(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 730 531 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
14.05.2014 Bulletin 2014/20

(51) Int Cl.:
B66C 13/06 *(2006.01)*

(21) Application number: **13191978.9**

(22) Date of filing: **07.11.2013**

(84) Designated Contracting States:
AL 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 RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **08.11.2012 IT MI20121903**

(71) Applicant: **Cifa S.P.A.**
20030 Senago, Milano (IT)

(72) Inventors:
- **Mantineo, Massimo**
  20023 Cerro Maggiore (MI) (IT)
- **Maini, Paolo Dario**
  20052 Monza (IT)
- **Resta, Ferruccio**
  20123 Milano (IT)
- **Ripamonti, Francesco**
  20036 Erba (CO) (IT)
- **Tosi, Alessandro**
  20146 Milano (IT)

(74) Representative: **Petraz, Gilberto Luigi et al**
GLP S.r.l.
Viale Europa Unita, 171
33100 Udine (IT)

(54) Apparatus and corresponding method to control the vibrations of an articulated arm

(57) Apparatus to actively control the vibrations of an articulated arm, for example for pumping concrete, consisting of a plurality of segments pivoted to each other in correspondence to their own pivoting ends and of drive actuators each cooperating with two of said segments in order to extend and/or fold back the articulated arm. Each of the drive actuators is connected to a drive circuit in order to act on a vertical plane substantially defined by the two segments of the articulated arm to which it is associated. Said apparatus also comprises at least one auxiliary actuator associated to at least one of said segments of the articulated arm in proximity to at least one of the pivoting ends, said auxiliary actuator being provided with at least two operative ends, each of said operative ends being connected to a corresponding support, said supports being provided on said segment distanced to each other along the longitudinal development of said corresponding segment and defining, on the segment, respective application zones, said auxiliary actuator being selectively activable to induce, in said application zones, compensation forces acting on a damping plane which is different from said vertical plane.

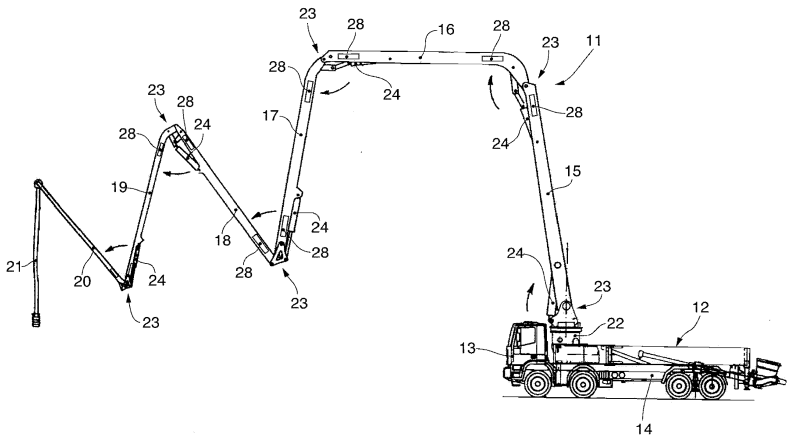

fig. 2

EP 2 730 531 A1

Description

FIELD OF THE INVENTION

[0001] The present invention concerns an apparatus, and the corresponding method, to control the vibrations of an articulated arm, in particular but not only used for pumping concrete and associated with transport vehicles in so-called truck-mounted pumps.

[0002] More particularly, the invention concerns an apparatus for active control used to reduce the vibrations to which the various segments of an articulated arm are subjected, which articulated arm is used for pumping concrete in operating machines such as for example truck-mounted pumps, concrete mixer trucks or suchlike. A device to control the vibrations of an articulated arm to pump concrete is disclosed in EP-A-2347988.

BACKGROUND OF THE INVENTION

[0003] Heavy work vehicles are known, used in the building trade, normally consisting of a truck on which an articulated arm is mounted to distribute and cast concrete. The trucks may or may not be equipped with a concrete mixer.

[0004] Extendible articulated arms of a known type consist of a plurality of segments pivoted to each other at the respective ends and able to be folded back on each other, by driving suitable actuators, so they can assume a folded configuration, close up to the truck, and work configurations that allow them to reach areas that can even be very far from the truck.

[0005] One of the most important characteristics of these extendible arms is, on the one hand, they are able to reach the greatest possible heights and/or lengths, so as to guarantee maximum flexibility and versatility with the same truck and, on the other hand, they can reduce the weight, given the same overall length.

[0006] It is also known that one disadvantage for the correct operations of such arms, which as the overall length and/or lightness of the arm and the number of segments increases becomes a more serious problem, is the phenomenon of oscillations, or rather vibrations, to which the arm is subjected in its entirety as the concrete is delivered and when the arm is moved. This disadvantage, magnified when arms made at least partly of carbon are used, entails considerable operating difficulties both for the operator responsible for the positioning and manual orientation of the exit pipe of the concrete, and also for the operator who moves the arm using remote control.

