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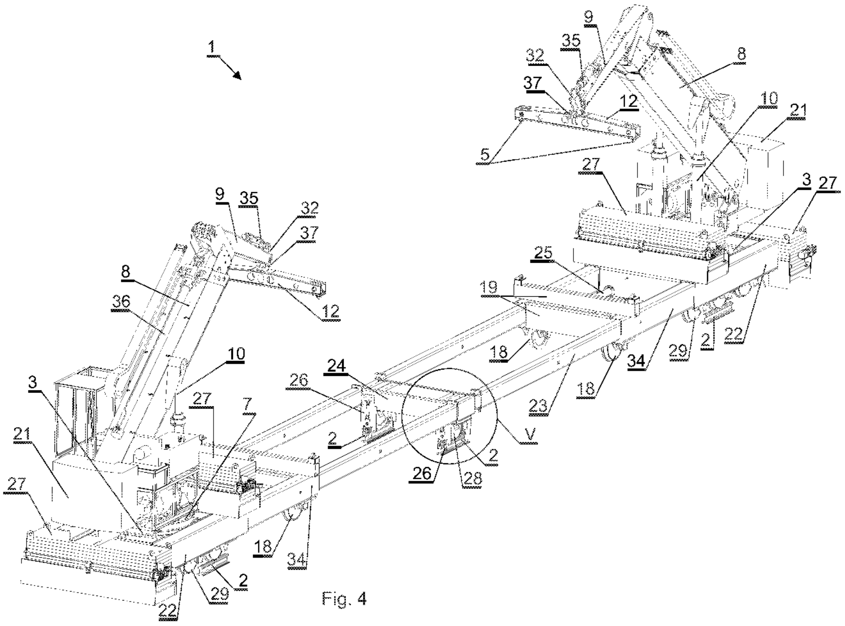

Fig. 4

(57) **Abstract:** Railway container transhipment apparatus (1) containing undercarriage units (3) and a lifting mechanism (4) mounted on the undercarriage units (3). The lifting mechanism (4) consists of two crane units (6). Between the undercarriage units (3) supporting units (19) are arranged. The apparatus (1) is provided with dynamic counterweights (27). The undercarriage units (3) are connected to one another with a pair of connecting elements comprising telescopic elements sliding into each other coaxially. The outer elements (22) of the telescopic elements are formed in the undercarriage units (3). Its internal elements (23) are connected to a fixing unit (24). The intermediate elements (34) are provided with hydraulic working cylinders (25). The fixing unit (24) is provided with wheels (28) fitting on the rail-track (2) and with fixing mechanisms (26).

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RAILWAY CONTAINER TRANSHIPMENT APPARATUS

The present invention relates to a railway container transhipment apparatus comprising two undercarriage units moved on a rail-track, a lifting mechanism fixed to the undercarriage unit and container fixing elements. The lifting mechanism consists of two mirror-symmetrically arranged crane units, suitable for cooperating with each other. The crane unit consists of a rotating platform, a lower boom, an upper boom, a lower moving mechanism, an upper moving mechanism and a lifting beam. The angle between the top-view longitudinal axis of the container lifting crane units and the longitudinal axis of the container transhipment apparatus is varied as a function of the distance between the undercarriage units. For temporary support of the container supporting units provided with supporting wheels resting on the rail-track are arranged between the undercarriage units. The apparatus is provided with dynamic counterweights movable perpendicular to the longitudinal axis of the rail-track.

Due to environmental protection reasons, it is a primary goal of the European countries to direct a part of the road freight traffic to the railway lines. One problem with this is that presently it is quite difficult to take over the containers from camions to freight wagons and from freight wagons to camions. The containers are most commonly taken over using overhead travelling cranes or rubber-wheeled side-loaders. This transhipment apparatus usually lifts the container from the top which has significant disadvantages in case of under catenary. In these cases, the wagons are pulled to a railway track without catenary by a diesel locomotive for taking the containers over which is quite time consuming and requires significant energy. Various low-lift height transhipment devices which can also be used under catenary are known, the stability of which is ensured by a support structure. Their disadvantage is that a pair of supporting rail-track for the stability resulting from the mass of the container and its own structure must be built which significantly increases the cost of installation. A further disadvantage of the rubber-wheeled forklift trucks and the known horizontal loaders is, that they are difficult to move between the rails and can only work at one side.

Several technical solutions are known in the art in which the aim is to ensure the stability of a lifting apparatus having a robotic arm, a crane or a boom by using a so called dynamic, variably positioned counterweight.

Patent application CN 105830755 describes a dynamic counterweight for a relatively small robotic arm. The counterweight positioned on the opposite side of the stretched robotic arm and placed on a frame is moved by an electromechanics structure. Since the robot can rotate about the vertical axis, this solution is similar to cranes having a rotating platform. The disadvantage of this solution is that it does not provide sufficient stability for a lifting device to move loads weighing more than 10 tons.

