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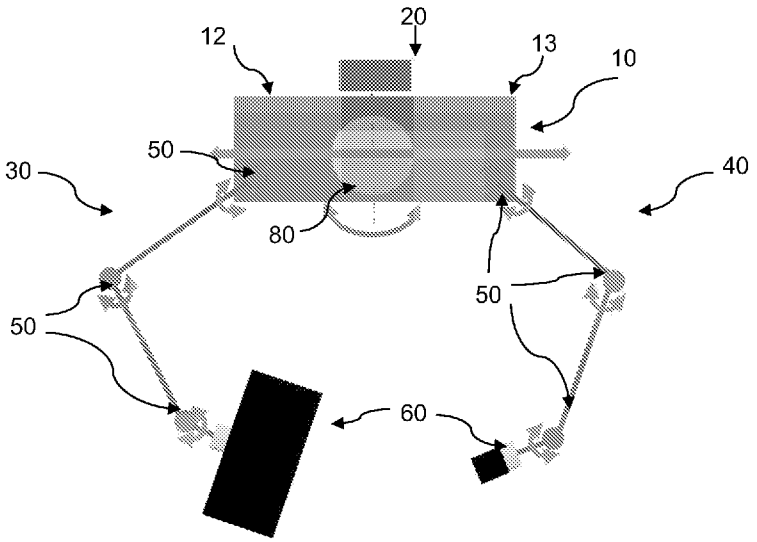

Figure 1

(57) Abstract: The current invention refers to a mechanism for a mobile platform for modular work with robotic arms, useful for performing diverse activities by coupling working tools appropriate for the requirement at the free end of the last link of the left arm and the right arm respectively, such a mechanism contains the modular characteristics to integrate into an elevation system available through appropriate support elements, for example: telescopic cranes or lifts. The robotic arms mounted on a mobile platform have, by way of their independent degrees of freedom, autonomous movement versatility to execute tasks such as: cleaning, inspection, repairs, to mention a few; through tools designed to couple in the free end of the last arm, right and left, respectively.

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MODULAR MOBILE PLATFORM WITH ROBOTIC ARMS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from U.S. Provisional Application Serial No. 62/461,740 filed on February 21, 2017, which is incorporated herein by reference in its entirety.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable.

FIELD

[0003] The current invention relates to a mechanism for a mobile platform for modular work with robotic arms.

INTRODUCTION

[0004] Manual work activities performed at considerable heights by several workers pose a high risk for them, activities such as cleaning, inspection or repairs in elevated structures, just to mention a few, can be avoided by implementing a system that allows operating with a higher degree of security and certainty in the execution of the activities; in such a way that the work can of performed in less time, with better final results without compromising the integrity of the workers.

[0005] The state of the technique reveals some automatic and semi-automatic mechanisms that precede the current invention, by way of service platforms that include robust robotic systems that can perform activities such as cleaning and inspection.

[0006] US Pub. No. 20120305331, describes a service platform, explicitly used to cleaning wind turbines, integrates a mounting point comprised by an assembling element, through which a basket a basket can be raised together with a plurality of cylindrical brushes attached to the basket, such brushes have horizontal mobility and incorporate approximation sensors and water and detergent. Such service platform is elevated through the use of a telescopic crane.

[0007] Patent CN201735562U, describes a robot for cleaning, which comprises of a

control device, a mobile cart, an elevation platform, a movement platform, a telescopic, sliding platform and mechanical arms. The mechanical arms are connected with the telescopic sliding platform, the mobile cart is comprised of a variety of balance holders and rotating support. The mechanical arms can fulfill the functions of elevation, stretching and movement, in accordance with the shape of the objects to clean (high tension equipment), and the brushes on the outside of the mechanical arms can rotate.

[0008] US Pat. No. 3,439,372, describes a mechanism that uses a telescopic manipulator where a single person controls all the movements, both from the vehicle as well as from the system, uses cardan joint system to adjust the incidence angles, its cleaning is done with orbital brushes, perpendicular to the surface, the brush ‘s axis is deformable, to adapt to the surface.

SUMMARY

[0009] The object of the current invention consists of a mechanism of a mobile platform for modular work with two robotic arms, mounted on a horizontal display with their axes parallel to the mobile platform that supports them; and each one of them with a minimum of two degrees of freedom.

[0010] Such invention is useful for performing diverse activities by coupling working tools appropriate for the requirement at the end of the last link of the left and right arm, respectively; such a mechanism contains the modular characteristic to couple into the elevation system available through appropriate support elements, for example: telescopic cranes or lifts; it is thus possible to perform tasks at any required height.

[0011] The robotic arms are mounted on a mobile platform, with proper means for guidance and drive which allow independent mobility for each robotic arm or for both together in right or left linear direction and with rotating capacity on a perpendicular layout; those arms have, by way of their independent degrees of freedom, movement versatility to execute tasks, such as: cleaning, inspection, repairs; to mention a few; through tools designed to join on the free end of the last link of the left and right arm, respectively, and capable of performing independent trajectories, manually or automatically controlled to be repeated by a closed-loop control system independent for each robotic arm.

[0012] These and other features, aspects and advantages of the present teachings will become better understood with reference to the following description, examples and appended claims.

DRAWINGS

[0013] Those of skill in the art will understand that the drawings, described below, are for illustrative purposes only. The drawings are not intended to limit the scope of the present teachings in any way.

[0014] Figure 1.- Conceptual diagram from an upper view of the mechanism of a mobile platform for modular work with robotic arms at the center of the mobile platform and its degrees of freedom;

[0015] Figure 2.-. Conceptual diagram from an upper view of the mechanism of a mobile platform for modular work with robotic arms to the right of the mobile platform and its degrees of freedom;

[0016] Figure 3.- Conceptual diagram from an upper view of the mechanism of a mobile platform for modular work with robotic arms with the mobile platform rotated in the horizontal plane;

[0017] Figure 4.- Conceptual diagram from a lateral view of the mechanism of a mobile platform for modular work with two robotic arms and its degrees of freedom;

[0018] Figure 5.- Schematic of the mechanism of a mobile platform for modular work with two robotic arms, in an example of cleaning

[0019] Figure 6.- Lateral view of the mechanism of a mobile platform for modular work with two robotic arms, in an example of cleaning

[0020] Figure 7.- Schematic of the joint detail of a brush

[0021] Figure 8.- Schematic exploited of the joint detail of a brush

[0022] Figure 9.- Schematic of the initial link of a robotic arm

[0023] Figure 10.- Schematic second link of a robotic arm

[0024] Figure 11.- Schematic of the mechanism of a mobile platform for modular work with two robotic arms, with rotated brushes.

