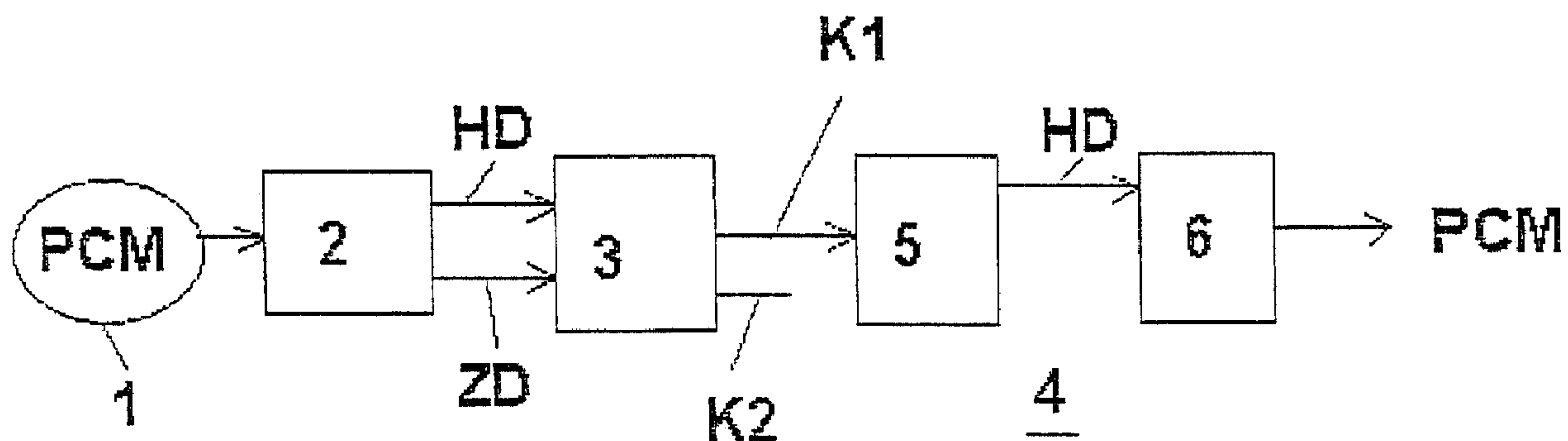




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(54) Titre : PROCÉDE POUR LA PREPARATION DE DONNEES EN CODE SOURCE, AINSI QUE L'EMETTEUR ET LE
RECEPTEUR
(54) Title: METHOD FOR PREPARATION OF SOURCE-CODED DATA, AND TRANSMITTER AND RECEIVER
THEREFOR



(57) Abrégé/Abstract:

Audio data from a useful signal source (1) are separated (2) into a main data stream (HD) and an auxiliary data stream (ZD). The main data stream (HD) contains at least the amount of information that is required for a comprehensive reproduction of at least one useful signal source (1). Main- and auxiliary data stream are transmitted in different channels (K1, K2) within a predetermined channel raster. It is possible to increase the reproduction quality of the audio signal within a predetermined channel raster.



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Abstract

Audio data from a useful signal source (1) are separated (2) into a main data stream (HD) and an auxiliary data stream (ZD). The main data stream (HD) contains at least the amount of information that is required for a comprehensive reproduction of at least one useful signal source (1). Main- and auxiliary data stream are transmitted in different channels (K1, K2) within a predetermined channel raster.

10 It is possible to increase the reproduction quality of the audio signal within a predetermined channel raster.

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Method for Preparation of Source-Coded Data, and Transmitter
and Receiver Therefor

Prior Art

The invention is based on a method for
5 transmitter-end or receiver-end preparation of source-coded
audio data of at least one useful signal source, in
particular for transmission via AM channels of a
predetermined channel raster.

