

DESCRIPTION

TITLE OF THE INVENTION: RECYCLABLE STEERING WHEEL

CORRESPONDING APPLICATION

The present international application under the PCT claims the priority of the prior international application N°PCT/IB2023/052419 filed on March 13, 2023 in the name of SOFTCAR SA, the content of that prior application being incorporated by reference in its entirety into the present application.

TECHNICAL FIELD

The present invention relates to the construction of a steering wheel, for example for a motor vehicle, that is recyclable, and to the manufacturing methods employed for producing it, using materials that are ecological and recyclable in a circular economy.

The invention also relates to a steering wheel that diffuses light, thus becoming a driving aid, a security element, a route-guidance element and an esthetic element for the interior cabin of a vehicle.

PRIOR ART

Since the early days of the automobile, steering wheels have been produced in wood, then in steel, in wood-trimmed steel, in aluminum, in steel-framed aluminum, and in the form of a metal frame overmolded with thermosetting resin, often opaque and dark in color.

Nowadays, the universal process used in the manufacture of steering wheels relies on four distinct industrial operations:

- The manufacture of a splined insert made of steel that forms the connection with the steering column.
- The pressure overmolding of a magnesium-aluminum frame onto the splined steel insert. This frame forms the rigid core of the steering wheel. The magnesium contributes performance associated with its low density (lightness of weight, polar inertia, integration of functions, crashworthiness, etc.). In addition, magnesium (AM50 and AM60B in particular) contributes a high impact-energy absorption capacity, and a very good vibration damping capacity. Note that there are embodiments in which the frame is made from steel, from aluminum, from reinforced thermoplastic sheet (RTS) or from advanced composite (which is recyclable).
- The overmolding of the ring onto the frame. The element referred to in the present application as a "ring" is the generally toric or near-torus-shaped part that forms the periphery of the steering wheel and on which the user chiefly places their hands. It is sometimes referred to as a hoop, a rim, or by another term, but will be termed a "ring" here. The overmolding of the ring on the frame is performed under compression using polyurethane (PU) and then by foaming this polyurethane. This operation makes it possible to create a skin with a nice appearance and also achieve foaming within the same material and during the same molding cycle. This overmolding forms a solid component around the frame. Prior to the chemical reaction, the components are liquid. There is

therefore no void or empty space inside the ring. This overmolding makes it possible to obtain an entry-level steering wheel, in a single piece, with perfect adhesion to the frame. The soft PU protects the user from the metal of the steering wheel, particularly in a crash. It also gives the steering wheel an ergonomic shape and contact that is pleasant to the touch.

- The addition of trim for a soft and pleasant feel: in top-of-the-range products, the PU is covered with hand-stitched genuine leather. For more conventional steering wheels, the trim is made of artificial leather with artificial stitching directly molded into it. Steering wheel coverings are increasingly being made of leather alternatives of non-animal origin containing no product that has been tested on animals. Animal leather is thus replaced by "vegan" leathers such as orange-peel leather, pineapple-skin leather (Pinatex), grape leather, Muskin (made from fungi) or else cork etc.

The steering wheel is then completed with parts forming a central housing and a cover for the central housing, the central housing being able to contain technical elements (such as for example: ignition switch, horn, airbag, pyrotechnic triggering system, airbag triggering computer, various control buttons, etc.) and acting as a trim for the central part of the steering wheel. These parts are overmolded in PU or injection-molded in polymer and assembled on the steering wheel, for example using screw-fastening or clip-fastening or other equivalent means.

This construction gives rise to problems in all the stages of the life of the steering wheels:

- From a design standpoint, because of the exothermal chemical reaction and the temperature generated during the process of overmolding and foaming the PU, no electrical or electronic component can be incorporated into the ring of the steering wheel. Because polyurethane is a thermoset, it is opaque and is unable to diffuse any light.
- At the point of manufacture, soft PU foam is produced by combining, by chemical reaction, two liquid components: the isocyanate MDI (4,4'-methylene diphenylmethane diisocyanate) and polyisocyanate. The polyaddition chemical reaction takes place within the tooling. Those working in the manufacturing workshops are therefore directly exposed to isocyanates which are irritants.
- During the use of the vehicle, the PU releases MDI vapors considered to be toxic. These vapors are invisible and odorless, but will thus pollute the air in the cabin of the vehicle.
- Thermosets are, by definition, impossible to recycle because the three-dimensional chemical reaction in their synthesis is irreversible. It is therefore difficult to separate the materials of the steering wheel because of the adhesion between the metal frame and the overmolded PU. While in theory the PU can be shredded while it is on the frame, there is no economically viable reuse or monetization route. At the end of life, the steering wheel can be burnt, but burning PU releases isocyanates, carbon monoxide and hydrocyanic acid. The flame-retardant substances in PU

release gases that are toxic to the human nervous system. It is thus not possible to recycle present-day steering wheels in a circular economy, and recycling is practically impossible. If the vehicle is reconditioned, the steering wheel will be removed together with the air bag and thrown in with the waste, which then raises ecological problems.

