

**(12) STANDARD PATENT**  
**(19) AUSTRALIAN PATENT OFFICE**

(11) Application No. **AU 2012353050 B2**

(54) Title  
**Railway wheel**

(51) International Patent Classification(s)  
**B60B 17/00** (2006.01)                      **B61F 13/00** (2006.01)

(21) Application No: **2012353050**                      (22) Date of Filing: **2012.12.14**

(87) WIPO No: **WO13/089596**

(30) Priority Data

(31) Number	(32) Date	(33) Country
<b>2011151692</b>	<b>2011.12.16</b>	<b>RU</b>

(43) Publication Date: **2013.06.20**

(44) Accepted Journal Date: **2016.09.22**

(71) Applicant(s)  
**Joint Stock Company "Vyksa Steel Works"**

(72) Inventor(s)  
**Golyshkov, Roman Anatolievich; Kerentsev, Dmitry Evgenievich**

(74) Agent / Attorney  
**Watermark Patent and Trade Marks Attorneys, 302 Burwood Road, Hawthorn, VIC, 3122**

(56) Related Art  
**US 5039152**  
**EP1470006**

(12) МЕЖДУНАРОДНАЯ ЗАЯВКА, ОПУБЛИКОВАННАЯ В СООТВЕТСТВИИ С  
ДОГОВОРом О ПАТЕНТНОЙ КООПЕРАЦИИ (РСТ)

(19) Всемирная Организация  
Интеллектуальной Собственности  
Международное бюро



(10) Номер международной публикации  
**WO 2013/089596 A1**

(43) Дата международной публикации  
**20 июня 2013 (20.06.2013)**

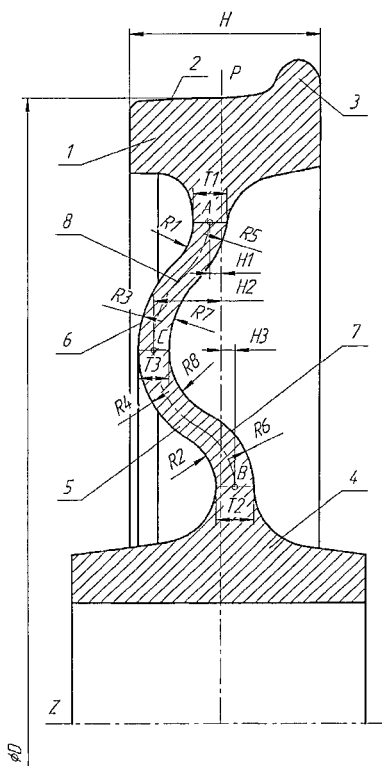
**WIPO | РСТ**

- (51) Международная патентная классификация:  
**B60B 17/00 (2006.01) B61F 13/00 (2006.01)**
- (21) Номер международной заявки: РСТ/RU2012/001072
- (22) Дата международной подачи:  
14 декабря 2012 (14.12.2012)
- (25) Язык подачи: Русский
- (26) Язык публикации: Русский
- (30) Данные о приоритете:  
2011151692 16 декабря 2011 (16.12.2011) RU
- (71) Заявитель: **ОТКРЫТОЕ АКЦИОНЕРНОЕ  
ОБЩЕСТВО "ВЫКСУНСКИЙ  
МЕТАЛЛУРГИЧЕСКИЙ ЗАВОД" (JOINT STOCK  
COMPANY "VUKSA STEEL WORKS")** [RU/RU]; ул.  
Братьев Батапёвых, 45, Выкса, Нижегородская обл.,  
607060, Выкса (RU).
- (72) Изобретатели: **ГОЛЫШКОВ, Роман Анатольевич  
(GOLYSHKOV, Roman Anatolievich)**; мкр.  
Жуковского, 10-58, Выкса, Нижегородская обл.,  
607060, Выкса (RU). **КЕРЕНЦЕВ, Дмитрий  
Евгеньевич (KERENTSEV, Dmitry Evgenievich)**; ул.  
Стара-Загора, 168-60, Самара, 443114, Samara (RU).
- (74) Агенты: **МИЦ, Александр Владимирович и др.  
(MITS, Alexander Vladimirovich et al.)**; ОБЩЕСТВО С  
ОГРАНИЧЕННОЙ ОТВЕТСТВЕННОСТЬЮ  
"ЮРИДИЧЕСКАЯ ФИРМА ГОРОДИССКИЙ И  
ПАРТНЕРЫ", ул. Б. Спасская, 25/3, Москва, 129090,  
Moscow (RU).
- (81) Указанные государства (если не указано иначе, для  
каждого вида национальной охраны): 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, DK, DM,  
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,  
HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP,  
KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD,

[продолжение на следующей странице]

