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(54) **Circuit breaker pole**

(57) A circuit breaker pole 10 comprises an actuator 31 for actuating an interrupter 26. The actuator 31 has an opening 33 surrounding the longitudinal axis L of the circuit breaker 10. An electrical path 56 to be connected and disconnected by the interrupter extends through the axial opening 33 of the actuator 31.

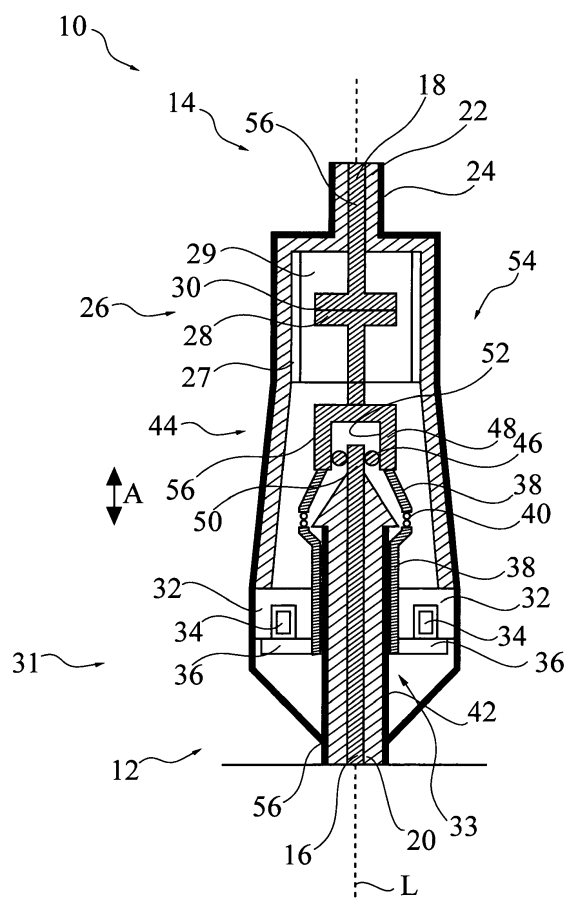


Fig.1

Description

FIELD OF THE INVENTION

[0001] The invention relates to the field of magnetic actuators. In particular, the invention relates to a circuit breaker pole and a medium voltage circuit breaker.

BACKGROUND OF THE INVENTION

[0002] In general, a circuit breaker or switchgear comprises a circuit breaker pole for each phase of the current to be switched on and off. Such a circuit breaker pole may comprise two contacts that are moved or pushed together by a drive or actuator to form an electrical contact for closing the circuit breaker pole. These contacts are moved away from each other to interrupt the electrical contact for opening the circuit breaker pole. The two contacts form the interrupter of the circuit breaker pole, which for example may be a vacuum interrupter.

[0003] In the attempt to design a compact (medium voltage) switchgear, a general obstacle is that the room directly below the (vacuum) interrupter would be an ideal place for both, the mechanical connection of the drive and the conduction of the cable that is connected to the (movable) contact of the interrupter. In most designs, the magnetic drive is coupled directly below the interrupter, while the current path is bended aside, resulting in a larger switchgear and a longer current path with corresponding ohmic losses.

DESCRIPTION OF THE INVENTION

[0004] It is an object of the invention to provide a compact circuit breaker pole.

[0005] This object is achieved by the subject-matter of the independent claims. Further exemplary embodiments are evident from the dependent claims.

[0006] A first aspect of the invention relates to a circuit breaker pole.

[0007] According to an embodiment of the invention, the circuit breaker pole comprises an interrupter for connecting and disconnecting an electrical path. The interrupter may comprise a first electrical contact and a second electrical contact that are movable with respect to each other along a longitudinal axis of the circuit breaker. The interrupter may be or may comprise a vacuum interrupter.

[0008] The contacts of the interrupter may be part of the electrical path. The electrical path may further comprise lines for connecting the circuit breaker pole with the circuit breaker or with a cable to be interrupted by the circuit breaker pole.

[0009] According to an embodiment of the invention, the circuit breaker pole comprises an actuator for actuating the interrupter, for example by moving the first electrical contact and the second electrical contact with respect to each other along the longitudinal axis. The ac-

tuator may comprise a force transferring element mechanically connected to the actuator and to an electrical contact of the interrupter. The actuator may be or may comprise a magnetic drive.

[0010] According to an embodiment of the invention, the actuator has an (axial) opening surrounding the longitudinal axis. The electrical path extends through the axial opening.

[0011] Thus, the complete electrical path is arranged near the (central) longitudinal axis and the extension of the circuit breaker pole in a radial direction may be reduced, since the conductors of the circuit breaker pole need not to be guided away from the central axis.

[0012] The (vacuum) interrupter and the actuator (for example the magnetic drive) may be arranged in a way that they are axially symmetric. The magnetic drive may be hollow in its centre. Through this centre, a medium voltage cable or line can be lead that connects one of the terminals of the vacuum interrupter. With an arrangement like this, a circuit breaker pole may be integrated in a cable, resulting in an extremely compact medium voltage switching and interrupting unit.

[0013] According to an embodiment of the invention, the electrical path comprises a line for electrically connecting a cable with the circuit breaker pole and the line extends through the opening of actuator. In this case the opening within the actuator has only to accommodate the line (for example a conductor and its isolation) and the opening may be small with respect to the whole actuator.

