



(51) International Patent Classification:

A61N 5/06 (2006.01) A61G 11/00 (2006.01)

(21) International Application Number:

PCT/IN2019/050493

(22) International Filing Date:

02 July 2019 (02.07.2019)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

201841024663 02 July 2018 (02.07.2018) IN

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH,

(54) Title: PHOTOTHERAPY SYSTEM, APPARATUS, AND KIT

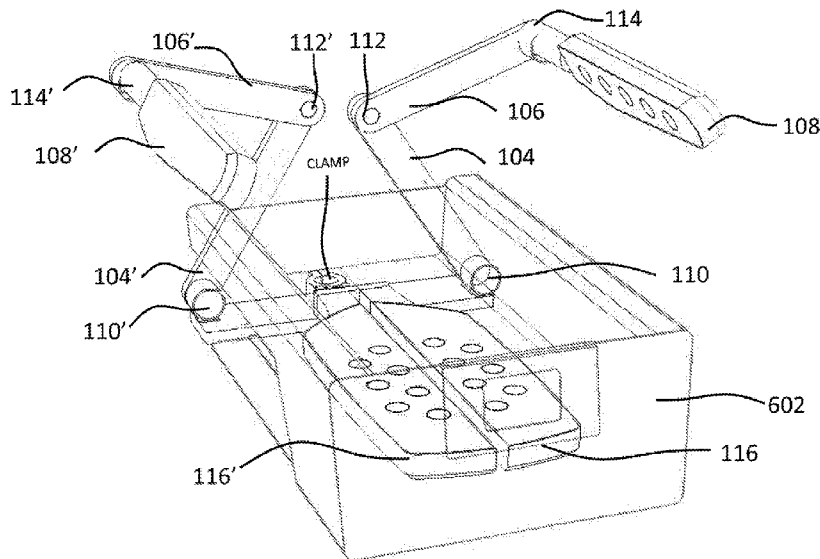


Figure 4

(57) Abstract: The present invention relates to phototherapy systems. In particular, the invention comprises systems, apparatuses and kits for infant therapy – (including without limitation, neonatal jaundice therapy, and treatment of etiological conditions relating to any of mild moderate and severe hyperbilirubinemia in neonates). In certain embodiments, the device includes a phototherapeutic light or lights, and a structure or structures for holding the light(s) and for supporting the subject (typically an infant). The device also includes means for adjusting various phototherapy parameters in different modes suitable for various treatment approaches and clinical conditions. The invention additionally provides systems, apparatuses and kits phototherapy of infants.



GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to the identity of the inventor (Rule 4.17(i))*
- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*
- *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

Phototherapy System, Apparatus, and Kit

Field of the Invention

[001] The present invention relates to phototherapy systems. In particular, the invention comprises systems, apparatuses and kits for infant therapy.

Background

[002] Phototherapy offers an acknowledged treatment option for the cure of hemolytic disease of the new-born child, due to prenatal jaundice. It has been found that by exposing an infant's skin to intense light, such as azure light generated by fluorescent tubes or LEDs lights, indirect and non hydrosoluble bilirubin, generated by the haemoglobin coming from the walls of the red corpuscles, is changed into hydrosoluble bilirubin which is eliminated either by the hepatic canal or by the renal canal.

[003] Present phototherapy apparatuses for infant phototherapy are crude apparatuses, typically comprising a light bar or light generating surface suspended directly above the infant, or above the infant but not directly above, with the light generating surface angled towards the infant, disposed beneath a glass surface on which the infant has been placed and being angled in an upward direction – so that emitted radiations from the light generating surface is directed towards the infant. Such apparatuses are bulky, immoveable and unwieldy, and do not offer solutions that allow incorporation into incubators (which are typically small in size), or which allow the phototherapy apparatus to be operated simultaneously with other clinical apparatuses - such as radiant warmers etc.

[004] Additionally, existing devices that offer phototherapy from multiple angles are typically expensive and lack ready configurability. In current scenarios, clinicians use more than one phototherapy devices to provide multiple surface phototherapy to treat neonatal hyperbilirubinemia ranging from mild, moderate and severe conditions. There are presently no devices available which offer multiple surfaces phototherapy which can be adjustable at multiple angles.

[005] There is accordingly a need for a compact, phototherapy device that is capable of illuminating phototherapy light from multiple angles on infant, and which angles can be altered or configured dynamically. There is additionally a need to regulate and control various phototherapy parameters including positioning of the phototherapy illumination sources and intensity of the illumination in response to feedback regarding the neonatal bilirubin concentration, and to provide optimum irradiance required for that specific condition of a neonate.

Brief Description of the Accompanying Drawings

[006] Figure 1 illustrate embodiments of a phototherapy apparatus in accordance with teachings of the present invention.

[007] Figures 1 to 3, 4(a), 5, and 8(b) illustrate embodiments of a phototherapy apparatus in accordance with the present invention.

[008] Figure 4, 4(b), 6(a), 7, 9, 10, 11(a), 13 and 14 illustrate embodiments of a phototherapy apparatus in use with a bassinet in accordance with the present invention.

[009] Figure 6(b) illustrates a bassinet in accordance with the present invention.

[0010] Figures 8(a), 11(b) and 12 illustrate embodiments of a phototherapy apparatus and bassinet in use for providing phototherapy to an infant placed within the bassinet.

[0011] Figure 14(b) illustrates an embodiment of the phototherapy apparatus having detachable light generating surfaces and a fabric pouch or housing constructed to house the detachable light generating surfaces while simultaneously swaddling an infant.

[0012] Figures 15 to 22 illustrate embodiments of a stand configured for use with the phototherapy apparatus and bassinet of the present invention.

[0013] Figure 23 illustrates electronic components within the phototherapy apparatus of the present invention.

[0014] Figure 24 illustrates a computing system configurable to implement the teachings of the present invention.

Summary

[0015] The present invention relates to phototherapy systems. In particular, the invention comprises systems, apparatuses and kits for infant therapy – (including without limitation, neonatal jaundice therapy, and treatment of etiological conditions relating to any of mild moderate and severe hyperbilirubinemia in neonates). In certain embodiments, the device includes a phototherapeutic light or lights, and a structure or structures for holding the light(s) and for supporting the subject (typically an infant). The device also includes means for adjusting various phototherapy parameters in different modes suitable for various treatment approaches and clinical conditions.

[0016] The invention provides an articulated phototherapy apparatus comprising (i) at least two light generating surfaces, (ii) an articulated arm structure interconnecting the first of the at least two light generating surfaces with the second of the at least two light generating surfaces, wherein (a) the articulated arm structure comprises a first arm and a second arm that are pivotably interconnected, (b) the first arm has a first end connected to the first light generating surface, and an opposed second end that is pivotably affixed to a first end of a second arm, (c) a pivot interconnecting the first arm and the second arm, such that (I) the second arm is rotatable about the pivot and (II) a second end of the second arm that is opposed to the first end of the second arm is movable between (1) a first position where the first arm and the second arm, form an acute angle relative to each other and (2) a second position where the first arm and the second arm either form an obtuse angle relative to each other, or are positioned linearly.

[0017] In an embodiment of the articulated phototherapy apparatus, the first end of the first arm is pivotably coupled to the first of the at least two light generating surfaces, such that said first light generating surface is rotatable about an axis that is perpendicular to a longitudinal axis of the first arm.

[0018] The second end of the second arm may be pivotably coupled to the second of the at least two light generating surfaces, such that said second light generating surface is rotatable about an axis that is perpendicular to a longitudinal axis of the second arm.

[0019] The apparatus may include three third light generating surfaces, (i) the first light generating surface is interconnected with the second light generating surface through a first articulated arm structure comprising a first arm and a second arm that are pivotably interconnected, (ii) the first arm has a first end connected to the first light generating surface, and an opposed second end that is pivotably affixed to a first end of a second arm, (iii) the pivot interconnecting the first arm and the second arm enables rotation of the second arm about the pivot connecting it to the first arm, such that a second end of the second arm that is opposed to the first end of the second arm is moveable between (i) a first position where the first arm and the second arm, form an acute angle relative to each other, and (ii) a second position where the first arm and the second arm form an obtuse angle relative to each other, or are positioned linearly, (iv) the first light generating surface is interconnected with the third light generating surface through a second articulated arm structure comprising a third arm and a fourth arm that are pivotably interconnected, (v) the third arm has a first end connected to the first light generating surface, and an opposed second end that is pivotably affixed to a first end of a fourth arm, and (vi) the pivot interconnecting the third arm and the fourth arm enables rotation of the fourth arm about the pivot, such that a second end of the fourth arm that is opposed to the first end of the fourth arm is moveable between (a) a first position where the third arm and the fourth arm form an acute angle relative to each other, and (b) a second position where the third arm and the fourth arm form an obtuse angle relative to each other, or are linearly positioned.

[0020] The first end of the first arm may be pivotably coupled to the first light generating surface, such that said first light generating surface is rotatable about an axis that is perpendicular to the longitudinal axis of the first arm.

[0021] The second end of the second arm may be pivotably coupled to the second of the at least two light generating surfaces, such that said second light generating surface is rotatable about an axis that is perpendicular to the longitudinal axis of the second arm.

[0022] The first end of the third arm may be pivotably coupled to the first light generating surface, such that said first light generating surface is rotatable about an axis that is substantially perpendicular to the longitudinal axis of the third arm.

[0023] The second end of the fourth arm may be pivotably coupled to the third light generating surface, such that said third light generating surface is rotatable about an axis that is substantially perpendicular to the longitudinal axis of the fourth arm.

[0024] In an embodiment, the first arm and the third arm are the same arm, and the second arm and the fourth arm are distinct arms. In an embodiment, the first arm and the third arm are distinct arms, and the second arm and the fourth arm are distinct arms.

[0025] The apparatus may include (i) one or more sensors configured to detect one or more environmental parameters or physiological parameters associated with a subject positioned within a region under a region of incidence of illumination corresponding to at least one of the light generating surfaces, (ii) one or more actuators configured to (a) move or rotate one or more arms of the articulated phototherapy apparatus about a pivot that connects said arm(s) with another arm or with a light generating surface, or (b) move or rotate one or more light generating surfaces about a pivot that connects said light generating surface to an arm or to the phototherapy apparatus, and (iii) one or more controllers configured to change one or more of position, angle or intensity of illumination of one or more of the light generating surfaces based on parameters detected by the one or more sensors.

[0026] The phototherapy apparatus may be configured such that the light generating surfaces are arrangeable such that at least one of the light generating surfaces is positioned to direct illuminating radiations on a first target incidence area within which a first infant is positioned, and at least one other of the light generating surfaces is positioned to direct illuminating radiations on a second target incidence area within which a second infant is positioned.

[0027] One or more of the light generating surfaces may be detachable from the articulated phototherapy apparatus, and are configured to generate illuminating radiations when attached to the articulated phototherapy apparatus, as well as when detached from the articulated phototherapy apparatus

[0028] The detachable light generating surfaces may be configured to be enclosed within a fabric pouch, wherein said fabric pouch comprises a biocompatible material and is provided with fabric arms that are configured to swaddle an infant positioned on the fabric pouch with the detachable light generating surfaces positioned to direct illuminating radiations on the swaddle infant.

[0029] The detachable light generating surfaces may be powered by an auto backup battery system.

[0030] The phototherapy apparatus may in an embodiment be configured to be folded into a compact configuration such that it can be placed on a bed or within an incubator.

[0031] The invention additionally provides a kit for phototherapy. The kit comprises (i) a phototherapy apparatus according to any of the embodiments described in the present description, and (ii) a bassinet that is at least partially transparent or partially translucent, and comprising one or more recesses formed beneath or within the sides of said bassinet, wherein said one or more recesses are configured to at least partially accommodate one or more of the light generating surfaces of the phototherapy apparatus.

[0032] Said kit may include a vertical stand comprising a base, a vertical structure affixed to said base; and a support frame affixed to the vertical strut. The support frame (i) may comprise a collapsible frame configured to alternately conform to a collapsed c-shape configuration and an expanded polygonal configuration, and (ii) may be affixed to the vertical strut by a swivel coupling which enables the support frame to be moved between a vertical orientation and a horizontal orientation. In a vertical orientation, the support frame conforms to the collapsed c-shape configuration, said support frame enables the phototherapy apparatus to be affixed thereto, in a configuration where all light generating surfaces of the phototherapy apparatus are positioned within a linear plane. In a horizontal orientation, the support frame conforms to the expanded polygonal configuration, said support frame forms a horizontal support surface that enables the bassinet and the phototherapy apparatus to be supported thereon.

[0033] The kit may additionally include a fabric pouch configured to house the detachable light generating surfaces, wherein said fabric pouch comprises a biocompatible material and is provided with fabric arms that are configured to swaddle an infant positioned on the fabric pouch with the detachable light generating surfaces positioned to direct illuminating radiations on the swaddle infant.

Detailed Description

[0034] The present invention provides an articulated phototherapy apparatus that is configured to provide at least two (and preferably three or more) light generating surfaces arranged on an

articulated frame such that the phototherapy apparatus can be moved between (i) a first configuration where the at least two light generating surfaces are arranged substantially linearly such that each of the at least two light generating surfaces emit illuminating radiations substantially in a direction parallel to the direction of illuminating radiations emitted by the other of the at least two light generating surfaces, and (ii) a second configuration, wherein the at least two light generating surfaces are positioned non-linearly, in parallel or intersecting planes, such that each of the at least two light generating surfaces emits illuminating radiations in a direction that intersects with illuminating radiations emitted by the other of the at least two light generating surfaces.

[0035] The invention achieves the above by virtue of at least one articulated arm structure interconnecting the first of the at least two light generating surfaces with the second of the at least two light generating surfaces – wherein the articulated arm structure comprises a first arm and a second arm that are pivotably interconnected. The first arm has a first end directly or indirectly connected to the first light generating surface, and an opposed second end that is pivotably affixed to a first end of a second arm. The pivoting arrangement interconnecting the first arm and the second arm enables the second arm to be rotated about the pivot connecting it to the first arm, such that a second end of the second arm that is opposed to the first end of the second arm can be moved from (i) a first position where the first arm and the second arm, form an acute angle relative to each other to (ii) a second position where the first arm and the second arm form an obtuse angle relative to each other, or where the first arm and the second arm are arranged substantially linearly relative to each other such that the first of the at least two light generating surfaces and the second of the at least two light generating surfaces are positioned at opposite ends of the substantially linear arrangement of the first arm and the second arm.

[0036] In an embodiment, the first end of the first arm may be pivotably coupled to the first of the at least two light generating surfaces, such that said first light generating surface can be rotated about an axis that is substantially perpendicular to the longitudinal axis of the first arm. The second end of the second arm may be pivotably coupled to the second of the at least two light generating surfaces, such that said second light generating surface can be rotated about an axis that is substantially perpendicular to the longitudinal axis of the second arm.

[0037] In a specific embodiment, the invention comprises an articulated phototherapy apparatus that provides at least three light generating surfaces arranged on an articulated frame such that the phototherapy apparatus can be moved between (i) a first configuration where the at least three light generating surfaces are arranged substantially linearly such that each of the at least three light generating surfaces emit illuminating radiations substantially in a direction parallel to the direction of illuminating radiations emitted by the other of the at least two light generating surfaces, and (ii) a second configuration, wherein at least two of the three (and preferably all three) light generating surfaces are positioned non-linearly, in parallel or intersecting planes, such that two (and preferably all three) of the light generating surfaces emit illuminating radiations in a direction that intersects with illuminating radiations emitted by the other light generating surfaces.

[0038] In this embodiment, the above may be achieved through a plurality of articulated arm structures interconnecting both a first light generating surface with both of a second light generating surface and a third light generating surface.

[0039] The first light generating surface is interconnected with the second light generating surface through a first articulated arm structure comprising a first arm and a second arm that are pivotably interconnected. The first arm has a first end directly or indirectly connected to the first light generating surface, and an opposed second end that is pivotably affixed to a first end of a second

arm. The pivoting arrangement interconnecting the first arm and the second arm enables the second arm to be rotated about the pivot connecting it to the first arm, such that a second end of the second arm that is opposed to the first end of the second arm can be moved from (i) a first position where the first arm and the second arm, form an acute angle relative to each other, to (ii) a second position where the first arm and the second arm form an obtuse angle relative to each other, or where the first arm and the second arm are arranged substantially linearly relative to each other such that the first light generating surface and the second light generating surface are positioned at opposite ends of the substantially linear arrangement of the first arm and the second arm.

[0040] In an embodiment, the first end of the first arm may be pivotably coupled to the first light generating surface, such that said first light generating surface can be rotated about an axis that is substantially perpendicular to the longitudinal axis of the first arm. The second end of the second arm may be pivotably coupled to the second of the at least two light generating surfaces, such that said second light generating surface can be rotated about an axis that is substantially perpendicular to the longitudinal axis of the second arm.

[0041] The first light generating surface is also interconnected with the third light generating surface through a second articulated arm structure comprising a third arm and a fourth arm that are pivotably interconnected. The third arm has a first end directly or indirectly connected to the first light generating surface, and an opposed second end that is pivotably affixed to a first end of a fourth arm. The pivoting arrangement interconnecting the third arm and the fourth arm enables the fourth arm to be rotated about the pivot connecting it to the third arm, such that a second end of the fourth arm that is opposed to the first end of the fourth arm can be moved from (i) a first position where the third arm and the fourth arm form an acute angle relative to each other, to (ii) a second position where the third arm and the fourth arm form an obtuse angle relative to each other, or where the third arm and the fourth arm are arranged substantially linearly relative to each other such that the first light generating surface and the third light generating surface are positioned at opposite ends of the substantially linear arrangement of the third arm and the fourth arm.

[0042] In an embodiment, the first end of the third arm may be pivotably coupled to the first light generating surface, such that said first light generating surface can be rotated about an axis that is substantially perpendicular to the longitudinal axis of the third arm. The second end of the fourth arm may be pivotably coupled to the third light generating surface, such that said third light generating surface can be rotated about an axis that is substantially perpendicular to the longitudinal axis of the fourth arm.

[0043] In one embodiment, the first arm and the third arm are the same arm, while the second arm and the fourth arm are mutually distinct arms. In another embodiment, the first arm and the third arm are mutually distinct arms, and the second arm and the fourth arm are mutually distinct arms.

[0044] It would be understood that each of the first, second and third light generating surfaces discussed in connection with the invention embodiments above may comprise unitary light generating surfaces or may comprise light generating surfaces that are themselves composites or combinations of two or more light generating surfaces.

[0045] The above configurations of the device in accordance with the present invention are explained in more detail below with reference to the figures.

[0046] In one embodiment of the invention shown in Figure 1, the apparatus 100 is an articulated apparatus comprising base 102 having a first swing-arm 104 pivotably affixed thereto through a first pivot 110 – which pivot enables first swing-arm 104 to be selectively positioned at any angle within a first range of angles with respect to base 102. In one embodiment said first range of angles may comprise any angle α between 0 degrees and 360 degrees, or any angle between 0 degrees and 180 degrees, or any angle between 0 degrees and 90 degrees, or any angle between 0 and 45 degrees.

