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(54) Process for reducing friction coefficient and increasing corrosion strength in components for safety belt rewinding devices

(57) A plurality of locking forks 2 or other components of coiling devices for safety belts is introduced together with a mass of granular elements (13) in a container (8). The container is repeatedly agitated in such a way that the impacts of the granular elements (13) on each component (2) flatten the superficial irregularities typical of the material.

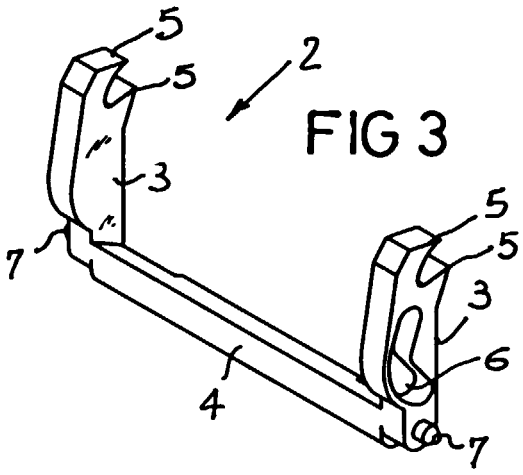

FIG 3

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Description

[0001] The present invention relates to a method for reducing the friction coefficient and increasing the corrosion resistance of components for safety belt coiling devices. In the embodiment whereto particular reference shall be made in the course of the present description, the invention is aimed at the realisation of arresting forks employed for selectively stopping the coiling drums of devices for rolling up safety belts for motor vehicles and the like. However, the innovative concepts of the invention can be advantageously exploited for the realisation of any other component of the coiling device.

[0002] As is well known, the devices for rolling up safety belts usually employed on motor vehicles and the like are fitted with a drum for coiling the belt on whose opposite ends are obtained circumferential teeth able to be operatively engaged by the opposite arms of a locking fork. More specifically, the fork is engaged, in a manner allowing it to oscillate, to a fixed structure of the coiling device, by means of a pair of hinge pins projecting from the opposite ends of a connecting bar extending between the aforementioned arms. Each of the arms of the fork presents a shaped groove or recess wherein is operatively engaged a command organ which is sensitive to acceleration and/or to other critical parameters to command, if necessary, the coiling drum to lock. The locking action is performed by clutching teeth borne terminally by the arms of the fork element and operatively engaging with the circumferential teeth present on the drum.

[0003] Forks of the type described above are generally manufactured by die-casting an aluminium alloy.

[0004] Particular care is taken in designing and manufacturing the dies employed to manufacture the forks which, being part of a device able to intervene in emergency conditions to ensure persons' safety, must meet strict geometric and shape tolerances to guarantee the proper operation and the reliability of the device itself.

[0005] Particular care is furthermore devoted to the execution of suitable surface treatments able to render the component undergoing the work immune from corrosion and wear, as well as to reduce its sliding friction with respect to other parts of the device operatively engaged to the component itself.

[0006] More specifically, the current state of the art provides for this purpose for the forks or other components of the coiling devices to be subjected to the application of an anti-friction coating, commonly called "AF-Coating", essentially constituted by a suspension of tiny particles of solid lubricant, for instance based on molybdenum disulphide, graphite and/or polytetrafluoroethylene, in organic or inorganic chemical binders.

[0007] The application of the anti-friction coating requires an intensive superficial pre-treatment of the component undergoing the work process, wherefrom depends to a great degree the adhesiveness and hence the duration of the coating itself.

[0008] It is first of all necessary for the component coming from the die-casting phase to be thoroughly degreased with the aid of suitable organic solvents, such as petrol or acetone, or with alkaline solvents in appropriate washing plants.

[0009] The component is subsequently made to undergo a sanding treatment, which allows to obtain an increase in surface roughness aimed at improving the adhesion of the anti-friction coating.

[0010] The component being processed is then subjected to an anodic oxidation treatment, proceeding then with the application of the anti-friction coating, which essentially entails the immersion of the component in a solution containing the anti-friction agents, the elimination of excess solution by centrifuging, and subsequent kiln-drying. It should be observed that, the locking forks being rather delicate components, the immersion and subsequent centrifuging process must perforce be effected in a piecemeal manner on small lots of components.

[0011] It may moreover be found necessary to repeat the immersion, centrifuging and drying operations a second time to guarantee the complete coverage of the component being processed.

[0012] Once the application is complete, thorough quality controls need to be performed in order to ascertain the correct application of the coating on the entire surface of the piece and, above all, to verify that the coating itself has not formed deposits in the aforementioned shaped recesses or in other critical points of the component itself.