[0014] According to an embodiment of the invention, the actuator comprises a magnetic drive with a coil in a core for attracting a movable plate. The force from the movable plate may be transferred to the interrupter by an element extending through the opening. Not only the current but also the force for moving the interrupter contact is transferred through the opening.

[0015] According to an embodiment of the invention, the force transferring element is a tube surrounding the line. This may be the case, when the movable plate is on one side of the core and the interrupter is on another side of the core, i. e. in the case when the actuator and the interrupter are arranged in sequence along the longitudinal axis. In a radial direction the conductor of the first line, an insulating layer of the first line and the tube may extend through the opening of the actuator.

[0016] The coil, the core, the movable plate may be axially symmetric and/or all parts may have an (axial) opening through which the electrical path, in particular the first line, and the force transferring element extend.

[0017] According to an embodiment of the invention, the force transferring element is the first electrical contact of the interrupter. This may be the case, when the interrupter is arranged at least partly in the hollow centre of the actuator.

[0018] According to an embodiment of the invention, the circuit breaker comprises a contact system for providing an electrical connection between the (first electri-

cal contact of the) interrupter and a first line for connecting the interrupter with a cable to be interrupted by the circuit breaker pole, while the first electrical contact and the first line are moving with respect to each other along the longitudinal axis. The contact system may be arranged between the interrupter and the actuator or may be arranged on the side of the actuator opposite to the interrupter. The contact system may be (at least partially) rotational symmetric to allow the interrupter to be rotated with respect to the line without losing electrical contact. Thus, the contact system may provide a continuous electrical contact by a longitudinal and a rotational movement of the interrupter.

[0019] According to an embodiment of the invention, the contact system may comprise a spiral contact on a first conductor end, wherein the ring is situated within an contact tube mechanically connected to a second conductor end. The first conductor end may be the end of the conductor of a line of the circuit breaker pole and the second conductor end may be part of an electrical contact of the interrupter.

[0020] According to an embodiment of the invention, the interrupter, the contact system and the actuator are arranged in sequence along the axial direction. This may result in a compact circuit breaker pole with respect to a radial direction. The arrangement may be that first the interrupter, second the contact system and third the actuator are aligned along the longitudinal direction. It may also be possible that first the interrupter, second the actuator, third the contact system are aligned after each other.

[0021] According to an embodiment of the invention, the interrupter extends (at least partially) through the opening of the actuator. This may compact the circuit breaker pole with respect to a longitudinal direction.

[0022] According to an embodiment of the invention, the interrupter is rotatable about the longitudinal axis with respect to a first line, wherein in a first rotational position, the circuit breaker is electrically connected to a busbar contact and in a second rotational position, the circuit breaker is electrically connected to an earthing contact. The contact may be with the second line or the second electrical contact of the interrupter. Nearly all components of the circuit breaker pole may be axially symmetric with respect to the longitudinal axis resulting in an axially symmetric circuit breaker pole which may be rotated with respect to the line.

[0023] The line for making the contact, for example a terminal or foot of an electrical contact, may extend within a first section in an axial direction, may bend and may extend within a second section in a radial direction, such that the end of the line is moving between the first and second rotational position, when the circuit breaker is rotated.

[0024] According to an embodiment of the invention, the interrupter is rigidly connected with a housing of the circuit breaker pole, the housing is rotatable with respect to the first line. In other words, the circuit breaker may

be rotated as a whole for switching between the busbar contact and the earthing contact.

[0025] According to an embodiment of the invention, the interrupter is rotatable with respect to a housing of the circuit breaker pole. In this case, the busbar contact, the earthing contact and the circuit breaker may have a common housing for isolating and shielding the busbar contact, the earthing contact and the circuit breaker.

[0026] A further aspect of the invention relates to a medium voltage circuit breaker or medium voltage switchgear with a circuit breaker pole as described in the above and in the following.

[0027] If technically possible but not explicitly mentioned, also combinations of embodiments of the invention described in the above and in the following may be embodiments of the circuit breaker pole and the medium voltage breaker. According to a further embodiment of the invention, the magnetic drive may contain permanent magnets that hold the pole in closed position without current flowing in the coil of the magnetic drive. For opening the pole, the magnetic drive may contain a second coil or an opening spring.

[0028] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] The subject matter of the invention will be explained in more detail in the following text with reference to exemplary embodiments which are illustrated in the attached drawings.

Fig.1 schematically shows a longitudinal section through a circuit breaker pole according to an embodiment of the invention.

Fig. 2 shows the circuit breaker pole of Fig. 1 in an opened position.

Fig. 3 schematically shows a longitudinal section through a circuit breaker pole according to a further embodiment of the invention.

Fig. 4 schematically shows a longitudinal section through a circuit breaker pole according to a further embodiment of the invention.

Fig. 5 schematically shows a longitudinal section through a circuit breaker pole according to a further embodiment of the invention.

[0030] The reference symbols used in the drawings, and their meanings, are listed in summary form in the list of reference symbols. In principle, identical parts are provided with the same reference symbols in the figures.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0031] Fig.1 shows a circuit breaker pole 10 for generating an electrical contact between a first line 12 and a second line 14. The first line 12 comprises a first conductor 16 that is insulated by a first insulation layer 20 and the second line 14 comprises a second conductor 18 that is insulated by a second insulation layer 22.

