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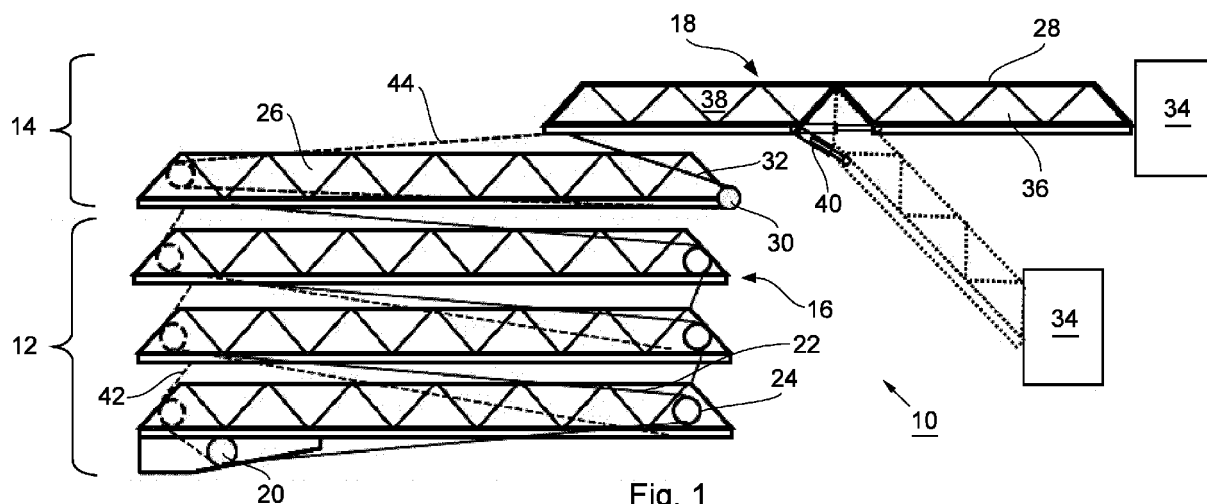
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(54) **LADDER SYSTEM FOR RESCUE VEHICLES**

(57) The invention refers to a ladder system for hoisting rescue vehicles, comprising a plurality of ladder segments being telescopically extendable with regard to each other. A bottom ladder set is mounted on top of a base part of the vehicle and an top ladder set is supported on top of the bottom ladder set, each of the bottom ladder set and the top ladder set comprising a plurality of ladder segments. The ladder system comprises two independ-

ent telescopic drives for driving the extension of the respective ladder segments of the bottom ladder set and the top ladder set, wherein the telescopic drives comprise a bottom drive for extending the bottom ladder segments of the bottom ladder set and a top drive for extending the top ladder segments of the top ladder set and being mounted to the top ladder set.



Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims priority from Italian patent application No. 102018000006663 filed on 26/06/2018.

TECHNICAL FIELD

[0002] The invention relates to a ladder system for hoisting rescue vehicles, according to the preamble of claim 1.

BACKGROUND OF THE INVENTION

[0003] Ladder systems of the above kind are used for rescuing persons in emergency situations. An example of such ladder systems is demonstrated in EP2182164 B1, demonstrating a ladder set to be mounted on top of a rescue vehicle like a firefighting vehicle. As disclosed in the state of the art, such ladders may be turntable ladders mounted on a rotating frame and adjusted to occupy different inclinations. A ladder system comprises a plurality of ladder segments which are telescopically extendable with regard to each other, so that they can be shifted with respect to each other along their linear extension direction by at least one drive. The top ladder segment may carry a rescue cage, for example.

[0004] For extending the ladder set, a telescopic drive is provided. In many common ladder systems, a winch as one example of a telescopic drive is mounted at a base part of the vehicle to extract the ladder segments via a pulling rope which is guided over guide rollers and deflecting rollers through the ladder segments. The arrangement of such a pulling rope (and a corresponding additional pulling rope to carry out a retraction movement of the ladder segments toward their original non-use position) can be selected according to the loads and the forces necessary to carry out the extension/retraction movement.