For the transmission of digital audio data,
10 particularly via AM channels of a predetermined channel
raster with channels that are 9 or 10 kHz in width
(mediumwave in America) in medium- and longwave formats, as
well as in shortwave format, three different transmission
systems were developed within the DRM consortium (Digital
15 Radio Mondiale). All of these systems use a conventional AM
channel for transmission. In the T2M method, the digital
information can be linked via an auxiliary carrier to the
low-frequency input of the transmitter and can be
transmitted parallel to the AM analog signal (Funkschau
20 [Radio Show] no. 14, 1998, pp 44 to 46). The Skywave 2000
method uses a multiple carrier method with TCM modulation
(Trellis Code Modulation) in connection with QAM (Conference
Paper of the 51st Broadcast Engineering Conference, NAB 97,
pp. 27 to 48, Progress Towards the Development of Digital
25 Modulation in the Longwave, Mediumwave, and Shortwave Bands;
IBE, Transmission Engineering, March 1999, pp. 53 and 54).

Advantages of the Invention

According to one broad aspect, the invention
provides a method for transmission-end preparation of
30 source-coded audio data of at least one useful signal

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source, in particular for transmission via AM channels of a predetermined channel raster, with the following features: the source-coded audio data of at least one useful signal source are separated into a main data stream and at least
5 one auxiliary data stream, where the main data stream contains at least the amount of information that is required for a comprehensible reproduction of at least one useful signal source and the auxiliary data stream contains information for quality improvement, the main- and auxiliary
10 data streams are modulated and accommodated in respective different channels of the predetermined channel raster.

The invention also provides a method for receiver-end preparation of audio data, which are contained in main- and auxiliary data streams, in particular, for reception via
15 AM channels of a predetermined channel raster, where mutually associated main- and auxiliary data streams each originate from at least one useful signal source and the mutually associated main- and auxiliary data stream are accommodated in respective different channels of the
20 predetermined channel raster, including the following steps: a receiver with a low reproduction quality is used to demodulate and decode only the main data stream, a receiver with higher reproduction quality is intentionally used to demodulate and decode only the main data stream or the main
25 data stream and at least one associated auxiliary data stream are demodulated and decoded, where mutually associated demodulated and decoded data streams are linked to one another in such a way that an increase is achieved in the reproduction quality for the at least one useful data
30 source.

In accordance with a further aspect of the invention, there is provided a transmitter for the

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preparation of source-coded audio data from at least one useful signal source, in particular for transmission via AM channels of a predetermined channel raster, with the following features: a separation device for separating the audio data of a useful signal source into a main data stream and at least one associated auxiliary data stream, a modulation unit modulating the main- and auxiliary data streams, where this modulation unit can in particular be supplied with carrier signals in such a way that mutually associated main- and auxiliary data streams can be transmitted in respective different channels of a predetermined channel raster.

There is also provided a receiver for receiver-end preparation of source-coded audio data, which are accommodated in main- and auxiliary data streams, in particular for reception via AM channels of a predetermined channel raster, with the following features: a demodulation unit and decoding unit for at least main data streams, an evaluation unit for signaling and optionally encoding additional information, where the signaling indicates which channel contains an auxiliary data stream associated with a main data stream and the optionally provided additional information indicate what information the auxiliary data stream contains and how the main data stream is to be combined with the at least one auxiliary data stream on the receiver end, a linkage unit for mutually associated main- and auxiliary data streams, which can be controlled by the evaluation unit.

In some embodiments, it is possible to achieve an increase in reproduction quality, for example an improved tonal quality, without having to deviate from the predetermined channel raster, as is required in the methods

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mentioned at the beginning or which can only be achieved by these methods without quality loss by means of an expensive encoding. With a method according to an embodiment of the invention, with a coupling of a main data stream and at least one auxiliary data stream in different channels of the channel raster, the receiver-end useful data rate can be increased and therefore a quality improvement can be achieved in comparison with conventional methods. With a method according to an embodiment of the invention, it is possible, through the use of simpler receivers, to demodulate and decode only the main data stream, which results in a comprehensible reproduction with a low bit rate of approximately 24 kilobit/s. Receivers with a high reproduction quality demodulate and decode both the main data stream and also at least one auxiliary data stream of a useful signal and link these two data streams so that a higher reproduction quality is achieved.

