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(54) **FLOATING BEARING FOR ELECTRICAL CONNECTORS**

(57) A system for connecting industrial connectors (1) comprises a first industrial connector (1) and a second industrial connector (1), each having a bearing assembly (100, 200). At least one bearing assembly is a floating bearing assembly (100) that allows movement between the industrial connectors in at least one direction different to a mating direction to facilitate alignment during a mating process. The floating bearing assembly (100) includes a housing structure, at least one sliding block (120) movably mounted within the housing structure, at

least one elastic element (160) connected between the housing structure and the sliding block (120), and a connector mounting portion on the sliding block (120) for attaching the industrial connector (1). The elastic element (160) allows controlled movement of the sliding block (120) relative to the housing structure to accommodate misalignments during the mating process while providing a centering force to maintain the industrial connector (1) in a neutral position when not engaged.

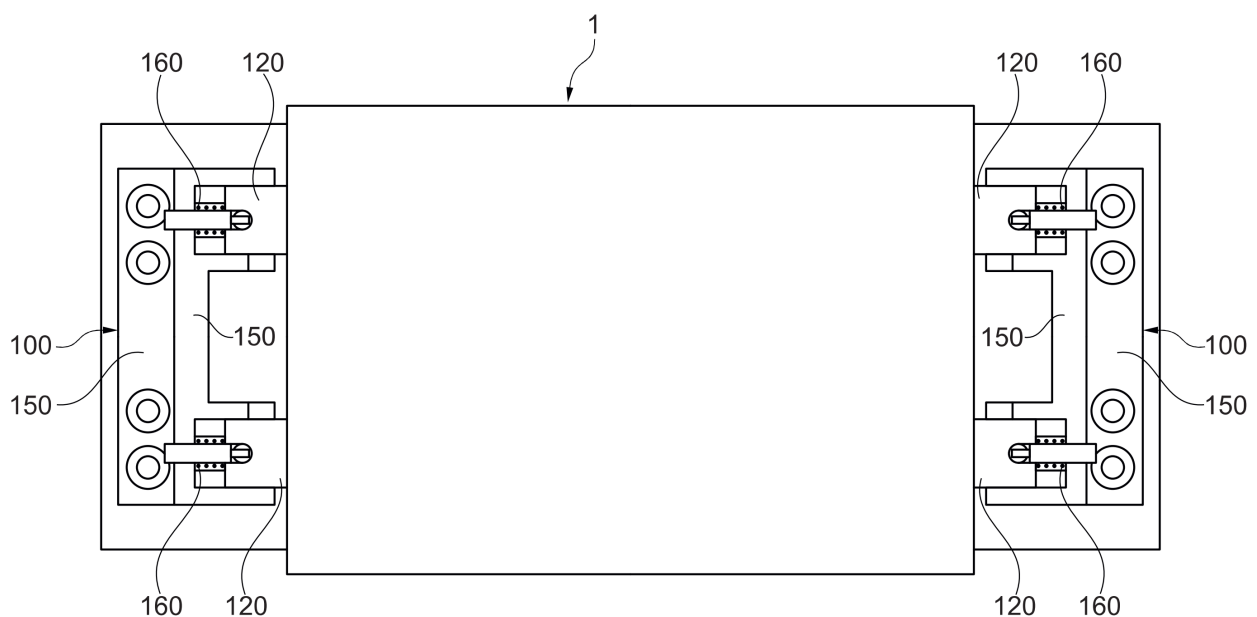


Fig. 10

Description

FIELD OF THE INVENTION

[0001] The present invention relates to industrial connector systems used in various manufacturing and automation applications. Industrial connectors play a crucial role in establishing reliable electrical and data connections between equipment and machinery. These connectors are designed to withstand harsh environmental conditions while maintaining secure and efficient connectivity. Advanced connector systems often incorporate features such as self-aligning mechanisms, environmental sealing, and quick-connect capabilities to improve operational efficiency and reduce downtime during installation and maintenance procedures.

BACKGROUND OF THE INVENTION

[0002] In industrial settings, electrical connectors play a crucial role in establishing connections between devices. However, existing connector designs often face challenges related to environmental exposure and alignment. When not engaged, connector mating faces may be susceptible to contaminants like dust and moisture, potentially leading to degradation of the connection over time. Additionally, many current connector systems rely on manual processes for alignment and protection, which can be inefficient and introduce the possibility of human error.

PRIOR ART

[0003] Existing solutions often lack effective self-alignment capabilities, relying on manual intervention for proper connector engagement. This dependence on user handling increases the risk of misalignment, potentially leading to unreliable connections and higher maintenance costs. The absence of automatic self-alignment mechanisms in these systems can result in incomplete sealing and compromised connection integrity.

[0004] Prior art solutions include electrical connectors with pivotable protective flaps designed for harsh environments. While these connectors offer environmental protection, they often lack sophisticated self-alignment features. The flaps may require manual operation or additional components to open during coupling, complicating the design and potentially hindering the self-alignment process.

[0005] A significant challenge in existing connector designs is achieving precise self-alignment during coupling without excessive complexity. Many systems employ intricate centering mechanisms that, while aiming to improve alignment, often extend the overall coupling length and reduce efficiency.

[0006] The present invention addresses the need for a connector device that incorporates effective self-alignment features. It aims to ensure automatic alignment and

opening of protective covers with minimal insertion force, while maintaining contact protection in an uncoupled state. The invention focuses on facilitating efficient coupling through simplified, yet highly effective self-centering mechanisms.

TASK

[0007] The present invention addresses the need for a system for connecting industrial connectors that facilitates alignment during the mating process, to overcome limitations in prior art solutions by incorporating effective self-alignment capabilities, improving reliability and efficiency in industrial connector applications.

[0008] This is achieved by a system for connecting industrial connectors according to claim 1, a floating bearing assembly for an industrial connector system according to claim 14, and a method of manufacturing the system according to claim 15. Further developments are given in the dependent claims.

SUMMARY OF THE INVENTION

[0009] According to the inventive system, the bearing assembly of the first industrial connector is a floating bearing assembly, and the bearing assembly of the second industrial connector is a fixed bearing assembly. This configuration provides an optimal balance between flexibility and stability in the connection system. The floating bearing assembly allows for small adjustments to accommodate manufacturing tolerances, thermal expansion, or slight misalignments, while the fixed bearing assembly provides a stable reference point. This combination ensures precise alignment during the mating process while still allowing for some degree of movement to prevent stress on the connectors. Alternative implementations could include using two floating bearing assemblies with different degrees of freedom, or incorporating a semi-floating bearing that allows movement in only specific directions.

[0010] In a further preferred embodiment of the inventive system, the floating bearing assembly allows movement between the first industrial connector and the second industrial connector in any direction that is perpendicular to the mating direction. This multi-directional flexibility is crucial for accommodating various types of misalignments that may occur during the mating process. It allows the connectors to self-align in both horizontal and vertical planes perpendicular to the mating axis, ensuring optimal contact even if the mounting surfaces are not perfectly parallel. Alternative designs could include limiting movement to specific axes or incorporating graduated resistance to movement in different directions to prioritize certain alignment aspects.

[0011] In a further preferred embodiment of the inventive system, the floating bearing assembly comprises: a housing structure; at least one sliding block movably mounted within the housing structure; at least one elastic

element connected between the housing structure and the sliding block; and a connector mounting portion on the sliding block for attaching the industrial connector, wherein the elastic element allows controlled movement of the sliding block relative to the housing structure to accommodate misalignments during the mating process while providing a centering force to maintain the industrial connector in a neutral position when not engaged. This design provides a robust and self-centering mechanism for the connector. The sliding block allows for smooth, low-friction movement, while the elastic element ensures that the connector returns to a neutral position when not in use, facilitating subsequent mating operations. The housing structure provides protection and guidance for the internal components. Alternative implementations could use different types of elastic elements such as coil springs, leaf springs, or elastomeric materials, each offering different force characteristics and durability profiles. The sliding block could be replaced with a ball-and-socket joint or a flexible coupling for different movement characteristics.

[0012] In a further preferred embodiment of the inventive system, each industrial connector comprises four sliding blocks arranged symmetrically around the industrial connector, wherein the sliding blocks provide support and guide movement of the industrial connector within the housing structure. This symmetrical arrangement ensures balanced support and movement in all directions, preventing tilting or uneven loading of the connector during the mating process. The use of four sliding blocks provides redundancy and stability, distributing the forces evenly across the connector. Alternative designs could use three sliding blocks in a triangular arrangement for reduced complexity, or more than four for increased stability in high-vibration environments. The sliding blocks could also be integrated with rollers or ball bearings to further reduce friction and wear.

[0013] In a further preferred embodiment of the inventive system, the floating bearing assembly comprises a damping mechanism to reduce vibrations and shock during the mating process. This feature is particularly beneficial in industrial environments where equipment vibrations or sudden movements could affect the connection process. The damping mechanism helps to smooth out the mating action, reducing wear on the connectors and ensuring a more consistent and reliable connection. It also helps to prevent damage from accidental impacts during mating. Alternative implementations could include hydraulic dampers, magnetorheological fluid dampers for adjustable damping characteristics, or elastomeric damping elements integrated into the sliding block design.

