

EP 2 551 872 A1

(51) Int Cl.:
H01H 3/60 (2006.01)

(22) Date of filing: **29.07.2011**

- **Mechler, Günther**
68542 Heddesheim (DE)
- **Chladny, Ryan**
Muskego, WI 53120 (US)
- **Stengel, Gregor**
76227 Karlsruhe (DE)
- **Derkx, Jeroen**
72219 Västerås (SE)

(74) Representative: **Schmidt, Karl Michael**
ABB AG
GF-IP
Oberhausener Strasse 33
40472 Ratingen (DE)

(54) **Actuator for a circuit breaker**

of the actuator 12 is absorbed by a damper element 54, 55.

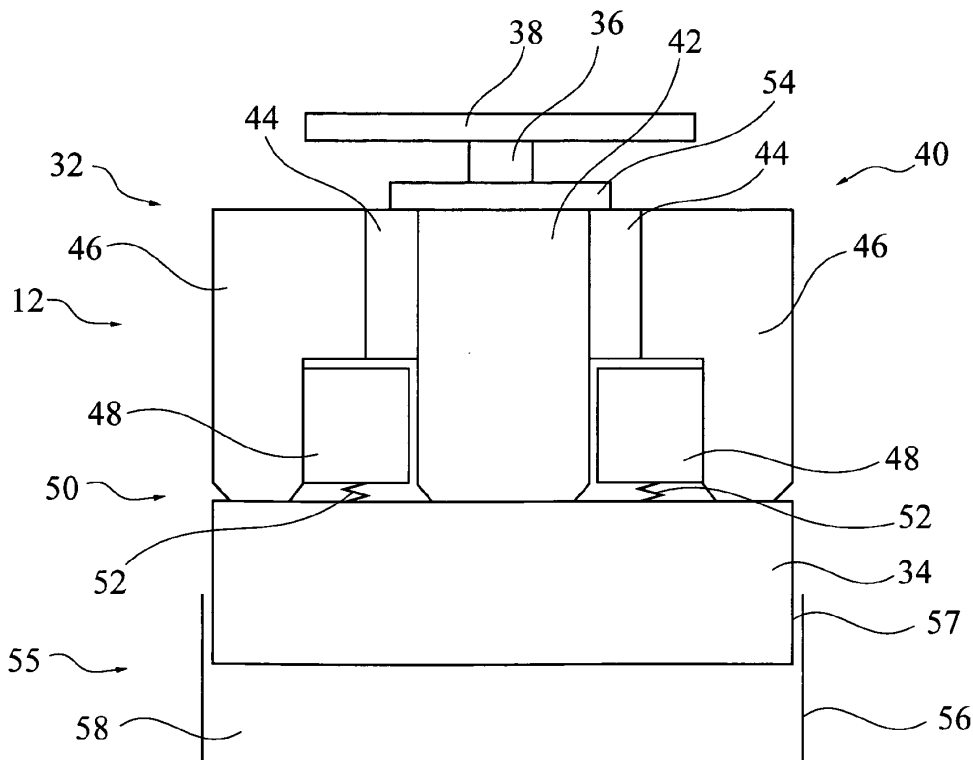


Fig. 2

Description

FIELD OF THE INVENTION

[0001] The invention relates to the field of high power circuit breakers. In particular, the invention relates to an actuator for a circuit breaker and a circuit breaker.

BACKGROUND OF THE INVENTION

[0002] An automatic circuit breaker usually comprises a switching chamber in which two terminals are connected or disconnected for opening and closing an electric path between the two terminals, and an actuator which is used for generating a relative movement of the two terminals.

[0003] For example, an actuator for generating a linear movement may comprise an armature and a stator that are adapted to move relative to each other and a coil in which a magnetic field may be induced that causes the movement of the stator and the armature from a closed into an opened position.

[0004] The armature is accelerated with respect to the stator, when the actuator has to be moved from the closed position into the opened state. The movement stops, when the armature hits mechanical components that limit its movement. Due to the abrupt interaction of the components of the actuator, the components of the actuator are subjected to large mechanical stress. Additionally, once the armature approaches the stator, it may have a high speed relative to the stator and a thus a high kinetic energy and the collision with the stationary structure may cause a mechanical bouncing according to the structural properties of the frame of the device.

[0005] This bouncing effect may generate an over-travel and/or a back-travel of the actuator components, for example the stator and the armature, as well as of the moving terminal of the circuit breaker. This may degrade the switching properties of the circuit breaker.

DESCRIPTION OF THE INVENTION

[0006] It may be an object of the invention to provide a circuit breaker with well-defined switching properties.

[0007] This objective may be achieved by the subject-matter of the independent claims. Further exemplary embodiments are evident from the dependent claims and the following description.

[0008] A first aspect of the invention relates to an actuator for a circuit breaker. For example, the circuit breaker may be a medium voltage circuit breaker, wherein a medium voltage may be a voltage between 1 kV and 50 kV.

