

(19)



(11)

EP 4 086 930 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:

02.07.2025 Bulletin 2025/27

(21) Application number: **21172726.8**

(22) Date of filing: **07.05.2021**

(51) International Patent Classification (IPC):

H01H 3/62 (2006.01)

(52) Cooperative Patent Classification (CPC):

H01H 3/62; H01H 3/24; H01H 3/26; H01H 3/28; H01H 3/30

(54) METAL DRIVE FOR ELECTRICAL SWITCH

METALLISCHER ANTRIEB FÜR ELEKTRISCHEN SCHALTER

ENTRAÎNEMENT MÉTALLIQUE POUR COMMUTATEUR ÉLECTRIQUE

(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

(43) Date of publication of application:

09.11.2022 Bulletin 2022/45

(73) Proprietor: **ABB Schweiz AG**

5400 Baden (CH)

(72) Inventors:

- **VIERTEL, Julia**
725 91 Västerås (SE)

• **PAULSSON, Göran**

725 91 Västerås (SE)

• **SINGH, Shailendra**

3720 Skien (NO)

(74) Representative: **Kransell & Wennborg KB**

P.O. Box 27834

115 93 Stockholm (SE)

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a metal drive for operating an electrical switch of a switchgear, in which drive different parts of the drive move in relation to, and in contact with, each other, e.g. by rolling or sliding.

BACKGROUND

[0002] Circuit breakers and switches in switchgears, such as ring main units, are operated by drives comprising spring type mechanisms, magnetic or pneumatic actuators etc. or a combination thereof. During energizing and operation of the drive, several different mechanical parts move and their surfaces slide against each other at high speed or they stay in contact with each other during energy storage. To prevent wear of the mechanical contact surfaces and to provide low friction during movement, the parts are conventionally lubricated with grease.

[0003] Grease lubricated drives need maintenance in form of re-greasing or replacement in certain time intervals as the lifetime of the grease is limited compared to the 25-30 years of lifetime of the switchgears. Moreover, the right type of grease needs to be chosen, depending on the climate conditions of the place where the switchgear is positioned when operating. Additionally, grease is only useful within a limited temperature range. In case of aged grease or wrong type of grease there is an increased risk for failure of the drive mechanism which prevents the switching operation of the switchgear.

[0004] As an alternative to metal drives, there are polymer drives available for low energy switching applications, but they face fatigue and low/high temperature operation strength related issues.

[0005] The all polymer drives are used for low energy applications and still have to scale up when higher currents and voltages are involved during switching. The fatigue curve (SN diagram) for polymers (for e.g. epoxy) shows much lower strength even at 10 000 cycles, which is the operating requirement for M2 qualification in a switchgear certification. There are some inherent limitations (material deterioration) of polymer drives when exposed to outdoor environment. There is also much more change in structural properties compared to metals at ambient temperatures of -40°C or below and of 60°C and above, limiting the usefulness of polymer drives.

[0006] Document US2889434 discloses a device according to the preamble of claim 1.

SUMMARY

[0007] It is an objective of the present invention to provide an improved drive for an electrical switch, with reduced maintenance need compared to greased metal drives, and with improved strength and temperature re-

sistance compared to polymer drives.

[0008] Proposed is a metal drive which may be regarded as a hybrid drive, in which a core of at least one of the parts of the drive is metal to provide strength, while at least one surface of the part is coated with a polymer material to provide protection against the ambient environment and improved performance. The moving, e.g. sliding and/or rolling, parts of the drive may be at least partly coated with the polymer coating discussed herein, while some other surfaces may be coated by e.g. a combination of polymer and/or metallic coating providing resistance against material degradation of the core metallic structure of the drive parts. An idea is to combine the strengths of metal and polymer drives in a hybrid drive, where the core is made up of metal (having relatively high strength and durability) and a surface is polymer-based providing lower friction and reduced maintenance need. Wear and corrosion resistance may be provided over the entire life-time of the drive and in different environmental conditions such as moderate, arctic or tropic climates.

[0009] According to an aspect of the present invention, there is provided a metal drive according to claim 1.

[0010] According to another aspect of the present invention, there is provided a switchgear comprising an embodiment of the metal drive of the present disclosure, and comprising the electrical switch.