[0013] For the reasons described above, the application of the anti-friction coating is therefore complex and costly, entailing a considerable increase in the costs of production which, at least as far as locking forks are concerned, can be estimated in an amount exceeding 10% of the overall cost of the component.

[0014] According to the invention, the Applicant has aimed to eliminate the need to perform the application of the aforesaid anti-friction coatings, to obtain considerable advantages in terms of simplification of the productive processes with consequent lowering of the costs, whilst also improving the qualitative and technical/functional characteristics of the finished product.

[0015] In this regard the Applicant has noted that it is possible unexpectedly to attain excellent corrosion resistance and especially mechanical smoothness capabilities with low friction coefficient if the component being processed, with no need to effect any preliminary treatment after die-casting, is essentially subjected to localised impacts such as to determine a flattening by plastic deformation of the asperities typical of the surface roughness of the component itself. More in particular, the subject of the invention is a method for reducing the friction coefficient and increasing the corrosion resistance of components for safety belt coiling devices comprising the characteristics defined in the characterising part of claim 1.

[0016] Additional features and advantages shall become more readily apparent from the detailed description of at least one preferred, but not exclusive, embodiment of a method for reducing the friction coefficient and increasing the corrosion resistance of components for safety belt coiling devices, according to the present invention. The description shall be provided hereafter with reference to the accompanying drawings, provided purely by way of non limiting indication, wherein:

- Fig. 1 schematically shows a partially sectioned view of an agitator device employable to realise the method according to the present invention;
- Fig. 2 shows, in considerably enlarged perspective, a granular element employable in accordance with the present invention;
- Fig. 3 shows by way of indication a device for safety belt coiling devices, whereon the subject method can be realised.

[0017] With particular reference to Fig. 1, the number 1 indicates in its entirety an agitator device usable to realise a method for reducing the friction coefficient and increasing the corrosion resistance of components for safety belt coiling devices, according to the present invention.

[0018] More in particular, the components whereon the method according to the invention is realised are for instance constituted by forks 2 tasked with locking the coiling drum of an aforesaid rewinding device.

[0019] As shown in Fig. 3, each fork 2 essentially comprises a pair of parallel arms 3, each of which presents an end connected to a corresponding end of the other arm 3 by means of a connecting bar 4. Each arm 3 is smooth or it presents one or more clutching teeth 5 oriented on the opposite side to the end connected to the connecting bar 3. On an outer lateral surface of each arm 3 are set at least one guiding recess 6 and a hinge pin 7 projecting perpendicularly in correspondence with the attachment end of the connecting bar 3.

[0020] In order to guarantee the correct functionality and reliability of the coiling device, it is of fundamental importance that the fork 2 present an adequate resistance to external atmospheric agents and a reduced friction coefficient, especially in correspondence with the lateral hinge pins 7, of the guiding recesses 6 and of the clutching teeth 5 destined to come into sliding contact relationship with other components of the device whereto the fork itself is to be associated.

[0021] In order to confer to the fork 2, or other structural component of the coiling device, the aforesaid qualitative characteristics, the method according to the invention essentially provides for the fork itself, made of aluminium, zinc or magnesium alloys and obtained from a die-casting process, to be repeatedly subjected to localised impact actions, homogeneously distributed over its entire surface, thereby determining a flattening of the superficial asperities typically present thereon when it is extracted from the die used for casting or other work process.

[0022] For the purposes of the present description, superficial asperities are taken to mean the micrometric asperities which characterise the superficial roughness of the die-cast or otherwise worked piece.

[0023] In order to effect the aforesaid impact actions, a plurality of forks 2 and/or other components for coiling devices of the type specified are introduced into a container 8, essentially shaped in the manner of a tub, together with a mass of granular elements having preferably greater hardness than that of the material constituting the components themselves. One of such granular elements is shown in enlarged scale and indicated with the number 13 in Fig. 2.

[0024] To the container 8, connected to a fixed structure 9 by means of springs 10 or equivalent elastic means, are associated means for shaking comprising for instance one or more electric motors 11 fastened to the container itself and set to actuate the rotation of respective eccentric masses 12.

[0025] The rotation of the eccentric masses 12 transmits to the container 8, and hence to the mass of granular elements 13 and to the components 2 introduced therein, a continuous vibratory shaking motion, such that the surfaces of each fork 2 are repeatedly subjected to localised impact actions on the part of the individual granular elements 13.

