PRIVATE LINE TELEPHONE SERVICE

VOLUME LIMITER FOR SPECIAL SERVICES

DESCRIPTION

1. GENERAL

1.01 This section is issued to describe the operating principles and transmission characteristics of the hybrid circuit volume limiter per SD-69174-01. This device is intended for use where the output of subscriber operated equipment is connected to leased channels provided by the Telephone Company.

1.02 The characteristics of the limiter make it suitable for use in radio systems, paging systems, and some classes of program service. It may also be used in other special service circuits to limit levels or reduce contrast in the transmission of voice announcements or signal tones. The device is relatively slow in operation and so should not be expected to prevent clicks or hits on other circuits caused by short duration high-level impulses in the circuit to which the limiter has been applied.

2. PRINCIPLE OF OPERATION

2.01 The volume limiter consists of two repeating coils and several resistive elements connected in a hybrid circuit. A simplified schematic of this circuit is shown in Fig. 1. Energy which is introduced into the input repeating coil divides into two paths. These two paths include resistive elements with controlled resistance-temperature characteristics. The two paths are combined at the output repeating coil in such a fashion that the currents flowing in them induce opposing fields in the core of this coil. If the currents in the two paths were equal, the magnetic fields would mutually cancel and the output would be zero. The values of the resistive elements are chosen so that the hybrid is not normally balanced but the degree of balance in the hybrid circuit is dependent on the amount of energy which is transmitted to the circuit. As greater amounts of energy are dissipated in the resistive elements the resistance lamps and the thermistor change resistance in the direction which would tend to bring the hybrid into balance.

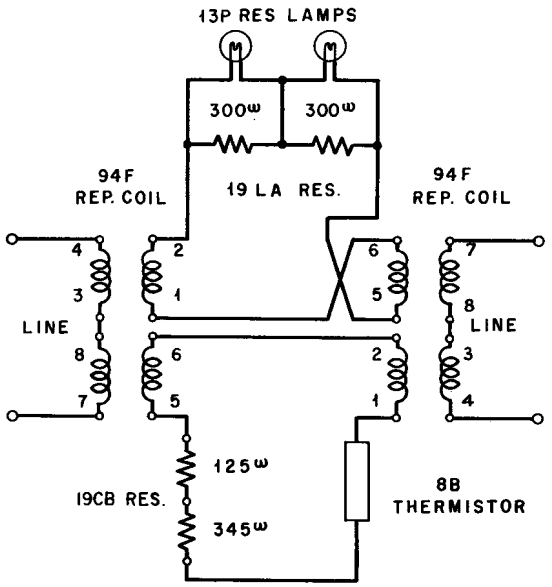

Fig. 1 - Simplified Schematic of Limiter

2.02 The thermistor has a negative temperature resistance characteristic and the resistance lamp a positive characteristic. At low input volumes, the thermistor resistance is high and the lamp resistance low compared with the line impedance. Consequently, under these conditions, the hybrid coil is unbalanced and the loss inserted in the line is relatively low. When the speech volume increases to a value where the energy dissipated in the thermistor is sufficient to change its temperature, the resistance of this element will decrease. Also, as the volume input increases in the limiting range, the resistance of the lamps will increase. The changes in these two elements result in a greater hybrid coil balance and the loss through the arrangement is thereby correspondingly increased. The circuit elements have been so selected that in the limiting range, the increase in insertion loss is equal to the increase in input volume and, therefore, the output volume remains practically constant. Fig. 2 illustrates the change in the resistance of the two paths with variation of input level.

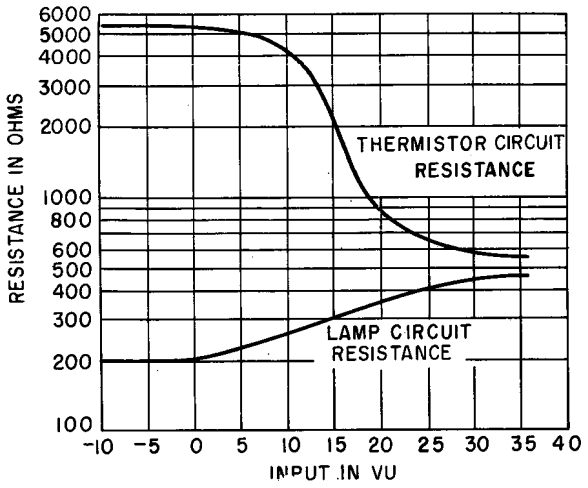

Fig. 2-Variation in Branch Circuit Resistance with Variation of Input Level

3. TRANSMISSION CHARACTERISTICS

3.01 The transmission characteristics of this limiter are as follows:

(1) Maximum output volume = +8 vu (ambient temperature 75°F)

(2) Maximum allowable input volume = +35 vu (3.2 watts is the maximum power the limiter is designed to dissipate.)

(3) Impedance with 600-ohm termination = 700 to 1200 ohms (varies with volume).

(4) Average insertion loss at low input volume = 5 db.

(5) Ambient temperature range = 40° to 120°F.

(6) Frequency response less than 2 db variation from 200 to 8000 cps.

(7) Distortion on speech is not noticeable in the volume and temperature ranges listed above.

(8) Speed of operation - 1 to 4 seconds, depending on the amount of level change.