[0014] In a further preferred embodiment of the inventive system, the industrial connectors comprise a locking mechanism to secure the connectors in a mated position. This ensures that the connection remains stable and secure even in high-vibration environments or where there might be tension on the cables. The locking me-

chanism prevents accidental disconnection, enhancing the reliability and safety of the electrical connection. Various types of locking mechanisms could be employed, such as bayonet locks, threaded collars, or spring-loaded latches. Alternative designs might include electronic locking mechanisms that can be remotely activated or deactivated, or safety interlocks that prevent disconnection while power is flowing through the connector.

[0015] In a further preferred embodiment of the inventive system, the industrial connectors comprise a protective cover movable between an open position and a closed position to protect electrical contacts when the connectors are not mated. This feature significantly enhances the durability and reliability of the connectors by shielding the sensitive electrical contacts from dust, moisture, and physical damage when not in use. The movable cover design allows for easy access during mating while ensuring protection at other times. Alternative implementations could include sliding covers, iris-style covers, or multiple overlapping protective flaps. The cover material could be selected for specific environmental resistances, such as corrosion-resistant metals or high-impact plastics.

[0016] In a further preferred embodiment of the inventive system, the protective cover is automatically actuated by the mating process. This automation simplifies the connection process, reducing the risk of operator error and ensuring that the protective cover is always opened during mating and closed when unmated. It eliminates the need for manual intervention, speeding up the connection process and improving reliability. The automatic actuation could be achieved through mechanical linkages, spring-loaded mechanisms, or cam systems that interact during the mating process. Alternative designs might include electrically actuated covers or covers that respond to the presence of the mating connector through proximity sensors.

[0017] In a further preferred embodiment of the inventive system, the industrial connectors comprise a sealing mechanism to provide environmental protection when mated. This feature is crucial for maintaining the integrity of the electrical connection in harsh industrial environments where dust, moisture, or corrosive substances may be present. The sealing mechanism ensures that the connection remains protected even when the protective covers are open during mating. Various sealing technologies could be employed, such as O-rings, gaskets, or labyrinth seals. Alternative implementations might include pressurized sealing systems, gel-based sealants that flow into gaps, or adaptive sealing materials that respond to environmental conditions.

[0018] In a further preferred embodiment of the inventive system, the industrial connectors comprise alignment features to ensure proper orientation during the mating process. These features prevent incorrect mating orientations, reducing the risk of damage to the connectors and ensuring that the correct contacts are always aligned. Alignment features can simplify and speed up

the mating process, especially in low-visibility conditions. Common alignment features include keying systems, guide pins, or asymmetrical connector shapes. Alternative designs might incorporate optical alignment systems, magnetic guidance, or RFID-based positioning to assist in proper orientation, especially for complex multi-pin connectors.

[0019] In a further preferred embodiment of the inventive system, the floating bearing assembly comprises adjustable tension elements to modify the centering force applied to the industrial connector. This adjustability allows the system to be fine-tuned for different connector weights, cable tensions, or environmental conditions. It ensures optimal performance across a range of applications and can compensate for wear over time. The adjustable tension could be implemented through threaded spring adjusters, replaceable elastic elements of different strengths, or even active electronic control systems. Alternative approaches might include self-adjusting systems that respond to the force applied during mating, or preset configurations that can be easily switched for different operating conditions.

[0020] In a further preferred embodiment of the inventive system, the industrial connectors comprise a power transmission interface and/or a data transmission interface and/or a signal transmission interface. This versatility allows the connector system to handle both power and data transmission, making it suitable for a wide range of industrial applications. The combination of power and data in a single connector can simplify wiring and reduce the number of connection points needed in a system. For power transmission, the connector could be designed to handle various voltage and current ratings. The data transmission interface could support different protocols such as Ethernet, CAN bus, or fiber optic signals. Alternative designs might include modular connectors where power and data modules can be combined as needed, or advanced connectors with built-in signal conditioning or power management capabilities. A signal transmission interface can preferably be used for applications where signals without protocols are common (e.g. UIC Train interface for an application in trains).

The Figures depict:

[0021]

- Figure 1 shows a perspective view of the system, illustrating one of the industrial connectors 1, with its connector housing 5, linear guide 3, actuation unit 41 and centering unit 42.
- Figure 2 shows a detailed view of industrial connector 1, in an almost closed (unmated) position. The spring force F is indicated.
- Figure 3 shows a detailed view of industrial connector 1, in the same position as in Fig. 2. The

mating direction A is indicated.

- Figure 4 shows the movement of the protective cover 2 around the pivot joint 6 due to the pin 51 and actuation surface 21, while guided along the linear guide 3.
- Figure 5 shows the stop 43 that prevents over-opening around the pivot joint 6 of the protective cover 2.
- Figure 6 shows a further embodiment of the industrial connector 1 with a fine centering unit comprising a fine centering pin 61 and a fine centering opening 62.
- Figure 7 shows an isometric view of two opposing industrial connectors 1 with actuation units 41, centering units 42, and vehicle connections 150.
- Figure 8 shows a side view of sliding blocks 120, elastic elements 160, and vehicle connections 150 in a linear configuration.
- Figure 9 shows an isometric view of elastic elements 160 and sliding blocks 120 arranged in a linear pattern.
- Figure 10 shows a top view of an industrial connector 1 with two floating bearings 100 and elastic elements 160.
- Figure 11 shows an isometric view of multiple industrial connectors 1 with floating bearing 100 and fixed bearing 200 assemblies.

[0022] Fig. 1 illustrates one of the industrial connectors 1 of a system for mating and unmating a mating face of a connector 1. The system consists of two of said industrial connectors 1 (merely one shown here), wherein the actuation unit 41 of the first industrial connector 1 faces and touches the centering unit 42 of the second industrial connectors 1, wherein the actuation unit 41 of the second industrial connector 1 faces and touches the centering unit 42 of the first industrial connector 1.

[0023] The industrial connector 1 includes a connector housing 5 designed to hold the linear guide 3 as well as the pin 51 (not shown here). Both are fixed to the housing 5. The pin 51 can preferably but optionally be integral with the housing 5.

[0024] The pivot joint 6 can move along the linear guide 3 (along the left-right direction of the view in Fig. 1), wherein the protective cover 2 is pivotally fixed to the pivot joint 6 in order to open and close the protective cover 2 with respect to the industrial connector 1. When a force is acting on the actuation unit 41 and/or the centering unit 42 from the right to the left (according to the view in Fig. 1),

both the actuation unit 41 and the centering unit 42 are moved to the left, along the linear guide 3. Furthermore, by that movement, the protective cover 2 is pivotally opened and moved to the left as well, as will be explained in the next figures.

[0025] The linear guide 3 provides precise movement control for the components, ensuring alignment during the mating process (coupling process). The protective cover 2 serves to protect the internal components, especially the contacts 7 (covered by the protective cover 2 so cannot be seen in Fig. 1) on the mating face when the industrial connector 1 is in an unmated state (closed).

[0026] Fig. 2 provides a closer view of the system. The protective cover 2 is shown in an almost closed (unmated) position. The spring force F is acting on the pivot joint 6 along the linear guide 3, from the right to the left (according to Fig. 2) so that the protective cover 2, that is pivotally fixed to the pivot joint 6, is forced to the left as well. However, with the surface of the protective cover 2, especially with the surface of its actuation surface 21 and its guide surface 23, the protective cover 2 is in contact with the pin 51 that is fixed to the connector housing 5 or is an integrally molded part of it.

[0027] Furthermore, the pivot joint 6 with the protective cover 2 is movable relatively to the housing 5, along the left-right-direction of Fig. 2 (parallel to the mating direction as well as to the spring force acting direction F).

[0028] When the pivot joint 6 with the protective cover 2 is moving relatively to the housing 5 (along the left-right-direction of Fig. 2), the actuation surface 21 and guide surface 23 of the protective cover 2 are in surface contact (respectively meshing contact) with the pin 51 that is fixed to the connector housing 5 or an integrally molded part of it. Thereby, the protective cover 2 is forced to move relatively to the connector housing 5 via the following movements:

A. Rotational or pivotal movement around the pivot joint 6

B. Translational movement along the left-right-direction of Fig. 2 (parallel to the plug/mating direction as well as the spring force acting direction F)

[0029] Both movements take place simultaneously and are superimposed.

[0030] In a completely closed (unmated) position, the actuation surface 21 and guide surface 23 interact with the pin 51 to maintain the cover's 2 position, preventing unwanted opening.

[0031] Fig. 3 shows the same view as Fig. 2, wherein the mating direction (plug direction) A is indicated. In this direction (which is parallel to the force acting direction F as shown in Fig. 2) both industrial connectors 1 of the system are moving against each other, coming into contact, to be connected and mated.

[0032] Fig. 4 illustrates how the protective cover 2 moves as guided by the pin 51 and the actuation surface

21 and guide surface 23. This movement is crucial for ensuring that the cover 2 opens and closes smoothly, reducing mechanical stress and wear on the components.

[0033] Furthermore, the contacts 7, that were covered in the foregoing figures, emerge.

