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(54) **Method for manufacturing ratchet gear with its teeth pattern by involving forging**

(57) The present invention is relating to method of manufacturing ratchet gear with its teeth pattern, a component to be applied in power transmission systems, and more particularly to be used in motor cycles; wherein the whole structural features of said ratchet gear, along with its teeth pattern therein, is achieved during the horizontal hot forging (Upsetting & forming) process or by warm forging followed by controlled cooling (continuous furnace).

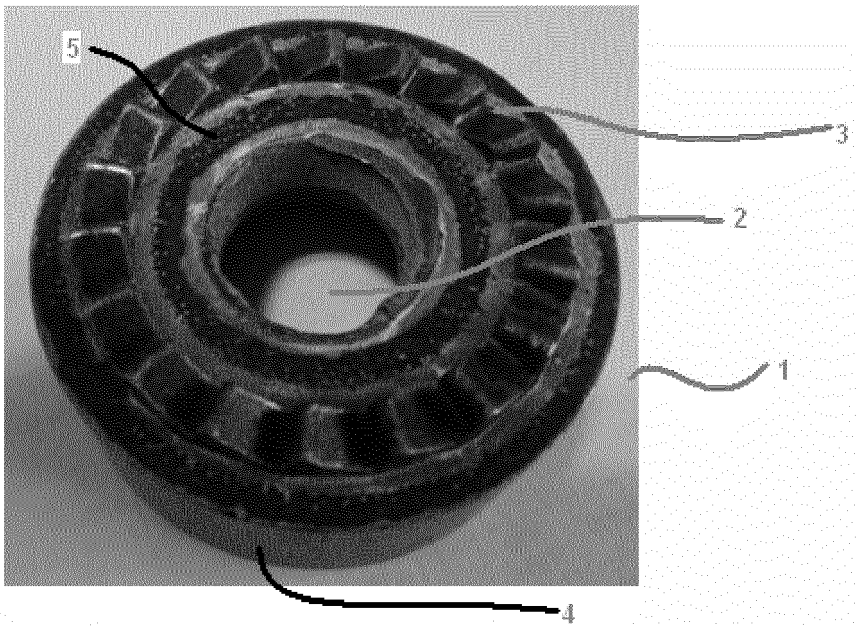


Figure 1

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## Description

### Field of the present invention:

**[0001]** The present invention relates to a method for manufacturing ratchet gear with its teeth profile, particularly to be used in motor cycles; wherein the whole structural features of said ratchet gear, along with its teeth pattern therein, is achieved during the forging operations either during horizontal hot (Upsetting & forming) forging or optionally during vertical warm forging operation. Though the forged ingot achieves all its structural features in the forging stage only, it is further subjected to a series of optional auxiliary operations towards strengthening and smoothening of structural features and surface pattern thereof, including the teeth pattern of the said ratchet gear component.

### Prior art and object of the present invention:

**[0002]** Conventionally a ratchet gear is a specialized gear type that may preferably turns only in one direction. Most ratchet gears have teeth that are round on one side and flat on the other. The section of the ratchet that interacts with the gear, called a pawl, will slide over the rounded side, but will get caught on the flat side.

**[0003]** In one conventional practice, after casting of the main body of the said gear, it is subjected to substantial machining to create all the structural features, hole piercing for shaft assembly, and teeth pattern cutting etc.

**[0004]** Thus, such practice is time consuming. It doesn't provide desired structural strength in the final product and thus, mainly responsible for its reduced functional life. Due to such methodology of the ratchet gear produced, the product is associated with the low abrasion resistance property, lack of perfection and less probability of customized installation in the power transmission system, more prone to noise during functioning, and very sensitive to accidental damage.

**[0005]** Further, in an alternate practice for ratchet gear manufacturing, the piece of raw material, cut in suitable size, is subjected to partial forging or extrusion, mainly to obtain a basic plane ingot, suitable for series of machining operations, namely surface profile creation by machining/cutting; hole piercing; ingot's surface profile refining and strengthening; teeth pattern cutting etc. Most importantly, all such practices involve substantial machining towards structural features development on the ingot and for creation of the series of its teeth pattern. Teeth cutting are usually done by one-by-one teeth cutting or hobbing of teeth therein. Further this method is so time consuming that it is insufficient in fulfilling the requirements/demands of the concerned auto industry.

