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OVEREXTENSION HINGE SYSTEMS FOR GLASSES DEVICES

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BACKGROUND

[0001] Smart devices are becoming increasingly integrated with wearable technology, such as glasses and other head-mounted devices. In various examples, smart devices may include a camera and display elements incorporated on or within glasses frames. The smart device may provide content through visual means, and provide unique usage features and experiences, including but not limited to virtual reality (VR), an augmented reality (AR), a mixed reality (MR), a hybrid reality, or some combination and/or derivatives thereof.

[0002] Smart glasses face unique challenges compared to traditional glasses, given the additional hardware and software components that may need to be provided within a limited area, e.g., within the frames. Smart glasses face additional user constraints and design considerations, given the anatomical differences between users, such as differing head sizes. For example, conventional eyewear frames may be more compliant and/or adjustable for varying head widths since they do not require the additional computing components and hardware. Smart glasses also often have larger cross sections to house internal electronics and hardware, making for inflexible frames. Frame extension and overextension of smart glasses are further limited, since overextension may be detrimental to internal systems, interfere with alignment, connectivity, etc., and typically should be avoided in many cases.

[0003] Accordingly, adjustability for varying head widths may not be readily performed on smart glasses because the internal mechanicals may not easily tolerate deformation. In addition, frames of smart glasses are usually injection molded, which doesn't take adjustment as easily as conventional eyewear made from wire or acetate. Such challenges may therefore result in user discomfort, e.g., head squeeze. Image clarity is also sensitive to deformation and bending of glasses frames, and other components, such as projectors, require isolation from contact to various enclosures. Thus, improvements are needed to address various design and usage considerations.

SUMMARY

[0004] In meeting the described challenges, the present disclosure provides systems, methods, and devices, for an overextension hinge, usable with various glasses technologies. According to various examples, an overextension hinge module may include a hinge base, a

paddle connected to the hinge base via a travel pin, and a preloaded spring maintaining a base position between the hinge base and the paddle. In various examples, the paddle may include a cylindrical bearing surface to receive the travel pin, and the paddle may enable movement of the hinge base relative to the paddle along a predefined range. In other examples, the movement of the hinge base relative to the paddle along the predefined range may require a force corresponding a stiffness of the preloaded spring.

[0005] According to various aspects and examples, the predefined range may be up to about ten degrees. The hinge base may further include a first pair of attachments to secure the hinge base to a frame, and a second pair of attachments to secure the hinge base to a frame arm. Additionally, the stiffness of the preloaded spring is between 29-37 N/mm.

[0006] Additional advantages will be set forth in part in the description which follows or may be learned by practice. The advantages will be realized and attained by means of the elements and combinations particularly pointed out in the appended claims. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive, as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The summary, as well as the following detailed description, is further understood when read in conjunction with the appended drawings. For the purpose of illustrating the disclosed subject matter, there are shown in the drawings exemplary embodiments of the disclosed subject matter; however, the disclosed subject matter is not limited to the specific methods, compositions, and devices disclosed. In addition, the drawings are not necessarily drawn to scale. In the drawings:

[0008] FIG. 1 illustrates overextension on glasses modules, and corresponding temple force versus displacement, in accordance with various aspects discussed herein.

[0009] FIG. 2A illustrates another example of pivot axes corresponding to a hinge module, in accordance with various aspects discussed herein.

[0010] FIG. 2B illustrates a hinge module and attachment mechanisms, in accordance with various aspects discussed herein.

[0011] FIG. 3 illustrates overextension bearing surfaces in accordance with various aspects discussed herein.

[0012] FIG. 4 illustrates a pivot implementation, in accordance with various aspects discussed herein.

[0013] FIG. 5 illustrates hinge module actuation (nominal vs. over-extended) in accordance with various aspects discussed herein.

[0014] FIG. 6 illustrates a hinge paddle in accordance with various aspects discussed herein.

[0015] FIG. 7 illustrates stiffness approximations in accordance with various aspects discussed herein.

[0016] FIG. 8 illustrates two-dimensional overextension in accordance with various aspects discussed herein.

[0017] FIG. 9 illustrates a grounding path for the hinge module and associated components in accordance with various aspects discussed herein.

[0018] FIG. 10 illustrates an artificial reality system comprising a headset, in accordance with various aspects discussed herein.

[0019] FIG. 11 illustrates a block diagram of an example device in accordance with various aspects discussed herein.

[0020] FIG. 12 illustrates a block diagram of an example computing system in accordance with various aspects discussed herein.

[0021] FIG. 13 illustrates a computing system in accordance with various aspects discussed herein.

[0022] The figures depict various examples for purposes of illustration only. One skilled in the art will readily recognize from the following discussion that alternative examples of the structures and methods illustrated herein may be employed without departing from the principles described herein.

DETAILED DESCRIPTION

[0023] The present disclosure can be understood more readily by reference to the following detailed description taken in connection with the accompanying figures and examples, which form a part of this disclosure. It is to be understood that this disclosure is not limited to the specific devices, methods, applications, conditions or parameters described and/or shown herein, and that the terminology used herein is for the purpose of describing particular embodiments by way of example only and is not intended to be limiting of the claimed subject matter.

[0024] Some examples of the present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all examples of the invention are shown. Indeed, various examples of the invention may be embodied in many different forms and should not be construed as limited to the examples set forth herein. Like reference numerals refer to like elements throughout. As used herein, the terms “data,” “content,” “information” and similar terms may be used interchangeably to refer to data capable of being transmitted, received and/or stored in accordance with examples of the invention. Moreover, the term “exemplary”, as used herein, is not provided to convey any qualitative assessment, but instead merely to convey an illustration of an example. Thus, use of any such terms should not be taken to limit the spirit and scope of examples of the invention.

[0025] As defined herein a “computer-readable storage medium,” which refers to a non- transitory, physical or tangible storage medium (e.g., volatile or non-volatile memory device), may be differentiated from a “computer-readable transmission medium,” which refers to an electromagnetic signal.

[0026] References in this description to “an example”, “one example”, or the like, may mean that the particular feature, function, or characteristic being described is included in at least one example of the present invention. Occurrences of such phrases in this specification do not necessarily all refer to the same example, nor are they necessarily mutually exclusive.

[0027] Also, as used in the specification including the appended claims, the singular forms “a,” “an,” and “the” include the plural, and reference to a particular numerical value includes at least that particular value, unless the context clearly dictates otherwise. The term “plurality”, as used herein, means more than one. When a range of values is expressed, another embodiment includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by use of the antecedent “about,” it will be understood that the particular value forms another embodiment. All ranges are inclusive and combinable. It is to be understood that the terminology used herein is for the purpose of describing particular aspects only and is not intended to be limiting.

[0028] It is to be appreciated that certain features of the disclosed subject matter which are, for clarity, described herein in the context of separate embodiments, can also be provided in combination in a single embodiment. Conversely, various features of the disclosed subject matter that are, for brevity, described in the context of a single embodiment, can also be provided separately or in any sub-combination. Further, any reference to values stated in ranges includes each and every value within that range. Any documents cited herein are incorporated herein by reference in their entireties for any and all purposes.

[0029] In various aspects, systems, methods, and devices provide an overextension mechanism applicable to wearable technology such as glasses and other head-mounted devices. The techniques and aspects discussed herein differentiate and improve upon conventional systems, at least by providing a mechanism to resist deflection to protect internal electrical, optical, and mechanical systems. In various embodiments, such as smart glasses, and head-mounted systems, a frame may include a front-frame and a temple-arm enclosure to resist excessive deflection.

[0030] Systems, methods, and devices further enable the ability to incorporate rigid components and still be compliant to fit varying head widths, by at least incorporating an overextension hinge. Such hinge may provide a torsionally sprung pivot axis between frames and temples, which allow for a range of temple width positions to accommodate varying head widths with one common design.

[0031] FIG. 1 illustrates a top view of a glasses system 100 and a corresponding Force vs. Displacement graph 130 corresponding to "head squeeze." Frame arms of glasses 100 may extend a distance, d, 120, for example, to adjust for varying head sizes and width. A corresponding Force, F, 110, corresponds to the inward force of the frame arms, which may be exerted on a wearer's head. Graph 130 illustrates how, for a given stiffness (e.g., 1.5 g/mm, 3.0 g/mm, or 8.0 g/mm), the force changes relative to displacement, d, 120. Forces greater than about 1 Newton may be considered uncomfortable by users, and therefore, there is a need to both accommodate varying head sizes and widths while reducing the amount of pressure, e.g., "head squeeze" on a user's temples.

[0032] Moreover, image clarity on smart glasses may be very sensitive to waveguide bending, and any projectors may need to be isolated from contact with various components, such as the frames and other enclosures. According to various examples discussed herein, projectors for smart glasses may be placed within, or substantially near the frame joint. Since clearance is required around projectors, clearance spacing may be up to approximately 1 mm.

[0033] FIGs. 2A-2B illustrates an example hinge mechanism including a "sliding design" with an overextension pivot along an outer axis of the frame. FIG. 2A illustrates a primary pivot axis 220 corresponding to a mechanical pivot joint allowing a frame arm to close and extend. Aspects of the present disclosure provide an external pivot axis 210 for overextension. In other words, when the frame arm overextends, it pivots around external pivot axis 120, and the external pivot axis prevents both gaps between the frame and arm, as well as rubbing/contact between the components.

[0034] FIG. 2B provides additional views and details regarding the hinge module and operation. The frame 230 may include an attachment mechanism 235 that connects to hinge module 240, e.g., via one or more screws and/or interlocks. The screws may be vertically disposed, e.g., along the primary pivot axis 220. The primary pivot axis 220 enables closure of the arms relative to the frame, for example, when storing the glasses and otherwise when not in use. The hinge module 240 may further attach 245 to the frame arm. In some examples, one or more screws may attach to the frame arm, and may horizontally attach to the frame arm 250. In some examples the first set of attachments 235 linking the frame 230 and hinge module 240 may be orthogonal to the set of attachments 245 linking the hinge module to the frame arm 250.

[0035] The hinge module 240 may reside complete within the frame arms. During a closure of the frame arms, wherein the frame arm 250 is brought closer to the frame 230, or an extension of the frame arms, wherein the frame arm 250 is brought away from the frame 230 but not overextended, the frame arms 250 may rotate about the primary pivot axis. During an overextension, wherein the frame arm 250 is extended beyond its natural open position, the hinge module 240 enables pivoting along the external pivot axis 210.

[0036] In various examples, a bistable lock may be implemented such that when the frame arms reach a particular “closed” or “open” position, they remain in place, stable, until a force sufficient to overcome the stable position allows pivoting along either the primary pivot axis 220 or the external pivot axis 210.

[0037] FIG. 3 illustrates a top view of the “sliding design” and overextension mechanism discussed in FIGs. 2A-2B. The overextension axis 310 corresponds to the external pivot axis 210 illustrated in FIG. 2A. The pivot axis may be defined by a cylindrical bearing surface comprising attachments 320, which connect the frame to the arm. The attachments 320 may comprise a spatial area allowing for a pivoting within a certain range, such as 5, 10, 15, 20 degrees or more. It should be appreciated that FIG. 3 illustrates just one way, as an example, for attaching the frame and arms to define the overextension external pivot axis 210, and any of a variety of attachment positions, points, and arrangements may be implemented according to design considerations, hardware/software considerations, internal components, and the like.

[0038] FIG. 4 illustrates a pivot implementation according to various aspects discussed herein. A hinge base 420 attaches to paddle 400 to form the basis of the overextension sliding design, as discussed herein. The paddle 400 includes cylindrical bearing surfaces 410, which provides the range of overextension and defines the external pivot axis.

