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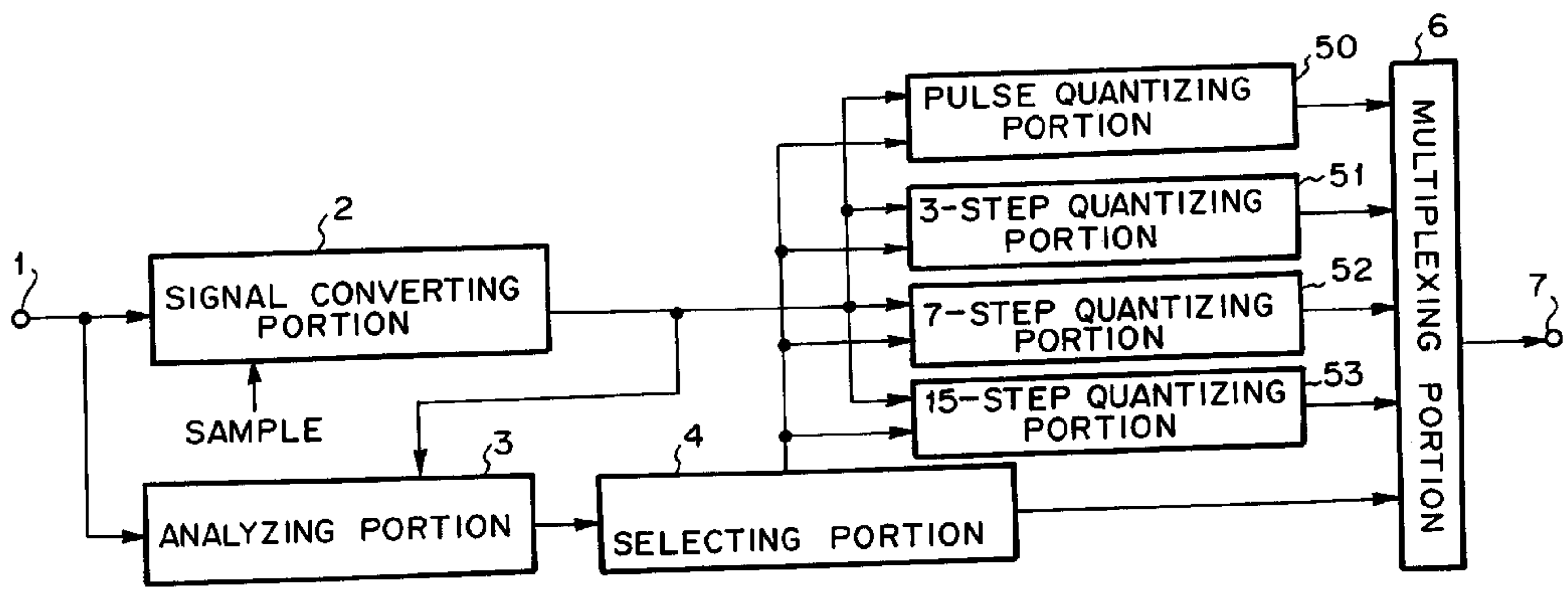
(54) **SYSTEME DE CODAGE ET DE DECODAGE DE SIGNAUX AUDIO**

(54) **ENCODING SYSTEM AND DECODING SYSTEM FOR AUDIO SIGNALS**



(57) An encoding system comprises an input terminal for receiving an input signal, a signal converting portion for converting the input signal into frequency-domain signals and grouping several frequency-domain signals into blocks, an analyzing portion for analyzing the input signal and the frequency-domain signals and obtaining an allowable error, a selecting portion for selecting one of a plurality of quantizing portions that quantizes frequency-domain signals of each block corresponding to the allowable error, a plurality of quantizing portions for quantizing frequency-domain signals corresponding to selection information and calculating amplitude information and codes, a multiplexing portion for multiplexing the amplitude information, codes, and selection information, and an output terminal for outputting the multiplexed signal.

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ABSTRACT

An encoding system comprises an input terminal for receiving an input signal, a signal converting portion for converting the input signal into frequency-domain signals and grouping several frequency-domain signals into blocks, an analyzing portion for analyzing the input signal and the frequency-domain signals and obtaining an allowable error, a selecting portion for selecting one of a plurality of quantizing portions that quantizes frequency-domain signals of each block corresponding to the allowable error, a plurality of quantizing portions for quantizing frequency-domain signals corresponding to selection information and calculating amplitude information and codes, a multiplexing portion for multiplexing the amplitude information, codes, and selection information, and an output terminal for outputting the multiplexed signal.

ENCODING SYSTEM AND DECODING SYSTEM FOR AUDIO SIGNALS

The present invention relates to a system for effectively encoding and decoding a speech signal, an audio signal, and the like.

In a digital encoding system for a speech signal, an audio signal, and so forth, the signal transmission or recording rate is decreased removing the redundancy thereof. As a related art reference, an encoding system defined in ISO/IEC (International Organisation for Standardisation/International Electro-technical Commission) 11172-3 (referred to as MPEG/Audio) Layer I will be described with reference to Figures 3 and 4.

A conventional encoder shown in Figure 3 is composed of an input terminal 1, a signal converting portion 2, an analyzing portion 3, a selecting portion 4, quantizing portions 51 to 53, a multiplexing portion 6, and an output terminal 7. The quantizing portions 51 to 53 differ from each other in the number of quantization steps. In this example, the quantizing portion 51 has three quantization steps. The quantizing portion 52 has seven quantization steps. The quantizing portion 53 has 15 quantization steps. Quantizing portions with more steps than 15 steps are provided in the related art reference, but they are omitted here for simplification.

