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**METHOD OF REMOVING PORTIONS OF COATING
BY GLOW DISCHARGE**

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5 Claims

ABSTRACT OF THE DISCLOSURE

Lubricating oil is reliably confined to a workpiece portion by means of a barrier consisting of an oil repelling layer coated on the workpiece around said portion thereof. Firstly, the whole workpiece is coated with the oil repelling layer. This layer is then removed from said portion by exposing the latter at a place where it will be hit by an electrical discharge which crosses the gap between two electrodes with a substantially constant intensity and without sparking.

BACKGROUND OF THE INVENTION**(1) Field of the invention**

This invention relates to antifrictional surface treatments for workpieces having some predetermined portion of their surface which is intended to be submitted to frictional engagements and has to be lubricated for that purpose. The invention relates more particularly to the methods of treating such workpieces in order that lubricating oil is reliably confined to the workpiece portion which has to remain lubricated and whereby an oil repelling barrier is formed on the workpiece around said portion.

(2) Description of the prior art

The workpieces having only some predetermined portion of their surface which is to be lubricated and with which oil has the tendency to spread over the whole surface of the workpiece are usually submitted to surface treatments adapted for preventing oil from spreading. The best treatments of that type, which are known in the art, consist of coating the workpieces with a very thin adsorbed oil repelling layer. Such an adsorbed layer has namely the advantage to remain intact even under the action of strong chemical agents such as for instance chromic acid or tetrachlorethylene as used for cleaning the workpieces.

When workpieces having been treated in that way are lubricated with oil, the lubricant remains collected in a drop on the surface of the workpiece, even after a long period of time. The workpieces submitted to these known surface treatments have, however, quite generally the drawback that there is almost no adhesion between the oil drops and the workpiece surface. The lubricant may thus likely leave the coated workpiece surface, for instance if the workpiece is submitted to an impact or even to a strong acceleration.

Some known surface treatments permit to avoid this drawback. According to these known treatments the oil

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repelling layer is not set over the whole workpiece surface, but only around the portion thereof, which is to be lubricated. In this case, the oil repelling layer constitutes a barrier around said portion of the workpiece surface and this barrier prevents the lubricant from spreading beyond the boundaries of the surface portion which is surrounded by the oil repelling layer.

Forming an oil repelling layer only over some portion of the surface of a workpiece, however, places the manufacturer before a problem, the known solutions of which do not fulfill all the usual requirements of a rationalized manufacture.

SUMMARY OF THE INVENTION

In order to remove the oil repelling layer previously coated on the whole workpiece surface from the exact portion thereof which shall remain lubricated, the antifrictional surface treatment according to the invention comprises the step of exposing said portion of the workpiece at a place where it will be hit by an electrical discharge which crosses the gap between two electrodes with a substantially constant intensity and without sparking.

**DESCRIPTION OF THE PREFERRED
EMBODIMENTS**

Two cases have to be considered when carrying out the method according to the invention. The workpieces to be treated are either electrically conductive such as pieces of steel, brass, etc., or electrically nonconductive such as jewels of corundum.

If the workpiece to be treated by the method according to the invention is electrically conductive, it may constitute one of the two electrodes between which one produces the electrical discharge intended for removing the oil repelling layer from the workpiece portion which is to be lubricated.

In order to prevent particles of the workpiece from being torn away and the mechanical smoothness of the workpiece surface from being destroyed or even the sizes of the workpiece from being altered, the electrical discharge used for treating the workpieces according to the invention must of course be absolutely free of sparkles. This result will be obtained if the circuit comprising the electrodes has an extremely small capacity. An electrical discharge can easily be produced without sparking between two electrodes by connecting a high resistor to the circuit of the electrodes in the immediate vicinity of at least one of them. The shape and the sizes of the space crossed by the electrical discharge, which is something like a glow discharge, can be modified within broad limits by modifying the shape of the electrodes, the distance between them and the bias thereof. The resistor, which is connected to the circuit of the electrodes, in the vicinity of at least one of them, is then increased until the discharge between the electrodes is free of sparkles.

In the case of an electrically conductive workpiece constituting one electrode, the other electrode can be made with such a shape and located at such a place relative to the workpiece that the electrical discharge will exactly hit that portion of the workpiece surface which is to be lubricated.

An electrical discharge of the type indicated above has the property of destroying almost instantaneously the oil repelling layer with which the workpiece surface were

previously coated. Whichever may be the nature of the oil repelling layer and even if it consists of a strongly bound adsorbed coating, this layer is destroyed almost instantaneously on the workpiece portion which has been hit by the glow discharge. The workpieces to be treated can thus be placed on appropriate conveying means which cause them to travel one after the other either at constant speed or stepwise through a path which is adjusted in such manner relative to the fixed electrode or electrodes that the portion of these workpieces which is to be lubricated will move opposite said electrodes and cause thereby the electrical discharge to take place under such conditions that the right workpiece portion will be hit by that discharge. The workpieces can be moved at a constant speed by their conveying means even if they operate as electrodes, because the glow discharge instantaneously takes place between the fixed electrode and a workpiece as soon as this workpiece moves opposite the fixed electrode.

