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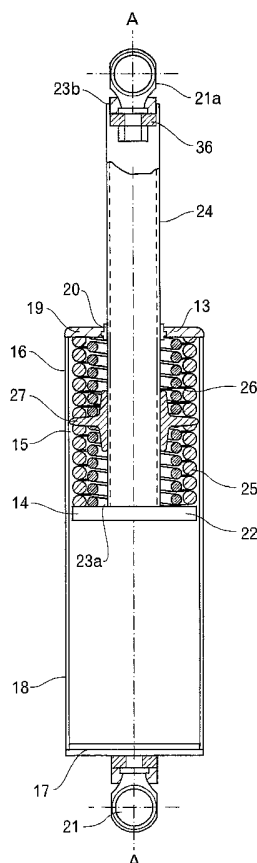
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(54) Title: BALANCING DEVICE ARRANGED WITH A GUIDE ELEMENT BETWEEN A FIRST AND A SECOND COMPRESSION SPRING



(57) Abstract: An industrial robot (1) comprising a first robot part (3) and a second part (5) arranged to be movable in relation to each other, and a balancing device (8), acting therebetween, comprising at least a first attachment (12, 45, 46) and a second attachment (14, 47) for articulated attachment to the respective robot part (3), (7, 6), and wherein the balancing device (8) comprises a compression spring unit (15) arranged to counteract the gravitational force upon relative rotation of the robot parts (3), (7, 6).



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BALANCING DEVICE ARRANGED WITH A GUIDE ELEMENT BETWEEN A FIRST AND A SECOND COMPRESSION SPRING.

TECHNICAL FIELD

5 The present invention relates to an industrial robot with a balancing device composed of a helical spring, and to a method for and use of the robot.

BACKGROUND ART

10

Industrial robots usually comprise a robot foot, a stand and a robot arm. The stand is rotatably arranged on the robot foot. The robot arm is rotatably arranged in a joint on the stand. The robot arm consists of arm parts rotatably
15 arranged in relation to each other. The arm of the robot comprises, for example, a first and a second arm part and a wrist arranged with a tool attachment. In its initial position, which may also be a rest position, the arm is oriented with the first arm part approximately vertical. When
20 the robot is moving/operating, the arm is rotated in relation to the stand while at the same time the arm parts rotate in relation to each other. The total load on the robot consists of the handling weight applied to the wrist as well as the current dead weight of the robot. Upon rota-
25 tion, the motor concerned rotates the robot arm whereby the gravitational force acting on the arm generates a torque.

In industrial robots comprising a plurality of robot parts which are rotatably arranged in relation to one another,
30 strong, current-demanding motors are required for the rotation of the robot parts. Strong, current-demanding motors are large, heavy and expensive, so there is a need of alternative solutions. One alternative is to supplement the robot with a device which, upon rotation of the robot,
35 takes part in the rotation by taking up a torque during the rotation from a rest position/initial position, that is, when the robot starts an operating cycle. The expression rotation from a rest position/initial position in this

context means a rotation in a direction where the gravitational force contributes to the rotation. The device is so constructed that, during the rotation from the rest position, it generates a torque, which acts to return the robot to its rest position/initial position and thus assists/-relieves the drive motor concerned during the lifting/-rotation back. The expression rotation back to the rest position/initial position thus means a rotation that counteracts and hence compensates for the gravitational force. This rotation is called balancing in the following. The device according to the above is thus considered to be a balancing device.

By arranging an industrial robot with at least one balancing device, which aids and relieves the drive motor concerned, the robot manufacturer is not forced to install unnecessarily large and powerful motors in the robot. The reverse is also true, that is, a powerful drive motor in combination with a powerful balancing device increases the lifting capacity of a large industrial robot in the wrist. However, it entails an increased dead weight of both the motor and the balancing device and hence a larger moving mass, which in turn imposes even higher demands on the drive motor concerned.

A balancing device thus assists the motor in question in balancing the applied handling weight as well as the dead weight relevant to the robot when rotation occurs. Balancing devices generally consist of weights, gas-hydraulic devices or resilient devices in the form of balancing cylinders composed of a compression spring, a tension spring, a torsion spring and/or of gas. Apart from the counterweights, the above-mentioned devices are expensive, heavy and sensitive structures. In addition, gas-hydraulic devices suffer from problems with tightness.

Patent document EP 0 947 296 shows a robot arranged with a gravitation-compensating resilient device. The device com-

prises a spring housing comprising at least two compression springs, a spring seat and a drawbar connected to the spring seat. The compression springs have different diameters and are arranged so as to circumscribe each other. The spring seat is moved inside the spring housing when the drawbar is pulled out and the springs are thus compressed. The aim is to provide a balancing device of a comparatively small physical size but of comparatively large spring force. The device has the advantage that it is easy to replace used compression springs with new ones.

A balancing device makes it easier for the motor concerned to rotate the arm back to the above-mentioned initial position. Thus, when rotating the robot back, the motor should be capable of handling a residual torque, which constitutes the sum of the torque from the total load of the robot as well as the oppositely directed torque generated in the balancing device. The torque generated by the balancing device and the strength of the drive motor concerned are thus jointly interdependent.

A balancing device for a robot comprises, for example, a helical spring unit or a coil spring unit. The helical spring unit is either arranged to be withdrawn or compressed upon loading. The development of industrial robots proceeds towards larger robots which are capable of handling larger weights in their wrists. This entails a need of balancing devices with a long length of stroke and/or great spring force and hence a need of spring-equipped balancing devices provided with longer compression or tension springs. The size of the balancing device is an important factor since it influences both the possibilities of movement and the operating volume of the robot, both of which decrease with increasing size of the balancing device.

In balancing devices comprising a helical spring, a helical spring included will be compressed when applying a load. When an initially long helical spring is compressed, the

probability of the spring being deflected to the side, that is, bending/breaking, is increased.

