(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 October 2019 (31.10.2019)

WIPO | PCT

(10) International Publication Number
WO 2019/205060 A1

(51) International Patent Classification:
B61F 7/00 (2006.01)

(21) International Application Number:
PCT/CN2018/084661

(22) International Filing Date:
26 April 2018 (26.04.2018)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: **SCHAEFFLER TECHNOLOGIES AG & CO. KG** [DE/DE]; Industriestrasse 1-3, 91074 Herzogenaurach (DE).

(72) Inventor; and

(71) Applicant *(for SC only)*: **HONG, Mingxing** [CN/CN]; Room 1103, Building 1, Hejingfenghui Block, Yuanhe Street, Xiangcheng District, Suzhou, Jiangsu 215131 (CN).

(74) Agent: **LINDA LIU & PARTNERS**; F16 Tower C, Beijing Global Trade Center, 36 North Third Ring East Road, Dongcheng District, Beijing 100013 (CN).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,

(54) Title: WHEEL GAUGE ADJUSTMENT MECHANISM, BOGIE, AND METHOD FOR ADJUSTING WHEEL GAUGE OF TRAIN

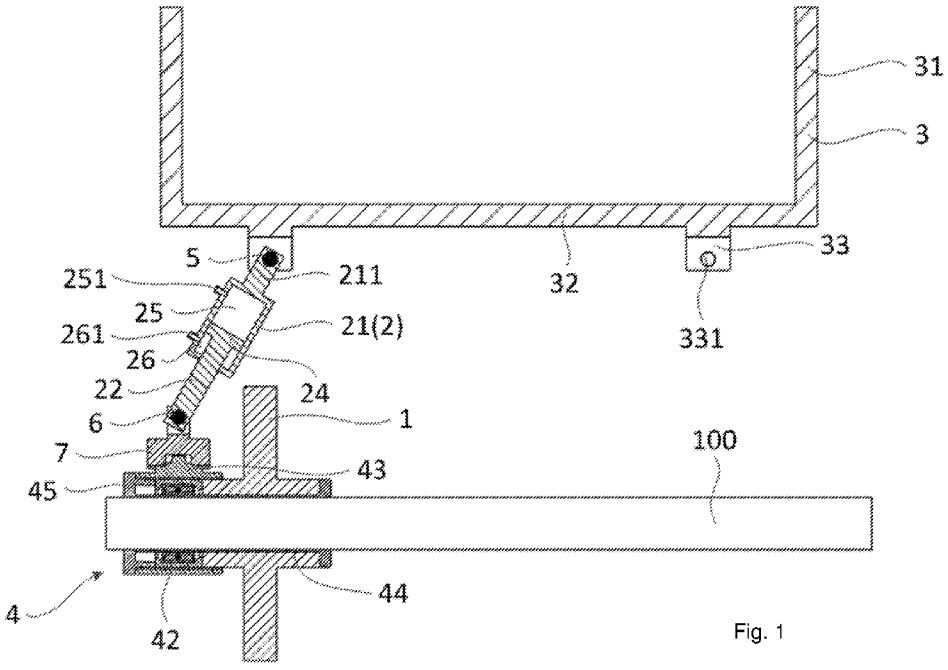

Fig. 1

(57) Abstract: A wheel gauge adjustment mechanism, a bogie, and a method for adjusting a wheel gauge of a train. The wheel gauge adjustment mechanism includes a hydraulic cylinder (2) and two connecting devices (5, 6) configured for connecting two end parts (21, 22) of the hydraulic cylinder (2) on a carriage (3) and a wheel module (4), respectively, wherein states of the hydraulic cylinder (2) and/or the connecting devices (5, 6) are changeable, such that the wheel gauge adjustment mechanism is changeable between a locking state where the carriage (3) is supported by the wheel module (4) and an adjusting state where the wheel gauge is changeable.

WO 2019/205060 A1

[Continued on next page]

MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

WHEEL GAUGE ADJUSTMENT MECHANISM, BOGIE, AND METHOD FOR ADJUSTING WHEEL GAUGE OF TRAIN

FIELD

This disclosure relates to a wheel gauge adjustment mechanism, a bogie, and a method for adjusting a wheel gauge of a train.

RELATED ART

With the pushing of One Belt and One Road, the high-speed train will go across different countries or districts. Now there are three kinds of rail gauges. The width of the standard gauge is 1435 mm. The width of the wide gauge is 1520 mm. The width of the narrow gauge is 1000 mm.

So it's necessary to design a system for adjusting a wheel gauge of a train to fit different rail gauges in different countries or districts.

There is a known design where a spring is provided between a carriage and an axle box adjacent to a wheel, the axle box being supported by a drive shaft via a railway bearing. For different rail gauges, it needs to move the wheel and the railway bearing to different positions, but the positions of the spring and the axle box maintain unchanged. For standard gauge, the load centerline (extending along the spring and the axle box) of the railway bearing aligns with the bearing centerline. It's a good working condition for the railway bearing. But for the wide gauge and the narrow gauge, there is a big offset between the load centerline and the bearing centerline. It's a bad working condition for the railway bearing. This offset will cause the lifetime of the railway bearing declining rapidly.