SUMMARY OF THE INVENTION

The present invention makes it possible to alleviate all of the disadvantages mentioned hereinabove, particularly by eliminating the PU and the associated operation of foaming the steering wheel, and replacing them with thermoplastic polymer shells obtained by injection molding, which are then attached to the frame.

The frame is, for example, molded or cast entirely in magnesium-aluminum, as a single piece without the separate steel insert described in the prior art.

Preferably, according to embodiments of the invention, the frame is produced in two parts: a main body or frame, preferably made of magnesium-aluminum and a splined insert preferably made of steel. These two parts are assembled after they have been manufactured and the splined steel insert may be fitted or removed at any time. It is centered in the frame and then assembled, preferably by screw-fastening. At the point of recycling, the insert can easily be separated from the frame and the metals are therefore separated very easily.

The elements for covering and for grasping are themselves injection molded in an inert thermoplastic and form two half-shells, one at the front (facing the driver) and the other at the rear (facing the steering column) of the steering

wheel. The cycle time involved in production is thus shortened. Toxic vapors are eliminated.

To allow the materials to be separated easily and recycled along dedicated pathways, these covering elements are advantageously assembled to the frame by clip-fastening and/or screw-fastening. At the point of recycling, they are thus easily disassembled enabling the materials to be separated instantly and recovered with a view to re-use in a circular economy model. This advantageously provides the ability to change the half-shells on the frame in just a few seconds, for example to restore a worn steering wheel covering when reconditioning a vehicle for hygiene reasons; the invention makes it possible to enjoy the benefit of aseptic new shells for example in the event of a vehicle being loaned. The invention allows the style or color of the steering wheel to be changed at any moment by changing the polymer shells.

According to embodiments of the invention, the steering wheel may be produced in three parts: a specific central frame, a front half-shell and a rear half-shell. It can also be produced with a higher number of parts and comprise, for example, similar parts in the upper and lower half-shells.

Advantageously, the thermoplastic polymer used to form the half-shells is preferably a pure or bio-sourced thermoplastic resin able to be in contact with the skin of the fingers without any risk, for example a semitransparent polypropylene or a copolyester, advantageously bio sourced and advantageously having an existing recycling pathway. The material of which the half-shells is made may also be foamed during the injection-molding process.

The half-shells may also be produced from transparent or translucent polymers that allow light to pass or that diffuse light, for example PMMA, SMMA, PC, PLA, TPE, copolyester, PET or else other equivalent materials, so that information or decoration can be displayed directly on the steering wheel, via screens (for example LCD screens), LEDs, LED strips, image projectors or other display means. In that case, the information will be transmitted to the driver through the transparency of the polymer or diffusion through the half-shells. In the case of opaque half-shells, the displays may be placed in openings at the surface of said shells. In both instances, this creates a head-up display directly incorporated into the steering wheel.

The addition of electrical or electronic components in the ring of the steering wheel is rendered possible by the elimination of the operation of overmolding PU onto the frame, thereby freeing up space in the ring and avoiding damaging the components in question. These electrical components are display components, but may also be vibrators, accelerometers, sensors or other equivalent means, or even a GPS integrated circuit allowing the steering wheel to incorporate additional and novel functions.

The addition of these electrical components into the steering wheel offers numerous novel possibilities, for example for safety, navigation, ergonomics, battery state of charge visible from outside the vehicle, or as a replacement for GPS. This list is of course nonlimiting.

In embodiments, the invention relates to a steering wheel, for example for a motor vehicle, comprising a rigid frame, and thermoplastic first covering parts arranged as half-shells, said first covering parts being assembled on said frame

by fastening means, said first covering parts forming the covering of said frame so that said steering wheel can be gripped.

In embodiments, the steering wheel comprises thermoplastic second covering parts, said second covering parts being assembled on said frame by fastening means.

These covering parts are assembled on said frame advantageously by clip-fastening and/or screw-fastening and by means of fastening such as clips and/or screws, or by any other appropriate means of fastening and said frame may comprise fastening interfaces for the covering parts.

In embodiments, said first covering parts comprise: a rear ring, a front ring, said second covering parts comprising a housing and a cover, said frame being sandwiched between said first and second covering parts, said first and second covering parts being fastened to one another and/or fastened directly to said frame, it being possible for said first covering parts and/or said second covering parts to be replaced quickly and easily.

In embodiments, the steering wheel comprises at least one steering wheel display enabling luminous information and/or mood lighting to be diffused from the steering wheel in the field of view of the driver.

In embodiments, one or more of said covering parts is (are) partially or fully transparent or translucent and enable luminous information and/or mood lighting to be diffused to the driver by transparency.

In embodiments, the rear ring and the front ring are preferably identical. Preferably, they comprise means (clips, complimentary shapes, etc.) for fastening one to the other.

In embodiments, said covering parts form a rear part and/or a front part, said rear part comprising the rear ring and the housing, and said front part comprising the front ring and the cover.

