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PROPERTY NUMBERS Total: 1

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DATE SIGNED:	04/28/2014
	This document serves as an Oath/Declaration (37 CFR 1.63).

Total Attachments: 12
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Docket No.:

DECLARATION FOR PATENT APPLICATION AND ASSIGNMENT

Title of the Invention: DEVICE AND METHOD FOR MANUFACTURING A METAL WHEEL

As a below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number PCT/EP2012/004444 filed on October 24, 2012.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

WHEREAS, RONAL AG

(hereinafter referred to as Assignee) having a place of business at: Lerchenbühl 3, CH-4624 Härkingen / Switzerland

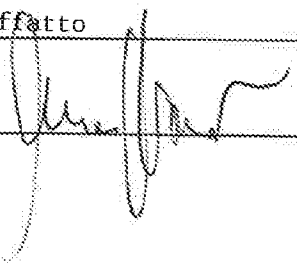
is desirous of acquiring the entire right, title and interest to said invention and in the Letters Patent to be obtained therefor from the United States;

NOW THEREFORE, be it known by all whom it may concern, that for and in consideration of the sum of One Dollar ($1.00) (or the equivalent thereof in foreign currency) and other valuable consideration, the receipt of which is hereby acknowledged, I have assigned, sold and set over and by these presents do assign, sell and set over unto the said Assignee for the territory of the United States of America and not elsewhere, the full and exclusive right, title and interest in and to the said invention, said invention, application and Letters Patent to be held and enjoyed by the said Assignee for its own use and behoof and for the use and behoof of its successors and assigns to the full end of the term for which said Letters Patent is granted, as fully and entirely as the same would have been held by me had this Assignment and sale not been made.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than (5) years, or both.

LEGAL NAME OF INVENTOR

INVENTOR: Giorgio Muffatto

→Inventor's signature 

→Date March 17, 2013

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Docket #74752

DEVICE AND METHOD FOR MANUFACTURING A METAL WHEEL

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a United States National Phase Application of International Application PCT/EP2012/004444 filed October 24, 2012 and claims the benefit of priority under 35 U.S.C. § 119 of German Patent Application DE 10 2011 117 034.4 filed October 27, 2011, the entire contents of which are incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The invention relates to a device for manufacturing a light-metal wheel from a pre-form with stretching rolls engaging on the rim region of the pre-form, by means of which rolls a rim of the wheel is end-formed. The invention also relates to A method for manufacturing a metal wheel from a pre-form, wherein the pre-form of the metal wheel to be manufactured is placed on a clamping mandrel and caused to rotate, stretching rolls engage in the upper region of

a rotation-symmetrical jacket of the pre-form with the exertion of radial pressure, and move along the jacket wall of the pre-form with compression and stretching of the jacket wall to form a rim with a main movement component parallel with the axis of rotation of the pre-form.

[0003] The invention relates in particular to the manufacture of light metal wheels light-alloy wheels particularly made of aluminum or aluminum alloy by means of flow forming. This a sub-form of shear forming, whilst in German different terms, such as flow pressure rolling, rotary rolling or stretch rolling are used and the latter term is to be used here. Stretch rolling is a non-cutting forming process for end-forming rotating bodies of light metal such as aluminum or aluminum alloys, particularly metal wheels.

BACKGROUND OF THE INVENTION

[0004] In this case the pre-form of a wheel with a rotation-symmetrical jacket configuration is placed on a simple rotating tool, a clamping mandrel, which is caused to rotate with the pre-form. On the peripheral edge a plurality of differently shaped stretching rolls engage with radial pressure on the rotation-symmetrical peripheral wall of the pre-form and are moved along this, i.e. in an axial component during the rotation of the pre-form, which on the one hand compresses the material and on the other stretches this material by means of the stretching rolls moving essentially in the axial direction, thereby deforming it to form the rim when a metal wheel is manufactured. On the lower peripheral edge the generally inner rim flange of the wheel to be formed is formed on a recess of the rotary mandrel. This machining process, which is actually a cold forming process, may be carried out an elevated temperature of up to 350°C, but it

must be borne in mind here that heating takes place in any case simply because the deformation process takes place by means of the stretching rolls. Such processes are in principle disclosed in US 2003/0145466 A1 or ITVI20040061 A.

[0005] One disadvantage is the fact that the inner or lower side of the wheel to be produced is predetermined by the shape of the stretching mandrel and that the peripheral edge of the rim flange can only be end-formed at high cost by lowering the same with the stretching rolls, for which purpose complicated processes are required for controlling the movement on the one hand, and the clamping mandrel may cause interference on the other.

SUMMARY OF THE INVENTION

[0006] The objective of the invention is therefore to develop a suitable device for manufacturing metal wheels to the extent that the inner rim flange in particular can be formed more quickly and less expensively.

