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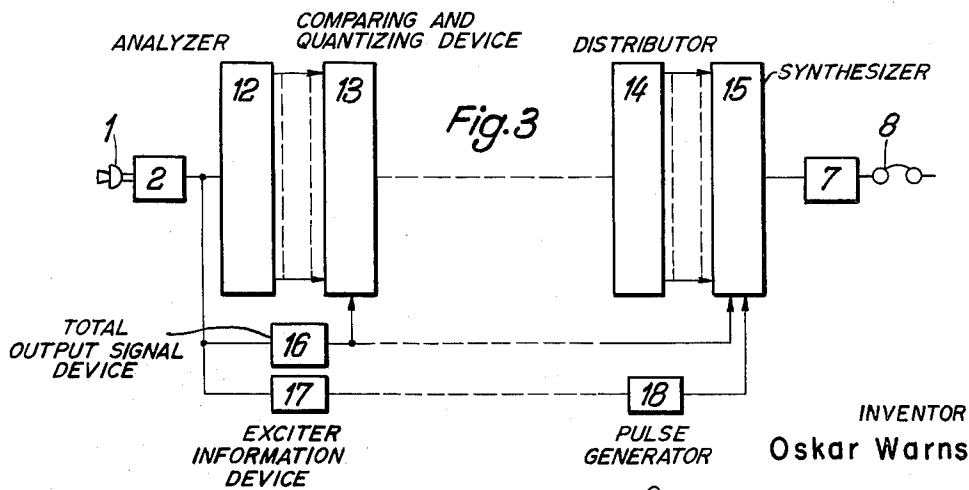
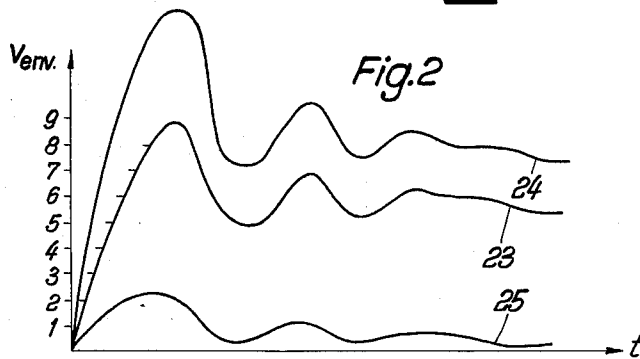
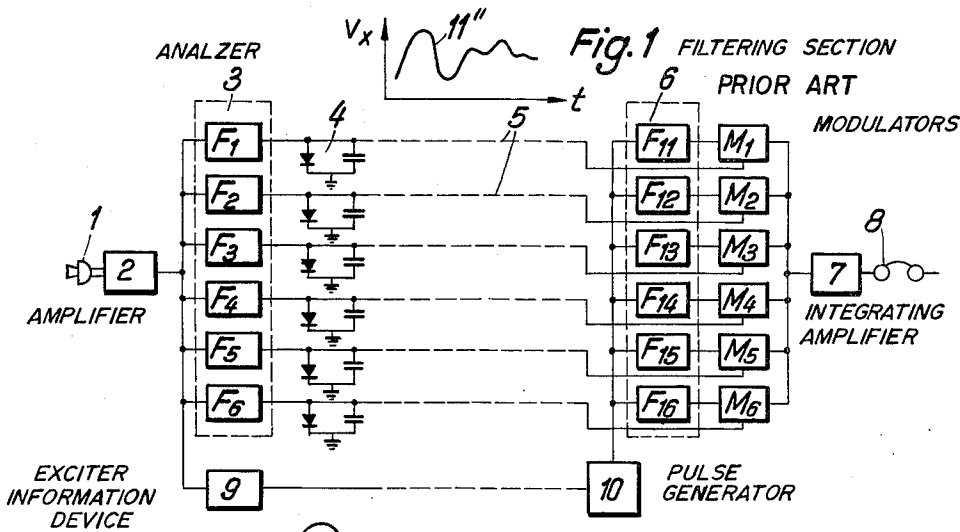
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3,211,833

