channel 12 L-to-L group connector. It can also be used for H44-loaded cable and other types of cable facilities where the envelope delay characteristics approach a straight line across the frequency band.

(f) ***384F Delay Equalizer:*** The 384F equalizer provides delay equalization for an average LMX-2 channel 1 L-to-L group connector.

(g) ***384G Delay Equalizer:*** The 384G equalizer provides delay equalization for an average LMX-2 channel 12 L-to-L group connector. It can also be used for H44-loaded cable and other types of cable facilities where the envelope delay characteristics approach a straight line across the frequency band.

(h) ***384H and 384J Delay Equalizers:*** Due to the large number of components required to supply this delay characteristic, the components are housed in two containers; therefore the H and J equalizers are always used in pairs. They are used to equalize one pair of Japanese CSIB channel banks. The equalizers need not be matched pairs, and may be plugged into the equalizer shelf in any order.

TABLE A

227C AND D AMPLIFIERS – ENVELOPE DELAY IN MICROSECONDS FOR VARIOUS 1-KHZ GAINS

FREQUENCY (HZ)	227D, OR 227C DATED 3/66 OR EARLIER				227C DATED 4/66 OR LATER			
	LOW- AND MEDIUM-GAIN RANGES	HIGH-GAIN RANGE			LOW- AND MEDIUM-GAIN RANGES	HIGH-GAIN RANGE		
	10, 20 DB	30 DB	MAX	MIN	10, 20 DB	30 DB	MAX	MIN
300	75	125	80	150	100	210	120	250
400	50	75	50	90	60	120	75	140
500	40	55	45	60	45	85	55	95
800	25	35	30	40	30	45	35	50
1000	25	30	30	30	25	35	30	40
2000	20	25	25	25	20	25	25	25
3000	20	25	25	20	20	20	20	20

TABLE B

DELAY EQUALIZERS AND THEIR APPLICATION

FIXED EQUALIZER	APPLICATION
384A (MD) 384M	Average equalization for 1 pair of A channel banks.
384B (MD) 384N	Minimum equalization for 1 pair of A channel banks.
384C	Equalization for 1 pair of N2 Carrier terminals.
384D	Average equalization for LMX-1 L-to-L group connector for channel 1.
384E	Average equalization for LMX-1 L-to-L group connector for channel 12.
384F	Average equalization for LMX-2 L-to-L group connector for channel 1.
384G	Average equalization for LMX-2 L-to-L group connector for channel 12.
384H 384J	Average equalization for 1 pair of Japanese CSIB channel banks.
384K 384L	Average equalization for 1 pair of British Mark II channel banks.
ADJUSTABLE EQUALIZER	**APPLICATION**
385A	Low frequency equalizer adjustable in four steps.
385B	High frequency equalizer adjustable in six steps.

(i) ***384K and 384L Delay Equalizers:*** Due to the large number of components required to supply this delay characteristic, the components are housed in two containers; therefore the K and L equalizers are always used in pairs. They are used to equalize one pair of British Mark II channel banks. The equalizers need not be matched pairs, and may be plugged into the equalizer shelf in any order.

(j) ***384M Delay Equalizer:*** The 384M equalizer provides the same delay equalization as the 384A, which it replaces. However, the 384M attenuation-frequency response is flat at 2.15 dB over the 600-3000 Hz band.

(k) ***384N Delay Equalizer:*** The 384N equalizer provides the same delay equalization as the 384B, which it replaces. However, the 384N attenuation-frequency response is flat at 1.45 dB over the 600-3000 Hz band.

3.04 The following paragraphs provide a brief description and suggested application of the 385-type equalizers. Curves showing the envelope delay with respect to frequency are shown in Fig. 14 and 15.

(a) ***385A Delay Equalizer:*** The 385A equalizer is a low frequency adjustable-delay equalizer with four steps. The first step is zero delay; the other steps are as shown on the graph. This equalizer is used in combination with other equalizers to provide additional low-frequency delay equalization.

(b) ***385B Delay Equalizer:*** The 385B equalizer is a high frequency adjustable-delay equalizer with six steps. The first step is zero delay; the other steps are as shown on the graph. This equalizer is used in combination with other equalizers to provide additional high-frequency delay equalization.

3.05 ***The 433A plug*** is a shorting plug that is used in the equalizer shelf when a full complement of equalizers (four) are not required. An equalizer or a 433A plug must be provided in each mounting shelf socket to provide continuity.

3.06 ***Attenuation-Frequency Characteristics:*** Attenuation-frequency characteristics of the 384-type equalizers are given in Table C. Attenuation-frequency characteristics of the 385A and 385B adjustable equalizers are given in Tables D and E, respectively.

3.07 ***Envelope Delay Characteristics:*** Envelope delay characterisitics of the 384-type equalizers are given in Table F. Envelope delay characteristics of the 385-type equalizers are given in Table G.

3.08 A guide to aid in the selection of equalizers is given in Table H. A number of facility make-ups and the equalizers to be used on a prescription basis are shown in the table.

3.09 Settings for the 359G and 359H attenuation equalizers are given in Section 314-016-125.

4. REFERENCES

4.01 The following documents provide additional information relating to the 384- and 385-type equalizers.

SECTION	TITLE
AA381.334	Amplitude and/or Delay Equalizing Units For Use With Voice Frequency Circuits
AB27.025	Envelope Delay Characteristics of Telephone Facilities—General Information
AB27.025.90	Equalizer Selection Programs—DELDIS and DELMAN for the GE 235 Time-Sharing Computer System
024-140-103	227C And 227D Amplifiers—Description
314-016-125	TWX Service—Attenuation Equalization Arrangements and Adjustments Using 44V4 Repeaters
855-310-101	Carrier Engineering System Application—Analog Multiplex Terminals—General
SD-&CD-99750-1	Common Systems Voice Frequency Transmission—Amplitude and Delay Equalizing Circuit
EL-907	Availability of 384M and 384N Delay Equalizers
PEM-9751	Data Transmission—Additional 384-Type Envelope Delay Equalizers

TABLE C

ATTENUATION-FREQUENCY RESPONSE OF 384-TYPE EQUALIZERS
NOMINAL LOSS IN DB

FREQ (HZ)	384A (MD)	384B (MD)	384C	384D	384E	384F	384G	384H 384J	384K 384L	384M	384N
300	1.70	1.28	0.63	1.73	1.19	1.39	1.01	2.54	5.28	—	—
400	1.85	1.38	0.65	1.76	1.19	1.43	1.04	2.56	5.24	—	—
600	2.01	1.56	0.70	1.79	1.17	1.48	1.10	2.50	5.37	2.15	1.45
800	2.16	1.79	0.74	1.82	1.15	1.49	1.12	2.50	5.25	▲	▲
1000	2.35	1.90	0.75	1.81	1.15	1.45	1.13	2.50	5.38	▲	▲
1200	2.41	1.89	0.73	1.75	1.16	1.42	1.13	2.49	5.39	▲	▲
1400	2.36	1.86	0.71	1.73	1.16	1.42	1.12	2.52	5.42	▲	▲
1600	2.23	1.79	0.70	1.76	1.17	1.43	1.11	2.54	5.42	▲	▲
1800	2.14	1.76	0.71	1.78	1.17	1.45	1.11	2.56	5.44	▲	▲
2000	2.17	1.79	0.71	1.77	1.18	1.46	1.12	2.54	5.42	▲	▲
2200	2.28	1.86	0.71	1.76	1.19	1.48	1.12	2.56	5.47	▲	▲
2400	2.34	1.92	0.72	1.76	1.20	1.49	1.12	2.56	5.45	▲	▲
2600	2.23	1.85	0.72	1.77	1.19	1.49	1.12	2.54	5.46	▲	▲
2800	2.09	1.68	0.72	1.79	1.11	1.49	1.10	2.50	5.37	▼	▼
3000	1.97	1.44	0.72	1.80	0.98	1.49	1.04	2.50	5.39	2.15	1.45