In DVB signals, there is also a separation into a base layer and an enhancement layer. However, these layers are transmitted on the same channel. By contrast to the invention, with this system, a simple receiver must receive the entire data stream and can only execute a separation afterward.

A method according to an embodiment of the invention permits the achievement of numerous combinations for increasing reproduction quality, for example in order to reduce the amount of coding artifacts, increase audio bandwidth, or increase the impression of three-dimensional sound, e.g. the transitions from mono to stereo.

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Drawings

Exemplary embodiments of the invention will be explained in detail in conjunction with the drawings.

Fig. 1 shows the transmitter-end and receiver-end
5 preparation of audio data according to an embodiment of the invention,

Fig. 2 shows the AM channels within a predetermined channel raster,

Fig. 3 shows the transmitter-end and receiver-end
10 preparation of audio data according to an embodiment of the invention, with a receiver for high-quality reproduction,

Fig. 4 shows the preparation of a stereo signal,

Fig. 5 shows combinations for separating and combining audio data in a base layer and
5 an enhancement layer.

Description of the Exemplary Embodiments

10 In the embodiment of the invention according to Fig. 1, for example PCM data of a useful signal source 1 are encoded on the transmitter end by means of a source encoder 2. In this case, the encoded signal is separated into a main data stream HD (base layer) and at least one auxiliary data stream ZD (enhancement layer), i.e. the source encoder 2 in this exemplary embodiment functions simultaneously as a separation device for the
15 audio data of the useful signal source 1. The main- and auxiliary data stream are modulated by means of a modulation unit 3 and are accommodated in respective different channels that are spaced apart by 9 kHz, for example the adjacent channels K1 and K2 shown in Fig. 2 of the predetermined channel raster, e.g. of the AM middle channel raster. For the transmission of the main- and auxiliary data stream into the different
20 channels K1 and K2, the respective carrier signals for these channels are supplied to the modulation unit 3. Naturally, these channels do not have to be adjacent, as shown in Fig. 2, but can be accommodated at any location in the predetermined channel raster. Channels that can be used for the auxiliary data ZD can include, for example, channels that are freed by parallel program broadcasting due to the increased range of digital
25 modulation or channels that have been or will be created through band expansion as a result of channels no longer being needed by other services (coastal radio, marine radio, aeronautical radio), for example expansion of the AM mediumwave range in the USA between 1600 and 1660 kHz or the shortwave range in the 31, 25, and 19 meter band.

30 The data streams transmitted via separate channels are demodulated and decoded on the receiver end. In the exemplary embodiment according to Fig. 1, a base receiver 4

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is provided, i.e. a receiver with low reproduction quality, which demodulates and decodes only the main data stream HD by means of the demodulator 5 and source decoder 6. This is possible because the main data stream according to the invention contains at least the amount of information from a useful signal source that is required for a comprehensible reproduction of the useful signal source. For example, the main data stream HD contains just enough information from the useful signal source for the reproduction quality not to differ from the reproduction quality in the AM channels in mediumwave, longwave, and shortwave formats, i.e. acceptable speech comprehension, but with quality losses in music transmissions.

In the exemplary embodiment according to Fig. 3, on the transmitter end, the same signal preparation occurs as in the exemplary embodiment according to Fig. 1, but on the receiver end, a receiver 7 with high reproduction quality, for example CD quality, is provided, which demodulates and decodes both the main data stream HD and the associated auxiliary data stream ZD by means of the demodulation unit 8 and the decoding unit 9. In a linking device, the main data stream HD and the associated auxiliary data stream ZD are linked to each other in order to achieve a quality improvement of the audio signal received. In the exemplary embodiment according to Fig. 3, the source decoding unit 9 simultaneously functions as a linkage unit. For the correct linkage of a mutually associated main- and auxiliary data streams, a signaling is incorporated into the main data stream HD (base layer) on the transmitter end, which indicates whether an auxiliary data stream ZD (enhancement layer) is provided for the same useful signal source (program source) and at what frequency, i.e. in what channel, it is provided. Preferably additional information