In embodiments, the covering parts are preferably customization elements and can be easily interchanged since they are attached in a manner that allows for disassembly. In the present application, the concept of disassembly indicates that the assembly or the fastening are reversible: the mounting of the assembled parts can be undone; the parts can be "disassembled" and separated, for example for recycling them.

In embodiments, at least one covering part diffuses information indicating what direction to follow by reading it directly and intuitively off the steering wheel itself, off part or all of the peripheral circular surface of said steering wheel, thus shortening the cognitive circuit.

In embodiments, the state of charge of the battery is diffused in the form of a luminous indication on the rear ring of the steering wheel.

In embodiments, the light diffused by the steering wheel is of high enough intensity to be visible from outside the vehicle, thus enabling the vehicle to be found with ease, for example in a parking lot containing a great many motor cars.

In embodiments, the steering wheel is coupled to a GPRS GPS positioning software, to an angular-position sensor, and to a speed indicator so that a geographical position and/or an angular position and/or speed can be indicated on the steering wheel display.

In embodiments, the steering wheel incorporates components of a GPS system and communicates directly through the windshield glass.

In embodiments, the steering wheel forms both a GPS driving aid and an instrument for turning the steered wheels of the vehicle indicating (preferably with high precision) the direction-changes to be made.

In embodiments, said frame comprises a splined insert and a frame main body which are assembled in such a way as to be able to be disassembled.

In embodiments, the steering wheel comprises a serrated cut to simulate the stitching of a trim element.

In embodiments, the invention relates to a vehicle (motor car, truck, etc.) comprising a steering wheel as described and illustrated in the present application.

In embodiments, the invention relates to a method for producing a steering wheel, for example for a motor vehicle, as described in the present application, said method preferably using neither thermoset resin nor overmolding.

In embodiments, the invention relates to a method for producing a steering wheel, wherein:

-) a rigid frame is produced,
-) at least first covering parts are produced, for example by injection molding or an other equivalent method,
-) the frame and the first covering parts are combined, preferably using a form of assembly that can be disassembled, to form a steering wheel.

In embodiments, the first covering parts can be disassembled without affecting the airbag.

In embodiments, the first covering parts comprise a front ring and a rear ring.

In embodiments, second covering parts which comprise a cover and a housing are produced and the frame and the second covering parts are combined using a form of assembly that can be disassembled.

In embodiments, the assembly of the frame and of the first and second covering parts using a form of assembly that can be disassembled is achieved using clip-fastening and/or screw-fastening.

In embodiments, the first and second covering parts are made of thermoplastic(s), for example of thermoplastic polymer(s). Other equivalent materials are possible, as described in the present application.

In embodiments, the thermoplastic used for manufacturing the covering parts has an identified recycling pathway, preferably being PET for example.

Preferably, the covering parts are produced by injection molding.

In embodiments, the front ring and the cover are formed as a single piece and/or the rear ring and the housing are formed as a single piece.

In embodiments, the assembly of the frame and of the covering parts using a form of assembly that can be disassembled is achieved using clip-fastening and/or screw-fastening.

In embodiments, in order to produce the rigid frame, a frame main body and a splined insert are produced and these are then assembled in a manner that allows for disassembly.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention and its advantages will become better apparent from the below description of embodiments which are given by way of nonlimiting examples, with reference to the attached drawings in which:

- Figure 1 depicts a perspective view of the steering wheel, from the front,
- Figure 2 depicts a perspective view of the steering wheel, from the rear,
- Figure 3 depicts a an exploded view of the steering wheel,
- Figure 4 depicts a front view of the frame of the steering wheel with the rear parts fitted,
- Figure 5 depicts a rear view of the frame of the steering wheel with the front parts fitted,
- Figure 6 depicts a view in cross section of a clip of the steering wheel,

- Figure 7 depicts a view of the steering wheel in three parts,
- Figure 8 depicts a specific form of cut between the front and rear rings,
- Figure 9 depicts the steering wheel with transparent half-shells fitted with electrical displays,
- Figure 10 depicts a view in cross section of the steering wheel fitted with a display lying flush with the ring,
- Figure 11 depicts a view in cross section of the steering wheel fitted with a display internal to the steering wheel inside the ring,
- Figure 12 depicts an exploded view in cross section of the steering wheel fitted with a display lying flush with the ring,
- Figure 13 depicts a face-on perspective view of the frame in two parts,
- Figure 14 depicts an exploded view of the frame in two parts.

NUMERICAL REFERENCES OF THE ELEMENTS

- 01: steering wheel
- 02: serrated cut
- 03: steering wheel display
- 10: frame
- 101: splined insert
- 101a: splined insert taper
- 102: frame main body
- 102a: frame main body taper
- 103: frame pin
- 104: frame screw
- 105: frame nut
- 11: spline for connecting to the steering column

- 12: tapped fixing holes
- 13: clip-fastening cavity
- 14: hoop
- 15: groove
- 20: rear ring
- 21: rear ring clips
- 21a: rear clip-fastening face
- 21b: rear unclipping faces
- 22: rear ring rib
- 30: front ring
- 31: front ring clips
- 31a: front clip-fastening face
- 31b: front unclipping faces
- 32: front ring rib
- 33: opening
- 40: housing
- 50: cover
- 51: screw-fastening recess
- 60: housing fastening screw
- 70: cover fastening screw

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

The invention is not restricted to the forms of embodiment or to the embodiments described, but can be modified by introducing means equivalent to those described. The invention and the principle thereof therefore relate to a steering wheel construction, to a steering wheel with particular functions, and

to an ecological method for the industrial scale manufacture of said steering wheel.

