



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
24.03.2021 Bulletin 2021/12

(51) Int Cl.:
H01H 1/38 (2006.01) **H01H 1/02** (2006.01)
H01H 33/12 (2006.01)

(21) Application number: **19198641.3**

(22) Date of filing: **20.09.2019**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(72) Inventors:
• **Bagale, Tammaraya**
431005 Aurangabad, Maharashtra (IN)
• **Kale, Subodh**
431005 Nasik, Maharashtra (IN)
• **Marathe, Nakul**
422009 Nashik, Maharashtra (IN)

(71) Applicant: **Siemens Energy Global GmbH & Co. KG**
81739 München (DE)

(74) Representative: **Patentanwaltskanzlei WILHELM & BECK**
Prinzenstraße 13
80639 München (DE)

(54) **CONTACT ARRANGEMENT**

(57) Embodiments herein describe a tube contact (300) configured for receiving the pin contact (401), the tube contact (300) comprising a top portion (301) configured for establishing an arc with the pin contact (401) and a bottom portion (302) extending from the top portion (301) in a substantially longitudinal direction of the tube

contact (300) characterized in, that the bottom portion (302) is a high strength portion made of a material having a Young's modulus of 190 GPa to 220 GPa. Embodiments herein further describe a contact arrangement (400) and a circuit breaker (100) comprising the disclosed tube contact (300) contact arrangement (400).

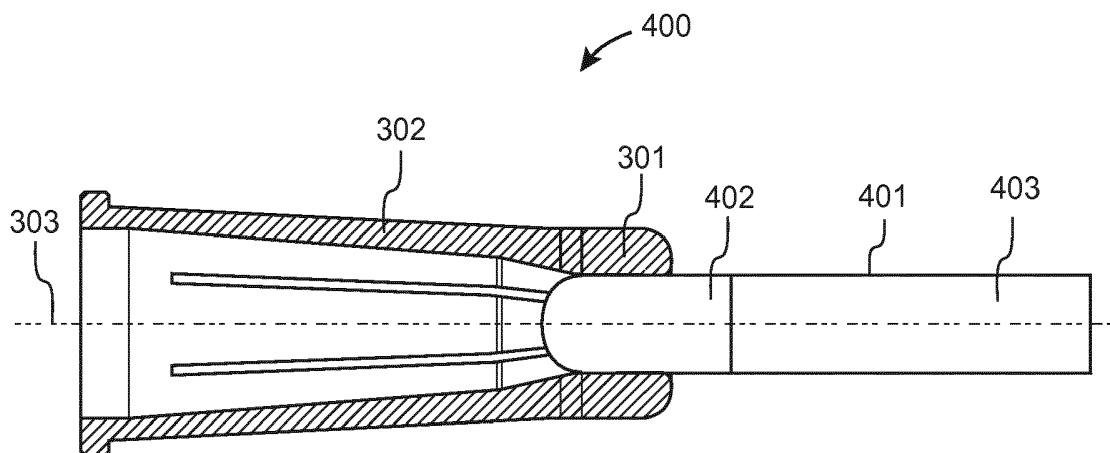


FIG. 4

Description

[0001] Embodiments of the present disclosure generally relates to contact arrangement and contact arrangement for circuit breakers.

[0002] Conventionally, a circuit breaker 100 includes three pole columns, 101a, 101b and 101c, resting on a common breaker base 102, as illustrated by FIG. 1. The three pole columns are connected by tubes to a gas compartment 103. To operate the three poles, the circuit breaker has an interrupter unit 104 and a connecting mechanism. The interrupter unit 104 has 2 parts, the main contact and the arcing contact.

[0003] In a circuit breaker opening operation, the main contact that exists between the contact laminations and the heat cylinder will get open. The arcing contact comprising the pin contact 201 and the tube contact 202 remains closed, with the result that the current commutates onto the arcing contact. However with the large short-circuiting currents, the quenching gas surrounding the pin contact in the arcing chamber gets heated up by the arc's energy. The arcing contacts get open to clear the short circuit current and it will get closed in normal condition, as depicted in FIG. 2.

[0004] During short circuit, peak current withstand and interruption, the tube contact must apply enough pressure to hold the pin contact with sufficient force. In the existing arrangement of the tube contact, the bottom portion of the tube contact is made of CuCrZr material, which results in a problem that the tube contact loses its mechanical properties at elevated temperature. Further, the stiffness of the bottom portion should be sufficient enough to hold the pin contact intact.

[0005] Document, which may be useful for understanding the field of technology, include EP 2797095A1.