Patent applications EP 0 779 235, EP 3 075 701 and EP 3 448 796 describe dynamic counterweight for use on rubber-wheeled or crawler cranes, the position of which varies in proportion to the lifted weight. Both the crane boom structure and the counterweight rotate about the vertical axis of rotation of the crane. The grip of the counterweight can be rocking or moving horizontally on a slider. This solution is able to ensure the stability of cranes similar to mobile cranes with a boom. The disadvantage of it is that it cannot be used in the narrow space between the rail-tracks, and it cannot ensure the stability of the horizontal container transhipment apparatuses.

Patent application EP 2436639 describes a dynamic counterweight mounted on a rotating platform and moved by telescopic hydraulic working cylinders placed on a frame structure. The disadvantage of this solution is that for horizontal container transhipment to lift a payload of 34 tons the counterweight requires a large displacement space between the rail-tracks which is not available.

EP 2497740 discloses a movable counterweight which can be disassembled and assembled on site. This solution is suitable for achieving the maximum load of heavy-duty cranes which are not installed but assembled on site of the lifting task. This solution is not suitable for use in case of an apparatus installed on site. Furthermore, transhipment of containers usually takes place at permanent sites, it is unnecessary and expensive to direct the heavy-duty cranes to the site and with additional operation make them suitable for the task.

Patent application EP 1401693/HU223759 describes a railway container transhipment device whose stability is ensured by a wheeled supporting structure and a pair of supporting rails. This solution can be used in cases where there is enough space to install the pair of supporting rails, but at the same time the supporting structure and the rail on the road side do not impede service of the truck. The disadvantage of this solution is that the cost of the application is increased by the installation of the pair of supporting rails. Furthermore, the right and left lifting units are connected by a connecting element whose one end is connected to a length supporting unit with a constant size. The disadvantage of it is that, despite the change in distance between the right and left undercarriage units, the length (approximately 26 m) of the machine does not change. Furthermore, moving of the undercarriage units relative to each other is difficult because of the deformation resulting from the pay-load of 34 tons and the depression of the rails. The referenced document mentions a hinged element, the operation of which is not detailed, i.e., how the lifting beam can be rotated (to ensure a position perpendicular to the track axis) and tilted (to ensure parallelism with the ground). In the solution according to the present invention, the rotation of the lifting beam is ensured by an electromechanical or hydraulic rotating unit forming part of the hinged element, and the parallelism with the ground is ensured by the tilting working cylinder. In the referenced patent, the stability of the device is ensured by the transversal supporting unit, while in the case of the solution according to the present invention, the dynamic counterweights and their positioning ensure the stability. Furthermore, in the solution according to the referenced patent, support wheels which can be slipped out and retracted ensure the stability of the structure. The operation of the support wheels requires laying of an auxiliary track. The solution according to the present invention can be operated without an auxiliary track, which is a significant work and cost-saving solution. Furthermore, in the referenced document, the fixing point of the structure (longitudinal supporting unit) is formed at one end of the device, i.e., the intermediate crane is moved between the fixing point and the more distant crane unit. Furthermore, the intermediate crane is "strung" on the connecting element located between the fixing point and the more distant crane unit. The supporting unit is fixed to one of the telescopic elements, so that only the supporting wheels roll on the pair of rails, in contrast to the solution according to the present invention. Furthermore, the axial moving mechanism is not telescopic. The reference to the telescopic solution in the description is incorrect, since such an embodiment is not described in any way in the referred patent, even at the level of a concrete reference.

GB 2015970 discloses a container transhipment device which is incapable of gripping adjacent containers of different heights. It is not able to stack containers on the unloading side. It describes a forced mechanical connection in which a geared, lifting mechanism is used which, under certain conditions, is able to ensure the position of the lifting beam perpendicular to the track axis. This movement does not have an independent drive and control therefore it can be used when the lifting device is rotated in a limited angular range. The movement of the beam according to this invention is not suitable in cases where the container is not parallel to the transfer device.

The other end of the lifting arm is a spherical pivot to which a transverse support beam is attached. The beam is provided at both ends with a screw-operated screw closure to cooperate with the upper corner fitting elements at one end of the container. In order to keep the beam in a suitable position relative to the longitudinal axis of the assembly, and thus to align the rotating means with the corner fitting elements of the container, a bevel wheel is mounted on a shaft fixed in the frame.

It is also a deficiency of the construction described in the document that the parallelism of the beam with the ground cannot be ensured with the container laid at different heights. A spherical surface is used to provide the necessary displacement, but the movement has no control. That is, to grip the container on the ground, the downwardly tilted lifting device deflects the beam from the horizontal plane. This makes it difficult to orient the grip precisely, as the correct position of the beam can only be adjusted in contact with the corner fitting element of the container. The solution used in the present invention provides a much wider range of motion for the container gripping structure.

Patent application GB 1163241 describes a container handling device which is provided with a dynamic counterweight. The construction disclosed here is not suitable for lifting a nominally loaded 40-foot container (34 tons). Not only because the range of motion of the counterweight is unable to ensure the stability of the vehicle, but also because the weight of the road vehicle can be at most 45 tons in the case of intermodal freight transport. If the container weight is 34 tons of this, there is not enough weight left to ensure the stability according to the described operation. Figure 3 of the above-mentioned patent illustrates the counterweight movement mechanism from which the range of motion can be estimated. Due to its height, the container transporting device according to the described technical solution is not suitable for operation under a railway overhead line or for gripping containers of different heights close to each other. Furthermore, the operation and design of the telescope are not described. The operation/operating of the connecting element (indicated by item number 26 in the description) between the front and rear axles is not described clearly, i.e., its operation will not be apparent even to a person skilled in the art.