TABLE D

ATTENUATION-FREQUENCY RESPONSE OF 385A
EQUALIZER – NOMINAL LOSS IN DB

FREQ, HZ	STEP 1	STEP 2	STEP 3	STEP 4
300	0	0.48	0.93	1.41
400	0	0.79	0.99	1.78
600	0	0.85	1.11	1.96
800	0	0.91	1.18	2.09
1000	0	0.93	1.14	2.07
1200	0	0.91	1.08	1.99
1400	0	0.87	1.04	1.91
1600	0	0.84	1.03	1.87
1800	0	0.85	1.04	1.89
2000	0	0.87	1.05	1.92
2200	0	0.88	1.06	1.94
2400	0	0.89	1.07	1.96
2600	0	0.90	1.08	1.98
2800	0	0.91	1.08	1.99
3000	0	0.93	1.09	2.02

TABLE E

ATTENUATION-FREQUENCY RESPONSE OF 385B EQUALIZER
NOMINAL LOSS IN DB

FREQ (HZ)	STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6
300	0	0.50	0.66	1.16	1.32	1.81
400	0	0.50	0.66	1.16	1.32	1.81
600	0	0.50	0.67	1.17	1.34	1.83
800	0	0.51	0.68	1.19	1.36	1.86
1000	0	0.51	0.69	1.20	1.38	1.88
1200	0	0.50	0.69	1.19	1.38	1.87
1400	0	0.50	0.70	1.20	1.40	1.89
1600	0	0.51	0.72	1.23	1.44	1.94
1800	0	0.51	0.73	1.24	1.46	1.96
2000	0	0.51	0.75	1.26	1.50	2.00
2200	0	0.52	0.76	1.27	1.52	2.02
2400	0	0.51	0.76	1.27	1.52	2.02
2600	0	0.50	0.74	1.24	1.48	1.97
2800	0	0.47	0.69	1.16	1.38	1.84
3000	0	0.44	0.63	1.16	1.26	1.78

TABLE F

384-TYPE EQUALIZERS ENVELOPE DELAY IN MICROSECONDS RELATIVE TO 1800 HZ

FREQ, HZ	384A 384M	384B 384N	384C	384D	384E	384F	384G	384H&J	384K&L
400	−985	−634	−120	−647	+152	−443	+ 90	−1398	−2365
600	−526	−420	− 68	−481	+142	−309	+ 84	− 929	− 933
800	−313	−225	− 21	−298	+120	−198	+ 71	− 541	− 555
1000	−164	−130	+ 4	−173	+ 98	−137	+ 57	− 269	− 231
1200	− 98	− 76	+ 8	−124	+ 81	− 84	+ 48	− 126	− 45
1400	− 53	− 32	+ 3	− 87	+ 58	− 48	+ 32	− 50	+ 20
1600	− 14	− 22	+ 2	− 40	+ 34	− 23	+ 15	− 9	+ 14
1800	0	0	0	0	0	0	0	0	0
2000	− 3	− 6	− 10	+ 22	− 37	+ 22	− 18	− 28	− 51
2200	− 36	− 32	− 29	+ 35	− 81	+ 38	− 49	− 103	− 209
2400	− 72	− 60	− 49	+ 51	−133	+ 55	− 83	− 243	− 486
2600	−137	−118	− 67	+ 75	−214	+ 64	−124	− 528	− 870
2800	−257	−192	− 93	+ 98	−349	+ 72	−181	− 923	−1789
3000	−430	−355	−141	+ 97	−527	+ 76	−260	−1559	−2935
Absolute delay in μsec at 1800 Hz	2471	1482	721	1672	1502	1430	941	2826	3884

TABLE G

385-TYPE EQUALIZERS – ENVELOPE DELAY IN MICROSECONDS RELATIVE TO 1800 HZ

FREQ (HZ)	STEPS ON 385A			STEPS ON 385B				
	2	3	4	2	3	4	5	6
400	−165	−407	−572	− 3	+ 1	− 2	+ 2	− 1
600	−124	−266	−390	− 2	+ 3	+ 1	+ 6	+ 4
800	− 78	−140	−218	− 1	+ 2	+ 1	+ 4	+ 3
1000	− 40	− 78	−118	− 1	− 1	− 2	− 2	− 3
1200	+ 16	− 48	− 64	− 1	− 2	− 3	− 4	− 5
1400	− 9	− 19	− 28	− 2	− 1	− 3	− 2	− 4
1600	− 7	− 6	− 13	0	0	0	0	0
1800	0	0	0	0	0	0	0	0
2000	+ 6	+ 7	+ 13	− 1	− 3	− 4	− 6	− 7
2200	+ 5	+ 4	+ 9	− 6	− 15	− 21	− 30	− 36
2400	+ 2	+ 5	+ 7	− 18	− 38	− 56	− 76	− 94
2600	0	+ 6	+ 6	− 41	− 77	−118	−154	−195
2800	+ 5	+ 5	+ 10	− 70	−137	−207	−274	−344
3000	+ 7	+ 2	+ 9	−105	−204	−309	−408	−513
Loss in dB at 1800 Hz	0.85	1.04	1.89	0.51	0.73	1.24	1.46	1.96
Absolute delay in μsec at 1800 Hz	655	1260	1920	420	695	1120	1390	1810

Note: Step 1 of each equalizer is 0.

TABLE H

SELECTION OF DELAY EQUALIZERS

FACILITY MAKEUP									DELAY EQUALIZERS							
							H44 LOADED CABLE									
A5 CHANNEL BANKS	L-TO-L CONN	T1, N2	JAPANESE CSIB CHANNEL BANKS	BRITISH MARK II CHANNEL BANKS	NL CABLE 0-3 MI	3-15 MI	15-30 MI	30-50 MI	384M[2,3]	384N[3]	384C	384D-G[4]	384H & J[5]	384K & L[5]	385A (LF)	385B (HF)
X					X				X							
X	X				X					X		X			X	X
X	X					X				X		X			X	X
X	X	X			X					X		X			X	X
X						X			X							X
X							X			X		X			X	X
X								X		X		X			X	X
X		X			X				X		X					
X		X				X				X		X			X	X
		X			X						X					
		X				X					X					X
		X					X				X	X				X
		X						X				X			X	X
						X										X
							X					X				X
								X				X			X	X
X			X										X		X	X
X				X										X	X	X

NOTES:

1. NONLOADED CABLE NOT TO EXCEED 18,000 FEET.
2. THE 384A EQUALIZER SHOULD BE ADEQUATE IN MOST CASES. HOWEVER, IT MAY BE NECESSARY IN SOME CASES TO REPLACE 384A BY 384B + 385A + 385B.
3. THE 384M AND 384N REPLACE THE 384A AND 384B, RESPECTIVELY.
4. CHOICE OF APPROPRIATE EQUALIZER IS MADE ACCORDING TO TYPE OF GROUP CONNECTOR AND CHANNEL NUMBER: LMX1, CHANNEL 1, 384D; LMX1, CHANNEL 12, 384E; LMX2, CHANNEL 1, 384F; LMX2, CHANNEL 12, 384G. CHANNELS 2 THROUGH 11 DO NOT REQUIRE EQUALIZATION.
5. THE 384H AND 384J, AND THE 384K AND 384L ARE USED IN PAIRS ONLY.

