(19) Europäisches Patentamt
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(11) **EP 2 223 840 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
01.09.2010 Bulletin 2010/35

(51) Int Cl.:
B61B 12/02 *(2006.01)*

(21) Application number: **10154884.0**

(22) Date of filing: **26.02.2010**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
AL BA RS

(30) Priority: **26.02.2009 IT MI20090287**

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(54) **Cable transportation system control method, and cable transportation system**

(57) A method of controlling a cable transportation system (1) having a tensioned cable (6) looped about at least a first pulley (4) movable along a given path (P1), and about a second pulley (5); and transportation units (7) connectable selectively to the cable (6). The method provides for selecting between a first control mode, in which the tension of the cable (6) is kept within a first assigned range (I_T) by adjusting the position of the first pulley (4) along the given path (P1), and a second control mode, in which the position of the first pulley (4) along the given path (P1) is kept within a second assigned range (I_P).

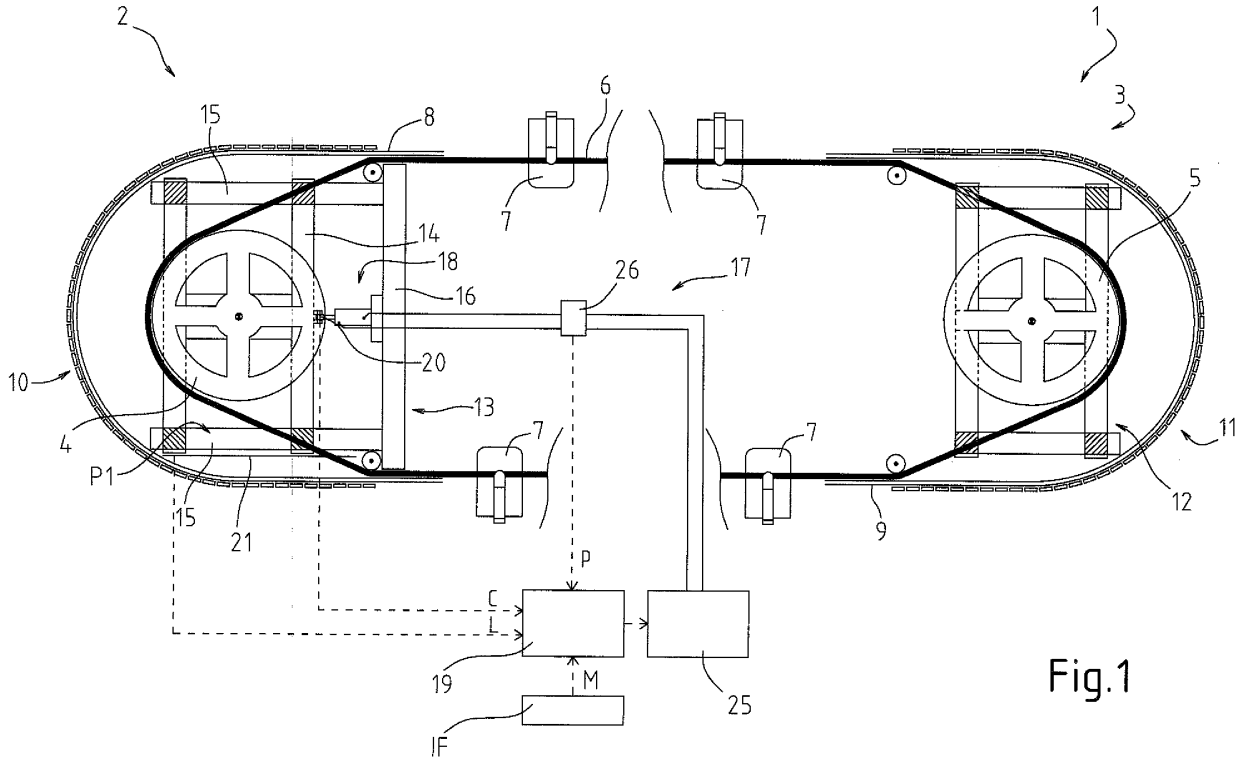

Fig.1

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Description

[0001] The present invention relates to a cable transportation system control method, and to a cable transportation system.