This system is based on a sub-band encoding system where an input signal is divided into a plurality of frequency-domain signals and each frequency-domain signal is independently encoded. As speech and audio signals generally have larger amplitudes at lower frequency, the necessary transmission rate can be decreased by assigning larger bits at lower frequency and smaller bits at higher frequency.

In reality, a digitized audio signal, for example, PCM audio samples, is supplied via the input terminal 1. Whenever 32 samples of audio signal are input, the signal converting portion 2 divides the input audio signal into frequency bands and converts it into 32 frequency-domain signals. The signal converting portion 2 stores 12 sets of frequency-domain signals in a buffer, a set of frequency-domain signals being the 32 frequency-domain signals obtained by one conversion. The 12 sets of frequency-domain signals at the same frequency are referred to as one block (32 x 12 = 384 samples/frame).

The analyzing portion 3 calculates an allowable error at each frequency band in quantizing the frequency-domain signals. For example, when an objective S/N ratio is used in evaluating the coding quality, the allowable error is kept constant for each frequency-domain signal. When an audio signal is encoded, not only an objective value such as S/N ratio, but a subjective evaluation based on, for example, test listening, is highly considered. Thus, encoding noise may be controlled using psychoacoustic analysis techniques so as to minimize the deterioration of sound quality. Consequently, based on at least one of the input audio signal and the frequency-domain signals, the allowable error should be obtained.

The selecting portion 4 selects one of the quantizing portions 51 to 53 that quantizes frequency-domain signals for each block.

Each of the quantizing portions 51 to 53 receives a block of frequency-domain signals, calculates amplitude information of frequency-domain signals of each block, encodes the frequency-domain signals with the amplitude information, and outputs the amplitude information and codes of the encoded frequency-domain signals. The amplitude information is obtained with an accuracy of 2 dB as shown in Table 1.

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Table 1 Relationship between index and amplitude

Index	Amplitude
0	2.0
1	1.587
2	1.260
3	1.0
4	0.794
5	0.630
6	0.5
7	0.397
8	0.315
..	....
62	0.00000120

Each of the quantizing portions 51 to 53 detects the maximum absolute amplitude value of the frequency-domain signals in each block and treats the rounded-up value with the accuracy of 2 dB as amplitude information. According to this standard, 63 amplitude information indexes are provided. To send the amplitude information, six bits are required.

In this standard, the quantization characteristic is linear. Assuming that the magnitude value of a frequency-domain signal is C, the value of the amplitude information is L, and the number of quantization steps is S, with coefficients A and B corresponding to the number of quantization steps S in Table 2, the expression

[{A x (C / L) + B} x (S + 1) / 2]

is calculated. The fragments to the right of the decimal point of the result calculated are rounded off and the significant high order N bits are obtained. Thereafter, by inverting the most significant bit of the N bits, a code of the frequency-domain signal is obtained.

Table 2

Relationship of the number of quantizing steps S, to coefficients A and B, and bits N

Number of Steps S	N	A	B
3	2	0.75	-0.25
7	3	0.875	-0.125
15	4	0.9375	-0.0625

In a dequantizing portion of a decoding apparatus as shown in Figure 4, the most significant bit of the code is inverted and a result Q is obtained. By calculating [{2 x (Q + 1) / S} x L], a dequantized signal of the frequency-domain signal can be obtained.

Next, real quantizing and dequantizing processes in a case where the amplitude values of frequency-domain signals of one block are 0.10, -0.15, -0.03, 0.20, 0.05, 0.44, 0.05, -0.11, 0.32, -0.40, 0.92, and 0.04 will be described.

In this block, since the maximum amplitude value is 0.92, 1.0 (index = 3) is selected as the amplitude value. Corresponding to the above-described calculation, codes obtained in the 15-step quantizing process are 8, 6, 7, 9, 7, 10, 7, 6, 9, 4, 14, and 7. The dequantizing portion dequantizes these codes and obtains 0.133, -0.133, 0.0, 0.267, 0.0, 0.4, 0.0, -0.133, 0.267, -0.400, 0.933, and 0.0.

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The 15-step quantizing unit 53 requires four bits for sending a code of one frequency-domain signal. Thus, to send codes of 12 frequency-domain signals of one block, the 15-step quantizing unit 53 requires 48 bits. To send amplitude information, the 15-step quantizing unit 53 requires six bits. Thus, the 15-step quantizing unit 53 requires a total of 54 bits.

When the quantizing portion selecting portion 4 selects the three-step quantizing portions, codes 1, 1, 1, 1, 1, 2, 1, 1, 1, 0, 2, and 1 are obtained. The dequantized values are 0.0, 0.0, 0.0, 0.0, 0.0, 0.667, 0.0, 0.0, 0.0, -0.667, 0.667 and 0.0.

Thus, the number of bits necessary for sending one block is a total of 30 bits composed of 12 two-bit codes each of which represents a three-level quantized value of each frequency-domain signal and six bits that represent the amplitude information of the block.

As with the dequantizing calculation, the magnitude of the quantizing error is proportional to {(amplitude value L) / (number of quantizing steps S)} of each block. Therefore, as the number of quantizing steps S is large, the quantizing accuracy of frequency-domain signals can be improved. However, when the number of quantizing steps S becomes large, the number of bits N that represent each code becomes large. Thus, the transmission rate increases. Consequently, while the quantizing selecting portion 4 is adjusting the magnitude of the quantizing error of each frequency-domain signal so that it is proportional to the allowable error defined by the analyzing portion 3, the quantizing selecting portion 4 selects a quantizing portion in such a manner that the number of bits necessary for encoding all frequency-domain signals is in a range corresponding to the transmission rate.

