DATA SYSTEMS — COMMON CIRCUITS, EQUIPMENT AND PROCEDURES
ATTENUATION EQUALIZERS AND NOISE FILTER
FOR
TELEPHOTO AND OTHER SPECIAL SERVICES

CONTENTS PAGE

1. GENERAL

1.01 This issue replaces issue 1 dated March, 1958 and Addendum issue 1, dated September, 1960.

1.02 This section describes attenuation equalizers and a noise filter constructed in accordance with Long Lines Department Drawings SM-11605-SD Schematic, SM-11605-ED Equipment, SM-11605-T Wiring, and 21616-SD Schematic, 21616-ED Equipment, 21616-T Wiring. These drawings may be obtained on request from:

American Telephone and Telegraph Company
Long Lines Department
Assistant Director of Operations — Engineering
32 Avenue of the Americas
New York 13, New York

1.03 The attenuation equalizers are required to meet the loss-frequency characteristics needed when telephone facilities are used for telephotograph or other critical services.

1.04 Sections of telephotograph networks or other special service circuits composed of 44-type repeaters and 4-wire cable facilities can usually meet their gain-frequency requirements through the use of equalizing arrangements which are a part of the input and output phantom composite equalizers.

1.05 Sections consisting of channels of C, H, J, K, or L carrier telephone systems have no equalizing arrangements normally available. When a number of carrier channels are connected in tandem in a telephotograph or other type special service circuit, the cumulative result of the transmission frequency characteristics may require special equalization in order to meet desired limits.

1.06 The limits imposed on the loss-frequency characteristics of local channels used for telephotograph service are such that any considerable length of nonloaded cable requires equalization. Equalization by means of inequality ratio transformers introduces impedance irregularities and so is undesirable. The equalization should be provided by means of repeater equalization and/or by the application of an attenuation equalizer.

1.07 The equalizers, with such repeater equalization as may be normally available, will provide a simple and satisfactory means of meeting the limits for net loss-frequency characteristics of all types of sections of telephotograph or other critical circuits.

1.08 Open-wire circuits are subject to interference, such as telegraph thump, which is usually in the low-frequency range; below the frequency spectrum of telephotography. The low-frequency noise must be removed because the

harmonics of this noise together with intermodulation products will cause picture impairments.

1.09 The noise filter provides a simple and satisfactory means of suppressing low-frequency noise and is always used where a physical open-wire circuit is employed in a telephotograph network.

2. DESCRIPTION OF CIRCUITS AND EQUIPMENT

2.01 The attenuation equalizers and noise filter are shown on two Long Lines Department Drawings, SM-11605-SD and 21616-SD. Figs. 16, 17, and 21 of SM-11605-SD are duplicates of Figs. 23, 41, and 18, respectively, of 21616-SD. The drawing, SM-11605-SD, is the more recent revision of telephotograph central office equipment, therefore it does not contain corresponding figures for Figs. 11 and 32 of 21616-SD as this equipment is rated manufacture discontinued. Figs. 11 and 32 of 21616-SD will not be described in as much detail as the SM-11605-SD figures but are included since many central offices have such equipment. Table A provides a cross reference between the figures of the two drawings and the circuit order symbols for each figure. Table A also indicates the figure of this section which illustrates schematically the equalizers and filter.

TABLE A

CROSS-REFERENCE TABLE

TABLE A
CROSS-REFERENCE TABLE

SM11605-SD FIGS.	21616-SD FIGS.	FIGS THIS SECTION	CIRCUIT ORDER SYMBOL
ATTENUATION EQUALIZERS			
16	23	1	LE
17	41	3	GE
(NONE)	11(T OPTION)(MD)	8	CE
(NONE)	11(S OPTION)(MD)	8	BE
(NONE)	32 (MD)	11	KE
NOISE FILTER			
21	18	13	NF

2.02 Each of the equalizers has an impedance of approximately 600 ohms in the voice-frequency range.

(A) Equalizer per SM-11605-SD, Fig. 16 or 21616-SD, Fig. 23

2.03 Fig. 1 attached shows that the equalizer (SM-11605-SD, Fig. 16 or 21616-SD, Fig. 23) is composed of a 1C pad socket, 251B inductor and two (0.092 MF) 187A capacitors. The strap between Terminals 5 and 6 of the 1C pad socket has been removed and replaced with Terminals 3 and 8 of the 251B inductor. The multiple unit (0.092 MF) 187A capacitors are connected, one between Terminals 1 and 3, and the other between Terminals 2 and 4 of the 1C pad socket. Since one capacitor is wired in the tip and the other in the ring, they must be adjusted by measurement to within $\pm 2\%$ of each other in order to maintain balance in the circuit.

2.04 Different degrees of decreasing loss-frequency deviations may be obtained by plugging different 89-type resistors into the modified 1C pad socket, the capacitance and inductance remaining fixed. The 89-type resistor is used as a resistance element only and hence the insertion loss will not be the same as the figures stamped on the 89-type resistors.

2.05 Representative curves for different 89-type resistor values and the 1000-cycle losses of the equalizer are given in Fig. 2 attached and the data from which they were plotted are given in Table C attached along with data on a number of other characteristics. Other slopes may be obtained by inserting other 89-type resistors. The proper 89-type resistors needed to give a desired characteristic not found in Fig. 2 may be obtained by interpolation and with the assistance of Table C.

(B) Equalizer per SM-11605-SD, Fig. 17 or 21616-SD, Fig. 41

2.06 Fig. 3 attached illustrates that this equalizer (SM-11605-SD, Fig. 17 or 21616-SD, Fig. 41) is composed of the following equipment:

(1) A standard 1C pad socket (A) for building out the 1000-cycle loss to a prescribed value.

(2) Four 144B electron tube sockets which, with one pair of capacitors of 0.0544 mf and one pair of inductors of 0.0197 henrys, may be interconnected by four 89-type resistors so as to form a lattice-type network of 600 ohms impedance. The loss-frequency characteristic of this network is controlled by changing the 89-type resistors plugged into the 144B electron tube sockets which are designated A1, A2, B1, and B2. The resistance of A1 and A2 causes increasing loss with decreasing fre-

quency whereas the resistance of B1 and B2 causes increasing loss with increasing frequency.

