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(54) **A crane**

(57) A crane, comprising two interconnected beams and, for the displacement of each beam respectively, at least two cylinder/piston units (2), each of which comprises a piston rod (5) that is displaceable in a cylinder (3) and a piston (4) that is connected to the piston rod (5) and separates the cylinder chamber in a cylinder side chamber (6) and a piston rod side chamber (7), said cylinder (3) being provided with an opening (8) in the cylinder gable (9) in order to permit a displacement of the piston rod (5) out of and into the cylinder, a first conduit (10) for conducting a pressure fluid from a pressure fluid source (11) to the cylinder side chambers (6), and a second conduit (13) for conducting pressure fluid from the piston rod side chambers (7) to a pressure fluid reservoir (14) that has a lower pressure than the pressure fluid source (11), and a third conduit (15) for regenerative conduction of pressure fluid from the piston rod side chamber (7) of a first hydraulic unit (2) to the cylinder side chamber (6) thereof. The crane comprises a fourth conduit (24) for regenerative conduction of pressure fluid from the piston rod side chamber (7) of a second hydraulic unit (2) to the cylinder side chamber (6) thereof.

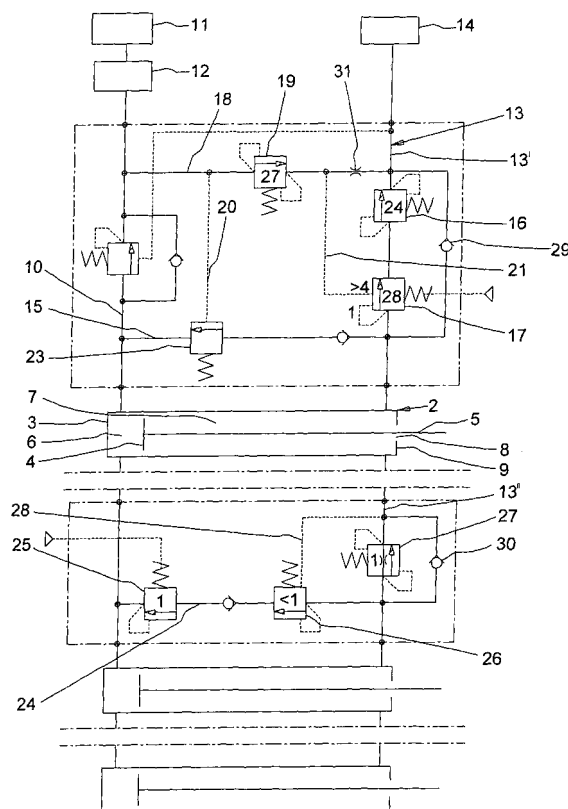


Fig 2

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a crane, comprising two interconnected beams and, for the displacement of each beam respectively, at least two cylinder/piston units each of which comprises a piston rod that is displaceable in a cylinder and a piston that is connected to the piston rod and separates the cylinder chamber in a cylinder side chamber and a piston rod side chamber, said cylinder being provided with an opening in the cylinder gable in order to permit a displacement of the piston rod out of and into the cylinder, a first conduit for conducting a pressure fluid from a pressure fluid source to the cylinder side chambers, and a second conduit for conducting pressure fluid from the piston rod side chambers to a pressure fluid reservoir that has a lower pressure than the pressure fluid source, and a third conduit for regenerative conduction of pressure fluid from the piston rod side chamber of the first hydraulic unit to the cylinder side chamber thereof,

[0002] The invention is applicable to all types of cranes, but is particularly applicable to cranes for lifting piece goods, presenting a considerable overhang when in an extended position. The invention will therefore be described by way of example with reference to such an application.

[0003] It should be understood that the hydraulic units according to the invention can be utilized for the purpose of imparting swinging movements as well as longitudinal movements of any beam that forms a part of the crane.

[0004] Even though not necessary restricted to such an embodiment, the invention is particularly suitable for cranes that comprise a plurality of beams that are arranged in a telescopic way. In order to elongate or extend such a crane, the beams are displaced in relation to each other by means of a plurality of hydraulic cylinder/piston units, one for each arm.

[0005] The invention is particularly related to cranes by which said units are successively arranged, or bus-type connected, in the meaning that a first one thereof is more adjacent the pressure source and the reservoir in terms of fluid flow distance than the second one, and that there is a conduit between each pair of units for the purpose of conducting pressure fluid from the piston rod side chamber of one of the units to the piston rod side chamber of the other unit.

