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**(54) VISION CAMERA FOR A DRIVER MONITORING SYSTEM AND METHOD FOR ASSEMBLING A VISION CAMERA**

SICHTKAMERA FÜR EIN FAHRER-ÜBERWACHUNGSSYSTEM UND VERFAHREN ZUR MONTAGE EINER SICHTKAMERA

CAMÉRA DE VISION POUR SYSTÈME DE SURVEILLANCE D'UN CONDUCTEUR ET PROCÉDÉ D'ASSEMBLAGE D'UNE CAMÉRA DE VISION

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(73) Proprietor: **Magna Electronics Sweden AB  
447 37 Vårgårda (SE)**

(72) Inventors:

- **URSACHI, Constantin  
700051 Iasi (RO)**
- **GIREADA, Alexandru  
700051 Iasi (RO)**

(74) Representative: **Reichert & Lindner  
Partnerschaft Patentanwälte  
Prüfeninger Straße 21  
93049 Regensburg (DE)**

(56) References cited:

**EP-A1- 3 982 197 US-A1- 2017 264 797**

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## Description

### FIELD OF THE INVENTION

**[0001]** The invention relates to a vision camera for a driver monitoring system. The vision camera comprises a housing and a cover. The housing carries a lens and a printed circuit board with IR diodes on either side of the lens. A printed circuit board for the camera is positioned in the housing.

**[0002]** Further, the invention relates to a method for assembling a vision camera for a driver monitoring system.

### DESCRIPTION OF THE BACKGROUND ART

**[0003]** The awareness of a driver of a vehicle is monitored by a Driver Monitoring System (DMS) based on a vision camera. According to the prior art, the vision camera is positioned inside the vehicle such that the driver is predictably in the center of the camera's field of view. Illumination is provided by an infrared light (IR) source, with the illumination positioned in the vicinity of the vision camera because the provided natural light is insufficient and the driver is not distracted by the IR illumination. The IR illumination is provided by IR diodes placed on two printed circuit boards (PCB) fixed with screws at a defined angle through a housing.

**[0004]** In the current configuration (see Fig. 2), the printed circuit boards are populated with connectors needed to power the IR diodes on the two printed circuit boards. Complicated assembly steps are needed to ensure the assembly of all these components and the electrical connections required for operation of the driver monitoring system. Automatic assembly of the vision camera is difficult to be implemented due to the wire connections between the different printed circuit boards of the housing for the vision camera. EP3982197A1 and US2017/264797A1 describe other driving monitoring systems based on a vision camera and IR illumination.

### SUMMARY OF THE INVENTION

**[0005]** It is an object of the present invention to provide a vision camera for a driver monitoring system which is easy to assemble and whose total number of parts is reduced.

**[0006]** The above object is achieved by a vision camera for a driver monitoring system according to the features of claim 1.

**[0007]** A further object of the present invention is to provide a method for assembling a vision camera for a driver monitoring system, which allows an automatization of the assembly steps and reduces the total number of parts.

**[0008]** The above object is achieved by a method for assembling a vision camera for a driver monitoring system according to the features of claim 12.

**[0009]** In an embodiment of the vision camera for a driver monitoring system according to the invention, the vision camera comprises a housing and a cover. The housing carrying a lens, a printed circuit board with IR diodes on either side of the lens, and a printed circuit board for the camera positioned in the housing.

**[0010]** An embodiment of the vision camera according to the invention comprises a bridge having an opening for the lens and an illumination opening. The illumination openings (e.g., two) are arranged on either side of the opening for the lens. A plurality of electrical connectors are integral parts of the bridge. The electrical connectors electrically contact the printed circuit board with IR diodes and the printed circuit board for the camera once the bridge is mounted to the housing of the vision camera.

**[0011]** This construction has the advantage of allowing automatic assembly of the vision camera and simplifying the overall architecture of the driver monitoring system is. During the assembly of the vision camera, it is ensured that all required electrical connections are established. Furthermore, a certain degree of mechanical protection for the 2-IR diodes is achieved.

**[0012]** According to a further embodiment, inside the housing, an ISP printed circuit board is electrically connected to the printed circuit board for the camera.

**[0013]** According to another embodiment of the invention, each of the plurality of electrical connectors of the bridge is in the form of a hook. A single electrical connector has a first contacting pin at a first free end and a second contacting pin at a second free end.

**[0014]** In an embodiment of the invention, the bridge is made by an injection molding process, and an injection molded plastic material of the bridge incorporates a plurality of at least partially embedded and overmolded electrical connectors. The overmolded electrical connectors are provided at a first end and a second end of the bridge.

**[0015]** In an embodiment of the invention, the first contacting pins of the electrical connectors, embedded in the bridge, electrically contact the printed circuit board with the IR diodes. The second contacting pins of the electrical connectors, embedded in the bridge, electrically contact the printed circuit board for the camera.

**[0016]** The advantage of such electrical connectors, embedded in the bridge, is that the electrical contact between the printed circuit board with the IR diodes and the printed circuit board for the camera is established during the insertion of the bridge into the housing. This eliminates the need for a screw connection by the housing and for connectors on the printed circuit boards of the vision camera.

**[0017]** According to an embodiment of the housing, an assembly surface for the lens is provided. Two cooling geometries are located laterally the assembly surface for the lens. At least one mounting feature for the bridge is located at or close to each cooling geometry.

**[0018]** With different materials and construction variations of at least the housing, good heat (thermal) man-

agement can be achieved.

**[0019]** According to an embodiment of the vision camera, the bridge has formed a plurality of individual and separated legs at a first end and a second end. At least two legs carry embedded and overmolded electrical connectors, or at least two of the embedded and overmolded electrical connectors are part of the individual legs. Each cooling geometry of the housing has formed a plurality of fins thereon. Between each of two successive fins, an individual mounting opening is formed. The mounting openings are arranged to receive the individual legs of the bridge. Each of the individual legs may have a section with a grip and press geometry that cooperates with the mounting opening.

**[0020]** The bridge, which is configured to add two printed circuit boards with IR diodes, may have various embodiments with respect to the number of legs with electrical connectors. The individual legs with the electrical connectors may carry injection moulded plastic press-fits (assembly features), which can cooperate with mounting openings of the housing.

**[0021]** According to a further embodiment of the vision camera, the bridge carries a one-piece leg at a first end and at a second end of the bridge. In the one-piece leg, at least two electrical connectors are embedded and overmolded and form an integral part of the one-piece leg. The cooling geometry on the housing has formed a plurality of fins and an elongated mounting opening. The two mounting openings are arranged to receive one of the two one-piece legs of the bridge. Each one-piece leg may have a section with an assembly feature that cooperates with the mounting opening so that the bridge is securely mounted to the housing.

**[0022]** The bridge may be manufactured using a plastic injection molding process. The electrical connectors are initially placed in the mold at locations where the electrical connectors should be present due the various types of the bridge. After the molding process is finished, a bridge may be used to ensure the electrical connection between the printed circuit board with IR diodes and printed circuit board for the camera. At least two electrical connectors are part of each leg of the bridge. The position and number of the electrical connectors in the legs may vary, so that different configurations of the bridge are possible.

**[0023]** Another advantage of the present invention is that the architecture of the vision camera allows modularity of the parts that make up the vision camera. Furthermore, the different versions of the bridges (number of electrical connectors embedded in the bridges) lead to a variation in the position and number of legs that allow the press-fits for mounting the bridges to the housing.

**[0024]** With the present invention it is possible to remove screw connections for assembling the printed circuit boards for the IR diodes and the printed circuit board for the camera on the housing and to eliminate the connectors between the printed circuit boards for the IR diodes and the printed circuit board for the camera. The bridge with the embedded connectors, according

to the invention, provides an electrical connection between the printed circuit boards for the IR diodes and the printed circuit board for the camera using the press-fit pins. The bridge results in a subassembly with three printed circuit board which are electrically connected.

**[0025]** A vision camera arrangement for a driver monitoring system comprises a vision camera installation according to any one of the preceding embodiments.

**[0026]** A method for assembling a vision camera for a driver monitoring comprises several steps. In a first step, a printed circuit board with IR diodes is mounted to each illumination opening of a bridge. Preferably, the bridge has two illumination openings on either side of an opening for a lens. An electrical connection to the printed circuit board with IR diodes is established, for example by means of first contacting pins of the electrical connectors, which are an integral part of the bridge. The electric connection is achieved by pressing the printed circuit boards with the IR diodes into the inside of the bridge. This temporarily fixes the printed circuit board with the IR diodes to the bridge.

**[0027]** In the next assembly step, the bridge with the printed circuit board with IR diodes is attached to the housing. The legs of the bridge may have sections with a grip and press geometry for mounting the bridge to the housing. The grip and press geometry of the legs cooperates with at least one respective mounting opening, provided on opposing sides of the housing, respectively, to securely fix the bridge to the housing. Preferably, the at least one mounting opening of the housing matches with the assembly feature or features of the legs.

**[0028]** In a third step, a printed circuit board for the camera is inserted into the housing, thus electrically connecting the printed circuit board to the bridge. For example, the printed circuit board for the camera is pressed against the legs of the bridge, causing second contacting pins to establish the electrical contact and securing the printed circuit board for the camera in the housing.

**[0029]** Next, an optical filter is slid into the housing and fixed with a screw.

**[0030]** Next, an ISP printed circuit board is placed in the housing and electrically connected to the printed circuit board for the camera. A cover is attached to the housing to close the bottom of the housing. For example, the ISP printed circuit board is fixed in the housing by the cover together with four screws (fastening elements) in each corner.

**[0031]** The last assembly step is to assemble the lens into the housing. Final adjustments may be made. After this final assembly step, the assembly of the vision camera is completed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0032]** The numerous advantages of the disclosure may be better understood by those skilled in the art by reference to the accompanying figures in which:

**Figure 1** shows an embodiment of an arrangement of a driver monitoring system inside a motor vehicle.

**Figure 2** shows an exemplary prior art design of a vision camera for a driver monitoring system.

**Figure 3** shows an exploded view of one embodiment of the vision camera according to one embodiment.

**Figure 4** shows the assembled vision camera according to the embodiment of Fig. 3.

**Figure 5** shows an exploded view of the vision camera according to a further embodiment.

**Figure 6** shows the assembled vision camera according to the embodiment shown in Fig. 5.

**Figure 7A** and **7B** show two different perspective views of a bridge according to one embodiment.

**Figure 8A** to **8C** show the installation process of the printed circuit boards to the bridge as shown in Fig. 7A and 7B.

**Figure 9A** to **9C** show perspective views of various embodiments of the electrical contacting of the printed circuit boards for the IR diodes.

**Figure 10A** to **10E** show an embodiment of the bridge with detailed views of various construction elements of the bridge.

**Figure 11A** and **11B** show various embodiments of the printed circuit boards for IR diodes.

**Figure 12** shows a perspective view of the housing for the camera of Fig. 4 with detailed views of specific housing features.

**Figure 13A** to **13F** show the mounting sequence of the bridge together with other components of the camera as shown in Fig. 3.

**Figure 14A** and **14B** show two different perspective views of a bridge according to a further embodiment.

**Figure 15** shows an embodiment of the printed circuit board for IR diodes used in conjunction with the bridge of Fig. 14.

**Figure 16A** and **16B** show the installation process of printed circuit boards to the bridge as shown in Fig. 14A and 14B.

**Figure 17A** and **17C** show various embodiments of the printed circuit boards for IR diodes.

**Figures 18A** to **D** show the bridge of Fig. 14 with detailed views of various construction elements of the bridge.

**Figure 19** is a perspective view of the housing for the camera of Fig. 6 with detailed views of specific housing features.

**Figure 20A** to **20F** show the mounting sequence of the further embodiment of bridge together with other components of the camera as shown in Fig. 5.

## DETAILED DESCRIPTION

15 **[0033]** In the ensuing description, numerous specific details are provided to enable maximum understanding of the embodiments that are provided by way of example. The embodiments may be implemented with or without specific details, or else with other methods, components,

20 materials, etc. In other circumstances, well-known structures, materials, or operations are not illustrated or described in detail so that various aspects of the embodiments will not be obscured. Reference in the course of the present description to "an embodiment" or "one embodiment" means that a particular structure, peculiarity, or characteristic described in connection with its imple-

25 mentation is comprised in at least one embodiment. Hence, phrases such as "in an embodiment" or "in one embodiment" that may recur in various points of the present description do not necessarily refer to one and the same embodiment. Furthermore, the particular structures, peculiarities, or characteristics may be combined in any convenient way in one or more embodiments.

30 **[0034]** Same reference numerals refer to same elements or elements of similar function throughout the various figures. Furthermore, only reference numerals necessary for the description of the respective figure are shown in the figures. The shown embodiments represent only examples of how the invention can be carried out.

35 40 This should not be regarded as a limitation of the invention.

45 **[0035]** **Figure 1** shows an embodiment of an arrangement of a driver monitoring system **1** (DMS) inside a motor vehicle **2**. The driver monitoring system **1** is mounted on or in the vicinity of a windshield **3** of motor vehicle **2**, so that at least one vision device of the driver monitoring system **1** is directed towards a driver **5** of the motor vehicle **2**. In particular, a lens **4** of the vision device, which is for example a vision camera, is directed towards driver **5**.

50 **[0036]** **Figure 2** shows an exemplary prior art design of a vision camera **10** for a driver monitoring system **1** (see Fig. 1). Vision camera **10** is positioned inside vehicle **2** such that driver **5** is predictably located in the center of vision camera's **10** field of view (not shown here). A housing **13** of vision camera **10** carries two printed circuit boards **11**, each of which is equipped with IR diodes **12** for illumination. The IR diodes **12**, which provide a source of

infrared (IR) light, are positioned in the vicinity a lens 4 of vision camera 10. A cover 14 closes housing 13. The printed circuit boards 11 with the IR diodes 12 are positioned at an angle defined by housing 13 and secured to housing 13 by screws 8.

[0037] **Figure 3** shows an exploded view according to one embodiment of the vision camera 10. Housing 13 is the basic carrier for the features of vision camera 10. The printed circuit boards 11 with the IR diodes 12 are attached to a bridge 20 and rest against housing 13 once bridge 20 is attached to housing 13. In addition, a lens 4 is inserted into housing 13. Opposite bridge 20, a printed circuit board 16 for the vision camera 10 and a printed circuit board 17 for in-system programming (ISP) are positioned in housing 13. An optical filter 15 is positioned between lens 4 and housing 13 and is fixed with a screw 8. Housing 13 is closed by a cover 14. Cover 14 is fixed to housing 13 by fasteners 18. The fasteners 18 may be screws.