5 The development of industrial robots according to the above leads to a need of larger spring forces and hence comparatively longer helical springs. When manufacturing long helical springs, a long and coarse starting material is required, which is considerably more expensive than that which has been used in too short helical springs. The costs
10 of manufacturing long helical springs are therefore very high, which in an economically unacceptable way renders the manufacture of industrial robots expensive. In certain cases, the material itself, i.e. from which the springs are manufactured, is a limiting factor.

15 When a robot is handling large weights in its wrist according to the above, a balancing device is forced to operate with large forces. This increases the likelihood of a balancing device, provided with a compression spring or a
20 tension spring, being damaged during this operation. Abrasion effects will arise, for example, which reduce the service life of the balancing device. This results in undesired and expensive shutdowns in production and in undesired costs of spare parts.

25 When the wrist is subjected to large loads according to the above, it is most important that a balancing device with a comparatively long compression spring unit should operate in the proper way. When a compression spring is deflected-
30 /bent, very disturbing sound effects arise. This has led to solutions to reduce these sound effects, for example an increased distance between the packet of springs and the spring housing, which in turn leads to a comparatively larger balancing device, which is unfavourable according to
35 the above.

When manufacturing industrial robots of the above-mentioned kind, there is thus a need of a balancing device provided

with a compression or tension spring, which manages high loads, is silent in operation, and comparatively inexpensive to manufacture.

- 5 These requirements cannot be fulfilled by the balancing device according to the above-mentioned EP document.

SUMMARY OF THE INVENTION

- 10 It is an object of the invention to provide a balancing device, equipped with a spring, for an industrial robot intended to handle comparatively large weights in the wrist. It is a further object to suggest a balancing device according to the above, the service life of which is as
15 long as that of the robot.

- These objects are achieved, according to a first aspect of the invention, by an industrial robot comprising the characteristic features described in claim 1, and according
20 to a second aspect of the invention by a device for balancing an industrial robot comprising the characteristic features described in claim 10, and according to a third aspect of the invention by a method for balancing an industrial robot comprising the characteristic features de-
25 scribed in claim 11.

Advantageous embodiments are defined in the dependent claims.

- 30 According to the first aspect of the invention, an industrial robot is described comprising a first robot part and a second robot part arranged movable in relation to each other, and a balancing device, acting therebetween, comprising a first attachment and a second attachment for articu-
35 lated attachment to the respective robot part. The balancing device comprises a spring unit designed to counteract the gravitational force upon relative rotation of the robot parts. The spring unit comprises at least a first spring

packet, a second spring packet and a guide element, which are arranged in the longitudinal direction one after the other along a common symmetry line. The guide element is arranged between the first and second spring packets.

5

In an advantageous embodiment of the invention, the balancing device comprises a compression spring unit. The object of the invention is achieved by eliminating the need of comparatively long compression springs in balancing devices for robots according to the above. This results in the compression spring unit becoming smaller, and hence the surrounding spring housing included in the balancing device can be made smaller in size.

15 It is part of the inventive concept that the balancing device according to the invention should be arranged between arm parts of the robot which are not directly connected to each other. Further, the inventive concept comprises equipping the robot with one or more balancing devices.

20

In an embodiment of the invention, the balancing device comprises a drawbar on which the guide element is slidably arranged for movement in the longitudinal direction along the above-mentioned symmetry axis. In an advantageous embodiment of the invention, the guide element is rotatably journalled on the drawbar.

25

It is also part of the inventive concept that the bearing should be formed so as to prevent rotation of the guide element about the symmetry axis A.

30

In an alternative embodiment, the drawbar is included in a telescopic unit.

35 It is part of the inventive concept that the guide element should comprise a first part consisting of a sliding bushing. Upon movement in a sliding bearing, no sound effects

arise and the bearing thus contributes to a silent operation of the balancing device.

5 It is part of the inventive concept that the guide element should comprise a second part consisting of a contact plate. In an advantageous embodiment, the contact plate comprises a first and a second contact surface.

10 In one embodiment of the invention, the balancing device comprises a spring housing and a guide element slidably arranged for movement in the longitudinal direction along the above-mentioned symmetry axis. The guide element is slidably arranged for sliding along the inner envelope surface of the spring housing.

15 In one embodiment of the invention, at least one contact surface comprises members designed to centre a first end of a helical spring packet. The balancing device provides a more silent running by centring the ends of the spring
20 packet, hence preventing them from moving either against each other or against the inner wall of a surrounding spring housing.

25 According to the invention, these members on the guide element are shaped, for example, as level differences, flanges, or loose elements. They achieve a centring of the respective helical spring end, which counteracts relative movement between said spring end and the guide element.

30 According to the second aspect, the invention suggests a device for balancing an industrial robot comprising a compression spring unit (15). The compression spring unit comprises at least a first compression spring packet, a second compression spring packet and a guide element, which are
35 arranged in the longitudinal direction one after the other along a common symmetry line, the guide element being arranged between the first and second compression spring packets.

According to the third aspect, the invention suggests a device for balancing an industrial robot comprising a first robot part and a second robot part arranged to be movable in relation to each other, and a balancing device acting therebetween comprising a first attachment and a second attachment for articulated attachment to the respective robot part. The balancing device comprises a helical spring unit configured to counteract the gravitational force upon relative rotation of the robot parts. The helical spring unit is brought to comprise at least a first helical spring packet, a second helical spring packet and a guide element, which are all arranged in the longitudinal direction one after the other along a common symmetry line. The guide element is brought to be arranged between a first end of the first helical spring packet and a second end of the second helical spring packet, whereby the guide elements are brought to make contact with and guide the ends of the respective helical spring packet upon relative rotation of the robot parts.

It is part of the inventive concept that the guide elements are brought to guide one end of at least one spring packet upon compression of the helical spring packet. Further, the inventive concept comprises bringing the guide element to guide one end of at least one spring packet upon rotation of the helical spring packet.

It is part of the inventive concept that two helical spring packets in a balancing device have different longitudinal extensions in the non-loaded state.