[0007] Furthermore, these vibrations limit the working life of the machine and reduce safety for the operators.

[0008] The vibrations, intended as oscillation forces, can be resolved both on a vertical plane in which the articulated arm in its extended condition is contained, that is, in the direction in which the actuators that move the arm act, and also in lateral directions, that is, inclined and substantially transverse with respect to the vertical plane.

[0009] An important contribution to the entity of these vibrations also derives from the type of these machines and the relative characteristics of inertia, elasticity and thinness, as well as the type of construction.

[0010] Furthermore, the forced pulsed functioning associated with the piston pump used for pumping the concrete is also added to these effects, which often takes place at frequencies near those of the machine itself.

[0011] Apparatuses are known for controlling and damping the vibrations of an articulated arm which provide that the action of controlling, reducing and possibly canceling the vibrations is performed by the drive actuators themselves, which move the articulated arm to open and close it. In this case, each of the actuators is connected to a hydraulic drive circuit, in order to drive the arm, and to an auxiliary control circuit, to control the vibrations to which the arm is subjected.

[0012] One disadvantage of these known apparatuses is that they are able to control and damp only the vibrations that are generated on the vertical plane defined by the articulated arm in its extended condition.

[0013] Purpose of the present invention is to obtain an apparatus, and corresponding method, to control and damp the vibrations of an articulated arm, which is able to improve the action of controlling and damping the vibrations of the articulated arm during use.

[0014] The Applicant has devised, tested and embodied the present invention to overcome the shortcomings of the state of the art and to obtain these and other purposes and advantages.

SUMMARY OF THE INVENTION

[0015] The present invention is set forth and characterized in the independent claims, while the dependent claims describe other characteristics of the invention or variants to the main inventive idea.

[0016] In accordance with the above purpose, a control apparatus according to the present invention, which overcomes the limitations of the state of the art and eliminates the defects present therein, is used to control and damp the vibrations of an articulated arm, for example used for pumping concrete.

[0017] The articulated arm consists of a plurality of segments pivoted to each other in correspondence with their pivoting ends, and of drive actuators each cooperating with one of the segments in order to extend and/or fold back the articulated arm.

[0018] Each of the drive actuators is connected to a drive circuit to act on a vertical plane defined substantially by the two segments of the arm to which it is associated.

[0019] According to one feature of the present invention, the control apparatus comprises at least one auxiliary actuator associated to at least a corresponding segment of the articulated arm in proximity to at least one of said pivoting ends. The auxiliary actuator is disposed so as to act on a damping plane which is different from said

vertical plane, so as to be selectively activated to damp the lateral vibrations to which the articulated arm can be subjected.

[0020] One or more auxiliary actuators are therefore associated with a corresponding segment to contrast and damp the lateral vibrations that known apparatuses using the same drive actuators are unable to contrast.

[0021] In one embodiment, the auxiliary actuator is provided with at least two operative ends, each of said operative ends being connected to a corresponding support. The supports are located on the corresponding segment distanced to each other along the longitudinal development of the segment and they define, on said segment, respective application zones. The auxiliary actuator is selectively activable to induce, in said application zones, compensation forces acting on a damping plane which is different from said vertical plane.

[0022] In one form of embodiment, each segment of the articulated arm is associated with one or more auxiliary actuators.

[0023] The auxiliary actuators are in addition to the drive actuators which, as we said, can damp only the vibrations that act on the vertical plane containing the segments.

[0024] This characteristic entails a greater control of the machine, both in terms of performance and in terms of safety for the operators.

[0025] According to another feature of the present invention, each of the auxiliary actuators is connected to a control circuit that is independent of the drive circuit.

[0026] Advantageously, the presence of the independent control circuit allows a greater control, safer and more effective, of the vibrations in question, since it is particularly configured for this application.

[0027] According to another feature of the present invention, the damping plane is orthogonal with respect to the vertical plane.

[0028] Therefore, the orthogonal disposition allows a consistent damping of the lateral vibrations to which the articulated arm is subjected.

[0029] According to another feature of the present invention, each of the auxiliary actuators is associated with an adjustment device able to adjust the inclination of the auxiliary actuator with respect to the corresponding segment of the articulated arm.

[0030] This allows to selectively adjust the direction in which the auxiliary actuator is disposed, so as to adapt the configuration of the auxiliary actuator as a function of the entity and/or direction of the lateral vibrations to which the articulated arm is subjected.