The multiplexing portion 6 multiplexes the quantizing portion selection information and an output of a quantizing portion for each block, forms a bit stream, and supplies it through the output terminal 7.

The conventional decoding apparatus is composed of an input terminal 11, a demultiplexing portion 12, a three-step dequantizing portion 81, a seven-step dequantizing portion 82, a 15-step dequantizing portion 83, a signal inverse converting portion 13, and an output terminal 14.

The decoding apparatus receives a multiplexed signal via the input terminal 11. The demultiplexing portion 12 demultiplexes the multiplexed signal into quantizing portion selection information and an output of a quantizing portion. With the quantizing portion selection information, a dequantizing portion corresponding to the quantizing method on the encoding side is selected from the three-step dequantizing portion 81, the seven-step dequantizing portion 82, and the 15-step dequantizing portion 83. Each of the dequantizing portions 81 to 83 separates the output of a quantizing portion into amplitude information and codes of frequency-domain signals. As described above, with the amplitude information, the codes of the frequency-domain signals are dequantized and the frequency-domain signals of each block are reproduced. The signal inverse converting portion 13 inversely converts the frequency-domain signals into a time-domain signal and supplies the resultant signal through the output terminal 14.

In the related art reference, a quantizing portion that is in common with a block is used. Thus, when the amplitude distribution of frequency-domain signals is not equal, for example, when a few numbers of frequency-domain signals in the block have large projecting amplitudes, the distribution of quantized codes becomes irregular and the encoding efficiency deteriorates.

An object of the present invention is to provide a system for converting a sound and/or speech signal into frequency-domain signals to form blocks and suppressing the number of quantizing bits so as to accomplish high encoding quality, even if a few values of frequency-domain signals in the blocks have projecting amplitudes.

The present invention is an encoding system for a speech signal, an audio signal, and so forth, comprising a signal converting portion for converting an input signal into frequency-domain signals and grouping a plurality of frequency-domain signals into blocks, an analyzing portion for analyzing the input signal and the frequency-domain signals and obtaining an allowable error, a selecting portion for outputting selection information for selecting one of a plurality of quantizing portions corresponding to the allowable error, each of the quantizing portions quantizing frequency-domain signals of each block corresponding to the selection information so as to calculate amplitude information and codes, and a multiplexing portion for multiplexing the amplitude information, the codes, and the quantizing portion selection information, wherein said quantizing portions include at least one first quantizing portion for encoding all frequency-domain signals of the blocks and at least one second quantizing portion for encoding only part of frequency-domain signals of the blocks.

In the encoding system according to the present invention, outputs of the second quantizing portion are amplitude information, a polarity code, and an index.

In the encoding system according to the present invention, outputs of the second quantizing portion are representative amplitude information, a plurality of frequency indexes, and plurality of polarity codes.

In the encoding system according to the present invention, in the determination of part of frequency-domain signals of the block to be encoded in the second quantizing portion, the signal indexes are previously divided into groups and only one index is selectable from each of the groups.

The present invention is a decoding system for a speech signal, an audio signal, and so forth, comprising a demultiplexing portion for demultiplexing an input signal into amplitude information, codes, and selection information, a plurality of dequantizing portions for dequantizing the codes with the amplitude information corresponding to the selection information, and a signal inverse converting portion for converting a block of output signals of said dequantizing portions, wherein said dequantizing portions include at least one first dequantizing portion for decoding all frequency-domain signals of each block and at least one second dequantizing portion for decoding only part of frequency-domain signals of each block.

In the decoding system according to the present invention, inputs of the second dequantizing portion are amplitude information, a polarity code, and an index.

In the decoding system according to the present invention, inputs of the second dequantizing portion are representative amplitude information, a plurality of frequency indexes, and a plurality of polarity codes.

In the decoding system according to the present invention, the signal indexes are previously divided by the second dequantizing portion and with only one index of each of the groups from which a frequency-domain signal can be decoded.

Frequency-domain signals with large projecting amplitudes are quantized/dequantized with amplitude information, polarity information, and signal index.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, wherein:

Figure 1 is a block diagram showing an encoding system according to the present invention;

Figure 2 is a block diagram showing a decoding system according to the present invention;

Figure 3 is a block diagram showing a conventional encoding system; and

Figure 4 is a block diagram showing a conventional decoding system.

With reference to Figures 1 and 2, four types of quantizing portions and four types of dequantizing portions are used. However, it should be noted that the number of types of quantizing portions and dequantizing portions is not limited.

An encoding apparatus according to the present invention is composed of an input terminal 1, a signal converting portion 2, an analyzing portion 3, a selecting portion 4, quantizing portions 50 to 53, a multiplexing portion 6, and an output terminal 7. The quantizing portions 50 to 53 are composed of a pulse quantizing portion 50 as well as a three-step quantizing portion 51, a seven-step quantizing portion 52, and a 15-step quantizing portion 53 that are the same as those used in the conventional encoding apparatus.

A digital audio signal, for example PCM audio samples, is supplied via the input terminal 1. Whenever 32 samples of an audio signal are input, the signal converting portion 2 converts a band of the audio signal into 32 frequency-domain signals and stores 12 sets of frequency-domain signals as a set of frequency-domain signals. The 12 sets of frequency-domain signals of each frequency compose one block. As a signal converting process, a plurality of converted coefficients with successive frequency indexes may be grouped as a block by a Fourier transforming process or a discrete cosine transforming process instead of the band dividing process.