[0039] FIG. 5 illustrates the nominal position 510 and over-extended position 520 resulting from the connections between the hinge base, paddle, and spring mechanism. The paddle 400 may be held in its base position 515 by a preloaded spring 530. The preloaded spring 530 may further be held in place by spring screw 560. A travel pin 540 may provide additional attachment security between hinge base 420 and paddle 400.

[0040] In the nominal position 510, wherein the frame arm is in its natural, extended position, preloaded spring 540 secures the position of the hinge base 420 relative to the paddle 400. Spring 540 may assist in providing the stable position for the bistable lock discussed herein.

[0041] When the frame arm is in the overextended position 520, travel pin(s) 540 travels along the surface defined by the cylindrical bearing surface 410 to allow the overextension along the external pivot axis along an overextension angle range 550. In some examples, the travel pin(s) 540 may provide travel stops, limiting overextension via the cylindrical bearing surface, within a desired range. According to various examples, the overextension may be within a range of 5, 10, 15, or 20 degrees past the nominal position 510. Moreover, in the over-extended position 520, the arms of the preloaded spring 530 may provide a force, depending on the stiffness of the spring, to bring the hinge base 420 and paddle 400 back to the nominal position 510. The force may be provided by spring arms extending from the preloaded spring 530.

[0042] According to various aspects, any of a plurality of materials may be used for various components of the hinge systems discussed herein. For example, a hinge base 420 (see, e.g., FIG. 4) may include stainless steel, such as 316 grade stainless steel. The hinge base may be formed using metal injection molding (MIM) and/or computer numerical control (CNC).

[0043] Travel pins 540 may likewise include stainless steel, and according to some aspects, may be formed using a screw machine. Bearings 410 may include nylon, and manufacturing processes may utilize injection molding. Paddle 400 may include stainless steel and/or nylon. The paddle (see, e.g., FIG. 6) may be formed using MIM, overmolding, and/or CNC. A spring post, upon which spring 530 is attached, may include stainless steel, such as 316 grade stainless steel and formed using CNC. The spring 530 may include spring steel, springform, and/or any of a plurality of materials and manufacturing methods in accordance with aspects discussed herein. Spring screw 560 may also include stainless steel, such as 316 grade stainless steel, and may be formed using a screw machine.

[0044] According to some aspects, as illustrated in FIG. 6, the paddle may include metal to reinforce strength and grounding. FIG. 6 illustrates a top, perspective view 610 of the paddle, a top, perspective, transparent view 620, and a bottom, perspective view 630 of the paddle. According to various aspects, the paddle base 615 may be formed using metal injection molding. An over mold 625 may form the remaining contours of the paddle. A secondary machining device may add any additional features, contours, and abutments, as needed to form the paddle.

[0045] In a similar manner, the hinge base 420 may be formed using metal injection molding. Tapping may be applied to form the necessary openings, for example, for travel pins 540, a receptacle for the spring post, and the like.

[0046] According to various aspects, an assembly sequence may include placing a bearing on a base, placing the paddle on the bearing, installing travel pins, installing the spring post, installing the spring, and installing the spring screw. In other examples, one or more components may be formed using 3D printing methods.

[0047] In various testing scenarios, finite element analysis (FEA) was applied to analyze spring performance. According to various aspects, as illustrated in FIG. 7, the hinge systems discussed herein may be analyzed as springs in series, wherein the frame stiffness (k_f) and the hinge stiffness (k_h) may form the system stiffness (k_s). The equivalent spring constant for the system may be calculated using the equation provided in FIG. 7.

[0048] Calculations approximating the spring as a cantilever beam and combining the cantilever beam with the moment of inertia, may be used to determine various wire diameters usable in various examples discussed herein.

[0049] Table 1 provides a comparison of spring performance, based on various spring diameters, predicted force, stiffness, von Mises (VM) stress, yield stress, and VM/Yield Stress. FEA predicts a spring wire diameter of ~0.88mm, and various prototyping sample wire gauges included 0.0907 mm, 0.0808 mm, 0.072 mm, 0.0641 mm. According to Table 1, for a target stiffness of 31.4 N/mm, a spring diameter of 0.88 was found to be ideal. According to various examples, the stiffness of the preloaded spring may be between 29-37 N/mm.

Table 1: Spring Performance, Target Stiffness = 31.4 N/mm

Diameter (mm)	**Force (N)**	**Stiffness (N/mm)**	**VM Stress (MPa)**	**Yield Stress (MPa)**	**VM stress/Yield stress**
0.91	31.8	36.6	2161	2200	0.98
0.88	27.2	31.3	1923	2200	0.87
0.87	25.3	29.1	1844	2200	0.84

[0050] FIG. 8 illustrates an additional embodiment, enabling overextension in the two dimensions. In various examples, the bearing may be a spherical bearing, thus allowing additional temple deflection. The frame may extend in a vertical direction, e.g., about a horizontal axis, or in a lateral direction, e.g., about a vertical axis.

[0051] According to additional embodiments, as illustrated in FIG. 9, a ground path may be established, e.g., for grounding a circuit board adjacent to or nearby the hinge system. According to some examples, a circuit board (A) may contact one or more components of the hinge system. At (B), the screw may contact exposed copper on a circuit board. At (C), the hinge paddle, which may be a steel paddle, may be threaded to the board and other components. At (D), the spring touches the paddle, and at (E), the spring touches the spring screw. At (F) the rear, base of the hinge may receive the spring screw. At (G) the hinge screw may thread into the rear base of the hinge. At (H), the front of the hinge base may contact the hinge screw.

[0052] According to various examples of the present disclosure, grounding may occur primarily through the spring. A minimum contact force may exist, such as for example a 15 N contact force. The sliding contact at the spring tip may be less than 0.3 mm.

[0053] FIG. 10 illustrates an example smart glasses, artificial reality system 1000. The artificial reality system 1000 can include a head-mounted display (HMD) 1010 (e.g., glasses) comprising a frame 1012, one or more displays 1014, and a computing device 1008 (also referred to herein as computing device 1008). The displays 1014 can be transparent or translucent allowing a user wearing the HMD 1010 to look through the displays 1014 to see the real world and displaying visual artificial reality content to the user at the same time. The HMD 1010 can include an audio device 1006 (e.g., speaker/microphone 38 of FIG. 11) that can provide audio artificial reality content to users. The HMD 1010 can include one or more cameras 1016 which can capture images and videos of environments. The HMD 1010 can include an eye tracking system to track the vergence movement of the user wearing the HMD 1010. In one example embodiment, the camera 1016 can be the eye tracking system. The HMD 1010 can include a microphone of the audio device 1006 to capture voice input from the user. The artificial reality system 1000 can further include a controller 1018 (e.g., processor 32 of FIG. 11) comprising a trackpad and one or more buttons. The controller can receive inputs from users and relay the inputs to the computing device 1008. The controller can also provide haptic feedback to users. The computing device 1008 can be connected to the HMD 1010 and the controller through cables or wireless connections. The computing device 1008 can control the HMD 1010 and the controller to provide the augmented reality content to and receive inputs from one or more users. In some example embodiments, the controller 1018 can be a standalone controller or integrated within the HMD 1010. The computing device 1008 can be a standalone host computer device, an on-board computer device integrated with the HMD 1010, a mobile device, or any other hardware platform capable of providing artificial reality content to and receiving inputs from users. In some exemplary embodiments, HMD 1010 can include an artificial reality system/virtual reality system (e.g., artificial reality system).

[0054] FIG. 11 illustrates a block diagram of an exemplary hardware/software architecture of a UE 30. As shown in FIG. 11, the UE 30 (also referred to herein as node 30) can include a processor 32, non-removable memory 44, removable memory 46, a speaker/microphone 38, a keypad 40, a display, touchpad, and/or indicators 42, a power source 48, a global positioning system (GPS) chipset 50, and other peripherals 52. The UE 30 can also include a camera 54. In an exemplary embodiment, the camera 54 is a smart camera configured to sense images appearing within one or more bounding boxes. The UE 30 can also include communication circuitry, such as a transceiver 34 and a transmit/receive element 36. It will be appreciated the UE 30 can include any sub-combination of the foregoing elements while remaining consistent with an embodiment.

[0055] The processor 32 can be a special purpose processor, a digital signal processor (DSP), a plurality of microprocessors, one or more microprocessors in association with a DSP core, a controller, a microcontroller, Application Specific Integrated Circuits (ASICs), Field Programmable Gate Array (FPGAs) circuits, any other type of integrated circuit (IC), a state machine, and the like. In general, the processor 32 can execute computer-executable instructions stored in the memory (e.g., non-removable memory 44 and/or memory 46) of the node 30 in order to perform the various required functions of the node. For example, the processor 32 can perform signal coding, data processing, power control, input/output processing, and/or any other functionality that enables the node 30 to operate in a wireless or wired environment. The processor 32 can run application-layer programs (e.g., browsers) and/or radio access-layer (RAN) programs and/or other communications programs. The processor 32 can also perform security operations such as authentication, security key agreement, and/or cryptographic operations, such as at the access-layer and/or application layer for example.

[0056] The processor 32 is coupled to its communication circuitry (e.g., transceiver 34 and transmit/receive element 36). The processor 32, through the execution of computer executable instructions, can control the communication circuitry in order to cause the node 30 to communicate with other nodes via the network to which it is connected.

[0057] The transmit/receive element 36 can be configured to transmit signals to, or receive signals from, other nodes or networking equipment. For example, in an embodiment, the transmit/receive element 36 can be an antenna configured to transmit and/or receive radio frequency (RF) signals. The transmit/receive element 36 can support various networks and air interfaces, such as wireless local area network (WLAN), wireless personal area network (WPAN), cellular, and the like. In yet another embodiment, the transmit/receive element 36 can be configured to transmit and receive both RF and light signals. It will be appreciated that the transmit/receive element 36 can be configured to transmit and/or receive any combination of wireless or wired signals.

[0058] The transceiver 34 can be configured to modulate the signals that are to be transmitted by the transmit/receive element 36 and to demodulate the signals that are received by the transmit/receive element 36. As noted above, the node 30 can have multi-mode capabilities. Thus, the transceiver 34 can include multiple transceivers for enabling the node 30 to communicate via multiple radio access technologies (RATs), such as universal terrestrial radio access (UTRA) and Institute of Electrical and Electronics Engineers (IEEE 802.11), for example.

[0059] The processor 32 can access information from, and store data in, any type of suitable memory, such as the non-removable memory 44 and/or the removable memory 46. For example, the processor 32 can store session context in its memory, as described above. The non-removable memory 44 can include RAM, ROM, a hard disk, or any other type of memory storage device. The removable memory 46 can include a subscriber identity module (SIM) card, a memory stick, a secure digital (SD) memory card, and the like. In other embodiments, the processor 32 can access information from, and store data in, memory that is not physically located on the node 30, such as on a server or a home computer.

[0060] The processor 32 can receive power from the power source 48, and can be configured to distribute and/or control the power to the other components in the node 30. The power source 48 can be any suitable device for powering the node 30. For example, the power source 48 can include one or more dry cell batteries (e.g., nickel-cadmium (NiCd), nickel-zinc (NiZn), nickel metal hydride (NiMH), lithium-ion (Li-ion), etc.), solar cells, fuel cells, and the like.

[0061] The processor 32 can also be coupled to the GPS chipset 50, which can be configured to provide location information (e.g., longitude and latitude) regarding the current location of the node 30. It will be appreciated that the node 30 can acquire location information by way of any suitable location-determination method while remaining consistent with an exemplary embodiment.