SUMMARY

In view of the above condition, this disclosure provides a wheel gauge adjustment mechanism, a bogie, and a method for adjusting a wheel gauge of a train.

There proposes a wheel gauge adjustment mechanism comprising a hydraulic cylinder and two connecting devices configured for connecting two end parts of the hydraulic cylinder on a carriage and a wheel module, respectively, wherein states of the hydraulic cylinder and/or the connecting devices are changeable, such that the wheel gauge adjustment mechanism is changeable between a locking state where the carriage is supported by the wheel module and an adjusting state where the wheel gauge is changeable.

In at least one embodiment of this disclosure, the hydraulic cylinder comprises a cylinder body and a piston located in the cylinder body, the piston being movable in the cylinder body, such that a distance between a first connecting point for connecting the carriage and the hydraulic cylinder and a second connecting point for connecting the wheel module and the hydraulic cylinder is changeable.

In at least one embodiment of this disclosure, in the adjusting state of the wheel gauge adjustment mechanism, at least one of the two connecting devices is in a releasing state where the hydraulic cylinder is rotatable relative to the carriage or the wheel module.

In at least one embodiment of this disclosure, in the locking state of the wheel gauge adjustment mechanism, at least one of the two connecting devices is in an engaging state where the hydraulic cylinder is not rotatable relative to the carriage or the wheel module.

In at least one embodiment of this disclosure, the connecting device comprises a shaft insertable in a hole in the carriage or the wheel module, or insertable in a hole in the hydraulic cylinder, or

the connecting device comprises a hole in which a shaft on the carriage or the wheel module is insertable.

In at least one embodiment of this disclosure, the shaft comprises a engaging part having a noncircular cross section and a releasing part, the shaft and the hole are configured such that the shaft is not rotatable in the hole when the engaging part is inserted in the hole and that the shaft is rotatable in the hole when the releasing part is inserted in the hole.

In at least one embodiment of this disclosure, the engaging part comprises spline teeth matching the profile of the hole.

In at least one embodiment of this disclosure, the hydraulic cylinder is controlled by a hydraulic device, the hydraulic device comprising a solenoid directional valve connected to two cavities of the hydraulic cylinder divided by a piston and a hydraulic pump connected to the solenoid directional valve.

In at least one embodiment of this disclosure, the connecting devices are connected to additional hydraulic cylinders for changing the connecting devices between the releasing state and the engaging state, respectively.

There proposes a bogie comprising

a shaft,

two wheel modules mounted on the shaft, and

at least one wheel gauge adjustment mechanism according to this disclosure configured for adjusting the wheel gauge defined by the two wheel modules.

In at least one embodiment of this disclosure, at least one of the two wheel modules moves along the shaft as a whole when the wheel gauge is adjusted.

In at least one embodiment of this disclosure, wherein the wheel module comprises a wheel mounted on the shaft, a railway bearing adjacent to the wheel, and an axle box or adaptor supported by the shaft via the railway bearing.

There proposes method for adjusting a wheel gauge of a train using the wheel gauge adjustment mechanism according to this disclosure.

In at least one embodiment of this disclosure, the method comprises steps of

changing the two connecting devices to a releasing state where the hydraulic cylinder is rotatable relative to the carriage and the wheel module from a engaging state where the hydraulic cylinder is not rotatable relative to the carriage and the wheel module,

adjusting the wheel gauge and a length of the hydraulic cylinder, and

changing the two connecting devices to the engaging state from the releasing state such that the carriage is supported by the wheel module.

In at least one embodiment of this disclosure, the method further comprises a step of supporting the carriage before adjusting the wheel gauge and the length of the hydraulic cylinder, wherein the wheel gauge is adjusted by adjusting the length of the hydraulic cylinder.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 schematically illustrates a wheel gauge adjustment mechanism of this disclosure.

Fig. 2 schematically illustrates a hydraulic device for changing and keeping a length of a hydraulic cylinder of the wheel gauge adjustment mechanism in Fig. 1.

Fig. 3 schematically illustrates a first spline shaft in Fig. 1.

Fig. 4 schematically illustrates an engaging state of a second spline shaft in Fig. 1.

Fig. 5 schematically illustrates a releasing state of the second spline shaft in Fig. 1.

List of reference numbers

1 wheel

2 hydraulic cylinder

21 cylinder body

22 piston rod

211 pillar

24 piston

25 first cavity

251 first port

26 second cavity

261 second port

3 carriage

31 side wall

32 bottom wall

33 lug

331 splined hole

4 wheel module

42 railway bearing

43 axle box or adaptor

44 journal bearing

45 cover

5 first spline shaft

51 first spline part

52 first shaft part

6 second spline shaft

61 second spline part

62 second shaft part

7 support member

8 solenoid directional valve

9 pressure regulating valve

10 filter

11 oil pump

12 oil tank

100 shaft

DESCRIPTION OF THE EMBODIMENTS

The following describes in detail preferable exemplary embodiments of this disclosure with reference to the attached drawings.