[0011] By means of the polymer coating, a dry lubricant is provided, reducing or eliminating the need for lubrication maintenance during the lifetime of the drive, while maintaining the advantages of a metal drive over a polymer drive by means of the metal cores of the drive parts.

[0012] Other objectives, features and advantages of the enclosed embodiments will be apparent from the following detailed disclosure, from the attached dependent claims as well as from the drawings.

[0013] Generally, all terms used in the claims are to be interpreted according to their ordinary meaning in the technical field, unless explicitly defined otherwise herein.

All references to "a/an/the element, apparatus, component, means, step, etc." are to be interpreted openly as referring to at least one instance of the element, apparatus, component, means, step, etc., unless explicitly stated otherwise. The steps of any method disclosed herein do not have to be performed in the exact order disclosed, unless explicitly stated. The use of "first", "second" etc. for different features/components of the present disclosure are only intended to distinguish the features/components from other similar features/components and not to impart any order or hierarchy to the features/components.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Embodiments will be described, by way of example, with reference to the accompanying drawings, in which:

Fig 1 is a schematic block diagram of a switchgear and drive thereof, in accordance with some embodiments of the present invention.

Fig 2 is a schematic circuit diagram of a switchgear, in accordance with some embodiments of the present invention.

DETAILED DESCRIPTION

[0015] Embodiments will now be described more fully hereinafter with reference to the accompanying drawings, in which certain embodiments are shown. However, other embodiments in many different forms are possible within the scope of the present disclosure. Rather, the following embodiments are provided by way of example so that this disclosure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art. Like numbers refer to like elements throughout the description.

[0016] Figure 1 illustrates a switchgear 10 comprising a drive 1 for operating an electrical switch of the switchgear. The drive may be actuated in any conventional way, e.g. spring, magnetically or pneumatically actuated. The drive 1 comprises a plurality of parts 2 which are arranged to move in relation to each other during operation of the drive. The drive 1 is a metal drive, implying that at least the core 4 of each of the parts is of a metallic material. Two parts 2 which are arranged to move in relation to, and in contact with, each other each comprises a contact surface 3 for making contact with the corresponding contact surface 3 of the other part 2. At least one contact surface 3 of at least one part 2 of the drive 1 has a polymer coating 5 of a polymer material 6. The polymer coating is arranged to act as a dry lubricant. That the contact surface 3 has a polymer coating 5 implies that the contact surface is (at least partly) provided by the polymer coating, since the polymer coating 5 provides an outermost surface of the part 2, which then becomes the contact surface 3. In some embodiments, the coated part 2 is coated only where it is arranged to contact another part 2 of the drive 1. Alternatively, in some other embodiments, the coated part 2 is coated also on other surfaces, the metal core 4 being partly or fully enclosed by the polymer coating 5.

[0017] The polymer coating 5 is applied directly on a metallic material 7 of the part 2. Typically, the metallic material 7 is of the metal core 4, implying that the polymer coating is applied directly onto the metal core, without any intermediate layer, but in some embodiments, the metallic material 7 may be provided by intermediate layer 8 provided between the metal core 4 and the polymer coating 5, e.g. an anti-corrosion layer such as a nickel containing layer. Metallic anti-corrosion nickel layers are conventionally used.

[0018] In the example of figure 1, two parts 2 of the drive 1 are shown, a first part 2a and a second part 2b. The first part 2a comprises a first contact surface 3a arranged to move (as indicated by the downward pointing arrow in the figure) in relation to, and in contact with, a

second contact surface 3b of the second part 2b. Each of the first and second parts 2a and 2b comprises a metal core 4a and 4b. The first contact surface 3a has a dry lubricant polymer coating 5 of a polymer material 6 applied directly on a metallic material 7, e.g. of the metal core 4a or of a metallic intermediate layer 8.

[0019] Often, the second contact surface 3b is metallic, e.g. of the metal core 4b or of a metallic coating 8. However, in some embodiments, also the second contact surface 3b has a dry lubricant polymer coating 5 of a polymer material 6 applied directly on a metallic material 7. The polymer material of the second contact surface according to the invention is different than, the polymer material of the first contact surface. Typically, the tribological properties when the two contact surfaces 3a and 3b move in contact with each other are improved when surface materials are different rather than the same, why it is preferred that the polymer coating 5 of the second contact surface 3b is of a different polymer material 6 than the polymer coating 5 of the first contact surface 3a. It is envisioned that it may in some applications be preferred with the second contact surface being of a polymer material 6 rather than being metallic, e.g. for improved tribological properties or reduced heat formation when the first and second contact surfaces move in contact with each other.