[0009] According to an embodiment of the invention the actuator comprises a stator and an armature, which are movable with respect to each other between a closed position and an opened position, a coil for generating a magnetic field, which is adapted to cause a relative move-

ment of the stator and the armature from the closed position into the opened position, and a damper element for absorbing kinetic energy of the relative movement of the stator and the armature in the opened position. The damper element may be adapted to absorb a significant part of the kinetic energy of the actuator. In particular, the damper element may damp the movement of the armature during or at the end of the opening operation of the actuator, i.e., when the actuator reaches its opened position.

[0010] In other words, during the opening operation of the actuator, the kinetic energy of the movement of the actuator may be absorbed by a damper element.

[0011] Because the damper element may convert the kinetic energy into other energy forms like heat or pressure, the bouncing effect may be reduced, in particular, such that a well-defined over-travel and back-travel value of the actuator is reached. With a damper element, the damping of armature bouncing will be more effective and the danger of unwanted effects on technical components in or in the environment of the drive of the circuit breaker, i.e. the actuator, may be reduced.

[0012] According to an embodiment of the invention, the damper element comprises a compressible damper material. The damper material may be rubber, a foam material, or a gas like air.

[0013] According to an embodiment of the invention, the damper element comprises a plate of damping material positioned between the stator and the armature. The plate may be positioned in such a way, that, in the opened position, it contacts the faces of the armature and the stator that otherwise would hit each other in the opened position. For example, a compressible damper material sheet may be positioned between yoke and a small armature disk and may provide a damping effect.

[0014] According to an embodiment of the invention the armature comprises a shaft, wherein the stator has a hole through which the shaft extends, wherein the plate of damping material has a hole through which the shaft extends. The plate may be a disk of damper material between an armature disk and the stator.

[0015] According to an embodiment of the invention the damper element comprises a cylinder and piston arrangement, wherein a cylinder and a piston of the cylinder and piston arrangement are mechanically connected to the actuator such that a fluid inside the cylinder is compressed by the piston, when the actuator reaches the opened position. For example, the fluid inside the cylinder, which may be air, may be compressed, when the actuator presses the piston into the cylinder. The damper element may comprise an air damper for the opening operation of the actuator. Due to the rising pressure inside the cylinder, the damping effect may rise, when the actuator approaches the opened position.

[0016] According to an embodiment of the invention, the cylinder and piston arrangement allows the flow of compressed fluid out of the cylinder such that an over-pressure in the cylinder is reduced. During the opening

operation of the actuator, the fluid inside the cylinder is compressed and would generate a force that would generate a movement of the armature back in the closed position. This movement may be prevented by slowly allowing the fluid to exit the cylinder. For example, the cylinder or the piston may have a hole, or there may be a gap between the inside of the cylinder and an outside of the piston that allows the flowing of the fluid out of the cylinder. The hole or the gap should be as small that the movement of the actuator may be damped by compressing the fluid and after that the overpressure inside the cylinder may be reduced due to fluid that slowly leaves the cylinder.

[0017] According to an embodiment of the invention the cylinder and piston arrangement has a unidirectional valve for allowing fluid to flow into the cylinder. The unidirectional valve may allow fluid to enter the cylinder but may prevent fluid from leaving the cylinder. The unidirectional valve may have the effect that the movement of the armature and the stator from the opened into the closed position is not or nearly not damped by the cylinder and piston arrangement.

[0018] According to an embodiment of the invention, the armature comprises the piston. For example, an end of an armature disk of the armature provides the piston. In such a way, the part of the actuator facing in the direction in which the actuator moves during the opening operation may be used to press the piston into the cylinder. In particular, the piston may be part of the armature or may be integrally formed with the armature disk.

[0019] Summarized, the bouncing effect at the end of the opening operation of the actuator for a power breaker may be reduced using an air filled volume (formed by the piston and the cylinder) that is compressed during the opening motion. Thus, at least parts of the kinetic energy may be dissipated to heat energy and armature speed is reduced. The air volume may comprise a vessel with guiding side walls allowing to seal the volume against the moving part limiting the volume at one side as a piston moving into a cylinder.

[0020] According to an embodiment of the invention, the damper element comprises a Newton pendulum, which is adapted to absorb at least a part of the kinetic energy of the actuator. In the opened position, the armature may hit the body of the Newton pendulum, which absorbs the kinetic energy of the armature and stops the movement of the armature. The movement of the body of the pendulum may be damped by a damping material damping plate onto which the body hits or by damping the mounting of the pendulum. For example, the mounting of the body of the Newton pendulum may have a bearing absorbing the kinetic energy by friction. Summarized, the use of a Newton pendulum may decouple the damping from the armature motion.

[0021] According to an embodiment of the invention, the actuator comprises a frame, wherein the stator is rigidly connected to the frame and the armature is movable with respect to the frame. With this arrangement, the

damper element may damp the movement of the armature into the opened position.