The present invention relates to a fixed track container transhipment apparatus with a maximum load of 20 tons per axle. The two counterweights used per machine side have a total weight of more than 34 tons and have a range of movement large enough to ensure stability.

Although the application of counterweight is part of the technique of lifting engines for many decades, determining the weight of the counterweight required for the desired lifting load, the number of counterweights, and the manner and range of movement thereof is a complex and complicated task.

The object of the present invention is to eliminate the drawbacks of the previous solutions and to develop a railway container transhipment apparatus which can work even with an electrified track, its installation cost is low, and it is possible to implement it with standard technical solutions. It is capable of gripping ISO containers from above and can also be used for other types of unit loads (swap bodies). Furthermore, it does not require special preparation of the area for its placement.

It has been realized that if space-saving and co-operating crane units are equipped with dynamic counterweights moving perpendicular to the track, and the undercarriage units are telescopically connected to each other, and the relative fixed point of movement is in the middle of the apparatus, a more favorable solution can be provided.

The present invention relates to a railway container transhipment apparatus comprising two undercarriage units moved on a rail-track, a lifting mechanism mounted on the undercarriage units and container fixing elements. The lifting mechanism consists of two mirror-symmetrically arranged, interoperable crane units. The crane unit comprises a rotating platform, a lower boom, an upper boom, a lower moving mechanism, an upper moving mechanism and a lifting beam. The angle formed by the top-view longitudinal axes of the container lifting crane units and the longitudinal axis of the container transshipment apparatus is varied depending on the distance between the undercarriage units. Between the undercarriage units supporting units for temporary support of the container are arranged, the supporting units are provided with supporting wheels resting on the rail-track. The undercarriage units are connected to each other with a pair of connecting elements comprising telescopic elements sliding into each other coaxially, in a telescopic manner and arranged parallel to each other and to the direction of movement of the undercarriage units. The outer elements of the telescopic elements are formed in the undercarriage units. Its internal elements are connected to a fixing unit. The connecting elements are provided with hydraulic working cylinders. The fixing unit is provided with wheels fitting on the rail-track and with fixing mechanisms. The apparatus is provided with dynamic counterweights which can be moved perpendicular to the longitudinal axis of the rail-track.

The embodiment of the invention will be described with reference to the accompanying drawings in which:

Figure 1 is the side view of the apparatus;

Figure 2 is the top-view of the apparatus where the container is placed on the supporting unit;

Figure 3 is the top-view of the apparatus when the crane unit is in its turned-out state with the container placed on the lifting beam, after being removed from the transport unit or before being placed on the transport unit;

Figure 4 is a perspective view of the apparatus when the crane units are completely spaced apart, i.e., the connecting element is extended substantially over its entire length;

Figure 5 is an enlarged perspective view of the portion of the fixing mechanism shown in the circle V in Figure 4.

The railway container transhipment apparatus 1 according to the present invention is located on the rail-track 2. It consists of two undercarriage units 3 and additional elements for moving the crane units 6 on the undercarriage units 3 along the longitudinal axis 15 of the apparatus 1 (Figures 1 to 4). The additional elements of the undercarriage unit 3 are the carriage wheels 29, the supporting wheels 18 and the wheels 28, which allow the apparatus 1 and the undercarriage units 3 to be moved on the rail-track 2.

The lifting mechanism 4 consists of two crane units 6, which consist of the container fixing elements 5, rotating platform 7, lower booms 8, upper booms 9, lower moving mechanisms 10, upper moving mechanisms 11 and the lifting beams 12.

The rotating platform 7 allows the crane unit 6 to pivot about the vertical axis line 30 (Fig. 1) at an angle 16 enclosed by the longitudinal axis 15 and the top-view longitudinal axis 14 (Fig. 3). This angle 16 is substantially between 0° and 90° in the direction of both sides of the apparatus 1 (Figure 3). The static counterweight 21 is also arranged on the crane unit 6. The distance 17 of the vertical axis lines 30 depends on the size of the container 13. In the case where the container 13 is on the supporting unit 19 of the apparatus 1, the distance 17 is the largest. In this case, the difference between the distance 17 and the lifting beam 33 distance is the largest (Figure 2). In the case when the container 13 is furthest from the apparatus 1 at the time of transhipment of the container 13, the lifting beam 12 fixed to the hinged member 32 is fixed in the corner fitting element axis line 31 by the container fixing element 5, then the distance 17 is the smallest which is equal with the lifting beam distance 33 (Fig. 3). The hinged member 32 is operated by the tilting working cylinder 35. The rotating unit 37 ensures the rotation of the lifting beam 12 (ensuring a position perpendicular to the rail-track axis), its tilting (parallelism to the ground) is ensured by the tilting working cylinder 35.

