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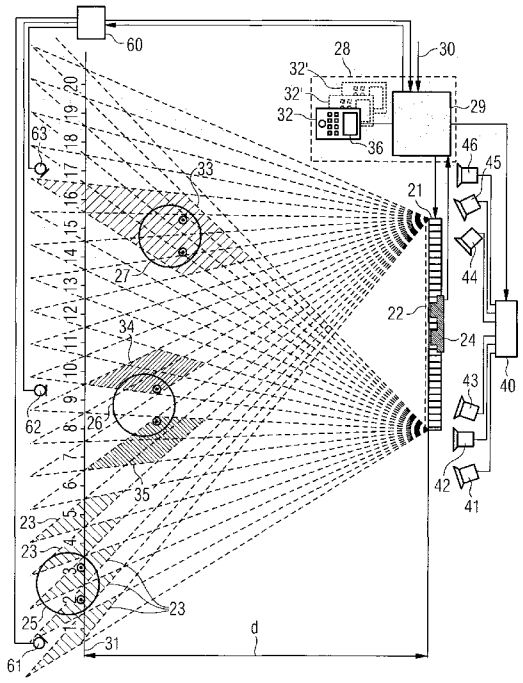
[Continued on next page]

(54) **Title**: PLAYBACK DEVICE FOR AUDIO AND VIDEO

FIG 1



(57) **Abstract**: The invention relates to a playback device for audio and video. This playback device includes an image display apparatus for the simultaneous display of a plurality of at least two different images which are visible from at least one of different laterally offset viewing zones (23) and an audio playback apparatus having a plurality of at least two loudspeakers for a directed sound generation, and a control unit (28) for controlling the image display apparatus in dependence on image information (30) of the different images and for controlling the audio playback apparatus in dependence on at least two different audio channels. In this respect, the control unit (28) is configured to input input commands which independently define, for at least two different viewers (25, 26, 27) a respective individual image content of different possible image contents and an individual audio channel from the different audio channels and for controlling the image display apparatus and the audio playback apparatus in dependence on these input commands.

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Playback device for audio and video

The invention relates to a playback device for audio and video which includes an image display apparatus for the simultaneous display of a plurality of at least two different images which are visible from at least a respective one of different laterally offset viewing zones as well as to a control unit for controlling the image display apparatus in dependence on image information of the different images.

Such playback devices are known per se as autostereoscopic monitors. Usually, such monitors are operated in that a respective one of a plurality of stereoscopic half-images which are complementary pair-wise are displayed such that each of these half-images is visible from one of the viewing zones. In this respect, the displayed images can admittedly be viewed by a plurality of viewers simultaneously, but it is not possible to take individual desires of the

different viewers into account either in the selection of the image contents to be presented or in the kind of display.

It is therefore the underlying object of the invention to propose a corresponding playback device with which images can be simultaneously shown to different viewers, wherein the viewers should be able to select the displayed contents - defined e.g. by different television programs or video channels - individually in an expedient manner in accordance with their respective own wishes.

This object is achieved in accordance with the invention by a method having the features of the main claim. Advantageous embodiments and further developments of the invention result from the features of the dependent claims.

A playback device for audio and video is therefore proposed, comprising

an image display apparatus for simultaneously displaying a plurality of at least two different images which are each visible from a respective at least one of different laterally offset viewing zones;

and an audio playback apparatus having a plurality of at least two loudspeakers for a directed sound generation; and

a control unit for controlling the image display apparatus in dependence on image information of the different images and for controlling the audio

playback apparatus in dependence on at least two different audio channels,

wherein the control unit is configured

- for inputting input commands which respectively define an individual image content of different possible image contents and an individual audio channel from the different audio channels independently for at least two different viewers;

- and for controlling the image display apparatus and the audio playback apparatus in dependence on these input commands such that

each of the selected image contents is visible from at least one of the viewing zones which is associated with the viewer for whom this image content is selected and is not visible from at least one further viewing zone which is associated with the other respective viewer or viewers;

and each of the selected audio channels is played back through a respective at least one of the loudspeakers which is associated with the viewer for whom this audio channel is selected, with this loudspeaker not playing back any audio channel which is not selected for this viewer,

wherein the loudspeakers are arranged so that each of the loudspeakers is directed to a region which includes the viewing zone or at least one of the viewing zones which is/are associated with the viewer with whom this loudspeaker is associated.

It thereby becomes possible in an advantageous manner that the different viewers cannot only select individual image contents, but rather also an

individual audio matching said image contents. In this respect, due to the directed loudspeakers it is not necessary that the viewers wear headphones to avoid interference from other audio channels which may be selected for other viewers. This brings about high comfort for the viewers as users of the playback device.

It is advantageous if the playback device furthermore has a tracking device for detecting respectively one head position or two eye positions of the at least two viewers of the image display apparatus wherein the control unit is then configured to control the image display apparatus and the audio playback apparatus such that the viewing zones associated with each viewer contain the eye positions of this viewer. The playback device can then be adapted to an instantaneous positioning of the viewer, with a movement of the viewer also being able to be compensated or tracked in an advantageous manner. In this case, it is naturally of advantage if a main direction of sound of the loudspeakers is adjustable, e.g. by pivoting the loudspeakers.

The loudspeakers can in particular be provided by ultrasound loudspeakers which are configured to radiate ultrasound serving as a carrier and having audio signals which are modulated thereon and which represent the respective audio channel. Such ultrasound loudspeakers are shown e.g. in the dissertation of Dirk Olszewski "Stark gerichtete audio-Beschallung mit parametrischem Ultraschall-Lautsprecher" [Tightly directed acoustic radiation with a parametric ultrasound loudspeaker], Paderborn University, EIM-E/237, whose content is referred to with respect to the operation; see in particular

Figure 3.10 from the named dissertation. A sufficiently well-directed generation of sound is possible using the ultrasound loudspeakers known per se e.g. from the description there to realize the acoustic radiation described here to the different viewers with spatially local audio channels superimposed on the viewing zones and with individual audio channels following them.

The image display apparatus can e.g. be an autostereoscopic monitor. A typical setup provides that the monitor has a matrix screen having a plurality of pixels arranged in columns and rows and has a grating arranged in front of the matrix screen having a structure orientated parallel to the columns to direct light emanating from the pixels of the matrix screen into the different viewing zones.

In a particularly advantageous embodiment, the control device is also configured for inputting input commands which additionally define in each case one of different possible image contents and one of different selectable display modes for at least two different viewers independently, wherein the selectable display modes include a monoscopic image mode and an individual stereoscopic image mode. In addition, the control unit is configured to control the monitor in dependence on these input commands and on the eye positions detected by the tracking device in that different disjunctive excerpts of columns of the matrix screen are defined and in each case at least one of different images is reproduced on each of the excerpts, and indeed such that one of the excerpts is associated with each of the detected eye positions of each viewer, said one excerpt including at least all columns of the matrix screen visible

through the grating from this eye position. In this respect, the control unit is configured to control the pixels of this excerpt so that the at least one image displayed on this excerpt shows the image content defined for this viewer, wherein the same excerpt is associated with the two eye positions of each viewer for whom the monoscopic mode is selected as the display mode and the image displayed on said excerpt is a monoscopic image, whereas two different excerpts are associated with the two eye positions of every viewer for whom the individual stereoscopic image mode is selected as the display mode and two mutually complementary stereoscopic half-images are displayed on these excerpts.

Two things are thereby advantageously achieved. First, different viewers who want to have different image contents displayed to them - e.g. different television channels or video channels or image contents defined by video games - can use the same monitor simultaneously and can in particular be in the same room, that is they are not dependent on using different devices. Second, it can be avoided by the display mode individually selectable for each viewer that in this respect one of the viewers is forced to be satisfied with a less detailed representation, e.g. mono instead of stereo - or a representation less pleasing for him - e.g. stereo instead of mono. In particular individual vision habits can thus be taken into account. In this respect, the individual desires can be realized in an advantageously simple manner by corresponding input commands.