It is part of the inventive concept that at least two spring packets and a guide element located therebetween should be arranged in the longitudinal direction one after the other along a common symmetry line. The definition defines that the longitudinal axis of the respective spring packet should coincide with the common symmetry line. In addition, it defines that the symmetry line of the guide

element, which may also be a longitudinal axis or a rotational axis, should coincide with the common symmetry line. The common symmetry line is defined as a straight line but the inventive concept also comprises a curved symmetry
5 line.

It is part of the inventive concept that, for example, lubricating grease should be applied to the compression springs included in a balancing device, in order to reduce
10 the risk of abrasion damage due to friction and to eliminate disagreeable sound experience if a compression spring should get into contact with either the envelope surface of the spring housing or another spring.

15 BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be explained in greater detail, by description of an embodiment, with reference to the accompanying drawings, wherein:

20

Figure 1 is a balancing device according to the present invention with the drawbar being retracted,

Figure 2 is a balancing device according to Figure 1 with
25 the drawbar being extended,

Figures 3a-g are alternative embodiments of a guide element according to the invention,

30 Figure 4 is an alternative embodiment of the invention comprising a telescopic unit,

Figure 5 is a balancing device according to Figure 4 with the drawbar being extended,

35

Figure 6 is an industrial robot with a balancing device according to the invention,

Figure 7 is an alternative industrial robot provided with a balancing device according to the invention,

Figure 8 is an axial cross section through the balancing
5 device of Figure 7,

Figure 9 is a guide element according to the present invention arranged on a piston rod in a balancing device according to Figures 7 and 8.

10

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An industrial robot 1 (Figure 6) comprises a robot foot 2, a stand 3 rotatably arranged on the robot foot 2, and a
15 robot arm 5 connected in a joint 4 on the stand 3, the robot arm comprising a first and a second arm part 6 and 7, respectively. The robot arm 5 is rotated about a horizontal axis of rotation B in the joint 4. A balancing device 8 is mounted on the robot 1 (Figure 1). The balancing device 8
20 comprises at its first end 9 a first attachment 10 to be articulately attached to the stand 3 and at its second end 11 a second attachment 12 to be articulately attached to the first arm part 6.

25 The balancing device 8 comprises a first spring seat 13 and a second spring seat 14 between which the compression spring unit 15 is arranged (Figure 2). The first spring seat 13 comprises a spring housing 16 which is arranged with a first end wall 17, a cylindrical envelope surface 18
30 and a second end wall 19 provided with an opening 20. An attachment in the form of a first attachment lug 21 is arranged on the outside of the first end wall 17. The second spring seat 14 comprises a piston 22 which is secured to the first end 23a of a drawbar 24. The drawbar 24 together
35 with the piston is displaceably arranged in the longitudinal direction inside the spring housing 16. The drawbar 24 extends from the piston 22, through part of the spring housing 16 and out through the opening 20 in the second end

wall 19 of the spring housing. At its second end 23b, the drawbar 24 is provided with a second attachment 12 in the form of a second attachment lug 21a.

5 The balancing device of Figure 1 comprises a compression spring unit 15 which comprises a first compression spring packet 25, a second compression spring packet 26 and a guide element 27 arranged between said compression spring packets. The first 25 and second 26 compression spring
10 packets and a guide element 27 are arranged one after the other along, and with the respective longitudinal axis coinciding with, a common symmetry axis A. In this embodiment, the symmetry axis is a rectilinear axis of symmetry and rotation. The first compression spring packet 25 has a
15 first end 31 and a second end 32 and comprises two helical springs 25a and 25b, which are coaxially arranged. In a corresponding way, the second helical spring packet 26 has a first end 33 and a second end 34 and comprises two helical springs 26a and 26b, which are coaxially arranged. The
20 first 25 and second 26 compression spring packets are arranged inside the spring housing 16 between the piston 22 and the second end wall 19 of the spring housing 16. The guide element is arranged between the two spring packets and makes contact with the first end 31 of the first compression spring packet and the second end 34 of the second
25 compression spring packet.

Upon relative rotation of the robot parts 3 and 5, the drawbar 24 is pulled out of the spring housing 16, the
30 spring packets 25 and 26 being compressed thus generating a spring force that tends to push out the compression spring and hence pull the drawbar 24 back into the spring housing 16. The generated spring force is thus utilized for balancing. During compression of the respective spring packet,
35 the guide element 27 brings about guiding of the ends 31 and 34 of the respective compression spring packet.

In the embodiment according to Figure 1, the first attachment lug 21 is secured to the end wall 17 and the second attachment lug 21a is rotatably journalled in the drawbar 24. In the embodiment according to Figure 2, the first
5 attachment lug 21 is arranged to be rotatably journalled in the end wall 17 and the second attachment lug 21a is rotatably journalled in the drawbar 24. Alternatively, an embodiment according to Figure 2 is formed, where the second attachment lug 21a is secured to the drawbar (not shown).

10

The guide element 27 comprises a first part 28a shaped as a sliding bushing and a second part 28b shaped as a disc comprising a first 29 and a second 30 contact surface for receiving one end of a spring packet (Figures 3a-g). In
15 Figure 3a, the disc-shaped part is arranged symmetrically with respect to the shape of the bushing in the longitudinal direction. In Figure 3b, the disc-shaped part is displaced in the longitudinal direction from the symmetry position of the bushing. In an alternative embodiment (Figure
20 3c), the disc-shaped part is shaped with centring members 35 in the form of level differences 36 for centring one end of the respective helical spring that forms part of a spring packet. Figure 3d shows an alternative embodiment of the guide element with a second part 28b shaped as a disc
25 of a comparatively large thickness. In Figure 3d, the guide element 27 is provided with centring members in the form of flanges 37. In Figure 3e, two guide elements are arranged next to each other, which permits relative motion between the guide elements. The centring members are arranged in
30 the form of loose elements 38 in the form of rings 42 with an L-shaped cross section. Compression springs 43 are symbolically illustrated to show how they secure two alternatively shaped rings 42a and 42b.