This disclosure provides a wheel gauge adjustment mechanism for adjusting a wheel gauge to fit different rail gauges in different countries or districts. This disclosure also provides a bogie including the wheel gauge adjustment mechanism and a method for adjusting the wheel gauge of a train using the wheel gauge adjustment mechanism.

Firstly, the wheel gauge adjustment mechanism and the bogie are described below by referring to Figs. 1 to 5.

As shown in Fig. 1 and Fig. 3, the wheel gauge adjustment mechanism for adjusting the wheel gauge, i.e. the distance between two wheels (only one wheel 1 is shown in Fig. 1) of a train comprises a hydraulic cylinder 2, a first spline shaft 5 as a first connecting device, a second spline shaft 6 as a second connecting device and a support member 7.

The hydraulic cylinder 2 is used for connecting a carriage 3 and a wheel module 4 of the train to support the carriage 3 by the wheel module 4. The hydraulic cylinder 2 comprises a cylinder body 21, a piston rod 22, and a piston 24. The cylinder body 21 has a pillar 211 extending from a first end thereof. On the tip of the pillar 211, a splined hole is provided. The piston 24 divides the cavity of the cylinder body 21 into a first cavity 25 and a second cavity 26. The piston rod 22 connects with the piston 24 and protrudes from a second end of the cylinder body 21. On the tip of the piston rod 22, a splined hole is provided. The first cavity 25 communicates with a first port 251, and the second cavity 26 communicates with a second port 261.

The first spline shaft 5 comprises a first spline part 51 as a first engaging part and a first shaft part 52 as a first releasing part. The second spline shaft 6 may have the same structure as that of the first spline shaft 5. As shown in Figs. 4 and 5, the second spline shaft 6 comprises a second spline part 61 as a second engaging part and a second shaft part 62 as a second releasing part.

As shown in Fig. 1, the carriage 3 comprises side walls 31 and a bottom wall 32. Lugs 33 extend from the bottom face of the bottom wall 32. Each lug 33 has a splined hole 331. The first spline part 51 of the first spline shaft 5 matches with the splined hole of the pillar 211 and the splined hole 331 of the lug 33.

The wheel module 4 comprises the wheel 1 mounted on a shaft 100 such as a drive shaft, a railway bearing (for example, a rolling bearing) 42 adjacent to the wheel 1, and an axle box or adaptor 43 disposed between the support member 7 and the railway bearing 42.

The support member 7 comprises a splined hole matching with the second spline part 61 of the second spline shaft 6. The support member 7

connects with the piston rod 22 at the splined hole by the second spline shaft 6. The support member 7 also connects with the axle box or adaptor 43 in such a way that the support member 7 is movable together with the axle box or adaptor 43, the railway bearing 42 and the wheel 1 along the shaft 100.

When the pillar 211 and the lug 33 are connected by the first spline part 51 of the first spline shaft 5, the hydraulic cylinder 2 is non-rotatable relative to the carriage 3. When the piston rod 22 and the support member 7 are connected by the second spline part 61 of the second spline shaft 6, the hydraulic cylinder 2 is non-rotatable relative to the support member 7 and thus the hydraulic cylinder 2 is non-rotatable relative to the wheel module 4. In such a locking state, the carriage 3 can be supported by the wheel module 4 stably.

When the pillar 211 and the lug 33 are connected by the first shaft part 52 of the first spline shaft 5, the hydraulic cylinder 2 is rotatable relative to the carriage 3. When the piston rod 22 and the support member 7 are connected by the second shaft part 62 of the second spline shaft 6, the hydraulic cylinder 2 is rotatable relative to the support member 7 and thus the hydraulic cylinder 2 is rotatable relative to the wheel module 4. In such an adjusting state, the railway bearing 42, the axle box or adaptor 43, the support member 7 and the wheel 1 can move along the shaft 100 and the wheel gauge can be adjusted.

When the wheel gauge is adjusted, the length of the hydraulic cylinder 2 is also changed to maintain the level of the carriage 3.

The hydraulic cylinder 2 may be an oil cylinder. The following describes a case where the hydraulic cylinder 2 is an oil cylinder.

As shown in Figs. 1 and 2, the wheel gauge adjustment mechanism further comprises a hydraulic device includes a solenoid directional valve 8 connected to the hydraulic cylinder 2 through the first port 251 and the second port 261 to lengthen and shorten the hydraulic cylinder 2.

Fig. 2 shows a condition where the hydraulic cylinder 2 is lengthened. An oil pump 11 pumps oil from an oil tank 12 through a filter 10, a pressure regulating valve 9, and the solenoid directional valve 8 into the first cavity 25 of the hydraulic cylinder 2, and then the first cavity 25 expands. The piston 24 and the piston rod 22 are pushed by the oil in the first cavity 25 and the piston rod 22 further protrudes from the cylinder body 21. At the same time, the

second cavity 26 contracts in it length, and the oil in the second cavity 26 flows into the oil tank 12 through the solenoid directional valve 8.