[0022] As already said, the actuator may be constructed in such a way, that the coil directly causes the movement of the armature relative to the stator. However, it may be also possible, that the coil causes the movement in an indirect way while reducing the counterforce of another driving force in opening direction.

[0023] There are several alternatives, how the coil may move the stator and the armature with respect to each other. For example, the coil is connected to one of the parts of the actuator and may attract the other part, when energized. Another possibility is that the coil induces a magnetic field in the stator and/or the armature which counteracts a further magnetic field, for example generated by a permanent magnet, thus causing a force which separates the stator from the armature.

[0024] According to an embodiment of the invention, the actuator comprises a permanent magnet for generating a force in a closing direction of the stator and the armature. For example, the permanent magnet may be a part of the stator and the armature may comprise a ferromagnetic material that is attracted by the magnetic field that is induced by the permanent magnet in the material of the actuator.

[0025] According to an embodiment of the invention, the actuator comprises a spring element for generating a force in an opening direction opposite to the closing direction. In other words, the force generated by the spring element may counteract the force of the permanent magnet. The permanent magnet and the spring element may be chosen, such that the actuator has two stable positions, i.e. the opened position and the closed position. To achieve this, the force of the permanent magnet may be bigger than the force of the spring in the closed position and the magnetic force caused by the permanent magnet on a smaller disk of the armature is sufficient to hold the armature in the opened position while the spring force is relatively small. For example, the magnetic force between the stator and the armature may decrease when the two components of the actuator are moved away from each other and the spring element may be a helical spring that has a nearly stepwise linearly changing force when being compressed or extended.

[0026] According to an embodiment of the invention, a sum of a magnetic force caused by the coil supplied with a voltage and a force of the spring element is bigger than the force caused by the permanent magnet. In other words, the coil is located in the actuator in such a way, that the magnetic field of the coil caused by an applied voltage counteracts the magnetic field of the permanent magnet. For example, the coil may be wound around the stator in such a way, that it generates a magnetic field in the opposite direction of the field caused by the permanent magnet.

[0027] A further aspect of the invention relates to a circuit breaker.

[0028] According to an embodiment of the invention,

the circuit breaker comprises an actuator as described in the above and the following, and a switching chamber with a first terminal and a second terminal, wherein the actuator is mechanically connected to the first terminal of the switching chamber, such that the actuator is adapted to move the first terminal between a closed position, in which the first terminal is electrically connected with the second terminal, and an opened position in which the first terminal is electrically disconnected from the second terminal. For example, the first terminal of the switching chamber is movable with respect to the switching chamber, which may be a vacuum interrupter, and the second terminal is fixed with respect to the switching chamber. Since such a circuit breaker has an actuator with a well-defined moving behaviour, with well-defined over-travel and back-travel, such a circuit breaker may have a well-defined switching behaviour, and in particular a very well-defined switching time.

[0029] It has to be noted, that the closed and opened position of the switching chamber of the circuit breaker may be reached, when the actuator reaches its closed position and opened position, respectively. However, it may also be possible, that the switching chamber reaches its closed position, when the actuator reaches its opened position and vice versa.

[0030] 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

[0031] 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 circuit breaker according to an embodiment of the invention.

Fig. 2 schematically shows a cross-sectional view of an actuator in a closed position according to an embodiment of the invention.

Fig. 3 schematically shows a cross-sectional view of the actuator of Fig. 2 in an opened position.

Fig. 4 schematically shows a three dimensional view of the actuator of Fig. 2 and 3.

Fig. 5 schematically shows an actuator according to a further embodiment of the invention.

[0032] 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

[0033] Fig. 1 schematically shows a circuit breaker 10 which comprises an actuator 12 and a switching chamber 14. The circuit breaker 10 may be any switching device in particular any medium voltage switching device. The actuator 12 is adapted to generate a linear movement of a rod 16 that is mechanically connected to a first terminal 18 of the switching chamber 14, which is movable connected to the switching chamber 14. The first terminal 18 may be pushed onto the second terminal 20 by the actuator 12, thus moving the switching chamber 14 or respective the circuit breaker 10 into a closed position, in which the contacts 22 of the circuit breaker are in electrical contact. Further, the terminal 18 may be moved away from the terminal 20 by the actuator 12, such moving the switching chamber 14 of the circuit breaker 10 into an opened position, in which the contacts 22 are electrically disconnected from each other.

[0034] The actuator 12 is an electromagnetic actuator that is connected over an electrical line 24 with a voltage source 54. The actuator 12 has an electromagnetic coil 28 that is connectable to the voltage source in such a way that a magnetic field is induced in the coil 28 which causes the actuator 12 to move from a closed into an opened position as will be explained in the following.

[0035] Fig. 2 schematically shows a cross-sectional view of an actuator 12. The actuator 12 has an armature 32 comprising a main armature disk 34, a shaft 36 and a small armature disk 38. The armature disks 34 and 38 may be ferromagnetic steel disks. The armature disks 34 and 38 are parallel to each other and are mechanically connected by the shaft 36 which is used for guiding the armature through a hole of the stator 40 relative to the stator 40. The stator 40 comprises an inner yoke 42 which has a hole through which the shaft 36 as part of the armature 32 is guided relative to the stator 40.