2.07 Table D and Fig. 4 attached illustrate some of the characteristic loss-frequency values and curves obtained from the Fig. 17 equalizer when it is arranged to give decreasing loss with increasing frequency. These conditions were obtained by installing 89A (0 db) resistors in sockets B1 and B2 and by inserting various pairs of 89-type resistors in sockets A1 and A2.

2.08 Table E and Fig. 5 attached illustrate some of the characteristic loss-frequency values and curves obtained from the Fig. 17 equalizer when it is arranged to give increasing loss with increasing frequency. These characteristics are obtained when 89A (0 db) resistors are used in sockets A1 and A2 and various pairs of 89-type resistors are used in sockets B1 and B2.

2.09 The characteristic for other values of 89-type resistor pairs (with 89A resistors in the other pair) may be obtained by interpolation of the curves in Figs. 4 and 5.

2.10 A few of the many different characteristics which may be obtained by using pairs of resistance pads other than 89A in both socket pairs are given in Figs. 6 and 7 attached.

Caution: In order to maintain circuit balance and to keep the equalizer impedance at 600 ohms, the same value of resistor must be used in socket A2 as is used in socket A1. Similarly, the same value of resistor must be used in socket B2 as is used in socket B1.

(C) Equalizer per 21616-SD, Fig. 11, T Option

2.11 This equalizer is illustrated in Fig. 8 attached. It is composed of the following equipment:

(1) A standard 1C pad socket (P) for building out the 1000-cycle loss to a prescribed value.

(2) Two 119C coils with four 17E and two 17F attenuation equalizers connected in series between them. The 17-type equalizers are the same as those used in program transmission, each having a socket in which to plug an 89-type resistor for the purpose of controlling the loss-frequency characteristics. For additional information on 17-type units refer to Section E47.059.

2.12 An increase from 0 db to 4.0 db in the value of the 89-type resistor plugged into a 17E unit will increase the loss of frequencies above 1000 cycles as compared to the 1000-cycle loss. The loss begins to decline for values of resistors above 4.0 db. See Table F and Fig. 9 attached.

2.13 An increase in the value of the 89-type resistor plugged into a 17F unit will decrease the loss of frequencies above 1000 cycles as compared to the 1000-cycle loss. See Table F and Fig. 10 attached.

(D) Equalizer per 21616-SD, Fig. 11, S Option

2.14 Fig. 8 attached also shows the S option equalizer. The S option equalizer has only one 17E unit and one 17F unit. The loss-frequency characteristic is governed by the values of 89-type resistors in the 17E and 17F units in the same manner as described in Paragraphs 2.12 and 2.13. See Table F and Figs. 9 and 10.

(E) Equalizer per 21616-SD, Fig. 32

2.15 Fig. 11 attached illustrates the (Fig. 32) equalizer. It is composed of:

(1) A standard 1C pad socket (A) for building out the 1000-cycle loss to a prescribed value.

(2) A modified 1C pad socket (B) for the purpose of effecting various degrees of increasing loss-frequency deviations by the insertion of 89-type resistors.

(3) A 144B electron tube socket (C) into which 89-type resistors are inserted for the purpose of keeping the loss from decreasing too rapidly below 1000 cycles. The minimum loss of the equalizer is determined by the 89-type resistor used in this socket.

(4) A modified 1C pad socket (D) for the purpose of effecting various degrees of decreasing loss-frequency deviations by the insertion of 89-type resistors. (This modified 1C pad socket (D) is the same as the equalizer described in Paragraphs 2.03, 2.04, 2.05; Figs. 1 and 2; and Table C.)

2.16 As pointed out, the value of 89-type resistors in sockets B and C determines increasing loss-frequency deviation and the value of 89-type resistors in socket D determines decreasing loss-frequency deviation. Therefore the loss-frequency characteristic is determined by the combination of the increasing and decreasing loss-frequency deviations. Deviations from 1000-cycle losses for various values of 89-type resistors for socket (D) alone will be the same as those indicated in Table B. The loss-frequency characteristics for various values of 89-type resistors in sockets (B) and (C), and zero pad values in sockets (A) and (D) are shown in Table G and Fig. 12 attached.

(F) Low-Frequency Noise Filter per SM-11605-SD, Fig. 21 or 21616-SD, Fig. 18

2.17 Fig. 13 attached illustrates the noise filter. It is composed of a 139QA (2.14 - 2.18 mf) capacitor and a 141QA (1.07 - 1.09 mf) capacitor connected in series in the tip and the same in the ring. Connected across the tip and ring is a 254A inductor (0.5 henry).

2.18 This noise filter is very similar to the filter used to prevent false operation of 44A and 1A Echo Suppressors due to telegraph interference.

2.19 The 1000-cycle loss of the noise filter is 0.4 db between 600 ohms. The loss for frequencies below 1000 cycles increases as the frequency decreases. Fig. 14 illustrates a typical loss-frequency curve for a noise filter.

3. APPLICATION OF EQUALIZERS AND NOISE FILTER

(A) Assignment

3.01 The assignment of the equalizers and noise filter will be shown on the circuit layout card. In general, the assignments are made, according to the availability of the equipment, as indicated in Table B.

3.02 When a BE, CE, GE, or KE is assigned, the circuit layout card should indicate a loss for the equalizer. This loss figure is the over-all 1000-cycle loss to which the equalizer should be built out and ***should not be interpreted as 89-type resistor values.***

3.03 When an LE is assigned, the circuit layout card should indicate a loss for the equalizer. This loss figure is the over-all 1000-cycle loss of the equalizer and the value of the 89-type resistor to effect this loss can be determined by referring to Table C. (Note that the 1000-cycle

TABLE B

TYPE FACILITY	ORDER OF PREFERENCE		
	1ST CHOICE	2ND CHOIC	3RD CHOICE
Loaded Cable — Main Line	GE	BE	KE
Carrier Channel Type — C	CE	GE	KE
— J	GE	BE	KE
— K	GE	BE	KE
— L	GE	BE	KE
Local Channels — Loaded or Nonloaded up to 12 db at 2 kc.	LE	BE	—
Open Wire Physical	NF	—	—

Note 1: Refer to Table A (page 2) for drawing and figure numbers of codes.