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is incorporated into the auxiliary data stream, which indicates what information the auxiliary data stream ZD contains and optionally, how the main data stream HD is to be combined with the at least one associated auxiliary data stream ZD. In order to evaluate the signaling and/or the additional information, an evaluation unit 10 is provided that is preferably associated with the demodulation unit. This evaluation unit 10 controls the linkage unit and the source decoder 9 in accordance with the evaluated signals so that the linkage of associated main- and auxiliary data streams occurs synchronously with one another.

A receiver with high reproduction quality can naturally also execute an intentional demodulation and decoding of only the main data stream HD and can thus be operated as a base receiver.

5

Examples will be given below for separating out audio data from a useful signal source and possible combinations of the main data stream (base layer) and auxiliary data stream(s) (enhancement layer(s)). In the channel K1 according to Fig. 2, for example, the complete mono audio signal of a program source (useful signal source) can be contained
10 in the main data stream with a low bit rate; channel K2 can contain an auxiliary data stream ZD with all additionally required data for a stereo program, with a possibly higher bit rate. In principle, the separation into the two data streams can be produced with the scalability of MPEG 4. First generation receivers as well as simple favorable receivers are intended to demodulate one channel and decode a monophonic signal. Receivers with
15 higher reproduction quality are provided for the demodulation of both channels K1 and K2 and for the decoding of a stereophonic signal. Consequently, this represents a sensible transition scenario from the use of one channel to the use of two channels. With the introduction of DRM, receivers can be developed which decode only the base layer. After the second channel is subsequently brought on line, these receivers can also receive the
20 base layer along with the enhancement layer. In addition to stereo reproduction, through the linkage of the main data stream with the at least one auxiliary data stream, a quality improvement can be achieved in the following directions: the auxiliary data stream reduces the amount of coding artifacts, the auxiliary data stream broadens the audio bandwidth.

25

Naturally, any combination of these quality improvement steps can also be made with the addition of stereo reproduction.

Examples of separations between the base- and enhancement layers in
30 mono/stereo encoding are achieved as follows:

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Various methods for encoding a stereo signal are provided in the MPEG 4 standard. Of these, the following methods 2 and 3 are suitable for the method according to the invention:

5 1. Encoding of the right (R) and left (L) channel.

 2. MS stereo encoding: based on the original signal, a sum signal (mid) and a difference signal (side) are produced before it is quantified. This is shown in Fig. 4. The mid signal is transmitted in the base layer,
10 the side signal is transmitted in the enhancement layer.

 3. Intensity stereo: the right and left channel are transmitted separately. Only a main channel (base layer) and an additional directional signal (enhancement layer) are transmitted, from which a stereo signal is
15 produced.

Examples for the separation and combination of the main data stream and auxiliary data stream(s) for the production of a variable bit rate are shown in Fig. 5. The first channel, for example channel K1, is used to transmit
20 an encoded signal with a bit rate x. The second channel, for example channel K2, is used to transmit all of the information required for achieving a higher bit rate. As shown by Fig. 5, in addition to an additional bit rate in the enhancement layer, a combination with stereo signals is
25 also possible. Fig. 5 also lists an example for different encoder types, CELP encoders for the base layer and AAC encoders (Advanced Audio Coding) for the enhancement layer.

The different separations below are also possible:

- the base layer contains two audio data streams
30 from different program sources. The enhancement layer

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contains the data streams for increasing the useful data from the audio program,

- two or more different base layers in different channels each contain a respective audio data stream. The
5 enhancement layer of one channel contains the additional useful data from two or more audio data streams.

Numerous previously proposed methods are suitable for digital modulation, for example the QAM, MPSK, or APSK methods.