[0007] To achieve this objective a device according to the invention is characterized by freely rotatable rolls arranged underneath the stretching rolls and cooperating with them. A method according to the invention is characterized, for achieving the objective, in that the pre-form is gripped from below by freely rotating rolls which are arranged at the same circumferential angles as the stretching rolls around the periphery of the pre-form so that the stretching rolls form a rim flange by stretching pre-form material against the freely rotating rolls gripping from below.

[0008] The inventive device has an inner mandrel receiving the pre-form of a wheel and stretching rolls, which engage initially in the outer region of a rotation-symmetric circumferential wall of the pre-form (the outer region of the pre-form placed for working to the top). The stretching rolls are movable along the circumferential wall of the pre-form as well exerting radial force and compressing it - radially - as - axially - stretching the circumferential wall. Accordingly the stretching rolls finish or endform the rim of the wheel along the mandrel.

[0009] The clamping mandrel inside the pre-form of the wheel or inside the wheel which is to be produced is a body with rotational symmetry which does not have any undercuts in the jacket area; ideally, the clamping mandrel is slightly conical from the outside to the inside of the wheel.

[0010] The clamping mandrel must not, as would be the case of undercuts, be a body consisting of several party, whose individual parts would have to be retracted by means of additional hydraulic gripping elements, which would make such a tool design vulnerable and would also impair the precision of the wheel with regard to roundness and could cause imbalance. The clamping mandrel protrudes up to the height of the inner rim flange into the wheel which is to be produced; however it does not grip the wheel from below.

[0011] The device according to the invention is designed so that at least one of the stretching rolls which engage with the side of the wheel cause the (flow)forming of the jacket of the wheel over its entire height, including the formation of the outside of the inner rim flange.

[0012] The forming may be performed as hot or cold forming. In the first case working is done with hot tools and, hot pre-form, in the second case with cold tools and cold pre-form, but which warms up by of the working process to a certain degree. Hot forming is preferably used for cast pre-forms, cold forming for forged pre-forms.

[0013] A device according to the invention may also be characterized, in its design, in that the freely rotating rolls have an axis of rotation inclined at an angle of inclination of 50° to 70° to an axis of rotation of the pre-form, wherein, in particular, the angle of inclination of the axes of rotation of the freely rotating rolls is adjustable to the axis of rotation of the pre-form.

[0014] Further designs of the device according to the invention provide that the freely rotating rolls grip the rim flange to be formed from underneath with their jacket wall, wherein, in particular, the freely rotating rolls are in the shape of a truncated cone and/or the jacket wall of the freely rotating rolls enclose an angle of between 20° and 40° to the axis of rotation of the freely rotating rolls. A profile stretching roll end-forming a rim flange may also be provided.

[0015] The method according to the invention provides, in a further development, that the freely rotating rolls rotate about axes which enclose the angle of inclination of 50° to 70° to the axis of rotation of the pre-form, wherein, in particular, the freely rotating rolls grip the lower edge of the pre-form from below with their jacket, which encloses an angle of 20° to 40° to the axis of rotation of the freely rotating rolls. Provision may also be made, in particular, at least one profile stretching roll to engage against the rim flange formed between the stretching rolls and

freely rotating rolls for end-forming the rim flange. The invention provides, in particular, the possibility of rapid, accurate and optimum formation of the inner rim flange of a light metal wheel.

[0016] The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its uses, reference is made to the accompanying drawings and descriptive matter in which preferred embodiments of the invention are illustrated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] In the drawings:

[0018] Fig. 1 is a side view of essential parts of a device according to the invention for manufacturing a light metal wheel – without a profile stretching roll;

[0019] Fig. 2 is a perspective oblique elevation view of a wheel and essential parts of the device according to the invention (profile stretching rolls not visible);

[0020] Fig. 3 is a perspective view from below of the essential features of the device according to the invention; and

[0021] Fig. 4 is a partial view, according to Fig. 1, with a profile stretching roll engaging on the lower or inner rim flange.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] Referring to the drawings in particular, Figs. 1 and 4 show a motor vehicle metal wheel 1, as a dotted line, as a pre-form and drawn with its final contour in sectional representation (only as a partial representation in Fig. 4). Wheel 1 has a rim 1.1 and at its outer side 1a a wheel disc or a spoke region 1.3 with a hub 1.4. Openings 1.5 are provided in the inner region of the wheel disc 1.3 outside hub 1.4 for fixing the wheel to the vehicle by means of bolts. Rim 1.1 has an outer rim flange 1.6 close to wheel disc 1.3 and an inner rim flange 1.7 at its inner side 1b, facing away from wheel disc 1.3.

[0023] Whereas the outer region of the pre-form 1.8, particularly the wheel disc or spoke region 1.3 are already identical or at least very much approached to the final shape of the wheel the circumferential wall of the pre-form 1.8, particularly at its inner region (shown below in the drawings) extends substantially radially beyond the final contour of the wheel. Also the circumferential wall of the pre-form 1.8 extends only along a part, particularly along 50% to the 70% of the height of the final wheel.