Note 2: The Circuit Layout Engineer is responsible for determining the necessity and the type equipment to assign to facilities not included in this table.

loss is always less than the value of 89-type resistor used.) The 89-type resistor provides the equalization required for the particular facility. If an 89-type resistor for a particular 1000-cycle loss does not provide correct equalization, an investigation should be conducted to determine the cause. Incorrect cable make-up data, bridged taps, and calculation mistakes could be reasons for the improper equalization.

3.04 In assigning losses to equalizers, the Circuit Layout Engineer is guided by the following:

(1) The loss incurred in providing the necessary equalization.

(2) The availability of other equipment (such as amplifiers).

(3) The necessity of specifying the 1000-cycle levels at a sufficient level to protect the telephoto frequencies from noise and crosstalk. During a transmission of a picture on a telephoto circuit, the telephoto-frequency levels vary as much as 32 db. Since the maximum level of the telephoto frequency is the same as the 1000-cycle level, the lowest level possible will be 32 db below the 1000-cycle level. Therefore, the 1000-cycle level at the output of any equalizer should never drop below −20 dbm. Note 9 on Drawing 21616-SD specifies certain losses are desirable for BE and GE equalizers. These losses are not fixed and may be assigned by the Circuit Layout Engineer to meet circuit objectives. See Fig. 15. Losses indicated are commonly used.

3.05 The circuit layout card should indicate the position in a circuit to locate equalizers. Normally, the equalizers are located in the transmit side (pre-equalization) because, (1) standardization (2) pre-equalization has a slight advantage over post-equalization in that it increases the signal-to-noise ratio by whatever amount the low frequencies are attenuated by the equalizer. (See Fig. 15, equalizer location between offices A and C, A and G, A and B.) Exceptions to this are:

(1) When equalizing 4-wire local channels, the equalizers are located in the transmit and receive sides since no equalizing equipment is located at the customer's location. (See Fig. 15, equalizer location between office B and customer 2.)

(2) When the equalizing equipment is not available at one facility terminal office but is available at the other facility terminal office. (See Fig. 15, equalizer location between offices A and D.)

3.06 The noise filter should always be located on the receiving side of a physical open-wire circuit. (See Fig. 15, noise filter location between offices D and E.)

3.07 An equalizer can be assigned to equalize tandem channels if the intermediate office(s) is not a bridging office. (See Fig. 15, equalizer locations between offices A, F, and G. Note that had the loss-frequency characteristic been such to warrant it, equalizers could have been located at office F also.)

(B) Equalization

3.08 The loss-frequency characteristic of a facility to be equalized should be verified per limits established in sections covering the particular type facility. ***A trouble condition in a facility should never be "equalized out" with an attenuation equalizer.***

3.09 The loss-frequency requirements for telephoto circuits are listed in Section 314-728-500. Requirements for other special services are contained in their respective maintenance sections.

3.10 The desired result of attenuation equalization is to have the frequencies being transmitted from any one transmitting device reach all receiving devices in the same relationship within certain prescribed limits. To accomplish this, the Circuit Layout Engineer assigns equalizers in a circuit on a sectional basis. These sections are equalized to the "flattest" possible loss-frequency characteristic; This should result in the over-all circuit equalization (any transmit device to receive device(s)) being within prescribed limits.

3.11 As an example of proper equation, refer to Fig. 15. If properly equalized, each section equipped with equalizers (office A to C, office A to D, office A to B, office A to G, and office B to customer 2) would be individually adjusted for the "flattest" possible loss-frequency characteristic for that particular section. Observe

that the section, office A to G, is equalized overall with no regard to office F, whereas the section, office A to E, is equalized only in the portion from office A to D. Also, observe that equalization of local channels between office B and customer 2 is separated from other equalization at office B. Further, observe that the equalization at offices C, G, and E has no relation with the local channels. If these sections are properly equalized, an over-all check of equalization from all customer transmit connections to all customer receive connections should meet prescribed limits.

Attached:
Figs. 1 — 15
Tables C — G

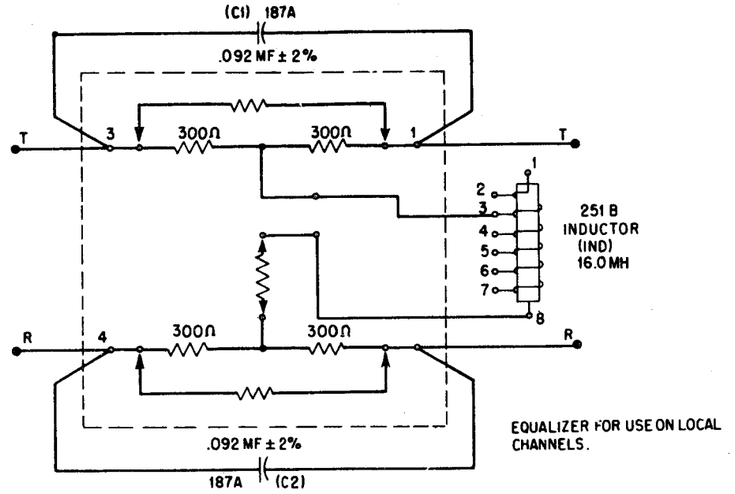


Fig. 1 – Constant Impedance Equalizer with Decreasing Loss-Frequency Characteristics (Fig. 16 of Dwg. SM11605-SD or Fig. 23 of Dwg. 21616-SD)

TABLE C

Deviations from 1000-Cycle Losses for Different Values of 89-Type Resistors in Modified 1C Pad Socket.
(Fig. 16 of Dwg. SM-11605-SD or Fig. 23 of Dwg. 21616-SD)