The solenoid directional valve 8 may be a three-position four-way valve. The volume of the first cavity 25 and the volume of the second cavity 26 can be maintained or changed by changing the state of the solenoid directional valve 8 (the position of the valve core).

This disclosure of course is not limited to the structure in Fig. 2. To lengthen and shorten the hydraulic cylinder 2, another structure can be used.

To change connecting positions of the first spine shaft 5 and the second spline shaft 6, a first drive such as a motor or an additional hydraulic cylinder and a second drive such as a motor or an additional hydraulic cylinder can be provided. The first drive is configured for driving the spine shaft 5 to change its connecting position with the cylinder body 21 and the carriage 3, and the second drive is configured for driving the second spline shaft 6 to change its connecting position with the piston rod 22 and the support member 7. The additional hydraulic cylinder for driving the first spline shaft 5 or the second spline shaft 6 may work on the same principle of the hydraulic cylinder 2.

As shown in Fig. 1 the wheel module 4 further comprises a journal bearing 44 (for example, a sliding bearing) disposed between the railway bearing 42 and the shaft 100 and between the wheel 1 and the shaft 100, in order to reduce friction between the railway bearing 42, the wheel 1 and the shaft 100 when the wheel gauge is adjusted. The wheel module 4 further comprises a cover 45 for securing the position of the railway bearing 42 between the cover 45 and the wheel 1.

As explained above, this disclosure uses the hydraulic cylinder 2 instead of a spring to support the carriage 3. The length of the hydraulic cylinder 2 is controlled by the hydraulic device comprising the solenoid directional valve 8 and the oil pump 11 to fit different rail gauges. Normally the spline shafts 5 and 6 work at an engaging state by their spline parts 51 and 61 as shown in Fig. 4.

When passing the railway where a change of the rail gauge happens, the carriage 3 should be supported by another means (not shown), the spline shafts 5 and 6 are driven by drives and the spline shafts 5 and 6 work at a releasing state by their shaft parts 52 and 62 as shown in Fig. 5, such that the

hydraulic cylinder 2 is rotatable relative to the carriage 3 and the support member 7. In this adjusting state, the length of the hydraulic cylinder 2 is changed by the hydraulic device as shown in Fig. 2 to move the wheel module 4 along the shaft 100 and fit the new rail gauge. Then the spline shafts 5 and 6 are driven by drives and work at the engaging state by their spline parts 51 and 61 as shown in Fig. 4. The carriage 3 is supported by the hydraulic cylinder 2 and the wheel module 4 again.

In this disclosure, when the wheel gauge is adjusted, the axle box or adaptor 43, the railway bearing 42, the support member 7, the wheel 1 and the spline shaft 6 move together along the shaft 100, and thus the load centerline of the railway bearing always aligns with the bearing centerline for three rail gauges including the standard gauge, the wide gauge and the narrow gauge. There is no offset between the load centerline and the bearing centerline anymore. Therefore it's good for the working lifetime of the railway bearing 42.

Additionally, the spline shafts 5 and 6 can endure higher load and can stop carriage 3 moving. The hydraulic cylinder 2 is controlled by the hydraulic device to fit different rail gauges, therefore automatic gauge adjusting can be realized.

It should be understood that this disclosure is not limited to the above content.

For example, the first and second connecting devices are not limited to the spline shafts 5 and 6. The engaging part may also have other non-circle cross section such as triangular or rectangular cross section, as long as the engaging part can connect the hydraulic cylinder 2 and the carriage 3 or the hydraulic cylinder 2 and the support member 7 by shape locking, such that the hydraulic cylinder 2 is non-rotatable relative to the carriage 3 or the support member 7. The shaft part (releasing part) also is not limited to have circle cross section, as long as the hydraulic cylinder 2 is rotatable relative to the carriage 3 and the wheel module 4 when the hydraulic cylinder 2 and the carriage 3 or the wheel module 4 are connected by the shaft part (releasing part).

The spline shaft 5 may be a separate member or a part of the carriage 3 or the hydraulic cylinder 2. The spline shaft 6 may be a separate member or a part of the support member 7 or the hydraulic cylinder 2.

The support member 7 can also be omitted and the splined hole for connecting with the spline shaft 6 may directly form on the axle box or adaptor 43.

For example, the piston rod 22 can be connected to the carriage 3 and then the cylinder body 21 can be connected to the support member 7.

For example, the wheel module 4 may have other structure instead of that shown in Fig. 1.

The other side (the right side in Fig. 1) of the shaft 100 may use the same mechanism as the above explained wheel gauge adjustment mechanism. The other mechanism on the same shaft 100 can form a mirror image of the wheel gauge adjustment mechanism disclosed herein. In such a condition, two wheels on the same shaft can move in the opposite directions when the wheel gauge is adjusted.