[0031] According to another feature of the present invention, each of the auxiliary actuators is able to be driven by drive components of the electrical type, associated with one or more sensors disposed in proximity to the pivoting ends and able to detect parameters necessary for the functioning of the electrical type component.

[0032] According to another feature of the present invention, each of the sensors is able to detect at least one parameter including amplitude of oscillation and frequency of oscillation of the pivoting end, and configuration of the articulated arm.

[0033] The control action is thus determined, for example, as a function of a mathematical algorithm that takes into consideration said three parameters.

[0034] According to a variant, each of the sensors is able to detect a speed of oscillation of the pivoting end on which it is disposed.

[0035] According to another feature of the present invention, each of the auxiliary actuators is able to be driven by drive components of the piezoelectric type, associated with one or more sensors disposed in proximity to the pivoting end.

[0036] Therefore, each of the components of a piezoelectric type is able to supply a force to the corresponding auxiliary actuator.

[0037] According to another feature of the present invention, each of the auxiliary actuators is connected to a voltage source outside the articulated arm.

[0038] For example, the external voltage source can be the 24V source already present on the vehicle on which the articulated arm is mounted for pumping concrete.

[0039] According to a variant, each of the auxiliary actuators is connected to a solar energy source. Advantageously, in this case, the auxiliary actuator does not need any electric supply.

[0040] The present invention also concerns a method to actively control the vibrations of an articulated arm, for example for pumping concrete, consisting of a plurality of segments pivoted to each other in correspondence with their pivoting ends, and of drive actuators each cooperating with two of the segments in order to extend and/or fold back the articulated arm. Each of the drive actuators is connected to a drive circuit to act on a vertical plane defined substantially by the two segments of the articulated arm to which it is associated.

[0041] According to one feature of the present invention, the method provides at least a damping step in which at least one auxiliary actuator, associated to at least one of the segments of the articulated arm in proximity to at least one of the pivoting ends, acts on a damping plane which is different from the vertical plane.

[0042] According to another feature of the present invention, the damping step comprises at least a first sub-step in which one or more sensors detect parameters associated to the corresponding pivoting end, a second sub-step in which the sensors send a signal to a drive component, and a third sub-step in which the drive component drives the auxiliary actuator.

BRIEF DESCRIPTION OF THE DRAWINGS

[0043] These and other characteristics of the present invention will become apparent from the following description of a preferential form of embodiment, given as a non-restrictive example with reference to the attached

drawings wherein:

- fig. 1 shows schematically an operating machine with an articulated arm, in a first configuration, for distributing concrete in which the control apparatus according to the present invention is applied;
- fig. 2 shows schematically the operating machine in fig. 1, in a second configuration;
- fig. 3 is a schematic view of an enlarged detail of the operating machine in figs. 1 and 2.

DETAILED DESCRIPTION OF ONE FORM OF EMBODIMENT

[0044] With reference to fig. 1, an extendible articulated arm 11, able to distribute concrete or analogous material for the building trade, is shown in a position mounted on a heavy work vehicle 12, in a folded condition used for transport, and comprises a control apparatus 10 to control and damp the vibrations to which the articulated arm 11 is subjected during working conditions.

[0045] The articulated arm 11 is configured to pass from the folded condition shown in fig. 1 to an extended condition, or work condition, of which an example is shown in fig. 2.

[0046] The heavy work vehicle 12 comprises a driver's cabin 13 and a support frame 14 on which the articulated arm 11 is mounted.

[0047] The articulated arm 11 comprises a plurality of articulated segments, for example, in the solution shown, six segments, respectively a first 15, a second 16, a third 17, a fourth 18, a fifth 19 and a sixth 20, pivoted to each other at their respective pivoting ends 23, and a flexible terminal segment 21, from the free end of which the concrete is delivered.

[0048] The first segment 15 is pivoted in a known manner to a turret 22 attached to the support frame 14 and is rotatable around a vertical axis by means of its own actuator so as to allow the end of the articulated arm 11 to reach all the points surrounding the turret 22.

[0049] In a known manner, and with systems that are not shown here, the combination of the segments 15-20 can thus be rotated, even by 360°.

[0050] When they are in the folded condition (fig. 1), the segments 15-20 of the articulated arm 11 are, in their entirety, disposed so as to occupy substantially the whole width of the heavy work vehicle 12.

[0051] From the work condition (fig. 2), it can be appreciated how the segments 15-20 are substantially disposed, in relation to the overall development of the articulated arm 11, on the same vertical movement plane, in any case considering the misalignment between the segments to allow them to be folded back into the transport condition.

[0052] It is clear that the vertical drive plane varies depending on the rotation of the turret 22.

[0053] The segments 15-20, as we said, are sequentially pivoted to each other at their respective pivoting ends 23 and can be driven individually, in the vertical plane, by means of their own drive actuators 24, in this case of the oil-dynamic type and disposed between the respective segments 15-20 in proximity to said pivoting ends 23.