[0034] Fig. 5 demonstrates the role of the stop 43 in preventing the over-opening of the protective cover 2. This feature ensures that the cover 2 remains in a defined fully opened position, providing stability and preventing damage to the cover 2 or other components during operation.

[0035] The stop 43 does not perform the movement A (rotating) as defined with regard to Fig. 2, but does perform the movement B (translating). Thus, the protective cover 2 is relatively movable against the stop 43. The shapes of the protective cover 2 as well as the protective cover 2 are configured in a way that they are coming in contact when the cover 2 comes to its fully opened position. Both (protective cover 2 and stop 43) thus block any further rotational movement in relation to each other.

[0036] Fig. 6 shows a further embodiment of an industrial connector 1 of a system with an improved centering performance. The connector 1 comprises a fine centering unit with a fine centering pin 61 and a fine centering opening 62. The remaining features of this embodiment correspond to those of the other embodiment as illustrated and described with reference to Figs. 1 to 5.

[0037] The fine centering pin 61 protrudes parallelly and into the same direction (mating direction) as the actuation unit 41 and is configured to be inserted into a fine centering opening 62 of another corresponding connector 1 during the mating process (coupling process).

[0038] Analogous to this, the fine centering opening 62 is configured to be entered by a fine centering pin 61 of another corresponding connector 1 during the mating process (coupling process). Furthermore, the fine centering opening 62 is configured to accommodate said fine centering pin 61.

[0039] Fig. 7 shows a side view of an industrial connector assembly, illustrating the arrangement of components along a mating direction. The assembly includes two industrial connectors 1 positioned opposite each other, with only one connector 1 shown in this figure. Each industrial connector 1 incorporates an actuation unit 41 and a centering unit 42 that protrude outward in the mating direction. These units are arranged to interact with their corresponding counterparts during the mating process, ensuring precise alignment and engagement.

[0040] The assembly features fine centering elements, including centering pins 61 and centering openings 62. These components are strategically positioned to provide precise alignment when the industrial connectors 1 are brought together. During engagement, the centering pins 61 align with the centering openings 62 of the opposing connector, facilitating a smooth and accurate connection process. This fine centering mechanism en-

hances the overall reliability of the connection by minimizing the risk of misalignment.

[0041] Vehicle connections 150 are distributed at specific points along the assembly, providing robust mounting points for system integration. These connections ensure that the industrial connectors 1 remain securely positioned within the larger system, contributing to the overall stability and reliability of the electrical connection.

[0042] The assembly forms part of a floating bearing 100 system that enables proper mechanical connectivity between the industrial connectors 1.

[0043] This floating bearing 100 mechanically connects the industrial connector 1 with the vehicle connection 150, allowing for slight movements and adjustments to accommodate manufacturing tolerances, thermal expansion, and angled or offset alignment between the industrial connectors during the mating process. This flexibility is crucial for maintaining optimal contact pressure and alignment in various operating conditions and mating scenarios.

[0044] The floating bearing 100 could be implemented using various mechanisms, such as a ball-and-socket joint or a flexible coupling. These mechanisms would allow for small degrees of movement in multiple axes, ensuring that the connectors can align properly even if there are slight misalignments in the mounting structure. This feature is particularly important in applications where vibration or thermal cycling could cause slight shifts in component positions over time.

[0045] Fig. 8 presents a side view of one industrial connector 1 of a connector assembly, showcasing the internal arrangement of components in a linear configuration. The floating bearing 100 incorporates sliding blocks 120 positioned at specific intervals along the structure. These sliding blocks 120 serve as mounting points for the industrial connectors 1, allowing for controlled movement along the assembly.

[0046] Multiple elastic elements 160 are arranged in a systematic pattern throughout the assembly, extending through designated positions. These elastic elements 160 play a crucial role in maintaining proper tension and alignment within the system. They could be implemented as springs, elastomeric materials, or other flexible components that provide both support and adaptability to the assembly.

[0047] The elastic elements 160 are distributed in a symmetrical arrangement, passing through the structure at regular intervals. This symmetrical distribution ensures balanced forces throughout the assembly, contributing to the overall stability and reliability of the connection system. The elastic nature of these elements allows for some degree of movement and shock absorption, which can be beneficial in environments subject to vibration or sudden movements.

[0048] Vehicle connections 150 are integrated at specific points along the assembly, providing structural support and maintaining proper positioning of the components during operation. These connections serve as

anchor points, ensuring that the assembly remains securely attached to the vehicle or equipment while still allowing for the controlled movement provided by the sliding blocks 120 and elastic elements 160.

[0049] The industrial connector 1 is held by the sliding blocks 120, allowing it to move up and down (with reference to Fig. 8) in relation to the vehicle connections 150. This vertical movement capability is crucial for accommodating manufacturing tolerances, thermal expansion, and potential misalignments during the mating process. It ensures that the connectors can engage properly even if there are slight variations in the mounting positions or dimensions of the mating components.

[0050] Fig. 9 shows an isometric view of a connector system illustrating the arrangement of mechanical components. The view displays multiple elastic elements 160 arranged in a linear configuration along the connector assembly. These elastic elements 160 could be implemented as springs or flexible materials, providing mechanical flexibility.

[0051] Sliding blocks 120 are positioned at specific intervals, serving as support and guide structures for the elastic elements 160. The arrangement shows how the elastic elements 160 are integrated with the sliding blocks 120 in a systematic pattern, with the elastic elements 160 extending through the structure at designated locations. This integration ensures consistent spacing and alignment throughout the connector system, contributing to reliable mechanical connections.

[0052] The design demonstrates a symmetrical arrangement of elastic elements 160 and sliding blocks 120, which is crucial for maintaining uniform pressure and mechanical performance across all connection points. This symmetry also helps in evenly distributing mechanical stresses, potentially extending the lifespan of the components.

[0053] The sliding blocks 120 are integrated into the structure to provide stable mounting points for the elastic elements 160. They could be made of a durable, low-friction material to facilitate smooth movement while maintaining precise positioning. This combination of rigid support (sliding blocks) and flexible connectivity (elastic elements) allows the system to adapt to small misalignments or dimensional changes while maintaining reliable mechanical connection. The vehicle connections 150 and the connector are shown transparent in this isometric view, allowing visibility of the internal components.

[0054] Fig. 10 illustrates a section view of a connector assembly, showcasing the arrangement of components along a linear configuration. The view displays only one industrial connector 1 (simplified as a rectangle), which is equipped with two floating bearings 100. These floating bearings 100 allow the industrial connector 1 to move from left to right (according to Fig. 10) and vice versa, providing a degree of flexibility in the connection system.

[0055] The elastic elements 160 play a crucial role in this assembly, ensuring that the industrial connector 1 is held in a middle position when not engaged. This center-

ing function is important for maintaining proper alignment and facilitating smooth engagement during the mating process. The elastic elements 160 could be implemented as springs or other flexible components that provide both positioning force and the ability to accommodate movement.

[0056] Multiple sliding blocks 120 are arranged in a systematic pattern along the assembly. These sliding blocks 120 are positioned at specific intervals between the industrial connectors 1, providing support and guiding the movement of the connector. The sliding blocks 120 could be made of a low-friction material to ensure smooth operation and minimal wear over repeated mating cycles.

[0057] The arrangement demonstrates how the sliding blocks 120 and elastic elements 160 are integrated between the industrial connectors 1. This integration allows for controlled movement while maintaining proper alignment and contact pressure. The vehicle connections 150 secure the industrial connectors 1 in position within the larger system or vehicle structure.

[0058] The floating bearing 100 system enables proper mechanical connection between components while allowing for small adjustments to accommodate manufacturing tolerances or thermal expansion. This flexibility is crucial for maintaining optimal contact and alignment in various operating conditions. The floating bearings 100 could be implemented using various mechanisms such as ball joints or flexible couplings, allowing movement in multiple axes to ensure proper mating even with slight misalignments.

[0059] Fig. 11 presents an isometric view of a connector system arrangement comprising two industrial connectors 1 positioned in a linear configuration. The system includes components of both a floating bearing 100 and a fixed bearing 200 assembly, showcasing a hybrid approach to connector mounting.

[0060] The industrial connectors 1 are arranged with protruding actuation units 41 and centering units 42 extending outward in the mating direction. These units are strategically positioned to enable proper alignment and engagement during connector mating operations. The actuation units 41 and centering units 42 could have complementary shapes, such as conical or tapered designs, to guide the connectors into proper alignment as they are brought together.

[0061] Centering pins 61 are integrated into the assembly structure, providing additional alignment features for the connection system. These centering pins 61 work in conjunction with the actuation and centering units to ensure precise mating of the connectors. They could be made of a durable, low-friction material to withstand repeated mating cycles while maintaining accuracy.

[0062] Vehicle connections 150 are distributed at specific intervals along the assembly, providing mounting points for system integration. These connections ensure that the connector assembly is securely attached to the vehicle or equipment structure while maintaining proper positioning and alignment of the industrial connectors 1.

[0063] The arrangement demonstrates how the industrial connectors 1 are positioned relative to each other, with the actuation units 41 and centering units 42 oriented to facilitate proper mechanical engagement. The floating bearing 100 and fixed bearing 200 assemblies work together to provide the necessary support and alignment for the connector system. This combination of floating and fixed bearings allows for a balance between flexibility and stability in the mounting system.