The analyzing portion 3 calculates the amount of the allowable error for each frequency using the input audio signal, frequency-domain signals, and so forth in the same manner as the conventional method.

While the selecting portion 4 is adjusting the magnitude of the quantizing error of each frequency-domain signal so that it is proportional to the allowable error defined by the analyzing portion 3, the selecting portion 4 selects a quantizing portion in such a manner that the number of bits necessary for encoding frequency-domain signals of all blocks is in an allowable range corresponding to the transmission rate. The selected quantizing portion encodes the frequency-domain signal of each block as will be described later.

The multiplexing portion 6 multiplexes the quantizing portion selection information and the output of a quantizing portion for each block, forms a bit-stream, and supplies it through the output terminal 7.

A decoding apparatus according to the present invention is composed of an input terminal 11, a demultiplexing portion 12, a pulse dequantizing portion 80, a three-step dequantizing portion 81, a seven-step dequantizing portion 82, a 15-step dequantizing portion 83, a signal inverse converting portion 13, and an output terminal 14.

A multiplexed signal is received via the input terminal 11. The demultiplexing portion 12 demultiplexes the received signal into the selection information and an output of quantizing portion. With the selection information, a dequantizing portion corresponding to the quantizing method on the encoding side is selected from among the pulse dequantizing portion 80, the three-step dequantizing portion 81, the seven-step dequantizing portion 82, and the 15-step dequantizing portion 83. As will be described later, the selected dequantizing portion reproduces frequency-domain signals of each block corresponding to the input of the quantizing portion. The signal inverse converting portion 13 inversely converts the frequency-domain signals into a time-domain signal and supplies the resultant signal to the output terminal 14.

Next, several examples of the quantizing process and the dequantizing process according to the present invention will be described.

As a first example, when frequency-domain signals of each block are encoded, the pulse quantizing portion 50 encodes frequency-domain signals with large projecting amplitude values. The conventional quantizing portions encode other frequency-domain signals. In the example of the related art reference, the pulse quantizing portion 80 quantizes the 11-th subband signal with an amplitude value 0.92. The conventional quantizing portions quantize other frequency-domain signals with amplitude values 0.10, -0.15, -0.03, 0.20, 0.05, 0.44, 0.05, -011, 0.32, -0.40, and 0.04.

The pulse quantizing portion calculates the amplitude value, the polarity, and the index of one subband signal and outputs them. In the case where the pulse quantizing portion 50 processes the frequency-domain signal with an amplitude value 0.92, when the relation between index and amplitude information shown in Table 1 is applied, the pulse quantizing portion 50 outputs amplitude information 1.0 (index = 3) and polarity information positive. Since the frequency-domain signal with the amplitude value 0.92 is placed at the 11-th position of the block, the index information is 11. Thus, the output of the pulse quantizing portion 50 requires six bits for the amplitude information, one bit for the polarity information, and four bits for the frequency index information that identifies 12 signals of the block. Since frequency-domain signals with large projecting amplitude values are excluded, the maximum absolute amplitude value of other frequency-domain signals is decreased from 0.92 to 0.44. Thus, the amplitude information of these frequency-domain signals becomes 0.5 (index = 6). Because the quantizing error is proportional to {(amplitude value L) / (number of quantizing steps S)} of each block, when frequency-domain signals are quantized with the similar quantizing error as those of the 15-step quantizing portion and the 15-step dequantizing portion, the number of steps required can be decreased from 15 to 7. Therefore, the number of bits necessary for sending each code can be reduced from 4 to 3. The seven-step quantizing portion quantizes the 11 subband signals and gets the codes of 4, 2, 3, 4, 3, 6, 3, 2, 5, 0, and 3. At the decoding side, the seven-step dequantizing portion 82 decodes these codes and obtains the reproduced frequency-domain signals of 0.143, -0.143, 0.0, 0.143, 0.0, 0.429, 0.0, -0.143, 0.286, -0.429, and 0.0.

Finally, according to the present invention, as shown in Table 3, with a total of 50 bits, codes of all frequency-domain signals of one block can be sent. In comparison with the 54 bits of the related art reference, the number of bits required can be decreased by four bits.

Table 3
Bit assignment

Item		**Number of Bits**
Quantizing Signal with Large Amplitude Value	Amplitude information	6
	Polarity	1
	Index	4
Quantizing Other Signals	Amplitude information	6
	Code	33
	Total	50

Next, in the case where the number of quantizing steps is 3, the pulse quantizing process and the pulse dequantizing process will be described with the input signal of the related art reference.

When the number of quantizing steps is three at a block, the amplitude values of quantized frequency-domain signals are " 0 " and " ± " (the same or negative values of the value indicated by the amplitude information). In other words, when pulses with negative and positive amplitude values are disposed with a center of "0", frequency-domain signals of the block can be represented. Information to be sent is amplitude information in common with frequency-domain signals of the block , a frequency index of each frequency-domain signal imitated with a pulse, and a polarity code.

In the example of the input signal of the related art reference, since frequency-domain signals of a block can be imitated with three pulses, a bit assignment is shown in Table 4 when the number of frequency-domain signals represented in one block is limited to four. Since frequency-domain signals imitated with pulses are signals 6 (0.44), 10 (-0.40), and 11 (0.92), information 6, 10, and 11 are encoded as dexes. The polarities of these codes are positive, negative, and positive. As amplitude information, 1.0 (index = 3) as the maximum amplitude value or 0.630 (index 5) as the average of the amplitude values of three frequency-domain signals to be imitated is used.