[0054] Each drive actuator 24 is driven by a drive circuit 25 (fig. 3) commanded by an operator.

[0055] The drive actuators 24 can be connected not only to the drive circuit 25 but also to a control circuit 26, selectively activated to damp, in the vertical movement plane, vibrations that are generated along the articulated arm 11, especially in proximity to the pivoting ends 23 of each segment.

[0056] In the solution shown here by way of example, on each segment 15-20 there are also corresponding supports 27a, 27b on which a respective auxiliary actuator 28 is mounted, able to damp lateral vibrations that occur on the segment and more generally on the whole arm, especially in correspondence with the pivoting ends 23.

[0057] In particular, each of the auxiliary actuators 28 is provided with at least two operative ends 28a and 28b. Each operative ends 28a, and 28b is connected to one of the supports 27a, 27b. The supports 27a, 27b define corresponding application zones 127a and 127b of the forces of the auxiliary actuator 28.

[0058] The supports 27a, 27b are distanced to each other along the longitudinal development of the segment 15-20. Said auxiliary actuator 28 is selectively activable to induce, in the application zones 127a and 127b, compensation forces that are suitable to control the lateral vibration of the articulated arm 11 and, therefore, to prevent lateral oscillation of the latter with respect to the vertical plane.

[0059] In one embodiment of the present invention, the auxiliary actuator 28 is a linear actuator.

[0060] In other embodiments, the auxiliary actuator 28 is disposed and connected substantially parallel to the longitudinal development of the segment 15-20.

[0061] According to some embodiments of the present invention, the auxiliary actuator 28 is connected to the segment 15-20 laterally with respect to the cross section bulk of the segment 15-20.

[0062] The auxiliary actuator 28 induces compression or traction forces in the segment 15-20 and, in particular, in the area comprised between the two application zones 127a, 127b, that compensate the lateral vibrations that act on a plane different from that where the segments and the respective actuators lie.

[0063] In one embodiment at least one of the segment 15-20 has a tubular shape, is provided with a plurality of walls reciprocally connected to each other in a single body.

[0064] According to one embodiment, the auxiliary actuator 28 is connected to one of the walls of the segment 15-20 that lie on a plane substantially parallel with respect to the vertical plane. In other words, the auxiliary actuator 28 is not connected to the extrados or intrados walls of

the segment 15-20, on which the action of the auxiliary actuator 28 is not effective for the lateral oscillations.

[0065] The auxiliary actuator 28 can be disposed on the external side of the respective wall, as disclosed in fig. 3 or, according to a variant not shown, can be disposed on the internal side of the wall.

[0066] The lateral vibrations can be generated for example by windy atmospheric conditions or other unfavorable atmospheric conditions, or by particular configurations of the articulated arm 11.

[0067] It comes within the field of the invention to provide that not all the segments are equipped with the auxiliary actuator 28.

[0068] It also comes within the field of the invention to provide that one segment is equipped with two or more auxiliary actuators 28, all acting in a respective plane, different from the movement plane where the drive actuators 24 act.

[0069] In this case, in order to damp the lateral vibrations, each auxiliary actuator 28 is disposed with its longitudinal development parallel to the vertical plane on which the drive actuator 24 acts.

[0070] The lateral forces in play during the lateral vibrations of the structure are generally less than those that act in the vertical plane. This characteristic allows to use auxiliary actuators 28 of a type different from oil-dynamic ones.

[0071] In this case, and merely by way of example, the auxiliary actuators 28 are the electrical type, for example driven by drive components, such as an electric motor 29 connected to one or more sensors 30 able to detect three parameters, that is, the amplitude and frequency of vibration of the corresponding pivoting end 23 and the configuration of the articulated arm 11.

[0072] In this case, the control circuit 26 is connected both to the electric motor 29 and also to the sensor 30, so as to drive the auxiliary actuator 28.

[0073] The control apparatus 10 also comprises a supply source, in this case advantageously already present on the heavy work vehicle 12, which for example could be the 24V power source, not shown in the drawings, to supply the electric motor 29.

[0074] According to a variant, the control apparatus 10 comprises a solar energy supply source.

[0075] According to a variant, the sensor 30 connected to the electric motor 29 that drives the auxiliary actuator 28 is the type able to detect the speed of oscillation of the attachment points of the auxiliary actuator 28. In this case too, the control apparatus 10 comprises a voltage source already present on the heavy work vehicle 12 or a solar energy source.

[0076] According to a variant, the auxiliary actuators 28 are the piezoelectric type, exploiting the deformation of a piezoelectric element disposed near the pivoting end 23 of the corresponding segment. In this case, the piezoelectric element is able to supply a force able to drive the corresponding auxiliary actuator 28, depending on the deformation to which it is subjected. Advantageously, in this case the supply source is not required.