DETAILED DESCRIPTION

[0025] Modular Mobile Platform with Robotic Arms

[0026] The current invention refers to a mechanism for a mobile platform for modular work with two robotic arms, mounted on a horizontal display with their parallel axes over the mobile platform that supports them; and with a minimum of two degrees of freedom on each of those arms.

[0027] Such invention is useful for performing diverse activities by coupling working tools appropriate for the requirement at the end of the last link of the left and right

arm, respectively; such a mechanism contains the modular characteristic to couple into the elevation system available through appropriate support elements, for example: telescopic cranes or lifts; it is thus possible to perform tasks at any required height.

[0028] The robotic arms are mounted on a mobile platform, with proper means for guidance and drive which allow independent mobility for each robotic arm or for both together in right or left linear direction and with rotating capacity on a perpendicular layout; those arms have, by way of their degree of freedom, independent movement versatility to execute tasks such as: cleaning, inspection, repairs, to mention a few; through tools designed to join on the free end of the last link of the left and right arm, respectively, able to perform independent trajectories, manually or automatically controlled to be repeated by an independent closed-loop control system for each robotized arm.

[0029] The mechanism of a mobile platform for modular work with two robotic arms has a base with means for balancing that allows mounting an elevation system (crane or lift, not included in the current invention). It also allows a secure walking zone for the operator, with the appropriate means to avoid falls or weather inclemency's, having a restraining harness. It also supplies a cabinet with the necessary means for the system's control and safety.

[0030] The mechanism of a mobile platform for modular work with robotic arms is useful to operate activities in heights that pose a risk for workers, it also allows to perform tasks with a greater degree of security and certainty; thus work can be done in less time, with better final results without compromising the integrity of the workers.

[0031] It should be noted that the current invention allows performing tasks at considerable heights that can pose a risk for conventional practices, in which workers are suspended to perform tasks such as cleaning, inspection or repairs in elevated structures; in such a way that this is an invention that increases the degree of security.

[0032] Elimination of dirt and residues accumulated in time in high places and that are difficult to reach in any given kind of infrastructure can diminish its usefulness, reducing its useful life or diminishing its capacities, and as part of every maintenance routine it is necessary to perform inspection in cases where maintaining specific conditions is fundamental and in case necessary, to intervene timely and perform preventive or corrective repairs.

[0033] Through the coupling of working tools appropriate for the requirement at the end of the last link of the left and right arm, respectively; such invention allows performing tasks such as cleaning, inspection and repairs at any required height level.

[0034] The robotic arms are mounted on a mobile platform, with proper means for guidance and drive which allow independent mobility for each robotic arm or for both together in right or left linear direction, and with rotating capacity on a perpendicular layout; it is possible then to manipulate the movements in a versatile manner and with a high capacity for reaching. Such robotic arms are characterized for performing work trajectories in an independent manner, appropriate to the working tools, so depending on the objective activity, it is possible to execute work in a quick manner and with higher precision, for example; removing filth, acquiring data for the inspection of diverse variables or repairing surfaces.

[0035] The tools designed to couple in the free end of the last arm, right and left, respectively, allow the use of the current invention in a diversity of tasks; as for every specific case it is possible to mount a tool for cleaning, inspection or repairs, to mention a few.

[0036] Additionally, it is worth mentioning that even though in the state of the technique there are also working robots with a drive in the horizontal plane, these are mounted over a column, and in general do not have a mobile platform, and their last axis is generally on a perpendicular plane from the floor, which limits the type of work that can be performed. If it is true that there are mobile platforms for the movement of mechanisms displacement of mechanisms or robots, these platforms are fixed to the floor following conditions of weight and inertness of the mechanisms or displaced robots.

[0037] According to various aspects, the current invention refers to a mechanism for a mobile platform for modular work with robotic arms, comprised of a mobile platform (10), a control cabinet (20), two robotic arms (30) and (40) which have a minimum of two degrees of freedom each one of them, actuators (50) of the robotic arms, tools (60) adaptable to the end of the last link of the robotic arm (30) and (40), left and right, respectively, a protection basket (70) for the safety of the operator and actuators (80) of the composed mobile base, Figure 1.

[0038] The composed mobile platform (10), is formed by a major base (11), a minor base left (12) and a minor base right (13); the major base (11) supports the minor bases left and right (12) and (13) respectively, allows a rotation and translation movement granted by a pair of actuators (80) located on the lower part of the composed mobile platform (10). Additionally, and through the integration of an actuator for the minor base left and right (12) and (13) respectively it is possible to have an independent translation movement for each of

such minor bases (12) and (13), Figure 4.

[0039] Over the minor base left (12) is the robot arm (30) that has a minimum two degrees of freedom and has actuators (50) to control and drive its respective relative angular positions between them in the joint of each link of the robotic arm (30), starting with the joint between the minor base left (12) and the first link of the robotic arm (30). The tools (60) are adaptable to the end of the last link of the robotic arm left (30). In a symmetric, analog manner over the minor base right (13) is the robot arm (40) that has a minimum two degrees of freedom and has actuators (50) to control and drive its respective relative angular positions between them in the joint of each link of the robotic arm (40), starting with the joint between the minor base right (13) and the first link of the robotic arm (40). The tools (60) are adaptable to the end of the last link of the robotic arm (40).