[0047] First swing-arm 104 is connected to second swing-arm 106 through a second pivot 112 – which second pivot enables second swing-arm 106 to be selectively positioned at any angle within a second range of angles with respect to first swing-arm 104. In one embodiment said second range of angles may comprise any angle between 0 degrees and 360 degrees, or any angle between 0 degrees and 180 degrees, or any angle between 0 degrees and 90 degrees, or any angle between 0 and 45 degrees.

[0048] Second swing-arm 106 is connected to a light generating surface 108 (for example a light bar, light tube, LED array, or any other apparatus having at least one light generating surface), through third pivot 114. In an embodiment, said third pivot 114 enables light generating surface 108 to be rotated about axis A – thereby ensuring that the angle of the light generating surface can be selectively modified in relation to a horizontal or vertical plane.

[0049] In an embodiment of the invention, the swingarms 104,106 and light generating surface 108 may include a locking system disposed at one or more of the pivots 110,112,114 in order to lockingly hold them in desired positions or angles – and for the locking system to be disengaged to enable the swingarms and / or light generating surface to be moved from one position or angle to another.

[0050] In another embodiment of the invention shown in Figure 2, the apparatus 100 is an articulated apparatus comprising all of the components illustrated in Figure 1, and additionally where base 102 has a third swing-arm 104' pivotably affixed thereto through a fourth pivot 110' – which fourth pivot 110' enables third swing-arm 104' to be selectively positioned at any angle within a third range of angles with respect to base 102. In one embodiment said third range of angles may comprise any angle Θ between 0 degrees and 360 degrees, or any angle between 0 degrees and 180 degrees, or any angle between 0 degrees and 90 degrees, or any angle between 0 and 45 degrees.

[0051] Third swing-arm 104' is connected to fourth swing-arm 106' through a fifth pivot 112' – which fifth pivot enables fourth swing-arm 106' to be selectively positioned at any angle within a fourth range of angles with respect to third swing-arm 104'. In one embodiment said fourth range of angles may comprise any angle γ between 0 degrees and 360 degrees, or any angle between 0 degrees and 180 degrees, or any angle between 0 degrees and 90 degrees, or any angle between 0 and 45 degrees.

[0052] Fourth swing-arm 106' is connected to a light generating surface 108' (for example a light bar, light tube, or any other apparatus having at least one light generating surface, through sixth pivot 114'. In an embodiment, said sixth pivot 114' enables light generating surface 108' to be rotated about axis A' – thereby ensuring that the angle of the light generating surface can be selectively modified in relation to a horizontal or vertical plane.

[0053] It would be understood that light generating surfaces 108 and 108' may be rotated such that light emitted from said surfaces is directed in a desired direction, which direction may be any direction from vertically downwards to vertically upwards, and any direction in between.

[0054] In an embodiment of the invention shown in Figure 2, the swingarms 104, 104', 106, 106' and light generating surfaces 108, 108' may include locking system(s) disposed at one or more of the pivots 110, 110', 112, 112', 114, 114' in order to lockingly hold them in desired positions or angles – and for the locking system to be disengaged to enable the swingarms and / or light generating surfaces to be moved from one position or angle to another.

[0055] As illustrated in Figure 2, base 102 may additionally include a clamp that can be used to clamp the base to another object (for example to a vertical stand or to a clamping projection provided on a surface or object to which base 102 is intended to be clamped).

[0056] In a further embodiment of the apparatus 100 as illustrated in Figure 3, base 102 may have one or more additional light generating surfaces 116, 116' directly affixed thereto, and configured to emit light in an upward direction i.e. in the direction indicated by arrow u.

[0057] In the embodiment illustrated in Figure 3, light generating surfaces 116, 116' are configured to emit light in an upward direction, while light generating surfaces 108, 108' are configured and positioned to emit light in a downward direction, and by placing an infant between said light generating surfaces, the apparatus 100 ensures that an infant can receive illuminating radiations from all directions.

[0058] Due to the articulated structure of apparatus 100, it would be understood that light generating surfaces can be arranged in any of a multitude of arrangements relative to each other, including the exemplary arrangement shown in Figure 3 (where light generating surfaces 108, 108' direct light vertically downwards, while light generating surfaces 116, 116' direct light vertically upwards), in Figure 4 (where the light generating surfaces 108, 108' have been moved further away from each other and in the direction of base 102 and are angled to direct illuminating radiations in a downward angled direction, or in Figure 5 where the entire apparatus 100 has been folded flat such that all of light generating surfaces 108, 108', 116, 116' are arranged flat or substantially within a linear plane, and are directing illuminating radiations in the same direction.

[0059] It would be understood from the illustration of Figures 1 and 2, that the phototherapy apparatus of the present invention enables the light generating surfaces to be arranged in a variety of positions, configurations and angles most suited to the surrounding environment, applicable space constraints, and the condition of the infant / neonate. Reference to Figures 3, 4, 4(a), 4(b) and 5 establishes an exemplary set of positions that the phototherapy apparatus 100 can be positioned in to deliver illuminating radiations from a variety of angles to a neonate positioned in a bassinet (for example bassinet 602). More specifically:

- Figure 3 illustrates a mode / position where light generating surfaces 108 and 108' are positioned close to each other, and in a configuration such that they direct illuminating radiations in a downward direction, while light generating surfaces 116, 116' are angled in an opposite direction so as to direct illuminating radiations upward.
- Figures 4, 4(a) and 4(b) illustrate a mode / position where the light generating surfaces 108, 108' have been moved further away from each other and towards base 102. Additionally, said light generating surfaces are angled to direct light towards each other and in a downward direction, while light generating surfaces 116, 116' are angled so as to direct illuminating radiations upward. As shown in Figures 4 and 4(b), the phototherapy apparatus 100 may be positioned / engaged with a bassinet 602 such that an infant

positioned within said bassinet 602 would receive the illuminations directed at an inward and downward angle by light generating surfaces 116, 116' while simultaneously receiving upwardly directed illuminations from light generating surfaces 116, 116'. The bassinet 602 of Figures 4 and 4(b) may be transparent or partially transparent or translucent to ensure that the bassinet 602 does not interfere with incidence of the illuminating radiations on the infant.

- Figure 5 illustrates a mode / position where the light generating surfaces 108, 108' have been aligned alongside light generating surfaces 116, 116' such that all four light generating surfaces are now positioned to direct illuminating radiations in the same direction. In this embodiment, the phototherapy apparatus may either be positioned beneath the infant (for example, beneath transparent bassinet 602) to direct illuminating radiations onto the neonate from beneath, or may be positioned above the infant (for example by clamping the phototherapy apparatus 100 on a vertical stand, with the illuminating surfaces 108, 108', 116 and 116' facing a downward direction) to direct illuminating radiations onto the neonate from above

[0060] As shown in Figures 4, 4(b), 6(a) 6(b), the invention additionally provides a transparent bassinet 602 for housing an infant. Said transparent bassinet may be designed to conform to apparatus 100, such that light generating surfaces 116, 116' can be placed in slots, recesses, cavities or other spaces formed within or under the base of bassinet 602 – so that the bassinet 602 can be seated stably on a flat surface, while apparatus 100 can be positioned such that at least light generating surfaces 116, 116' are positioned within said spaces formed within or under said bassinet 602, and which can direct illuminating radiations upwards from a transparent bottom surface of the bassinet 602 and onto the back of an infant placed within the bassinet. In one embodiment apparatus shown in Figure 6A, apparatus 100 may be positioned such that light generating surfaces 116, 116' is disposed in the recess under the bassinet 602 and directs light upward onto the infant, while light generating surfaces 108, 108' are positioned above the bassinet and direct illuminating radiations in a downward direction onto the infant placed within bassinet 602.

[0061] As shown in Figure 6B, The transparent bassinet may additionally be provided with a plurality of recesses or spaces formed on the sides or in the base, which allow light generating surfaces 108, 108' to be moved into position underneath the bassinet, when apparatus 100 is folded flat, such that all of light generating surfaces 108, 108', 116, 116' are positioned beneath the bassinet without interfering with the stable positioning of the bassinet on a flat surface – and can direct illuminating radiations in an upward direction onto an infant placed in the bassinet 602.

[0062] In an embodiment, one or more of the hinge arrangements described above may be configured such that as one or more of the first, second, third or fourth swing-arms is moved, one or more of light generating surfaces 108, 108' are caused to rotate about axis A, A' such that radiation from light generating surfaces 108, 108' continues to be directed on the bassinet despite movement of the swing-arms and / or light generating surfaces relative to the bassinet.

[0063] In some embodiments embodiment, base 102 may be provided with a clamp such that said base may be clamped to a vertical stand – thereby enabling the apparatus 100 to be clamped in any of the arrangements shown in the accompanying illustrations. In another embodiment base 102 may be affixed to bassinet 602.

[0064] As shown in Figures 4(b), 6(a) and 6(b), bassinet 602 may be provide with a display unit, and one or more controls – which display unit and controls can be configured to display or enable selection of any one or more phototherapy parameters (such as for example, selection of a phototherapy mode, selection of a phototherapy configuration for apparatus 100, selection of an illumination intensity of one or more of the light generating surfaces, selection of a locked mode or an unlocked mode for one or more of the pivots etc.). In another embodiment, the invention may include one or more sensors disposed on or within phototherapy apparatus 100 or bassinet 602 (including power readings, temperature readings, irradiance sensor readings, readings corresponding to the weight of an infant, readings corresponding to bilirubin levels of an infant placed within bassinet 602 etc.) – and the display unit may be configured to provide readouts from said one or more sensors.

[0065] In specific embodiments, the bassinet and apparatus 100 are sized and configured such that when apparatus is folded into a completely flat configuration and inserted completely into the recesses provided in the bassinet, the entire arrangement can be inserted along with the bassinet into an incubator.

[0066] In other embodiments, the arms of apparatus 100 can be positioned to ensure that the apparatus 100 is small enough to fit into an incubator or other device, along with the bassinet, while continuing to provide phototherapy illuminations to the infant in the bassinet.

[0067] In specific embodiments, one or more of the hinges in apparatus 100 may comprise locking hinges which require a specific unlocking action before the connected swing-arm(s) can be pivoted about said hinge(s).

[0068] In other embodiments, the apparatus 100 may be provided with sensors that determine the distance, angle and/or relative positions of the light generating surfaces 108, 108' or 116 with respect to the bassinet or infant, and control the intensity of generated illumination based on the determined distance, angle and/or relative position. The apparatus 100 may additionally be provided with one or more actuators configured to (i) move or rotate one or more arms of the articulated apparatus about a pivot that connects said arm(s) with another arm or with a light generating surface, and / or (ii) move or rotate one or more light generating surface(s) about a pivot that connects said light generating surface(s) to an arm or other component of apparatus 100. Said actuators may comprise any electrically, electronically, or pressure controlled actuators that would be apparent to the skilled person and may include without limitation, motors, servos or other actuators.

[0069] In certain embodiments, the apparatus 100 or bassinet 602 may be provided with or coupled to one or more sensors capable of determining bilirubin levels (or any other relevant physiological parameters) of an infant placed within bassinet 602 – and the phototherapy apparatus may be configured to vary one or more of intensity of illumination generated by the light generating surfaces 108, 108', 116, 116', and / or distance, angle and/or relative positions of the light generating surfaces 108, 108' or 116 with respect to the bassinet or infant – in response to the determined bilirubin level (or other physiological parameters) and based on or more predefined rules or settings.

[0070] In other embodiments, the bilirubin levels (or any other relevant physiological parameters) of an infant placed within bassinet 602 may be entered manually by a health care provider – and the phototherapy apparatus may be configured to vary the intensity of illumination generated by the phototherapy light generating surfaces 108, 108', 116, 116', and / or distance, angle and/or relative positions of the light generating surfaces 108, 108' or 116 with respect to the bassinet or

infant – in response to the input bilirubin level (or other physiological parameters) and based on or more predefined rules or settings.

[0071] In an embodiment of the invention, the apparatus 100 may be coupled with at least two sensors – each of which are connected to a controller by a separate data channel. Each one of the two sensors is used to monitor a separate infant or bassinet – and the light generating surfaces of the apparatus 100 are controlled based on the feedback data received from each of the two sensors to control the intensity of illumination generated by the phototherapy light generating surfaces 108, 108', 116, 116', and / or distance, angle and/or relative positions of the light generating surfaces 108, 108' or 116 with respect to each of the two bassinets or infants – in response to the input bilirubin level (or other physiological parameters) received from the corresponding sensor and data channel - and based on or more predefined rules or settings. In an embodiment, one or more light generating surfaces are controlled based on data received from a first sensor (for example, a sensor disposed to measure parameters corresponding to a first infant or first subject), while one or more other light generating surfaces are controlled based on data received from a second sensor (for example, a sensor disposed to measure parameters corresponding to a second infant or second subject).

[0072] In certain embodiments, the apparatus 100 may be configured to enable both sensor based and manual input based control of one or more of the intensity of illumination generated by the phototherapy light generating surfaces 108, 108', 116, 116', and / or distance, angle and/or relative positions of the light generating surfaces 108, 108' or 116 with respect to the bassinet or infant, wherein the sensors / manual input correspond to bilirubin levels or other physiological parameters. In preferred embodiments where the apparatus 100 has both sensor and manual input based control capabilities, said apparatus 100 may additionally be configured to enable a manual input based control override of the sensor based controls – which would allow a health care provider or physician to override the sensor based settings with manual input based setting.

[0073] In an embodiment of the invention, phototherapy apparatus 100 and / or bassinet 602 may include an irradiance feedback system – which displays (for example through the display unit within bassinet 602, irradiance (intensity of light per unit square area with respect to distance) directed onto the infant positioned within bassinet 602 - in order to ensure that sufficient amount of irradiance is being delivered (for example in accordance with guidelines prescribed by the American Association of Pediatrics).

[0074] In an embodiment of the invention, the apparatus 100 may be configured such that when folded down into an appropriate configuration (for example, a flat or a near flat configuration or a compact configuration) said apparatus can be fitted into a pocket or lining of a garment, sheet or blanket which can be draped or arranged around an infant. In this arrangement, phototherapy can be delivered through apparatus 100 by draping the infant in the garment or sheet having the apparatus 100 disposed therein – thereby promoting kangaroo mother care and breastfeeding.

[0075] As shown in Figure 14(b), in an embodiment of apparatus 100, light units 116, 116' are configured in a modular fashion. The said light units 116, 116' can be unplugged from its joints 119, 119' like lego blocks respectively. The light units are sleek enough to slide them into a breast feeding mode treatment pouch 1400, which breast feeding mode treatment pouch is manufactured a biocompatible material or biocompatible fabric, having fabric or other slots to house the modular light units 116, 116' and also a nested or pouch slot to hold the baby and extended fabric arms which swaddles the baby. This pouch will promote both kangaroo mother care and breast feeding while providing the treatment.

[0076] Figure 7 illustrates an exemplary configuration in which phototherapy apparatus 100 may be folded flat and positioned within the base of bassinet 602 – so that the bassinet and phototherapy apparatus can be used in combination with a conventional overhead phototherapy apparatus that has been clamped to a vertical stand to provide phototherapy illuminations in a downward direction.

[0077] Figure 8(a) illustrates an embodiment of the apparatus 100 and bassinet 602 used with a table as a support surface, with an infant positioned within bassinet 602 to simultaneously receive downward directed radiations from light generating surfaces 108, 108' and upward directed radiations from light generating surfaces 116, 116'.

[0078] Figure 8(b) illustrates phototherapy apparatus 100 positioned on a table as a support surface, without bassinet 602.

[0079] Figure 9 illustrates an embodiment of the apparatus 100 and bassinet 602 positioned within an open incubator tray / neonatal ICU (NICU) bed.

[0080] Figure 10 illustrates an embodiment of the apparatus 100 and bassinet 602 positioned within an NICU bed, and wherein light bearing surfaces 108 and 108' are positioned apart from each other such that radiant warmth from a vertically disposed radiant warmer 1002 can reach the infant in the bassinet, without being blocked or obstructed by light bearing surfaces 108, 108' and without in turn interfering with the phototherapy session.

[0081] It would be understood from Figures 8(a), 8(b), 9 and 10 that when docked with bassinet 602, phototherapy apparatus 100 can be used on any surface such as a table / bed top, beds in hospital wards or home, cradle, table, NICU beds under radiant warmer, within an ambulance, incubator etc.

[0082] Figures 11(a) and 11(b) illustrate various positions / configurations / modes in which apparatus 100 can be used so as to ensure simultaneous and appropriate phototherapy to multiple neonates. As shown in Figure 11(b), the configuration of apparatus 100 enables simultaneous phototherapy to be delivered to multiple neonates. In the embodiments shown in Figures 11(a) and 11(b), a first infant may be placed in bassinet 602 – such that said first infant receives illuminating phototherapy radiations from light generating surfaces 116, 116' which are positioned within bassinet 602 and are directing phototherapy radiations in an upward direction through transparent bassinet 602 in an upward direction. Simultaneously, swingarms 104, 106 and 104', 106' are positioned such that light generating surfaces 108 and 108' are angled in a sideward and downward direction so as to direct phototherapy radiations on a second infant positioned adjacent to bassinet 602. It would be understood that while Figure 11(b) illustrates the second infant placed on the table surface, said second infant can also be placed in a second bassinet.

[0083] Figure 12 illustrates the apparatus folded into flat configuration, where light generating surfaces 108, 108' are folded under the bassinet, so that the apparatus 100 and bassinet 602 can be placed within a closed incubator along with the infant.

[0084] Reference to Figures 10 to 12 establishes that the apparatus 100 is portable enough to provide phototherapy while simultaneously placing the neonate under a radiant warmer or in an incubator – which provides the additional advantage of maintaining baby homeostasis by

preventing hypothermia and insensible water loss. The apparatus 100 is additionally robust enough to work efficiently in a long run under various ambiance and stress conditions.

[0085] Figure 13 illustrates an embodiment of the invention wherein phototherapy apparatus 100 is engaged with bassinet 602 and the entire apparatus is supported by a vertical stand to which apparatus 100 is affixed by virtue of the clamp provided on base 602. In this configuration, other components can also be affixed to the vertical stand (for example a radiant warmer) to simultaneously act on the infant within the bassinet.

[0086] Figure 14(a) illustrates an embodiment where the phototherapy apparatus has been folded flat such that all of light generating surfaces 108, 108', 116, 116' are arranged flat and are directing illuminating radiations in the same direction and wherein said phototherapy apparatus is clamped (through clamp on base 102) to a vertical stand such that all light generating surfaces direct illumination in a downward direction towards bassinet 602 – and so that the infant receives phototherapy from all light generating surfaces from an upward direction.

[0087] Figure 14(b) illustrates a specific use of the phototherapy apparatus 100, wherein light generating surfaces 116, 116' are detached from the rest of apparatus and is placed within a breast feeding mode pouch that has been described in more detail above – and which breast feeding mode pouch is used to swaddle the infant while simultaneously providing phototherapy illuminations to the baby through light generating surfaces 116, 116'.