(54) Title: RAILWAY WHEEL

(54) Название изобретения : ЖЕЛЕЗНОДОРОЖНОЕ КОЛЕСО



Фиг. 1

(57) Abstract: The invention relates to transport engineering, more specifically to wheels for railway vehicles. On the outside surface of the disk of the railway wheel, the radii of the first and second outside radii of curvature are from 0.04 to 0.05 of the rim diameter. The radius of the third outside radius of curvature is from 0.08 to 0.1 of the rim diameter. The radius of the fourth outside radius of curvature is from 0.07 to 0.09 of the rim diameter. For the inside surface of the disk, the radius of the first inside radius of curvature is from 0.08 to 0.1 of the rim diameter. The radii of the second and third inside radii of curvature are from 0.06 to 0.08 of the rim diameter. The radius of the fourth inside radius of curvature is from 0.04 to 0.06 of the rim diameter, wherein a first point is offset from the median plane in a direction away from the flange by a distance of not more than 0.08 of the width of the rim. A centre point is offset from the median plane by a distance in a range of from 0.35 to 0.4 of the width of the rim, and a second point is offset from the median plane in a direction towards the flange by a distance of not more than 0.1 of the width of the rim. The ratio of the thickness of the disk at the first point to the thickness of the disk at the second point is from 0.7 to 1.1, and the ratio of the thickness of the disk at the centre point to the thickness of the disk at the second point is from 0.7 to 0.9. The result is the low-stress state of the wheel under the effect of different types of working loads, a minimal mass, and a satisfactory degree of lateral deformation of the rim under thermal stress.

(57) Реферат:

[продолжение на следующей странице]

WO 2013/089596 A1



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, 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.

IE, IS, IT, LT, LU, LV, 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, ML, MR, NE, SN, TD, TG).

**Опубликована:**

**(84) Указанные государства** (если не указано иначе, для каждого вида региональной охраны): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), евразийский (AM, AZ, BY, KG, KZ, RU, TJ, TM), европейский патент (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU,

- с отчётом о международном поиске (статья 21.3)
- до истечения срока для изменения формулы изобретения и с повторной публикацией в случае получения изменений (правило 48.2(h))

Изобретение относится к транспортному машиностроению, в частности к колесам железнодорожных транспортных средств. На наружной поверхности диска железнодорожное колесо радиусы первой и второй наружных радиусных кривых составляют от 0,04 до 0,05 диаметра круга катания. Радиус третьей наружной радиусной кривой составляет от 0,08 до 0,1 диаметра круга катания. Радиус четвертой наружной радиусной кривой составляет от 0,07 до 0,09 диаметра круга катания. Для внутренней поверхности диска радиус первой внутренней радиусной кривой составляет от 0,08 до 0,1 диаметра круга катания. Радиусы второй и третьей внутренних радиусных кривых составляют от 0,06 до 0,08 диаметра круга катания. Радиус четвертой внутренней радиусной кривой составляет от 0,04 до 0,06 диаметра круга катания, причем первая точка смещена на расстояние не более 0,08 ширины обода от центральной плоскости в противоположном к гребню направлении. Центральная точка смещена от центральной плоскости на расстояние в интервале значений от 0,35 до 0,4 ширины обода, а вторая точка смещена на расстояние не более 0,1 ширины обода от центральной плоскости в направлении к гребню. Соотношение толщины диска в первой точке к толщине диска во второй точке составляет от 0,7 до 1,1, а соотношение толщины диска в центральной точке к толщине во второй точке составляет от 0,7 до 0,9. Достигается низконапряженное состояние колеса от действия различных видов эксплуатационных нагрузок, минимальной массы и удовлетворительной степени боковой деформации обода при тепловом нагружении.

**RAILWAY WHEEL****FIELD OF THE INVENTION**

The invention relates to transport engineering, in particular to railway wheel design.

**BACKGROUND**

Railway wheels used in different countries have differences in design which are associated with operation conditions of rolling stock, designs of cars and locomotives as well as with certain traditions developed in the production of wheel sets and their operation in railway transport. Alongside with that, a wheel in any case consists of three main parts: a rim, a hub and a web.

The choice of shape of a wheel web is the most important task to provide wheel basic performance characteristics such as weight, stiffness and load capacity.

Wheels with webs of different design are known in world practice, the design being often dictated by size and a mutual position of the rim relative to the hub. The present invention is intended for use in the European railway system, where the most widely used are standard wheels with tangential web profile, so-called ORE-wheels, which are currently used for loads up to 22.5 tnf per axle of a wheel set. This wheel design has high levels of stresses under thermal loads arising from friction of wheels against brake shoes, as well as mechanical loads acting on the wheel when it runs on curved sections of the track. In addition, a significant drawback of the ORE-wheels is their high weight.

The railway wheel design according to the patent DE 3 117 572 is known with a bell-shaped web, where the midline is determined by a cosine function, which received wide circulation in the European railways at maximum loads up to 23.5 ton-forces (tnf) per axle of a wheel set. The present design has minimum weight among all known analogues. However, in order to use the present wheel design for higher axle loads an increase in the thickness of the web and walls of the hub is required hereupon the advantage of the lower weight of the wheel is lost.