In the apparatus 1, the supporting units 19, which rest on the rail-track 2 with the supporting wheels 18, serve to properly support the container 13, i.e., to avoid deformation of the connecting element 20. Optionally, on each side of the supporting units 19 two supporting wheels 18 can be provided (not shown). The connecting element 20 consists of telescopic elements which are able to slide into one another telescopically, coaxially, arranged parallel to each other and to the rail-track 2, and parallel to the direction of movement of the undercarriage units 3. The telescopic element consists of an outer element 22 located in the undercarriage unit 3, an intermediate element 34 inserted in the outer element 22 and an internal element 23 (Fig. 1). Between the supporting units 19 for temporarily supporting the containers 13, resting on wheels 28 the fixing unit 24 is arranged, which can be fixed to the rail-track 2 when the container 13 is unloaded to the right or left. The undercarriage units 3 move relative to the fixing unit 24. Fixing of the apparatus 1 to the rail-track 2 is performed by the fixing mechanisms 26 of the fixing unit 24 (Fig. 5). Optionally, the fixing unit 24 may be provided with two wheels 28 (not shown) on each side. The fixing mechanism 26 of the apparatus 1 has a locking role, not a braking one. The purpose of the fixing mechanism 26 is not to decelerate, or braking of the whole apparatus 1 at a stop, but to provide a fixed reference/fixing point for controlling the movements (approaching or moving away of the undercarriage units relative to each other) in the axle of the rail-track 2.

The ends of the internal elements 23 remote from the undercarriage unit 3 are fixed to the fixing unit 24, while the ends of the intermediate element 34 remote from the undercarriage unit 3 are fixed to the supporting units 19. The supporting units 19 and the undercarriage units 3 are provided with hydraulic working cylinders 25 in order to ensure that the supporting units 19 are always at a suitable distance from the undercarriage unit 3. Furthermore, with the hydraulic cylinders 25, the outer elements 22 and the intermediate elements 34 of the telescopic connecting elements 20 can be retracted into each other and into the undercarriage unit 3, respectively. The internal elements 23 and the intermediate elements 34 can be pushed together and pulled apart by driving the undercarriage units 3. Proper balancing of the crane unit 6 is ensured by the dynamic counterweights 27 located on the undercarriage unit 3. According to a possible solution, they are provided with wheels and can be moved electromechanically or hydraulically in a suitable track, in the opposite direction to the rotation of the crane unit 6 (Fig. 3).

The appropriate length of the lower boom 8 is adjusted by the moving mechanism 36 located inside the lower boom 8 in the embodiment of Figure 1. In the embodiment according to Fig. 4, it is fixed to the lower boom 8 from the outside. The moving mechanism 36 may be a hydraulic working cylinder or a screw spindle, but any conventional device may be used to adjust the length of lower boom 8 shaped telescopically from two or more parts.

The lifting beam 12 to which the container fixing elements 5 are connected is coupled to the upper boom 9 via the hinged member 32. The movement of the hinged member 32 is performed by the tilting working cylinders 35 and the rotating units 37.

The operation of the apparatus 1 will be described with reference to Figures 1 to 3. The side view of the apparatus 1 is shown in Fig. 1 and the top-view is shown in Fig. 2. The figures show the operating phase when the lifting beams 12 on the crane units 6 are connected to the container 13 by the container fixing element 5. The parts of the telescopic connecting element 20 – the outer element 22, the intermediate element 34 and the internal element 23 – are pulled apart so that the crane units 6 are sufficiently spaced apart and the lifting beams 12 can be connected to the corresponding connection points of the container 13 as shown in Figures 1 and 2.

The stability of the apparatus 1 is ensured by the supporting units 19 supporting the container 13, the static counterweights 21 and the dynamic counterweights 27. In this work phase the dynamic counterweights 27 are arranged symmetrically (in the middle) with respect to the longitudinal axis 15.

In Fig. 3, the apparatus 1 is viewed from above during operation. The apparatus 1 is located on the rail-track 2. The container 13 can be moved for example between a wagon on an adjacent rail-track 2 and/or the apparatus 1 and/or a truck on the road next to the apparatus 1 and another wagon. The direction and destination of the container 13 are optional, the destination is the forwarding vehicle during loading and the unloading vehicle during unloading.

The apparatus 1 can be provided with a coupling element which allows it to be moved on the rail-track 2 by means of a suitable towing device between transhipment points which are far (several 10 kilometers) apart. The undercarriage units 3 also have their own drive for moving the crane units 6 in the direction of the rail-track. These embodiments are not shown, as implementation of them is obvious to a person skilled in the art.

The container 13 is held by the crane units 6 via the lifting beam 12. To do this, first the undercarriage units 3 had to move away from the fixing unit 24 according to the length of the container 13. During lifting of the container 13 onto the supporting unit 19 of the apparatus 1, the crane units 6 on the rotating platform 7 turn in an opposite direction, preferably inwardly, mirror symmetrically, and both undercarriage units 3 move away in the opposite direction from the fixing unit 24 due to the geometric constraint path. The undercarriage units 3 are moved by the driving mechanisms of the carriage wheels 29. The same driving mechanisms allow the whole of the apparatus 1 to be moved on the rail within the transfer area.

