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(54) **Title**: REARVIEW MIRROR CONFIGURATION METHOD

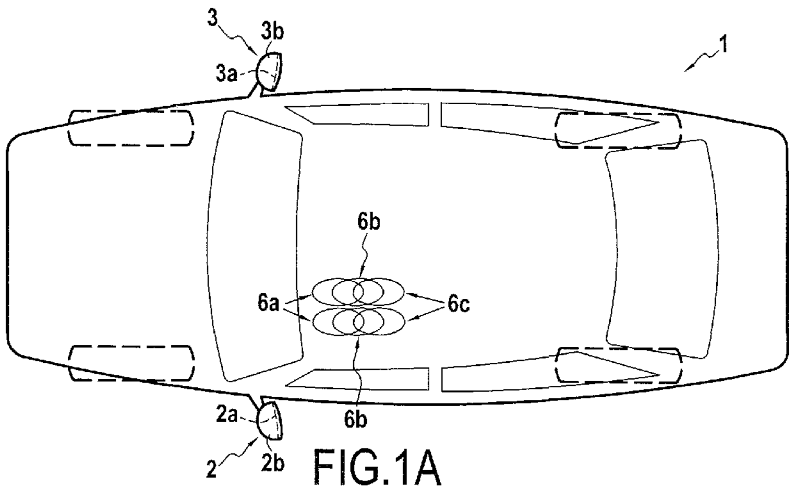

FIG.1A

(57) **Abstract**: The present invention relates to the field of vehicle rearview mirrors. In particular, it relates to a computer-implemented method for configuring a rearview mirror 2,3 to be mounted externally on a vehicle 1, a rearview mirror 2,3 configured accordingly, and a method for producing this rearview mirror 2,3. The configuration method comprises the steps of determining position and shape of at least one pair of eyellipses 6a,6b,6c for a predetermined driver population, determining, for each driver of a statistically representative sample of said driver population, field of view preferences including a preferred horizon height and vehicle body visibility in the rearview mirror 2,3, and calculating, for at least one predetermined external mounting position of the rearview mirror (2,3), a minimum mirror angle adjustment range suitable for covering, from a plurality of outermost points 7,8,9,10 of said at least one pair of eyellipses 6a,6b,6c, field of view preferences of predetermined minimum subsets of said driver population sample.

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REARVIEW MIRROR CONFIGURATION METHOD

TECHNICAL FIELD

The disclosure relates to the field of vehicle rearview mirrors, and in particular to a computer-implemented method for configuring a rearview mirror to be mounted externally on a vehicle, as well as a method for producing such a rearview mirror, and a rearview mirror configured accordingly.

BACKGROUND

Rearview mirrors are a well-known and often legally compulsory accessory of vehicles, in particular road vehicles such as automobiles and trucks. Typically, such a vehicle may comprise, besides an internally mounted rearview mirror, one or two externally mounted rearview mirrors.

The purpose of a rearview mirror in a vehicle is to allow a user to view the immediate surroundings behind the vehicle without taking the eyes from the vehicle's path ahead. Consequently, a driver may avoid a collision with another vehicle when turning or changing lanes.

The angle of the reflecting surface in such rearview mirrors is usually adjustable in order to provide an adequate field of view to drivers of different sizes. To characterize driver populations, SAE Recommended Practice J941 and the corresponding international standard ISO 4513 describes the so-called "eyellipses", statistical representations of driver eye locations for ergonomic purposes, including rearview mirror configuration. Each eyellipse is formed by a tridimensional elliptical model representing tangent cut-off percentiles of driver eye locations, for instance for the eye locations of 95th percentiles of a given driver population. Different eyellipses may be used to represent different driver populations, for example according to geographical region.

Often, legal requirements and industry standards dictate the shape and size of a minimum field of view. But apart from this, different drivers may have different field of view preferences. For instance, different drivers may have different preferences with regard to the horizon height as seen on the reflecting surface , that is, the vertical adjustment of the mirror, or with regard to the visibility of the vehicle body as seen on the mirror surface, that is, the horizontal adjustment of the mirror. In order to accommodate those preferences, mirror adjustment mechanisms with large adjustment angles are usually incorporated in the rearview mirror. However, such mechanisms have cost and reliability drawbacks, and also increase the bulk of the externally mounted rearview mirrors, which a vehicle manufacturer usually seeks to minimize in order to reduce both their aerodynamic drag and their risk of accidental collision with nearby obstacles and other vehicles. It is therefore desirable to provide rearview mirrors that can offer their preferred field of view to a large majority of potential drivers without a particularly large mirror angle adjustment range.

SUMMARY

A first object of the disclosure is that of providing a computer-implemented method for configuring a rearview mirror to be mounted externally on a vehicle and which can offer a preferred field of view for a large majority of potential drivers with a minimum mirror angle adjustment range.

Accordingly, according to a first aspect of the present disclosure, such a method may comprise the steps of:

determining position and shape of at least one pair of eyellipses for a predetermined driver population;

determining, for each driver of a statistically representative sample of said driver population, field of view preferences including a preferred horizon height and vehicle body visibility in the external rearview mirror; and

calculating, for at least one mounting position of the rearview mirror, a minimum mirror angle adjustment range suitable for covering, from a plurality of outermost points of said at least one pair of eyellipses, field of view preferences of predetermined minimum subsets of said driver population sample.

Consequently, using this computer-implemented method, the mirror angle adjustment range of the rearview mirror may be narrowed while still fulfilling the field of view preferences of a vast majority of potential drivers. Indeed, this computer-implemented method may even provide a narrower mirror angle adjustment range with better comfort and safety for a significant number of drivers than previous methods which did not take the individual driver preferences into account.

According to a second aspect of the present disclosure, said mirror angle adjustment range may be suitable for covering, from frontmost points of said pair of eyellipses, the preferred vehicle body visibility of each driver of at least a predetermined minimum subset of said driver population sample, for example at least 75% of said driver population sample.

According to a third aspect of the present disclosure, said mirror angle adjustment range may be suitable for covering, from highest points of said pair of eyellipses, the preferred horizon height of each driver of at least a predetermined minimum subset of said driver population sample, for example at least 95% of said driver population sample.

According to a fourth aspect of the present disclosure, said mirror angle adjustment range may be suitable for covering, from rearmost points of said pair of eyellipses, the preferred vehicle body visibility of each driver of at least a predetermined minimum subset of said driver population sample, for example at least 95% of said driver population sample.

According to a fifth aspect of the present disclosure, said mirror angle adjustment range may be suitable for covering, from lowest points of said pair of eyellipses, the preferred horizon height of each driver of at least a predetermined minimum subset of said driver population sample, for example at least 95% of said driver population sample.

Consequently to these second to fifth aspects, the mirror adjustment range can be specifically tailored to suit a large majority of the driver population represented by each pair of eyellipses.

According to a sixth aspect of the present disclosure, the eyellipse and mirror adjustment preference determination steps may be carried out for a plurality of different driver populations, and a minimum mirror adjustment range may be calculated which is suitable for covering, from outermost points of said eyellipses, the field of view preferences of each driver of predetermined minimum subsets of the statistically representative samples of said driver populations. Consequently, the mirror adjustment range can be tailored to suit many drivers of a plurality of different driver populations.

According to a seventh aspect of the present disclosure, said minimum mirror angle adjustment range may be calculated for mounting positions both at a driver side and a passenger side of the vehicle. Consequently, with a single mirror adjustment range suitable for mirrors mounted on both sides of the vehicle, it becomes possible to configure a single mirror actuating mechanism suitable for mirrors on both sides, thus reducing the number of different parts required for assembling rearview mirrors for both sides of the vehicle, rationalizing supply and assembly lines and thus possibly reducing production costs while still offering improved comfort and safety.

According to an eighth aspect of the present disclosure, each eyellipse may contain the eye positions of at least 95% of the corresponding driver population, also contributing to adapt the mirror adjustment range to a large majority of the driver population represented by each eyellipse.

According to a ninth aspect of the present disclosure, said at least one eyellipse may be stored in a database and retrieved from said database for the minimum mirror angle adjustment range calculation step.