35 Figure 3f shows a cross section of part of a balancing device. A guide element 27 is slidably journalled for sliding against the inner envelope surface 18a of a spring housing 16. A drawbar 24 is arranged according to the above

and the embodiment exhibits a gap 44 in the radial direction between the drawbar 24 and the guide element 27.

Figure 3g is an alternative of the embodiment according to Figure 3c, with the level differences 36 arranged in the reverse order, as viewed in the radial direction.

In Figure 4, the drawbar 24 forms part of a telescopic unit 40. Coaxially inside the spring housing 16, a guide tube 39 is secured to the inside of the first end wall 17. The guide tube 39 extends inside the spring housing 16 from the first end wall 17 and almost up to the second end wall 19. Thus, the guide tube 39 has a length that is smaller than that of the spring housing 16 along the symmetry axis A. The guide tube 39 has an outer diameter that is somewhat smaller than the inner diameter of the tubular drawbar 24 (see Figure 5). When displacing the drawbar 24 (Figure 5) through the opening 20 in the end wall 19, the drawbar 24 slides telescopically outside the guide tube 39, which thus together constitute a telescopic unit 40. The possibility of the helical spring packets 25 and 26, located between the piston 22 and the second end wall 19 of the spring housing, to be compressed decides how far the drawbar 24 may be pulled out of the spring housing 16. From Figures 4 and 5 it is clear that the guide tube 39 and the drawbar 24 are telescopically accommodated in each other to a sufficient extent to provide an exact guiding and good stability when the drawbar 24 is pulled out to its maximum extent.

Figure 7 is an alternative industrial robot 1a provided with a balancing device 8 according to the invention, connected to the stand 3a at two joints 45 and 46 arranged on the outer envelope surface 18b of the balancing device for rotation of the balancing device about an axis of rotation C. A drawbar 24 included in the balancing device 8 comprises a third attachment lug 47, which is articulately connected to the arm part 6a at a joint 48 (see Figure 8). In

an alternative embodiment, the attachment lug 47 is rotatably journalled on the drawbar 24 (not shown).

5 In Figure 9, part of an axial section through a balancing device 8 according to the invention, comprising a guide element 27, is slidably journalled on a drawbar which alternatively consists of a piston rod 41.

CLAIMS

1. An industrial robot (1) comprising a first robot part (3) and a second robot part (5) arranged to be movable in relation to each other, and a balancing device (8), arranged therebetween, comprising at least a first attachment (12, 45, 46) and a second attachment (14, 47) for articulated attachment to the respective robot part (3), (7, 6), and wherein the balancing device (8) comprises a compression spring unit (15) arranged to counteract the gravitational force upon relative rotation of the robot parts (3), (7, 6), **characterized** in that the compression spring unit (15) comprises at least one first compression spring packet (25), one second compression spring packet (26) and one guide element (27), which are arranged in the longitudinal direction one after the other along a common symmetry line (A), and that the guide element (27) is arranged between the first (25) and second (26) compression spring packets.
2. An industrial robot according to claim 1, wherein the balancing device (8) comprises a drawbar (24) on which the guide element (27) is journalled.
3. An industrial robot according to claim 2, wherein the guide element (27) is slidably journalled on the drawbar (24).
4. An industrial robot according to claim 2, wherein the drawbar (24) forms part of a telescopic unit (40).
5. An industrial robot according to claim 1, wherein the balancing device (8) comprises a spring housing (16) in which the guide element (27) is slidably journalled along the inner envelope surface (18a) of the housing.
6. An industrial robot according to any of the preceding claims, wherein the guide element (27) comprises a sliding bushing part (28).

7. An industrial robot according to any of the preceding claims, wherein the guide element (27) comprises a first contact surface (29).
- 5 8. An industrial robot according to any of the preceding claims, wherein the guide element (27) comprises a second contact surface (30).
9. An industrial robot according to any of the preceding
10 claims, wherein the guide element (27) comprises members (35) arranged to centre a compression spring.
10. A device (8) for balancing an industrial robot, comprising a compression spring unit (15), **characterized** in that
15 the compression spring unit (15) comprises at least a first compression spring packet (25), a second compression spring packet (26) and a guide element (27), which are arranged in the longitudinal direction one after the other along a common symmetry line (A), and that the guide element (27) is
20 arranged between the first (25) and second (26) compression spring packets.
11. A method for balancing an industrial robot (1, 1a) comprising a first robot part (3) and a second robot part (5)
25 arranged to be movable in relation to each other, and a balancing device (8), acting therebetween, comprising a first attachment (12) and a second attachment (14) for articulated attachment to the respective robot part (3), (7), wherein the balancing device (8) comprises a compression
30 spring unit (15) arranged to counteract the gravitational force upon relative rotation of the robot parts (3), (5), **characterized** in that the compression spring unit (15) is brought to comprise at least a first compression spring packet (25), a second compression spring packet (26) and a
35 guide element (27), which are arranged in the longitudinal direction one after the other along a common symmetry line (A), that the guide element (27) is brought to be arranged between a first end (31) of the first compression spring

packet (25) and a second end (34) of the second compression
spring packet (26), whereby the guide element (27) is
brought to guide one end (26, 34) of at least one compres-
sion spring packet (25, 26) upon compression of the com-
5 pression spring packet (25, 26).

12. A method according to claim 11, wherein the guide ele-
ment (27) is brought to guide the ends (26, 34) of the res-
pective spring packet upon rotation of the compression
10 spring unit (15).

13. A method according to any of the preceding claims,
wherein the guide element is brought to slide along a draw-
bar (24) included in the balancing device.

15 14. A method according to any of claim 11 or 12, wherein
the guide element is brought to slide along the inner enve-
lope surface (18a) of a spring housing (16) included in the
balancing device.

