



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
22.05.2013 Bulletin 2013/21

(51) Int Cl.:
H01H 71/14 (2006.01) H01H 71/40 (2006.01)

(21) Application number: **11460056.2**

(22) Date of filing: **21.11.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(72) Inventors:
• **Ruszczyk, Adam**
30-316 Krakow (PL)
• **Mrozek, Adrian**
44-280 Rydułtowy (PL)

(71) Applicant: **ABB Technology AG**
8050 Zürich (CH)

(74) Representative: **Chochorowska-Winiarska, Krystyna**
ABB Sp. z o. o.,
Ul. Zeganska 1
04-713 Warszawa (PL)

(54) **Thermo-magnetic release mechanism for circuit breakers**

(57) The invention relates to a thermo-magnetic release mechanism for a circuit breaker protecting electric circuits in electric transmission networks, and in particular for a circuit breaker protecting the electric circuit of an electric energy receiver or receivers against short circuits or overloads. The thermo-magnetic release mechanism (4,4') for an electric power circuit breaker (2) comprises an electric circuit and a magnetic circuit, both connected mechanically and electrically with a drive element (5) of the circuit breaker. The magnetic circuit comprises a permanent magnet (8) and elements of a magnetically soft material connected to its poles, which elements are the yokes of the circuit (9a,9b) or (9a,9b'), between which

the armature of the magnetic circuit is located. The invention is characterized in that the armature is an electromagnet (10), made of two separable cores, one immovable (10a) and one movable (10b) or (10b'), individually connected with the respective pair of yokes (9a, 9b) or (9a,9b') and contacting each other frontally in the closed state of the release mechanism (4,4'), and it is made of a ferromagnetic material which when heated above the Curie (T_C) temperature changes its ferromagnetic characteristics to paramagnetic characteristics, and the coils (11a, 11b) of the electromagnet (10) are wound on separable elements of the core (10a, 10b or 10b') in directions opposite to one another with respect to both separable elements.

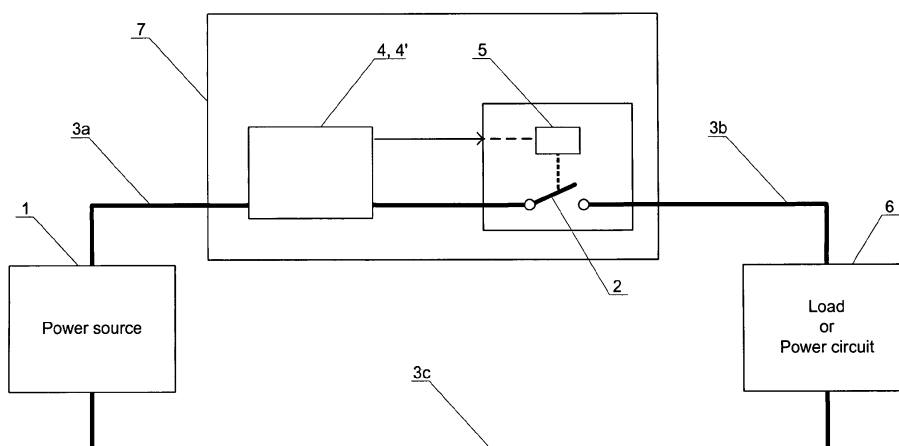


Fig. 1

Description

[0001] The invention relates to a thermo-magnetic release mechanism for circuit breakers protecting electric circuits in electric transmission networks, and in particular for circuit breakers protecting the electric circuits of electric energy receivers against short circuits or overloads.

[0002] There are commonly known devices for releasing a circuit breaker which protects an electric circuit, in which two independent mechanisms are used. One is an electromagnetic release which reacts to the occurrence of short circuit current, i.e. a current of a value many times exceeding the value of the rated current of the protected device. The other is a thermobimetal element which reacts to the occurrence of overload current, i.e. a slowly growing current of a value exceeding the value of the rated current of the protected device by not more than a few dozen percent.