One solution variant of the present problem is described in the invention EP 1 470 006 taken as a prototype of the present invention, where the transverse profile of the wheel web is located around the theoretical midline passing through three characteristic points, while the indicated first point in the place of matching the web with the rim and the indicated second point in the place of matching the web with the hub are located in the same plane which is perpendicular to the axis of wheel rotation and is offset from the central plane towards the external surface of the wheel rim. The distance between said plane and the indicated central point of the theoretical midline of the wheel web is maximum 0.5 of the wheel rim width. The advantage of this design is the possibility of increasing the thickness of the web in the zone in which it matches the hub, where the level of stresses caused by mechanical loads is high, but the weight of the present structure and the level of stresses from thermal loads is greatly increased in comparison with the wheel according to the patent DE 3 117 572. The wheels

of the present design are not widely used.

#### **SUMMARY OF THE INVENTION**

The present invention is directed to selecting the optimal shape of the wheel web that can provide enhanced performance characteristics of railway wheels, namely:

- the low-stressed state of the wheel from the action of operating loads;

- the possibility of use at maximum load higher than 23.5 tnf per axle, while ensuring minimal structural weight among all known analogues;

- the low degree of lateral deformation of the wheel rim during its heating in the process of friction against the brake shoes and subsequent cooling.

Thus, according to a first aspect of the invention, there is provided a railway wheel having a central plane perpendicular to an axis of rotation of the wheel which includes a rim formed by a tread surface and a flange, and also includes a hub and a web formed by external and internal surfaces and made in such a way that a theoretical midline of a transverse web profile passes through a first point located in a place of matching the web with the rim, a central point where the theoretical midline has maximum offset from the central plane in a direction opposite to the flange, and a second point located in a place of matching the web with the hub, wherein an external surface of the web is formed on a rim side by a first external radius curve and on a hub side by a second external radius curve with a curvature that coincides in a direction with the curvature of

the first external radius curve, said curves matching each other in a central part of the web by a third, on the rim side, and a fourth, on the hub side, external radius curves with a curvature opposite to the direction of the curvature of the first and second external radius curves, while an internal surface of the web is formed on the rim side by a first internal radius curve and on the hub side by a second internal radius curve with a curvature that coincides to the direction of the curvature of the first internal radius curve, said curves matching each other in the central part of the web by the third, on the rim side, and the fourth, on the hub side, internal radius curves with the curvature opposite to the direction of the curvature of the first and the second internal radius curves, wherein

radiuses of the first and the second external radius curves for the external web surface are from 0.04 to 0.05 of a tread diameter, the radius of the third external radius curve is from 0.08 to 0.1 of the tread diameter, the radius of the fourth external radius curve is from 0.07 to 0.09 of the tread diameter, and the radius of the first internal radius curve for an internal web surface is from 0.08 to 0.1 of the tread diameter, radiuses of the second and the third internal radius curves are from 0.06 to 0.08 of the tread diameter, the radius of the fourth internal radius curve is from 0.04 to 0.06 of the tread diameter, wherein the first point is offset to a distance not more than 0.08 of the rim width from the central plane in the direction opposite to the flange, the central point is offset from the central plane to a distance within a range of

values from 0.35 to 0.4 of the rim width, and the second point is offset to a distance not more than 0.1 of the rim width from the central plane towards the flange, while a ratio of a web thickness at the first point to a web thickness at the second point is from 0.7 to 1.1 and the ratio of a web thickness at the central point to the web thickness at the second point is from 0.7 to 0.9.

During operation of the shoe brakes, the wheel is able to absorb repeated cycles of thermal loading of 55 kW for 45 minutes without any adverse effects with respect to the rim deformation degree when the rim is heated and then cooled. Besides, the ratio of the web thickness at the first point to the web thickness at the second point within a range of from 0.7 to 1.1 and the ratio of the web thickness at the central point to the web thickness at the second point within a range of from 0.7 to 0.9, along with the web configuration above, make it possible to strengthen the most stressed parts of the wheel in places where the web matches the rim and the hub, thereby to provide the possibility to use the wheels at a maximum load of above 23.5 tnf per axle with the structure weight being by 5 to 10 % lower than that of all known analogues.

Selection of other values for radiuses of curves which form the external and internal surfaces of the web of the wheel having said configuration, intervals and directions of offsets of the characteristic points of the web theoretical midline from the central plane, as well as the ratios of thicknesses in these points do not allow accomplishment of an optimal combination of

the low-stressed state of the wheel design under action of various kinds of operating loads, the minimum weight and the satisfactory degree of lateral rim deformation under thermal loading.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

The essence of the invention is explained by following drawings and diagrams, wherein:

Fig. 1 is a radial section of a railway wheel;

Fig. 2 is a diagram for comparative estimation of mechanical properties of the claimed design and prior art designs of railroad wheels;

Figs. 3a, 3b and 4a, 4b are diagrams for comparative estimation of thermomechanical properties of the claimed design prior art designs of railroad wheels.

#### **DESCRIPTION OF PREFERRED EMBODIMENTS**

The railway wheel shown in Fig. 1 has a central plane P perpendicular to a rotation axis Z of the wheel that includes a rim 1 formed by a tread surface 2 and a flange 3, and includes a hub 4, and a web 5 formed by external 6 and internal 7 surfaces and designed in such a way that a theoretical midline 8 of a web cross profile passes through a first point A located in the place of matching the web with the rim 1, a central point C where the theoretical midline 8 has maximum offset from the central plane P in a direction opposite to the flange 3, and a second point B located in the place of matching the web 5 with the hub 4. The specified central plane P of the wheel web 5 passes through the wheel rim 1 in the place where a tread

diameter  $D$  is measured.