[0062] FIG. 12 is a block diagram of a computing system 800 which can also be used to implement components of the system or be part of the UE 30. The computing system 800 can comprise a computer or server and can be controlled primarily by computer readable instructions, which can be in the form of software, wherever, or by whatever means such software is stored or accessed. Such computer readable instructions can be executed within a processor, such as central processing unit (CPU) 91, to cause computing system 800 to operate. In many workstations, servers, and personal computers, central processing unit 91 can be implemented by a single-chip CPU called a microprocessor. In other machines, the central processing unit 91 can comprise multiple processors. Coprocessor 81 can be an optional processor, distinct from main CPU 91, that performs additional functions or assists CPU 91.

[0063] In operation, CPU 91 fetches, decodes, and executes instructions, and transfers information to and from other resources via the computer's main data-transfer path, system bus 80. Such a system bus connects the components in computing system 800 and defines the medium for data exchange. System bus 80 typically includes data lines for sending data, address lines for sending addresses, and control lines for sending interrupts and for operating the system bus. An example of such a system bus 80 is the Peripheral Component Interconnect (PCI) bus.

[0064] Memories coupled to system bus 80 include RAM 82 and ROM 93. Such memories can include circuitry that allows information to be stored and retrieved. ROMs 93 generally contain stored data that cannot easily be modified. Data stored in RAM 82 can be read or changed by CPU 91 or other hardware devices. Access to RAM 82 and/or ROM 93 can be controlled by memory controller 92. Memory controller 92 can provide an address translation function that translates virtual addresses into physical addresses as instructions are executed. Memory controller 92 can also provide a memory protection function that isolates processes within the system and isolates system processes from user processes. Thus, a program running in a first mode can access only memory mapped by its own process virtual address space; it cannot access memory within another process's virtual address space unless memory sharing between the processes has been set up.

[0065] In addition, computing system 800 can contain peripherals controller 83 responsible for communicating instructions from CPU 91 to peripherals, such as printer 94, keyboard 84, mouse 95, and disk drive 85.

[0066] Display 86, which is controlled by display controller 96, is used to display visual output generated by computing system 800. Such visual output can include text, graphics, animated graphics, and video. Display 86 can be implemented with a cathode-ray tube (CRT)-based video display, a liquid-crystal display (LCD)-based flat-panel display, gas plasma-based flat-panel display, or a touch-panel. Display controller 96 includes electronic components required to generate a video signal that is sent to display 86.

[0067] Further, computing system 800 can contain communication circuitry, such as for example a network adaptor 97, that can be used to connect computing system 800 to an external communications network, such as network 12 of FIG. 7, to enable the computing system 800 to communicate with other nodes (e.g., UE 30) of the network.

[0068] FIG. 13 illustrates an example computer system 1300. In exemplary embodiments, one or more computer systems 1300 perform one or more steps of one or more methods described or illustrated herein. In particular embodiments, one or more computer systems 1300 provide functionality described or illustrated herein. In exemplary embodiments, software running on one or more computer systems 1300 performs one or more steps of one or more methods described or illustrated herein or provides functionality described or illustrated herein. Exemplary embodiments include one or more portions of one or more computer systems 1300. Herein, reference to a computer system can encompass a computing device, and vice versa, where appropriate. Moreover, reference to a computer system can encompass one or more computer systems, where appropriate.

[0069] This disclosure contemplates any suitable number of computer systems 1300. This disclosure contemplates computer system 1300 taking any suitable physical form. As example and not by way of limitation, computer system 1300 can be an embedded computer system, a system-on-chip (SOC), a single-board computer system (SBC) (such as, for example, a computer-on-module (COM) or system-on-module (SOM)), a desktop computer system, a laptop or notebook computer system, an interactive kiosk, a mainframe, a mesh of computer systems, a mobile telephone, a personal digital assistant (PDA), a server, a tablet computer system, or a combination of two or more of these. Where appropriate, computer system 1300 can include one or more computer systems 1300; be unitary or distributed; span multiple locations; span multiple machines; span multiple data centers; or reside in a cloud, which can include one or more cloud components in one or more networks. Where appropriate, one or more computer systems 1300 can perform without substantial spatial or temporal limitation one or more steps of one or more methods described or illustrated herein. As an example, and not by way of limitation, one or more computer systems 1300 can perform in real time or in batch mode one or more steps of one or more methods described or illustrated herein. One or more computer systems 1300 can perform at different times or at different locations one or more steps of one or more methods described or illustrated herein, where appropriate.

[0070] In exemplary embodiments, computer system 1300 includes a processor 1302, memory 1304, storage 1306, an input/output (I/O) interface 1308, a communication interface 1310, and a bus 1312. Although this disclosure describes and illustrates a particular computer system having a particular number of particular components in a particular arrangement, this disclosure contemplates any suitable computer system having any suitable number of any suitable components in any suitable arrangement.

[0071] In exemplary embodiments, processor 1302 includes hardware for executing instructions, such as those making up a computer program. As an example and not by way of limitation, to execute instructions, processor 1302 can retrieve (or fetch) the instructions from an internal register, an internal cache, memory 1304, or storage 1306; decode and execute them; and then write one or more results to an internal register, an internal cache, memory 1304, or storage 1306. In particular embodiments, processor 1302 can include one or more internal caches for data, instructions, or addresses. This disclosure contemplates processor 1302 including any suitable number of any suitable internal caches, where appropriate. As an example and not by way of limitation, processor 1302 can include one or more instruction caches, one or more data caches, and one or more translation lookaside buffers (TLBs). Instructions in the instruction caches can be copies of instructions in memory 1304 or storage 1306, and the instruction caches can speed up retrieval of those instructions by processor 1302. Data in the data caches can be copies of data in memory 1304 or storage 1306 for instructions executing at processor 1302 to operate on; the results of previous instructions executed at processor 1302 for access by subsequent instructions executing at processor 1302 or for writing to memory 1304 or storage 1306; or other suitable data. The data caches can speed up read or write operations by processor 1302. The TLBs can speed up virtual-address translation for processor 1302. In particular embodiments, processor 1302 can include one or more internal registers for data, instructions, or addresses. This disclosure contemplates processor 1302 including any suitable number of any suitable internal registers, where appropriate. Where appropriate, processor 1302 can include one or more arithmetic logic units (ALUs); be a multi-core processor; or include one or more processors 1302. Although this disclosure describes and illustrates a particular processor, this disclosure contemplates any suitable processor.

[0072] In exemplary embodiments, memory 1304 includes main memory for storing instructions for processor 1302 to execute or data for processor 1302 to operate on. As an example and not by way of limitation, computer system 1300 can load instructions from storage 1306 or another source (such as, for example, another computer system 1300) to memory 1304. Processor 1302 can then load the instructions from memory 1304 to an internal register or internal cache. To execute the instructions, processor 1302 can retrieve the instructions from the internal register or internal cache and decode them. During or after execution of the instructions, processor 1302 can write one or more results (which can be intermediate or final results) to the internal register or internal cache. Processor 1302 can then write one or more of those results to memory 1304. In particular embodiments, processor 1302 executes only instructions in one or more internal registers or internal caches or in memory 1304 (as opposed to storage 1306 or elsewhere) and operates only on data in one or more internal registers or internal caches or in memory 1304 (as opposed to storage 1306 or elsewhere). One or more memory buses (which can each include an address bus and a data bus) can couple processor 1302 to memory 1304. Bus 1312 can include one or more memory buses, as described below. In exemplary embodiments, one or more memory management units (MMUs) reside between processor 1302 and memory 1304 and facilitate accesses to memory 1304 requested by processor 1302. In particular embodiments, memory 1304 includes random access memory (RAM). This RAM can be volatile memory, where appropriate. Where appropriate, this RAM can be dynamic RAM (DRAM) or static RAM (SRAM). Moreover, where appropriate, this RAM can be single-ported or multi-ported RAM. This disclosure contemplates any suitable RAM. Memory 1304 can include one or more memories 1304, where appropriate. Although this disclosure describes and illustrates particular memory, this disclosure contemplates any suitable memory.

[0073] In exemplary embodiments, storage 1306 includes mass storage for data or instructions. As an example, and not by way of limitation, storage 1306 can include a hard disk drive (HDD), a floppy disk drive, flash memory, an optical disc, a magneto-optical disc, magnetic tape, or a Universal Serial Bus (USB) drive or a combination of two or more of these. Storage 1306 can include removable or non-removable (or fixed) media, where appropriate. Storage 1306 can be internal or external to computer system 1300, where appropriate. In exemplary embodiments, storage 1306 is non-volatile, solid-state memory. In particular embodiments, storage 1306 includes read-only memory (ROM). Where appropriate, this ROM can be mask-programmed ROM, programmable ROM (PROM), erasable PROM (EPROM), electrically erasable PROM (EEPROM), electrically alterable ROM (EAROM), or flash memory or a combination of two or more of these. This disclosure contemplates mass storage 1306 taking any suitable physical form. Storage 1306 can include one or more storage control units facilitating communication between processor 1302 and storage 1306, where appropriate. Where appropriate, storage 1306 can include one or more storages 1306. Although this disclosure describes and illustrates particular storage, this disclosure contemplates any suitable storage.

[0074] In exemplary embodiments, I/O interface 1308 includes hardware, software, or both, providing one or more interfaces for communication between computer system 1300 and one or more I/O devices. Computer system 1300 can include one or more of these I/O devices, where appropriate. One or more of these I/O devices can enable communication between a person and computer system 1300. As an example and not by way of limitation, an I/O device can include a keyboard, keypad, microphone, monitor, mouse, printer, scanner, speaker, still camera, stylus, tablet, touch screen, trackball, video camera, another suitable I/O device or a combination of two or more of these. An I/O device can include one or more sensors. This disclosure contemplates any suitable I/O devices and any suitable I/O interfaces 1308 for them. Where appropriate, I/O interface 1308 can include one or more device or software drivers enabling processor 1302 to drive one or more of these I/O devices. I/O interface 1308 can include one or more I/O interfaces 1308, where appropriate. Although this disclosure describes and illustrates a particular I/O interface, this disclosure contemplates any suitable I/O interface.

[0075] In exemplary embodiments, communication interface 1310 includes hardware, software, or both providing one or more interfaces for communication (such as, for example, packet-based communication) between computer system 1300 and one or more other computer systems 1300 or one or more networks. As an example and not by way of limitation, communication interface 1310 can include a network interface controller (NIC) or network adapter for communicating with an Ethernet or other wire-based network or a wireless NIC (WNIC) or wireless adapter for communicating with a wireless network, such as a WI-FI network. This disclosure contemplates any suitable network and any suitable communication interface 1310 for it. As an example and not by way of limitation, computer system 1300 can communicate with an ad hoc network, a personal area network (PAN), a local area network (LAN), a wide area network (WAN), a metropolitan area network (MAN), or one or more portions of the Internet or a combination of two or more of these. One or more portions of one or more of these networks can be wired or wireless. As an example, computer system 1300 can communicate with a wireless PAN (WPAN) (such as, for example, a BLUETOOTH WPAN), a WI-FI network, a WI-MAX network, a cellular telephone network (such as, for example, a Global System for Mobile Communications (GSM) network), or other suitable wireless network or a combination of two or more of these. Computer system 1300 can include any suitable communication interface 1310 for any of these networks, where appropriate. Communication interface 1310 can include one or more communication interfaces 1310, where appropriate. Although this disclosure describes and illustrates a particular communication interface, this disclosure contemplates any suitable communication interface.