[0002] More specifically, the present invention relates to a method of controlling a cable transportation system comprising a tensioned cable looped about at least a first pulley movable along a given path, and about a second pulley; and transportation units connectable selectively to the cable.

[0003] Cable transportation systems of the above type include detachable cable transportation systems, and are designed to operate in a work condition, in which the system runs the transportation units cyclically between a first and second turnaround station; in a bare-cable condition, in which there are no transportation units on the cable; in a first transient condition from bare-cable to work condition; and in a second transient condition from work to bare-cable condition.

[0004] The cable tension of cable transportation systems of the above type varies widely as a function of load, which depends on the number of transportation units connected to the cable, occupancy of the units, and system operating condition. The first and second transient conditions are especially critical.

[0005] As stated in EP 1,364,852, regardless of the operating condition of the cable transportation system, known control methods provide for continuously adjusting the position of the first pulley along the given path, for maintaining a constant cable tension.

[0006] Using known methods, the cable transportation system must have fairly long structures for the given path of the first pulley, the adjustment travel of which increases with the length of the span. Sometimes, however, the space available at a turnaround station of the system is not enough to accommodate the necessary given path.

[0007] It is an object of the present invention to provide a cable transportation system control method designed to eliminate the drawbacks of the known art.

[0008] Another object of the present invention is to provide a cable transportation system control method designed to guarantee safe operation of the system.

[0009] According to the present invention, there is provided a cable transportation system control method, the cable transportation system comprising a tensioned cable, preferably a load-bearing draw cable, looped about at least a first pulley movable along a given path, and about a second pulley; and transportation units connectable selectively to the cable; and the method comprising the step of selecting between a first control mode, in which the tension of the cable is kept within a first assigned range by adjusting the position of the first pulley along the given path, and a second control mode, in which the position of the first pulley along the given path is kept within a second assigned range.

[0010] Another object of the present invention is to provide a cable transportation system designed to eliminate the drawbacks of the known art.

[0011] According to the present invention, there is provided a cable transportation system comprising a tensioned cable looped about at least a first pulley movable along a given path, and about a second pulley; transportation units connectable selectively to the cable; and a control device comprising an actuator connected to the first pulley to selectively control the cable transportation system in a first control mode, in which the tension of the cable is kept within a first assigned range by adjusting the position of the first pulley along the given path, or in a second control mode, in which the position of the first pulley along the given path is kept within a second assigned range.

[0012] A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a schematic top plan view, with parts removed for clarity, of a cable transportation system in accordance with the present invention;

Figure 2 shows a larger-scale side view, with parts removed for clarity, of a detail of the Figure 1 cable transportation system.

[0013] Number 1 in Figure 1 indicates as a whole a cable transportation system comprising a first turnaround station 2; a second turnaround station 3; a first pulley 4 at first station 2; a second pulley 5 at second station 3; a tensioned cable 6 looped about first and second pulleys 4 and 5; and transportation units 7 - in the example shown, cars - connectable selectively to cable 6. In fact, cable transportation system 1 is a detachable cable transportation system, in which transportation units 7 at first and second turnaround stations 2 and 3 are detached from cable 6 and fed along respective first and second guides 8 and 9 by respective first and second auxiliary conveyor device 10 and 11.

[0014] The present invention also applies in general to non-detachable cable transportation systems.

[0015] Second pulley 5 is supported for rotation by a frame 12, and connected to a drive mechanism and a known electric motor not shown in the drawings.

[0016] First pulley 4 is fitted to a frame 13 and to a tension carriage 14 mounted to slide with respect to frame 13 along a given path P1, and is fitted in rotary manner to tension carriage 14, so that the position of first pulley 4 along given path P1 is defined by the position of tension carriage 14 along given path P1.