[0005] The provision of only one telescopic drive poses constructional problems related to the limited space within the ladder system and the forces acting to the different components. With increasing number of ladder segments, difficulties arise in arranging the desired number of force transmission components and/or guiding components (for example, guiding rollers or deflecting rollers) within the ladder segments, which have to share their arrangement space with other components needed in the operation of the ladder system. With a large number of ladder segments, large forces are necessary to carry out the telescopic extension movement, increasing the demands of strength and stability of all components of the telescopic drive. Because of these forces and the decreased size of components, increased wear of these components becomes an additional problem.

[0006] Moreover, in some cases it is desired to choose

the order of extraction of adjacent ladder segments according to the load acting on the ladder system, for example, according to the measured or estimated deflection to the top portion of the ladder set which is fully extracted. However, in the known ladder systems the extraction order of the ladder segments is predetermined according to the mechanical arrangement of the components of the telescopic drive.

[0007] There is the additional problem that in conventional extraction systems, the uppermost ladder segment is always extracted at least partially in any extracted position of the ladder system. However, as this ladder segment carries the load at the ladder tip, it is prone to be deformed by torsion forces with increasing extraction length. Moreover, it must be ensured that the rungs of different segments of the ladder set are aligned with a permissible offset, to ensure continuity of passage of a person along the ladder. This rung alignment restricts the freedom to extract the ladder segments to full extend, because a mutual position correction of the ladder segments may involve retraction movements. These correction movements may be small between adjacent ladder segments but may sum up to a larger distance in total. The overall extension length of the ladder system may be seriously affected by this safety requirement.

[0008] It is therefore an object of the present invention to provide an improved ladder system of the above kind with a telescopic drive for extending the ladder segments which consumes less construction space in the ladder system and allows different ways of carrying out the telescopic extraction movement, in particular with regard to the order of extraction of the different ladder segments. Another object is to increase the stability of the uppermost ladder segment against torsion forces also in extracted positions of the ladder system, and to fulfil the requirement of the rung alignment with less restrictions concerning the full extension length of the ladder system.

SUMMARY OF THE INVENTION

[0009] This object is achieved by the provision of a ladder system comprising the features of the appended set of claims.

[0010] The ladder system according to the present invention comprises a bottom ladder set and a top ladder set mounted on top of the bottom ladder set. The bottom ladder set is mounted on top of the base part of the vehicle and comprises its own telescopic drive, comprising a bottom drive for extending the bottom ladder segments comprised within the bottom ladder set. An additional telescopic drive is provided for driving the extension of the ladder segments of the top ladder set. This additional telescopic drive comprises a top drive which is mounted to the top ladder set. Hence the ladder system according to the present invention comprises at least two independent telescopic drives for driving the extension of the respective ladder segments of the bottom ladder set and the top ladder set supported thereon.

[0011] As a result, the ladder segments of the bottom ladder set and the top ladder set can be extended independently by operating the respective telescopic drive, i. e. the bottom drive or the top drive. A force transmission means of the bottom drive, like an extraction rope of a bottom winch, does not need to be guided through all ladder segments comprised within the ladder system, but only as far as to reach the top segment comprised within the bottom ladder set or further to be fixed to the first following segment belonging to the top ladder set, such that the top ladder set as a whole can be extracted from the bottom ladder set by means of the bottom drive. However, there is no need for an additional force transmission means connecting the bottom drive with the top end segment of the top ladder set, because the extraction of the ladder segments of the top ladder set is driven by the top drive.

[0012] Consequently, the overall construction, in particular with regard to the guiding components and/or force transmission components of the telescopic drive for extracting the bottom ladder set, can be lighter and with less restrictions with respect to their strength and stability. On the other hand, the telescopic drive components for extracting the top ladder set can be relatively light and simple. Just as one example, a top winch may have a lighter weight than a bottom winch, because of the decreased pulling force requirements for extracting the limited number of ladder segments of the top ladder set.