[0088] The invention also include a novel stand that is capable of moving between (i) a first configuration optimized for supporting or being coupled with the phototherapy apparatus 100 when it is in a flat, near flat, or compact configuration, such that all light generating surfaces are directing illuminating radiations in the same (or substantially same direction) and (ii) a second configuration optimized for supporting both a bassinet 602 and the phototherapy apparatus 100, wherein the phototherapy apparatus 100 is in a configuration where at least one light generating surface is positioned beneath bassinet 602 and is directing illuminating radiations in an upward direction, and one or more light generating surfaces are positioned above bassinet 602 and are directing illuminating radiations in a downward direction towards bassinet 602. Figures 15 to 22 illustrate embodiments of stand 1400.

[0089] As shown in Figure 15, stand 1500 comprises a base 1502 having at least one vertical strut 1504 affixed thereto, and having a support frame 1506 affixed to vertical strut 1504 by means of a coupling 1508. Based 1502 may have one or more wheels 1510 affixed thereto, to ensure mobility of stand 1500.

[0090] As shown in Figures 15 to 17, support frame 1506 is a collapsible frame that can be moved between a collapsed c-shape configuration (see Figure 16) and an expanded rectangular (or polygonal) configuration (see Figure 17). In the illustrated embodiment, support frame 1506 comprises comprising two vertical frame members 1512 and 1512', two lower crossbar members 1514, 1514' and two upper crossbar members 1516, 1516' that are interconnected to form a rectangular or polygonal frame. The two lower crossbar members 1514, 1514' are interconnected by a first hinge 1518, while the two upper crossbar members 1516, 1516' are interconnected by a second hinge 1518'. The first hinge 1518 and second hinge 1518' are configured to enable the two vertical frame members 1512 and 1512' (i) to be moved towards each other to achieve the collapsed c-shape frame configuration shown in Figure 16 and (ii) to be moved away from each other to achieve the expanded rectangular or polygonal frame configuration shown in Figure 17.

[0091] Additionally, coupling 1508 comprises a swivel coupling, that enables support frame 1506 to be moved between a vertical or upright configuration (of the type illustrated in Figures 15 to 17) and a horizontal or flat configuration (of the type illustrated in Figure 18).

[0092] As shown in Figures 19 and 20, when support frame 1506 is moved to a vertically oriented configuration where support frame 1506 is in a collapsed c-shape configuration, said support frame can be used to clamp or affix phototherapy apparatus 100 (which is arranged in a compact configuration where all light generating surfaces are positioned substantially within the same linear plane to direct illuminating radiations in the same direction), so that said light generating surfaces direct illuminating radiations in a downward direction. In this configuration, stand 1500 may be used as a vertical stand for clamping and holding phototherapy apparatus above a bassinet or an infant in a bassinet – which bassinet may be placed on a table or other support surface beneath the phototherapy apparatus 100.

[0093] As shown in Figures 21 and 22, when support frame 1506 is moved to a horizontally oriented position, the rectangular or polygonal support frame 1506 provides a horizontal support surface on which a bassinet 602 and a phototherapy apparatus 100 can be placed – such that an infant within the bassinet receives illuminating radiations from beneath the bassinet (i.e. from light generating surfaces positioned beneath the bassinet to direct illuminating radiations in an upward direction) and also from above the bassinet (i.e. from light generating surfaces positioned above the bassinet). In this configuration, stand 1500 eliminates the requirement for a table or other support surface on which the bassinet and phototherapy device can be placed.

[0094] Figure 23 illustrates electronic components within phototherapy apparatus 100.

[0095] Phototherapy apparatus 100 comprises an operator interface 1002, a processor 1004 and a transceiver 1006. Operator interface 1002 permits for manual inputs through one or more input devices or peripherals – and which manual inputs may be used to control performance and functioning of the phototherapy apparatus. Processor 1004 may comprise a data processor, and transceiver 1006 may comprise a data transceiver configured to enable data to be sent and received by processor 1004. Phototherapy apparatus 100 also includes one or more sensors 1008 – which sensors may be configured to measure one or more environmental parameters or one or more physiological parameters of an infant, and in exemplary embodiments comprises any of power sensors, temperature sensors, irradiance sensors, light sensors, weight sensors, bilirubin sensors and / or blood analyte sensors, or other fluid sensors. Communication between processor 1004 and the one or more sensors 1008 may be controlled and effected through sensor channel controller 1010 which implements data communication over one or more data channels connecting said sensors 1008 with sensor channel controller 1010.

[0096] The phototherapy apparatus 100 also includes arm position actuation controller 1012, illumination surface position actuation controller 1014, irradiance controller 1016 and irradiance profile database 1018. Arm position actuation controller 1012 is a processor implemented instance of a controller configured to control actuators provided within phototherapy apparatus 100 for moving one or more of the arms connecting the light generating surfaces – to change the position and / or angle of one or more light generating surfaces relative to a target area of illumination (for example a bassinet or an infant positioned within the bassinet). Illumination surface position actuation controller 1012 is a processor implemented instance of a controller configured to control actuators provided within phototherapy apparatus 100 for moving or rotating one or one or more of the light generating surfaces – to change the position and / or angle of one or more light generating surfaces relative to a target area of illumination (for example a bassinet or an infant positioned within the bassinet). Irradiance controller 1012 is a processor implemented instance of

a controller configured to control illumination generated by one or more light generating surfaces – to change the intensity of illumination from one or more light generating surfaces that is incident at a target area of illumination (for example a bassinet or an infant positioned within the bassinet). Irradiance profile database 1018 is a database comprising one or more profiles or rules that correlate environmental and / or physiological parameters with corresponding positions and angles for the light generating surfaces, and intensities of illumination generated at said light generating surfaces. Responsive to detection of one or more environmental or physiological parameters by sensors 1008, processor 1004 selects one or more profiles or rules (from database 1018) that correspond to the detected parameters – and controls (using one or more of controllers 1012, 1014 and 1016) one or more of the positions and angles for the light generating surfaces, and intensities of illumination generated at said light generating surfaces – for providing an infant with phototherapy in an optimal manner.

[0097] Owing to the ability to be arranged in various configurations and accommodated wholly or partially within the base of a bassinet, the apparatus 100 and / or combination of apparatus 100 and bassinet 602 offer the following advantages:

- Ability to change the position and angle of the light generating surfaces with respect to the bassinet and an infant placed on the bassinet,
- Ability to be folded into compact arrangements that can fit into other devices such as incubators, radiant warmers, baby bassinets or cribs, mobile units.
- Ability to vary the position, angle and distance of the one or more light generating surfaces with respect to infant / bassinet
- Ability to vary one or more of intensity of illumination generated by the light generating surfaces and / or distance, angle and/or relative positions of the light generating surfaces with respect to the bassinet or infant – in response to the determined or measured physiological parameters (for example bilirubin level) that is received from one or more sensors disposed within or coupled with the phototherapy apparatus or the bassinet,
- Ability to vary the intensity of phototherapy by changing the position of light delivered to the bassinet / infant
- Ability to use the phototherapy device without interfering with other devices such as radiant warmers, incubators, baby bassinets or cribs etc.
- Ability to provide multiple configurations for phototherapy included single sided phototherapy (i.e. from top or bottom), two-sided phototherapy (i.e. from top and bottom), or multiple sided phototherapy (i.e. from top, bottom and one or more sides).
- Ability to operate with any portable DC power source suitable for the device specification, enabling the apparatus to operate independent of ac power supply - so that it can be operated even during power breakdowns or within resource constraints in clinics, at home or in any geographical conditions etc.
- Ability to deliver phototherapy through the apparatus by draping the infant in the garment or sheet having the apparatus disposed therein – thereby promoting kangaroo mother care.

- Ability of obtaining irradiance feedback to ensure optimum phototherapy irradiance is delivered to the baby in any configuration.
- Ability to deliver efficient phototherapy simultaneously to multiple babies.

[0098] The invention additionally includes a kit comprising one or more of apparatus 100, a bassinet 602, and stand 1500 configured according to one of the embodiments discussed above, and / or a garment / sheet / blanket configured to accommodate apparatus 100 in a pocket or lining (in accordance with one of the embodiments discussed above).

[001] Figure 24 illustrates an exemplary computer system according to which various embodiments of the present invention may be implemented.

[002] System 2400 includes computer system 2402 which in turn comprises one or more processors 2404 and at least one memory 2406. Processor 2404 is configured to execute program instructions - and may be a real processor or a virtual processor. It will be understood that computer system 2402 does not suggest any limitation as to scope of use or functionality of described embodiments. The computer system 2402 may include, but is not be limited to, one or more of a general-purpose computer, a programmed microprocessor, a micro-controller, an integrated circuit, and other devices or arrangements of devices that are capable of implementing the steps that constitute the method of the present invention. Exemplary embodiments of a computer system 2402 in accordance with the present invention may include one or more servers, desktops, laptops, tablets, smart phones, mobile phones, mobile communication devices, tablets, phablets and personal digital assistants. In an embodiment of the present invention, the memory 2406 may store software for implementing various embodiments of the present invention. The computer system 2402 may have additional components. For example, the computer system 2402 may include one or more communication channels 2408, one or more input devices 2410, one or more output devices 2412, and storage 2414. An interconnection mechanism (not shown) such as a bus, controller, or network, interconnects the components of the computer system 2402. In various embodiments of the present invention, operating system software (not shown) provides an operating environment for various softwares executing in the computer system 2402 using a processor 2404, and manages different functionalities of the components of the computer system 2402.

[003] The communication channel(s) 2408 allow communication over a communication medium to various other computing entities. The communication medium provides information such as program instructions, or other data in a communication media. The communication media includes, but is not limited to, wired or wireless methodologies implemented with an electrical, optical, RF, infrared, acoustic, microwave, Bluetooth or other transmission media.

[004] The input device(s) 2410 may include, but is not limited to, a touch screen, a keyboard, mouse, pen, joystick, trackball, a voice device, a scanning device, or any another device that is capable of providing input to the computer system 2402. In an embodiment of the present invention, the input device(s) 2410 may be a sound card or similar device that accepts audio input in analog or digital form. The output device(s) 2412 may include, but not be limited to, a user interface on CRT, LCD, LED display, or any other display associated with any of servers, desktops, laptops, tablets, smart phones, mobile phones, mobile communication devices, tablets, phablets and personal digital assistants, printer, speaker, CD/DVD writer, or any other device that provides output from the computer system 2402.

[005] The storage 2414 may include, but not be limited to, magnetic disks, magnetic tapes, CD-ROMs, CD-RWs, DVDs, any types of computer memory, magnetic stripes, smart cards, printed barcodes or any other transitory or non-transitory medium which can be used to store information and can be accessed by the computer system 2402. In various embodiments of the present invention, the storage 2414 may contain program instructions for implementing any of the described embodiments.

[006] In an embodiment of the present invention, the computer system 2402 is part of a distributed network or a part of a set of available cloud resources.

[007] The present invention may be implemented in numerous ways including as a system, a method, or a computer program product such as a computer readable storage medium or a computer network wherein programming instructions are communicated from a remote location.

[008] The present invention may suitably be embodied as a computer program product for use with the computer system 2402. The method described herein is typically implemented as a computer program product, comprising a set of program instructions that is executed by the computer system 2402 or any other similar device. The set of program instructions may be a series of computer readable codes stored on a tangible medium, such as a computer readable storage medium (storage 2414), for example, diskette, CD-ROM, ROM, flash drives or hard disk, or transmittable to the computer system 2402, via a modem or other interface device, over either a tangible medium, including but not limited to optical or analogue communications channel(s) 2408. The implementation of the invention as a computer program product may be in an intangible form using wireless techniques, including but not limited to microwave, infrared, Bluetooth or other transmission techniques. These instructions can be preloaded into a system or recorded on a storage medium such as a CD-ROM, or made available for downloading over a network such as the Internet or a mobile telephone network. The series of computer readable instructions may embody all or part of the functionality previously described herein.

[0099] While the exemplary embodiments of the present invention are described and illustrated herein, it will be appreciated that they are merely illustrative. It will be understood by those skilled in the art that various modifications in form and detail may be made therein without departing from or offending the spirit and scope of the invention as defined by the appended claims. Additionally, the invention illustratively disclosed herein suitably may be practiced in the absence of any element which is not specifically disclosed herein – and in a particular embodiment that is specifically contemplated, the invention is intended to be practiced in the absence of any one or more element which are not specifically disclosed herein.

We Claim:

1. An articulated phototherapy apparatus comprising:

at least two light generating surfaces;

an articulated arm structure interconnecting the first of the at least two light generating surfaces with the second of the at least two light generating surfaces, wherein:

the articulated arm structure comprises a first arm and a second arm that are pivotably interconnected;

the first arm has a first end connected to the first light generating surface, and an opposed second end that is pivotably affixed to a first end of a second arm;

a pivot interconnecting the first arm and the second arm, such that:

the second arm is rotatable about the pivot; and

a second end of the second arm that is opposed to the first end of the second arm is movable between (i) a first position where the first arm and the second arm, form an acute angle relative to each other and (ii) a second position where the first arm and the second arm either form an obtuse angle relative to each other, or are positioned linearly.

2. The articulated phototherapy apparatus as claimed in claim 1, wherein the first end of the first arm is pivotably coupled to the first of the at least two light generating surfaces, such that said first light generating surface is rotatable about an axis that is perpendicular to a longitudinal axis of the first arm.

3. The articulated phototherapy apparatus as claimed in claim 2, wherein the second end of the second arm is pivotably coupled to the second of the at least two light generating surfaces, such that said second light generating surface is rotatable about an axis that is perpendicular to a longitudinal axis of the second arm.

4. The articulated phototherapy apparatus as claimed in claim 1, wherein said apparatus includes three light generating surfaces, and wherein:

the first light generating surface is interconnected with the second light generating surface through a first articulated arm structure comprising a first arm and a second arm that are pivotably interconnected;

the first arm has a first end connected to the first light generating surface, and an opposed second end that is pivotably affixed to a first end of a second arm;

the pivot interconnecting the first arm and the second arm enables rotation of the second arm about the pivot connecting it to the first arm, such that a second end of the second arm that is opposed to the first end of the second arm is moveable between (i) a first position where the first arm and the second arm, form an acute angle relative to each other, and (ii) a second position where the first arm and the second arm form an obtuse angle relative to each other, or are positioned linearly;

the first light generating surface is interconnected with the third light generating surface through a second articulated arm structure comprising a third arm and a fourth arm that are pivotably interconnected;

the third arm has a first end connected to the first light generating surface, and an opposed second end that is pivotably affixed to a first end of a fourth arm;

the pivot interconnecting the third arm and the fourth arm enables rotation of the fourth arm about the pivot, such that a second end of the fourth arm that is opposed to the first end of the fourth arm is moveable between (i) a first position where the third arm and the fourth arm form an acute angle relative to each other, and (ii) a second position where the third arm and the fourth arm form an obtuse angle relative to each other, or are linearly positioned.

5. The articulated phototherapy apparatus as claimed in claim 4, wherein the first end of the first arm is pivotably coupled to the first light generating surface, such that said first light generating surface is rotatable about an axis that is perpendicular to the longitudinal axis of the first arm.

6. The articulated phototherapy apparatus as claimed in claim 4, wherein the second end of the second arm is pivotably coupled to the second of the at least two light generating surfaces, such that said second light generating surface is rotatable about an axis that is perpendicular to the longitudinal axis of the second arm.

7. The articulated phototherapy apparatus as claimed in claim 6, wherein the first end of the third arm is pivotably coupled to the first light generating surface, such that said first light generating surface is rotatable about an axis that is substantially perpendicular to the longitudinal axis of the third arm.

8. The articulated phototherapy apparatus as claimed in claim 7, wherein the second end of the fourth arm is pivotably coupled to the third light generating surface, such that said third light generating surface is rotatable about an axis that is substantially perpendicular to the longitudinal axis of the fourth arm.

9. The articulated phototherapy apparatus as claimed in claim 8, wherein:

the first arm and the third arm are the same arm, and the second arm and the fourth arm are distinct arms; or

the first arm and the third arm are distinct arms, and the second arm and the fourth arm are distinct arms.

10. The articulated phototherapy apparatus as claimed in claim 1, wherein said apparatus includes:

one or more sensors configured to detect one or more environmental parameters or physiological parameters associated with a subject positioned within a region under a region of incidence of illumination corresponding to at least one of the light generating surfaces;

one or more actuators configured to:

move or rotate one or more arms of the articulated phototherapy apparatus about a pivot that connects said arm(s) with another arm or with a light generating surface; or

move or rotate one or more light generating surfaces about a pivot that connects said light generating surface to an arm or to the phototherapy apparatus;

one or more controllers configured to change one or more of position, angle or intensity of illumination of one or more of the light generating surfaces based on parameters detected by the one or more sensors.

11. The articulated phototherapy apparatus as claimed in claim 1, wherein the light generating surfaces are arrangeable such that at least one of the light generating surfaces is positioned to direct illuminating radiations on a first target incidence area within which a first infant is positioned, and at least one other of the light generating surfaces is positioned to direct illuminating radiations on a second target incidence area within which a second infant is positioned.

12. The articulated phototherapy apparatus as claimed in claim 1, wherein one or more of the light generating surfaces are detachable from the articulated phototherapy apparatus, and are configured to generate illuminating radiations when attached to the articulated phototherapy apparatus, as well as when detached from the articulated phototherapy apparatus

13. The articulated phototherapy apparatus as claimed in claim 1, wherein the detachable light generating surfaces are configured to be enclosed within a fabric pouch, wherein said fabric pouch comprises a biocompatible material and is provided with fabric arms that are configured to swaddle an infant positioned on the fabric pouch with the detachable light generating surfaces positioned to direct illuminating radiations on the swaddle infant.

14. The articulated phototherapy apparatus as claimed in claim 1, wherein the detachable light generating surfaces are powered by an auto backup battery system.

15. The articulated phototherapy apparatus as claimed in claim 1, wherein said phototherapy apparatus is configured to be folded into a compact configuration such that it can be placed on a bed or within an incubator.

16. A kit for phototherapy comprising:

an articulated phototherapy apparatus, comprising:

at least two light generating surfaces;

an articulated arm structure interconnecting the first of the at least two light generating surfaces with the second of the at least two light generating surfaces, wherein:

the articulated arm structure comprises a first arm and a second arm that are pivotably interconnected;

the first arm has a first end connected to the first light generating surface, and an opposed second end that is pivotably affixed to a first end of a second arm;

a pivot interconnecting the first arm and the second arm, such that:

the second arm is rotatable about the pivot; and

a second end of the second arm that is opposed to the first end of the second arm is movable between (i) a first position where the first arm and the second arm, form an acute angle relative to each other and (ii) a second position where the first arm and the second arm either form an obtuse angle relative to each other, or are positioned linearly;

and

a bassinet that is at least partially transparent or partially translucent, and comprising one or more recesses formed beneath or within the sides of said bassinet, wherein said one or more recesses are configured to at least partially accommodate one or more of the light generating surfaces of the phototherapy apparatus.