Provision can therefore be made that the control unit for inputting the input commands includes one or more

operating devices separate from a central processing unit of the control unit which can be connected to the central processing unit via cable connections or by means of wireless data transfer. In the case of a plurality of operating devices, each of the viewers can thus input the input commands relevant to him in an advantageous manner at an operating device associated with him alone.

The pixels of the matrix screen will typically be subpixels of three different basic colors which combine to form one picture element. In this respect, different arrangements are conceivable, wherein the basic colors naturally alternate preferably in every column from top to bottom and typically also in every row from left to right in a cyclic order.

Typically, the different excerpts are formed by different columns of the matrix screen which are disposed next to one another and which can accordingly be controlled simultaneously. However, the possibility of a screen in which the excerpts are controlled sequentially in time and are formed in each case by the same pixels at different times while the grating is changeable over time should also explicitly not be excluded. An excerpt is then not only defined by the pixels included therein, but rather also by the position or the condition of the grating. Such a screen is e.g. shown in the document WO 2009/001161 A1. The matrix screen used can also provide a color sequential representation in which image portions of different basic colors are generated sequentially and are made visible at respectively the same pixel positions. In this respect, e.g. micromechanical elements can be

combined with a color sequential backlight - that is with a color changing illumination.

In an advantageous embodiment, the selectable display modes further include a multiview stereoscopic image mode, wherein the control unit is then configured to control the monitor so that the same excerpt is associated with the two eye positions of each viewer for whom the multiview stereoscopic image mode is selected as the display mode by a corresponding input command and a respective one stereoscopic half-image of a band of complementary stereoscopic half-images is displayed on different subsets of columns of this excerpt. If a plurality of viewers select the same image content and this multiview stereoscopic image mode, the excerpt can naturally also be selected to be so large that it includes all columns which are visible from at least one of the eye positions of any one of these viewers. The monitor then works as a conventional multiview display for these viewers.

In this case the control unit can include a renderer which is configured to calculate control data for the matrix screen required for the representation of the band of stereoscopic half-images from image information on the image content which is defined by the input commands for the viewer for whom the multiview stereoscopic image mode is selected as the display mode. This can in particular be provided when the image content is defined by a video game.

So that the viewer can move within boundaries which are as wide as possible without having to accept losses in the image quality or having fully to lose sight of the respective image, the tracking device is preferably configured to detect a movement of the eye

positions, while the control unit is configured to redefine the excerpts in dependence on the detected movement. For this purpose, the tracking device can in particular be realized by a stereoscopic camera having a corresponding image evaluation.

It is particularly practical if the control unit is configured to accept the input commands for the at least two viewers successively as registrations of the viewers. The control unit can moreover have an output unit to be able to display information on the available image contents and/or on the display modes selectable for the respective image content and/or on whether a last input command can be executed. This output unit can e.g. be realized by a display. In this case, the control unit can in particular be configured by a corresponding programming to determine and to display on the display unit in dependence on already input input commands and on the detected eye positions whether a further viewer can be registered and/or whether or how a positioning of already registered viewers has to be changed so that a further viewer can be registered or a last input input command can be executed.

It is also conceivable in a further development that the playback device can recognize the viewers - e.g. by an image evaluation of images taken using the tracking device - and, on recognition of a viewer, automatically selects a setting (e.g. a playback mode) which is preset for this viewer. The control unit can also be configured to correct an image depth presented to a viewer in accordance with a preset of this viewer.

Parts of the matrix screen not covered by the named excerpts can finally be filled with suitable image content in order also to allow bystanders to be able to follow at least the one or the other image content.

The different excerpts will form a respective strip including a band of one or more columns on the matrix screen, wherein the strips belonging to the different excerpts typically alternate in a cyclic order. If an excerpt is in turn broken down into different subsets or subgroups of columns in order to realize the multiview stereo mode in the previously described manner, the subsets or subgroups typically respectively comprise a column in each of the strips belonging to this excerpt.

To reduce as much as possible any crosstalk of the different audio channels, which may not be able to be completely excluded under certain circumstances despite the use of loudspeakers of the described type, the following measures can additionally be taken. The playback device can have an acoustic receiver for at least one of the viewers with which crosstalk between the audio channel selected for this viewer and at least one other of the audio channels can be detected. The control unit can then be configured to control the loudspeakers associated with this viewer in dependence on an output signal of the acoustic receiver so that these loudspeakers additionally generate an acoustic component at least partially cancelling the crosstalk. This acoustic component can be defined and generated such that it destructively interferes with the unwanted portion of the sound arrived at the named viewer which is due to one or more other audio channels.

An embodiment of the invention will be explained in the following with reference to Figures 1 to 5. There is shown

Fig. 1 in a schematic representation, a plan view of a playback device for audio and video with which image information for three different viewers is presented simultaneously:

Fig. 2 a block diagram which illustrates a manner of operation of a control unit of the playback device of Fig. 1;

Fig. 3 a flowchart to illustrate a function of an interactive operating device of the control unit of the playback device;

Fig. 4 a flowchart having a process routine for suppressing crosstalk between different audio channels; and

Fig. 5 the operation of a loudspeaker used in the playback device in a schematic manner.

An image display device is therefore shown in Fig. 1 which is designed as a playback device for audio and video and which is realized using an autostereoscopic monitor. This monitor has a matrix screen 21 having a plurality of pixels arranged in rows and columns and has a grating 22 arranged in front of the matrix screen 21 which is suitable to direct light emanating from the pixels of the matrix screen 21 in each case into a different one of a plurality of laterally offset viewing zones 23. These viewing zones 23 are

numbered consecutively here and correspond to twenty image channels 1 to 20 of the screen. The grating 22 can also be called a beam splitter grating or a barrier grating. On a finer division of the matrix screen, a much larger number of possible image channels can naturally also be provided.

The matrix screen 21 is a liquid crystal screen. The pixels of this matrix screen 21 are subpixels of three different basic colors, with in each case red, green and blue subpixels alternating in a cyclic order in each row and in each column. Instead, an OLED display could e.g. also be used. Each picture element displayed on the matrix screen 21 is formed by a pixel group or a cluster of a plurality of subpixels and extends over three lines so that any desired color can be displayed in its true color independently of a width of the picture element or of the pixel group or of the cluster. In a modified embodiment, the matrix screen 21 can instead be provided by a color sequentially working monitor. The individual pixels then do not have to extend over more than one row. The picture elements can then rather in each case be realized by a single pixel which reproduces different basic colors in a cyclic order.

The grating 22 can e.g. be designed as a slit grating or as a cylindrical lens grating, with slits or cylindrical lenses of the grating 22 - assuming a corresponding arrangement of the columns - being able to be orientated vertically or also inclined from a vertical by approximately 20 degrees. In every case, a structure of the grating 22 is orientated parallel to the columns. The columns of the matrix screen 21 are therefore not necessarily to be understood in the

present connection as columns of subpixels extending perpendicular to the horizontal rows, but rather as strings of subpixels extending parallel to the named structure - that is e.g. parallel to the slits or to the cylinder lenses of the grating 22 - even if they include an angle differing from 90° with the rows.

In addition to the actual autostereoscopic screen having the matrix screen 21 and the grating 22, the image display device has a tracking device 24 for detecting two respective eye positions of, in the present case, a first viewer 25, a second viewer 26 and a third viewer 27 of the monitor. This tracking device 24 is realized by a stereoscopic image camera having two lenses which is configured for automatic image evaluation. It is not significant in this respect whether the image evaluation allows the eye positions to be recognized directly or whether first only head positions are detected and the eye positions are determined in dependence on the head positions using a typical eye spacing of approx. 65 mm as the basis.

Finally, the image display device has a control unit 28 which includes a data processing system 29 and is configured from a technical programming aspect to control the matrix screen 21. For this purpose, the control unit 28 can control the pixels of the matrix screen 21 in dependence on image information 30 of different images, in particular in dependence on image information of different stereoscopic half-images. The image information 30 can for this purpose be selected from a data store - e.g. from a DVD or other data carriers. Audio information for the different audio channels can then also be stored in this data store. Alternatively, the image information

30 and the audio information can also be output by a TV receiver or by a games console for video games.