According to a tenth aspect of the present disclosure, said field of view preferences may be stored in a database and retrieved from said database for the minimum mirror angle adjustment range calculation step.

The present disclosure also relates to a method for producing a rearview mirror to be mounted externally on a vehicle in at least one predetermined mounting position, wherein a mirror angle adjustment mechanism with at least a minimum mirror angle adjustment range calculated using a computer-implemented method according to any one of the abovementioned first to tenth aspects, as well as to a rearview mirror configured according a computer-implemented method according to any one of the abovementioned first to tenth aspects.

The above summary of some particular aspects is not intended to describe each disclosed embodiment or every implementation of the invention. In particular, selected features of any illustrative embodiment within this specification may be incorporated into an additional embodiment unless clearly stated to the contrary.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be more completely understood in consideration of the following detailed description of various embodiments in connection with the accompanying drawings, in which:

- FIGS. 1A to 1C are, respectively, schematic plan, side and front views of a left-hand-drive motor vehicle equipped with two side-mounted rearview mirrors;
- FIGS. 2A to 2D are schematic examples of extreme field of view preferences through a side-mounted rearview mirror;
- FIG. 3 is a schematic perspective view of a side-mounted rearview mirror;
- FIG. 4 is a graph illustrating minimum mirror angle adjustment ranges for a driver-side rearview mirror, a passenger-side rearview mirror and both driver- and passenger-side rearview mirrors;
- FIGS. 5A to 5D show graphs illustrating driver population sample percentiles corresponding to field of view preferences;

- FIG. 6 is a flow chart illustrating an iterative process of mirror angle estimation;
- FIG. 7 illustrates a difference from a target horizon height in a rearview mirror;
- FIG. 8 illustrates a divergence from a target vehicle body visibility in a rearview mirror;
- FIG. 9 illustrates how the reflection of a vehicle body in a side-mounted rearview mirror is predicted;
- FIG. 10 illustrates the geometry of the reflection of a light ray on a mirror glass;
- FIG. 11 illustrates how the view of a rearview mirror can be partially obstructed by a mirror visor; and
- FIG. 12 illustrates a predicted rearview mirror self-reflection and self-obstruction and the body visibility in the same rearview mirror.

While the invention is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail. It should be understood, however, that the intention is not to limit aspects of the invention to the particular embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the scope of the invention.

DETAILED DESCRIPTION

For the following defined terms, these definitions shall be applied, unless a different definition is given in the claims or elsewhere in this specification.

All numeric values are herein assumed to be preceded by the term "about", whether or not explicitly indicated. The term "about" generally refers to a range of numbers that one of skill in the art would consider equivalent to the recited value (i.e. having the same function or result). In many instances, the term "about" may be indicative as including numbers that are rounded to the nearest significant figure.

Although some suitable dimension ranges and/or values pertaining to various components, features and/or specifications are disclosed, one of skill in the art, incited by the present disclosure, would understand desired dimensions, ranges and/or values may deviate from those expressly disclosed.

As used in this specification and the appended claims, the singular forms "a", "an", and "the" include plural referents unless the content clearly dictates otherwise. As used in this specification and the appended claims, the term "or" is generally employed in its sense including "and/or" unless the content clearly dictates otherwise.

The following detailed description should be read with reference to the drawings in which similar elements in different drawings are numbered the same. The detailed description and the drawings, which are not necessarily to scale, depict illustrative embodiments and are not intended to limit the scope of the invention. The illustrative embodiments depicted are intended only as exemplary. Selected features of any illustrative embodiment may be incorporated into an additional embodiment unless clearly stated to the contrary.

FIGS. 1A to 1C illustrate a left-hand-drive motor vehicle 1 equipped with externally-mounted driver-side and passenger-side rearview mirrors 2,3. Each rearview mirror 2,3 comprises a mirror glass 2a,3a, a mirror angle adjustment mechanism (not illustrated), and a mirror fairing 2b, 3b comprising a visor surrounding the mirror glass 2a, 3a. The mirror angle adjustment mechanisms may be manually actuated or, preferably, include an actuator each, and in particular an electrical actuator such as, for example, a stepping motor.

The motor vehicle 1 is supported by four wheels 4, each of which being suspended so that its hub presents a certain vertical travel with respect to the vehicle body. As a result, depending on the load distribution between the wheels, the angle of the ground line 5 on which the four wheels 4 rest can vary within a certain range depending on the parameters of the vehicle suspension, as illustrated in FIG. 1B.

FIGS. 1A to 1C also illustrate, within the motor vehicle 1, a set of pairs of so-called "eyellipses" 6a, 6b and 6c, as defined by international standard ISO 4513. Each eyellipse is formed by a three-dimensional elliptical model representing tangent cut-off percentiles of driver eye locations. The eyellipses' position within the motor vehicle 1 can be determined on the basis of parameters of the motor vehicle, such as the position of the steering wheel center, the positions of the accelerator heel point and ball of foot reference point as defined by SAE J1100, the position of the seating reference point as defined by international standard ISO 6549, and the presence or absence of a clutch pedal. Since each eyellipse is a statistical representation of driver eye locations, different driver populations can be represented by different pairs of eyellipses. In the illustrated example, the first pair of eyellipses 6a corresponds to 95th percentiles of a 50/50 mixed gender Japanese driver population, the second pair of eyellipses 6b to 95th percentiles of a 50/50 mixed gender US driver population and the third pair of eyellipses 6c to 95th percentiles of a 50/50 mixed gender Dutch driver population.

Apart from different eye positions, different drivers may also have different preferences as to the field of view through the rearview mirrors 2, 3. So, for instance, some drivers may prefer to set the rearview mirrors so that the line of the horizon H is set particularly low in the mirror, as shown in FIG. 2B, whereas others may prefer to set them so that the line of the horizon H is set particularly high in the mirror, as shown in FIG. 2D. Preferences may also differ as to the horizontal angle of view. So, for instance, some drivers may prefer to set the rearview mirrors looking in a particularly inwards direction towards the car, so as to increase the visibility of the vehicle body through the mirror, as shown in FIG. 2A, whereas others may prefer to set the rearview mirrors looking in a particularly outwards direction, so as to decrease the visibility of the vehicle body through the mirror, as shown in FIG. 2C.

In a computer-implemented method for configuring the rearview mirrors 2,3, both the body shapes and the personal preferences of one or more driver populations can be taken into account, besides other factors, in order to calculate a minimum mirror angle adjustment range. For this purpose, in a first step of at least one particular embodiment of this method, the position and shape of representative eyellipses for at least one driver population are determined. For example, the abovementioned pairs of 95^{th} percentile eyellipses 6a,6b and 6c for Japanese, US and Dutch drivers may be determined following the method described in ISO 4513. They may then be stored in a database for later use.

In the next step, the field of view preferences of representative samples of these driver populations, including a preferred horizon height and vehicle body visibility in the rearview mirrors 2,3, are also determined and eventually stored in a database for later use.

Other possible inputs are i.a. geometric data about the shape of the rearview mirrors 2, 3 and of the motor vehicle 1, range of inclination of the ground line 5, and seat and suspension tolerances.

Based on the eyellipses 6a, 6b, 6c, the extreme eyepoints for the corresponding set of driver populations can then be defined. In the shown example, these extreme eyepoints are the foremost and lowest pairs of eyepoints 7,10 of the pair of eyellipses 6a representing the Japanese driver population, and the highest and rearmost pairs of eyepoints 8, 9 of the pair of eyellipses 6c representing the Dutch driver population.

In the following step, it is then possible to calculate, for each one of these extremes, and taking into account the mirror and vehicle shapes as well as the seat and suspension tolerances and the foremost and rearmost extremes of inclination of the ground line 5, the mirror angles α and β required to accommodate the field of view preferences of predetermined minimum subsets of said driver population sample. As illustrated in FIG. 3, the mirror angle α is an angle of inclination in a horizontal plane XY of a vector N, normal to the mirror glass 2a,3a at a predetermined point of the mirror glass 2a, 3a, with respect to a reference axis X, whereas the mirror angle β is the angle of inclination in a vertical plane XZ of the same normal vector N with respect to the same reference axis X. The mirror angle α is considered to be positive when the normal vector N diverges in an outboard direction with respect to the reference axis X, and negative when the normal vector N diverges in an inboard direction with respect to the reference axis X. FIG. 4 is a graph plotting pairs of such mirror angles α and β for both the driver- and passenger-side mirrors 2, 3, with the horizontal axis representing horizontal mirror angle α and the vertical axis representing vertical mirror angle β.