The external surface 6 of the web 5 is formed on the rim 1 side by a first external radius curve  $R1$  and on the hub 4 side by a second external radius curve  $R2$  with a curvature that coincides in a direction with the curvature of the first external radius curve  $R1$ , said curves matching each other in a central part of the web by a third  $R3$ , on the rim 1 side, and a fourth  $R4$ , on the hub 4 side, external radius curves with a curvature opposite to the direction of curvature of the first  $R1$  and second  $R2$  external radial curves, and the internal surface 7 of the web 5 is formed on the rim 1 side by a first internal radius curve  $R5$  and on the hub 4 side by a second internal radius curve  $R6$  with a curvature that coincides to the direction of the curvature of the first internal radius curve  $R5$ , said curves matching each other in the central part of the web 5 by a third  $R7$ , on the rim 1 side, and a fourth  $R8$ , on the hub 4 side, internal radius curves with a curvature opposite in the direction of the curvature of the first  $R5$  and second  $R6$  internal radial curves.

The first point  $A$  is offset to a distance  $H1$  not more than 0.08 of a rim width  $H$  from the central plane  $P$  in the direction opposite to the flange 3, the central point  $C$  is offset from the central plane  $P$  to a distance  $H2$  from 0.35 to 0.4 of the rim width  $H$ , and the second point  $B$  is offset to a distance  $H3$  not more than 0.1 of the rim width  $H$  from the central plane  $P$  towards the flange 3.

A ratio of a thickness  $T1$  of the web 5 at the first point  $A$

to a thickness T2 of the web 5 at the second point B is from 0.7 to 1.1, and a ratio of a thickness T3 of the web 5 at the central point C to a thickness T2 at the second point B is from 0.7 to 0.9.

According to the invention, selection of an optimal shape of the wheel web is performed using the finite element analysis of different variants of the designs according to techniques described in UIC 510-5 standard and UIC B 169/RP 17 report that make it possible to determine the stress-strain state of the wheel from action of mechanical and thermal loads mostly critical in operation.

As a result of computations performed in accordance with requirements of EN 13979-1, the claimed design, as shown in Fig. 2, has fatigue strength characteristics of the web which are better as compared to the designs of similar purpose wheels VAZ14/324 and VAZ18/319, along with provision for a structural weight that is lower by 7 and 19 kg, respectively

The analysis of the state of the art conducted by the Applicant that included search of patent and research-and-technology sources of information and detection of sources that contain data on analogues of the claimed invention showed that the applicant did not find an analogue characterized by the features identical to all essential features of the claimed invention.

In the process of determination of a prototype from among a list of detected analogues a set of essential characteristic features of the claimed Railway Wheel with respect to the target

technical result was identified that are described in the claims.

Results of computer simulation of bench tests at application of brakes to wheels, as shown in Figs. 3a, 3b and 4a, 4b and performed in accordance with UIC B 169/RP 17, characterize the claimed design by the degree of lateral deformation of the rim and the level of stresses in the wheel comparable with that in the existing analogues.

The analysis of the prior art conducted by the Applicant and including the search through patent and scientific-and-research references, and the detection of references containing information about analogues of the present invention make it possible to establish that the Applicant could not detect an analogue defined by features adequate (identical) to all essential features of the claimed invention.

Definition of the prototype from the list of detected analogues allowed detection of the combination of features essential with respect to the discerned technical result in the claimed "Railway Wheel" and stated in the set of claims.

The search results showed that the claimed invention does not explicitly appear for an expert from the prior art determined by the Applicant, and no influence of transformations provided for by the essential features of the claimed invention on accomplishment of the technical result was detected.

The proposed invention can be used for all models of railway transportation facilities vehicles that use shoe brakes, especially for railroad freight cars, leading vehicles and

locomotives. Good consistency of fatigue strength in critical zones of the wheel - in the places of wheel web transition to the hub and to the rim - permits use of the present design also for the railway transport where disc brakes are used instead of shoe brakes, as is the case with regard to passenger cars. According to the invention, a wheel can be manufactured from steel of any quality used in the railroad industry, and produced in accordance with well-known technical requirements and standards by rolling, forging or casting.

Theoretical studies and testing of railway wheels with the web configuration according to the claimed set of claims with respect to freight cars for the European railway system have shown compliance with all safety requirements and the ability to provide the optimal level of performance of the wheels. This proves the achievement of the technical result indicated by the Applicant.