[0006] It is an object of the present invention to overcome the above-described problem. More specifically, it is an object of the present invention to provide an improved mechanism for providing high current withstanding capability or arc interruption or arc establishment in circuit breakers using simple and inexpensive means.

[0007] According to the invention, the foregoing object is achieved by an improved tube contact, contact arrangement and the circuit breaker as disclosed in the independent claims.

[0008] According to a first aspect of the present invention, the object is achieved by a tube contact configured for receiving the pin contact, the tube contact comprising a top portion configured for establishing an arc with the pin contact and a bottom portion extending from the top portion in a substantially longitudinal direction of the tube contact, characterized in, that the bottom portion is a high strength portion made of a material having a Young's modulus of 190 GPa to 220 GPa. By selecting a material having a Young's modulus in a range of 190GPa to 220GPa for the bottom portion, the tube contact exhibits improved mechanical properties at elevated temperature for a low cost as compared to known contact elements

for circuit breakers. Here the tube contact develop a force supplementary to hold the pin contact in place when a top portion of the pin contact engages with the tube contact during a short circuit.

[0009] In a preferred embodiment, the bottom portion of the tube contact is made of a material comprising at least steel.

[0010] In another preferred embodiment, the bottom portion of the tube contact is made of a material comprising at least a steel alloy having a carbon content of at least 0.002wt%-2.1325wt%. The properties of steel and steel alloys, such as high electrical conductivity, thermal conductivity, high reaction resistance, high melting point and low material and processing cost, makes steel and steel alloys an ideal material for making contact elements.

[0011] In yet another preferred embodiment, a stiffness of the bottom portion is directly proportional to the Young's modulus of the material. This makes it possible to reduce the force exerted by the tube contact on the pin contact to obtain a required contact pressure to withstand a short circuit current.

[0012] According to a second aspect of the invention, the object is achieved by a contact arrangement comprising a tube contact and a pin contact.

[0013] In another preferred embodiment, the bottom portion of the pin contact is made of a high strength material, such as a steel or steel alloy having a carbon content of at least 0.002wt%-2.1325wt% and having a Young's modulus of 190 GPa to 220 GPa.

[0014] According to a third aspect of the invention, the object is achieved by a circuit breaker comprising the tube contact and the contact arrangement.

[0015] Although the invention is illustrated and described herein as a tube contact, a contact arrangement and its use in circuit breakers, it is not intended to be limited to the details shown, since various modifications may be made therein within the scope and the range of the claims. The invention, however, together with additional objects and advantages will be best understood from the following description and in connection with the accompanying drawings.

[0016] In the following the invention is based on the embodiments shown in the drawings and described below:

FIG 1 is a schematic diagram illustrating a circuit breaker design, according to prior art.

FIG 2 is a schematic diagram illustrating the operation of an interrupter unit of a circuit breaker, according to prior art.

FIG 3 is a cross-sectional view of a tube contact according to an embodiment of the present invention.

FIG 4 is a cross-sectional view of a contact arrangement according to another embodiment of the present invention.

FIG 5 is a schematic diagram illustrating a circuit breaker with the contact arrangement according to

yet another embodiment of the present invention.

FIG 6 is a graph showing a variation of modulus of elasticity with respect to stiffness of the bottom portion according to an embodiment of the present invention.

[0017] Various embodiments of the present disclosure will now be described in detail with reference to the accompanying drawings. In the following description, specific details such as detailed configuration and components are merely provided to assist the overall understanding of these embodiments of the present disclosure. Therefore, it should be apparent to those skilled in the art that various changes and modifications of the embodiments described herein can be made without departing from the scope and spirit of the present disclosure. In addition, descriptions of well-known functions and constructions are omitted for clarity and conciseness.

[0018] Also, the various embodiments described herein are not necessarily mutually exclusive, as some embodiments can be combined with one or more other embodiments to form new embodiments.

[0019] Referring now to drawings, FIG 3 is a cross-sectional view of the tube contact 300, according to the present invention. The tube contact 300 comprises a top portion 301 and a bottom portion 302. The bottom portion 302 extends from the top portion 301 in a substantially longitudinal direction of the tube contact 300. The top portion 301 may be made of, for example, a Tungsten-Copper, WCu material, having a weight range of WCu 90/10, WCu 85/15, WCu 80/20, WCu 75/25, WCu 70/30, WCu 65/35, WCu 60/40, WCu 55/45, WCu 50/50, a Silver Nickel (AgNi) material or Silver Tungsten (AgW), thereby combining a high melting point and arc erosion resistance of tungsten with the low melting point and good electrical conductivity of copper or the high conductivity of silver. The bottom portion 302 is made of a material having a Young's modulus of 190 GPa to 220 GPa. The selection of the material having a Young's modulus in the defined range makes the bottom section a high-strength portion. Here the top portion 301 and bottom portion 302 is joined by welding/brazing.