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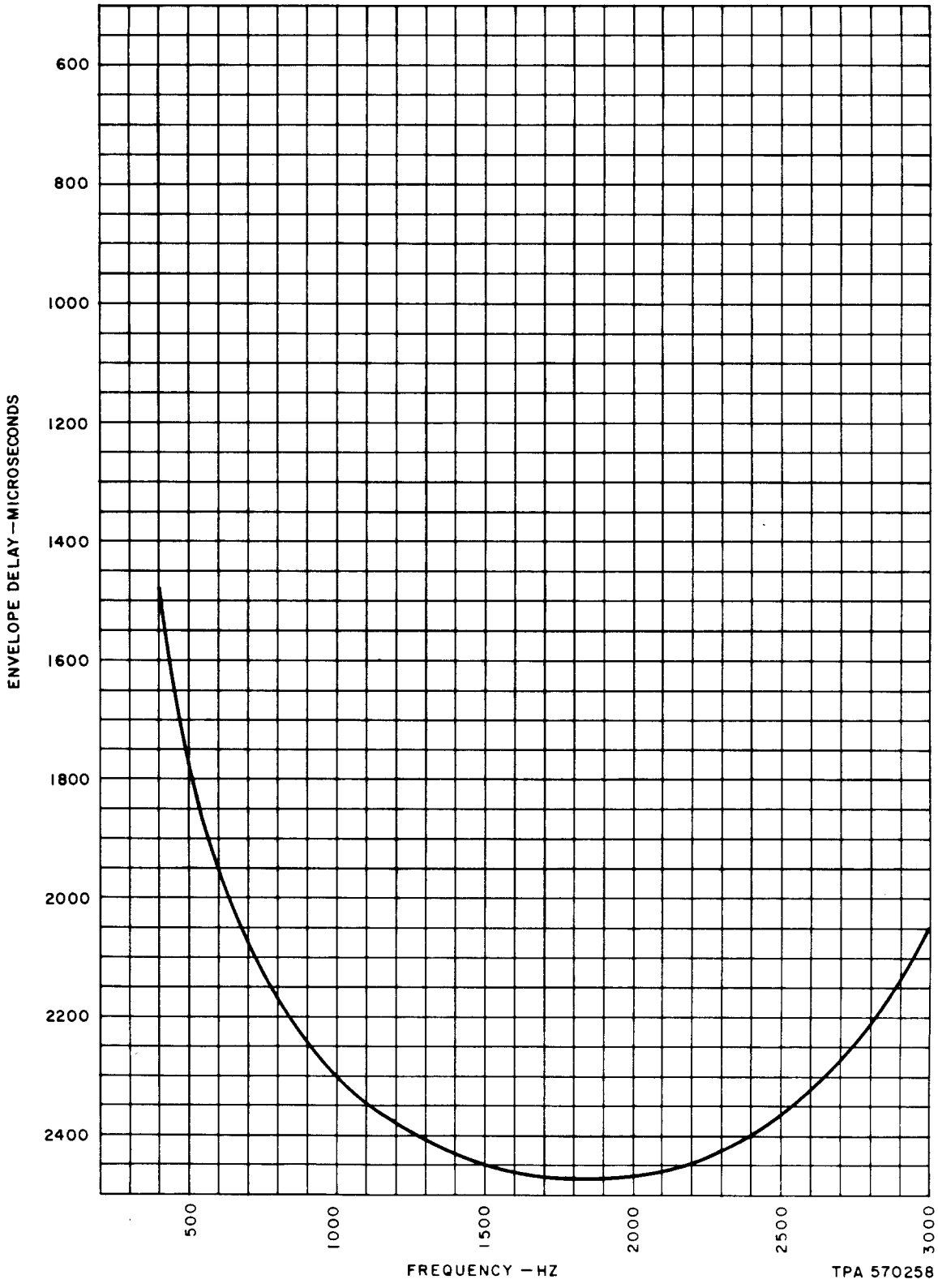