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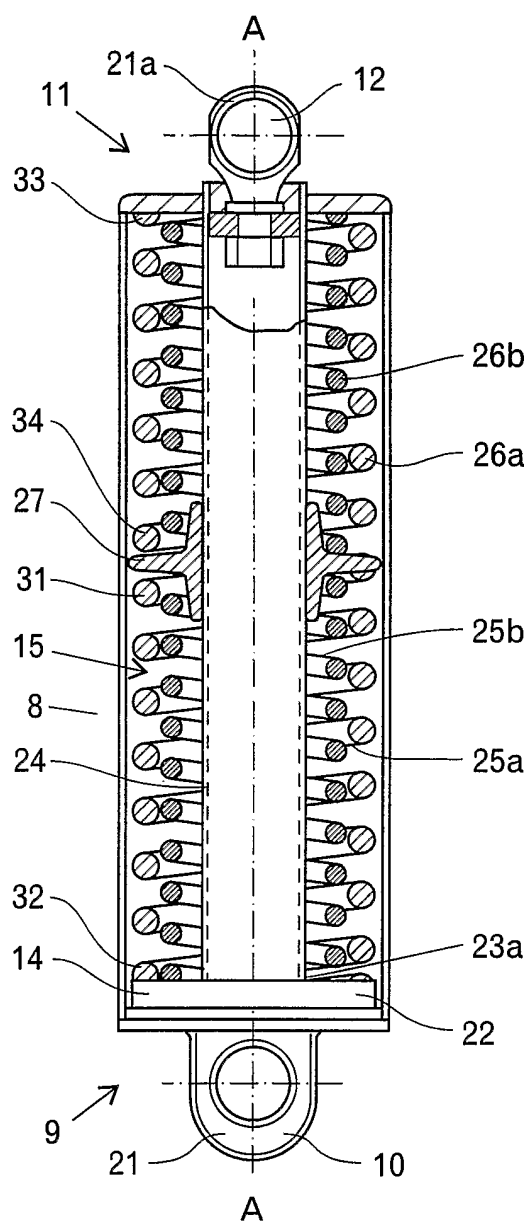


Fig 1

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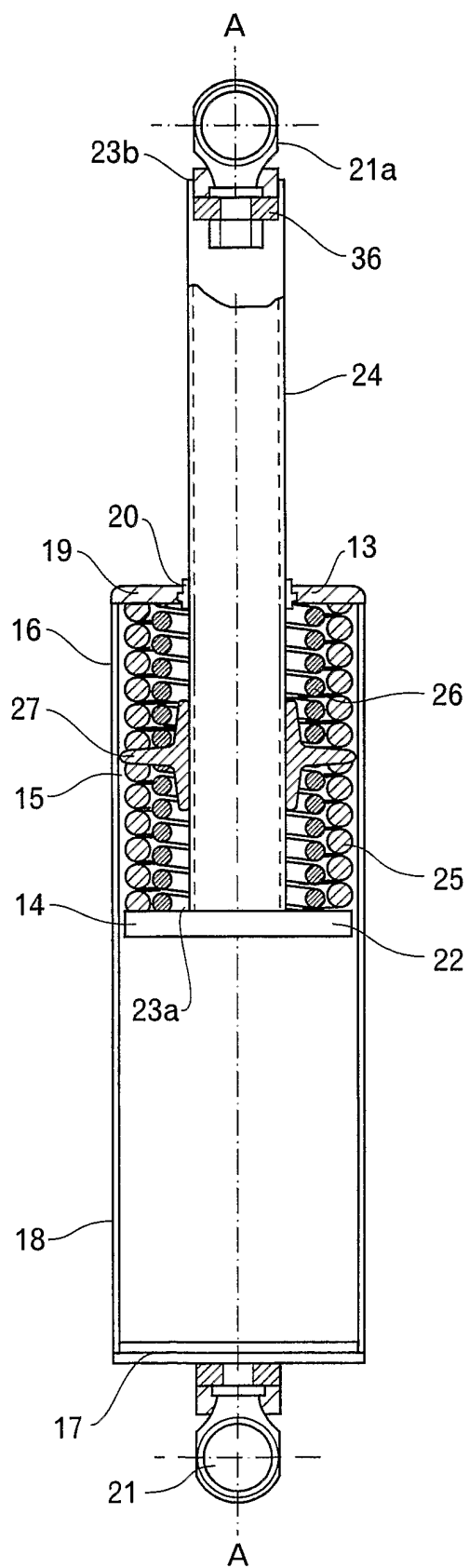