While this disclosure has been described with reference to exemplary embodiments, it is to be understood that this disclosure is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

What is claimed is:

1. A wheel gauge adjustment mechanism comprising a hydraulic cylinder (2) and two connecting devices (5, 6) configured for connecting two end parts (21, 22) of the hydraulic cylinder (2) on a carriage (3) and a wheel module (4), respectively, wherein states of the hydraulic cylinder (2) and/or the connecting devices (5, 6) are changeable, such that the wheel gauge adjustment mechanism is changeable between a locking state where the carriage (3) is supported by the wheel module (4) and an adjusting state where the wheel gauge is changeable.

2. The wheel gauge adjustment mechanism according to claim 1, wherein the hydraulic cylinder (2) comprises a cylinder body (21) and a piston (24) located in the cylinder body (21), the piston (24) being movable in the cylinder body (21), such that a distance between a first connecting point for connecting the carriage (3) and the hydraulic cylinder (2) and a second connecting point for connecting the wheel module (4) and the hydraulic cylinder (2) is changeable.

3. The wheel gauge adjustment mechanism according to claim 1 or 2, wherein in the adjusting state of the wheel gauge adjustment mechanism, at least one of the two connecting devices (5, 6) is in a releasing state where the hydraulic cylinder (2) is rotatable relative to the carriage (3) or the wheel module (4).

4. The wheel gauge adjustment mechanism according to any of the preceding claims, wherein in the locking state of the wheel gauge adjustment mechanism, at least one of the two connecting devices (5, 6) is in an engaging state where the hydraulic cylinder (2) is not rotatable relative to the carriage (3) or the wheel module (4).

5. The wheel gauge adjustment mechanism according to any of the preceding claims, wherein the connecting device (5, 6) comprises a shaft insertable in a hole in the carriage (3) or the wheel module (4), or insertable in a hole in the hydraulic cylinder (2), or

the connecting device (5, 6) comprises a hole in which a shaft on the carriage (3) or the wheel module (4) is insertable.

6. The wheel gauge adjustment mechanism according to any of the

preceding claims, wherein the shaft comprises a engaging part having a noncircular cross section and a releasing part, the shaft and the hole are configured such that the shaft is not rotatable in the hole when the engaging part is inserted in the hole and that the shaft is rotatable in the hole when the releasing part is inserted in the hole.

7. The wheel gauge adjustment mechanism according to any of the preceding claims, wherein the engaging part comprises spline teeth matching the profile of the hole.

8. The wheel gauge adjustment mechanism according to any of the preceding claims, wherein the hydraulic cylinder (2) is controlled by a hydraulic device, the hydraulic device comprising a solenoid directional valve (8) connected to two cavities of the hydraulic cylinder (2) divided by a piston (24) and a hydraulic pump (11) connected to the solenoid directional valve (8).

9. The wheel gauge adjustment mechanism according to any of the preceding claims, wherein the connecting devices (5, 6) are connected to additional hydraulic cylinders for changing the connecting devices (5, 6) between the releasing state and the engaging state, respectively.

10. A bogie comprising

a shaft (100),

two wheel modules (4) mounted on the shaft (100), and

at least one wheel gauge adjustment mechanism according to any of the preceding claims configured for adjusting the wheel gauge defined by the two wheel modules (4).

11. The bogie according to the preceding claim, wherein at least one of the two wheel modules (4) moves along the shaft (100) as a whole when the wheel gauge is adjusted.

12. The bogie according to claim 10 or 11, wherein the wheel module (4) comprises a wheel (1) mounted on the shaft (100), a railway bearing (42) adjacent to the wheel (1), and an axle box or adaptor supported by the shaft (100) via the railway bearing (42).

13. A method for adjusting a wheel gauge of a train using the wheel gauge adjustment mechanism according to any of claims 1 to 9.

14. The method according to claim 13 comprising steps of

changing the two connecting devices (5, 6) to a releasing state where the hydraulic cylinder (2) is rotatable relative to the carriage (3) and the wheel module (4) from a engaging state where the hydraulic cylinder (2) is not rotatable relative to the carriage (3) and the wheel module (4),

adjusting the wheel gauge and a length of the hydraulic cylinder (2), and

changing the two connecting devices (5, 6) to the engaging state from the releasing state such that the carriage (3) is supported by the wheel module (4).

15. The method according to claim 13 or 14 comprising a step of supporting the carriage (3) before adjusting the wheel gauge and the length of the hydraulic cylinder (2), wherein the wheel gauge is adjusted by adjusting the length of the hydraulic cylinder (2).