[0020] According to the embodiments herein the Young's modulus of the material selected for the bottom contact is determined based on:

$$E = P * L^3 / 3 * I * \delta l$$

where, E is the Modulus of elasticity of the material, P is the force exerted in N, L is the span (length) of force to be applied by the tube contact on the pin contact in mm, I is the moment of inertia in mm³ and δl is the deflection in mm. Here Young's modulus is a mechanical property of a material that measures the ability of a material to withstand changes in length when a tension or compression is applied along a length of the material.

[0021] According to the embodiments herein, the bottom portion 302 or the high-strength portion is made of steel or steel alloys. The steel alloy contains, for example, at least one of the components of Aluminium from 0.1wt% to 2.25wt%, Chromium from 0.5wt% to 18wt%, Copper from 0.1wt% to 0.4wt%, Manganese from 0.25wt% to 13wt%, Molybdenum from 0.25wt% to 5wt%, Nickel 0.2wt%-20wt%, Silicon 0.2wt%-2wt%, Carbon 0.002wt%-2.14wt%, Sulphur 0.08wt%-0.15wt%, Titanium 0.25wt%-2.60wt%, Vanadium 0.10wt%-1.50wt%. Further the steel alloy may comprise a very less percentage of Boron, Cobalt, Niobium, Nitrogen, Phosphorus, Zirconium and other elements. The aforementioned %weight may vary according to different standard data.

[0022] By using steel alloy for the bottom portion 302, the required tensile strength can be provided. The tensile strength of the bottom portion 302 may be ranging, for instance, from 470MPa to 630Mpa. Further the steel alloys are highly formable, which reduces the impact of the tube contact 300 with the corresponding pin contact (plug) during high speed closing operation of the circuit breaker. Additionally, since steel alloys have a high melting point temperature, the application of the steel alloys in the tube contact 300 according to the embodiments described herein causes only minimal contact erosion. Further, the tube contact 300 is configured for applications with increased closing speeds and high voltage conditions.

[0023] FIG 4 is a cross sectional view of contact arrangement 400 according to the present invention. The contact arrangement 400 comprises the tube contact 300 and a pin contact 401. The tube contact 300 is configured for receiving the pin contact 401, which acts as a plug when the contacts close. The tube contact 300 comprises a top portion 301 and a bottom portion 302 for receiving the corresponding plug. The pin contact 401 comprises a top portion 402 and a bottom portion 403. The bottom portion 403 of the pin contact 401 may be made of steel or steel alloy having a Young's modulus of 190 GPa to 220 GPa, where the steel alloy have a carbon content of at least 0.002wt%-2.1325wt%.

[0024] Typically, the tube contact 300 and the pin contact 401 are movable relative to each other along the longitudinal axis 303 of the tube contact 300 to establish or interrupt an electrical (and mechanical) contact.

[0025] In an embodiment, the force exerted by the tube contact 300 on the pin contact 401 to obtain contact pressure required for receiving the top portion 402 of the pin contact 401 during a normal breaker closed condition is calculated as,

$$P (N) : (3 * E_s * I * \delta_s) / l^3;$$

[0026] Where E_s is the permissible modulus of elasticity of steel; I is the moment of inertia, δ_s is the maximum deformation obtained on the bottom portion 302 and 1 is

the length of a cantilever beam from which the force is applied.

[0027] The bottom portion 302 of the tube contact 300 is designed in a way to increase the stiffness of the bottom portion 302 along a longitudinal direction, so as to hold the pin contact 401 during the closing operation when the pin contact 401 moves inside the tube contact 300. Here the increase in stiffness of the bottom portion 302 is achieved by selecting a material, such as steel, or any steel alloy having the Young's modulus within the range of 190GPa to 220GPa.

[0028] FIG 5 is a schematic diagram illustrating a circuit breaker 100 with the contact arrangement 400 according to the present invention. The contact arrangement 400 comprises a tube contact 300 adapted to be employed in the circuit breaker 100 and configured for receiving a corresponding pin contact 401 during a closing operation. According to the embodiments herein, the circuit breaker 100 herein is a high-voltage circuit breaker. The tube contact 300 and the pin contact 401 is adapted for connecting current paths, carry the current in a closed position, to interrupt current during an arc interrupt and to isolate current paths from each other during high voltage operation of the circuit breaker