**CLAIM**

1. A railway wheel having a central plane perpendicular to an axis of rotation of the wheel which includes a rim formed by a tread surface and a flange, and also includes a hub and a web formed by external and internal surfaces and made in such a way that a theoretical midline of a transverse web profile passes through a first point located in a place of matching the web with the rim, a central point where the theoretical midline has maximum offset from the central plane in a direction opposite to the flange, and a second point located in a place of matching the web with the hub, wherein an external surface of the web is formed on a rim side by a first external radius curve and on a hub side by a second external radius curve with a curvature that coincides in a direction with the curvature of the first external radius curve, said curves matching each other in a central part of the web by a third, on the rim side, and a fourth, on the hub side, external radius curves with a curvature opposite in the direction to the curvature of the first and second external radius curves, while an internal surface of the web is formed on the rim side by a first internal radius curve and on the hub side by a second internal radius curve with a curvature that coincides to the direction with the curvature of the first internal radius curve, said curves matching each other in the central part of the web by the third, on the rim side, and the fourth, on the hub side, internal radius curves with the curvature opposite in the direction to the curvature of the first and the second internal radius curves, said railway wheel

being characterized in that radiuses of the first and the second external radius curves for the external web surface are from 0.04 to 0.05 of a tread diameter, the radius of the third external radius curve is from 0.08 to 0.1 of the tread diameter, the radius of the fourth external radius curve is from 0.07 to 0.09 of the tread diameter, and the radius of the first internal radius curve for the internal web surface is from 0.08 to 0.1 of the tread diameter, radiuses of the second and the third internal radius curves are from 0.06 to 0.08 of the tread diameter, the radius of the fourth internal radius curve is from 0.04 to 0.06 of the tread diameter, wherein the first point is offset to a distance not more than 0.08 of the rim width from the central plane in the direction opposite to the flange, the central point is offset from the central plane to a distance within a range of values from 0.35 to 0.4 of the rim width, and the second point is offset to a distance not more than 0.1 of the rim width from the central plane towards the flange, while the ratio of a web thickness at the first point to a web thickness at the second point is from 0.7 to 1.1 and a ratio of a web thickness at the central point to the web thickness at the second point is from 0.7 to 0.9.