[0076] In particular embodiments, bus 1312 includes hardware, software, or both coupling components of computer system 1300 to each other. As an example and not by way of limitation, bus 1312 can include an Accelerated Graphics Port (AGP) or other graphics bus, an Enhanced Industry Standard Architecture (EISA) bus, a front-side bus (FSB), a HYPERTRANSPORT (HT) interconnect, an Industry Standard Architecture (ISA) bus, an

INFINIBAND interconnect, a low-pin-count (LPC) bus, a memory bus, a Micro Channel Architecture (MCA) bus, a Peripheral Component Interconnect (PCI) bus, a PCI-Express (PCIe) bus, a serial advanced technology attachment (SATA) bus, a Video Electronics Standards Association local (VLB) bus, or another suitable bus or a combination of two or more of these. Bus 1312 can include one or more buses 1312, where appropriate. Although this disclosure describes and illustrates a particular bus, this disclosure contemplates any suitable bus or interconnect.

[0077] Herein, a computer-readable non-transitory storage medium or media can include one or more semiconductor-based or other integrated circuits (ICs) (such, as for example, field-programmable gate arrays (FPGAs) or application-specific ICs (ASICs)), hard disk drives (HDDs), hybrid hard drives (HHDs), optical discs, optical disc drives (ODDs), magneto-optical discs, magneto-optical drives, floppy diskettes, floppy disk drives (FDDs), magnetic tapes, solid-state drives (SSDs), RAM-drives, SECURE DIGITAL cards or drives, any other suitable computer-readable non-transitory storage media, computer readable medium or any suitable combination of two or more of these, where appropriate. A computer-readable non-transitory storage medium can be volatile, non-volatile, or a combination of volatile and non-volatile, where appropriate.

[0078] Herein, "or" is inclusive and not exclusive, unless expressly indicated otherwise or indicated otherwise by context. Therefore, herein, "A or B" means "A, B, or both," unless expressly indicated otherwise or indicated otherwise by context. Moreover, "and" is both joint and several, unless expressly indicated otherwise or indicated otherwise by context. Therefore, herein, "A and B" means "A and B, jointly or severally," unless expressly indicated otherwise or indicated otherwise by context.

[0079] The scope of this disclosure encompasses all changes, substitutions, variations, alterations, and modifications to the example embodiments described or illustrated herein that a person having ordinary skill in the art would comprehend. The scope of this disclosure is not limited to the example embodiments described or illustrated herein. Moreover, although this disclosure describes and illustrates respective embodiments herein as including particular components, elements, feature, functions, operations, or steps, any of these embodiments can include any combination or permutation of any of the components, elements, features, functions, operations, or steps described or illustrated anywhere herein that a person having ordinary skill in the art would comprehend. Furthermore, reference in the appended claims to an apparatus or system or a component of an apparatus or system being adapted to, arranged to, capable of, configured to, enabled to, operable to, or operative to perform a particular function encompasses that apparatus, system, component, whether or not it or that particular function is activated, turned on, or unlocked, as long as that apparatus, system, or component is so adapted, arranged, capable, configured, enabled, operable, or operative. Additionally, although this disclosure describes or illustrates particular embodiments as providing particular advantages, particular embodiments can provide none, some, or all of these advantages.

What is Claimed:

1. An over-extension hinge system for glasses, comprising:

a primary pivot axis defining movement between a frame arm attached to a glasses frame, wherein the primary pivot axis provides an axis of rotation during closure and extension of the frame arm relative to the glasses frame between a first position and second position;

an external pivot axis along an outer edge of the frame arm, wherein the external pivot axis is parallel to the primary pivot axis, wherein the external pivot axis provides an axis of rotation during an over-extension of the pivot arm relative to the frame; and

a hinge module connecting the glasses frame and the frame arm, wherein the hinge module defines the primary pivot axis and external pivot axis.

2. The system of claim 1, wherein over-extension occurs when an angle between the frame arm and the glasses frame exceeds 90 degrees.

3. The system of claim 1, wherein the hinge module enables over-extension up to about ten degrees.

4. A hinge module, comprising:

a hinge base;

a paddle connected to the hinge base via a travel pin, wherein the paddle comprises a cylindrical bearing surface to receive the travel pin, and enable movement of the hinge base relative to the paddle along a predefined range; and

a preloaded spring maintaining a base position between the hinge base and the paddle, wherein movement of the hinge base relative to the paddle along the predefined range requires a force corresponding a stiffness of the preloaded spring.

5. The hinge module of claim 4, wherein the predefined range is within ten degrees.

6. The hinge module of claim 4, comprising a first pair of attachments to secure the hinge base to a frame, and a second pair of attachments to secure the hinge base to a frame arm.

7. The hinge module of claim 4, wherein the stiffness of the preloaded spring is between 29-37 N/mm.

ABSTRACT

Systems, methods, and devices, and computer program products are provided for hinge modules for smart glasses systems, and overextension hinge modules usable with one or more electronic components. In an example, an overextension hinge module may include a hinge base, a paddle connected to the hinge base via a travel pin, and a preloaded spring maintaining a base position between the hinge base and the paddle, allowing movement of the hinge base relative to the paddle along a predefined range. Various examples may include a primary pivot axis defining movement between a frame arm attached to a glasses frame, and an external pivot axis along an outer edge of the frame arm defining an over-extension of the pivot arm relative to the frame.

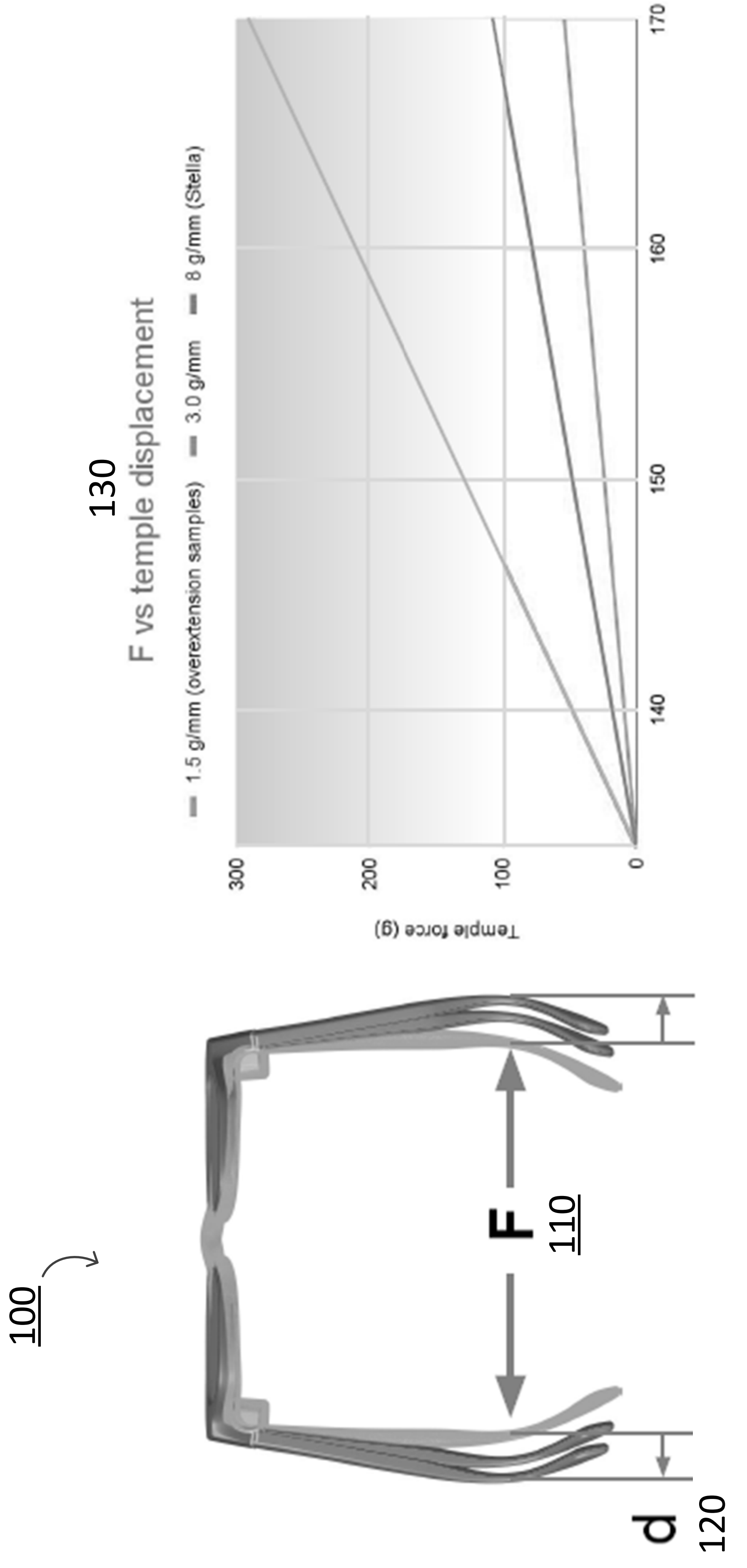
100
F
110
d
120
130
F vs temple displacement
1.5 g/mm (overextension samples)
3.0 g/mm
8 g/mm (Stella)
Temple force (g)
300
200
100
0
140
150
160
170

FIG. 1

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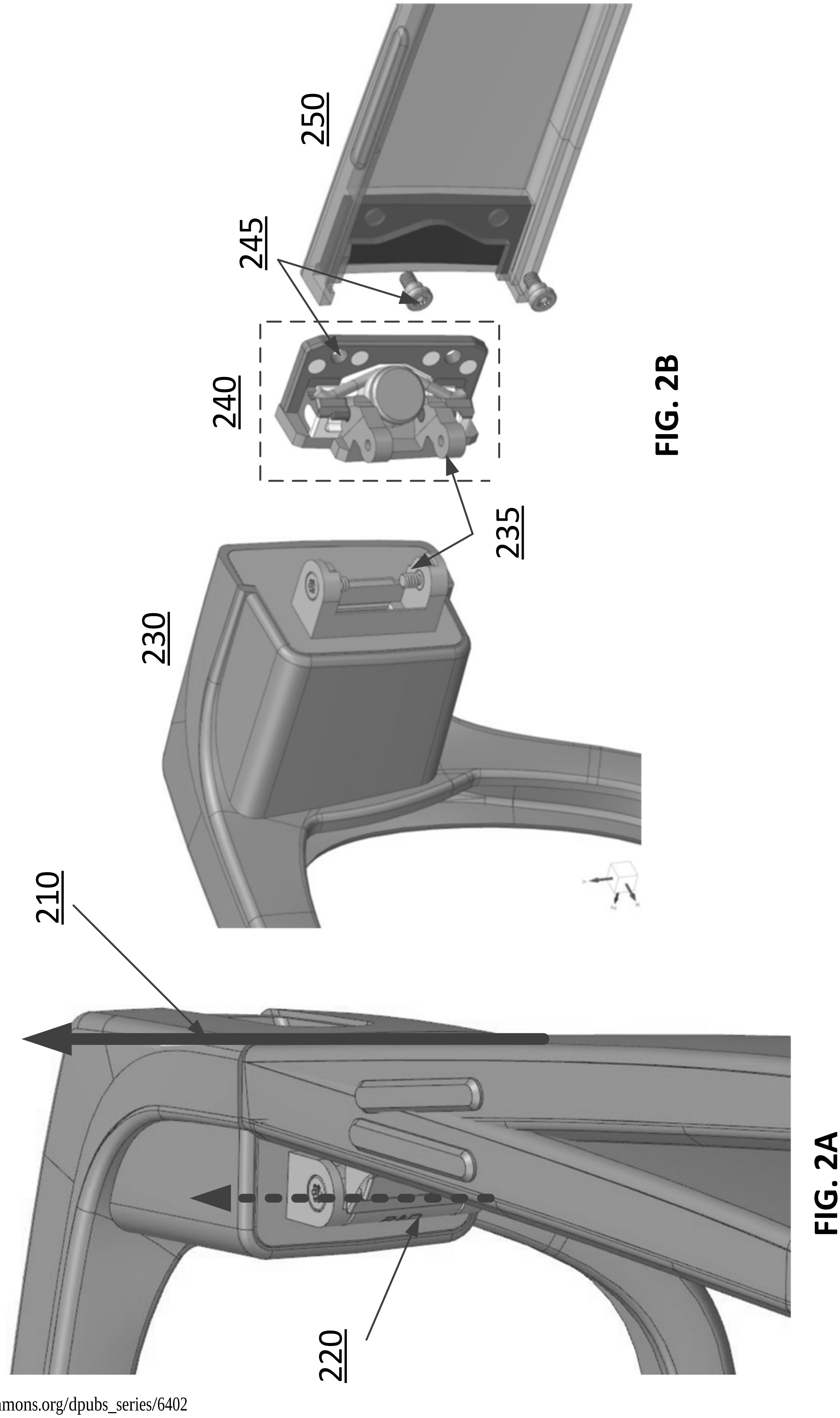