[0029] During high speed closing operation, e.g. of a circuit breaker for which a tube contact 300 as described herein can be employed, the kinetic energy is introduced into the contact elements, e.g. the tube contact 300 and/or the corresponding pin contact 401. Hence, during closing operation of the circuit breaker, the tube contact 300 is subjected to high mechanical stress. According to embodiments, the tube contact 300 is configured to deflect when it form contact with the corresponding pin contact 401. In particular, by providing a high-strength material for the bottom portion 302, the tube contact do not deform or break upon high speed closing operations. By avoiding the deformation of the tube contact due to the high-strength bottom portion 302, the contact pressure between the tube contact 300 and the pin 400 can be assured. Thus by providing a tube contact 300 with a high strength bottom portion 302 as described herein, an improved circuit breaker functionality with respect to its electrical and thermal conductivity and reaction resistance to different operating environments using low material and processing cost can be achieved.

[0030] FIG 6 is a graph showing a variation of modulus of elasticity with respect to stiffness of the bottom portion according to an embodiment of the present invention. The stiffness of the material depends upon the young modulus of material and also varies with loading condition, shape and size. As Young's modulus of a material increases, the stiffness of the material also increases. When the stiffness increases, the contact force to be exerted by the tube contact on the pin contact also increases. So in order to hold the pin contact, when the pin contact plugs with the tube contact during closing operation of the circuit breaker, thickness of the bottom portion is reduced according to the present invention.

[0031] The foregoing description of the specific embodiments will so fully reveal the general nature of the embodiments herein that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. Therefore, while the embodiments herein have been described in terms of preferred embodiments, those skilled in the art will recognize that the embodiments herein can be practiced with modification within the spirit and scope of the embodiments as described herein. While the disclosure has been described with reference to the embodiment(s) mentioned above, it is to be understood that modifications and variations can be made without departing from the scope of the present disclosure, and such modifications and variations shall remain within the field and scope of the disclosure.

Reference list:

[0032]

100- Circuit breaker
101A, 101B, 101C - pole columns
102 - common breaker base
103 - a gas compartment
300- Tube contact
301- Top portion of tube contact
302- Bottom portion of tube contact
303- Longitudinal axis
400- Contact arrangement
401- Pin contact
402- Top portion of pin contact
403- Bottom portion of pin contact

Claims

1. A tube contact (300) configured for receiving a pin contact (401), the tube contact (300) comprising:
 - a top portion (301) configured for establishing an arc with the pin contact (401), and
 - a bottom portion (302) extending from the top portion (301) in a substantially longitudinal direction of the tube contact (300), **characterized in, that** the bottom portion (302) is a high strength portion made of a material having a Young's modulus of 190 GPa to 220 GPa.
2. The tube contact (300) according to claim 1, wherein the bottom portion (302) of the tube contact (300) is made of a material comprising at least steel.

3. The tube contact (300) according to claim 1, wherein the bottom portion (302) of the tube contact (300) is made of a material comprising at least a steel alloy having a carbon content of at least 0.002wt%-2.1325wt%. 5
4. The tube contact (300) according to claim 1, wherein a stiffness of the bottom portion (302) is directly proportional to the Young's modulus. 10
5. A contact arrangement (400) comprising a tube contact (300) and a pin contact (401) as claimed in any of the claims 1-4.
6. The contact arrangement (400) of claim 5, wherein a bottom portion (403) of the pin contact (401) is made of a material having a Young's modulus of 190 GPa to 220 GPa. 15
7. The contact arrangement (400) of claim 5, wherein the bottom portion (403) of the pin contact (401) is made of at least a material comprising steel. 20
8. The contact arrangement (400) of claim 5, wherein the bottom portion (401) of the pin contact (401) is made of a material comprising at least a steel alloy having a carbon content of at least 0.002wt%-2.1325wt%. 25
9. A circuit breaker (100) comprising a tube contact (300) according to any of the claims 1-4 and the contact arrangement according to any of the claims 5-8. 30