The response of the limiter at low frequencies will depend on whether or not it has been wired for through signaling. Frequency response typical of the two conditions is as follows:

	Attentuation of Limiter, 0 vu Input	
Frequency	Signaling Not Required	Wired for Through Signaling
60 cycles	14 db	2.9 db
100	9.5	8.0
160	7.5	17.5
200	6.9	11.0
300	6.3	7.5
500	5.7	6.0
1000	5.4	5.4
2000	5.5	5.5
3000	5.6	5.6
4000	5.8	5.8
5000	6.0	6.0
6000	6.5	6.5
7000	6.9	6.9
8000	7.3	7.3

3.02 Typical input-output characteristics of the volume limiter for speech at an ambient temperature of 75°F and for 1000-cycle steady tone for ambient temperature of 0°F, 40°F, 75°F and 120°F are shown on Fig. 3. At 75°F for both speech and 1000-cycle tone, the limiter introduces a loss of approximately 5 db between 600-ohm resistances for low input levels and this loss is substantially constant until the output volume reaches the point where limiting action begins. For speech, the output volume is limited to +8 vu but for 1000-cycle tone the output is limited to about +6 dbm. This difference results from the fact that the heating effect of speech on the nonlinear elements for a given volume indicator reading in vu is not the same as for a steady tone of the same number of dbm. In the limiting range, a volume indicator reading on the speech output level will depend on whether the speech is steady or intermittent. For speech at ambient temperatures of 40°F and 120°F the curves will follow closely the corresponding curves for 1000-cycle tone up to the limiting range and then will follow the speech output characteristic for 75°F. Thus, for speech a temperature change from 40°F to 120°F will change the insertion loss at 0 vu from 4.6 to 6.3 db; at +15 vu input the output will change from 7.5 to 4 vu; at inputs above +25 vu there will be no change. At ambient temperatures below 40°F the limiting characteristic begins to peak at about -16 vu input or higher and at -30°F the limiting characteristic is lost and the device becomes for all practical purposes a resistance

VOLUME LIMITER
INPUT-OUTPUT CHARACTERISTICS
(BETWEEN 600ω RESISTANCES)

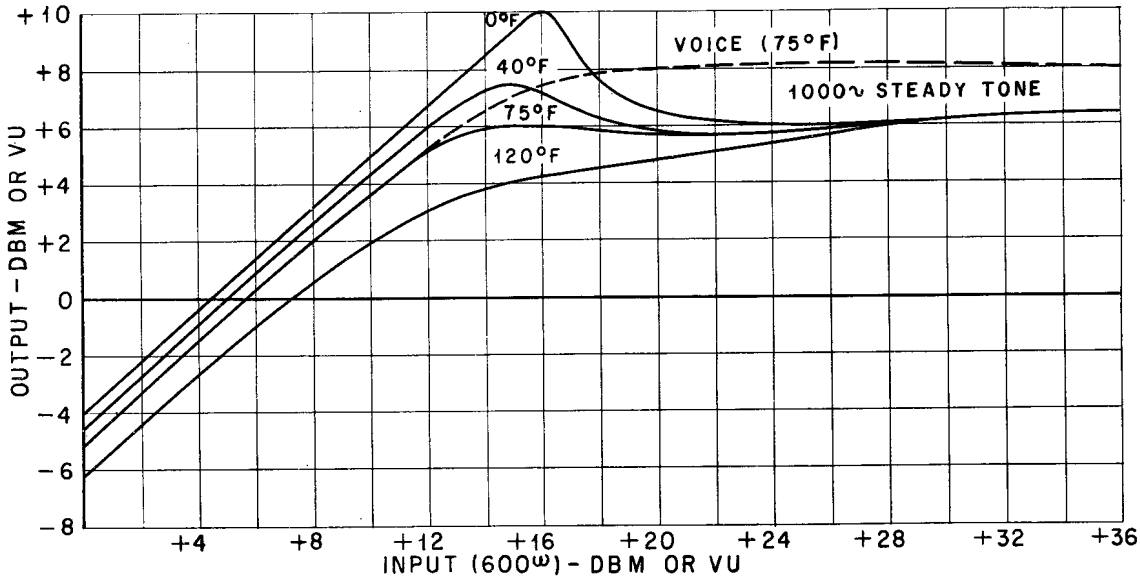

Fig. 3 - Input-Output Level Characteristics

pad having an insertion loss in a 600-ohm circuit of about 4 db. At 0°F the device should hold the volume to +12 vu or lower. At ambient temperatures above 120°F greater loss is introduced in the circuit. For many applications this may not be a serious limitation and temperatures up to about 160°F may be permissible. As a general rule it is advisable to locate the limiter with respect to other equipment so that the ambient temperature remains below 120°F.

3.03 Because of the time required for heating and cooling the thermistor, the limiter will not adjust its loss instantaneously to extreme volume changes. If it were fast enough to follow syllabic variations distortion might result. Consequently, by design the device is slow in adjusting for extreme changes of volume in the limiting range. For a small change in input a rapid adjustment of network loss is not necessary but for a sudden and extreme change in input level the limiter will rapidly make the major adjustment in loss and then taper off eventually to approach the steady condition. However, it is not fast enough to suppress clicks and, therefore, the limiter should not be used as a click reducer. The time required for the device to adjust the output to within 1 db of the steady condition varies from 1 to 4 seconds, the longer adjustment time occurring for small changes in level.

3.04 The impedance of the limiter when terminated in a 600-ohm resistance varies from 1000 ohms at low input levels to 1200 ohms at +10 dbm input. At higher levels the impedance drops to about 700 ohms which is constant over the limiting range.

3.05 Additional information concerning this volume limiter may be found as follows:

Circuit details: Drawing SD-69174-01
Installation details: Section 310-440-200
Transmission Test Requirements: Section 310-440-500