Table 4

Bit assignment

Item		Number of bits
Amplitude information		6
Number information of frequency-domain signals to be encoded		2
Quantizing first sample	Polarity Frequency index	1 4
Quantizing second sample	Polarity index	1 4
Quantizing third sample	Polarity Frequency index	1 4

The numbers of bits for the amplitude information, the index, and the polarity code are six, four, and one, respectively. Thus, the total number of bits is 23 bits which is smaller than 30 bits in the related art reference.

When the number of bits of number information of frequency-domain signals to be encoded is varied to one, two, three, or four, up to two, four, eight, and 16 frequency-domain signals can be imitated. Assuming that the number of frequency-domain signals to be imitated is M and the number of bits for number information of frequency-domain signals to be encoded is N (N = 1 to 4), the number of bits required can be expressed by 6 + N + M x (4 + 1). Thus, when the number of frequency-domain signals represented in one frame is limited to four, in comparison with the related art reference in which three-step quantizing process is used, the number of bits required is always reduced.

In the case where the pulse quantizing process and the pulse dequantizing process are used, when the selection of frequency-domain signals to be encoded is restricted, the number of bits can be reduced. For example, restrictions on how the 12 frequency-domain signals of one block are divided into three groups and on which frequency-domain signal of each group is encoded are applied. As a grouping method, the first, fourth, seventh, and tenth frequency-domain signals are assigned to the first group. The second, fifth, eighth, and eleventh frequency-domain signals are assigned to the second group. The third, sixth, ninth, and twelfth frequency-domain signals are assigned to the third group. As a criterion for selecting one frequency-domain signal from each group, an amplitude value is used.

In the example of the frequency-domain signals of the related art reference, the frequency-domain signal with the largest absolute amplitude value of the first group is the tenth frequency-domain signal (-0.40). The frequency-domain signal with the largest absolute amplitude value of the second group is the eleventh frequency-domain signal (0.92). The frequency-domain signal with the largest absolute amplitude value of the third group is the sixth frequency-domain signal (0.44). In the frequency-domain signals assigned to the individual groups, the fourth frequency-domain signal, the fourth frequency-domain signal, and the second frequency-domain signal have the largest amplitude values. Thus, when 4, 4, and 2 as the indexes of the selected frequency-domain signals and negative, positive, and positive as the polarity information are sent in addition to the amplitude information, the frequency-domain signals can be reproduced on the decoding side. At this point, as with the above-described example, as the amplitude value, 1.0 (index = 3) based on the maximum amplitude value or 0.630 (index = 5) based on the average value of the amplitude values of three frequency-domain signals to be imitated is used.

The number of bits necessary for sending frequency-domain signals of one block is six bits for the amplitude information of the block, two bits for an index for selecting one of four frequency-domain signals, and one bit for representing the polarity of the amplitude of the selected frequency-domain signal as shown in Table 5. Thus, since a total of 15 bits are used, the number of bits required is reduced in comparison with the above-described embodiment.

Table 5

Bit assignment

Item		Number of bits
Amplitude information		6
Quantizing frequency-domain signals of first group	Polarity	1
	index	2
Quantizing frequency-domain signals of second group	Polarity	1
	index	2
Quantizing frequency-domain signals of third group	Polarity	1
	index	2

As a grouping method for grouping frequency-domain signals of one block, the first, second, third, and fourth signals may be assigned to the first group. The fifth, sixth, seventh, and eighth signals may be assigned to the second group. The ninth, tenth, eleventh, and twelfth frequency-domain signals may be assigned to the third group.

In the above-described embodiment, an audio signal was exemplified. However, it should be noted that a video signal with an projecting luminance or an extreme color may be handled with a pulse quantizing portion and a pulse dequantizing portion so as to decrease the total number of bits.

With a pulse quantizing portion 50 and a pulse dequantizing portion 80 that can encode and decode part of frequency-domain signals of a block, the number of bits necessary for the quantizing process can be reduced. Thus, for a signal source with a larger projecting amplitude than other signals in a block, the same encoding quality as the conventional method can be accomplished with a smaller number of bits than the conventional method. Consequently, the encoding efficiency can be improved.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. An encoding system for signals, comprising:

a signal converting portion for converting an input signal into frequency-domain signals and grouping a plurality of frequency-domain signals into blocks;

an analyzing portion for analyzing the input signal and the frequency-domain signals and obtaining an allowable error;

a plurality of quantizing portions for quantizing frequency-domain signals of each block to calculate amplitude information and codes;

a selecting portion for outputting quantizing portion selection information for selecting one of said plurality of quantizing portions corresponding to the allowable error; and

a multiplexing portion for multiplexing the amplitude information, the codes, and the quantizing portion selection information,

wherein said quantizing portions include at least one first quantizing portion for encoding all frequency-domain signals of the blocks and at least one second quantizing portion for encoding only part of frequency-domain signals of the blocks.

2. An encoding system as set forth in claim 1, wherein outputs of the second quantizing portion are amplitude information, a polarity code, and an index.

3. An encoding system as set forth in claim 1, wherein outputs of the second quantizing portion are representative amplitude information, a plurality of indexes, and a plurality of polarity codes.