[0003] Patent description EP1526560 describes a circuit breaker comprising an electromagnetic release and a thermal release which are located in a common housing. The main current path of the circuit breaker contains the contacts of the main circuit breaker, an electromagnetic release and a thermal release. The electromagnetic release is the main current coil placed on a magnetic core. If a short circuit current flows through the coil winding in the main path, the electromagnetic release causes the opening of the contacts of the main circuit breaker. If an overload current occurs, the thermal release located in the auxiliary current path activates an additional disconnecting mechanism which opens the contacts of the main circuit breaker. The thermal release is an electromagnetic circuit comprising a magnetic core, an auxiliary current coil placed on the core yoke, a magnetic armature and a thermobimetal element or a permanent magnet made of a material with variable magnetic permeability. The current coil heats up the thermobimetal element or the permanent magnet which after reaching a suitable temperature cause the movement of the magnetic armature which closes the magnetic circuit of the thermal release and activates the additional disconnecting mechanism for the contacts of the main circuit breaker. The presented solution includes two independent mechanisms for releasing the circuit breaker, which complicates the design of the release and lengthens the current path of the circuit breaker.

[0004] The essence of the thermo-magnetic release mechanism for an electric power circuit breaker, comprising an electric circuit and a magnetic circuit, both mechanically and electrically connected with the drive mechanism of the circuit breaker, in which the magnetic circuit comprises a permanent magnet and elements made of a magnetically soft material connected to its poles, which elements are the yokes of the circuit between which the magnetic circuit armature is located, the armature is an electromagnet made of two separable cores, one immovable and one movable, individually connected with the

respective pair of yokes and contacting each other frontally in the closed state of the release mechanism. The cores are made of a ferromagnetic material which when heated above the Curie temperature (T_c) changes its characteristics from ferromagnetic to paramagnetic. The coils of the electromagnet are wound in directions opposite to one another on the separable elements of the core with respect to the two separable elements.

[0005] Preferably, the movable core of the electromagnet is permanently connected with the yoke of the magnetic circuit fixed by pivot to the pole of the permanent magnet.

[0006] Preferably, a tension spring of a tension force smaller than the attractive force between the elements of the electromagnet core, which is generated by the permanent magnet, is fixed to the yoke fixed by pivot to a pole of the permanent magnet.

[0007] Alternatively, the movable core of the electromagnet is slidably connected with the yoke of the magnetic circuit, which is permanently fixed to the pole of a permanent magnet, and it is permanently connected with one end of a push rod situated in the yoke opening and protruding outside the external surface of the yoke.

[0008] Preferably, on the push rod that protrudes outside the external surface of the yoke there is located a tension spring whose one end rests on the external surface of the yoke and the other end rests on a resistance element fixed to the other end of the push rod. The expanding force of the tension spring is smaller than the attractive force between the cores of the electromagnet, generated by the permanent magnet.

[0009] Preferably, the core of the electromagnet is made of a material whose Curie temperature T_c ranges from 60 to 150°C.

[0010] Preferably, the core of the electromagnet is made of ferro powders or sinters of magnetically soft materials, super-paramagnetic materials in the form of: powders, sinters, suspensions or other forms of ferromagnetic particles in nanometric or micrometric sizes, gadolinium-based alloys or composites, Perovskite structures.

[0011] Preferably, the numbers of turns of the coils (11a, 11b) is different.

[0012] Preferably, the electromagnet coil located on the immovable core is connected with that core by means of a thermally conducting paste or cement.

[0013] The advantage of the thermo-magnetic release mechanism according to the invention is its simple design permitting substitution of two independent release mechanisms with one mechanism which reacts both to a short circuit and to an overload of the protected circuit. This results in simplification of the current path in the protective circuit breaker. The release mechanism is applicable to circuit breakers which require small dimensions of the release mechanism and simplification of the current path enclosed in the circuit breaker that protects an electric circuit.

[0014] The subject of the invention is presented as an

embodiment in the drawings wherein fig. 1 shows schematically the protective system with a circuit breaker incorporating the release mechanism according to the present invention, fig. 2 - the release mechanism in closed state in the first embodiment of the invention, fig. 3 - the release mechanism in open state in the first embodiment of the invention, fig. 4 - the release mechanism in closed state in the second embodiment of the invention, fig. 5 - the release mechanism in open state in the second embodiment of the invention.

