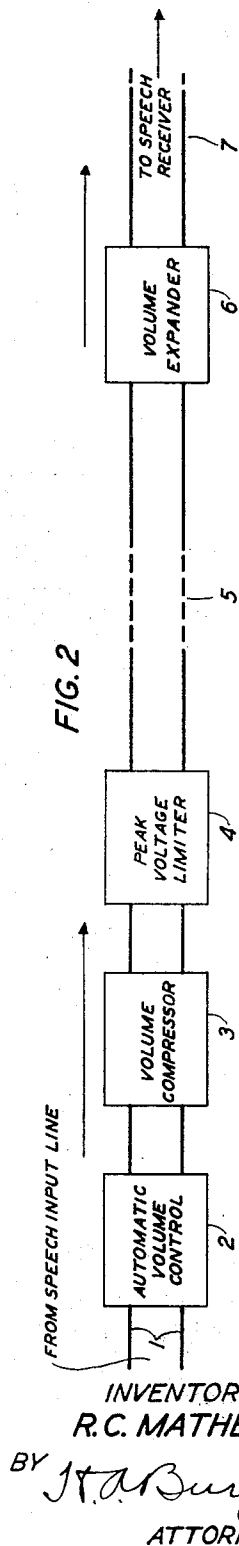
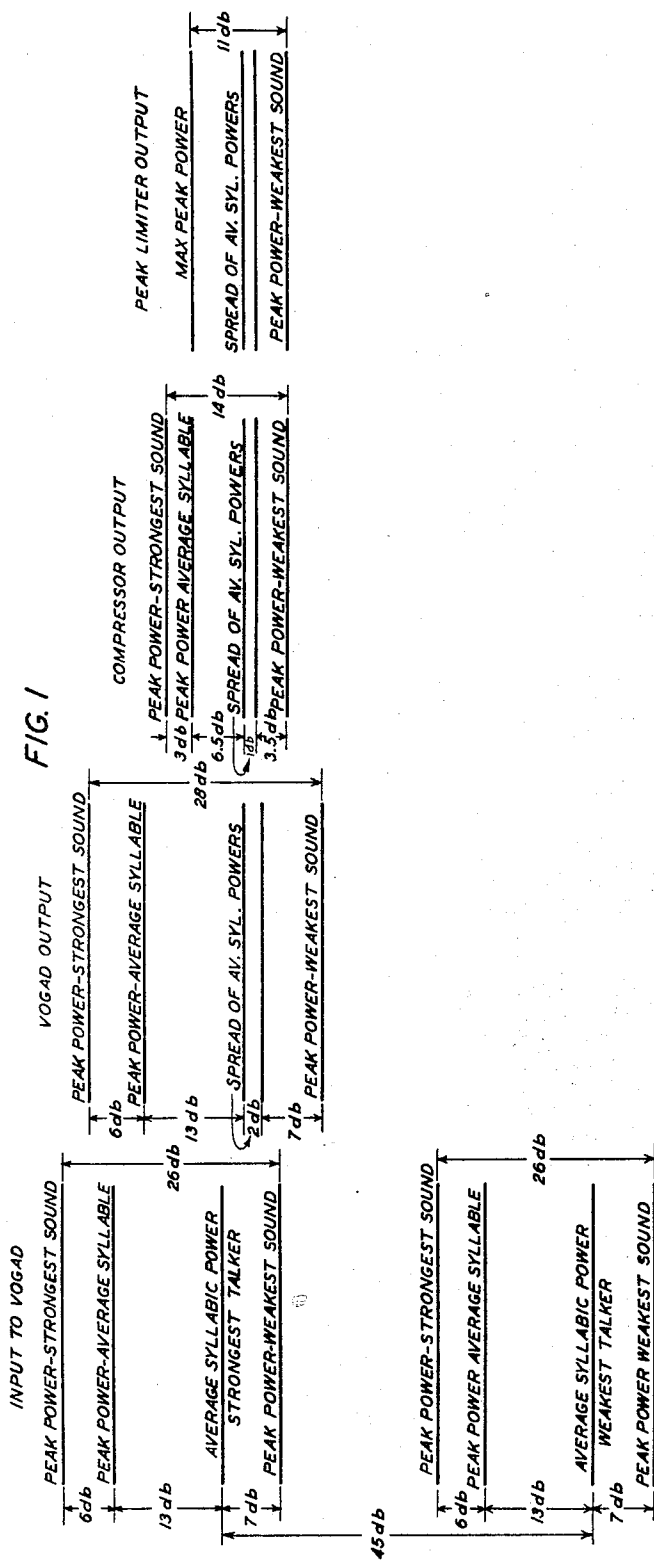


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R. C. MATHES
SPEECH AMPLITUDE CONTROL

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1,947,209



INVENTOR
R.C. MATHES

BY *H. A. Burgess*
ATTORNEY

UNITED STATES PATENT OFFICE

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SPEECH AMPLITUDE CONTROL

Robert C. Mathes, Wyoming, N. J., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application June 30, 1932, Serial No. 620,156,
and in Great Britain February 27, 1932

6 Claims. (Cl. 178—44)

The present invention relates to changing the volumes or amplitudes of speech and music or similar waves from a wide range of amplitudes to a narrow range of amplitudes to render them more suitable for transmission through apparatus or over a line.

