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Description

The present invention relates to a method for cooling and machining a wire and a draw-peeling apparatus for machining the wire.

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Thin wires with high surface quality are produced in draw-peeling apparatus. Thereby, the starting material that may have surface defects and geometrical deviations can first be drawn by means of a drawing disc through one or several dies. Hereby, the starting material is plastically deformed and has a smaller diameter after drawing through the die than before the die. To improve the surface quality, the wire is pulled through a peeling die, whereby the outermost layer of the wire is removed by machining.

The cutting forces occurring during peeling briefly generate such a high frictional heat that can lead to an undesirable microstructural change on the wire surface. Frictional martensite can form on the wire surface, in particular. The frictional martensite is not plastically deformable due to its hardness; as such further wire drawing operations are not possible.

The state of the art is cooling the wire and the peeling die with water. However, the cooling capacity of water is not sufficient to prevent frictional martensite formation. The reason is that the cooling water does not reach critical points. Critical points are the point of contact between peeling die and the wire and the area of the cutting clearance angle of the peeling die in the pulling direction behind the point of contact between the peeling die and wire, which is also called free-cutting area.

It is therefore known that frictional martensite is completely removed after peeling, by means of targeted heat treatment, by the so-called solution annealing. This solution annealing is an additional, complex operation with high-energy consumption.

The generic DE 23 34 041 relates to a method and apparatus for the surface finish of wires, thus the draw peeling and drawing of wires. The purpose of this document is to allow the removal of undesired surface defects on wires, while improving their physical and mechanical properties. Furthermore, the stability and uniformity of the peeling process and the surface quality should be improved with close tolerances. According to DE 23 34 041, the wire is heated to a temperature above 120°C prior to machining.

In JP S62 236618A a device for peeling a wire is disclosed, in which cooling of the wire can take place.

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Based on this, the present invention has the object, at least to partially solve the problems described with reference to the state of the art and in particular to provide a method and an apparatus that make subsequent heat treatment unnecessary. These tasks are solved with a method and a draw-peeling apparatus according to the features of the independent claims. Further advantageous embodiments of the invention are specified in the respectively formulated dependent claims.

By free-cutting area one means the area of the blade-free angle of the at least one first machining element in the drawing direction behind the point of contact between peeling die and wire.

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The method is therefore particularly suitable for operating a draw-peeling apparatus for producing thin wires with high surface quality. The wire produced in the process is free of cracks, defects and frictional martensite and has a blank surface. By using cold gases for cooling, the draw-peeling apparatus and the wire are not contaminated. The gas can be removed by means of a suction apparatus.

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The wire is usually conveyed through the draw-peeling apparatus by means of a drawing disc. The first machining element is in particular a peeling die, on which the uppermost layer of the wire is peeled off. The cooling gas is preferably fed into the draw-peeling apparatus with lines and exits through one or several nozzles that are directed towards the wire surface and/or the first machining element. In particular, the nozzle is directed into the free-cutting area between the wire surface and the first machining element.

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The cooling gas is preferably a cryogenic liquefied gas under pressure, which, upon exiting the nozzle, possibly changes the state of aggregation. Thus, it is achieved that gaseous, liquid and/or solid cooling gas passes under pressure and high exit velocity deep into the area of the contact point between the first machining element and wire. By using a cooling gas having a temperature of preferably below 0°C, in particular below -50°C or even -75°C, a short-term increase in the surface temperature of the wire over the critical martensite formation temperature is avoided. The wire is thus plastically deformable without subsequent heat treatment in further drawing operations. Costly and energy intensive subsequent heat treatment can be dispensed with. The wire surface thus produced can be described as bright and clean. Oxides produced by a heat treatment on the surface do not occur. The next step can be performed without descaling and/or pickling the surface.

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To rejuvenate the wire before peeling, it is proposed in a further development of the invention that the wire be routed through at least one further machining element, in particular a die for plastic deformation of the wire in the direction of the wire in front of the first machining element within and/or outside the raw-peeling apparatus. In the arrangement of said further machining element in which the wire is cooled by the cooling gas during passage through the further machining element or the further machining element.

In order to taper the wire after peeling, it is proposed according to the invention that the wire is guided through at least one second machining element for plastic deformation, in particular a die, of the wire in the direction of the wire after the first machining within the draw-peeling apparatus. In this arrangement of the second machining element within the draw-peeling apparatus, in the tapering process of the wire, the wire and/or the second machining element can be cooled with the cooling gas.

Furthermore, it is proposed that also the second machining element is acted upon by a cooling gas.