From the foremost eyepoints 7, the worst case is that of accommodating the field of view preferences of drivers wishing a high visibility of the vehicle body in the rearview mirror, as shown in FIG. 2A. This worst case is plotted in FIG. 4 as point A for the driver-side mirror 2 and point A' for the passenger-side mirror 3. More specifically, plot point A corresponds to the mirror angles α_A and β_A required to obtain the preferred vehicle body visibility of a 75th percentile of the representative sample of the driver population corresponding to eyellipses 6a (that is, in the present example, the Japanese driver population) with the average preferred horizon height, in the field of view of the driver-side mirror 2, looking from the foremost eyepoints 7, rotated towards the driver-side mirror 2 according to a predetermined head rotation model. Analogously, plot point A' corresponds to the mirror angles required to accommodate the same preferred vehicle body visibility and horizon height in the field of view of the passenger-side mirror 3 looking from the foremost eyepoints 7, rotated towards the passenger-side mirror 2.

From the highest eyepoints 8, the worst case is that of accommodating the field of view preferences of drivers wishing a low horizon height in the rearview mirror, as shown in FIG. 2B, with the strongest possible rearward inclination of the vehicle 1 with respect to the ground line 5. This worst case is plotted in FIG. 4 as point B for the driver-side mirror 2 and point B' for the passenger-side mirror 3. More specifically, plot point B corresponds to the mirror angles α_B and β_B required to accommodate the preferred horizon height of a 5th percentile of the representative sample of the driver population corresponding to eyellipses 6c, that is, in the present example, the Dutch driver population, with the average preferred vehicle body visibility, in the field of view of the driver-side mirror 2, looking from the highest eyepoints 8, rotated towards the driver-side mirror 2. Analogously, plot point B′ corresponds to the mirror angles required to accommodate the same preferred vehicle body visibility and horizon height in the field of view of the passenger-side mirror 3 looking from the highest eyepoints 8, rotated towards the passenger-side mirror 3.

From the rearmost eyepoints 9, the worst case is that of accommodating the field of view preferences of drivers wishing a low visibility of the vehicle body in the rearview mirror, as shown in FIG. 2C. This worst case is plotted in FIG. 4 as point C for the driver-side mirror 2 and point C′ for the passenger-side mirror 3. More specifically, plot point C corresponds to the mirror angles α_C and β_C required to accommodate the vehicle body visibility of a 5^{th} percentile of the representative sample of the driver population corresponding to eyellipses 6c, that is, in the present example, the Dutch driver population, with the average preferred horizon height, in the field of view of the driver-side mirror 2, looking from the rearmost eyepoints 9, rotated towards the driver-side mirror 2. Analogously, plot point C′ corresponds to the mirror angles required to accommodate the same preferred vehicle body visibility and horizon height in the field of view of the passenger-side mirror 3 looking from the rearmost eyepoints 9, rotated towards the passenger-side mirror 3.

From the lowest eyepoints 10, the worst case is that of accommodating the field of view preferences of drivers wishing a high horizon height in the rearview mirror, as shown in FIG. 2D, with the strongest possible forward inclination of the vehicle 1 with respect to the ground line 5. This worst case is plotted in FIG. 4 as point D for the driver-side mirror 2 and point D′ for the passenger-side mirror 3. More specifically, plot point D corresponds to the mirror angles α_D and β_D required to accommodate the preferred horizon height of a 95^{th} percentile of the representative sample of the driver population corresponding to eyellipses 6a, that is, in the present example, the Japanese driver population, with the average preferred body visibility, in the field of view of the driver-side mirror 2, looking from the lowest eyepoints 10, rotated towards the driver-side mirror 2. Analogously, plot point D′ corresponds to the mirror angles required to accommodate the same preferred vehicle body visibility and horizon height in the field of view of the passenger-side mirror 3 looking from the lowest eyepoints 10, rotated towards the passenger-side mirror 3.

In the present context, said percentiles of the representative samples of each driver population are ordered in terms of increasing preferred vehicle body visibility and increasing preferred horizon height, as illustrated in FIGS. 5A to 5D. In the illustrated embodiment a 75th percentile, rather than a 95th percentile, has been chosen for plot points A and A′, because it has been empirically found that drivers closest to the foremost eyepoints 7 are comparatively less likely to prefer a high vehicle body visibility. In alternative embodiments, however, different percentiles may be used for each one of plot points A to D and A′ to D′.

For each of these extremes, in order to estimate the mirror angles α and β for a target horizon height and vehicle visibility from a given pair of eyepoints, an iterative process can be used which is illustrated in the flow chart of FIG. 6. After an iteration counter i is initiated in a first step S701 of this process by being set as i=0, initial mirror angles α_0 and β_0 are set in step S702. In the next step S703, the iteration counter is increased by one, and then, in step S704, starting from vertical mirror angle β_{i-1}, a new vertical mirror angle β_i is calculated by minimizing a residual r_β using a well-known iterative optimization algorithm such as that defined by the "optimize" function in the R programming language. That particular optimization algorithm is a combination of golden section search and successive parabolic interpolation. However, other well-known optimization algorithms such as Newton's method or the gradient method may be used instead. Said residual r_β is calculated as a function of the divergence between the target horizon height and the horizon height. It can be calculated, for instance, by tracing, in the vertical plane XZ, a ray 11 originating at a middle point E between the eyepoints and reflected at the target horizon height 12, as shown in FIG. 7, and calculating the scalar product of a unitary vector of the reflected ray 11 and a unitary vector of the ground line 5 in said vertical plane XZ. The residual r_β can be equal to one minus said scalar product. Since the scalar product of two unitary vectors is equal to the cosine of the angle between the vectors, residual r_β will approach 0 as the angle difference $\Delta\beta$ between the reflected ray 11 and the ground line decreases. However, alternative methods of calculating such a residual may also be considered.

In the following step S705, a new horizontal mirror angle α_i is calculated by minimizing a residual r_α using also a well-known iterative optimization algorithm such as any one of those mentioned above for step S704, starting from horizontal mirror angle α_{i-1}. Said residual r_α can correspond to the horizontal distance between the predicted edge V_p of the vehicle body reflection in the mirror and the target position V_T of said edge, as shown in FIG. 8. In each iteration of this optimization algorithm, the vertical mirror angle β_i is maintained as the horizontal mirror angle, starting from α_{i-1}, converges towards a value α_i for which said residual r_α equals zero. After thus setting the new horizontal and vertical mirror angles α_i and β_i, it is then checked in step S706 whether iteration counter i has reached 3. If the iteration counter i is still lower than 3, the process loops back to step S703, but if the iteration counter i is equal or greater than 3, the process proceeds to its end. Although in this particular embodiment this iterative process has three iterations, different numbers of iterations may alternatively be considered.

A field of view prediction such as that carried out in step S704 can be provided by calculating the points P on the surface of the mirror glass where rays 13 originating from a variety of vehicle body points are reflected in order to reach the middle point E between the eyepoints of the driver, as shown in FIG. 9. This calculation can be carried out using an iterative method of residual minimization in order to meet two criteria illustrated in FIG. 10. The first criterion is that a vector N which is normal to the surface of the mirror glass at the reflection point P is within a plane OPE defined by the point of origin O of the reflected ray 13, the reflection point P, and the middle point E between the eyepoints. This first criterion is fulfilled, for instance, when the scalar product of a vector normal to the OPE plane and said vector N equals zero. The second criterion is that the angle γ_1 between the line OP linking the point of origin O and the reflection point P and said normal vector N is equal to the angle γ_2 between the normal vector N and the line PE linking the reflection point P to the middle point E between the eyepoints. This method can be used not only to predict the visibility of the vehicle body, as in step S705 of the iterative process illustrated in FIG. 6, but also, by using other appropriate points of origin instead of, or in combination with, abovementioned plurality of vehicle body points, to predict the reflection of the edges of the mirror visor in the mirror glass and/or the visibility of a minimum rearview area mandated by regulation. This can be complemented by predicting also the eventual degree of obstruction of the mirror glass by the mirror visor, which can easily be calculated by tracing a plurality of lines 14, tangential to the mirror visor, going from the middle point E to the mirror glass surface, and marking the points S where they intersect the mirror glass surface, as shown in FIG. 11. An example of a resulting rearview mirror field of view prediction is shown in FIG. 12, wherein area SO is the area obscured by the mirror visor, area BV corresponds to the reflection of the vehicle body, and area SR corresponds to the reflection of the mirror visor.