The angle 16 between the top-view longitudinal axis 14 of the crane unit 6 lifting the container 13 and the longitudinal axis 15 of the apparatus 1 is proportional to the distance 17 between the undercarriage units 3. In Figure 2 the container 13 is shown in its entirely turned-in state. The distance 17 between the undercarriage units 3 is the largest in this case. Then, the longitudinal axis 15 and the top-view longitudinal axis 14 are parallel to each other.

When the container 13 is completely turned away from the apparatus 1 in the manner shown in Fig. 3 in order to be transferred to the transport vehicle, the top-view longitudinal axes 14 of the crane units 6 are perpendicular to the longitudinal axis 15 of the apparatus 1. In this case, the distance 17 and the lifting beam distance 33 are the same. In this operation, the dynamic counterweights 27 are displaced to the side of the apparatus 1 opposite the lifting beams 12 and the container 13 by a known moving mechanism. This moving mechanism is not described in detail, its implementation is known. The dynamic counterweights 27 are displaced in proportion to the weight of the load lifted by the crane units 6. That is, the displacement of the dynamic counterweights 27 is proportional to the angle 16 between the top-view longitudinal axis 14 and the longitudinal axis 15 of the crane unit 6 capable of rotating about the vertical axis line 30.

The railway container transhipment apparatus according to the present invention has several advantages. It allows for faster spread of rail freight as a result of lower installation costs. It can also be used on tracks with catenary. The low lifting height of the containers reduces the overall accident risk associated with lifting. It is cheaper to produce than the known container handling apparatuses. Its operation is also cheaper, because the container transhipment can be almost entirely automated. It is also particularly advantageous that there is no need for a special transhipment area, for the construction of a support rail, and the construction of a container terminal, further, the use of a diesel locomotive can be avoided. The railway container transhipment apparatus of the present invention is suitable for transhipment of any container with a length generally 6-12 m (20-40 ft). If the apparatus has to lower the container for some reason, such as moving it along the railway track as a vehicle, it can be placed on the supporting unit by tilting the upper boom. The lifting beam is primarily suitable for gripping ISO-compliant containers through upper corner fitting elements. The railway container transhipment apparatus according to the invention can be implemented in many other ways within the scope of invention.

Claims

1. Railway container transhipment apparatus containing two undercarriage units (3) moved on a rail-track (2), a lifting mechanism (4) mounted on the undercarriage units (3) and container fixing elements (5), the lifting element consists of two mirror-symmetrically arranged crane units (6), suitable for cooperating with each other, the crane unit (6) consists of a rotating element (7), a lower boom (8), an upper boom (9), a lower moving mechanism (10), an upper moving mechanism (11) and a lifting beam (12), the undercarriage units (3) are able to vary the angle between the top-view longitudinal axis of the crane units (6) lifting the container (13) and the longitudinal axis (15) of the container transhipment apparatus (1) as a function of the distance (17) between the undercarriage units (3), for temporary support of the container supporting units (19) provided with supporting wheels (18) resting on the rail-track (2) are arranged between the undercarriage units (3), and the apparatus (1) is provided with dynamic counterweights (27) movable perpendicular to the longitudinal axis (15) of the rail-track (2) characterized in that said undercarriage units (3) are connected to each other with a pair of connecting elements (20) comprising telescopic elements sliding into each other coaxially, and arranged parallel to each other and to the direction of movement of said undercarriage units (3), the outer elements (22) of the telescopic elements are formed in said undercarriage units (3) its internal elements (23) are connected to a fixing unit (24), the intermediate elements (34) are provided with hydraulic working cylinders (25), and the fixing unit (24) is provided with wheels (28) fitting on the rail-track (2) and with fixing mechanisms (26).

2. Apparatus according to claim 1 characterized in that said fixing mechanisms (26) of said fixing unit (24) are connected to the rail-track (2) by means of a gripping unit operated hydraulically or pneumatically.

3. Apparatus according to claim 1 or 2 characterized in that each side of said supporting unit (19) is provided with two supporting wheels (18).

4. Apparatus (1) according to any of claims 1 – 3 characterized in that said fixing unit (24) is provided with two wheels (28) on each side.

