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(54) **MEDIUM OR HIGH VOLTAGE CIRCUIT BREAKER**

(57) The present invention relates to a medium or high voltage circuit breaker (1). The circuit breaker comprises a first vacuum interrupter (10), a second vacuum interrupter (20), and a heat sink (30). The heat sink is in thermal contact with a fixed contact carrier (12) of the first vacuum interrupter. The heat sink is in thermal contact with a fixed contact carrier (22) of the second vacuum interrupter.

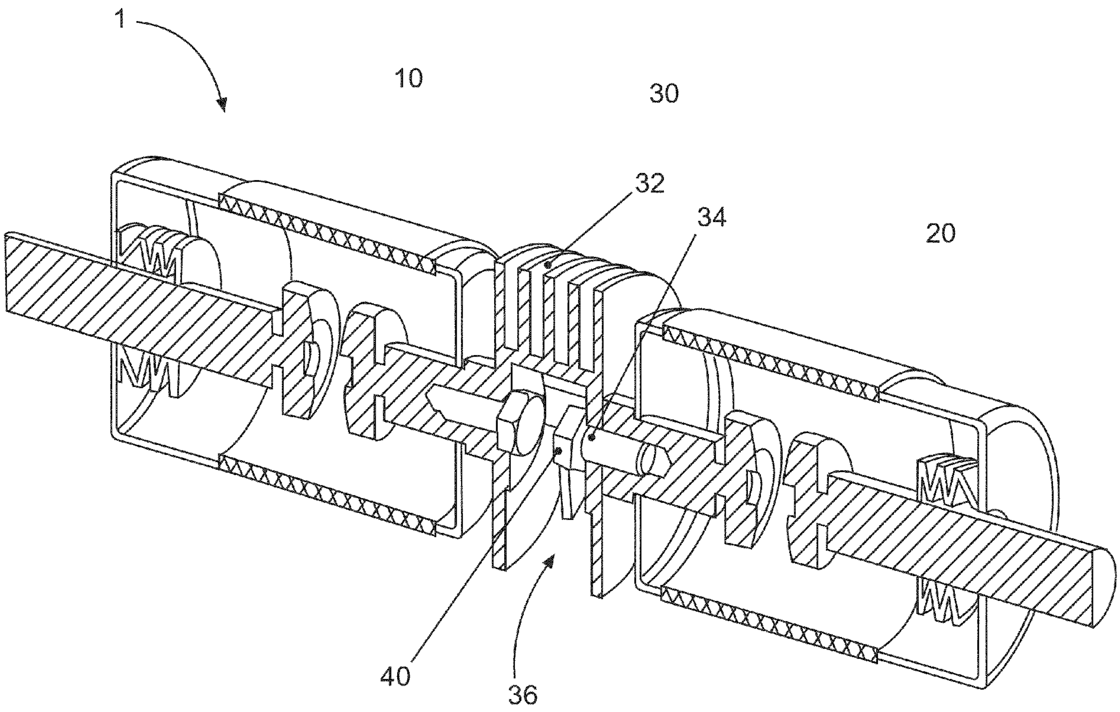

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a medium or high voltage circuit breaker, and to a medium or high voltage switching system.

BACKGROUND OF THE INVENTION

[0002] Switching poles or circuit breakers (CBs) are used in switching systems such as switchgear. Such circuit breakers can utilise a vacuum interrupter (VI). For high voltage (HV) applications, but also for some medium voltage (MV) applications, it is known to connect two VI in series to increase the possible rated voltage of a CB.

[0003] Considering the thermal management of a CB pole, the VI is generally the thermal hotspot of the CB pole, because the cross-sections of the conductors in the VI are as small as possible for cost reasons.

[0004] This situation is exacerbated for a circuit breaker having two Vis in series.

[0005] There is a need to address this situation.

SUMMARY OF THE INVENTION

[0006] Therefore, it would be advantageous to have an improved medium or voltage circuit breaker that has two vacuum interrupters in series.

[0007] The object of the present invention is solved with the subject matter of the independent claims, wherein further embodiments are incorporated in the dependent claims.

[0008] In a first aspect, there is provided a medium or high voltage circuit breaker, comprising:

- a first vacuum interrupter;
- a second vacuum interrupter; and
- a heat sink.

[0009] The heat sink is in thermal contact with a fixed contact carrier of the first vacuum interrupter. The heat sink is in thermal contact with a fixed contact carrier of the second vacuum interrupter.

[0010] In this way, a circuit breaker can have a higher voltage rating because it is formed from two vacuum interrupters placed in series, but now thermal management is provided via each vacuum interrupter being connected to the other with the heat sink provided at the connection point to dissipate heat into the environment and enabling higher current flow for set cross sections of contacts or lower cross-section contacts to be utilised for a set current.

[0011] In an example, a centre axis of the first vacuum interrupter is aligned parallel to a centre axis of the second vacuum interrupter.

[0012] In an example, the centre axis of the first vacuum interrupter is the same axis as the centre axis of the second vacuum interrupter.