In an operating mode which is not the focus of interest in the present case, the monitor can be operated as a conventional multiview screen (multiview display) in that image information of twenty mutually complementary stereoscopic half-images are displayed on the pixels of the matrix screen 21 in a cyclic order so that a respective one of these stereoscopic half-images is visible from each of the laterally offset viewing zones 23. In a plane 31 which is remote from the matrix screen 21 by a nominal viewing distance d and in which the viewing zones 23 can have a maximum width (typically a width of approximately a mean eye spacing of 65 mm or a little less), a plurality of persons can then simultaneously perceive stereoscopic images of the same scene autostereoscopically.

A different method of displaying images using the image display device will be described here. To carry this out, the control unit 28 also has, in addition to the data processing system 29, an operating device 32 for inputting input commands which independently define the in each case one of different image contents and one of different possible display modes for the viewers 25, 26 and 27 as well as under certain circumstances also for further viewers as well as one of different audio channels - typically matching the respective image content. Corresponding further operating devices 32' can naturally also be provided in addition to the operating device 32 so that each of the viewers 25, 26, 27 can input the input commands relative for him to his own operating device 32 or 32'. The statements only given for the

operating device 32 in the following then also apply accordingly to the further operating devices 32'.

These selectable display modes in particular include a monoscopic image mode, an individual stereoscopic image mode and a multiview stereoscopic image mode. The viewers 25, 26 and 27 can also select an individually adjustable depth of a representation of the images respectively associated with them via the input commands. The operating device 32 can be connected to the data processing system 29 of the control unit 28 via a cable connection or by a wireless data transfer. The image contents can each e.g. be defined by a TV channel, a video channel or a video game.

Let it be assumed that in a shown situation the first viewer 25 has selected the multiview stereoscopic image mode, the second viewer 26 has selected the individual stereoscopic image mode and the third viewer 27 has selected the monoscopic image mode and have input corresponding input commands into the operating device 32. In the multiview stereoscopic image mode, depending on the design of the matrix screen 21, either a central perspective multiview representation, a parallel perspective integral imaging representation, a modification derived therefrom or a diverging view with a point of intersection of corresponding image rays behind the matrix screen 21 is displayed by the matrix screen. These types of presentation are described, for example, in US 7,671,889 B2.

The control unit 28 is now configured from a technical program aspect to control the matrix screen 21 in the manner described in the following not only

in dependence on the image information 30, but also in dependence on these input commands and on the eye positions detected by the tracking device 24.

First, different disjunctive excerpts of columns of the matrix screen 21 are defined such that one of the excerpts is associated with each of the detected eye positions of each of the viewers 25, 26 and 27, said one excerpt including at least all columns of the matrix screen 21 visible from this eye position through the grating 22. In this respect, a single excerpt which includes all columns which are visible from both eye positions of this viewer is defined for every viewer for whom the monoscopic image mode is selected as the display mode. In the present case, this is the case for the third viewer 27. An image displayed on this excerpt is visible from a region 33 in which both eye positions of the viewer 27 are located.

Two different excerpts are in contrast associated with the two eye positions of each viewer for whom the individual stereo image mode is selected as the display mode, that is one excerpt with a left eye position and one excerpt with a right eye position. This applies here to the second viewer 26. An image which is displayed on the excerpt which is associated with the left eye position of the viewer 26 is visible from a region 34, whereas an image displayed on the other excerpt is visible from a region 35 which is laterally offset with respect to the region 34.

A common excerpt is again associated with the two eye positions of each viewer for whom the multiview stereo image mode is selected as the display mode.

This applies here to the first viewer 25. Like the other excerpts, this excerpt also comprises a band of strips which each include a plurality of columns and which alternate with the strips of the other excerpts from left to right over the matrix screen 21 in a cyclic order. The excerpt which is associated with the eye positions of the viewer 25 is moreover broken down into a plurality of subgroups, five in the present case, wherein these subgroups each include exactly one column from each of the named strips of this excerpt. An image which is displayed on one of these subgroups can then be seen from exactly one of the five viewing positions 23 drawn as hatched in Fig. 1.

Now in each case at least one of different images is displayed on each of the excerpts, wherein the pixels of each excerpt are controlled so that the at least one image displayed on this excerpt shows the image content which is defined for the viewer 25, 26 or 27 by the input commands input into the operating device 32. The images will naturally typically be moving images.

In this respect, exactly one image, namely a monoscopic image which can be seen by the viewer 27, is displayed on the excerpt which is associated with the eye positions of the third viewer 27. The same applies accordingly to other viewers if they select the monoscopic image mode by a corresponding input into the operating device 32.

Two mutually complementary stereoscopic half-images are displayed on the two excerpts which are associated with the second viewer 26 so that a left half-image is visible from the region 34 and a right

half-image is visible from the region 35 and the viewer 26 can see a stereoscopic image which these half-images combine to form. The same applies accordingly to other viewers if they select the individual stereoscopic image mode by a corresponding input into the operating device 32.

A whole band of mutually complementary half-images, five in the present case, is displayed on the excerpt which is associated with the first viewer 25 or with any other viewer who has selected the multiview stereoscopic image mode and for whom a corresponding input has been made into the operating device 32, and indeed on each of the named sub-groups of each one so that the viewer 25 sees a stereoscopic image, and indeed from a perspective which depends on where exactly his eye positions are located.

If the image information 30 does not include all control data for the matrix screen 21 which is required for displaying the stereoscopic half-images for the viewer 25, these control data can also be calculated by rendering by the data processing system 29 from a lower quantity of image data which are present for the corresponding image content.

The tracking device 24 can naturally also detect a movement of the eye positions, whereas the control unit is configured then to redefine the excerpts in dependence on the detected movement.

The playback device additionally now has an audio playback apparatus 40 which is controlled by the control unit 28 and which has six loudspeakers 41, 42, 43, 44, 45 and 46 in the present case. Each of these loudspeakers 41 to 46 is a tightly directional

ultrasound loudspeaker. Loudspeakers of this kind are shown in the already named dissertation of Dirk Olszewski "Tightly directed acoustic radiation with a parametric ultrasound loudspeaker", Paderborn University, EIM-E/237, see there, in particular Figure 3.10. The loudspeakers 41 to 46 are in particular configured to modulate an audio signal corresponding to the respective audio channel to ultrasonic waves serving as carriers. Demodulation takes place with an increasing distance from the loudspeakers 41 to 46 as a consequence of a damping of the ultrasonic waves serving as carriers substantially amplified with respect to a damping of the audio signal. In this respect, a propagation of the audio signal remaining due to construction interference only occurs along a main direction of radiation of the respective loudspeaker, whereby a strong directional effect is achieved. This is shown schematically in Fig. 5 for the loudspeaker 41 by way of example. The loudspeaker 41 transmits an ultrasonic signal 52 modulated with an audio signal 51. At a spacing 53 from the loudspeaker 41, the ultrasonic signal 52 is damped so much that only the audio signal 51 which becomes audible there remains. The spacing 53 amounts to some meters, for example. The demodulation therefore takes place automatically in the air, and indeed in each case in an environment of the ears of the viewers 25, 26, 27; however, only if they are located in the main direction of radiation of the respective loudspeaker because constructional interference reconstructing the audio signal only occurs there.

Two of the loudspeakers 41 to 46 are associated with each of the viewers 25, 26 and 27, and indeed loudspeakers 41 and 44 with the first viewer 25,

loudspeakers 42 and 45 with the second viewer 26 and loudspeakers 43 and 46 with the third viewer 27. The audio playback apparatus 40 is now controlled in dependence on the audio channels selected for the viewers 25, 26 and 27, and indeed such that the loudspeakers 41 and 44 play back two stereo audio signals in accordance with the audio channel which is selected by the input commands for the first viewer 25, whereas the loudspeakers 42 and 45 play back two stereo audio signals in accordance with the audio channel selected for the second viewer 26 and the loudspeakers 43 and 46 play back two stereo audio signals in accordance with the audio channel selected for the third viewer 27.