[0077] The control apparatus 10 described is very simple to instal and at the same time allows to damp the lateral vibrations that known apparatuses are not configured to damp.

[0078] Furthermore, the combination on one hand of the orientation and on the other hand the type of auxiliary actuators 28 confers a limited bulk on the control apparatus 10 and the articulated arm 11 in its entirety.

[0079] It is clear that modifications and/or additions of parts may be made to the control apparatus as described heretofore, without departing from the field and scope of the present invention.

[0080] It is also clear that, although the present invention has been described with reference to some specific examples, a person of skill in the art shall certainly be able to achieve many other equivalent forms of control apparatus, having the characteristics as set forth in the claims and hence all coming within the field of protection defined thereby.

Claims

1. Apparatus to actively control the vibrations of an articulated arm (11), for example for pumping concrete, said articulated arm (11) comprising a plurality of segments (15-20) pivoted to each other in correspondence to pivoting ends (23) of said segments (15-20), and drive actuators (24) each cooperating with two of said segments (15-20) in order to extend and/or fold back said articulated arm (11), each of said drive actuators (24) being connected to a drive circuit (25) in order to act on a vertical plane substantially defined by the two segments (15-20) of said articulated arm (11) to which it is associated, **characterized in that** it comprises at least one auxiliary actuator (28) associated to at least one of said segments (15-20), said auxiliary actuator (28) being provided with at least two operative ends (28a, 28b), each of said operative ends (28a, 28b) being connected to a corresponding support (27a, 27b), said supports (27a, 27b) being provided on said segment (15-20) distanced to each other along the longitudinal development of said corresponding segment (15-20) and defining, on the segment (15-20), respective application zones (127a, 127b), said auxiliary actuator (28) being selectively activable to induce, in said application zones (127a, 127b), compensation forces acting on a damping plane which is different from said vertical plane.

2. Apparatus as in claim 1 or 2, **characterized in that** said auxiliary actuator (18) is associated, to the corresponding segment (15-20), in proximity to at least one of said pivoting ends (23).

3. Apparatus as in claim 1 or 2, **characterized in that**

each of said auxiliary actuators (28) is connected to a control circuit (26) which is independent from said drive circuit (25).

4. Apparatus as in claim 1, 2 or 3, **characterized in that** said damping plane is orthogonal to said vertical plane.

5. Apparatus as in any claim hereinbefore, **characterized in that** each of said auxiliary actuators (28) is associated to an adjustment device able to adjust the orientation of said auxiliary actuator (28) with respect to the corresponding segment (15-20).

6. Apparatus as in any claim hereinbefore, **characterized in that** each of said auxiliary actuators (28) is able to be driven by drive components (29) of the electrical type associated to one or more sensors (30) disposed in proximity to said pivoting end (23) and able to detect parameters for the functioning of said drive components (29) of the electrical type.

7. Apparatus as in claim 5, **characterized in that** each of said one or more sensors (30) is able to detect at least a parameter including amplitude of oscillation and frequency of oscillation of said pivoting end (23), and configuration of said articulated arm (11).

8. Apparatus as in claim 5 or 6, **characterized in that** each of said one or more sensors (30) is able to detect an oscillation speed of said pivoting ends (23) on which it is disposed.

9. Apparatus as in any claim hereinbefore, **characterized in that** each of said auxiliary actuators (28) is able to be driven by drive components of the piezoelectric type associated to one or more sensors disposed in proximity to said pivoting end (23).

10. Apparatus as in claim 9, **characterized in that** each of said components of the piezoelectric type is able to supply a force to said auxiliary actuator (28).

11. Apparatus as in any claim hereinbefore, **characterized in that** each of said auxiliary actuators (28) is connected to a voltage source outside said articulated arm (11).

12. Apparatus as any claim hereinbefore, **characterized in that** each of said auxiliary actuators (28) is connected to a solar energy source.

13. Method to actively control the vibrations of an articulated arm (11), for example for pumping concrete, consisting of a plurality of segments (15-20) pivoted to each other in correspondence with their own pivoting ends (23), and of drive actuators (24) each cooperating with two of said segments (15-20) in order to extend and/or fold back said articulated arm (11), each of said drive actuators (24) being connected to a drive circuit (25) in order to act on a vertical plane substantially defined by the two segments (15-20) of said articulated arm (11) to which it is associated, **characterized in that** it comprises at least a damping step in which at least one auxiliary actuator (28) selectively induces to at least one of said segments (15-20) compensation forces acting on a damping plane which is different from said vertical plane, said auxiliary actuator (28) being provided with at least two operative ends (28a, 28b), each of said operative ends (28a, 28b) being connected to a corresponding support (27a, 27b), said supports (27a, 27b) being provided on said segment (15-20) distanced to each other along the longitudinal development of said segment (15-20) and defining, on said segment (15-20), respective application zones (127a, 127b) where said compensation forces act.