[0013] In an example, the centre axis of the first vacuum interrupter is angled to the centre axis of the second vacuum interrupter.

[0014] Thus, the two vacuum interrupters can be aligned longitudinally. They could however be angled one to the other if necessary.

[0015] In an example, the heat sink comprises a plurality of ribs.

[0016] In an example, the plurality of ribs extend radially from the heat sink.

[0017] In an example, each rib has a length and a thickness perpendicular to the length and the length of each rib extends around at least a substantial part of the circumference of the heat sink.

[0018] In this manner, the circuit breaker can be orientated horizontally and the ribs of the heat sink are aligned vertically thereby improving the cooling effect.

[0019] In an example, each rib has a length and a thickness perpendicular to the length and the length of each rib extends in an axial direction of the heat sink.

[0020] Thus, the circuit breaker can be orientated vertically and the ribs of the heat sink are aligned vertically thereby improving the cooling effect.

[0021] In an example, at least one rib of the plurality of ribs extends in an axial direction past a gap between the fixed contact carrier and a movable contact carrier of the first vacuum interrupter.

[0022] In an example, at least one rib of the plurality of ribs extends in an axial direction past a gap between the fixed contact carrier and a movable contact carrier of the second vacuum interrupter.

[0023] Thus, the heat sink by providing electrically conductive extensions towards the movable contacts of the Vis, past the gap between the fixed and movable contacts when the Vis are in an open configuration or during opening, they can control the electrical field in order to obtain an improved symmetry of the voltages across each VI in the situation when the VIs are open or during opening. The electrical capacitance between such an extended heat sink and the moveable contacts of the VIs preferably measures 60 to 250pF.

[0024] In an example, the heat sink is connected to a first end wall of the fixed contact carrier of the first vacuum interrupter, and the heat sink is connected to a second end wall of the fixed contact carrier of the second vacuum interrupter.

[0025] In other words, the heat sink is directly between the two vacuum interrupters and current will flow through the heatsink when the vacuum interrupters close. This provides for effective cooling, because the heat sink itself is heated due to current flow through it and the heatsink can then dissipate that heat effectively.

[0026] In an example, the heat sink is bolted to the fixed contact carrier of the first vacuum interrupter with a first bolt through a hole in the first end wall of the heat sink. The heat sink in this example is also bolted to the fixed contact carrier of the second vacuum interrupter with a second bolt through a hole in the second end wall of the heat sink.

[0027] In an example, at least one side portion of the heat sink has no ribs and is open to enable access to a head of the first bolt and to enable access to a head of the second bolt.

[0028] Thus, a lateral opening is provided enabling the bolt connections between the heatsink to be accessed and the bolts tightened or loosened for dismantling the circuit breaker for example.

[0029] In an example, the fixed contact carrier of the first vacuum interrupter is bolted to the fixed contact carrier of the second vacuum interrupter with a bolt.

[0030] In other words, the heat sink is not directly between the two vacuum interrupters and does not form part of the current path, but is still in thermal connection with the fixed contacts of the vacuum interrupters to dissipate heat when current flows. As the heat sink does not need to carry current, it does not need to have specific electrical conductivity characteristics or withstand high currents, but should have good thermal conductivity characteristics to dissipate heat. Thus, the heat sink could be fabricated from Aluminium or even thermoplastics.

[0031] Thus, a stretch bolt can be screwed into the fixed contacts of both vacuum interrupters through rotation of the fixed contacts. In other words, with respect to a set direction one fixed contact can be rotated clockwise whilst the other is rotated anticlockwise (a person at each end of the vacuum interrupter will be rotating each fixed contact in the same direction) and in doing so the two fixed contacts become locked one to the other. In reality, the fixed contacts of each vacuum interrupter are fixed within the vacuum interrupter and as such the whole vacuum interrupter will be rotated rather than just fixed contact.

[0032] In an example, a first end wall of the heat sink is adjacent to an end face of the fixed contact carrier of the first vacuum interrupter, and a second end wall of the heat sink is adjacent to an end face of the fixed contact carrier of the second vacuum interrupter. The bolt in this example then extends through a centre hole of the heat sink.

[0033] In an example, an end face of the fixed contact carrier of the first vacuum interrupter is adjacent to an end face of the fixed contact carrier of the second vacuum interrupter. In this example, an inner surface of the heat sink is adjacent to a cylindrical outer surface of the fixed contact carrier of the first vacuum interrupter and/or an inner surface of the heat sink is adjacent to a cylindrical outer surface of the fixed contact carrier of the second vacuum interrupter.

[0034] In an example, a first threaded hole in the fixed contact carrier of the first vacuum interrupter accommodates the bolt and a second threaded hole in the fixed contact carrier of the second vacuum interrupter accommodates the bolt. The bolt is configured such that the bolt is at the bottom of the first threaded hole but not at the bottom of the second threaded hole when the fixed contact carrier of the first vacuum interrupter is bolted to the fixed contact carrier of the second vacuum interrupter.

