

950A-TYPE EQUALIZER

DESCRIPTION

CONTENTS	PAGE
1. GENERAL	1
2. PHYSICAL DESCRIPTION	1
3. FUNCTIONAL DESCRIPTION	1
4. REFERENCES	16

1. GENERAL

1.01 This section provides a description of the 950A-type (amplitude) equalizer, which is designed to plug into the J99347AA voice frequency amplitude and delay equalizer unit (hereafter referred to as the J-board). A description of the J-board is provided in the section entitled J99347 VF Amplitude and Delay Equalizing Equipment—Description (314-820-106). Complementary to the function of the 950A-type (amplitude) equalizer is the 950B-type (delay) equalizer, which is described in the section entitled 950B-Type Equalizer—Description (314-820-108).

1.02 The 950A-type equalizer can be adjusted to properly compensate for amplitude distortion in the voiceband. Its primary application is to equalize distortion of carrier facilities or a combination of carrier facilities and loaded cable. The 950A-type equalizer provides a gain (or loss) bump. The amplitude, width, and center frequency of the bump are all independently adjustable. Because the center frequency of the bump shape is adjustable over the full audio frequency band, a single 950A-type can equalize for rolloff at either low or high frequencies; it may also be used for mop-up in the middle of the frequency band. When both low- and high-frequency equalization is desired, two or more 950A-type equalizers can be connected in tandem.

1.03 A 950A-type equalizer is designed to equalize transmission requirements of basic and C1-through C5-conditioned lines to within the limits specified in the section entitled Voice Bandwidth Private Line Data Circuits—Tests and Requirements

(Section 314-410-500). The 950A-type is a new product. When used with the 950B-type (delay) equalizer, if necessary, and connected onto a J-board equalizer unit, an effective replacement for many presently available equalizers can be realized.

2. PHYSICAL DESCRIPTION

2.01 The 950A-type equalizer (Fig. 1) is contained in a plastic box which measures approximately 3.7 inches long, 2.3 inches wide, and 1.0 inch thick. The bottom of the box is provided with pins which connect to the internal circuitry and are used for mounting onto a J-board equalizer unit. Plastic spines on the box prevent the 950A-type equalizer from being mounted backward. When necessary, up to five 950A-type (or combined with 950B-type) equalizers may be mounted on a J-board.

2.02 The 950A-type equalizer circuitry consists of the 113A hybrid integrated circuit (HIC) plus capacitors which are inside the box. On the top of the plastic box are six 6-position slide switches. Contacts of the slide switches selectively short out thin film resistors on the 113A HIC, permitting adjustment of the equalizer.

2.03 Operating voltages for the 950A-type equalizer are normally provided by the J-board equalizer unit circuits. The operational amplifiers on the 113A HIC require a source of both +12 Vdc and -12 Vdc and appropriate ground returns.

3. FUNCTIONAL DESCRIPTION

3.01 A simplified circuit diagram of the 950A-type equalizer is shown in Fig. 2, while the complete circuit diagram is shown in Fig. 3.

3.02 The three operational amplifiers (IC1, IC2, and IC3) and associated resistors and capacitors form a feedback loop which generates a resonance.

3.03 The resonant frequency and the sharpness of resonance are controlled by these resistors and capacitors. Both are adjustable by means of the appropriate set of switched resistors.