14. Method as in claim 13, **characterized in that** said damping step comprises at least a first sub-step in which one or more sensors (30) detect parameters associated to the corresponding pivoting end (23), a second sub-step in which said sensors (30) send a signal to a drive component (29), and a third sub-step in which said drive component (29) drives said auxiliary actuator (28).

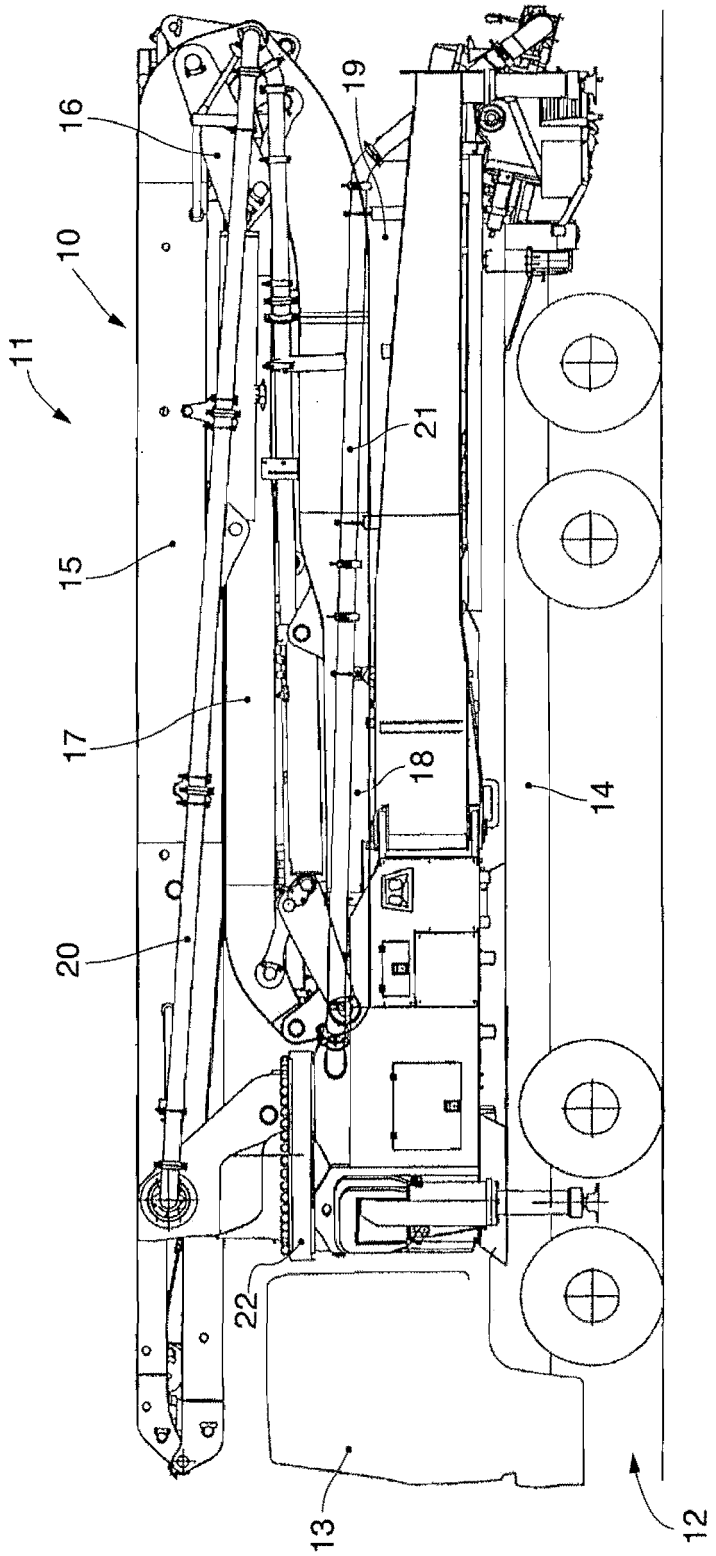

fig. 1

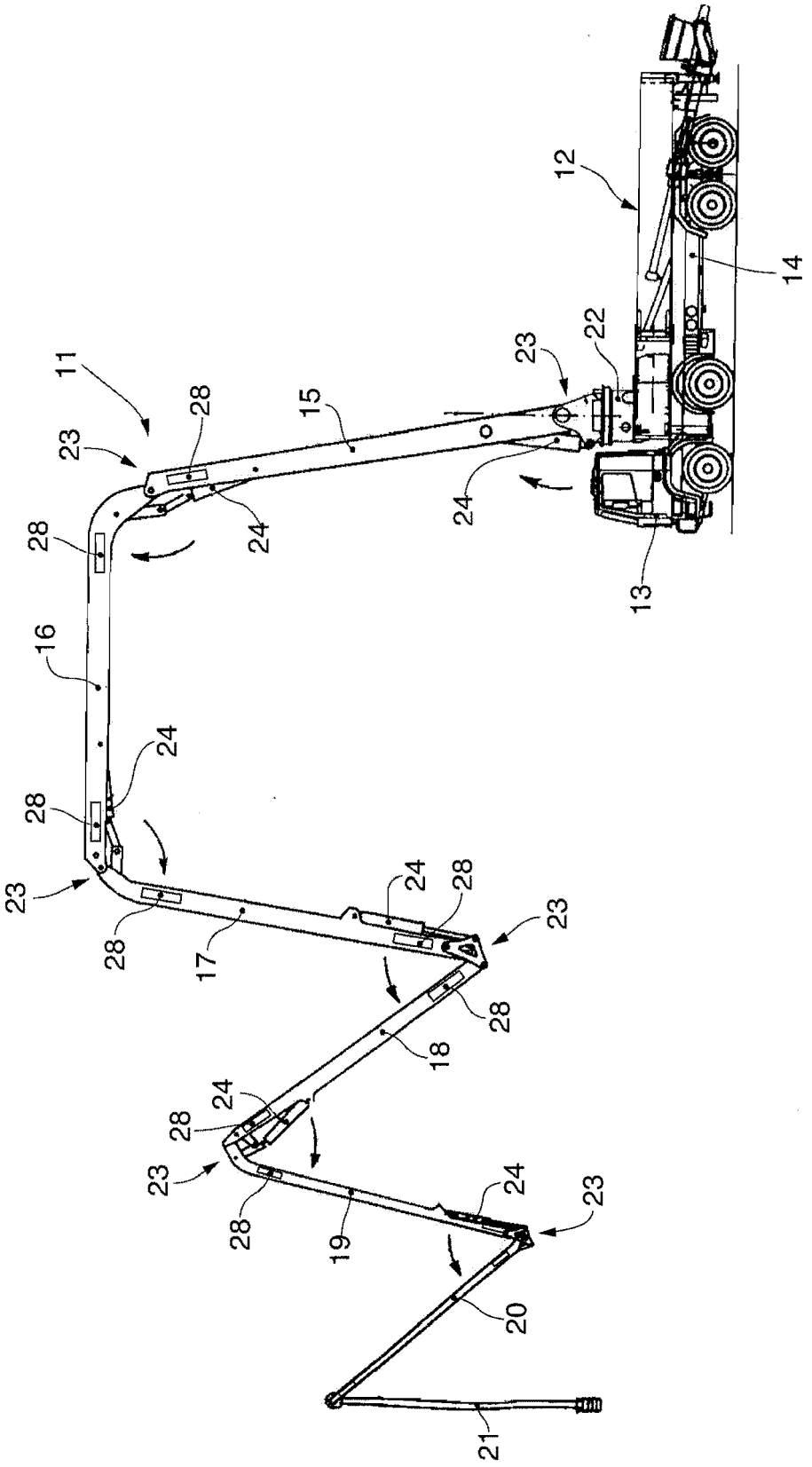

fig. 2

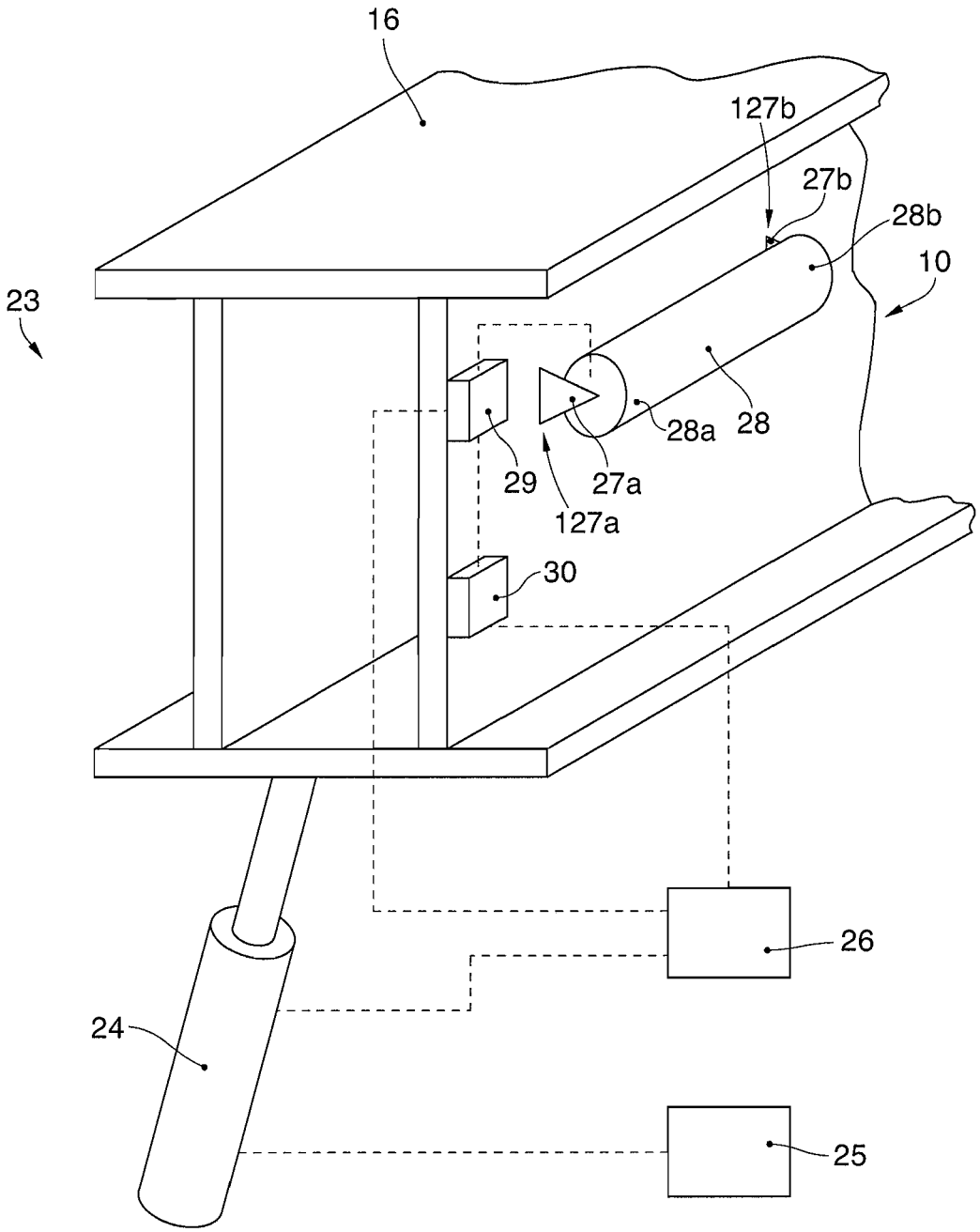

fig. 3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 13 19 1978

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 2 347 988 A1 (CIFA SPA [IT]) 27 July 2011 (2011-07-27) * abstract; claims 1-3; figures 1,2 * * paragraphs [0042] - [0044], [0047], [0065], [0066], [0068] * -----	1-14	INV. B66C13/06