Fig. 5—Nominal Envelope Delay of 384A and M Equalizers

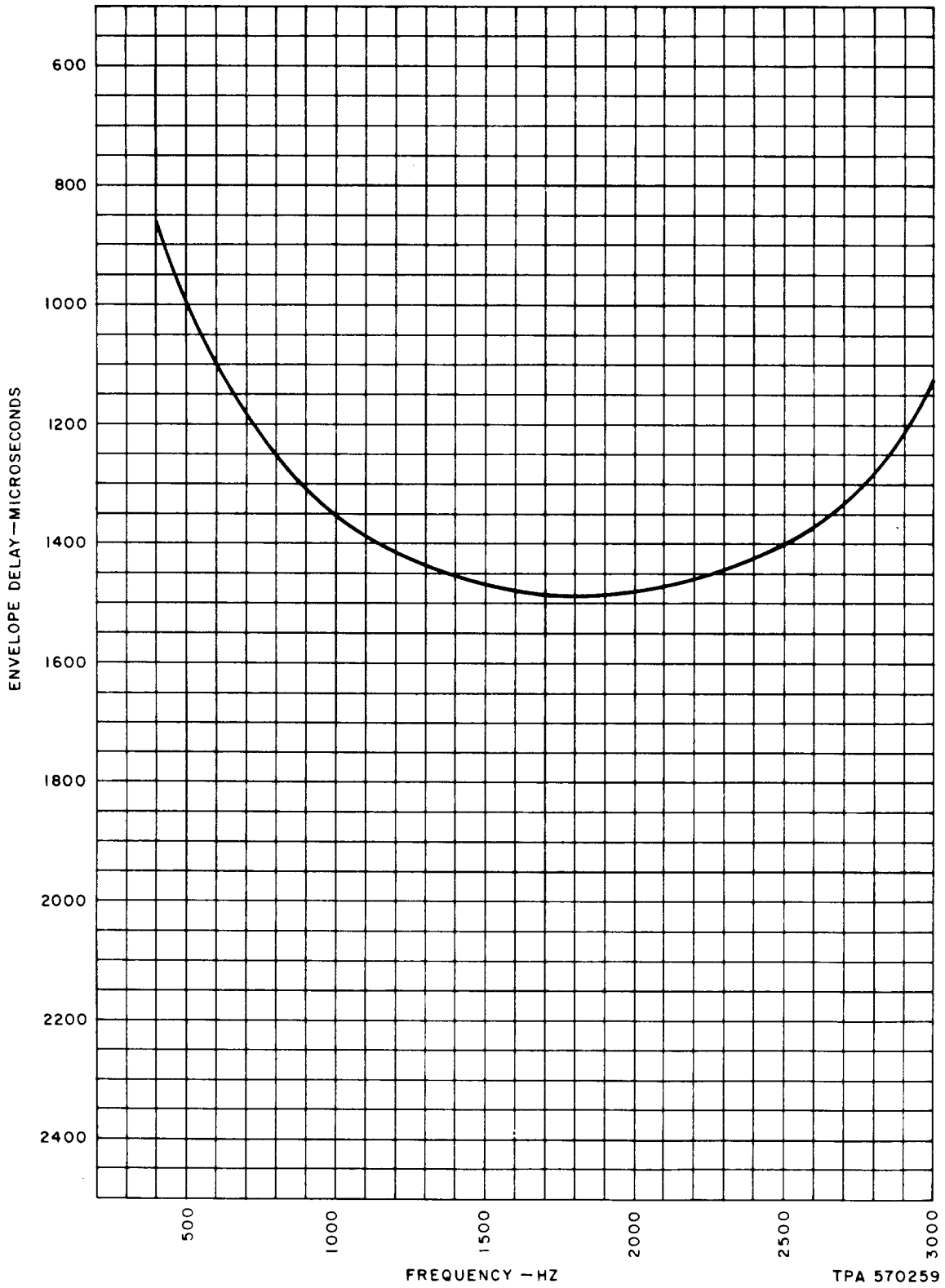

Fig. 6—Nominal Envelope Delay of 384B and N Equalizers

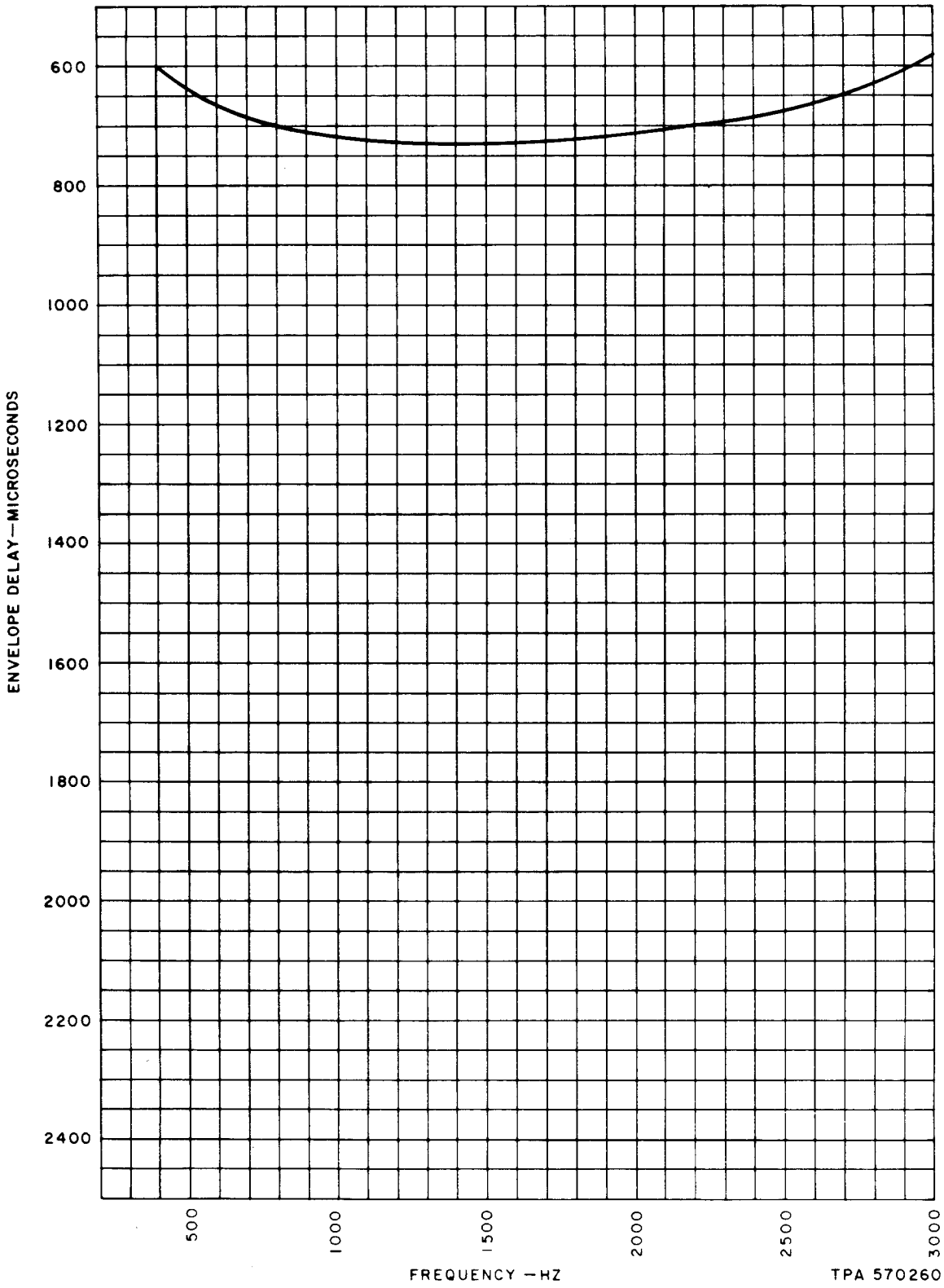