[0032] The first line 12 enters a housing 24 (that may be an earthed shield 24) of the circuit breaker pole 10 from below and can be brought into contact or interrupted by the interrupter 26 of the circuit breaker pole 10 with the second line 14, which enters to housing 24 from above. The interrupter 26 comprises a first electrical contact 28 electrically connected with the first conductor 16 and a second electrical contact 30 electrically connected with the second conductor 18. The interrupter 26 is a vacuum interrupter 26 and has a vacuum chamber 27 containing a vacuum 29.

[0033] The second electrical contact 30 is rigidly connected with the housing 24 of the circuit breaker pole 24 and is not movable with respect to the housing 24. Contrary to this, the first contact 28 is movable within the housing 24 in an axial direction A along a longitudinal axis L of the circuit breaker pole 10. The terms "below" and "above" may be understood that they both indicate opposite directions parallel to the axial direction A.

[0034] For moving or pushing the first contact 28 towards the second contact 30, the circuit breaker 10 has a magnetic drive 31 or actuator 31 within the housing 24. The magnetic drive 31 is situated below the interrupter 26. The magnetic drive 31 comprises a core 32, a coil 34 and a movable plate 36. When the coil 34 of the magnetic drive 31 is energised, the movable plate 36 is attracted towards the core 32. The actuator 31 and in particular its components 32, 34, 36 are rotational symmetric with respect to the axis L and comprise an opening 33 surrounding the axis L. The first line 12, i. e. the conductor 16 and the insulation layer 20, extend through the opening 33.

[0035] The force of the magnetic drive 31 is transferred using an insulating tube 38 that also may contain a contact spring 40. The motion of the movable plate 36 is transferred with the insulating tube 38 that extends through the opening 33 and the contact spring 40 to the first contact 28 of the interrupter 26. In other words, the actuator 31 has a hollow central axis, allowing the first line 12, in particular the first conductor 16 and the first insulating layer 20, to cross the actuator 31 (or to extend through the actuator 31) and to connect the first line 12 to the interrupter 26.

[0036] If an opening spring (for generating a force opposite to the attracting force of the coil 34) is required, this may be installed between the core 32 and the plate 36 of the magnetic actuator.

[0037] In the embodiment shown in Fig. 1 the earthed shield 24 has a tubelike part 42 for electrically shielding the first line 12 that extends through the opening 33 of

the actuator 31. Thus, arranged in an radial direction, the conductor 16, the insulation layer 20, the tubelike part 42 and the insulating tube 38 are surrounding each other and extend through the opening 33.

[0038] The tubelike part 42 of the earthed shield may be the earthed outer layer 42 for the first line 12. It may be possible that the first insulation layer 20 and the earthed layer 42 of the first line 12 are extended into the circuit breaker pole 10, to further reduce the dimensions of a corresponding switchboard or switchgear - or to realise a panel-less switchboard.

[0039] The circuit breaker pole 10 comprises further a contact system 44 that electrically connects the fixed first conductor 16 of the second line 14 (that is rigidly connected to the housing 24) to the movable first contact 28 of the vacuum interrupter 26. The contact system comprises a spiral contact 46 surrounding the cylindrical end 50 of the first conductor 16 and a contact tube 48 with a cylindrical inner wall 52 for accommodating the spiral contact 46. The spiral contact 46 is slidable on the end 50 and/or on the inner wall 52. On a below end, the contact tube 48 is mechanically connected with the insulating tube 38. On an above end, the contact tube is mechanically connected with the first contact 28. The movable plate 36, the insulating tube 38, the contact tube 48 and the first contact 28 are rigidly connected with each other and form a movable system 54 within the circuit breaker pole 10. The movable system 54 is movable in the axial direction A of the circuit breaker 10. Also spiral contact 46 may be movable in the axial direction A and may be part of the movable system 54. The other parts of the circuit breaker pole 10 may all be rigidly connected with each other.

[0040] The circuit breaker pole 10 has an electrical path 56 comprising the first conductor 16, the contact system 44, the interrupter 26 and the second conductor 18. If the interrupter 26 is in the connecting position, all components 16, 44, 26, 18 of the electrical path 56 are energized with the medium voltage. The components 16, 44, 26, 18 of the electrical path 56 are located near the longitudinal axis L and are rotational symmetric with respect to the axis L. All components of the electrical path 56 are insulated from the environment of the circuit breaker pole 10 by the insulating layers 20, 22. The insulation layer 22 may extend inside the housing 24 from the second conductor 18 up to the actuator 31 and may surround the interrupter 26 and the contact system 44.

[0041] The circuit breaker pole 10 may be part of a switchgear for connecting and disconnecting (for example three) phases of a medium voltage. The first and second lines 12, 14 may be parts of a medium voltage cable conducting one of the phases of the medium voltage.

[0042] While Fig. 1 shows the circuit breaker pole in a closed position (the electrical contacts 28, 30 of the interrupter 26 are contacting), Fig. 2 shows the circuit breaker pole 10 of Fig. 1 in an opened position. The movable plate 36 is not attracted by the core 32. For example, the movable plate 36 and the components 38, 40, 44, 28

may fall down, when no current flows through the coil 34.