[0035] In this manner, because the bolt and threaded holes are configured in such a way that the bolt bottoms out in one threaded hole but not in the other when the bolt is bottomed out in one threaded hole the two vacuum interrupters can be rotated one with respect to the other in order to lock them together with the required torque.

[0036] In a second aspect, there is provided a medium or high voltage switching system, comprising at least one medium or high voltage circuit breaker according to the first aspect

[0037] The above aspects and examples will become apparent from and be elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] Exemplary embodiments will be described in the following with reference to the following drawings:

Fig. 1 shows a sectional view of an example of a medium or high voltage circuit breaker;

Fig. 2 shows a sectional view of an example of a medium or high voltage circuit breaker;

Fig. 3 shows a sectional view of an example of a medium or high voltage circuit breaker; and

Fig. 4 shows a sectional view of an example of a medium or high voltage circuit breaker.

DETAILED DESCRIPTION OF EMBODIMENTS

[0039] Figs. 1-4 relate to examples of a medium or high voltage circuit breaker.

[0040] In an example, a medium or high voltage circuit breaker 1 comprises a first vacuum interrupter 10 a second vacuum interrupter 20 and a heat sink 30. The first and second vacuum interrupters are in series. The heat sink is in thermal contact with a fixed contact carrier 12 of the first vacuum interrupter, and the heat sink is in thermal contact with a fixed contact carrier 22 of the second vacuum interrupter.

[0041] According to an example, a centre axis of the first vacuum interrupter is aligned parallel to a centre axis of the second vacuum interrupter.

[0042] According to an example, the centre axis of the first vacuum interrupter is angled to the centre axis of the second vacuum interrupter.

[0043] According to an example, the centre axis of the first vacuum interrupter is the same axis as the centre axis of the second vacuum interrupter.

[0044] This is clearly shown in the specific embodiments of Figs. 1-4

[0045] According to an example, the heat sink comprises a plurality of ribs 32.

[0046] According to an example, the plurality of ribs extend radially from the heat sink.

[0047] According to an example, each rib has a length and a thickness perpendicular to the length and the length of each rib extends around at least a substantial part of the circumference of the heat sink.

[0048] This is shown in the specific embodiments of Figs. 1, 3 and 4.

[0049] According to an example, each rib has a length and a thickness perpendicular to the length and wherein the length of each rib extends in an axial direction of the heat sink.

[0050] This is shown in the specific embodiment of Fig. 2.

[0051] According to an example, at least one rib 39 of the plurality of ribs extends in an axial direction past a gap between the fixed contact carrier and a movable contact carrier of the first vacuum interrupter.

[0052] According to an example, at least one rib 39 of the plurality of ribs extends in an axial direction past a gap between the fixed contact carrier and a movable contact carrier of the second vacuum interrupter.

[0053] This is shown in the specific embodiments of Figs. 2 and 3.

[0054] The embodiment shown in Fig. 3 shows the extensions 39 of the heat sink 30 for controlling the electrical field, and these can completely surround the two vacuum interrupters to provide particular utility for electric field control. However, as shown in Fig. 2 even axially extending ribs in the form of planar fins can provide for electric field control, with particular utility found when all the ribs extend past the VI gaps rather than just the one rib 39 doing so in Fig. 2.

[0055] In an example, the at least one rib of the plurality of ribs that extends in an axial direction past the gap between the fixed contact carrier and the movable contact carrier of the first vacuum interrupter is the same as the at least one rib of the plurality of ribs that extends in an axial direction past the gap between the fixed contact carrier and the movable contact carrier of the second vacuum interrupter.

[0056] In an example, the at least one rib of the plurality of ribs that extends in an axial direction past the gap between the fixed contact carrier and the movable contact carrier of the first vacuum interrupter is different to the at least one rib of the plurality of ribs that extends in an axial direction past the gap between the fixed contact carrier and the movable contact carrier of the second vacuum interrupter.

[0057] According to an example, the heat sink is connected to a first end wall of the fixed contact carrier of the first vacuum interrupter, and the heat sink is connected to a second end wall of the fixed contact carrier of the second vacuum interrupter.

[0058] This is shown in the specific embodiments of Figs. 1, 2 and 3.

[0059] According to an example, the heat sink is bolted to the fixed contact carrier of the first vacuum interrupter with a first bolt through a hole 34 in the first end wall of the heat sink, and the heat sink is bolted to the fixed contact carrier of the second vacuum interrupter with a second bolt through a hole 34 in the second end wall of the heat.

[0060] This is shown in the specific embodiments of Figs. 1 and 2.

[0061] According to an example, at least one side portion 36 of the heat sink has no ribs and is open to enable access to a head of the first bolt and to enable access to a head of the second bolt.

[0062] This is shown in the specific embodiments of Figs. 1 and 2.

[0063] According to an example, a first end wall of the heat sink is adjacent to an end face of the fixed contact carrier of the first vacuum interrupter, and a second end wall of the heat sink is adjacent to an end face of the fixed contact carrier of the second vacuum interrupter, and the bolt extends through a centre hole of the heat sink.

