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METHOD OF REMOVING MATERIAL FROM THE SURFACE OF BODIES
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Fig. 1

Fig. 2

Fig. 3

Fig. 4

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METHOD OF REMOVING MATERIAL FROM THE SURFACE OF BODIES

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The present invention relates to a method of removing material from the surfaces of bodies, by way of example of metal bodies, particularly for the purpose of producing incised lettering and drawings in such surfaces.

A large number of processes of incising lettering in 15 surfaces of bodies are known, either by engraving or impressing. These processes have proved generally satisfactory unless miniature lettering was required, by way of example to mark metal parts employed in the watch and instrument industry. For such miniature lettering, engraving of the letters by means of a so-called pantograph are much too time-consuming. The present invention, since the lines of the miniature lettering must be engraved consecutively, impressing eliminates this disadvantage since the complete lettering is impressed in the surface in question by means of a correspondingly designed press die in a single operation. But since a certain quantity of material must naturally be displaced in impressing, undesirable raised edges are formed along the letters and mechanical stresses are built up within the body to be processed, which may result in distortions and compressions highly undesirable in high-precision parts.

The said disadvantages of such mechanical processes may be eliminated by etching the miniature lettering chemically. However, the time required is again considerable for incising the said lettering to a depth of e.g. 0.1 mm. Furthermore, masking the surface areas not required to be etched involves not inconsiderable difficulties.

At any rate, no process of incising such miniature lettering has so far become known which requires only one operation as impressing and only a few seconds while straining the material so little that no mechanical stresses and no marked raising of the edges may occur. This is the case also for purposes other than incising lettering and drawings during which material is removed from the surface of bodies.

The present invention has for its object to provide such a method of removing material from the surface of bodies and is characterized by the fact that the entire material is removed in a single, brief operation by placing the body on a rigid support and securing it against horizontal displacement by lateral stops while leaving it free to perform vertical rising movements, that a flat die with rib-type projections on the operative face are forced against the surface of the body, caused to vibrate substantially normal to the said surface so that the body is encouraged to follow the vibrations, the vibration frequency being such as to cause material to be removed from the surface by a cutting action.

This method is applied, according to the present invention, for incising lettering in watch and instrument parts without causing distortion. A number of embodiments of the invention are described in greater detail in conjunction with the attached drawing, in which

FIG. 1 is a diagrammatic front elevational view of an arrangement for incising miniature lettering in a watch part;

FIG. 2 is a diagrammatic top plan view partly in section of the arrangement taken along the line II—II of FIG. 1;

FIG. 3 is a diagrammatic view of such lettering, and

FIG. 4 is a fragmentary section along line IV—IV of the die according to FIG. 1.

FIGS. 1 and 2 show an embodiment of an arrangement for the performance of the present method in its application to a watch part in the surface of which the miniature lettering "17 jewels" shown in FIG. 3 is to be incised. The watch part 10 is shown diagrammatically at an enlarged scale and its longitudinal dimension in actual fact is only about 10 mm. Accordingly, the lettering according to FIG. 3 has a length of only about 4 mm. and a height of .4 mm.

The watch part 10 rests on the rigid support 11, by way of example on a steel plate, and is secured against displacement along the support 11 by means of the three stops 12, 13 and 14. It is important that the watch part 10 can perform vertical lifting movements. If the part 10 is so compact that the surface area is incapable of performing bending vibrations itself, the part 10 must not be firmly clamped between the three stops 12, 13 and 14. A certain amount of play for the performance of vibrations at least normally to the support 11 must be provided. Accordingly, the stops 12, 13 and 14 are arranged at a distance a which is exaggerated in FIGS. 1 and 2 for the sake of clarity. A lateral play of .01 to .05 mm. between the stops 12, 13 and 14 has proved advantageous for a rigid watch part 10. On the other hand, if the watch part 10 is thin enough for the area to be processed by the die 15, 16 to perform elastic vertical vibrations, a may equal 0 and the part 10 may be clamped between the stops.