[0043] Fig. 3 shows a further embodiment of a circuit breaker pole 10 that is rotatable with respect to the first line 12. For a complete panel function, it may be required to disconnect and to earth the cable or line 14. This can be done by rotating the circuit breaker pole 10. In a first position (as shown in Fig. 3) the second line 14 is in electrical contact with a busbar contact 58, in a second position, the second line 14 may be in electrical contact with a earthing contact 60. In the shown position, the cable 12 or first line 12 that is coming from below is connected via the vacuum interrupter 26 to the busbar contact 58. When the circuit breaker pole 10 is rotated by 180° to the second position, the cable 12 can be earthed.

[0044] To allow for the rotation, the housing 24 of the circuit breaker pole 10 has an opening 62 through which the first line 12 extends. The earthing layer 42 of the first line 12 is not connected which the housing 24. In the embodiment of Fig. 3, it is proposed to rotate the complete magnetic actuator 31, the insulating tube 38, the contact spring 40, the contact system 44, the entire interrupter 26 and the insulation around the interrupter and the actuator 31. The first line 12 that is coming from below is not supposed to be rotated. The contact system 44 may allow for this relative movement. The common earth shield 24 is opened at its lower end to allow for the rotation. In other words, the first line 12, in particular the conductor 16, the insulation layer 20 and earthed layer 42 are rotatable with respect to the other parts of the circuit breaker pole 10.

[0045] Another embodiment for a circuit breaker pole 10 that may be earthed is shown in Fig. 4. Here it is proposed to include the busbar contact 58 and the earthing contact 60 into the housing 24 of the circuit breaker pole 10. The void 64 can be sealed and filled with silicone oil to reduce its size. The outer shell 24 of the circuit breaker pole 10 is not rotatable. The rotation is limited to some of the inner components, i.e. parts 36, 38, 40, 46, 48 and the complete interrupter 26. The interrupter 26 may be insulated separately by an insulation layer 66 and earthing layer 68. The rotation is enabled by sliding bearings 70 that do not permit any movement in the axial direction A.

[0046] Fig. 5 shows an embodiment of the circuit breaker pole 10, in which the actuator 31 is positioned around the interrupter 26. This reduces the axial length of the circuit breaker pole 10.

[0047] The movable plate 36 of the actuator 31 is transferring its force to a plate 38' extending in the radial direction. On one side of the plate 38' opposite to the interrupter 26, the contact system 44 is positioned, on the other side the movable plate 36 and the contact spring 40. Fig. 5 shows the "Off"-position or opened position in which the interrupter contacts 28, 30 do not contact. In the "On"-position or closed position, the contact spring creates a force that presses the contacts 38, 30 against each other. In the embodiment of Fig. 5 the foot 72 of the electrical contact 28 is the component of the electrical

path 56 and the component transferring the force of the actuator 31 within the opening 33 of the actuator 31.

[0048] While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art and practising the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. A single processor or controller or other unit may fulfil the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

LIST OF REFERENCE SYMBOLS

[0049]

10	circuit breaker pole
12	first line
14	second line
16	first conductor
18	second conductor
20	first insulation layer
22	second insulation layer
24	housing
26	vacuum interrupter
27	vacuum chamber
28	first electrical contact
29	vacuum
30	second electrical contact
A	axial direction
L	longitudinal axis
31	magnetic drive
32	core

33	opening		wherein the actuator (31) has an opening (33) surrounding the longitudinal axis (L) and the electrical path (56) extends through the axial opening (33).
34	coil		
36	movable plate	5	
38	insulating tube		2. The circuit breaker pole (10) of claim 1, wherein the electrical path further comprises a line (12) for electrically connecting a cable with the circuit breaker pole (10);
40	contact spring	10	wherein the line (12) extends through the opening (33) of actuator (31).
42	tubelike part of earthed shield		
44	contact system		3. The circuit breaker pole (10) of claim 1 or 2, wherein the actuator (31) comprises a magnetic drive (31) with a coil (34) in a core (32) for attracting a movable plate (36);
46	spiral contact	15	wherein the force from the movable plate (36) is transferred to the interrupter (26) by an element (38, 28) extending through the opening (33).
48	contact tube		
50	end of first conductor	20	
52	cylindrical wall		4. The circuit breaker pole (10) of claim 3, wherein the magnetic drive (31) also comprises permanent magnets to be able to hold the pole (10) in closed position without current flowing in the coil.
54	movable system		
56	electrical path	25	5. The circuit breaker pole (10) of claim 3 or 4, wherein the magnetic drive (31) comprises a second coil for the opening operation.
58	busbar contact		
60	earthing contact	30	6. The circuit breaker pole (10) of claim 3 or 5, wherein the magnetic drive (31) comprises an additional opening spring for supporting the opening operation.
62	opening		
64	void		
66	insulation layer	35	7. The circuit breaker pole (10) of claim 6, wherein the interrupter (26), the contact system (44) and the actuator (31) are arranged in sequence along the longitudinal axis (L).
68	earthing layer		
70	bearing	40	8. The circuit breaker pole (10) of one of the preceding claims, wherein the interrupter (26) extends through the opening (33) of the actuator (31).
72	foot		

Claims

1. A circuit breaker pole (10), comprising:

an interrupter (26) for connecting and disconnecting an electrical path (56),
 wherein the interrupter (26) comprises a first electrical contact (28) and a second electrical contact (30) that are movable with respect to each other along an longitudinal axis (L) of the circuit breaker (10);
 an actuator (31) for actuating the interrupter (26) by moving the first electrical contact (28) and the second electrical contact (30) with respect to each other along the longitudinal axis (L);

- 45 9. The circuit breaker pole (10) of one of the preceding claims,
 wherein the interrupter (26) is rotatable about the longitudinal axis (L) with respect to a first line (12);
 wherein in a first rotational position, the circuit breaker (10) is electrically connected to a busbar contact (58);
 wherein in a second rotational position, the circuit breaker (10) is electrically connected to an earthing contact (60)
- 50 10. The circuit breaker pole (10) of one of the preceding claims,
 wherein the interrupter (26) is rigidly connected with a housing (24) of the circuit breaker pole (10),

wherein the housing 24 is rotatable with respect to the a first line (12).