[0040] Through the structural disposition achieved with the two robotic arms (30) and (40) with the minimum two degrees of freedom, and the actuators (50) located on each joint of the links of such robotic arms, combined rotation and translation movements are achieved in horizontal and vertical planes, which allows a versatile movement capacity through which it is possible to perform complex tasks, to enable the tools (60) to reach positions required for performing different objectives. The robotic arms (30) and (40), left and right, respectively have the capacity of combined rotation and translation independent movement in horizontal and vertical planes, one with respect to the other; it is thus possible to perform a flexible manipulation depending on the specific task.

[0041] The actuators (50) that join the links of the robotic arms (30) and (40) can be of an appropriate type to perform rotation in horizontal or vertical plane, able to invert rotation and an option for fixed or variable speed.

[0042] The mechanism of a mobile platform for modular work with robotic arms has a base (90) with balancing means that allow its mounting on an elevation system such as crane or lift, to perform tasks at different heights (not included in the current invention). It also provides a safe walking zone for the operator, by integrating a protection basket (70), with the proper means to avoid falls or weather inclemency's, having a fastening harness. It also integrates a control cabinet (20) with the means necessary for the system's control and safety.

[0043] EXAMPLES

[0044] Aspects of the present teachings may be further understood in light of the following examples, which should not be construed as limiting the scope of the present

teachings in any way.

[0045] Example 1

[0046] The following detailed description has an illustrative objective of the constructive forms of the mechanism of a mobile platform for modular work with robotic arms, as an example in an application, oriented to cleaning with the robotic arms, protection basket, base and tools, not limited to the current patent of invention.

[0047] The mechanism of the mobile platform for modular work with robotic arms is formed by a pair of cleaning tools (61) and (62), robotic arms (30) and (40), a protection basket (70), minor rectangular base (14) and major rectangular base (15), Figure 5.

[0048] The cleaning tools (61) and (62), seek to maintain optimal contact over the surface to clean. Such tools (61) and (62) have cylindrical shape and can vary in length, given they are mounted on support structures (63) and (64) that can adjust its longitudinal dimension, in such base the actuators are mounted (65) and (66) which allow the rotation of the cleaning tools (61) and (62) respectively, to make the cycling swiping of cleaning and are able to invert rotation with the option for fixed or variable speed.

[0049] The coupling of the actuators (65) and (66) the support structures (63) and (64) correspondingly, Is performed through a pair of plates, one for each extreme, especially machined, which serve as guidance for the rotation axis (64a), and ease the coupling of the actuators (65) and (66) with the rotation axis (64a) of the cleaning tools (61) and (62), Figure 7 and 8.

[0050] The actuators (66a) and (66b) provide the support structures (63) and (64) and in consequence to the cleaning tools (61) and (62) rotation over a parallel axis to the horizontal plane, such actuators (66a) and (66b) have rotary reversal, which allows the cleaning tools (61) and (62) to change from a vertical position to a horizontal position and vice versa; in the same manner, this degree of movement is not restricted to two positions and if required, the cleaning tools (61) and (62) can be oriented towards intermediate positions, that is, in a range of 0° to 180° on both directions; while the actuators (67a) and (67b) provide a perpendicular rotation to the horizontal plane.

[0051] The cleaning tools (61) and (62) together with the structures (63) and (64) are joined on the links (31) and (41) through elements of rotational movement, known in the technique, which allow the cleaning tools (61) and (62) to position themselves horizontally or vertically at the same time allowing to open or close the attack angle for cleaning.

[0052] Each robotic arm (30) and (40) is formed by a couple of links (31), (32) and

(41), (42), respectively; rectangular with a geometry that allows the reach necessary for the cleaning tools (61) and (62) to envelop complex geometries (for example, inherent geometries in the wind turbines). Also, such robotic arms (30) and (40) have an element of power transmission (34) and (44) respectively, activated by the actuators (35) and (45), which allows mobility of each robotic arm (30) and (40), through the rotation of the links (32) and (42) with respect to the major rectangular base (15).

[0053] The robotic arm (40) is formed by the links (41) and (42), and the robotic arm (30) is formed by the links (31) and (32). The links (41) and (42) are joined by a hinge mechanism, known in the technique; the actuator (43) controls the opening or closing of the internal angle formed by such links (41) and (42), in an analogic manner, the links (31) and (32) is joined by a hinge mechanism, known in the technique; the actuator (33) controls the opening or closing of the internal angle formed by such links (31) and (32).

[0054] The minor rectangular base (14) is integrated to the major rectangular base (15), which is attached to the actuator (16) which allows the minor rectangular base (14) rotation over the horizontal, with reference to its geographical center.

[0055] The minor rectangular base (14) rests over the rigid bars (16a) and (16b) attached to the major rectangular base (15), as well as the actuator (17) is attached to the minor rectangular base (14), such actuator (17) through elements of power, known in the technique; boosts the minor rectangular base (14) to generate a linear movement driven by the rigid bars (16a) and (16b). The actuator (17) has rotating direction reversal to allow the minor rectangular base (14) to move in both directions.

[0056] The major rectangular base (15), has a con fastening point (18) in the lowest part, and can be considered relatively fixed, given such fastening point (18) serves for the major rectangular base (15) and in consequence for the whole system to be coupled into a telescopic crane or lift to perform tasks at different heights.

[0057] The structure of the protection basket (70) is formed in such a manner that it offers high resistance against the weather adversities, and provides a high level of security for the operators, in an analogic way it has the necessary elements to integrate safety fastening points, which are attached through welding to the structure itself.

[0058] The protection basket (70) is formed by two tubular structures (71) and (72), to support and protect the operator respectively, has a control cabinet (20), in with all the necessary elements to have closed-loop control.

[0059] The first link (32) and (42) of the robotic arms (30) and (40) have, on the end that joins the protection basket (70) the elements for power transmission (34) and (44)

respectively, and on the other end where it joins the second link (31) and (41) respectively the movement transmission is performed through the actuator (33) and (43) it integrates an axis (43a) in case of the actuator (43) and another analogical for the actuator (33), which transmits the movement to the second link (31) and (41), see Figure 9.

[0060] In the second link (31) and (41) there is an end with one actuator (67a) and (67b) which allows mobility of a third link, where the brushes are located (61) and (62), see Figure 10.