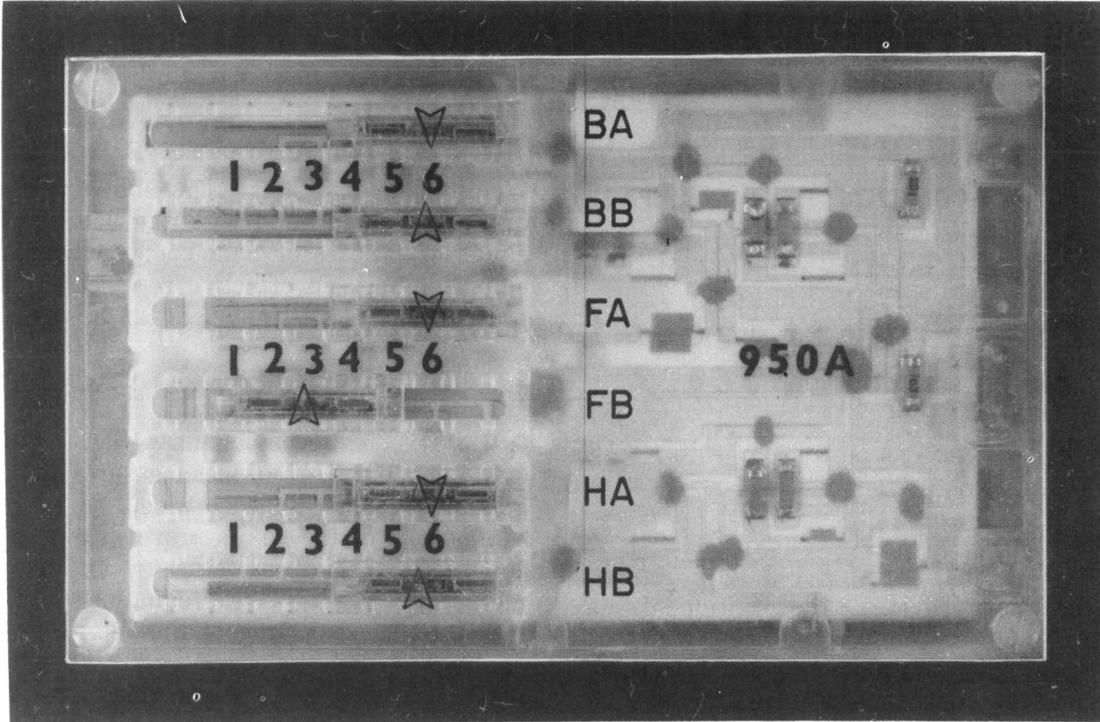


Fig. 1—950A-Type Amplitude Equalizer, Top View

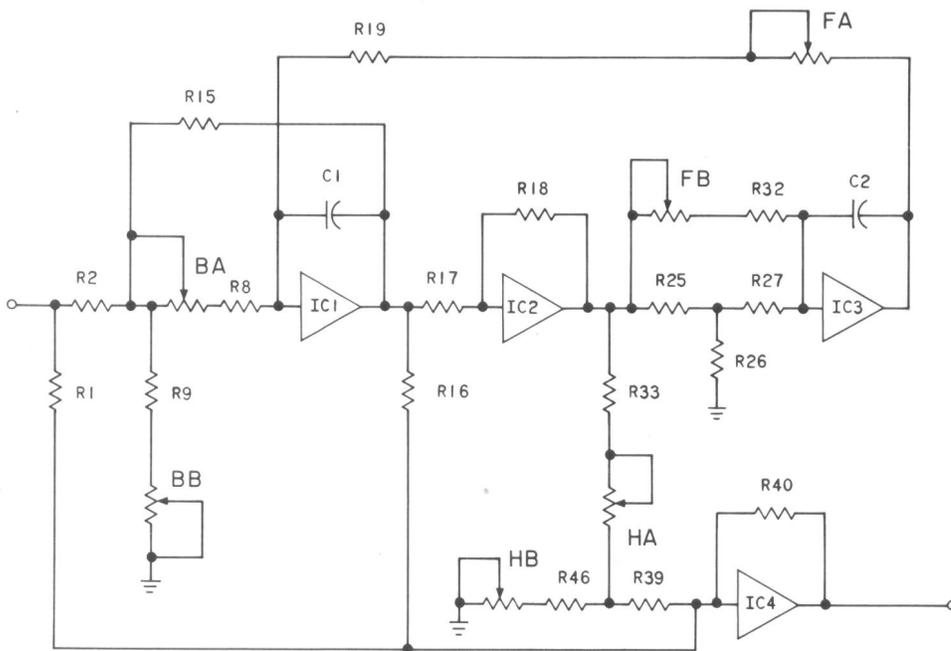


Fig. 2—950A-Type Amplitude Equalizer, Simplified Diagram

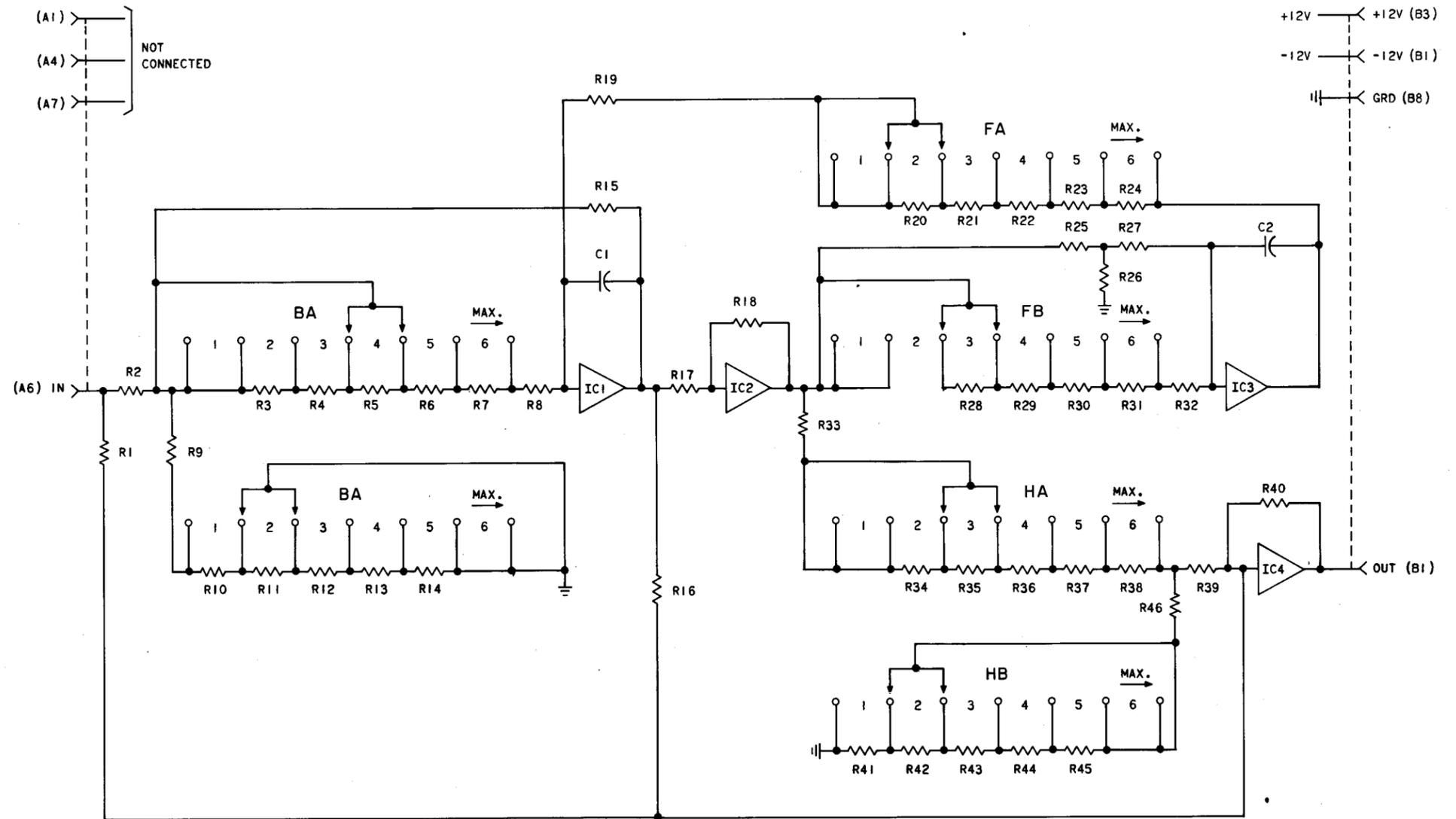


Fig. 3—950A-Type Amplitude Equalizer, Circuit Diagram

3.04 The output signals of IC1 and IC2, together with the original input signal, are summed by the operational amplifier IC4. This summation results in the desired bump shape for the equalizer.