11. The circuit breaker pole (10) of one of the preceding claims,
wherein the interrupter is rotatable with respect to a housing (24) of the circuit breaker pole (10). 5
12. A medium voltage circuit breaker with a circuit breaker pole (10) according to one of the preceding claims. 10

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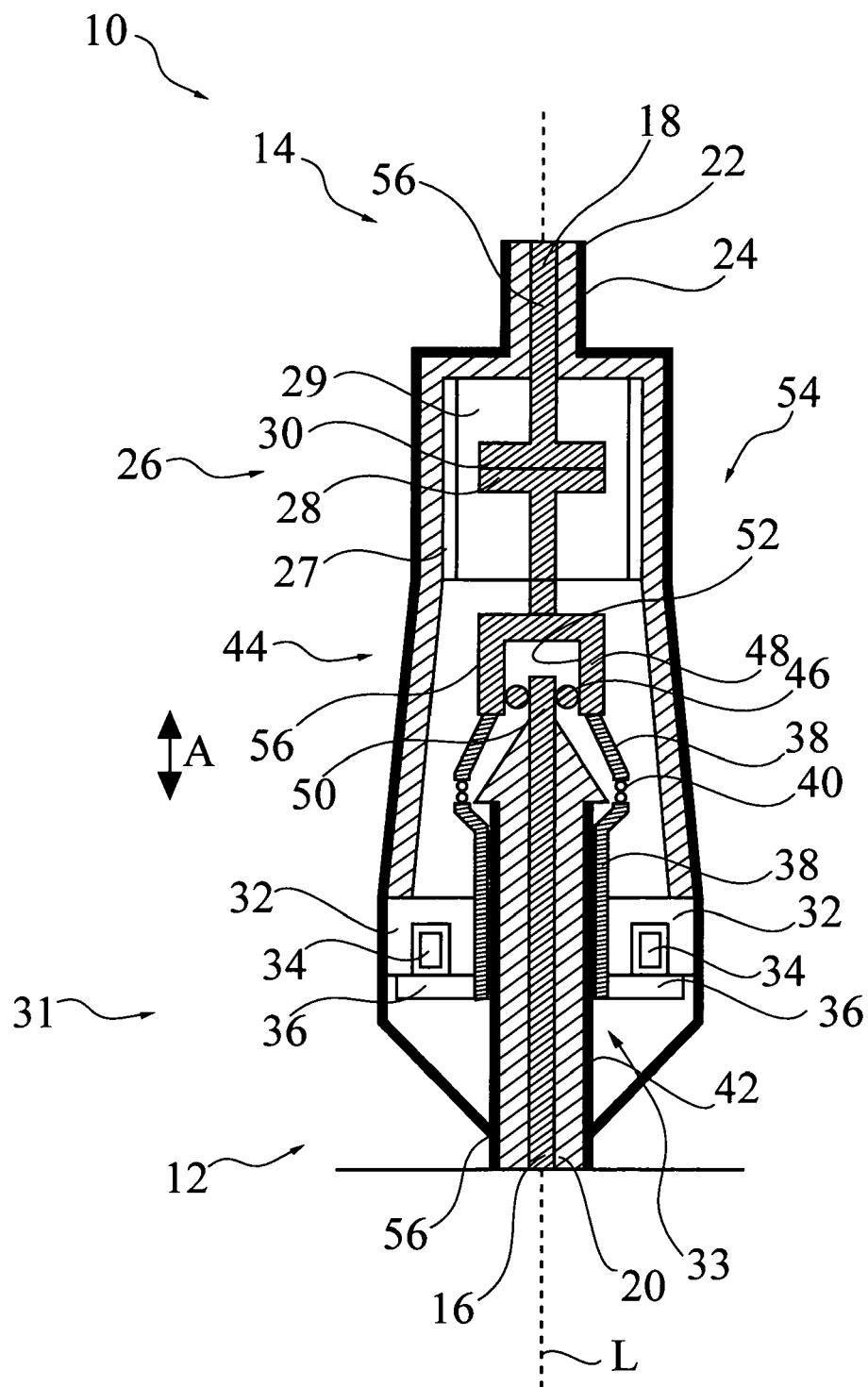