[0036] The stator 40 further comprises two permanent magnets 44 attached to side faces of the inner yoke 42 and two outer yokes 46 attached to the permanent magnets 44. The yokes 42, 46 and the permanent magnets 44 form a comb-like structure with teeth defined by the end of the yokes pointing into the direction of the armature disk 34. Between the teeth there are two gaps or windows in which a coil 48 is situated, which is wound around the inner yoke 42.

[0037] The actuator 12 shown in Fig. 2 is an actuator with two stable positions, i.e. a closed position shown in Fig. 2 and an opened position shown in Fig. 3. In the closed position shown in Fig. 2, the stator 40 and the armature 32 form a magnetic circuit with a closed air gap 50 between the stator 40 and the armature components 42 and 46. The permanent magnets 44 are placed in series into the magnetic circuit to provide a static magnetic flux that causes relative strong magnetic forces holding the air gap 50 closed. A spring element 52 is applied as a counterforce to the magnetic force generat-

ed by the permanent magnets 44. In the closed position shown in Fig. 2, the magnetic force generated by the permanent magnets 44 is larger than the spring force generated by the spring element 52. Thus, the closed position is stable even in the case of external mechanical excitations like earthquakes.

[0038] The opening operation of the actuator 12 is started by excitation of the magnetic coil 48 in a way that the magnetic flux in the magnetic circuit is reduced until the magnetic force is smaller than the spring force of the spring element 52. Once the total force on the armature 32 has a zero crossing, a net acceleration of the armature 32 will start the opening operation. The more the gap between stator 40 and armature 32 has increased, the more the spring force may dominate the magnetic force.

[0039] The actuator 12 comprises a damper element 54 with a compressible damper material 54 that is positioned between the stator 40 and the armature 32. In particular, the damper element 54 is a plate 54 in the form of a disk 54, with a hole through which the shaft 36 extends.

[0040] A further damper element of the actuator 12 is a cylinder and piston arrangement 55 with a piston 57 that is formed of the armature disk 34 and a damper cylinder 56 in the form of a cylindrical vessel arranged around the end of the armature disk 34. The used damper material is air 58 from the environment of the actuator 12, which is compressed during the opening operation of the actuator 12.

[0041] Fig. 3 shows schematically a longitudinal cross-section through the actuator 12 in the opened position. In the closed position, the stator 40 is abutting the armature disk 34 with the side that houses the coil 48. In the opened position, the stator 40 is abutting the damper element disk 54 with the opposite side and the damper element 54 is abutting the armature disk 38. Thus, in the opened position, the air gap 50 is maximal.

[0042] Once the air gap 50 between the stator 40 and the armature 32 has started to open, the spring force will dominate the magnetic force. During the opening movement the spring force is piecewise almost linearly decreasing. Once it has arrived in the opened position, the spring force may be negligible, but the magnetic force of the permanent magnets 44 acting on the small disk 38 may be sufficient to hold the armature 32 in the opened position. Therefore, the opened position shown in Fig. 3 is also a stable position of the actuator 12. However, since there may be always a force accelerating the relative movement of the armature 32 relative to the stator 40, it is getting faster when reaching the opened position. As long as the coil 48 is connected to the power supply 54, the current in the coil 48 will rise thus contributing together with the permanent magnet to the overall magnetic force. As long as the magnetic field caused by the coil is smaller than the magnetic field caused by the permanent magnet, both acting on the armature, the coil will contribute to the acceleration of the armature. In the opposite case the magnetic field will contribute to the deceleration of the

armature 32.

[0043] Once the armature 32 approaches its final opened position relative to the stator 40, shown in Fig. 3, it will approach a specific kinetic energy corresponding to a velocity of the armature 32 relative to the stator 40 that may be too high, if the movement of the armature 32 relative to the stator 40 is not damped. If the damper elements 54, 55 would not damp the movement of the actuator 12, this kinetic energy may cause a mechanical bouncing due to the collision of the components of the actuator 12 which would cause the above-mentioned degrading of the switching properties of the circuit breaker,

[0044] Fig. 4 schematically shows a three dimensional view of the actuator 12. As may be seen from Fig. 4, the stator 32 and the cylinder 56 are rigidly connected to a fix frame 60 of the actuator. Thus, when the coil 48 not shown in Fig. 4 is activated, the armature 32 moves in the direction of the arrow shown in Fig. 4. During the movement, the air 58 inside the cylinder 56 is compressed. Further, when the actuator 12 reaches its opened position, the stator 40 moves the damping plate 54 onto the armature disk 38 and compresses the plate 54. A further plate 62 is positioned between the inner yoke 42, the magnets 48 and the outer yokes 46 on one side and the damping plate 54 on the other side to distribute the force from the stator equally to the damping plate 54.