[0064] The floating bearing 100 allows for small adjustments in multiple axes, accommodating slight misalignments or dimensional changes due to thermal expansion or manufacturing tolerances. The fixed bearing 200, on the other hand, provides a stable reference point for the system, ensuring that the overall alignment is maintained while still allowing for the controlled flexibility provided by the floating bearing.

[0065] The combination of an industrial connector 1 with a fixed bearing 200 and another industrial connector 1 with a floating bearing 100 ensures that, during the coupling process, automatic centering can be performed. This hybrid approach allows for precise alignment and engagement of the connectors while accommodating small variations in mounting positions or component dimensions.

[0066] This arrangement could be particularly beneficial in applications where the connectors need to mate frequently or where environmental factors such as vibration or temperature fluctuations could affect alignment over time. The system's ability to self-center and adjust ensures reliable connections even under challenging conditions.

Further disclosures:

[0067] According to an aspect of the disclosure, a system comprising a first and a second industrial connector, both industrial connectors having a protecting unit for protecting a mating face of the industrial connector in an unmated state as well as for unmasking the mating face of the industrial connector in a mated state, wherein each mating face has at least one electrical contact, each protecting unit comprises a protective cover that is movable between a position referring to the mated state and a position referring to the unmated state; each protecting unit comprises an actuation and centering unit, with both the actuation unit and the centering unit protruding in a respective mating direction; each protecting unit comprises a spring-assisted mechanism designed to hold the protective cover on the mating face of the industrial connector by spring force in the unmated state, to protect the at least one contact of the industrial connector, and to enable opening and closing of the protective cover when the actuation and centering unit is subjected to an actuating force, wherein the system is designed such that, when the first and the second industrial connectors are moved towards each other in the mating direction, the actuating force acts between the actuation unit of the first industrial

connector and the centering unit of the second industrial connector and vice versa.

[0068] The technical advantage of this embodiment lies in providing robust protection for the connectors' mating faces when disconnected, preventing environmental damage such as dust and moisture ingress. The automatic alignment feature reduces manual handling errors, ensuring a secure and reliable connection every time, which is crucial for maintaining high performance in industrial environments.

[0069] A further technical advantage of this system is that it ensures efficient and reliable mating while maintaining protection of the contacts in an unmated state. Furthermore, Ingress Protection (IP-Protection) for the connectors in the unmated state is ensured.

[0070] According to a preferred embodiment of the disclosure, the system comprises a spring-assisted mechanism of the protecting unit that includes an actuation surface on the protective cover, a guide surface on the protective cover, a linear guide for guiding in the mating direction, a pivot joint to enable a rotational movement of the protective covers, a stop to block the rotational movement of the protective cover in a fully open position, wherein the actuation surface and guide surface of the protective cover are configured to act as a guiding area of a cam guide.

[0071] Furthermore, according to a preferred embodiment of the disclosure, the system comprises a spring-assisted mechanism of the protecting unit that includes an actuation surface on the protective cover, a guide surface on the protective cover, a linear guide for guiding in the mating direction, a pivot joint to enable a rotational movement of the protective covers, wherein the actuation surface and guide surface of the protective cover are configured to act as a guiding area of a cam guide.

[0072] The technical advantage of the above mentioned embodiments is that it ensures smooth and controlled movement of the protective cover during the mating process. The integration of a cam guide mechanism facilitates precise movement, reducing wear and tear on components and enhancing the durability of the system. This precision also minimizes the risk of mechanical failure, thereby extending the operational lifespan of the connectors. Furthermore, according to the above mentioned embodiments, no external control units and/or external power supply and/or pressed air and/or hydraulic oil is required.

[0073] According to a preferred embodiment of the disclosure, the system comprises a protecting unit that is either integrally molded with a housing of the respective industrial connector, or not integrally molded with the housing of the respective industrial connector, wherein, whether or not integrally molded, the housing has a pin for being a counterpart for the guiding area of the cam guide. The technical advantage of this embodiment is the flexibility in manufacturing and assembly, allowing for customization to specific application needs. By offering both integrally molded and separate options, the design can

be adapted to various industrial standards and requirements, facilitating easier integration and maintenance.

[0074] According to a preferred embodiment of the disclosure, the protecting unit or the housing of the system comprise a fine centering pin protruding in the mating direction, and a fine centering opening, wherein the system is designed that, when the first and the second industrial connectors are moved towards each other in the mating direction, the fine centering pin of the first industrial connector enters the fine centering opening of the second industrial connector and vice versa.

[0075] The technical advantage of this embodiment is a significantly improved centering performance.

[0076] According to a preferred embodiment of the disclosure, the system comprises a spring-assisted mechanism constructed such that the protective cover is pressed into the unmated position when no mating process takes place; and/or the respective pivot joint enables a rotational movement of the respective protective cover, allowing it to open and close automatically with minimal insertion.

[0077] The technical advantage of this embodiment is the automation of the protective cover, which significantly reduces the need for manual intervention. This automation enhances operational efficiency and reduces the potential for human error, thereby ensuring that the connectors are consistently protected and aligned, ultimately improving the reliability and safety of the electrical connection.

[0078] According to a preferred embodiment of the disclosure, the system defines that the actuation unit of the first industrial connector and the centering unit of the second industrial connector as well as the actuation unit of the second industrial connector and the centering unit of the first industrial connector having a conical shape fitting into each other, thereby ensuring precise centering of the industrial connectors during the mating process.

[0079] The technical advantage of this embodiment is the enhanced precision in alignment provided by the conical shapes, which guide the connectors into perfect alignment during mating. This precision minimizes the risk of misalignment, which can cause poor electrical contact or mechanical stress, thereby ensuring stable and efficient connections critical for industrial applications.

[0080] According to a preferred embodiment of the disclosure, the system comprises industrial connectors designed to allow mechanical locking between each other in the coupled state.

[0081] The technical advantage of this embodiment is the increased security and stability of the connection once engaged, preventing accidental disconnection. This mechanical locking feature is vital for applications where vibrations or dynamic forces are present, ensuring that the connection remains intact under various operational conditions.

[0082] According to a preferred embodiment of the disclosure, the system comprises a spring-assisted me-

chanism that includes an adjustable spring force that can be adapted to different operating conditions.

[0083] The technical advantage of this embodiment is the adaptability to various environmental conditions, allowing the system to maintain consistent performance across different applications. The adjustable spring force caters to different stress levels, ensuring that the protective mechanisms remain effective and reliable, regardless of the specific operational demands.

[0084] According to a preferred embodiment of the disclosure, the system defines that the actuation unit and the centering unit both having the same extension in the mating direction, thereby minimizing the plug path and the total extension of the industrial connector in the mating direction.

[0085] The technical advantage of this embodiment is the compact design, which reduces space requirements and facilitates easier installation in confined spaces. This compactness enhances the system's versatility, making it suitable for a broader range of industrial applications where space is at a premium.

[0086] Moreover, the embodiment ensures that the protective covers open with minimal insertion when enabling the connectors to be mated.

[0087] The expression "with minimal insertion" refers to the design feature of the system and/or the industrial connectors and/or the protection unit that allows the protective covers to open with a very short or reduced insertion path of the industrial connectors. This means that the industrial connectors can engage with each other efficiently and quickly, requiring less physical movement to transition from a unmated/protected state to a mated/-coupled state. This feature minimizes wear on components and enhances the speed and reliability of the coupling process.

[0088] Moreover, by minimizing the insertion path required to open the protective covers, the device reduces wear and tear, enhancing the longevity and maintenance efficiency of the connectors. The integration of actuation and centering units further streamlines the coupling process, ensuring precise alignment and engagement, which is critical for maintaining stable and continuous electrical connections.

[0089] According to a preferred embodiment of the disclosure, an industrial connector for use in a system according to the above mentioned system is separately disclosed, standing alone, with any of the above mentioned features or a technically reasonable selection of these.

[0090] The technical advantage of this embodiment is the versatility of the connector, allowing it to be used in a wide range of systems and applications. This adaptability ensures that the connector can be integrated into existing systems with minimal modification, providing a cost-effective solution for upgrading industrial connections.

[0091] According to a preferred embodiment of the disclosure, a protecting unit for use in an above mentioned system or in an above mentioned industrial con-

necter is separately disclosed, standing alone, with any of the above mentioned features or a technically reasonable selection of these.

[0092] The technical advantage of this embodiment is the standalone functionality of the protecting unit, enabling it to be integrated into existing systems without extensive modifications. This feature allows for easy retrofitting of existing systems, improving their protection and alignment capabilities without significant investment.

[0093] According to a preferred embodiment of the disclosure, a protecting unit is configured to accommodate a housing.

[0094] The technical advantage of this embodiment is the seamless integration with the housing, enhancing structural stability and protection. This integration ensures that the protecting unit fits securely and operates efficiently within the connector system, providing robust environmental shielding and mechanical support.

[0095] According to a preferred embodiment of the disclosure, a spring-assisted mechanism for use in an above mentioned system or in an above mentioned industrial connector or in an above mentioned protecting unit is separately disclosed, standing alone, with any of the above mentioned features or a technically reasonable selection of these.

