METHOD FOR RUNNING IN METAL COMPONENTS

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ABSTRACT
The invention relates to a method for running in metal components which move over, or mesh with each other, and to apparatus for performing the method. Parts are manufactured with normal tolerances and then are run together in a bath of material such as manganese phosphate. The phosphate material adheres to the parts as a solid coating which fills in low surface portions on the parts and is rubbed away, along with some metal, from the higher surface portions of the parts.

1 Claim, 4 Drawing Figures
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METHOD FOR RUNNING IN METAL COMPONENTS

The invention relates to a method for running in metal components which move over or mesh with each other, and to apparatus for performing this method. It is particularly advantageous to apply the surface coating continuously during the running-in process. With such a procedure not only are the "valleys" continuously filled in, but the scraped and therefore bright metal faces also receive a fresh surface coating each time and this improves the conditions during the subsequent abrading of the metal.

The running-in process is preferably carried out in a bath of liquid, with the help of which the material of the surface coating is caused to form on the metal components. By immersing the moving metal components in the bath it is possible to ensure that all the metal faces come into contact with the liquid in the bath.

The running-in process is expediently controlled in such a way that surface portions that have been in contact with an adjacent component are exposed to the action of the bath until a layer of the surface coating forms on bright metal faces, before they are again brought into contact with the adjacent components. This as a rule leads to relatively slow running-in movements, but ensures that a metal face that has been rendered bright by abrasion or scraping can only be subjected to renewed abrasion if a surface coating has been formed on it. Conversely, the running-in movement would not of course be so slow that the surface coating that forms is too thick to be removed again at the appropriate places.

Moreover, the metal components should be kept static in the bath prior to the commencement of the running-in process until a first layer of the surface coating has formed on the bright metal faces. This again ensures that even the first abrad- ing processes take place in the presence of the material of the surface coating. The preliminary static period needs to be only a fraction, in particular less than 20 percent, of the running-in period. In the case of a running-in period of 3 minutes, a static period of 2.5 seconds for example suffices.

It has already been mentioned that the method of the invention also permits plus tolerances which result in abrasion of the metal. In a preferred embodiment, the metal components, prior to running-in, are even fitted in such a way that a frictional force is set up when relative movement between them occurs. In this way it is ensured that the major part of the area over which the metal components interengage after running-in is formed by metal faces to which has been imparted an exact matching shape by appropriate abrasion, whereas only a smaller part of the interengaging area is formed by the material of the surface coating which is somewhat more sensitive to compressive stresses, etc.

The running-in method of the invention can be advantageously used particularly in the case of machines comprising rolling or rotary pistons, of interengaging pairs of gear wheels, especially where an externally toothed wheel meshes with an internally toothed ring, and of the friction wheels of friction gears. In such cases the object is to achieve, at each point through which the metal components rotate, the greatest possible constancy in contact between the parts.

According to the invention, apparatus for performing this method is characterized by a container for the liquid of the bath, an auxiliary device which can be introduced into the container and is for accommodating at least two metal components moveable relatively to each other, and a drive means for imparting relative movement to the components in the container.

PREFERABLY, in the case of disc-like metal components that rotate relatively to each other, the auxiliary device comprises two parallel side portions, which between them accommodate the metal components and are clamped together under a force corresponding to the force of the pressure occurring when the components are in use. In this way, even if they are not intended to have exactly parallel side-walls, the disc-like metal components acquire, even during the running-in operation in the auxiliary device, a shape such as they will of necessity acquire when subsequently assembled for operational use.

In this arrangement, the side portions should be held apart by a distance piece at a distance such that the rotating metal components can rotate with a side-wall play of at most a few
Since the surface coating to some extent also tends to form between the metal components and the side portions of the auxiliary device, this situation makes it necessary for the side portions to be rendered planar by lapping, after they have been used a number of times. On the other hand however, the metal components in this way acquire shapes giving an absolutely exact fit.

The invention will now be described in more detail by reference to an embodiment illustrated in the drawing, in which

FIG. 1 shows a plan view of a pair of metal components in the form of a toothed wheel and a toothed ring meshing therewith, which components are for treatment in accordance with the invention,

FIG. 2 shows, on a greatly enlarged scale, a cross-section through the toothed ring as received from the manufacturers,

FIG. 3 is a cross-section through the auxiliary device for use in accordance with the invention, and

FIG. 4 is a schematic illustration of apparatus for running-in these toothed elements.

The gear-wheel set seen in FIG. 1 consists of an externally toothed wheel 1 and an internally toothed ring 2, which between them form displacement chambers 3 which are sealed off from each other over a line 4 of contact between the two toothed components. If the toothed wheel 1 is driven in the direction of the arrow, the toothed ring 2 also rotates in the same direction, a pumping effect being achieved with the help of the displacement chambers 3. Conversely, fluid under pressure can be introduced into the displacement chambers 3, so that the arrangement operates as a motor.

It is clear that the wheel 1 and the ring 2 must be of precisely matching shapes so that a good seal is achieved at every point through which they rotate along the lines 4 of contact. The outer periphery of the wheel 1 and the inner periphery of the ring 2 would therefore have to be machined with extreme precision. This is however not possible on a practical basis. Although the teeth on the wheel 1 can be produced to relatively close tolerances with an externally applied milling cutter, this is not however the case as regards the teeth on the ring 2. As a rule these teeth have to be formed with a reamer, and this enables only a very inexact shape to be obtained.