The loudspeakers 41 to 46 are in this respect directed so that each of the viewers 25, 26 and 27 can hear at least as good as only the audio signals from the respective loudspeakers 41 and 44 or 42 and 45 or 43 and 46 respectively associated with them. The respective other audio channels are less audible by at least some orders of magnitude so that they are not disturbing.

The loudspeakers 41 to 46 are pivotable - likewise controlled by the control unit 28 - in dependence on the detected head positions or eye positions and are each set so that they are directed to the viewer with whom they are associated.

The operating device 32 also has, in addition to operating elements such as in particular keys, an output unit 36 in the form of a display on which the information on the available image contents and on the display modes selectable for the respective image content can be displayed. In addition, it can be

displayed on the output unit 36 whether a last input command can be executed. The input commands are in this respect typically input successively for the different observers 25, 26 and 27 and, optionally, for further viewers, as registrations of these viewers. The control unit 28 is in this respect also configured to determine and to display on the output unit 36 in dependence on already carried out registrations and on the detected eye positions of the corresponding viewers 25, 26 or 27 whether a further viewer can be registered (it could be precluded if there is no more room for further required excerpts on the matrix screen 21) and if so whether and optionally how a positioning of already registered viewers 25, 26 or 27 or of the viewer who wants to register has to be changed so that a further registration is possible or so that a last input input command can be executed.

The playback device shown in Fig. 1 furthermore has a respective one or more microphones 61, 62 and 63 for each of the viewers 25, 26 and 27 which are arranged in direct proximity to the respective viewer 25, 26 and 27 and serve as acoustic receivers to detect the sound arriving there. Output signals of the microphones 61, 62, 63 are compared with the audio channels in an apparatus 60, whereby crosstalk between the audio channel selected for this viewer 25, 26, 27 and at least one other of the audio channels is detected for each of the viewers 25, 26, 27.

The data processing system 29 of the control unit 28 is now configured so that for each of the viewers 25, 26, 27 it controls the loudspeakers 41 and 44 or 42 and 45 or 43 and 46 respectively associated with this

viewer 25, 26, 27 in dependence on output signals of the apparatus 60 so that at least some of these loudspeakers 41, 42, 43, 44, 45, 46 additionally respectively generate an acoustic component at least partially cancelling the crosstalk. These acoustic components compensate the crosstalk in that they destructively interfere with the respectively unwanted portion of the sound arriving at the respective viewer 25, 26, 27 which is due to the other audio channels. The named acoustic components can therefore be called anti-sound. In a modification of the embodiment shown here, additional loudspeakers can also be used for generating this anti-sound. Finally, the viewers 25, 26, 27 can also have the possibility of adapting the anti-sound range-wise with respect to the frequency in dependence on the perceived total impression. This can be done by corresponding inputs in the control units 32, 32'.

In Fig. 2, a possible architecture of the image display device and in particular of the control unit 28 is illustrated. Repeating features are in this respect again provided with the same reference numerals.

Fig. 3 in turn describes which steps are carried out by the control unit 28 - in dependence on any registrations already made - when one of the viewers 25, 26, 27 registers by inputting input commands into the operating device 32. In this respect, in particular the function of the positioning optimizer shown in Fig. 2 is described which checks whether one or more of the viewers 25, 26 or 27 have to be repositioned so that the current registration can be carried out. The selected display mode is here called a representation mode. The term "main lobe"

designates the region in which the two fields of rays intersect which are drawn in Fig. 1 and there emanate from two picture elements disposed at the very outside. This region can be displaced to the right or to the left by reallocation of image channels, which brings about an ever greater flexibility. Zones occur outside this region from which again the same images are visible as in the viewing zones 23 and the regions 33, 34 and 35. The subpixel positions on which the different channels are to be recorded are determined in dependence on the detected or selected viewer positions. Matching this, the audio generators are selected from the different loudspeakers 41 to 46 by which the corresponding audio channels are played back.

Fig. 4 illustrates a process routine with reference to a flowchart for generation destructive sound waves, said process routine being able to be additionally provided to at least partly suppress crosstalk between the audio channels in the previously described manner. This process is carried out by the control unit 28 in cooperation with the apparatus 60. The audio channels here also called selective acoustic events are accordingly associated with the acoustic sources - that is e.g. the loudspeakers 41 to 46 of Fig. 1 - in dependence on the selected programs and on the determined viewer positions. Depending on the acoustic signals which are received by the acoustic receivers at the viewer positions, sound waves are additionally generated which destructively interfere with the portions of the sound arriving at the respective viewer position which are to be suppressed. These portions will primarily be due to the audio channels which are associated with the respective other viewer

positions. The generation of the destructive sound waves can moreover be made dependent on spatial properties and/or on a calibration in addition to on inputs which the users can input into the control unit 32 or 32' for manual fine tuning.

An audiovisual playback device is therefore proposed comprising a monitor for the simultaneous display of a plurality of more than two and/or at least two different images which are each visible from a respective at least one of different laterally offset viewing zones and a plurality of more than two separately controllable, directed audio generation systems, wherein the direction of the radiation of sound of these systems is dynamically influenced by the position of the respective viewing zone occupied by a viewer and by the distance of the audible noise level from the distance of the viewer to be detected.

For this purpose, the audiovisual image display device preferably has a tracking device for detecting two respective eye positions of at least two observers of the monitor and at least one control unit for controlling the monitor and the audio generation systems which is configured for inputting input commands to define a respective one of different possible audiovisual contents and/or one of different selectable image display modes and/or one of different selectable audio playback modes independently for at least two different viewers.

A method is furthermore proposed for playing back audiovisual contents with which individual audio and video contents can be presented to different observers simultaneously in accordance with individually selectable playback modes without a

viewer being disturbed by a different video content selected by another viewer.

A plurality of 3D technologies are available to allow depth perception with today's displays. The qualitatively most comfortable solution in this respect focuses on autostereoscopic, electronically individually tracked processes using free content and display format association. 3D displays or 3D televisions are today not yet designed to change the presented depth individually in accordance with the wishes of one or more viewers. The latest solution approaches already point in the direction of multiview with a plurality of simultaneously presented individual contents. If this technology is to be used in the field of 3D TV sets or 3D home cinema systems, the corresponding acoustic information would have to be presented to each user in addition to the individual view. Especially in scenes which have a corresponding sound accompaniment, the audio events generated for further users can result in considerable disturbing noises. If headphone solutions are made use of, the experience of comfort is reduced.

Autostereoscopic multi-person displays with an individual image content association are still in the research stage. With stereoscopic displays (eyeglass solutions), the same question resulted in the examination of time-sequential solution approaches with active shutter glasses for up to four different image contents. The light yield, which is much too small due to the time sharing and the lack of transparency of shutter glasses, and the display brightness, which is required for its compensation and by which viewers without shutter glasses are

dazzled, make this direction of 3D presentation technology appear unreasonable. This problem had therefore not yet occurred with 3D presentations with TV sets or home cinema systems.

It is known that directed sound is adjusted to follow persons to inform them selectively. In this respect, the body's silhouette is detected, alternatively also skin colors or markers. In cases in which the acoustic radiation serves the accompaniment of image representations, only a region in front of the display is irradiated without tracking the position. In this respect, persons exposed to sound have no possibility to take influence on the kind (stereo/mono), language selection or volume of the acoustic radiation.

In the autostereoscopic 3D display technology, the head position and/or the eye position of the viewer is/are detected, the corresponding 3D sector has image information directly recorded on it and it is optionally tracked on a change of position of the viewer. Since the space requirement of a person, including a comfortable arm position, corresponds to approximately eight to ten times the eye spacing, a viewer takes up approximately that region in which an eight-channel multiview display of today's design distributes the eight different views. Three to four persons can therefore be positioned in the viewing zone with 24 to 30 views. Considerably looser seating arrangements can be achieved by utilizing the secondary lobes present in a number of autostereoscopic monitors and viewing positions can thereby be assigned to considerably more persons. This is achieved by matching the irradiation direction of the images or image columns. The

magnitude of guidance is determined using eye detection.