[0020] The drive 1 may have any number of parts 2 and any number of pairs of contact surfaces 3 arranged move in relation to, and in contact with, each other. In any of these pairs, at least one of the contact surfaces 3 may be provided by a polymer coating 5 as discussed herein. In case there is more than one pair of contact surfaces in the drive which are provided with a polymer coating 5, the polymer material 6 may be the same for all coatings 5, e.g. for simplifying the manufacture of the drive 1, or the polymer material 6 of at least one of the coatings 5 may be different from at least one other of the coatings 5. The use of different materials 6 allows the material 6 to be selected depending on the particular requirements on each contact surface, e.g. depending on the pressure, movement and/or temperature the contact surface is intended for.

[0021] Thus, in some embodiments of the present invention, wherein the drive 1 further comprises a third part 2 and a fourth part 2, the third part comprising a third contact surface 3 arranged to move in relation to, and in contact with, a fourth contact surface 3 of the fourth part. Similar to the first contact surface, the third contact surface has a dry lubricant polymer coating 5 of a polymer material 6 applied directly on a metallic material 7. In some embodiments, similar to the discussion about the first and second contact surfaces, also the fourth contact surface 3 has a dry lubricant polymer coating 5 of a polymer material 6 applied directly on a metallic material 7, the polymer material of the fourth contact surface being the same as or different than, preferably different than, the polymer material of the third contact surface. As discussed above, the polymer material 6 of the third contact surface 3 is the same or different than, preferably

different than, the polymer material 6 of the first contact surface 3a. Depending on the contact pressure and sliding speed of each mechanical contact in the drive 1, a combination of different coating materials 6 can be used within the same drive 1.

[0022] The polymer material 6 of any polymer coating 5 in the drive 1 may be any suitable polymer material. Since the drive is not involved in the conduction of an electrical current, that being handled by the switch of the switchgear, the polymer material does not have to be electrically conducting, and typically is electrically insulating though electrically conducting materials are not excluded.

[0023] The polymer material 6 may conveniently be or comprise a thermoplastic material or a thermosetting material, optionally comprising a filler material as an additive.

[0024] Examples of suitable thermoplastic materials 6 includes thermoplastic materials comprising or consisting of polyaryletherketones (PAEK), for instance polyether ether ketone (PEEK) or polyetherketone (PEK); fluoropolymers, for instance polytetrafluoroethylene (PTFE); ultrahigh molecular weight poly ethylene (UHWPE); polyamides (PA); polyimides (PI); and/or polyoxymethylen (POM). Preferably the polymer material comprises or consists of PEAK and/or PTFE.

[0025] Examples of suitable thermosetting materials 6 includes thermosetting materials comprising or consisting of an epoxy and/or phenolic varnish, preferably an epoxy varnish.

[0026] Examples of suitable filler additive includes a filler comprising or consisting of graphite, molybdenum disulphide (MoS_2), tungsten disulphide (WS_2) and/or PTFE, preferably MoS_2 and/or PTFE. A specific example of suitable polymer material 6 comprising a filler is an epoxy varnish comprising a MoS_2 and/or PTFE filler.

[0027] In some embodiments of the present invention, any or all polymer coating(s) 5 in the drive 1 has a thickness within the range of 5-100 μm , preferably within the range of 10-50 μm . The coating 5 may be applied to the part 2 using an automated coating process, e.g. including spray coating, drum coating or powder coating, depending on the polymer material 6 used.

[0028] In some embodiments of the present invention, the first contact surface 3a is arranged to move in relation to the second contact surface 3b by sliding or rolling, e.g. by sliding against the second contact surface. The same could apply for any further contact surface pairs in the drive 1. Examples of rolling contact may be in a ball bearing, e.g. where at least one of the balls is coated with the polymer material 6. Other examples of parts 2 include e.g. a spring actuator, or any part 2 arranged to be moved by an actuator e.g. a spring, magnetic or pneumatic actuator, in the drive 1.