[0013] According to a preferred embodiment of the present invention, the ladder system comprises a control device to operate both telescopic drives independent of each other and configured to start the operation of the bottom drive and the top drive in a predetermined order depending on one of the plurality of operation modes of the control device. Accordingly, the order of extracting the top ladder set and the bottom ladder set is different according to the operation mode to which the control device is set.

[0014] The option of extending the bottom ladder set first, while keeping the top ladder set in a compact retracted position, offers the advantage to keep the upper ladder segments, which are prone to the highest torsion forces, in a retracted (or at least partially retracted) mutual position as far as possible, being fully extended only in the full extension position of the ladder system as a whole. Additional guiding means to guide the uppermost ladder segment on the underlying ladder segment in an at least partially retracted mutual position may be provided, to improve the stability of the ladder system in its end segments. A guidance between the uppermost ladder segment on the underlying ladder segment is released only when these two ladder segments are further extended, which may be the case only when all other ladder segments have been extracted.

[0015] Another advantage lies in the fact that a rung alignment, as described above, can be carried out by position correction movements of the ladder segments independently in the bottom ladder set and in the top

ladder set. Namely, such correction movements may involve retraction movements in the bottom ladder set and extension movements in the top ladder set, and vice versa. In total, the rung alignment can be carried out with less restrictions concerning the full extension length of the ladder system.

[0016] Preferably the operation modes correspond to different loads acting on the ladder system in an at least partially extended state.

[0017] More preferably, these loads are derived from load data measured during the operation of the ladder system. These load data may represent, for example, a load acting of a rescue cage mounted to the top end ladder segment comprised within the top ladder set, and/or to a deflection of one or a plurality of ladder segments measured during operation. Suitable sensor devices may be provided within the ladder system to measure such load data.

[0018] More preferably, the loads are derived from load data acquired by estimation or calculation and/or being stored in a memory. Pre-stored load data or estimated load data can be used in combination with measured mode data, as described above.

[0019] More preferably, the control device comprises decision means configured to select the operation mode automatically based on load data. Such decision means may comprise a central processing unit (CPU) for processing the load data and, if necessary, additional data to take a decision on which operation mode is to be selected according to the present load situation.

[0020] According to another preferred embodiment of the present invention, the control device comprises selection means configured to select the operation mode by a human operator.

[0021] According to a preferred embodiment of the present invention, the plurality of operation mode comprises at least a first operation mode and a second operation mode, wherein in each of these two operation modes, one of the bottom drive and the top drive is operated first to extend the respective bottom ladder segments or top ladder segments completely, before the respective other of the bottom drive and the top drive starts operating. That is, in a first of these two operation modes, the bottom drive may be operated first to extend the bottom ladder segments, and if this extension operation is finished, the top drive is operated to extend the top ladder segments. In the respective second operation mode, the order of operating the top drive and the bottom drive is interchanged, i. e. the top drive is operated first, followed by the bottom drive.

[0022] Preferably, the top ladder set comprises at least a lower ladder segment and an upper ladder segment supported on the lower ladder segment, and the top drive is mounted at a front end of the bottom ladder segment for shifting the upper ladder segment with respect to the lower ladder segment.

[0023] More preferably, at least one of the bottom drive and the top drive is a winch.

BRIEF DESCRIPTION OF DRAWINGS

[0024] A preferred embodiment of the present invention will be described in more detail below with reference to the following drawings:

- Figure 1 is a schematic side view of a ladder system according to an embodiment of the present invention in a first operative condition; and
- Figure 2 is a schematic side view of the ladder of figure 1 in a second operative condition.

DETAILED DESCRIPTION OF THE INVENTION

[0025] The ladder system 10 shown in Fig. 1 comprises a plurality of ladder segments being telescopically extendable with regard to each other. These ladder segments are distributed into two different ladder sets, namely a bottom ladder set 12 which is mounted on top of a base part (not shown) of a vehicle and a top ladder set 14 which is supported on top of the bottom ladder set 12.