3.05 To illustrate how amplitude equalization is accomplished, consider the typical transmission function of the 950A-type amplitude equalizer as shown in Fig. 4. Three parameters characterize this gain (or loss) bump:

- (a) The center (or resonant) frequency F_0 , which is the frequency at which the maximum gain (or loss) is obtained
- (b) The height (HT), which is the gain (or loss) at the frequency F_0

(c) The bandwidth (BW), which roughly corresponds to the width of the bump at one-half the maximum height.

3.06 These three parameters of the 950A-type amplitude equalizer are independently adjustable by the six slide switches.

- (a) **Center Frequency:** The center frequency (F_0) can assume any of 36 distinct values in the 300-Hz to 3300-Hz range. It is controlled by the combination of slide switches FA and FB. Table A lists the values of F_0 which may be obtained.

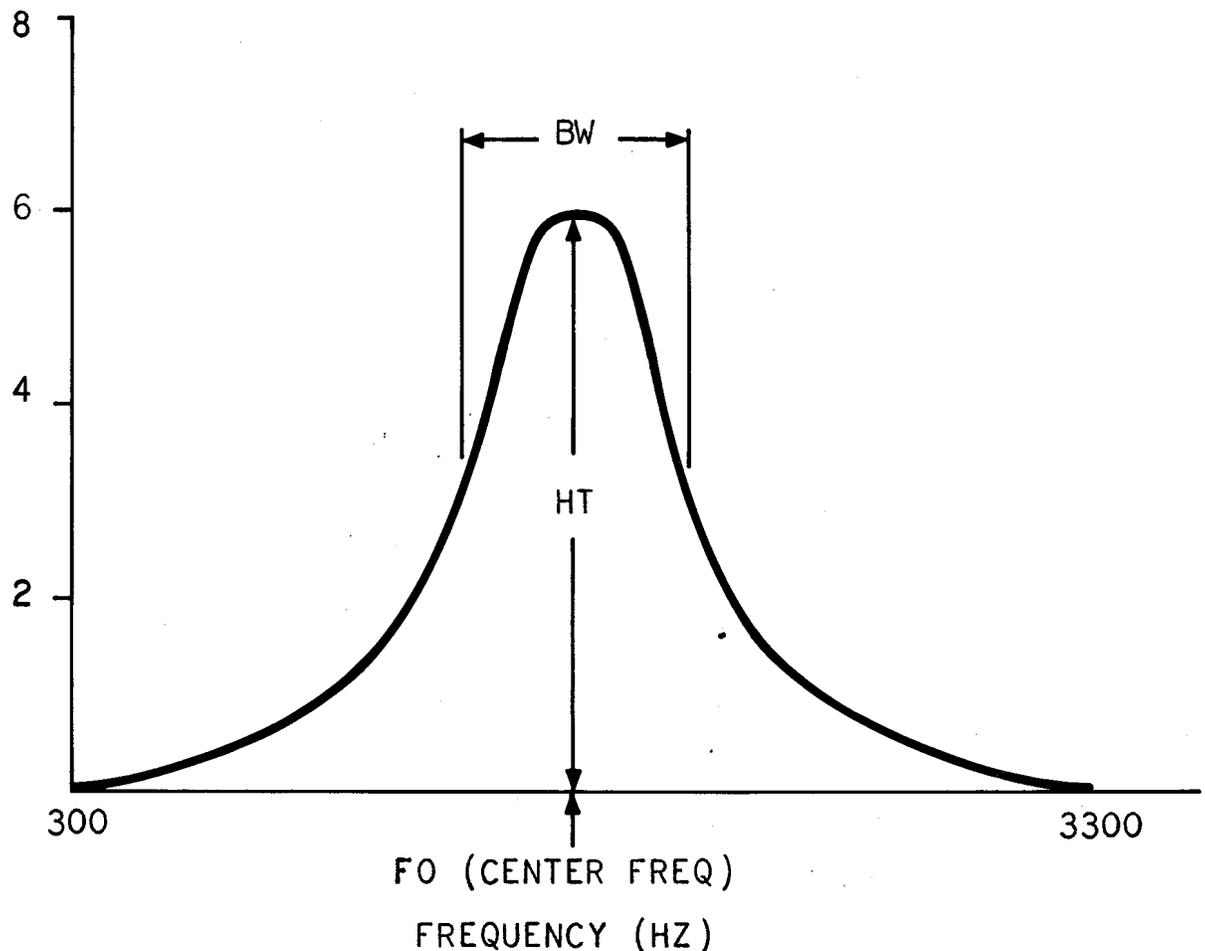


Fig. 4—Typical Characteristics of the 950A-Type Amplitude Equalizer

SECTION 314-820-107

(b) **Height:** The height (HT) can assume any of 36 distinct values in the range between +12.61 dB (gain) to -2.88 dB (loss). It is controlled by the combination of slide switches HA and HB as shown in Table B.

(c) **Bandwidth:** The bandwidth (BW) can assume any of 36 distinct values in the range between 100 Hz and 1600 Hz, as shown in Table C. It is controlled by slide switches BA and BB.

