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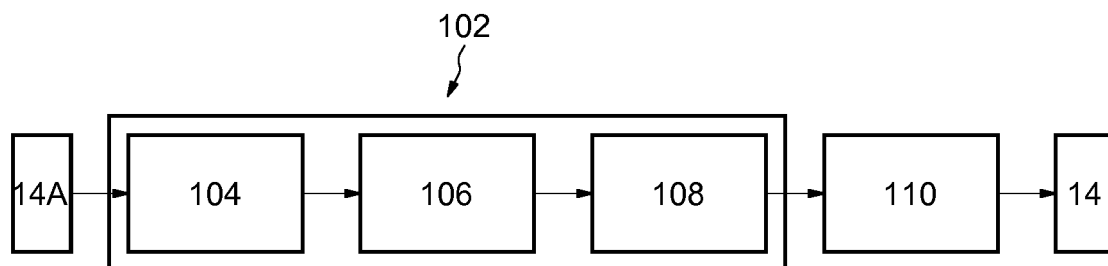
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(54) **METHOD FOR MANUFACTURING A PIN FOR CAM FOLLOWER ROLLER DEVICE**

(57) The method for manufacturing a pin (14) for cam follower roller device (10) comprises the following successive steps of:
- applying a through-hardening treatment (102) and a through-tempering treatment to obtain the pin (14) with

a predetermined hardness, and
- applying a local tempering treatment in which only pin ends (14b, 14c) of the hardened pin (14) are tempered in order to reduce the hardness of said pin ends (14b, 14c) relative to the hardness of the remainder of the pin.

FIG.2



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Description

[0001] The present invention relates to the field of cam follower roller devices used in automotive or industrial applications.

[0002] More particularly, the present invention relates to the manufacturing of a pin for cam follower roller device. Such a device may be used in a fuel injection pump intended for an internal combustion engine, in particular of a motor vehicle. A cam follower roller device may also be used in a rocker system intended for controlling valves of an internal combustion piston engine.

[0003] Such a cam follower roller device generally comprises an outer tappet body, the pin mounted on the tappet body, and a roller movable in rotation relative to the pin around its axis. When the cam follower roller device is in service in a fuel injection pump, the roller collaborates with a cam synchronized with the internal combustion engine camshaft or crankshaft. The rotation of the camshaft, or crankshaft, leads to a periodic displacement of a piston of the pump that rests against the tappet body, to allow fuel to be delivered.

[0004] Generally, only a central portion of the outer surface of the pin supporting the roller is hardened, for example by surface induction hardening, while leaving the remainder of said pin in a ductile condition. Accordingly, each end of the pin may be caulked, in other words plastically deformed, to create a mechanical interference in through-holes of the tappet body in order to fix axially and/or block the pin rotation. Such caulking steps may be provided since the pin ends are unaffected by the hardening process.

[0005] However, such a surface induction hardening treatment of the pin is expensive. Besides, such treatment may generate heterogeneity of the surface hardness.

[0006] One aim of the present invention is to overcome these drawbacks.

[0007] The invention relates to a method for manufacturing a pin adapted to equip a cam follower roller device. The method comprises the following successive steps of:

- applying a through-hardening treatment and a through-tempering treatment to obtain the pin with a predetermined hardness, and
- applying a local tempering treatment in which only pin ends of the hardened pin are tempered in order to reduce the hardness of said pin ends relative to the hardness of the remainder of the pin.

[0008] Thanks to the invention, the pin may be caulked on both opposite pin ends to create a mechanical connection with the tappet body since the hardness is locally reduced at said pin ends. After a first step where the entire pin is subjected to the through-hardening treatment, only hardened pin ends are then tempered by heating and not the central part of the pin which is adapted to receive the roller. A through-hardening treatment of

the whole pin is less expensive than a surface induction hardening treatment.

[0009] The through-hardening treatment step may comprise the following successive operations of:

- applying an austenization operation,
- applying a through-hardening operation, and
- applying a through-tempering operation to the whole pin.

[0010] Advantageously, the tempering temperature applied to the whole pin during the through-tempering operation is lower than the tempering temperature applied during the local tempering treatment step. For example, the whole pin may be tempered at a temperature within a range of 150°C to 250°C. For example, the pin ends may be tempered at a temperature and time during the local tempering treatment step which permit to get a hardness below 550 Vickers.

[0011] According to another aspect of the invention, the pin ends may be tempered with induction heating during the local tempering treatment step. Each pin end may be tempered with at least one inductor disposed in front of a lateral end face of said pin end.

[0012] Alternatively, the pin ends may be tempered by using any other appropriate heating means such as a liquid bath heated to the required temperature, a blow-pipe, etc.

[0013] The invention also relates to a cam follower roller device comprising a tappet body, a pin mounted into said tappet body, and a roller mounted on said pin. The pin is hardened by through-hardening treatment. The pin comprises pin ends having a reduced hardness with regard to a central portion of said pin supporting the roller.

[0014] In one embodiment, the pin ends may be caulked in through-holes provided on the tappet body. Alternatively, the device may further comprise an insert mounted in the tappet body, the pin ends being caulked in through-holes provided on said insert.