The acoustic radiation belonging to the viewing position can likewise be tracked using this magnitude of guidance. If an ultrasound loudspeaker is used for acoustic information transmission, the sound can be set in accordance with the location of the head of the viewer. The latest findings even show the availability of trackable loudspeaker systems for moving targets and even for a plurality of targets (see the above-named dissertation of Dirk Olszewski).

The plurality of possible irradiation directions results in a high number of necessary acoustic radiation systems between which a switch has to be made on tracking. Autostereoscopic monitors can be equipped with corresponding loudspeaker units in which acoustic radiation can be bundled, changed in direction and regulated in the distance of the audible acoustics development. This minimal equipment is sufficient for acoustic radiation in wide, open spaces. In closed spaces, additional passive and/or active elements are sensible for preventing or at least reducing unwanted propagation of audio radiation by reflection, absorption or cancellation to reduce the unwanted acoustic propagation. In this respect, a particularly high-quality sound result is made possible by selectively usable directed loudspeakers which are selected and activated by the determined head position and which can be positioned either in or at the ceiling and/or in seat furniture. This makes it possible to select individual acoustic radiation, language selection and sound effect (mono/stereo/surround) as soon as they are available. Combination possibilities such as mono image with

mono sound or stereo image with stereo sound, but also those such as multiview with stereo sound or stereo image with mono sound or mono image with surround sound thus result. These combinations can be instigated both due to the sound signal and by individual inputs or presettings.

The arrangement of the directed loudspeaker systems which can be pivotable both mechanically, acoustically or electronically, is dependent on the deflection angle of the loudspeakers, their overlap region and the maximum number of users. In this respect, the possibilities of tracking the spatial position of the visual main lobes and secondary lobes are limited by the number of persons who can be supplied in accordance with technical acoustic aspects when zones are used a multiple of times, e.g. in multiview mode, via the secondary lobes.

The control device therefore has to be designed from a technical program aspect that the resources of the audio and video representation can be ideally utilized. The loudspeakers are preferably arranged so that a sufficient overlap region of the addressable irradiation directions exists and are controlled so that no overlaps of the sound bundles occur.

The proposed apparatus and the proposed method have a series of advantages over known apparatus or methods. For instance, a plurality of viewers can have the audiovisual content set and presented to them individually in accordance with their interests, visual and aural habits. Compromises with respect to the viewing quality or with respect to the comfort of vision and hearing can be individually minimized by the viewers.

A spatial separation of the viewers with different visual and aural habits and specific interests (internet, teletext, games) is furthermore not necessary. The communication of the users with one another is not impaired by aids such as glasses or headphones to be worn on the body. All viewers can be presented with playback properties corresponding to their visual and aural habits and requirements.

It is furthermore advantageous that the overall comfort of 3D playback devices, in particular for 3D TV and 3D home cinema systems is expanded to include 3D specific, individually adaptable properties. In addition, a plurality of persons can select any desired contents simultaneously and adapt playback properties individually.

In addition to the already described features, the playback system can also provide headphones and/or seat acoustic radiation systems for the individual viewers 25 to 27 which can optionally be controlled instead of the loudspeakers 41 to 46 or in addition to the loudspeakers 41 to 46 and which each generate audible sound only, or largely only, for the respective viewer 25, 26 or 27. This can be helpful so that the individual viewers 25 to 27 are less disturbed by environmental noise - in particular by conversations of the respective other viewers 25, 26 or 27. For this purpose, a switchover capability from the loudspeakers 41 to 46 to the headphones or chair acoustic radiation systems can e.g. be provided. It is conceivable in this respect to instigate the switchover to headphones automatically as required with the aid of the tracking device 24 if it detects that one of the viewers 25 to 27 has put on the

headphones associated with them. For this purpose, the tracking device 24 can be supplemented by an identification system which e.g. provides LEDs on the headphones and so allows the headphones to be located and to switch over to them as required.

Claims

1. A playback device for audio and video comprising

an image display apparatus for simultaneously displaying a plurality of at least two different images which are each visible from a respective at least one of different laterally offset viewing zones (23);

and an audio playback apparatus having a plurality of at least two loudspeakers (41, 42, 43, 44, 45, 46) for a directed sound generation; and

a control unit (28) for controlling the image display apparatus in dependence on image information (30) of the different images and for controlling the audio playback apparatus in dependence on at least two different audio channels,

wherein the control unit (28) is configured

- for inputting input commands which respectively define an individual image content of different possible image contents and an individual audio channel from the different audio channels independently for at least two different viewers (25, 26, 27);

- and for controlling the image display

apparatus and the audio playback apparatus in dependence on these input commands such that

each of the selected image contents is visible from at least one of the viewing zones which is associated with the viewer for whom this image content is selected and is not visible from at least one further viewing zone which is associated with the other respective viewer or viewers;

and each of the selected audio channels is played back through at least one loudspeaker (41, 42, 43, 44, 45, 46) which is associated with the viewer for whom this audio channel is selected, with this loudspeaker (41, 42, 43, 44, 45, 46) not playing back any audio channel which is not selected for this viewer,

wherein the loudspeakers (41, 42, 43, 44, 45, 46) are arranged so that each of the loudspeakers (41, 42, 43, 44, 45, 46) is directed to a region which includes the viewing zone or at least one of the viewing zones which is/are associated with the viewer with whom this loudspeaker (41, 42, 43, 44, 45, 46) is associated.

2. A playback device in accordance with claim 1, characterized in that it furthermore has a tracking device (24) for detecting a respective head position or two eye positions of at least two viewers (25, 26, 27) of the image display apparatus, with the control unit (28) being configured to control the image display apparatus and the audio playback apparatus such that the viewing zones associated with each

viewer (25, 26, 27) contain the eye positions of this viewer (25, 26, 27).

3. A playback device in accordance with claim 2, characterized in that a main direction of radiation of the loudspeakers (41, 42, 43, 44, 45, 46) is adjustable.

4. A playback apparatus in accordance with one of the claims 1 to 3, characterized in that the loudspeakers (41, 42, 43, 44, 45, 46) are provided by ultrasound loudspeakers which are configured to radiate ultrasound serving as a carrier with audio signals modulated thereon which represent the respective audio channel.

5. A playback device in accordance with one of the claims 1 to 4, characterized in that the image display device is an autostereoscopic monitor.

6. A playback device in accordance with claim 5, characterized in that

the monitor has a matrix screen (21) having a plurality of pixels arranged in columns and rows as well as a grating (22) arranged in front of the matrix screen (21) and having a structure orientated parallel to the columns to direct light emanating from the pixels of the matrix screen (21) into the different viewing zones (23).

7. A playback device in accordance with claim 6, provided it is dependent on claim 2, characterized in that the control unit 28) is furthermore configured

- for inputting input commands which define in

each case one of different selectable display modes for the at least two different viewers (25, 26, 27) independently, wherein the selectable display modes include a monoscopic image mode and an individual stereoscopic image mode;

- and for controlling the monitor in dependence on these input commands and on the eye positions detected by the tracking device (24) in that different disjunctive excerpts of columns of the matrix screen are defined and in each case at least one of different images is displayed on each of the excerpts such that

one of the excerpts is associated with each of the detected eye positions of each viewer (25, 26, 27), said one excerpt including at least all columns of the matrix screen (21) visible from the respective eye position through the grating (22),

wherein the pixels of this excerpt are controlled so that the at least one image displayed on this excerpt shows the image content defined for this viewer (25, 26, 27), wherein

a) the same excerpt is associated with the two eye positions of each viewer (27) for whom the monoscopic image mode is selected as the display mode and the image displayed on said excerpt is a monoscopic image, whereas

b) two different excerpts are associated with the two eye positions of each viewer (26) for whom the individual stereo image mode is selected as the display mode and two stereoscopic half-images complementary to one another are displayed on these excerpts.

