



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
09.11.2022 Bulletin 2022/45

(51) International Patent Classification (IPC):
H01H 3/62 (2006.01)

(21) Application number: **21172726.8**

(52) Cooperative Patent Classification (CPC):
H01H 3/62; H01H 3/24; H01H 3/26; H01H 3/28;
H01H 3/30

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

(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:
• **VIERTEL, Julia**
725 91 Västerås (SE)
• **PAULSSON, Göran**
725 91 Västerås (SE)
• **SINGH, Shailendra**
3720 Skien (NO)

(71) Applicant: **ABB Schweiz AG**
5400 Baden (CH)

(74) Representative: **Kransell & Wennborg KB**
P.O. Box 27834
115 93 Stockholm (SE)

(54) **METAL DRIVE FOR ELECTRICAL SWITCH**

(57) The present disclosure relates to a metal drive (1) for operating an electrical switch of a switchgear (10). The drive comprises 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. The first contact surface has a dry lubricant polymer coating (5) of a polymer material (6) applied directly on a metallic material (7).

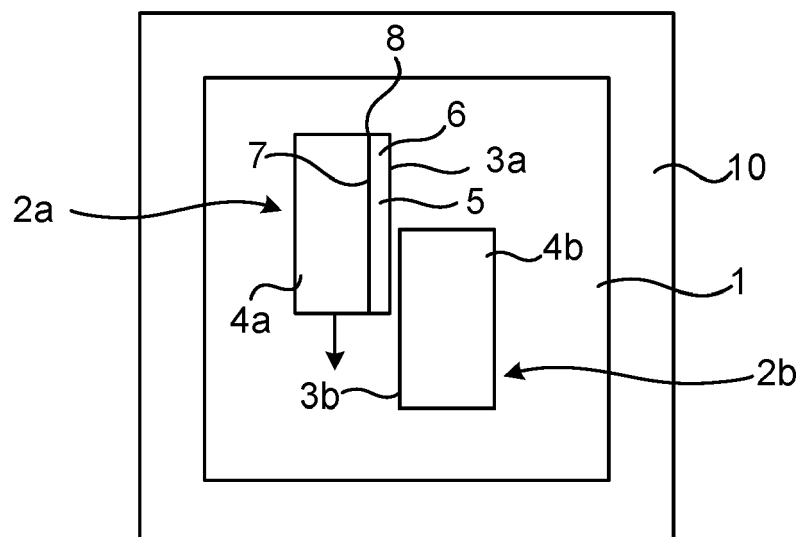


Fig. 1

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.

SUMMARY

[0006] 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 resistance compared to polymer drives.

[0007] Proposed is a metal drive which may be regard-

ed 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.

[0008] According to an aspect of the present invention, there is provided a metal drive for operating an electrical switch of a switchgear. The drive comprises at least a first part and a second part, the first part comprising a first contact surface arranged to move in relation to, and in contact with, a second contact surface of the second part. Each of the first and second parts comprises a metal core. The first contact surface has a dry lubricant polymer coating of a polymer material applied directly on a metallic material.

[0009] 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.

[0010] 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.

[0011] It is to be noted that any feature of any of the aspects may be applied to any other aspect, wherever appropriate. Likewise, any advantage of any of the aspects may apply to any of the other aspects. 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.

[0012] 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 fea-

tures/components from other similar features/components and not to impart any order or hierarchy to the features/components.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] 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

[0014] 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.

[0015] 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.

[0016] 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. e.g. an anti-corrosion layer such as a nickel containing layer. Metallic anti-corrosion nickel layers are conventionally used.

[0017] 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.

[0018] 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 may be the same as or different than, preferably 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.

[0019] The drive 1 may have any number of parts 2 and any number of pairs of contact surfaces 3 arranged to 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.

[0020] 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.

[0021] 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.

[0022] The polymer material 6 may conveniently be or comprise a thermoplastic material or a thermosetting material, optionally comprising a filler material as an additive.

[0023] 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 PAEK and/or PTFE.

[0024] Examples of suitable thermosetting materials 6 includes thermosetting materials comprising or consisting of an epoxy and/or phenolic varnish, preferably an epoxy varnish.

[0025] Examples of suitable filler additive includes a filler comprising or consisting of graphite, molybdenum disulphide (MoS₂), tungsten disulphide (WS₂) and/or PTFE, preferably MoS₂ and/or PTFE. A specific example of suitable polymer material 6 comprising a filler is an epoxy varnish comprising a MoS₂ and/or PTFE filler.

[0026] 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.