1/6

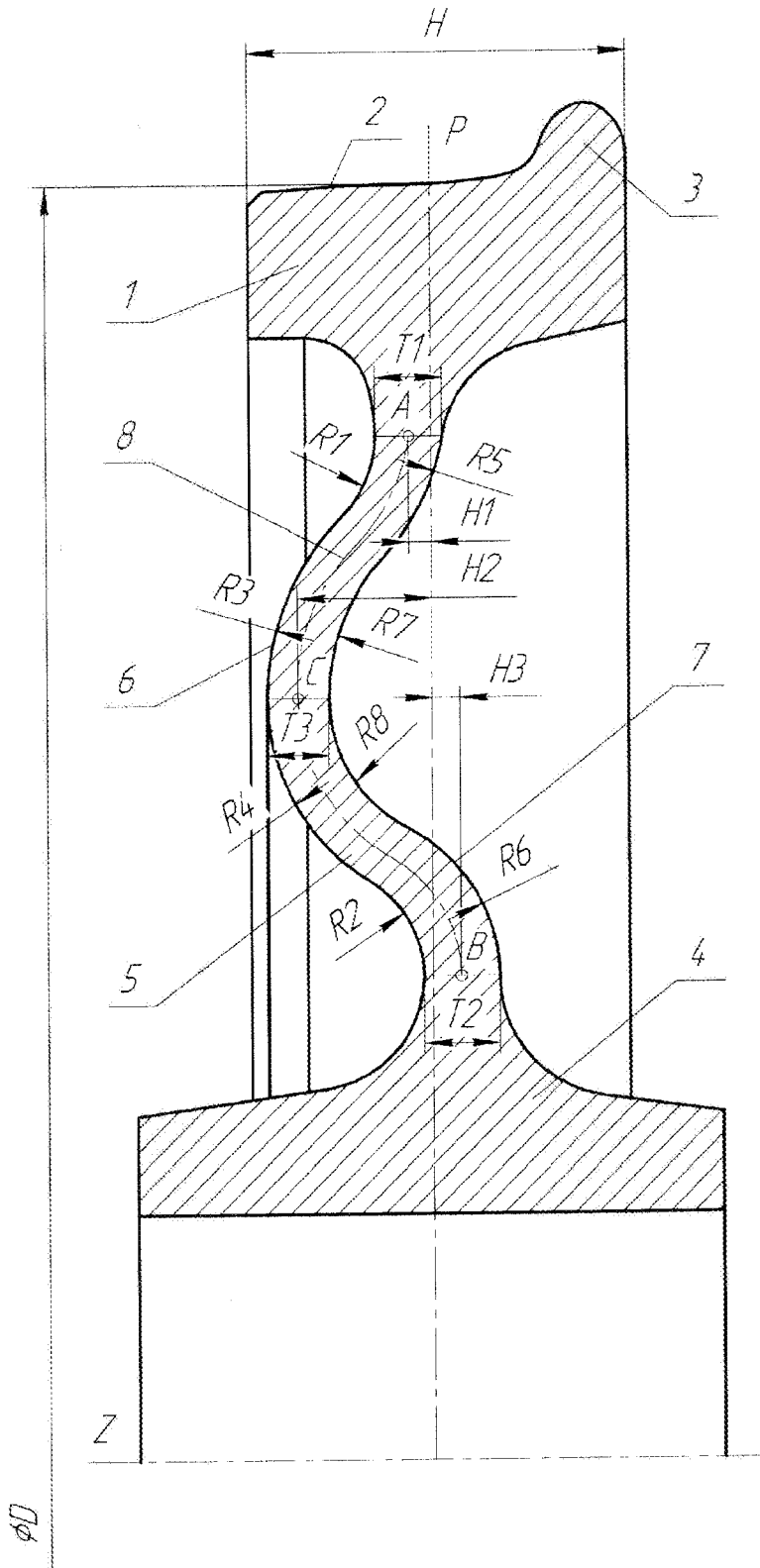


FIG. 1

Factor of safety at a permissible stress of 290 MPa  
as per a load of 25 tnf per axle

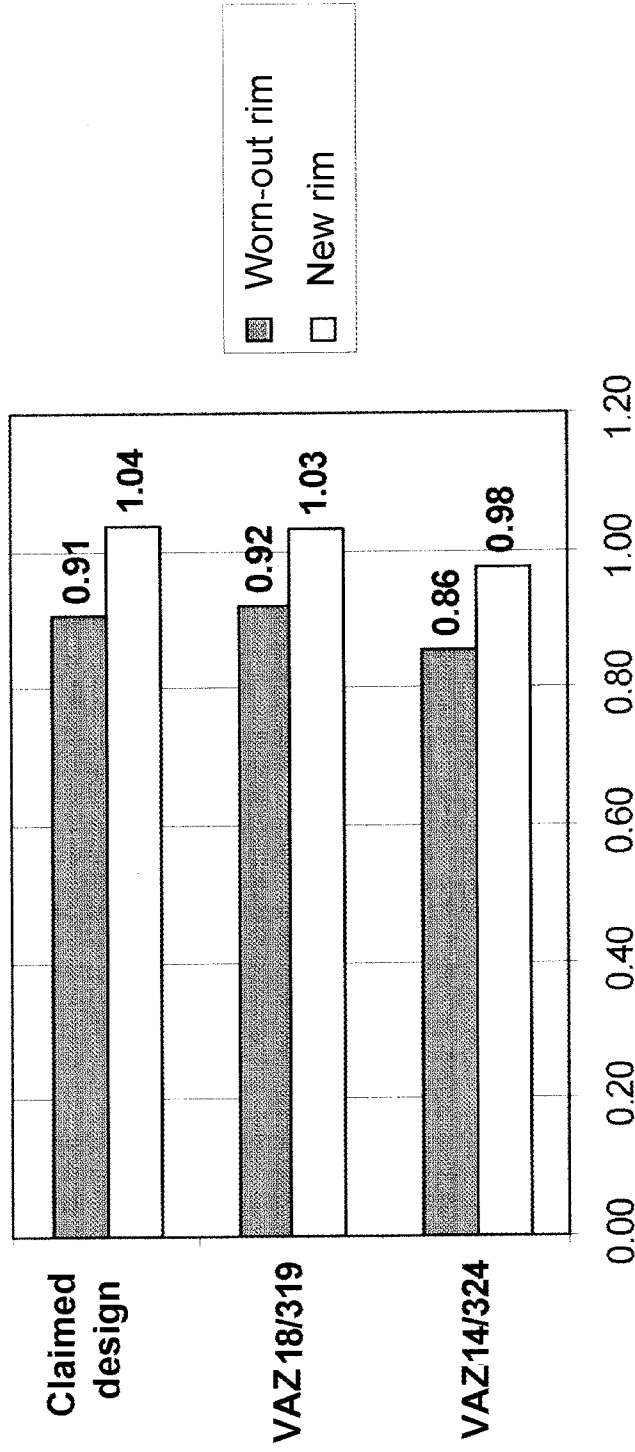


FIG. 2

Lateral deformation, mm, of the wheel rim  
at a permissible value of +3 mm, after braking