8. An playback device in accordance with claim 7, characterized in that the selectable display modes furthermore include a multiview stereoscopic image mode, wherein the control unit (28) is configured to control the screen so that the same excerpt is associated with the two eye positions of each viewer (25) for whom the multiview stereoscopic image mode is selected as the display mode and in each case one of a band of complementary stereoscopic half-images is displayed on different subsets of columns of this except.

9. A playback device in accordance with claim 8, characterized in that the control unit (28) includes a renderer which is configured to calculate control data for the matrix screen (21) required for the representation of the band of stereoscopic half-images from image information (30) on the image content which is defined by the input commands for the viewer (25) for whom the multiview stereoscopic image mode is selected as the display mode.

10. A playback device in accordance with one of the claims 7 to 9, characterized in that the tracking device (24) is configured to detect a movement of the eye positions, whereas the control unit (28) is configured to redefine the excerpts in dependence on the detected movement.

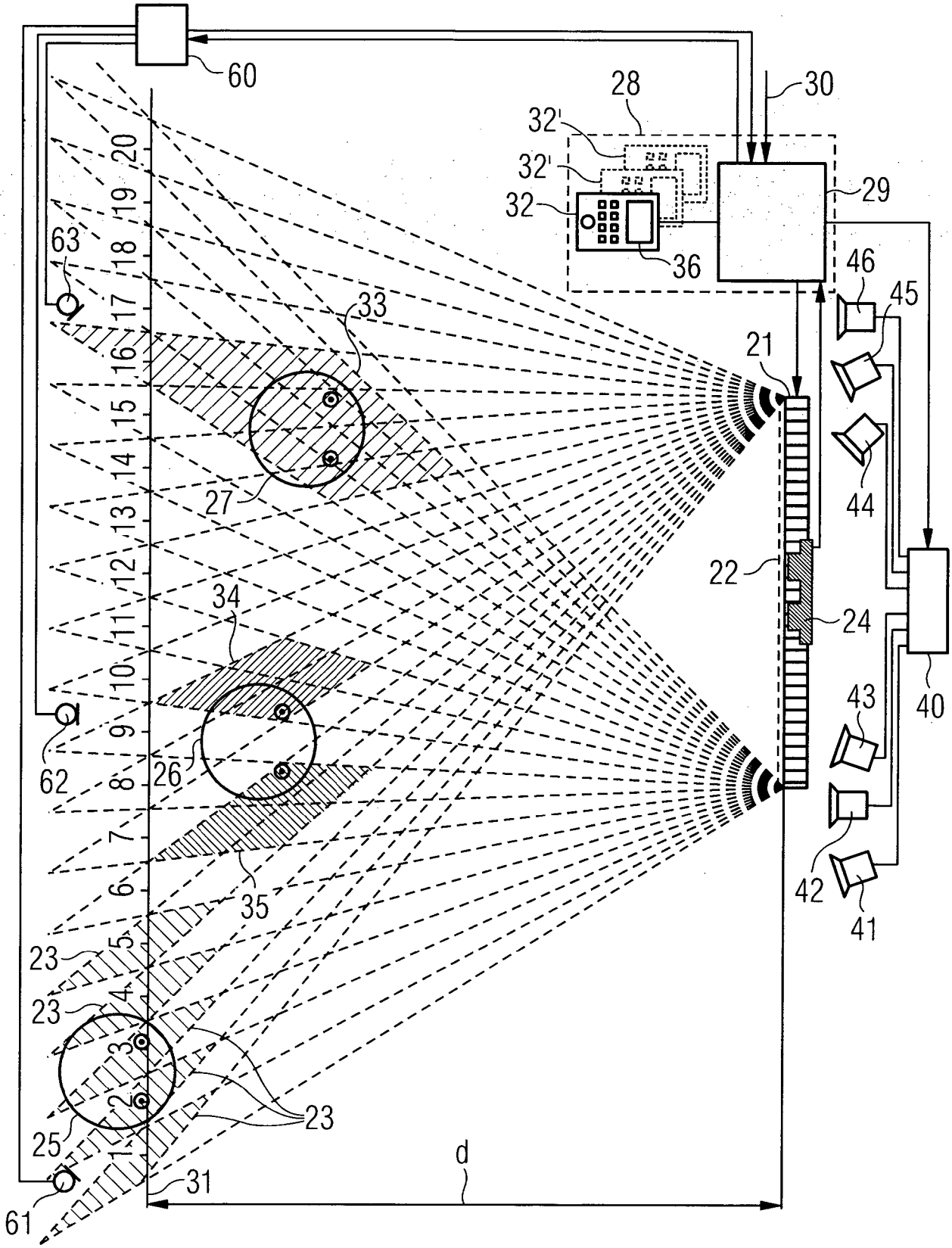
11. A playback device in accordance with one of the claims 1 to 10, characterized in that the control unit (28) is configured to accept the input commands for the at least two viewers (25, 26, 27) successively as registrations of the viewers (25, 26, 27).

12. A playback device in accordance with one of the claims 1 to 11, characterized in that the control unit (28) has an output unit (36) for displaying information on the available image contents and/or on the display modes selectable for the respective image content and/or on whether a last input command can be executed.

13. A playback device in accordance with claim 12, provided this relates to claim 11, characterized in that the control unit (28) is configured to determine and to display on the output unit (36) in dependence on already input input commands and on the detected eye positions whether a further viewer (25, 26, 27) can be registered and/or whether or how a positioning of already registered viewers (25, 26, 27) has to be changed so that a further viewer (25, 26, 27) can be registered or a last input input command can be executed.

14. A playback device in accordance with one of the claims 1 to 13, characterized in that it has an acoustic receiver for at least one of the viewers (25, 26, 27) for detecting crosstalk between the audio channel selected for this viewer (25, 26, 26) and at least one other of the audio channels, wherein the control unit (28) is configured to control the loudspeakers (41, 42, 43, 44, 45, 46) associated with this viewer in dependence on an output signal of the acoustic receiver so that these loudspeakers (41, 42, 43, 44, 45, 46) additionally generate an acoustic component at least partially cancelling the crosstalk.

FIG 1


60
28
30
32'
32'
32
29
36
63
46
45
33
21
27
44
22
34
24
40
43
62
26
42
35
41
23
23
25
23
d
31
61