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CLAIMS:

1. A method for transmission-end preparation of source-coded audio data of at least one useful signal source (1), in particular for transmission via AM channels of a predetermined channel raster, with the following features:

the source-coded audio data of at least one useful signal source (1) are separated (2) into a main data stream (HD) and at least one auxiliary data stream (ZD), where the main data stream (HD) contains at least the amount of information that is required for a comprehensible reproduction of at least one useful signal source (1) and the auxiliary data stream (ZD) contains information for quality improvement,

the main- and auxiliary data streams (HD, ZD) are modulated and accommodated in respective different channels (K1, K2) of the predetermined channel raster.

2. A method for receiver-end preparation of audio data, which are contained in main- and auxiliary data streams (HD, ZD), in particular, for reception via AM channels of a predetermined channel raster, where mutually associated main- and auxiliary data streams (HD, ZD) each originate from at least one useful signal source (1) and the mutually associated main- and auxiliary data stream are accommodated in respective different channels (K1, K2) of the predetermined channel raster, including the following steps:

a receiver (4) with a low reproduction quality is used to demodulate and decode only the main data stream (HD),

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a receiver (7) with higher reproduction quality is intentionally used to demodulate and decode only the main data stream (HD) or the main data stream (HD) and at least one associated auxiliary data stream (ZD) are demodulated and decoded, where mutually associated demodulated and decoded data streams are linked to one another in such a way that an increase is achieved in the reproduction quality for the at least one useful data source (1).

3. The method according to claim 1 or 2, characterized in that a signaling is incorporated into the main data stream (HD) on a transmitter end, which indicates whether an auxiliary data stream (ZD) is provided for the same useful signal source (1) and in what channel it is provided.

4. The method according to one of claims 1 to 3, characterized in that additional information is incorporated into an auxiliary data stream (ZD), which indicates what information the auxiliary data stream contains and optionally, how the main data stream (HD) is to be combined on a receiver end with the at least one associated auxiliary data stream (ZD).

5. The method according to one of claims 2 to 4, characterized in that the linkage of the associated main data- and auxiliary data streams is executed in accordance with at least one of the following criteria:

to reduce the amount of coding artifacts,

to increase bandwidth for the reproduction of audio data,

to generate a stereo signal.

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6. The method according to one of claims 1 to 5, characterized in that the scalability of MPEG 4 data streams is used to separate the source-coded audio data of the useful signal source (1) into the main data stream (HD) and at least one auxiliary data stream (ZD).

7. A transmitter for the preparation of source-coded audio data from at least one useful signal source (1), in particular for transmission via AM channels of a predetermined channel raster, with the following features:

10 a separation device (2) for separating the audio data of a useful signal source (1) into a main data stream (HD) and at least one associated auxiliary data stream (ZD),

a modulation unit (3) modulating the main- and auxiliary data streams, where this modulation unit (3) can in particular be supplied with carrier signals in such a way that mutually associated main- and auxiliary data streams can be transmitted in respective different channels of a predetermined channel raster.

8. A receiver for receiver-end preparation of source-coded audio data, which are accommodated in main- and auxiliary data streams, in particular for reception via AM channels of a predetermined channel raster, with the following features:

a demodulation unit (5, 8) and decoding unit (6, 9) for at least main data streams (HD),