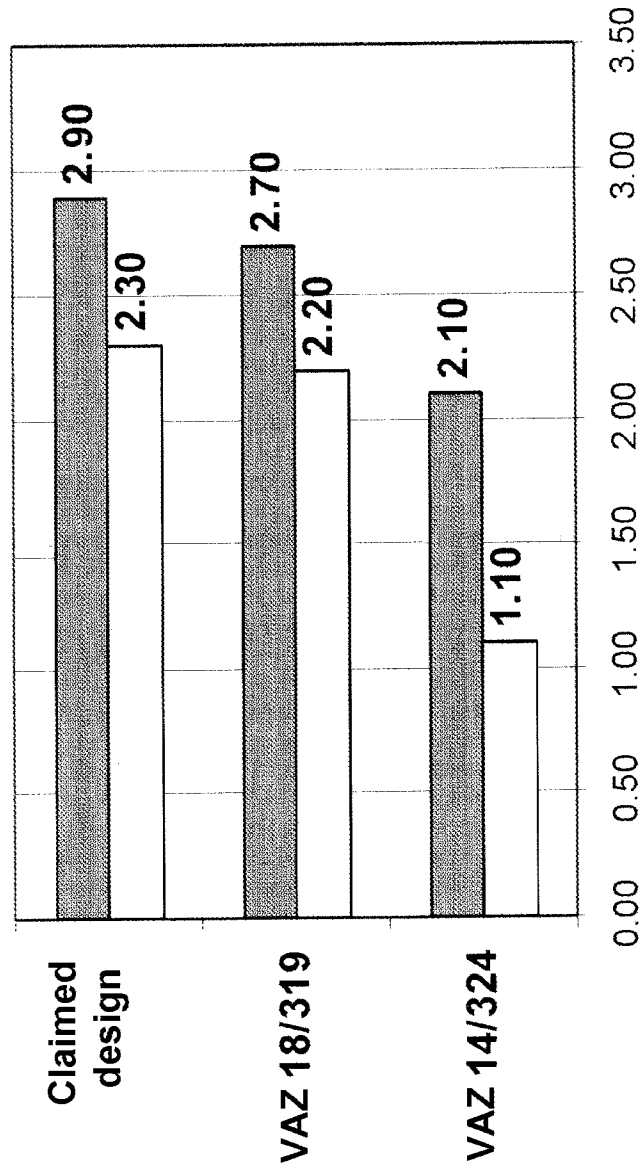


FIG. 3a

Lateral deformation, mm, of the wheel rim  
at a permissible value of +1.5 mm, after cooling