[0064] This is shown in the specific embodiment of Fig. 3.

[0065] According to an example, an end face of the fixed contact carrier of the first vacuum interrupter is adjacent to an end face of the fixed contact carrier of the second vacuum interrupter, and an inner surface of the heat sink is adjacent to a cylindrical outer surface of the fixed contact carrier of the first vacuum interrupter. Additionally or alternatively an inner surface of the heat sink is adjacent to a cylindrical outer surface of the fixed contact carrier of the second vacuum interrupter.

[0066] This is shown in the specific embodiment of Fig. 4.

[0067] According to an example, a first threaded hole in the fixed contact carrier of the first vacuum interrupter accommodates the bolt and wherein a second threaded hole in the fixed contact carrier of the second vacuum interrupter accommodates the bolt, and the bolt is configured such that the bolt is at the bottom of the first threaded hole but not at the bottom of the second threaded hole when the fixed contact carrier of the first vacuum interrupter is bolted to the fixed contact carrier of the second vacuum interrupter.

[0068] This is shown in the specific embodiments of Figs. 3 and 4.

[0069] A medium or high voltage switching system can utilize one or more medium or high voltage circuit breakers as described above.

[0070] Thus, in a new manner heat losses generated in the two VIs due to the flow of current can be transported by heat conduction to the two terminals of the CB pole, where the heat can be dissipated to the environment by help of contact arms, but this is now augmented through utilization of a heat sink positioned between the two Vis. Thus, a heating situation that would be exacerbated through a first VI being in thermal contact with the second VI, where both VIs become hot due to current flow, is mitigated through appropriate location of the heatsink at the contact point between the two Vis.

[0071] Continuing with the figures, the medium or high voltage circuit breaker and medium or high voltage switching system are described in further detail, with respect to specific embodiments.

[0072] Fig. 1 shows a sectional view of a principal arrangement of two VIs 10, 20 with a heat sink 30 in-between. The arrangement here is generally horizontal and the ribs 32 of the heat sink 30 are arranged vertically to exploit natural cooling with the surrounding atmosphere or medium. The direction of the ribs is perpendicular to the direction of current flow in this embodiment. The heat sink 30 provides two centered holes 34, one at the left and one at the right side, so that 30 can screwed with two screws 40 onto the two VIs 10, 20. For the tightening of the screw with a tool, a lateral opening 36 is provided in 30.

[0073] Fig. 2 shows a similar but generally vertical arrangement. The ribs 32 still need a vertical orientation to efficiently exploit the natural cooling. In this embodiment, the direction of the ribs is parallel to the direction of current flow.

[0074] Fig. 3 shows an arrangement where the connection of 10, 20 and 30 is realised with a stretch bolt 50. The advantage here is that no opening 36 is required in the heatsink 30, as the stretch bolt is tightened by a rotation of one VI with a defined torque while fixing the other VI.

[0075] The defined elongation of the stretch bolt depending on the tightening torque assures a controlled locking of the screwed connection. The stretch bolt is designed in a way that it has still a sufficient overlapping with the thread in VI 10 after having reached the end of the thread in the VI 20.

[0076] The embodiment shown in Fig 3 also shows that the ribs 32 can extend further than the region of the VIs to enhance natural cooling. Shown here for a horizontal extension, but also possible for a vertical extension, depending on the available space in the actual CB and switchgear.

[0077] Fig. 4 shows an arrangement similar to the arrangement shown in Fig. 3, but here the current does not flow through the heatsink. The fixed contact carrier 12, 22 of the two VIs are long enough so that they can touch in the middle of the heatsink where 12 and 22 are directly fixed with the stretch bolt. The central opening in the heatsink is now large enough for the assembly around the fixed contact carrier 12, 22.

[0078] For a good heat transfer from 12 and 22 to the heatsink, a tight fit between 12, 22 and the heatsink can be provided. This can be facilitated for example through a low nominal gap filled with heat-conductive paste, or a thermal shrink-fit. However, as indicated in Fig. 4, the heat sink can be provided with a clamping function via a slit 37 and for example two screws through the holes / threads 38. So, there is only one contact with one contact resistance in the current path, and the material of the heatsink can be chosen without considering a good electrical conductivity. For example, the heatsink can be made of aluminium, of another metal like steel, or even made of thermally conductive plastics or ceramics.

Reference Numerals

[0079]

1	Arrangement of two VIs and a heatsink - the new CB
10	First VI
12	Fixed contact carrier of 10
20	Second VI
22	Fixed contact carrier of 20
30	Heatsink
32	Ribs of 30
34	Hole in 30 for fixation with a screw
36	Opening in 30 for tool
37	Slit in 30
38	Hole / thread
39	Extension of 30 for field control
40	Screw
50	Stretch bolt

Claims

1. A medium or high voltage circuit breaker (1), comprising:

- a first vacuum interrupter (10);
- a second vacuum interrupter (20); and
- a heat sink (30);

wherein, the heat sink is in thermal contact with a fixed contact carrier (12) of the first vacuum interrupter; and
wherein, the heat sink is in thermal contact with a fixed contact carrier (22) of the second vacuum interrupter.