With reference to the figures, the steering wheel 01 comprises a frame 10, a rear ring 20, a front ring 30, a housing 40, a cover 50, housing fastening screws 60, and cover fastening screws 70. Said housing 40 and cover 50 may contain other elements such as control buttons, an airbag, a horn or an ignition switch, this list being nonlimiting, it being possible for other means to be incorporated.

Said frame 10 is mainly gravity-molded or high-pressure-molded, advantageously from a material that is stiff and strong, so that it can absorb the forces applied to said steering wheel 01 without the risk of breaking or of deforming excessively. The material in question is advantageously, for example, an alloy of aluminum and of magnesium. The aluminum contributes the necessary strength and stiffness. The addition of magnesium contributes performance associated with its low density (polar inertia, integration of functions, crashworthiness, etc.). In addition, magnesium (AM50 and AM60B in particular) contributes a high impact-energy absorption capacity, and a very good vibration damping capacity. Said frame 10 may also be made from another material, for example a magnesium alloy, an aluminum alloy, a steel or a reinforced thermoplastic composite. The frame will be configured to accept the fastening of the ring. Neither is the invention restricted to just one method of forming said frame 10. Said frame may just as well be machined, forged, pressed or produced using another process.

After the frame 10 has been formed, other operations may be performed on it. For example, the precision broaching for the centering insert for creating the

splines 11 for connecting to the steering column; or the machining of the tapped fixing holes 12.

According to another embodiment illustrated in figures 13 and 14, said frame 10 is formed from a frame main body 102 and a splined insert 101 that can be disassembled. Said frame main body 102 is manufactured using the methods and materials described hereinbelow for said frame. Said splined insert 101 is manufactured preferably from steel or another stiff material, by molding or casting, machining, forging, pressing or any other appropriate method. The aim of this embodiment is to have said splines 11 made from a high-strength material so that they do not become deteriorated (as this could cause safety problems), while at the same time maintaining, for the rest of said frame 10, the above-described properties of the aluminum and magnesium alloys (lightness of weight, polar inertia, integration of functions, crashworthiness, impact absorption, vibration damping, etc.). Overmolding said frame main body 102 onto said splined insert 101 using the earlier techniques would make the two parts impossible to separate and therefore to recycle. In this embodiment according to the invention, the assembly allows the disassembly, advantageously with frame centering pins 103 for centering the assembly and transmitting the torque from the hands of the driver via the frame to the steering column and to the wheels, and frame screws 104 for holding the two parts fixed against one another. Said frame screws 104 may be screwed directly into said splined insert 101, into said frame main body 102, or into frame nuts 105. Advantageously, said splined insert 101 has an insert taper 101a, and said frame main body 102 has a main body taper 102a, these being designed to be pressed against one another by the tightening of said frame screws 104. The taper-on-taper assembly thus provides the mutual centering of the two parts,

contributes, through friction, to the transmission of torque between the two parts, and strengthens, through a wedging effect, the mutual retention of the two parts. This mode of attachment is given by way of example, the invention not being limited thereto and other equivalent modes being possible.

Said rear ring 20, front ring 30, housing 40 and cover 50 are preferably injection molded in an inert thermoplastic polymer and form half-shells at the front (facing the driver) and at the rear (facing the steering column) of the steering wheel. The injection molding consists for example in heating polymer pellets and expelling them under pressure into an injection mold. Thus, there is no chemical reaction as there was in the PU manufacturing process that generates emissions of toxic vapors. These parts according to the invention are produced on an injection-molding press independently of said frame 10. They can therefore be assembled on said frame 10 at any moment during the course of the assembly process.

The injection-molding of said rear ring 20, front ring 30, housing 40 and cover 50 also makes it possible to enjoy better repeatability of the details of the injection mold (creation of textures, graining, etching of decorative patterns), to reduce the production time and to appreciably improve productivity (there is no insert that has to be placed in the tooling used for manufacturing the covering parts, injection is quicker than the operation for manufacturing thermosets, and the reject rate is markedly lower).

Advantageously, the thermoplastic polymer used for injection molding these covering parts (rear ring 20, front ring 30, housing 40 and cover 50) is a pure resin, which is able to be in contact with the skin without any risk of

contamination and does not release toxic compounds. Said resin may for example be a semitransparent polypropylene or a copolyester. However, the invention is not restricted to these thermoplastics and other equivalent materials are possible. The thermoplastic may also be foamed during injection or be produced by a water injection process.