**[0006]** Therefore, the present invention is mainly intended to propose a manufacturing method, which mainly involve hot or warm forging towards production of ratchet gear with its teeth profile, wherein the supporting optional secondary steps to the said hot or warm forging towards finalization of said gear formation are mainly controlled cooling (continuous furnace), Piercing, Shot Blasting, Bonderizing & lubrication, Sizing of teeth, CNC machining, Hobbing, Case Carburising, Shot Blasting (Hanger type), and Honning etc. The ratchet gear, manufactured by the present proposed method is much advanced in its properties in comparison to the similar conventional auto components prepared through conventional processes, namely in terms of very high stress bearing capacity, corrosion resistance, high temperature tolerance and very high structural strength etc.

**[0007]** The prim object of the present invention is to propose a method of manufacturing the ratchet gear with its teeth pattern, wherein major structural features of the said gear and its teeth pattern are formed during hot or warm forging operation and thereafter certain optional supportive machining processes are required for surface refining, product strengthening and finalizing the ratchet gear production.

**[0008]** Another prime objective of the present invention is to propose a novel method for manufacturing the ratchet gear with its teeth pattern, wherein the said method of manufacturing is characterized by performing the hot forging followed by normalizing, or optionally by warm forging followed by controlled cooling (continuous furnace) wherein the teeth pattern of the said ratchet gear is simultaneously forged during the formation of whole ratchet gear body, without performing any teeth cutting operation.

**[0009]** Another objective of the present invention is to propose the ratchet gear with its teeth pattern, which is characterized by its advanced properties in comparison to conventional such gears and the teeth pattern therein, mainly in terms of structural strength, stress tolerance, abrasive strength towards proper performance in high temperature environments and continuous performing in critical conditions without fatigue etc., primarily due to creation of complete component including the teeth pattern therein in horizontal hot or warm forging.

**[0010]** Another objective of the present invention is to propose a new set of dies designed for performing either said horizontal hot forging (Upsetting & forming) operation or optionally the vertical warm forging operation by controlled cooling (continuous furnace) in the state-of-the-art manner towards creating the said the ratchet gear with its teeth pattern in variable optional range of shape, size, dimension, surface pattern and configuration.

**Description of the present invention:**

**[0011]** The present proposed method of manufacturing the ratchet gear with its teeth pattern is mainly so designed that it simply forges the piece of raw material/ingot, after receiving the preliminary treatment therein, into the ratchet gear with all its structural features, desired surface patterns, and also its suitable teeth profile; mainly through (during the single step horizontal hot forging-cum-normalization process or in single step warm forging-cum-controlled cooling process). After completion of forging operation on the ingot, very limited machining operations is required, which are mainly of refining nature and towards finalizing the ratchet gear product.

**[0012]** Application of single step forging process for the production of Gear with teeth is not conventionally being practiced, due to various reasons such as: Technical complications in die designing for commercial production of the said component; Non-achievement of ideal forging conditions for producing commercially acceptable gear with teeth; and Involvement of so many dimensional aspects of the said auto component of various size range, namely the central hole creation, size optimization of the said component, teeth formation etc., which are difficult to consider in one single standardized process, mainly towards achieving all required and preferred structural and functional features of the said auto component.

**[0013]** The present invention elaborates the method for manufacturing ratchet gear with its teeth profile by forging; either by hot forging or optionally by warm forging.

- **The hot forging route:** In this route the raw material (ingot) is very quickly forged in single step and thus small parts like the present ratchet gear are formed at a rate of more than 150 parts per minute. The main advantages to this process are its high output rate and ability to accept low cost materials. Less labor is required to operate the machinery. There is no flash produced, so material savings are between 20 and 30 % over conventional forging. The final product is a consistent at very high temperature, ranging from 950°C to 1,250°C, depending upon the quality of the material of the ingot and therefore cooling the workpiece under normalization provisions resulting in a part that is still easily machinable.

Involving the normalization process after said proposed hot forging has several advantages, namely as under:

❖ Normalizing imparts both hardness and strength to iron and steel components. In addition, normalizing helps reduce internal stresses.

❖ Normalizing also improves micro-structural homogeneity and response to heat treatment (e.g. annealing or hardening) and enhances stability by imparting a "thermal memory" for subsequent lower-temperature processes. Parts that require maximum toughness and those subjected to impact are often normalized.

