Tulip contact for circuit breaker

Tulpenkontakt für einen Leistungsschalter
Contact du type tulipe pour un disjoncteur

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References cited:
EP-A1- 0 022 535
EP-A1- 0 700 062
EP-A1- 1 675 142
DE-A1- 3 002 803

Description

TECHNICAL FIELD

[0001] Embodiments of the present disclosure relate to a tulip contact for a circuit breaker configured for receiving a corresponding plug. Further, embodiments of the present disclosure relate to a circuit breaker comprising a tulip contact described herein and the corresponding plug. Additionally, embodiments of a method for producing a tulip contact for a circuit breaker are disclosed.

TECHNICAL BACKGROUND

[0002] Generally, tulip contacts are used in medium and/or high voltage circuit breakers which are typically used for interrupting a short circuit current when an electrical fault occurs. Typically, a tulip contact comprises multiple contact fingers for establishing and disconnecting an electrical contact with a mating contact, such as a corresponding plug.

[0003] Normally, the operating sequence of a circuit breaker is such that in case a fault is detected, 300 ms after an opening of the contact elements for clearing the short circuit current, the circuit breaker contact elements (i.e., a tulip contact and a corresponding mating plug) reclose in order to ensure system stability. Thereafter, in case the fault has vanished the circuit-breaker remains closed (i.e., with its contacts being closed). Otherwise, in cases in which the fault still exists, the contact elements close against the short circuit and immediately open again to clear the short circuit current. In such cases the circuit breaker closes against the full short circuit current. During that operation the contact elements of the circuit breaker are subjected to high dielectric stress, the load of which mainly depends on the voltage applied.

[0004] For ensuring the functionality of circuit breakers some of the key parameters among others are in particular a sufficient opening and closing speed of the contact elements. In detail, during opening of the contact elements of the circuit breaker and building up a contact distance the opening speed has to be high enough to interrupt a short circuit. Thereby, the contact distance has to be large enough to withstand a recovery voltage rising between the contact elements after current interruption. Accordingly, during closing of the contact elements a certain speed is required to limit the pre-arcing time, which is the time from the breakdown instant of the current to the instant of re-contact of the contact elements. Thereby a closure against a possibly still existing short circuit can be ensured.

[0005] The closing speed of the contact elements is a parameter which shall be increased for applications with increasing voltage ratings in order to ensure a controlled closing of the circuit breaker. Conventional circuit breakers are limited with respect to their performance due to the high loads occurring at high closing speeds and increased voltage ratings which may cause the contact elements to fail.

[0006] The invention starts from EP 0 700 062 A1, which discloses a high-voltage circuit breaker with contact fingers integrally formed into a metal tube by slotting. The tube is made of copper or self-resilient material, such as beryllium copper. In view of the above, it is an object of the present disclosure to provide a tulip contact that overcomes at least some of the problems in the art. This object is achieved at least to some extent by a tulip contact for a circuit breaker, a circuit breaker comprising a tulip contact described herein and a method for producing a tulip contact for a circuit breaker according to the independent claims. Further aspects, advantages, and features of the present disclosure are apparent from the dependent claims and their combinations, the description, and the accompanying drawings.

SUMMARY OF THE DISCLOSURE

[0007] According to the invention, a tulip contact for a circuit breaker according to claim 1 configured for receiving a corresponding plug is provided. The tulip contact comprises a tubular base portion from which a plurality of contact fingers extends substantially in a direction of a longitudinal axis of the tulip contact. A free-leading end portion of the contact fingers is configured for establishing an arc with the corresponding plug. Further, the tulip contact comprises a high-strength portion having a Young’s modulus of 90 GPa to 140 GPa and a yield stress of 500 MPa to 1350 MPa.

[0008] According to further aspects of the present disclosure, a circuit breaker comprising a tulip contact described herein and the corresponding plug according to claim 10 is provided.

[0009] According to another aspect of the present disclosure a method for producing a tulip contact for a circuit breaker according to claim 11 is provided, wherein the method comprises: providing a tubular raw material piece having a longitudinal axis and the accompanying drawings.

[0010] Further aspects, advantages, and features of the present disclosure are apparent from the dependent claims, the description, and the accompanying drawings.

BRIEF DESCRIPTION OF THE FIGURES

[0011] For better understanding the above recited features of the present disclosure in detail, a more particular description of the disclosure, as briefly summarized above, is given by reference to the embodiments. The accompanying drawings relate to some of the embodi-
The tulip contact 10 is employed for a circuit breaker 10 according to embodiments described herein.