[0045] The damping effect of the cylinder and piston arrangement 55 is supported or combined with the compressible damper material sheet 54 of a certain thickness with a hole to be penetrated by the armature shaft 36. The sheet 54 is positioned between the armature disk 38 and the plate 62, which may be a non-magnetic steel disk, that is a part of the stator 40.

[0046] Fig. 4 shows a notch 66, in which the spring element 52 not shown in Fig. 4 for opening the actuator 12 is positioned.

[0047] The cylindrical vessel of the cylinder 56 has bottom and side walls that are adapted to contain a part of the armature 32 that fits as the piston 57 into the vessel or cylinder, respectively. The arrangement 55 is able to compress the air 58 in the volume contained by the cylinder 56 and the piston 57 during the opening operation of the actuator.

[0048] The tolerance between vessel mantle, i. e. the inner wall of the cylinder 56, and the armature disk 34 serving as piston 57 is appropriate to avoid canting of the cylinder 56 and to allow for escape of compressed air 58 in an appropriate time.

[0049] During an opening operation the armature disk 34 dives into the cylinder 56 while compressing the air 58 in the cylinder. The compression time of the air 58 is much shorter than the escape time of the air 58 mentioned above. During the compression process the air 58 is heated up thus transferring kinetic energy into heat energy.

[0050] During closing operation the armature disk 34 will be moved out of the air damper cylinder 56 again. In

order to avoid damping effects due to air expansion working against the outer air pressure, a unidirectional blocking valve 62 at the bottom of the cylinder 56 is provided that allows free flow of air 58 into the cylinder 56.

[0051] In case that the armature disk 34 has a different form, the vessel mantle contour has to be adapted to the armature form, or the armature shape has to be redesigned.

[0052] The benefits offered by this arrangement are that the air damping effect in combination with other damping effects will reduce the armature speed at collision at the end of the opening motion. Thus the bouncing of the armature 12 at the end of the opening operation may be reduced significantly. The overtravel and back-travel in reference to the opened position of the armature 12 may be limited to specified bounds.

[0053] Fig. 5 schematically shows an actuator 12 with a Newton pendulum 70. The pendulum has a body 72 which is movable mounted with a mounting 74 to the fix frame 60.

[0054] The bouncing of the armature 32 at the end of the opening operation of the actuator 1 may be reduced by the Newton pendulum 72. In such an arrangement the impulse of the armature 32 is transferred to the body 72 with a mass that is equal to the mass of the armature 32 in a well defined elastic collision. After the collision the armature 32 is stopped relative to the inertial system of the stator 40 and the actuator 12. But the pendulum body has taken over the entire kinetic energy of the armature 32. Now the motion of the pendulum can be damped without influencing the motion of the armature 32. After the transfer of the impulse of the armature 32 to the pendulum 70, the armature can be positioned at its nominal open position. The form and position of the pendulum 70 and its rotation axes may be adapted to the spatial opportunities. The bearing for the rotation axes may be placed at a part stiffly connected to the earth frame of the breaker system.

[0055] The motion of the pendulum 70 may be damped like the motion of the armature 32 in the Fig. 1 to 3. For example, the motion may be damped by a damper element 76 situated behind the pendulum body 72. However, it is also possible to damp the motion with a mounting 74 with bearings that damp the motion of the body 72 by friction.

[0056] The arrangement shown in Fig. 5 may be combined with the damping elements of Fig. 1 to 3, for example with the damping plate 54 and the cylinder and piston arrangement 55.

[0057] 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. 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 numerals in the claims should not be construed as limiting the scope.

LIST OF REFERENCE SYMBOLS

[0058]

10	circuit breaker
12	actuator
14	switching chamber
16	rod
18	first terminal
20	second terminal
22	electrical contact
24	electrical line
32	armature
34	main armature disk
36	shaft
38	small armature disk
40	stator
42	inner yoke
44	permanent magnet
46	outer yoke
48	coil
50	air gap
52	spring element
54	damper element
55	cylinder and piston arrangement
56	damper cylinder
57	piston

58 air
 60 fix frame
 62 valve
 66 notch
 70 newton pendulum
 72 body
 74 mounting
 76 damper element

Claims

1. An actuator (12) for a circuit breaker (10), the actuator comprising:
 - a stator (40) and an armature (32), which are movable with respect to each other between a closed position and an opened position, a coil (48) for generating a magnetic field, which is adapted to cause a relative movement of the stator (40) and the armature (32) from the closed position into the opened position, damper elements (54 or 55 or (72 and 76)) or any combination of these for absorbing kinetic energy of the relative movement of the stator (40) and the armature (32).
2. The actuator of claim 1, wherein the damper elements (54, 55, 76) comprise a compressible damper material.
3. The actuator of claim 1 or 2, wherein the damper element (54) comprises a plate of damping material positioned between the stator and the armature.
4. The actuator (12) of one of the preceding claims, wherein the damper element comprises a cylinder and piston arrangement (55), wherein a cylinder (56) and a piston (57) of the cylinder and piston arrangement (55) are mechanically connected to the actuator such that a fluid (58) inside the cylinder (56) is compressed by the piston (57), when the actuator (12) approaches the opened position.
5. The actuator (12) of one of the preceding claims, wherein the cylinder and piston arrangement (55) allows the flowing of compressed fluid (58) out of the cylinder (56) such that the potential energy of the fluid 58 is reduced.