[0017] In the Figure 1 example, frame 13 comprises two guides 15 engaged by tension carriage 14; and a beam 16 crosswise to guides 15.

[0018] Cable transportation system 1 also comprises a control device 17 for controlling the tension of cable 6 and the position of tension carriage 14 along given path P1.

[0019] Control device 17 comprises an actuator 18; a control unit 19; a sensor 20 for emitting a signal C related

to the tension of cable 6; a sensor 21 for emitting a signal L related to the position of tension carriage 14 with respect to frame 13 along given path P1; and a user interface IF for sending control signals M to control unit 19.

[0020] Actuator 18 is located between beam 16 of frame 13 and tension carriage 14, and, in the example shown in the drawings, is a double-acting hydraulic cylinder connected to beam 16 and tension carriage 14 to move tension carriage 14 along given path P1. Actuator 18 is connected to tension carriage 14 by brackets 22 and 23 and a pin 24, which includes sensor 20, as shown in Figure 2. The sensor 20 preferably is a load cell.

[0021] Actuator 18 is controlled by a hydraulic central control unit 25 in turn controlled by control unit 19, and control device 17 comprises a further sensor 26 for detecting the delivery pressure of hydraulic central control unit 25.

[0022] Cable transportation system 1 is designed in general to operate in the following conditions:

a) a work condition, in which cable transportation system 1 feeds transportation units 7 cyclically between first and second turnaround stations 2 and 3;
b) a bare-cable condition, in which there are no transportation units 7 on cable 6;
c) a first transient condition from bare-cable to work condition - better known and referred to hereinafter as startup condition; and
d) a second transient condition from work to bare-cable condition - better known and referred to hereinafter as stand-down condition.

[0023] In stand-down condition, transportation units 7 are gradually detached and directed to a store - not shown in the drawings, and located at either of first and second turnaround stations 2, 3 - to switch to bare-cable condition.

[0024] Likewise, startup condition takes a certain length of time to switch from bare-cable condition to work condition.

[0025] Control device 17 can operate in a first control mode, in which the tension of cable 6 is kept within a tension range I_T by adjusting the position of tension carriage 14, and in a second control mode, in which the position of tension carriage 14 along given path P1 is kept within a position range I_P.

[0026] Both tension range I_T and position range I_P are preferably relatively small.

[0027] By means of signals M, user interface IF provides for entering commands indicating one of conditions a) to d) of cable transportation system 1, or one of the first and second control modes.

[0028] Control unit 19 receives signals C, L, P and M, and controls actuator 18 accordingly.

[0029] The first control mode of cable 6 is used when cable transportation system 1 is in condition a).

[0030] The second control mode of cable 6 is used when cable transportation system 1 is in any one of conditions b) to d).

[0031] In the first control mode of cable 6 and in work condition, control unit 19 checks cyclically that signal C is within an assigned range I_C of tension range I_T. When signal C deviates from the assigned range I_C, control unit 19 operates actuator 18 to correct the position of tension carriage 14 along given path P1 until signal C returns within the assigned range I_C. When and as long as signal C is within the assigned range I_C, the position of tension carriage 14 remains unchanged.

[0032] In cable transportation system 1 in work condition, signal C indicating the tension of cable 6 would vary as a function of passenger load within a range of $C_0 \pm X$, where C_0 is the value of the signal corresponding to the desired tension of cable 6, and X is the variation induced by the presence of passengers in transportation units 7. Range I_C is a sub-range of $C_0 \pm X$ centred about C_0. Before switching cable transportation system 1 to work condition, control unit 19 commands actuator 18 to position tension carriage 14 so that signal C equals C_0.

[0033] Before switching to startup and stand-down conditions c) and d), control unit 19 commands actuator 18 to position tension carriage 14 so that signal C equals C_{temp}.