Fig. 1 shows a cross-sectional view of a tulip contact in contact with a corresponding plug, according to embodiments described herein;

Fig. 2 shows a cross-sectional view of a tulip contact according to embodiments described herein;

Fig. 3 shows a cross-sectional view of a tulip contact according to a further embodiment described herein;

Fig. 4 shows a cross-sectional view of a tulip contact according to a another embodiment described herein;

Fig. 5 shows an embodiment of a method for producing a tulip contact according to embodiments described herein;

Fig. 6 shows a raw material piece for being used in the method for producing a tulip contact according to embodiments described herein.

DETAILED DESCRIPTION OF EMBODIMENTS

[0012] Reference will now be made in detail to the various embodiments, one or more examples of which are illustrated in each figure. Each example is provided by way of explanation and is not meant as a limitation. For example, features illustrated or described as part of one embodiment can be used on or in conjunction with any other embodiment to yield yet a further embodiment. It is intended that the present disclosure includes such modifications and variations.

[0013] Within the following description of the drawings, the same reference numbers refer to the same or to similar components. Generally, only the differences with respect to the individual embodiments are described. Unless specified otherwise, the description of a part or aspect in one embodiment applies to a corresponding part or aspect in another embodiment, as well.

[0014] In the present disclosure the term “finger root portion” is defined as a portion which partially extends into a base portion of the tulip contact and partially extends into the contact fingers extending from the tubular base portion. In case that the fingers are produced by cutting a tubular raw material piece from one end, the finger root portion is at the position at which the cut ends.

[0015] In the present disclosure the term “remaining portion” may be understood as all remaining portions of a tulip contact or as a remaining portion not including a base portion of a tulip contact.

[0016] Fig. 1 shows a cross-sectional view of a tulip contact 10 according to embodiments described herein. The tulip contact 10 is employed for a circuit breaker 10 and configured for receiving a corresponding plug. According to embodiments of the tulip contact 10 includes a tubular base portion 25 from which a plurality of contact fingers 20 extend substantially in a direction of a longitudinal axis 26 of the tulip contact 10. A free-leading end portion 23 of the contact fingers 20 is configured for establishing an arc with the corresponding plug 11. Typically, the corresponding plug and/or the tulip contact are movable relative to one another along a or the longitudinal axis 26 of the tulip contact to establish or interrupt an electrical (and mechanical) contact. Typical functional principles of a circuit breaker in which embodiments of the tulip contact described herein can be used are for example described in "Schaltanlagen Handbuch", 11. Edition, issued by H. Gremmel and G. Kopatsch for ABB AG Germany, Chapter 10.4.4, p. 454 ff. According to embodiments of the invention, the tulip contact 10 comprises a high-strength portion 21 having a Young’s modulus of 90 GPa to 140 GPa, particularly approximately 120 GPa, and a yield stress of 500 MPa to 1350 MPa.

[0017] According to embodiments, as exemplarily shown in Fig. 1, the high-strength portion 21 of the contact fingers 20 includes the base portion 25. Herein, the free-leading end portion 23 is welded to the high-strength portion 21. Accordingly, as exemplarily shown in Fig. 1, a welded joint 33 is provided between the high strength portion 21 and the free-leading end portion 23. Furthermore, the contact fingers 20 merge into the base portion at a particular position, such as shown by the exemplarily chosen position represented by the dotted line 24 in Fig. 1.

[0018] The plurality of contact fingers 20 can be arranged radially around the longitudinal axis 26 of the tulip contact 10. For establishing a contact with the corresponding plug, contact surfaces of the tulip contact, in particular contact surfaces of the contact fingers 20, preferably at the free-leading end portions 23 of the contact fingers 20, are provided. According to embodiments, the contact fingers 20 are configured such that in a closed state, i.e. when the tulip contact forms contact with the corresponding plug, a contact pressure is applied by the corresponding plug to the contact surfaces of the contact fingers.

[0019] According to embodiments the high-strength portion 21 has a Young’s modulus between a lower limiting value of 90 GPa, particularly 100 GPa, more particularly 110 GPa to a upper limiting value of 140 GPa, particularly 130 GPa, more particularly 120 GPa and a yield stress between a lower limiting value of 500 MPa, particularly 600 MPa, more particularly 700 MPa to an upper limiting value of 1350 MPa, particularly 1200 MPa, more particularly 1000 MPa. Thereby, compared to conventional contact elements of known circuit breakers a tulip contact having contact fingers which withstand high loads occurring during high speed closing operation of a circuit breaker is provided. In particular, providing a tulip contact including a high-strength portion 21 as described herein the contact fingers 20 are configured such that...
they do not deform or break upon high speed closing operations. Consequently, the tulip contact 10 is configured for applications with increasing closing speeds and increasing voltage ratings, since the tulip contact 10, in particular the contact fingers 20, can withstand increased mechanical and dielectric stresses.