89-TYPE RESISTORS IN MODIFIED 1C PAD SOCKET DB	FREQUENCY					
	500	1000*	1500	2000	2500	3000
5	0	5.0	0	−0.1	−0.2	−0.3
6	+0.1	5.9	−0.1	−0.2	−0.3	−0.5
7	+0.1	6.9	−0.1	−0.3	−0.6	−0.8
8	+0.1	7.9	−0.3	−0.4	−0.9	−1.2
9	+0.2	8.8	−0.4	−0.7	−1.2	−1.7
10	+0.3	9.6	−0.4	−0.9	−1.5	−2.2
11	+0.5	10.4	−0.5	−1.2	−2.0	−2.6
12	+0.7	11.2	−0.8	−1.5	−2.4	−3.3
13	+0.7	12.0	−1.1	−2.1	−2.6	−3.9
14	+0.8	12.6	−1.2	−2.4	−3.4	−4.3
15	+1.4	13.1	−1.2	−2.7	−3.8	−4.8
20	+2.8	15.3	−2.4	−4.4	−5.7	−6.9
30	+5.0	16.5	−3.1	−5.4	−7.1	−8.4
INF	+5.9	16.6	−3.4	−5.7	−7.3	−8.7

* Values shown are actual losses through equalizer.
Other values are deviations from 1000-cycle loss.
For values of 89-type resistors 5 through 15 db, equalizer values should measure within ±0.5 db of losses indicated on Table C; for 20, 30 and INF resistors, ±0.7 db.

NOTE: MINUS INDICATES LESS LOSS

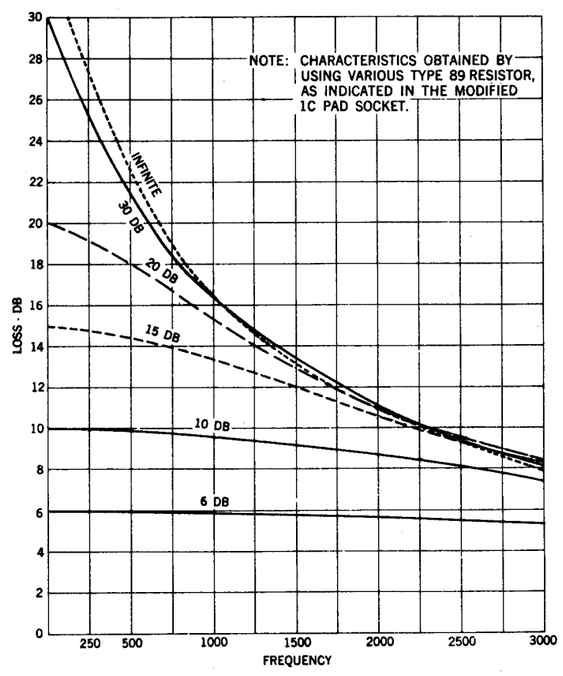


Fig. 2 – Loss-Frequency Characteristics of Fig. 16 (Dwg. SM-11605-SD) or Fig. 23 (Dwg. 21616-SD) Equaiizer

Fig. 1 & 2 Table C

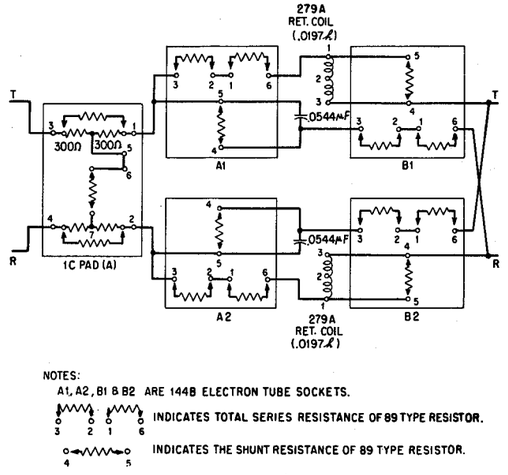


Fig. 3 – Constant Impedance Equalizer with Increasing or Decreasing Loss-Frequency Characteristics (Fig. 17 of Dwg. SM-11605-SD or Fig. 41 of Dwg. 21616-SD)

TABLE D

Deviations from 1000-Cycle Losses for Different Values of 89-Type Resistors in Sockets A1 and A2, and with Zero Pads (89A) in Sockets B1 and B2
(Fig. 17 of Dwg. SM-11605-SD or Fig. 41 of Dwg. 21616-SD)

89-TYPE RESISTORS IN 144B TUBE SOCKETS A1 & A2 db	FREQUENCY						
	250	500	1000*	1500	2000	2500	3000
1.5	+0.10	+0.10	3.15	−0.15	−0.35	−0.55	−0.80
2.0	+0.20	+0.15	4.40	−0.20	−0.50	−0.80	−1.15
2.5	+0.30	+0.25	5.75	−0.35	−0.70	−1.15	−1.45
3.0	+0.40	+0.30	7.20	−0.40	−1.00	−1.60	−2.10
3.5	+0.55	+0.45	8.85	−0.65	−1.35	−2.05	−2.70
4.0	+0.80	+0.65	10.70	−0.85	−1.20	−2.70	−3.55
4.5	+1.35	+1.05	12.95	−1.30	−2.50	−3.60	−4.65

* Values shown are actual losses through attenuator with zero pad in the 1C pad socket (A). Other values are deviations from the 1000-cycle losses shown.

NOTE: MINUS INDICATES LESS LOSS

TABLE E

Deviations from 1000-Cycle Losses for Different Values of 89-Type Resistors in Sockets B1 and B2, and with Zero Pads (89A) in Sockets A1 and A2
(Fig. 17 of Dwg. SM-11605-SD or Fig. 41 of Dwg. 21616-SD)

89-TYPE RESISTORS IN 144B TUBE SOCKETS B1 & B2 db	FREQUENCY						
	250	500	1000*	1500	2000	2500	3000
1.0	−0.08	−0.05	0.10	+0.10	+0.20	+0.35	+0.50
2.0	−0.10	−0.08	0.15	+0.25	+0.50	+0.70	+1.10
3.0	−0.20	−0.15	0.30	+0.30	+0.70	+1.20	+1.60
4.0	−0.25	−0.35	0.40	+0.50	+1.00	+1.60	+2.20
5.0	−0.40	−0.35	0.55	+0.60	+1.25	+2.00	+2.85
6.0	−0.60	−0.45	0.70	+0.70	+1.50	+2.40	+3.30
7.0	−0.65	−0.50	0.85	+0.80	+1.75	+2.70	+3.70

* Values shown are actual losses through attenuator with zero pad in the 1C pad socket (A). Other values are deviations from the 1000-cycle losses shown.