FIG. 2B

FIG. 2A

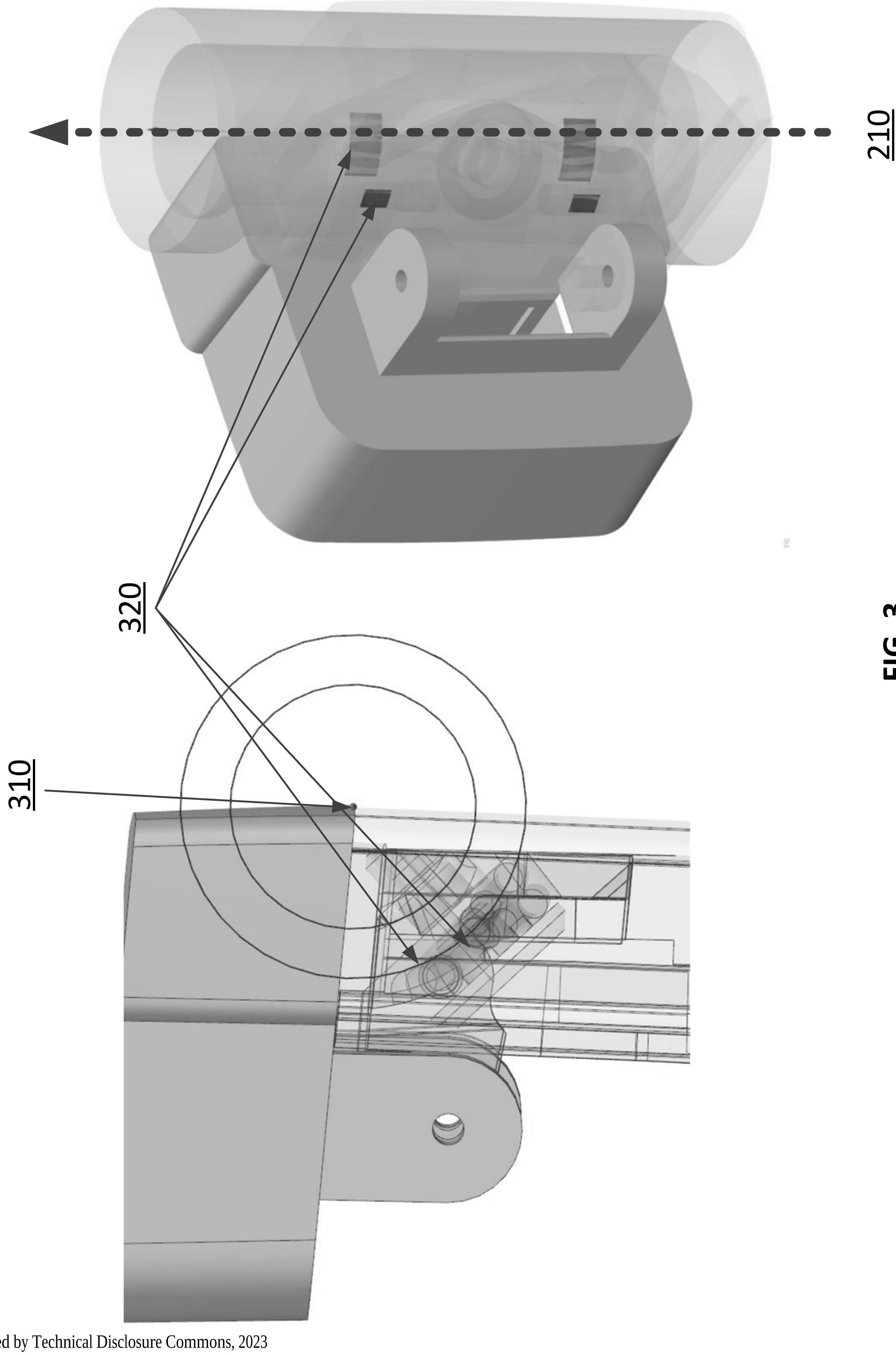

FIG. 3

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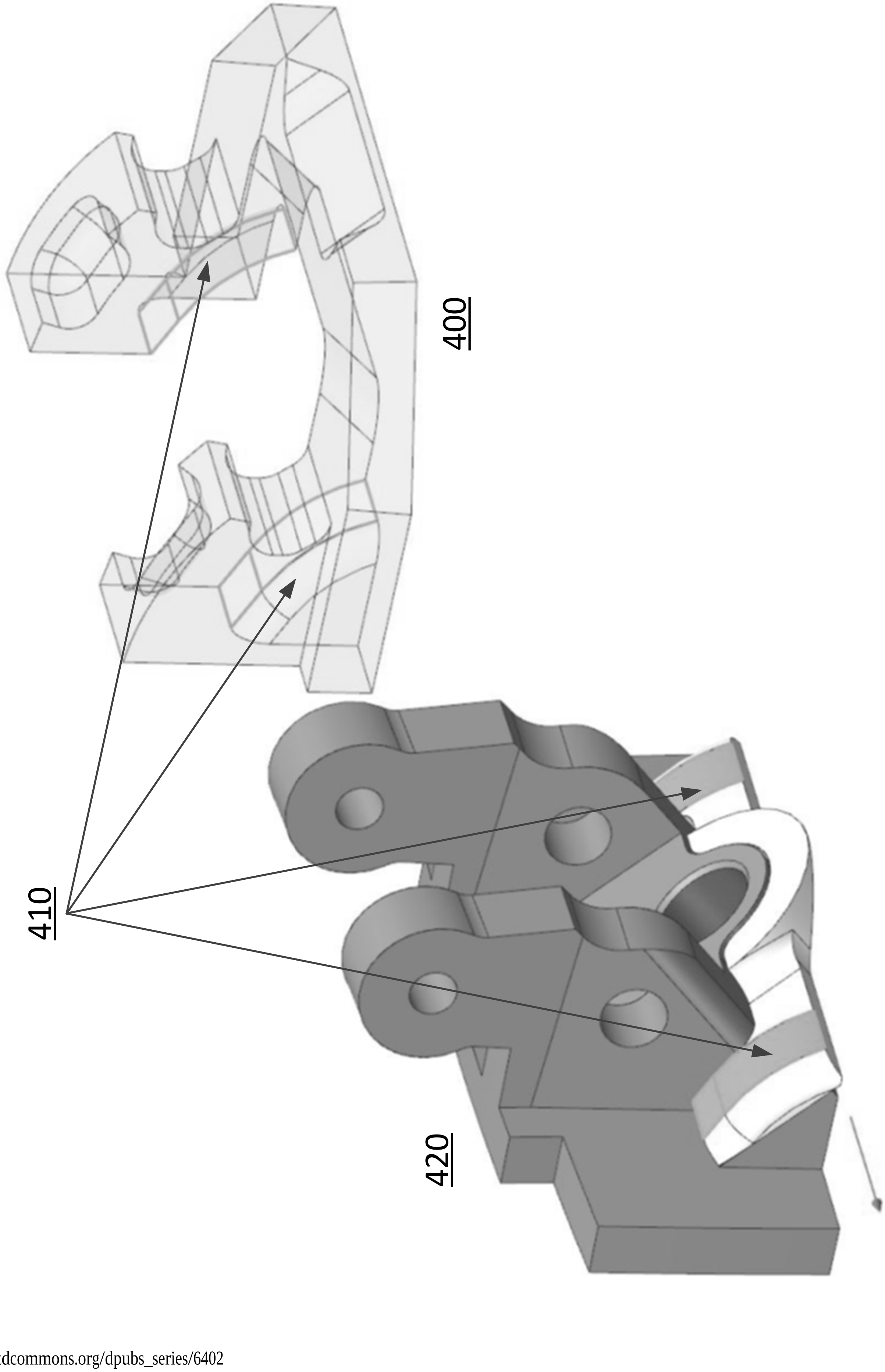