[0027] 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.

[0028] 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.

[0029] 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.

[0030] 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.

35 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); and wherein the first contact surface (3a) has a dry lubricant polymer coating (5) of a polymer material (6) applied directly on a metallic material (7).
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, UH-

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

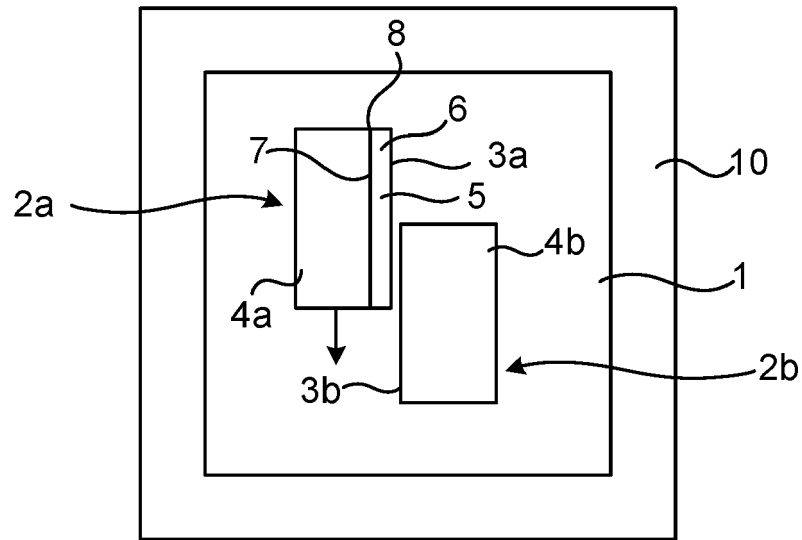


Fig. 1

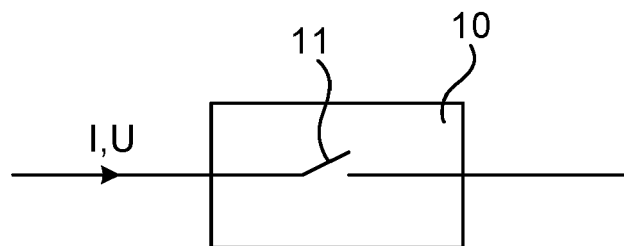


Fig. 2



EUROPEAN SEARCH REPORT

 Application Number
 EP 21 17 2726

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	US 2012/199558 A1 (FAULKNER ROGER W [US]) 9 August 2012 (2012-08-09) * abstract *	1,2,4,5,7-14 3,6	INV. H01H3/62
Y	----- US 2006/245675 A1 (LANG HUBERT [AT]) 2 November 2006 (2006-11-02) * paragraphs [0036], [0038] *	3	
Y	----- US 2013/157024 A1 (EIGENBROD VOLKMAR [DE]) 20 June 2013 (2013-06-20) * paragraphs [0019] - [0025] *	6	
A	----- US 8 119 577 B2 (STECHE CHRISTOPH [DE]; ACS COATING SYSTEMS GMBH [DE]) 21 February 2012 (2012-02-21) * column 3, lines 5-34 *	4	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			H01H B05D C09D F16C
Place of search		Date of completion of the search	Examiner
Munich		1 October 2021	Simonini, Stefano
CATEGORY OF CITED DOCUMENTS 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 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			

 1
 EPO FORM 1503 03.82 (P04C01)

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

EP 21 17 2726

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.

01-10-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012199558 A1	09-08-2012	US 2012199558 A1	09-08-2012
		US 2015122780 A1	07-05-2015

US 2006245675 A1	02-11-2006	AT 501878 A1	15-12-2006
		AT 531957 T	15-11-2011
		BR PI0601468 A	26-12-2006
		DK 1717469 T3	27-02-2012
		EP 1717469 A2	02-11-2006
		ES 2376583 T3	15-03-2012
		JP 4897343 B2	14-03-2012
		JP 2006308099 A	09-11-2006
		JP 2010151321 A	08-07-2010
		KR 20060113555 A	02-11-2006
		PT 1717469 E	07-02-2012
		RU 2329415 C2	20-07-2008
		US 2006245675 A1	02-11-2006

US 2013157024 A1	20-06-2013	DE 102011119731 A1	06-06-2013
		EP 2599843 A1	05-06-2013
		US 2013157024 A1	20-06-2013

US 8119577 B2	21-02-2012	DE 102005009552 A1	07-09-2006
		US 2008247687 A1	09-10-2008
		WO 2006092126 A1	08-09-2006