[0038] **Figure 4** shows the assembled vision camera 10 according to the embodiment shown in Fig. 3. To avoid repetition and avoid unnecessarily lengthening the description, emphasis is placed on the embodiment of bridge 20 that cooperates with housing 13 to provide a functional embodiment of vision camera 10. A plurality of electrical connectors 23 are an integral part of bridge 20. The electrical connectors 23 provide electric power to the printed circuit boards 11 for the IR diodes 12 located behind respective illumination openings 22 of bridge 20. In addition, the electrical connectors 23 supply electric power to camera printed circuit board 16 (see Fig. 3), which is in housing 13. Lens 4 is located behind an opening 21 of bridge 20.

[0039] **Figure 5** shows an exploded view of the vision camera 10 according to a further embodiment. The embodiment shown here differs from the embodiment in Fig. 3 in that a further embodiment of the bridge 20 is used to assemble vision camera 10. All other features are known from the exploded view of Fig. 3.

[0040] **Figure 6** shows the assembled vision camera 10 according to the exploded view of the embodiment shown in Fig. 5. Openings 22 are formed in bridge 20 for the printed circuit boards 11 for the IR diodes 12. The printed circuit boards 11 are located behind the respective illumination openings 22 of bridge 20. Lens 4 is located behind an opening 21 of bridge 20. Once bridge 20 is mounted to housing 13, an electric connection is established between the camera printed circuit board 16 (see Fig. 3) and the printed circuit boards 11 for the IR diodes 12 by means of fully embedded electrical connectors 23 (see Figs. 7A+B, 8A-C.).

[0041] **Figure 7A** and **7B** show two different perspective views of a bridge 20 according to one embodiment used for assembling a vision camera 10 as shown in Fig. 4. The electrical connectors 23 are partially embedded and overmolded with the material, forming the bridge 20, which is manufactured by injection molding a plastic material. The electrical connectors 23 are an integral

part of bridge 20. The embedded and overmolded electrical connectors 23 form individual legs 28, each of which having a section 29 with a grip and press geometry that provide an assembly feature to housing 13. The electrical connectors 23 are arranged at a first end 41 and at a second end 42 of bridge 20. Each electrical connector 23 has a first contacting pin 24 formed at a first free end 25 and a second contacting pin 26 formed at a second free end 27. The first contacting pins 24 reach into the illumination openings 22 arranged on either side of opening 21 for lens 4.

[0042] **Figure 8A to 8C** show the installation process of the printed circuit boards 11 for IR diodes 12 to the bridge 20, as shown in Figs. 7A and 7B. A pair of locating pins 39 are formed near each illumination opening 22. The locating pins 39 are made of the same plastic material as the injection molded part of the bridge 20. Each printed circuit board 11 for IR diodes 12 is placed in relation to the illumination openings 22 of bridge 20, and at least the pair of locating pins 39 provide a press fit for the printed circuit boards 11 for IR diodes 12 and hold the printed circuit boards 11 for IR diodes 12 in place. The locating pins 39 ensure that the first contacting pins 24 reach into corresponding receptacles (not shown), wherein each recess 45 of the printed circuit boards 11 for IR diodes 12 takes-up the corresponding locating pin 39. In the embodiment shown here, bridge 20 has four legs 28 at the first end 41 and four other legs 28 at the second end 42 of bridge 20. It is obvious to a person skilled in the art that the number of legs 28 having electrical connectors 23 should not be considered a limitation of the invention. For the sake of description, four electrical connectors 23 are provided here.

[0043] **Figure 9A to 9C** show perspective views of various embodiments of the electrical contacting of the printed circuit boards 11 for the IR diodes 12. Two printed circuit boards 11 for the IR diodes 12 are connected to the bridge 20. The embodiments shown here do not have an overmolded electrical connector 23 in each leg 28. The various arrangements of the electrical connectors 23 provide different contacting capabilities for the printed circuit boards 11 attached to bridge 20.

[0044] **Figure 10A to 10E** show an embodiment of the bridge 20 with detailed views of various construction elements of bridge 20. The electrical connectors 23 shown in Fig. 10A, which are used in the embodiment of the bridge 20, have the form of a hook. Each electrical connector 23 has a first contacting pin 24 at a first free end 25 and a second contacting pin 26 at a second free end 27. The electrical connectors 23 are stamped from a sheet material and placed into the mold for overmolding in a press-fit manner.

[0045] The first end 41 or the second end 42 of bridge 20 is shown in Fig. 10B. The electrical connectors 23 form an integral part of bridge 20, but are not completely overmolded by a plastic material 50. The overmolding step does not cover the first contacting pins 24 at the first free end 25 and the second contacting pins 26 at second

free end 27 of electrical connector 23 (see Figs. 10B and 10C).

**[0046]** Fig. 10D shows that the individual legs 28 carry an overmolded section 29. Section 29, if an electrical connector 23 is present, is formed around electrical connector 23 and is a grip with a press geometry. Leg 28 has section 29 formed even if an electrical connector 23 is not present at a specific position. Section 29 having an assembly feature 46 in the form of the grip with the press geometry is necessary for assembling bridge 20 to housing 13.

**[0047]** The printed circuit boards 11 with the IR diodes 12 are mounted to bridge 20 at a location of the illumination openings 22 of bridge 20 (see Fig. 10E). The locating pin 39 (see Fig. 8A, the pair of locating pins 39) assist in aligning and assembling printed circuit board 11 with IR diodes 12 to the illumination openings 22 of bridge 20.

**[0048]** **Figure 11A** and **11B** show various embodiments of the printed circuit boards 11 for IR diodes 12. The printed circuit boards 11 need to be adapted by means of appropriate holes or recesses 45 for press fits, and the position and number of pins may be customized according to requirements.

**[0049]** The printed circuit boards 11 for IR diodes 12 have recesses 45 formed which facilitate positioning of the printed circuit board 11 at the defined position of bridge 20. When positioning the printed circuit board 11, the first contacting pins 24 (see Fig. 8A) reach through passages 47 formed in the printed circuit board 11. At least two passages 47 are formed in the printed circuit board 11. The number of passages 47 depends on the number of electrical connectors 23 that are part of bridge 20.

**[0050]** **Figure 12** is a perspective view of the housing 13 for the camera 10 of Fig. 4 with detailed views (Figs. 12A to 12C) of specific housing features. Preferably, the housing 13 is suitable for aluminum die casting technology. An assembly surface 30 for lens 4 (not shown) is placed on a base 31 of housing 13 and between cooling geometries 32 of housing 13 and has a rounded shape (see Fig. 12A). Each cooling geometry 32 has a plurality of fins 33 arranged in a fan shape and open to one side of each cooling geometry 32 (see also Fig. 12B). An individual mounting opening 34 is formed between two fins 33 (see Fig. 12C). The individual mounting openings 34 are arranged on each cooling geometry 32 such that they receive the individual legs 28 of the embodiment of bridge 20 as shown in Figs. 7A to 7B. With the cooling geometries 32, the plurality of fins 33 and the mounting openings 34, geometries for cooling and thermal paste dispensing are formed.

**[0051]** **Figures 13A** to **13F** show the mounting sequence of a bridge 20 together with other components of the vision camera 10 as shown in Fig. 3. In an initial step (see Fig. 13A), the printed circuit boards 11 with IR diodes 12 are mounted to each illumination opening 22 (see Figs. 8A to 8C) of a bridge 20. In this process, the printed circuit boards 11 with IR diodes 12 are electrically con-

nected by the bridge 20. The circuit boards 11 are temporarily fixed to bridge 20 until the next step. In the next step (see Fig. 13B), bridge 20 is assembled to housing 13 together with the printed circuit boards 11. Section 29 (see Figs. 7A and 7B), with a grip and press geometry of the individual legs 28, provides an assembly feature on the housing 13 that holds bridge 20 in contact with the housing 13. The contact (see Fig. 13C) between the housing 13 and the printed circuit boards 11, which are located at the bridge 20, is established by pressing bridge 20 with printed circuit boards 11 against the cooling geometry 32. In addition, the printed circuit board 16 for the camera 10 is also brought into electrical contact with the second contacting pins 26 (see Figs. 7A and 7B) of bridge 20. The cooling geometry 32 of housing 13 matches the bridge 20. Next, as shown in Fig. 13D, the optical filter 15 is slid into housing 13 and secured with a screw 8. Furthermore, ISP printed circuit board 17 is inserted into housing 13. Cover 14 is fixed to housing 13 together with four fasteners 18. The fasteners 18 are, for example, screws placed at each corner of cover 14. The final assembly step is to assemble lens 4 through opening 21 for lens 4 in bridge 20. After this final step, the assembly of vision camera 10 is complete.

**[0052]** **Figure 14A** and **14B** show two different perspective views of a bridge 20 according to another embodiment of a vision camera 10. As shown in Fig. 6, bridge 20 is mounted to housing 13 of vision camera 10. Bridge 20 carries a one-piece leg 36 at the first end 41 and an opposite one-piece leg 36 at the second end 42. Bridge 20 is formed by an injection molding process, and the electrical connectors 23 (see Fig. 18A) are completely embedded in the one-piece legs 36 of bridge 20 made of a plastic material. However, the injection molding process is such that the first contacting pins 24 and the second contacting pins 26 of the electrical connectors 23 are not covered by the plastic material of bridge 20. The contacting pins 24 reach out to an inside 49 of bridge 20. In addition, the locating pins 39 are formed on the inside 49 of bridge 20. Each one-piece leg 36, in the embodiment shown here, has four electrical connectors 23 being part of the one-piece leg 36. As already mentioned in the description of bridge 20 in Figs. 7A and 7B, the embodiment shown in Figs. 14A and 14B also has an opening 21 for lens 4 and an illumination opening 22 on both sides of the opening 21 for lens 4.

**[0053]** **Figure 15** shows an embodiment of the printed circuit board 11 for IR diodes 12 in conjunction with bridge 20 of Figs. 14A and 14B. Printed circuit board 11 has formed four passages 47 which can receive the second contacting pins 26 once the printed circuit board 11 is positioned in bridge 20.

**[0054]** **Figure 16A** and **16B** show the installation process of printed circuit board 11 to the bridge 20 as shown in Figs. 14A and 14B. Printed circuit board 11 is lowered along an arrow 60 to the inside 49 toward the illumination opening 22 until printed circuit board 11 covers illumination opening 22 and is then correctly positioned by means

of the locating pins 39 and the first contacting pins 24 reach through the passages 47 of printed circuit board 11. [0055] Figure 17A and 17C show various embodiments of the printed circuit boards 11 for the IR diodes 12. The embodiments differ by the number of passages 47 for the first contacting pins 24. In Fig. 17A, the corresponding printed circuit board 11 has four passages 47, meaning that the one-piece leg 36 has integrated four electrical connectors 23 and, consequently, four first contacting pins 24 (see, for example, the embodiment of Figs. 16A and 16B). In Fig. 17B, the corresponding printed circuit board 11 has two passages 47, which means that the one-piece leg 36 has integrated two electrical connectors 23 and, consequently, two first contacting pins 24. In Fig. 17C, the corresponding printed circuit board 11 has three passages 47, which means that the one-piece leg 36 has integrated two electrical connectors 23 and, consequently, three first contacting pins 24. The different embodiments of the printed circuit boards 11 depend on the particular application.

[0056] Figures 18A to 18D show bridge 20 of Fig. 14 with detailed views of various structural elements of bridge 20. Electrical connector 23, which is part of bridge 20, is shown in Fig. 18A. Electrical connector 23 is also in the form of a hook. For example and as shown in Fig. 18A, electrical connector 23 is designed as a press-fit electrical connector having two bends initially placed in the mold (not shown). Each electrical connector 23 has a first contacting pin 24 at a first free end 25 and a second contacting pin 26 at a second free end 27. The electrical connectors 23 are placed in the mold for overmolding in a press-fit manner to form the bridge 20 with the one-piece legs 36. Fig. 18B shows a geometry 43, which is attached to each one-piece leg 36. Geometry 43 is used to mount bridge 20 with the attached printed circuit boards 11 (see Fig. 16B) to housing 13. Each one-piece leg 36 has an assembly feature 45 in a section 29 that is used to mount bridge 20 to housing 13 (see Fig. 18C). Preferably, geometry 43 is a grip and press geometry as previously described, i.e., which cooperates with mounting opening 34 to mount bridge 20 to housing 13. Fig. 18D shows a section through the inside 49 of bridge 20. The locating pin 39 on the inside 49 is used to position printed circuit board 11 (see Fig. 16B).

[0057] Figure 19 is a perspective view of the housing 13 for camera 10 of Fig. 6 with detailed views (Figs. 19A to 19C) of specific housing features. Preferably, housing 13 is suitable for aluminum die casting technology. An assembly surface 30 for lens 4 (not shown), which has a rounded shape (see Fig. 19A), is placed between cooling geometries 32 of housing 13. Each cooling geometry 32 has a plurality of parallel fins 33, which are open to one side of each cooling geometry 32. Following the parallel fins 33, a mounting opening 34 (see Fig. 19C) with an elongated shape is formed in housing 13. The mounting opening 34 of housing 13 cooperates with assembly feature 45 in section 29 of the one-piece leg 36 of bridge 20. The two mounting openings 34 each receive the one-

piece leg 36 of bridge 20 to mount bridge 20 to housing 13. With the cooling geometries 32, the plurality of fins 33 and the mounting openings 34, geometries for cooling and thermal paste dispensing are formed.

5 [0058] Figure 20A to 20F show the mounting sequence of bridge 20 together with other components of vision camera 10 as shown in Fig. 5. In an initial step (see Fig. 20A), the printed circuit boards 11 with IR diodes 12 are mounted to each illumination opening 22 of a bridge 10 10 20 (see Figs. 16A to 16b). In this process, the printed circuit boards 11 with IR diodes 12 are electrically connected by bridge 20. The circuit boards 11 are temporarily fixed to bridge 20 until the next step. In the next step (see Fig. 20B), bridge 20 is inserted into the cooling geometries 15 32 of housing 13 together with the printed circuit boards 11. Section 29 (see Fig. 18C) with assembly feature 45 of one-piece leg 36 is mounted to the housing 13 and holds bridge 20 in contact with housing 13. The contact (see Fig. 20C) between the cooling geometries 20 32 of housing 13 and the printed circuit boards 11, which are located on bridge 20, is established by pressing the bridge 20 with printed circuit boards 11 against the cooling geometry 32. Also, the printed circuit board 16 for the camera 10 is brought in electrical contact with the second contacting pins 26 (see Figs. 16A und 16B) of bridge 20. Next, as shown in Fig. 20D, the optical filter 15 is slid into the housing 13 and secured with a screw 8. Further, the ISP printed circuit board 17 is placed in housing 13. Cover 14 is attached to housing 13 together with four fasteners 18. Fasteners 18 are, for example, screws placed at each corner of cover 14. The final assembly step is to assemble lens 4 through opening 21 for lens 4 in the bridge 20. After this final step, the assembly of vision camera 10 is completed.