SOUND TRANSMITTING DEVICE

Filed Nov. 29, 1961

2 Sheets-Sheet 1



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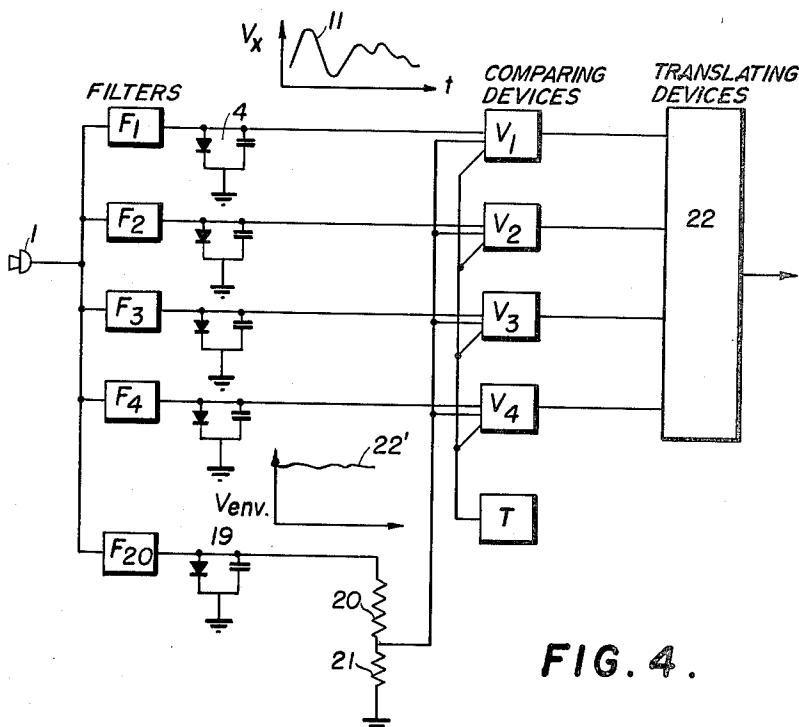


FIG. 4.

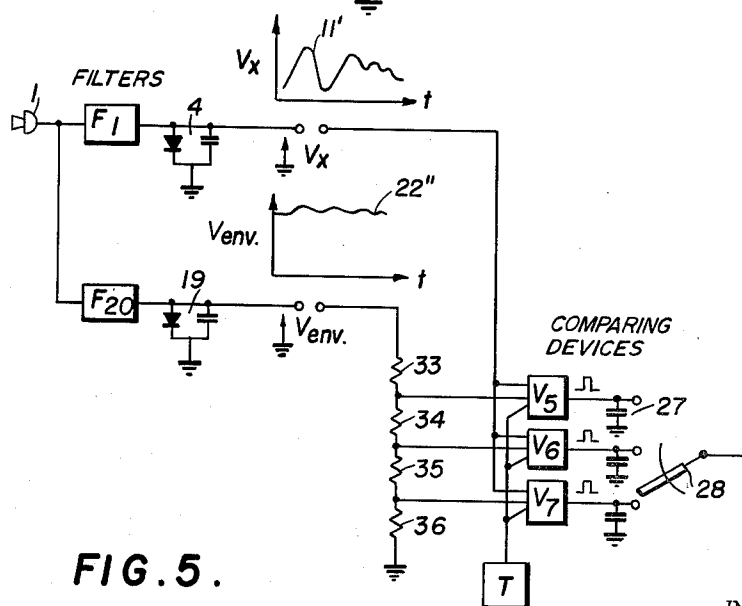


FIG. 5.

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SOUND TRANSMITTING DEVICE

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T 19,358

9 Claims. (Cl. 179—1)

The present invention relates generally to a process and apparatus for transmitting voice signals, and, more particularly, to such a system for simulating the short time spectrums of voice signals which are transmitted according to the Vocoder principle of voice transmission, and preferably using the pulse code modulation system of transmission.

In the Vocoder system, which is known, a considerable reduction of the transmission capacity is obtained by deriving slowly variable magnitudes, such as the short time spectrum, for example, by mean value formation from the voice signal. On the receiving end, the original voice signal is simulated from these slowly variable magnitudes.

In the Vocoder system, the principle of which is illustrated in FIGURE 1 of the drawing, the voice signals in the form of acoustical energy are picked up or received by a microphone 1 and converted into electric signals which are amplified by an amplifier 2 and fed to analyzer 3. This analyzer 3 comprises a number of filters in which the voice signal disposed in the range of about 300 to 3200 cycles per second is divided into a number of frequency ranges, such as ten, for example. However, for the sake of simplicity, in the embodiment illustrated in FIGURE 1, only six filters F_1 to F_6 are shown.

The mean amplitude in these partial bands is obtained by subsequent rectifiers and low pass filters 4 having a limit or cut-off frequency of 25 cycles per second, for example. These are transmitted by means of section 5 as so-called envelope curve information. Such envelope curve information in the individual frequency ranges represents what is called the short time spectrum of the voice signal. The quality of the speech or voice which is reproduced depends upon the accuracy with which this spectrum is transmitted in the amplitude range, and in the division of the signal into frequency bands and the simulation thereof on the receiving end.