[0015] The protective system comprises a power source 1, a circuit breaker 2 and a protected energy receiver 6. The power source 1 is connected with the circuit breaker 2 through a conductor 3a and a release mechanism 4, 4'. The circuit breaker 2 is electrically connected with the protected receiver 6 through a conductor 3b. The receiver 6 is connected with the power source 1 through a conductor 3c. The power source 1, the conductor 3a, the release mechanism 4, 4', the circuit breaker 2, the conductor 3b, the receiver 6 and the conductor 3c together form a closed electric circuit. The release mechanism 4, 4' is built in the form of a magnetic circuit. The circuit breaker 2 is connected with a drive element 5 preferably mechanically connected with the release mechanism 4, 4' and it is electrically connected with the protected receiver 6. The circuit breaker 2, the drive element 5 and the release mechanism 4, 4' can be located in a common housing 7.

[0016] The release mechanism 4, 4' contains a permanent magnet 8 whose poles are connected with elements made of a magnetically soft material which form the yokes of the magnetic circuit of the release mechanism, the first immovable yoke 9a being permanently connected with the first pole of the permanent magnet 8 and the second movable yoke 9b being rotationally connected with the second pole of the permanent magnet 8, as in the first embodiment of the invention, or the first immovable yoke 9a being permanently connected with the first pole of the permanent magnet 8, and the second immovable yoke 9b' being permanently connected with the second pole of the permanent magnet 8, as in the second embodiment of the invention. The yokes 9a, 9b and 9b' have the form of plates made of a magnetically soft material which are situated opposite one another. Between the yokes 9a and 9b, or 9a and 9b' there is located the armature of the magnetic circuit of the release mechanism 4, 4', which is an electromagnet 10 formed by two cores 10a and 10b, in the first embodiment of the invention, or 10a and 10b' in the second embodiment of the invention. Electric coils 11a and 11b which are electrically connected with the circuit breaker 2 and with the power source 1 through the conductor 3a are wound in directions opposite to one another on the cores 10a and 10b, or on the cores 10a and 10b'. The coil 11a is wound directly on the core 10a or it is fixed by means of a thermally conductive cement or a thermally conductive paste, which is not shown in the drawing. The coil 11b is wound on the core 10b or 10b' in such way that the core can freely move inside the

coil and the winding direction of the coil 11b is opposite to the winding direction of the coil 11a. The cores 10a, 10b, 10b' of the electromagnet are made of a magnetically soft ferromagnetic material which after exceeding the Curie temperature T_c , changes its characteristics from ferromagnetic to paramagnetic. In a temperature below the Curie temperature T_c the electromagnet cores 10a, 10b, 10b' behave as ferromagnetics and they present a convenient path for the magnetic flux generated by the permanent magnet 8, i.e. they have low magnetic reluctance. When the Curie temperature T_c is exceeded, the electromagnet core 10a, 10b, 10b' increases its magnetic reluctance and breaks the path for the magnetic flux generated by the permanent magnet 8. In the release mechanism 4, 4' the cores 10a, 10b, 10b' of the electromagnet 10 are made of a ferromagnetic material whose Curie temperature T_c is within the range from 60°C to 150°C. The following materials have such properties:

- ferro powders or sintered magnetically soft materials i.e. iron oxide, magnesium, nickel and zinc, for which the Curie temperature T_c is higher than 60°C and lower than 150°C,
- super-paramagnetics, i.e. powders, sintered materials, suspensions or other forms of ferromagnetic iron, cobalt, chromium, nickel, gadolinium in a nanometric or micrometric sizes, showing the effect of passing from ferromagnetic to paramagnetic state at Curie temperature T_c is higher than 60°C and lower than 150°C,
- gadolinium-based alloys or composites,
- Perovskite structures, for example ferromagnetic ceramics i.e. barium titanate of a Curie temperature T_c of approximately 120°C.