35 [0059] It is believed that the present disclosure and many of its attendant advantages will be understood by the foregoing description, and it will be apparent that various changes may be made in the form, construction, number and arrangement of the components without departing from the disclosed subject matter or without sacrificing all of its material advantages. The form described is merely explanatory, and it is the intention of the following claims to encompass and include such changes. Accordingly, the scope of the invention should 40 be limited only by the claims appended hereto.

#### LIST OF REFERENCE NUMERALS

##### [0060]

- |    |                          |
|----|--------------------------|
| 1  | driver monitoring system |
| 2  | motor vehicle            |
| 3  | windshield               |
| 4  | lens                     |
| 5  | driver                   |
| 8  | screw                    |
| 10 | camera                   |
| 11 | printed circuit board    |

12 IR diode  
 13 housing  
 14 cover  
 15 filter  
 16 printed circuit board for the camera  
 17 ISP printed circuit board  
 18 fastener  
 20 bridge  
 21 opening for lens  
 22 illumination opening  
 23 electrical connector  
 24 first contacting pin  
 25 first free end  
 26 second contacting pin  
 27 second free end  
 28 leg  
 29 section  
 30 assembly surface  
 31 base  
 32 cooling geometry  
 33 fin  
 34 mounting opening  
 36 one-piece leg  
 39 locating pin  
 41 first end  
 42 second end  
 43 geometry  
 45 recess  
 46 assembly feature  
 47 passage  
 49 inside  
 50 plastic material  
 60 arrow

### Claims

1. A vision camera (10) for a driver monitoring system (1), comprising

a housing (13), and  
 a cover (14),  
 the housing (13) carrying a lens (4), a printed circuit board (11) with IR diodes (12) on either side of the lens (4), and a printed circuit board (16) for the camera (10) positioned in the housing (13),

#### characterized by

a bridge (20) having an opening (21) for the lens (4) and an illumination opening (22) on either side of the opening (21) for the lens (4); and  
 a plurality of electrical connectors (23) that are an integral part of the bridge (20) and electrically contact the printed circuit board (11) with IR diodes (12) and the printed circuit board (16) for the camera (10) once the bridge (20) is mounted to the housing (13).

2. The vision camera (10) as claimed in claim 1, where-

in inside the housing (13), an ISP printed circuit board (17) is electrically connected to the printed circuit board (16) for the camera (10).

- 5 3. The vision camera (10) as claimed in any one of the preceding claims, wherein each of the plurality electrical connectors (23) of the bridge (20) is in the form of a hook having a first contacting pin (24) at a first free end (25) and a second contacting pin (26) at a second free end (27).
- 10 4. The vision camera (10) as claimed in claim 3, wherein the bridge (20) comprises an injection molded plastic material having a plurality of at least partially embedded and overmolded electrical connectors (23) provided at a first end (41) and a second end (42) of the bridge (20).
- 15 5. The vision camera (10) as claimed in claim 4, wherein the first contacting pins (24) of the electrical connectors (23), embedded in the bridge (20), electrically contact the printed circuit board (11) with the IR diodes (12), and the second contacting pins (26) of the electrical connectors (23), embedded in the bridge (20), electrically contact the printed circuit board (16) for the camera (10).
- 20 6. The vision camera (10) as claimed in any one of the preceding claims, wherein the housing (13) has formed an assembly surface (30) for the lens (4), two cooling geometries (32) located laterally the assembly surface (30) and at least one mounting feature (34) for the bridge (20) located at each cooling geometry (32).
- 25 7. The vision camera (10) as claimed in any one of the preceding claims, wherein individual legs (28) are formed at a first end (41) and a second end (42) of the bridge (20), wherein at least two of the embedded and overmolded electrical connectors (23) are part of the individual legs (28), and each cooling geometry (32) has formed a plurality of fins (33) thereon, wherein an individual mounting opening (34) is formed between each of two successive fins (33) arranged to receive the individual legs (28) of the bridge (20).
- 30 8. The vision camera (10) as claimed in claim 7, wherein each of the individual legs (28) comprises a section (29) with a grip and press geometry that cooperates with the mounting opening (34).
- 35 9. The vision camera (10) as claimed in any one of claims 1 to 6, wherein at a first end (41) and a second end (42) of the bridge (20), the at least two embedded and overmolded electrical connectors (23) together form a one-piece leg (36), and each cooling geometry (32) has formed a plurality of fins (33) and

an elongated mounting opening (38), which is arranged to receive the one-piece leg (36) of the bridge (20).

10. The vision camera (10) as claimed in claim 9, where-  
in each one-piece leg (36) has a section (29) with an  
assembly feature (45) cooperating with the mounting  
opening (38). 5

11. A vision camera arrangement for a driver monitoring  
system (1) comprising a vision camera (10) accord-  
ing to any one of the preceding claims. 10

12. A method for assembling a vision camera (10) for a  
driver monitoring system comprising the steps of: 15

mounting a printed circuit board (11) with IR  
diodes (12) to each illumination opening (22)  
of a bridge (20) and electrically connecting the  
printed circuit board (11) with IR diodes (12),  
attaching the bridge (20) with the printed circuit  
board (11) with IR diodes (12) to the housing  
(13);  
inserting a printed circuit board (16) for the cam-  
era (10) into the housing (13) and electrically  
connecting the printed circuit board (16) to the  
bridge (20);  
sliding an optical filter (9) into the housing (13)  
and securing the optical filter (9) in the housing  
(13);  
placing an ISP printed circuit board (17) in the  
housing and electrically connecting it to the  
printed circuit board (16) for the camera (10),  
and attaching a cover (14) to the housing (13);  
and  
assembling a lens (4) into the housing (13). 20

13. The method as claimed in claim 12, wherein the  
electric connection of the printed circuit board (11)  
with IR diodes (12) is established by means of first  
contacting pins (24). 25

14. The method as claimed in claim 12, wherein the  
electric connection of the printed circuit board (16)  
for the camera (10) is established by means of  
second contacting pins (26). 30

15. The method as claimed in any one of claims 12 to 14,  
wherein the bridge (20) comprises sections (29)  
having a grip and press geometry for mounting the  
bridge (20) to the housing (13). 35

#### Patentansprüche

1. Eine Sichtkamera (10) für ein Fahrerüberwachungs-  
system (1), mit ein Gehäuse (13), und

eine Abdeckung (14),  
wobei das Gehäuse (13) eine Linse (4), eine  
gedruckte Schaltungsplatte (11) mit IR-Dioden  
(12) auf beiden Seiten der Linse (4) und eine  
gedruckte Schaltungsplatte (16) für die Kamera  
(10) trägt, die in dem Gehäuse (13) angeordnet  
ist,

#### gekennzeichnet durch

eine Brücke (20) mit einer Öffnung (21) für die  
Linse (4) und einer Beleuchtungsöffnung (22)  
auf beiden Seiten der Öffnung (21) für die Linse  
(4); und

eine Vielzahl von elektrischen Verbindern (23),  
die ein integraler Bestandteil der Brücke (20)  
sind und die gedruckte Schaltungsplatte (11) mit  
IR-Dioden (12) und die gedruckte Schaltungs-  
platte (16) für die Kamera (10) elektrisch kontak-  
tieren, sobald die Brücke (20) an dem Gehäuse  
(13) montiert ist. 20

2. Die Sichtkamera (10) nach Anspruch 1, wobei inner-  
halb des Gehäuses (13) eine ISP-Leiterplatte (17)  
mit der gedruckten Schaltungsplatte (16) für die  
Kamera (10) elektrisch verbunden ist. 25

3. Die Sichtkamera (10) nach einem der vorhergeh-  
enden Ansprüche, wobei jeder der Vielzahl von  
elektrischen Verbindern (23) der Brücke (20) die  
Form eines Hakens mit einem ersten Kontaktie-  
rungsstift (24) an einem ersten freien Ende (25)  
und einem zweiten Kontaktierungsstift (26) an einem  
zweiten freien Ende (27) aufweist. 30

4. Die Sichtkamera (10) nach Anspruch 3, wobei die  
Brücke (20) ein spritzgegossenes Kunststoffmate-  
rial mit einer Vielzahl von zumindest teilweise ein-  
gebetteten und umspritzten elektrischen Verbindern  
(23) umfasst, die an einem ersten Ende (41) und  
einem zweiten Ende (42) der Brücke (20) vorgese-  
hen sind. 35

5. Die Sichtkamera (10) nach Anspruch 4, wobei die  
ersten Kontaktierungsstifte (24) der in der Brücke  
(20) eingebetteten elektrischen Verbinder (23) die  
gedruckte Schaltungsplatte (11) mit den IR-Dioden  
(12) elektrisch kontaktieren, und die zweiten Kon-  
taktierungsstifte (26) der in der Brücke (20) einge-  
betteten elektrischen Verbinder (23) die gedruckte  
Schaltungsplatte (16) für die Kamera (10) elektrisch  
kontaktieren. 40

6. Die Sichtkamera (10) nach einem der vorhergeh-  
enden Ansprüche, wobei das Gehäuse (13) eine  
Montagefläche (30) für die Linse (4), zwei seitlich  
der Montagefläche (30) angeordnete Kühlgeomet-  
rien (32) und mindestens ein an jeder Kühlgeometrie  
(32) angeordnetes Montageelement (34) für die Brü-  
cke (20) aufweist. 45

7. Die Sichtkamera (10) nach einem der vorhergehenden Ansprüche, wobei einzelne Schenkel (28) an einem ersten Ende (41) und einem zweiten Ende (42) der Brücke (20) ausgebildet sind, wobei mindestens zwei der eingebetteten und umspritzten elektrischen Verbinder (23) Teil der einzelnen Schenkel (28) sind, und jede Kühlgeometrie (32) eine Vielzahl von Rippen (33) darauf ausgebildet hat, wobei eine einzelne Montageöffnung (34) zwischen jeder von zwei aufeinanderfolgenden Rippen (33) ausgebildet ist, die angeordnet ist, um die einzelnen Schenkel (28) der Brücke (20) aufzunehmen. 5
8. Die Sichtkamera (10) nach Anspruch 7, wobei jeder der einzelnen Schenkel (28) einen Abschnitt (29) mit einer Greif- und Druckgeometrie aufweist, der mit der Montageöffnung (34) zusammenwirkt. 10
9. Die Sichtkamera (10) nach einem der Ansprüche 1 bis 6, wobei an einem ersten Ende (41) und einem zweiten Ende (42) der Brücke (20) die mindestens zwei eingebetteten und umspritzten elektrischen Verbinder (23) zusammen einen einteiligen Schenkel (36) bilden, und jede Kühlgeometrie (32) eine Vielzahl von Rippen (33) und eine längliche Montageöffnung (38) ausgebildet hat, die zur Aufnahme des einteiligen Schenkels (36) der Brücke (20) angeordnet ist. 15
10. Die Sichtkamera (10) nach Anspruch 9, wobei jeder einteilige Schenkel (36) einen Abschnitt (29) mit einem Montagemerkmal (45) aufweist, das mit der Montageöffnung (38) zusammenwirkt. 20
11. Eine Sichtkameraanordnung für ein Fahrerüberwachungssystem (1) mit einer Sichtkamera (10) nach einem der vorhergehenden Ansprüche. 30
12. Ein Verfahren zum Zusammenbau einer Sichtkamera (10) für ein Fahrerüberwachungssystem, die folgenden Schritte umfassend: 35
- Montieren einer gedruckten Schaltungsplatte (11) mit IR-Dioden (12) an jeder Beleuchtungsöffnung (22) einer Brücke (20) und elektrisches Verbinden der gedruckten Schaltungsplatte (11) mit IR-Dioden (12); 40
- Anbringen der Brücke (20) mit der gedruckten Schaltungsplatte (11) mit IR-Dioden (12) an dem Gehäuse (13); 45
- Einsetzen einer gedruckten Schaltungsplatte (16) für die Kamera (10) in das Gehäuse (13) und elektrisches Verbinden der gedruckten Schaltungsplatte (16) mit der Brücke (20); 50
- Einschieben eines optischen Filters (9) in das Gehäuse (13) und Befestigen des optischen Filters (9) in dem Gehäuse (13); 55
- Einsetzen einer ISP-Leiterplatte (17) in das Ge- häuse und elektrisches Verbinden dieser mit der gedruckten Schaltungsplatte (16) für die Kamera (10) und Anbringen einer Abdeckung (14) am Gehäuse (13); und
- Einsetzen einer Linse (4) in das Gehäuse (13). 5
13. Das Verfahren nach Anspruch 12, wobei die elektrische Verbindung der gedruckten Schaltungsplatte (11) mit IR-Dioden (12) mittels erster Kontaktierungsstifte (24) hergestellt wird. 10
14. Das Verfahren nach Anspruch 12, wobei die elektrische Verbindung der gedruckten Schaltungsplatte (16) für die Kamera (10) mittels zweiter Kontaktierungsstifte (26) hergestellt wird. 15
15. Das Verfahren nach einem der Ansprüche 12 bis 14, wobei die Brücke (20) Abschnitte (29) mit einer Greif- und Pressgeometrie zur Montage der Brücke (20) an dem Gehäuse (13) aufweist. 20