If the workpieces to be treated are electrically nonconductive, a permanent glow discharge of constant intensity is produced without sparking between two independent electrodes and the workpieces are then conveyed one after the other opposite these two electrodes so that their portion on which the oil repelling layer must be destroyed moves through the space crossed by said discharge.

If the oil repelling layer has to be destroyed on the wall of a bore of an electrically nonconductive workpiece, such as for instance of a jewel pivot bearing for a watch or a measuring instrument, two electrodes are provided on a common axis so that they can be reciprocated along that axis. The workpieces are then conveyed stepwise and one after the other between these electrodes. As long as the workpieces are moved by their conveying means, the electrodes are kept away from each other and there is no electrical discharge between them. When a workpiece lies between the electrodes so that its bore is coaxial thereto and is stopped in that position, the electrodes are moved toward each other until each one stands in the vicinity of one end of the workpiece bore and the glow discharge takes place. According to the sizes of the electrodes relative to the diameter of the workpiece bore, the oil repelling layer can be destroyed either only on the wall of the bore, or in addition thereto, on both sides of the workpiece, in more or less broad circular areas concentric to said bore.

If the workpiece surface portion which is to be lubricated extends on two workpiece facets separated from each other by an edge, as for instance with the resting face and the impulse face on the pallets of an escapement lever for watches, it can be observed, in particular if said edge is sharp, that the barrier constituted by the oil repelling layer does not prevent the lubricant from leaving the workpiece portion on which it should remain. According to the operation of the workpiece, the whole lubricant can indeed be brought mechanically from one of said workpiece facets onto the other one. With an escapement lever, the oil is brought by the teeth of the escape wheel from the resting faces of the lever pallets onto the impulse faces thereof. In such event, it can be observed that a sharp edge between said facets constitutes an even stronger oil barrier than the oil repelling layer. If the lubricant amount thus brought onto said second facet is larger than the capacity thereof, it can be observed that the lubricant forces the barrier which is constituted by the oil repelling layer and not that which is constituted by the sharp edge. As a consequence thereof, the lubricant does not flow back onto said first facet, but it spreads over workpiece portions where it is useless.

In order to remove this drawback, the edge between the two workpiece facets which are to be lubricated need only be machined so as to form a surface of transition between these two facets. A surface of transition having a very small radius of curvature is already proper. Tests have shown that a surface of transition having a radius comprised between .015 and .10 mm. already enables the

lubricant, which had been mechanically brought onto one of said two facets, to flow automatically back over the edge onto the first facet so as to uniformly cover the whole workpiece surface portion surrounded by the oil repelling layer. A surface of transition having a radius of curvature comprised between the above-mentioned limits does no longer oppose any resistance to the lubricant so that the same can freely flow within the barrier constituted by the oil repelling layer, as if this barrier would extend onto one and the same facet of the workpiece.

In order to machine said surface of transition between said two workpiece facets, any mechanical method known to those skilled in the art can be resorted to. In rounding up the edge between said two facets, care shall, however, be taken in order to avoid forming new sharp edges between the original edge which is going to be rounded up and either one of the two facets between which it extends, because said new sharp edges would of course constitute barrier preventing the lubricant being on one workpiece facet from freely flowing over the other facet. In other words, the rounded edge constituting the surface of transition must be tangent to either one of said two facets of the workpiece.

Moreover, the smoothness of the surface of the rounded edge must of course be the same as that of said two workpiece facets.

The small sizes of the surface of transition, which has to be provided between said two facets of the workpiece in order to ensure a free spreading of the lubricant over these two facets, permit the surface treatment according to the invention to be used even with workpieces, the operation of which requires a very precise shape, because said surface of transition does not modify the shape of the workpiece beyond an amount which is compatible with the operation, i.e. beyond the usual tolerances.

The surface of transition between said two workpiece facets is preferably formed before coating the workpiece with the oil repelling layer. After having carried out the required machining operation for forming the surface of transition, the workpiece can be handled as a workpiece having no edge extending across or within its portion to be lubricated. Said workpiece can thus be coated over its whole surface with the oil repelling layer and then be moved opposite either one electrode, if it is electrically conductive and may constitute the other electrode, or between two electrodes, if it is electrically nonconductive.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The embodiments described above are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed is:

1. In a method of treating a workpiece having at least one predetermined portion of its surface which is intended to be submitted to frictional engagements and to be lubricated for that purpose, the steps of coating the whole surface of the workpiece with an oil repelling layer and then removing said oil repelling layer from said predetermined portion by exposing said predetermined portion at a place where it is hit by an electrical discharge which crosses the gap between two electrodes with a substantially constant intensity and without sparking.

2. In the method of claim 1 for treating the surface of an electrically conductive workpiece, the step of producing said electrical discharge between an electrode independent of the workpiece and the portion of said workpiece which is to be lubricated.

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3. In the method of claim 1 for treating the surface of a workpiece having a portion to be lubricated which extends on two workpiece facets separated from each other by an edge, the step of machining said edge so as to form a surface of transition between said two facets.

4. In the method of claim 3, the step of machining said edge so as to form a surface of transition having a radius of curvature ranging at least between .015 and .10 mm.

5. In the method of claim 3, machining said edge before coating the workpiece with said oil repelling layer.

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