4. An encoding system as set forth in claim 3, wherein in the determination of part of frequency-domain signals of the block to be encoded by

the second quantizing portion, the indexes are previously divided into groups and only one index is selectable from each of the groups.

5. A decoding system for signals, comprising:

a demultiplexing portion for demultiplexing input signals into amplitude information, codes, and quantizing portion selection information;

a plurality of dequantizing portions for dequantizing the codes with the amplitude information corresponding to the quantizing portion selection information; and

a signal inverse converting portion for converting a block of output signals of said dequantizing portions,

wherein said dequantizing portions include at least one first dequantizing portion for decoding all frequency-domain signals of each block and at least one second dequantizing portion for decoding only part of frequency-domain signals of each block.

6. A decoding system as set forth in claim 5, wherein inputs of the second dequantizing portion are amplitude information, a polarity code, and a frequency index.

7. A decoding system as set forth in claim 5, wherein inputs of the second quantizing portion are representative amplitude information, a plurality of indexes, and a plurality of polarity codes.

8. A decoding system as set forth in claim 7, wherein the indexes are previously divided in the second dequantizing portion and with only one index of each of the groups from which a frequency-domain signal can be decoded.

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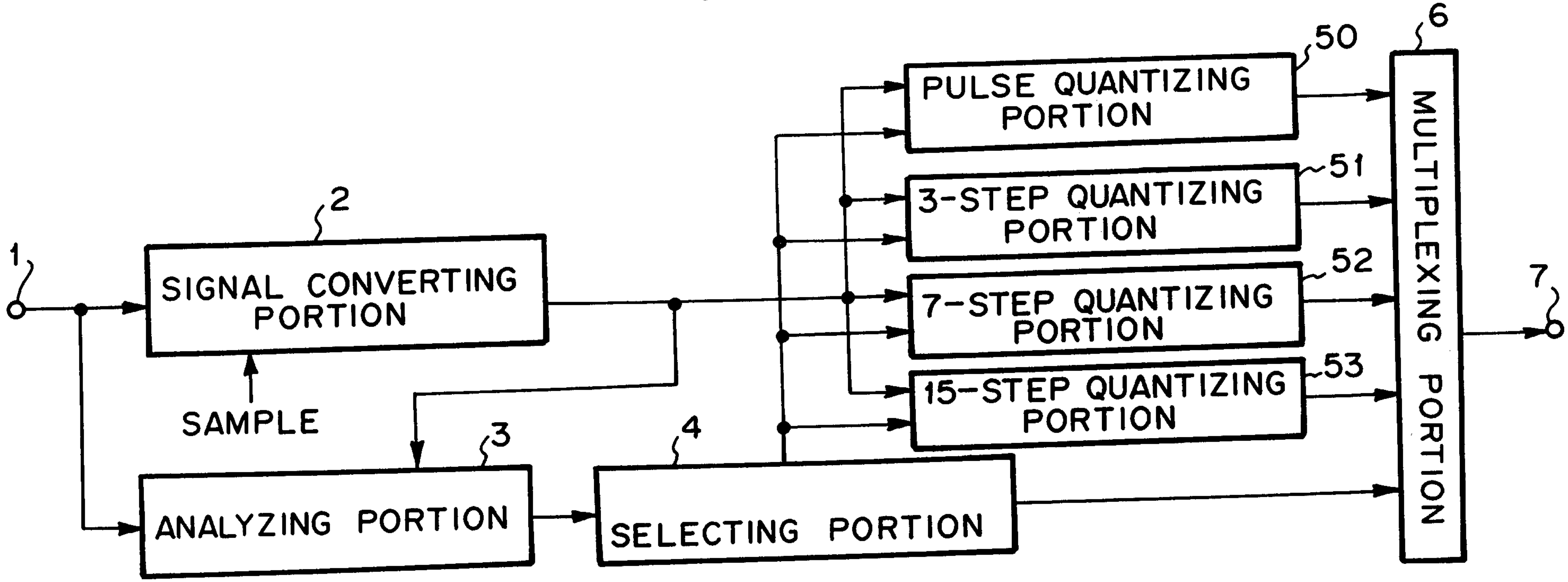
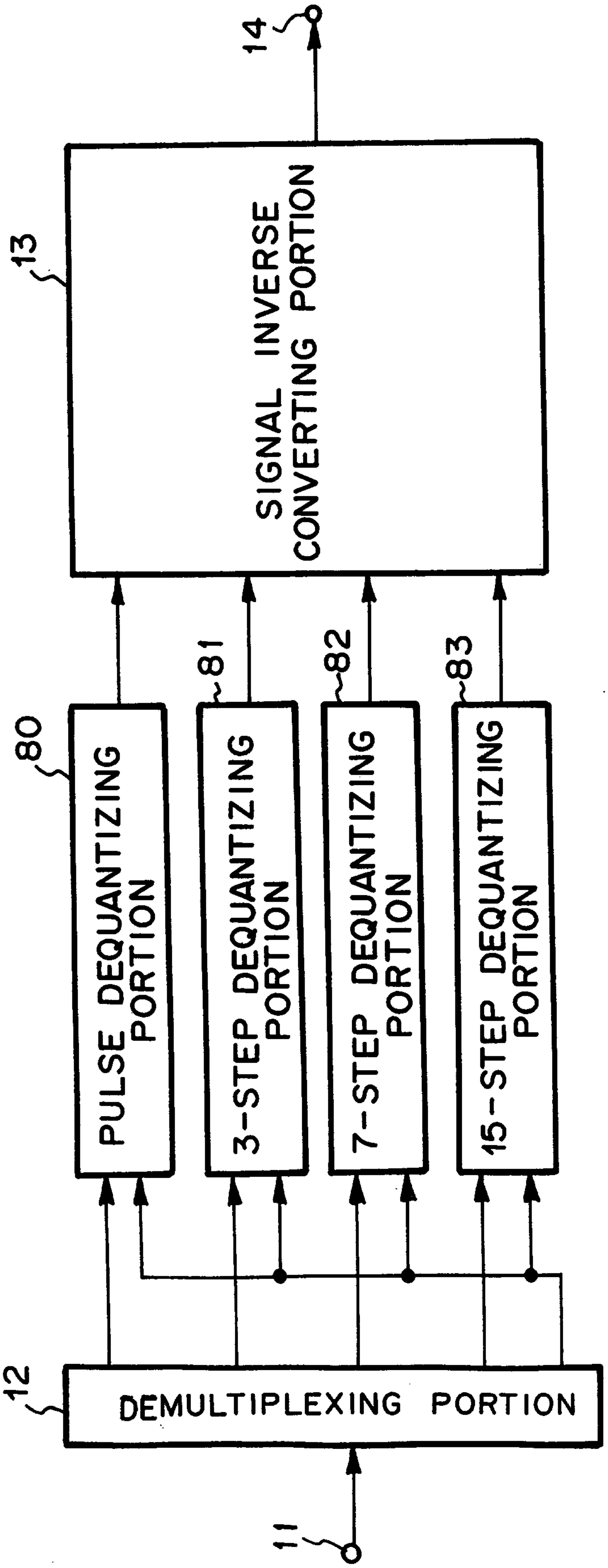
F I G.1