[0029] In some embodiments of the present invention, any of the respective metal cores 4 of the drive 1, e.g. the metal core 4a of the first part 2a and/or the metal core 4b of the second part 2b are of made of steel. Steel can provide the strength and durability desired for the drive 1.

In case the part 2 is in the form of, or part of, a spring, the core 4 may be made of a spring steel.

[0030] Figure 2 illustrates a switchgear 10 comprising an electrical switch 11 for switching an electrical current I having the voltage U. The switchgear 10 thus comprises the drive 1 discussed above, as well as the switch 11 (and possibly further switches 11). The switchgear 10 may be any switchgear configured for breaking or switching a current I by means of the at least one switch 11. The switchgear 10 may e.g. be configured for breaking or switching a current I having a voltage within the medium voltage range, e.g. within the range of 1-52 kV.

[0031] The present disclosure has mainly been described above with reference to a few embodiments. However, as is readily appreciated by a person skilled in the art, other embodiments than the ones disclosed above are equally possible within the scope of the present disclosure, as defined by the appended claims.

Claims

1. A metal drive (1) for operating an electrical switch (11) of a switchgear (10), the drive comprising at least a first part (2a) and a second part (2b), the first part comprising a first contact surface (3a) arranged to move in relation to, and in contact with, a second contact surface (3b) of the second part;

wherein each of the first and second parts comprises a metal core (4a, 4b);

characterised in that

the first contact surface (3a) has a dry lubricant polymer coating (5) of a polymer material (6) applied directly on a metallic material (7); and wherein also the second contact surface (3b) has a dry lubricant polymer coating (5) of a polymer material (6) applied directly on a metallic material (7), the polymer material of the second contact surface being different than the polymer material (6) of the first contact surface (3a).

2. The metal drive of claim 1, wherein the polymer material (6) is thermoplastic, e.g. comprising a polymer from the group consisting of:

polyaryletherketones, PAEK, for instance polyether ether ketone, PEEK, or polyetherketone, PEK; fluoropolymers, for instance polytetrafluoroethylene, PTFE; ultrahigh molecular weight poly ethylene, UHWPE; polyamides, PA; polyimides, PI; and polyoxymethylen, POM; or any combination thereof;

preferably the polymer material comprises or consists of PEAK and/or PTFE.

3. The metal drive of claim 1, wherein the polymer material (6) is thermosetting, e.g. comprising an epoxy and/or phenolic varnish, preferably epoxy.
4. The metal drive of any preceding claim, wherein the polymer material (6) comprises a filler, e.g. a filler comprising graphite, molybdenum disulphide, MoS₂, tungsten disulphide, WS₂, and/or PTFE, preferably MoS₂ and/or PTFE.
5. The metal drive of any preceding claim, wherein the metallic material (7) on which the polymer coating (5) is directly applied is of the metal core (4a) of the first part (2a).
6. The metal drive of any claim 1-4, wherein the metallic material (7) on which the polymer coating (5) is directly applied is of an intermediate layer (8) between the metal core (4a) and the polymer coating (5) of the first part (2a), e.g. an anticorrosion layer such as a nickel containing layer.
7. The metal drive of any preceding claim, wherein the polymer coating (5) has a thickness within the range of 5-100 µm, preferably within the range of 10-50 µm.
8. The metal drive of any preceding claim, wherein the first contact surface (3a) is arranged to move in relation to the second contact surface (3b) by sliding or rolling, e.g. by sliding against the second contact surface.
9. The metal drive of any preceding claim, wherein the metal core (4a) of the first part (2a) and/or the metal core (4b) of the second part (2b) are of made of steel, e.g. spring steel.
10. The metal drive of any preceding claim, wherein the drive (1) further comprises a third part (2) and a fourth part (2), the third part comprising a third contact surface (3) arranged to move in relation to, and in contact with, a fourth contact surface (3) of the fourth part;

wherein each of the third and fourth parts comprises a metal core (4); and

wherein the third contact surface has a dry lubricant polymer coating (5) of a polymer material (6) applied directly on a metallic material (7).
11. The metal drive of claim 10, wherein also the fourth contact surface (3) has a dry lubricant polymer coating (5) of a polymer material (6) applied directly on a metallic material (7), the polymer material of the

fourth contact surface being the same as or different than, preferably different than, the polymer material of the third contact surface.