17. The kit for phototherapy as claimed in claim 16, wherein said kit includes a vertical stand comprising:

a base;

a vertical structure affixed to said base; and

a support frame affixed to the vertical strut, wherein:

the support frame is a collapsible frame configured to alternately conform to a collapsed c-shape configuration and an expanded polygonal configuration;

the support frame is affixed to the vertical strut by a swivel coupling which enables the support frame to be moved between a vertical orientation and a horizontal orientation;

in a vertical orientation, where the support frame conforms to the collapsed c-shape configuration, said support frame enables the phototherapy apparatus to be affixed thereto, in a configuration where all light generating surfaces of the phototherapy apparatus are positioned within a linear plane; and

in a horizontal orientation, where the support frame conforms to the expanded polygonal configuration, said support frame forms a horizontal support surface that enables the bassinet and the phototherapy apparatus to be supported thereon.

18. The kit as claimed in claim 16, wherein one or more of the light generating surfaces are detachable from the articulated phototherapy apparatus, and are configured to generate illuminating radiations when attached to the articulated phototherapy apparatus, as well as when detached from the articulated phototherapy apparatus, the said light generating surfaces are powered by a battery unit when detached from the articulated phototherapy apparatus.

19. The kit as claimed in claim 18, wherein the kit includes a fabric pouch configured to house the detachable light generating surfaces, wherein said fabric pouch comprises a biocompatible material and is provided with fabric arms that are configured to swaddle an infant positioned on the fabric pouch with the detachable light generating surfaces positioned to direct illuminating radiations on the swaddle infant.

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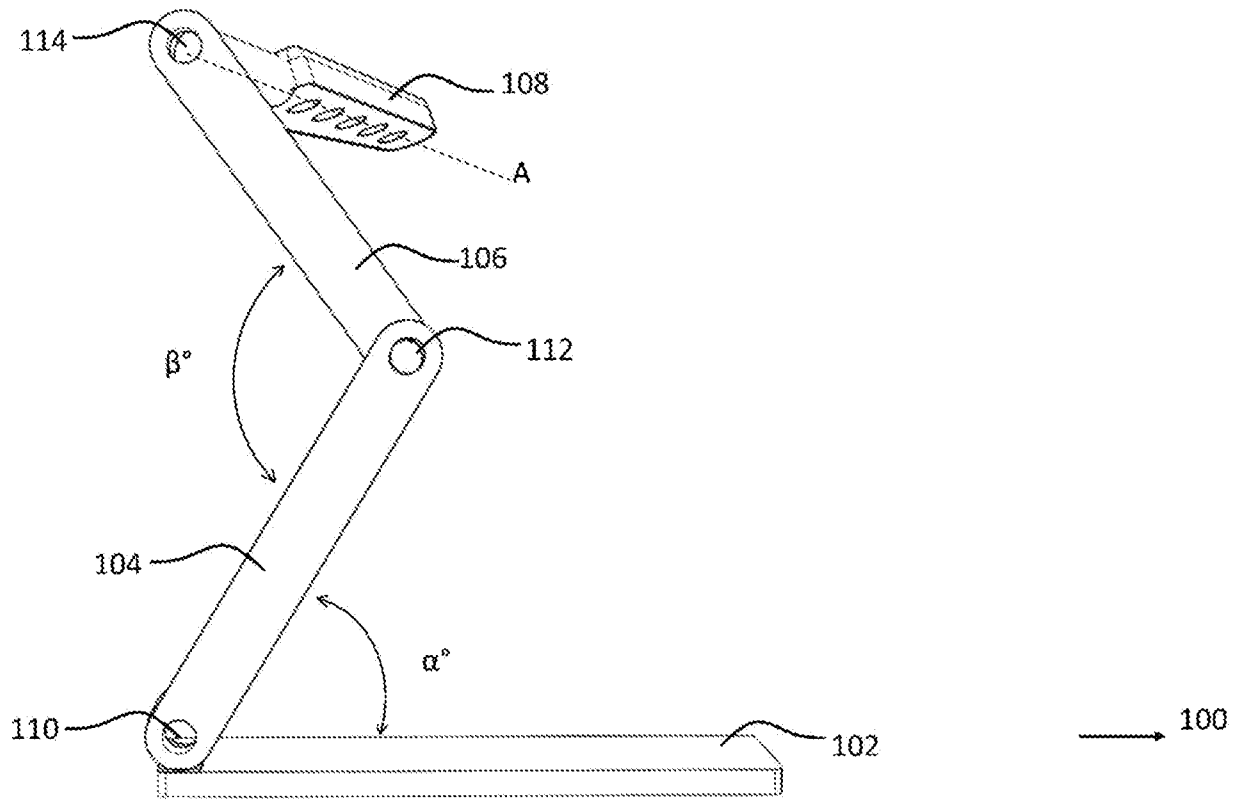


Figure 1

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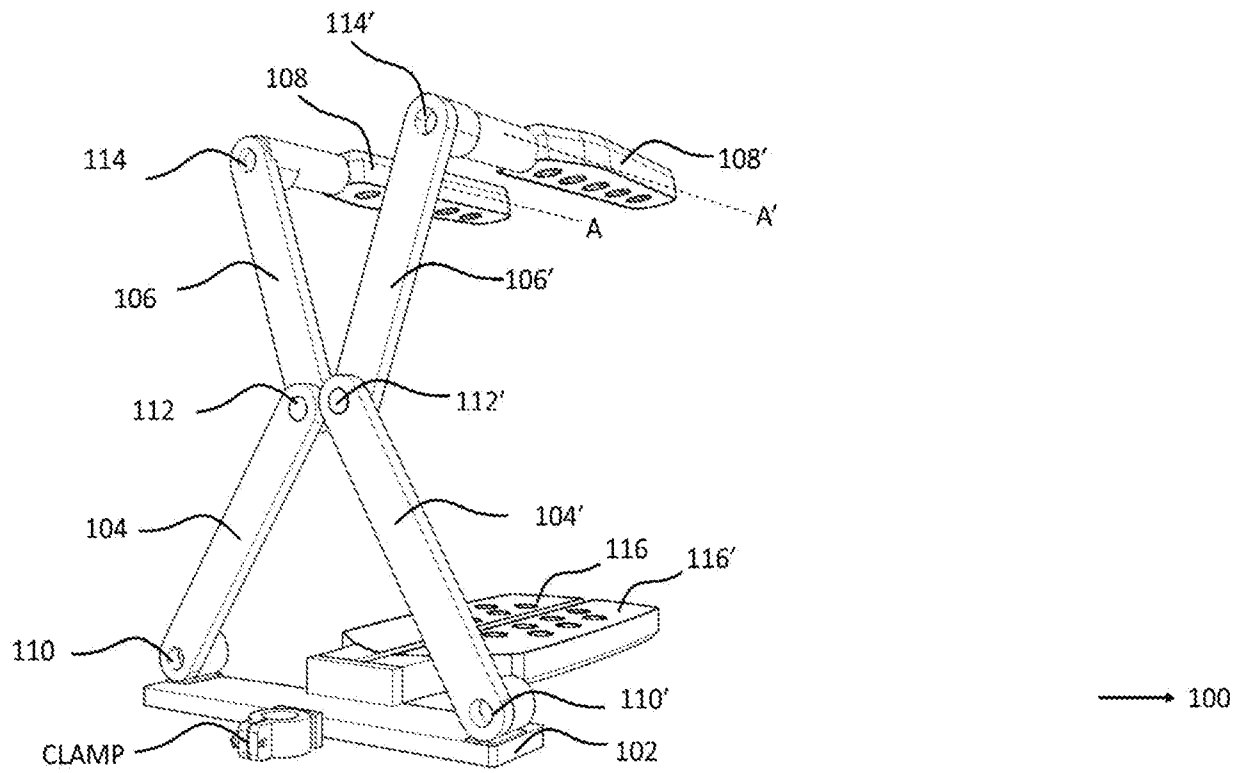


Figure 2

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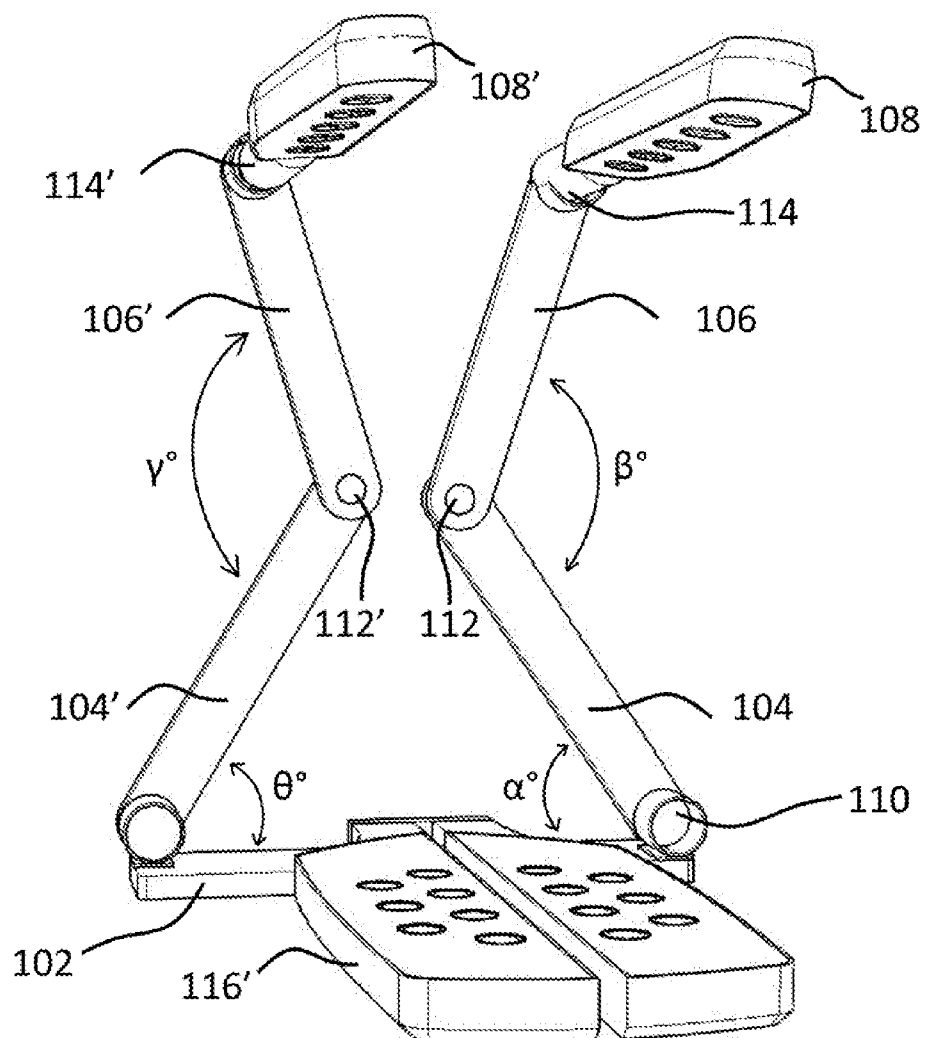


Figure 3

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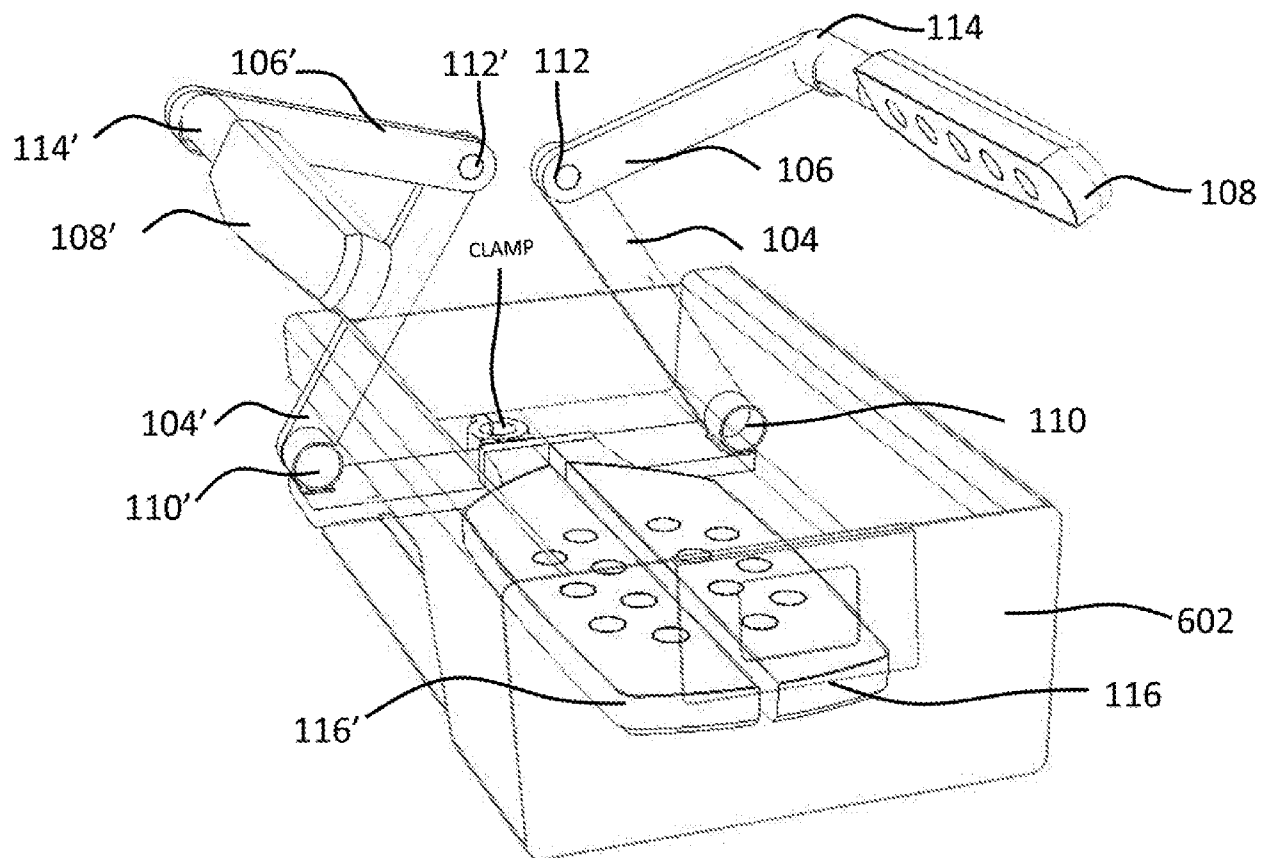


Figure 4

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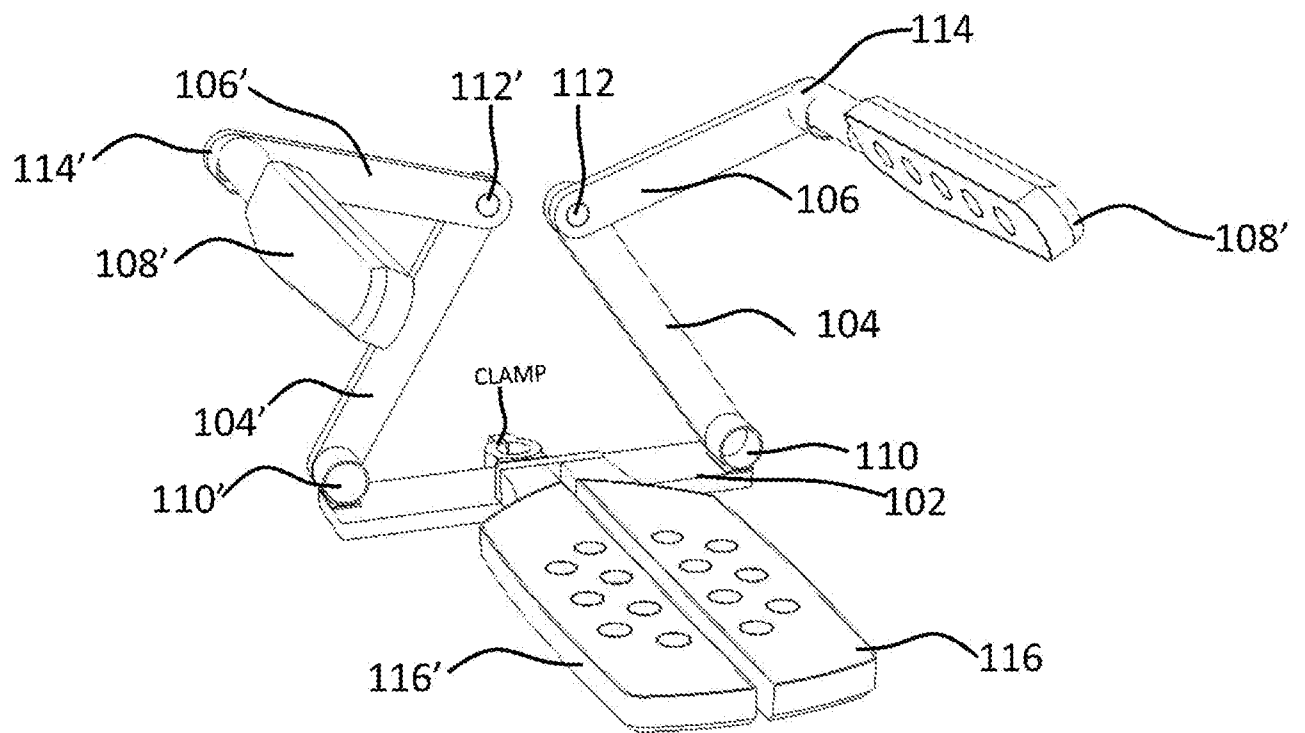


Figure 4(a)

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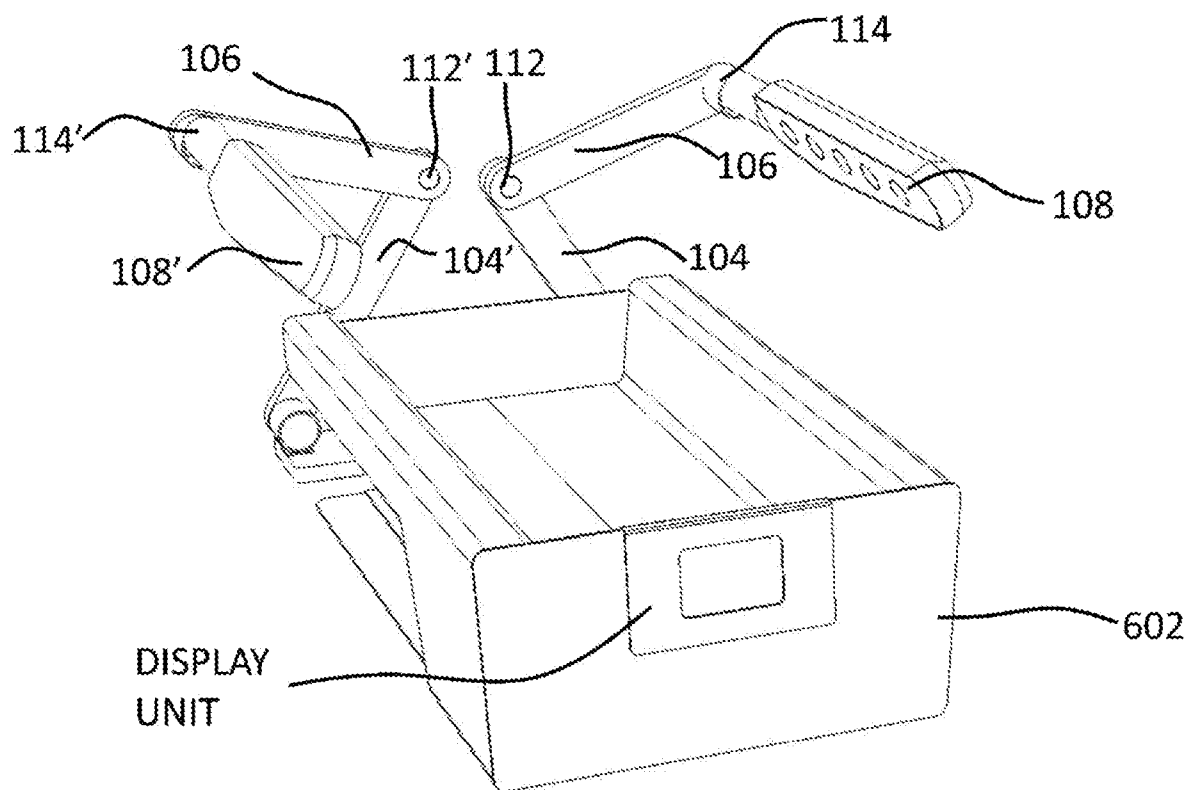