After injection, said rear ring 20, front ring 30, housing 40 and cover 50 are advantageously assembled with the frame by clip-fastening and/or screw-fastening. Thus, according to one nonlimiting embodiment set out in figures 1 to 6, said rear ring 20 and front ring 30 respectively have rear ring clips 21 and front ring clips 31 which become lodged in clip-fastening cavities 13 belonging to said frame 10. Said rear ring clips 21 have a rear clip-fastening face 21a that makes a shallow angle with the hoop 14 of said frame 10. This angle allows said rear ring clips 21 to be kept under constant strain so as to avoid there being any play between said frame and said rear ring 20. The fact that this angle is small prevents it from being too easy to disassemble said rear ring 20. Said front ring clips 31 have a front clip-fastening face 31a that has the same properties and behavior as said rear clip-fastening faces 21a. Said housing 40 is fastened to said frame 10 by screwing said housing fixing screws 60 into said tapped fixing holes 12 of said frame 10. Said cover 50 is fastened to that assembly by screwing said cover fixing screws 70 into the screw-fastening recesses 51 of said cover 50.

These assemblies are all reversible, enabling the steering wheel to be disassembled quickly and easily, it being possible for disassembly to be partial or full disassembly. At the point of recycling, the various parts are thus easily disassembled enabling the materials to be properly separated and recovered along dedicated pathways with a view to re-use in a circular economy model.

Said worn out housing 40 can thus be disassembled and reused, by injection molding, to form new housings 40. The same goes for said rear ring 20, said front ring 30 and said cover 50. That also allows said rear ring 20, front ring 30, housing 40 and cover 50 to be replaced on the frame. That approach may prove beneficial in a number of cases. Advantageously, said parts 20, 30, 40 and 50 are made from a material having an existing recycling pathway, such as PET, facilitating the recycling process described above.

Specifically, at the present time, there is a growing tendency toward leasing, long-term rental, or subscription deals on vehicle usage, which means that the vehicles need to be reconditioned as quickly as possible and with the lowest possible environmental impact upon the return of the vehicles at the end of the contract. Accordingly, the principle of the invention makes it possible, for example, to restore a damaged steering wheel 01, by changing these few injection-molded covering parts, without the need to change said frame 10 nor the elements internal to said housing 40 (buttons, airbag, horn, etc.). This may be beneficial in reconditioning operations for changing, quickly, at low cost, and without recourse to a specialist technician, parts that are lightweight and can then be recycled or discarded. In the case of car rental, car-sharing, and leasing firms, for garage work and naturally as far as the manufacturers are concerned, it may be beneficial, for the sake of hygiene, to refit new unused covering parts that have not already been handled by previous users. It is important, so far as the quality perceived by the user is concerned, to have a steering wheel of new and aseptic appearance. That may also be beneficial from an esthetic standpoint, if the user wishes to change the color and/or the shape of their steering wheel, this can be done easily by changing only these covering parts.

The changing of said rear ring 20 and front ring 30 can be accomplished in just a few seconds without the need to touch or deactivate the airbag trigger mechanism and the parts that have been disassembled can easily be recycled along dedicated pathways. Changing two half-shells that are lightweight (weighing for example 200 grams) made of recyclable polymer in just a few seconds has far less of an environmental impact than removing a conventional steering wheel that is heavy (weighing for example over a kilo), triggering the airbag and then putting all of these inseparable and non-recyclable materials in with the waste.

According to one particular embodiment in which there is a wish to keep the used shells of the steering wheel after disassembly, and where the shells are clip-fastened, said rear ring clips 21 and front ring clips to 31 are designed to allow for disassembly. Advantageously, disassembly is performed using local pressure on the rear unclipping faces 21b and the front unclipping faces 31b. This pressure may advantageously be applied by means of a rod passed through a small-sized hole produced during the molding of said shells.

However, the invention is not restricted to fastening by means of screw-fastening and clip-fastening. Said rear ring 20, front ring 30, housing 40 and cover 50 may also be adhesively bonded, ultrasound welded, die-headed or assembled by other means to said frame 10, the fastening means being able to be combined with one another.

During assembly, rear ring ribs 22 of said rear ring 20 and front ring ribs 32 of said front ring 30 become lodged in grooves 15 belonging to said frame 10. This interlocking allows torque to be transferred between said rear ring 20 and front

ring 30, and said frame 10. Configured in this way, said ribs 22 and 32 work in shear, which allows a high torque to be transferred without the risk of breakage or of play between the rings and the frame.

According to the construction and embodiments set out in figures 1 to 6, the covering parts are preferably four in number: said rear ring 20, said front ring 30, said housing 40 and said cover 50. Said steering wheel 01 thus comprises five parts these being said frame 10 and the four covering parts. According to one particular embodiment, said rear ring 20 and said front ring 30 are identical, and therefore come from the same injection molding tooling. The four covering parts are thus injection molded using just three tooling fixtures, or even fewer in the case of the use of family molds. In this embodiment, said rear ring clips 21, front ring clips 31, rear ring rib 22 and front ring rib 32 have to be configured in a particular way in order for each of these elements to find its way into a clip-fastening cavity 13 or into a groove 15.