THE BACKGROUND OF THE INVENTION AND PRIOR ART

[0006] Along with an increasing need of longer overhangs on piece goods cranes, the time and power needed for the extension of the crane to its maximum overhang has become an important issue in connection to the design of such cranes. Generally, there is a need of reducing the time that is required for attaining maximum

crane length.

[0007] Different ways of reducing the maximum power required for attaining maximum overhang have been proposed. Some prior art uses sequential extension of the arms. However, in sequentially controlled cranes, there is an important flow resistance for the pressure fluid that is used. A sequentially controlled crane will require less power and lower maximum load on the individual cylinder/piston unit than a non-sequentially controlled crane, but will be slower.

[0008] It has also been proposed to lower the extension resistance of the beams by means of lubrication thereof. However, lubricated beams often result in lubrication oil leaking out to the environment. In some applications, such leakage cannot be accepted and is therefore of disadvantage.

[0009] Accordingly, there is a strive to present a crane the extension of which is not performed sequentially and which does not require any lubrication of vital beam parts in order to attain maximum overhang.

[0010] In order to increase the extension speed of the crane it has been proposed to use regenerative conduction of the pressure fluid, normally oil, from the piston rod side chambers to the cylinder side chambers during the extension operation of the crane. Thereby, less oil has to be conducted from a pressurised oil source all the way to the cylinder side chambers, while, simultaneously the pressure of the oil that exits from the piston rod side chambers is taken advantage of for the purpose of filling the cylinder side chambers instead of only being conducted to a low pressure tank or reservoir.

[0011] In the case when the crane comprises a plurality of beams and a corresponding number of cylinder/piston units, a common conduit for the regeneration flow of oil is used for all units. This regeneration conduit may be arranged as a single conduit connected, in one end, to a conduit leading from a pressure fluid source to the cylinder side chambers of the cylinder-piston units, and, in the other end, to a conduit leading from the piston rod side chambers of said units to a reservoir of lower pressure than the pressure source. Preferably, the regeneration conduit is arranged downstream a first cylinder-piston unit, downstream being referred to as between said unit and the pressure source and reservoir respectively.

THE OBJECT OF THE INVENTION

[0012] It is an object of the present invention to present a crane as initially defined that, during extension of the hydraulic units of the crane, takes advantage of regenerative operation and minimises the effect of pressure loss during the regeneration and maximises the speed with which the beams of the crane are extended or swung.

[0013] It is a further object of the invention to present a crane and a method as initially defined that is readily applicable to existing crane constructions and that is ad-

vantageous because of its relative constructional simplicity and operation reliability.

SUMMARY OF THE INVENTION

[0014] The object of the present invention is achieved by means of a crane as initially defined, characterised in that it comprises a fourth conduit for regenerative conduction of pressure fluid from the piston rod side chamber of the second hydraulic unit to the cylinder side chamber thereof. It should be understood that, among a plurality of such units, the first and second unit do not necessarily need to be located adjacent to each other. It might even be preferred that there is at least one further unit physically located between said units.

[0015] If the cylinder-piston units are connected to each other in a bus type connection in which the second conduit comprises a plurality of sub conduits or intermediate conduits leading from one piston rod side chamber to another in a series, the regenerative flow does not need to go via all the (downstream) piston rod side chambers that are arranged in series before being regenerated via the third conduit and first conduit to the cylinder side chambers. The invention includes such an embodiment.

[0016] According to a preferred embodiment, the crane is further characterised in that it comprises at least one valve member arranged for permitting a regenerative flow through the fourth conduit under condition that the pressure in the first conduit is above a pre-determined absolute pressure level and that there is a flow of pressure fluid in the second conduit in a direction from the piston rod side chamber of the second hydraulic unit towards the reservoir. Thereby, unwanted opening of the fourth conduit when there is no extension of the crane ordered can be avoided.

[0017] Preferably, the crane according to the invention comprises a means for detecting whether the pressure in the first conduit is above said pre-determined level, and a means for detecting the fluid flow direction in the second conduit, these means being connected to the at least one valve member for the purpose of controlling the operation thereof.

[0018] Further preferred embodiments of the invention are presented in dependent claims 4-10.