NOTE: MINUS INDICATES LESS LOSS

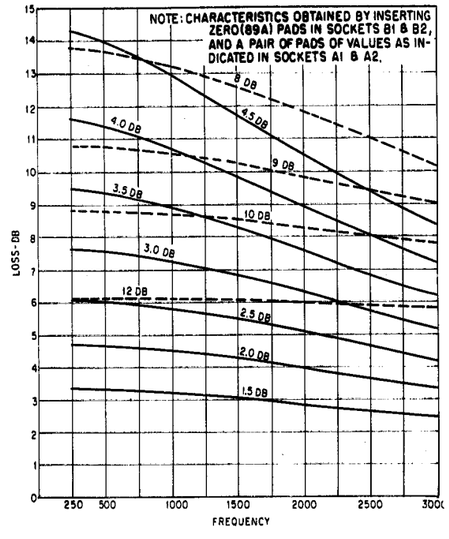


Fig. 4 – Loss-Frequency Characteristics of Fig. 17 (Dwg. SM-11605-SD) or Fig. 41 (Dwg. 21616-SD) Equalizer

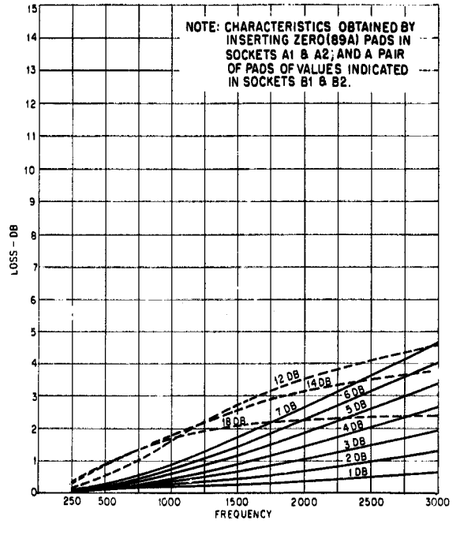


Fig. 5 – Loss-Frequency Characteristics of Fig. 17 (Dwg. SM-11605-SD) or Fig. 41 (Dwg. 21616-SD) Equalizer

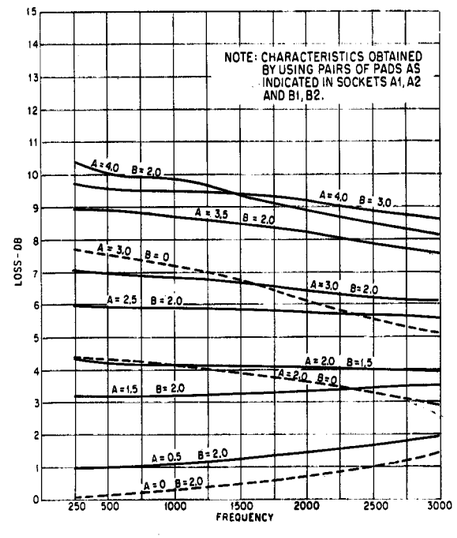


Fig. 6 – Loss-Frequency Characteristics of Fig. 17 (Dwg. SM-11605-SD) or Fig. 41 (Dwg. 21616-SD) Equalizer

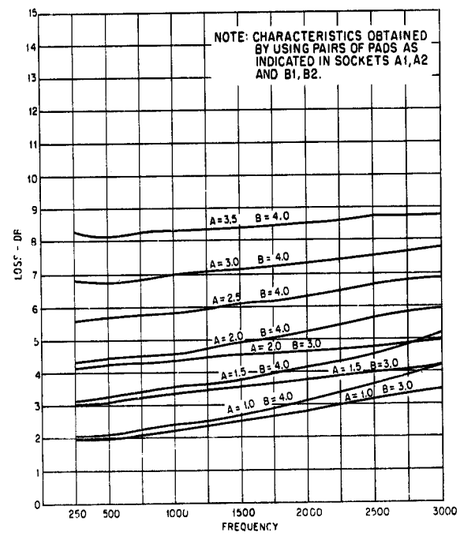


Fig. 7 – Loss-Frequency Characteristics of Fig. 17 (Dwg. SM-11605-SD) or Fig. 41 (Dwg. 21616-SD) Equalizer

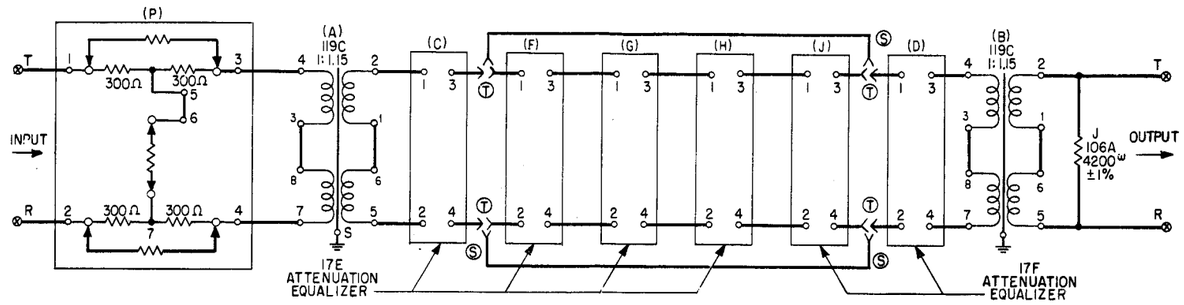


Fig. 8 – Attenuation Equalizer [Fig. 11(MD) Dwg. 21616-SD] Circuit for Adjusting Transmission Frequency Characteristic of Carrier Channels

TABLE F

Loss at 3000 Cycles with Respect to the 1000-Cycle Loss of One 17E or 17F Unit.