### Revendications

25. 1. Une caméra de vision (10) pour un système de surveillance du conducteur (1), comprenant un boîtier (13), et un couvercle (14), le boîtier (13) portant une lentille (4), une carte de circuit imprimé (11) avec des diodes IR (12) de chaque côté de la lentille (4), et une carte de circuit imprimé (16) pour la caméra (10) positionnée dans le boîtier (13), **caractérisée par** un pont (20) comportant une ouverture (21) pour la lentille (4) et une ouverture d'illumination (22) de chaque côté de l'ouverture (21) pour la lentille (4) ; et une pluralité de connecteurs électriques (23) qui font partie intégrante du pont (20) et qui sont en contact électrique avec la carte de circuit imprimé (11) avec des diodes IR (12) et la carte de circuit imprimé (16) pour la caméra (10) une fois que le pont (20) est monté sur le boîtier (13).
2. La caméra de vision (10) selon la revendication 1, dans laquelle, à l'intérieur du boîtier (13), une carte de circuit imprimé ISP (17) est connectée électrique- 50
- ment à la carte de circuit imprimé (16) pour la caméra (10).
3. La caméra de vision (10) selon l'une quelconque des revendications précédentes, dans laquelle chacun de la pluralité de connecteurs électriques (23) du pont (20) se présente sous la forme d'un crochet comportant une première broche de contact (24) à une première extrémité libre (25) et une deuxième 55

- broche de contact (26) à une deuxième extrémité libre (27).
4. La caméra de vision (10) selon la revendication 3, dans laquelle le pont (20) comprend une matière plastique moulée par injection comportant une pluralité de connecteurs électriques (23) au moins partiellement encastrés et surmoulés, prévus à une première extrémité (41) et à une deuxième extrémité (42) du pont (20).
5. La caméra de vision (10) selon la revendication 4, dans laquelle les premières broches de contact (24) des connecteurs électriques (23), encastrées dans le pont (20), sont en contact électrique avec la carte de circuit imprimé (11) avec les diodes IR (12), et les deuxièmes broches de contact (26) des connecteurs électriques (23), encastrées dans le pont (20), sont en contact électrique avec la carte de circuit imprimé (16) pour la caméra (10).
6. La caméra de vision (10) selon l'une quelconque des revendications précédentes, dans laquelle le boîtier (13) a formé une surface d'assemblage (30) pour la lentille (4), deux géométries de refroidissement (32) situées latéralement à la surface d'assemblage (30) et au moins un élément de montage (34) pour le pont (20) situé au niveau de chaque géométrie de refroidissement (32).
7. La caméra de vision (10) selon l'une quelconque des revendications précédentes, dans laquelle des jambes individuelles (28) sont formées à une première extrémité (41) et à une deuxième extrémité (42) du pont (20), dans laquelle au moins deux des connecteurs électriques encastrés et surmoulés (23) font partie des jambes individuelles (28), et chaque géométrie de refroidissement (32) a formé une pluralité d'ailerons (33) formées sur celle-ci, dans laquelle une ouverture de montage individuelle (34) est formée entre chacune des deux ailerons successives (33) agencées pour recevoir les jambes individuelles (28) du pont (20).
8. La caméra de vision (10) selon la revendication 7, dans laquelle chacune des jambes individuelles (28) comprend une section (29) avec une géométrie de préhension et de pression qui coopère avec l'ouverture de montage (34).
9. La caméra de vision (10) selon l'une quelconque des revendications 1 à 6, dans laquelle, à une première extrémité (41) et à une deuxième extrémité (42) du pont (20), les au moins deux connecteurs électriques encastrés et surmoulés (23) forment ensemble une jambe monobloc (36), et chaque géométrie de refroidissement (32) a formé une pluralité d'ailerons (33) et une ouverture de montage allongée (38), qui
- 5 est agencée pour recevoir la jambe monobloc (36) du pont (20).
10. La caméra de vision (10) selon la revendication 9, dans laquelle chaque jambe monobloc (36) comporte une section (29) avec une caractéristique d'assemblage (45) coopérant avec l'ouverture de montage (38).
- 10 11. Un agencement de caméra de vision pour un système de surveillance du conducteur (1) comprenant une caméra de vision (10) selon l'une quelconque des revendications précédentes.
- 15 12. Un procédé d'assemblage d'une caméra de vision (10) pour un système de surveillance du conducteur, comprenant les étapes consistant à :
- 20 monter une carte de circuit imprimé (11) avec des diodes IR (12) sur chaque ouverture d'illumination (22) d'un pont (20) et connecter électriquement la carte de circuit imprimé (11) avec des diodes IR (12) ;  
fixer le pont (20) avec la carte de circuit imprimé (11) avec des diodes IR (12) au boîtier (13) ;  
insérer une carte de circuit imprimé (16) pour la caméra (10) dans le boîtier (13) et connecter électriquement la carte de circuit imprimé (16) au pont (20) ;  
glisser un filtre optique (9) dans le boîtier (13) et fixer le filtre optique (9) dans le boîtier (13) ;  
placer une carte de circuit imprimé ISP (17) dans le boîtier et la connecter électriquement à la carte de circuit imprimé (16) pour la caméra (10), et fixer un couvercle (14) au boîtier (13) ; et assembler une lentille (4) dans le boîtier (13).
- 30 13. Le procédé selon la revendication 12, dans lequel la connexion électrique de la carte de circuit imprimé (11) avec des diodes IR (12) est établie au moyen de premières broches de contact (24).
- 35 14. Le procédé selon la revendication 12, dans lequel la connexion électrique de la carte de circuit imprimé (16) pour la caméra (10) est établie au moyen de deuxièmes broches de contact (26).
- 40 15. Le procédé selon l'une quelconque des revendications 12 à 14, dans lequel le pont (20) comprend des sections (29) présentant une géométrie de préhension et de pression pour monter le pont (20) sur le boîtier (13).
- 50
- 55

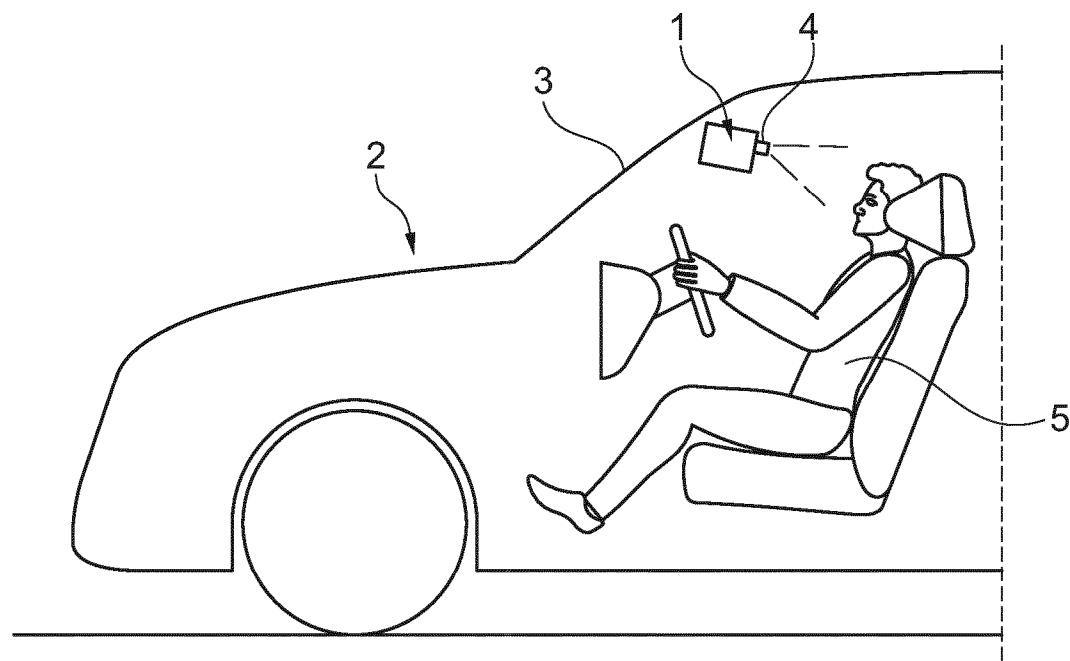
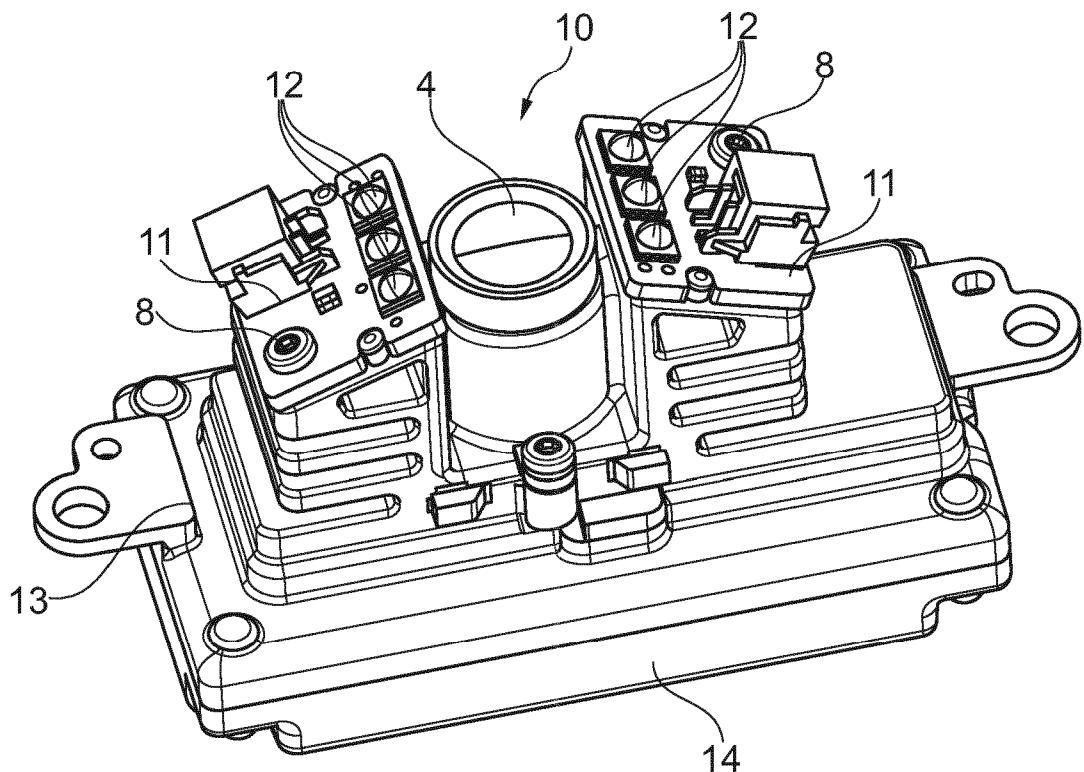