[0019] Further advantages and features of the invention will be presented in the following detailed description thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The invention will now be described by way of example with reference to the annexed drawings, on which.

Fig. 1 is a schematic view of a crane on which the invention might be applied,

Fig. 2 is a hydraulic scheme showing essential parts of the invention according to a first embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0021] Fig. 1 shows a crane according to the invention. The crane comprises a plurality of beams 1 that are telescopically arranged in relation to each other in order to permit adjustment of its length from a shortest length, in which the beams are inserted into each other, to a maximum length when they are fully extended. The crane comprises a plurality of hydraulic units 2 for driving the beams 1 in way known *per se*. According to fig. 2 each hydraulic unit 2 comprises a cylinder 3 and a piston 4 with a piston rod 5. the piston divides the cylinder chamber into a cylinder side chamber 6 and a piston rod side chamber 7. The piston area is larger on the cylinder side than on the piston rod side. The piston rod 5 is arranged to perform a reciprocating movement through an opening 8 in a gable 9 of the cylinder 3 for its operation.

[0022] For the actuation of the hydraulic unit the crane comprises a first conduit 10 that connects the cylinder side chambers 6 of the hydraulic units 2 with a pressure fluid source 11 via a direction valve 12 in a way known *per se*. The cylinder side chambers 6 may be regarded as connected in parallel with each other in relation to the source 11. The fluid pressure in the pressure fluid source may, for example, be 28 MPa.

[0023] The crane also comprises a second conduit 13 that connects the piston rod side chamber 7 of a first one of the hydraulic units 2 with a low pressure reservoir 14 for drainage of pressure fluid from the chamber 7 to the reservoir 14. The fluid pressure in the reservoir 14 may, as here, be equal to atmospheric pressure.

[0024] There is also provided a third conduit 15 that in one end is connected to the first conduit 10 and in another end is connected the second conduit 13. The third conduit 15 is arranged for controlled regenerative pressure fluid flow from the piston rod side chambers 7 to the cylinder side chambers 6 during extension of the crane.

[0025] According to fig. 2 the crane according to the invention comprises a pressure delimiting member 16 in the second conduit 13. There is also provided a pilot-controlled valve 17 in the second conduit 13. Upon activation of valve 17, it will permit a flow through the second conduit 13 towards the reservoir. During extension of the crane under regenerative operation, the regenerative flow through the third conduit 15 is stopped, or at least substantially reduced, as valve 17 is actuated in order to permit a flow of fluid from the piston rod side chamber 7 to the reservoir 14. Thereby, full extension of the hydraulic unit 2 in question can be attained with a remaining high or even further increased pressure on the cylinder side and a reduced, but still substantial, pressure on the piston rod side thanks to the pressure delimiting member 16. The pressure delimiting member

16 should comprise a counter pressure valve and may comprise any kind of throttle or constriction. It only opens for passage when the pressure in the piston rod side chamber exceeds a given value, in this example 24 MPa. Here, the pressure delimiting member 16 is arranged so as to delimit the pressure in the piston rod side chamber 7 to approximately 24 MPa while the pressure in the cylinder side chamber reaches approximately 28 MPa during the continued piston rod displacement without aid of regenerative flow.

[0026] It should be mentioned that, as an alternative to the above arrangement, there might be provided a pressure delimiting member in the first conduit 10 between the direction valve 12 and the cylinder side chamber 6, instead of having a pressure delimiting member corresponding to member 16 in the second conduit 13. Then, such a pressure delimiting member is actuated at the moment when the pressure on the cylinder side has reached a value by which the pilot controlled valve 17 is opened for passage and regenerative operation is ended. Thereby the pressure in the cylinder side chamber 6 is reduced to a given value while the pressure in the piston rod side chamber is reduced to generally the same pressure as in the reservoir 14 through activation of valve 17.

[0027] Preferably, there is provided a means 18, 19 for measuring or sensing the pressure in the cylinder side chamber 6 or at least a pressure directly corresponding to that pressure, such as the pressure in the first conduit 10 or third conduit 15 during regenerative operation.

[0028] Pilot-controlled valve 17 in the second conduit 13 is controlled based on the pressure value measured or detected by the measuring means 18, 19, by means pressure fluid connection from the measuring means 18, 19 to the valve 17 upon the presence of a given pressure in the first conduit 10. It should be emphasized that the term measurement as used in this context also may comprise simple indication of one specific pressure level, and not necessarily a literal measurement. Once a specific pressure acts on the measuring means 18, 19, an hydraulic pressure may be applied to the pilot-controlled valve, for example via a leak conduit from the measuring means 18, 19.