[0020] During high speed closing operation, e.g. of a circuit breaker for which a tulip contact 10 as described herein can be employed, the kinetic energy is introduced into the contact elements, e.g. the tulip contact 10 and/or the corresponding plug 11. Hence, during closing contact fingers 20 of a tulip contact 10 are subjected to high mechanical stress. According to embodiments, the contact fingers 20 are configured such that they are forced to deflect when they form contact with the corresponding mating plug 11. In particular, a deflection of the contact fingers 20 yields an increased material stress particularly in the root portions of the contact fingers 10. Thus, an impact of the contact fingers 10 with the corresponding plug 11 at high closing speeds can lead to critical material stress in the contact fingers 10, especially in their root portions.

[0021] Hence, according to embodiments, the high-strength portion 21 includes a finger root portion at which the contact fingers 20 extend from the base portion 25. Thereby, a portion of the contact fingers, which is disadvantageously prone to high material stress is improved with respect to its material strength. In particular, by providing the contact fingers 20 with a high-strength portion 21 it can substantially be avoided that a stress resulting from an impact of the contact elements 10, 11 during closing exceeds the yield stress of the contact finger material. In particular, by providing a high-strength portion 21 the contact fingers 20 are configured such that they do not deform or break upon high speed closing operations. Hence, a deformation of the contact fingers 20 such that they may even remain plasticized is substantially avoided. By avoiding a permanent deformation of the contact fingers 20 due to the high-strength portion 21 a constant contact pressure between the contact fingers 20 and the corresponding plug 11 can be assured. Accordingly, a reduction of the electrical conductivity of the arcing contacts 10, 11 can substantially be prevented. Hence, by providing a tulip contact 10 having a high-strength portion 21 as described herein, an improved tulip contact 10 with respect to its loading capacity, particularly regarding its toughness of the finger root portions, is provided.

[0022] According to embodiments, the high-strength portion 21 contains less than 10 wt% copper (Cu), preferably is copperless, and wherein a remaining portion of the tulip contact 10 comprises copper, preferably more than 50 wt% copper. Thereby, a tulip contact 10 comprising the required electrical conductivity properties, mainly represented by the copper containing portions, with high-strength material properties, mainly represented by the high-strength portion 21, is provided.

[0023] According to embodiments, the Young's modulus of the high-strength portion 21 substantially corresponds to the Young's modulus of the remaining portion of the tulip contact 10 which typically comprises copper, preferably more than 50 wt% copper. Furthermore, the yield stress of the high-strength portion 21 shall substantially be twice the yield stress of the remaining portion of the tulip contact which may comprise copper, preferably more than 50 wt% copper. Thereby, the mechanical properties of the tulip contact 10 can be improved while essentially achieving electrical conductivity properties comparable to known contact elements for circuit breakers. Particularly, by providing the tulip contact 10 with a high-strength portion 21 as described herein a tulip contact 10 with improved mechanical performance is provided without changing the dimensions of the particular design of the tulip contact 10.

[0024] According to embodiments, the high-strength portion 21 comprises titanium. In embodiments, the high-strength portion 21 comprises titanium alloy including at least one of an alpha phase, near-alpha phase and alpha-beta phase. According to embodiments, the titanium alloy comprises at least one of the components of Al (Aluminum) from 4 wt% to 10 wt%, Sn (Tin) from 1 wt% to 13 wt%, V (Vanadium) from 2 wt% to 15 wt%, Zr (Zirconium) from 0 wt% to 6 wt%; Mo (Molybdenum) from 0 wt% to 13 wt%, Si (Silicium) from 0 wt% to 3 wt%, Cr (Chromium) from 0 wt% to 13 wt%.

[0025] By using titanium alloy for the high-strength portion 21 the required tensile strength can be provided. Further, since titanium alloys are light in weight their application as a material for the tulip contact 10 as described herein, e.g. for the high-strength portion 21, results in a reduction of the total weight of the tulip contact 10. Thereby a reduction of the impact of the tulip contact 10 with the corresponding plug 11 during high speed closing operation of the circuit breaker can be achieved. Additionally, since titanium alloys have a high melting point temperature their application in the tulip contact 10 according to the embodiments described herein leads to a prevention of erosion, at least to some extent.

[0026] According to embodiments, the free-leading end portion 23 contains CuW (Copper-Tungsten). By providing a CuW-comprising free-leading end portion 23, a leading end portion having high heat resistance, high electrical and thermal conductivity, and low thermal expansion is provided. Further, by providing a free-leading end portion 23 comprising CuW as contact material, a contact finger leading end is provided which is substantially resistant to erosion caused by an electric arc.