[0034] In startup and stand-down conditions c) and d), control unit 19 checks cyclically that signal L is within an assigned range I_L of $LA \pm x1$ related to position range I_P, and commands actuator 18 to keep tension carriage 14 within position range I_P.

[0035] Before switching cable transportation system 1 to stand-down condition, control unit 19 positions tension carriage 14 so that signal C equals C_{temp}, which in this case equals $C_0 - X$.

[0036] In conditions a) to d) of cable transportation system 1, control unit 19 checks cyclically that signal C indicating the tension of cable 6 is above a value C_{min}.

[0037] According to the present invention, the given path P1 along which tension carriage 14 moves is much shorter than in the known art, which means it is no longer necessary to provide larger turnaround stations simply to provide enough room for the adjustment travel of tension carriage 14. This advantage is made possible by controlling the cable transportation system in two distinct modes.

Claims

1. A cable transportation system control method, the cable transportation system (1) comprising a tensioned cable (6), preferably a load-bearing draw cable, looped about at least a first pulley (4) movable along a given path (P1), and about a second pulley (5); and transportation units (7) connectable selectively to the cable (6); and the method comprising the step of selecting between a first control mode, in which the tension of the cable (6) is kept within a first assigned range (I_T) by adjusting the position of the

first pulley (4) along the given path (P1), and a second control mode, in which the position of the first pulley (4) along the given path (P1) is kept within a second assigned range (I_P).

2. A cable transportation system control method as claimed in Claim 1, and comprising the step of determining the position of the first pulley (4) along said given path (P1).

3. A cable transportation system control method as claimed in Claim 1 or 2, and comprising the step of determining the tension of the cable (6).

4. A cable transportation system control method as claimed in any one of the foregoing Claims, wherein the cable transportation system (1) is suitable for operating in a work condition, in which the cable transportation system (1) feeds the transportation units (7) cyclically between a first (2) and second (3) turnaround station; in a bare-cable condition, in which there are no transportation units (7) on the cable (6); in a first transient condition from bare-cable condition to work condition; and in a second transient condition from work condition to bare-cable condition; the method comprising the step of using the first control mode when the cable transportation system (1) is in the work mode.

5. A cable transportation system control method as claimed in Claim 4, and comprising the step of using the second control mode when the cable transportation system (1) is in the first and second transient condition.

6. A cable transportation system control method as claimed in Claim 4 or 5, and comprising the step of positioning the first pulley (4) along the given path (P1) so that the tension of the cable (6) equals an assigned temporary tension (C_{temp}), before the cable transportation system (1) switches to the first or second transient condition.

7. A cable transportation system (1) comprising a tensioned cable (6) looped about at least a first pulley (4) movable along a given path (P1), and about a second pulley (5); transportation units (7) connectable selectively to the cable (6); and a control device (17) comprising an actuator (18) connected to the first pulley (4) to selectively control the cable transportation system (1) in a first control mode, in which the tension of the cable (6) is kept within a first assigned range (I_T) by adjusting the position of the first pulley (4) along the given path (P1), or in a second control mode, in which the position of the first pulley (4) along the given path (P1) is kept within a second assigned range (I_P).

8. A cable transportation system as claimed in Claim 7, wherein said control device (17) comprises a control unit (19) for controlling the actuator (18).

9. A cable transportation system as claimed in Claim 7 or 8, and comprising a first sensor (20) for determining the tension of the cable (6).

10. A cable transportation system as claimed in any one of Claims 7 to 9, and comprising a second sensor (21) for determining the position of the first pulley (4) along said given path (P1).

11. A cable transportation system as claimed in any one of Claims 7 to 10, and comprising a frame (13); and a tension carriage (14) supporting the first pulley (4); said actuator (18) being connected to the frame (13) and to the tension carriage (14) to move the first pulley (4) along the given path (P1).

12. A cable transportation system as claimed in Claims 9 and 11, wherein said first sensor (20) is located between the actuator (18) and the tension carriage (14), or between the actuator (18) and said frame (13); the first sensor (20) preferably being a load cell.