[0061] Other Embodiments

[0062] The detailed description set-forth above is provided to aid those skilled in the art in practicing the present invention. However, the invention described and claimed herein is not to be limited in scope by the specific embodiments herein disclosed because these embodiments are intended as illustration of several aspects of the invention. Any equivalent embodiments are intended to be within the scope of this invention. Indeed, various modifications of the invention in addition to those shown and described herein will become apparent to those skilled in the art from the foregoing description which do not depart from the spirit or scope of the present inventive discovery. Such modifications are also intended to fall within the scope of the appended claims.

[0063] References Cited

[0064] All publications, patents, patent applications and other references cited in this application are incorporated herein by reference in their entirety for all purposes to the same extent as if each individual publication, patent, patent application or other reference was specifically and individually indicated to be incorporated by reference in its entirety for all purposes. Citation of a reference herein shall not be construed as an admission that such is prior art to the present invention.

CLAIMS

What is claimed is:

1. A mobile platform for modular work with robotic arms, the mobile platform comprising a composite mobile platform, a control cabinet, two robotic arms left and right, actuators of the robotic arms, a protection basket for the safety of the operator, and actuators of the composed mobile base.

2. The mobile platform of claim 1, wherein the composite mobile platform is formed by a major base, a minor base left and a minor base right; the major base supports the minor bases left and right respectively, and allows a rotation and translation movement granted by a pair of actuators located on the lower part of the composed mobile platform.

3. The mobile platform of claim 2, wherein the composite mobile platform, through the integration of an actuator for the minor base left and right respectively; it is possible to have an independent translation movement in left or right direction, for each of such minor bases.

4. The mobile platform of claim 2, wherein on the minor base left is the robot arm left, that has a minimum two degrees of freedom and has actuators to control and drive its respective relative angular positions between them, in the joint of every link of the robotic arm left.

5. The mobile platform of claim 4, wherein the robotic arm left begins at the joint between the minor base left and the first link of the robotic arm left.

6. The mobile platform of claim 4, wherein the robotic arm right is located over the minor base right, that has a minimum two degrees of freedom and has actuators to control and drive its respective relative angular positions between them in the joint of each link of the robotic arm.

7. The mobile platform of claim 6, wherein the robotic arm right begins at the joint between the minor base right and the first link of the robotic arm right.

8. The mobile platform of claim 1, wherein the robotic arms can integrate diverse tools at the end of the last link of the robotic arm left and right, to execute tasks, such as cleaning, inspection and repairs; not limited to the previous ones.

9. The mobile platform of claim 1, wherein through the particular structural layout achieved with the two robotic arms left and right, and the actuators on each joint of the links of such robotic arms, combined rotation and translation movements are achieved in horizontal and vertical planes, which allow a versatile movement capacity, through which it is possible to perform complex tasks, to enable the tools to reach positions required for

performing different objectives.

10. The mobile platform of claim 1, wherein the robotic arms left and right, together with actuators and links, have the capacity of combined rotation and translation independent movement in horizontal and vertical planes, one with respect to the other; it is thus possible to perform a flexible manipulation depending on the specific task.

11. The mobile platform of claim 1, wherein the actuators that join the links of the robotic arms left and right can be of an appropriate type to perform rotation in horizontal or vertical plane, able to invert rotation and an option for fixed or variable speed.

12. The mobile platform of claim 1, wherein the platform has a base with balancing means, which allows its mounting on an elevation system such as crane or lift, to perform tasks at different heights.

13. The mobile platform of claim 1, wherein the platform provides a safe walking zone for the operator, by integrating a protection basket, with the proper means to avoid falls or weather inclemency's, as it integrates safety elements.

14. The mobile platform of claim 2, wherein the platform integrates a control cabinet with the necessary elements for a closed-loop control and the safety of the mechanism.