[0015] The present invention and its advantages will be better understood by studying the detailed description of a specific embodiment given by way of a non-limiting example and illustrated by the appended drawings on which:

- Figure 1 is a cross-section of a cam follower roller device according to an example of the invention,
- Figure 2 shows schematically the steps for manufacturing a pin of the device of Figure 1, and
- Figure 3 is a cross-section of the pin of the device of Figure 1 during a local tempering treatment step.

[0016] As shown on Figure 1, a cam follower roller device 10 comprises a tappet housing or body 12 extending along an axis 12a, a shaft or pin 14 extending along an axis 14a perpendicular to the axis 12a, and a roller 16, with an axis 16a coaxial with the axis 14, mounted on the pin and movable in rotation relative to said pin.

[0017] The pin 14 is mounted on the tappet body 12. The tappet body 12 supports the pin 14. The pin 14 comprises two opposite pin ends 14b, 14c and a central portion 14d extending between said pin ends. The pin ends 14b, 14c are mounted in through-holes (not referenced) provided on the tappet body 12 and facing one another. The pin ends 14b, 14c are caulked into said through-holes by push-fitting. Each pin end 14b, 14c comprises a radial frontal end face. The opposite end faces axially delimit the pin 14.

[0018] The central portion 14d of the pin delimits a cylindrical outer bearing seat for the roller 16. The portion of the pin 14 left free by the tappet body 12 delimits the central portion 14d. The pin ends 14b, 14c extend axially on either side of the roller 16. In the disclosed embodiment, the roller 16 is directly mounted on the central portion 14d of the pin. Alternatively, a rolling bearing or a plain bearing may be radially interposed.

[0019] In the disclosed example, the tappet body 12 is made in one part. The tappet body 12 delimits a first open cavity 18 inside which is located the roller 16. The roller 16 is mounted inside the cavity 18. The roller 16 axially protrudes outwards with respect to an upper face 12b of the tappet body. The tappet body 12 also comprises a lower face 12c which delimits axially together with the upper face 12d said body. The tappet body 12 also delimits a second open cavity 20 oriented axially on the side opposite to the cavity 18. A movable element 21, such as a piston of a fuel injection pump, extends into the cavity 20. Said element 21 axially bears against a rear abutment surface of the tappet body.

[0020] Referring to Figure 2, it will be now described successive steps permitting to manufacture the pin 14 from a pin 14A already machined. The material of the pin 14A has a composition dedicated to through-hardening treatment, for example a steel grade made of 100 Cr6.

[0021] In a first step 102, a through-hardening treatment is applied to the whole pin 14A to obtain a pin with a predetermined hardness, for example a hardness higher than 650 Vickers. During this first step, the pin 14A is submitted to an austenitization operation 104, for example into an oven at a predetermined temperature, for example equal to 850°C, and during a predetermined duration. Then, a through-hardening operation 106, for example in an oil bath, and a through-tempering operation 108 are successively carried out on the pin. During the through-tempering operation 108, the whole pin is tempered for example at a temperature within a range of 150°C to 250°C, for example into an oven.

[0022] After the through-hardening treatment step 102, in a following second step 108, a further local tempering treatment is applied to the hardened pin. Contrary to the first step 102 where the through-hardening treatment is applied on the whole pin, in the second step 110, only pin ends are tempered in order to obtain the desired ductility for said pin ends.

[0023] As shown on Figure 3, during this second step, an inductor 22, 24 is for example disposed in front of

each end face of the pin. Each inductor 22, 24 heats only the associated pin end in order to obtain a local tempering treatment of the pin. For example, each pin end may be tempered at a temperature and time to reach a hardness below 550 Vickers. Only the pin ends on chosen depth are tempered not the entire pin. After that, the desired pin 14 is obtained. On Figure 3, the end pins 14b, 14c are delimited by dashed lines.

[0024] With such local hardening treatment, the pin ends 14b, 14c have a reduced hardness with regard to the hardness of the central part 14d of the pin. Accordingly, each pin end 14b, 14c may be easily caulked by press-fit in through-holes of the tappet body. For example, the outer surface of the central part 14d of the pin may have at least a hardness of 650 Vickers. Each pin end 14b, 14c may have a hardness lower than 550 Vickers.

[0025] The invention has been illustrated on the basis of a cam follower roller device comprising a pin mounted directly on the tappet body. Alternatively, the device may comprise an insert supporting the pin while the tappet body supports said insert. In this case, the ends of the pin may be press-fitted in through-holes provided on said insert.

Claims

1. Method for manufacturing a pin for cam follower roller device comprising the following successive steps of:
 - applying a through-hardening treatment and a through-tempering treatment to obtain the pin with a predetermined hardness, and
 - applying a local tempering treatment in which only pin ends of the hardened pin are tempered in order to reduce the hardness of said pin ends relative to the hardness of the remainder of the pin.
2. Method according to claim 1, wherein the through-hardening treatment step comprises the following successive operations of:
 - applying an austenitization operation,
 - applying a through-hardening operation, and
 - applying a through-tempering operation to the whole pin.
3. Method according to claim 2, wherein the tempering temperature applied to the whole pin during the through-tempering operation is lower than the tempering temperature applied during the local tempering treatment step.
4. Method according to claim 2 or 3, wherein the whole pin is tempered at a temperature within a range of

150°C to 250°C during the through-tempering operation.