In order to obtain efficient cooling of the wire and/or the first peeling die, it is proposed that the nozzle for applying cooling gas to the contact point and/or the free-cutting area between the wire and machining element is directed against the wire running direction.

Advantageously, the cooling gas comprises at least one element of the following group when it comes into contact with the wire and/or the first machining element:

- solid carbon dioxide (CO₂ snow),
- liquid nitrogen (N₂),
- gaseous carbon dioxide (CO₂) at a temperature below -10°C,
- gaseous nitrogen at a temperature below - 50°C

According to a further aspect of the invention, a draw-peeling apparatus for machining the wire according to claim 5 is proposed.

The details and advantages disclosed for the method according to the invention can be transferred and applied to the apparatus according to the invention and vice versa.

The invention and the technical surrounding will be explained by way of example with reference to the figure. It should be noted that the figure shows a particularly preferred embodiment of the invention, but it is not limited thereto. Schematically shown are:

Fig. 1: an embodiment of an unloaded draw-peeling apparatus,

Fig. 2: another embodiment of an unloaded draw-peeling apparatus.

5 Figure 1 shows a cross-section of a draw-peeling apparatus. The draw-peeling apparatus 1 comprises a peeling die 3 as a first machining element, as well as a drawing disc 9. Furthermore, the draw-peeling apparatus 1 comprises a feed 4 with a line 7 and a nozzle 8 for supplying a cooling gas.

10 In operation, a wire 2 is pulled in the wire running direction 6 from the drawing disc 9 through the draw-peeling apparatus 1. Thereby, the wire 2 passes through the peeling die 3 where the uppermost layer of the wire 2 is peeled off by machining. This improves the quality of the surface of the wire 2. A cooling gas is introduced through the line 7 and the nozzle 8 in the free-cutting area 10 between the wire 2 and the peeling die 3. The cooling gas in particular is liquid carbon dioxide, which changes its state of aggregation upon exiting the nozzle 8 and impinges on the wire 2 and the peeling die 3 as
15 carbon dioxide snow or carbon dioxide gas or as liquid nitrogen in liquid or gaseous form, reaches in the narrow gap, the free-cutting area 10, between the wire 2 and the peeling die 3.

By using cooling gas, the wire 2 and the first peeling die 3 are cooled so much that temperature increase of the surface of the wire during peeling does not take place to temperature above a critical
20 martensite formation temperature. Therefore, a cost and energy intensive, downstream heat treatment can be dispensed with.

Figure 2 schematically depicts a further embodiment of a draw-peeling apparatus, in cross-section. The draw-peeling apparatus 1 comprises a die 5 as another machining element and a peeling die 3 as a
25 first machining element, as well as a drawing disc 9.

Furthermore, the draw-peeling apparatus 1 comprises two feeds 4 with a line 7 and a nozzle 8 for supplying a cooling gas.

30 In operation, a wire 2 is pulled in the wire running direction 6 from the drawing disc 9 through the draw-peeling apparatus 1. Thereby, the wire 2 first passes through the die 5, whereby the wire 2 is plastically deformed and its cross section is tapered. Finally, the wire 2 passes through the peeling die 3 where the uppermost layer of the wire 2 is peeled off by machining. For further explanations, reference is made to the comments on Figure 1.

Patentkrav

1. Fremgangsmåde til køling og bearbejdning af en tråd (2) med en trådoverflade, omfattende mindst de følgende trin:

- 5 - indføring af tråden (2) i en trækskrabe-indretning (1),
- føring af tråden gennem i det mindste en første skrabesten (3) med henblik på spåntagende bearbejdning af trådoverfladen,
- påvirkning af i det mindste trådoverfladen eller den første skrabesten (3) i trækskrabe-indretningen (1) med et kølemiddel, og
- 10 - føring af tråden (2) gennem i det mindste et andet bearbejdningselement (5) med henblik på plastisk deformering af tråden (2) i trådens bevægelsesretning (6) efter det første bearbejdningselement (2), **kendetegnet ved, at**
 - kølemidlet er en kølegas,
 - 15 - et kontaktpunkt mellem den mindst ene første skrabesten (3) og tråden (2) og/eller et friskæringsområde (10) for den mindst ene første skrabesten (3) påvirkes med kølegassen, og
 - det mindst ene andet bearbejdningselement (5) er
 - 20 placeret inden i trækskrabe-indretningen (1).