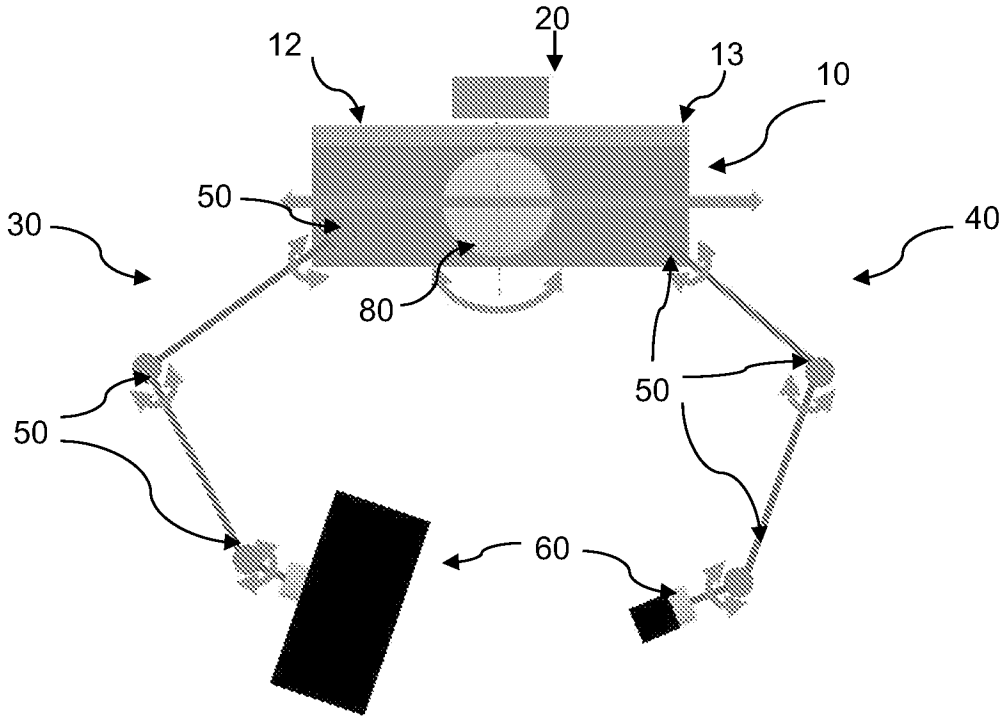
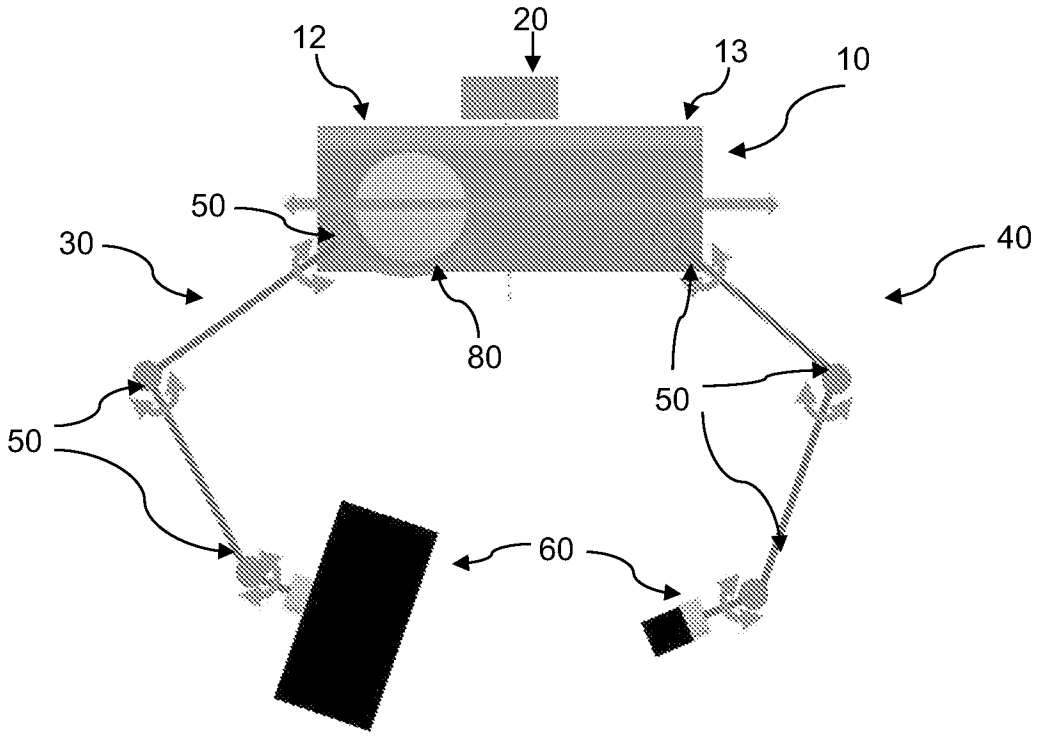


Figure 1



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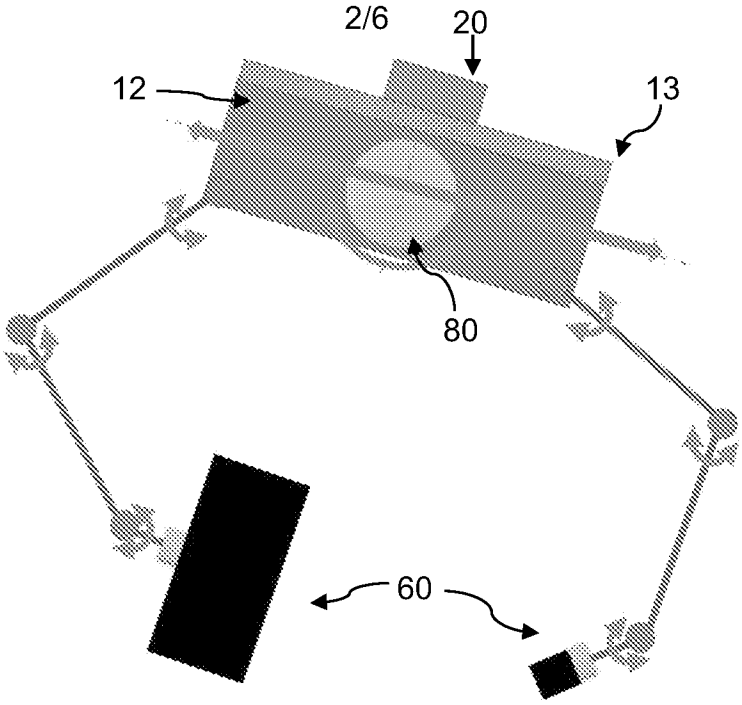

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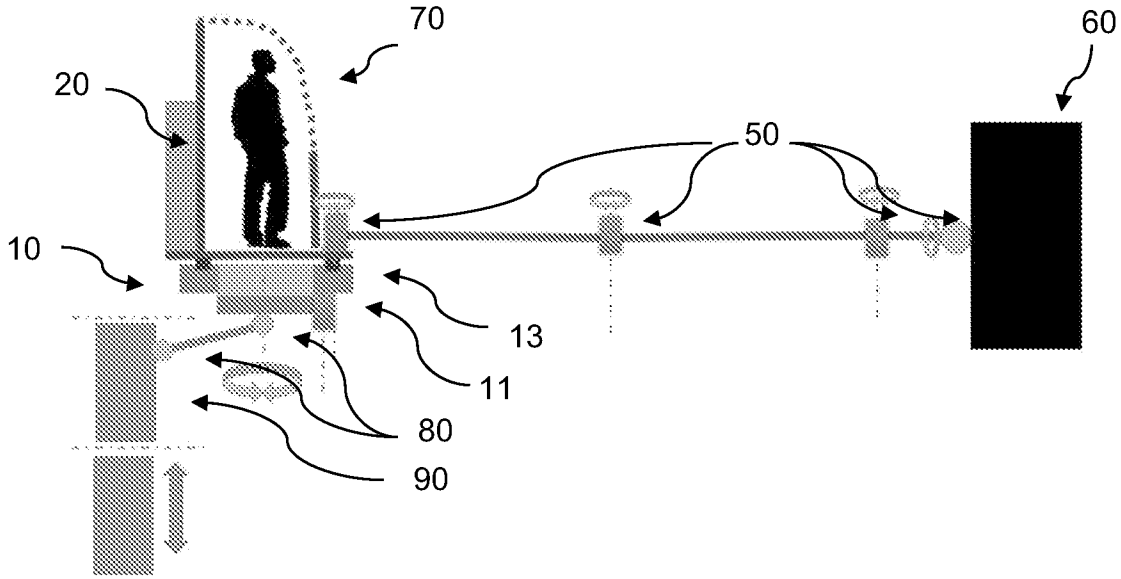