5. Method according to any of the preceding claims, wherein the pin ends are tempered during the local tempering treatment step to obtain a hardness lower than 550 Vickers. 5
6. Method according to any of the preceding claims, wherein the pin ends are tempered with induction heating during the local tempering treatment step. 10
7. Method according to claim 6, wherein each pin end is tempered with at least one inductor disposed in front of a lateral end face of said pin end. 15
8. Cam follower roller device comprising a tappet body (12), a pin (14) mounted into said tappet body, and a roller (16) mounted on said pin, **characterized in that** the pin is hardened by through-hardening treatment, said pin comprising pin ends having a reduced hardness with regard to a central portion supporting the roller. 20
9. Device according to claim 8, wherein the pin ends are caulked in through-holes provided on the tappet body (12). 25
10. Device according to claim 8, further comprising an insert mounted in the tappet body (12), the pin ends being caulked in through-holes provided on said insert. 30

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FIG.1

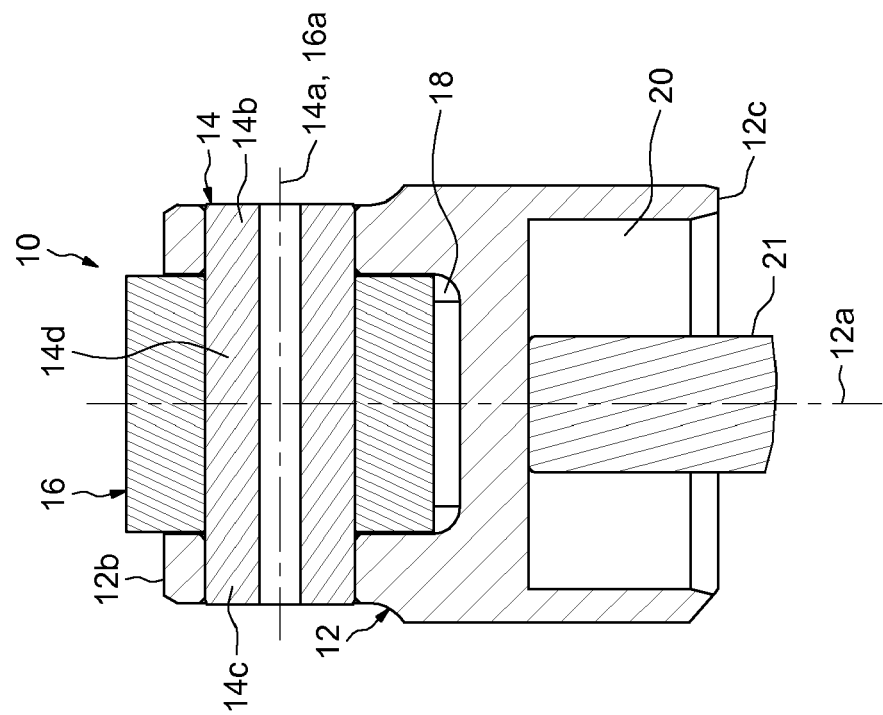


FIG.2

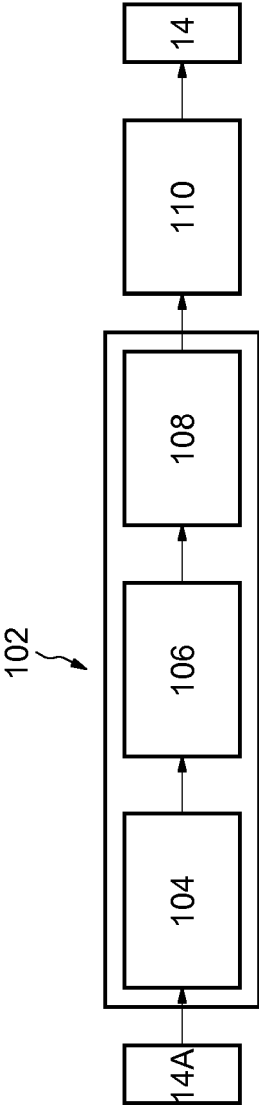
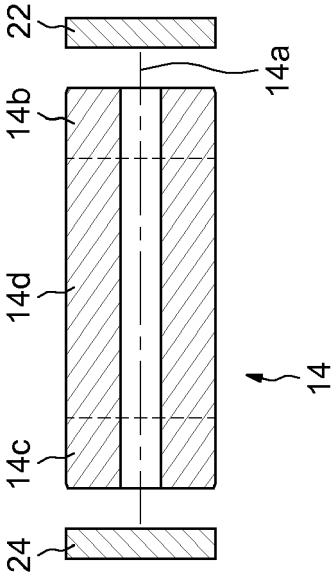


FIG.3





EUROPEAN SEARCH REPORT

 Application Number
 EP 15 30 7020

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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		4 March 2016	Paquay, Jeannot
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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The members are as contained in the European Patent Office EDP file on
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