Figure 4(b)

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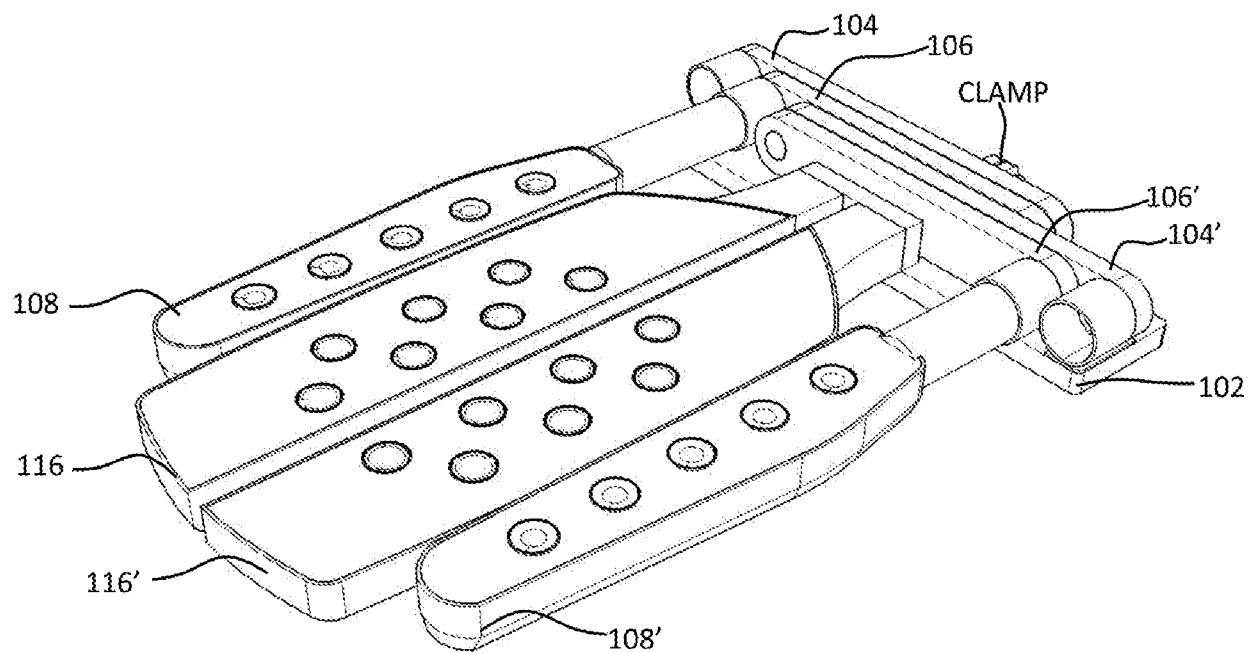


Figure 5

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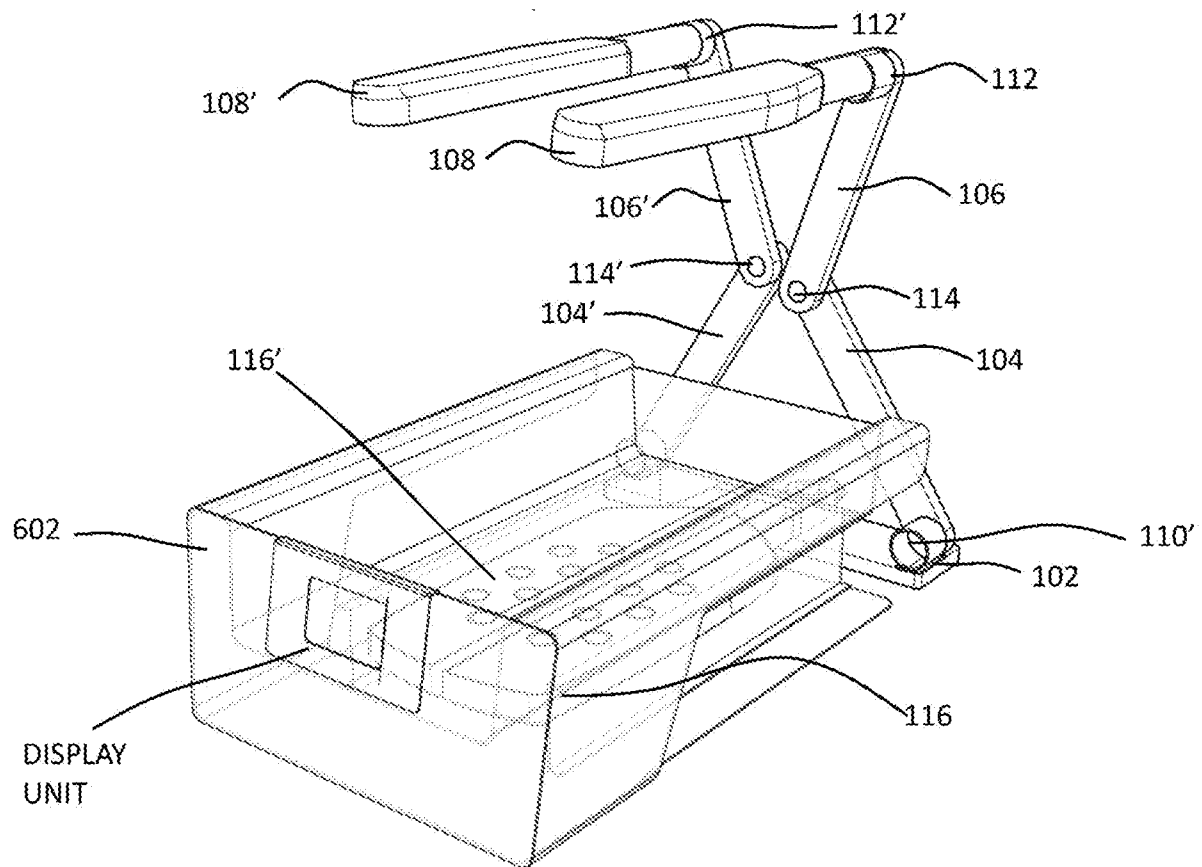


Figure 6(a)

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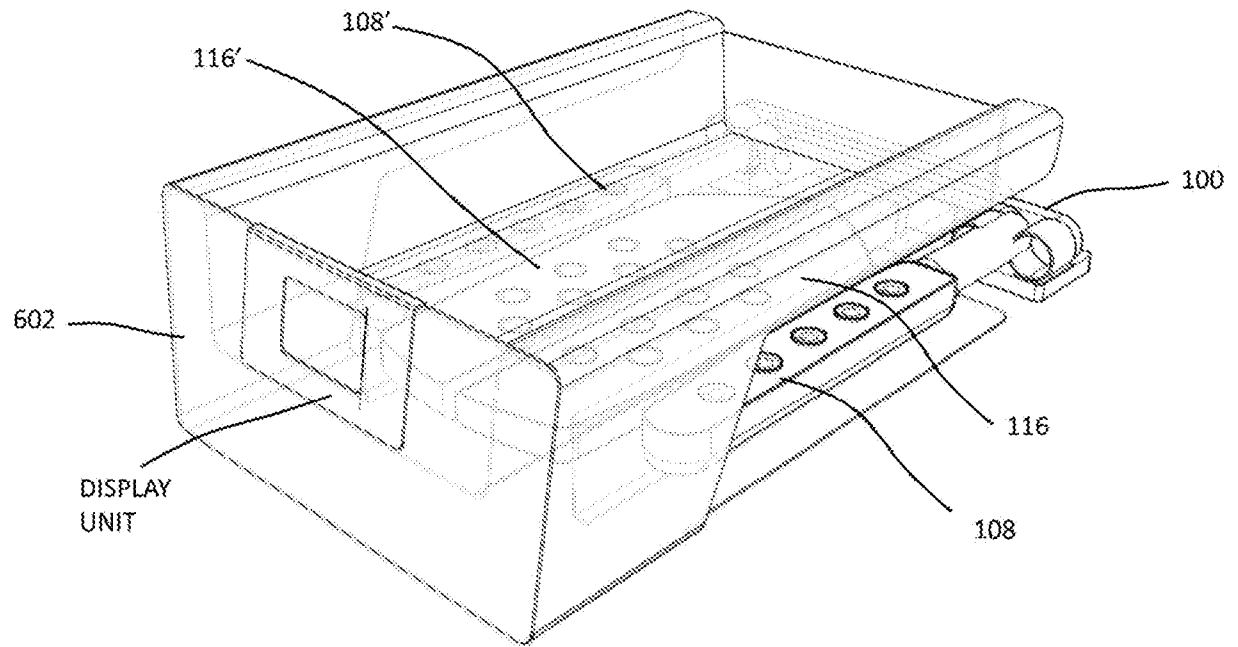


Figure 6(b)

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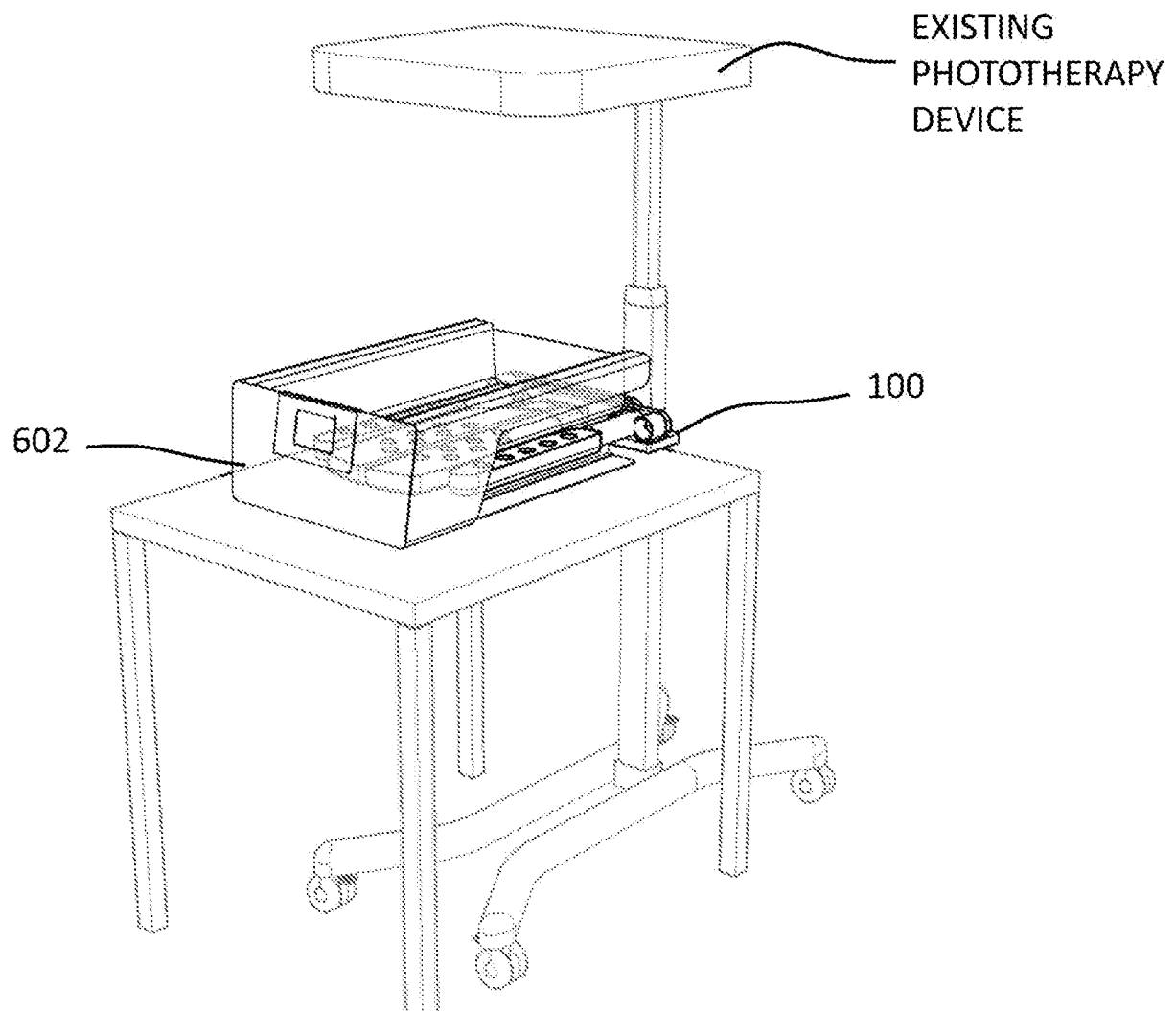


Figure 7

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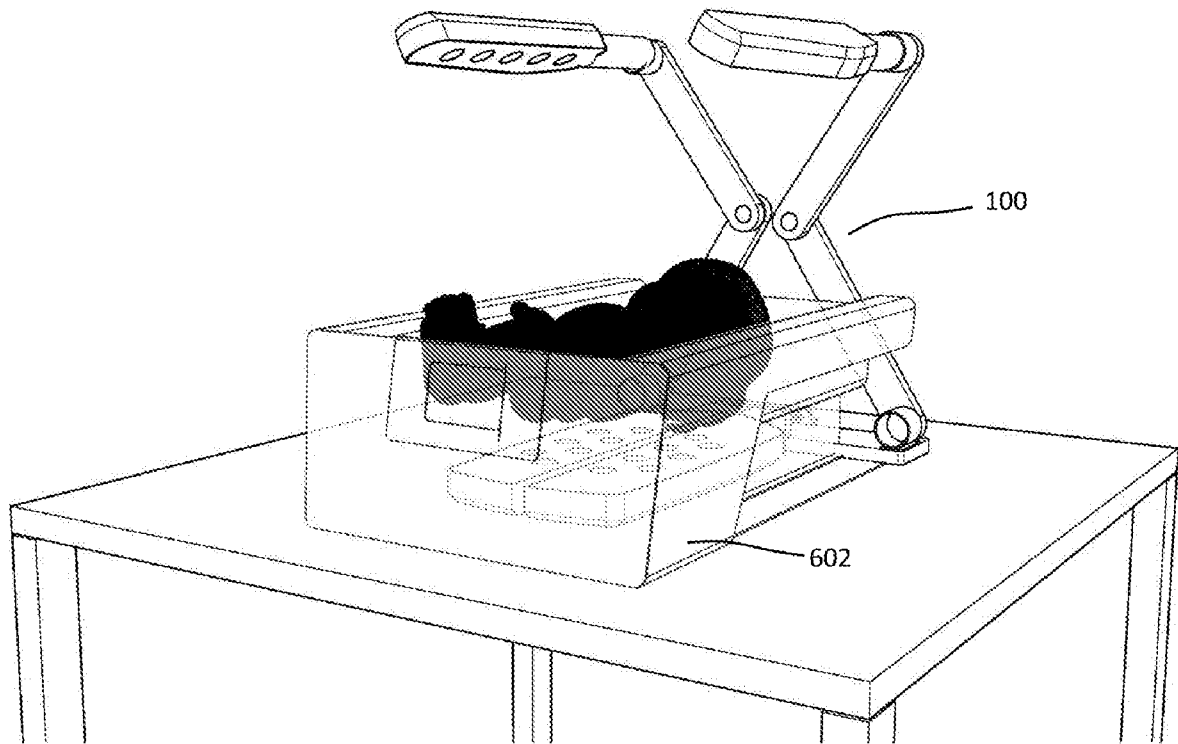


Figure 8(a)

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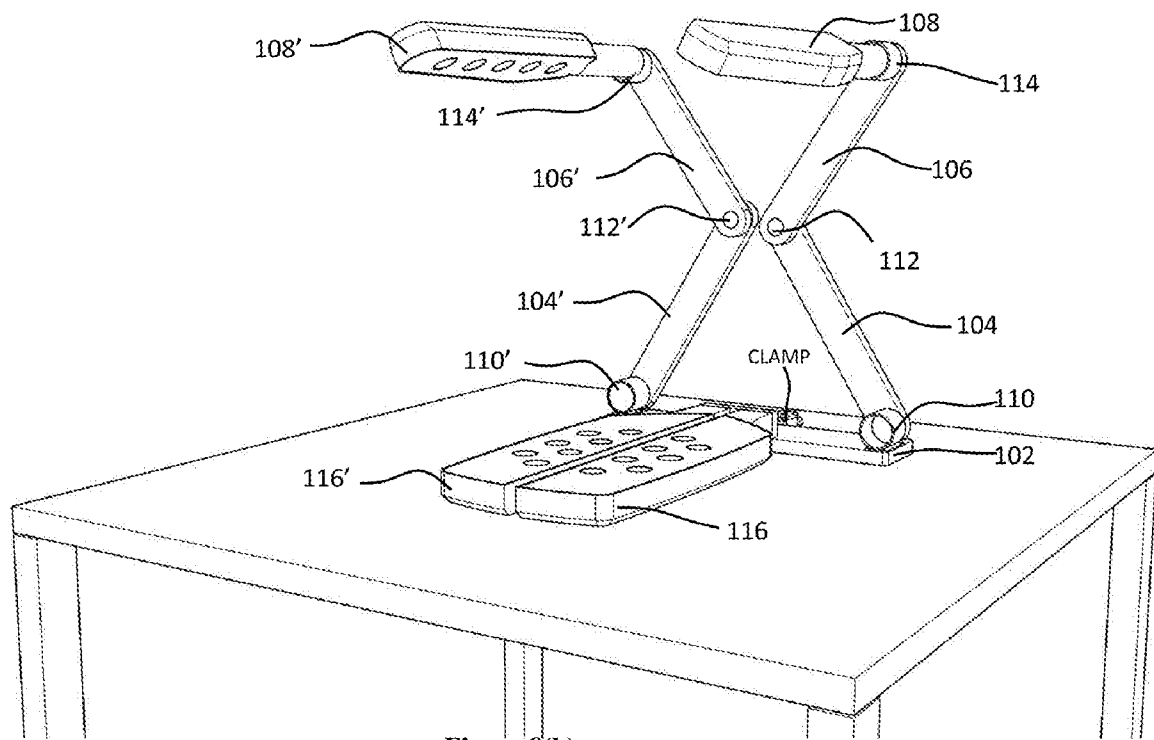