[0017] In the first embodiment of the invention the immovable yoke 9a is permanently fixed to one of the poles of the permanent magnet 8. The movable yoke 9b is fixed to the other pole of the permanent magnet 8 by means of a pivot 12 in such way that the yoke 9b can rotate within a limited range around the axis of rotation of the pivot 12 without losing contact with the permanent magnet 8. The magnetic cores 10a and 10b are permanently attached to the free ends of the yokes 9a and 9b in such way that in the closed state of the release mechanism 4 the free ends of the cores contact each other frontally. On the cores 10a and 10b there are electric coils 11a and 11b wound in directions opposite to one another, preferably of copper wire, which are electrically connected with the conductor 3a and the circuit breaker 2. The coils 11a, 11b are used to generate a magnetic field in the cores 10a and 10b. The direction of winding opposite to one another of the electric coils 11a and 11b means that the coil 11a on the magnetic core 10a is wound in one direction, and the coil 11b on the magnetic core 10b

is wound in the opposite direction, and owing to that the coil 11a magnetizes the core 10a with the opposite magnetic polarization to the magnetic polarization of the core 10b magnetized by the coil 11b. Oppositely magnetized cores will repel each other and the repulsion force will depend on the value of the current flowing through the coils 11a and 11b. The permanent magnet 8, the yokes 9a, 9b of a magnetically soft material and the cores 10a, 10b form a magnetic circuit which is closed when the cores 10a and 10b contact each other, i.e. in the closed state of the release mechanism 4. To the movable yoke 9b there is fixed a tension spring 13, one of its ends being permanently connected to the circuit breaker housing, which is not shown in the drawing. Magnetic cores 10a and 10b can contact one another or disconnect, depending on the change in the position of the movable yoke 9b of the magnetic circuit that forms the magnetic path for the magnetic flux generated by the permanent magnet 8. The magnetic flux whose source is the permanent magnet 8 generates such force of magnetic attraction that makes the core 10b of the movable yoke 9b attracted and frontally contacts the core 10a of the immovable yoke 9a of the magnetic circuit. The tension force of the spring 13 attached to the movable yoke 9b counteracts the force of magnetic attraction generated by the permanent magnet 8. Also the repulsion force generated by the cores 10a and 10b counteracts the force of magnetic attraction. If the tension force of the spring 13 compare to the mutual repulsion of the cores 10a and 10b is smaller than the force of magnetic attraction caused by the permanent magnet 8, then the magnetic circuit remains closed, i.e. it remains in the closed state of the release mechanism 4 - fig. 2.

[0018] The principle of operation of the release mechanism 4 according to the first embodiment of the invention depends on the type of the factor causing the action of the release mechanism and it is different in the case of occurrence of a short circuit and in the case of occurrence of an overload in the system protected by the circuit breaker.

[0019] In the case of a short circuit the release mechanism 4 operates in the following way.

[0020] When short-circuit current flows through the coils 11a and 11b, the coil 11a generates a magnetic field in the first core 10a of the electromagnet and the coil 11b generates a magnetic field in the other core 10b of the electromagnet. As both parts of the coils are wound in directions opposite to one another, the magnetic fields generated in both cores 10a and 10b, generated as a result of flow of the same current, will also be directed in directions opposite to each other. The oppositely directed magnetic fields in both cores will repel each other creating a force of repulsion of magnetic fields, in the drawing indicated by the arrow F_c . If the force F_c in both cores 10a and 10b is larger than the force of magnetic attraction of these cores generated by the permanent magnet 8, in the drawing indicated by the arrow F_M , and reduced by the tension force of the spring 13, in the drawing indicated

by the arrow F_s , then the cores 10a and 10b will repel each other, and the movable yoke 9b together with the core 10b and the push rod 15 will turn around the axis of rotation of the pivot 12 by an angle α - fig. 3. The rotation of the yoke 9b and the change in the position of the push rod 15 activates the drive 5 of the circuit breaker 2.

In the case of overload the release mechanism 4 operates in the following way.