[0026] The bottom ladder set 12 comprises three ladder segments in total, which shall be designated as bottom ladder segments 16 in general. Correspondingly, the ladder segments disclosed within the top ladder set 14 shall be designated as top ladder segments 18. In the present embodiment, three bottom ladder segments 16 are provided to be telescopically extendable with regard to each other, while two top ladder segments 18 are provided.

[0027] The ladder set 10 comprises two telescopic drives for driving the extension of the respective ladder segments of the bottom ladder set 12 and the top ladder set 14, respectively. These two telescopic drives work independently, such that the bottom ladder segments 14 can be driven for themselves, without driving the top ladder segments 18 at the same time, which can be driven by their own telescopic drive, which will be further explained in the following. However, control means can be provided for controlling the operation of these independent drives with regard to each other and to coordinate the different extension movements of the bottom ladder set 12 in the top ladder set 14.

[0028] The telescopic drive comprises, as one example of a bottom drive, a bottom winch 20 for extending the bottom ladder segments 16 of the bottom ladder set 12. In the present embodiment, the bottom winch 20 is one example of a bottom drive and can be replaced by any other kind of bottom drive. To this purpose, a bottom extraction rope 22 is wound up on a reel of this bottom winch 20 and guided via deflection rollers (generally designated by reference 24) through the bottom ladder segments 26 and being fixed to a lower ladder segment 26 of the top ladder set 14. The guiding path of the extraction rope 22 can be chosen suitably, for example, as disclosed by EP 2 182 164 B1 in one of the embodiments shown therein, such that a pulling force exerted on the extraction rope 22 by rotation of the reel of the bottom winch 20 is

converted into a sliding movement of the bottom segments 16 with regard to each other, as demonstrated in Fig. 2. Since the upper end of the extraction rope 22 is fixed to the lower ladder segment 26 of the top ladder set 14, the top ladder set 14 as a whole, with all its top ladder segments 18 included, is shifted in a front end direction (horizontal direction to the right in Fig. 1 and 2) i. e. away from the bottom winch 20 so as to join the extension movement of the bottom ladder set 12. It is noted that this extension movement, caused by the operation of the bottom winch 20, does not include any extension movement of an upper ladder segment 28 of the top ladder segments 18 with respect to a lower ladder segment 26, on which it is supported.

[0029] The telescopic drives of the present ladder system 10 further comprise a top winch 30 mounted on the front end of the lower ladder segment 26 of the top ladder segments 14. In the present embodiment, the top winch 30 is one example of a top drive and can be replaced by any other kind of top drive. This top winch 30 is configured to pull a top extraction rope 32 wound on a reel of the top winch 30, with its end being fixed at a rear end of the upper ladder segment 28. A pulling force is generated by a rotation of a reel of the top winch 30 is transmitted via the top extraction rope 32 to the upper ladder segment 28, such that the upper ladder segment 28 is shifted with respect to the lower ladder segment 26, resulting in a telescopic extension of the top ladder set 14, independent from any extension movement of the bottom ladder set 12.

[0030] It is noted that the upper ladder segment 28 carries a rescue cage 34 at its free end. The upper ladder segment 28 is divided into a front portion 36 and a rear portion 38, wherein the front portion 36, carrying the rescue cage 34, can be articulated downward (as indicated in Fig. 1) by means of an articulation drive 40. The following description shall refer to the case in which the front portion 36 and the rear portion 38 are disposed in a straight line, such that the upper ladder segment 28 can be shifted in top of the lower ladder segment 26.

[0031] It is further noted that the bottom ladder set 12 and the top ladder set 14 each comprise a retraction rope 42, 44, respectively, which is also connected to the respective winch, namely the bottom winch 20 or the top winch 30, such as to reverse the extension movement and to retract the respective ladder set 12 or 14 by turning the reel of the respective winch 20 or 30 in the opposite direction.

[0032] The ladder system 10 further comprises a control device (not shown in the figures) to operate both telescopic drives independent of each other but in a predetermined order, depending on the selection of one of a plurality of operation modes. This selection depends on a load or different loads acting on the ladder system 10 in a state in which it is at least partially extended, or fully extended. The loads are either estimated or calculated from the present position of the ladder segments comprises within the ladder system 10. They can be stored

in a memory to be derived from it according to the position of the ladder system 10.