In the Vocoder system, the mean frequency of the vocal lip vibration is obtained from the voice signal by further analysis, and this magnitude or value appears in the output of device 9 and is transmitted as exciter information. Whereas the envelope curve information is essential for articulation and intelligibility of the transmitted speech, the exciter information provides the simulated speech with a natural sounding quality.

On the receiving end of the apparatus, the exciter information is used for controlling a pulse generator 10, the output pulses of which are fed to the connected inputs of a filtering section 6. This section 6 includes the individual filters F_{11} to F_{16} and has a design which is analogous to the analyzer 3 which is also constructed of a set of filters.

The output amplitudes of these filters are controlled via modulators M_1 to M_6 , for example, ring modulators, by the envelope curve information. The results of modulation are fed to an integrating amplifier 7 and then to the earphone 8, which may be considered the output.

A main object of the present invention is to provide a voice transmitting system which reduces the transmission capacity to less than that of the prior art.

Another object of this invention is to provide apparatus for carrying out this transmission method which may be constructed at a relatively low cost.

These objects and others ancillary thereto are accomplished according to preferred embodiments of the invention, wherein in the transmission of voice signals according to the Vocoder system, there is transmission of the envelope curve information of only those frequency ranges wherein the envelope curve amplitude exceeds a given or predetermined portion of the momentary total envelope curve amplitude. There is practically no loss of information in this reduction of the transmission capacity because the omission to transmit partial ranges by the selection according to the present invention does not affect either the articulation and intelligibility or the naturalness of the transmitted speech. Statistical evaluation of short time spectrums of voice indicates that the energy is concentrated in a few frequency regions, although these regions may appear anywhere in the frequency range of the voice signal. This energy distribution permits further reduction of the transmission capacity.

In carrying out the process according to the present invention, it is advantageous to transmit the envelope curve information of only those frequency ranges wherein the envelope curve amplitude exceeds 10%, and preferably 20%, of the momentary total envelope curve amplitude. This selection considerably reduces the quantity of data to be transmitted and thus accomplishes reduction of the necessary transmission capacity.

The envelope curve may be quantized and the selection of the envelope curve amplitudes of the individual partial ranges exceeding a certain percentage of the total curve amplitude may be combined with a so-called sliding quantization process, which will be described in further detail below.

Additional objects and advantages of the present invention will become apparent upon consideration of the following description when taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a circuit diagram in block form a Vocoder system of the prior art.

FIGURE 2 is a graph illustrating the total energy of a voice signal.

FIGURE 3 is a simplified block diagram of apparatus according to the present invention.

FIGURE 4 is a circuit diagram of one type of special circuit device which may be used in the transmission device of FIGURE 3.

FIGURE 5 is another special circuit device which may be used with the transmission device of FIGURE 3.

With more particular reference to the drawings, the following discussion in relation to FIGURE 2 will clarify the meaning of the term "sliding quantization." FIGURE 2 illustrates the total envelope curve amplitude V_{env} which is plotted against time t . In this diagram three curves 23, 24, and 25 are illustrated which represent the total energy of the voice signal. In the quantization process, the total amplitude range is divided into individual stages, nine of which are illustrated in FIGURE 2 along the V_{env} axis. This division into stages properly accommodates the shape of the amplitude envelope curve 23. If the total amplitude curve is represented by curve 25, corresponding to a voice signal of lower energy, then the quantization takes place in considerably larger stages, that is, only the three stages 0, 1, and 2. When the total envelope curve has a shape such as that represented by curve 24, then the opposite is true.

Therefore, if the quantized transmission of the envelope curve information is used in the individual frequency ranges, the amplitude stages used for the quantization process dependent upon the momentary total envelope

curve amplitude, and at the same time the total envelope curve amplitude is transmitted separately.

A simplified diagram of the apparatus according to the invention is illustrated in FIGURE 3, and the process for transmitting according to the present invention will now be described. The voice signal in the form of acoustical energy is converted by the microphone 1 into analogous type of electrical energy, or into an electrical signal, which is amplified in amplifier 2, and is then divided into sixteen partial frequency ranges, for example, by analyzer 12, which use filters. Within each of the partial ranges, the envelope curve information is obtained by using rectifiers and low pass filters having a limit or cut-off frequency of, for example, 25 cycles per second. At the same time, the envelope curve of the total input signal is obtained by device 16.