Fig. 7—Nominal Envelope Delay of 384C Equalizer

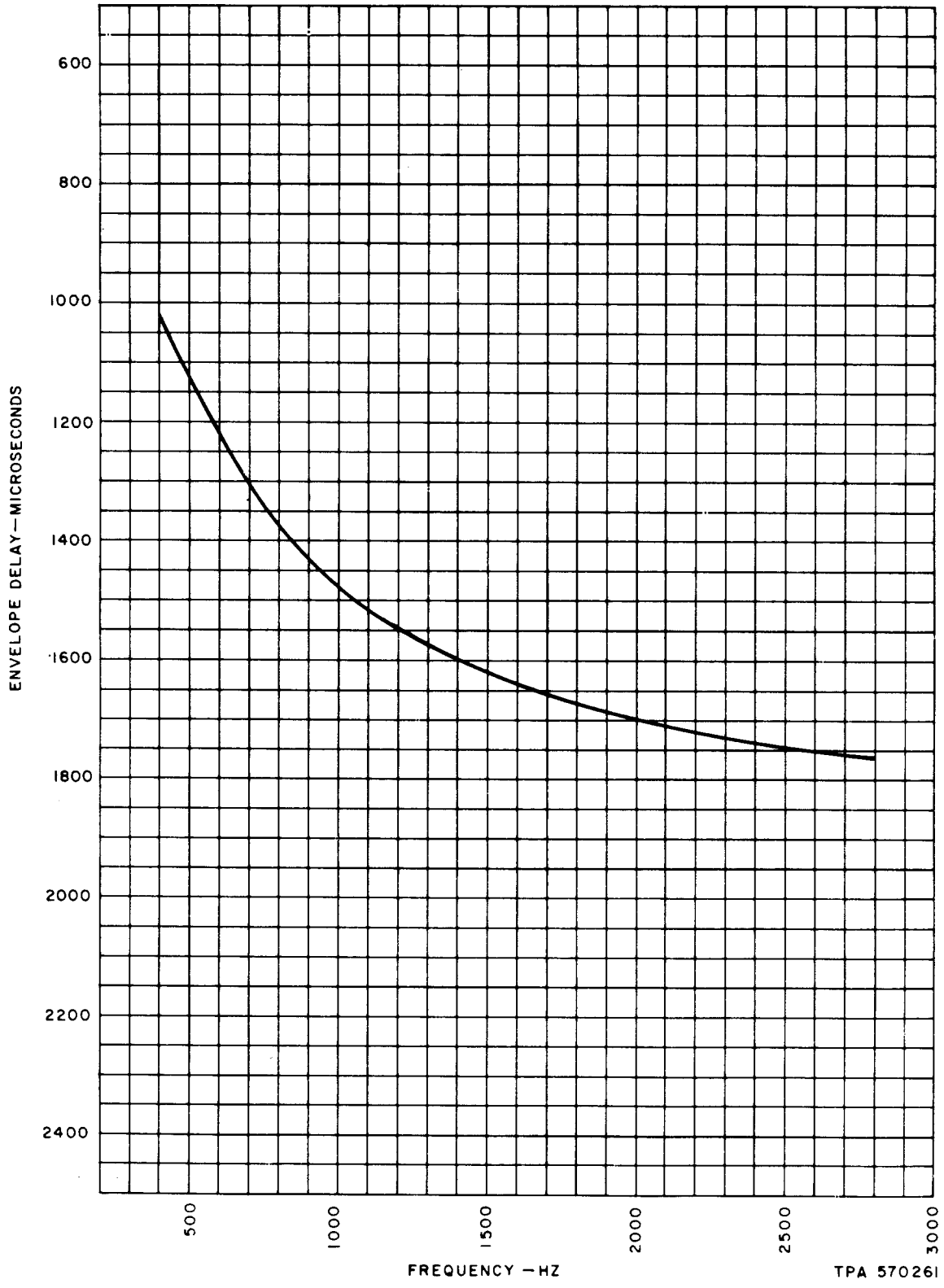

Fig. 8—Nominal Envelope Delay of 384D Equalizer

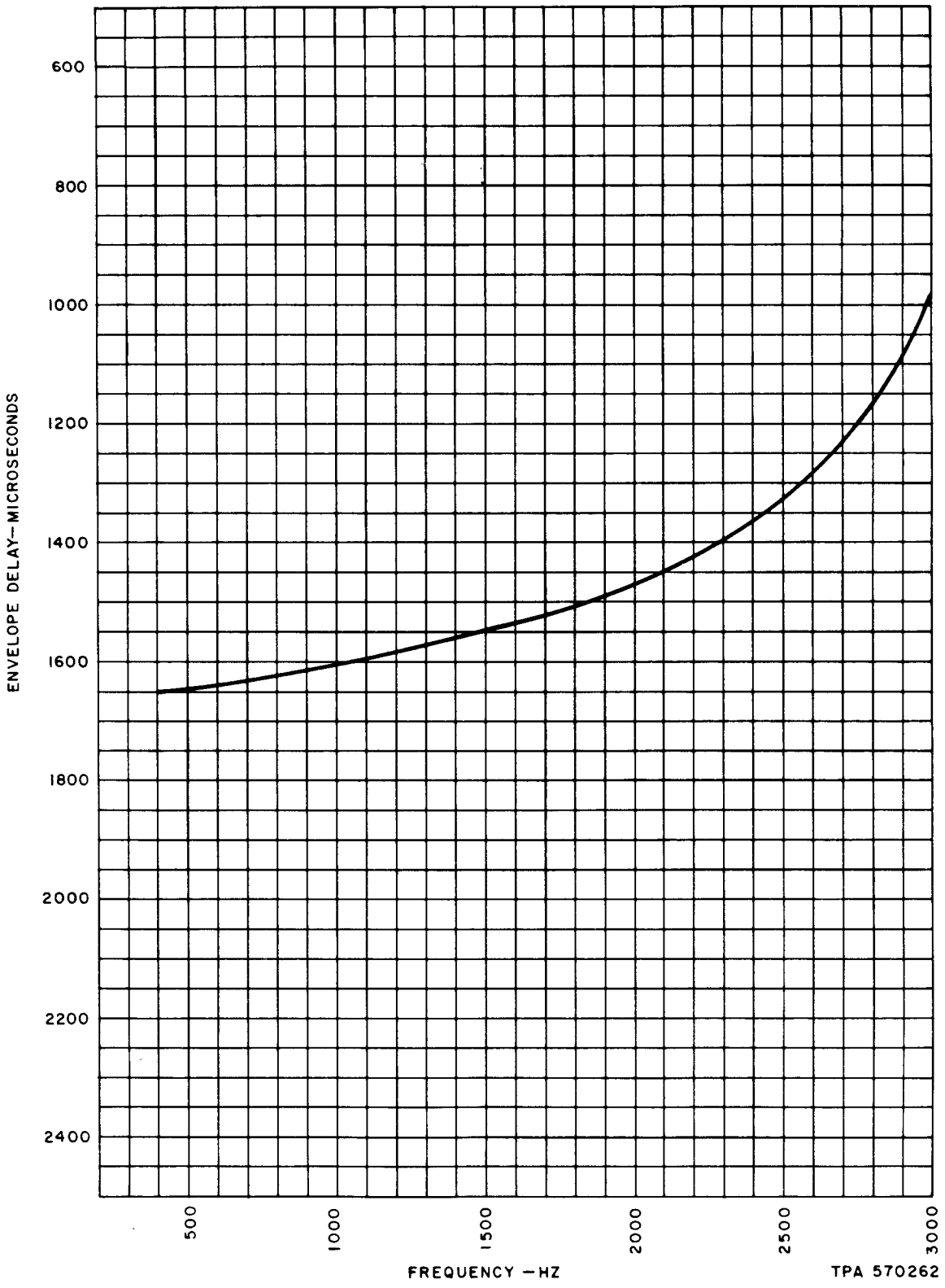