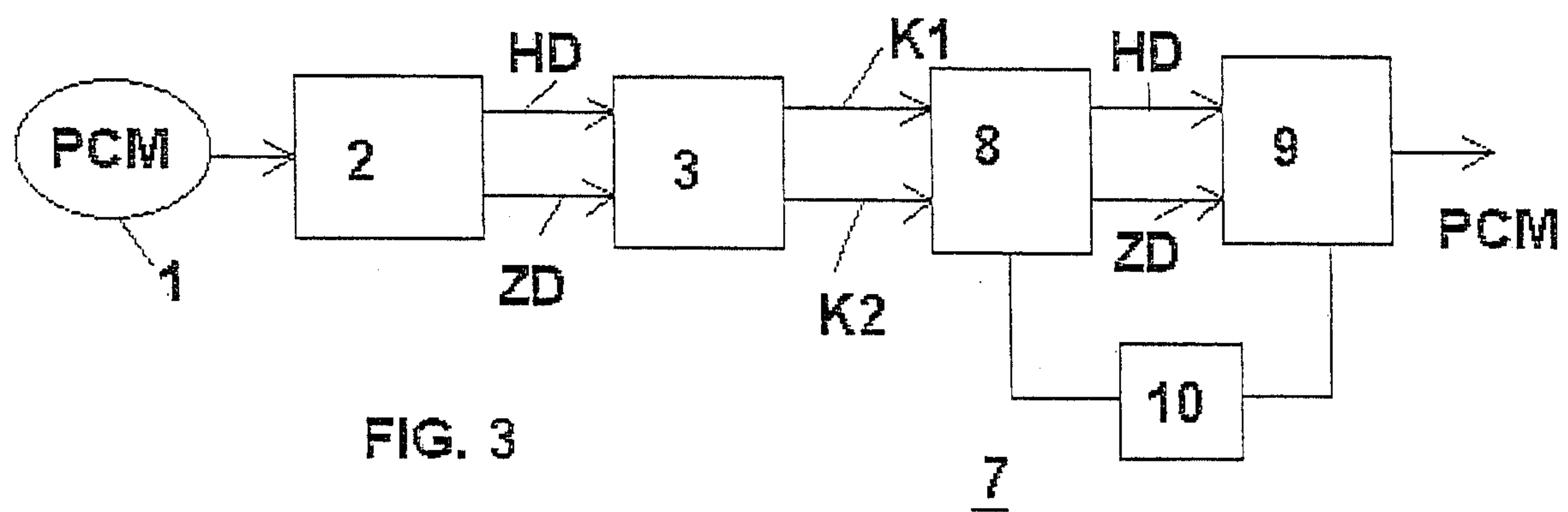
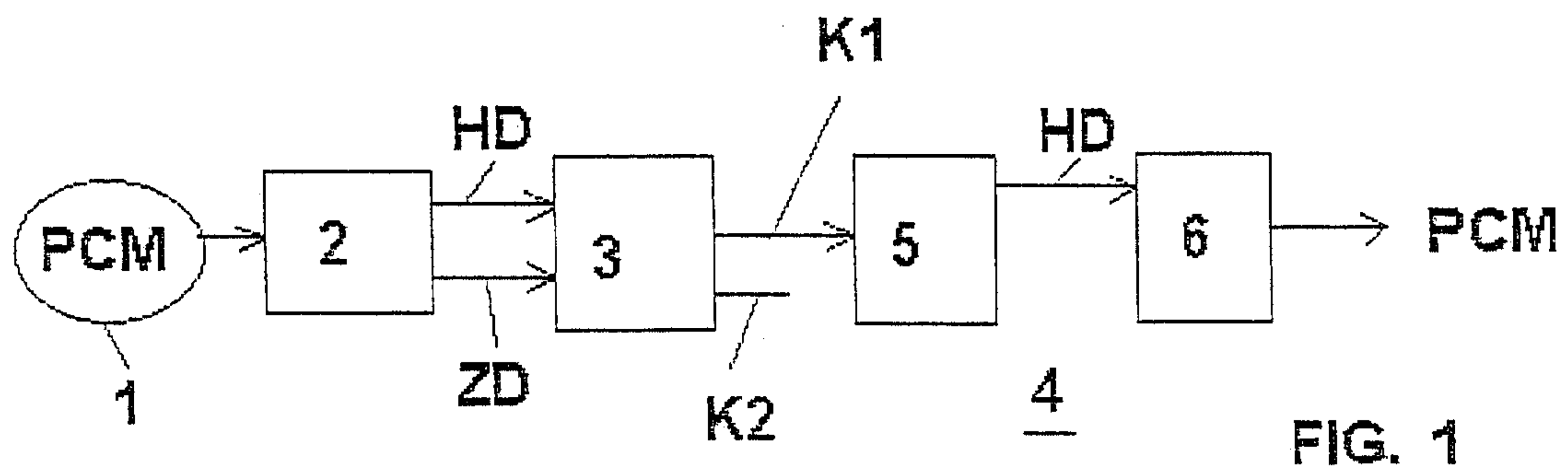
an evaluation unit (10) for signaling and optionally encoding additional information, where the signaling indicates which channel contains an auxiliary data stream (ZD) associated with a main data stream (HD) and the optionally provided additional information indicate what