2. Fremgangsmåde ifølge krav 1, omfattende i det mindste et af de følgende trin:

- føring af tråden (2) gennem i det mindste et andet bearbejdningselement (5) med henblik på plastisk deformering af
- 25 tråden (2) i trådens løberetning (6) før den første skrabesten (3) inden i trækskrabe-indretningen (1),
- føring af tråden (2) gennem i det mindste et yderligere bearbejdningselement (5) med henblik på plastisk deformering af
- tråden (2) i trådens løberetning (6) før den første skrabesten (3) uden
- 30 for trækskrabe-indretningen (1),

- påvirkning af det andet, henholdsvis det yderligere bearbejdningsselement (5) med en kølegas.

3. Fremgangsmåde ifølge krav 1 eller 2, hvorved tråden (2) i umiddelbar nærhed
5 af den første skrabesten (3) og den første skrabesten (3) fra et sted i trådens løberetning (6) bagved det første bearbejdningsselement (3) påvirkes med kølegassen.

4. Fremgangsmåde ifølge et hvilket som helst af de foregående krav, hvorved
10 kølegassen i det mindste omfatter et element i den følgende gruppe:

- fast kuldioxid (CO_2),
- flydende nitrogen (N_2),
- gasformigt kuldioxid (CO_2) med en temperatur, som er lavere end -10°C ,
- 15 - gasformigt nitrogen med en temperatur, der er lavere end -50°C .

5. Trækskrabe-indretning (1) til spåntagende bearbejdning af en tråd (2), omfattende i det mindste en første skrabesten (3) og en tilførsel (4) for et kølemiddel, og som er således arrangeret og rettet, at mindst et af de følgende
20 elementer:

- tråden (2) og
- den første skrabesten (3) under driften kan påvirkes med kølemidlet i trækskrabe-indretningen (1), og hvorved i det mindste et andet bearbejdningsselement (5) med henblik på plastisk deformation i trådens
25 løberetning (6) er anbragt bag ved det første bearbejdningsselement (3),

kendetegnet ved, at

- tilførslen (4) af et kølemiddel er en tilførsel af en kølegas, og som er således arrangeret og rettet, at et kontaktpunkt mellem den mindst ene første skrabesten (3) og tråden (2) og/eller et friskærområde (10) for
30 den mindst ene skrabesten (3) under driften påvirkes med kølegassen, og

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- det mindst ene andet bearbejdningselement (5) er anbragt inden i trækskrabe-indretningen (1).

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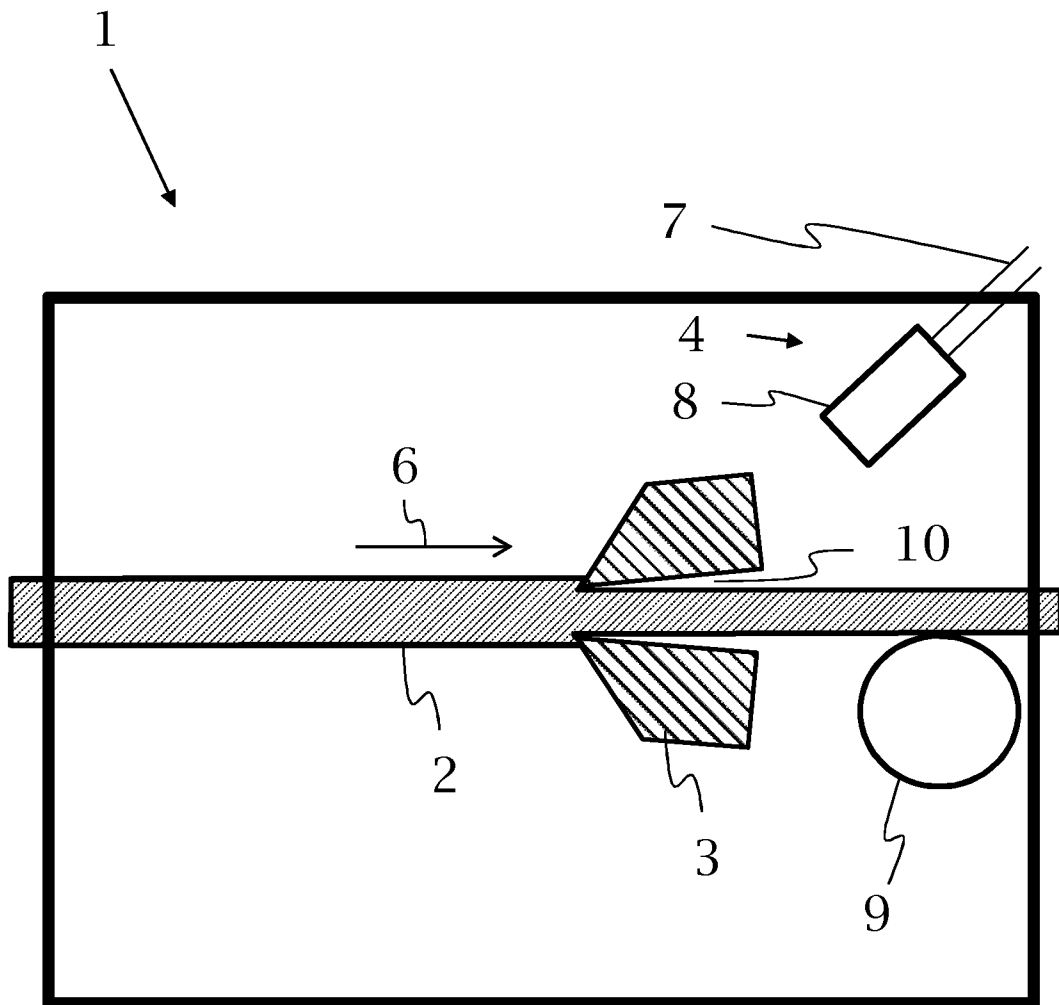