13. A cable transportation system as claimed in any one of Claims 7 to 12, wherein the actuator (18) is a double-acting hydraulic cylinder; the control device (17) comprising a hydraulic central control unit (25), which is controlled by the control device (17) and controls the hydraulic cylinder by delivery pressure.

14. A cable transportation system as claimed in Claim 13, and comprising a third sensor (26) for determining the delivery pressure of the hydraulic central control unit (25); the control device (17) controlling the hydraulic central control unit (25) as a function of the delivery pressure of the hydraulic central control unit (25).

15. A cable transportation system as claimed in any one of Claims 7 to 14, wherein the control device (17) comprises a user interface (IF) for transmitting commands to the control device (17).

16. A cable transportation system as claimed in any one of Claims 7 to 15, wherein said cable (6) is a load-bearing draw cable.

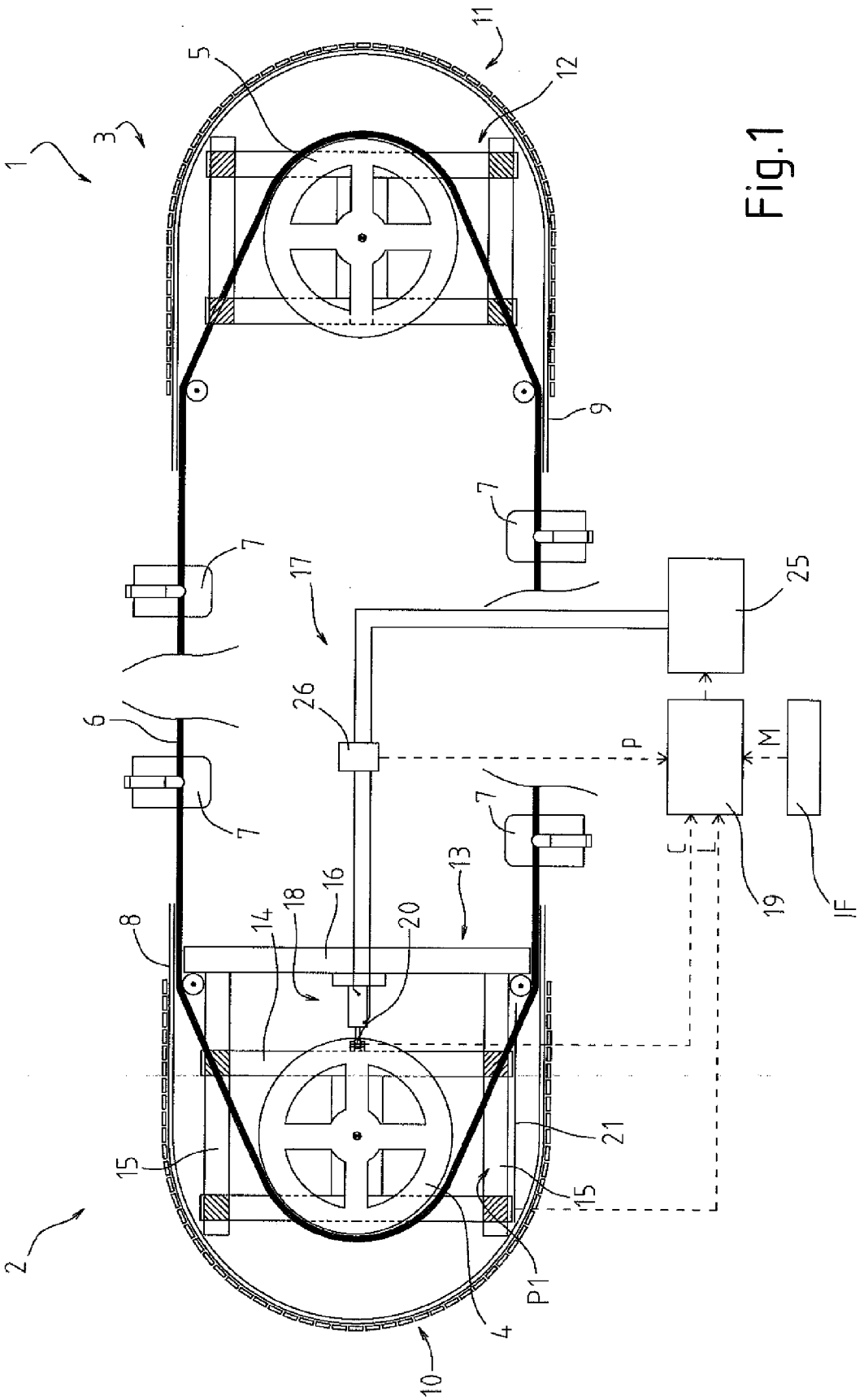
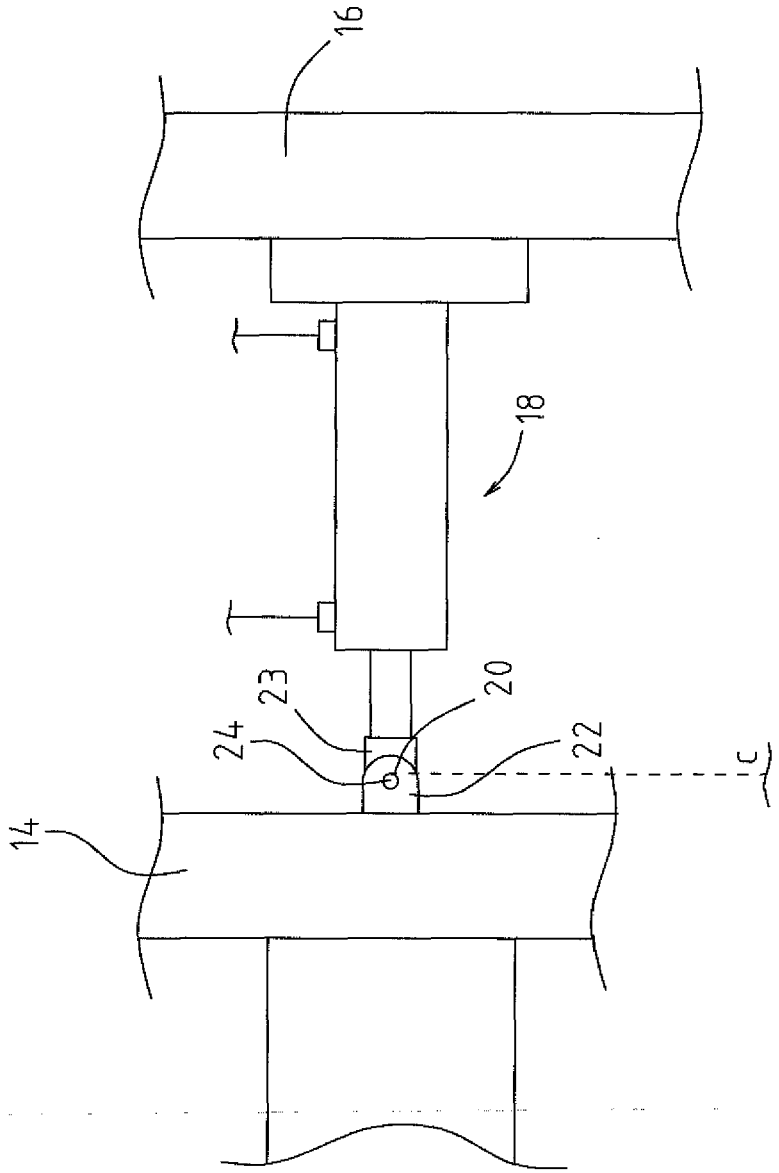


Fig.1

Fig.2



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EUROPEAN SEARCH REPORT

Application Number
EP 10 15 4884

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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
Munich	20 April 2010	Lorandi, Lorenzo

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