2. Medium or high voltage circuit breaker according to claim 1, wherein a centre axis of the first vacuum interrupter is aligned parallel to a centre axis of the second vacuum interrupter.

3. Medium or high voltage circuit breaker according to claim 2, wherein the centre axis of the first vacuum interrupter is the same axis as the centre axis of the second vacuum interrupter.

4. Medium or high voltage circuit breaker according to claim 1, wherein a centre axis of the first vacuum interrupter is angled to a centre axis of the second vacuum interrupter.

5. Medium or high voltage circuit breaker according to any of claims 1-4, wherein the heat sink comprises a plurality of ribs (32).

6. Medium or high voltage circuit breaker according to claim 5, wherein the plurality of ribs extend radially from the heat sink.

7. Medium or high voltage circuit breaker according to any of claims 5-6, wherein each rib has a length and a thickness perpendicular to the length and wherein the length of each rib extends around at least a substantial part of the circumference of the heat sink.

8. Medium or high voltage circuit breaker according to any of claims 5-6, wherein each rib has a length and a thickness perpendicular to the length and wherein the length of each rib extends in an axial direction of the heat sink.

9. Medium or high voltage circuit breaker according to any of claims 5-8, wherein at least one rib (39) of the plurality of ribs extends in an axial direction past a gap between the fixed contact carrier and a movable contact carrier of the first vacuum interrupter.

10. Medium or high voltage circuit breaker according to any of claims 5-9, wherein at least one rib (39) of the plurality of ribs extends in an axial direction past a gap between the fixed contact carrier and a movable contact carrier of the second vacuum interrupter.

11. Medium or high voltage circuit breaker according to any of claims 1-10, wherein the heat sink is connected to a first end wall of the fixed contact carrier of the first vacuum interrupter, and wherein the heat sink is connected to a second end wall of the fixed contact carrier of the second vacuum interrupter.

12. Medium or high voltage circuit breaker according to claim 11, wherein the heat sink is bolted to the fixed contact carrier of the first vacuum interrupter with a first bolt through a hole (34) in the first end wall of the heat sink, and wherein the heat sink is bolted to the fixed contact carrier of the second vacuum interrupter with a second bolt through a hole (34) in the second end wall of the heat.

13. Medium or high voltage circuit breaker according to claim 12 when dependent upon any of claim 5-10, wherein at least one side portion (36) of the heat sink has no ribs and is open to enable access to a head of the first bolt and to enable access to a head of the second bolt.

14. Medium or high voltage circuit breaker according to any of claims 1-10, wherein the fixed contact carrier of the first vacuum interrupter is bolted to the fixed contact carrier of the second vacuum interrupter with a bolt.

15. Medium or high voltage circuit breaker according to claim 14, wherein a first end wall of the heat sink is adjacent to an end face of the fixed contact carrier of the first vacuum interrupter, and wherein a second end wall of the heat sink is adjacent to an end face of the fixed contact carrier of the second vacuum interrupter, and wherein the bolt extends through a centre hole of the heat sink.

16. Medium or high voltage circuit breaker according to claim 14, wherein an end face of the fixed contact carrier of the first vacuum interrupter is adjacent to an end face of the fixed contact carrier of the second vacuum interrupter, and wherein an inner surface of the heat sink is adjacent to a cylindrical outer surface of the fixed contact carrier of the first vacuum interrupter and/or an inner surface of the heat sink is adjacent to a cylindrical outer surface of the fixed contact carrier of the second vacuum interrupter.

17. Medium or high voltage circuit breaker according to any of claims 14-16, wherein a first threaded hole in the fixed contact carrier of the first vacuum interrupter accommodates the bolt and wherein a second threaded hole in the fixed contact carrier of the second vacuum interrupter accommodates the bolt, and the bolt is configured such that the bolt is at the bottom of the first threaded hole but not at the bottom of the second threaded hole when the fixed contact carrier of the first vacuum interrupter is bolted to the fixed contact carrier of the second vacuum interrupter.

18. A medium or high voltage switching system, comprising at least one medium or high voltage circuit breaker according to any of claims 1-17.