TABLE A

CENTER FREQUENCY SETTINGS FOR 950A-TYPE AMPLITUDE EQUALIZER

FB SWITCH POSITION	FA SWITCH POSITION	F _O FREQUENCY (Hz)
1	1	300
1	2	360
1	3	420
1	4	480
1	5	540
1	6	600
2	1	700
2	2	840
2	3	980
2	4	1120
2	5	1260
2	6	1400
3	1	1500
3	2	1800
3	3	2100
3	4	2400
3	5	2700
3	6	3000
4	1	1550
4	2	1860
4	3	2170
4	4	2480
4	5	2790
4	6	3100
5	1	1600
5	2	1920
5	3	2240
5	4	2560
5	5	2880
5	6	3200
6	1	1650
6	2	1980
6	3	2310
6	4	2640
6	5	2970
6	6	3300

TABLE B

HEIGHT SETTINGS FOR 950A-TYPE AMPLITUDE EQUALIZER

HA SWITCH POSITION	HB SWITCH POSITION	HT VALUE (dB)
1	1	- 2.877
1	2	- 2.390
1	3	- 1.907
1	4	- 1.426
1	5	- 0.949
1	6	- 0.473
2	1	0.000
2	2	+ 0.469
2	3	+ 0.937
2	4	+ 1.401
2	5	+ 1.864
2	6	+ 2.324
3	1	+ 2.782
3	2	+ 3.237
3	3	+ 3.690
3	4	+ 4.140
3	5	+ 4.588
3	6	+ 5.034
4	1	+ 5.478
4	2	+ 5.918
4	3	+ 6.357
4	4	+ 6.793
4	5	+ 7.226
4	6	+ 7.657
5	1	+ 8.086
5	2	+ 8.512
5	3	+ 8.935
5	4	+ 9.355
5	5	+ 9.772
5	6	+10.187
6	1	+10.600
6	2	+11.008
6	3	+11.414
6	4	+11.816
6	5	+12.215
6	6	+12.611

TABLE C
SIGNAL BANDWIDTH SETTINGS
FOR 950A-TYPE AMPLITUDE EQUALIZER

BA SWITCH POSITION	BB SWITCH POSITION	SIGNAL BANDWIDTH (Hz)
1	1	100.0
1	2	109.5
1	3	119.8
1	4	131.1
1	5	143.4
1	6	156.8
2	1	171.5
2	2	187.4
2	3	204.7
2	4	223.6
2	5	244.0
2	6	266.2
3	1	290.3
3	2	316.3
3	3	344.5
3	4	375.0
3	5	407.8
3	6	443.1
4	1	481.1
4	2	522.0
4	3	565.7
4	4	612.4
4	5	662.2
4	6	715.3
5	1	771.6
5	2	831.3
5	3	894.3
5	4	960.6
5	5	1030.3
5	6	1103.2
6	1	1179.2
6	2	1258.2
6	3	1340.1
6	4	1424.5
6	5	1511.2
6	6	1600.0

3.07 Note that because the three parameters may each assume any of 36 distinct values, a total of 36^3 (or 46,656) distinct equalizing shapes are available. A computer program will be available to determine the number of equalizers needed, together with the correct switch settings. Instructions for this program will be found in the section entitled ADE 950 Equalizer Program (856-200-100).

3.08 Although it is impractical to illustrate *all* the shapes available from the 950A-type amplitude equalizer, Fig. 5, 6, 7, and 8 show representative examples. In Fig. 5 and 6 the center frequency (F_0) is fixed at 3000 Hz to illustrate compensation for high frequency rolloff. In Fig. 5, the height (HT) is also fixed and the effect of bandwidth (BW) variation is studied by letting the bandwidth assume 10 of its 36 available settings. In Fig. 6, the bandwidth is fixed while the height assumes 10 of its 36 available settings. In Fig. 7 and 8, the center frequency is fixed at 300 Hz to illustrate compensation for low-frequency rolloff. Again the effects of bandwidth and height adjustments are displayed.

3.09 The 950A-type amplitude equalizer also introduces some delay distortion. Tables D, E, F and G list the various delay times in microseconds (μsec) for the settings shown in Fig. 5, 6, 7 and 8, respectively.

3.10 The 950A-type amplitude equalizer with its active circuitry is designed to be driven by a low source impedance (less than 100 ohms) and to drive a high output impedance (greater than 1200 ohms). The J-board normally provides for proper operation.

3.11 The 1000-Hz loss of the 950A-type amplitude equalizer is a function of the switch settings. It is a nominal 0 dB when equalizing high or low frequency rolloff. When the resonant frequency is close to 1000 Hz, the loss at 1000 Hz will also be affected. The J-board equalizer provides a variable gain adjustment between -4 dB and +3 dB to compensate for this.

3.12 The maximum signal voltage output varies from 7 to 10 Vac (peak) depending upon the switch settings.

TABLE D
DELAY CHARACTERISTICS OF THE 950A-TYPE AMPLITUDE EQUALIZER
WITH VARYING BANDWIDTH (FREQUENCY AND HEIGHT REMAIN CONSTANT)