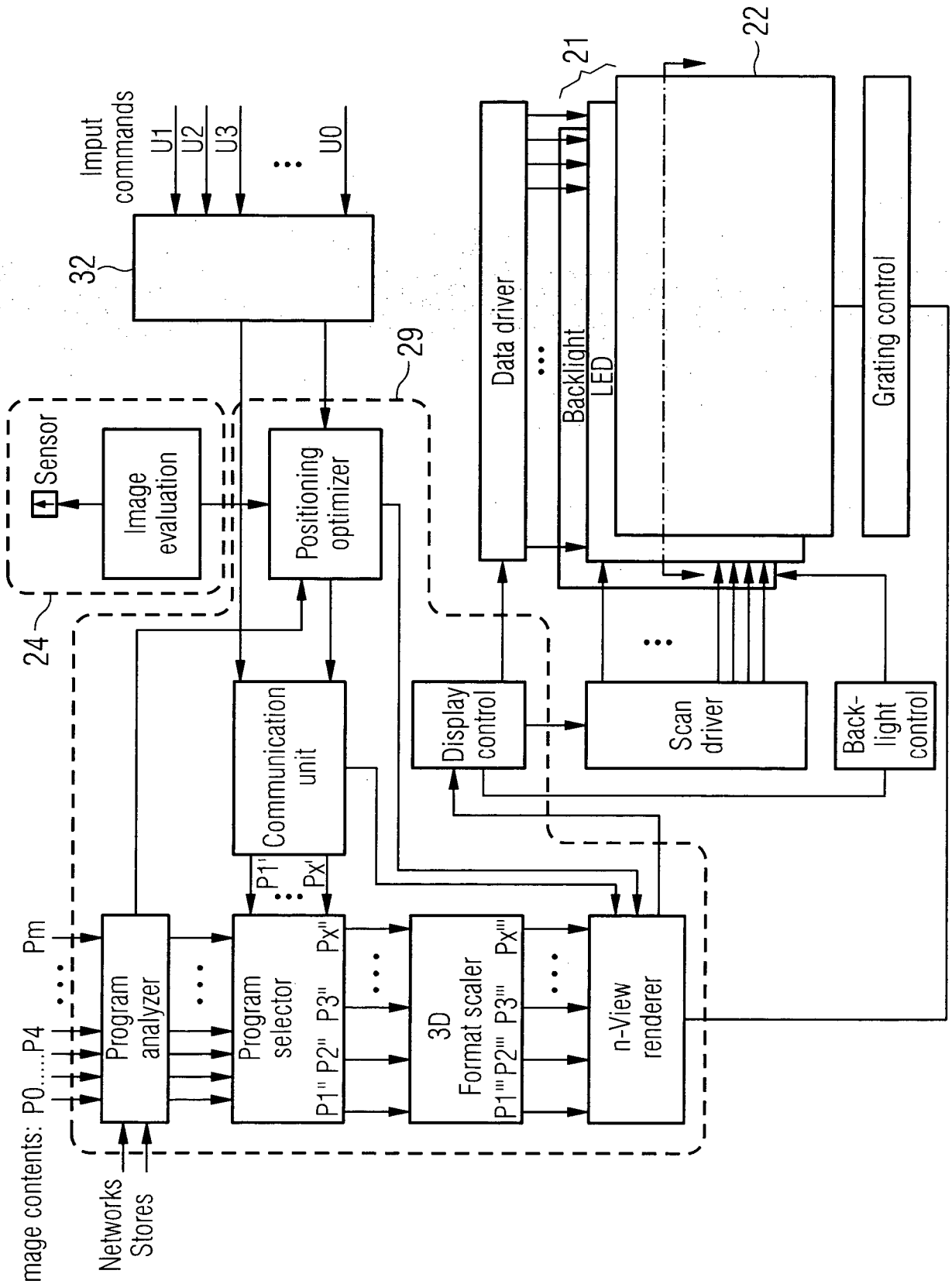
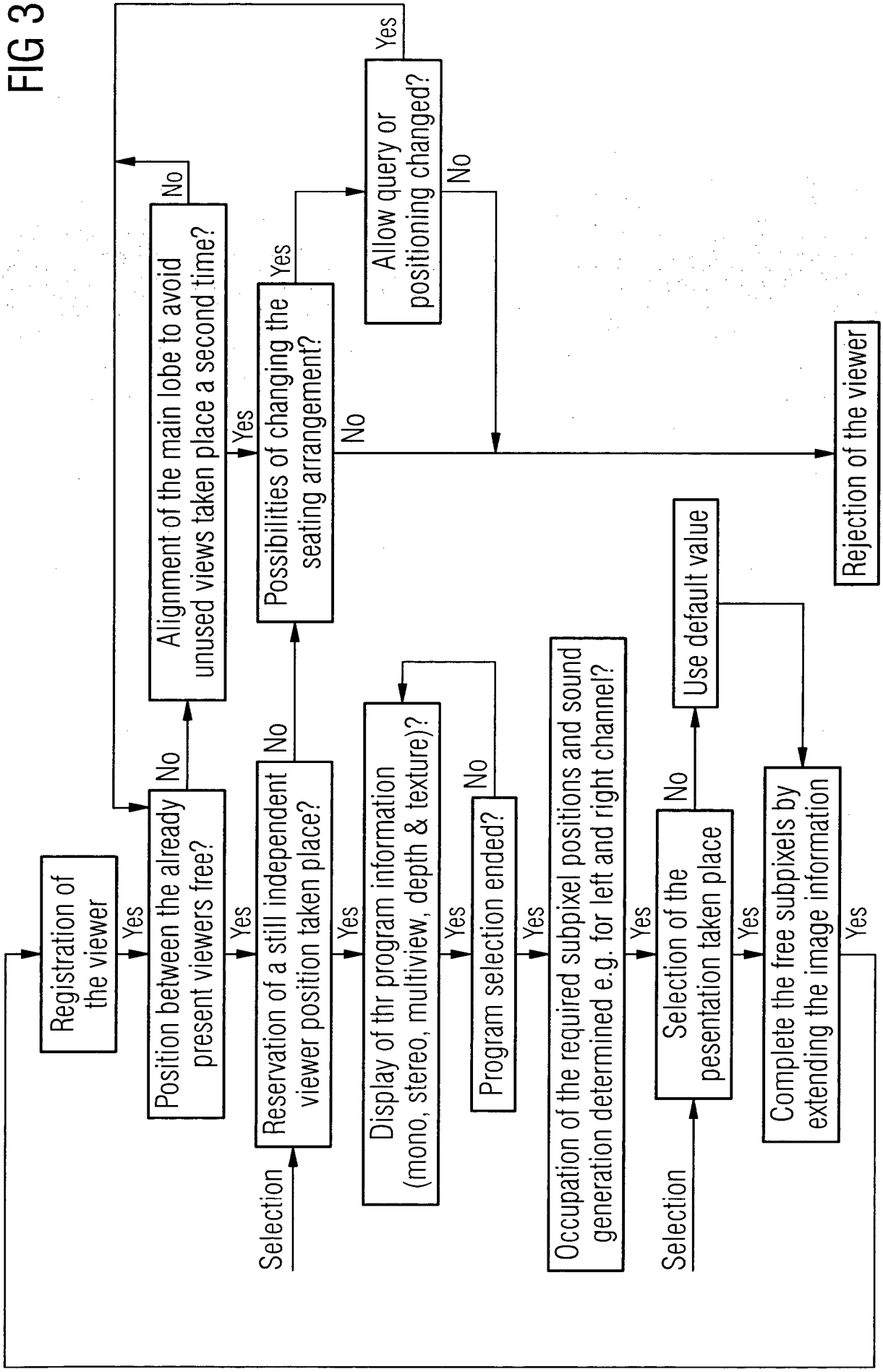

Imput commands
U1
U2
U3
U0
32
29
Sensor
Image evaluation
Positioning optimizer
24
Communication unit
P1'
Px'
Pm
P0.....P4
Program analyzer
Program selector
Px''
P1'' P2'' P3''
3D Format scaler
Px'''
P1''' P2''' P3'''
n-View renderer
Networks
Stores
Selectable image contents:
Display control
Scan driver
Back-light control
Data driver
Backlight LED
21
22
Grating control

FIG 2

FIG 3


Registration of the viewer
Yes
Position between the already present viewers free?
No
Yes
Alignment of the main lobe to avoid unused views taken place a second time?
No
Yes
Reservation of a still independent viewer position taken place?
No
Yes
Possibilities of changing the seating arrangement?
Yes
No
Allow query or positioning changed?
Yes
No
Rejection of the viewer
Selection
Display of thr program information (mono, stereo, multiview, depth & texture)?
Yes
Program selection ended?
No
Yes
Occupation of the required subpixel positions and sound generation determined e.g. for left and right channel?
Yes
Selection
Selection of the pesentation taken place
No
Use default value
Yes
Complete the free subpixels by extending the image information
Yes