[0033] These load data reflect a present load situation, according to which the operation mode is selected. This selection can be formed automatically by the control device. To this purpose, the control device may comprise a decision means, like a central processing unit (CPU) or the like, which is configured to select the operation mode automatically based on the load data. It is also possible that the control device comprises selection means configured to select the operation mode by a human operator. Such selection means can be provided, for example, as a switch to choose between two operation modes, or any other input means, according to the present load situation which may be indicated by a display of the control device.

[0034] These operation modes correspond to different orders of operating the bottom winch 20 and the top winch 30. In a first operation mode, which is demonstrated in Fig. 1, the top winch 30 is operated first to extend the top ladder segments 18 with respect to each other, while the bottom winch 20 is not operated, with the result that the bottom ladder set 12 keeps its retracted position during the telescopic extraction of the top ladder set 14. After the top ladder set 14 is extracted at least partially, the operation of the bottom winch 20 may start to extract the bottom ladder segments 16.

[0035] In a second operation mode, the order of operation of the bottom winch 20 and the top winch 30 is reversed. This is demonstrated in Fig. 2. In this case the bottom winch 20 is operated first, to extract the bottom ladder segments 16, while the top ladder segments 18 are not extended with respect to each other. In a situation in which the bottom ladder segments 18 have been extended at least partially or completely, the top ladder segments 18 may also start to extract with regard to each other by operation of the top winch 30.

[0036] Since the upper ladder segment 28 carries the rescue cage 34, it is prone to torsion forces. To keep the stiffness and stability of the top ladder set 14, it is advantageous to keep its top ladder segments 18 in their retracted state as far as possible during extension of the ladder system 10. This is possible by an operation in the second operation mode. The stability of the upper ladder segment 28 can be increased by mechanical guiding means providing a sliding engagement of the upper ladder segment 28 with the lower ladder segment 26 in or near the retracted position of the upper ladder segment 28 with respect to the lower ladder segment 26. In the second operation mode, this engagement can be maintained as long as possible during the extension of the bottom ladder set 12. One of these two operation modes (including the first operation mode and the second operation mode, as described above) can be selected corresponding to the different loads acting on the ladder system, according to load data acquired as described above. Different loads may be caused, for example, by changing the number of persons carried in the rescue cage 34, or

by changing the articulation position of ladder system 10, which is shown in a horizontal position in Fig. 1 and 2 but can be lifted around a horizontal axis such that the rescue cage 34 is elevated, and all ladder segments are inclined. Torsion acting on the ladder segments as well as heavy asymmetrical loads may influence the load situation. For standard loads and a maximum outreach of the top ladder set 14, the top ladder segments 18 may be extended first, while for heavy loads, only the bottom ladder set 12 may be extended. In some embodiments, the top ladder segments 18 may have a lighter weight than the bottom ladder segments 16, such that an extension of the top ladder segments 18 by operating the top winch 30 may not cause excessive load to the ladder system 10.

Claims

1. Ladder system (10) for hoisting rescue vehicles, comprising a plurality of ladder segments being telescopically extendable with regard to each other, **characterized by** a bottom ladder set (12) mounted on top of a base part of the vehicle and an top ladder set (14) supported on top of the bottom ladder set (12), each of the bottom ladder set (12) and the top ladder set (14) comprising a plurality of ladder segments, wherein the ladder system comprises two independent telescopic drives for driving the extension of the respective ladder segments of the bottom ladder set (12) and the top ladder set (14), wherein the telescopic drives comprise a bottom drive (20) for extending the bottom ladder segments (16) of the bottom ladder set (12) and a top drive (30) for extending the top ladder segments (18) of the top ladder set (14) and being mounted to the top ladder set (14).
2. Ladder system according to claim 1, **characterized by** a control device to operate both telescopic drives independent of each other and configured to start the operation of the bottom drive (20) and the top drive (30) in a predetermined order depending on one of a plurality of operation modes of the control device.
3. Ladder system according to claim 2, **characterized in that** the operation modes correspond to different loads acting on the ladder system in an at least partially extended state.
4. Ladder system according to claim 3, **characterized in that** the loads are derived from load data measured during operation of the ladder system.
5. Ladder system according to claim 3 or 4, **characterized in that** the loads are derived from load data acquired by estimation or calculation and/or being stored in a memory.