FIG. 4

- 24 -

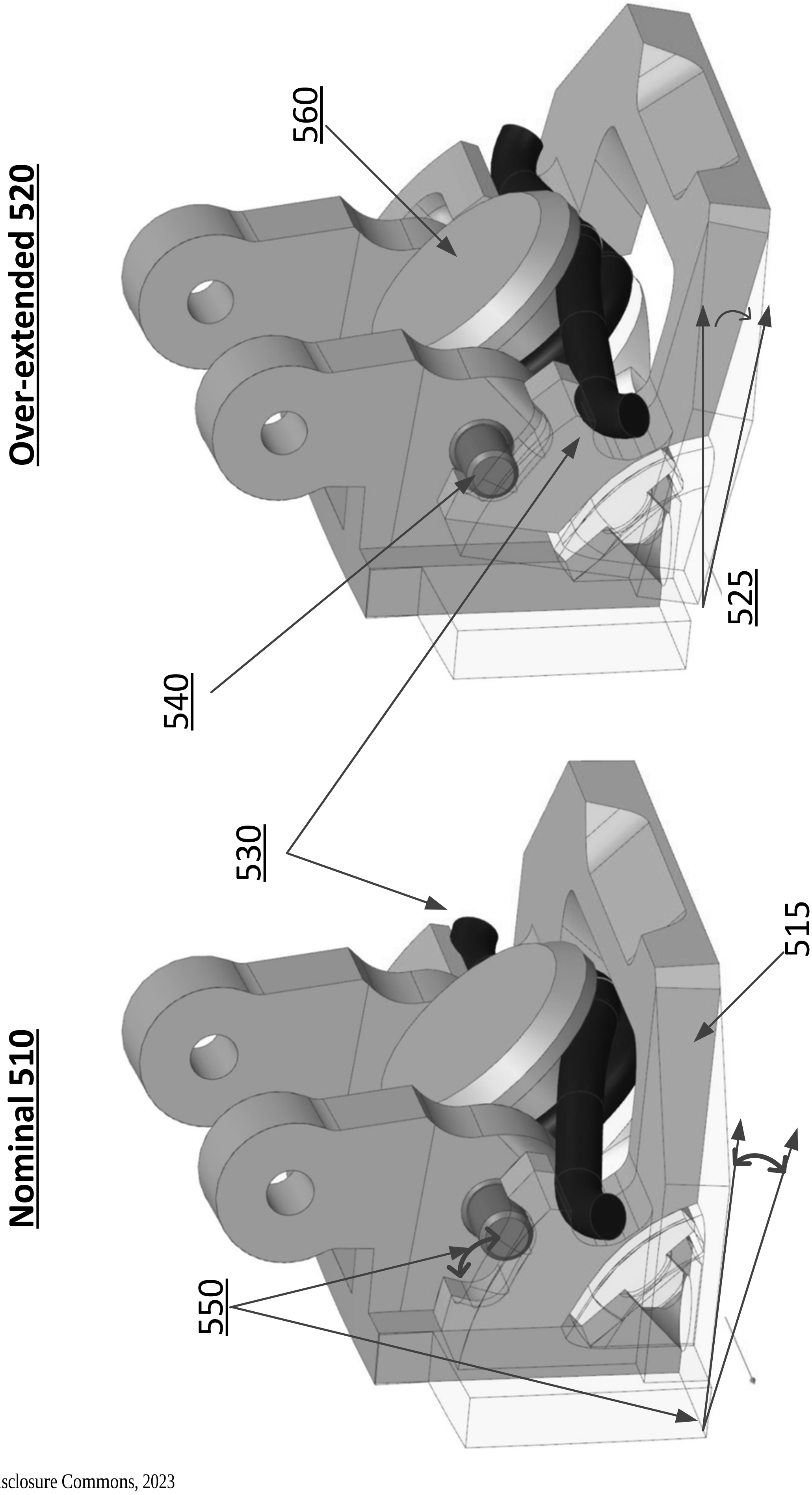

FIG. 5

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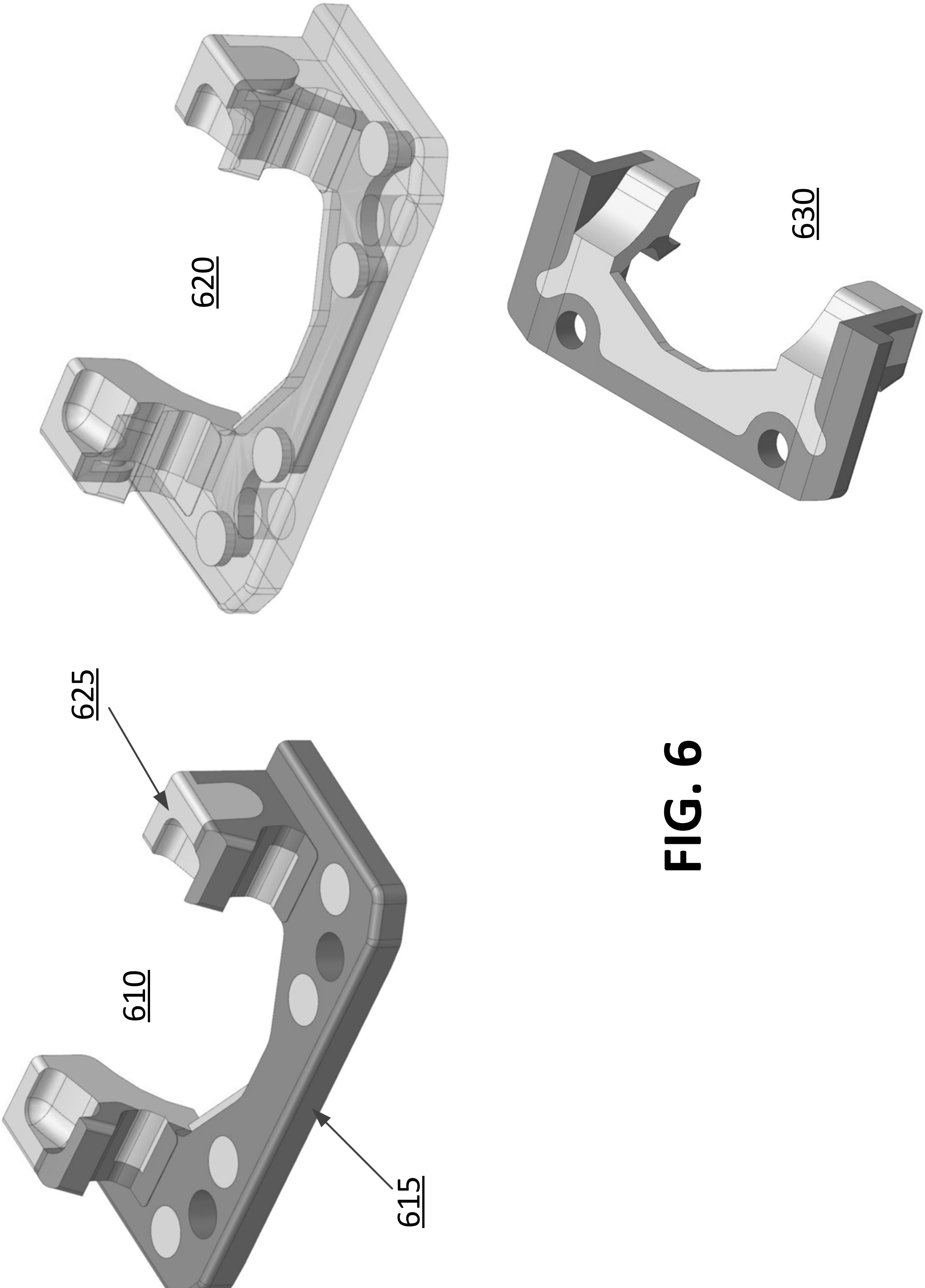


FIG. 6

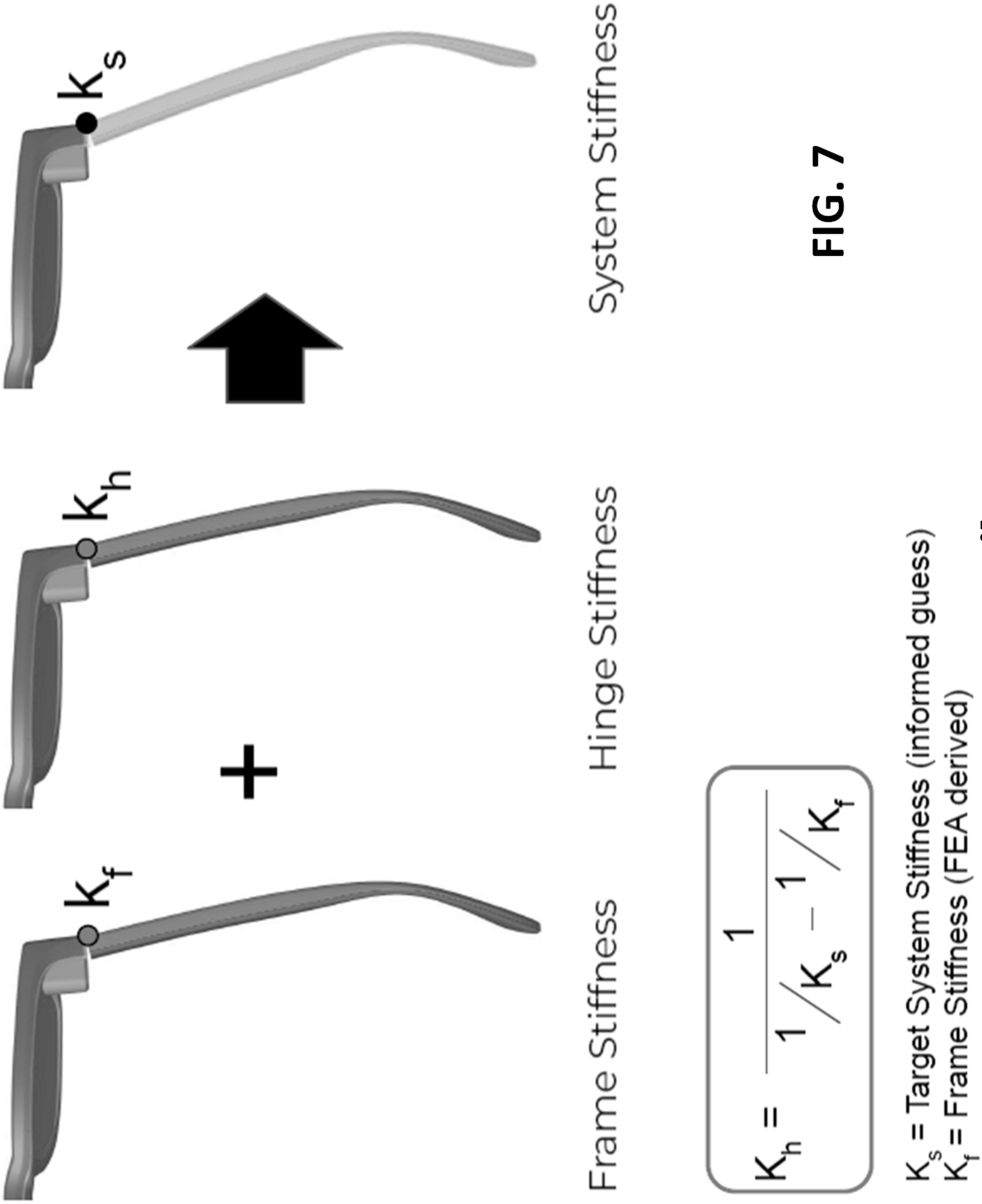

K_f
Frame Stiffness
+
K_h
Hinge Stiffness
K_s
System Stiffness
$K_h = \frac{1}{1/K_s - 1/K_f}$
K_s = Target System Stiffness (informed guess)
K_f = Frame Stiffness (FEA derived)