In one embodiment set out in figure 7, said rear ring 20 and said housing 40 form a single piece, and said front ring 30 and said cover 50 form a single piece. In this embodiment, the covering parts are two in number and said steering wheel 01 thus comprises three parts, these being said frame 10 and the two covering parts. In this case, the triggering of the airbag will necessitate the disassembly or detachment of the cover/front ring part.

Whatever the configuration and the way in which the covering parts are formed, a trim may be added as with the traditional steering wheel. This trim may be made from animal leather, imitation leather, vegan leather, orange-peel leather,

pineapple-skin leather (Pinatex), grape leather, Muskin, cork etc. The invention is not restricted to these trims which are given by way of nonlimiting examples.

A serrated cut 02 between said rear ring 20 and said front ring 30, as depicted in figure 8, may also give the illusion of there being a trim, by reproducing the pattern of a stitched seam.

The fact that said rear ring 20 and said front ring 30 are produced by injection molding rather than by overmolding said frame 10 makes it possible to have parts forming half-shells around said frame 10, thereby freeing up space inside said rear ring 20 and front ring 30. The space now free allows one or more electronic components to be incorporated into said rear ring 20 and front ring 30. This is not possible in the case of a conventional steering wheel, because the heat released and the chemical reaction accompanying the forming of the PU would fry, oxidize and/or destroy all the electrical or electronic components incorporated into said steering wheel 01, or in any case would be detrimental to the integrity of such components.

A steering wheel display 03 may thus be incorporated into said front ring 30, inserted into an opening 33 made in said front ring 30 as depicted in figures 10 and 12, so as to display information directly on the steering wheel, said steering wheel display 03 being able to be a screen, LEDs, or any other electrical or electronic display means. Said steering wheel display 03 may be fastened inside said steering wheel 01 using screws, clips, bonding, die-heading or any other means of fastening. Said steering wheel 01 may comprise just one or several openings 33 able to accommodate just one or several steering wheel displays 03 according to this configuration, as illustrated in figure 9.

Said front ring 30 may also be made from a translucent or transparent polymer allowing light to pass or diffusing light, for example from PMMA, SMMA, PC, PLA, copolyester or PET (or still other equivalent materials), the invention not being restricted to these materials alone. In that case, said steering wheel display 03 may be placed inside said steering wheel 01 in the space situated between said frame 10 and said front ring 30, as depicted in figure 11, without the need to create an opening, thus maintaining the smooth surface of said front ring 30 and protecting said steering wheel display from external elements such as liquids or any other element that could potentially damage them. Said steering wheel 01 may comprise just one or several steering wheel displays 03 according to this configuration.

In the same way, steering wheel displays 03 may also be mounted in said rear ring 20, housing 40 and cover 50, either through an opening or without an opening using one or more transparent parts to allow the light of said steering wheel display to pass through.

This novel function of the steering wheel allows use to be made of a large circular surface on part or the entirety of the periphery of said steering wheel 01, positioned at the best possible location close to the eyes of the driver and in the field of view on the fundamental component used for steering the vehicle. This function therefore creates a "head-up display" directly incorporated into the steering wheel. Support for the display elements (LEDs, screens, etc.) may advantageously be mechanically incorporated into said frame 10. The supply of electrical power as the steering wheel 01 turns is provided by the same rotary connector as is used for the horn or the airbag, namely the "clock spring". Light

collecting elements (for example solar cells) arranged for example on the rear ring 20 may also be provided for generating electrical energy used for the displays 03.

The covering parts 20, 30, 40, 50 may be used for collecting and/or diffusing light or for transmitting information to the user by illuminating segments. The information diffused may signal dangers, warnings, obstacles or cars slowing or changing lanes, indicate speed, acceleration, braking, battery state of charge, fuel fill level, turn signal flashing, signal an alarm regarding proximity, the crossing of a white line, departure beyond the boundaries of the roadway, a wrong turn, or any other information habitually displayed on the dashboard.

The invention contributes novel intuitive safety as light is produced directly on the steering wheel allowing a dangerous situation to be corrected using avoidance or other means without the driver diverting their gaze from the danger itself as the display is situated directly on the instrument by means of which the driver is able to alter the direction of the vehicle.

According to the invention, the state of charge of the battery may for example be displayed, and this may then be visible at a single glance through the windscreen from outside the motorcar. This highly visible information in the field of view of the driver and very close to their line of sight, after the manner of a head-up display, makes it possible to shorten the cognitive pathway and hierarchically rank driving information of fundamental importance to the driver. This head-up display differs from the display module behind the steering wheel or from the display module in the center of the vehicle which, for their part, contain secondary or infotainment information and/or more general

information intended for the passengers. The information close to the line of sight of the driver makes it possible to reduce the size of the information display, freeing up space in the cockpit.