[0027] As exemplarily shown in Fig. 2, according to embodiments of the tulip contact 10, a base side of the high-strength portion 21 is welded to the base portion 25, and a tip side of the high-strength portion 21 is welded to a transition portion 22 which is welded to the free-leading end portion 23. Hence, a first welded joint 31 can be provided between the base side of the high-strength portion 21 and the base portion 25, a second welded joint 32 can be provided between the tip side of the high-
According to embodiments, as exemplarily shown in Fig. 1, the tip side of the high-strength portion 21 is welded to the adjacent free-leading end portion 23. Thereby, a tulip contact 10 having a high-strength portion 21 which extends from the base portion to the free-leading end portion 23 is provided. In embodiments as previously described, a titanium alloy is used for the high-strength portion 21. Hence, the material strength of the tulip contact 10, in particular of the tulip contact fingers 20, can be increased while also a reduction of weight can be achieved. In addition, a sufficient electrical conductivity can be maintained. Thereby, the performance of the tulip contact 10 is further improved.

According to embodiments, as exemplarily shown by a schematic cross-section of a tulip contact 20 as depicted Fig. 3, the tulip contact 20 can further comprise a conductor stripe 40. The tulip contact 10 can comprise at least one conductor stripe 40 connected to the free-leading end portion 23 for conducting an arcing current to the base portion 25. In particular, the at least one conductor stripe 40 is configured being elastic such that the conductor stripe 40 can assimilate deflections of the contact fingers 20 during opening and/or closing operations of the circuit breaker.

According to embodiments, the at least one conductor stripe 40 comprises a copper alloy, the copper alloy having preferably a copper content of at least 70 wt%, particularly at least 80 wt%, more particularly at least 90 wt%. In embodiments, the at least one conductor stripe 40 is made of pure copper. Furthermore, the conductor stripe 40 is configured for conducting a current having a current rating between a lower limiting value of 1 kA, particularly 2 kA, more particularly 4 kA and an upper limiting value of 10 kA, particularly 7 kA, more particularly 5 kA.

According to embodiments, the contact resistance between the conductor stripe 40 and the free-leading end portion 23 as well as the contact resistance between the conductor stripe 40 and the base portion 25 is below 60 $\mu\Omega$, particularly below 50 $\mu\Omega$, more particularly below 40 $\mu\Omega$. In embodiments, the at least one conductor stripe 40 is fixed to the contact fingers 20, e.g. the leading end portion 23 and the base portion 25 by screws or clamps. Furthermore, the conductor stripe 40 can be fixed to the contact fingers 20 via welding. According to embodiments, the electrical resistivity of the conductor stripe 40 is below 60 $\mu\Omega \cdot m$, particularly below 50 $\mu\Omega \cdot m$, more particularly below 40 $\mu\Omega \cdot m$.

According to embodiments, as exemplarily shown by a schematic cross-section of a tulip contact 10 as depicted Fig. 4, the tulip contact 10 comprises a conductor stripe 40 which is attached on an outer radial surface of the contact fingers 20 along a length ranging from the base portion 25 to the free-leading end portion 23. Such embodiments are beneficial with respect of the method of producing the tulip contact 10, since the conductor stripe 40 can be attached prior to cutting a tubular raw material piece from which the tulip contact 10 is produced.

By providing a tulip contact 10 with a conductor stripe 40 an optimized tulip contact 10 is provided. In particular, the conductor stripe 40 guarantees the required electrical conductivity whereas the high-strength portion 21 according to embodiments described herein provides the required mechanical strength for high voltage applications.

According to a further aspect of the present disclosure, a circuit breaker (not shown) comprising a tulip contact 10 described herein and the corresponding plug 11 is provided. Typically, the circuit breaker is configured for voltage ratings from a lower limit of 50 kV, particularly 100 kV, more particularly 200 kV to an upper limit of 700 kV, particularly 500 kV, more particularly 300 kV.

According to another aspect of the present disclosure a method for producing a tulip contact 10 is provided. Fig. 5 shows an embodiment of a method for producing a tulip contact 10. In embodiments, the method for producing a tulip contact 10 includes: providing 510 a tubular raw material piece 520 having a longitudinal axis 26 and comprising a base portion 25, an end portion 23 and a high-strength portion 21 containing a material having a Young's modulus of 90 GPa to 140 GPa, particularly approximately 120 GPa, and a yield strength of 500 MPa to 1350 MPa; shaping 520 the tubular raw material piece 50, preferably by milling; cutting 530 the tubular raw material piece 50 from the side of the end portion 23 in a direction of the longitudinal axis 26, thereby forming contact fingers 20 extending substantially in a direction of the longitudinal axis 26 of the tulip contact 10. Typically, the base portion 25 is the portion which follows behind the cut by which the fingers 20 are formed.