FIG. 7

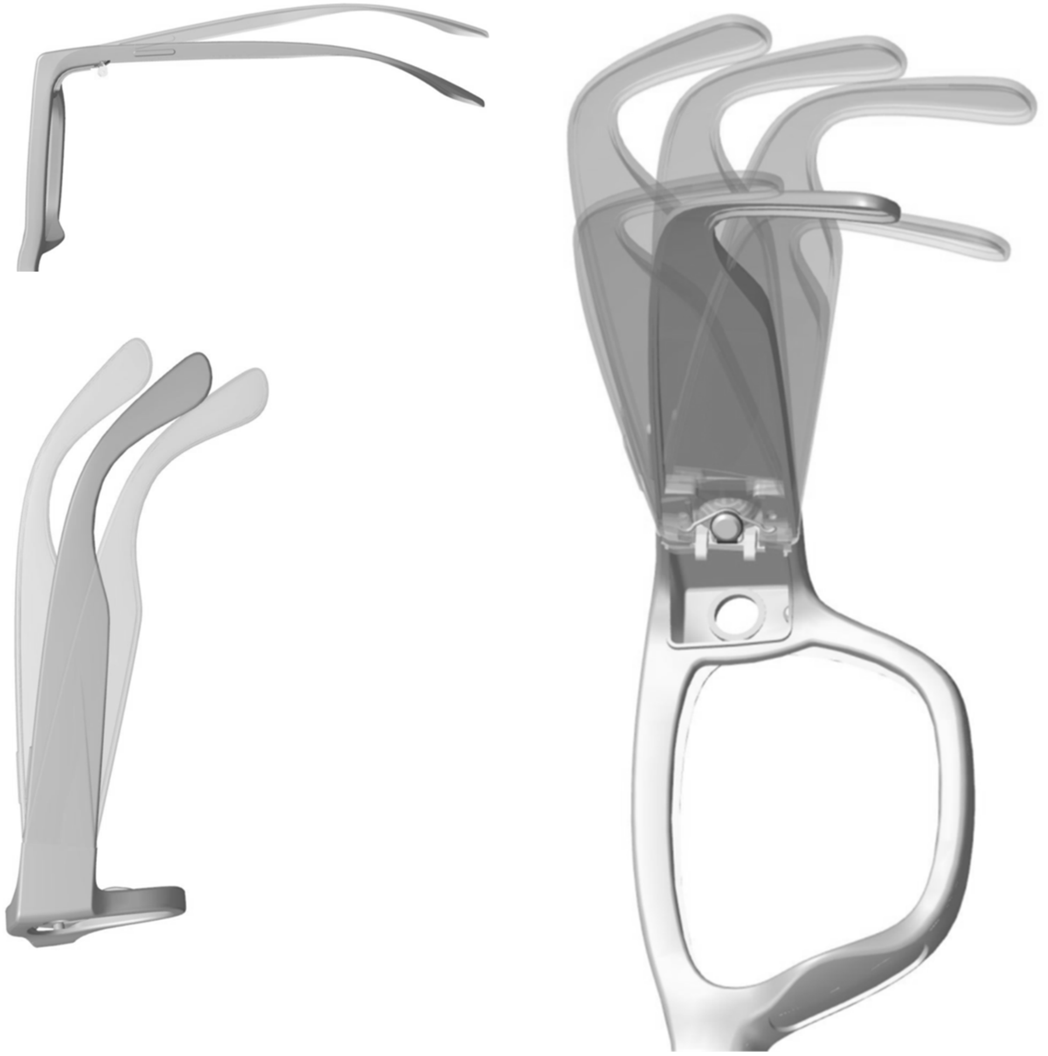
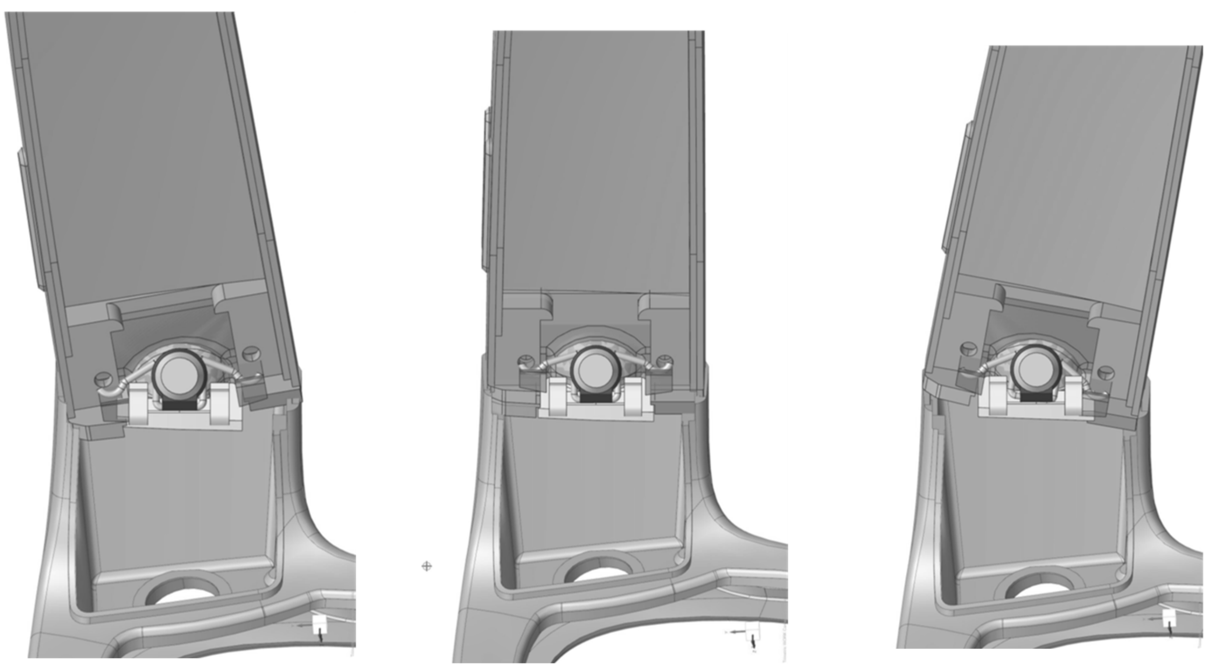


Fig. 8



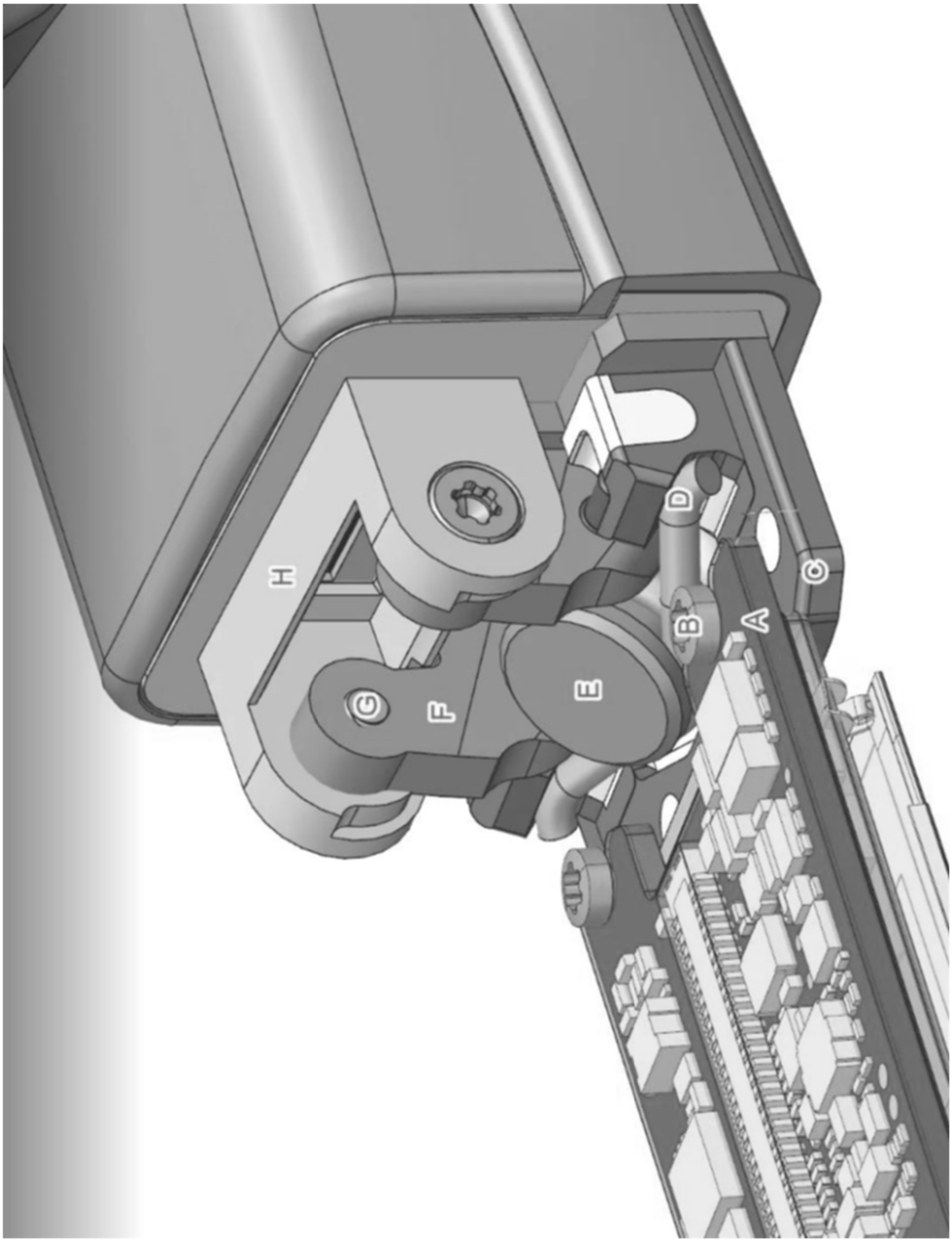


FIG. 9

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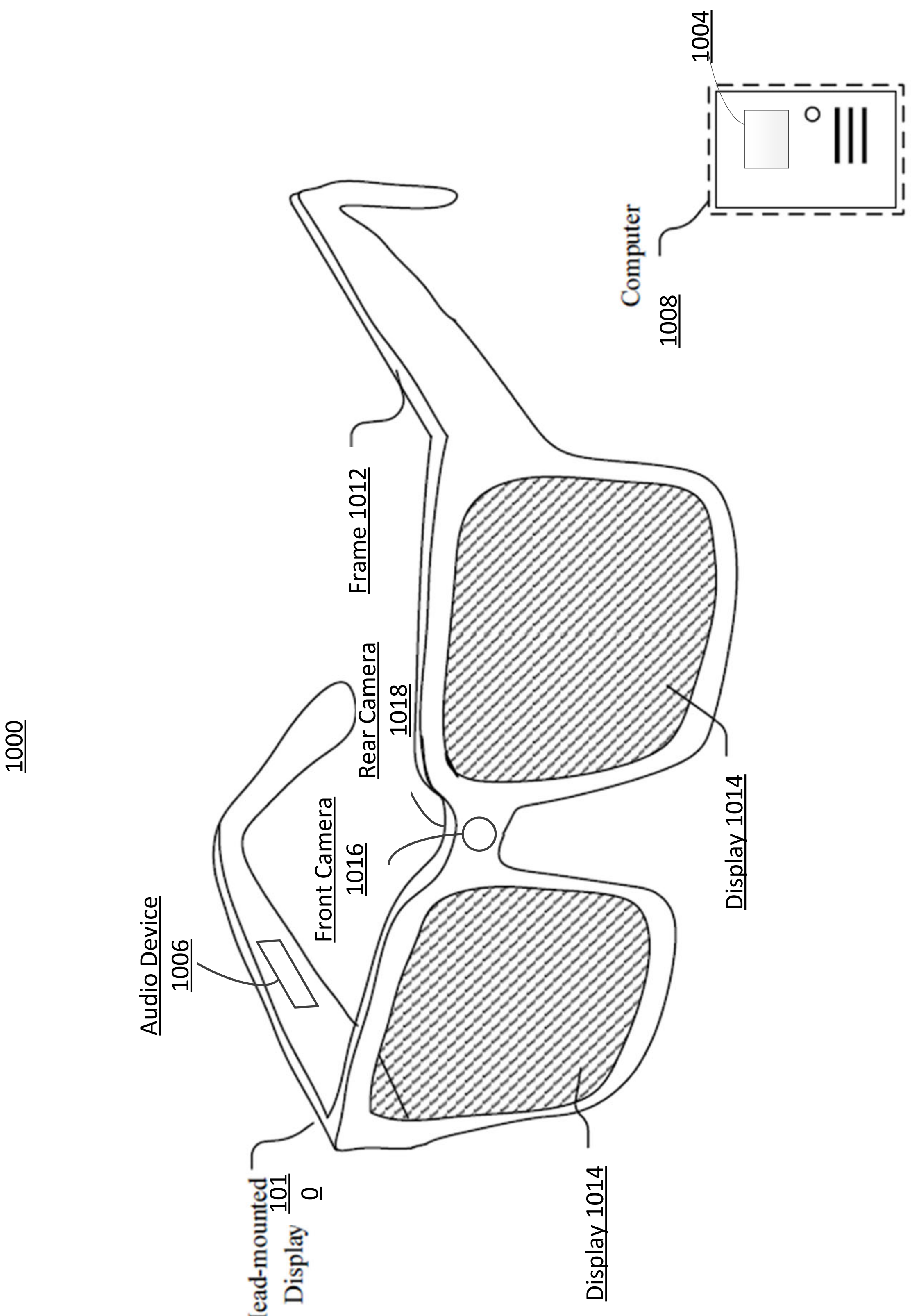
1000
Head-mounted Display 101
0
Audio Device 1006
Front Camera 1016
Rear Camera 1018
Frame 1012
Display 1014
Display 1014
Computer 1008
1004

