PROCESS FOR FORMING ON SURFACE OF ARTICLES RELIEF FEATURING PROJECTIONS AND RECESSES OF UNIFORM HEIGHT SHAPE AND DISPOSITION SMOOTHLY CHANGING FROM ONE INTO THE OTHER, AND DEVICES FOR ACCOMPLISHING SAME


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ABSTRACT

The invention is concerned with processes related to changing the relief of an article surface by way of introducing into the surface layer of said article a hard deforming member. The invention makes it possible to form on the surface of articles a relief whose projections rise above recesses to a value of the order of tens of microns.

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PROCESS FOR FORMING ON SURFACE OF ARTICLES RELIEF FEATURING PROJECTIONS AND RECESSES OF UNIFORM HEIGHT SHAPE AND DISPOSITION SMOOTHLY CHANGING FROM ONE INTO THE OTHER, AND DEVICES FOR ACCOMPLISHING SAME

The processes and devices according to the present invention can be employed most advantageously for treating parts rubbing against rubber sealing under conditions of fluid lubrication, for treating parts which should possess stable light-reflecting properties, as well as for treating parts operating under conditions of friction.

In addition, said processes and devices help restore the dimensions of worn out precision parts manufactured from scarce materials.

The processes according to the invention provide for rotary or progressive movement of the part being treated and, respectively, for progressive or rotary movement of a spring-biased sphere-shaped deforming member, so that the direction of movement of the article portion being treated be at an angle to the direction of movement of the deforming member. Simultaneously, the deforming member performs reciprocation in the direction of its progressive movement or, in the case of rotary movement, along the radius drawn from the rotation axis of said member to the point of its introduction into the article body.

The present invention relates to processes for changing the relief of the surface of a solid by way of introducing into the surface layer of said solid a hard deforming member and, more particularly, it relates to processes for forming on the surface of such articles a relief featuring projections and recesses of uniform height, shape and disposition, smoothly changing from one into the other, and to devices for accomplishing said processes. The invention makes it possible to form on the surface of articles a relief whose projections rise above adjacent recesses to a height on the order of tens of microns.

The processes and devices according to the present invention can be most advantageously employed for treating parts rubbing against rubber sealing under conditions of fluid lubrication, for treating parts which should possess stable light-reflecting properties, as well as for treating parts operating under conditions of friction.

At present, relief on the surface of solids, featuring projections and recesses which are relatively uniform in height, shape and disposition, is formed on parts designed for being held, turned or linearly displaced by the operator manually. Simultaneously, such a relief serves decorative purposes. The height of the relief projections is no less than 0.5 mm.

The relief is formed by introducing into the surface layer of an article being treated a deforming member whose hardness exceeds that of the surface layer material of the article. The deforming member is usually a roller with projections and recesses corresponding to the desired relief, and the article presenting a solid of rotation rotates relative to said roller which is forced against the article. The difficulty of manufacturing such a roller is obvious, while the problem boils down to obtaining a nice-looking rough surface featuring a uniform "pattern".

In the case of flat-shaped bodies which are not solids of rotation, the relief is formed by rolling said roller under pressure on the surface of the bodies or by planing on a planing machine, which is rather inefficient.

It is an object of the present invention to obviate the above-mentioned disadvantages of said known processes and devices.

The invention is aimed at the solution of the technical problem of developing a highly efficient process for forming on the surface of a solid a relief featuring projections and recesses uniform in height, shape and disposition and smoothly changing from one into the other, as well as a device for accomplishing said process, that provides for the use of a simple spring-biased deforming member performing such a movement which, in combination with the article movement, facilitates the formation of the relief projections and recesses by forcing out part of the material from the body into the projections.

It is no less important to obtain rounded projections and recesses, which helps to improve the quality of sealing under conditions of fluid friction of metal parts against rubber.

In the solution of these other problems of the invention, a sphere-shaped body used as the deforming member is simultaneously imparted two movements, of which one is progressive and parallel to the rotational axis of the article being treated, while the second movement is a reciprocating movement along or parallel to said first movement. The rate of the first movement should be sufficiently low so that no separate, i.e., disconnected, grooves are formed on the article surface nor any portions of the initial surface are left untreated, while the force of introducing the sphere-shaped body should be sufficiently great to effect forcing out of the material from the surface layer of the article into projections thus formed. In such a manner a relief can be formed on curvilinear surfaces of solids, for example, outer and inner surfaces of a hollow cylinder can be treated in this manner.