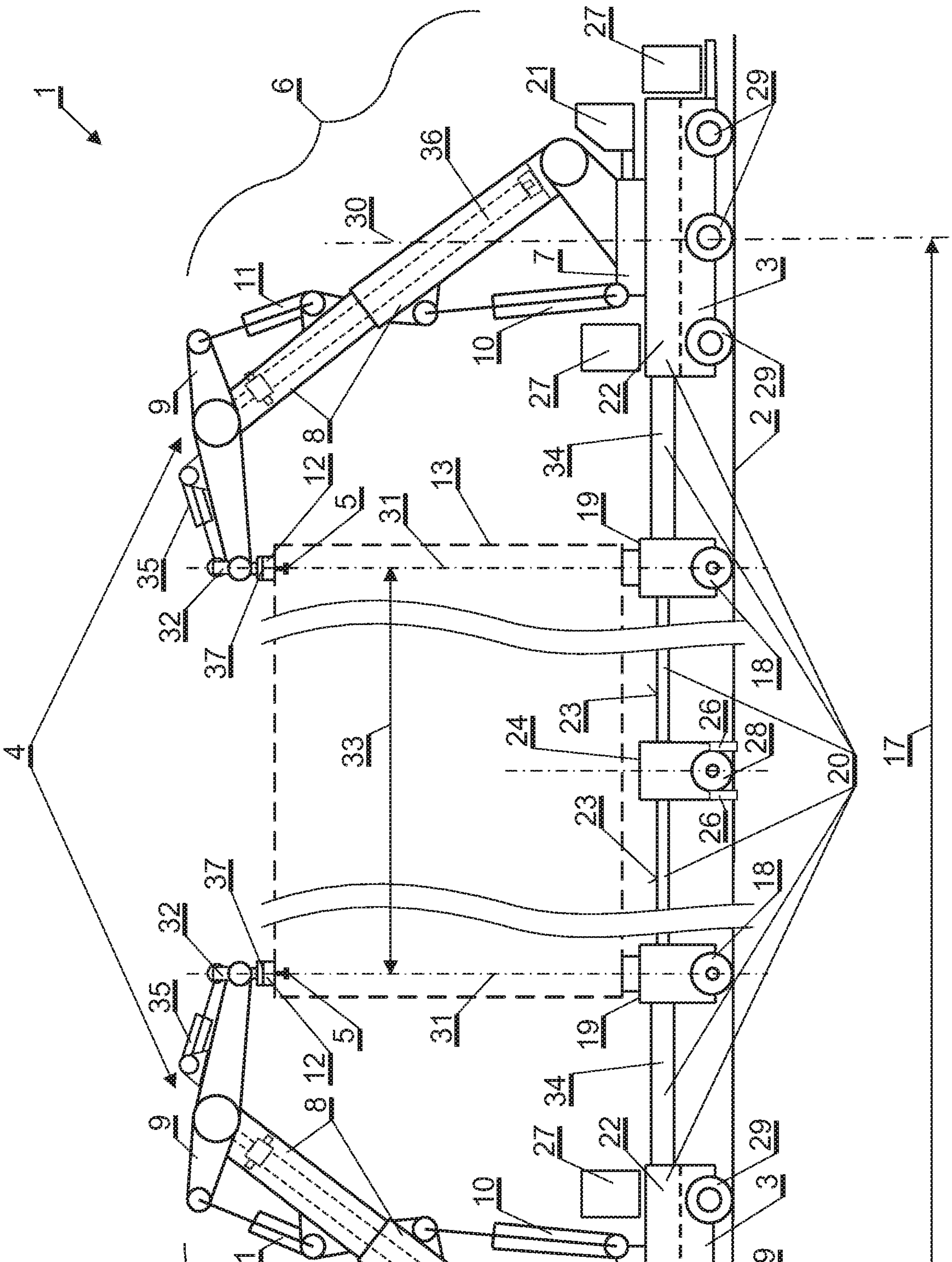
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Fig. 1