TRACE REFERENCE (SEE FIG. 5)		DELAY IN MICROSECONDS									
		1	2	3	4	5	6	7	8	9	10
FREQUENCY (HZ)	300	-54	-43	-33	-25	-18	-13	-9	-7	-5	-4
	600	-53	-44	-35	-27	-20	-14	-10	-7	-5	-4
	900	-50	-45	-38	-30	-23	-17	-12	-8	-6	-5
	1200	-44	-45	-41	-34	-27	-20	-15	-10	-7	-6
	1500	-33	-41	-43	-40	-34	-26	-19	-14	-10	-8
	1800	-12	-29	-41	-46	-43	-36	-28	-20	-15	-11
	2100	21	-13	-26	-45	-54	-52	-44	-34	-25	-19
	2400	69	53	25	-12	-48	-70	-74	-64	-51	-40
	2500	86	78	55	16	-30	-69	-86	-83	-69	-56
	2600	103	106	94	60	7	-51	-93	-106	-96	-82
	2700	118	132	138	123	77	3	-74	-125	-138	-128
	2800	128	154	181	201	194	138	34	-87	-174	-201
	2900	133	166	212	271	337	390	387	280	68	-117
	3000	131	167	219	294	402	560	789	1120	1600	2100
	3100	124	156	199	255	319	373	377	285	88	-92
3200	113	137	164	186	186	144	53	-61	-151	-185	
3300	100	115	124	119	86	25	-48	-103	-124	-120	
VARIABLE SETTINGS	BA	6	6	5	4	4	3	2	2	1	1
	BB	6	2	4	6	2	4	6	2	4	1

CONSTANT SETTINGS	FA = 6	HA = 5
	FB = 3	HB = 4

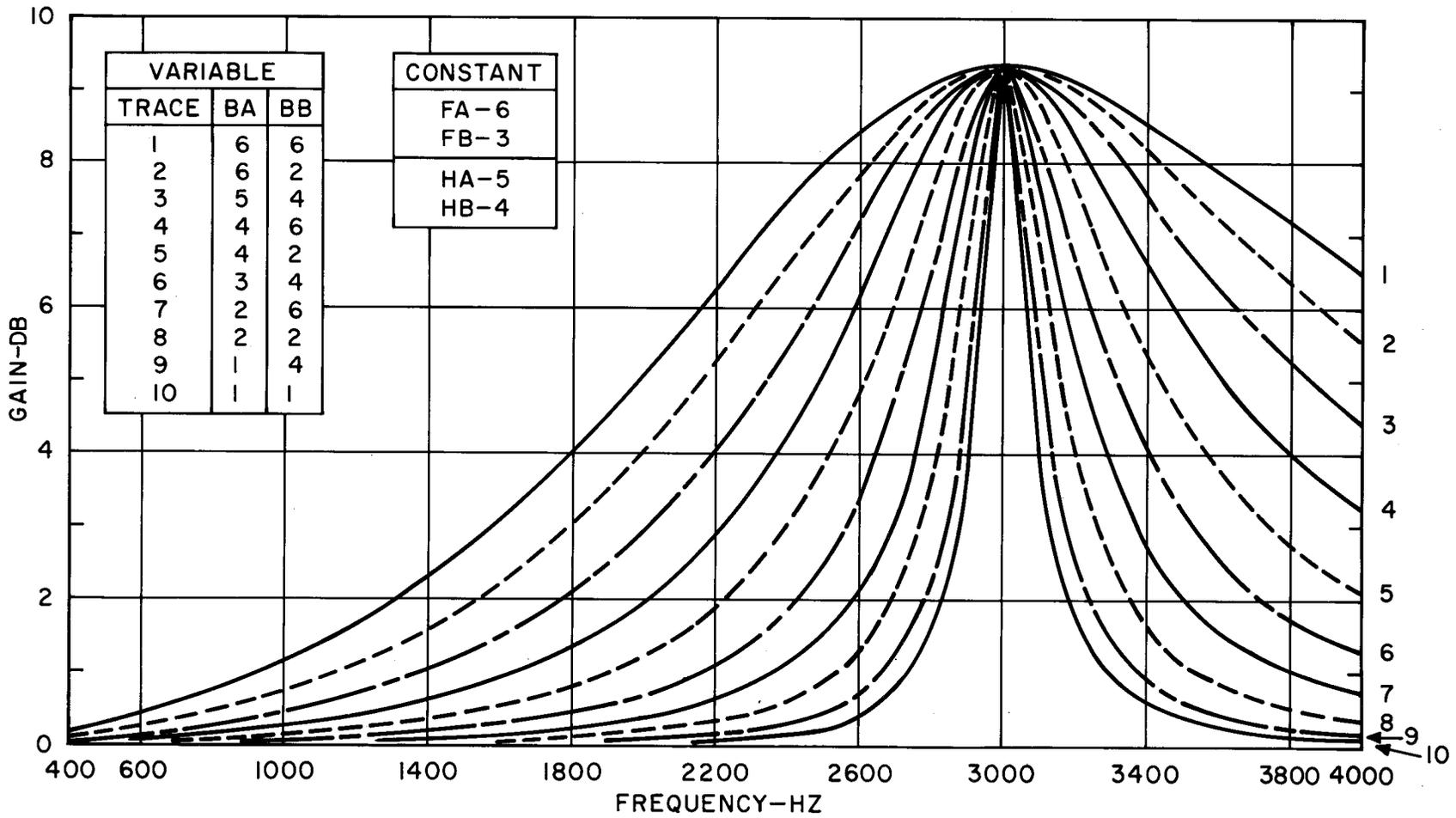


Fig. 5—Nominal Gain Characteristics of the 950A-Type Amplitude Equalizer Showing Effect of Bandwidth Variation

TABLE E

DELAY CHARACTERISTICS OF THE 950A-TYPE AMPLITUDE EQUALIZER
WITH VARYING HEIGHT (FREQUENCY AND BANDWIDTH REMAIN CONSTANT)