[0029] Said measuring means 18, 19 comprises a conduit 18 connected to the first conduit 10 and the reservoir 14, via the second conduit, and a (spring-loaded non-return) valve 19. When the pressure fall over the (non-return) valve 19, that closes for flow towards the reservoir 14, reaches or exceeds a threshold value, a piloting impulse of pressure fluid is conducted via a further conduit, here indicated with a broken line 21 from the piloting valve 19 to the pilot-controlled valve 17 for the actuation thereof. A constriction 31 is arranged downstream valve 19 in said conduit 18 in order to, together with valve 19, determine the pressure at which the pilot-controlled valve 17 is to open.

[0030] In the embodiment shown in fig. 2, there is also

provided a spring loaded, pilot-controlled valve 23 in the third conduit 15 for regenerative flow. The regeneration valve 23 is actuated by the pressure of the first conduit 10, with which it is connected via a pilot flow conduit 20. Said pilot controlled valve 23, upon actuation thereof, opens for regenerative flow of pressure fluid from piston rod side chamber 7 to cylinder side chamber 6. In series with pilot-controlled valve 23 in the third conduit 15 there is provided a non-return valve that prevents flow in the opposite direction, that is from cylinder side chamber 6 to piston rod side chamber 7. Valve 23 defines a means for breaking or interrupting the regenerative operation. It should be understood that, as an alternative, the third conduit 15 could be directly connected with, for example, the direction valve 12, and that the latter could then be equipped with a slide valve that would take the place and function of the regeneration valve 23 and the non-return valve in series therewith.

[0031] As indicated in fig. 2, the individual piston rod side chambers 7 are connected in bus-type in a series via a plurality of conduits 13" each of which is provided between two consecutive piston rod side chambers in the row of hydraulic units 2. However, they could also be connected in a connection of a star-type. Said intermediate conduits 13" can be regarded as parts of the second conduit 13 or as sub-conduits of the second conduit 13. A piston rod side chamber 7 of a first hydraulic unit is connected via the second conduit 13 to the low pressure reservoir 14. Each cylinder-piston unit is arranged for the purpose of displacing or swinging a respective beam of the crane. Except the first unit in such a series of units, which is connected to a crane base in one end and a first beam in the other end, each unit is connected to two adjacent beams for interrelated movement thereof.

[0032] Between two consecutive hydraulic units 2, there is a fourth conduit 24 for regenerative conduction of pressure fluid from the piston rod side chamber 7 of one of the hydraulic units 2 to the cylinder side chamber 6 thereof. Here, a first end of the fourth conduit 24 is connected to the first conduit 10 and a second end thereof is connected to the intermediate conduit 13" that leads from the piston rod side chamber 7 of one of the units 2 to the piston rod side chamber 7 of the other one of said units 2.

[0033] The crane comprises a first valve member 25 arranged for permitting a regenerative flow through the fourth conduit under condition that the pressure in the first conduit is above a pre-determined absolute pressure level. There is also a second valve member 26 arranged for permitting a regenerative flow through the fourth conduit under condition that there is a flow of pressure fluid in the second conduit 13 in a direction from the cylinder side chamber 6 of the second hydraulic unit 2 towards the reservoir 14.

[0034] There is also provided a means for detecting whether the pressure in the first conduit 10 is above said pre-determined level. This pressure sensing means is

incorporated in the first valve member 25 since the latter is designed as a spring loaded valve, the spring of which is under action of the pressure in the first conduit 10, the valve 25 being arranged for opening when the force generated by the pressure fluid in the first conduit 10 and acting on the spring exceeds the spring force.

[0035] There is also provided a means 27 for detecting the fluid flow direction in the intermediate second conduit 13". The second valve member 26 is a pilot-controlled valve member controlled by the means 27 for detecting the flow direction in the intermediate second conduit 13".

[0036] There is a hydraulic connection 28 between the second valve member 26 and the means 27 for detecting the flow direction in the intermediate second conduit 13". The hydraulic connection 28 defines a means for sensing the pressure fall over the means 27 for detecting the flow direction.