More specifically, the invention concerns the use in certain combinations of different types of voice control devices for altering the amplitude characteristics of speech.

Without some kind of volume or amplitude control telephone circuits would be required to transmit a wide range of power because of the nature of the speech itself and more especially because of the wide variations between the loudness of the speech coming from different talkers, or received over different lines, etc. The permissible upper limit of power is set by cross-talk requirements, load carrying capacity of amplifiers, breakdown voltage of insulating material, non-linear characteristics, etc. The lower limit is set by interference such as induction from power circuits, cross-talk from neighboring speech circuits, or amplifier or thermal noise. When the variation of speech power is a minimum which is consistent with satisfactory quality, the most economical design and most efficient use of facilities results. The advantages accruing are especially marked in certain cases such as transatlantic radio or cable circuits in connection with multi-hand privacy systems, or with multi-channel carrier systems.

In my prior Patent No. 1,816,599 granted July 28, 1931, means are disclosed for effecting a very great reduction in the total amplitude range of speech before it is impressed upon the transmission line or apparatus. That patent discloses the use of a volume control and a volume compressor associated in the most advantageous way in a given case for effecting the reduction in total amplitude range.

The present invention goes a step further than the disclosure of that patent in that I have discovered that a further and material reduction in the total amplitude or volume range transmitted may be secured by cutting off or suppressing the peaks of the speech waves above a certain limit without a sacrifice in the quality of the transmitted speech which can most advantageously be applied in combination with the previously disclosed devices.

A more detailed description of the invention will now be given, reference being had to the accompanying drawing in which:

Fig. 1 shows a diagram of speech volumes or

amplitudes illustrating how the range of powers may be reduced in accordance with the invention; and

Fig. 2 is a schematic circuit diagram of a system for practising the invention.

Volume tests on toll circuits have shown that 90% of talkers produce volumes as read on the volume indicator which differ by not more than 20 db. but that the difference between operators' volume which is ordinarily rather high and that of the weakest talker to whom satisfactory service can be given is about 45 db.

The volume indicator referred to does not give instantaneous speech power, but shows the integrated power over intervals of time long enough to include several syllables or words. Its readings therefore enable the relative speech power of different talkers to be compared, but give no indication of the instantaneous power variations in the speech of a given talker.

The automatic volume control, sometimes referred to as a voice operated gain adjusting device (abbreviated "Vogad") is capable of reducing speech volumes or powers differing in the order of 45 db. to practically a zero or insignificant variation so that, for example, a volume indicator on the output side of the volume control device would show a constant reading for all talkers. Moreover, the automatic volume control does not operate on instantaneous variations in speech amplitude, but its time constants are so chosen that the ratios between individual syllabic and speech powers are preserved.

The foregoing relations are illustrated on Fig. 1 where in the left-hand column of the figure, a spread of 45 db. is indicated between the average syllabic power of the strongest talker and that of the weakest talker. The volume control, however, as seen from the second column of the figure, reduces this spread to only about 2 db. As is also shown in these two columns of the figure, the volume control device does not affect the range between the weakest and strongest peak power in the case of any given speech. This range has been taken for illustration as amounting to 26 db. The total range in speech power on the output of the volume control is indicated as 28 db. on account of the 2 db. spread which remains between average power of strongest and weakest talkers.

A device known as a volume compressor is capable of reducing this 28 db. range to a very much smaller range, for example, 14 db. as indicated in column 3 of Fig. 1. Thus a total range of 71 db. between speech power input to the volume

control has been reduced by the volume control and the volume compressor to a total range of only 14 db.

These two steps in reduction of the total power range and the means for carrying them out are disclosed and claimed in my prior patent above referred to. A still further reduction is made in accordance with the present invention by the use of a speech voltage limiter which reduces the range from 14 db. to say 11 db. This voltage limiter is arranged to have the output proportional to the input over a predetermined range and beyond that range the output is constant. The action is practically instantaneous and consequently when a complex wave is impressed upon it, the peaks which exceed the limiting value are cut off. It has been found by experiment that the limiting voltage may be selected at about one-half the maximum peak voltage of uncompressed speech without seriously affecting the naturalness or intelligibility of speech. The difference between speech and average power is thereby reduced by 6 db. in the case of the strongest sound. The reduction referred to compressed speech is of the order of 3 db. under the conditions assumed.