According to embodiments the high-strength portion 21 has a Young's modulus between a lower limiting value of 90 GPa, particularly 100 GPa, more particularly 110 GPa to an upper limiting value of 140 GPa, particularly 130 GPa, more particularly 120 GPa and a yield stress between a lower limiting value of 500 MPa, particularly 600 MPa, more particularly 700 MPa to an upper limiting value of 1350 MPa, particularly 1200 MPa, more particularly 1000 MPa.

According to embodiments, the high-strength portion 21 contains less than 10 wt% copper, preferably is copperless, and wherein a remaining portion of the tulip contact 10 comprises copper, preferably more than 50 wt% copper. Thereby, a tulip contact 10 combining the required electrical conductivity properties, mainly represented by the copper containing portions, with high-strength material properties, mainly represented by the high-strength portion, is provided.

According to embodiments, the the high-
strength portion 21 comprises titanium. In embodiments, the high-strength portion 21 comprises titanium alloy including at least one of an alpha phase, near-alpha phase and alpha-beta phase. According to other embodiments, the titanium alloy comprises at least one of the components of Al from 4 wt% to 10 wt%, Sn from 1 wt% to 13 wt%, V from 2 wt% to 15 wt%, Zr from 0 wt% to 6 wt%; Mo from 0 wt% to 13 wt%, Si from 0 wt% to 3 wt%, Cr from 0 wt% to 13 wt%.

[0039] According to embodiments, the end portion 23 contains CuW. By providing a CuW-comprising end portion 23, a leading end portion having high heat resistance, high electrical and thermal conductivity, and low thermal expansion is provided. Further, by providing an end portion comprising CuW as contact material, a contact finger leading end is provided which is substantially resistant to erosion caused by an electric arc.

[0040] According to embodiments, the Young’s modulus of the high-strength portion 21 substantially corresponds to the Young’s modulus of the remaining portion of the tulip contact 10 which can comprise copper, preferably more than 50 wt% copper. Further, the yield stress of the high-strength portion 21 can be chosen to be substantially twice the yield stress of the remaining portion of the tulip contact which can comprise copper, preferably more than 50 wt% copper.

[0041] According to embodiments the raw material piece used for the method for producing the tulip contact 10 is a tubular raw material piece 50, comprising a base portion 25, a high strength portion 21, and an end portion 23 (see Fig. 6). In embodiments, the tubular raw material piece 50 further comprises a transition portion 22 provided between the high strength portion 21 and the end portion 23, as exemplarily shown in Fig. 6.

[0042] According to embodiments a base side of the high-strength portion 21 of the raw material piece is welded to the base portion 25, and a tip side of the high-strength portion 21 is welded to the transition portion 22 which is welded to the end portion 23 (see Fig. 6). Hence, typically the raw material piece is provided with a first welded joint 31 between the base side of the high-strength portion 21 and the base portion 25, a second welded joint 32 between the tip side of the high-strength portion 21 and the transition portion 22, and a third welded joint 33 between the transition portion 22 and the end portion 23. Typically, a copper containing material, preferably pure copper, is employed for the formation of the first, second, and a third welded joint 31, 32, 33.

[0043] According to the embodiments of the method for producing a tulip contact 10 providing 510 the tubular raw material piece 50 includes welding the high-strength portion 21 to a base portion 25 and to a transition portion 22, as well as welding the transition portion 22 to the end portion 23.

[0044] Furthermore, according to embodiments of the method for producing a tulip contact 10 includes attaching a conductor stripe 40 to at least the end portion 23 of the shaped tubular raw material piece 50 prior to the cutting the contact fingers 20.

[0045] According to embodiments, the at least one conductor stripe 40 comprises a copper alloy, the copper alloy having preferably a copper content of at least 70 wt%, particularly at least 80 wt%, more particularly at least 90 wt%. In embodiments, the at least one conductor stripe 40 is made of pure copper. Further, the conductor stripe 40 is typically configured for conducting a current having a current rating between a lower limiting value of 1 kA, particularly 2 kA, more particularly 4 kA and a upper limiting value of 10 kA, particularly 7 kA, more particularly 5 kA.

[0046] According to embodiments, the contact resistance between the conductor stripe 40 and the end portion 23 as well as the contact resistance between the conductor stripe 40 and the base portion 25 is below 60 μΩ, particularly below 50 μΩ, more particularly below 40 μΩ. In embodiments, the at least one conductor stripe 40 is fixed to the contact fingers 20, e.g. the leading 23 end portion and/or the base portion 25, by screws or clamps. Alternatively, the conductor stripe 40 can be fixed to the contact fingers 20 via welding. According to embodiments, the electrical resistivity of the conductor stripe 40 is below 60 μΩ·m, particularly below 50 μΩ·m, more particularly below 40 μΩ·m.