[0037] The means 27 for detecting the flow direction in the intermediate second conduit 13" comprises a spring loaded valve, the spring of which is under action of the pressure in the intermediate second conduit upstream said one way valve 27 as seen in flow direction from the second unit 2 towards the reservoir 14. The valve 27 is opened when the force generated by the pressure fluid in the second conduit and acting on the spring of the valve 27 exceeds the spring force. A fluid pressure pulse from valve 27 will then flow via connection 28 and affect the opening of second valve member 26.

[0038] Apart from the elements that have been described above, the crane comprises a number of elements the function of which are important for a reliable and effective operation of the crane. Accordingly there is a non-return valve 29 provided in parallel with the pressure delimiting member 16 in the second conduit, for allowing a flow of pressure fluid from the reservoir 14 towards the piston rod chambers 7 without throttling caused by the pressure delimiting member 16. A non-return valve 30 is arranged in a corresponding way and for a corresponding purpose, in parallel with the flow direction detecting means 27.

[0039] It should be understood that non-return valves that normally permit the regenerative flow towards the cylinder side chamber 6 but prevent a flow in the opposite direction, are a natural part of any embodiment of the invention, in order to further improve the operation of the crane.

[0040] It should be realised that the above presentation of the invention has been made by way of example, and that alternative embodiments will be obvious for a man skilled in the art without going beyond the scope of protection as claimed in the annexed patent claims supported by the description and the annexed drawings.

Claims

1. A crane, comprising

- two interconnected beams and, for the displacement of each beam respectively, at least two cylinder/piston units (2), each of which comprises a piston rod (5) that is displaceable in a cylinder (3) and a piston (4) that is connected to the piston rod (5) and separates the cylinder chamber in a cylinder side chamber (6) and a piston rod side chamber (7), said cylinder (3) being provided with an opening (8) in the cylinder gable (9) in order to permit a displacement of the piston rod (5) out of and into the cylinder,
- a first conduit (10) for conducting a pressure fluid from a pressure fluid source (11) to the cylinder side chambers (6), and
- a second conduit (13) for conducting pressure fluid from the piston rod side chambers (7) to a pressure fluid reservoir (14) that has a lower pressure than the pressure fluid source (11), and
- a third conduit for regenerative conduction of pressure fluid from the piston rod side chamber (7) of a first hydraulic unit (2) to the cylinder side chamber (6) thereof,

characterized in that it comprises a fourth conduit (24) for regenerative conduction of pressure fluid from the piston rod side chamber (7) of a second hydraulic unit (2) to the cylinder side chamber (6) thereof.

2. A crane according to claim 1, **characterised in that** it comprises at least one valve member (25, 26) arranged for permitting a regenerative flow through the fourth conduit (24) under condition that the pressure in the first conduit is above a pre-determined absolute pressure level and that there is a flow of pressure fluid in the second conduit (13) in a direction from the piston rod side chamber (7) of the second hydraulic unit (2) towards the reservoir (14).

3. A crane according to claim 2, **characterised in that** it comprises a means for detecting whether the pressure in the first conduit (10) is above said pre-determined level, and a means (27) for detecting the fluid flow direction in the second conduit (13").

4. A crane according to claim 3, **characterised in that** said at least one valve member (25, 26) is operatively connected to said detecting means (27), and controlled on basis of the detected absolute pressure in first conduit (10) and the detected flow direction in the second conduit (13").

5. A crane according to any one of claims 1-4, **characterised in that** the second conduit (13) comprises a first part (13') leading from the piston rod side chamber (7) of the first unit to the reservoir (14) and a second part (13'') leading from the piston rod side chamber (7) of the second unit (2) to the piston rod side chamber (7) of the first unit (2), and that the means (27) for detecting the flow direction in the second conduit (13) detects the flow direction in said second part(13'') of the second conduit (13). 5 10
6. A crane according to any one of claims 3-5, **characterised in that** said at least one valve member (26) is a pilot-controlled valve member controlled by the detecting means (27) for detecting the flow direction in the second conduit. 15
7. A crane according to any one of claims 3-6, **characterised in that** it comprises a hydraulic connection between the at least one valve member (26) and the means(27) for detecting the flow direction in the second conduit (13). 20
8. A crane according to any one of claims 3-7, **characterised in that** the at least one valve member (25) comprises a spring loaded valve, the spring of which is under action of the pressure in the first conduit (10), the valve being arranged for opening when the force generated by the pressure fluid in the first conduit (10) and acting on the spring exceeds the spring force. 25 30
9. A crane according to any one of claims 3-8, **characterised in that** the means (27) for detecting the flow direction in the second conduit (13'') comprises a spring loaded valve (27), the spring of which is under action of the pressure in the second conduit (13'') upstream said one way valve as seen in flow direction from the second unit towards the reservoir (14), and that said valve (27) is opened when the force generated by the pressure fluid in the second conduit (13'') on the spring exceeds the spring force. 35 40