[0021] The load current flows through the electric coils 11a and 11b which are made of a conductor, e.g. copper wire, of a specific resistance. Flow of load current through the coils 11a and 11b results in loss of power dissipated in the form of heat. The amount of emitted heat depends on the strength of the load current of the receiver 6. An increase in the strength of the current increases the amount of emitted heat which affects the increase in the temperature of the coils 11a and 11b. Since the coils 11a and 11b are wound on the cores 10a and 10b, these cores 10a and 10b heat up from them. A load current larger than the rated current will heat up the cores 10a, 10b stronger. If the temperature of the cores 10a, 10b grows above the Curie temperature T_c , the cores 10a, 10b will pass from ferromagnetic state to paramagnetic state, increasing the reluctance of the magnetic circuit through which the magnetic flux generated by the permanent magnet 8 closes. In consequence, the magnetic flux generated by the permanent magnet 8 decreases and the force of magnetic attraction of the cores 10a and 10b, indicated in the drawing by the arrow F_M , decreases. If the force F_M is less than the tension force of the spring 13, indicated in the drawing by the arrow F_s , then the movable yoke 9b together with the core 10b and the push rod 15 will turn around the axis of rotation of the pivot 12 by an angle α -fig. 3. The turn of the yoke 9b and the change in the position of the push rod 15 actuates the drive 5 of the circuit breaker 2.

[0022] In the second embodiment of the invention, the immovable yoke 9a, made of a magnetically soft material, whose other end is permanently connected with the core 10a, is permanently connected to one pole of the permanent magnet 8. The other pole of the permanent magnet 8 is permanently connected with the second immovable yoke 9b'. In the yoke 9b' there is an opening 14 through which the movable core 10b' moves. Magnetic flux, whose source is the permanent magnet 8, generates such force of magnetic attraction that the movable core 10b' of the immovable yoke 9b' is attracted and frontally contacts the immovable core 10a of the yoke 9a of the magnetic circuit. In such case a closed magnetic circuit is formed for the flux generated by the permanent magnet 8. The core 10b' has a mechanical element 15 attached to it, in the form of a push rod or a pull rod on which a expanding spring 16 is located. With its one end the expanding spring rests on the external surface of the yoke 9b', and the other end rests on a resistance element 17 fixed to the other end of the push rod 15. The mechanical

element 15 transfers the expansion force of the spring 16 which attempts to move the core 10b' towards the opening 14 in the yoke 9b' and break the magnetic circuit of the magnetic flux generated by the permanent magnet 8. If the expansion force of the spring 16 is smaller than the force of magnetic attraction caused by the permanent magnet 8, the magnetic circuit remains closed, i.e. in the closed state of the release mechanism 4' - fig. 4.

[0023] The principle of operation of the release mechanism 4' according to the second embodiment of the invention depends on the type of the factor causing the action of the release mechanism and it is different in the case of occurrence of a short circuit and in the case of occurrence of an overload in the system protected by the circuit breaker.

[0024] In the case of a short circuit the release mechanism 4' operates in the following way.

[0025] When short-circuit current flows through the coils 11a and 11b, the coil 11a generates a magnetic field in the first core 10a of the electromagnet and the coil 11b generates a magnetic field in the other core 10b' of the electromagnet. As both parts of the coils are wound in directions opposite to each other, the magnetic fields generated in both cores 10a and 10b', generated as a result of flow of the same current, will also be directed in directions opposite to each other. The oppositely directed magnetic fields in both cores will repel each other creating a force of repulsion of magnetic fields, in the drawing indicated by the arrow F_C . If the force F_C in both cores 10a and 10b' is larger than the force of magnetic attraction generated by the permanent magnet 8, in the drawing indicated by the arrow F_M , and reduced by the expansion force of the spring 16, in the drawing indicated by the arrow F_S , the cores 10a and 10b' will repel each other, and the movable core 10b' will move by a distance x indicated in the drawing, towards the opening 14 at the same time moving the push rod 15 outside the release mechanism 4' - fig. 5. The shift of the push rod 15 by the distance x activates the drive 5 of the circuit breaker 2.