According to one embodiment, said steering wheel 01 has display means over the entire periphery of said front ring 30 which then becomes a dial, and said steering wheel 01 is equipped with a sensor, for example an angular sensor or an accelerometer, enabling the on-board computer to know the position of said steering wheel 01 at any moment. The display may thus be set up so that the information diffused does not rotate even when the steering wheel is itself turning. For example, the vehicle speed is displayed at the top of said steering wheel 01 (see figure 9) when said steering wheel 01 and the wheels are straight. When the driver turns the steering wheel to the right by 10 degrees, the computer detects the rotation, and displays the speed 10 degrees further to the left, so that the speed is still displayed at the top of said steering wheel 01 even though the latter has been turned 10 degrees to the right. The invention is not restricted to this particular example given by way of illustration and this principle can be applied to any information displayed on the steering wheel.

By being coupled to a GPRS GPS positioning program/software, said steering wheel 01 is able to diffuse ultraprecise information regarding the direction to follow. For example, said steering wheel 01 may illuminate a segment of said steering wheel 20 degrees from the vertical to indicate to the driver that in order to take the next bend they will need to turn said steering wheel 01 by 20 degrees in order to bring said illuminated segment to the vertical. The invention is of course not restricted to this particular example given by way of illustration. Thus, in order to make a turn at a complex junction where there are two possible

roads and the driver has just a few tenths of a second to assimilate the information from their GPS, said driver has the navigation information directly in their field of view and does not need to refocus their gaze on the GPS screen that is usually situated on the windshield or on the dashboard. The steering wheel then becomes both a main navigational-information indicator and the instrument by which to steer the vehicle. The steering wheel may indicate whether the angle adopted by the vehicle is too great or not enough for following the correct direction, for example by displaying the direction-indicating cursor at an angle with respect to the vertical or by changing the color of said steering wheel 01 or the color of the cursor indicating the direction to follow. This feedback of information provides the driver with a great feeling of safety and of calmness brought about by the fact that the driver is reading directly and knows with certainty and with precision, by following the indications on the steering wheel, which direction to take. This certainty comes from the ultrashort cognitive circuit that requires very little movement on the part of the driver. It avoids the driver possibly panicking in the face of hesitation and therefore limits accidents. This feedback of information and this level of certainty regarding the information does not presently exist in any system.

With positioning software and anticipation software the invention makes it possible, in the case of a sports, for example rallying or rally raid steering wheel, to indicate precisely, in advance, and in the field of view of the driver (head-up display) the exact angle to which the steering wheel 01 needs to be turned the next bend. This information can support or replace the co-driver.

Said steering wheel 01, coupled to a GPRS GPS positioning software, to an angular-position sensor, and to a speed indicator, makes it possible to know

relatively precisely the position of the vehicle in space and therefore to reduce the exchanges of signals with the positioning satellite, thus limiting the energy consumption of the computational servers and reducing CO2 emissions.

A steering wheel with such display means may also be beneficial for learning to drive and serve as a learner-driver aid. It may teach how to follow smoother paths (without abrupt movements of the steering wheel), how to perform maneuvers or how to countersteer for example.

In the space now free between said frame 10 and said rear ring 20 and front ring 30, said steering wheel may incorporate other elements apart from displays, for example a vibrator which, in addition to lighting, is able to alert the driver either to their having exceeded the boundaries of the roadway, crossed a line, or taken a wrong turn. Coupled with a camera or other means of detecting whether the driver has their eyes open, said vibrator may also come into action if the driver closes their eyes, in an attempt to reawaken them.

Said steering wheel 01 may also contain a radar, a lidar or a camera. These components are used to film, when stationary or when driving, and help the vehicle to be steered. Incorporating them into said steering wheel 01 thus makes it possible to free up the windshield space otherwise occupied by these components.

The steering wheel according to the present invention may also be coupled to a "black box" of the vehicle and serve, in the event of an accident, to understand how the vehicle had maneuvered: for example information transmitted to the driver and driver reactions to said information.

Of course, the principles behind the invention can also be transferred to the field of gaming: for the steering wheels of driving and racing simulators for example.

The embodiments have been described with the purpose of providing an overall understanding of the principles of the structure, of the function, of the manufacture and of the use of the systems and methods described in the present application. One or more of these embodiments are illustrated in the attached drawings. The systems and methods specifically described in the present application and illustrated in the attached drawings are nonlimiting embodiments and the scope of the present invention is not defined solely by the claims. Features illustrated or described in connection with one embodiment may be combined with the features of other embodiments. Such modifications and variants are intended to be included within the scope of the present invention. A certain number of problems with the conventional methods and systems have been noted here and the methods and systems described here may address one or more of these problems. In addition, although this invention has been described in conjunction with a certain number of embodiments, the alternatives, modifications, equivalents and variants that fall within the spirit and scope of the present invention are also covered by the present application.