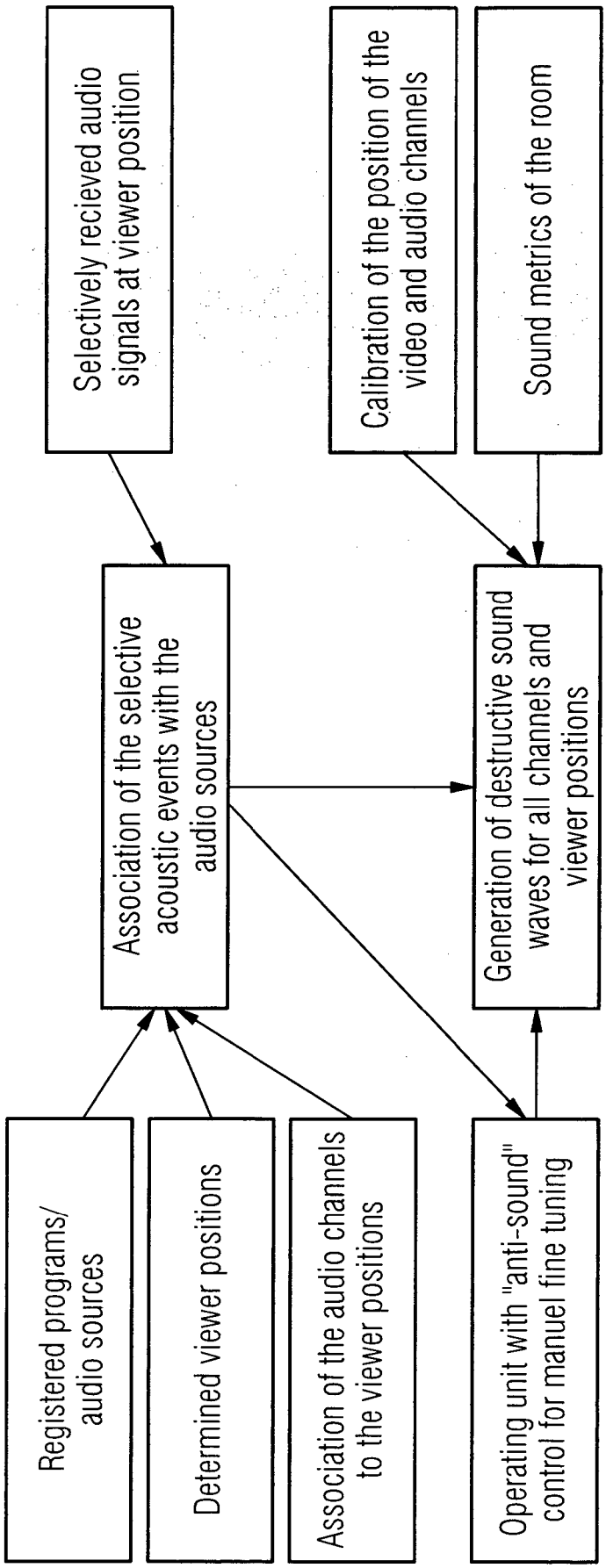
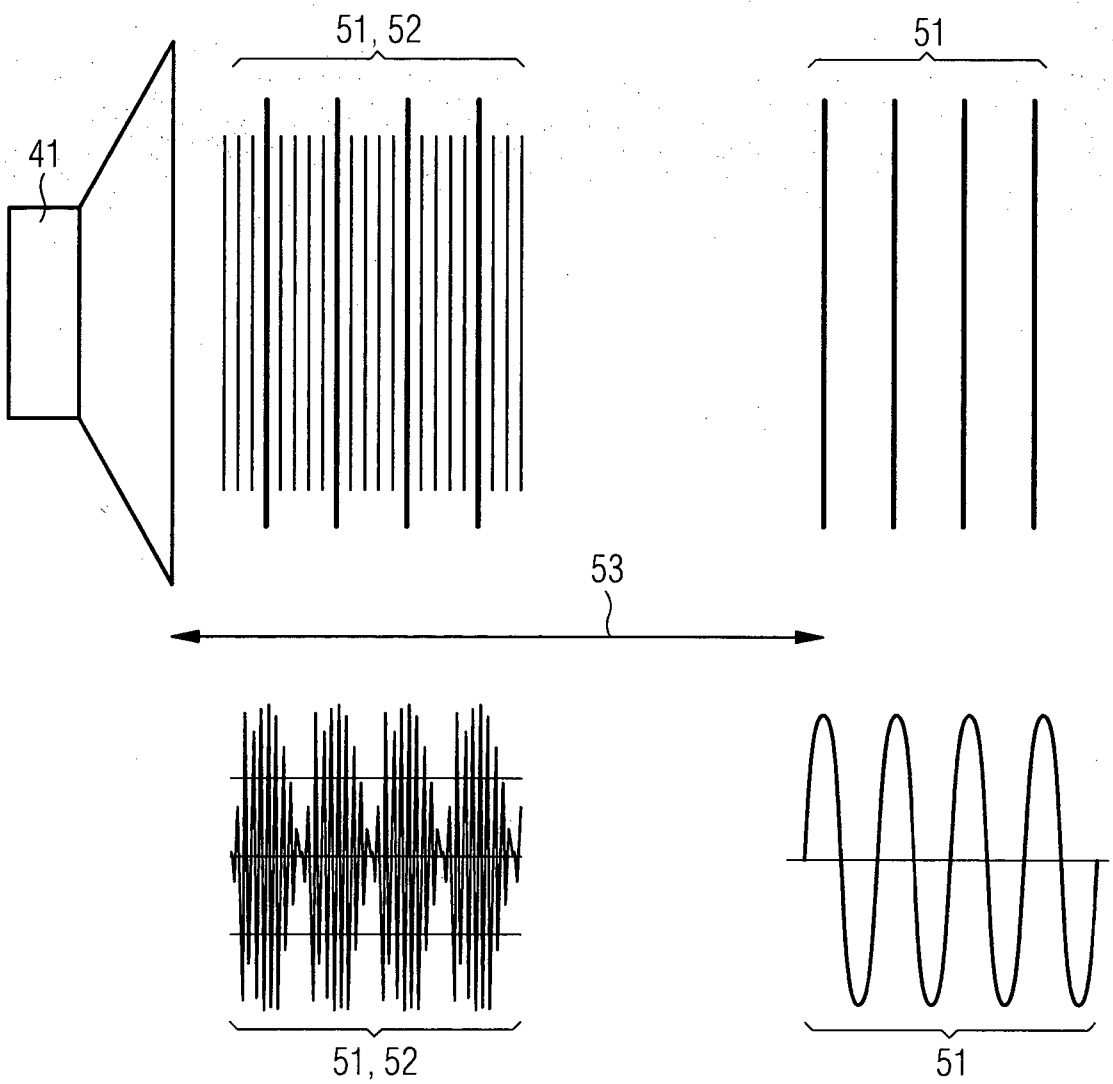

Selectively recieved audio signals at viewer position
Calibration of the position of the video and audio channels
Sound metrics of the room
Association of the selective acoustic events with the audio sources
Generation of destructive sound waves for all channels and viewer positions
Registered programs/ audio sources
Determined viewer positions
Association of the audio channels to the viewer positions
Operating unit with "anti-sound" control for manuel fine tuning

FIG 4

FIG 5



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/001604

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04N13/04 H04R1/20 H04R1/34
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04N H04R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2006/262185 A1 (CHA KYUNG-HOON [KR] ET AL) 23 November 2006 (2006-11-23) abstract paragraphs [0011], [0024], [0031] - [0037]; figure 2A	1,5-9, 11-13 2-4,10, 14
Y A	WO 2007/144843 A2 (KONINKL PHILIPS ELECTRONICS NV [NL]; KRIJN MARCELLINUS P C M [NL]; WIL) 21 December 2007 (2007-12-21) abstract the whole document	2,3 1,4-14
Y	EP 1 284 586 A2 (DAIMLER CHRYSLER AG [DE]) 19 February 2003 (2003-02-19) abstract	4

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 July 2012	26/07/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Prange, Stefan

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/001604

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	paragraphs [0015], [0047]	9

Y	DE 10 2005 036867 A1 (DAIMLER CHRYSLER AG [DE]) 18 January 2007 (2007-01-18) paragraph [0010]	14

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2012/001604

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		EP 2035882 A2	18-03-2009
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DE 102009041783 A1	24-03-2011	NONE	
DE 102005036867 A1	18-01-2007	DE 102005036867 A1	18-01-2007
		WO 2007009505 A1	25-01-2007