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(54) IMPROVEMENTS IN OR RELATING TO BYPASS SWITCHES FOR CHAIN-LINK MODULES

(57) In the field of bypass switches for chain-link modules there is a need for an improved such bypass switch.

A bypass switch (40), for a chain-link module (26) operable with other chain-link modules (26) to form a chain-link converter (24) to selectively provide a stepped variable voltage source within a voltage source converter (10), comprises a switch chassis (42) which has a vacuum interrupter (46) mounted thereon. The vacuum interrupter (46) includes first and second switch contacts (50, 52). The first switch contact (50) is fixed relative to the switch chassis (42) and the second switch contact (52) is moveable relative to the switch chassis (42), whereby the second switch contact (52) is moveable between a first position in which it is spaced from the first switch contact (50) wherein the bypass switch (10) does not provide a bypass current flow path and a second position in which the second switch contact (52) abuts the first switch contact (50) wherein the bypass switch (10) provides a bypass current flow path. The bypass switch (40) also includes a resilient biasing member (68) that is arranged in abutment with the second switch contact (52) to urge the second switch contact (52) towards its second position. Additionally, the bypass switch (40) also includes an interlock (74) which is configured to hold the second switch contact (52) in its first position against the urging of the resilient biasing member (68). The interlock (74) is selectively operable to release the second switch contact (52) from its second position whereby the resilient biasing member (68) moves the second switch contact (52) into its second position and the bypass switch (10) provides a bypass current flow path.

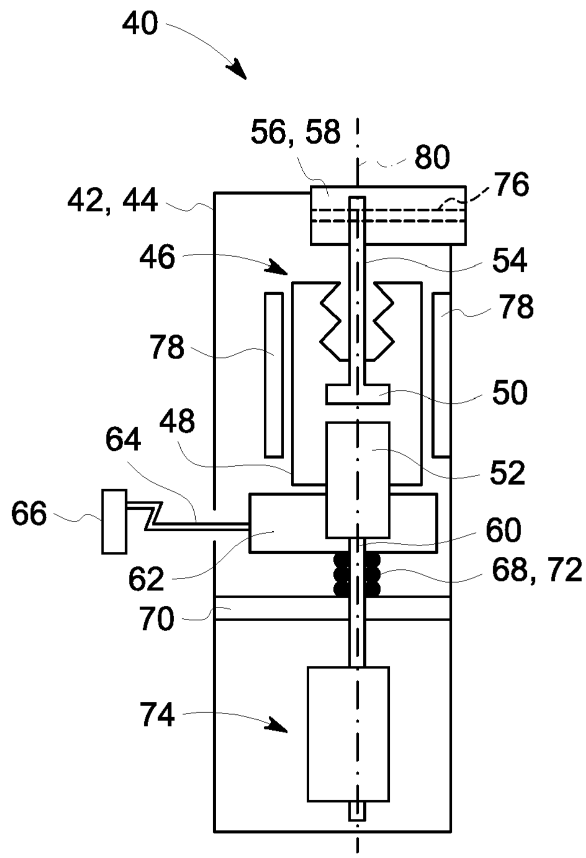

FIG. 2

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Description

[0001] This invention relates to a bypass switch, for a chain-link module which is operable with other chain-link modules to form a chain-link converter to selectively provide a stepped variable voltage source within a voltage source converter, and to a method of operating such a bypass switch.

[0002] In HVDC power transmission networks AC power is typically converted to DC power for transmission via overhead lines, under-sea cables and/or underground cables. This conversion removes the need to compensate for the AC capacitive load effects imposed by the power transmission medium, i.e. the transmission line or cable, and reduces the cost per kilometre of the lines and/or cables, and thus becomes cost-effective when power needs to be transmitted over a long distance. DC power may also be transmitted directly from offshore wind parks to onshore AC power transmission networks

[0003] The conversion between DC power and AC power is utilised where it is necessary to interconnect DC and AC networks. In any such power transmission network, converters (i.e. power converters) are required at each interface between AC and DC power to affect the required conversion from AC to DC or from DC to AC.

[0004] One type of power converter is a voltage source converter 10, as shown schematically in Figure 1, although other types of power converter are also possible.

[0005] The voltage source converter 10 includes first and second DC terminals 12, 14, between which extends a converter limb 16. Other voltage source converters may include more than one converter limb and, in particular, may include three converter limbs each of which corresponds to a given phase of a three-phase electrical power system.

[0006] The converter limb 16 includes first and second limb portions 18, 20 which are separated by an AC terminal 22.

[0007] In use the first and second DC terminals 12, 14 are connected to a DC network, and the AC terminal 22 is connected to an AC network.

[0008] Each limb portion 18, 20 includes a chain-link converter 24 which extends between the AC terminal 22 and a corresponding one of the first or the second DC terminal 12, 14.

[0009] Each chain-link converter 24 includes a plurality of series connected chain-link modules 26.