Fig. 9—Nominal Envelope Delay of 384E Equalizer

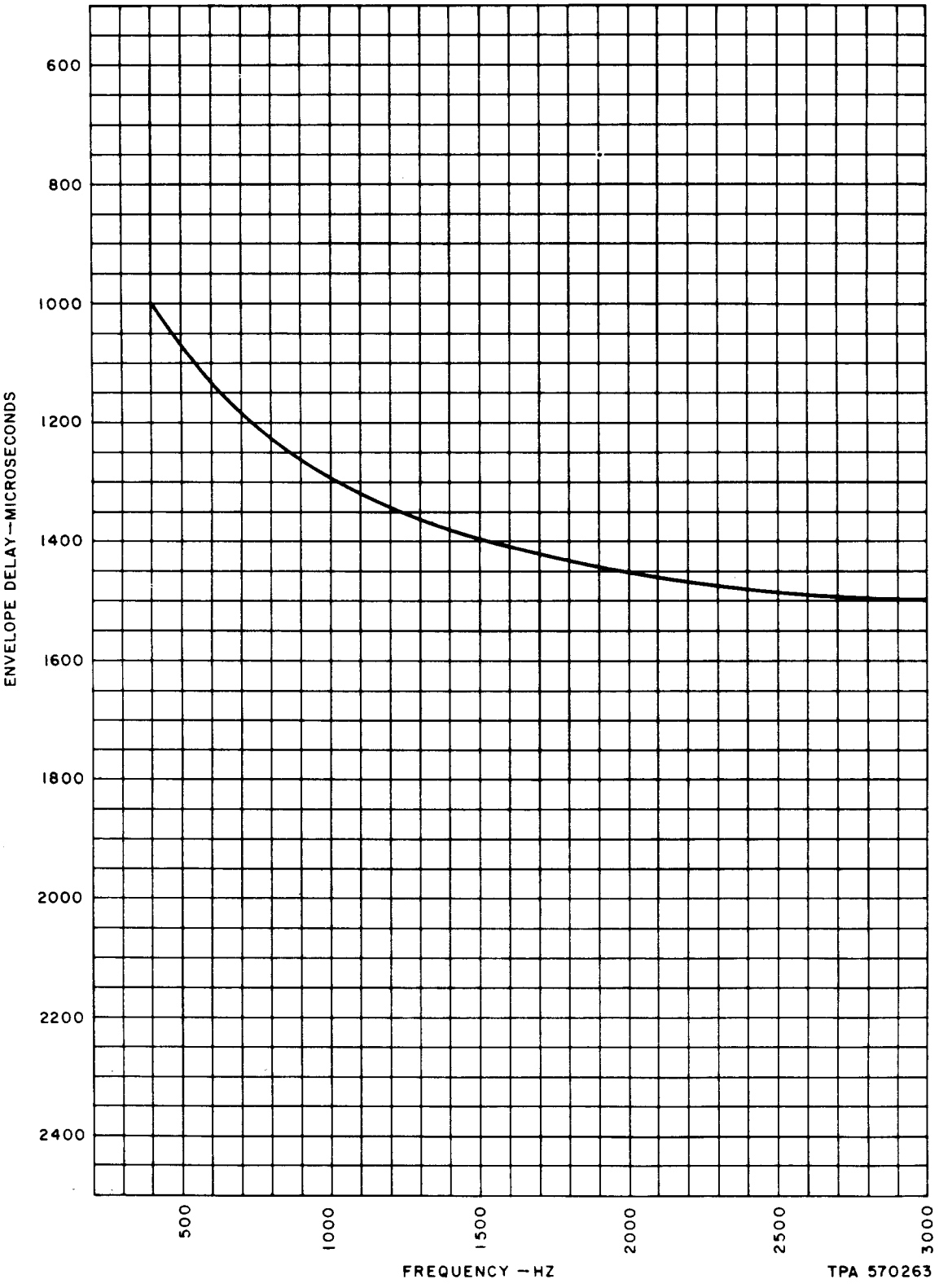

Fig. 10—Nominal Envelope Delay of 384F Equalizer

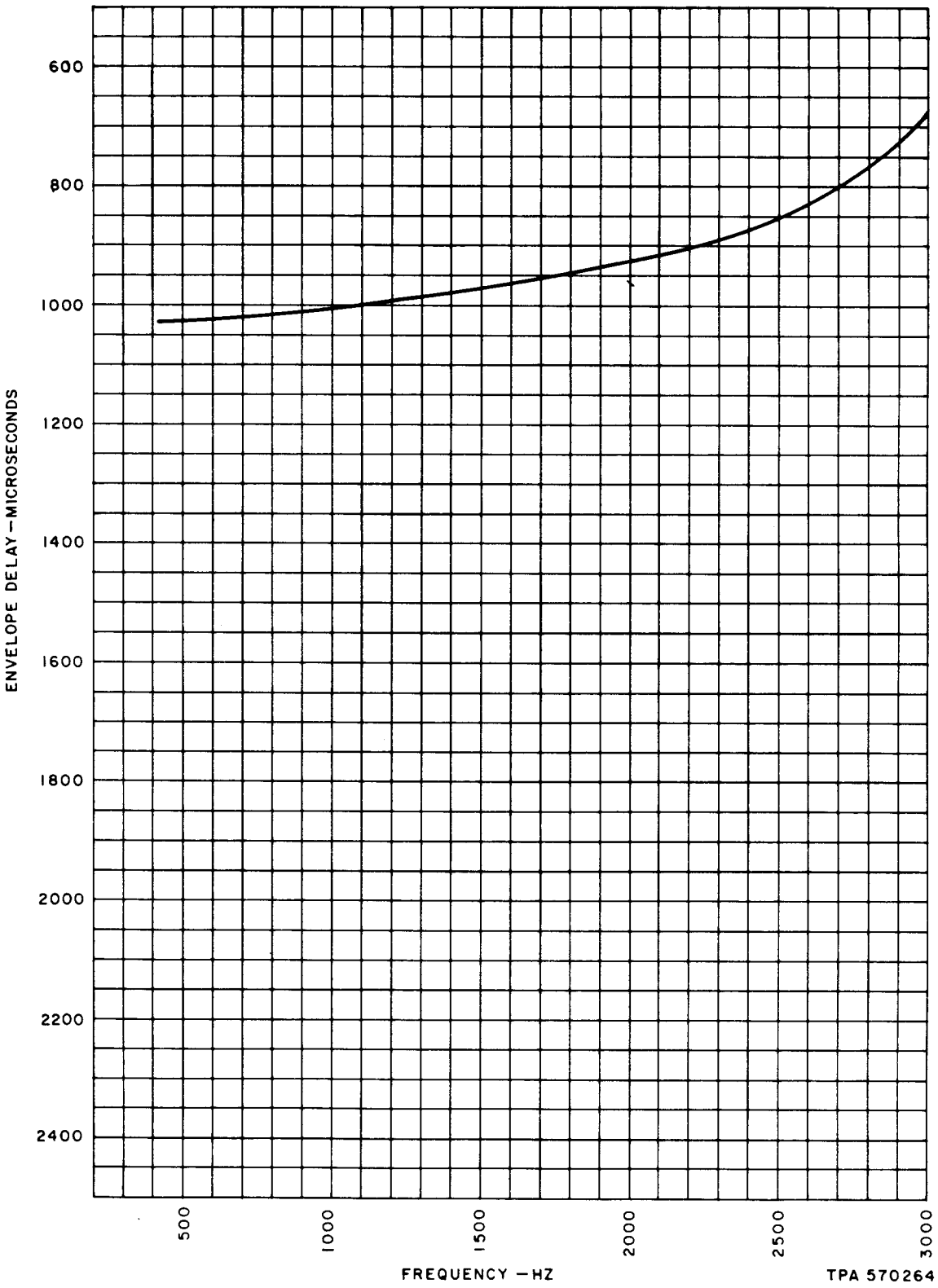

Fig. 11—Nominal Envelope Delay of 384G Equalizer