❖ Further, Normalizing is typically performed in order to: Improve machinability, Improve dimensional stability, Modify and/or refine the grain structure, Produce a homogeneous microstructure, reduce banding, Improve ductility, provide a more consistent response when hardening or case hardening.

Horizontal hot forging (Upsetting & Forging), as proposed herein, has a number of cost-saving advantages which underscore its increasing use as a manufacturing method. Actually Hot forging is the plastic deformation of metal at a temperature and strain rate such that recrystallization occurs simultaneously with deformation, thus avoiding strain hardening. For this to occur, high workpiece temperature (matching the metal's recrystallization temperature) needs to be attained throughout the process. An exemplary and preferred form of hot forging herein is the isothermal forging, where materials and dies are heated to the same temperature. Isothermal forging is conducted on super alloys in a vacuum or highly controlled atmosphere to prevent oxidation.

**[0014]** The proposed horizontal hot forging (Upsetting & Forging) is actually a metal shaping process, wherein a uniquely designed closed (split type) die plays important role; further wherein the heated workpiece of uniform thickness is gripped between split female dies while a heading die (punch) is forced against the workpiece, deforming and enlarging the need of workpiece. A sequence of die cavities may be used to control the workpiece geometry gradually until it achieves its final shape.

**[0015]** For proposed horizontal hot forging herein, not only a particular range of temperature is Important, but several other factors require especial strategic planning, namely: a very effective selection/designing of die for supporting hot forging of the desired article; material for making said die; customized state of the art technology involvement towards die making; selection of suitable lubricant to be used for hot forging; adopting the forging conditions according to material of the ingot undergoing proposed hot forging etc. The ingot, concerning the present invention, usually of steel or alloy material with pre-determined carbon content plays important role towards selecting an optimized hot forging conditions and thereafter performing other supportive operations, depending upon the structural features of the final product, structural strength, functional features of the product etc.

The preferred forging press used for carrying out the proposed hot forging (Upsetting & forging) by horizontal route is

Hatebur AMP30. After performing the said hot forging on the piece of raw material, the hot forged ingot, which gets almost all structural features and teeth pattern therein of the desired ratchet gear, is subjected to normalization, and followed by visual inspection of forging. Suitably cooled said forged component is further subjected to a series of certain optional machining operations, mainly towards surface refining and enhancing the structural strength of the forged component towards finishing the product. One schematic scheme for performing all essential and optional operations towards manufacturing ratchet gear by proposed method herein is shown in table 1

- Warm forging route: Warm forging has a number of cost-saving advantages which underscore its increasing use as a manufacturing method. The temperature range for the warm forging of steel runs from above room temperature to below the recrystallization temperature or preferably between 450°C to about 1000°C. However, the narrower range of from 550°C to 750°C is emerging as the most appropriate range for warm forging, suitable for commercial production of auto component like present ratchet gear. Compared with cold forging, warm forging has the potential advantages of: (i) Reduced tooling loads, (ii) reduced press loads, (iii) increased steel ductility, (iv) elimination of need to anneal prior to forging, and (v) favorable as-forged properties that can eliminate heat treatment.

For such warm forging not only a particular range of temperature is Important, but several other factors require especial strategic planning, namely: (i) a very effective selection/designing of die for warm forging of the desired article; (ii) material for making said die; (iii) customized, state of the art technology involvement towards die making; (iv) selection of suitable lubricant, to be used for ingot undergoing warm forging etc. The ingot, concerning the present invention, usually of steel or alloy material with pre-determined carbon content plays important role towards selecting an optimized warm forging conditions and thereafter performing other supportive operations, depending upon the structural features of the final product, structural strength, functional features of the product etc.
The preferred forging press used for carrying out the proposed warm forging in vertical route is KP30T. After performing said warm forging on the piece of raw material, the forged ingot, which gets almost all structural features and teeth profile therein of the desired ratchet gear, is subjected to controlled cooling in . Suitably cooled said forged component is further subjected to a series of certain optional machining operations, mainly towards surface refining and enhancing the structural strength of the forged component towards finishing the product. One schematic scheme for performing all essential and optional operations towards manufacturing ratchet gear by proposed method herein is shown in following table 1 hereinbelow:

**Table 1**

| No. of Step | Particular of the step performed during Ratchet Gear manufacturing by Hot Forging Process. | Particular of the step performed during Ratchet Gear manufacturing by Warm Forging Process. |
|---|---|---|
| 1 | Raw Material receipt | Raw Material |
| 2 | Ratchet Gear Formation by horizontal Hot Forging (Upsetting & Forming), Hot Part Former | Shearing / Sawing |
| 3 | Normalizing | Warm Forging (Ratchet Gear Formation) |
| 4 | Visual Inspection of Forging | Controlled cooling (Continues Furnace) |
| 5 | Piercing | Piercing |
| 6 | Shot Blasting | Shot Blasting |
| 7 | Bonderizing and Lub. | Bonderizing and Lub. |
| 8 | Sizing of Teeth | Sizing of Teeth |
| 9 | Visual Inspection of Final Forging | CNC machining |
| 10 | CNC machining (CNC-1 & CNC-2) | Hobbing |
| 11 | Hobbing | Case Carburising |
| 12 | Case Carburising | Shot Blasting (Hanger Type) |
| 13 | Shot Blasting (Hanger Type) | Honning |
| 14 | Honning | Gear rolling |
| 15 | Gear rolling | |

**[0016]** Controlled cooling in continuous furnace therein, the warm forged component attains the suitable temperature for further machining operations, mainly piercing, shot blasting, bonderizing, sizing of teeth therein, and CNC machining, in stepwise manner.

**[0017]** The ratchet gear 1, formed by proposed horizontal forging (either by hot (Upsetting & Forming) process or by warm foreign process) herein, comprises of all essential structural and functional features. The central hole 2 of said gear 1, the teeth profile 3, and all major surface patterns, as shown by numerals 4 and 5 in the figure, are achieved during hot forging. Machining operations, such as piercing, sizing of teeth, CNC machining, shot blasting, case carborization, hobbing, honing etc. are basically performed to refine the structural features and surface pattern of said ratchet gear 1, and to further strengthen the said gear 1 and its surfaces/teeth.

**[0018]** Achieving the ratchet gear with all its major structural features including the teeth pattern therein is mainly due to customized creation of a suitable closed die for the purpose and performing the hot forging operation successfully thereof. Due to such novel step, the proposed method and ratchet gear manufacturing is a great help to auto industry, as large production of such gears may become much economical in comparison to previous practices.

**[0019]** Although the invention has been described with reference to specific embodiments, this description is not meant to be construed in a limiting sense. Various modifications of the disclosed embodiments, as well as alternate embodiments of the invention, will become apparent to persons skilled in the art upon reference to the description of the invention. It is therefore contemplated that such modifications can be made without departing from the spirit or scope of the present invention as defined.

## Claims

1. A method of manufacturing the ratchet gear with its teeth pattern, wherein the said method mainly involves forging operation, either hot forging (Upsetting & Forming) or optionally warm foreign, using a suitable set of dies for forming the said ratchet gear; wherein major structural features of the said ratchet gear and its teeth pattern are achieved in said forging operation; and wherein said forging operation is followed by supplementary optional operations towards refining the surface pattern, strengthening the material of said gear and finalizing the said gear.

2. A method of manufacturing the ratchet gear with its teeth profile, as claimed in claim 1, wherein towards making of an embodiment of said ratchet gear said method of manufacturing therein is **characterized by** performing the hot forging followed by normalization, wherein the teeth profile of the said ratchet gear is simultaneously forged during the formation of whole ratchet gear body, without performing any teeth cutting operation.

3. A method of manufacturing the ratchet gear with its teeth profile, as claimed in claim 1, wherein towards making of an embodiment of said ratchet gear said method, after performing horizontal hot forging (upsetting and forming) followed by normalization is **characterized by** supportive optional operations namely, visual inspection of forging, Piercing, Shot Blasting, Bonderizing & lubrication, Sizing of teeth, Visual Inspection of Final Forging, followed by CNC machining (CNC-1 & CNC-2), Hobbing, Case Carburizing, Shot Blasting (Hanger type) and Honning in stepwise manner.

4. A method of manufacturing the ratchet gear with its teeth profile, as claimed in claim 1, wherein towards making of an embodiment of said ratchet gear said method of manufacturing therein is **characterized by** performing the warm forging followed by controlled cooling (continuous furnace), wherein the teeth profile of the said ratchet gear is simultaneously forged during the formation of whole ratchet gear body, without performing any teeth cutting operation.