[0010] Each chain-link module 26 includes a number of switching elements (not shown) which are connected in parallel with an energy storage device, typically in the form of a capacitor, although other types of energy storage device, i.e. any device that is capable of storing and releasing energy to selectively provide a voltage, e.g. a fuel cell or battery, may also be used.

[0011] The provision of a plurality of chain-link modules 26 means that it is possible to build up a combined voltage across each chain-link converter 24, via the insertion of the energy storage devices, i.e. the capacitors, of multiple chain-link modules 26 (with each chain-link module 26 providing its own voltage), which is higher than the voltage available from each individual chain-link module 26.

[0012] Accordingly, each of the chain-link modules 26 work together to permit the chain-link converter 24 to provide a stepped variable voltage source. This permits the generation of a voltage waveform across each chain-link converter 24 using a step-wise approximation. As such each chain-link converter is capable of providing a wide range of complex waveforms.

[0013] For example, operation of each chain-link converter 24 in the foregoing manner can be used to generate an AC voltage waveform at the AC terminal 22, and thereby enable the voltage source converter 10 to provide the aforementioned power transfer functionality between the AC and DC networks.

[0014] According to a first aspect of the invention there is provided a bypass switch, for a chain-link module operable with other chain-link modules to form a chain-link converter to selectively provide a stepped variable voltage source within a voltage source converter, comprising:

a switch chassis having a vacuum interrupter mounted thereon, the vacuum interrupter including first and second switch contacts, the first switch contact being fixed relative to the switch chassis and the second switch contact being moveable relative to the switch chassis whereby the second switch contact is moveable between a first position in which it is spaced from the first switch contact wherein the bypass switch does not provide a bypass current flow path and a second position in which the second switch contact abuts the first switch contact wherein the bypass switch provides a bypass current flow path;
a resilient biasing member arranged in abutment with the second switch contact to urge the second switch contact towards its second position; and
an interlock configured to hold the second switch contact in its first position against the urging of the resilient biasing member,
the interlock being selectively operable to release the second switch contact from its second position whereby the resilient biasing member moves the second switch contact into its second position and the bypass switch provides a bypass current flow path.

[0015] Arranging the resilient biasing member in abutment with the second switch contact advantageously allows the resulting biasing force to act directly on a contact interface between the first and second switch contacts when the second switch contact is in its second position, i.e. when the bypass switch is acting to provide a bypass current flow path.

[0016] This, in turn, is highly desirable because maintaining good, reliable, abutting contact between the first and second switch contacts is vital during operation of the bypass switch, e.g. when it might have to carry a continuous bypass current up to around 2 kA, because poor abutting contact results in arching and overheating, which can lead to failure of the bypass switch, a fire in chain-link module with which the bypass switch is operating and, ultimately shutdown of any voltage source converter in which the chain-link module is located.

[0017] Additionally, having the resilient biasing member abut the second switch contact avoids the need for an intermediate member, e.g. an elongate axial component, to interconnect the resilient biasing member with the second switch contact.

[0018] Such an intermediate member is vulnerable to damage, e.g. shattering by impact forces resulting from an explosion caused by electromagnetic forces arising when a transient peak bypass current in excess of 400 kA initially flows through the bypass switch. Such damage of the intermediate member can adversely impact on the transfer of the resilient biasing member's urging force by the intermediate member to the second switch contact, and thus degrade the abutting contact between the first and second switch contact which can lead to the arching and overheating problems mentioned above.

[0019] Often an intermediate member of the type mentioned above must also include a portion formed from an insulating material, typically a plastics material, in order to provide a degree of electrical isolation from the second switch contact. Such an insulating material is vulnerable to softening or melting, e.g. if poor abutting contact between the first and second switch contacts causes overheating. Such softening or melting can lead to deformation of the intermediate member and further degradation of the abutting contact causing increased overheating, with the risk of a thermal runaway and failure of the bypass switch with the attendant adverse consequences mentioned above to any associated chain-link module and voltage source converter.

[0020] Furthermore, having the second switch contact and the resilient biasing member spaced from one another by an intermediate member, increases the risk of the second switch contact being deflected laterally, i.e. radially sideways, in the event of an energy storage device of an associated chain-link module exploding. Such lateral deflection can arise because of the degree of freedom provided by interconnecting the resilient biasing member and the second switch contact in such a way, or because of flexing of the switch chassis caused by the explosion. In any event, such deflection is highly undesirable as it can again lead to a degradation of the abutting contact between the first and second switch contacts and the resulting arching and overheating difficulties which potentially lead to catastrophic failure.

[0021] In addition to the foregoing, having the resilient biasing member abut the second switch contact provides for a compact arrangement allows a greater proportion of any explosive energy from a failed energy storage device of an associated chain-link module to be dissipated in other, less critical components rather than the bypass switch of the invention, and thus reduces the risk of the bypass switching being damaged and failing. Also, such a compact arrangement better allows the resilient biasing member to absorb and dampen the recoil blow off force that arises when the first and second switch contacts abut one another.