Fig 2

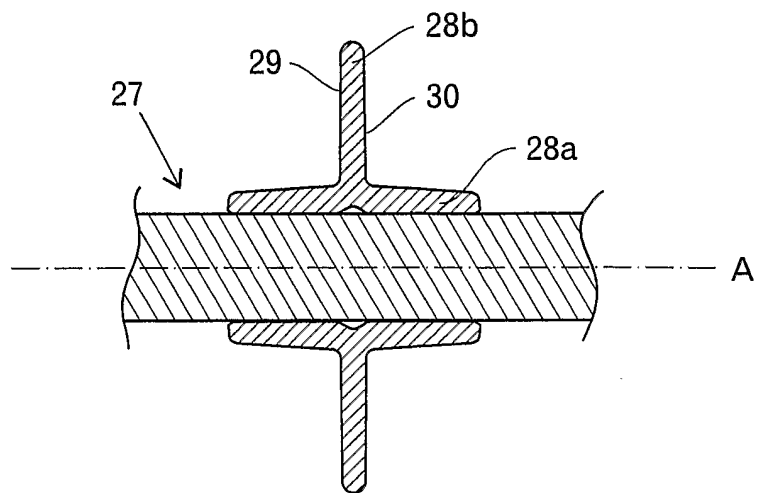


Fig 3a

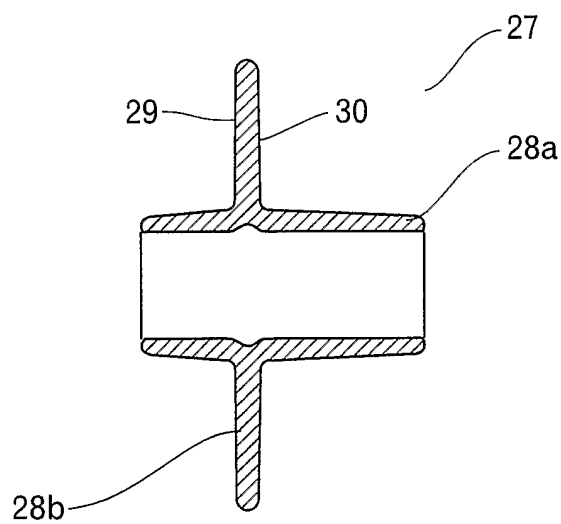


Fig 3b

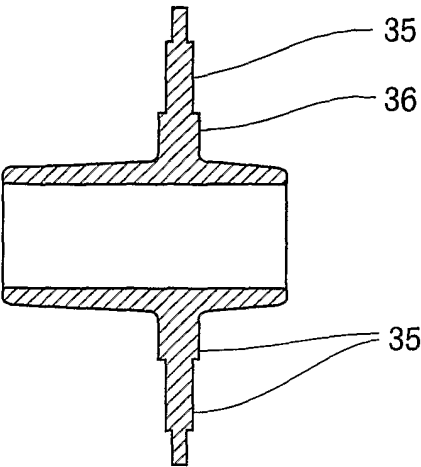


Fig 3c

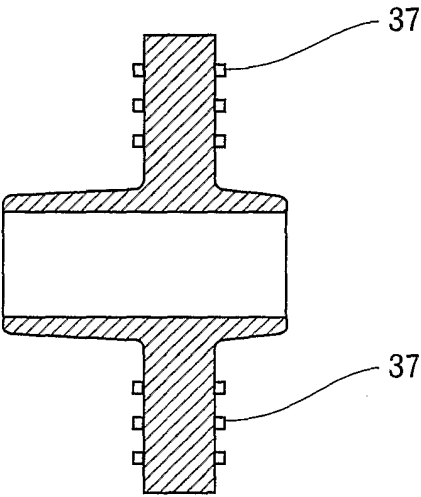


Fig 3d

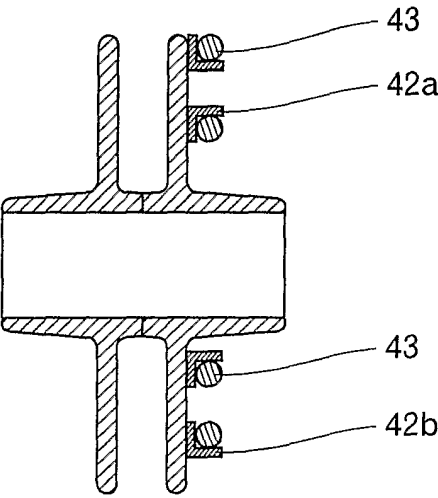


Fig 3e