35

40

45

50

55

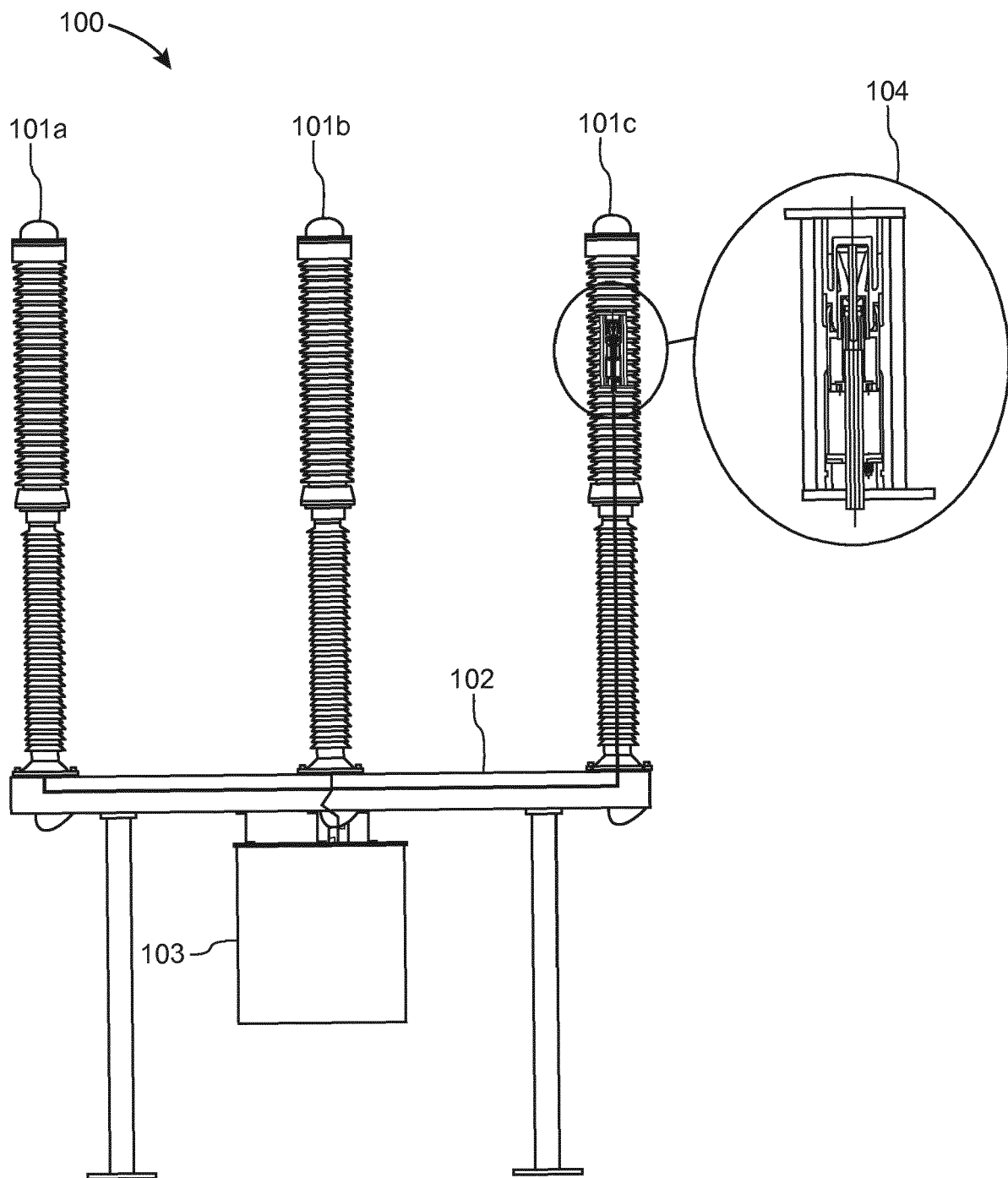


FIG. 1 (Prior Art)