[0022] Preferably the second switch contact includes a second connection terminal to which is fixedly secured a second clamp member to provide an electrical connection to the second switch contact.

[0023] Such a second clamp member allows three-dimensional current flow through a large joint area as well as providing a large clamping area to grip the second connection terminal very securely.

[0024] Optionally the resilient biasing member is arranged in abutment with one or both of the second connection terminal and the second clamp member.

[0025] Such features help to ensure the reliable and compact abutment of the resilient biasing member with the second switch contact in a manner that provides manufacturing flexibility, as well as bypass switch configuration flexibility to suit operation with a given chain-link module.

[0026] The second clamp member may include a flexible electrical coupling for connecting the second clamp member to a second fixed electrical connector of a chain-link module.

[0027] In another preferred embodiment of the invention the second clamp member is mounted within a conductor plate which allows one or both of axial and radial movement of the second clamp member relative to the conductor plate, the conductor plate being connected in-use to a second fixed electrical connector of a chain-link module.

[0028] Each such arrangement permits movement of the second clamp member, and thus the second switch contact, relative to the switch chassis and thereby allows the second switch contact to move between its first and second positions while nevertheless permitting, in use, a continuous and reliable electrical connection between the second switch contact and a second fixed electrical connection of a chain-link module with which the bypass switch of the invention is intended to operate.

[0029] Preferably the vacuum interrupter includes an interrupter housing within which the first and second switch contacts are located, the first switch contact being moveable relative to the interrupter housing and the second switch contact being fixed relative to the interrupter housing.

[0030] Typically the switch contact of a vacuum interrupter which is moveable relative to the interrupter housing is more vulnerable to damage, e.g. from radial impact forces applied to it by an explosion caused by electromagnetic forces arising when a transient peak bypass current initially flows through the bypass switch, than the switch contact that is fixed relative to the interrupter housing.

[0031] Consequently, arranging the moveable switch contact as the first switch contact in the bypass switch of the invention means that such a vulnerable switch contact is fixed relative to the switch chassis, and thus mechanically supported to a greater degree and thereby less susceptible to damage, e.g. from radial impact forces.

[0032] Moreover the mass of, i.e. the inertia associated with, each of the switch contact moveable relative to the interrupter housing, i.e. the first switch contact, and the switch contact fixed relative to the interrupter housing, i.e. the second switch contact, can be arranged to be, or often are, very similar, and so the closing time of the first and second switch contacts, i.e. the time taken for the second switch contact to move from its first position to its second position, is essentially unaffected by having the second switch contact and the interrupter housing with which it is fixed move relative to the switch chassis, rather than by having the first switch contact move relative to the switch chassis as might ordinarily be the case.

[0033] Hence the aforementioned benefit of mechanically supporting the more vulnerable first switch contact to a greater extent can be achieved without adversely impacting on the overall closing response time of the bypass switch of the invention.

[0034] Optionally the switch chassis includes one or more guide members to guide axial movement of the interrupter housing.

[0035] The inclusion of one or more such guide members desirably limits any sideways or radial movement of the interrupter housing which, in turn, helps to limit the impact of any sideways explosive forces, e.g. as caused by electromagnetic forces arising when a transient peak bypass current initially flows through the bypass switch, on unwanted sideways or radial movement of the second switch contact to which the interrupter housing is fixed.

[0036] In a further preferred embodiment of the invention the first switch contact includes a first connection terminal to which is fixedly secured a first clamp member to provide an electrical connection to the first switch contact, the first clamp member including a fluid conduit for receiving cooling fluid from a voltage source converter cooling device.

[0037] The switch contact of a vacuum interrupter which is moveable relative to the interrupter housing, i.e. the first switch contact in the bypass switch of the invention, often also has a lower current rating than the switch contact that is fixed relative to the interrupter housing, i.e. the second switch contact of the invention, e.g. because the moveable switch contact inevitably has a smaller conductor cross-sectional area in order to accommodate the elements, such as bellows, which allow its movement relative to the interrupter housing.

[0038] Meanwhile, because the energy associated with current flow is dominated by a current squared term, for a given resistance, a further limiting factor on the current rating of such a switch contact, i.e. the first switch contact of the invention, is its ability to manage the resistive heat output produced by an elevated and continuous flow of current therethrough.

[0039] As a result, the ability to efficiently cool and draw heat away from the first switch contact of the invention increases its effective current rating to a level comparable to that of the second switch contact.

[0040] In turn a bypass switch with an increased overall current rating (because of the higher effective current rating of a cooled first switch contact) can be used alongside a chain-link module which also has an increased current rating, and so makes it possible to build voltage source converters from multiple such high-current-rating chain-link modules that are able to operate as a STATCOM, i.e. a static synchronous compensator to source or sink of reactive AC power in an electricity network, without having to use costly chains of lower current rated chain-link modules connected in parallel.

[0041] Accordingly the bypass switch of the invention, so cooled, advantageously permits the cost-effective production of such STATCOM converters.