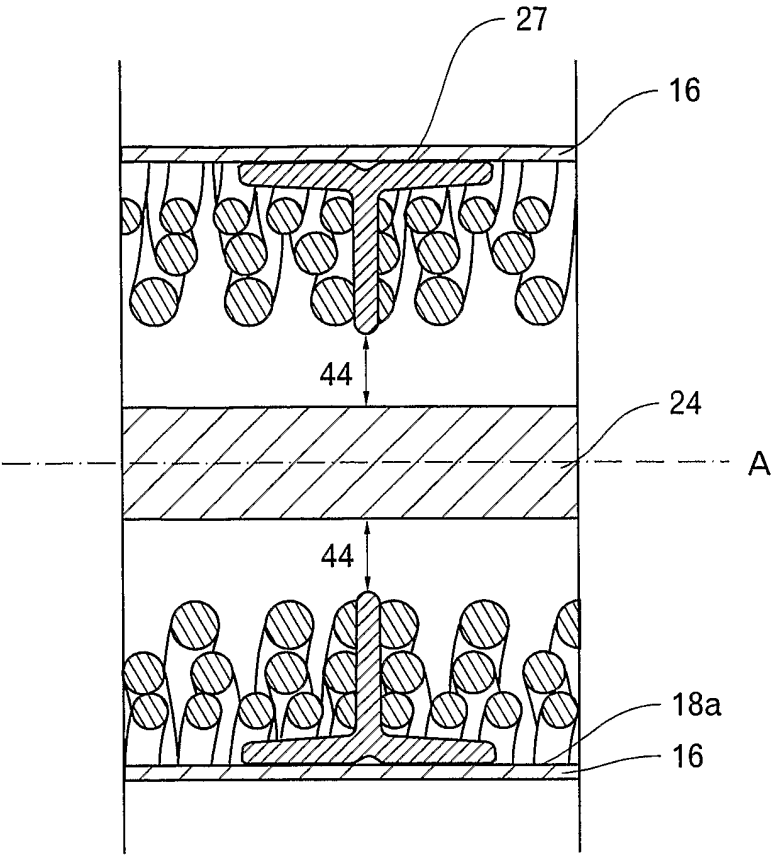


Fig 3f

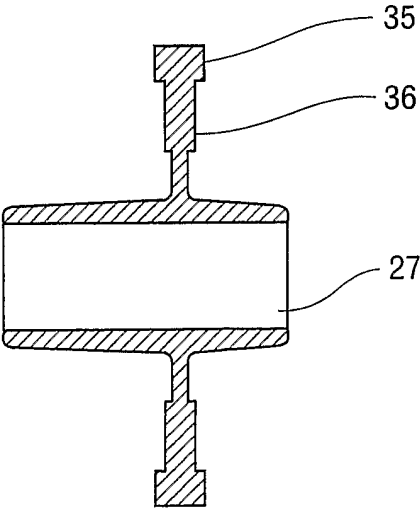


Fig 3g

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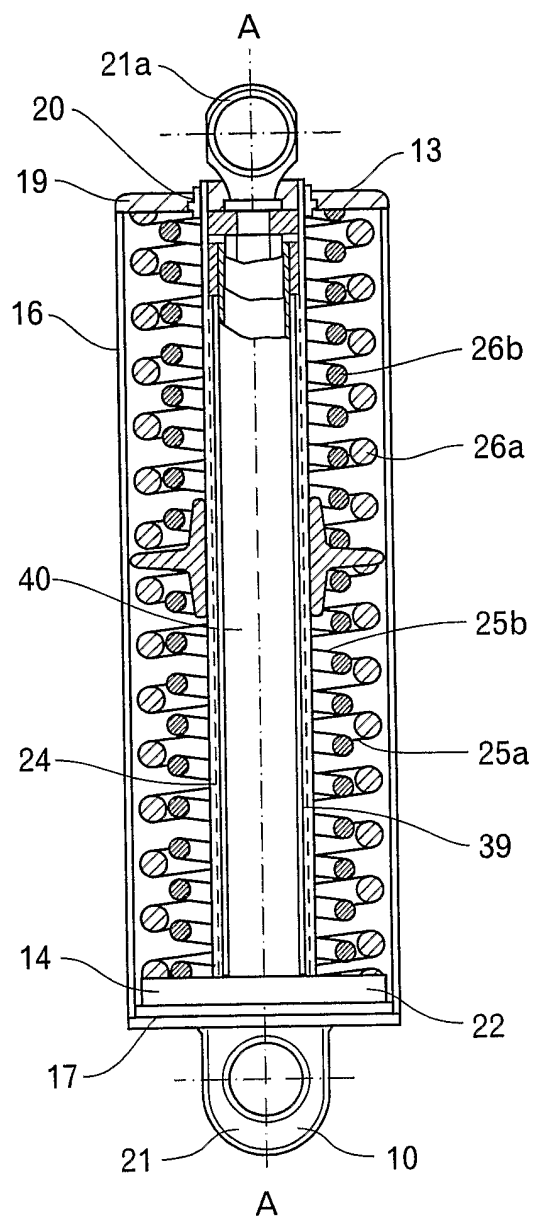


Fig 4

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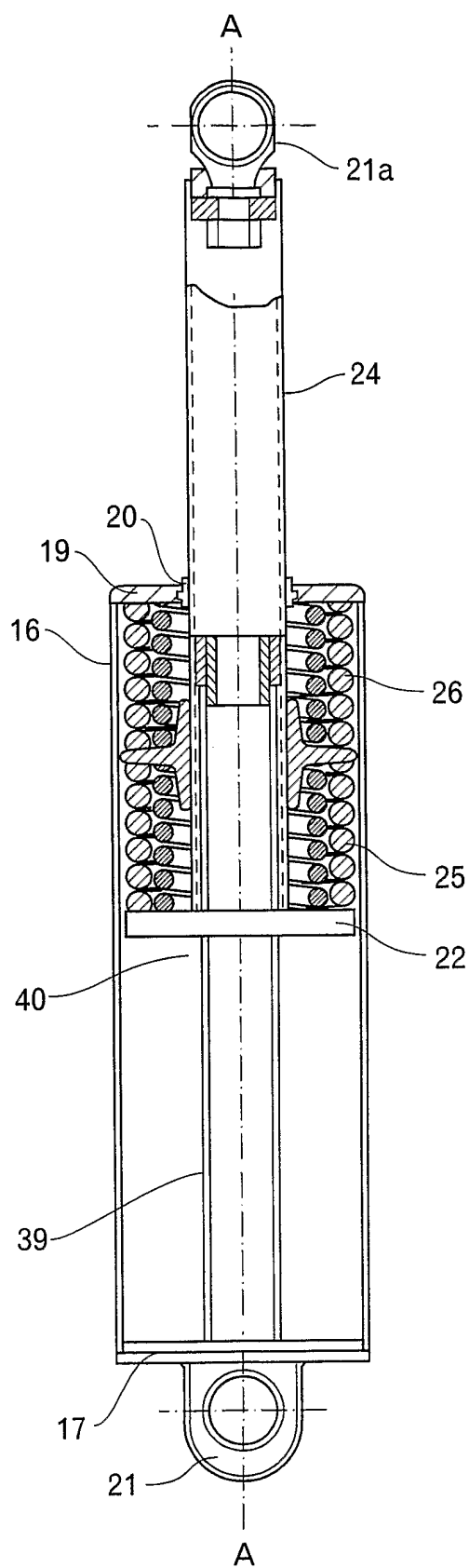