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information the auxiliary data stream (ZD) contains and how the main data stream (HD) is to be combined with the at least one auxiliary data stream (ZD) on the receiver end,

5 a linkage unit (9) for mutually associated main- and auxiliary data streams, which can be controlled by the evaluation unit (10).

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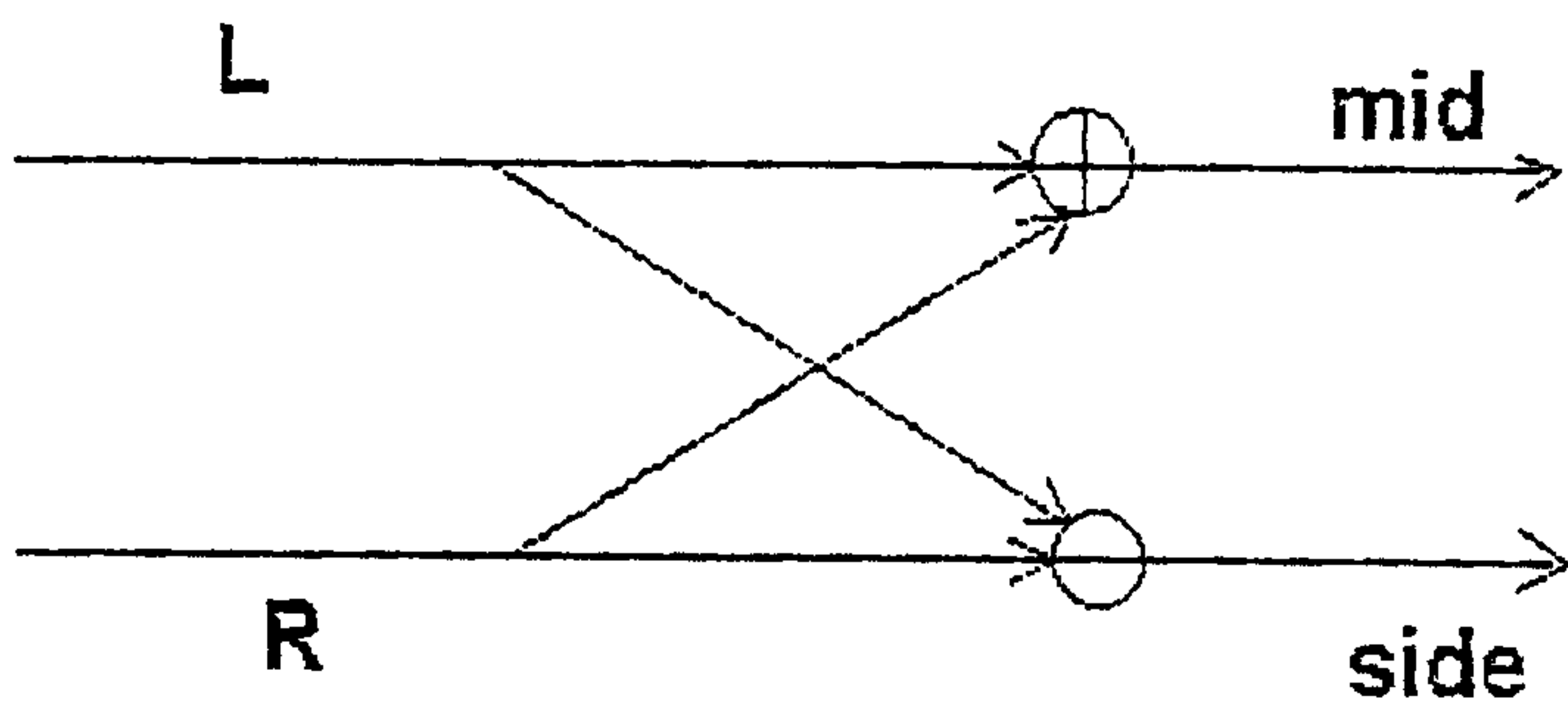
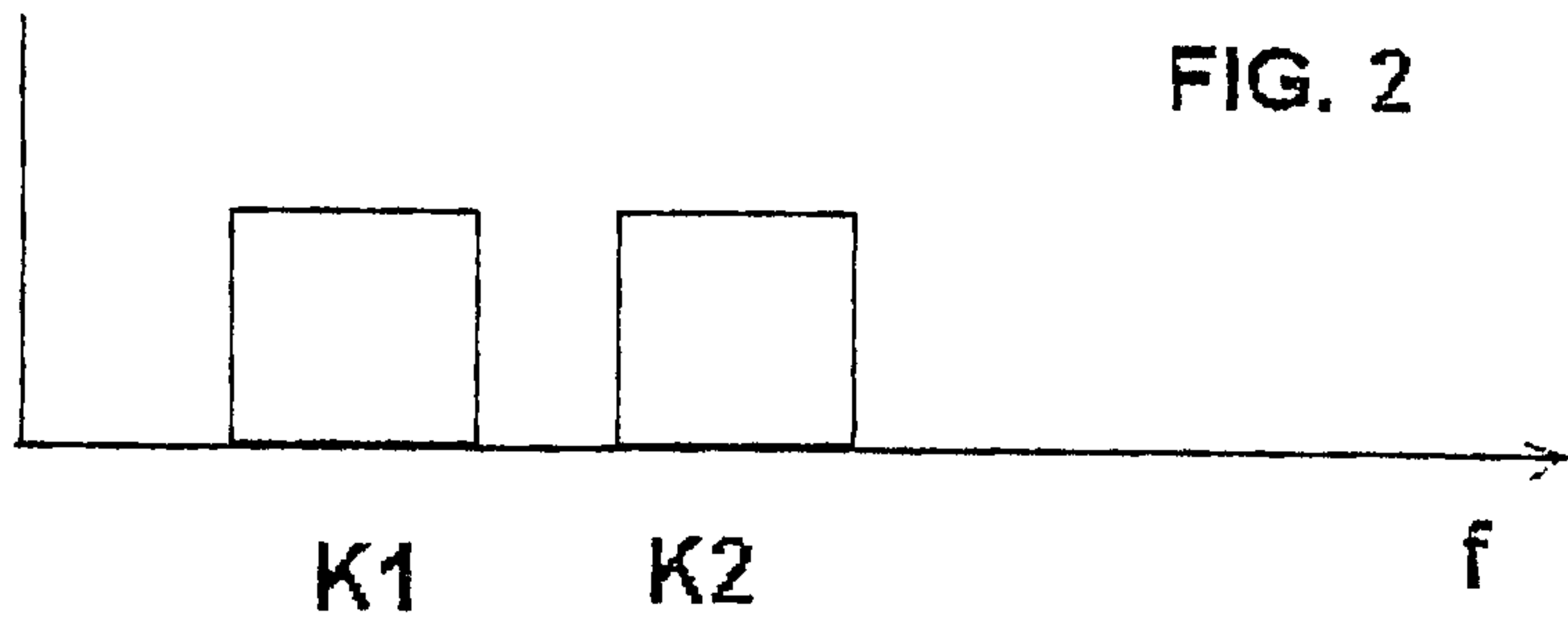


FIG. 5

base layer	enhancement layer
mono, bit rate x	stereo auxiliary signal, auxiliary bit rate
mono, bit rate x	auxiliary bit rate
mono, bit rate x	stereo auxiliary signal
stereo, bit rate x	auxiliary bit rate
encoder 1 (e.g. CELP)	encoder 2 (e.g. AAC)