[0047] According to embodiments of the method for producing a tulip contact attaching the conductor stripe 40 includes at least one of welding, screwing and clamping. Typically, attaching the conductor stripe 40 is performed prior to cutting 530 the tubular raw material piece 50. Thereby, the method for producing a tulip contact 10 can be simplified and carried out more cost-efficiently.

Claims

1. A tulip contact (10) for a circuit breaker configured for receiving a corresponding plug (11), wherein the tulip contact (10) comprises a tubular base portion (25) from which a plurality of contact fingers (20) extend substantially in a direction of a longitudinal axis (26) of the tulip contact (10), wherein a free-leading end portion (23) of the contact fingers (20) is configured for establishing an arc with the corresponding plug (11), characterized in that the tulip contact (10) comprises a high-strength portion (21) having a Young's modulus of 90 GPa to 140 GPa and a yield stress of 500 MPa to 1350 MPa and containing less than 10 wt% copper, and that a remaining portion of the tulip contact (10) comprises more than 50 wt% copper.

2. The tulip contact (10) according to claim 1, wherein the high-strength portion (21) includes a finger root portion (21), at which the contact fingers (20) extend from the base portion (25).

3. The tulip contact (10) according to claim 1 or 2,
wherein the high-strength portion (21) is copperless.

4. The tulip contact (10) according to any of claims 1 to 3, wherein the high-strength portion (21) comprises titanium.

5. The tulip contact (10) according to claim 4, wherein the high-strength portion (21) comprises a titanium alloy including at least one of a alpha phase, near-alpha phase and alpha-beta phase, and wherein the titanium alloy comprises at least one of the components of Al from 4 wt% to 13 wt%, V from 2 wt% to 15 wt%, Zr from 0 wt% to 6 wt%, Mo from 0 wt% to 13 wt%, Si from 0 wt% to 3 wt%, Cr from 0 wt% to 13 wt%.

6. The tulip contact (10) according to any of claims 1 to 5, wherein the free-leading end portion (23) contains CuW.

7. The tulip contact (10) according to any of claims 1 to 6, wherein a base side of the high-strength portion (21) is welded to the base portion (25), and wherein a tip side of the high-strength portion (21) is welded to one of (i) a transition portion (22) welded to the free-leading end portion (23), or (ii) the adjacent free-leading end portion (23).

8. The tulip contact (10) according to any of claims 1 to 7, wherein the tulip contact (10) comprises at least one conductor stripe (40) connected to the free-leading end portion (23) and the base portion (25) for conducting an arcing current to the leading end portion.

9. The tulip contact (10) according to claim 8, wherein the at least one conductor stripe (40) comprises one of pure copper and a copper alloy, the copper alloy having preferably a copper content of at least 80 wt%.

10. A circuit breaker comprising a tulip contact (10) according to any of claims 1 to 9 and the corresponding plug (11).

11. Method for producing a tulip contact (10) for a circuit breaker, wherein the method comprises:

   a) providing (510) a tubular raw material piece (50) having a longitudinal axis (26) and comprising a base portion (25) and an end portion (23);
   b) shaping (520) the tubular raw material piece (50), preferably by milling;
   c) cutting (530) into the tubular raw material piece (50) from the side of the end portion (23) in a direction of the longitudinal axis (26), thereby forming contact fingers (20) extending substantially in a direction of the longitudinal axis (26) of the tulip contact (10), characterised in that the tubular raw material piece (50) has a high-strength portion (21) containing a material having a Young's modulus of 90 GPa to 140 GPa and a yield stress of 500 MPa to 1350 MPa and containing less than 10 wt% copper, and that a remaining portion of the tulip contact (10) comprises more than 50 wt% copper.

12. Method for producing a tulip contact (10) according to claim 11, wherein providing (510) the tubular raw material piece (50) includes welding the high-strength portion (21) to the base portion (25) and to a transition portion (22), as well as welding the transition portion (22) to the end portion (23).

13. Method for producing a tulip contact (10) according to claim 11 or 12, wherein the method includes attaching a conductor stripe (40) to at least the end portion (23) prior to the cutting of the contact fingers (20).

14. Method for producing a tulip contact (10) according to claim 13, wherein attaching the conductor stripe (40) includes at least one of welding, screwing and clamping.