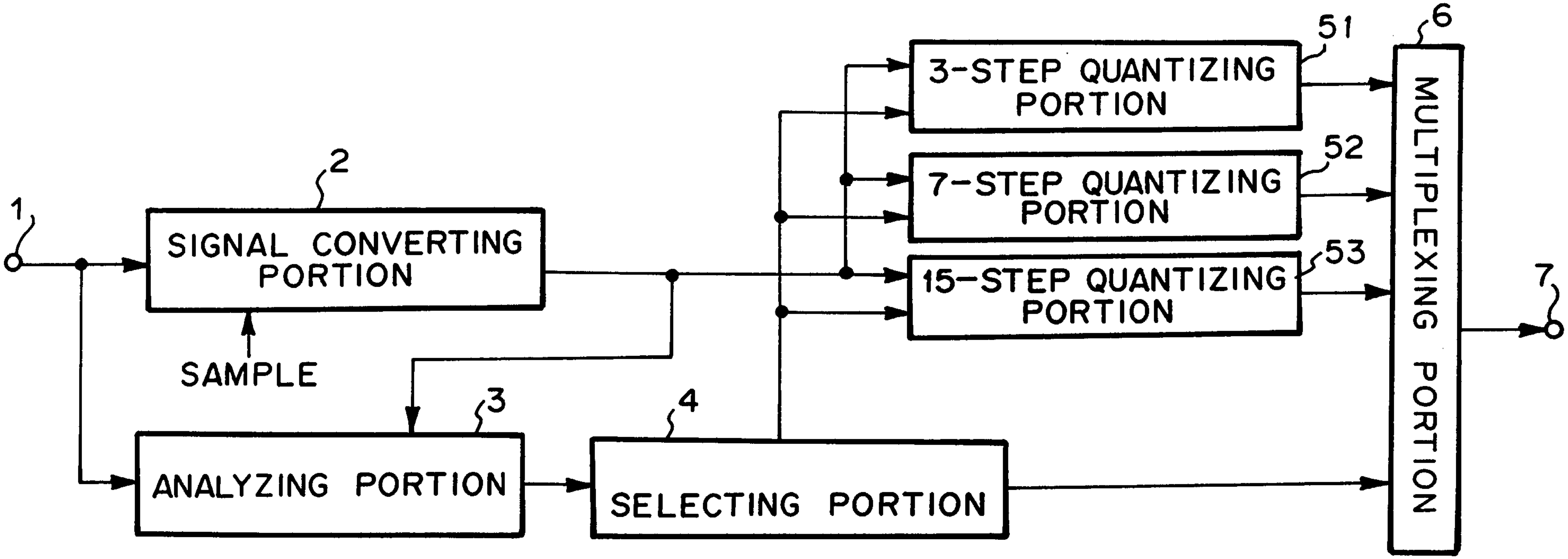


F I G. 2


14
13
SIGNAL INVERSE CONVERTING PORTION
80
PULSE DEQUANTIZING PORTION
81
3-STEP DEQUANTIZING PORTION
82
7-STEP DEQUANTIZING PORTION
83
15-STEP DEQUANTIZING PORTION
12
DEMULTIPLEXING PORTION
11