FIG. 10

- 30 -

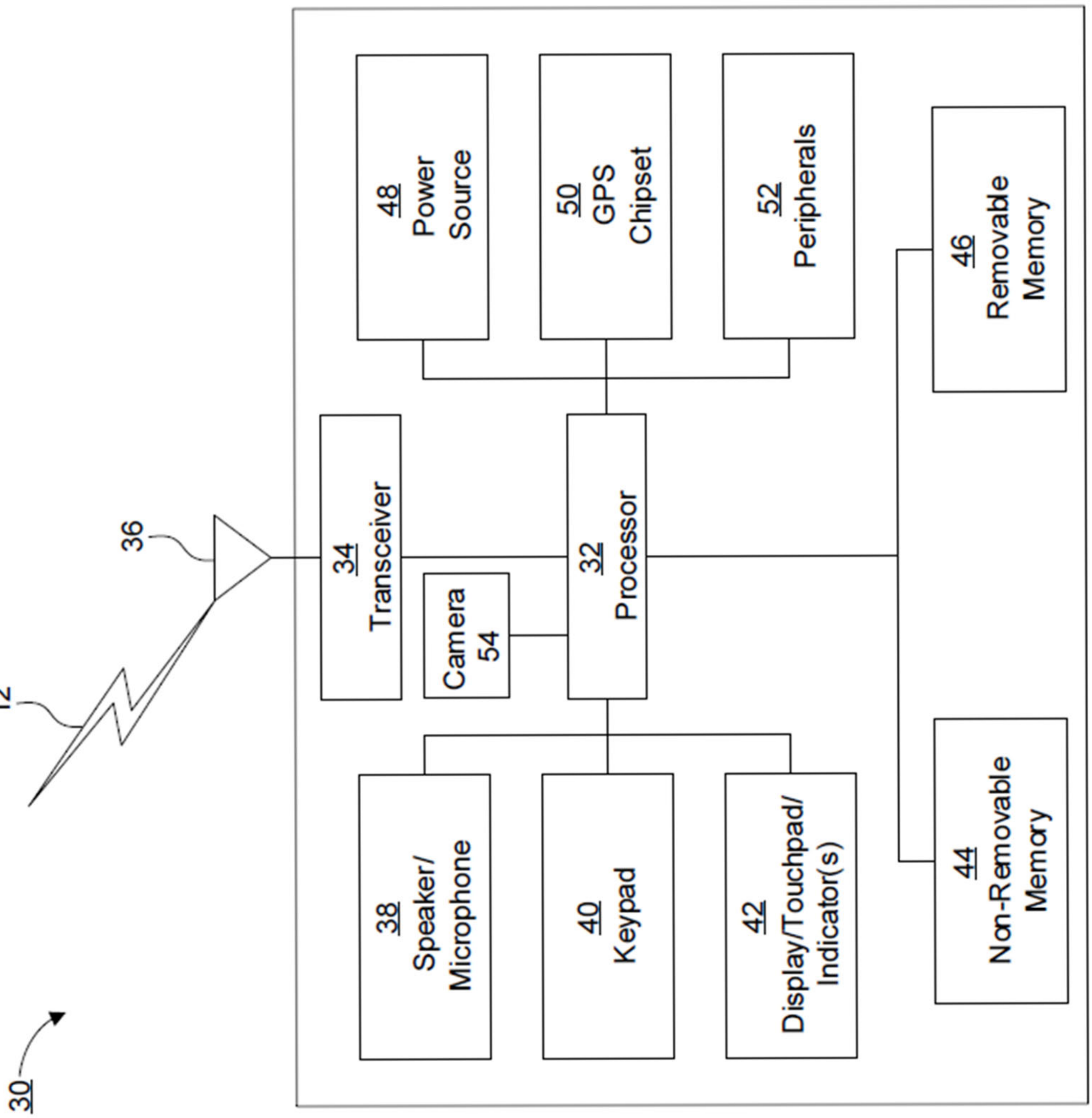
30
12
36
34
Transceiver
Camera
54
32
Processor
38
Speaker/
Microphone
40
Keypad
42
Display/Touchpad/
Indicator(s)
44
Non-Removable
Memory
46
Removable
Memory
48
Power
Source
50
GPS
Chipset
52
Peripherals

FIG. 11

- 31 -

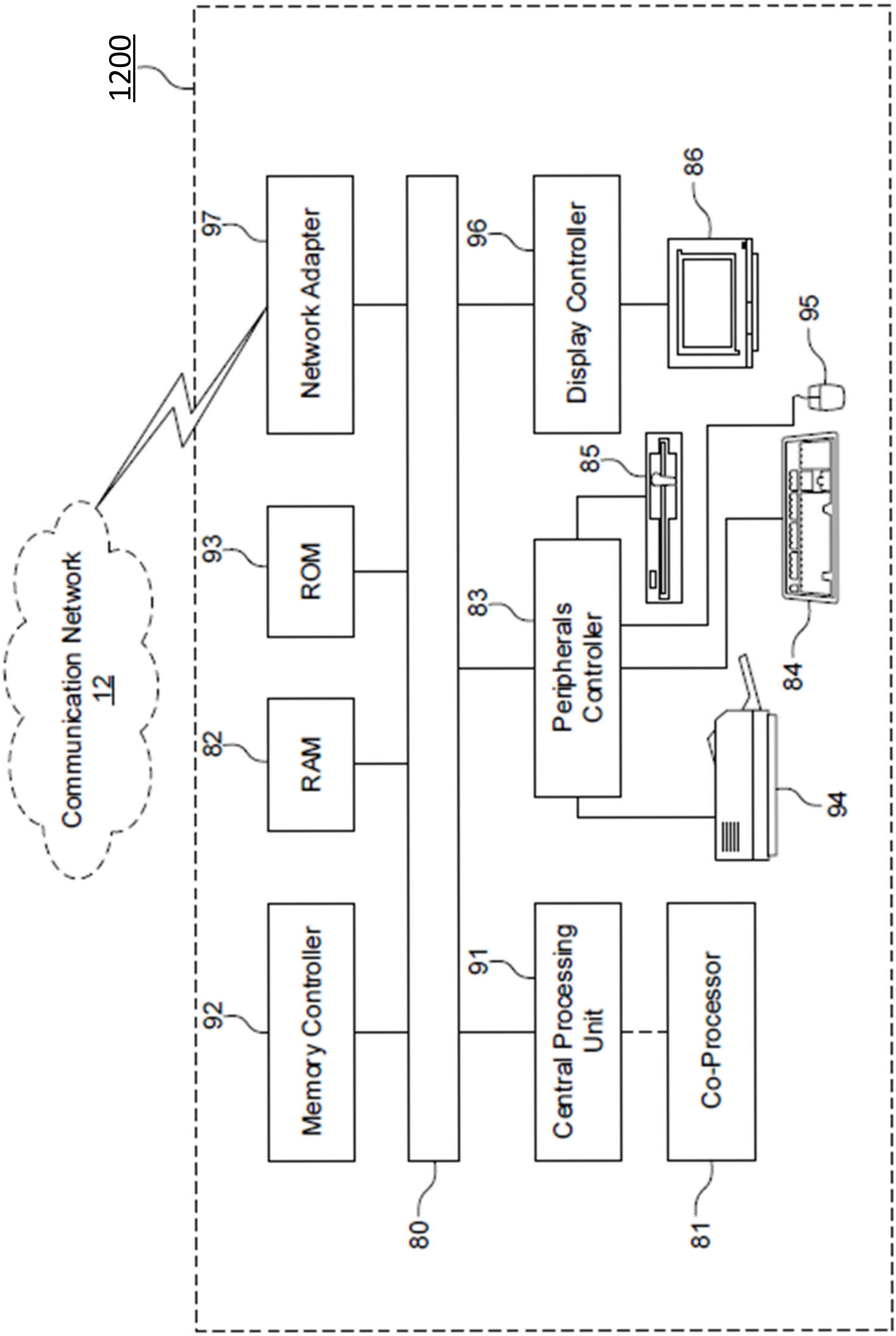
1200
Communication Network
12
97
Network Adapter
93
ROM
82
RAM
92
Memory Controller
96
Display Controller
86
95
85
83
Peripherals Controller
84
94
91
Central Processing Unit
Co-Processor
80
81

FIG. 12

- 32 -

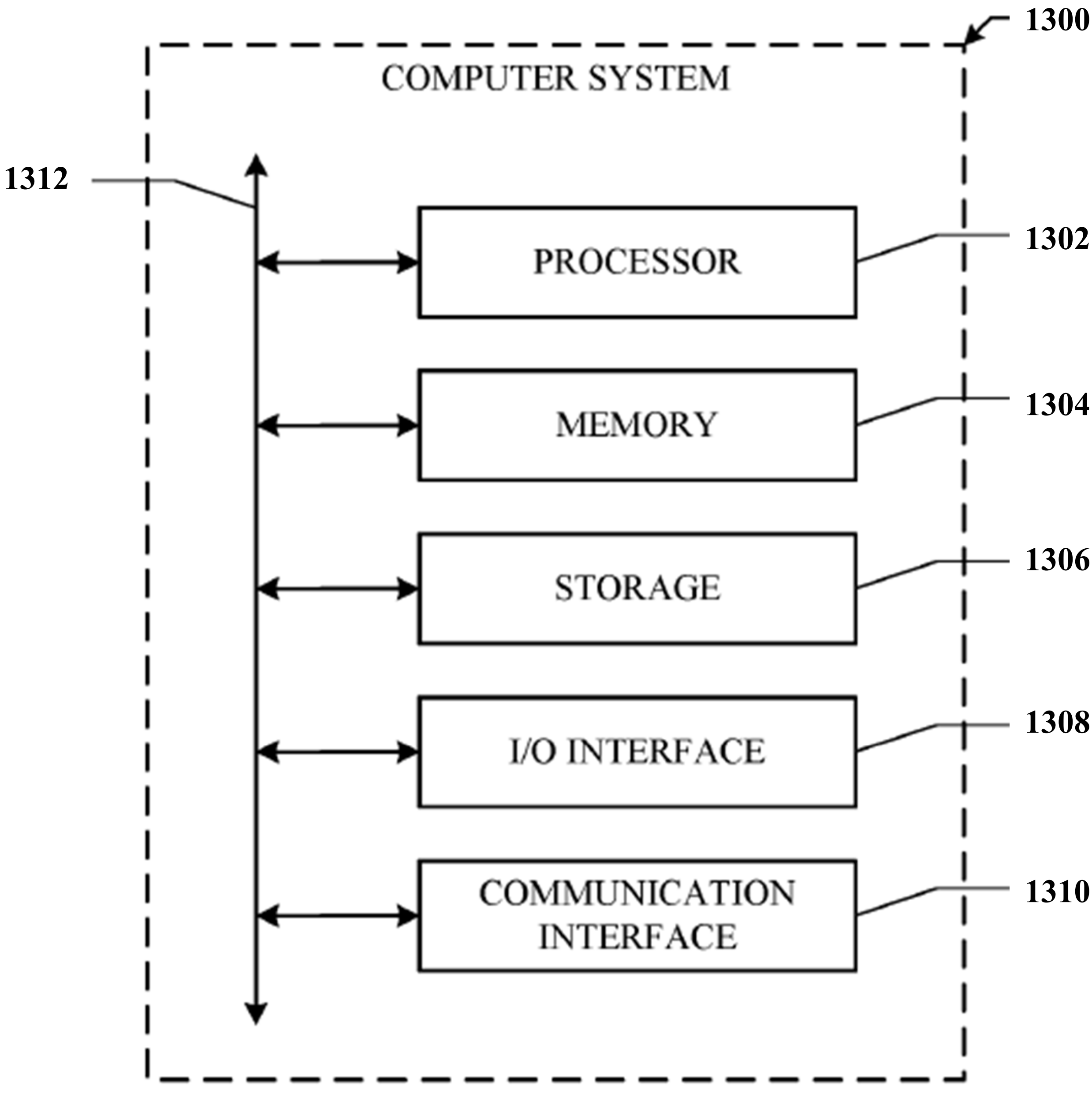
1300
COMPUTER SYSTEM
1312
PROCESSOR
1302
MEMORY
1304
STORAGE
1306
I/O INTERFACE
1308
COMMUNICATION
INTERFACE
1310

FIG. 13