[0096] The technical advantage of this embodiment is the improved mechanism design that enhances ease of use and reliability in various configurations. The spring-assisted mechanism provides consistent performance, reducing wear on components and ensuring long-term durability and effectiveness across multiple applications.

[0097] The present disclosure relates to a system composed of several components, which are functional both in combination and in isolation.

[0098] The industrial connector is preferably a standalone module within the system, designed to enable reliable electrical connections. The industrial connector can be used independently of the entire system to function autonomously in various industrial applications.

[0099] The protecting unit is preferably integrated into the industrial connector but can also act as an independent component. It provides protection for the electrical contacts and can be incorporated into other systems requiring similar protection without necessitating the entire industrial connector.

[0100] The spring-assisted mechanism is a versatile element preferably integrated into the system, the industrial connector, and/or the protecting unit. Its functionality extends to applications requiring spring-assisted mechanics. It also can be used in isolation to support movements or regulate forces, independent of the other components.

[0101] This modular design ensures that each component of the invention can be employed both in conjunction and as an individual element, allowing for flexible adaptation to various technical requirements. Therefore, the application also discloses the above mentioned elements in isolated form.

Reference Numbers

[0102]

1	Industrial Connector
2	Protective cover
3	Linear guide
5	Housing
6	Pivot joint
7	Electrical contacts / mating face
10	Protecting unit
21	Actuation surface
23	Guide surface
41	Actuation unit
42	Centering unit
43	Stop
51	Pin
61	Fine centering pin
62	Fine centering opening
100	Floating bearing
120	Sliding block
150	Vehicle connection
160	Elastic element
200	Fixed bearing
A	Mating direction
F	Spring force
M	Spring-assisted mechanism

Claims

1. A system for connecting industrial connectors (1), comprising:
 - a first industrial connector (1) and a second industrial connector (1), wherein
 - each industrial connector (1) has a bearing assembly (100, 200), wherein
 - at least the bearing assembly (100, 200) of the first industrial connector (1) or the bearing assembly (100, 200) of the second industrial connector (1) is a floating bearing assembly (100), wherein
 - the at least one floating bearing assembly (100) allows movement between the first industrial connector (1) and the second industrial connector (1) in at least one direction that is different to a mating direction to facilitate alignment during a mating process.
2. The system of claim 1, wherein the bearing assembly (100) of the first industrial connector (1) is a floating bearing assembly (100), and the bearing assembly (200) of the second industrial connector (1) is a fixed bearing assembly (200).
3. The system of claim 1 or 2, wherein the floating bearing assembly (100) allows movement between the first industrial connector (1) and the second in-

dustrial connector (1) in any direction that is perpendicular to the mating direction.

4. The system according to any of claims 1 to 3, wherein the floating bearing assembly (100) comprises:
 - a housing structure;
 - at least one sliding block (120) movably mounted within the housing structure;
 - at least one elastic element (160) connected between the housing structure and the sliding block (120); and
 - a connector mounting portion on the sliding block (120) for attaching the industrial connector (1),
 - wherein the elastic element (160) allows controlled movement of the sliding block (120) relative to the housing structure to accommodate misalignments during the mating process while providing a centering force to maintain the industrial connector (1) in a neutral position when not engaged.
5. The system according to any of claims 1 to 4, wherein each industrial connector (1) comprises four sliding blocks (120) arranged symmetrically around the industrial connector (1), wherein the sliding blocks (120) provide support and guide movement of the industrial connector (1) within the housing structure.
6. The system according to any of claims 1 to 5, wherein the floating bearing assembly (100) comprises a damping mechanism to reduce vibrations and shock during the mating process.
7. The system according to any of claims 1 to 6, wherein the industrial connectors (1) comprise a locking mechanism to secure the connectors in a mated position.
8. The system according to any of claims 1 to 7, wherein the industrial connectors (1) comprise a protective cover (2) movable between an open position and a closed position to protect electrical contacts (7) when the connectors (1) are not mated.
9. The system according to claim 8, wherein the protective cover (2) is automatically actuated by the mating process.
10. The system according to any of claims 1 to 9, wherein the industrial connectors (1) comprise a sealing mechanism to provide environmental protection when mated and/or when unmated.
11. The system according to any of claims 1 to 10, wherein the industrial connectors (1) comprise alignment features to ensure proper orientation during the

mating process.

12. The system according to any of claims 1 to 11, wherein the floating bearing assembly (100) comprises adjustable tension elements (160) to modify the centering force applied to the industrial connector (1). 5
13. The system according to any of claims 1 to 12, wherein the industrial connectors (1) comprise a power transmission interface and/or a data transmission interface and/or a signal transmission interface. 10
14. A floating bearing assembly (100) for an industrial connector system, comprising: 15
 - a housing structure;
 - at least one sliding block (120) movably mounted within the housing structure;
 - at least one elastic element (160) connected between the housing structure and the sliding block (120); and 20
 - a connector mounting portion on the sliding block (120) for attaching an industrial connector (1), 25
 - wherein the elastic element (160) allows controlled movement of the sliding block (120) relative to the housing structure in at least one direction that is different to a mating direction (A) of the industrial connector (1), and 30
 - wherein the elastic element (160) provides a centering force to maintain the industrial connector (1) in a neutral position when not engaged. 35
15. A method of manufacturing the system according to any of claims 4 to 13, or a method of manufacturing the floating bearing assembly (100) according to claim 14, comprising the steps of: 40
 - assembling the floating bearing assembly (100) with the sliding blocks (120) and elastic elements (160);
 - mounting the industrial connectors (1) to the floating bearing assembly (100); and optionally 45
 - comprising the steps of:
 - positioning the housing structure;
 - inserting the sliding block (120) into the housing structure; 50
 - connecting the elastic element (160) between the housing structure and the sliding block (120);
 - attaching the industrial connector (1) to the connector mounting portion on the sliding block (120). 55