12. The metal drive of claim 10 or 11, wherein the polymer material (6) of the third contact surface (3) is different than the polymer material (6) of the first contact surface (3a).
13. A switchgear (10) comprising the metal drive (1) of any preceding claim, and the switch (11).

Patentansprüche

1. Metallantrieb (1) zum Betreiben eines elektrischen Schalters (11) einer Schaltanlage (10), wobei der Antrieb mindestens einen ersten Teil (2a) und einen zweiten Teil (2b) umfasst, wobei der erste Teil eine erste Kontaktfläche (3a) umfasst, die so angeordnet ist, dass sie sich in Relation zu und in Kontakt mit einer zweiten Kontaktfläche (3b) des zweiten Teils bewegt;

wobei sowohl der erste als auch der zweite Teil einen Metallkern (4a, 4b) umfasst;

dadurch gekennzeichnet, dass

die erste Kontaktfläche (3a) eine Trockenschmierstoffpolymerbeschichtung (5) aus einem Polymermaterial (6) aufweist, die direkt auf ein metallisches Material (7) aufgebracht ist; und

wobei auch die zweite Kontaktfläche (3b) eine Trockenschmierstoffpolymerbeschichtung (5) aus einem Polymermaterial (6) aufweist, die direkt auf ein metallisches Material (7) aufgebracht ist, wobei sich das Polymermaterial der zweiten Kontaktfläche von dem Polymermaterial (6) der ersten Kontaktfläche (3a) unterscheidet.
2. Metallantrieb nach Anspruch 1, wobei das Polymermaterial (6) thermoplastisch ist, z. B. ein Polymer aus der Gruppe umfasst, die aus Folgendem besteht:

Polyaryletherketone, PAEK, beispielsweise Polyetheretherketon, PEEK, oder Polyetherketon, PEK;

Fluorpolymere, beispielsweise Polytetrafluorethylen, PTFE;

Polyethylen mit ultrahohem Molekulargewicht, UHWPE;

Polyamide, PA;

Polyimide, PI; und

Polyoxymethylen, POM;

oder eine beliebige Kombination davon;

wobei vorzugsweise das Polymermaterial PEAK und/oder PTFE umfasst oder daraus be-

steht.

3. Metallantrieb nach Anspruch 1, wobei das Polymermaterial (6) duroplastisch ist, z. B. ein Epoxid und/oder einen Phenollack, vorzugsweise Epoxid, umfasst. 5
4. Metallantrieb nach einem der vorhergehenden Ansprüche, wobei das Polymermaterial (6) einen Füllstoff umfasst, z. B. einen Füllstoff, der Graphit, Molybdändisulfid, MoS₂, Wolframdissulfid, WS₂ und/oder PTFE, vorzugsweise MoS₂ und/oder PTFE, umfasst. 10
5. Metallantrieb nach einem der vorhergehenden Ansprüche, wobei das metallische Material (7), auf das die Polymerbeschichtung (5) direkt aufgebracht ist, aus dem Metallkern (4a) des ersten Teils (2a) besteht. 15
6. Metallantrieb nach einem der Ansprüche 1-4, wobei das metallische Material (7), auf das die Polymerbeschichtung (5) direkt aufgebracht ist, aus einer Zwischenschicht (8) zwischen dem Metallkern (4a) und der Polymerbeschichtung (5) des ersten Teils (2a), z. B. einer Korrosionsschutzschicht, wie etwa einer Nickel enthaltenden Schicht, besteht. 20
7. Metallantrieb nach einem der vorhergehenden Ansprüche, wobei die Polymerbeschichtung (5) eine Dicke im Bereich von 5-100 µm, vorzugsweise im Bereich von 10-50 µm, aufweist. 25
8. Metallantrieb nach einem der vorhergehenden Ansprüche, wobei die erste Kontaktfläche (3a) so angeordnet ist, dass sie sich in Relation zu der zweiten Kontaktfläche (3b) durch Gleiten oder Rollen, z. B. durch Gleiten an der zweiten Kontaktfläche, bewegt. 30
9. Metallantrieb nach einem der vorhergehenden Ansprüche, wobei der Metallkern (4a) des ersten Teils (2a) und/oder der Metallkern (4b) des zweiten Teils (2b) aus Stahl, z. B. Federstahl, hergestellt sind. 35
10. Metallantrieb nach einem der vorhergehenden Ansprüche, wobei der Antrieb (1) ferner einen dritten Teil (2) und einen vierten Teil (2) umfasst, wobei der dritte Teil eine dritte Kontaktfläche (3) umfasst, die so angeordnet ist, dass sie sich in Relation zu und in Kontakt mit einer vierten Kontaktfläche (3) des vierten Teils bewegt; 40

wobei sowohl der dritte als auch der vierte Teil einen Metallkern (4) umfasst; und
wobei die dritte Kontaktfläche eine Trockenschmierstoffpolymerbeschichtung (5) aus einem Polymermaterial (6) aufweist, die direkt auf ein metallisches Material (7) aufgebracht ist. 45