In the case of overload the release mechanism 4' operates in the following way.

[0026] The load current flows through the electric coils 11a and 11b, which are made of a conductor, e.g. copper wire, of a specific resistance. Flow of load current through the coils 11a and 11b results in loss of power dissipated in the form of heat. The amount of emitted heat depends on the strength of the load current of the receiver 6. An increase in the current strength increases the amount of emitted heat which affects the increase in the temperature of the coils 11a and 11b. Since the coils 11a and 11b are wound on the cores 10a and 10b', the cores 10a and 10b' heat up from them. A load current larger than the rated current will heat up the cores 10a, 10b stronger. If the temperature of the cores 10a, 10b' grows above the Curie temperature T_C , the cores 10a, 10b' will pass from ferromagnetic state to paramagnetic state, increas-

ing the reluctance of the magnetic circuit through which the magnetic flux generated by the permanent magnet 8 closes. In consequence, the magnetic flux generated by the permanent magnet 8 decreases and the force of magnetic attraction of the cores 10a and 10b', indicated in the drawing by the arrow F_M , decreases. If the force F_M is less than the expansion force of the spring 16, indicated in the drawing by the arrow F_S , the movable core 10b' will move by a distance x in the drawing, towards the opening 14, at the same time moving the push rod 15 outside the release mechanism 4' - fig. 5. The shift of the push rod 15 by the distance x actuates the drive 5 of the circuit breaker 2.

[0027] For both embodiments, the yokes 9a, 9b and 9b' may take a different shape than that described in the example of the invention embodiment. The yokes 9a, 9b and 9b' can be a part of the permanent magnet 8, i.e. its poles, or they can form suitably shaped magnetic cores of the electromagnet 10. Individual coils 11a, 11b wound on the cores 10a, 10b and 10b' can have different number of turns depending on the operating needs of the release mechanism 4, 4'.

[0028] Key to the drawings

- 1 - power source
- 2 - circuit breaker
- 3a, 3b, 3c - electric conductors
- 4, 4' - release mechanism
- 5 - circuit breaker drive
- 6 - energy receiver - load
- 7 - circuit breaker housing
- 8 - permanent magnet
- 9a, 9b' - immovable yoke of the magnetic circuit
- 9b - movable yoke of the magnetic circuit
- 10 - electromagnet
- 10a - immovable core of electromagnet
- 10b, 10b' - movable cores of the electromagnet
- 11a, 11b - electromagnet coils
- 12 - pivot
- 13 - tension spring
- 14 - opening in yoke 9b'
- 15 - mechanical element - push rod
- 16 - expanding spring
- 17 - resistance element
- F_C - force of repulsion of magnetic fields
- F_M - force of attraction of magnetic cores
- F_S - tension or expansion force of spring

Claims

1. A thermo-magnetic release mechanism (4,4') for an electric power circuit breaker (2), comprising an electric circuit and a magnetic circuit, both mechanically and electrically connected with the drive mechanism (5) of the circuit breaker, in which the magnetic circuit comprises a permanent magnet (8) and elements of a magnetically soft material connected to its poles,