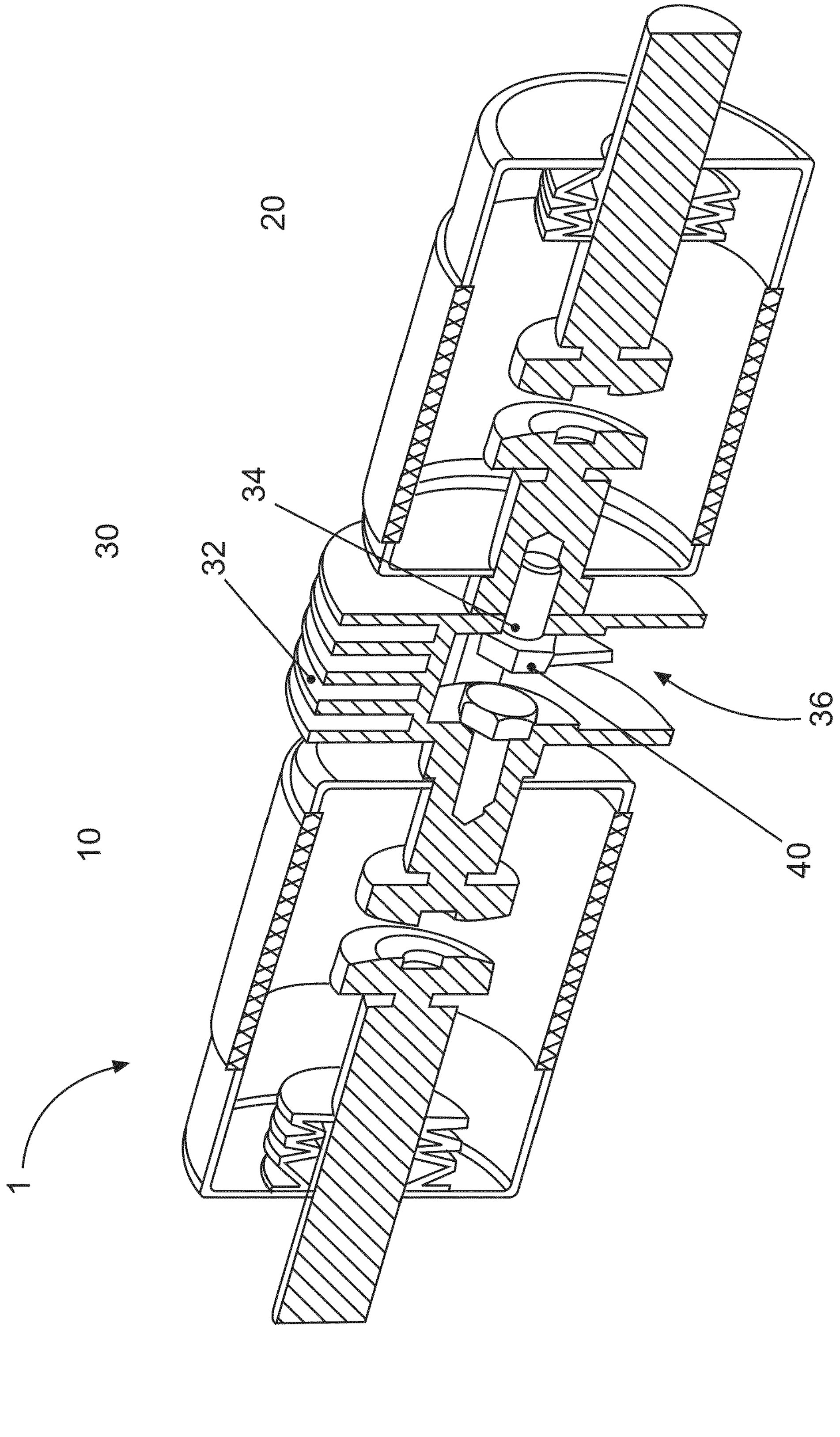

Fig. 1

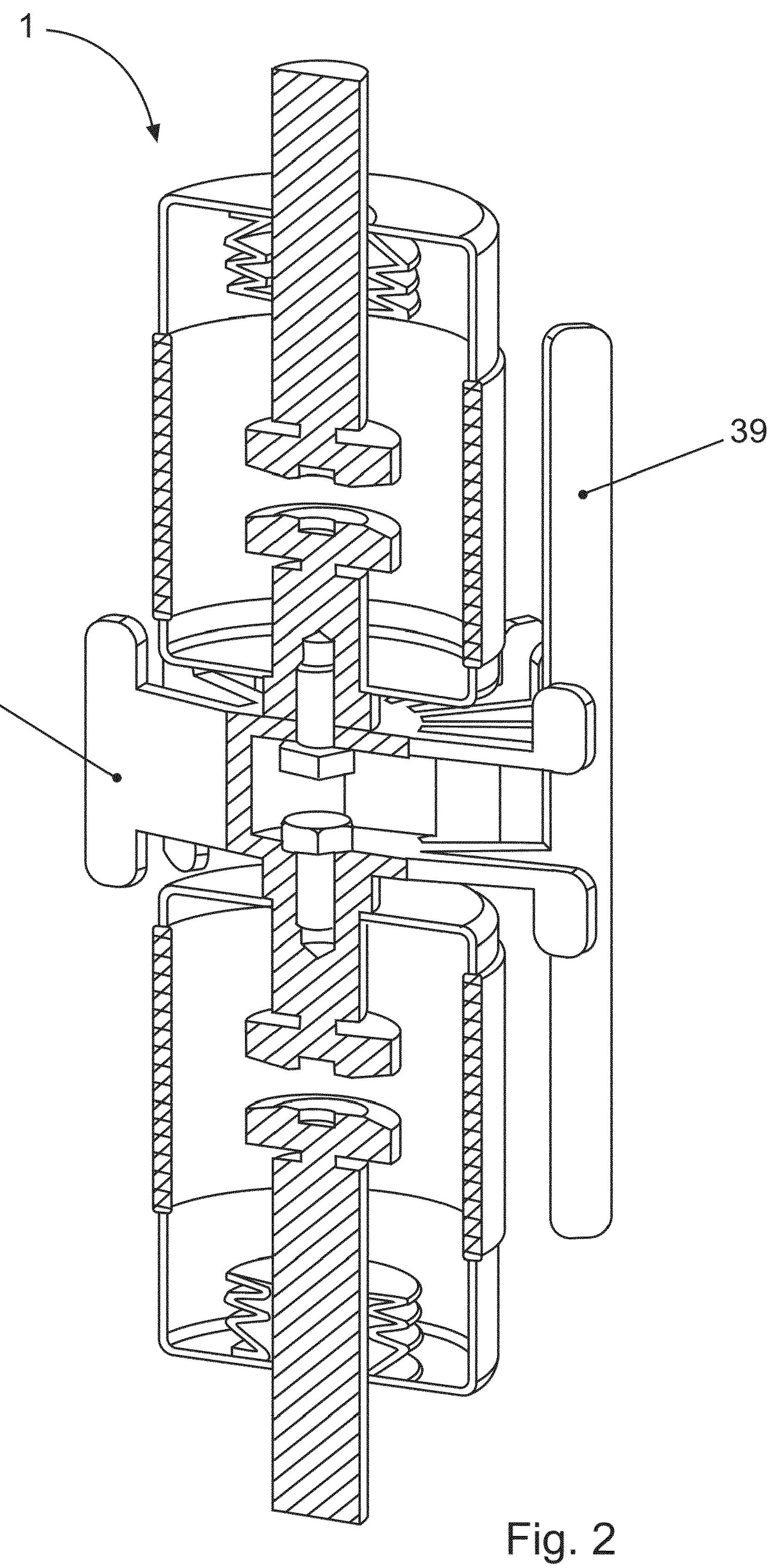

Fig. 2

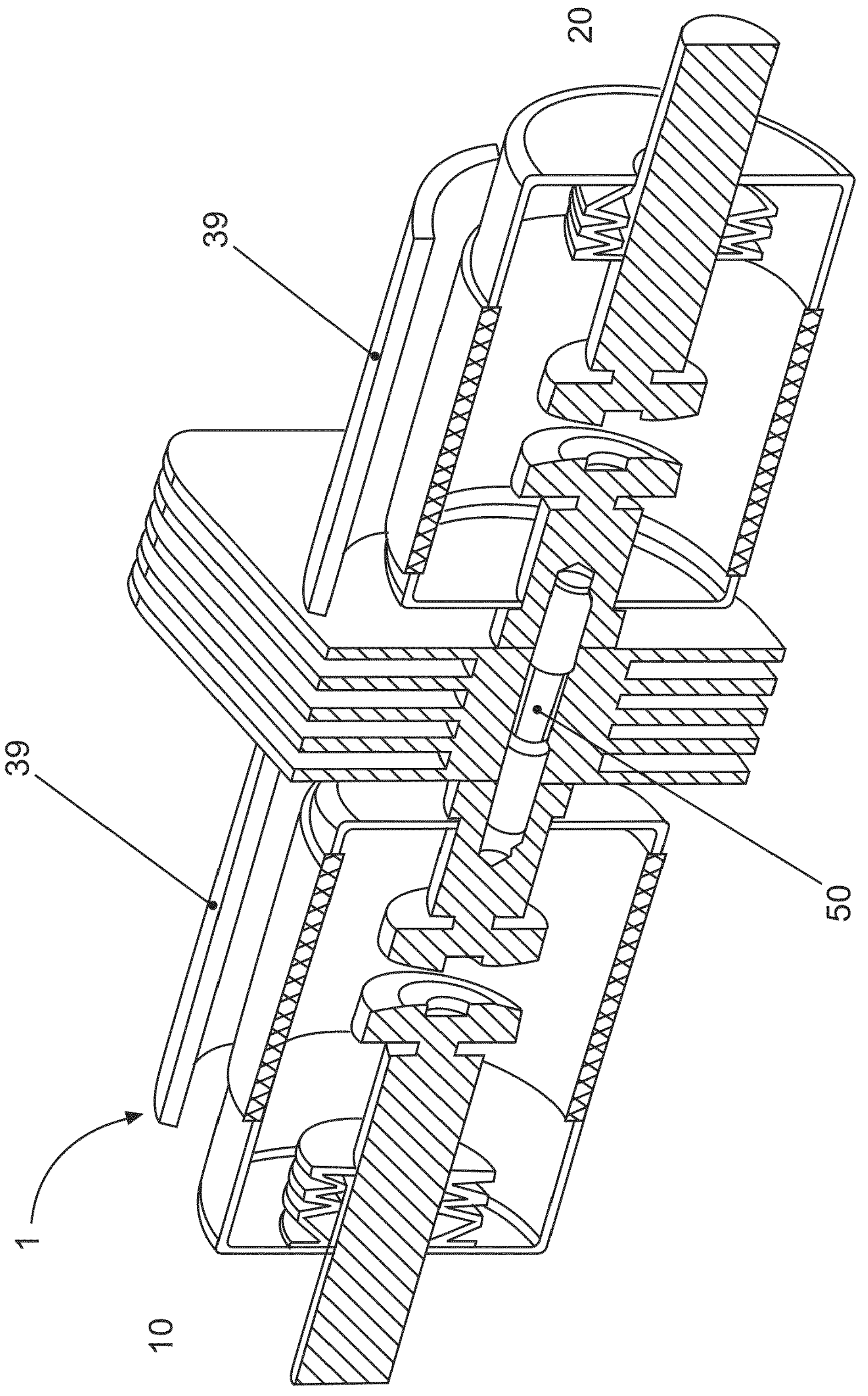

Fig. 3