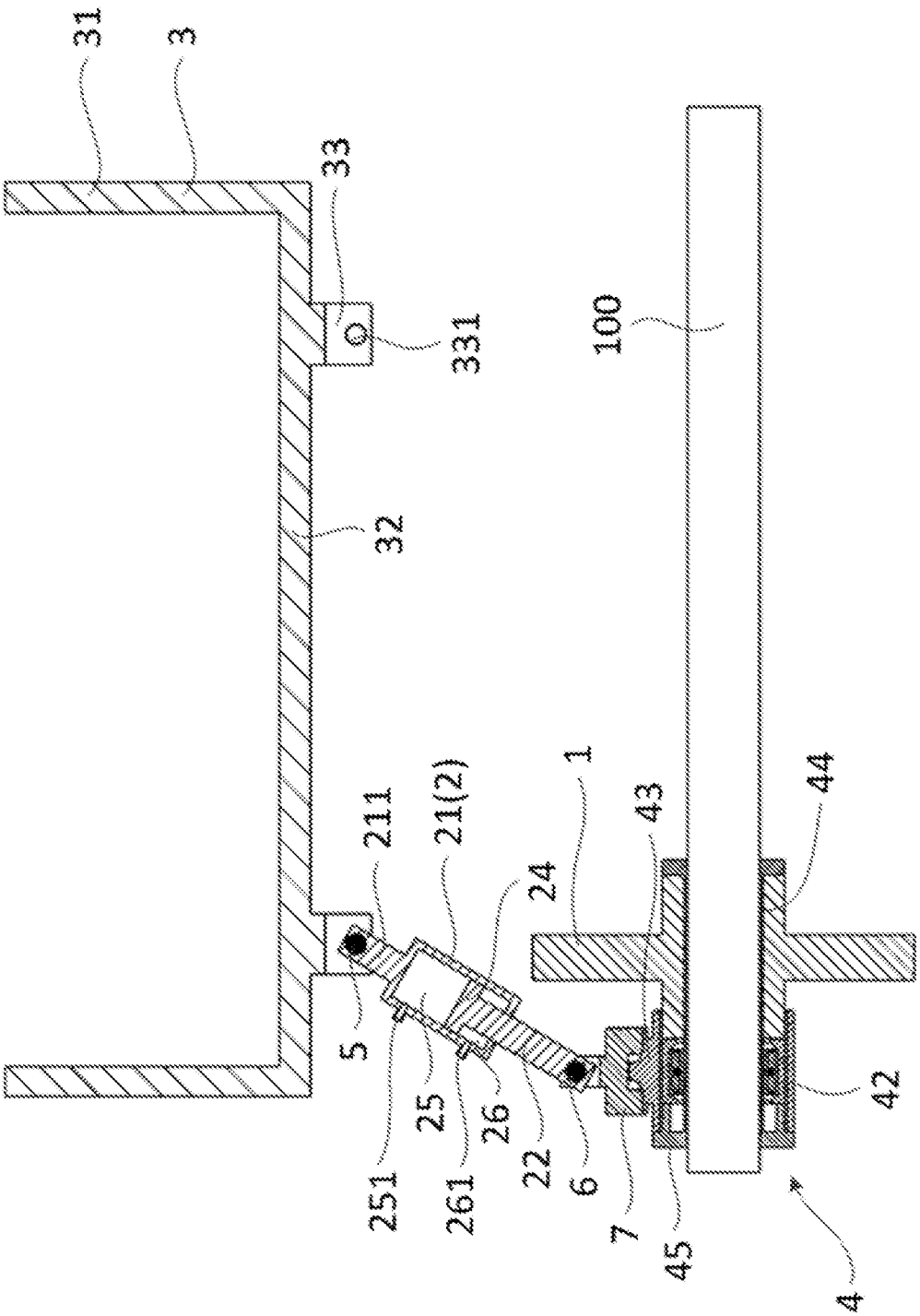

Fig. 1

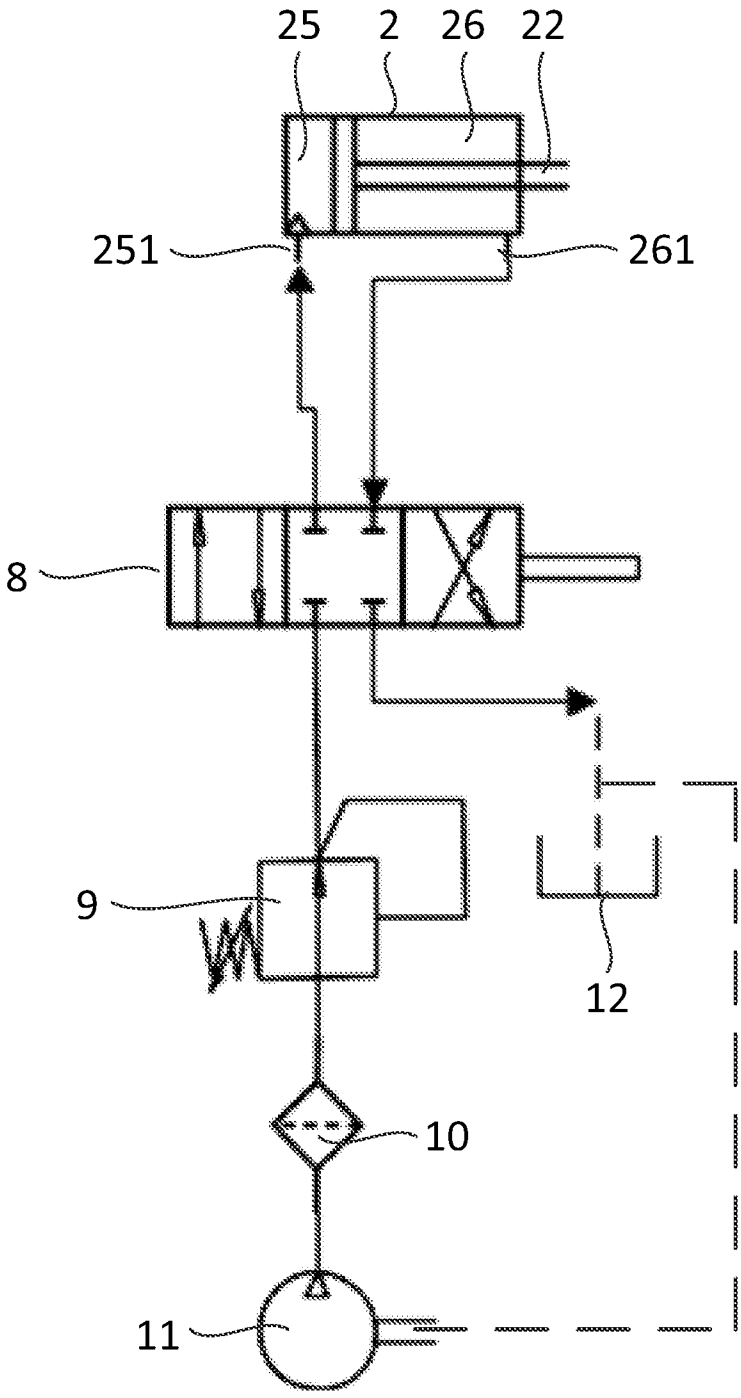

Fig. 2

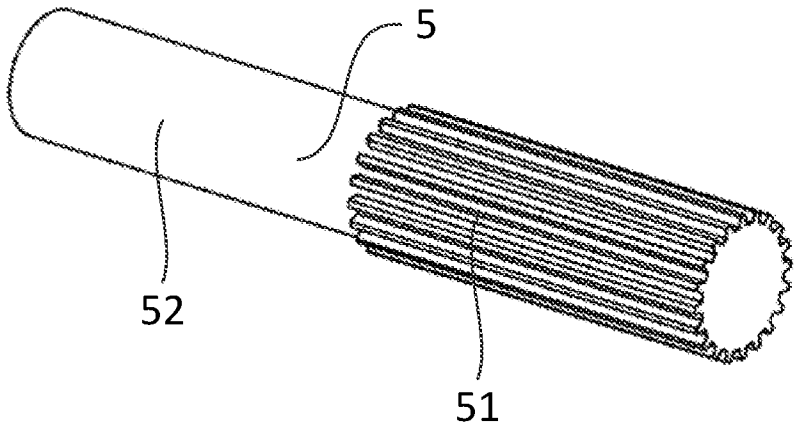

Fig. 3

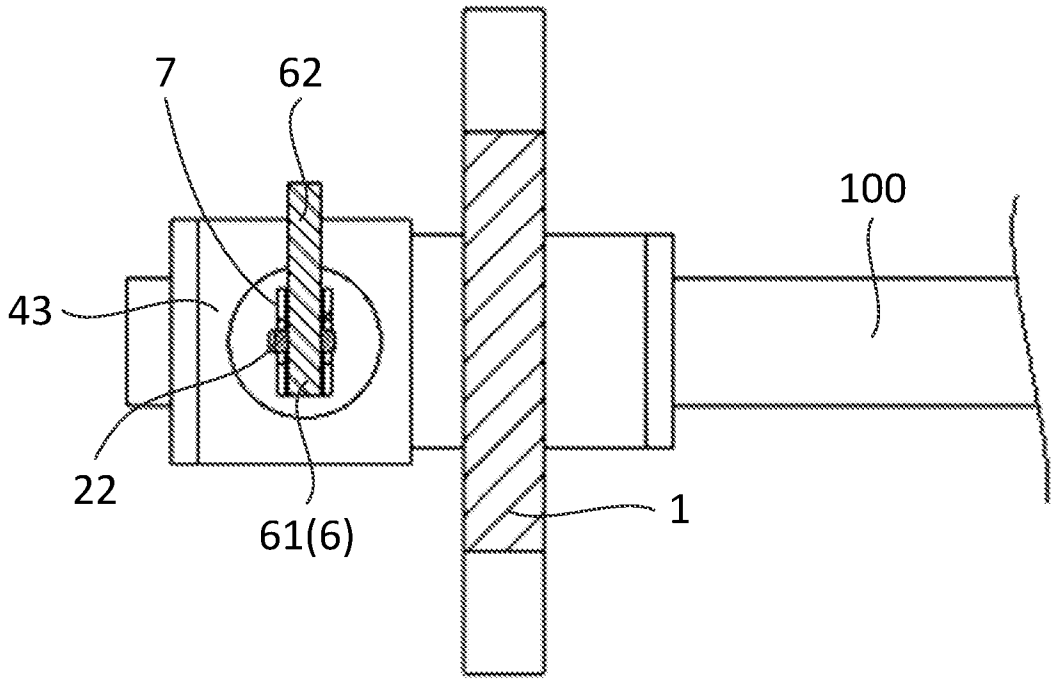

Fig. 4

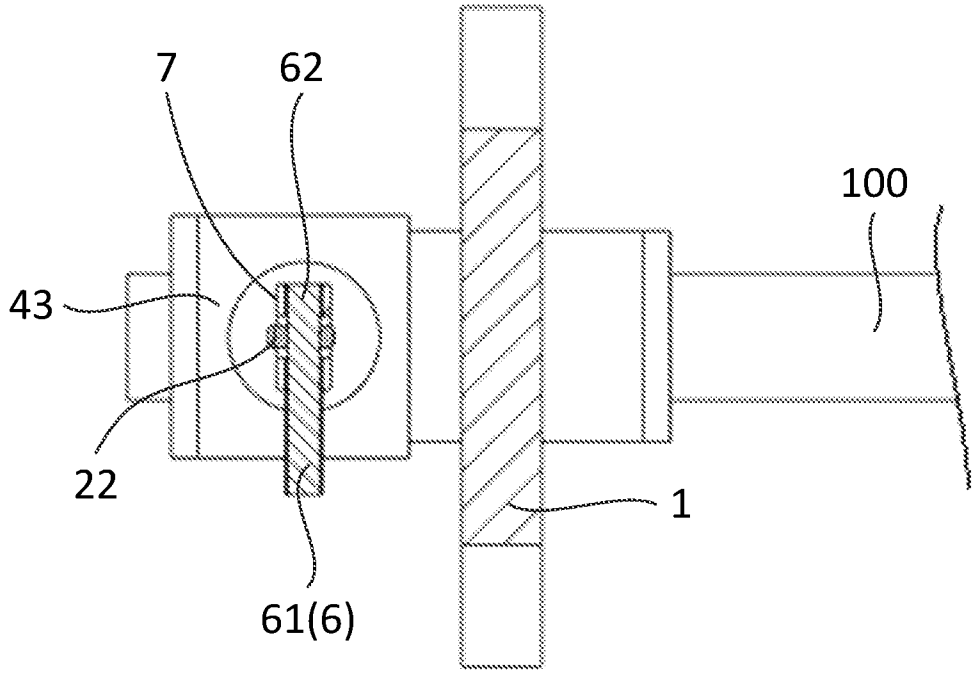

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2018/084661

A. CLASSIFICATION OF SUBJECT MATTER

B61F 7/00(2006.01)i

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)

B61F

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

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

CNPAT, WPI, EPODOC, CNKI: schaeffler, train, bogie, wheel, gauge, distance, adjust+, hydraulic, connect+, chang+, lock+, piston, spline, valve

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3306390 A (GEORGES, JAMME ANDRE) 28 February 1967 (1967-02-28) see description, column 2, line 19 to column 6, line 32 and figures 1 to 17	1-15