11. Metallantrieb nach Anspruch 10, wobei auch die vierte Kontaktfläche (3) eine Trockenschmierstoffpolymerbeschichtung (5) aus einem Polymermaterial (6) aufweist, die direkt auf ein metallisches Material (7) aufgebracht ist, wobei das Polymermaterial der vierten Kontaktfläche gleich dem Polymermaterial der dritten Kontaktfläche ist oder sich von diesem unterscheidet, vorzugsweise sich von diesem unterscheidet.
12. Metallantrieb nach Anspruch 10 oder 11, wobei sich das Polymermaterial (6) der dritten Kontaktfläche (3) von dem Polymermaterial (6) der ersten Kontaktfläche (3a) unterscheidet.
13. Schaltanlage (10), die den Metallantrieb (1) nach einem der vorhergehenden Ansprüche und den Schalter (11) umfasst.

Revendications

1. Entraînement métallique (1) pour faire fonctionner un commutateur électrique (11) d'un appareillage de commutation (10), l'entraînement comprenant au moins une première partie (2a) et une seconde partie (2b), la première partie comprenant une première surface de contact (3a) agencée pour se déplacer par rapport à, et en contact avec, une seconde surface de contact (3b) de la seconde partie ;

dans lequel chacune des première et seconde parties comprend un noyau métallique (4a, 4b) ;

caractérisé en ce que

la première surface de contact (3a) a un revêtement polymère lubrifiant sec (5) en matériau polymère (6) appliqué directement sur un matériau métallique (7) ; et

dans lequel la seconde surface de contact (3b) a également un revêtement polymère lubrifiant sec (5) en matériau polymère (6) appliqué directement sur un matériau métallique (7), le matériau polymère de la seconde surface de contact étant différent du matériau polymère (6) de la première surface de contact (3a).

2. Entraînement métallique selon la revendication 1, dans lequel le matériau polymère (6) est du thermoplastique, par exemple comprenant un polymère parmi le groupe constitué de :

polyaryléthercétone, PAEK, par exemple polyétheréthercétone, PEEK, ou polyéthercétone, PEK ;
fluoropolymères, par exemple polytétrafluoroéthylène, PTFE ;
polyéthylène de masse molaire très élevée, UHWPE ;