- which elements form the yokes (9a,9b) or (9a,9b') of the circuit, between which the armature of the magnetic circuit is located, **characterized in that** the armature is an electromagnet (10) which is made of two separable cores, one immovable (10a) and one movable (10b) or (10b'), individually connected with the respective pair of yokes (9a, 9b) or (9a, 9b') and contacting each other frontally in the closed state of the release mechanism (4,4'), and it is made of a ferromagnetic material which when heated above the Curie temperature (T_C) changes its ferromagnetic characteristics to paramagnetic characteristics, and the coils (11a, 11b) of the electromagnet (10) are wound on the separable elements of the core (10a, 10b or 10b') in directions opposite to one another with respect to the two separable elements.
2. A release mechanism according to claim 1, **characterized in that** the movable core (10b) of the electromagnet (10) is permanently connected with the yoke (9b) of the magnetic circuit, fixed by pivot to the pole of the permanent magnet (8).
 3. A release mechanism according to claim 2, **characterized in that** a tension spring (13) having a tension force (F_S) smaller than the force of magnetic attraction (F_M) between the elements of the core (10a, 10b) of the electromagnet, generated by the permanent magnet (8), is attached to the yoke (9b) of the magnetic circuit.
 4. A release mechanism according to claim 1, **characterized in that** the movable core (10b') of the electromagnet (10) is slidably connected with the yoke (9b') of the magnetic circuit, permanently fixed to the pole of the permanent magnet (8) and it is permanently connected with one end of a push rod (15) situated in the opening (14) of the yoke (9b') and protruding outside the external surface of the yoke (9b').
 5. A release mechanism according to claim 4, **characterized in that** on the push rod (15) there is located an expanding spring (16) whose one end rests on the external surface of the yoke (9b') and the other end rests on a resistance element (17) fixed to the other end of the push rod (15), the expansion force (F_S) of the expanding spring (16) being smaller than the force of magnetic attraction (F_M) between the cores (10a, 10b') of the electromagnet (10), generated by the permanent magnet (8).
 6. A release mechanism according to any of the claims 1-5, **characterized in that** the core (10a, 10b, 10b') is made of a material whose Curie temperature T_C is in the range from 60 to 150°C.
 7. A release mechanism according to any of the claims 1-6, **characterized in that** the core of the electromagnet (10) is made of ferro powders or sinters of magnetically soft materials, super-paramagnetic materials in the form of: powders, sinters, suspensions or other forms of ferromagnetic particles in nanometric or micrometric sizes, gadolinium-based alloys or composites, Perovskite structures.
 8. A release mechanism according to any of the claims 1-6, **characterized in that** the numbers of turns of the coils (11a, 11b) are different.
 9. A release mechanism according to any of the claims 1-6, **characterized in that** the coil (11a) is connected with the core of the electromagnet (10a) by means of a thermally conducting paste or cement.