Figure 8(b)

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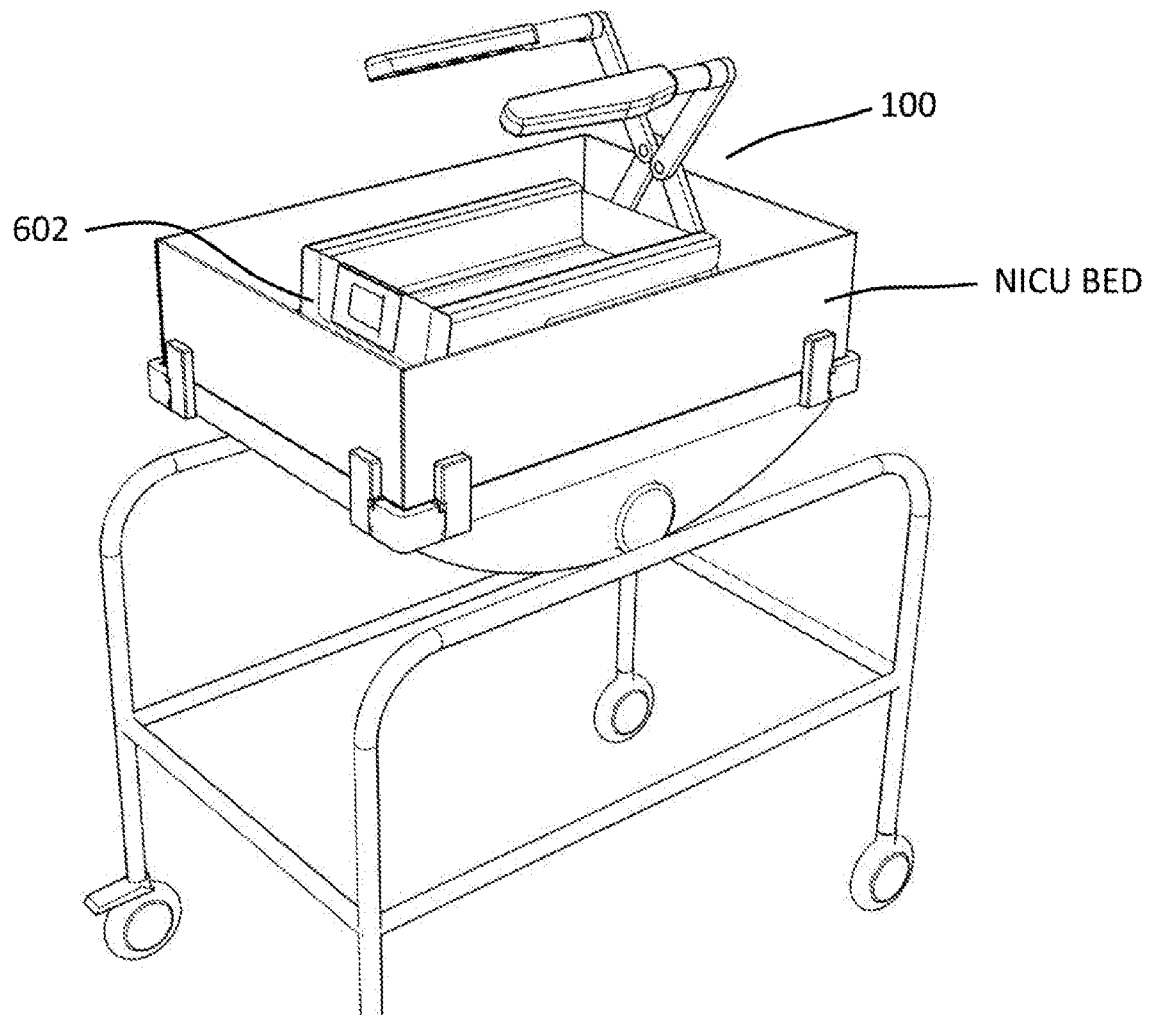


Figure 9

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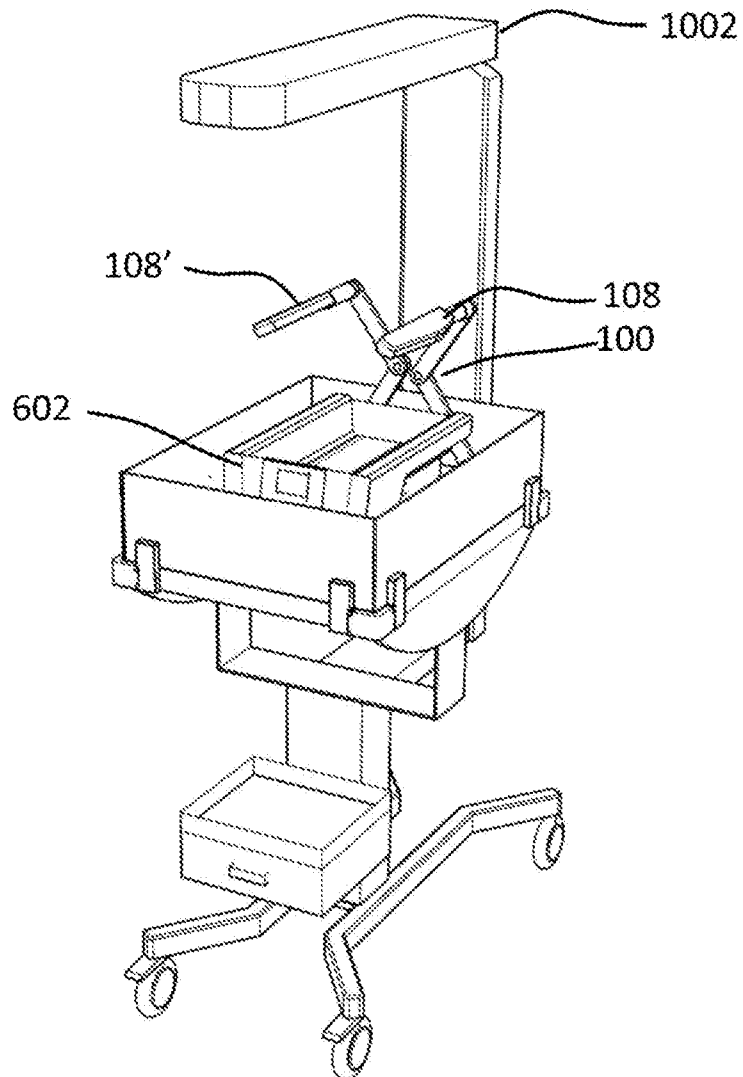


Figure 10

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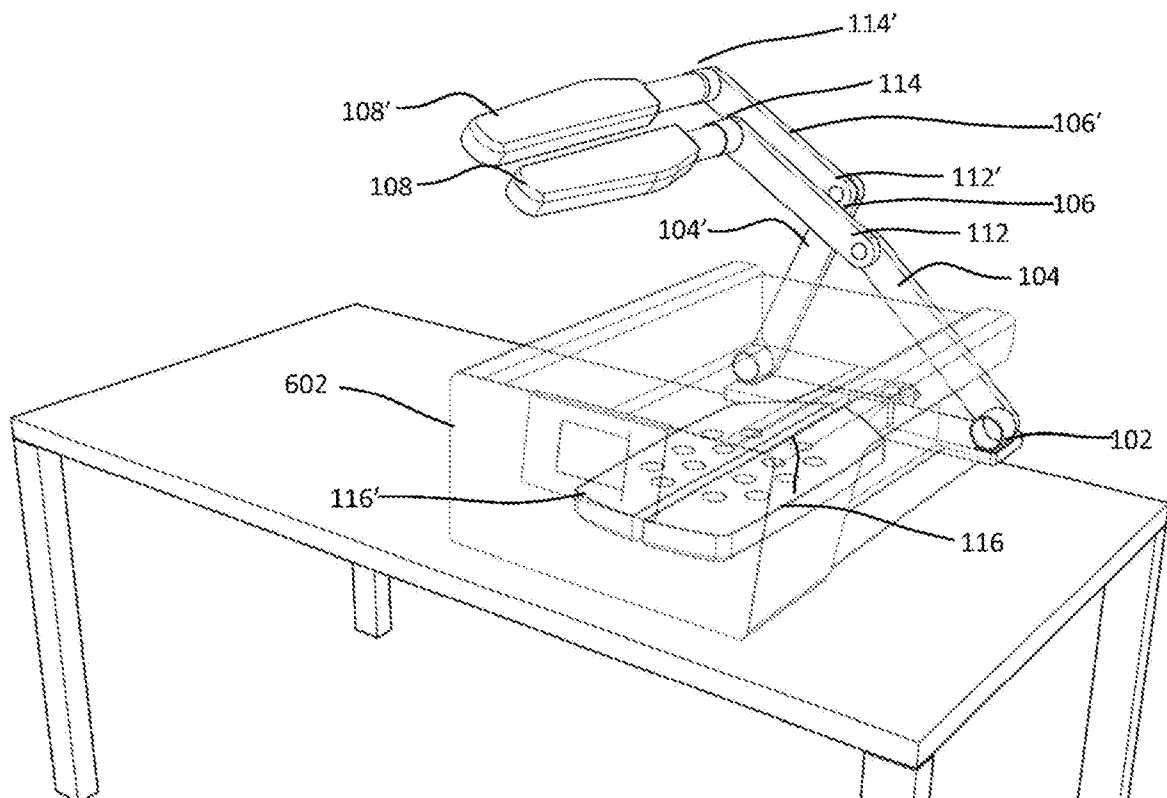


Figure 11(a)

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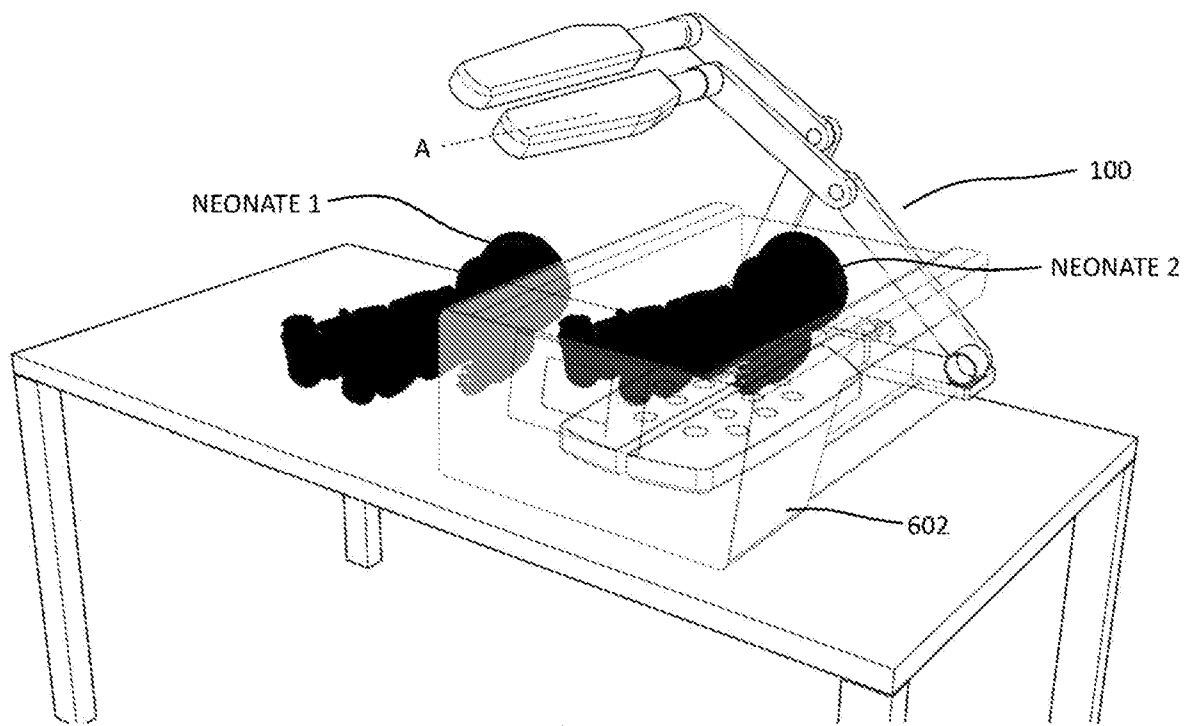


Figure 11(b)

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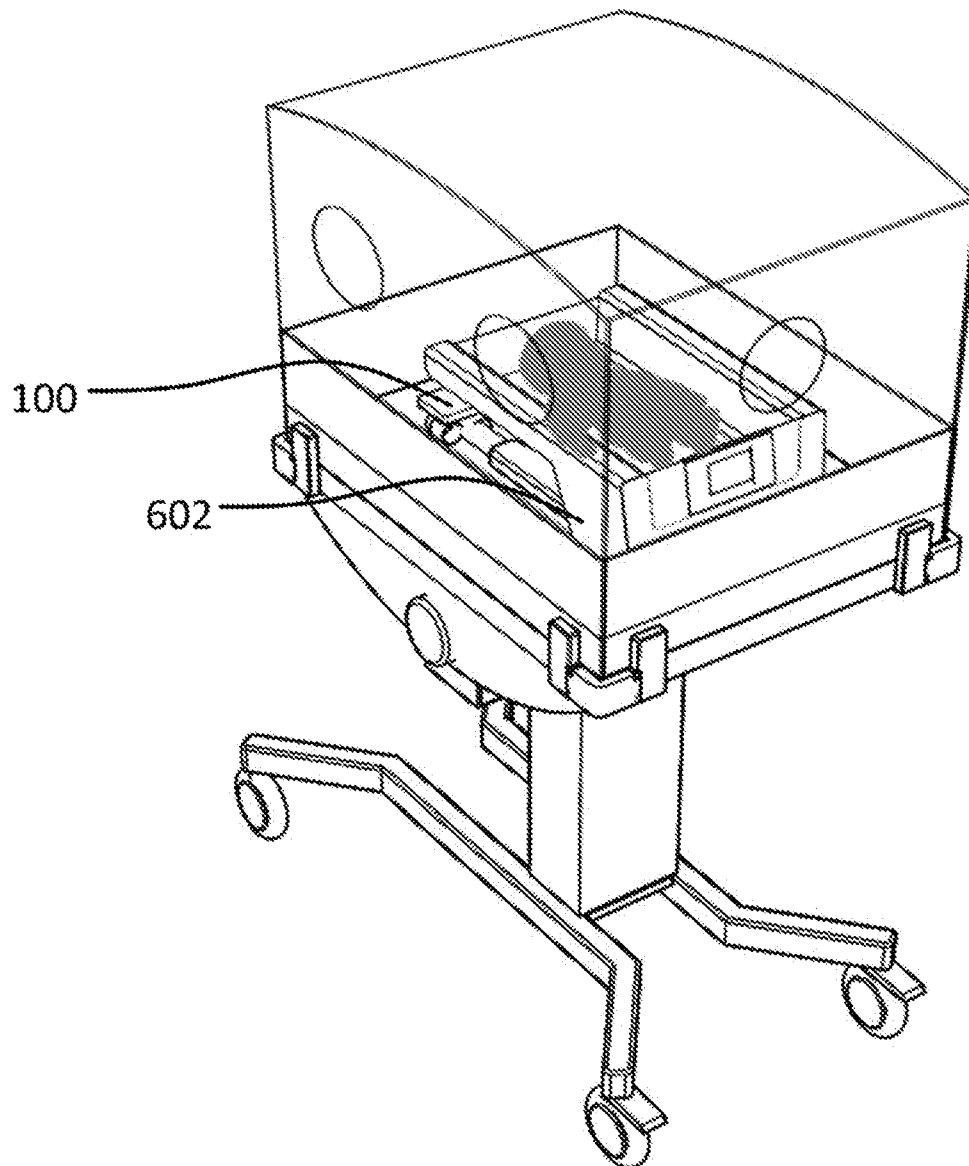


Figure 12

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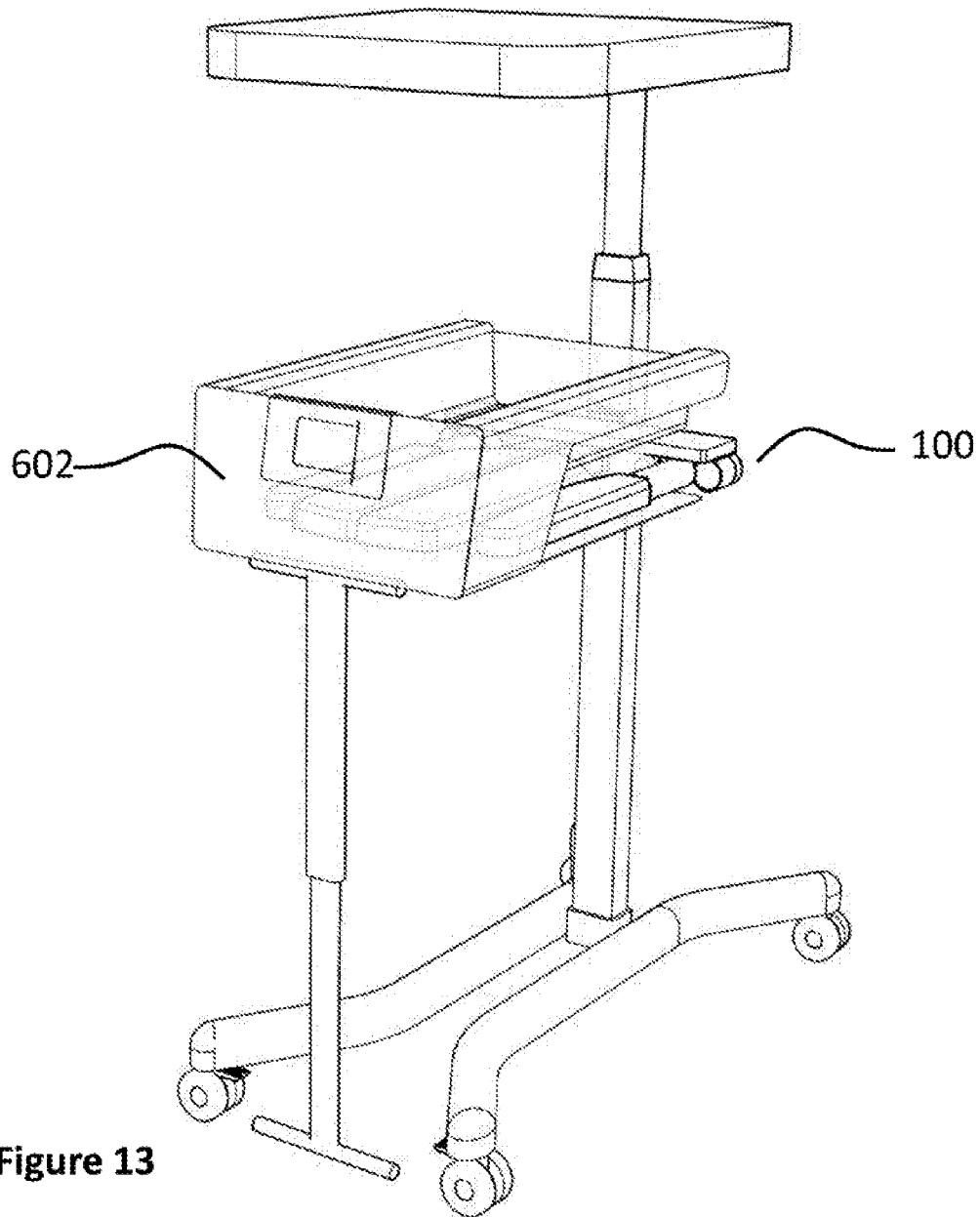