[0024] Figs. 1 to 4 also show the essential tool elements of the device according to the invention for manufacturing such a metal wheel, particularly a light metal wheel, from the pre-form, namely a simple tool 2 engaging in the pre-form or the wheel, in the form of a clamping

mandrel, a plurality of differently designed stretching rolls 3 engaging on the peripheral wall of the pre-form or wheel, freely rotating rolls 4 gripping the lower edge of the inner and lower rim edge 1.5 of the almost completed wheel 1 from below, and at least one profile stretching roll 5 (Figs. 3, 4). Only the half of stretching rolls 3 directed toward wheel 1 is shown. Stretching walls 3 are rotatable about an essentially vertically extending axis of rotation.

[0025] The pre-form of wheel 1 sits on a simple tool in the form of a clamping mandrel 2 designed as a rotary body, which mandrel determines the inner shape of wheel 1. The clamping mandrel 2 is in one piece. In the peripheral area it does not have any undercuts and increases slightly conically in diameter from the outside 1a of the wheel 1 to the inside 1b, so that the formed wheel can be easily removed from the clamping mandrel 2.

[0026] Stretching rolls 3 engage on the outer periphery of wheel 1, distributed uniformly, in particular, over the circumference, which rolls, as shown in the left-side superimposed representation in Fig. 1, may be of different designs. They initially engage in the upper region of the pre-form of wheel 1 and in doing so stretch downwards and at the same time compress part 1.8 of the pre-form of the wheel forming the subsequent wheel jacket or the actual rim 1.1 of wheel 1.

[0027] The pre-form of wheel 1 or wheel 1 are supported on one side by clamping mandrel 2. However, this mandrel does not grip from underneath the edge, the subsequent inner rim flange 1.7 of the wheel. This edge is instead gripped from below by additional freely rotating

rolls 4. Three rolls are preferably arranged so that they are evenly distributed over the circumference, each underneath a stretching roll 3.

[0028] In addition, as shown in Fig. 3 and particularly in Fig. 4, at least one profile stretching roll 5 is provided laterally in the region of the inner rim flange 1.7 to be formed, circumferentially between two freely rotating rolls 4, which roll end-forms the profile of the inner rim flange 1.7, by the radial exertion of pressure in its profile groove 5.1 provided on the circumference. As shown in Fig. 1, the freely rotating rolls 4 are aligned with its axis of rotation 4.1 to axis of rotation 2.1 of clamping mandrel 2, and hence of wheel 1 mounted on the mandrel in a fixed position at an angle α of approximately 60°. The freely rotating rolls 4 are designed in the shape of a truncated cone and are reduced from their lower to their upper side, wherein jacket wall 4.2 forms an angle from 20 to 30° to axis of rotation 4.1. The freely rotating rolls 4 engage with their jacket wall against the inner-lower side of wheel 1 to form the inner rim flange 1.7. The axis of rotation of the freely rotating rolls 4.1 is to a certain extent freely adjustable, for example between 50 and 70° relative to axis of rotation 2.1 of clamping mandrel 2, so that the inner front side of the inner flange rim 1.7 can therefore be adjusted by the angle of attack of axis of rotation 4.1.

[0029] The manufacturing process is essentially as follows:

[0030] The pre-form of wheel 1 is first cast and freed from connecting ports. The pre-form is then clamped onto clamping mandrel 2 and can be heated, ideally not above 350°C.

Stretching rolls 3 are then displaced in the upper region of the pre-form against the same and move, with the exertion of radial pressure, from the outer rim flange 1.6 down to the inner rim flange 1.7, thereby forming rim 1.1 and essentially rim flanges 1.6, 1.7. Here the material of the jacket of the wheel is on the one hand drawn, i.e. stretched, downwards into the region of the inner rim flange 1.7 to form the rim, and on the other the material of the wheel is compressed. As soon as the jacket material of the wheel has been stretched by stretching rolls 3 below the lower edge of clamping mandrel 2, the freely rotating rolls 4 engage at that point with their jacket wall 4.2, whilst profile stretching roll 4.5 engages in the interval between two freely rotating rolls 4, exerts radial pressure and forms and end-forms the inner rim flange 1.7 in its profile groove 5.1.

[0031] While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

ABSTRACT OF THE DISCLOSURE

A device for manufacturing a metal wheel (1) from a pre-form, with stretching rolls (3) engaging on the rim region of the pre-form, by means of which rolls a rim (1.1) is end-formed which, for forming a rim flange (1.7). Freely rotatable rolls (4) are arranged underneath the stretching rolls (3) and cooperate with them. A method for manufacturing a metal wheel (1) from a pre-form, the pre-form of the metal wheel (1) to be manufactured is placed on a clamping mandrel (2) and is caused to rotate, stretching rolls (3) engage in the upper region of a rotation-symmetrical jacket of the pre-form with the exertion of radial pressure, and move along the jacket wall of the pre-form with compression and stretching of the jacket wall to form a rim (1.1) with a main movement component parallel with the axis of rotation (2.1) of the pre-form.

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