- polyamides, PA ;
polyimides, PI ; et
polyoxyméthylène, POM ;
ou une quelconque combinaison de ceux-ci ;
de préférence le matériau polymère comprend 5
ou est constitué de PEAK et/ou PTFE.
3. Entraînement métallique selon la revendication 1,
dans lequel le matériau polymère (6) est thermodur- 10
cissable, par exemple comprenant un vernis époxy
et/ou phénolique, de préférence époxy.
4. Entraînement métallique selon l'une quelconque
des revendications précédentes, dans lequel le ma- 15
térial polymère (6) comprend une charge, par exem-
ple une charge comprenant du graphite, du disulfure
de molybdène, MoS₂, du disulfure de tungstène,
WS₂, et/ou du PTFE, de préférence du MoS₂ et/ou
du PTFE. 20
5. Entraînement métallique selon l'une quelconque
des revendications précédentes, dans lequel le ma-
térial métallique (7) sur lequel le revêtement poly-
mère (5) est directement appliqué fait partie du
noyau métallique (4a) de la première partie (2a). 25
6. Entraînement métallique selon l'une quelconque
des revendications 1 à 4, dans lequel le matériau
métallique (7) sur lequel le revêtement polymère (5)
est directement appliqué fait partie d'une couche 30
intermédiaire (8) entre le noyau métallique (4a) et
le revêtement polymère (5) de la première partie
(2a), par exemple une couche anticorrosion telle
qu'une couche contenant du nickel. 35
7. Entraînement métallique selon l'une quelconque
des revendications précédentes, dans lequel le re-
vêtement polymère (5) a une épaisseur dans la
plage de 5 à 100 µm, de préférence dans la plage
de 10 à 50 µm. 40
8. Entraînement métallique selon l'une quelconque
des revendications précédentes, dans lequel la pre-
mière surface de contact (3a) est agencée pour se
déplacer par rapport à la seconde surface de contact 45
(3b) par glissement ou roulement, par exemple en
glissant contre la seconde surface de contact.
9. Entraînement métallique selon l'une quelconque
des revendications précédentes, dans lequel le 50
noyau métallique (4a) de la première partie (2a)
et/ou le noyau métallique (4b) de la seconde partie
(2b) sont constitués d'acier, par exemple d'acier à
ressort. 55
10. Entraînement métallique selon l'une quelconque
des revendications précédentes, dans lequel l'en-
traînement (1) comprend en outre une troisième
- partie (2) et une quatrième partie (2), la troisième
partie comprenant une troisième surface de contact
(3) agencée pour se déplacer par rapport à, et en
contact avec, une quatrième surface de contact (3)
de la quatrième partie ;
- dans lequel chacune des troisième et quatrième
parties comprend un noyau métallique (4) ; et
dans lequel la troisième surface de contact a un
revêtement polymère lubrifiant sec (5) en maté-
riau polymère (6) appliqué directement sur un
matériau métallique (7).
11. Entraînement métallique selon la revendication 10,
dans lequel la quatrième surface de contact (3) a
également un revêtement polymère lubrifiant sec (5)
en matériau polymère (6) appliqué directement sur
un matériau métallique (7), le matériau polymère de
la quatrième surface de contact étant identique au ou
différent, de préférence différent, du matériau poly-
mère de la troisième surface de contact.
12. Entraînement métallique selon la revendication 10
ou 11, dans lequel le matériau polymère (6) de la
troisième surface de contact (3) est différent du
matériau polymère (6) de la première surface de
contact (3a).
13. Appareillage de commutation (10) comprenant l'en-
traînement métallique (1) selon l'une quelconque
des revendications précédentes, et le commutateur
(11).

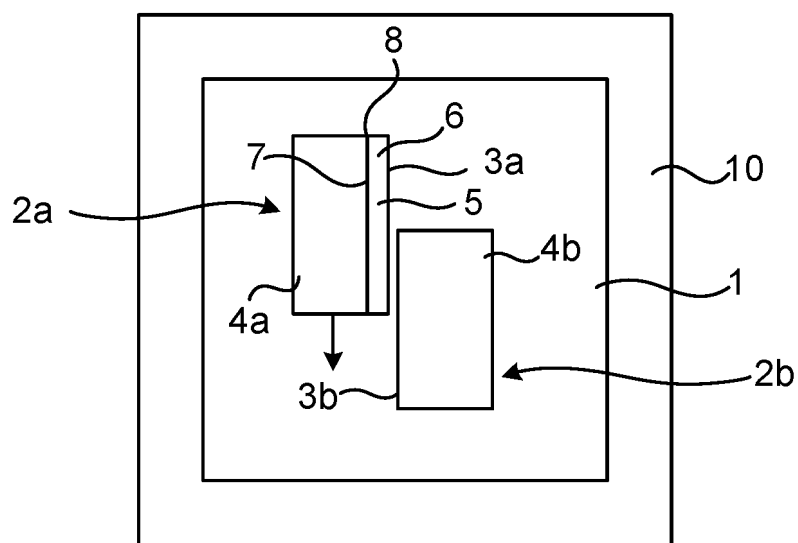


Fig. 1

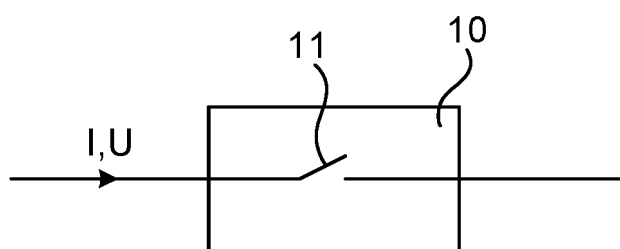


Fig. 2

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2889434 A [0006]