Turning back to FIG. 4, the sets of points A,B,C and D and A′,B′,C′ and D′ can be used to define the mirror angle adjustment ranges 12,13 within the two-dimensional α-β mirror angle space for, respectively, the driver-side rearview mirror 2 and the passenger-side rearview mirror 3. As shown in FIG. 4, these two-dimensional ranges 12, 13 can be satisfactorily approximated by drawing elliptical segments between the points of each set of points. A broader circular range 14 covering both ranges 12 and 13 can be defined as the smallest circumference enclosing both ranges 12 and 13.

If different mirror angle adjustment mechanisms are to be built for the driver-side rearview mirror 2 and for the passenger-side rearview mirror 3, they can just individually satisfy the corresponding minimum mirror angle adjustment range 12 or 13. However, if maximum parts commonality between driver- and passenger-side rearview mirrors 2, 3 is preferred, a common type of mirror angle adjustment mechanism can be used with at least the minimum mirror angle adjustment range corresponding to the circumference 14, wherein the center O of this circumference can correspond to the center position of this mechanism.

Consequently, a driver- and/or a passenger-side passenger mirror can be configured using this method, which is implemented using a computer, and then built and assembled to a motor vehicle. As "computer", it is understood, within this context, a general-purpose or specialized data computing device comprising an electronic processor, a memory and data input and output units, and suitable to execute a previously-stored set of instructions in order to implement the abovementioned method.

Those skilled in the art will recognize that the present invention may be manifested in a variety of forms other than the specific embodiments described and contemplated herein. Accordingly, departure in form and detail may be made without departing from the scope of the present invention as described in the appended claims.

CLAIMS

1. A computer-implemented method for configuring a rearview mirror (2,3) to be mounted externally on a vehicle (1), comprising the steps of:

determining position and shape of at least one pair of eyellipses (6a,6b,6c) for a predetermined driver population ;

determining, for each driver of a statistically representative sample of said driver population, field of view preferences including a preferred horizon height and vehicle body visibility in the rearview mirror (2,3) ;

calculating, for at least one predetermined external mounting position of the rearview mirror (2,3), a minimum mirror angle adjustment range suitable for covering, from a plurality of outermost points (7,8,9,10) of said at least one pair of eyellipses (6a,6b,6c), field of view preferences of predetermined minimum subsets of said driver population sample.

2. The computer-implemented method according to claim 1, wherein said mirror angle adjustment range is suitable for covering, from forwardmost points (7) of said eyellipses (6a,6b,6c), the preferred vehicle body visibility of each driver of at least a predetermined minimum subset of said driver population sample.

3. The computer-implemented method according to claim 2, wherein said mirror angle adjustment range is suitable for covering, from forwardmost points (7) of said eyellipses (6a,6b,6c), the preferred vehicle body visibility of each driver of at least 75% of said driver population sample.

4. The computer-implemented method according to any one of claims 1 to 3, wherein said mirror angle adjustment range is suitable for covering, from highest points (8) of said eyellipses (6a,6b,6c), the preferred horizon height of each driver of at least a predetermined minimum subset of said driver population sample.

5. The computer-implemented method according to claim 4, wherein said mirror angle adjustment range is suitable for covering, from highest points (8) of said eyellipses (6a,6b,6c), the preferred horizon height of each driver of at least 95% of said driver population sample.

6. The computer-implemented method according to any one of claims 1 to 5, wherein said mirror angle adjustment range is suitable for covering, from rearmost points (9) of said eyellipses, the preferred vehicle body visibility of each driver of at least a predetermined minimum subset of said driver population sample.

7. The computer-implemented method according to claim 6, wherein said mirror angle adjustment range is suitable for covering, from rearmost points (9) of said eyellipses, the preferred vehicle body visibility of each driver of at least 95% of said driver population sample.

8. The computer-implemented method according to any one of claims 1 to 3, wherein said mirror angle adjustment range is suitable for covering, from lowest points (10) of said eyellipses, the preferred horizon height of each driver of at least a predetermined minimum subset of said driver population sample.

9. The computer-implemented method according to claim 4, wherein said mirror angle adjustment range is suitable for covering, from lowest points (10) of said eyellipses, the preferred horizon height of each driver of at least 95% of said driver population sample.

10. The computer-implemented method according to any one of claims 1 to 9, wherein the eyellipse and mirror adjustment preference determination steps are carried out for a plurality of different driver populations, and a minimum mirror adjustment range is calculated which is suitable for covering, from outermost points of said eyellipses, the field of view preferences of each driver of predetermined minimum subsets of the statistically representative samples of said driver populations.

11. The computer-implemented method according to any one of claims 1 to 10, wherein said minimum mirror angle adjustment range is calculated for mounting positions both at a driver side and a passenger side of the vehicle.

12. The computer-implemented method according to any one of claims 1 to 11, wherein each eyellipse (6a,6b,6c) is defined by the eye positions of 95^{th} percentiles of the corresponding driver population.

13. The computer-implemented method according to any one of claims 1 to 12, wherein said at least one eyellipse (6a,6b,6c) is stored in a database and retrieved from said database for the minimum mirror angle adjustment range calculation step.

14. The computer-implemented method according to any one of claims 1 to 13, wherein said field of view preferences are stored in a database and retrieved from said database for the minimum mirror angle adjustment range calculation step.

15. A method for producing a rearview mirror (2,3) to be mounted externally on a vehicle (1) in at least one predetermined mounting position, wherein a mirror angle adjustment mechanism with at least a minimum mirror angle adjustment range calculated using the computer-implemented method of any one of claims 1 to 14 is incorporated in the rearview mirror (2,3).