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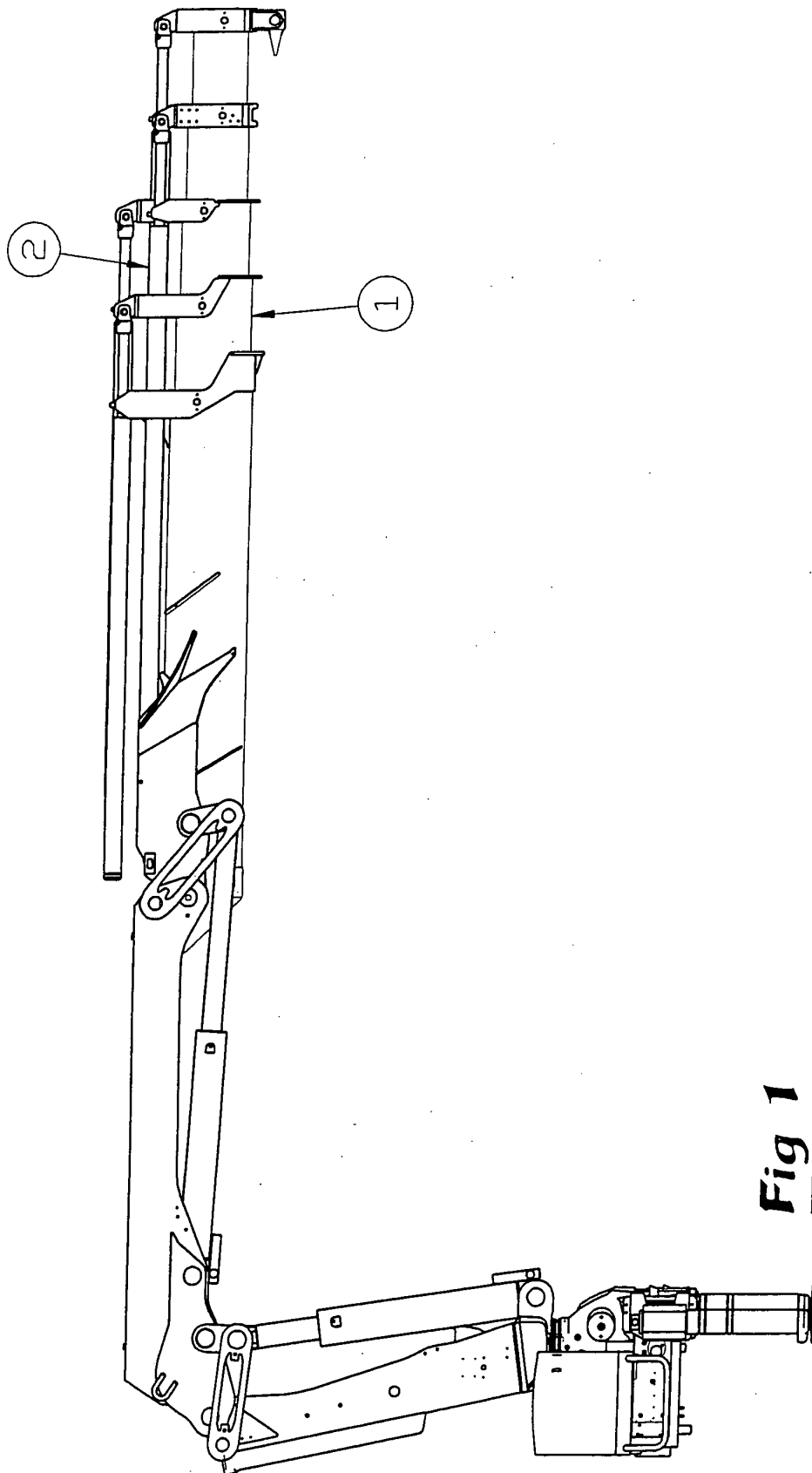