Fig. 1



Prior Art

Fig. 2

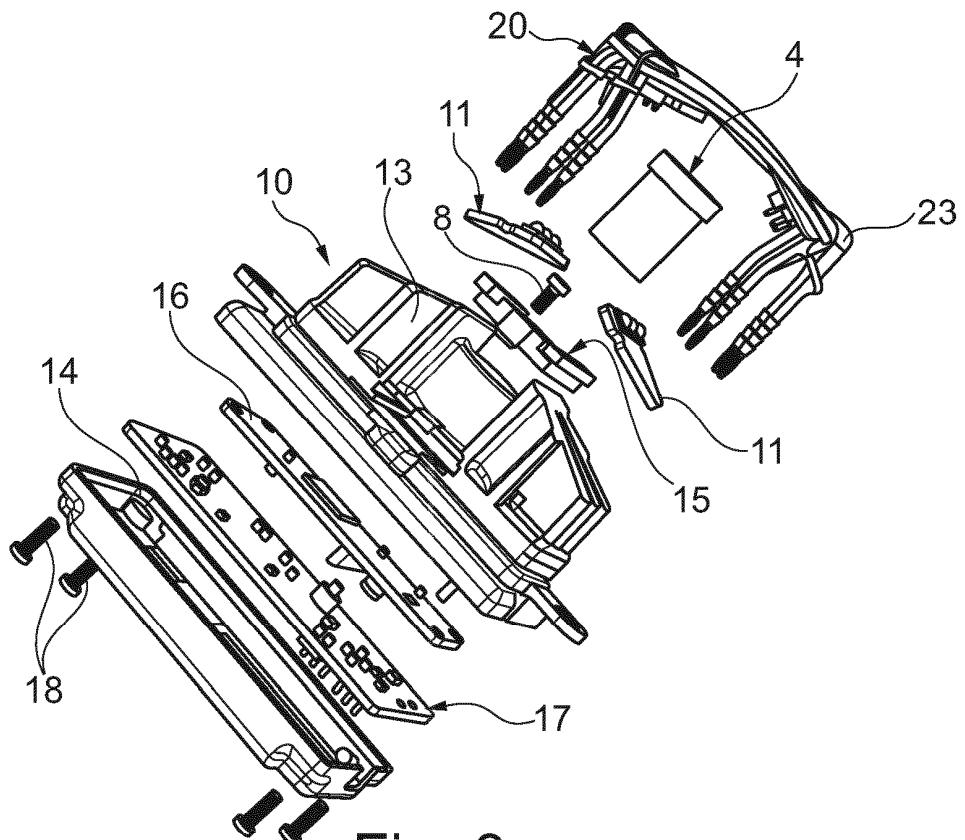


Fig. 3

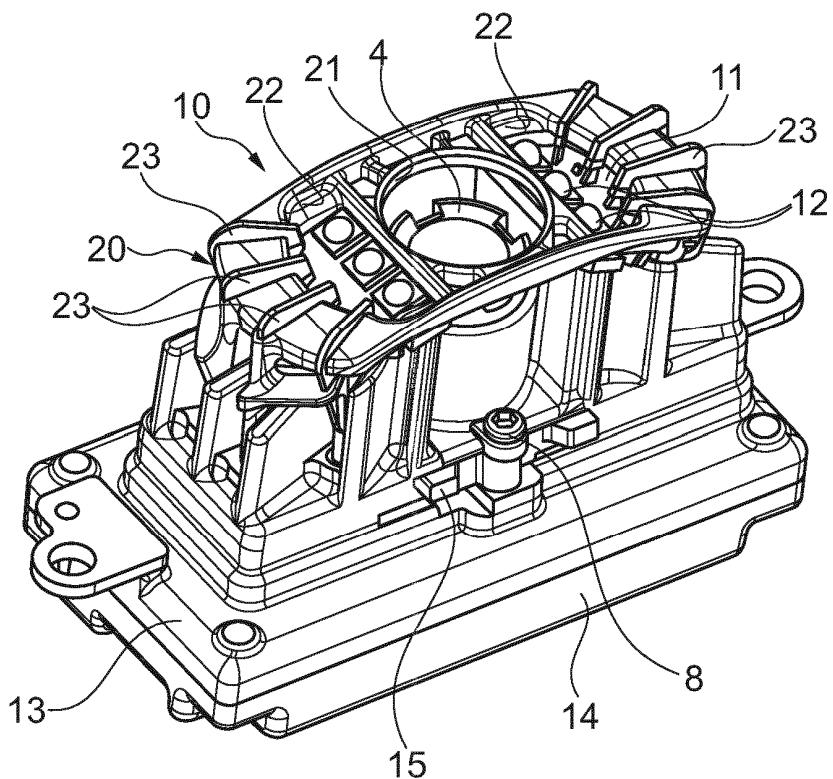


Fig. 4

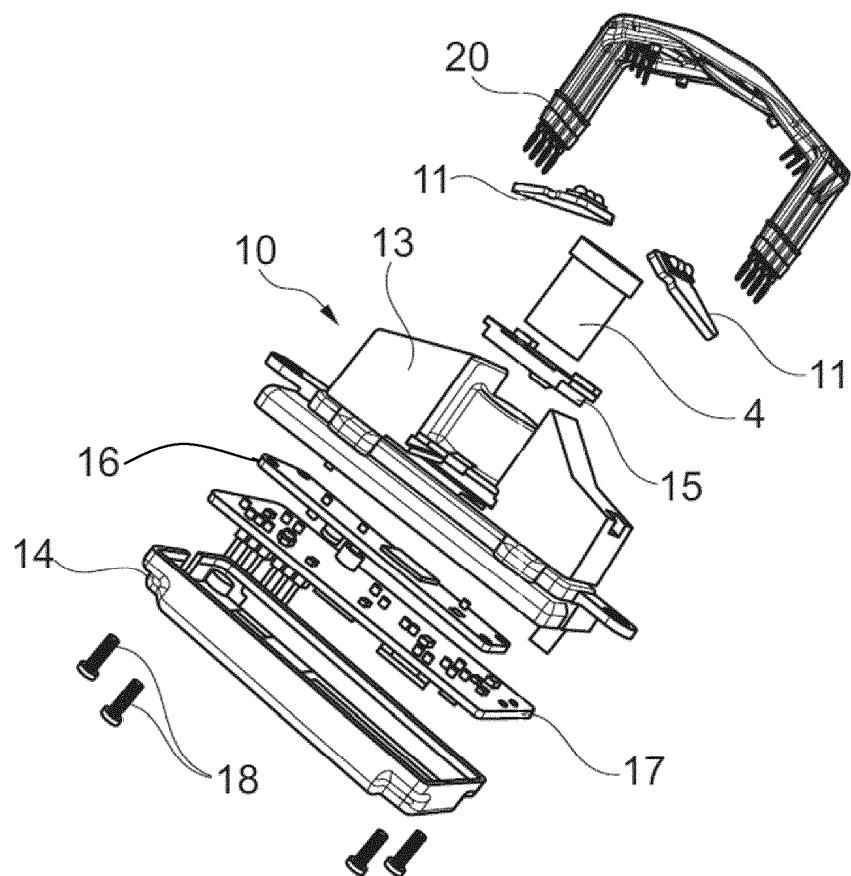


Fig. 5

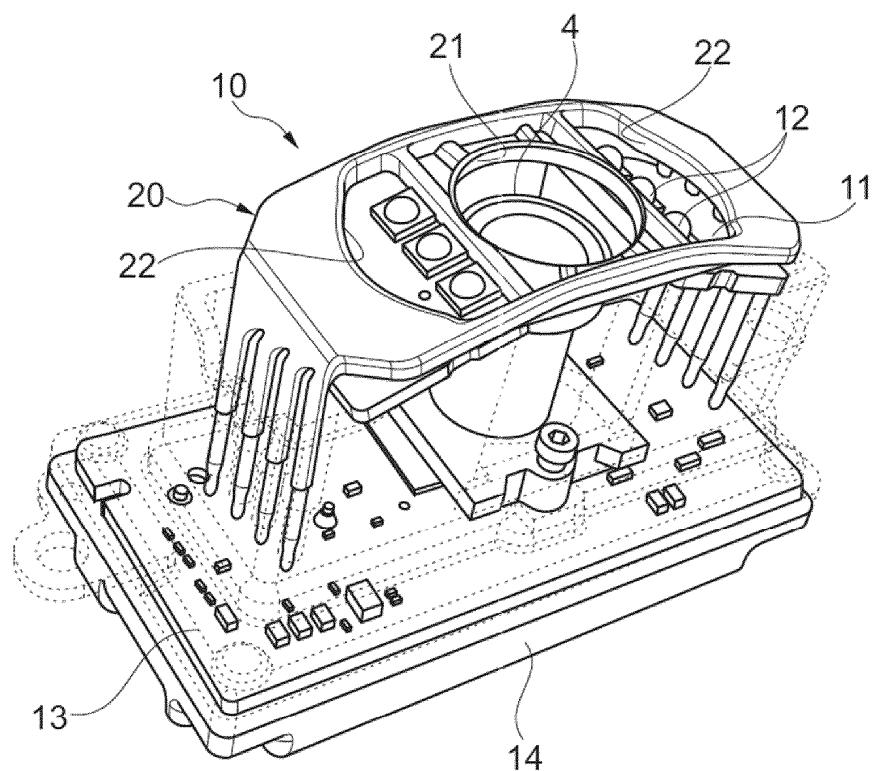


Fig. 6

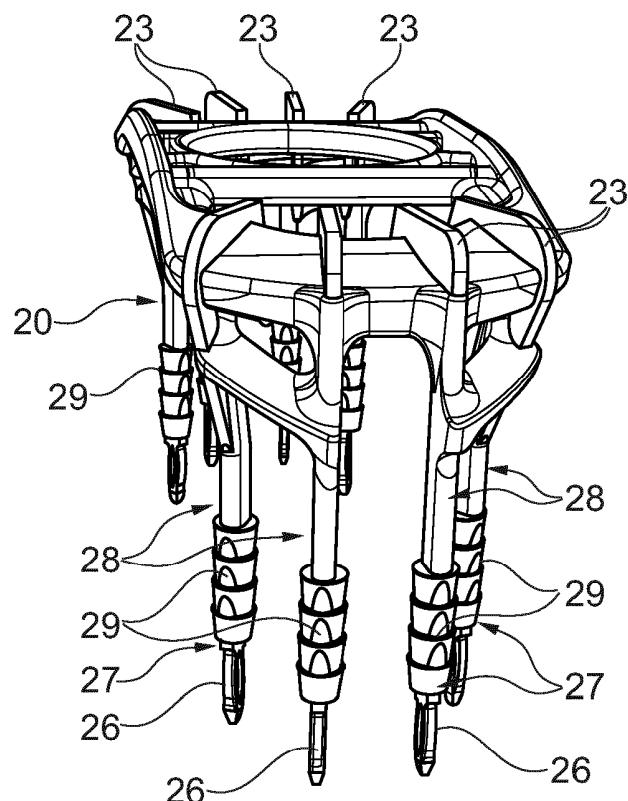


Fig. 7A

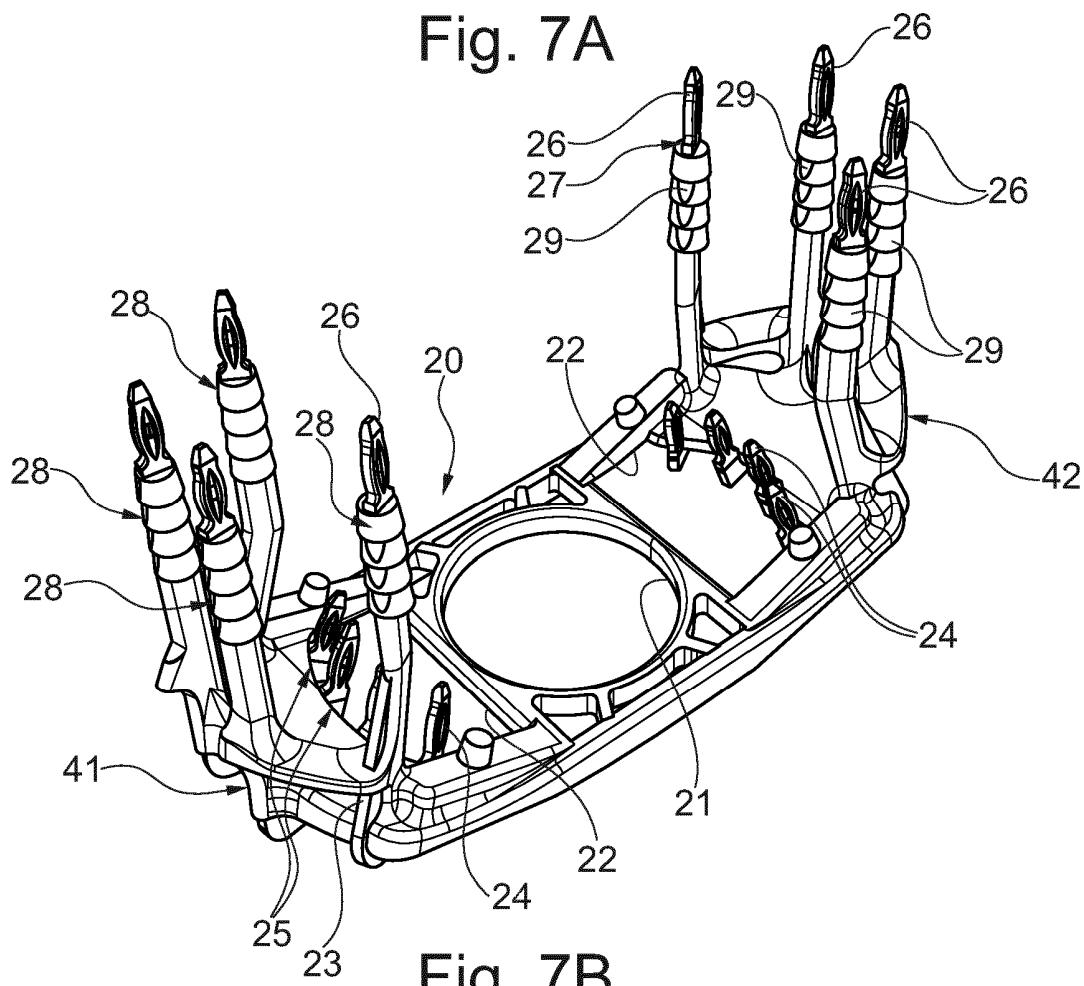