On the end faces of a solid of rotation, according to the invention, the relief is formed by simultaneously imparting to the deforming member two movements, the first of which, a progressive one, is normal to and crossing the rotational axis of the article being treated, while the second movement is reciprocation along or parallel to the first one.

On the surface of an article other than a solid of rotation the relief is formed by simultaneously imparting to the deforming member two movements, the first of which is a rotary movement about a stationary axis normal to the direction of the article movement, while the second movement is reciprocation along a radius drawn from said stationary axis to the point of introduction of the deforming member.

In order to accomplish the process of forming relief on the curvilinear surface of a solid of rotation, use is made of a device comprising: a holder of an article being treated, connected with a drive adapted to impart rotary movement to said holder; a base on which is secured a holder for a spring-biased sphere-shaped deforming member, said base being connected with a drive imparting to said base progressive movement along the rotational axis of the article holder; a drive for the deforming member holder, mounted on the base
and imparting to the latter holder reciprocating movement along the direction of the base movement. At the same time, the spring of the deforming member is provided with a conventional means for adjusting the degree of its compression and, consequently, the force with which the deforming member penetrates into the surface layer of the article being treated so that the material of the latter layer is forced out into projections being thus formed. A device used for forming relief on the end faces of solids of rotation differs from the aforesaid one only in that said base performs a progressive movement across the rotational axis of the article holder instead of along said axis.

An essential advantage of the process and devices according to the invention consists in that they make it possible to form a relief on a relatively great surface within an extremely short period of time and employing relatively simple means.

The present invention will be more apparent upon considering a detailed description of the process according to the invention for forming on surfaces of solids a relief featuring projections and recesses uniform in height, shape and disposition and smoothly changing from one into the other, as well as of an article treated in accordance with the process of the invention and devices for accomplishing said process, reference being had to the accompanying drawings, wherein:

FIGS. 1 to 4 are schematic diagrams of movement of the deforming member and articles, according to the present invention;

FIG. 5 in enlarged view shows a surface with a relief formed in accordance with the process of the invention;

FIGS. 6 and 7 graphically show irregularities of an article surface plotted prior to and after the treatment, according to the invention, respectively;

FIG. 8 is a diagrammatic view of a device for accomplishing the process illustrated in FIG. 1;

FIG. 9 is a diagrammatic view of a device for accomplishing the process illustrated in FIG. 2; and

FIG. 10 is a diagrammatic view of a device for accomplishing the process illustrated in FIG. 3.

The present invention provides for the use of a sphere-shaped deforming member 1 (FIG. 1) which is essentially a hardened steel ball or a sphere-shaped diamond sealed in a steel rod. The deforming member 1 is pressed, with a sufficiently great force, by means of a spring (not shown in the drawings) to the outer curvilinear surface of an article 2, the latter being essentially a solid of rotation and illustrated as comprising a cylinder. The article is imparted rotary motion about its longitudinal axis A—A in the direction of arrow B, and the deforming member together with its spring is imparted progressive motion parallel to the A—A axis, as is shown by arrow S. Simultaneously, the deforming member is imparted reciprocation, as shown by arrows N, directed along the direction of said progressive motion.

As a result of these movements, the deforming member 1 describes a sine curve arranged along a spiral. In order that no separate or disconnected grooves be formed in the surface layer and that the article material be forced out into projections of uniform height, shape and disposition, it is necessary that the rate of the progressive movement of the deforming member in the direction of arrow S be sufficiently low. This requires the observance of the condition

\[ 0 < S < \frac{\pi}{2} \left( \frac{d}{h} \right), \]

where \( S \) is the feed in the direction of arrow S, mm per revolution;

\( \xi \) is defined as \( \sqrt{d/h} \), where \( d \) is the diameter of the deforming member, in mm, and \( h \) is the depth to which said member is introduced into the surface layer of an article, in mm;

\( \rho \) is the amplitude of the reciprocating movement of the deforming member along arrows N, in mm;

\( i \) is defined as \( N/n \), where \( N \) is the number of the deforming member double strokes per minute along arrows N, and \( n \) is the article r.p.m.