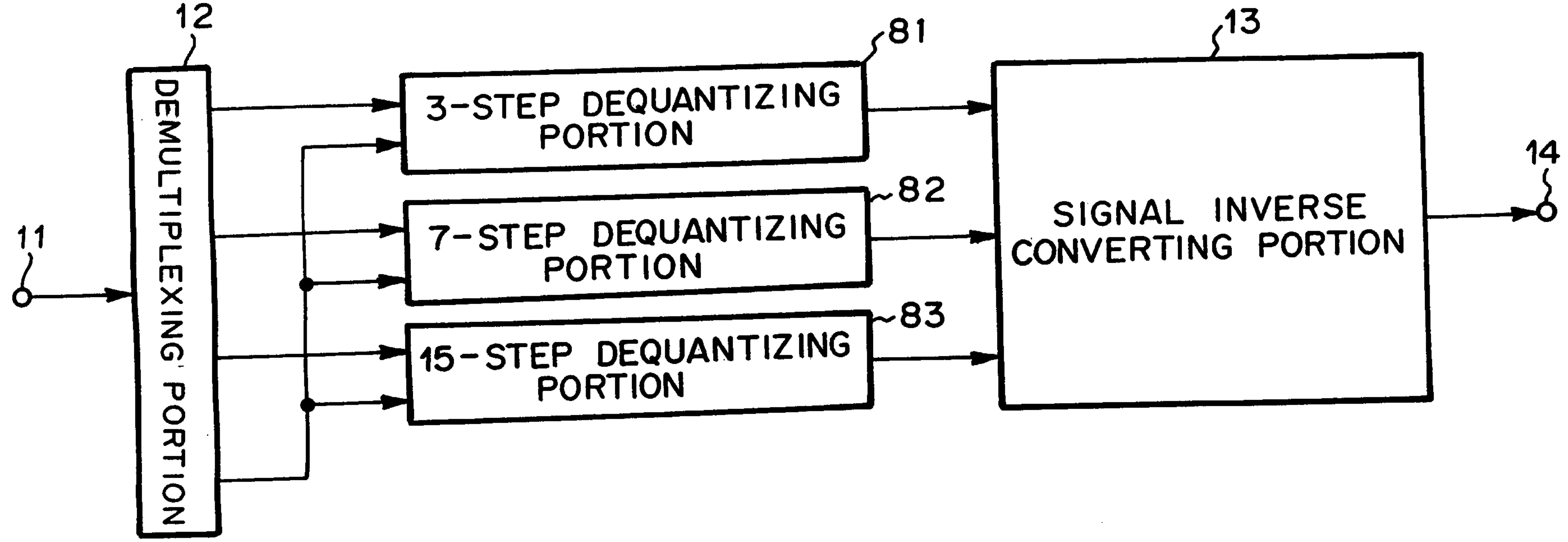
PRIOR ART

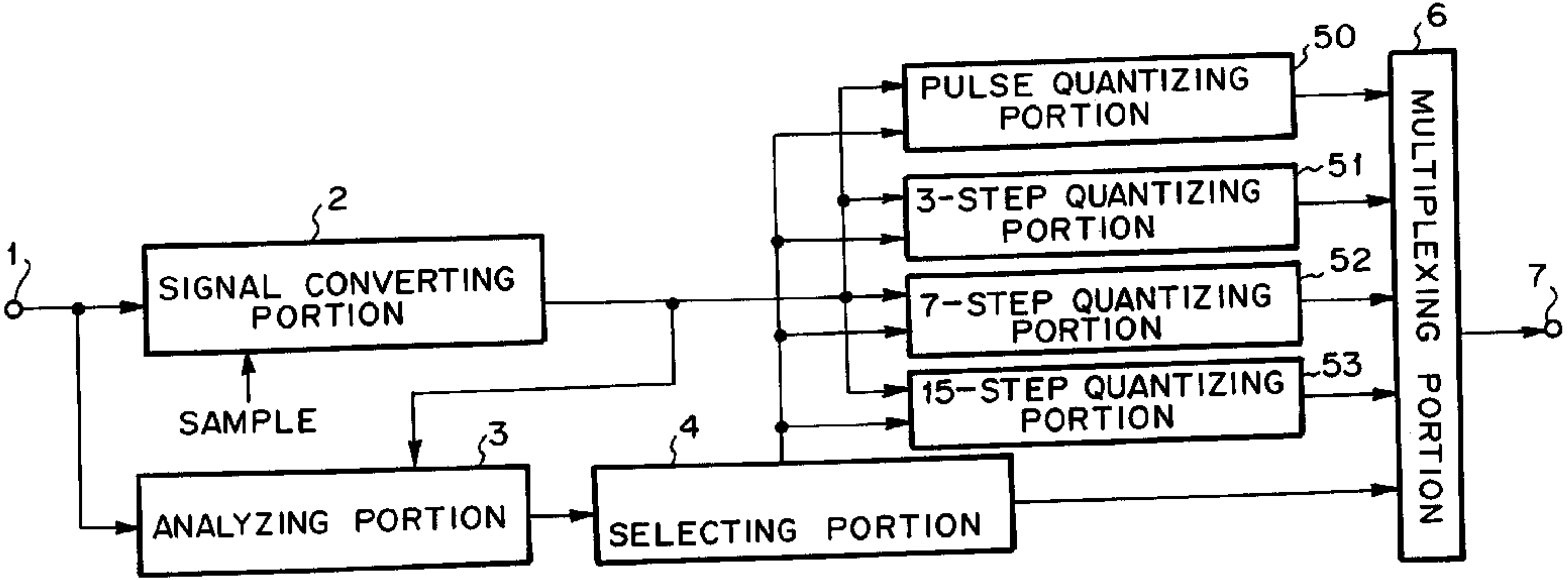
FIG.3



PRIOR ART

FIG.4




1
SIGNAL CONVERTING PORTION
2
SAMPLE
ANALYZING PORTION
3
SELECTING PORTION
4
PULSE QUANTIZING PORTION
50
3-STEP QUANTIZING PORTION
51
7-STEP QUANTIZING PORTION
52
15-STEP QUANTIZING PORTION
53
MULTIPLEXING PORTION
6
7