[0042] The switch chassis may include an abutment formation with which the resilient biasing member engages to urge the second switch contact into its second position.

[0043] Such a feature further assists in desirably positioning the resilient biasing member in abutment with the second switch contact while ensuring also the provision of an adequate urging force.

[0044] Optionally the switch chassis is or includes a switch housing.

[0045] The provision of a switch housing is desirable because it helps to increase the overall strength of the bypass switch of the invention, as well as contain any arcs that may develop. Additionally, it prevents ingress of foreign objects, e.g. maintenance operative fingers or tools, into the interlock. Also, depending on the choice of housing material, the switch housing can provide electrical isolation of the bypass switch from a chain-link module with which it is intended to be used.

[0046] According to a second aspect of the invention there is provided a method of operating a bypass switch, for a chain-link module operable with other chain-link modules to form a chain-link converter to selectively provide a stepped variable voltage source within a voltage source converter, the bypass switch comprising:

a switch chassis having a vacuum interrupter mounted thereon, the vacuum interrupter including first and second switch contacts, the first switch contact being fixed relative to the switch chassis and the second switch contact being moveable relative to the switch chassis whereby the second switch contact is moveable between a first position in which it is spaced from the first switch contact wherein the bypass switch does not provide a bypass current flow path and a second position in which the second switch contact abuts the first switch contact wherein the bypass switch provides a bypass current flow path;
a resilient biasing member arranged in abutment with the second switch contact to urge the second switch

contact towards its second position; and

an interlock configured to hold the second switch contact in its first position against the urging of the resilient biasing member,

the method of operating the bypass switch comprising the step of selectively operating the interlock to release the second switch contact from its second position whereby the resilient biasing member moves the second switch contact into its second position and the bypass switch provides a bypass current flow path.

[0047] The method of the invention shares the benefits of the corresponding features of the bypass switch of the invention.

[0048] It will be appreciated that the use of the terms "first" and "second", and the like, in this patent specification, e.g. in relation to first and second switch contacts, is merely intended to help distinguish between similar features, and is not intended to indicate the relative importance of one feature over another feature, unless otherwise specified.

[0049] Within the scope of this application it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs, and the claims and/or the following description and drawings, and in particular the individual features thereof, may be taken independently or in any combination. That is, all embodiments and all features of any embodiment can be combined in any way and/or combination, unless such features are incompatible. The applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner.

[0050] There now follows a brief description of preferred embodiments of the invention, by way of non-limiting example, with reference being made to the following figures in which:

Figure 1 shows a schematic view of a known voltage source converter;

Figure 2 shows a schematic, cross-sectional view of a bypass switch according to a first embodiment of the invention;

Figure 3 shows a perspective view of the first bypass switch shown schematically in Figure 2, absent a switch housing;

Figure 4 shows a perspective view of a switch chassis forming a part of the first bypass switch shown in Figure 3; and

Figure 5 shows an enlarged, elevational view of a resilient biasing member forming a part of the first bypass switch shown in Figure 3.

[0051] A bypass switch according to a first embodiment of the invention is designated generally by reference numeral 40, as shown in Figures 2 and 3.

[0052] The bypass switch 40 includes a switch chassis 42, as shown separately in Figure 4. In the embodiment shown the switch chassis 42 is formed separately from a switch housing 44 (not shown in Figures 3 to 5), although this need not necessarily be the case. In any event, preferably such a switch housing 44 is formed from an extruded glass reinforced plastic box section, although other materials may be used as well as other sections, such as a U-shaped or I-shaped sections. In this manner, the switch chassis 42 can be formed from a relatively inexpensive but potentially weaker material, but nevertheless still suitable for ensuring the correct positioning of various components of the bypass switch 40 relative to one another, while the switch housing 44 can provide a desired degree of structural strength to the combined assembly.

[0053] Meanwhile, the switch chassis 42 has a vacuum interrupter 46 mounted thereon. In the embodiment shown, the vacuum interrupter 46 includes an interrupter housing 48 within which first and second switch contacts 50, 52 are located. The first switch contact 50 is moveable relative to the interrupter housing 48 and the second switch contact 52 is fixed relative to the interrupter housing 48.

[0054] Additionally, the first switch contact 50 is fixed relative to the switch chassis 42, i.e. the switch housing 44, and more particularly the first switch contact 50 includes a first connection terminal 54 which is fixedly secured within a first clamp member 56 that forms a part of a first fixed electrical connector 58 of a chain-link module (not shown) with which the first bypass switch 40 is intended to be used. The first fixed electrical connector 58 may take the form of a first busbar, but that need not necessarily be the case.

[0055] The first clamp member (56) may also include a fluid conduit (76), an example path of which is shown by dashed line in Figure 2. One or more such fluid conduits may be so included to receive cooling fluid from a voltage source converter cooling device (not shown).