For forming a relief on the inner curvilinear surface of a hollow article 3 (FIG. 2), the latter article and the deforming member 1 are imparted the same movements as those performed by the article 2 and the deforming member 1 when accomplishing the process illustrated in FIG. 1.

The relief on a flat end face surface of the article 2 (FIG. 3) is formed by imparting to the article 2 rotation about its longitudinal axis A—A, whereas the deforming member 1 is imparted progressive movement across the article rotational axis A—A, as shown by arrow S, as well as reciprocating movement in the directions of arrows N along said progressive movement.

On the flat surface of an article 4 (FIG. 4), which is not a solid of rotation, relief is formed by imparting to the article a progressive movement along arrow S and to the deforming member 1 a rotary movement about stationary axis p—p' normal to the progressive movement of the article 4. Concurrently with the rotary motion, the deforming member 1 is imparted reciprocating movement along radius r drawn from the p—p' axis to the point of introduction of the deforming member 1 into the surface layer of the article 4, as is shown by arrows N.

As a result of accomplishing the processes illustrated in FIGS. 1 to 4, on the article surface there is formed a relief (FIG. 5) featuring recesses of uniform height, shape and disposition, smoothly changing from one into the other.

Irregularities (FIG. 6) on the initial surface of an article are turned into a relief having a regular sine-shaped cross-section, as is shown in FIG. 7.

In order to accomplish the process illustrated in FIG. 1, use is made of a device comprising a conventional holder 5 (FIG. 8) for the deforming member 1, made as a bent or L-shaped bar. The bar is mounted with the aid of a pin 6 in a sleeve 7 connected by means of a bolt 8 and nut 9 with a link 10. The link 10 is mounted on an eccentric 11 with the aid of a bearing 12. The eccentric 11 is rotated by an electric motor 12 mounted on a base 14.

Secured on the same base is a guide member 15 in which the sleeve 7 is guided for reciprocation in the directions of arrows N. Concurrently with the latter movement, the base 14 is imparted progressive movement in the direction of arrow S with the aid of a further drive (not shown in the drawings). On its free end the holder 5 is provided with
a node in the form of a head 16 wherein, on a pin 17, is mounted a bearing 18. On its outside the head is provided with a thread on which is screwed a cover 19 having a tapered opening 20. The latter opening houses the spherical deforming member 1. Since the minimum diameter of the opening 20 is less than the diameter of the deforming member 1, the latter is retained by the cover 19 and does not fall out in operation. The distance between the bearing 18 and cover 19 is selected such that the ball should not be jammed. Thereupon, the cover is locked in place by means of a lock nut 21.

In the wall of the sleeve 7, on the side opposite to that on which the head 16 is positioned, provision is made of a threaded opening in which a chuck 22 is screwed. The chuck 22 houses a spring 23 bearing at one end against the chuck movable bottom 24 fashioned as a threaded plug screwed into the lower portion of the chuck, which is threaded on the inside. At its other end the spring 23 is thrust against a pin 25 which, in its turn, is thrust against a recess 26 made in the holder 5. The article 2 is held between clamps or centers 27, of which one is driven about the A—A axis in the direction of arrow B by means of a drive (not shown in the drawings). The article 2 and the second clamp 27 thereby also rotate.

In order to keep the sleeve 7 from turning in the guide member 15, the latter is provided with a threaded opening adapted to receive a screw 28 locked in place by means of a lock nut 29. The screw 28 is accommodated by a port 30 provided in the sleeve 7.

For accomplishing the process illustrated in FIG. 2, use is made of a device differing from the afore-described one in that the holder 5a (FIG. 9) is made as a rectilinear bar, while the head 16a is a separate part screwed in a threaded opening provided in the holder 5a. This helps draw the deforming member closer to the longitudinal axis of the holder and, consequently, makes for the possibility of treating relatively small hollow parts.

Clamps 31 and 32 are essentially rings coupled with the aid of bolts 33 and nuts 34.

In order to form a relief on the end faces of solids of rotation in accordance with the process illustrated in FIG. 3, provision is made of a device differing from the one shown in FIG. 8 in that the base 14 (FIG. 10) is turned through 90° with respect to the article rotational axis A—A and moves across said axis. A holder 35 for the article 2 is essentially a chuck similar to that generally used in turning lathes.