Fig 5

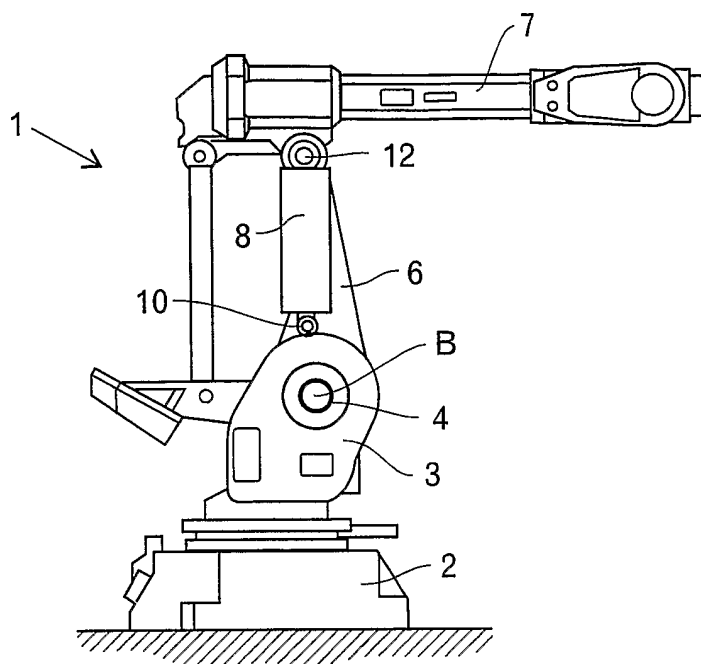


Fig 6

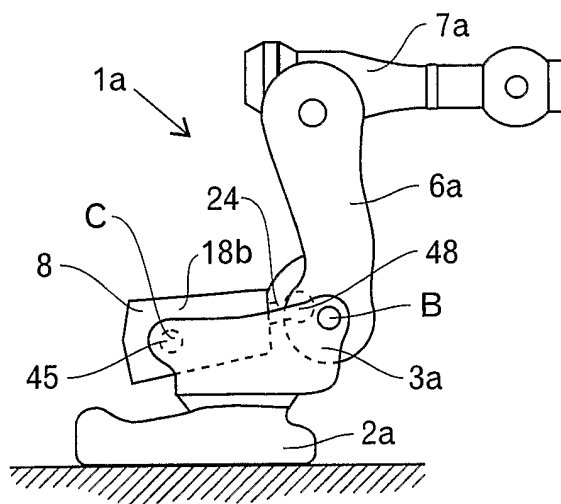


Fig 7

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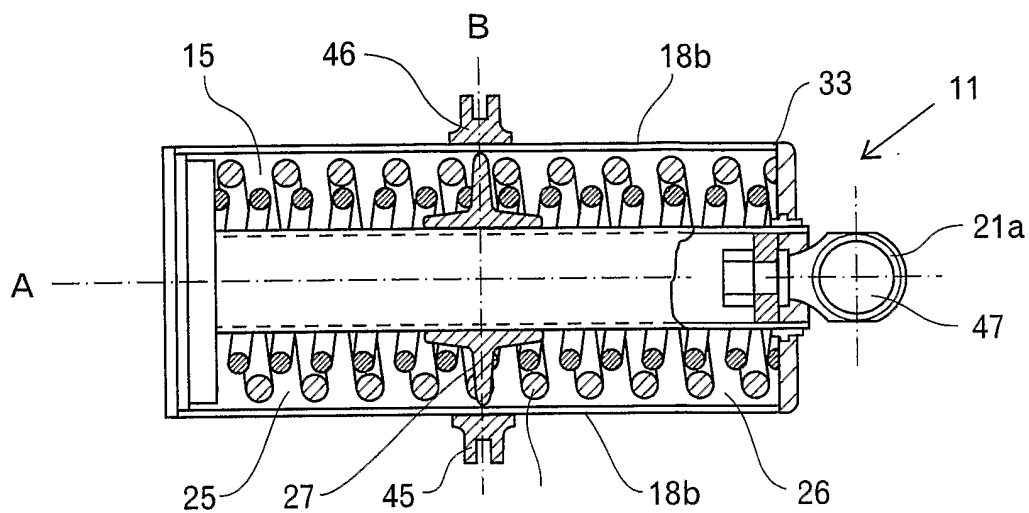


Fig 8

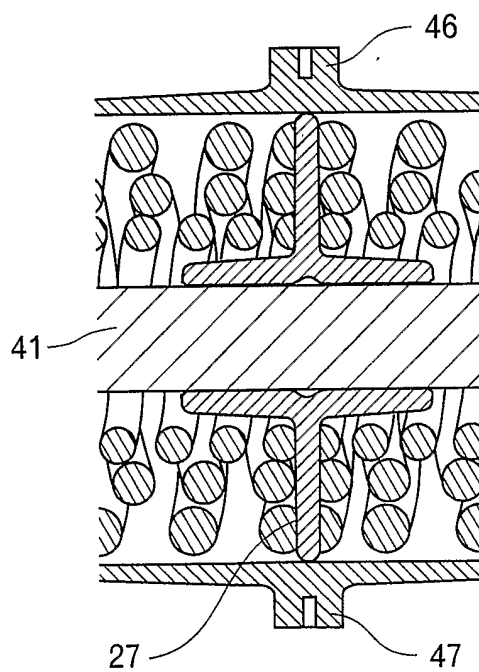


Fig 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 2005/000846

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B25J 19/00, F16F 1/13

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B25J, F16F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DATABASE WPI Week 199952 Derwent Publications Ltd., London, GB; Class D17, AN 1999-604200 & JP 11262889 A (MITSUBISHI JUKOGYO KK) 28 September 1999 (1999-09-28) abstract, figure 1-3 --	1-14
X	PATENT ABSTRACTS OF JAPAN vol. 006, no. 076 (M-128) 13 May 1982 (1982-05-13) & JP 57015135 A (SHIN MEIWA IND CO LTD) 26 January 1982 (1982-01-26) abstract, figure 1-9 --	1-14

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

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search	Date of mailing of the international search report
22 August 2005	08-09-2005

Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Ender Dag/MN Telephone No. +46 8 782 25 00
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 2005/000846

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 19801229 C1 (OTTO-VON-GUERICKE-UNIVERSITÄT MAGDEBURG), 17 December 1998 (17.12.1998), column 3, line 4 - line 67, figures 1-3 --	1-14
A	WO 0141978 A1 (ABB AB), 14 June 2001 (14.06.2001), page 6, line 10 - line 31, figures 1,2,6 --	1-14
A	US 20010022112 A1 (ALBERT BAYER ET AL), 20 Sept 2001 (20.09.2001), figures 1,2, abstract, [0020] -- -----	1-14

INTERNATIONAL SEARCH REPORT

Information on patent family members

08/07/2005

International application No.

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SE 9904500 A 10/06/2001
US 6848333 B 01/02/2005
US 20020162414 A 07/11/2002

US 20010022112 A1 20/09/2001 DE 10007251 A 23/08/2001
EP 1125696 A 22/08/2001
US 6564667 B 20/05/2003