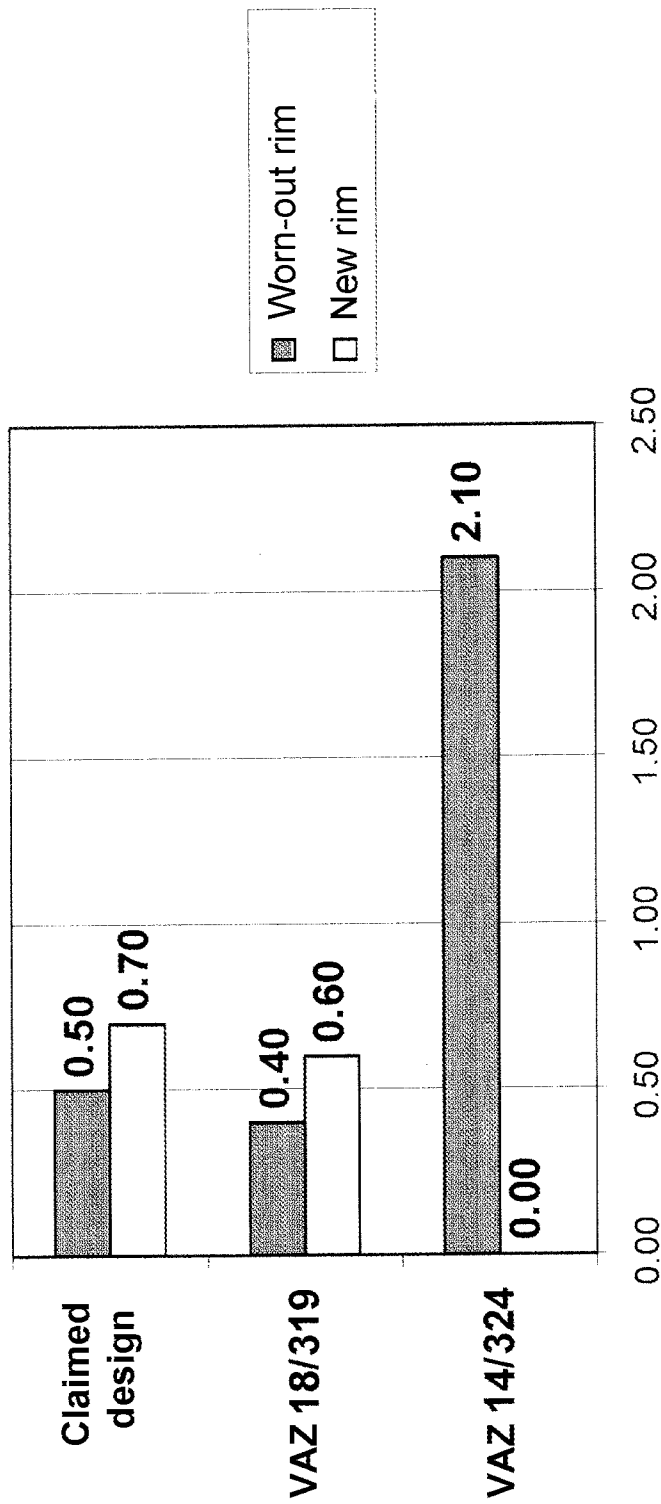


FIG. 3b

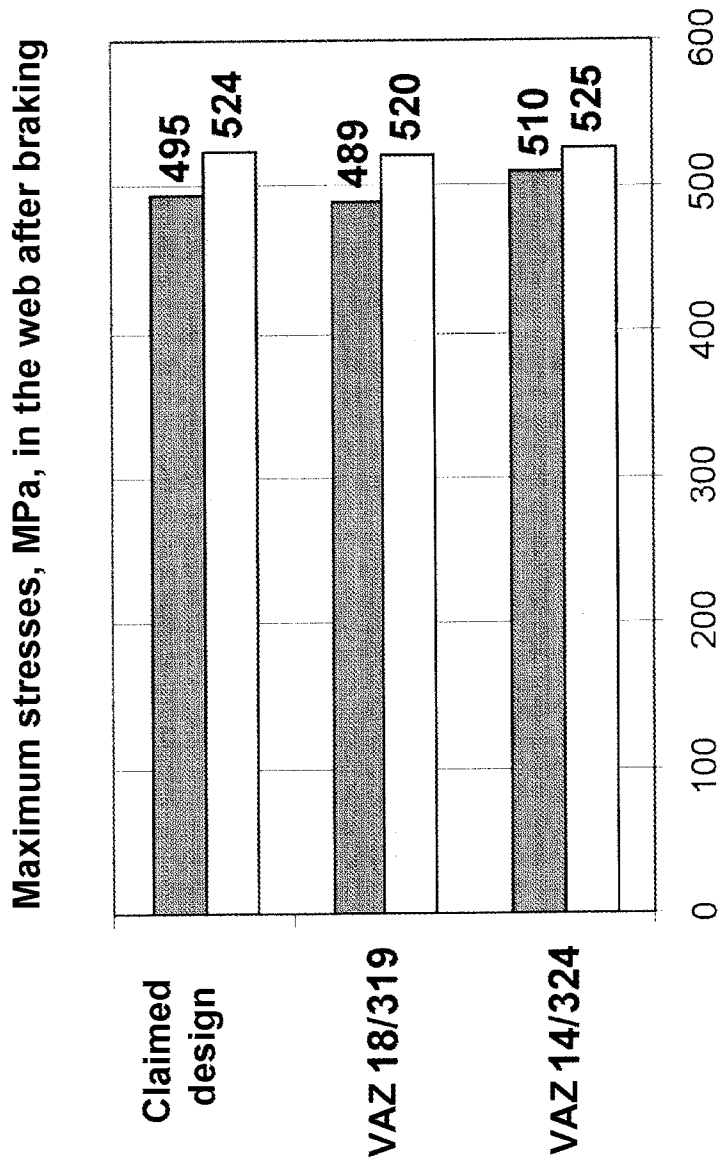


FIG. 4a

Maximum stresses, MPa, in the web after cooling

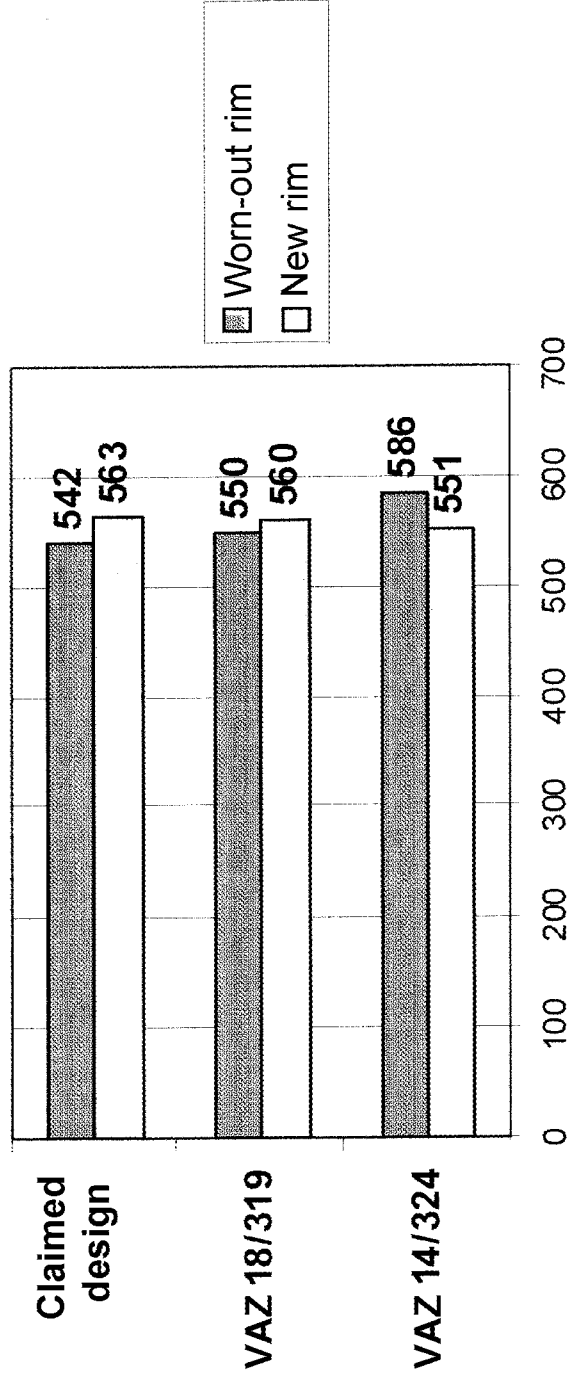


FIG. 4b