A	DE 195 03 895 A1 (PUTZMEISTER MASCHF [DE]) 8 August 1996 (1996-08-08) * column 4, line 13 - column 6, line 12; claims 1,2,6,7,15,16; figures 1,2,4,6 * -----	1-14	
A	Gabriele Cazzulani: "ACTIVE CONTROL OF A FLEXIBLE BOOM FOR THE CONCRETE: NUMERICAL AND EXPERIMENTAL ANALYSIS", , 24 July 2009 (2009-07-24), XP055057921, Porto/Portugal Retrieved from the Internet: URL:http://paginas.fe.up.pt/clme/IRF2009/PROCEEDINGS/PAPERS/P0310.pdf [retrieved on 2013-03-26] * page 2 - page 4; figures 1-3,7 * -----	1-14	TECHNICAL FIELDS SEARCHED (IPC) G05D F16F B66C
A	EP 2 103 760 A2 (CIFA SPA [IT]) 23 September 2009 (2009-09-23) * paragraphs [0045], [0047], [0049]; claims 8-9; figures 1-4 * -----	1-14	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 March 2014	Mallet, Philippe

CATEGORY OF CITED DOCUMENTS

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 19 1978

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

11-03-2014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2347988 A1	27-07-2011	CN 102134909 A	27-07-2011
		DK 2347988 T3	11-02-2013
		EP 2347988 A1	27-07-2011
		ES 2398940 T3	22-03-2013
		PT 2347988 E	06-02-2013
		US 2011179783 A1	28-07-2011
DE 19503895 A1	08-08-1996	NONE	
EP 2103760 A2	23-09-2009	CN 101538941 A	23-09-2009
		EP 2103760 A2	23-09-2009
		US 2009229457 A1	17-09-2009

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 2347988 A **[0002]**