16. A rearview mirror (2,3) configured according to the method of any one of claims 1 to 14.

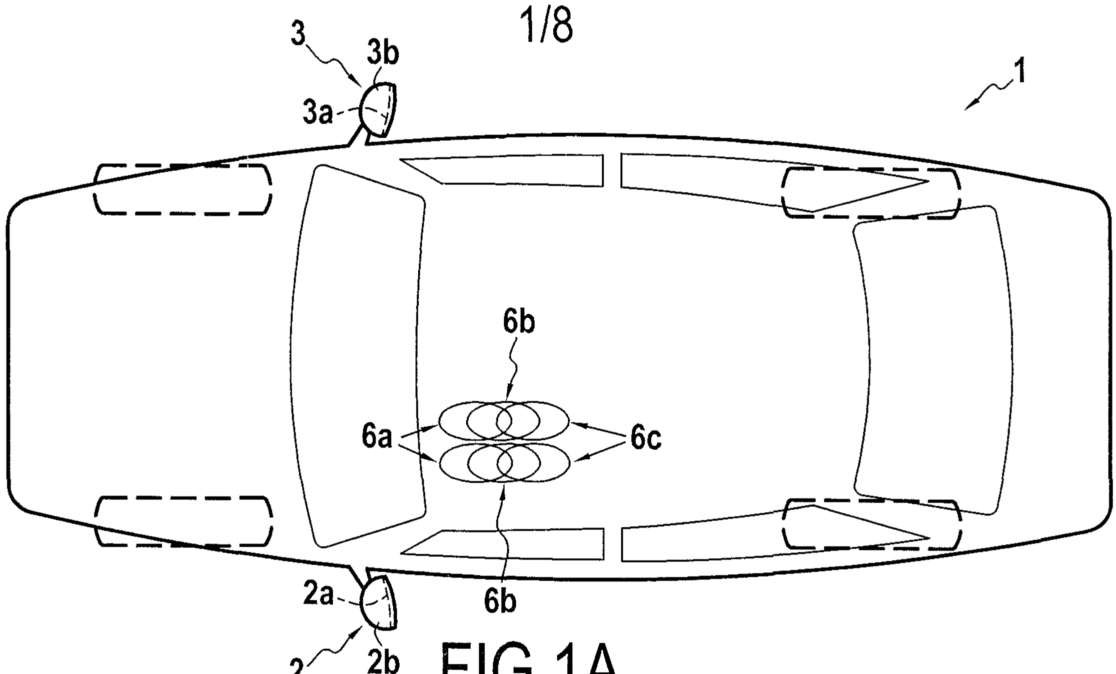

FIG.1A

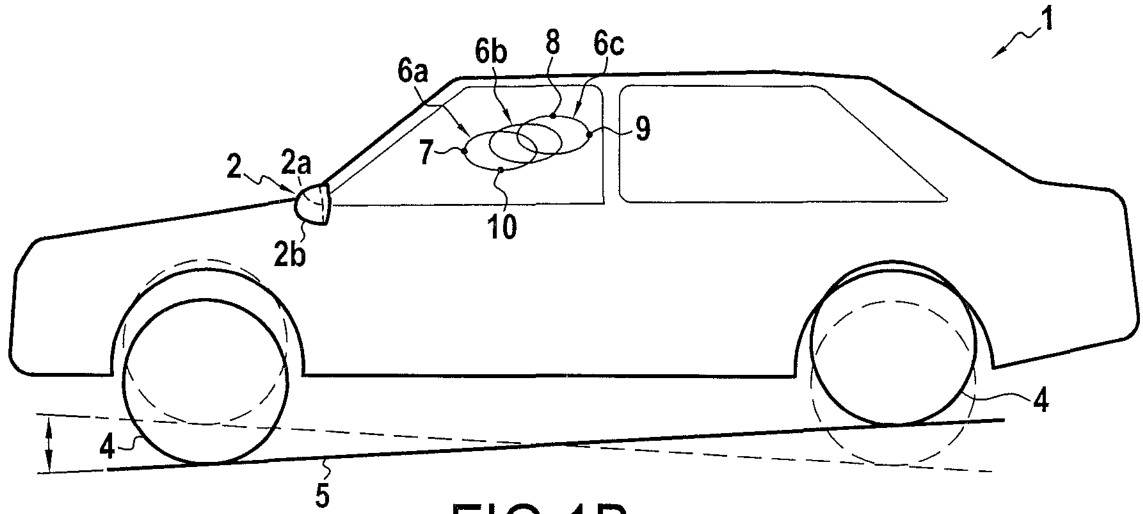

FIG.1B

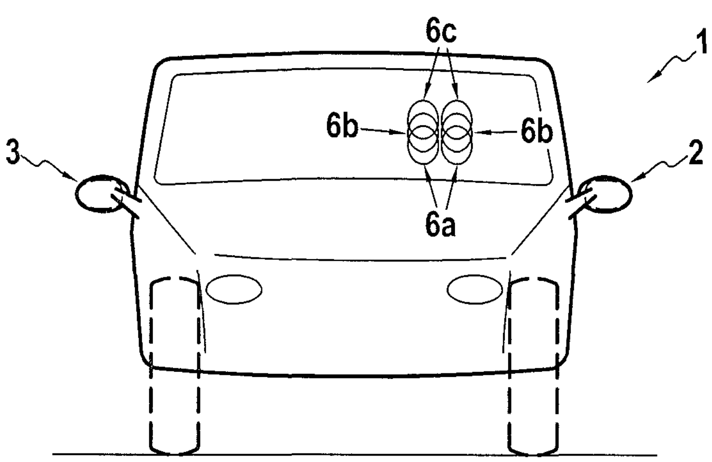

FIG.1C

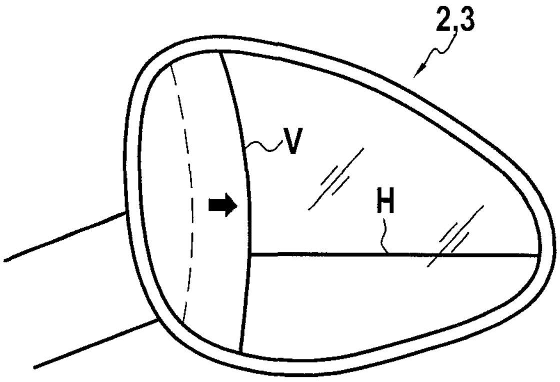

FIG.2A

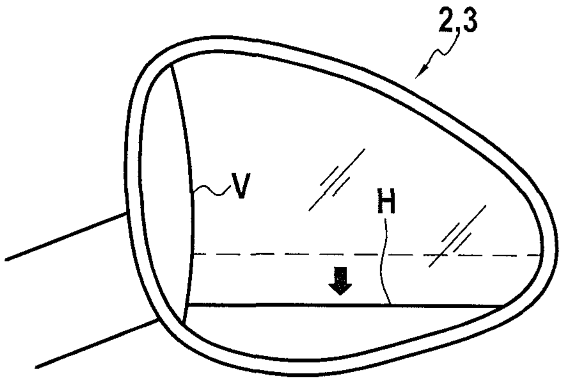