[0056] Meanwhile, the second switch contact 52 is moveable relative to the switch chassis 42, i.e. the switch housing 44. Such movement of the second switch contact 52 allows it to move between a first position in which it is spaced from the first switch contact 50, i.e. as shown in Figure 2, and a second position in which the second switch contact 52 abuts the first switch contact 50.

[0057] When the second switch contact 52 is in the first position the bypass switch 40 does not provide a bypass current flow path, i.e. the bypass switch 40 is inoperative, but when the second switch contact 52 is in the second position the bypass switch does provide a bypass current flow path, i.e. the bypass switch operates in its required bypass state.

[0058] In the embodiment shown the second switch contact 52 includes a second connection terminal 60 to which is fixedly secured a second clamp member 62 in order to provide an electrical connection to the second switch contact 52.

[0059] More particularly, the second clamp member 62 includes a flexible electrical coupling 64 to, in use, connect the second clamp member 62 to a second fixed electrical connector 66 of the chain-link module (not shown). The flexible electrical coupling 64 may be formed from a sandwich of laminated sheets, although other forms are possible and again, the second fixed electrical connector 66 may similarly take the form of a second busbar, although that need not necessarily be the case.

[0060] In other embodiments of the invention (not shown) the second clamp member may be mounted within a conductor plate which allows one or both of axial and radial movement of the second clamp member relative to the conductor plate. In turn, such a conductor plate may be connected, in-use, to the second fixed electrical connector of the chain-link module.

[0061] Returning to the embodiment shown, the bypass switch 40 also includes a resilient biasing member 68 which is arranged in abutment with the second switch contact 52 in order to urge the second switch contact 52 towards its second position, i.e. towards being in abutment with the first switch contact 50 whereby the bypass switch provides a bypass current flow path.

[0062] More particularly, and as best shown in Figure 5, the resilient biasing member 68 is arranged in abutment with the second connection terminal 60, although in other embodiments (not shown) it may instead abut both the second clamp member 62 and the second connection terminal 60, or abut just the second clamp member 62. In any event, all such arrangements arrange the resilient biasing member 68 in abutment with the second switch contact 52 in a manner suitable for the said resilient biasing member 68 to urge the second switch contact 52 towards its second position.

[0063] Additionally, in the embodiment shown, the switch chassis 42 includes an abutment formation 70 that is reinforced by first and second pins 82, which preferably are formed from a metal, and are coupled with the switch housing 44 to ensure a necessary degree of structural strength. The abutment formation 70 also includes an abutment plate 84, which preferably has a C-shaped cross-section, and ideally is similarly formed from a metal. The abutment plate 84 further reinforces the abutment formation 70 and helps to distribute the loading imparted by the resilient biasing member. In that regard, the resilient biasing member 68 abuts against the abutment plate 84 to urge the second switch contact 52 towards its second position. Other forms of abutment formation, with or without further reinforcing elements are also possible.

[0064] Preferably the resilient biasing member 68 is a spring, and more preferably a compression spring 72. Other types of biasing member, and indeed other forms of spring, may also be used however.

[0065] In addition to the foregoing, the bypass switch 40 further includes an interlock 74, which may have a known form and mode of operation, but in any event is configured to hold the second switch contact 52 in its first position against the urging of the resilient biasing member 68, i.e. the compression spring 72.

[0066] In use, the interlock 74 is selectively operable to release the second switch contact 52 from its second position whereby the resilient biasing member 68, i.e. the compression spring 72, moves the second switch contact 52 into its second position and the bypass switch 40 provides a bypass current flow path.

[0067] To assist with such movement of the second switch contact 52, the switch chassis 42 in the embodiment shown, may include two guide members 78 to guide axial movement of the interrupter housing 48, i.e. movement of the interrupter housing 48 along an axis 80 passing centrally through the first and second switch contacts 50, 52, and in turn, thereby guide axial movement of the second switch contact 52 which is fixed relative to the interrupter housing 48. The guide members 78 may be joined to one another by a plurality, e.g. three, connection formations 86, to help maintain their respective position relative to one another, although these need not necessarily be included.

Claims

1. A bypass switch (40), for a chain-link module (26) operable with other chain-link modules (26) to form a chain-link converter (24) to selectively provide a stepped variable voltage source within a voltage source converter (10), comprising:

a switch chassis (42) having a vacuum interrupter (46) mounted thereon, the vacuum interrupter (46) including first and second switch contacts (50, 52), the first switch contact (50) being fixed relative to the switch chassis (42) and the second switch contact (52) being moveable relative to the switch chassis (42) whereby the second switch contact (52) is moveable between a first position in which it is spaced from the first switch contact (50) wherein the bypass switch (10) does not provide a bypass current flow path and a second position in which the second switch contact (52) abuts the first switch contact (50) wherein the bypass switch (10) provides a bypass current flow path;

a resilient biasing member (68) arranged in abutment with the second switch contact (52) to urge the second switch contact (52) towards its second position; and

an interlock (74) configured to hold the second switch contact (52) in its first position against the urging of the resilient biasing member (68),

the interlock (74) being selectively operable to release the second switch contact (52) from its second position whereby the resilient biasing member (68) moves the second switch contact (52) into its second position and the bypass switch (10) provides a bypass current flow path.