Fig 1

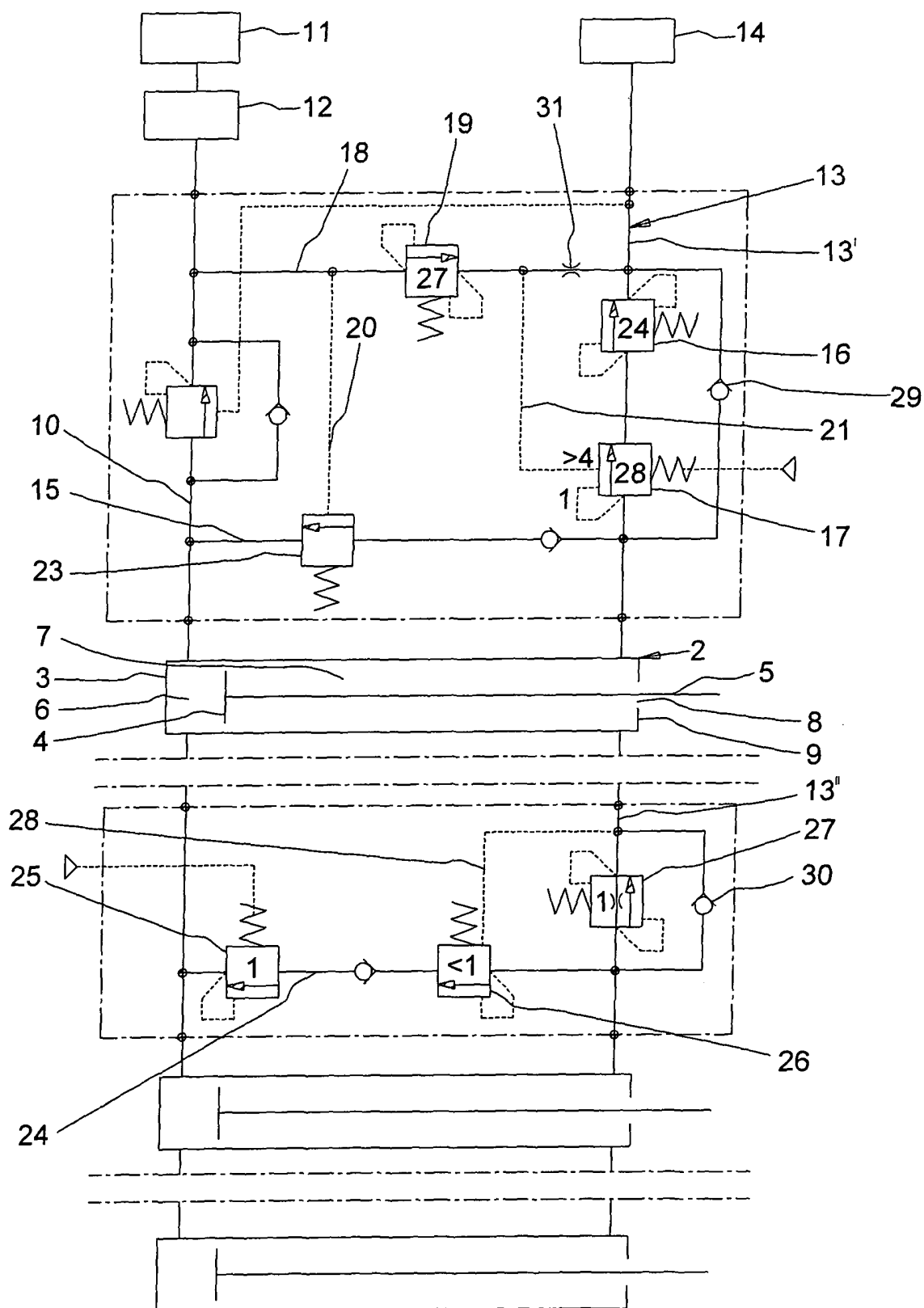


Fig 2



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 02 4718

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 4 125 974 A (KAY CHRISTOPHER G ET AL) 21 November 1978 (1978-11-21)	1,2	F15B11/024 B66C23/44
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			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			F15B B66C E02F B66B B66F
The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 2 April 2004	Examiner Laurer, M
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 03 02 4718

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
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02-04-2004

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