6. Ladder system according to one of claims 2 to 5,
characterized in that the control device comprises
decision means configured to select the operation
mode automatically based on load data.
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7. Ladder system according to one of claims 2 to 6,
characterized in that the control device comprises
selection means configured to select the operation
mode by a human operator.
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8. Ladder system according to one of claims 2 to 7,
characterized in that the plurality of operation
modes comprises at least a first operation mode and
a second operation mode, wherein in each of these
two operation modes, one of the bottom drive (20)
and the top drive (30) is operated first to extend the
respective bottom ladder segments (16) or top ladder
segments (18) completely, before the respective oth-
er of the bottom drive (20) and the top drive (30)
starts operating.
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9. Ladder system according to one of the preceding
claims, **characterized in that** the top ladder set (18)
comprises a lower ladder segment (26) and an upper
ladder segment (28) supported on the lower ladder
segment (26), and the top drive (30) is mounted at
a front end of the bottom ladder segment (26) for
shifting the upper ladder segment (28) with respect
to the lower ladder segment (26).
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10. Ladder system according to one of the preceding
claims, **characterized in that** at least one of the bot-
tom drive (20) and the top drive (30) is a winch.

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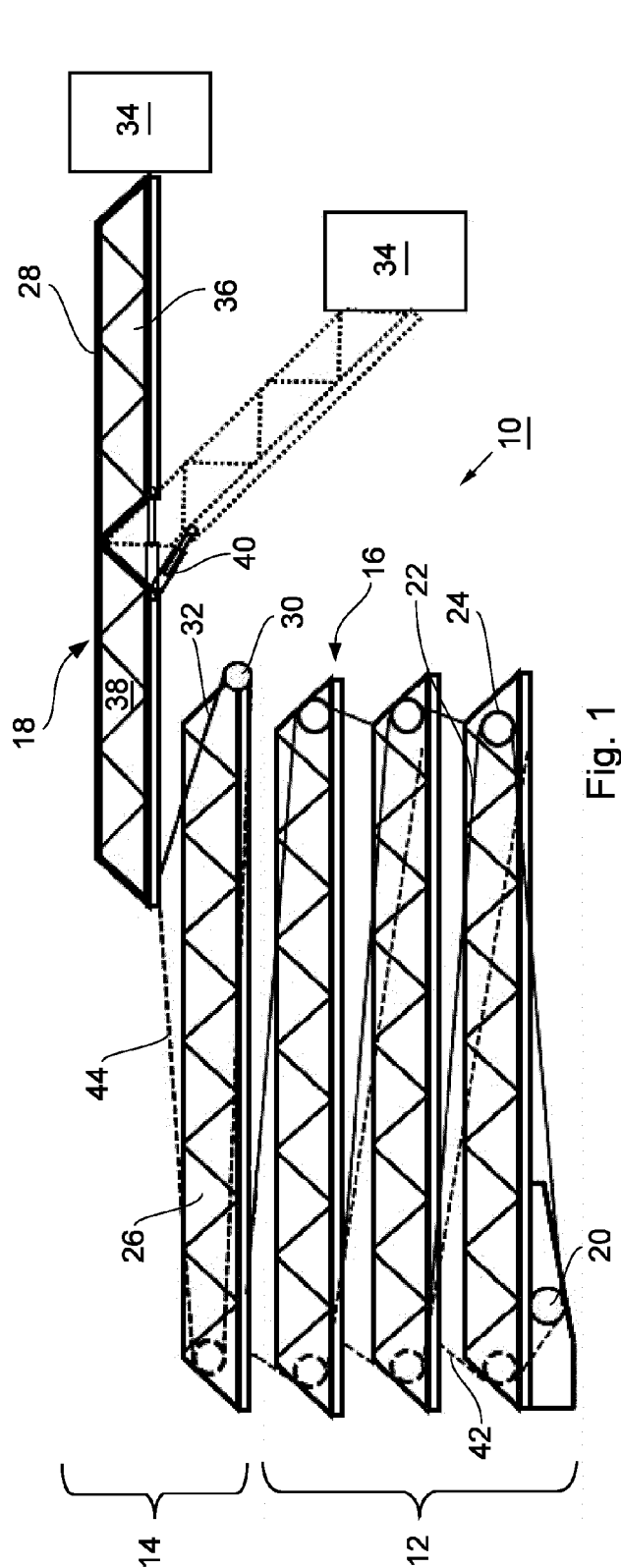