5. A method of manufacturing the ratchet gear with its teeth profile, as claimed in claim 1, wherein towards making of an embodiment of said ratchet gear said method, after performing vertical warm forging and controlled cooling (continuous furnace), is **characterized by** supportive optional operations namely, Piercing, Shot Blasting, Bonderizing & lubrication, and Sizing of teeth in stepwise manner involves operations of CNC machining, Hobbing, Case Carburizing, Shot Blasting (Hanger type) and Honning, in continuous stepwise manner.

6. A method of manufacturing the ratchet gear with its teeth profile, as claimed in claim 1, wherein performing normalization step after the hot forging of the gear workpiece or wherein optionally performing the controlled cooling (continuous furnace) step after the worm forging of the workpiece is **characterized by** effective conditioning the forged workpiece before subjecting it towards performing supportive optional operations in continuous stepwise manner.

7. A method of manufacturing the ratchet gear with its teeth profile, as claimed in claim 1, wherein after the hot forging

of the ingot followed by normalization or after the worm forging of the ingot, followed by controlled cooling (continuous furnace); carrying out the supportive optional operations in continuous stepwise manner is **characterized by** advanced properties of the said ratchet gear formed, mainly in terms of structural strength, stress tolerance, abrasive strength towards proper performance in high temperature environments and continuous performing in critical conditions without fatigue etc.

**8.** A method of manufacturing the ratchet gear with its teeth profile, as claimed in claim 1, wherein said method is **characterized by** application of a set of closed die for performing the said horizontal hot forging (upsetting and forming) or for optionally performing vertical warm forging operation towards creating the said the ratchet gear with its teeth profile in variable optional range of shape, size, dimension, surface pattern and configuration.

**9.** A method of manufacturing the ratchet gear with its teeth profile, as claimed in claim 1, wherein the said ratchet gear and its teeth profile, optionally of different shape, size, dimension, central hole size, surface pattern and configuration is manufactured by the said method involving suitable closed die of corresponding optional shape, size, dimension, central hole size, surface pattern and configuration therein during the said horizontal hot forging (upsetting and forming) or for optionally performing vertical warm forging operation.

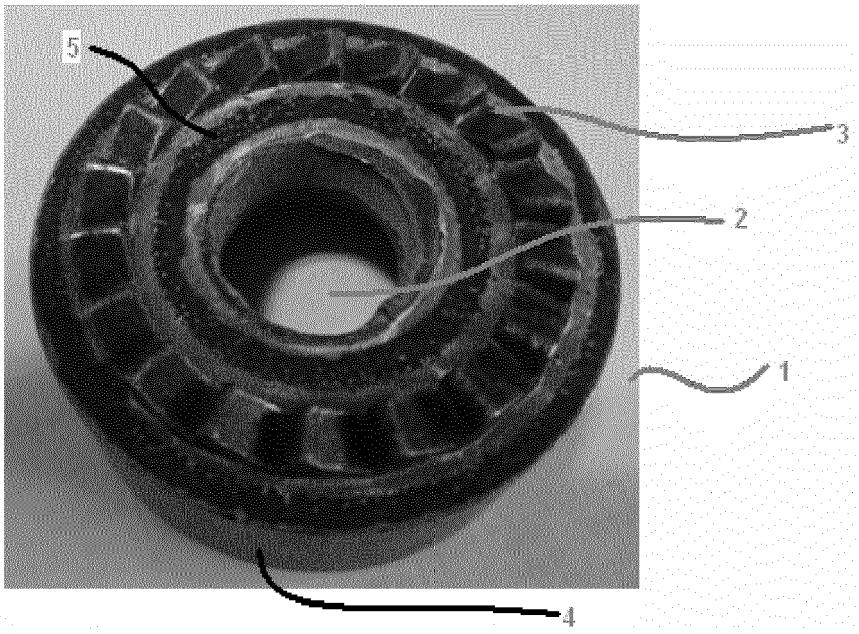


Figure 1

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# EUROPEAN SEARCH REPORT

Application Number
EP 13 19 9821

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| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
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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 |
|---|---|---|
| Munich | 12 June 2014 | Ritter, Florian |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 19 9821

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82