Figure 13

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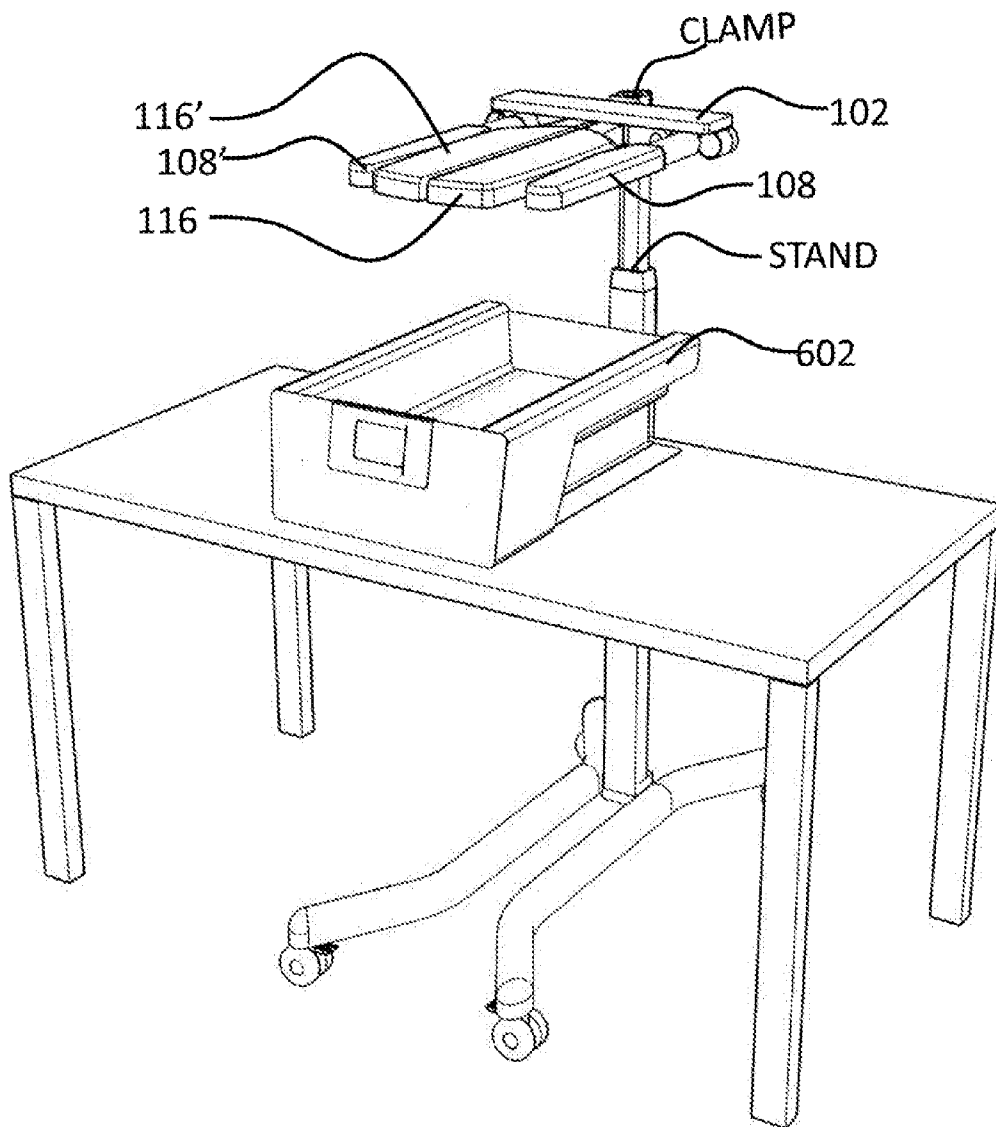


Figure 14(a)

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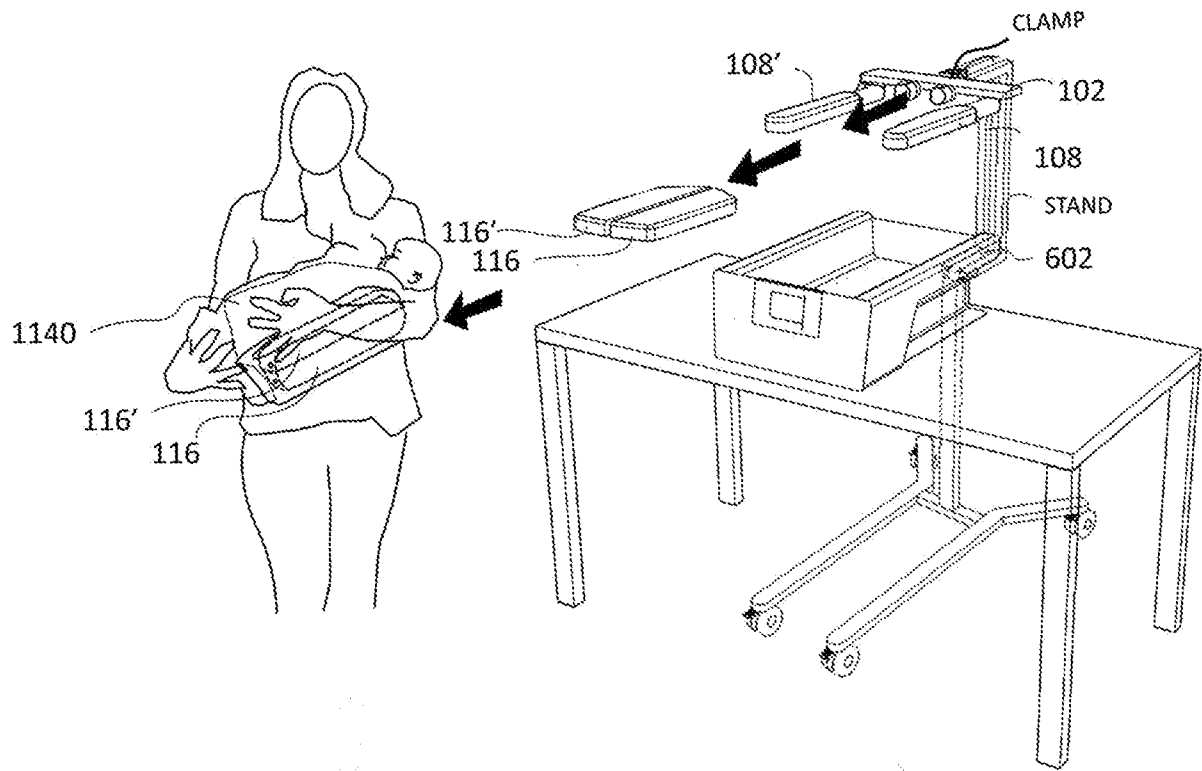


Figure 14(b)

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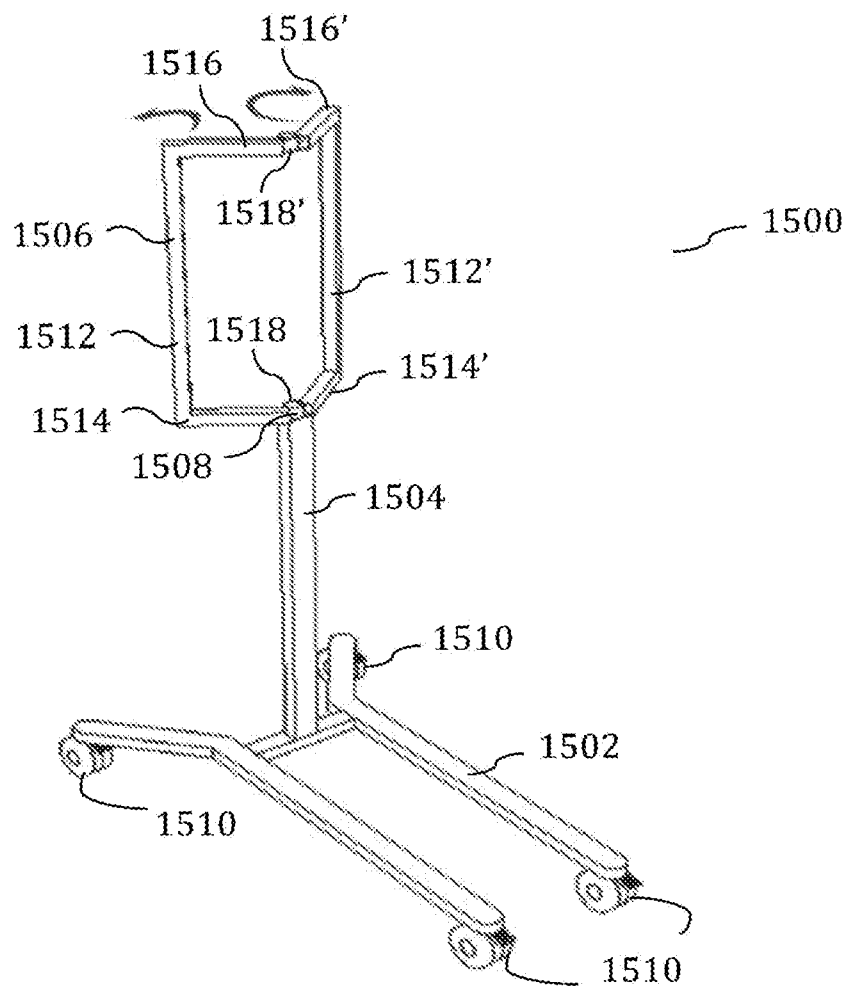


Figure 15

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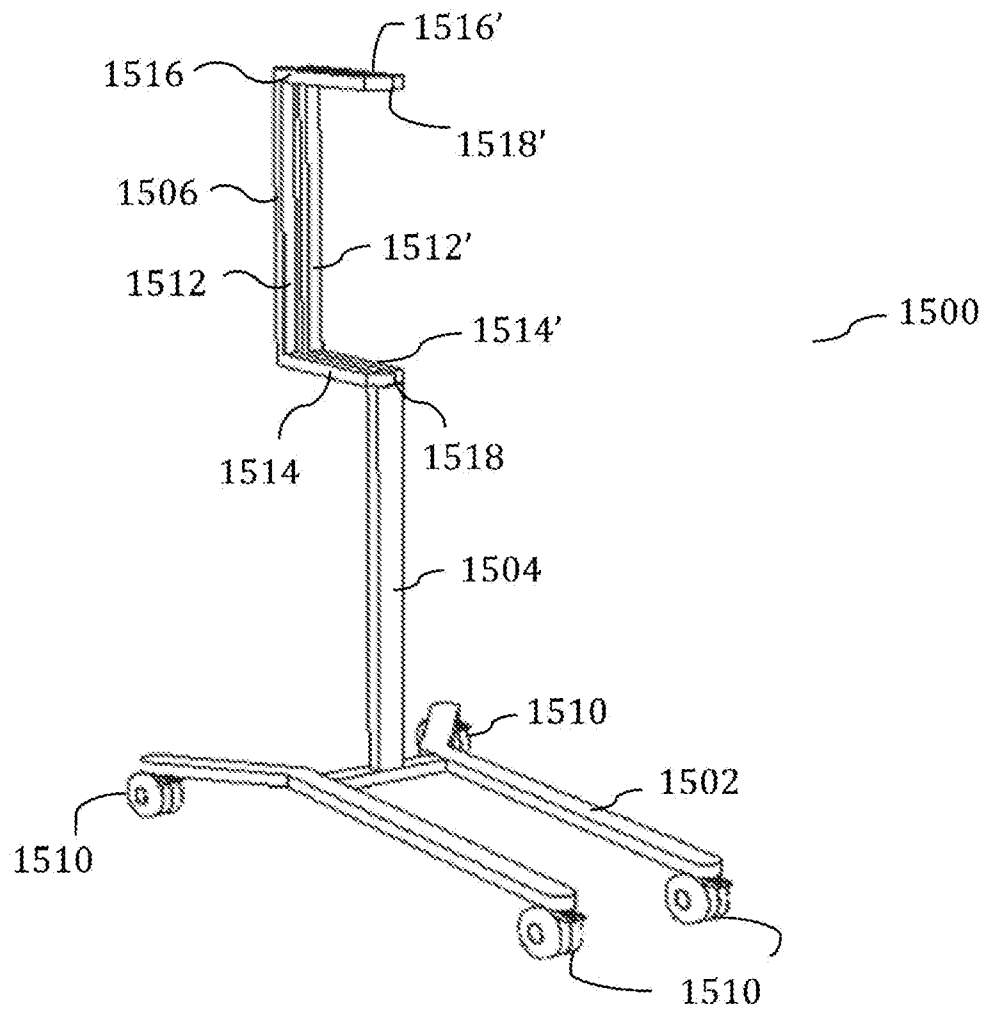


Figure 16

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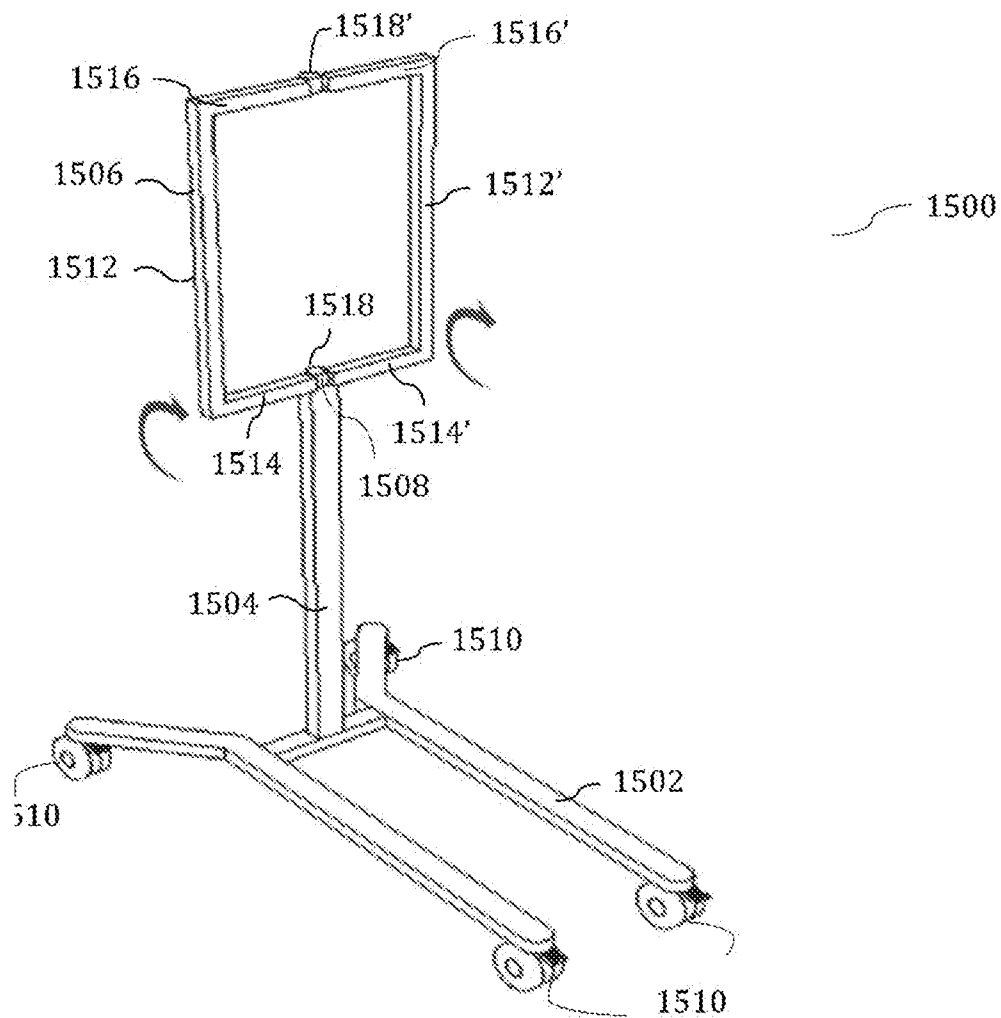


Figure 17

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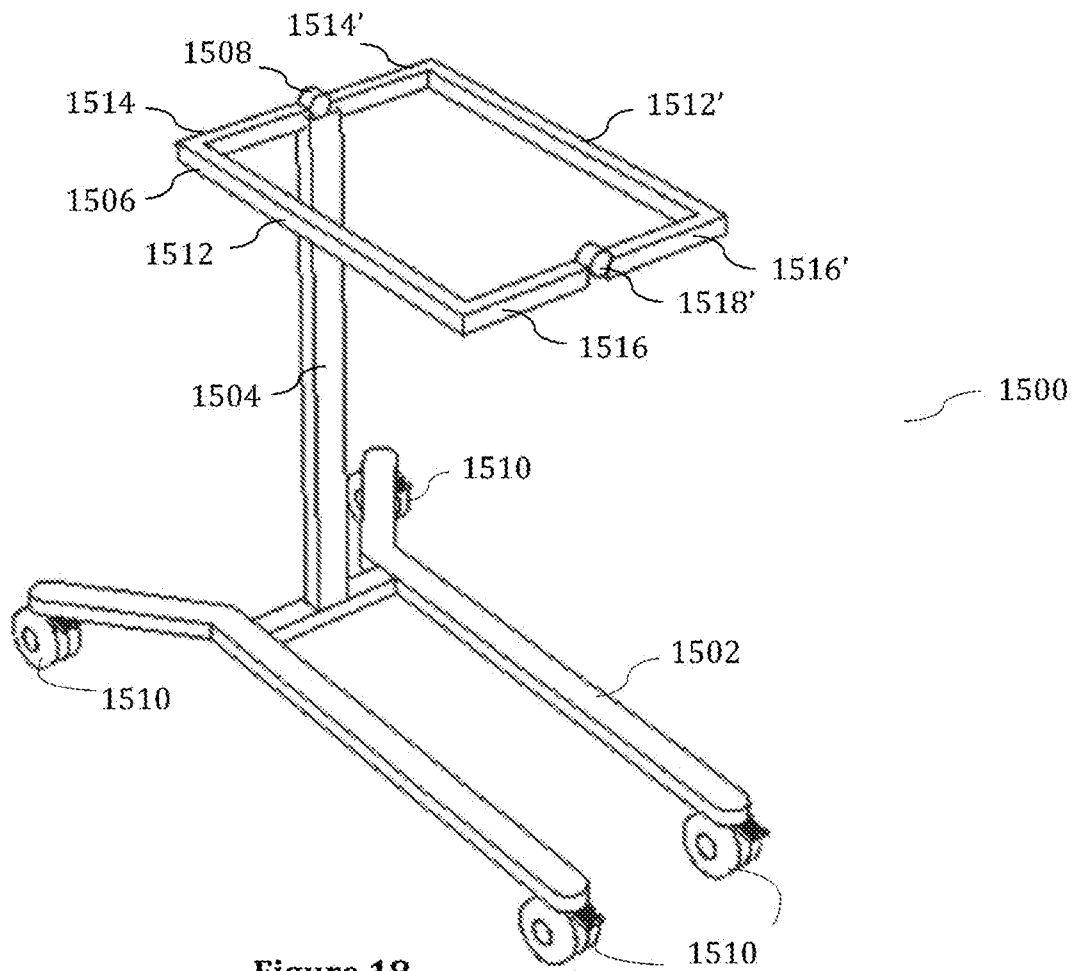