2. A bypass switch (40) according to Claim 1 wherein the second switch contact (52) includes a second connection terminal (60) to which is fixedly secured a second clamp member (62) to provide an electrical connection to the second switch contact (52).

3. A bypass switch (40) according to Claim 1 or Claim 2 wherein the resilient biasing member (68) is arranged in abutment with one or both of the second connection terminal (60) and the second clamp member (62).

4. A bypass switch (40) according to Claim 2 or Claim 3 wherein the second clamp member (62) includes a flexible electrical coupling (64) for connecting the second clamp member (62) to a second fixed electrical connector (66) of a chain-link module (26).

5. A bypass switch (40) according to Claim 2 or Claim 3 wherein the second clamp member is mounted within a conductor plate which allows one or both of axial and radial movement of the second clamp member relative to the conductor plate, the conductor plate being connected in-use to a second fixed electrical connector (66) of a chain-link module (26).

6. A bypass switch (40) according to any preceding claim wherein the vacuum interrupter (46) includes an interrupter housing (48) within which the first and second switch contacts (50, 52) are located, the first switch contact (50) being moveable relative to the interrupter housing (48) and the second switch contact (52) being fixed relative to the interrupter housing (48).

7. A bypass switch (40) according to Claim 6 wherein the switch chassis (42) includes one or more guide members (78) to guide axial movement of the interrupter housing (48).

8. A bypass switch (40) according to Claim 6 or Claim 7 wherein the first switch contact (50) includes a first connection terminal (54) to which is fixedly secured a first clamp member (56) to provide an electrical connection to the first switch contact (50), the first clamp member (56) including a fluid conduit (76) for receiving cooling fluid from a voltage source converter cooling device.

9. A bypass switch (40) according to any preceding claim wherein the switch chassis (42) includes an abutment formation (70) with which the resilient biasing member (68) engages to urge the second switch contact (52) into its second position.

10. A bypass switch (40) according to any preceding claim wherein the switch chassis (42) is or includes a switch housing (44).

11. A method of operating a bypass switch (40), for a chain-link module (26) operable with other chain-link modules (26) to form a chain-link converter (24) to selectively provide a stepped variable voltage source within a voltage source converter (10), the bypass switch (40) comprising:

a switch chassis (42) having a vacuum interrupter (46) mounted thereon, the vacuum interrupter (46) including first and second switch contacts (50, 52), the first switch contact (50) being fixed relative to the switch chassis (42) and the second switch contact (52) being moveable relative to the switch chassis (42) whereby the second switch contact (52) is moveable between a first position in which it is spaced from the first switch contact (50) wherein the bypass switch (40) does not provide a bypass current flow path and a second position in which the second switch contact (52) abuts the first switch contact (50) wherein the bypass switch (40) provides a bypass current flow path;
a resilient biasing member (68) arranged in abutment with the second switch contact (52) to urge the second switch contact (52) towards its second position; and
an interlock (74) configured to hold the second switch contact (52) in its first position against the urging of the resilient biasing member (68),
the method of operating the bypass switch (40) comprising the step of selectively operating the interlock (74) to release the second switch contact (52) from its second position whereby the resilient biasing member (68) moves the second switch contact (52) into its second position and the bypass switch (40) provides a bypass current flow path.

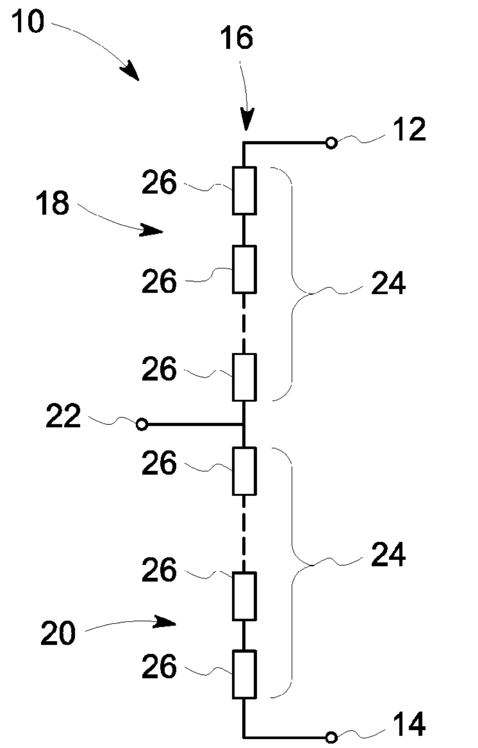
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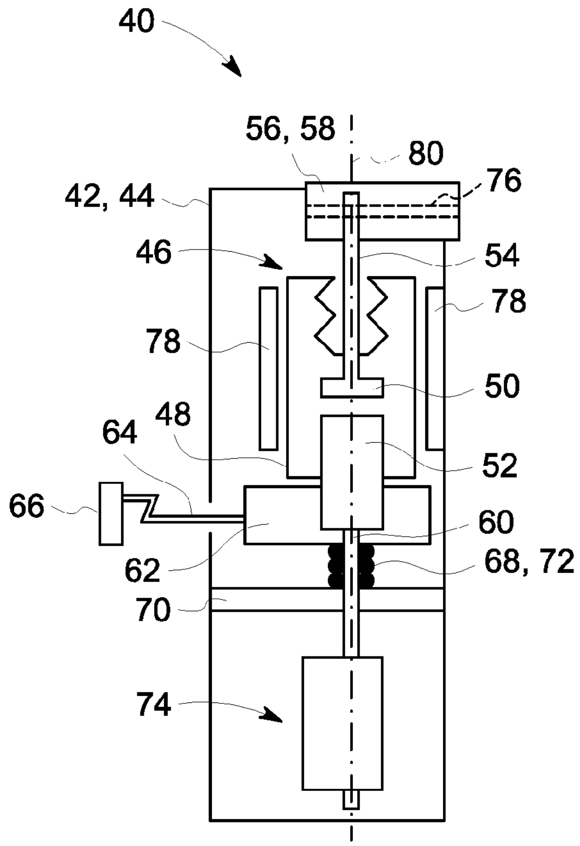
FIG. 1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74