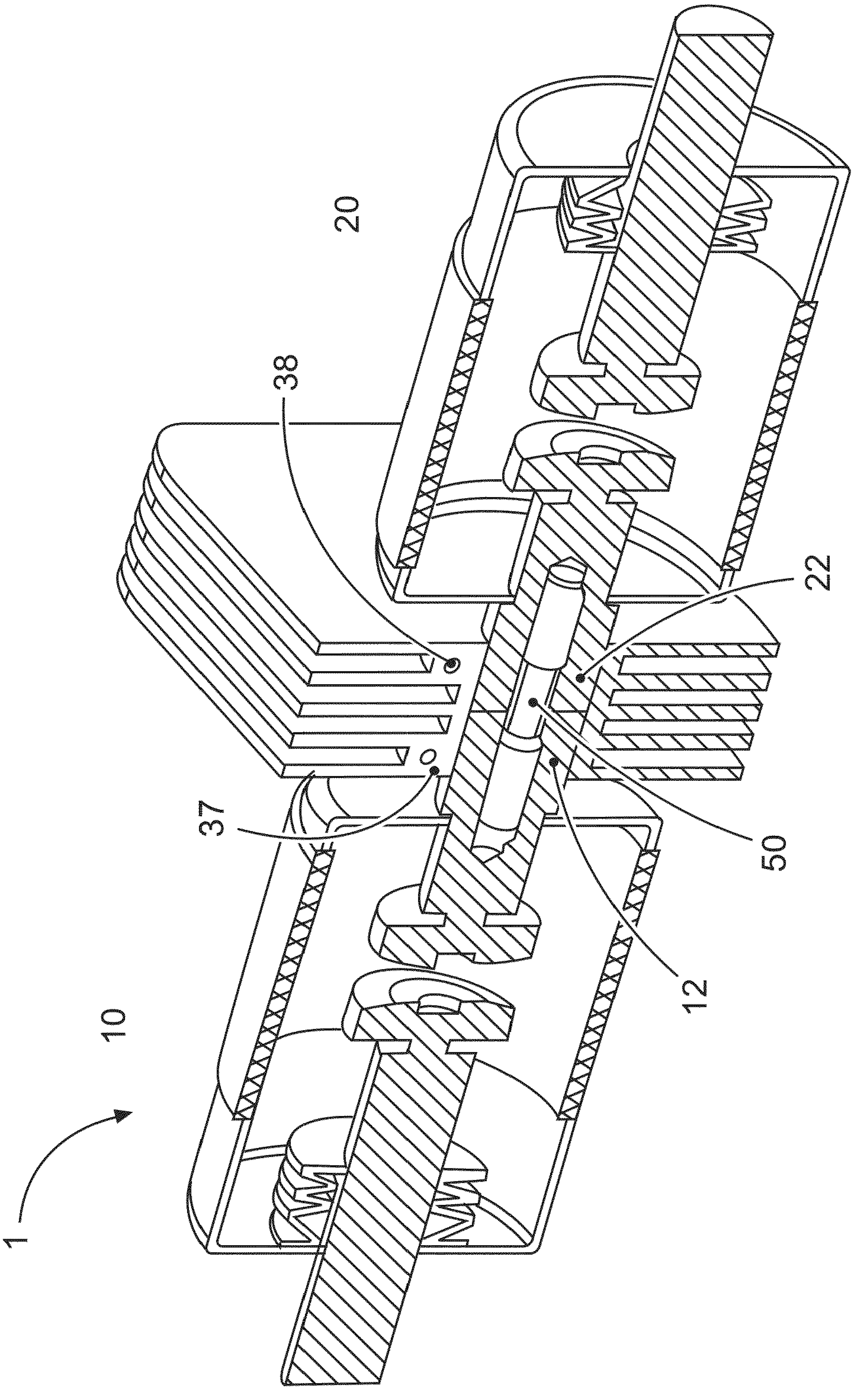

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 20 18 9853

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 January 2021	Glaman, C

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 18 9853

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