TRACE REFERENCE (SEE FIG. 6)		DELAY IN MICROSECONDS									
		1	2	3	4	5	6	7	8	9	10
FREQUENCY (HZ)	300	-28	-22	-17	-12	-9	-6	-3	-1	2	3
	600	-31	-24	-19	-14	-10	-6	-3	-1	2	3
	900	-35	-28	-21	-16	-11	-7	-3	-1	2	3
	1200	-41	-33	-26	-19	-13	-8	-4	-1	2	4
	1500	-49	-41	-32	-24	-18	-11	-6	-1	3	5
	1800	-59	-51	-43	-33	-24	-16	-8	-2	4	8
	2100	-64	-61	-56	-47	-36	-24	-13	-3	7	13
	2400	-38	-47	-53	-53	-47	-36	-21	-4	12	24
	2500	-8	-23	-36	-43	-43	-36	-23	-5	15	31
	2600	47	26	5	-12	-23	-27	-21	-5	17	36
	2700	141	115	87	57	30	7	-3	-2	12	31
	2800	291	262	226	185	139	92	46	7	-16	-20
	2900	458	426	387	339	281	210	126	27	-85	-174
	3000	493	462	424	376	316	242	149	33	-111	-242
	3100	358	329	294	253	203	146	83	16	-46	-85
3200	202	177	149	116	82	49	21	2	-2	6	
3300	98	78	56	33	13	-1	-7	-3	12	27	
VARIABLE SETTINGS	HA	6	6	5	4	4	3	2	2	1	1
	HB	6	2	4	6	2	4	6	2	4	1

CONSTANT SETTINGS	FA = 6	BA = 4
	FB = 3	BB = 1

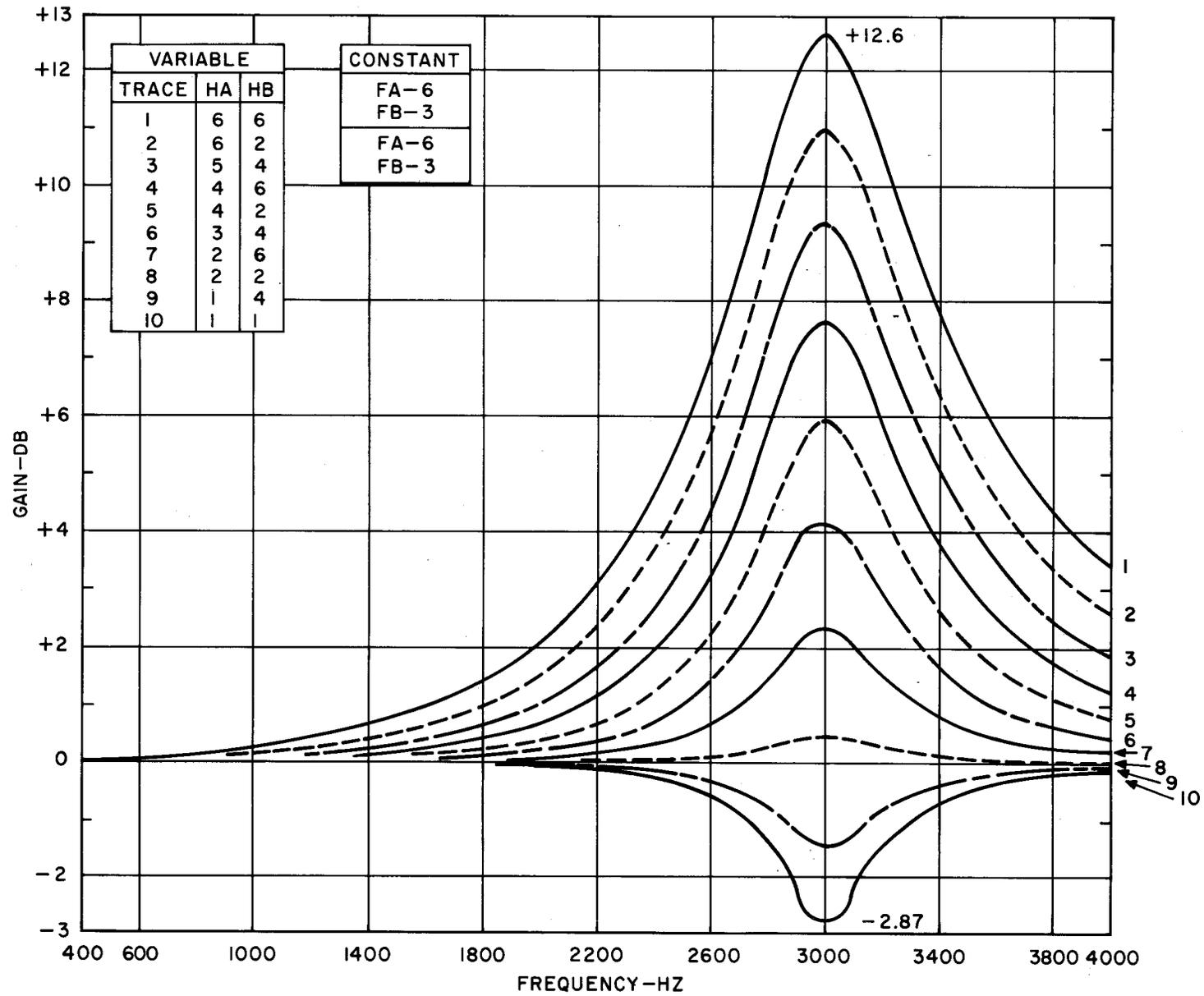


Fig. 6—Nominal Gain Characteristics of the 950A-Type Amplitude Equalizer Showing Effect of Height Variation

TABLE F

DELAY CHARACTERISTICS OF THE 950A-TYPE AMPLITUDE EQUALIZER
WITH VARYING BANDWIDTH (FREQUENCY AND HEIGHT REMAIN CONSTANT)