Patentansprüche

1. Tulpenkontakt (10) für einen Leistungsschalter zur Aufnahme eines entsprechenden Stifts (11), wobei der Tulpenkontakt (10) einen rohrförmigen Basisteil (25) aufweist, von dem aus sich mehrere Kontaktfinger (20) im Wesentlichen in einer Richtung einer Längsachse (26) eines Tulpenkontakts (10) erstrecken, wobei ein freier Endbereich (23) der Kontaktfinger (20) für das Erzeugen eines Lichtbogens mit dem entsprechenden Stift (11) konfiguriert ist, dadurch gekennzeichnet, dass der Tulpenkontakt (10) einen hochfesten Bereich (21) aufweist, der einen Elastizitätsmodul von 90 GPa bis 140 GPa und eine Streckgrenze von 500 MPa bis 1350 MPa aufweist und weniger als 10 Gew.-% Kupfer enthält, und dass ein übriger Teil des Tulpenkontakts (10) mehr als 50 Gew.-% Kupfer enthält.

2. Tulpenkontakt (10) nach Anspruch 1, wobei der hochfeste Bereich (21) einen Fingerwurzelbereich (22) aufweist, an dem sich der Kontaktfinger (20) vom Basisbereich (25) aus erstrecken.

3. Tulpenkontakt (10) nach Anspruch 1 oder 2, wobei der hochfeste Bereich (21) frei von Kupfer ist.

4. Tulpenkontakt (10) nach einem der Ansprüche 1 bis 3, wobei der hochfeste Bereich (21) Titan enthält.

6. Tulpenkontakt (10) nach einem der Ansprüche 1 bis 5, wobei der freie Endbereich (23) CuW aufweist.

7. Tulpenkontakt (10) nach einem der Ansprüche 1 bis 6, wobei eine Basisseite des hochfesten Bereichs (21) an den Basisbereich (25) angeschweißt ist, und wobei eine Spitzenseite des hochfesten Bereichs (21) an einen von (i) einem Übergangsbereich (22), der am freien Endbereich (23) angeschweißt ist, oder (ii) den angrenzenden freien Endbereich (23) angeschweißt ist.

8. Tulpenkontakt (10) nach einem der Ansprüche 1 bis 7, wobei der Tulpenkontakt (10) mindestens einen Leiterstreifen (40) aufweist, der mit dem freien Endbereich (23) zum führenden Endbereich verbunden ist.

9. Tulpenkontakt (10) nach Anspruch 8, wobei der mindestens eine Leiterstreifen (40) eines aus reinem Kupfer und einer Kupferlegierung aufweist, wobei die Kupferlegierung bevorzugt einen Kupfergehalt von mindestens 80 Gew.-% aufweist.

10. Leistungsschalter, aufweisend einen Tulpenkontakt (10) nach einem der Ansprüche 1 bis 9 und einen entsprechenden Stift (11).

11. Verfahren zum Herstellen eines Tulpenkontakts (10) für einen Leistungsschalter, wobei das Verfahren Folgendes aufweist:
    a) Bereitstellen (510) eines rohrförmigen Rohstoffstücks (50), aufweisend eine Längsachse (26) und einen Basisbereich (25) sowie einen Endbereich (23);
    b) Formen (520) des rohrförmigen Rohstoffstücks (50), bevorzugt durch Fräsen;
    c) Schneiden (530) in das rohrförmige Rohstoffstück (50) von der Seite des Endbereiches (23) aus einer Richtung der Längsachse (26), wobei die sich im Wesentlichen in einer Richtung der Längsachse (26) des Tulpenkontakts (10) erstreckenden Kontaktfinger (20) gebildet werden, dadurch gekennzeichnet, dass das rohrförmige Rohstoffstück (50) einen hochfesten Bereich (21) aufweist, der ein Material mit einem Elastizitätsmodul von 90 GPa bis 140 GPa und eine Streckgrenze von 500 MPa bis 1350 MPa aufweist und weniger als 10 Gew.-% Kupfer enthält, und dass ein übriger Teil des Tulpenkontakts (10) mehr als 50 Gew.-% Kupfer enthält.

12. Verfahren zum Herstellen eines Tulpenkontakts (10) nach Anspruch 11, wobei das Bereitstellen (510) eines rohrförmigen Rohstoffstücks (50) Schweißen des hochfesten Bereichs (21) an den Basisbereich (25) und an einen Übergangsbereich (22) sowie Schweißen des Übergangsbereichs (22) an den Endbereich (23) umfasst.

13. Verfahren zum Herstellen eines Tulpenkontakts (10) nach Anspruch 11 oder 12, wobei das Verfahren ein Anbringen eines Leiterstreifens (40) an mindestens dem Endbereich (23) vor dem Schneiden der Kontaktfinger (20) umfasst.