FIG.2B

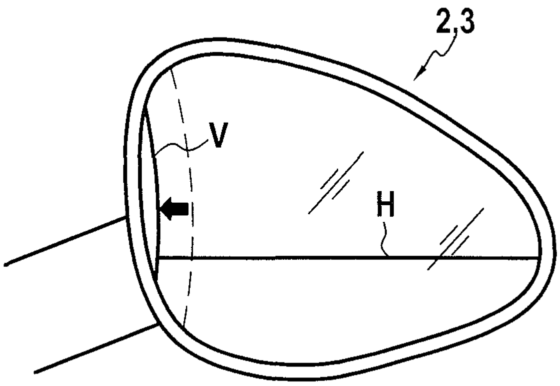

FIG.2C

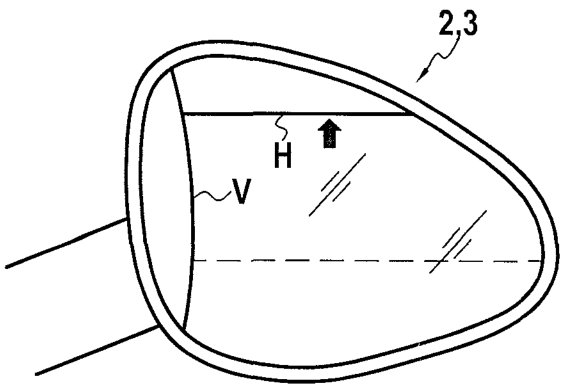

FIG.2D

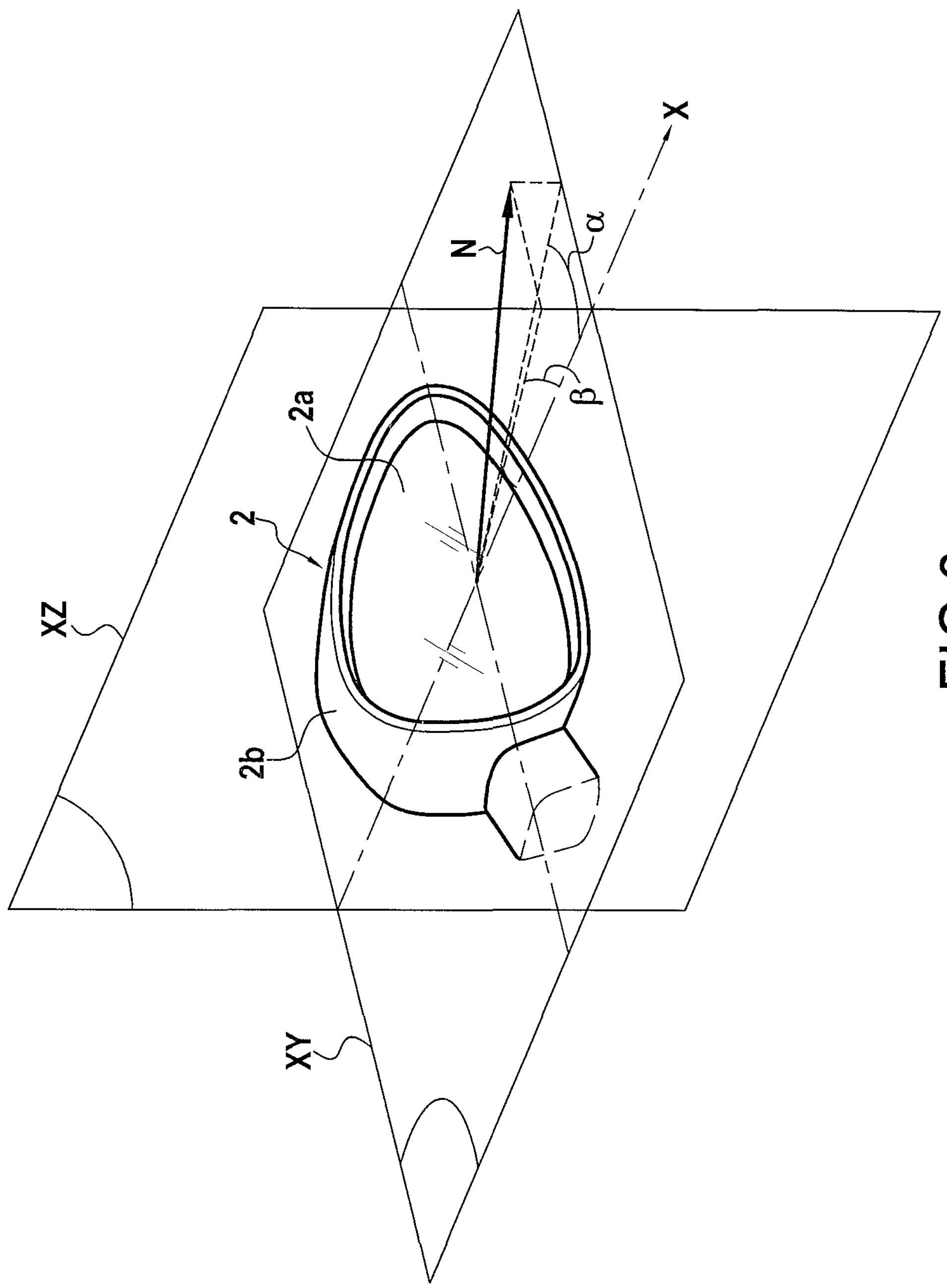

FIG.3

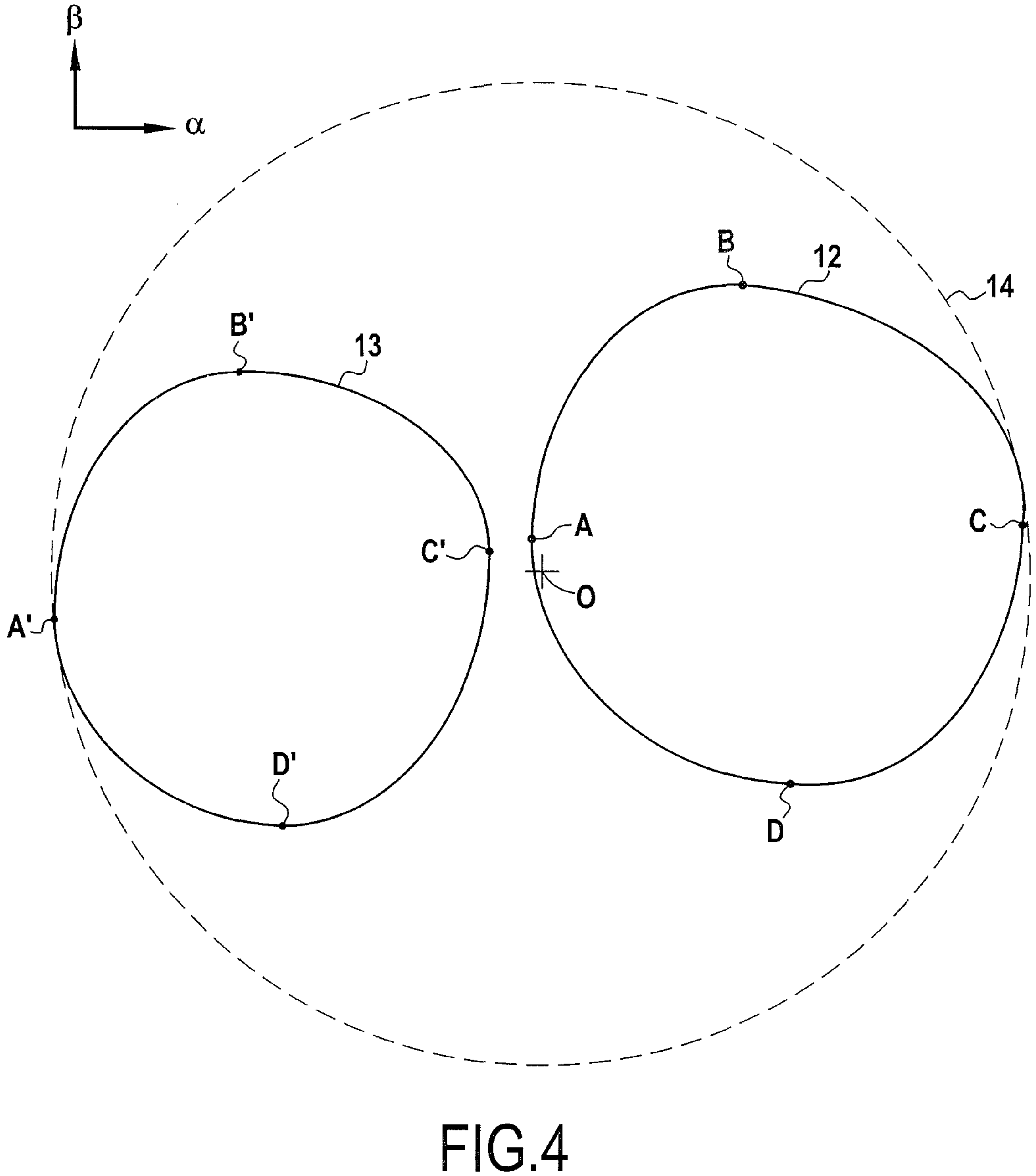

FIG.4

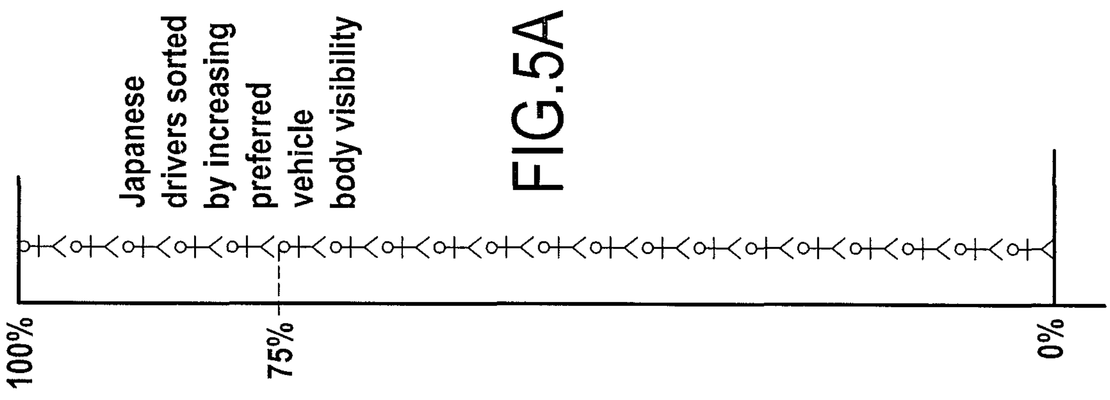

FIG.5A

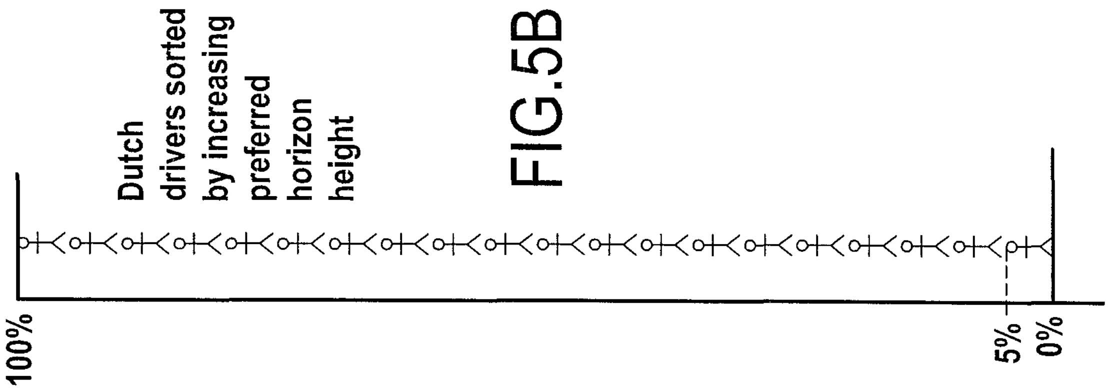

FIG.5B