Furthermore, when the reamer is passed through the ring, the cross-section of the latter is distorted in the manner shown in FIG. 2. It is here assumed that the reamer is inserted from above. Because of the axial load, the cross-section of the ring assumes the position shown in broken lines and then returns to the position shown in solid lines as a result of the inherent elasticity of the metal. In some circumstances permanent deformation occurs, this lying somewhere between the cross-sections shown in the broken and solid lines. The illustration is greatly exaggerated. In fact, deviations from the precise orthogonal directions in the order of magnitude of a few μ occur. A hydraulic motor produced in this way has an efficiency of approximately 70 percent after 200 revolutions, and this drops to about 55 percent after 2,000 service hours. When its gear wheels are further treated in accordance with the invention, the same motor has an efficiency of 75 to 80 percent after 200 revolutions, this figure remaining practically unchanged after 2,000 service hours.

The running-in treatment in accordance with the invention is carried out with the help of the apparatus illustrated in FIGS. 3 and 4. This comprises a container 5 for a bath liquid 6, with the help of which a surface coating is applied to the gear wheels. A suitable liquid consists, for example, of a dilute solution of acid metal phosphates, possibly with an addition of oxidation agents for reducing the reaction time, such as are marketed for example under the trade name Bonder R 98.

Hinged to an upright 7 is an arm 8, which can be supported on a stop 9 and carries an electric motor 10. Connected to the motor casing is an auxiliary device 11 through which the shaft 12 of the motor passes. The auxiliary device comprises a bush 13 with a first side portion 14, an annular distance piece 15 and a second side portion 16.

Between the side portions are the toothed ring 2 and the toothed wheel 1 which is mounted on the shaft 12. Screw-bolts 17 clamp the auxiliary device under a pressure corresponding to the pressure under which the ring and wheel will operate when in use, e.g. a specific pressure of 1,500 kg/cm². The side portions 14 and 16 are precisely parallel with each other, it being intended that the deviations be within ± 5 μ. The play in the toothed components 1 and 2 and between the side portions 14 and 16 is likewise limited to a few μ, 20 μ at most, but preferably less than 10 μ. The side portion 16 contains numerous orifices 18 through which the liquid 6 of the bath can pass into the displacement chambers 3. Consequently, a phosphate coating can be deposited on the exposed surfaces.

When the motor 10 is switched on and the toothed components 1 and 2 begin to rotate, fresh liquid from the bath is continuously introduced into the chambers 3 as a result of their increasing and diminishing in size, so that deposition proceeds without interruption.

When the toothed components 1 and 2 have been clamped in the auxiliary device 11, the latter is introduced into the container 5 as shown in FIG. 4. The assembly is then left for 25 seconds in the static state in the liquid in the bath. During this period a thin layer of the surface coat will deposit on the exposed portions of the toothed components 1 and 2, particularly on their peripheral surfaces. The motor 10 is then switched on for about 3 to 6 minutes. During the relative movements of the toothed components 1 and 2 that now takes place, there are places, e.g. in the zone 19, which do not come into contact with each other at all. The material of the surface coat can therefore deposit here in an unrestricted manner. Other zones, e.g. the point 20, come into frictional contact with each tooth of the wheel 1, the surface coat there formed not only being removed, but the metal below it being rubbed away. However, because of the presence of the material of the surface coat, this abrasion of metal does not lead to seizing or welding up.

After a prescribed period, all the "hills" are removed and all the "valleys" are filled in, so that the pair of gear-wheels will have acquired a very precise matching shape which cannot be improved by further running-in treatment.

The driving speed will depend upon the rate at which the surface coat is required to build up. The optimum value for this speed can readily be determined by tests. On the one hand, the drive should be so slow that each peripheral portion that has just formed a line 4 of contact and therefore possibly consists of bright metal as a result of abrasion, acquires a layer, albeit thin, of the material of the surface coat prior to the next moment at which it again forms a line 4 of contact. On the other hand, the drive should not be so slow that the deposited surface coat attains a thickness that renders further rotation difficult.

In an example illustrating the performance of the invention, the gear-wheel set comprised a wheel having six teeth and a ring having seven teeth; the outside diameter was 120 mm and the width was 10 mm. The machining operations were such that the two toothed components could rotate relatively to each other with a moment of rotation of 0.5 to 1.5 mkg.

The liquid 6 in the bath consisted of the "Gleitbinder 98" composition marketed by Metallgesellschaft AG of Frankfurt-Main; the composition had a points number of 50±2 and a temperature of 98° to 58° C.

The toothed components referred to were degreased and rinsed. They were then clamped in the auxiliary device 11.

The total clamping pressure was 10 tonnes.

The assembly was then immersed in the liquid 6 in the bath and first kept there in the static condition for 25 to 60 seconds maximum. The motor 10 was then switched on, the shaft 12 rotating at a speed of 10 rpm. After a running-in period of 3 to 6 minutes the effect could not be further improved. Speeds different from that stated were possible. However, below 2 rpm the surface coating was too thick, so that the gear-wheel set could hardly continue to rotate. At speeds in excess of 20 rpm only a trifling improvement in efficiency was achieved. At
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15 rpm a useful effect was achieved after a somewhat longer running-in period. The side portions 14 and 16 were lapped after each 5 running-in operations to render them sufficiently flat.

Based on a large number of tests it was found that good pairings, which could also occasionally be obtained by the appropriate choice of toothed components that had only been machined, suffered no deterioration at all, but that poor pairings were always very considerably improved to give a permanent efficiency of 75 to 80 percent.

I claim:

1. A method of forming meshing parts with substantially zero tolerances comprising the steps of forming the parts by machining, assembling said parts to form an assembly, placing said assembly in an inorganic manganese phosphate solution which adheres to said parts to form a coating thereon, and running said assembly during a running period to remove excess material by rubbing contact.

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