Fig. 7B

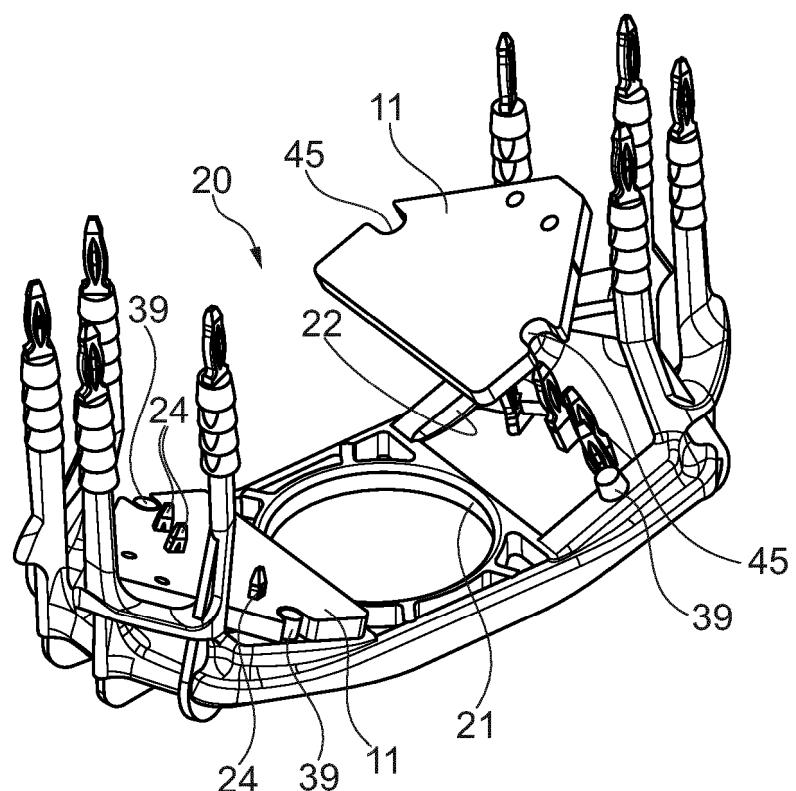


Fig. 8A

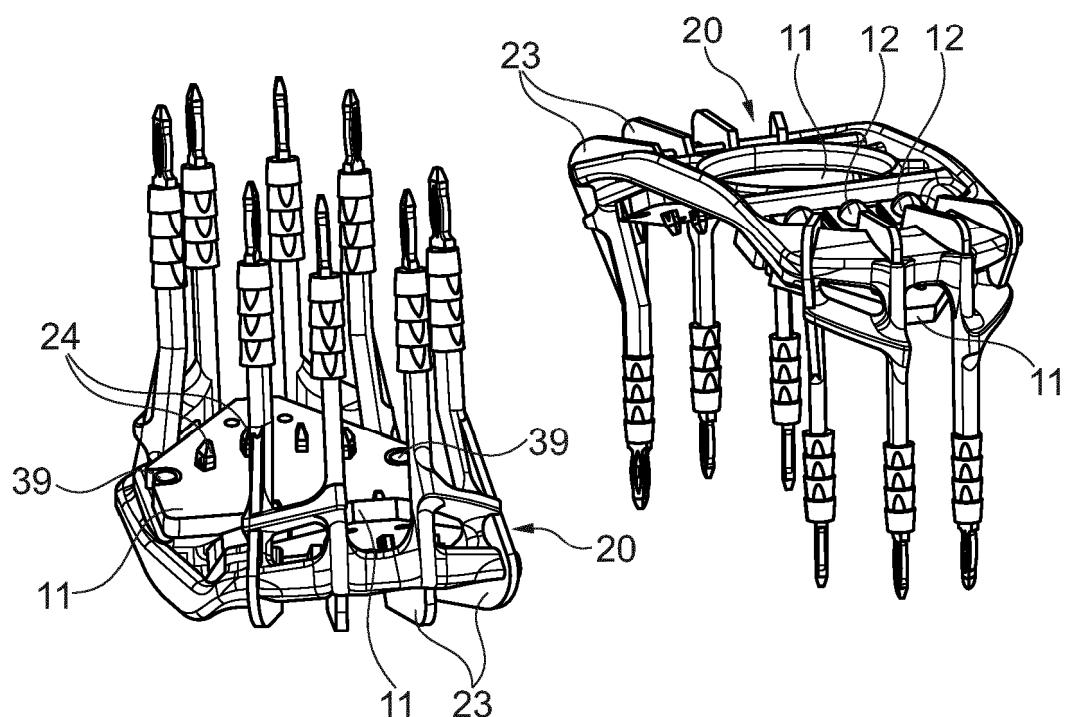


Fig. 8B

Fig. 8C

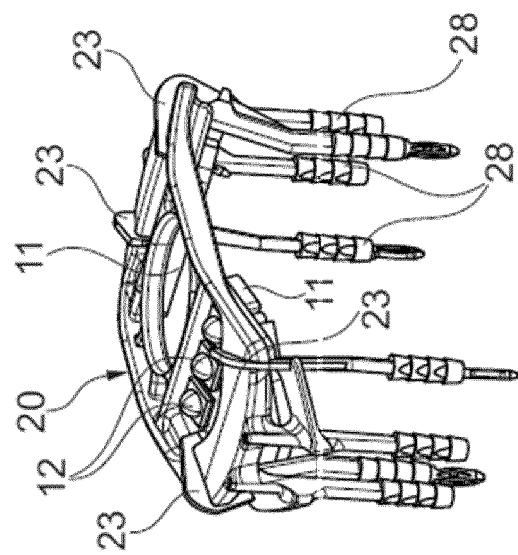


Fig. 9A

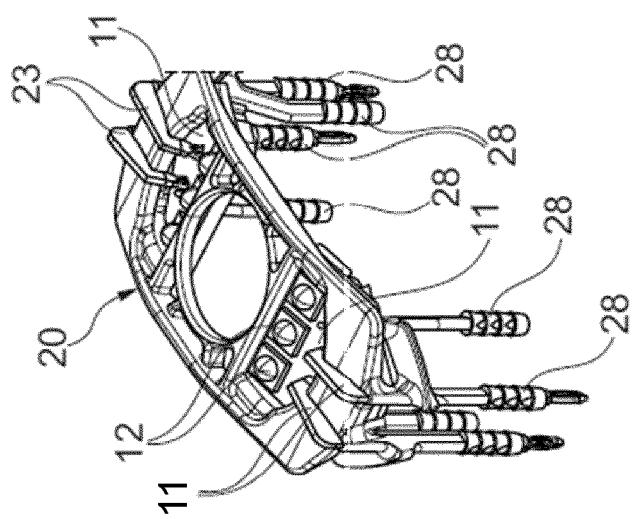


Fig. 9B

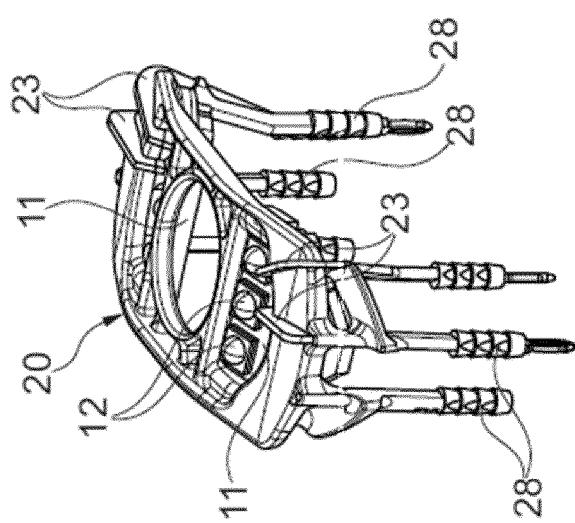
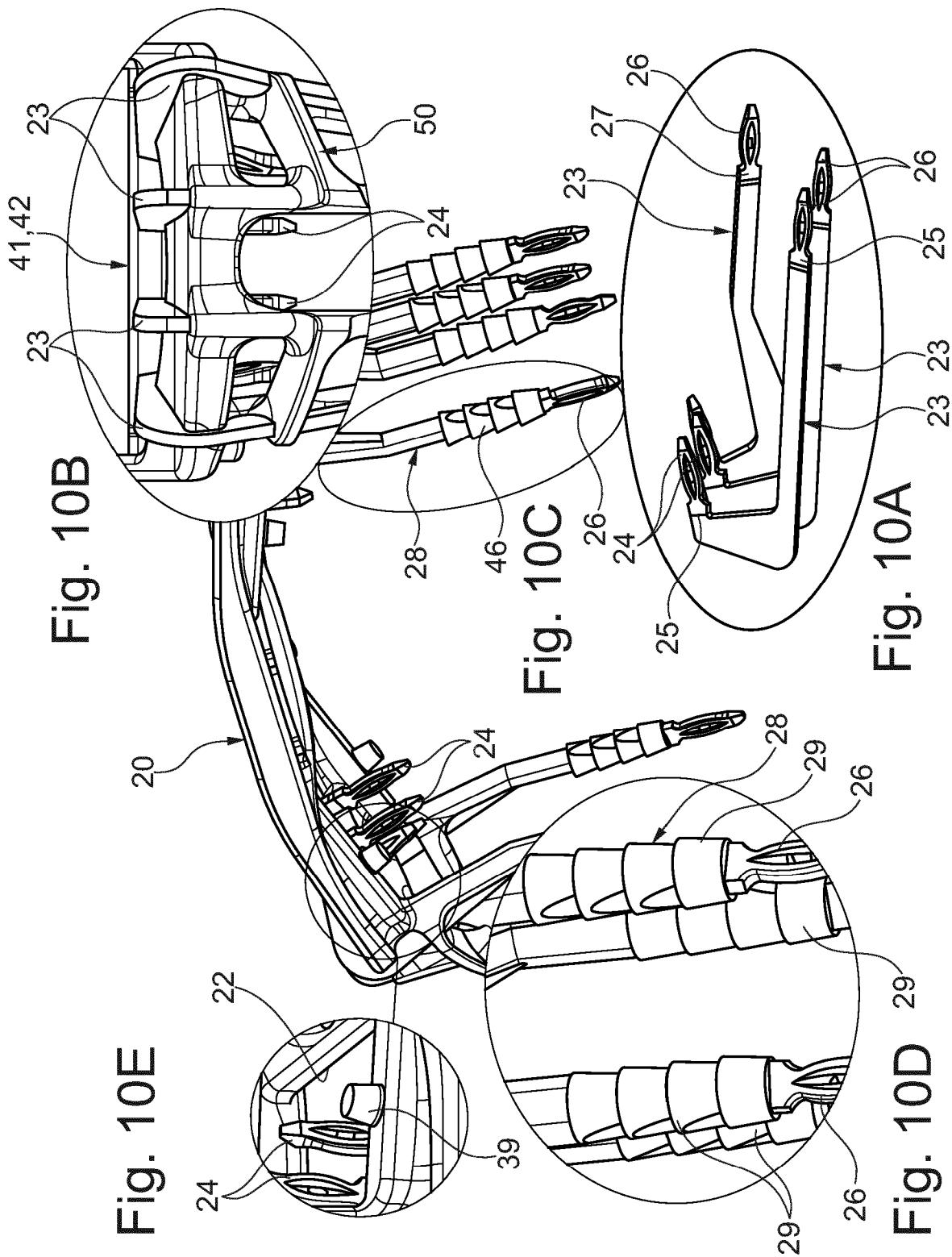