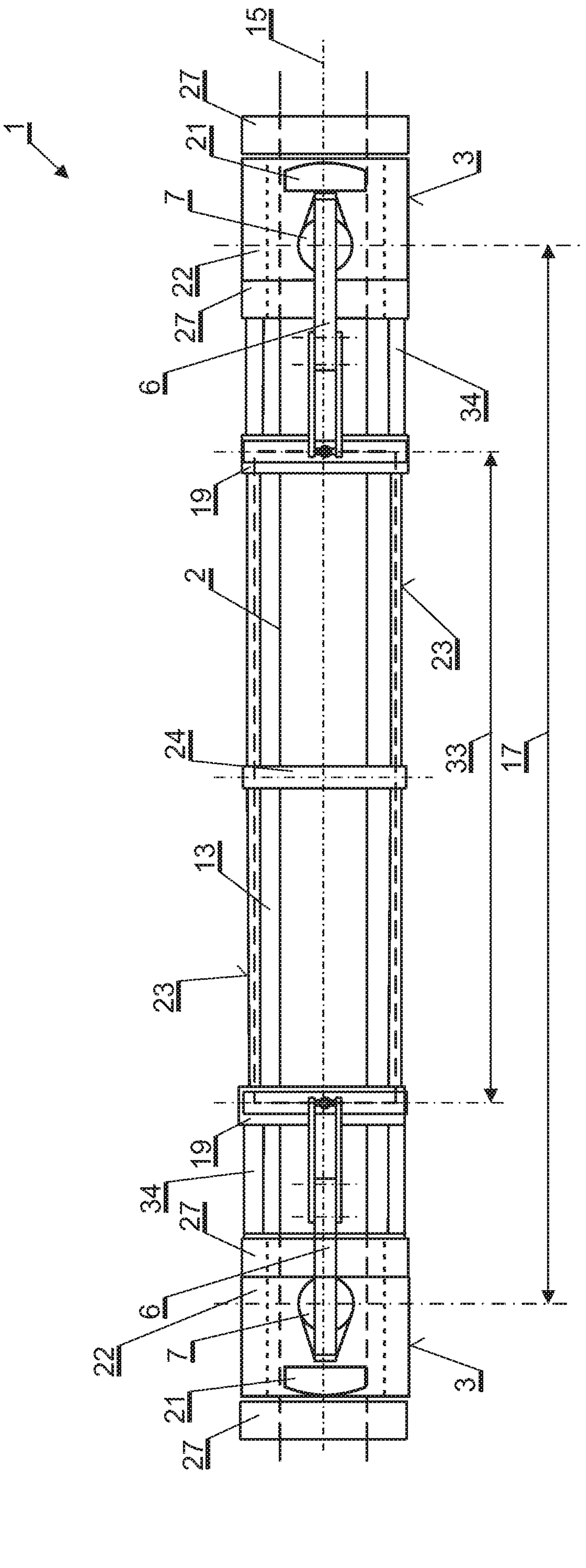

Fig. 2

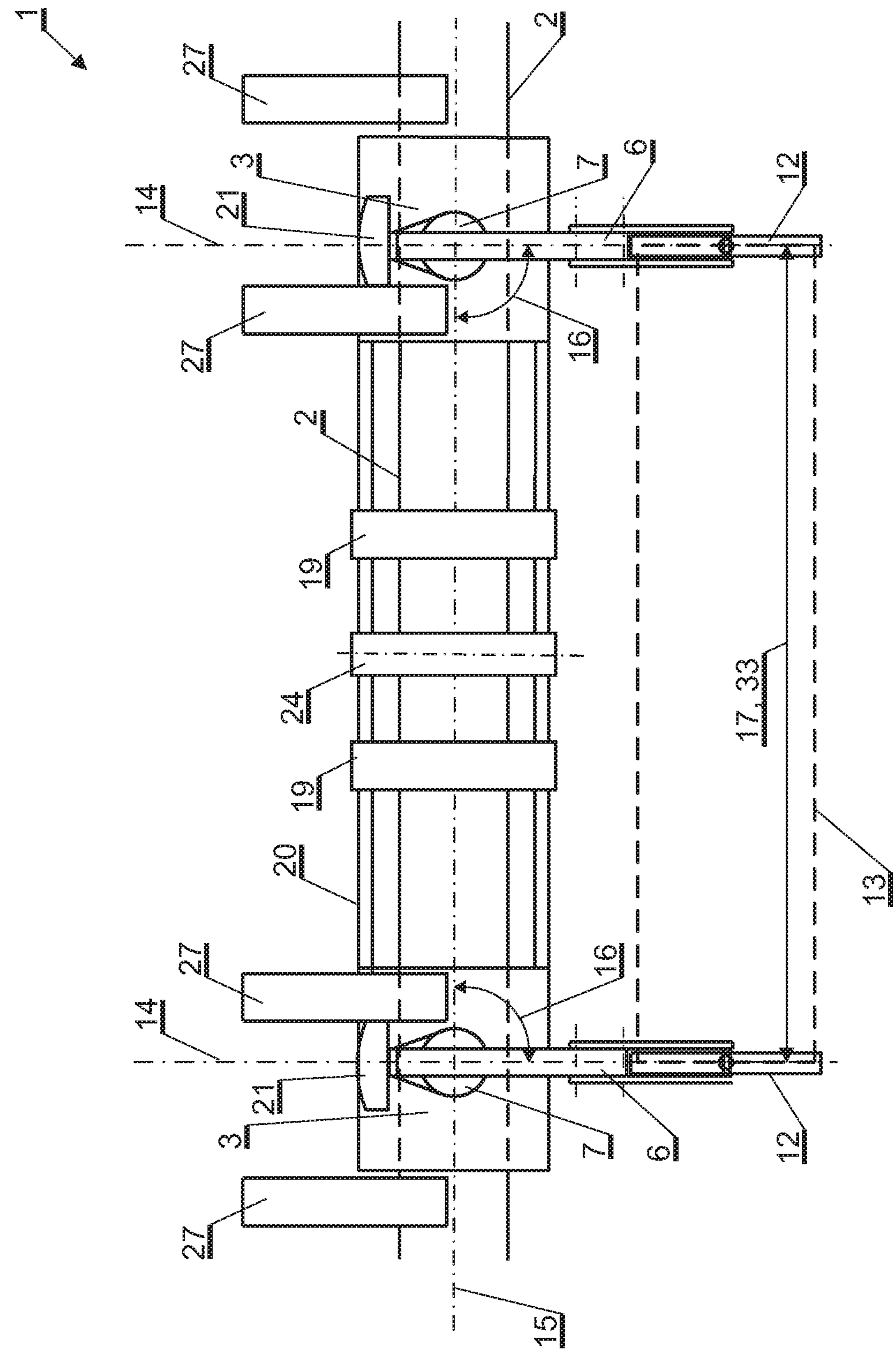

Fig. 3

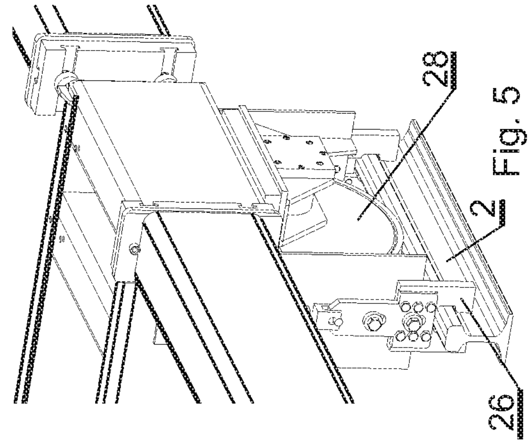
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Fig. 5