TRACE REFERENCE (SEE FIG. 7)		DELAY IN MICROSECONDS									
		1	2	3	4	5	6	7	8	9	10
FREQUENCY (HZ)	300	98	125	164	220	301	419	591	840	1198	1570
	400	75	95	121	154	194	227	227	160	23.4	-93
	500	62	76	92	106	110	88	32	-40	-93	-110
	600	53	63	71	71	57	21	-25	-60	-72	-69
	800	41	43	40	28	5	-20	-38	-35	-38	-32
	1000	31	29	21	6	-12	-26	-31	-29	-23	-19
	1200	23	18	8	-5	-17	-24	-24	-20	-16	-12
	1500	14	7	-2	-12	-18	-19	-17	-13	-10	-8
	2000	4	-3	-9	-13	-14	-12	-10	-7	-5	-4
	2500	-2	-6	-9	-11	-10	-8	-6	-5	-3	-2
3000	-4	-7	-9	-9	-8	-6	-5	-3	-2	-2	
VARIABLE SETTINGS	BA	6	6	5	4	4	3	2	2	1	1
	BB	6	2	4	6	2	4	6	2	4	1

CONSTANT SETTINGS	FA = 1	HA = 4
	FB = 1	HB = 2

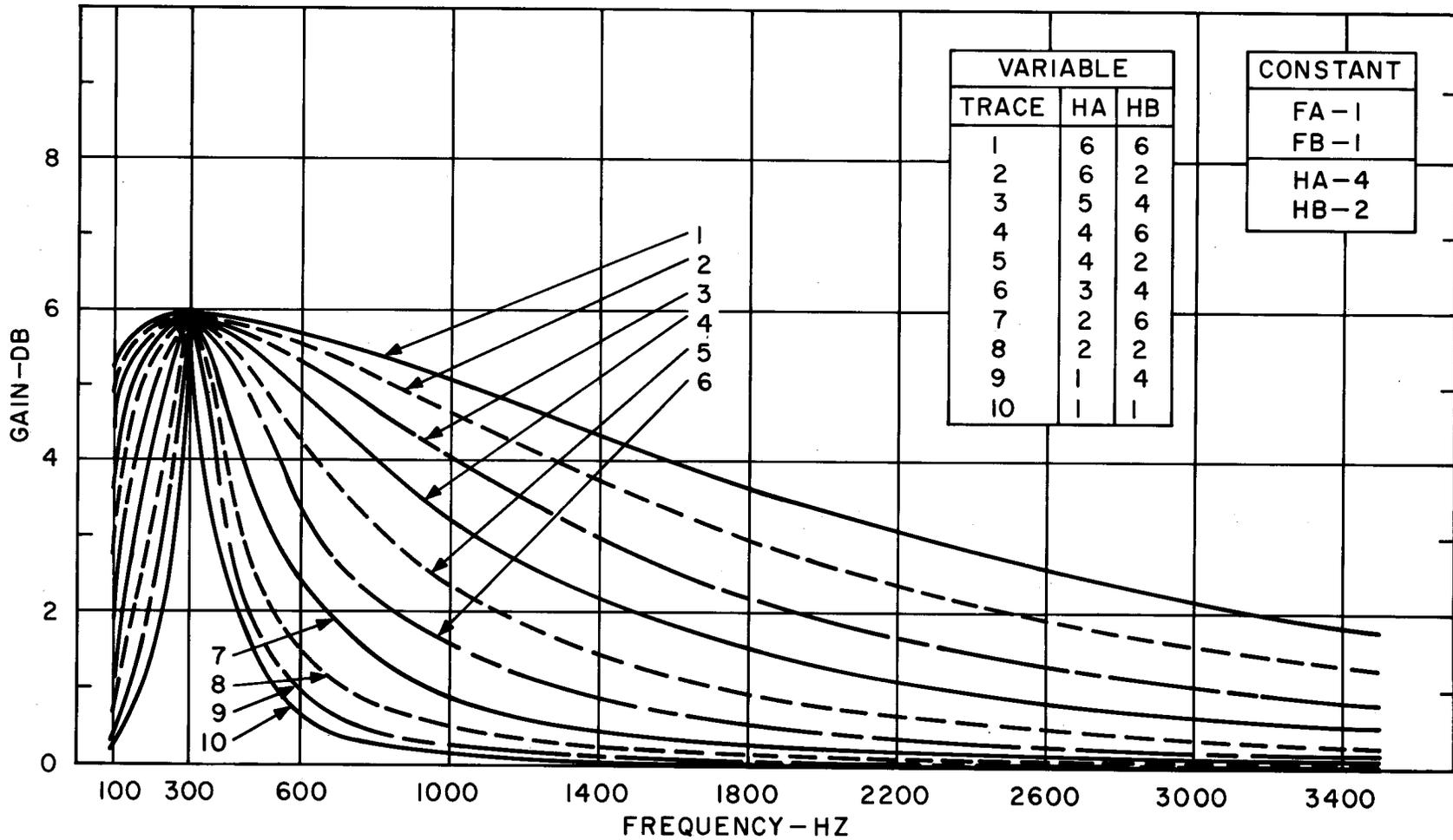


Fig. 7—Nominal Gain Characteristics of the 950A-Type Amplitude Equalizer Showing Effect of Bandwidth Variation

TABLE G
DELAY CHARACTERISTICS OF THE 950A-TYPE AMPLITUDE EQUALIZER
WITH VARYING HEIGHT (FREQUENCY AND BANDWIDTH REMAIN CONSTANT)