6. The actuator (12) of one of the preceding claims, wherein the cylinder and piston arrangement (55) has a unidirectional valve (62) for allowing fluid to flow into the cylinder (56).
7. The actuator (12) of one of the preceding claims, wherein the armature (32) comprises the piston (57).
8. The actuator (12) of one of the preceding claims, wherein the damper element comprises an Newton pendulum (70), which is adapted to absorb at least a part of the kinetic energy of the actuator (12).
9. The actuator (12) of one of the preceding claims, further comprising:

a frame (60),
 wherein the stator (40) is rigidly connected to the frame,
 wherein the armature (32) is movable with respect to the frame,
 wherein the damper elements (54 or 55 or (72 and 76)) or any combination of these are damping the movement of the armature (32) into the closed position.

10. A circuit breaker (10), comprising:

an actuator (12) according to one of the claims 1 to 9,
 a switching chamber (14) with a first terminal (18) and a second terminal (20),
 wherein the actuator (12) is mechanically connected to the first terminal (18) of the switching chamber (14), such that the actuator (12) is adapted to move the first terminal (18) between a closed position, in which the first terminal (18) is electrically connected with the second terminal (20), and an opened position, in which the first terminal (18) is electrically disconnected from the second terminal (20).

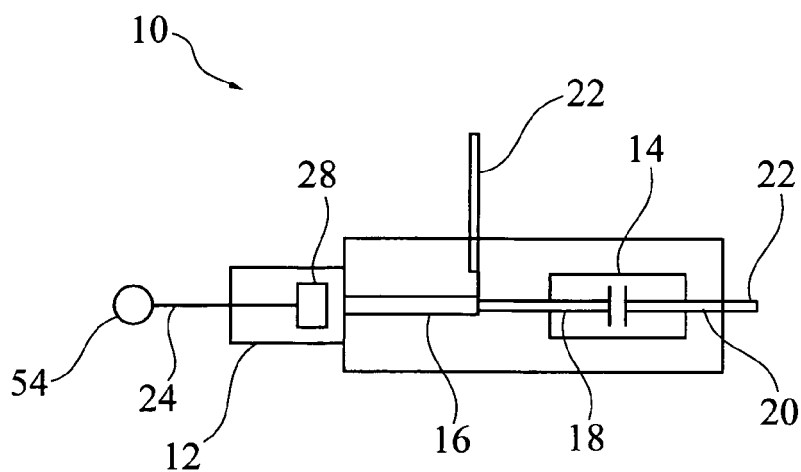


Fig. 1

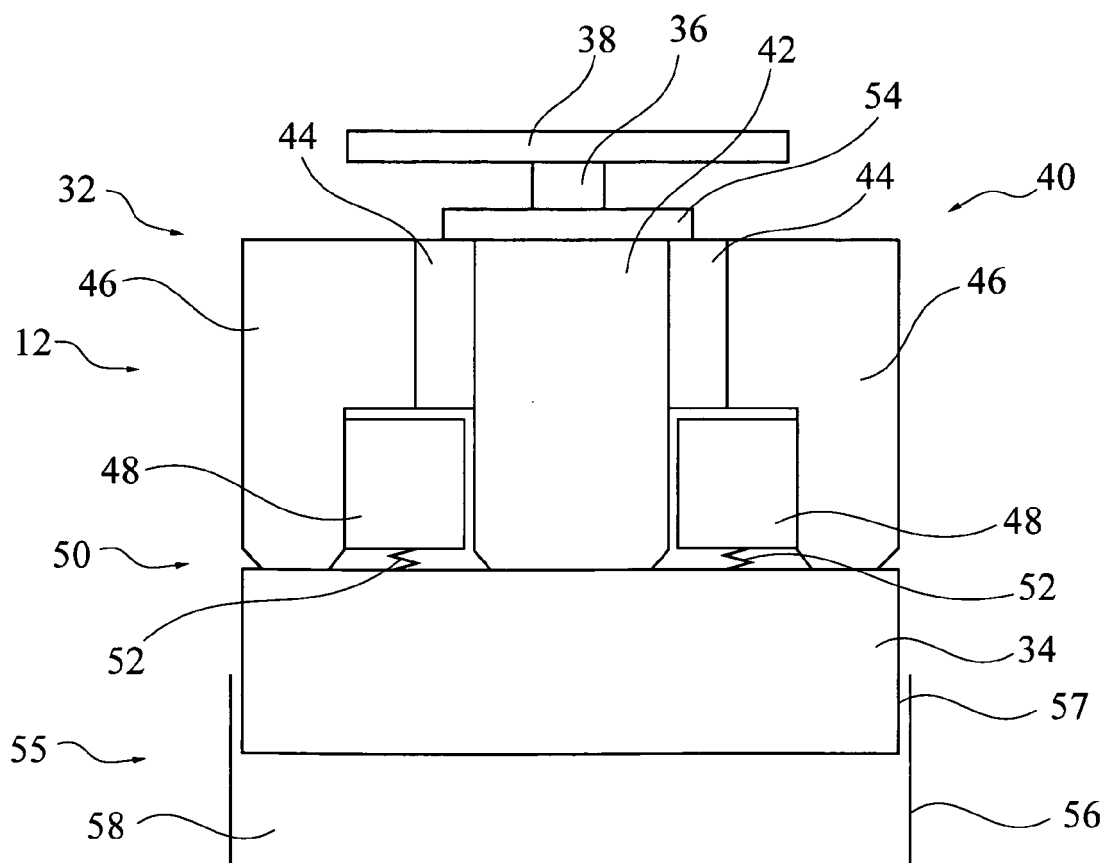
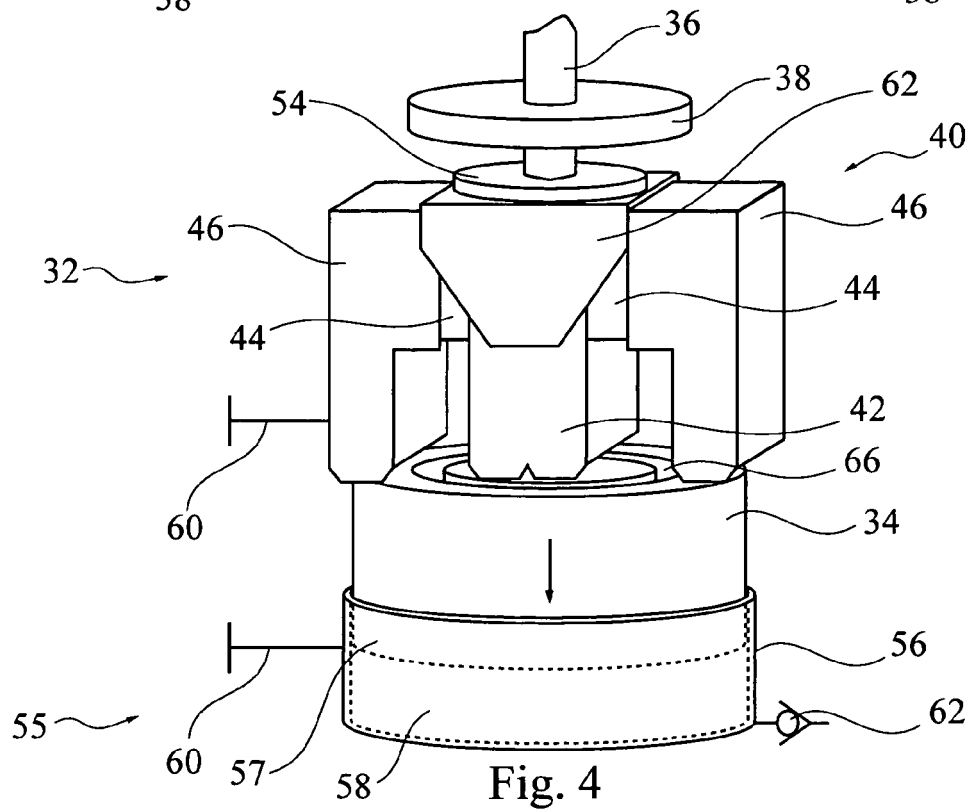
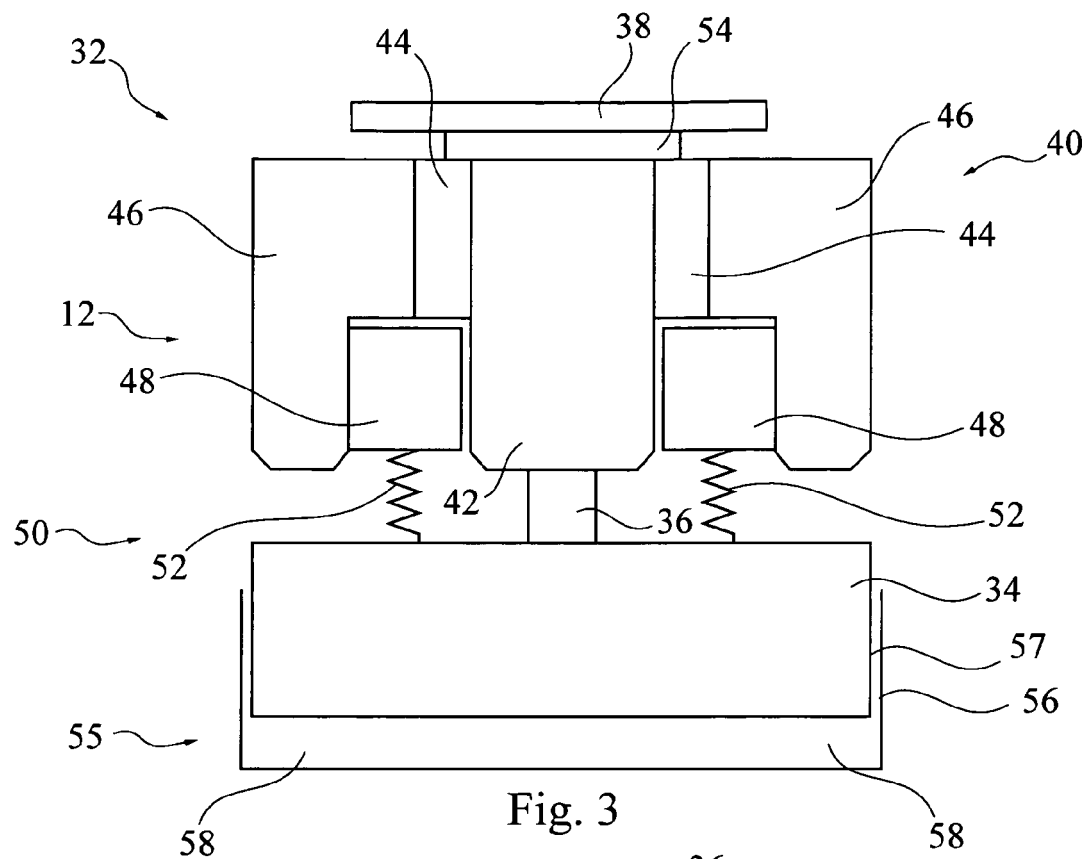