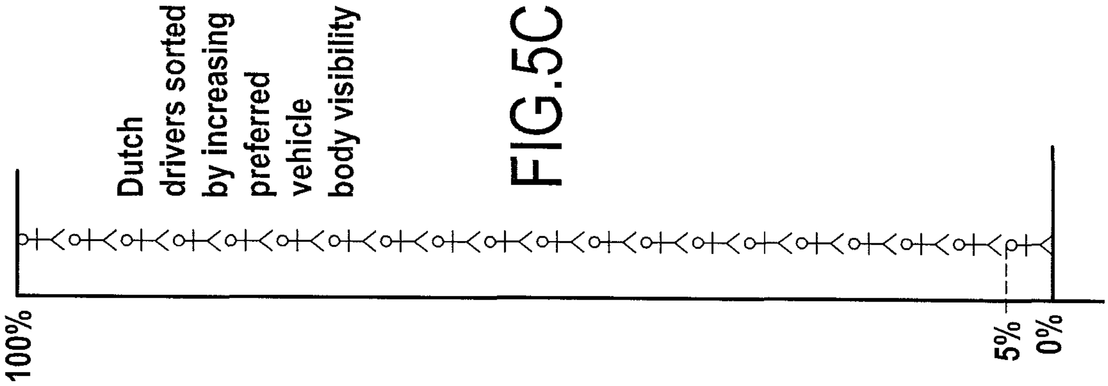

FIG.5C

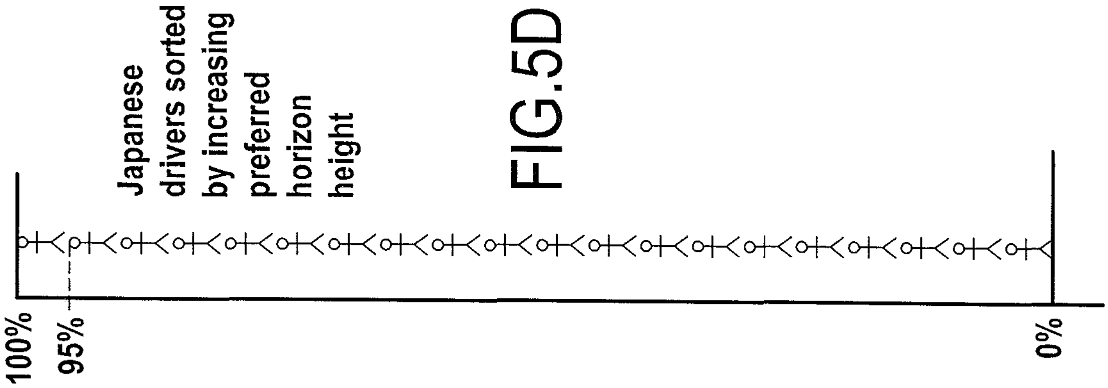

FIG.5D

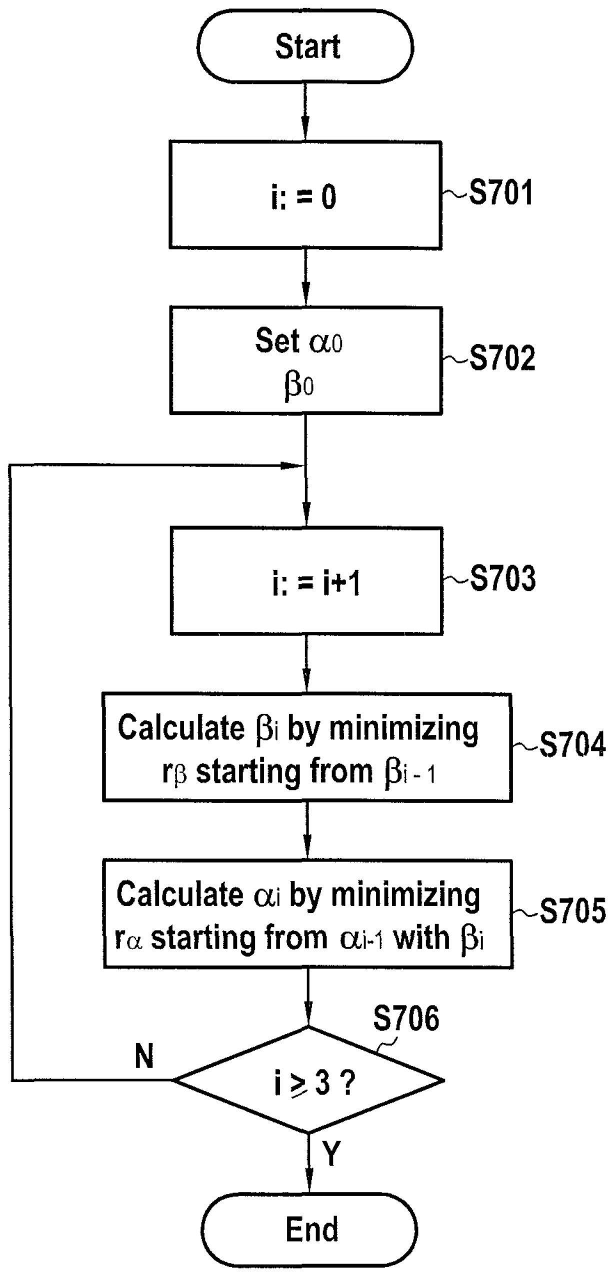
Start
i: = 0
S701
Set α_0
β_0
S702
i: = i+1
S703
Calculate β_i by minimizing
r_β starting from β_{i-1}
S704
Calculate α_i by minimizing
r_α starting from α_{i-1} with β_i
S705
S706
$i \geq 3$?
N
Y
End