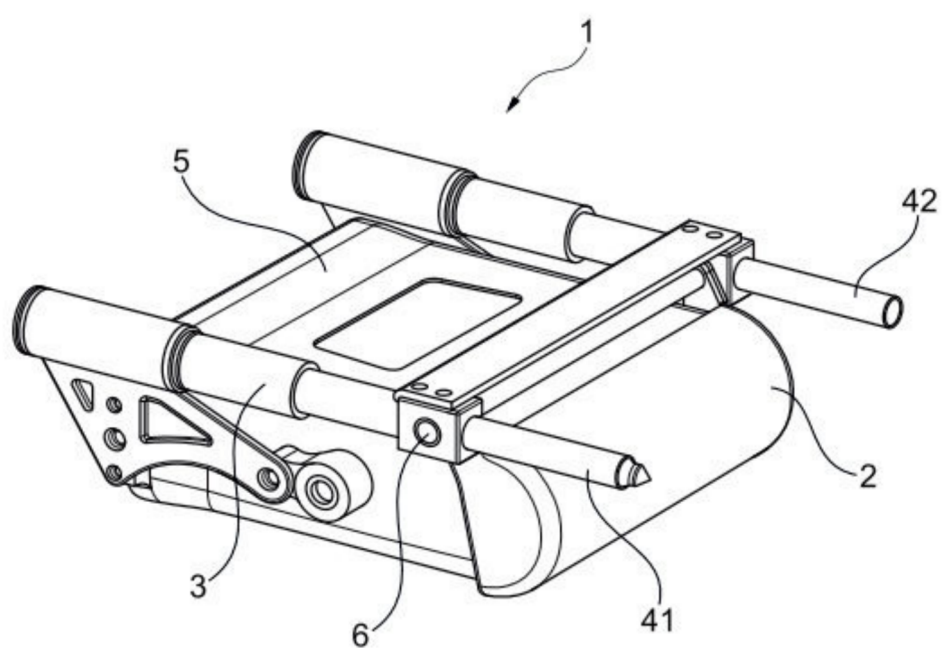


Fig. 1

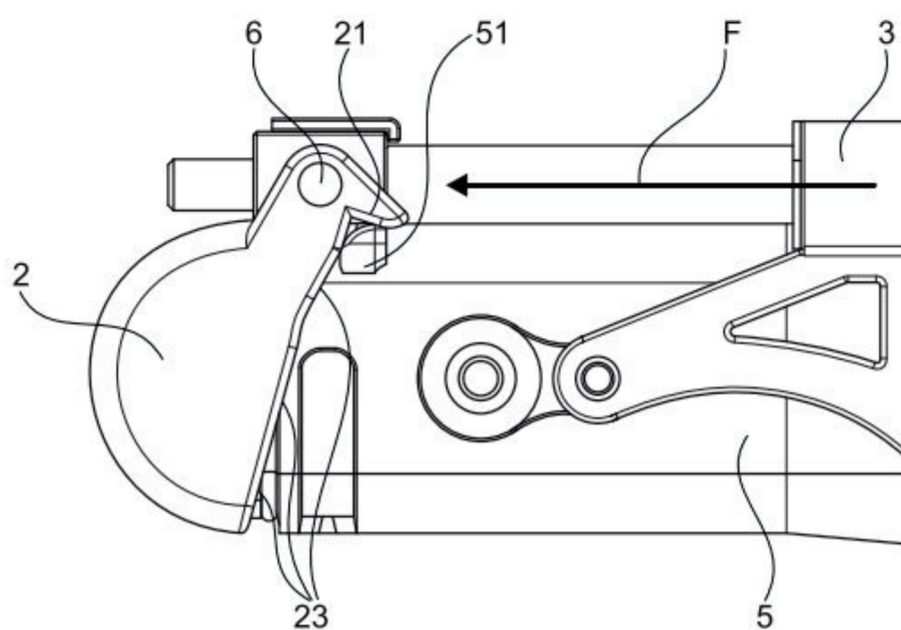


Fig. 2

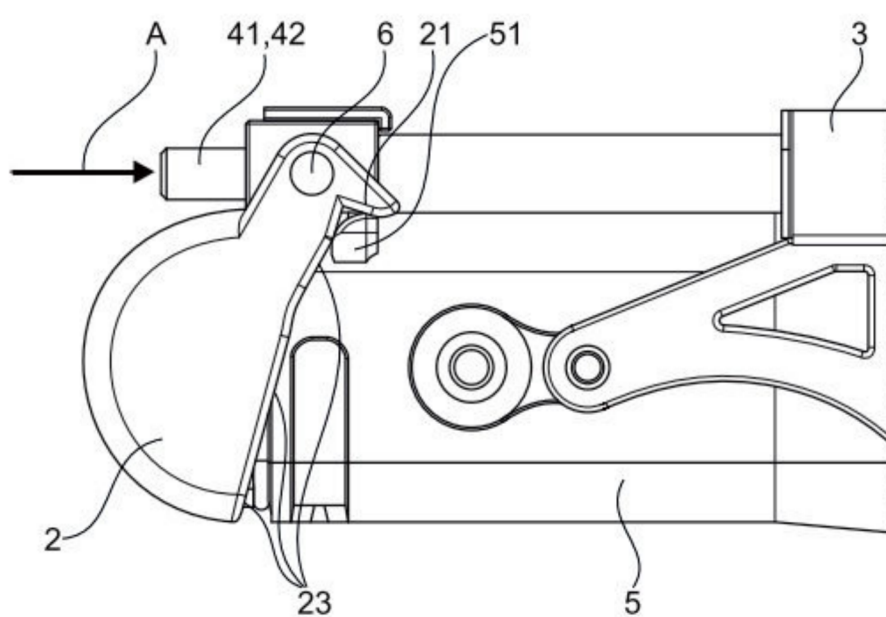


Fig. 3

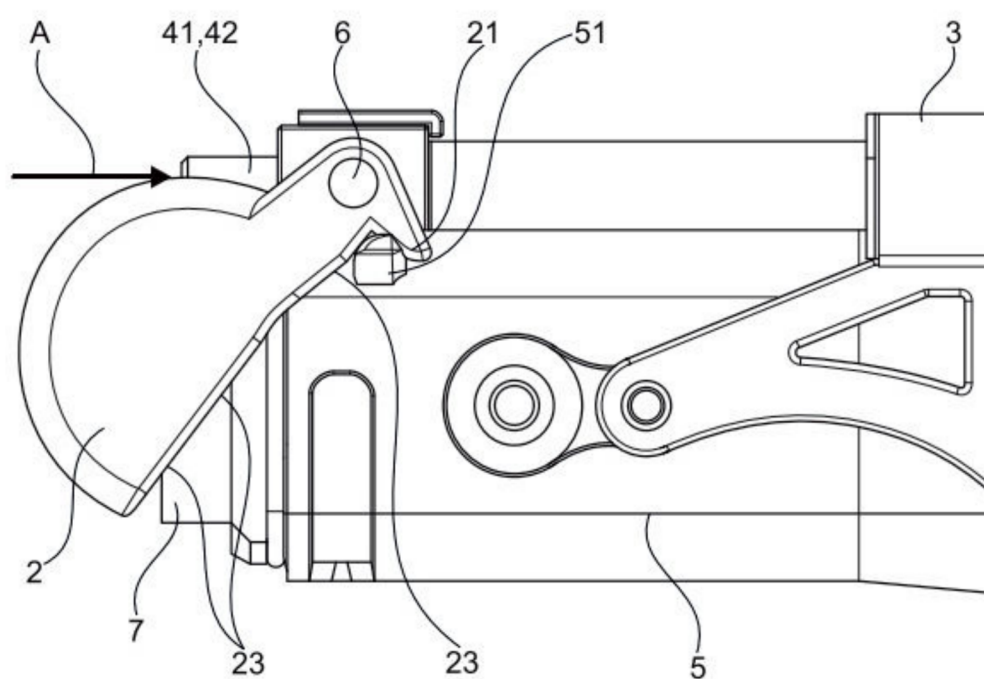


Fig. 4

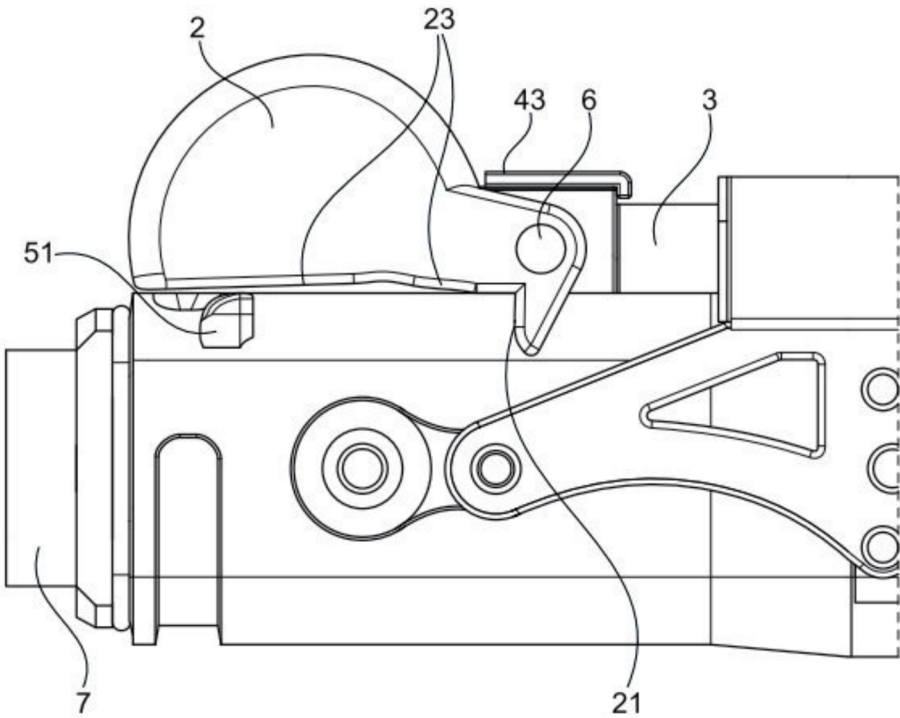


Fig. 5

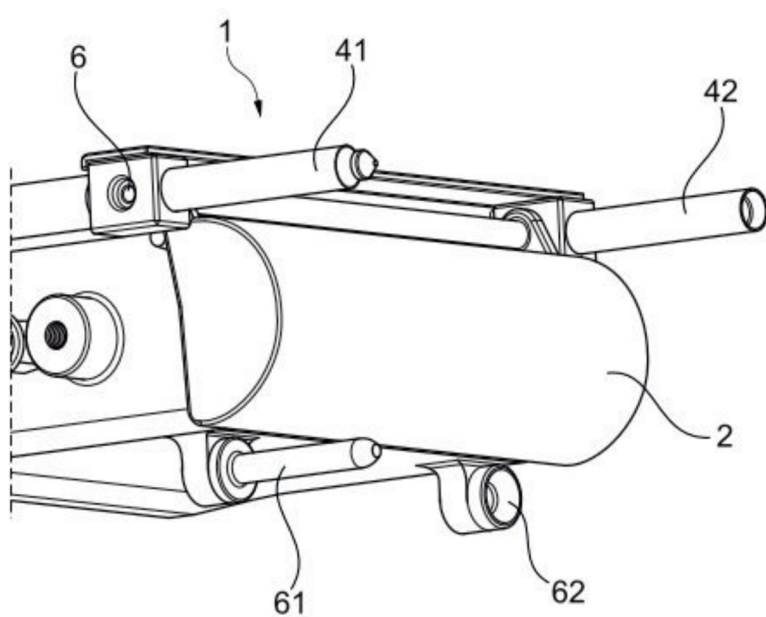


Fig .6