89-Type Resistor in a 17E or 17F	17E	17F
89A (0 db)	0	0
89E (1.0 db)	+0.4	−0.1
89J (2.0 db)	+0.9	−0.5
89N (3.0 db)	+1.1	−1.0
89T (4.0 db)	+1.1	−1.6
89AA (5.0 db)	+1.0	−2.0
89AE (6.0 db)	+0.9	−2.3
89AW (8.0 db)	+0.8	−2.7
NOTE: MINUS INDICATES LESS LOSS		

Fig. 8
Table F

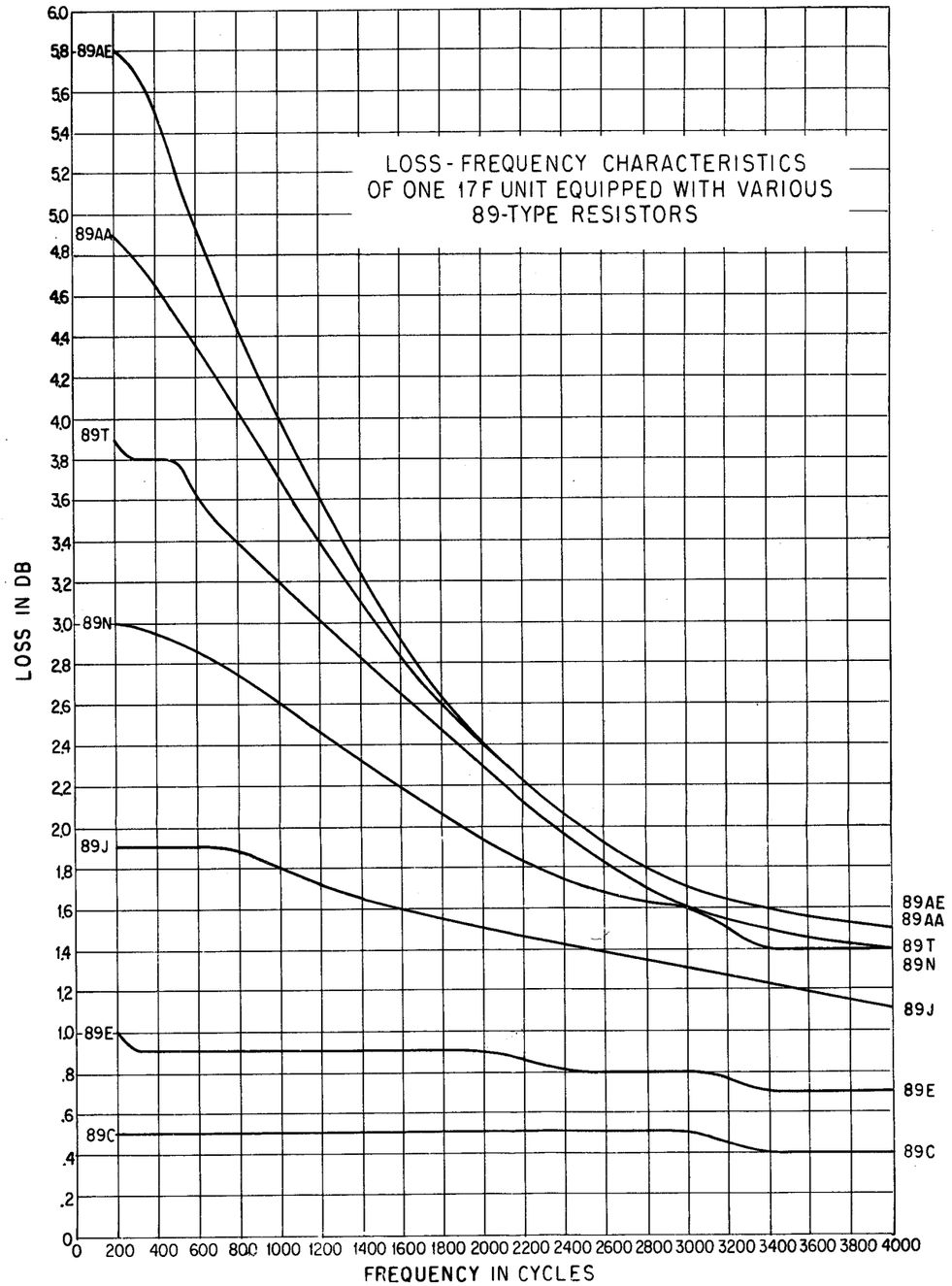


Fig. 10 – Loss-Frequency Characteristic of One 17F Unit Furnished in an Equalizer per Fig. 11 of Dwg. 21616-SD

Figs. 9 & 10

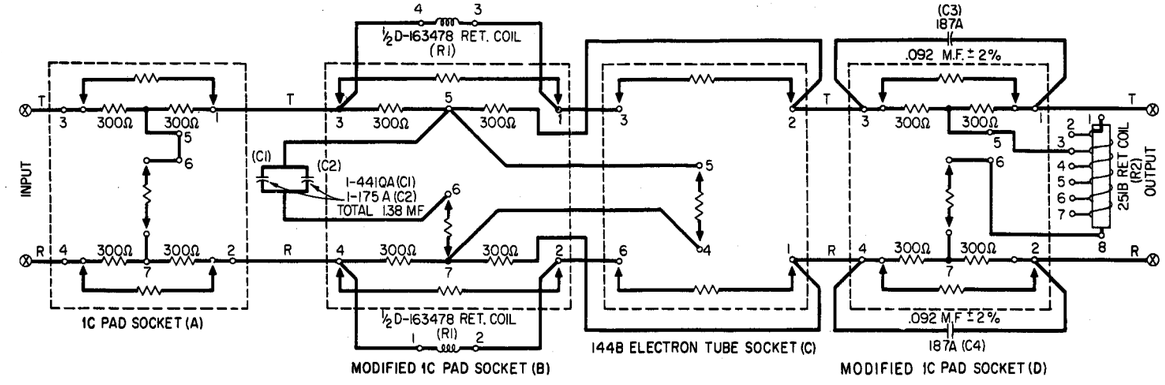


Fig. 11 – Attenuation Equalizer (Fig. 32 of Dwg. 21616-SD) with Constant Impedance Increasing or Decreasing Loss