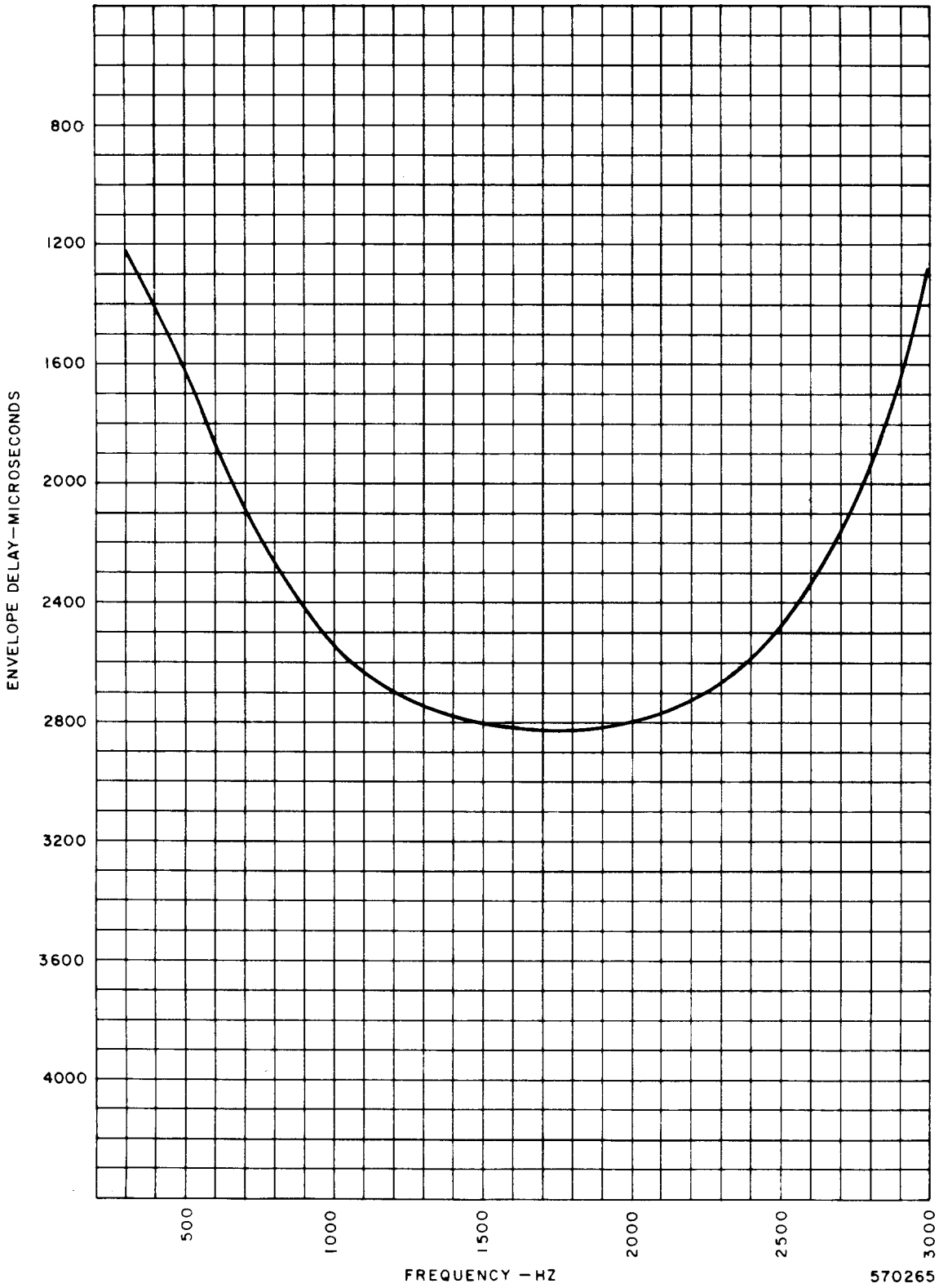

Fig. 12—Nominal Envelope Delay of 384H and J Equalizers

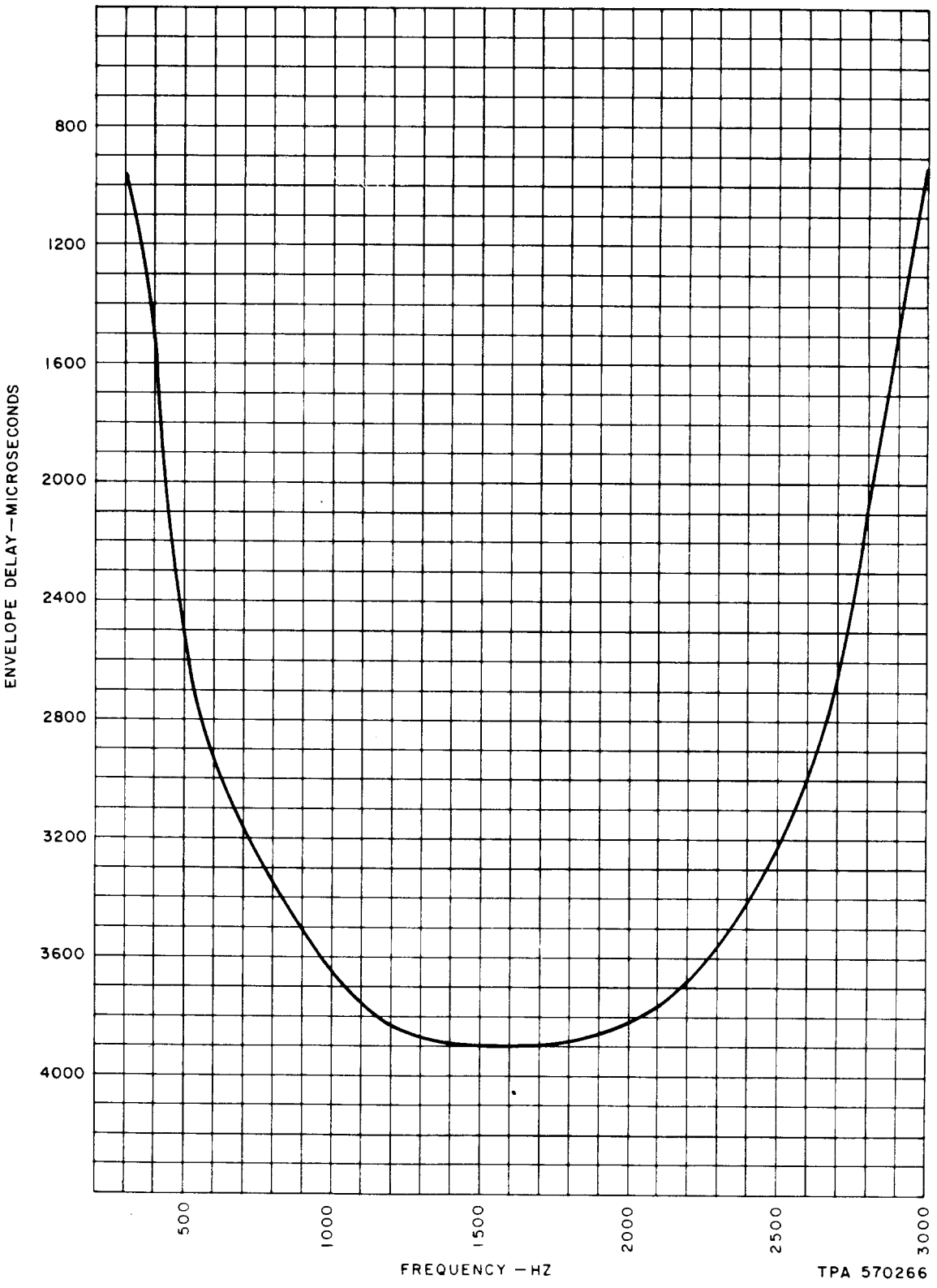

Fig. 13—Nominal Envelope Delay of 384K and L Equalizers