Forced against the surface of the watch part 10 is the die 15 with the die plate 16 which bears the raised lettering 17 in mirror writing, according to the lettering in FIG. 3. The die plate 16 is rigidly attached to the die 15, such as by hard soldering, and it is preferably formed of hardened steel. As the die plate 16 is subject to a certain amount of wear, comparatively simple interchangeability should be provided for. In section along line IV—IV in FIG. 1 the die plate 16 shows in the form illustrated in FIG. 4 with the ribs 17 of the raised lettering. These ribs 17 are preferably of triangular cross-section with an apex angle of between 40° and 90° if the surface to be processed is formed of brass. Slightly different apex angles but, nevertheless, smaller than 120° may be more advantageous for other materials.

The die 15 which should preferably be designed so as to be coolable, is caused to vibrate in the direction of arrow 18, advantageously within the ultrasonic frequency range. By way of example with lettering according to FIG. 3 of a length of 4 mm. and a height of .4 mm. by means of ultrasonic vibrations of 23.50 kilocycles per second with an acoustic power of about 3 watts, the lettering was incised to a depth of .1 to .2 mm. within 2 or 3 seconds.
3. During incision, the relatively light watch part 10 is caused to perform vertical vibrations. At any rate it has been shown that the above-mentioned lateral play is of importance with such a compact and rigid part 10 and that perfect incision of the lettering is impossible if the inelastic watch part 10 is clamped between the stops 12, 13 and 14. Closer examination of the incised lettering reveals that a cutting process occurs. Owing to this cutting incision no very high pressure need be applied for the groove formation so that no undesirable stresses occur in the machined watch part 10, i.e. that distortion or compression need not be anticipated.

Incision may be performed at lower frequencies in the sonic and ultrasonic range, but the frequency of vibration must be sufficiently high for the material to be removed by cutting. It may further be advantageous to improve the cutting operation of the ribs 17 during incision by means of a liquid jet (e.g. soluble oil). If desired, diamond dust or other boring dust may be emulsified in such a liquid jet. The individual steps 12, 13 and 14 may be replaced by a stop rim fully enclosing the watch part 10 in order to prevent the latter from being laterally displaced, or it may be held in a recess formed in the steel plate 11. In any case, however, a rigid part must not be clamped tightly but allowed a lateral play of about .01 mm., while an elastically vibrating part may be laterally clamped.

Apart from the incision of lettering, the present method may be employed for any other surface treatment in which a certain quantity of material, which is naturally relatively small, must be removed. By way of example, a herringbone or other line pattern may be produced on one or two sides without any loss of time. In particular cases, a mould may be provided in the rigid support with raised ribs while the part is caused to vibrate vertically by a flat vibrating plunger, the material being then removed from the underside of the part in question.

The removal of small quantities of material from the surface of a body without distortion and stress according to the present method may also be employed for de-burring. By way of example, the raised edges produced in drilling or stamping holes in metal disks may be removed by a die with file-type ribs that causes ultrasonic vibrations, which is pressed on the bore and slowly moved across the metal disk in a direction normal to the ribs.

Having now particularly described and ascertained the nature of our invention and in what manner the same is to be performed, we declare that what we claim is:

1. The method of removing chip material from a surface portion of a hard and rigid body comprising the steps of holding the body with at least said surface portion oscillatable in a direction perpendicular to said surface portion; bringing a tool edge having the outline of the material to be removed into abutting relationship with said surface portion of said body; and while in said abutting relationship producing ultrasonic vibrations passing in said direction through said tool edge and said body to excite said body to oscillate so that chip material is removed from said surface portion by said tool edge exactly matching the outline of said tool edge.