TABLE G

Deviations from 1000-Cycle Losses for Various Values of 89-Type Resistors in Sockets (B) and (C) and Zero Pads in Sockets (A) and (D) (Fig. 32 of Dwg. 21616-SD)

89-TYPE RESISTOR in Socket (C) db	FREQUENCY					
	500	1000*	1500	2000	2500	3000
	10 DB 89-TYPE RESISTOR IN SOCKET (B)					
15	−0.8	(17.6)	+0.4	+0.7	+0.9	+1.2
20	−0.5	(21.6)	+0.3	+0.5	+0.8	+1.1
25	−0.3	(25.9)	+0.2	+0.4	+0.6	+1.0
	15 DB 89-TYPE RESISTOR IN SOCKET (B)					
5	−3.1	(13.8)	+1.3	+2.0	+2.5	+2.9
10	−2.5	(15.9)	+1.1	+1.7	+2.1	+2.6
15	−1.7	(18.6)	+0.9	+1.5	+1.9	+2.3
20	−1.2	(22.2)	+0.7	+1.2	+1.6	+1.9
25	−0.7	(26.3)	+0.6	+0.9	+1.2	+1.6
	20 DB 89-TYPE RESISTOR IN SOCKET (B)					
5	−4.3	(15.0)	+2.4	+3.8	+4.7	+5.4
10	−3.4	(16.6)	+2.1	+3.4	+4.3	+5.0
15	−2.3	(18.9)	+1.8	+2.9	+3.7	+4.4
20	−1.5	(22.3)	+1.3	+2.1	+2.8	+3.4
25	−1.2	(26.6)	+0.6	+1.3	+1.8	+2.3

* Values shown are actual for 1000 cycles.
Other values are deviations from 1000-cycle loss.

NOTE: MINUS INDICATES LESS LOSS

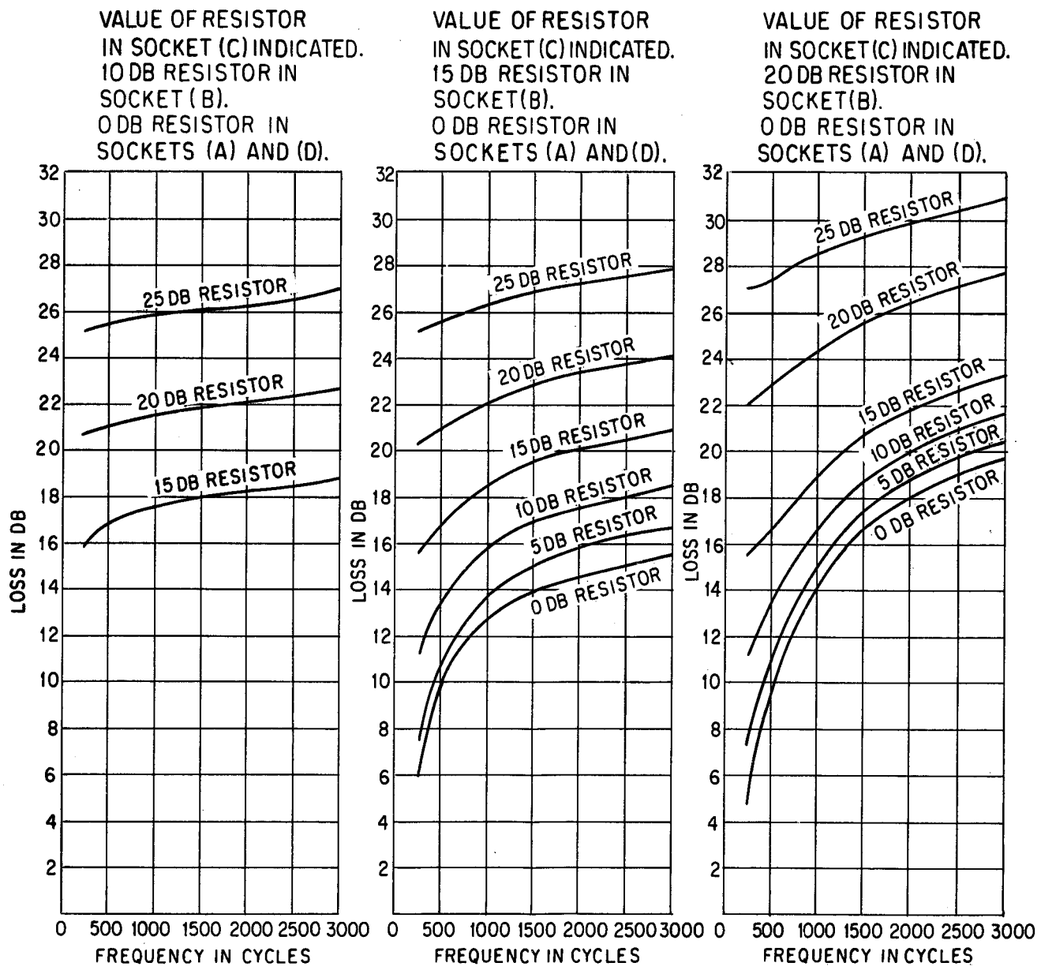


Fig. 12 – Loss-Frequency Characteristics for an Equalizer per Fig. 32 of 21616-SD

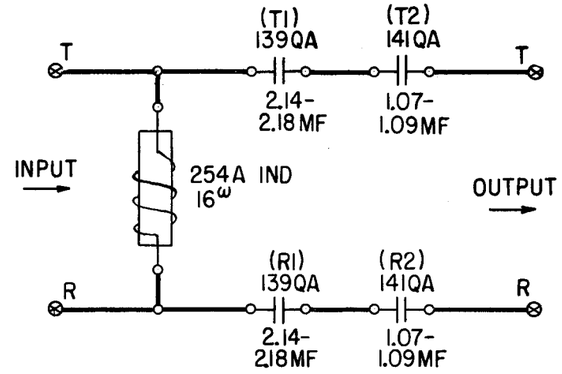


Fig. 13 – Low-Frequency Noise Filter (Fig. 21 of Dwg. SM-11605-SD or Fig. 18 of Dwg. 21616-SD