FIG. 2

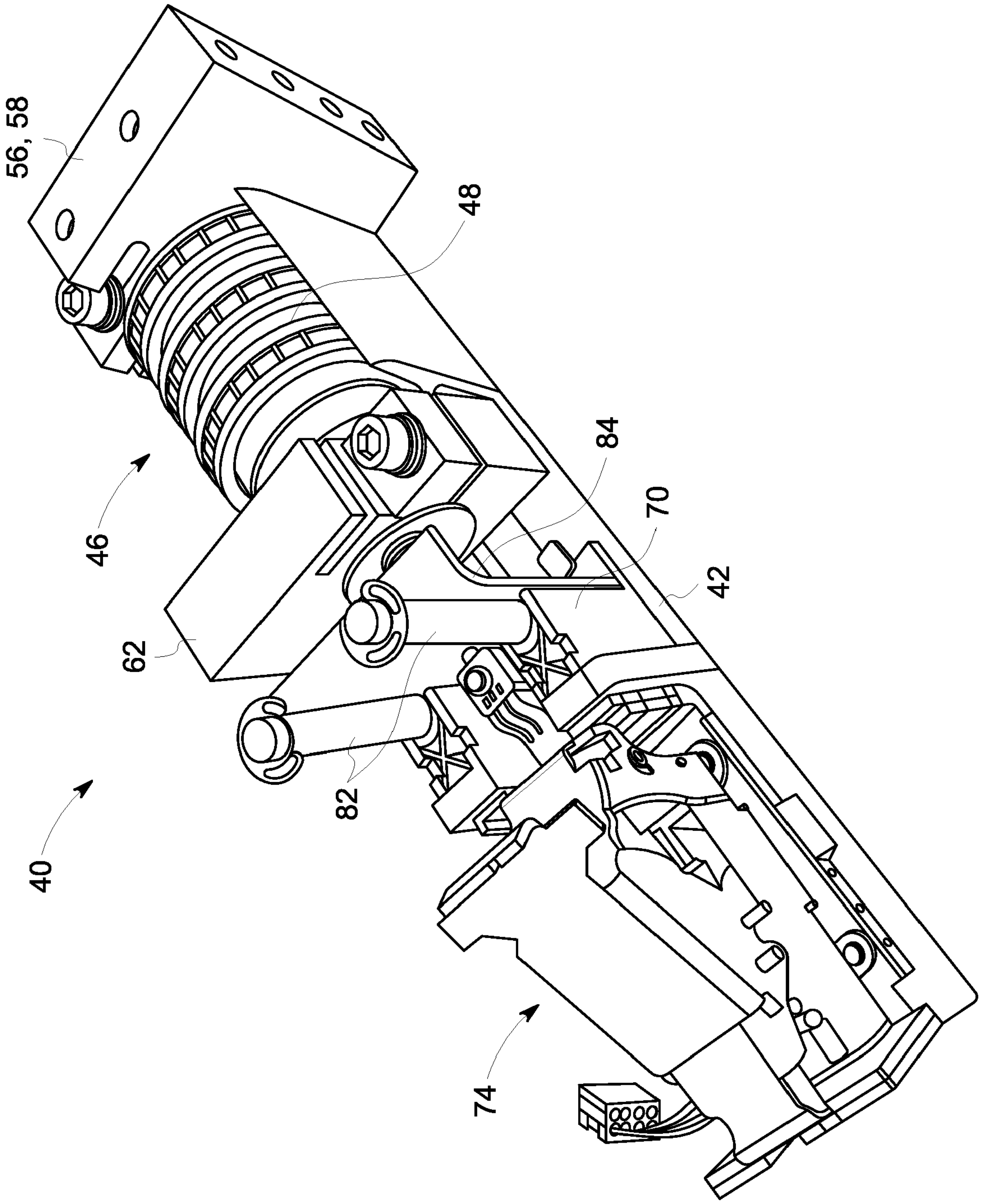

FIG. 3

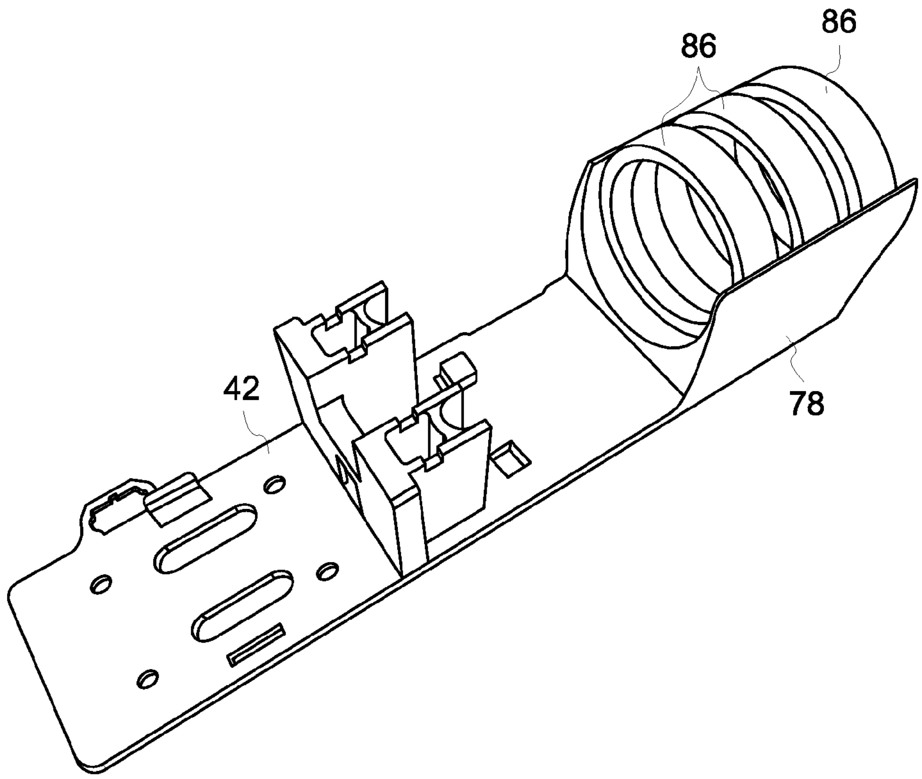

FIG. 4

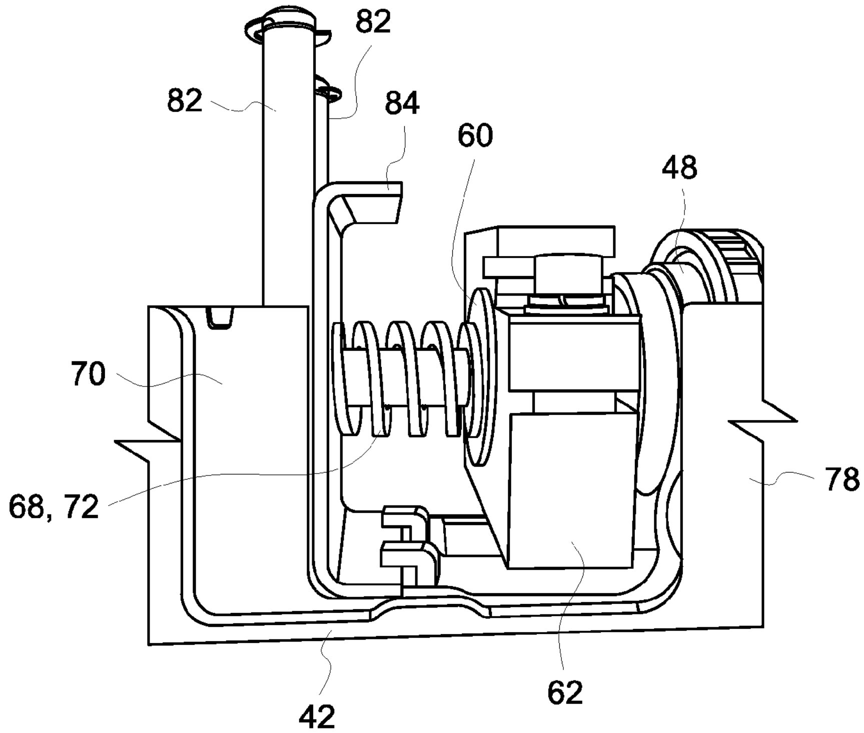

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 21 27 5193

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Place of search	Date of completion of the search	Examiner
Munich	19 May 2022	Ernst, Uwe

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