Fig. 2



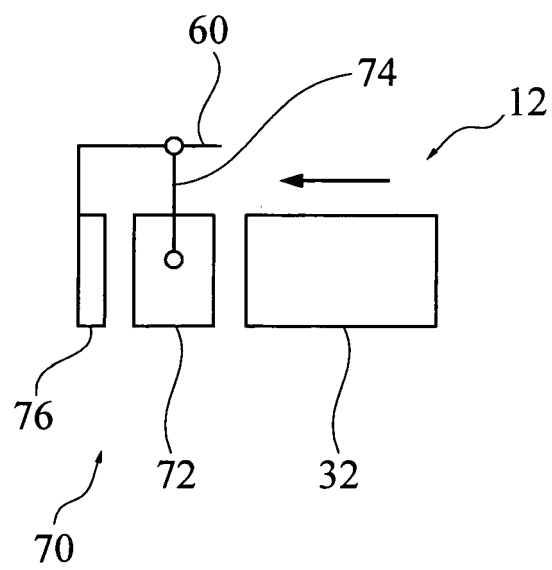


Fig. 5



EUROPEAN SEARCH REPORT

Application Number
EP 11 00 6250

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	WO 2007/064535 A1 (S & C ELECTRIC CO [US]; PFISTER ANDREW D [US]; FARGO JAMES F [US]; KLI) 7 June 2007 (2007-06-07)	1,4,7,9, 10	INV. H01H3/60
Y	* page 3, paragraph 0008 - page 5, paragraph 0014; figures 1,4,5,8 *	2,3,5,6, 8	
Y	WO 01/99133 A1 (SIEMENS AG [DE]; KUSSEROW JOERG [DE]; RENZ ROMAN [DE]) 27 December 2001 (2001-12-27) * page 5, paragraph 1 - page 6, paragraph 2; figure 2 *	2,3	
Y	US 6 347 615 B1 (HOEPFL KLAUS [DE] ET AL) 19 February 2002 (2002-02-19) * column 2, line 31 - column 4, line 26; figure 2 *	5,6	
Y	EP 1 770 302 A1 (ACANDIS GMBH & CO KG [DE]) 4 April 2007 (2007-04-04) * column 4, line 31 - column 5, line 36; figure 3 *	8	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			H01H
Place of search		Date of completion of the search	Examiner
Munich		9 December 2011	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	

 1
EPO FORM 1503 03.82 (P04C01)

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

EP 11 00 6250

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

09-12-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2007064535 A1	07-06-2007	CA 2569339 A1	01-06-2007
		WO 2007064535 A1	07-06-2007

WO 0199133 A1	27-12-2001	CN 1437757 A	20-08-2003
		DE 10030187 A1	03-01-2002
		EP 1292960 A1	19-03-2003
		JP 2003536222 A	02-12-2003
		US 2004124178 A1	01-07-2004
		WO 0199133 A1	27-12-2001

US 6347615 B1	19-02-2002	DE 19934383 A1	08-02-2001
		US 6347615 B1	19-02-2002

EP 1770302 A1	04-04-2007	EP 1770302 A1	04-04-2007
		EP 1928332 A2	11-06-2008
		US 2009025833 A1	29-01-2009
		WO 2007039271 A2	12-04-2007