TRACE REFERENCE (SEE FIG. 8)		DELAY IN MICROSECONDS									
		1	2	3	4	5	6	7	8	9	10
FREQUENCY (HZ)	300	915	859	788	701	591	453	281	62	-213	-470
	400	439	398	349	292	227	155	82	14	-36	-55
	500	156	127	95	63	32	8	-4	-3	14	35
	600	42	22	3	-14	-25	-27	-20	-5	16	35
	800	-28	-37	-42	-43	-39	-30	-17	-4	11	21
	1000	-41	-44	-43	-38	-31	-22	-12	-2	7	13
	1200	-41	-40	-37	-31	-24	-16	-9	-2	5	9
	1500	-35	-32	-28	-22	-16	-11	-6	-1	3	6
	2000	-25	-21	-18	-14	-10	-6	-3	-1	2	3
	2500	-18	-15	-12	-9	-6	-4	-2	0	1	2
3000	-13	-11	-9	-6	-4	-3	-1	0	1	1	
VARIABLE SETTINGS	HA	6	6	5	4	4	3	2	2	1	1
	HB	6	2	4	6	2	4	6	2	4	1

CONSTANT SETTINGS	FA = 1	BA = 2
	FB = 1	BB = 6

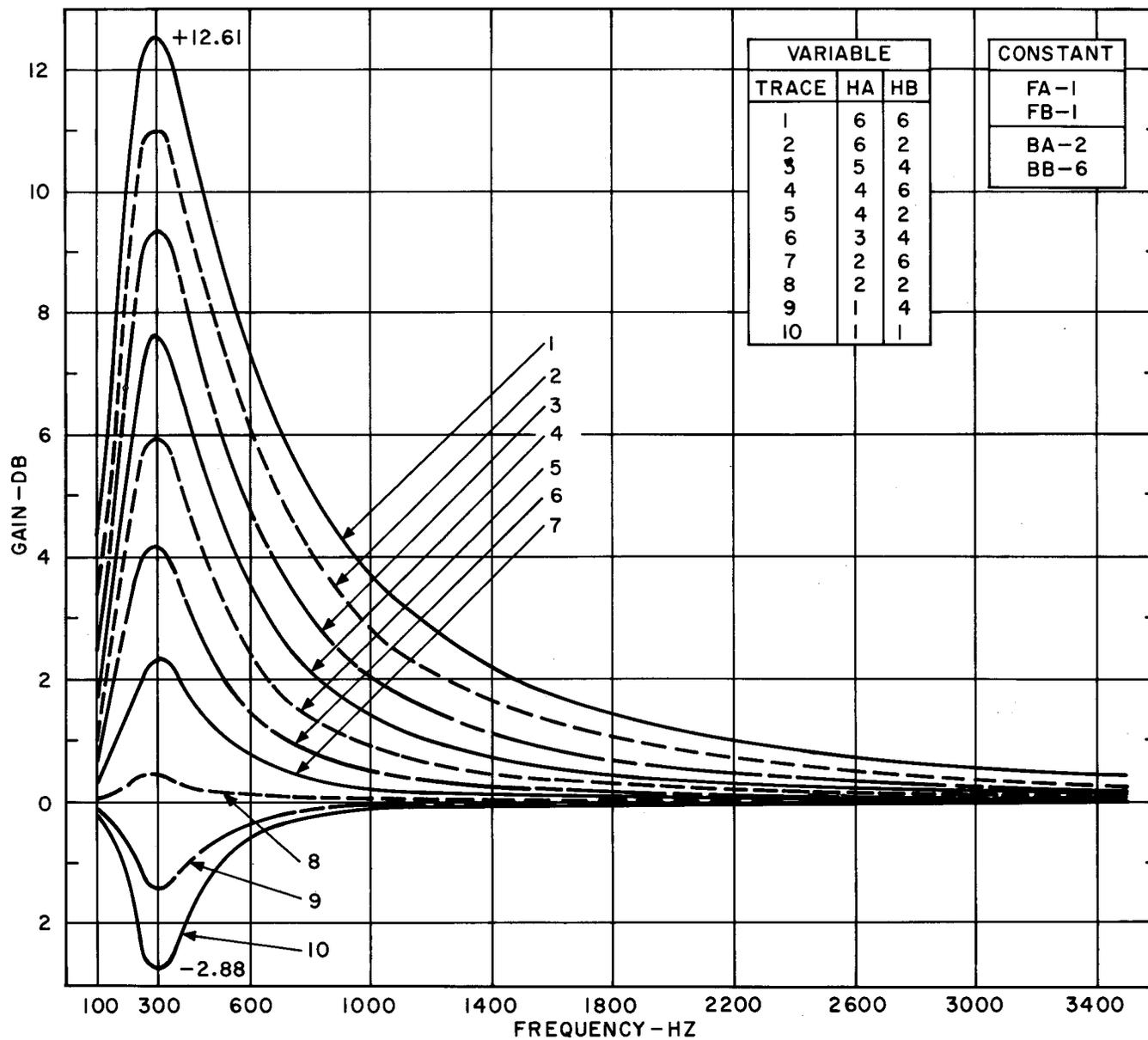


Fig. 8—Nominal Gain Characteristic of the 950A-Type Amplitude Equalizer Showing Effect of Height Variation

SECTION 314-820-107

4. REFERENCES

4.01 The following publication and document numbers are provided as a guide to supporting and supplementary information for this apparatus.

SECTION	TITLE
314-820-106	J99347 VF Amplitude and Delay Equalizing Equipment—Description
314-820-108	950B-Type Equalizer—Description
314-820-206	J99347 VF Amplitude and Delay Equalizing Equipment—Installation and Adjustment
314-820-506	J99347 VF Amplitude and Delay Equalizing Equipment—Maintenance Testing

SECTION	TITLE
332-414-105	4A Echo Suppressor—J689145A Test Extender—Description
801-401-153	Equipment Specifications for the J99347 Equalizer Equipments
856-200-100	ADE 950 Equalizer Program

NUMBER	TITLE
SD-66069-01	4A Echo Suppressor Test Extender
SD-99559-01	Common Systems, VF Amplitude and Delay Equalizer Circuit