[0026] By way of example, the eccentric masses 12, actuated in rotation at an angular rotation of 3,000 rotations per minute, can present an eccentricity indicatively ranging between 70 mm and 100 mm, referred to the centres of gravity of the masses themselves with respect to the axes of rotation, and an overall weight ranging between 1/30 and 1/70 of the total weight of the container 8 filled with the components 2 and the granular elements 13, in such a way as to impose to the container itself oscillations having an amplitude indicatively ranging between 1 mm and 5 mm. The weight, the eccentricity and the rotation velocity of the eccentric masses 12 should in any case not be considered constraining for the purposes of the invention, since they are widely variable and easy to determine one as a function of the other and as a function of other parameters, such as the rigidity of the springs 10 and/or the quantity of material introduced in the container 8.

[0027] It should be noted that the eccentricity of the masses 12 entails a continual variation of the orientation of the centrifugal forces induced thereby. Consequently, the direction according to which the vibratory motion is transmitted to the container 8 is not univocal, but changes at each instant. Through these variations, a continual mixing action is advantageously obtained of the forks 2 or other components in the mass of granular elements 13. This is found to be advantageous for the purposes of a homogeneous action of the granular elements 13 on the entire surface of each component 2

being processed.

[0028] Due to the repeated shaking, the granular elements 13 impart localised impact actions against the surfaces of the components 2 being processed, as a consequence thereof, on the surfaces themselves, plastic micro-deformations are brought about which determine the flattening of the superficial irregularities, with a consequent reduction in the surface roughness of the components themselves.

[0029] It is understood that the process also allows conveniently to eliminate any burrs and/or micro-burrs which may still be present on the components following the die-cast process aimed at the realisation of the components themselves.

[0030] In order to obtain the best impact action of the granular elements 13 on the surfaces of the components being processed, it is preferably provided for the volume occupied by the granular elements themselves within the container 8 not to be smaller than 1/3 the volume occupied by the components being processed, since the result could otherwise be negatively influenced by the mutual interference between the components themselves.

[0031] The granular elements 13 are preferably constituted by steel spheroidal elements with granulometry indicatively ranging between 1 and 7 mm. In a preferential embodiment each granular element 13, as shown in Fig. 2, presents a spherical central portion 14a with diameter of the order of 5 mm, provided with at least one annulus 14b with diameter of the order of 7 mm.

[0032] The use of granular elements 13 thus shaped provides the advantage of obtaining, thanks to the annulus 14b, impact actions also in hard to reach points, without having to use for that purpose granular elements of small size which would entail jamming problems.

[0033] The shaking action is protracted indicatively for a time ranging between ten and thirty minutes. Longer permanence times might entail excessive superficial deformations, whilst shorter permanence times might require an excessively energetic shaking action, with the risk of localised deformations on the components being processed. Preferably, to the mass of granular elements 13 is also added a lubricating agent, preferably constituted by soap water, with the dual function of easing mutual sliding and the detachment of the granular elements 13 from the components being processed 2 in the intermediate phases between impacts, to the advantage of the kinetic energy transmitted in the impact itself, as well as of the mixing action of the components 2 in the mass of granular elements 13.

[0034] The present invention attains the proposed aims.

[0035] Practical trials have demonstrated that the components 2 treated by means of the subject method present a mean superficial roughness no greater than 1 m, and in any case lower than the roughness measurable on the piece as it exits the casting die. Profilometer analysis further demonstrates that the reduction in roughness is due to a substantial flattening of the peaks or troughs typical of surface roughness, whereon the impact action on the part of the granular elements 13 has a greater effect.

[0036] Unlike those attained by the present invention, it should be noted that the components treated according to the prior art normally present mean roughness values well above 1 m, and oftentimes even greater than the roughness measurable on the component itself as it exits the casting die, also due to the sanding treatment necessarily performed before the application of the anti-friction coating.

[0037] The reduction in surface roughness induced, in accordance with the present invention, by the localised impact actions determines an advantageous reduction in the friction coefficient and an increase in corrosion resistance unexpectedly satisfactory for the specific uses whereto the components described above are destined.

[0038] In other words it is possible to attain the qualitative characteristics required in terms of friction coefficient and wear resistance without requiring the application of anti-friction coatings necessary in the prior art, and the execution of the elaborate operations necessary to prepare individual components for the application of such coatings.

[0039] It should also be noted that the invention attains the results described above without causing such superficial and/or geometric deformations of the structural component as would cause it not to meet the stringent tolerance margins typically prescribed for the components whereto the invention is specifically destined.

[0040] It should also be observed that the reduction in roughness attained by flattening surface irregularities by means of plastic deformation of the material, instead of by the removal thereof, introduces adjacently to the surfaces of the piece inner tensions which may reveal themselves to be advantageous for purposes of mechanical resistance.

[0041] It should further be stressed that the method according to the invention is suitable to be employed simultaneously on large quantities of components, without thereby entailing the risk of damaging them, to the further advantage of cost reduction with respect to the treatments required in the prior art.