FIG.6

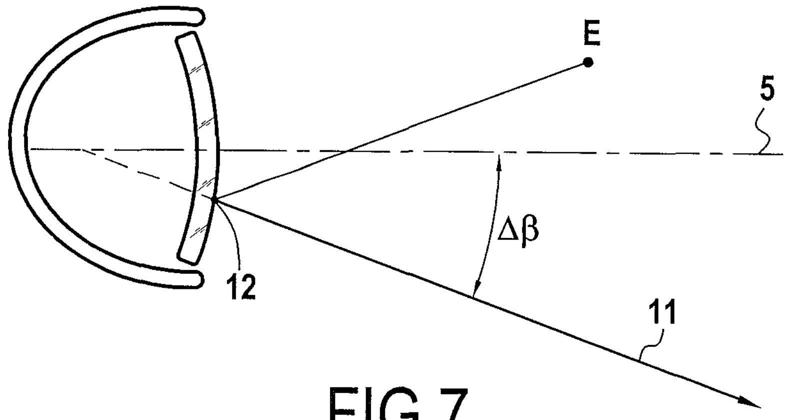

FIG.7

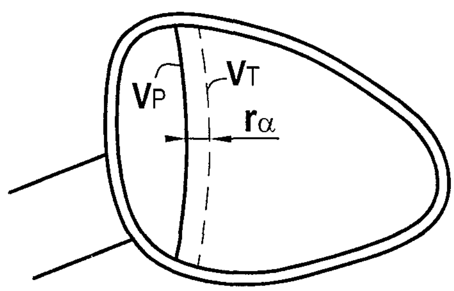

FIG.8

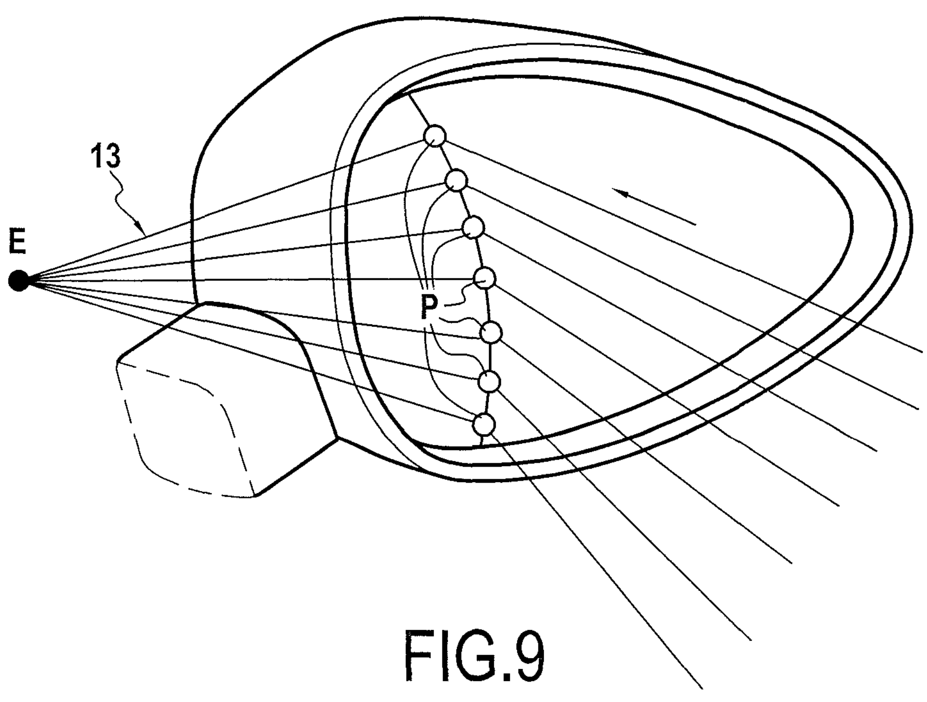

FIG.9

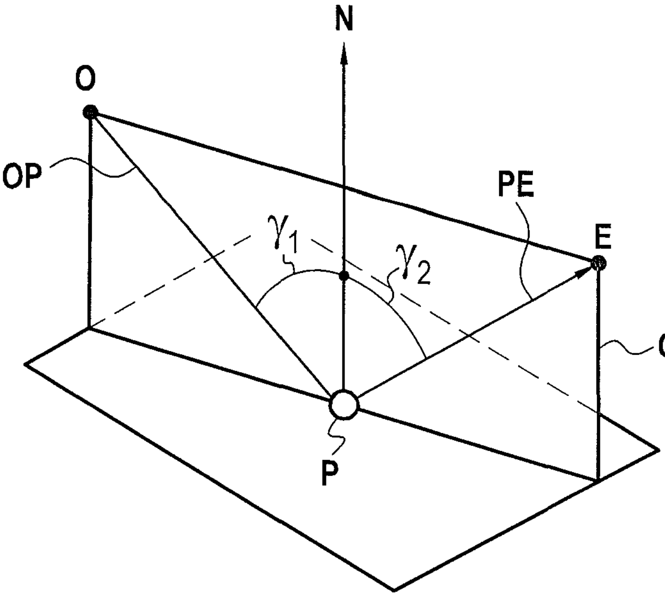

FIG.10

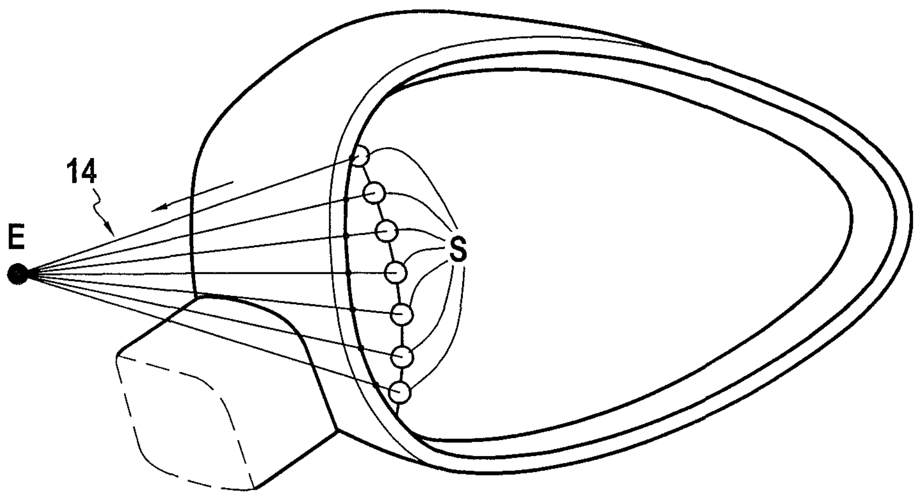

FIG.11

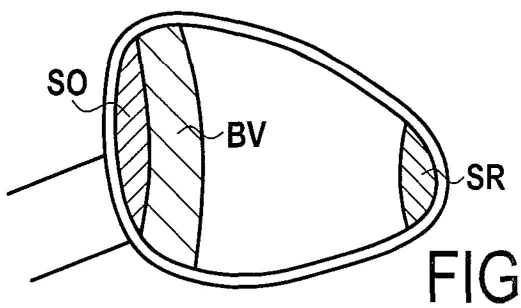

FIG.12

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/064102

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F17/50
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)
G06F

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	João Ferreira, Anna Tidstam, Francesco Furini, Alberto Rodrigues da Silva: "Modeling and Optimizing Ergonomic Activities in Automobile Product Development", , 31 December 2007 (2007-12-31), pages 1-6, XP002698818, Proceedings of International Conference on Ergonomics, Dec. 2007 (Kuala Lumpur, Malaysia) Retrieved from the Internet: URL:http://isg.inesc-id.pt/alb/static/papers/2007/i63-jf-Modeling_Ergonomics-ICE2007.pdf [retrieved on 2012-06-03] the whole article, in particular page 4, column 2, section headed "Mirror Certification" in combination with Figure -/--	1-15

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

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"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
13 June 2013	27/06/2013

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	Lerbinger, Klaus

1

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	7 -----	
Y	CAROL A C FLANNAGAN ET AL: "PREDICTING MIRROR ADJUSTMENT RANGE FOR DRIVER ACCOMODATION PASSAGE", PREDICTING MIRROR ADJUSTMENT RANGE FOR DRIVER ACCOMODATION, THE UNIVERSITY OF MICHIGAN TRANSPORTATION RESEARCH, US, no. UMTRI-98-45, 1 October 1998 (1998-10-01), pages 1-27, XP008122309, the whole document -----	1-15
X	US 6 616 288 B2 (DUROUX BERNARD [FR] ET AL) 9 September 2003 (2003-09-09)	16
A	the whole document, in particular column 1, lines 28-57 and claim 1 -----	1-15

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2012/064102

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6616288 B2	09-09-2003	BR 9800652 A	14-09-1999
		CN 1191822 A	02-09-1998
		DE 69819575 D1	18-12-2003
		DE 69819575 T2	16-09-2004
		EP 0860323 A2	26-08-1998
		JP H10230788 A	02-09-1998
		US 6224220 B1	01-05-2001
		US 2001013981 A1	16-08-2001