Fig.1

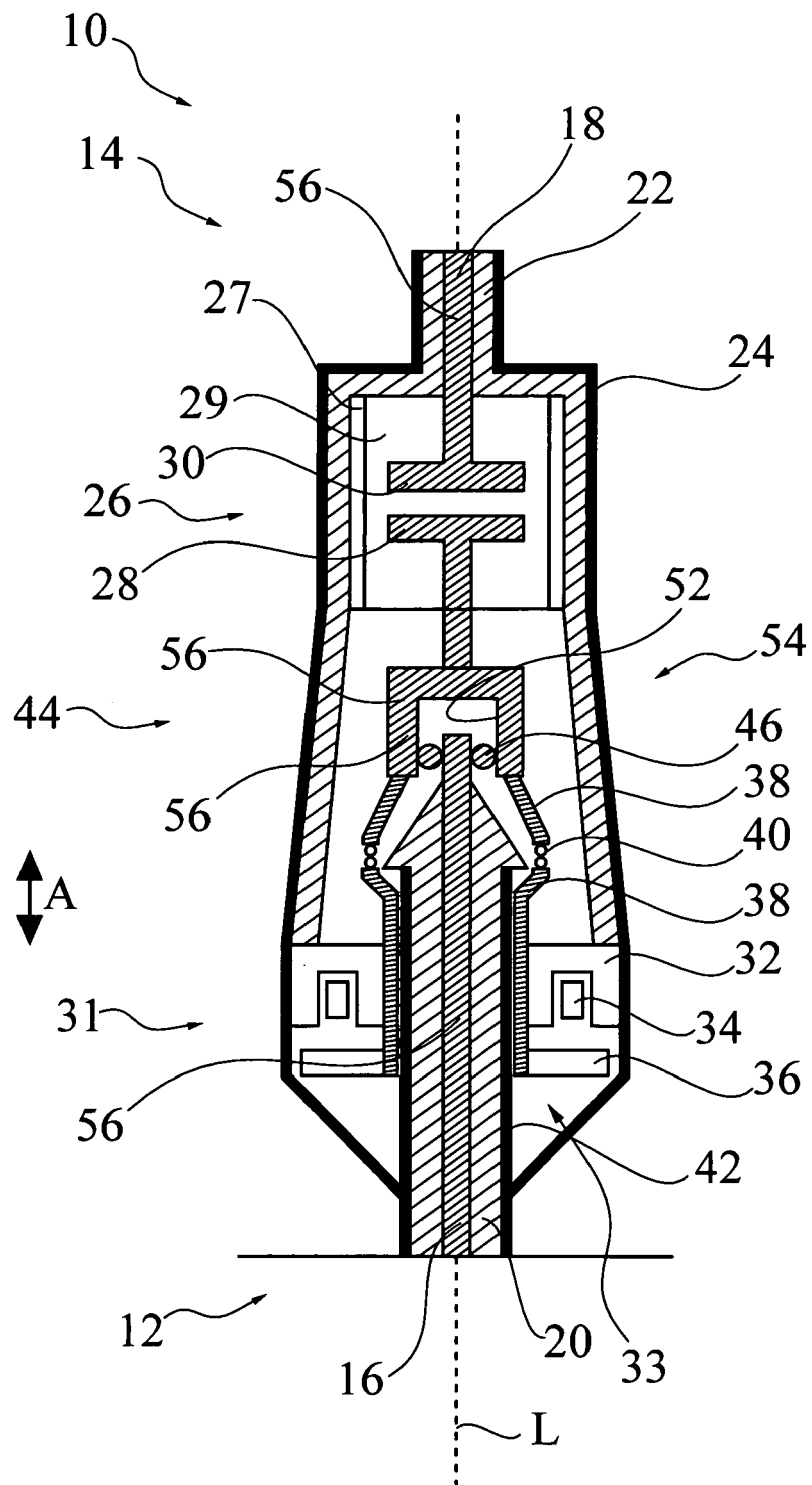


Fig.2

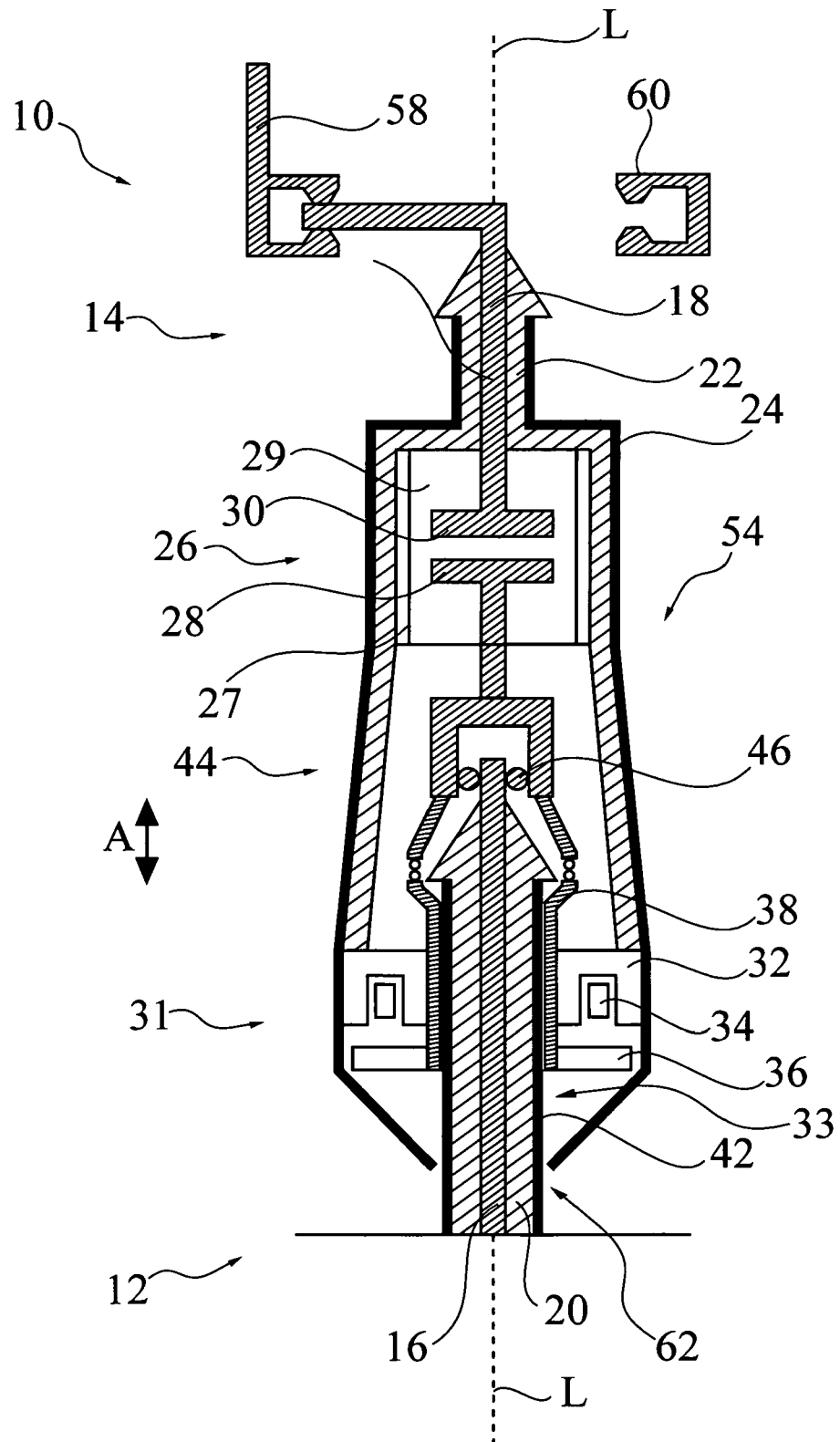


Fig.3

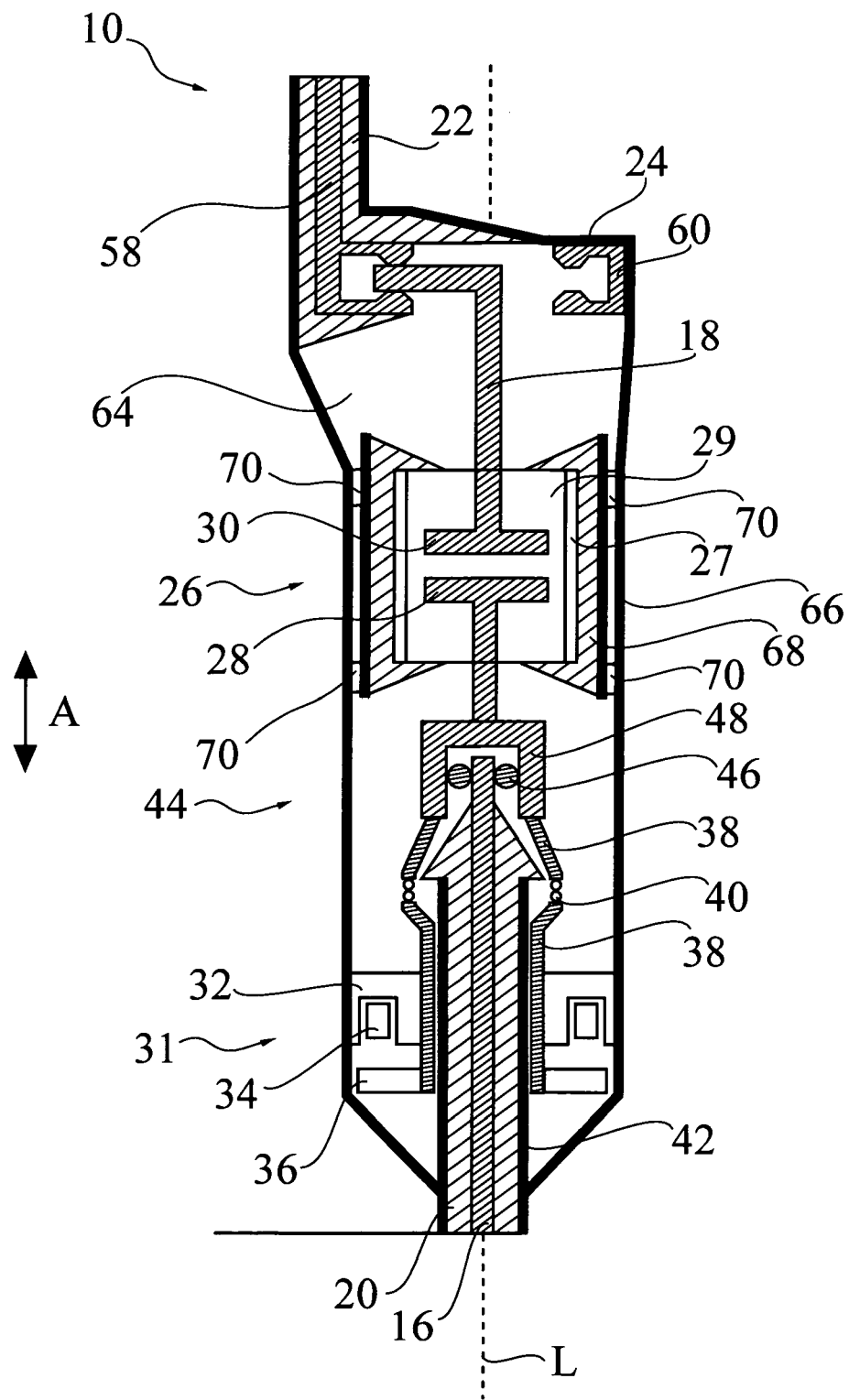


Fig.4

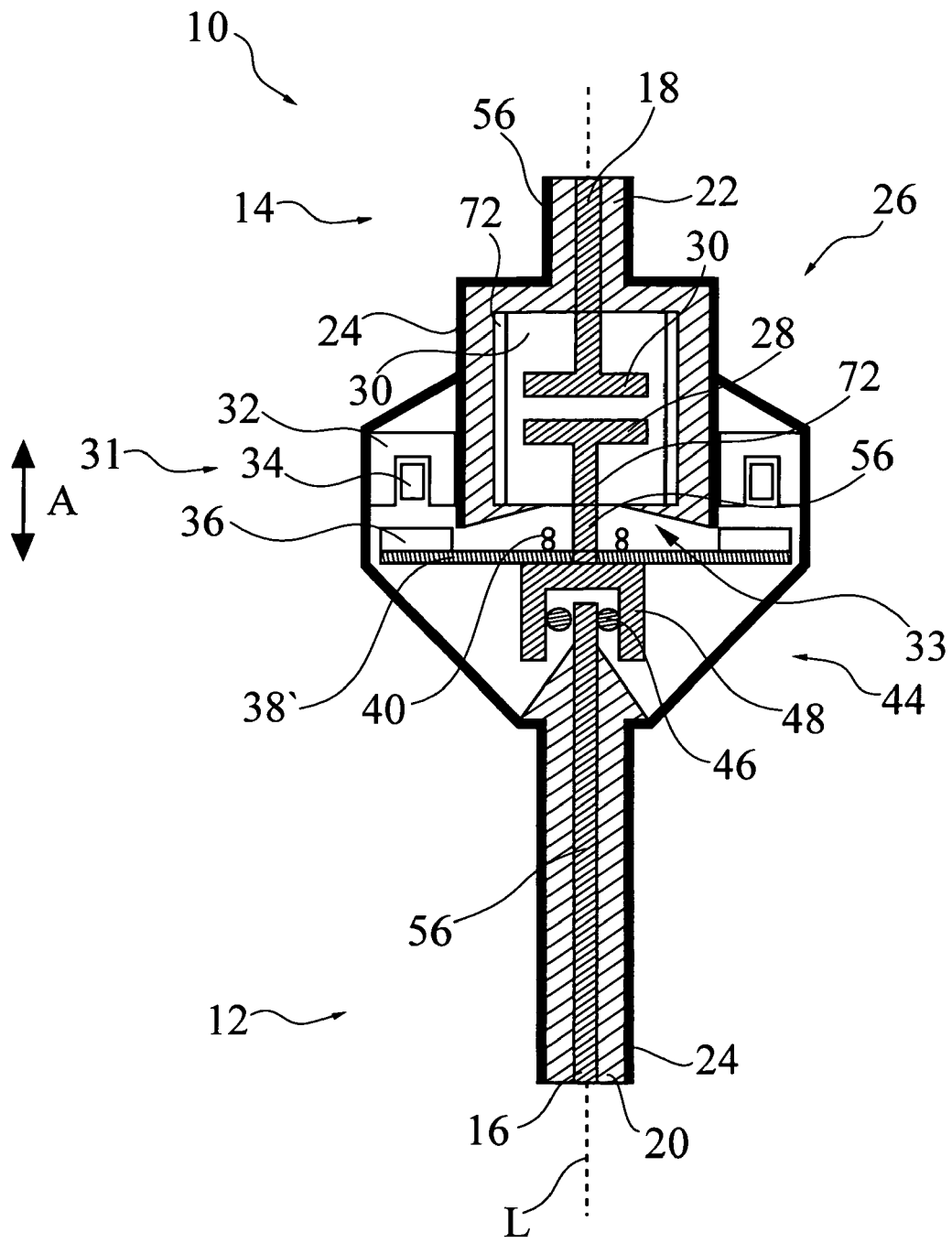


Fig.5



EUROPEAN SEARCH REPORT

Application Number
EP 10 01 5326

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 198 08 083 C1 (SIEMENS AG [DE]) 29 April 1999 (1999-04-29)	1-8,12	INV. H01H33/66
Y	* column 3, line 60 - column 5, line 15;	10	
A	figures 1,2 *	9	
Y	DE 198 57 170 A1 (ABB PATENT GMBH [DE] ABB AG [DE]) 15 June 2000 (2000-06-15)	10	
A	* column 2, line 45 - column 4, line 67; figure 1 *	1-9,11, 12	
A	US 2005/063107 A1 (BENKE JAMES J [US]) 24 March 2005 (2005-03-24) * abstract; figures 2-5 *	1-12	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01H
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 6 May 2011	Examiner Pavlov, Valeri
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			

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EPO FORM 1503 03.82 (P04C01)

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

EP 10 01 5326

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
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06-05-2011

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