CLAIMS

- Claim 1: A steering wheel (01), for example for a motor vehicle, comprising a rigid frame (10), and thermoplastic first covering parts (20, 30) arranged as half-shells, said first covering parts being assembled on said frame (10) by fastening means, said first covering parts forming the covering of said frame (10) so that said steering wheel (01) can be gripped.
- Claim 2: The steering wheel (01) as claimed in claim 1, comprising thermoplastic second covering parts (40, 50), said second covering parts being assembled on said frame (10) by fastening means.
- Claim 3: The steering wheel (01) as claimed in claim 1 or 2, wherein said first covering parts comprise: a rear ring (20), a front ring (30), said second covering parts comprising a housing (40) and a cover (50), said frame (10) being sandwiched between said first and second covering parts, said first and second covering parts being fastened to one another and/or fastened directly to said frame, it being possible for said first covering parts and/or said second covering parts to be replaced quickly and easily.
- Claim 4: The steering wheel (01) as claimed in one of the preceding claims, comprising at least one steering wheel display (03) enabling luminous information and/or mood lighting to be diffused from said steering wheel (03) in the field of view of the driver.

- Claim 5: The steering wheel (01) as claimed in one of the preceding claims, wherein one or more of said covering parts is (are) transparent or translucent and enable luminous information and/or mood lighting to be diffused to the driver by transparency.
- Claim 6: The steering wheel (01) as claimed in one of claims 3 to 5, wherein said rear ring (20) and said front ring (30) are identical.
- Claim 7: The steering wheel (01) as claimed in one of the preceding claims 2 to 5, wherein said covering parts form a rear part (20, 40) and/or a front part (30, 50), said rear part comprising the rear ring (20) and the housing (40), and said front part comprising the front ring (30) and the cover (50).
- Claim 8: The steering wheel (01) as claimed in one of the preceding claims, wherein the covering parts are customization elements that can be easily interchanged.
- Claim 9: The steering wheel (01) as claimed in one of the preceding claims, wherein at least one covering part diffuses information in the form of luminous information indicating what direction to follow by reading it directly and intuitively off the steering wheel itself, off part or all of the peripheral circular surface of said steering wheel (01), thus shortening the cognitive circuit.

- Claim 10: The steering wheel (01) as claimed in one of the preceding claims, wherein the state of charge of the battery is diffused in the form of a luminous indication on the rear ring (20) of the steering wheel.
- Claim 11: The steering wheel (01) as claimed in one of the preceding claims, wherein the light diffused by the steering wheel is of high enough intensity to be visible from outside the vehicle, thus enabling the vehicle to be found with ease, for example in a parking lot containing a great many motor cars.
- Claim 12: The steering wheel (01) as claimed in one of the preceding claims, said steering wheel (01) being coupled to a GPRS GPS positioning software, to an angular-position sensor, and to a speed indicator so that a geographical position and/or an angular position and/or speed can be indicated on the steering wheel display (03).
- Claim 13: The steering wheel (01) as claimed in the preceding claim, comprising components of a GPS system and communicating directly through the windshield glass.
- Claim 14: The steering wheel (01) as claimed in claim 12 or 13, said steering wheel forming both a GPS driving aid and an instrument for turning the steered wheels of the vehicle indicating the direction-changes to be made.

- Claim 15: The steering wheel (01) as claimed in one of the preceding claims, wherein said frame (10) comprises a splined insert (101) and a frame main body (102) which are assembled in such a way as to be able to be disassembled.
- Claim 16: The steering wheel (01) as claimed in one of the preceding claims, comprising a serrated cut (02) to simulate the stitching of a trim element.
- Claim 17: A vehicle comprising a steering wheel as claimed in one of the preceding claims.
- Claim 18: A method for producing a steering wheel (01), for example for a motor vehicle, as claimed in one of the preceding claims, said method using neither thermoset resin nor overmolding.
- Claim 19: The method for producing a steering wheel, wherein
-) a rigid frame is produced,
 -) at least first covering parts are produced,
 -) the frame and the first covering parts are combined, using a form of assembly that can be disassembled, to form a steering wheel.
- Claim 20: The production method as claimed in one of claims 18 or 19, wherein the first covering parts can be disassembled without affecting the airbag.

- Claim 21: The method as claimed in one of claims 18 to 20, wherein the first covering parts comprise a front ring and a rear ring.
- Claim 22: The method as claimed in one of claims 18 to 21, wherein second covering parts which comprise a cover and a housing are produced and the frame and the second covering parts are combined using a form of assembly that can be disassembled.
- Claim 23: The method as claimed in one of claims 18 to 22, wherein the reversible assembly of the frame and of the first and second covering parts is achieved using clip-fastening and/or screw-fastening.
- Claim 24: The method as claimed in one of claims 18 to 23, wherein the first and second covering parts are made of thermoplastic(s).
- Claim 25: The method as claimed in the preceding claim, wherein the thermoplastic used for manufacturing the covering parts has an identified recycling pathway, advantageously being PET.
- Claim 26: The method as claimed in one of claims 18 to 25, wherein the first and second covering parts are produced by injection molding.
- Claim 27: The method as claimed in one of claims 21 to 26, wherein the front ring and the cover are formed as a single piece and/or the rear ring and the housing are formed as a single piece.

Claim 28: The method as claimed in one of claims 21 to 27, wherein in order to produce the rigid frame, a frame main body and a splined insert are produced and these are then assembled in a manner that allows for disassembly.