Fig. 9C



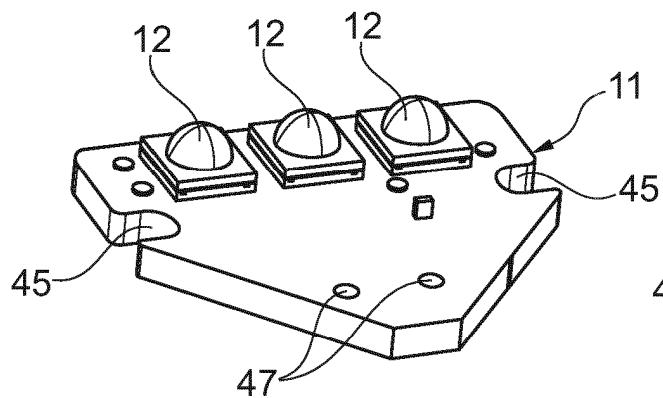


Fig. 11A

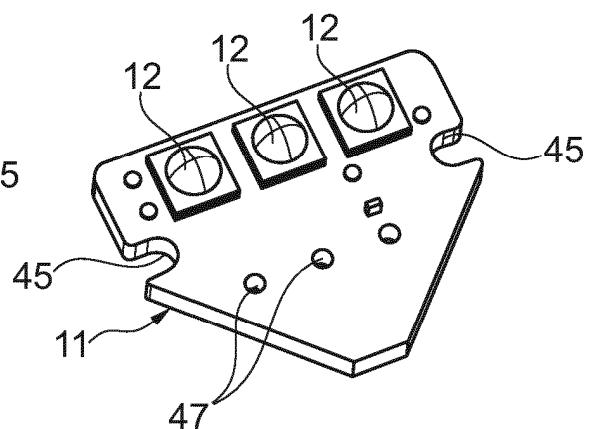


Fig. 11B

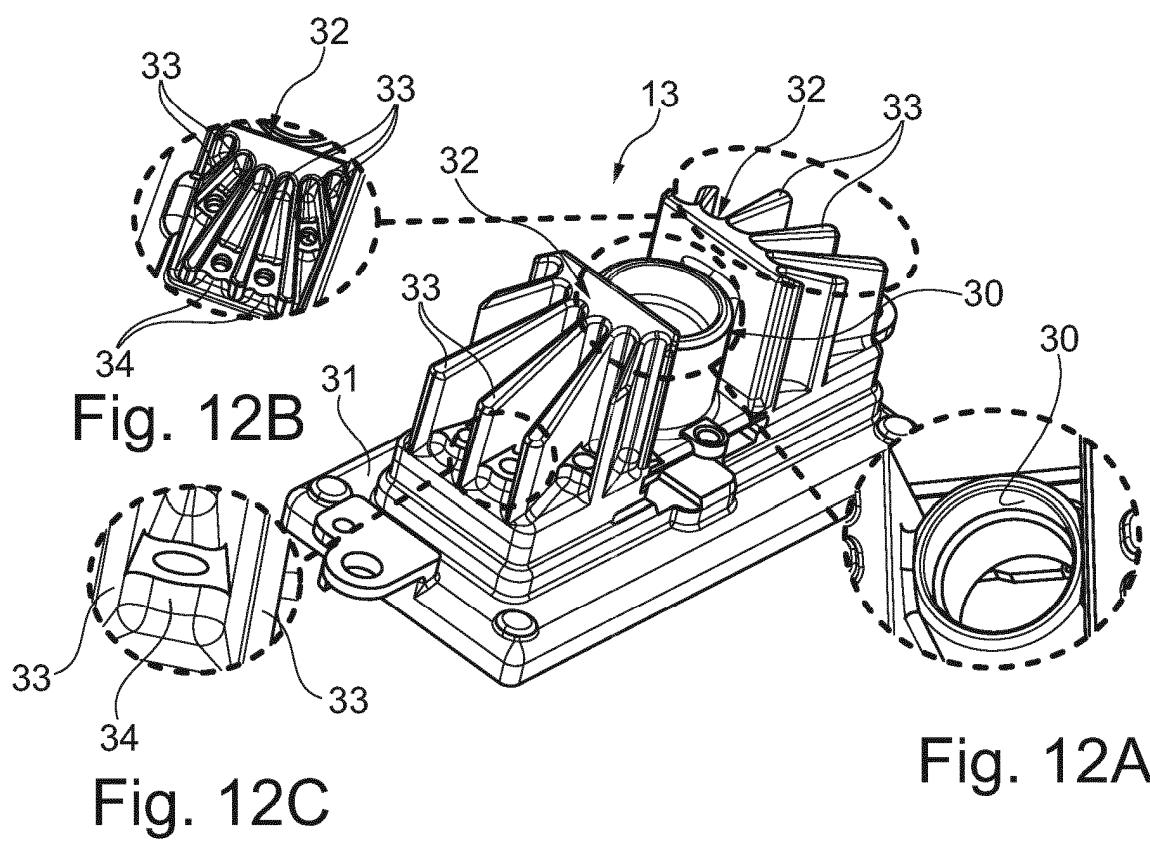


Fig. 12A

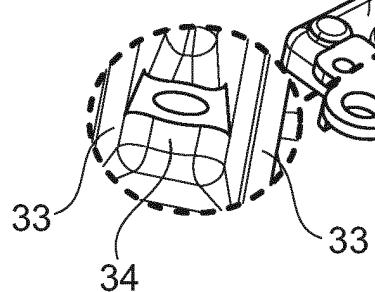


Fig. 12B

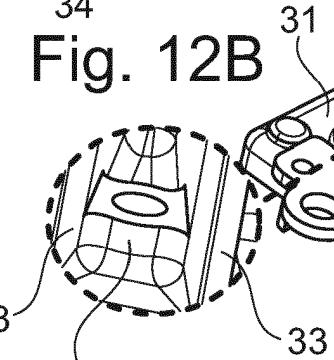


Fig. 12C

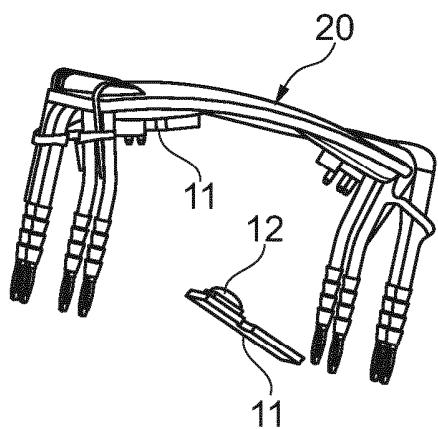


Fig. 13A

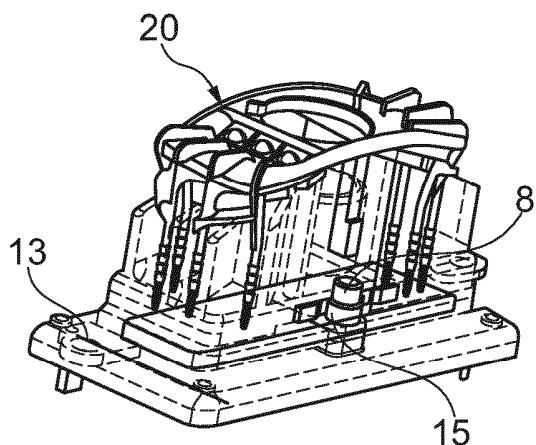


Fig. 13D

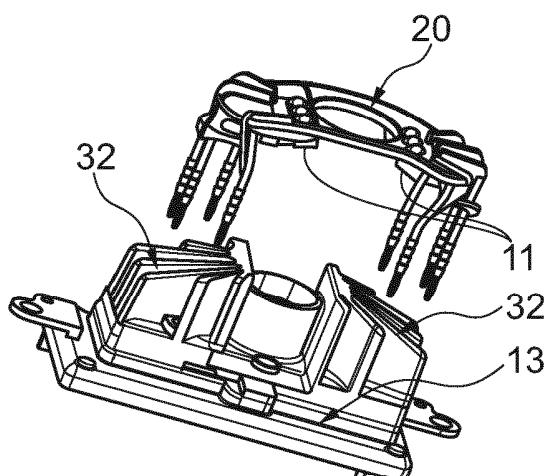


Fig. 13B

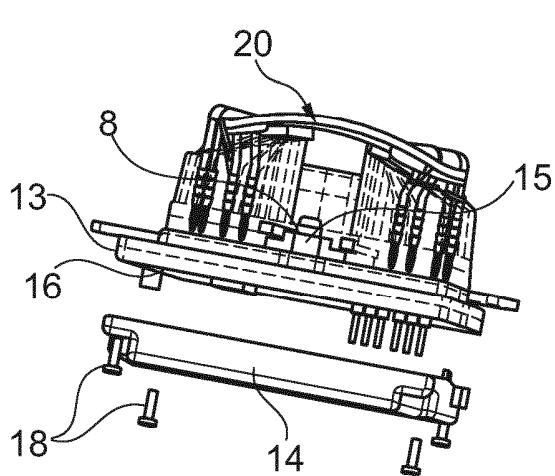


Fig. 13E

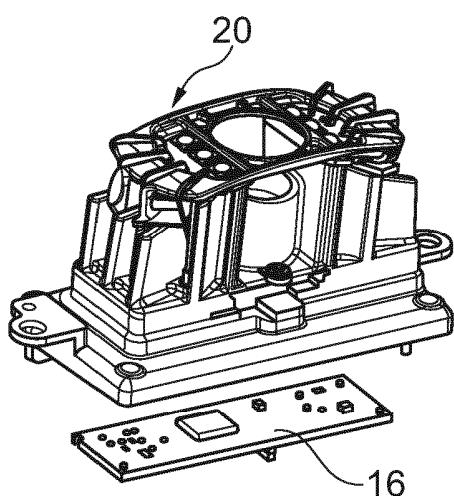


Fig. 13C

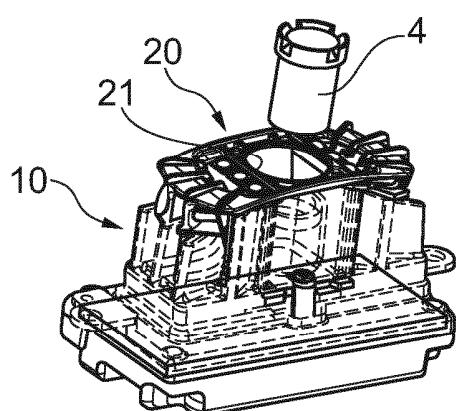


Fig. 13F

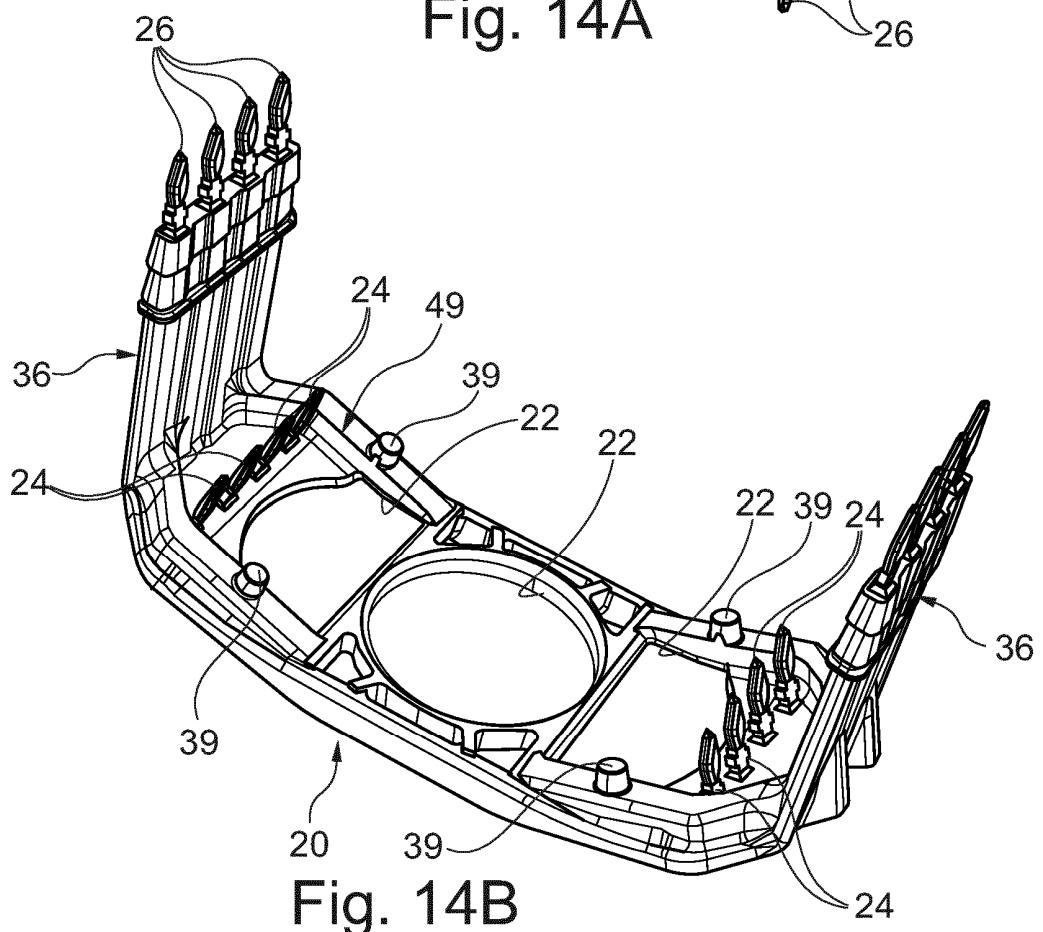
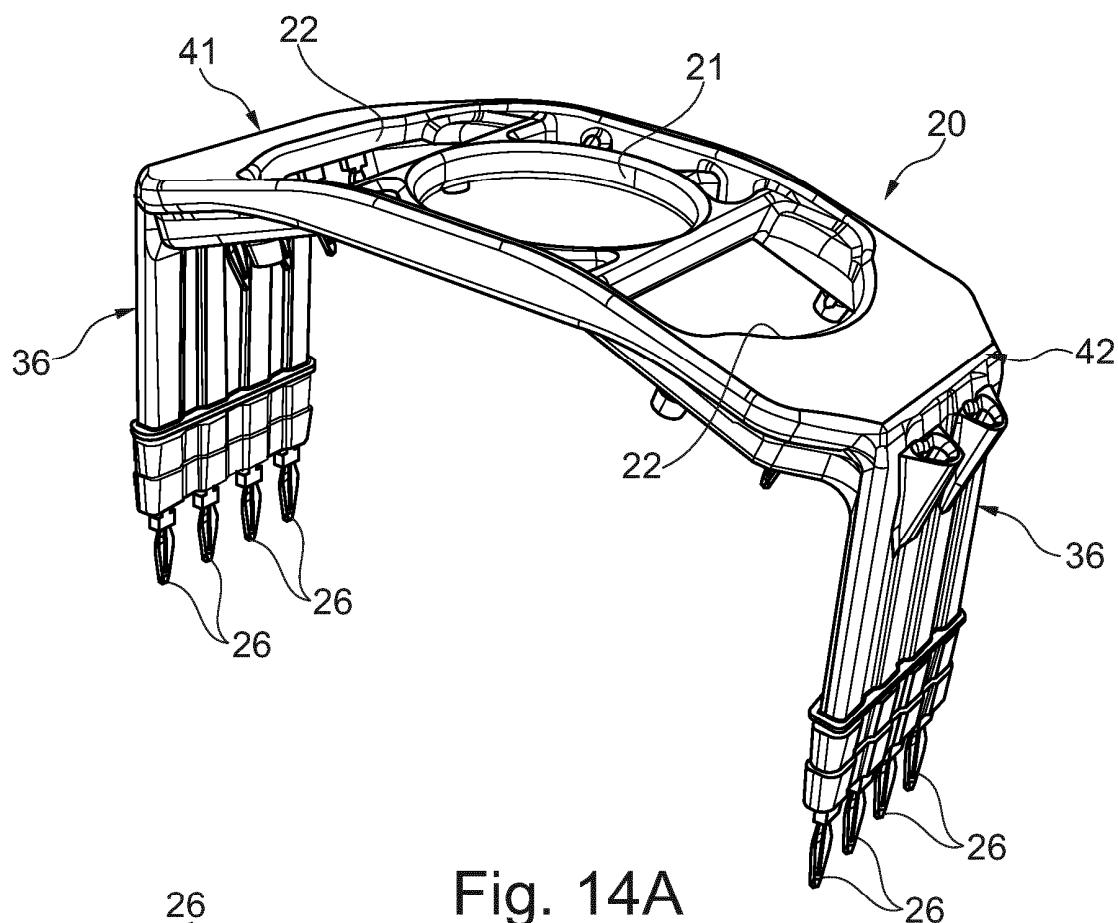


Fig. 15

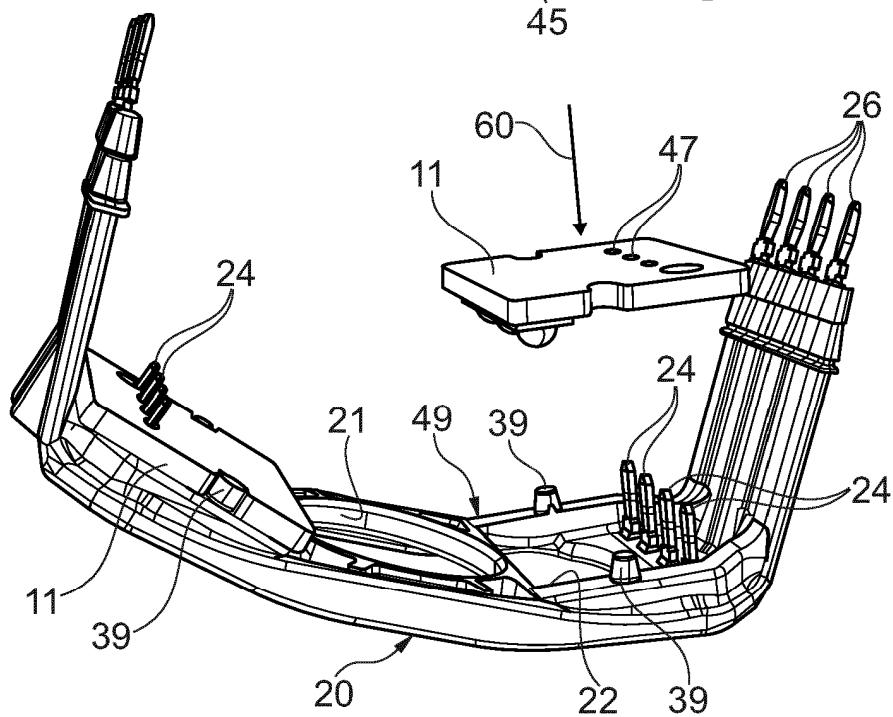
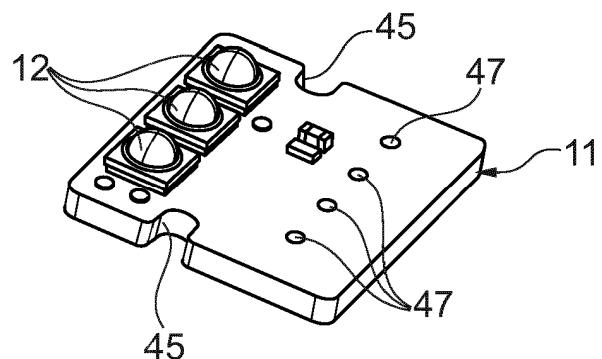