A	CN 2753635 Y (YANG, SHILAN) 25 January 2006 (2006-01-25) the whole document	1-15
A	CN 106882199 A (LI, YONG) 23 June 2017 (2017-06-23) the whole document	1-15
A	CN 200992209 Y (QIQIHAER ORBIT TRAFFIC EQUIP CO., LTD.) 19 December 2007 (2007-12-19) the whole document	1-15
A	KR 20030054574 A (KRRI) 02 July 2003 (2003-07-02) the whole document	1-15
A	WO 9319974 A1 (NOBAS AG.) 14 October 1993 (1993-10-14) the whole document	1-15

☐ Further documents are listed in the continuation of Box C.

☑ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"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)

"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

"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

"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

"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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 January 2019	**30 January 2019**

Name and mailing address of the ISA/CN	Authorized officer
National Intellectual Property Administration, PRC **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China**	**ZHANG,Xianglei**
Facsimile No. **(86-10)62019451**	Telephone No. **86-10-53961095**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2018/084661

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	3306390	A	28 February 1967	FR	1397165	A	30 April 1965
				GB	1050526	A	07 December 1966
CN	2753635	Y	25 January 2006	WO	2006039848	A1	20 April 2006
CN	106882199	A	23 June 2017		None		
CN	200992209	Y	19 December 2007		None		
KR	20030054574	A	02 July 2003	KR	100454425	B1	26 October 2004
WO	9319974	A1	14 October 1993	EP	0590123	A1	06 April 1994
				DE	4210532	C2	25 April 1996
				AT	132096	T	15 January 1996
				EP	0590123	B1	27 December 1995
				DE	4210532	A1	07 October 1993
				KR	305280	B1	30 November 2001
				DE	59301246	D1	08 February 1996