It should be noted that all of the numerical values that have been given are purely for illustrative purposes and while the values that have been chosen are reasonable, they should not be considered as in any wise limiting since wide variations from these values are possible in practice, depending upon conditions.

Referring to Fig. 2, the circuit diagram shows an incoming line 1 on which speech or music may be impressed from different talkers or sources at different times such as different subscribers, for example, and they may be located at different points so that the speech or program comes in over lines of different lengths. Line 1 leads to the automatic volume control 2 so that speech or music of widely different volume is impressed at different times on the volume control which serves to reduce all of these volumes to substantially the same output volume as described in connection with Fig. 1. This volume control may be of the type diagrammatically indicated in my previous Patent No. 1,816,599, or any other suitable type, for example, that disclosed in U. S. patent to J. L. Hogg et al, No. 1,853,974 of April 12, 1932.

The speech of constant volume from the output of volume control 2 is then impressed on volume compressor 3 which may be constructed as disclosed in Crisson Patent No. 1,737,830 of December 3, 1929 or as disclosed in my prior Patent No. 1,757,729 of May 6, 1930 or may be of any other suitable type for reducing the instantaneous or envelope variations of speech to a lower range of amplitudes as described in connection with Fig. 1.

The output of the volume compressor 3 is impressed on the peak voltage limiter 4 which suppresses transmission of the portions of the waves of highest amplitude. This voltage limiter may be of the type disclosed and claimed in W. A. Knoop Patent 1,869,484, dated August 2, 1932.

The speech waves of limited volume range and of limited peak voltage from limiter 4 are transmitted over transmission line 5 to the distant receiving point where there is included, among the other receiving apparatus, a volume expander 6 for restoring the naturalness or understandability of the speech before it is passed on to the speech receiver 7. The volume expander 6 may

be constructed as disclosed in the Crisson patent referred to, or in my Patent No. 1,757,729.

By use of the devices 2, 3 and 4, as described, the percent of the time that the line 5 is used at its maximum load carrying capacity is increased, or, in other words, there is an increase in the total amount of power transmitted without exceeding the limitations of the system. While in Fig. 2 the peak voltage limiter 4 is disclosed as following the volume compressor 3, the voltage limiter might precede the volume compressor. This arrangement would have the advantage of reducing the range over which the compressor would be required to function, the complementary expander 6 at the repeating end being simplified in similar degree. A possible disadvantage of this order of connection would be, however, that peaks might be produced in the operation of the compressor which would exceed the permissible limit, a condition which must be guarded against, for instance, on deep sea cables and high power radio transmitters. The proper order of connection of these devices will therefore depend upon the transmission system in which they are to be used.

As was stated above, the peak voltage limiter may limit the voltage to about half the maximum peak voltage of uncompressed speech without seriously affecting the naturalness or intelligibility of the speech. The difference between peak and average power is thereby reduced by 6 db. in the case of the strongest sounds. The invention comprehends the use of a peak voltage limiter following a volume control without the use of the compressor in situations where it is not desired to go to the complication involved in use of a compressor, as, for example, where it is desired not to use an expander at the receiving station. Reference to Fig. 1 in the light of the foregoing will show that a very material reduction in power range is achieved by use of the volume control followed by the peak limiter.

What is claimed is:

1. In a transmission system, an input circuit supplied with signals having substantially the same volume range and different average volume levels, volume control means for maintaining a constant maximum speech level for said received signals, volume compression means in series relation with said volume control means for reducing the volume range of said signals, and peak voltage limiting means in series relation with said volume compression means for reducing the ratio of maximum and minimum speech power of said signals.

2. The combination with a transmission path having a limited volume range of transmission of volume control means for converting input signals of different average power to substantially the same average power, volume compressing means for reducing the range of instantaneous power in said signals, and peak voltage limiting means for suppressing the maximum speech power of the resulting signals to bring them within the volume range of said transmission path.

3. In a telephone system, a speech path on which it is desired to limit the total range of speech power, a circuit for impressing speech waves on said path, said circuit including a volume control for reducing the spread between peak powers of strongest or weakest sounds of different talkers or different circuit connections, and a peak voltage limiter following said volume control for reducing still further the ratio of

maximum to minimum peak speech waves impressed on said path.

loss circuit having a response time long in comparison with syllable duration for reducing the range of long time average powers of the impressed speech, and a peak voltage limiter in series with said vario-loss circuit for reducing the ratio of the instantaneous peak powers of the speech waves from said vario-loss circuit. 80

6. The combination in a speech or music transmission system of a voice-operated volume control device, a volume compressor circuit, and a peak voltage limiter operating to reduce the ratio of instantaneous peak powers, all connected in series, in said system. 85

5. In a speech transmission circuit, a vario-

ROBERT C. MATHES.

15	90
20	95
25	100
30	105
35	110
40	115
45	120
50	125
55	130
60	135
65	140
70	145
75	150