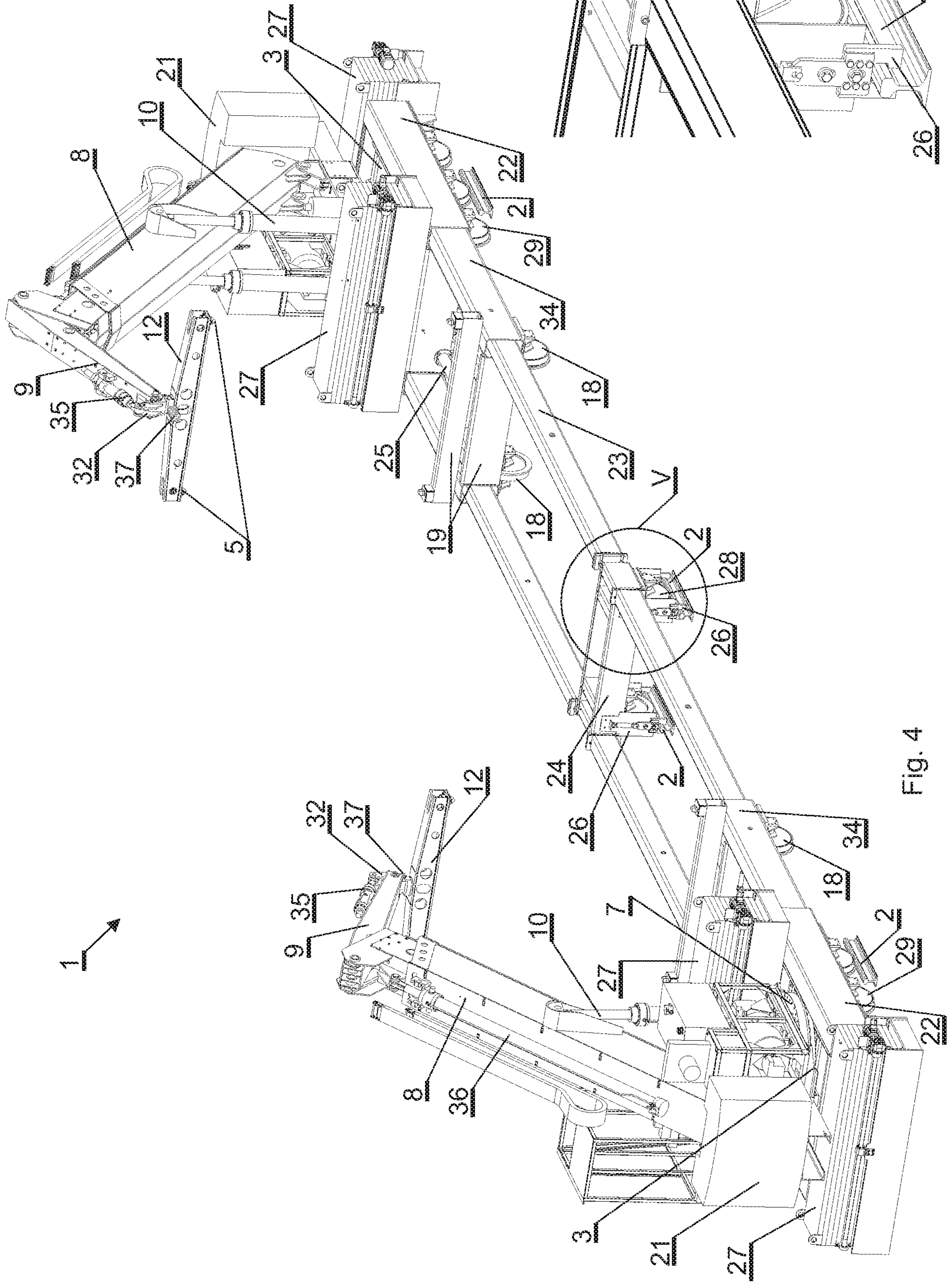
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Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/HU2021/050059

A. CLASSIFICATION OF SUBJECT MATTER
B65G 63/02, B65G 63/04, B65G 67/02, B66C 23/36, B66C 23/50, B66C 23/72
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)
IPC: **B65G, B66C**

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)

EPODOC, WPI, E-search (HIPO-Internal)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	HU 223759 B1 (VIDA László [HU]) 28 January 2005 (28.01.2005) Full document, Figures 1-10	1-4
Y	GB 1163241 A (COLES KRANE GmbH [DE]) 04 September 1969 (04.09.1969) Page 1, line 88 – Page 2, line 5; Page 2, lines 67-87; Page 3, line 75 – Page 4, line 23	1-4
Y	GB 2015970 A (STOTHERT & PITT LTD) 19 September 1979 (19.09.1979) Full document, Figures 1-5	1-4

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

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