Fig. 1

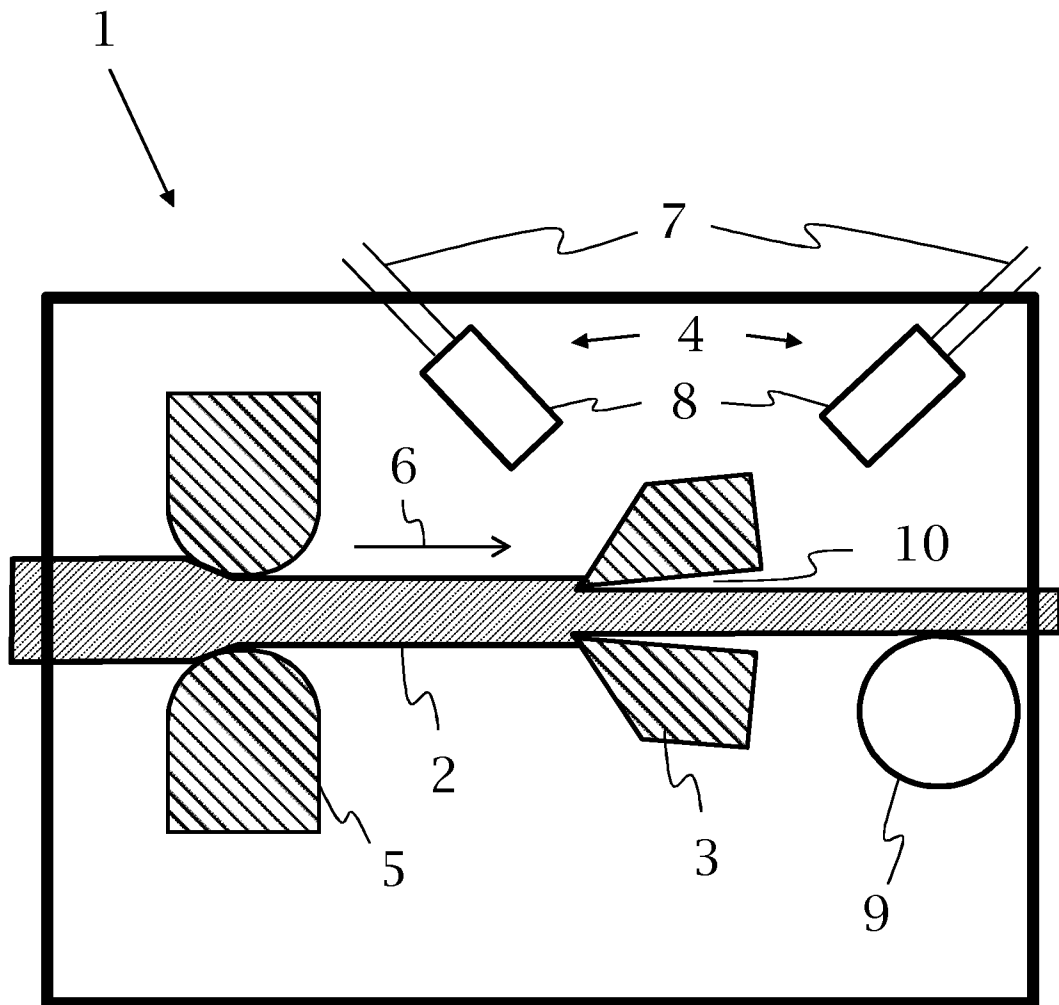


Fig. 2