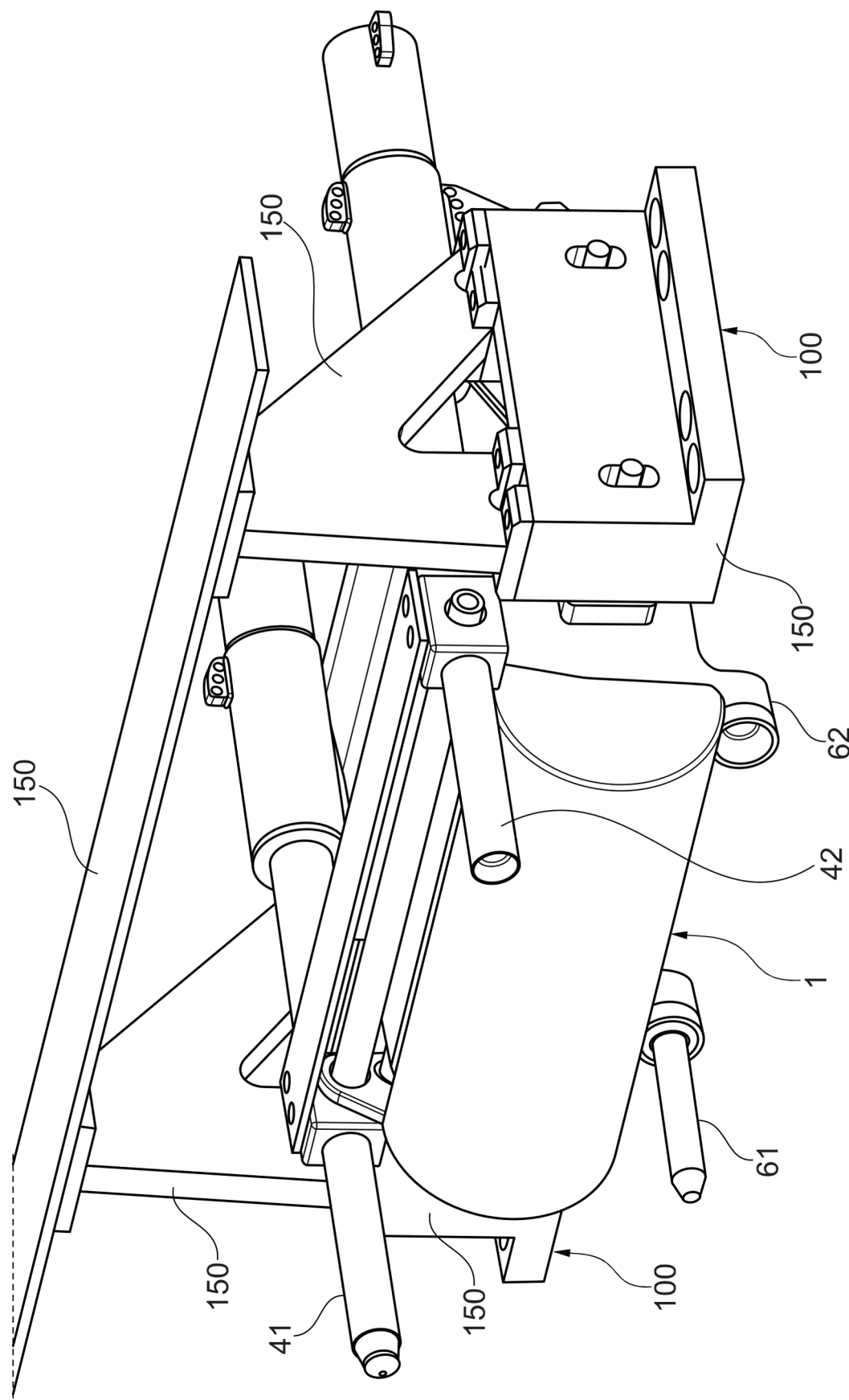


Fig. 7

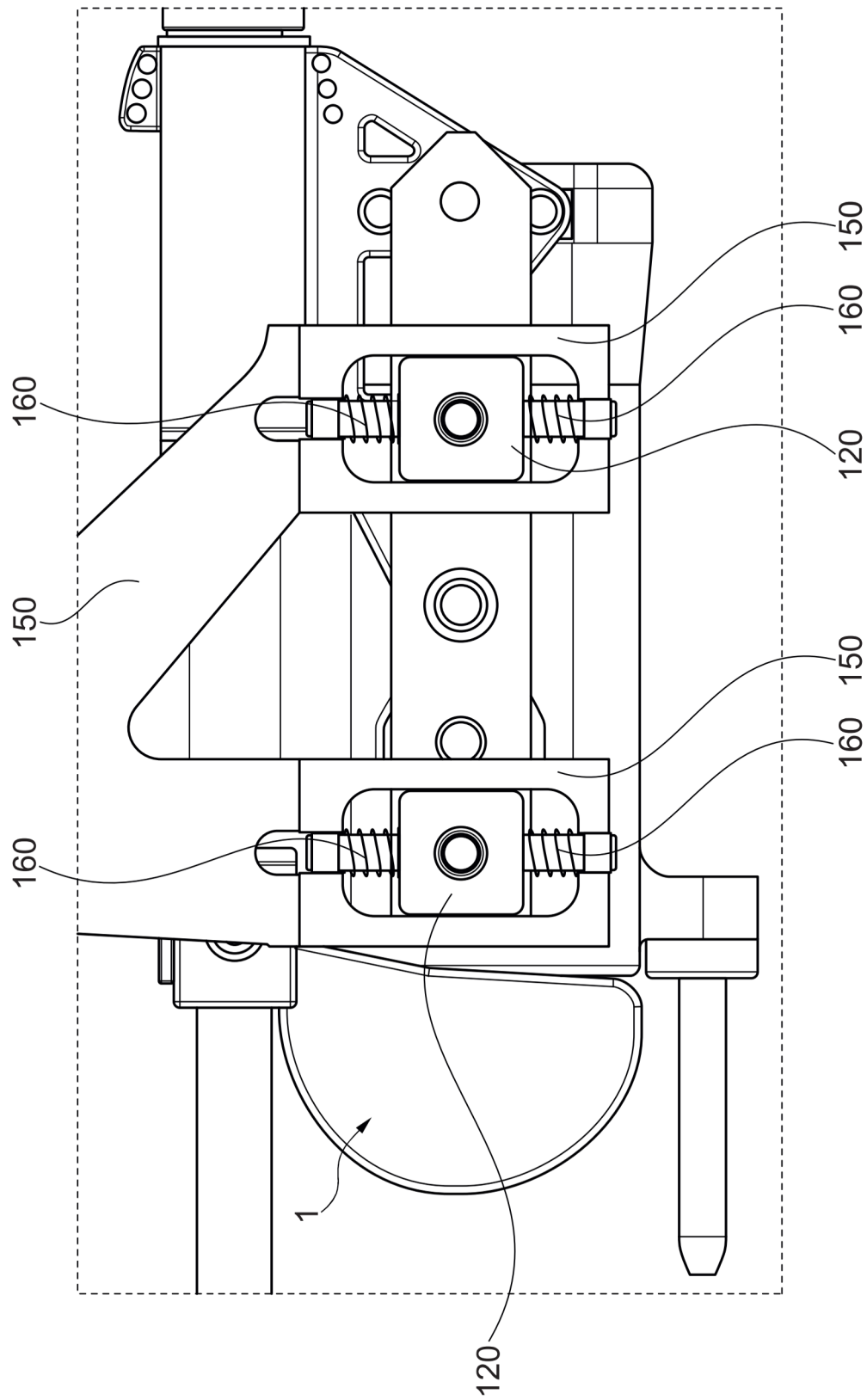


Fig. 8

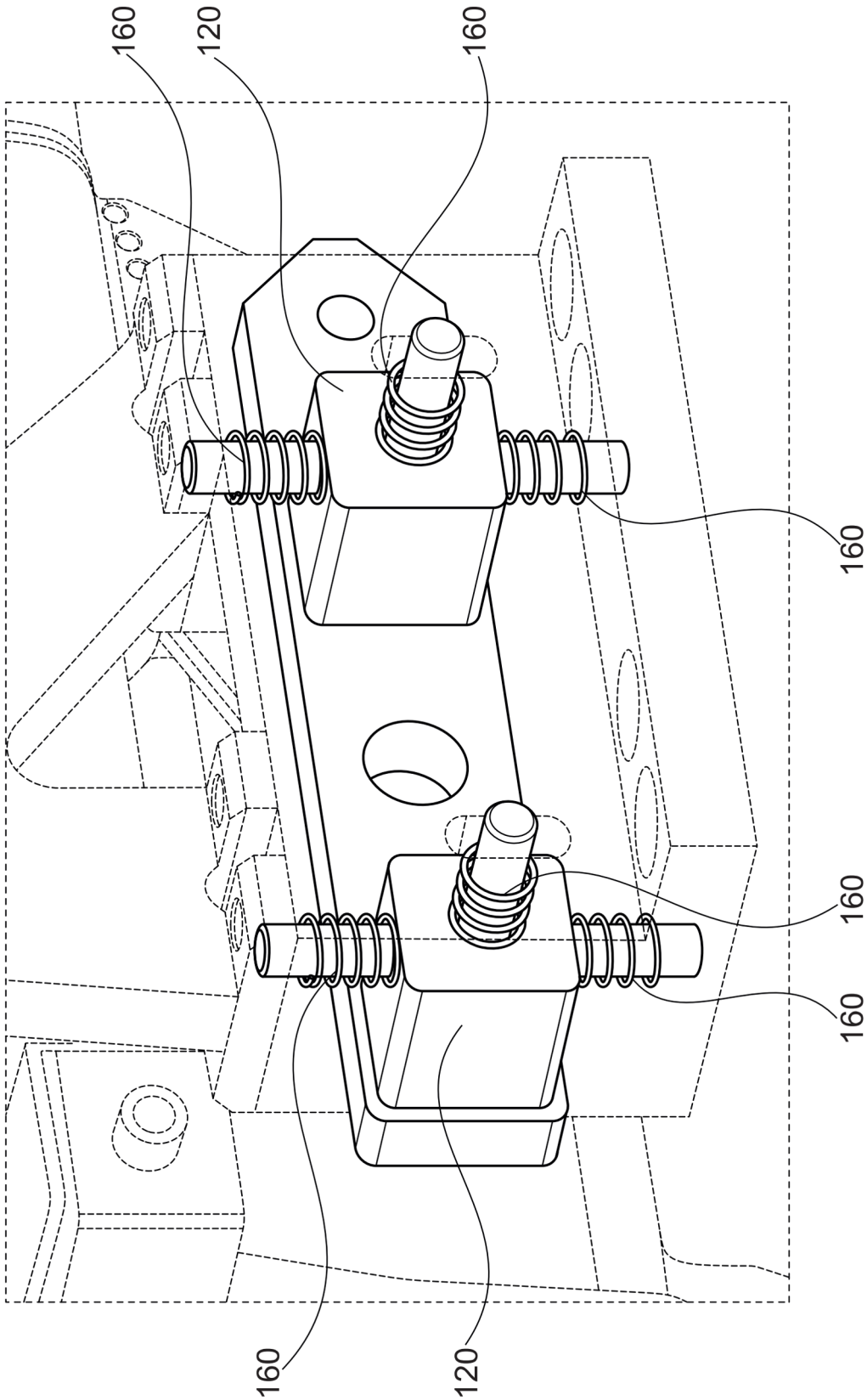


Fig. 9

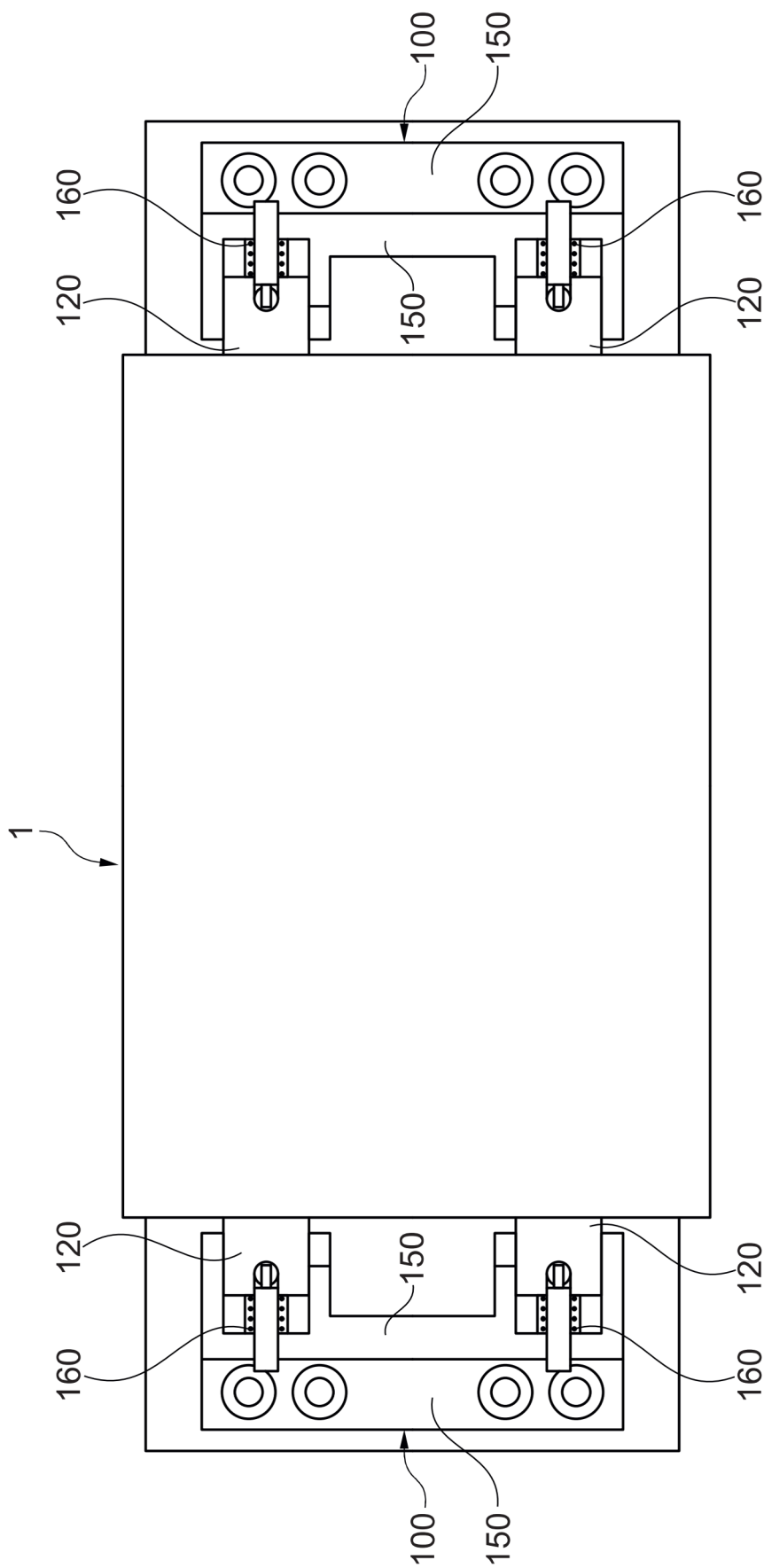


Fig. 10

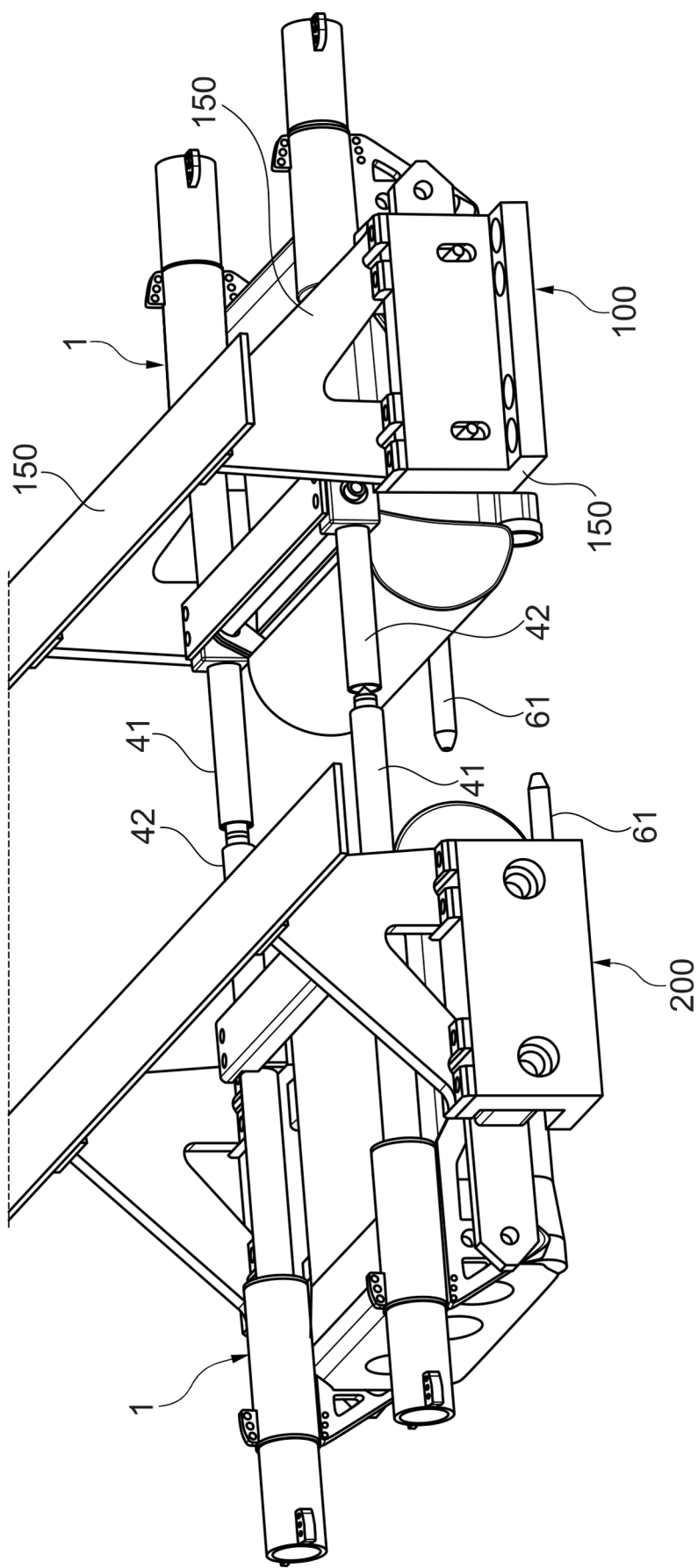


Fig. 11



EUROPEAN SEARCH REPORT

Application Number

EP 26 16 6178

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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		27 August 2026	Kandyla, Maria
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X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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