Fig. 1

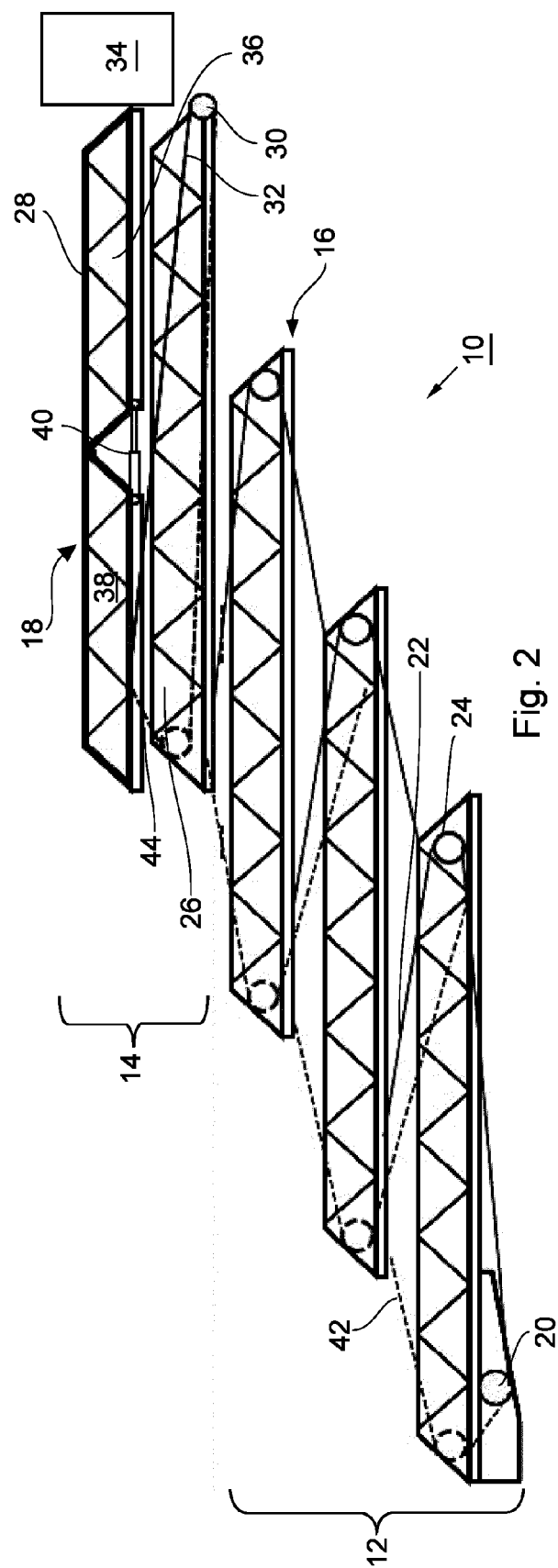


Fig. 2



EUROPEAN SEARCH REPORT

Application Number
EP 19 18 2723

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
			E06C
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 7 November 2019	Examiner Bauer, Josef
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 19 18 2723

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07-11-2019

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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