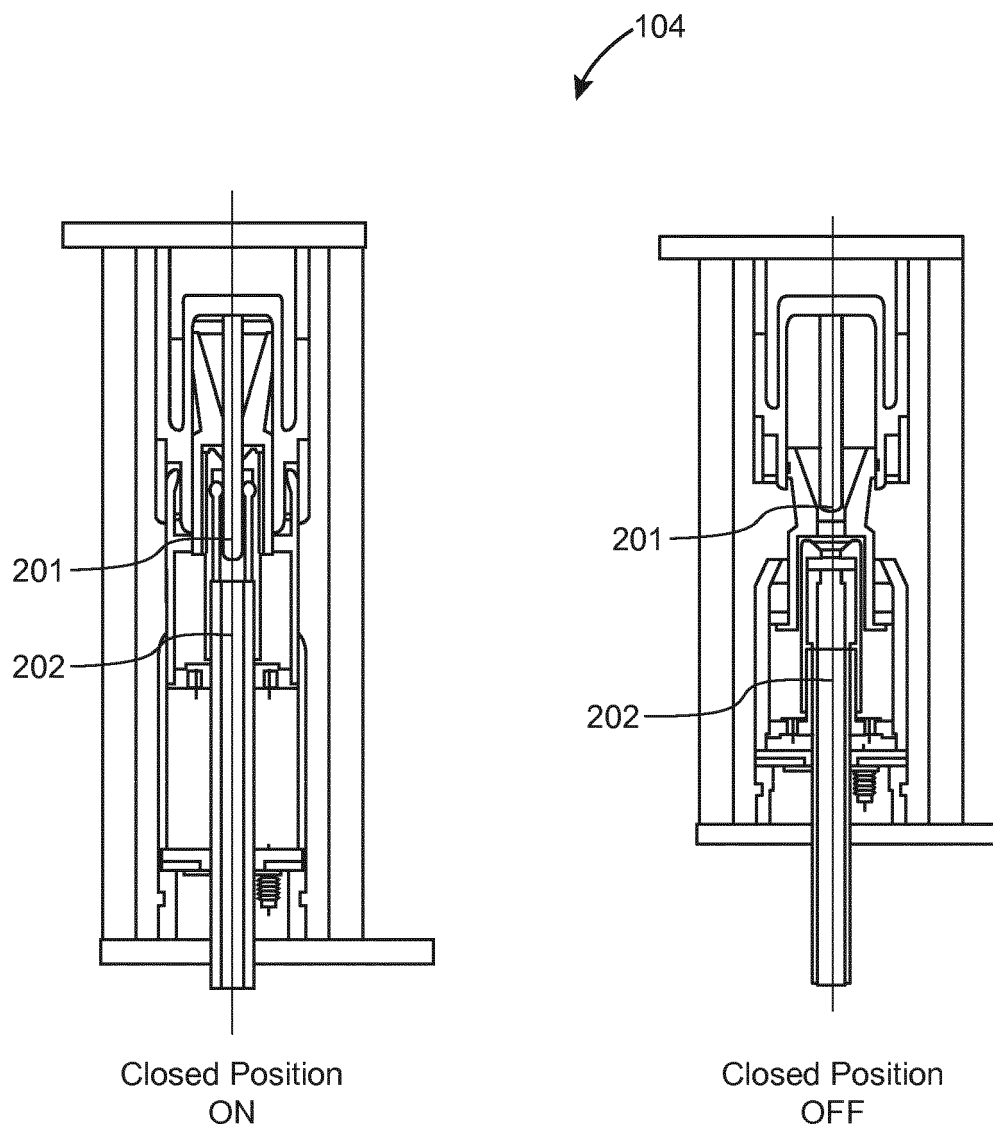


FIG. 2 (Prior Art)