Reverdiscaions 1. Contact (10) de type tulipe pour disjoncteur configuré pour recevoir une fiche (11) correspondante, le contact (10) de type tulipe comportant une partie (25) d’embase tubulaire à partir de laquelle une pluralité de doigts (20) de contact s’étend sensiblement dans la direction d’un axe longitudinal (26) du contact (10) de type tulipe, une partie (23) d’extrémité avant libre des doigts (20) de contact étant configurée pour établir un arc avec la fiche (11) correspondante, caractérisé en ce que le contact (10) de type tulipe comporte une partie (21) à haute résistance mécanique présentant un module de Young de 90 GPa à 140 GPa et une limite élastique de 500 MPa à 1350 MPa et contenant moins de 10% en masse de cuivre, et en ce qu’une partie restante du contact (10) de type tulipe comporte plus de 50% en masse de cuivre.

2. Contact (10) de type tulipe selon la revendication 1, la partie (21) à haute résistance mécanique comprenant une partie (21) d’emplanture de doigts, au niveau de laquelle les doigts (20) de contact s’étendent à partir de la partie (25) d’embase.

3. Contact (10) de type tulipe selon la revendication 1 ou 2, la partie (21) à haute résistance mécanique étant sans cuivre.

4. Contact (10) de type tulipe selon l’une quelconque des revendications 1 à 3, la partie (21) à haute ré-
sistance mécanique comportant du titane.

5. Contact (10) de type tulipe selon la revendication 4, la partie (21) à haute résistance mécanique comportant un alliage de titane comprenant au moins une phase parmi une phase alpha, une phase quasi-alpha et une phase alpha-beta, et l’alliage de titane comportant au moins un des composants parmi Al de 4% en masse à 10% en masse, Sn de 1% en masse à 13% en masse, V de 2% en masse à 15% en masse, Zr de 0% en masse à 6% en masse ; Mo de 0% en masse à 13% en masse, Si de 0% en masse à 3% en masse, Cr de 0% en masse à 13% en masse.

6. Contact (10) de type tulipe selon l’une quelconque des revendications 1 à 5, la partie (23) d’extrémité avant libre contenant du CuW.

7. Contact (10) de type tulipe selon l’une quelconque des revendications 1 à 6, un côté embase de la partie (21) à haute résistance mécanique étant soudé à la partie (25) d’embase, et un côté bout de la partie (21) à haute résistance mécanique étant soudé à une partie parmi (i) une partie (22) de transition soudée à la partie (23) d’extrémité avant libre, et (ii) la partie adjacente (23) d’extrémité avant libre.

8. Contact (10) de type tulipe selon l’une quelconque des revendications 1 à 7, le contact (10) de type tulipe comportant au moins un ruban conducteur (40) relié à la partie (23) d’extrémité avant libre et à la partie (25) d’embase pour conduire un courant d’arc jusqu’à la partie d’extrémité avant.

9. Contact (10) de type tulipe selon la revendication 8, le ou les rubans conducteurs (40) comportant soit du cuivre pur soit un alliage de cuivre, l’alliage de cuivre présentant de préférence une teneur en cuivre d’au moins 80% en masse.

10. Disjoncteur comportant un contact (10) de type tulipe selon l’une quelconque des revendications 1 à 9 et la fiche (11) correspondante.

11. Procédé de production d’un contact (10) de type tulipe destiné à un disjoncteur, le procédé comportant les étapes consistant à :
    a) réaliser (510) un tronçon tubulaire (50) de matière première présentant un axe longitudinal (26) et comportant une partie (25) d’embase et une partie (23) d’extrémité ;
    b) façonner (520) le tronçon tubulaire (50) de matière première, de préférence par fraisage ;
    c) entailler (530) le tronçon tubulaire (50) de matière première en partant du côté de la partie (23) d’extrémité dans une direction de l’axe lon-

12. Procédé de production d’un contact (10) de type tulipe selon la revendication 11, la réalisation (510) du tronçon tubulaire (50) de matière première comprenant les étapes consistant à souder la partie (21) à haute résistance mécanique à la partie (25) d’embase et à une partie (22) de transition, ainsi qu’à souder la partie (22) de transition à la partie (23) d’extrémité.

13. Procédé de production d’un contact (10) de type tulipe selon les revendications 11 ou 12, le procédé comprenant l’étape consistant à fixer un ruban conducteur (40) à au moins la partie (23) d’extrémité préalablement à la découpe des doigts (20) de contact.

14. Procédé de production d’un contact (10) de type tulipe selon la revendication 13, la fixation du ruban conducteur (40) comprenant au moins une opération parmi un soudage, un vissage et un bridage.
Fig. 6
REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

• EP 0700062 A1 [0006]

Non-patent literature cited in the description

• H. GREMMEL; G. KOPATSCH. Schaltanlagen Handbuch. ABB AG, 454 ff [0016]