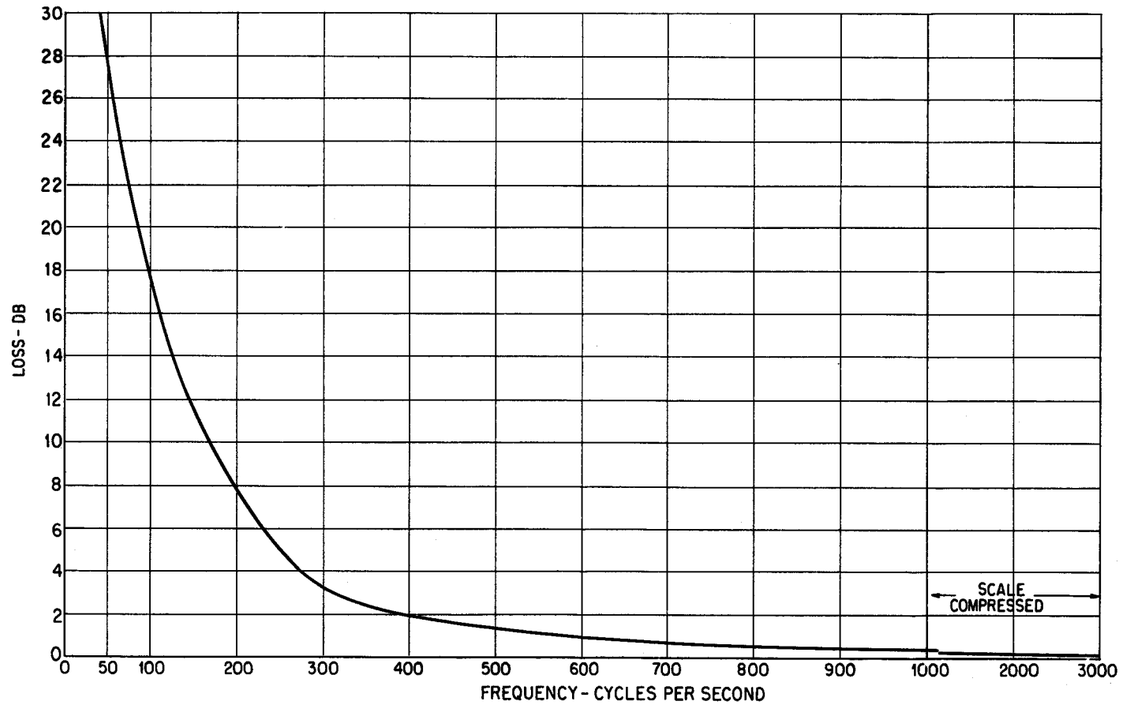
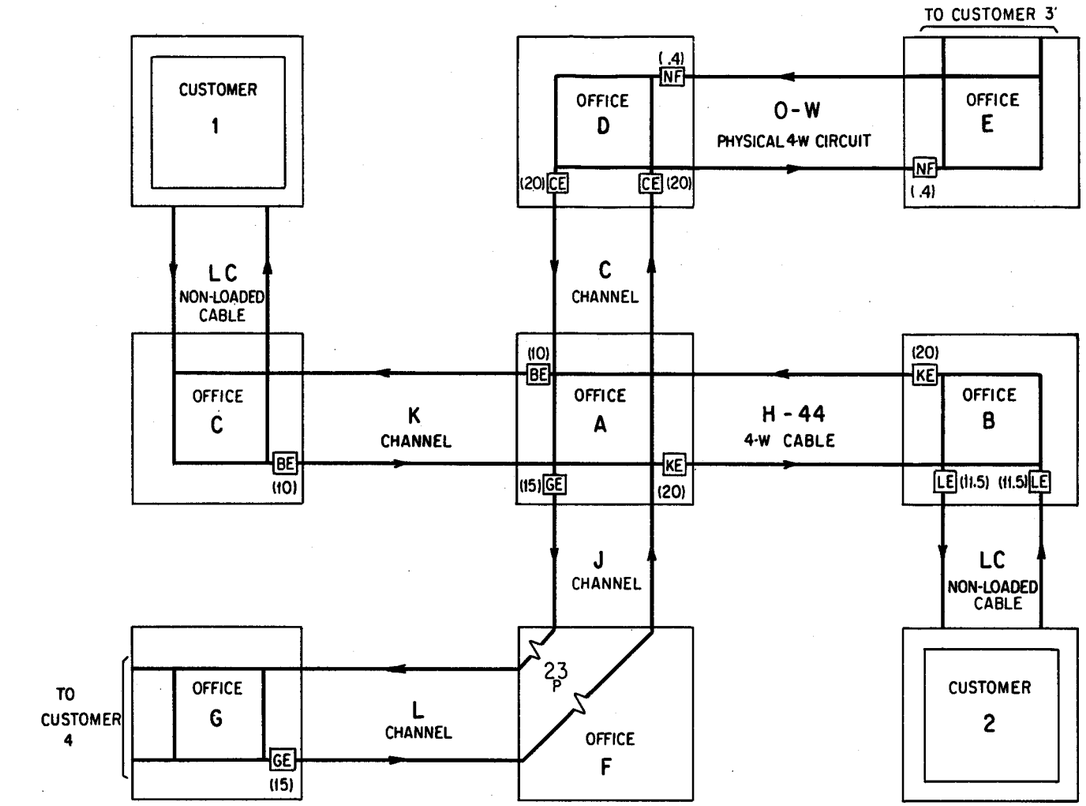


Fig. 14 – Loss-Frequency Characteristic of a Low-Frequency Noise Filter (Fig. 21 of Dwg. SM-11605-SD or Fig. 18 of Dwg. 21616-SD) between 600 Ohms



NOTES: NO OTHER EQUIPMENT SHOWN FOR SIMPLICITY.
LOSSES SHOWN IN( ).
LOSS-FREQUENCY CHARACTERISTICS BETWEEN OFFICE C AND CUSTOMER 1 IS SUCH THAT NO EQUALIZATION NEEDED.

Fig. 15 – Hypothetical Circuit — Illustrates Location of Attenuation Equalizers and Noise Filter