Claims

1. Method for reducing the friction coefficient and increasing the corrosion resistance of components for safety belt coiling devices,
   characterised in that it comprises the following phases:

   - introducing one or more of said components (2) in a container (8) together with a mass of gran-

ular elements (13);

- repeatedly shaking the container (8) to cause a flattening of the superficial irregularities of the components (2) as an effect of plastic deformations provoked by impact actions exerted by the granular elements (13) against the surfaces of the components themselves.

2. Method according to claim 1, wherein during the shaking phase a mixing action is effected of said components (2) in the mass of granular elements (13).

3. Method according to claim 1, wherein the volume occupied in the container (8) by the granular elements (13) is at least equal to one third of the volume occupied by said components (2).

4. Method according to claim 1, wherein said granular elements (13) comprise spheroidal bodies made of steel.

5. Method according to claim 1, wherein each granular element (13) comprises one spherical central portion (14a) wherefrom at least one annulus (14b) projects radially.

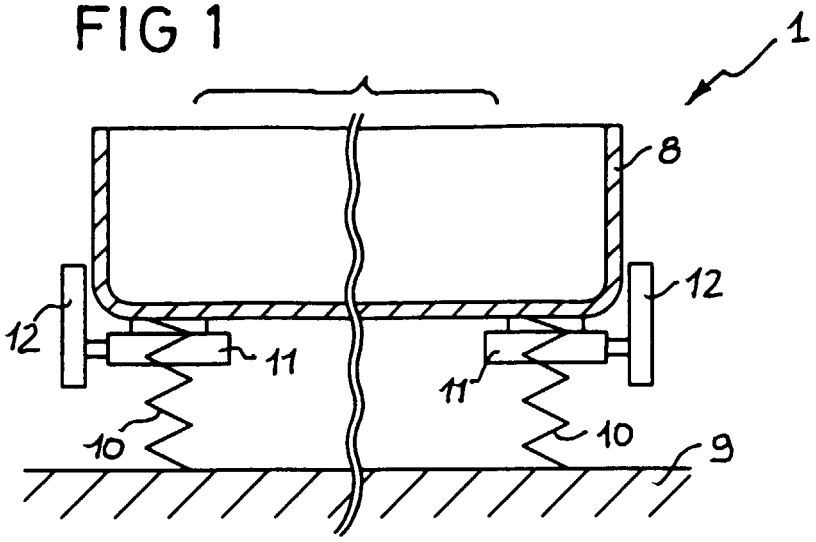
6. Method according to claim 1, wherein said granular elements (13) present granulometry ranging between 1 and 7 mm.

7. Method according to claim 1, wherein the shaking phase of the holding container (8) occurs for a time interval ranging between 10 and 30 minutes.

8. Method according to claim 1, wherein prior to the shaking phase a lubricating fluid is added in the mass of granular elements (13) inside the container (8).

9. Method according to claim 8, wherein said lubricating fluid comprises soap water.

FIG 1



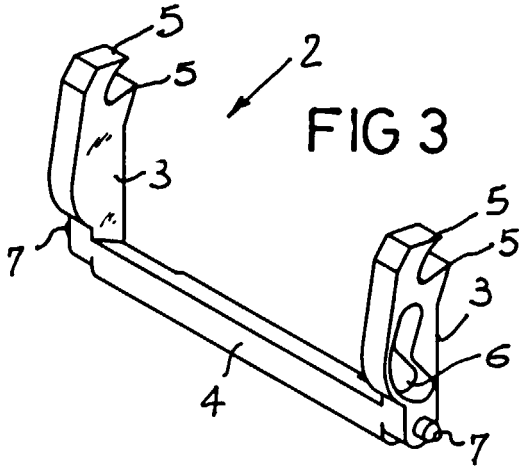


FIG 3

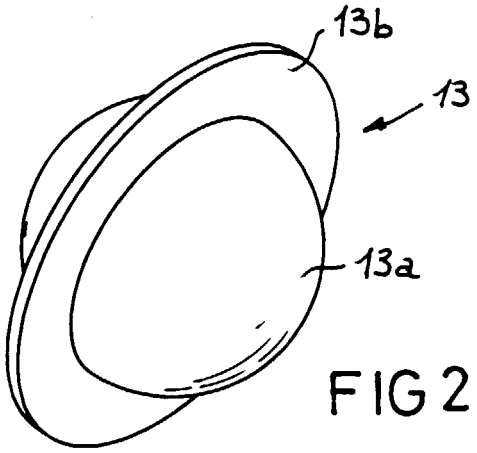


FIG 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 83 0471

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TECHNICAL FIELDS SEARCHED (Int.Cl.6)
B24B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	6 January 1999	Garella, M

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