In the comparing and quantizing arrangement 13, there is a selection, by means of the output signal of device 16, of those partial frequency ranges wherein the envelope curve amplitude exceeds a certain percentage of the total envelope curve amplitude. Also, the envelope curve amplitude is quantized in device 13. This data from device 13 is transmitted by means of the dashed connection illustrated, which may be, for example, a time division multiplex device.

At the receiving end of the assembly, the corresponding partial ranges are selected from synthesizer 15 which contains the same filter devices as the analyzer 12, and this selection is done by means of the distributor device 14. The correct amplitude conditions of the output signals are reproduced by means of the output signal from device 16. By this means a simulation of the short time spectrum of voice signals is obtained which is sufficient for the articulation and intelligibility of speech which is thus reproduced. Thus, at the same time, there is a considerable reduction of the transmission capacity when compared with the original Vocoder system of the type illustrated in FIGURE 1. The output signal of a pulse generator 18 provides the input signal for the filters of the synthesizer 15. Exciter information from device 17 is fed to pulse generator 18, similar to the feeding in the known Vocoder system described in connection with FIGURE 1.

In the embodiment illustrated in FIGURE 4, a comparing arrangement is provided in which the envelope curve amplitudes of the partial ranges whose values exceed a certain percentage of the total envelope curve amplitude, are ascertained and appear at the output. For simplicity, only four filters F_1 to F_4 of the analyzer and the subsequent rectifiers and low pass filters 4 have been shown. The envelope curve amplitudes of these four ranges are fed to comparing devices V_1 to V_4 . At the same time, the total envelope curve amplitude is ascertained in the filter F_{20} with its subsequent rectifier and low pass filter 19, and this is fed to a potentiometer comprising the two resistors 20 and 21.

The arrangement of the resistors is such that resistor 21 amounts to, for example, 20% of the total resistance of the two resistors 20 and 21. Thus, 20% of the total envelope curve amplitude is always fed from the connection point between the two resistors to the comparing devices V_1 to V_4 . This comparison may be carried out continuously; but, if desired, a special ticker T may be provided which initiates the comparison process for carrying it out at definite time intervals, for example, 20 milliseconds.

After the comparing operation, signals will appear in the outputs of the comparing devices V_1 to V_4 , only if the required amplitude value is exceeded. The outputs of V_1 to V_4 are connected to a translating or decoding device 22. In this device, designation codes are provided to the regions in which a signal exceeding the prescribed threshold has been transmitted so that the transmitted partial ranges arrive at the receiving end of the assembly under a certain designation code. In this em-

bodiment, the amplitude envelope curve pertaining to the partial ranges and to the total range is shown. For example, a partial range may have the shape of curve 11, while the total range may have the shape of curve 22'.

FIGURE 5 illustrates a circuit arrangement which is used for the quantized transmission of the envelope curve information of the individual partial ranges. In order to assure that the quantization of the total amplitude range takes place in the same number of stages, independently of the energy of the voice signals to be transmitted, there is a comparison of the total envelope curve amplitude with the envelope curve amplitude of a partial range. For this purpose it may be assumed that the curve 23 of FIGURE 2 is being used.

For simplicity, FIGURE 5 only shows the structure for obtaining the envelope curve information of a single partial range with the filter F_1 and its subsequent rectifier and low pass filter 4. In this range, the envelope curve amplitude V_x , which is with respect to ground, has the shape illustrated by curve 11 and which is plotted against time t . A filter F_{20} , and a subsequent rectifier and low pass filter 19, has the curve 22' associated therewith. This curve is plotted against total envelope curve amplitude V_{env} taken with respect to ground.

This total envelope curve amplitude is applied to a voltage divider which is constructed of a plurality of equal value resistors. Four resistors 33, 34, 35, and 36 are illustrated, and in this case the quantization will take place in four stages. The voltages which are tapped off from the various voltage divider stages are fed to the comparing stages V_5 , V_6 , and V_7 together with the voltage V_x . Since a quantization process takes place at the same time in these comparing stages, a pulse will appear at their output only if the voltage V_x has exceeded the corresponding partial value at the voltage divider. Thus, if the voltage V_x at instant t_0 exceeds the partial voltage which is tapped off at resistor 36, a pulse will appear at the output of the comparing device V_7 . If this voltage V_x exceeds the cumulative voltage appearing at resistors 35 and 36, a pulse will simultaneously occur at the output of the comparing device V_6 . These voltage pulses may be stored by means of storage elements 27 which are illustrated only symbolically, and may then be picked up by means of a distributor switch 28 which is a portion of a time division multiplex device.