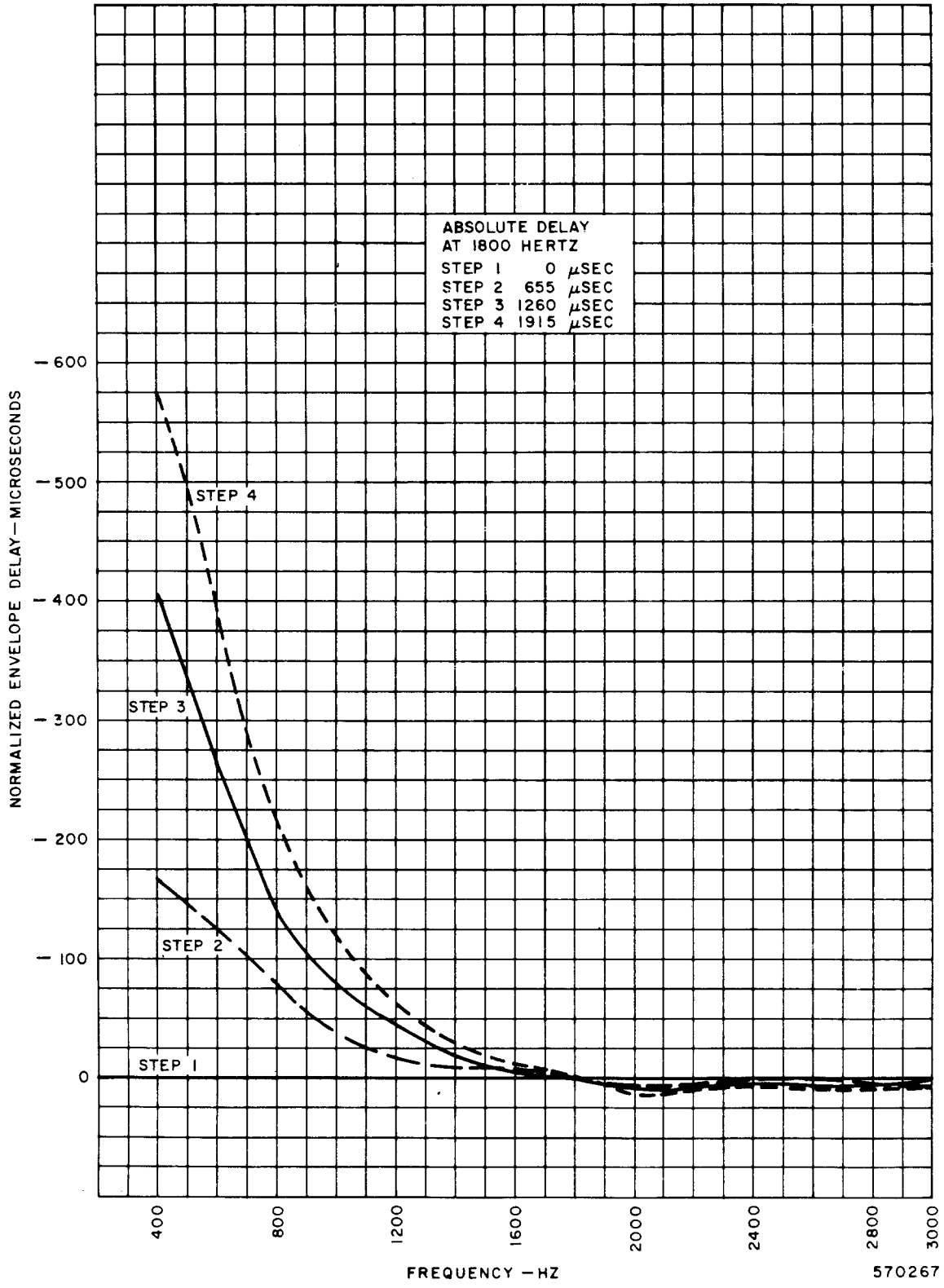

Fig. 14—Nominal Envelope Delay of 385A Equalizer

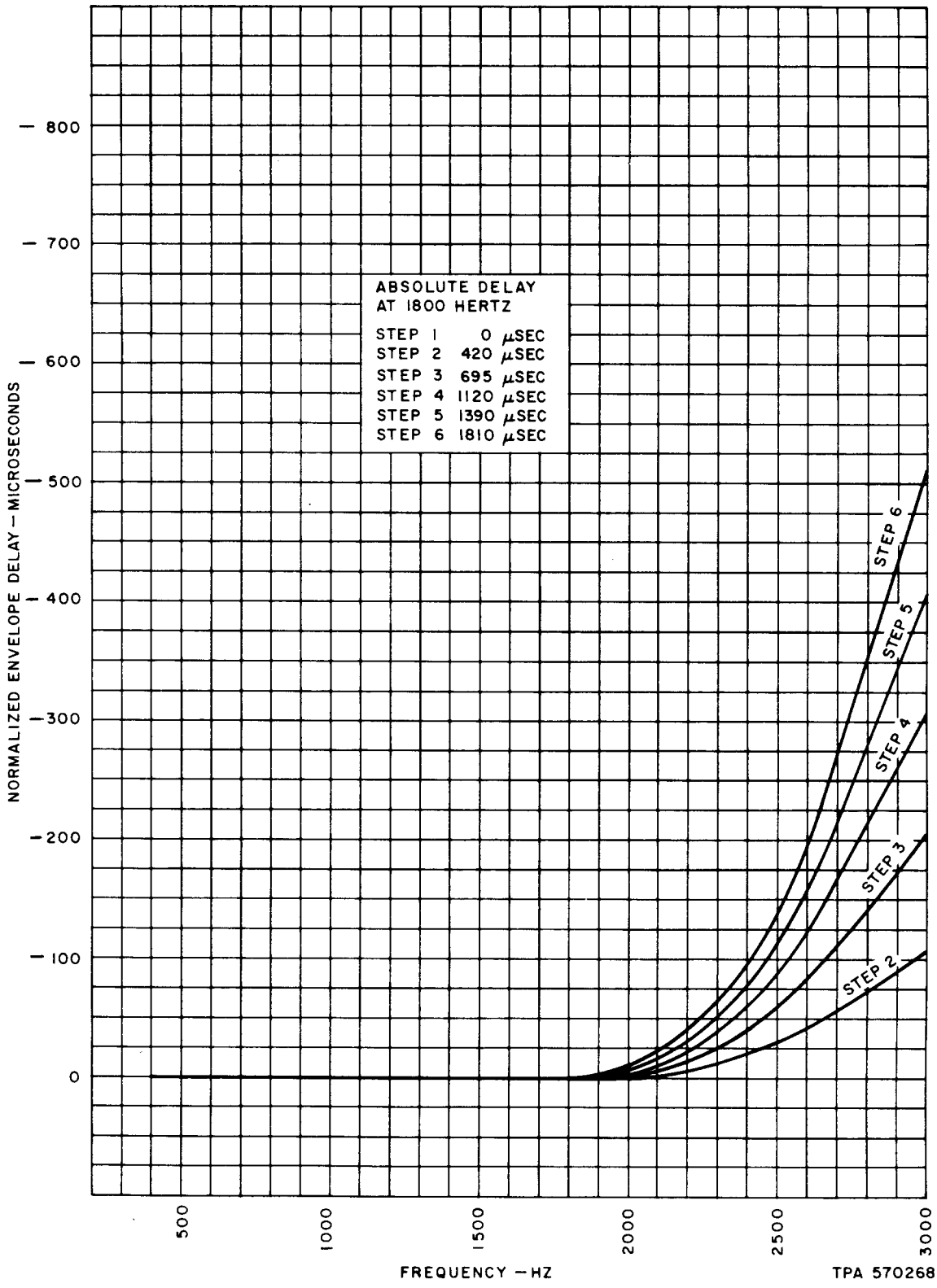

Fig. 15—Nominal Envelope Delay of 385B Equalizer