Figure 18

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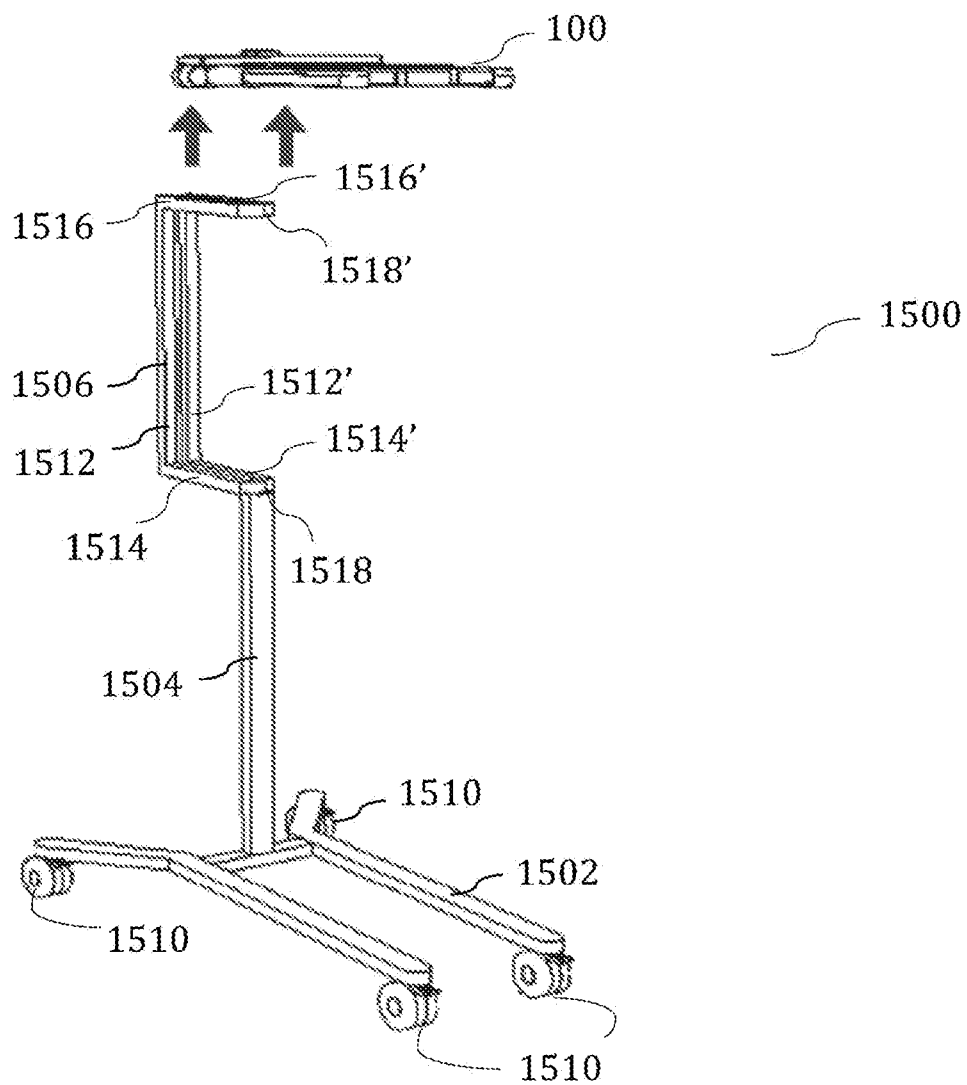


Figure 19

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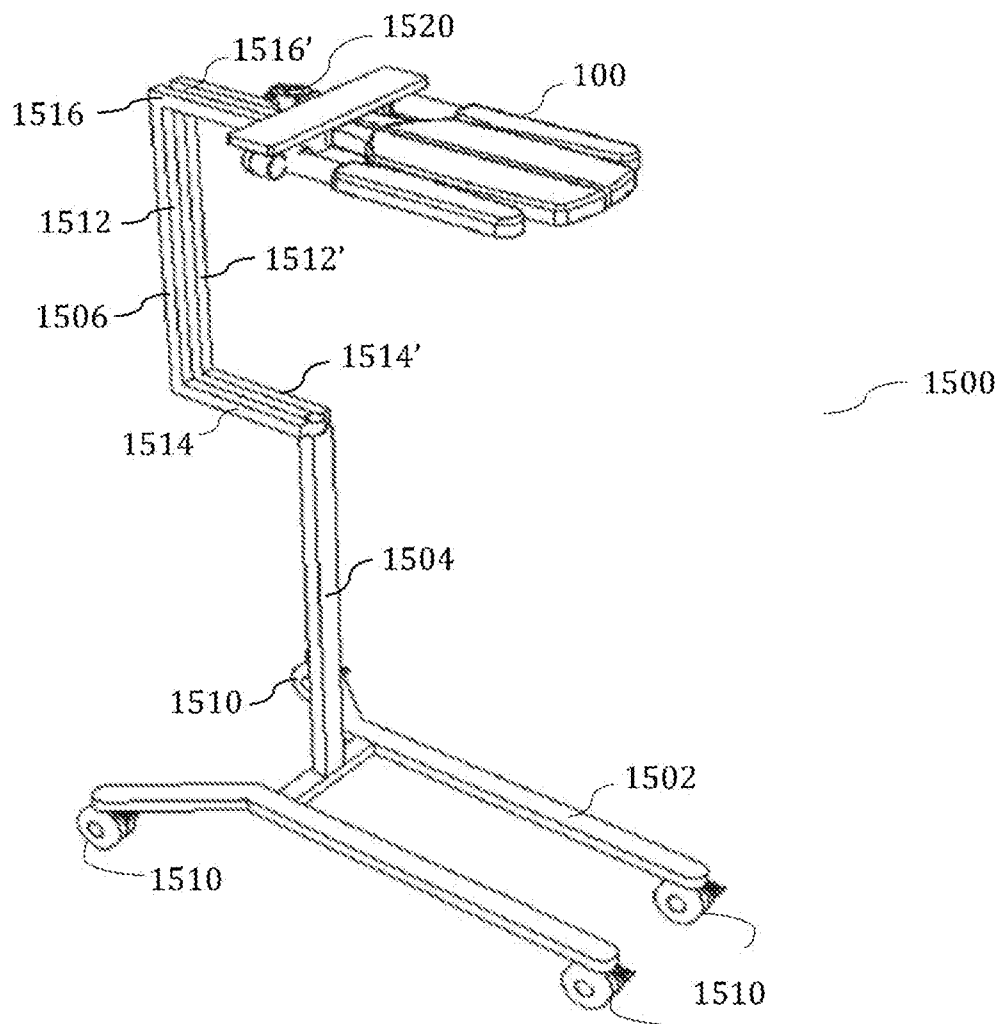


Figure 20

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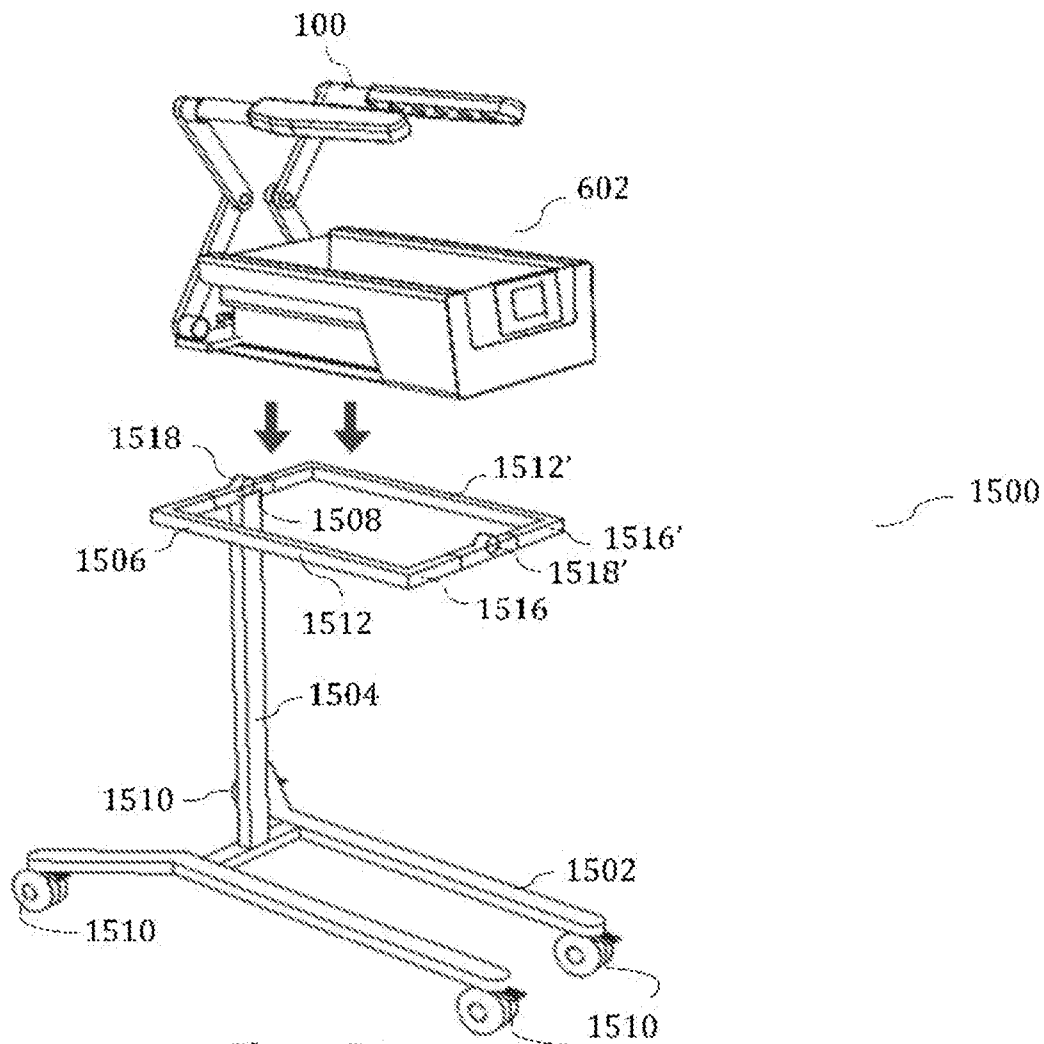


Figure 21

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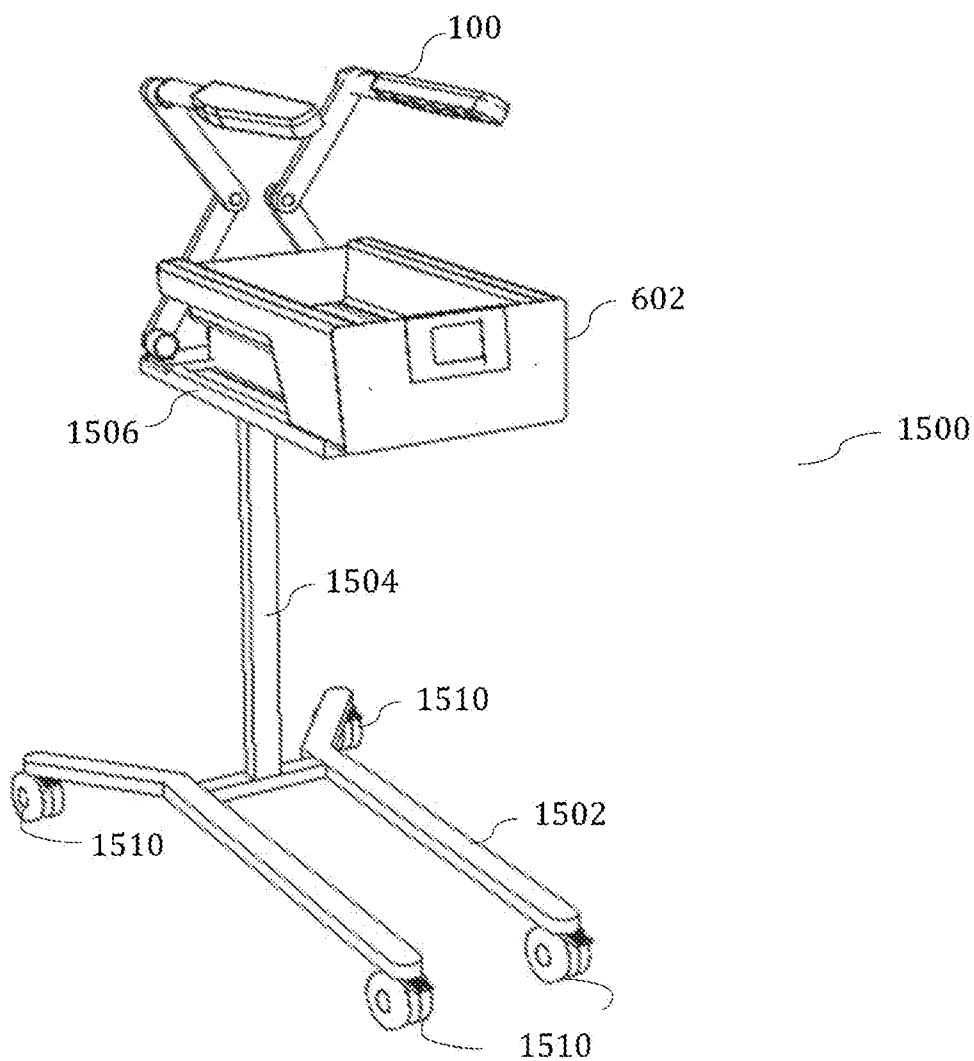


Figure 22

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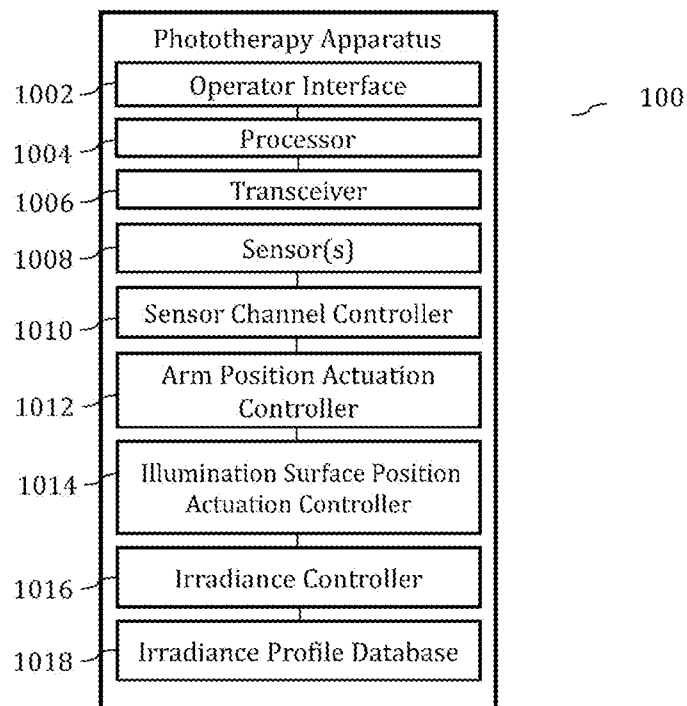
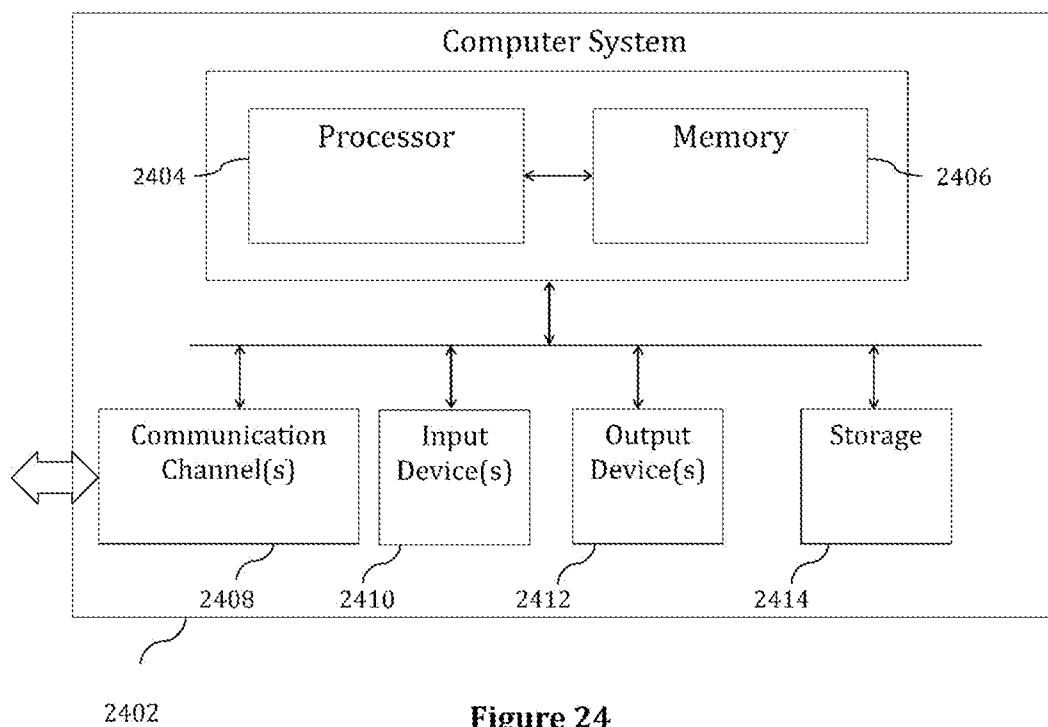


Figure 23

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2019/050493

A. CLASSIFICATION OF SUBJECT MATTER
A61N5/06, A61G11/00 Version=2019.01

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61N, A61G

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DATABASES: TotalPatent One, IPO Internal Database

KEYWORDS: movable, two, light, multidirection

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US5830123A (DRAEGERWERK AG AND CO KGAA) 03 November 1998 (03-11-1998) Abstract, column 1 line 10-17, figs 1-3	1-19
Y	US3877437A (FRANCESCO MAITAN, COSIMO VANNUCCHI) 15 April 1975 (15-04-1975) Abstract, column 3 line 1-5, figs 1-2	1-19

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"D" document cited by the applicant in the international application

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

31-10-2019

Date of mailing of the international search report

31-10-2019

Name and mailing address of the ISA/

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Facsimile No.

Authorized officer

Nikhil Saini

Telephone No. +91-1125300200

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IN2019/050493

Citation	Pub.Date	Family	Pub.Date
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