In a manner similar to that of the circuit device according to FIGURE 4, the comparison may be carried out either continuously or at selected time intervals. In case of the latter, a ticker T is again used, which is connected with the comparing devices V_5 , V_6 , and V_7 . At the receiving end of the assembly, the individual pulses will arrive successively and are again divided into the individual partial ranges by means of a synchronously operating switch. They are then combined to form the envelope curve information of the partial ranges.

It will be understood that the above description of the present invention is susceptible to various modifications, changes, and adaptations, and the same are intended to be comprehended within the meaning and range of equivalents of the appended claims.

What is claimed is:

1. In a device for transmitting a voice signal provided in the form of an electrical signal, the improvement comprising:

- (a) first means for receiving the electrical voice signal for dividing the electrical signal into a plurality of signals of different frequency ranges having envelope curve amplitudes;
- (b) second means for receiving the electrical voice signal for generating a total envelope curve amplitude signal from the electrical signal; and
- (c) means connected with said dividing means and said signal generating means for comparing each of the amplitude signals of the different frequency ranges with the total envelope curve amplitude signal

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and for transmitting the signals from only those frequency ranges wherein the envelope curve amplitude exceeds a given portion of the instantaneous total envelope curve amplitude by a predetermined amount.

2. A device as defined in claim 1 wherein said first and second means are connected to receive the electrical voice signal from the same source.

3. A device as defined in claim 1 wherein said comparing means includes a voltage divider of at least two resistors connected to receive the total amplitude signal and to divide this signal into two predetermined portions, at least one comparing device connected to a tap between the resistors and to the first means to receive one of the plurality of signals of different frequency ranges, the resistance ratio of said resistors providing the comparing device with the predetermined amount of the instantaneous total envelope curve amplitude.

4. A device as defined in claim 1 wherein said comparing means includes a voltage divider connected to receive the total amplitude signal and having two resistors, said resistors being arranged so that the ratio of their resistances determines the predetermined amount by which the envelope curve amplitude of the plurality of frequency ranges must exceed the instantaneous total envelope curve amplitude to be transmitted, and a comparing device for each frequency range with each being connected to a tap between said resistors.

5. A device as defined in claim 1 wherein said comparing means is arranged for providing quantized transmission of the envelope curve information of the individual partial ranges and includes a voltage divider connected to receive the total amplitude signal and having a resistor for each quantized unit desired with the resistors being of equal value and connected in series with each other, a number of comparing devices for each frequency range and each device for a range being connected to a tap between two resistors.

6. A device for transmitting voice signals, comprising, in combination:

- (a) means for receiving a voice signal in the form of acoustical energy for converting it into an electrical signal;
- (b) first means connected with said voice receiving means for dividing the electrical signal into a plurality of signals of different frequency ranges having envelope curve amplitudes;
- (c) second means connected with said voice receiving means for generating a total envelope curve amplitude signal from the electrical signal; and
- (d) means connected with said dividing means and said signal generating means for comparing each of the amplitude signals of the different frequency ranges with the total envelope curve amplitude signal and for transmitting the signals from only those frequency ranges wherein the envelope curve amplitude exceeds a given portion of the instantaneous total envelope curve amplitude by a predetermined amount.

7. A device as defined in claim 6, comprising trans-

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lator circuit means for designating the envelope curve information of the selected frequency ranges by designation codes.

8. A device for transmitting voice signals, comprising, in combination:

- (a) means for receiving a voice signal in the form of acoustical energy for converting it into an electrical signal;
- (b) means connected with said voice receiving means for amplifying the electrical signal;
- (c) first means connected with said amplifying means for dividing the electrical signal into a plurality of signals of different frequency ranges having envelope curve amplitudes;
- (d) second means connected with said amplifying means for generating a total envelope curve amplitude signal from the electrical signal; and
- (e) means connected with said dividing means and said signal generating means for comparing each of the amplitude signals of the different frequency ranges with the total envelope curve amplitude signal and for transmitting the signals from only those frequency ranges wherein the envelope curve amplitude exceeds a given portion of the instantaneous total envelope curve amplitude by a predetermined amount.

9. A system for transmitting voice signals, comprising, in combination:

- (a) means for transforming speech into electrical signals;
- (b) first means connected with said transforming means for distributing the electrical signals into a plurality of partial signals of different frequency ranges;
- (c) means for rectifying and smoothing the distributed signals and including rectifiers and low pass filters;
- (d) means connected to receive a full electrical signal from said transforming means for rectifying and smoothing the full signal; and
- (e) means connected to said distributed signal rectifying means and said full signal rectifying means for comparing each partial rectified and smoothed signal with the full rectified and smoothed signal and for selecting and transmitting only those partial signals which exceed a predetermined percentage of the full signal.

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