In the devices shown in FIGS. 8 to 10, the movable bottom 24 of the chuck 22 is designed for varying the force with which the deforming member 1 penetrates the surface layer of the article being treated.

Relief formed in accordance with the present invention on steel parts interacting with rubber sealing under conditions of fluid lubrication helps considerably improve the quality of sealing and prolong its service life. In addition, the processes and devices of the present invention make for restoring the dimensions of worn out precision parts manufactured from scarce materials, as well as for forming surfaces possessing desired light-reflecting properties.

I claim:

1. A process for forming on the curvilinear surface of an article being essentially a solid of rotation a relief featuring projections and recesses of uniform height, shape and disposition, smoothly changing from one into the other, said process comprising the steps of introducing into the surface layer of a rotatable article being treated a spring-biased sphere-shaped deforming member, simultaneously imparting two movements to the deforming member, of which one is progressive and parallel to the rotation axis of said article being treated, while the second movement is reciprocation along said first movement; at the same time, controlling the rate of said first movement to be sufficiently low so that no separate grooves are formed on the surface of said article nor any portions of the initial surface are left untreated, while the force of introducing said sphere-shaped member is controlled to be sufficiently great to effect forcing out the material from the surface layer of said article into the projections being thus formed.

2. A process for forming on the end face of an article being essentially a solid of rotation a relief featuring projections and recesses of uniform height, shape and disposition, smoothly changing from one into the other, said process comprising the steps of introducing in the end face of a rotatable article being treated a spring-biased sphere-shaped deforming member, imparting simultaneously two movements to the deforming member, the first of which is a progressive movement normal to and crossing the rotation axis of said article being treated, while the second movement is reciprocation along said first movement; at the same time, controlling the rate of said first movement to be sufficiently low so that no separate grooves are formed on the surface of said article nor any portions of the initial surface are left untreated, while the force of introducing said deforming member is controlled to be sufficiently great to effect forcing out the material from the surface layer of said article into the projections being thus formed.

3. A process for forming on the surface of a solid article of arbitrary shape a relief featuring projections and recesses of uniform height, shape and disposition, smoothly changing from one into the other, said process comprising the steps of introducing into the surface layer of a progressively displaceable article being treated a sphere-shaped deforming member, simultaneously imparting two movements to the deforming member, the first of which is a rotary movement about a stationary axis normal to the direction of movement of said article, while the second movement is reciprocation along a radius drawn from said stationary axis to the point of introduction of said deforming member into said surface layer of said article.

4. A device for forming on the curvilinear surface of an article being essentially a solid of rotation a relief featuring projections and recesses of uniform height, shape and disposition, smoothly changing from one into the other, by way of introducing into the surface layer of a rotatable article being treated a spring-biased sphere-shaped deforming member, said device comprising: a holder of said article being treated, connected with a drive adapted to impart rotary movement to said holder; a base on which is secured a holder of said spring-biased sphere-shaped deforming member, said base being connected with a drive serving to im-
part thereto a progressive movement along the rotation axis of said holder of said article; a drive of said holder of said deforming member, mounted on said base and serving to impart to the latter holder a reciprocating movement along the direction of movement of said base; the spring of said deforming member being provided with a conventional means adapted to adjust the degree of its compression and, consequently, the force with which said deforming member penetrates the surface layer of said article being controlled so that the material of the latter layer be forced out into the projections being thus formed.

5. A device for forming on the end face of an article being essentially a solid of rotation a relief featuring projections and recesses of uniform height, shape and disposition, smoothly changing from one into the other, by way of introducing in the end face of a rotatable article being treated a spring-biased sphere-shaped deforming member, said device comprising: a holder of said article being treated, connected with a drive adapted to impart rotary movement to said holder; a base on which is secured a holder of said spring-biased sphere-shaped deforming member, said base being connected with a drive serving to impart thereto a progressive movement across the rotation axis of said holder of said article; a drive of said holder of said deforming member, mounted on said base and serving to impart to the latter holder a reciprocating movement along the direction of movement of said base; the spring of said deforming member being provided with a conventional means adapted to adjust the degree of its compression and, consequently, the force with which said deforming member penetrates the surface layer of said article being treated so that the material of the latter layer be forced out into the projections being thus formed.

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