Fig. 16A

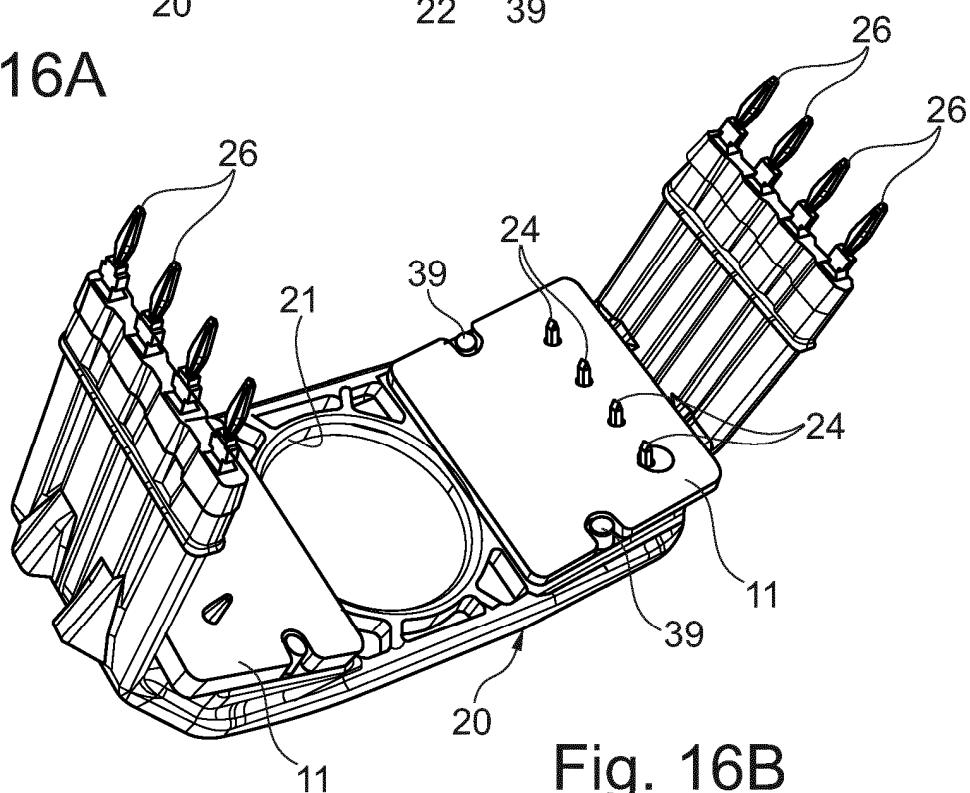


Fig. 16B

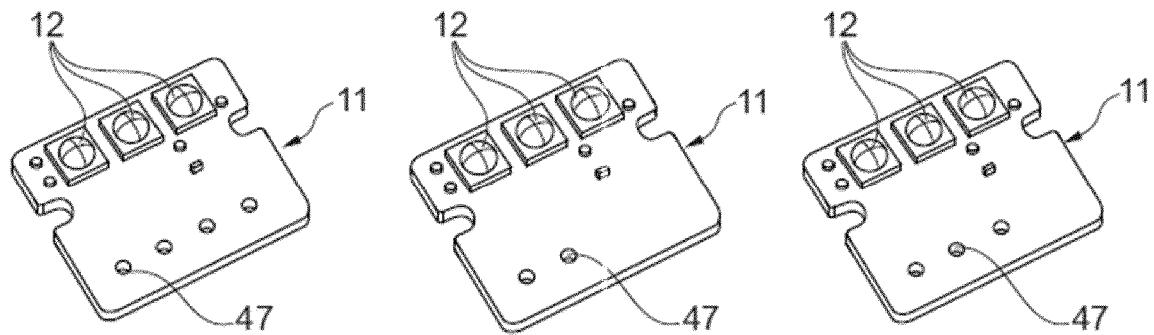


Fig. 17A

Fig. 17B

Fig. 17C

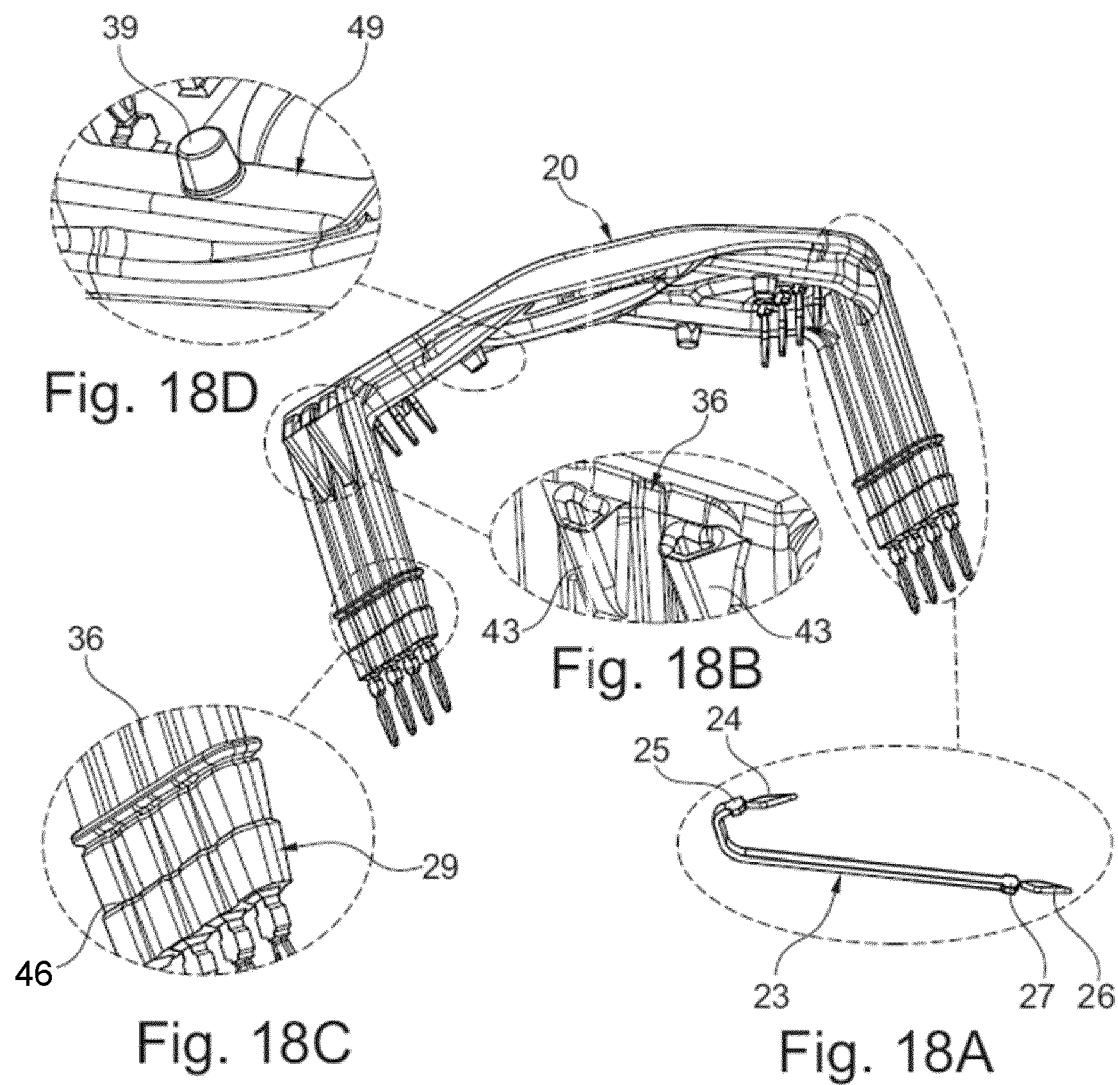


Fig. 18C

Fig. 18B

Fig. 18A

Fig. 19C

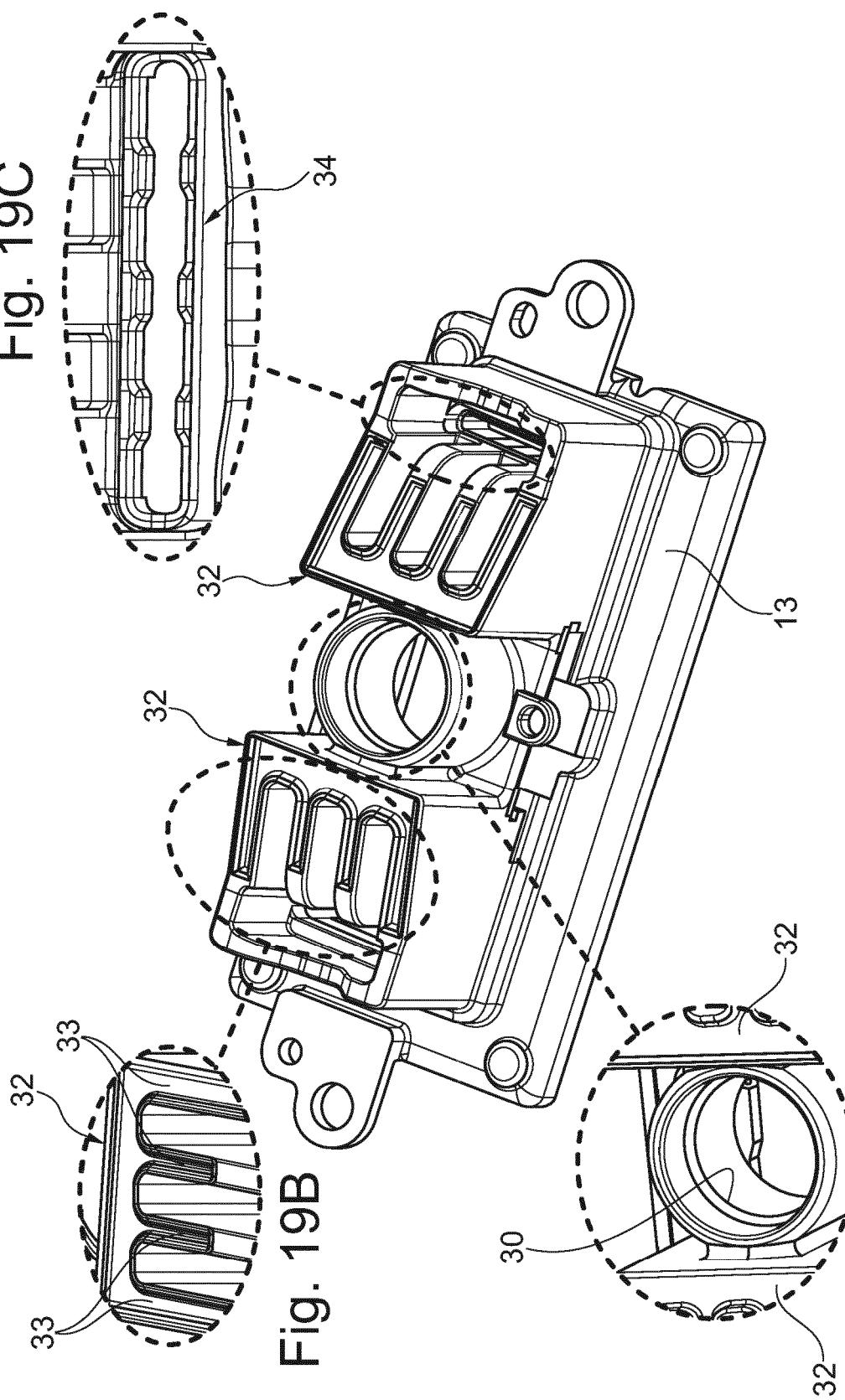


Fig. 19B

Fig. 19A

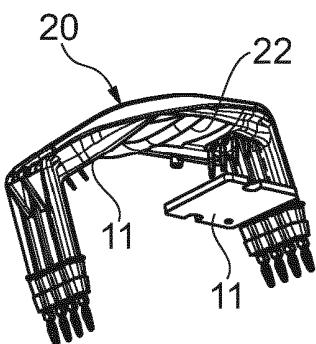


Fig. 20A

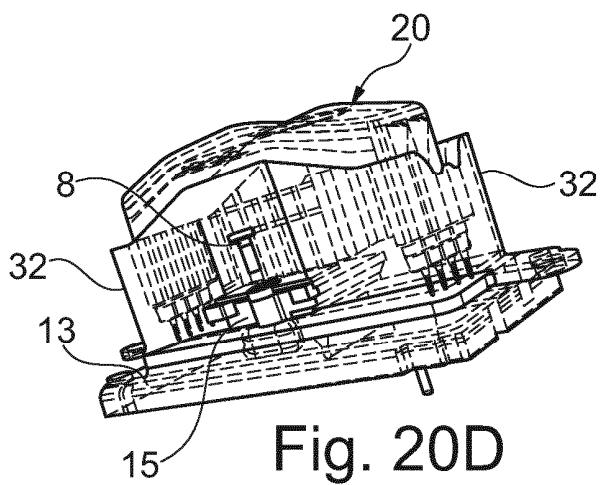


Fig. 20D

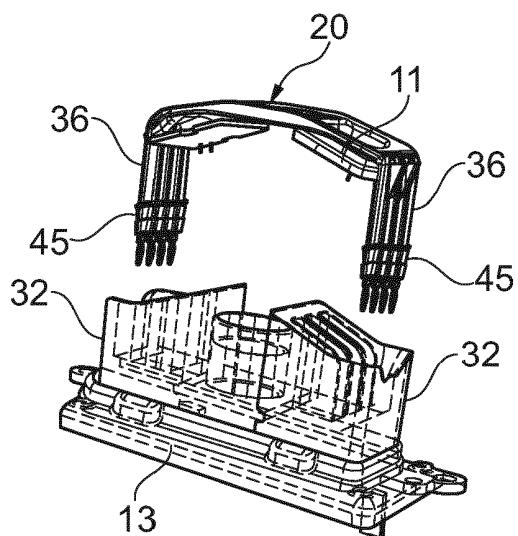


Fig. 20B

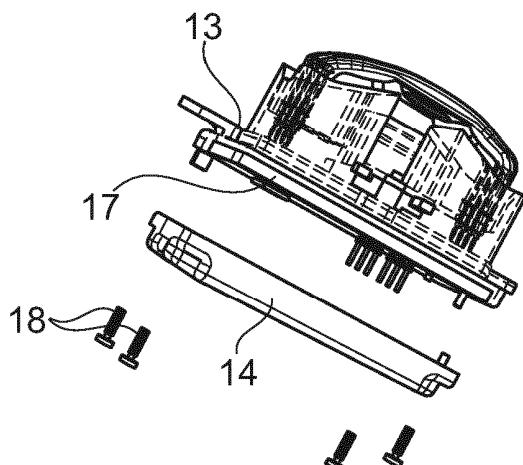


Fig. 20E

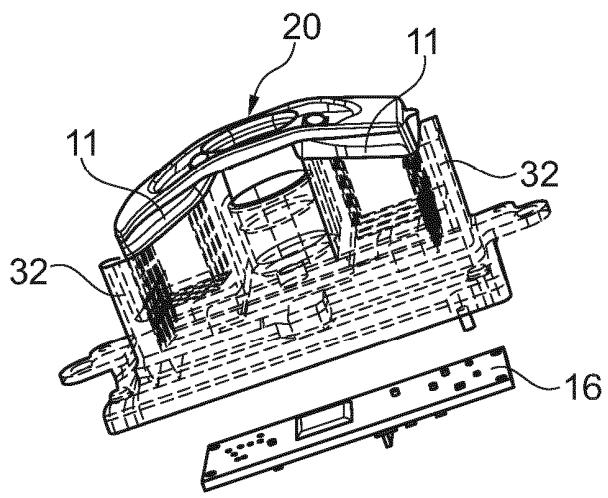


Fig. 20C

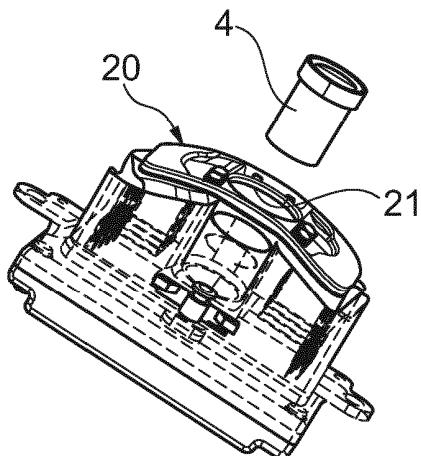


Fig. 20F

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- EP 3982197 A1 [0004]
- US 2017264797 A1 [0004]