2. The method of removing chip material from a surface portion of a hard and rigid body comprising the steps of holding parts of said body spaced from the portion having said surface portion so that said surface portion is oscillatable in a direction perpendicular to said surface portion; bringing a tool edge having the outline of the material to be removed into abutting relationship with said surface portion of said body; and while in said abutting relationship producing ultrasonic vibrations passing in said direction through said tool edge and said body to excite said body to oscillate so that chip material is removed from said surface portion by said tool edge exactly matching the outline of said tool edge.

3. The method of removing chip material from a surface portion of a hard and rigid body comprising the steps of holding the outer edges of said body against movement in the plane of said surface portion and oscillatable with said surface portion in a direction perpendicular to said surface portion; bringing a tool edge having the outline of said surface portion to be removed into abutting relationship with said surface portion of said body; and while in said abutting relationship producing ultrasonic vibrations passing in said direction through said tool edge and said body to excite said body to oscillate so that chip material is removed from said surface portion by said tool edge exactly matching the outline of said tool edge.

4. The method of removing chip material from a surface portion of a hard and rigid body comprising the steps of holding the body with at least said surface portion oscillatable in a direction perpendicular to said surface portion; bringing a tool edge having the outline of the material to be removed into abutting relationship with said surface portion of said body; and while in said abutting relationship producing ultrasonic vibrations passing in said direction through said tool edge and said body to excite said body to oscillate so that chip material is removed from said surface portion by said tool edge exactly matching the outline of said tool edge.

5. The method of removing chip material from a surface portion of a hard and rigid body comprising the steps of holding the body with at least said surface portion oscillatable in a direction perpendicular to said surface portion; bringing a tool edge having the outline of the material to be removed into abutting relationship with said surface portion of said body; and while in said abutting relationship producing ultrasonic vibrations having a frequency between 10 kilohertz and 100 kilohertz and passing in said direction through said tool edge and said body to excite said body to oscillate so that chip material is removed from said surface portion by said tool edge exactly matching the outline of said tool edge.

6. The method of incising a marking in a surface portion of a hard and rigid body comprising the steps of holding the body with at least said surface portion oscillatable in a direction perpendicular to said surface portion; bringing a tool edge having the outline of the marking and being harder than said material at such low pressure into abutting relationship with said surface portion of said body that said body is not deformed; and while in said abutting relationship producing ultrasonic vibrations passing in said direction through said tool edge and said body to excite said body to oscillate so that chip material is removed from said surface portion by said tool edge and a marking is incised exactly matching the outline of said tool edge.

7. The method of removing chip material forming a burr from a surface portion of a hard and rigid body comprising the steps of holding the body with at least said surface portion oscillatable in a direction perpendicular to said surface portion; bringing a tool edge having the outline of the burr to be removed and being harder than said material at such low pressure into abutting relationship with said surface portion of said body that said body is not deformed; and while in said abutting relationship producing ultrasonic vibrations passing in said direction through said tool edge and said body to excite said body to oscillate so that chip material forming said burr is removed from said surface portion by said tool edge exactly matching the outline of said tool edge.

8. Apparatus for removing small amounts of chip material from a surface portion of a hard and rigid body, comprising, in combination, a rigid support plate for the body; a plurality of spaced holding means mounted on said support plate for holding the body.
with at least the portion thereof having said surface portion oscillatable in a direction perpendicular to said support plate and said surface portion; a tool having a tool edge confronting said support plate and adapted to be placed and held in abutting relationship with said surface portion; and means for producing ultrasonic vibration in said tool edge and in said portion of said body for vibrating said tool edge and surface portion to excite said body to oscillate in said direction whereby chip material having the outline of said tool edge is removed from said surface portion.

9. Apparatus as set forth in claim 8, wherein said tool has a ridge having a triangular cross section, said tool edge extending along the apex of said triangular cross section, and the apex angle of said cross section being smaller than 120°.

10. Apparatus as set forth in claim 8, wherein said tool has a ridge having a triangular cross section, said tool edge extending along the apex of said triangular cross section, and the apex angle of said cross section being between 40° and 90°.

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