Figure 4

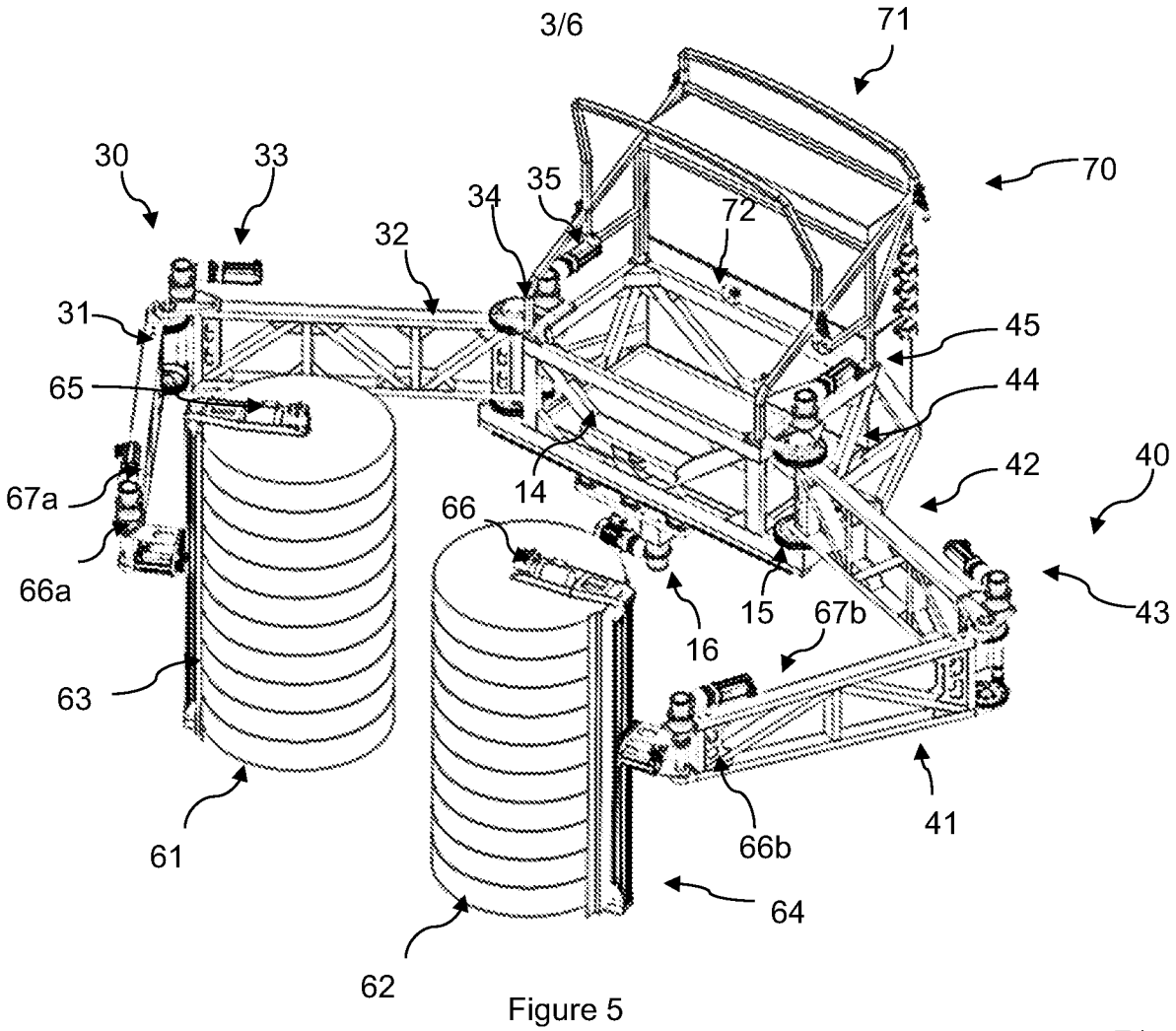

Figure 5

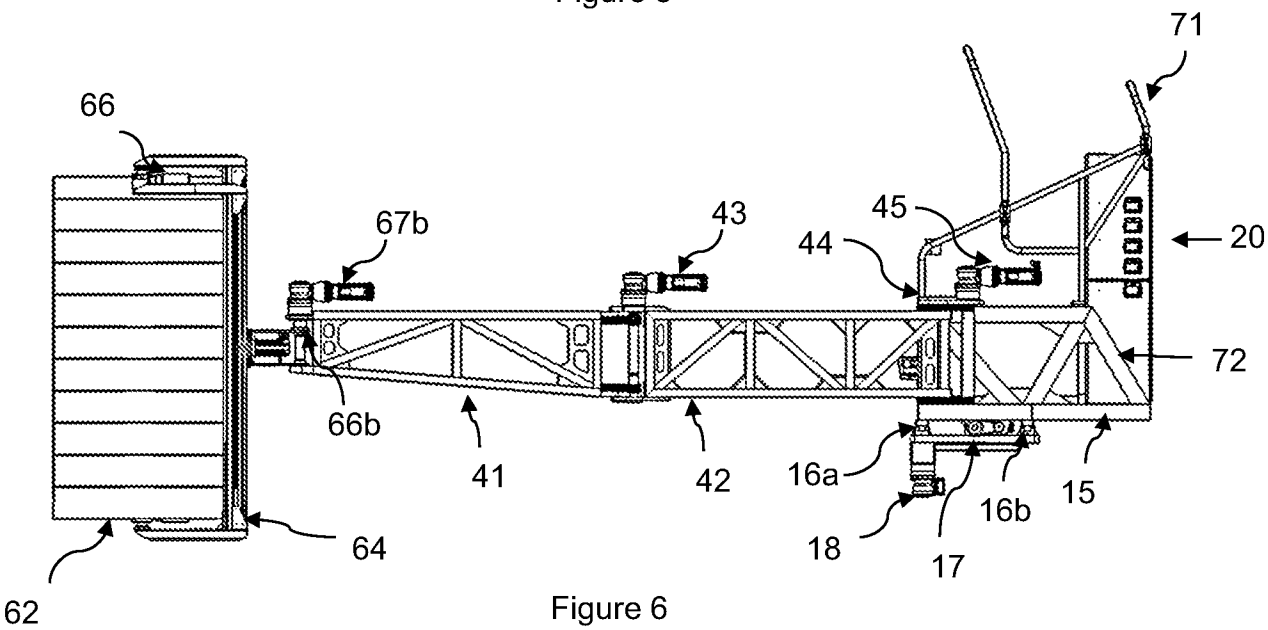

Figure 6

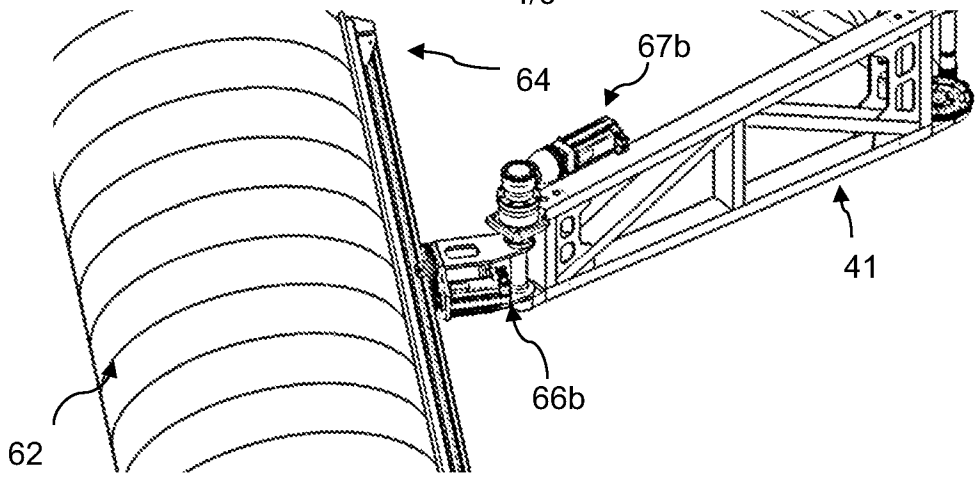

Figure 7

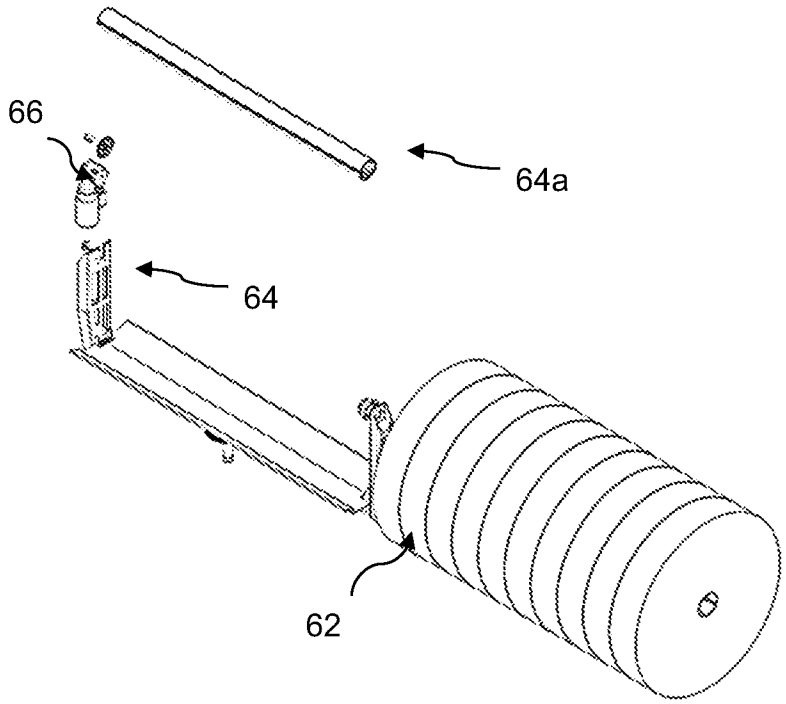

Figure 8

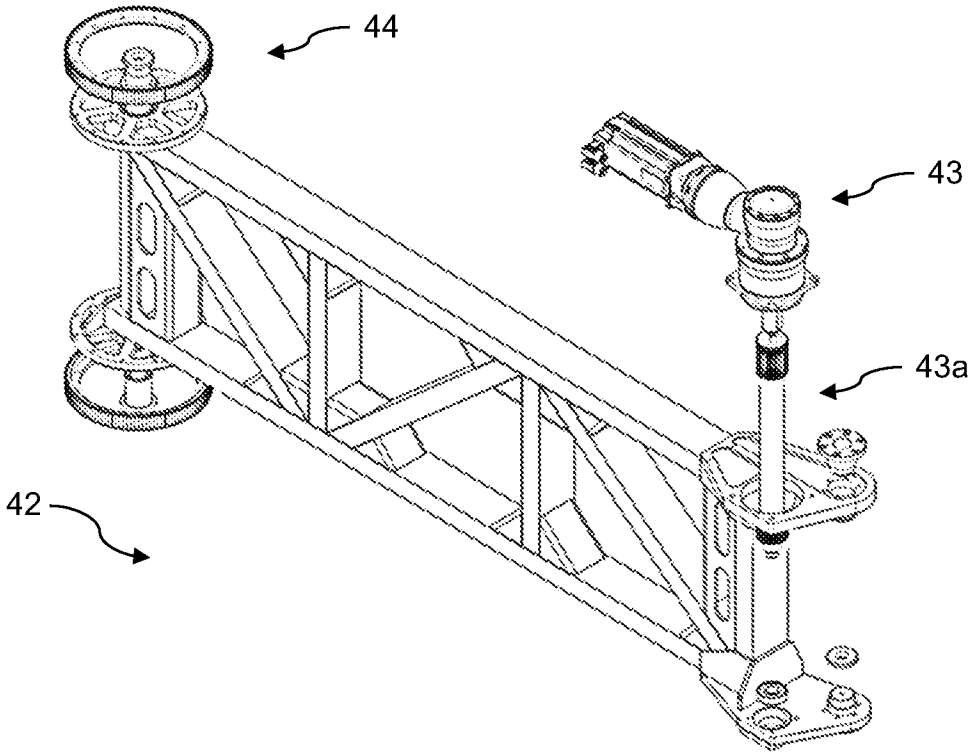

Figure 9

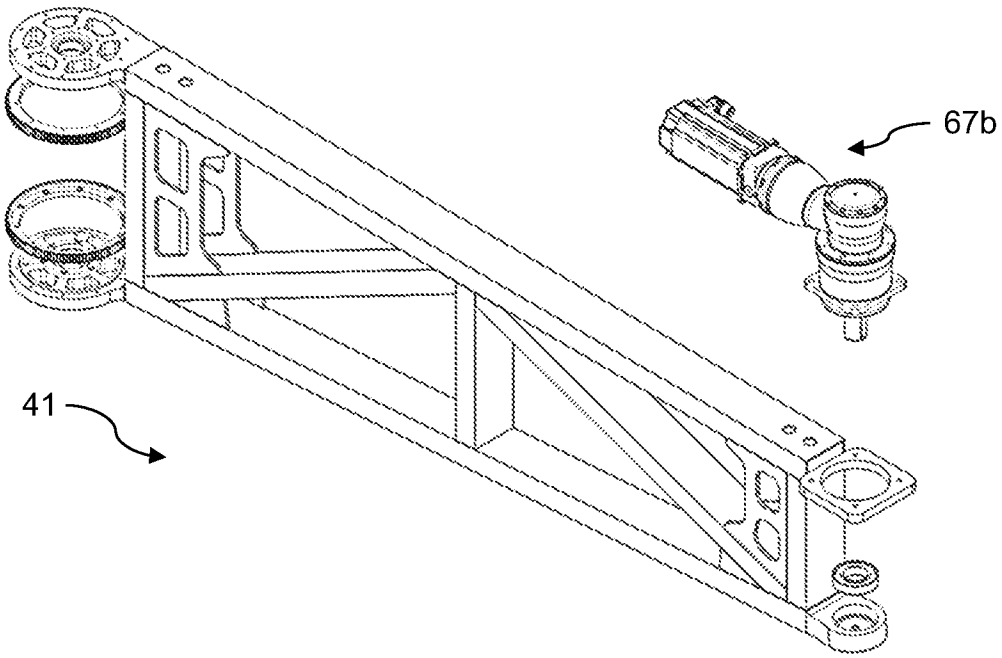

Figure 10

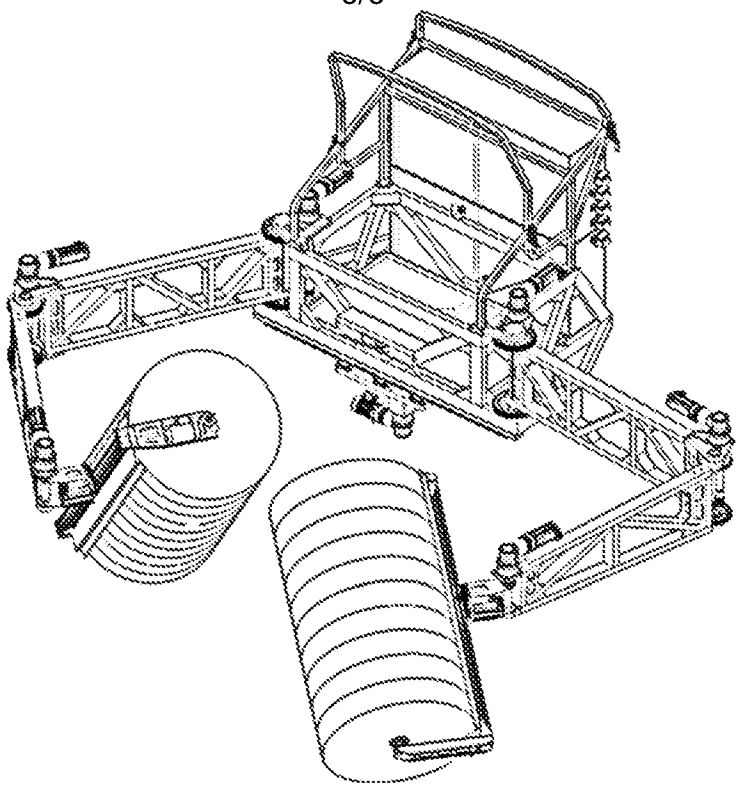

Figure 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/028575

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - E04G 3/28; B66F 11/04; E04G 3/24; E04G 3/30; E04G 3/32; F03D 80/40; F03D 80/50 (2018.01)

CPC - E04G 3/28; B66F 11/04; B66F 11/044; B66F 11/046; E04G 3/24; E04G 3/243; E04G 2003/286; E04G 3/30; E04G 3/305; E04G 3/32; F03D 80/40; F03D 80/50; F03D 80/55 (2018.08)

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)

See Search History document

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

USPC - 182/128; 182/141; 182/142; 182/143; 182/144; 182/150 (keyword delimited)

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

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/0305331 A1 (ROWELL) 06 December 2012 (06.12.2012) entire document	1, 8, 12, 13
---		---
Y		9-11
Y	US 2001/0055525 A1 (INOKUCHI et al) 27 December 2001 (27.12.2001) entire document	9-11
A	US 5,286,159 A (HONMA) 15 February 1994 (15.02.1994) entire document	1-14
A	US 2012/0168252 A1 (BOGAERT) 05 July 2012 (05.07.2012) entire document	1-14
A	US 2012/0325581 A1 (GUNTHER et al) 27 December 2012 (27.12.2012) entire document	1-14

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

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"O" document referring to an oral disclosure, use, exhibition or other means

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 August 2018	24 AUG 2018
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774