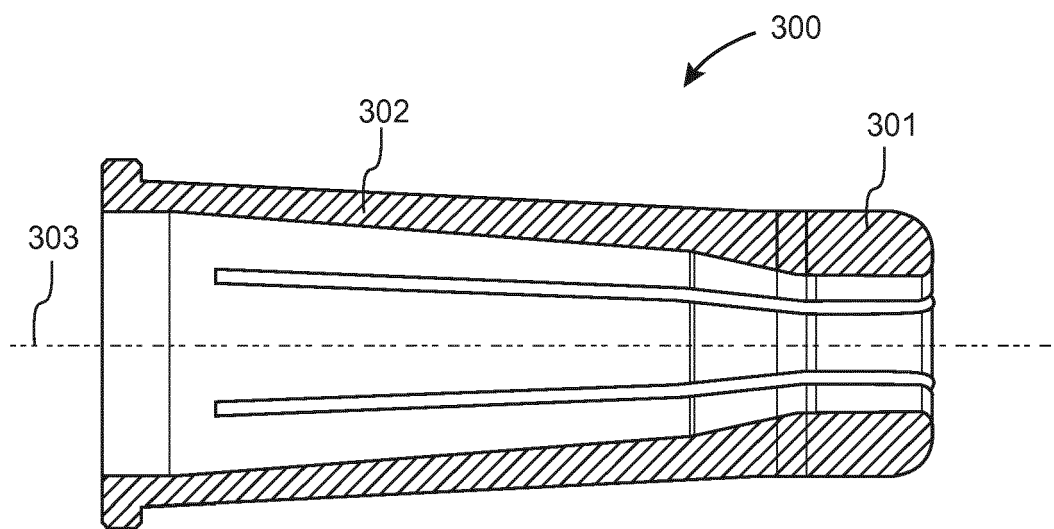


FIG. 3

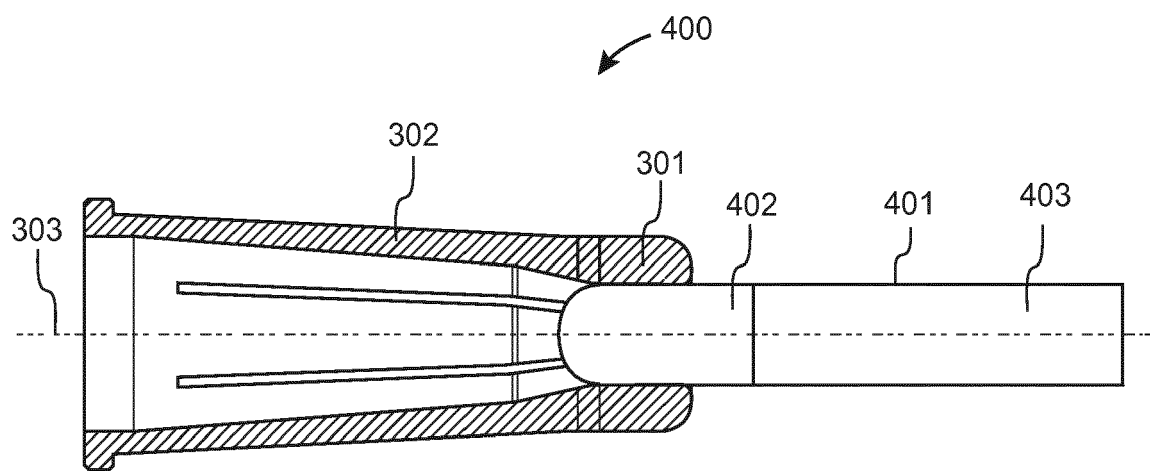


FIG. 4

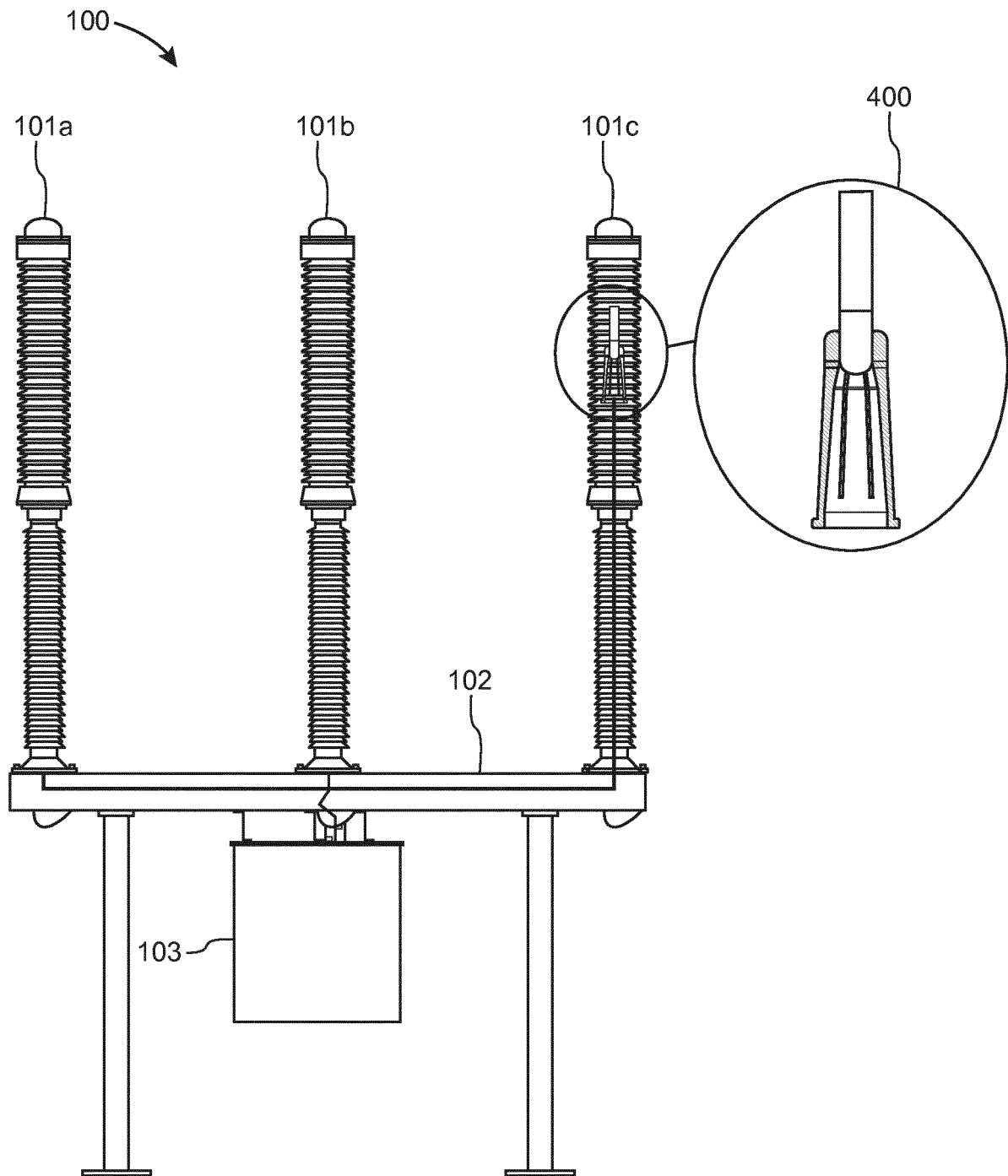


FIG. 5

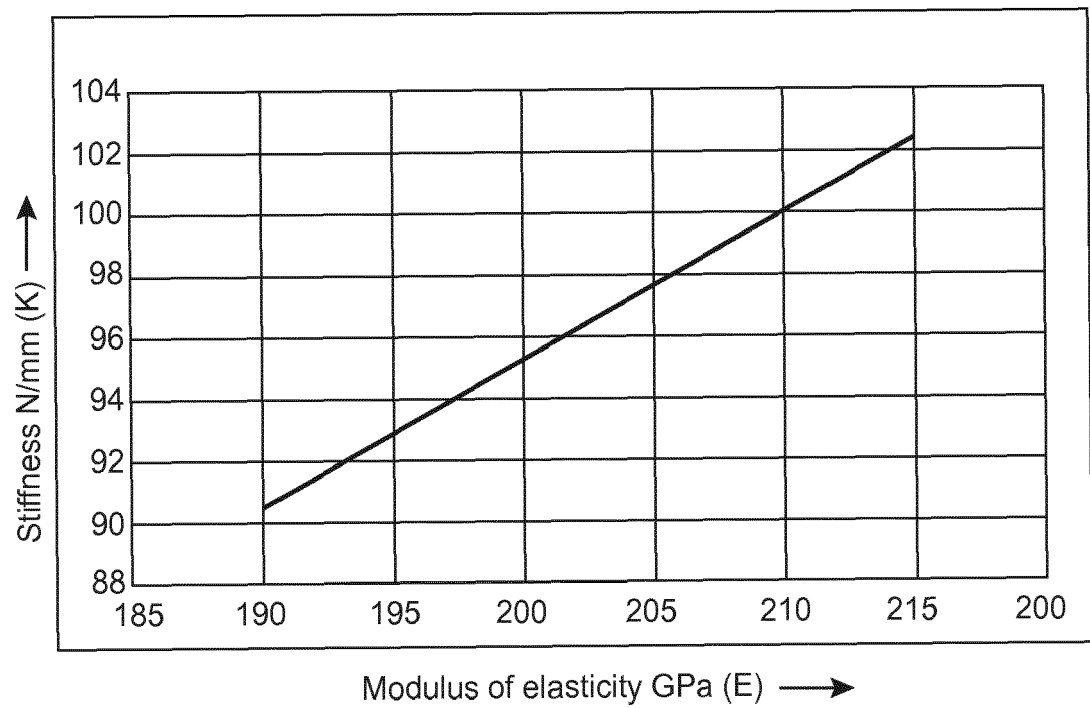


FIG. 6

Application Number
EP 19 19 8641

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 198 37 945 A1 (ASEA BROWN BOVERI [CH]) 24 February 2000 (2000-02-24) * column 3, line 63 - column 4, line 25 * * column 9, lines 18-22; claim 1 * * figures 1, 2a, 2b * -----	1-9	INV. H01H1/38 ADD. H01H1/02 H01H33/12
X	US 2014/360984 A1 (MORIYAMA TOMOHIRO [JP] ET AL) 11 December 2014 (2014-12-11) * paragraphs [0036] - [0048] * * figures 1,2,3 * -----	1-5,9	
A		6-8	
A,D	EP 2 797 095 A1 (ABB TECHNOLOGY AG [CH]) 29 October 2014 (2014-10-29) * abstract; figures 1, 2 * -----	1-9	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01H
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
Munich	6 March 2020	Glamán, C	
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 19 19 8641

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

06-03-2020

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19837945 A1	24-02-2000	CN 1245964 A	01-03-2000
		DE 19837945 A1	24-02-2000
		EP 0982748 A1	01-03-2000
		JP 2000067679 A	03-03-2000
		US 6211478 B1	03-04-2001

US 2014360984 A1	11-12-2014	CN 104241016 A	24-12-2014
		JP 2014235954 A	15-12-2014
		US 2014360984 A1	11-12-2014

EP 2797095 A1	29-10-2014	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 2797095 A1 [0005]