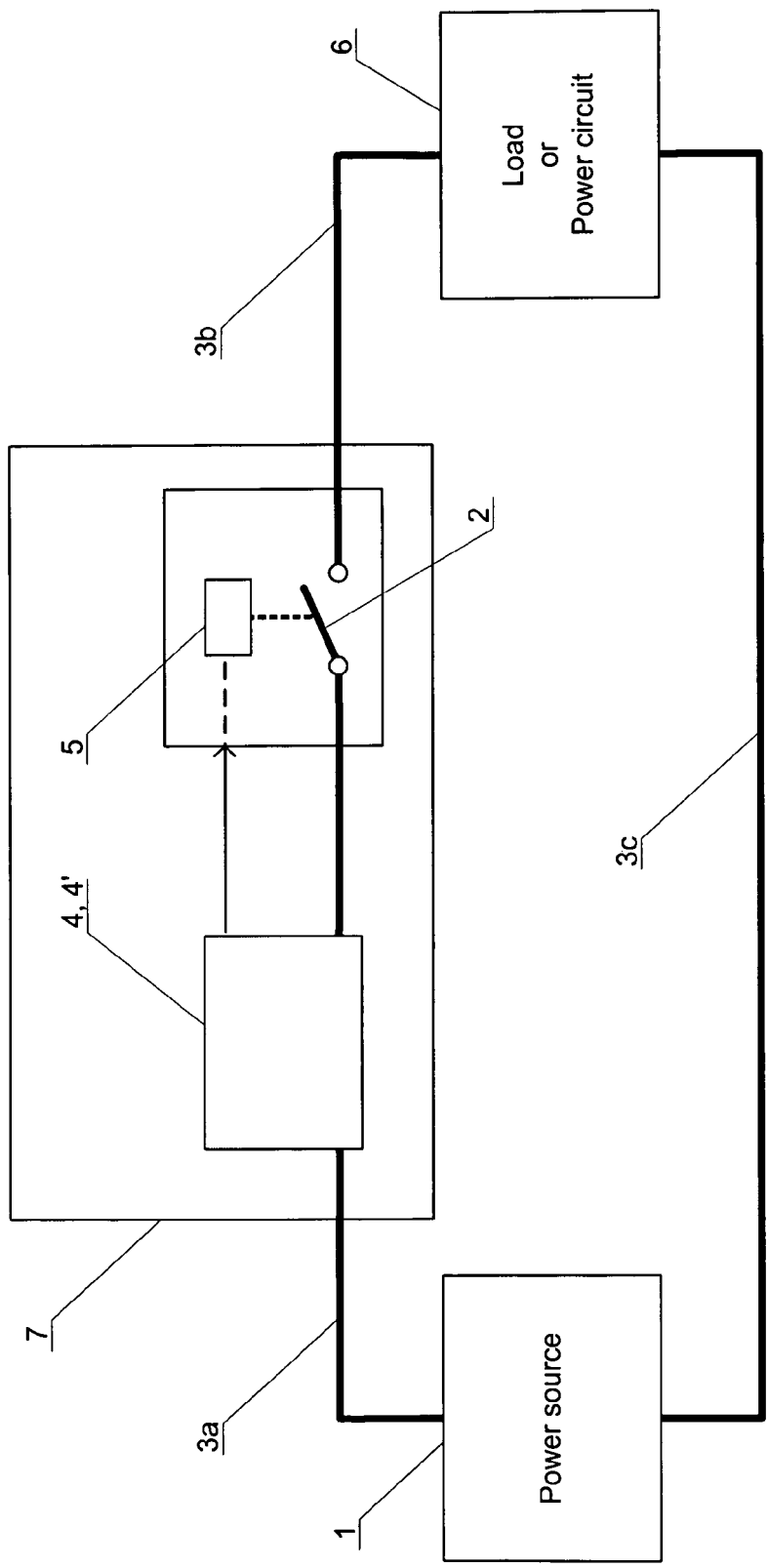


Fig. 1

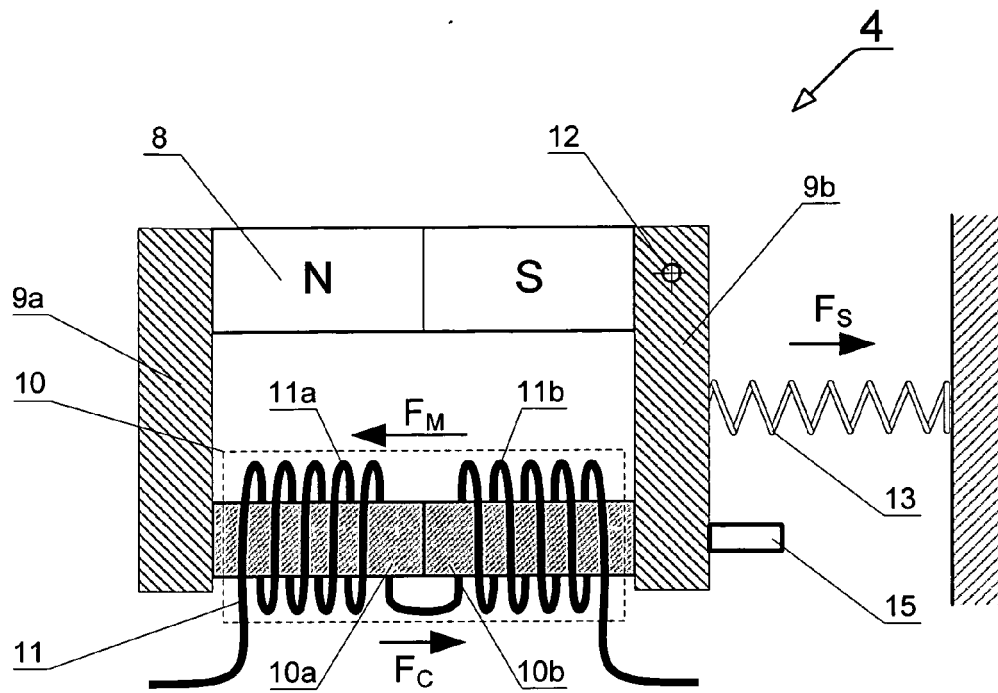


Fig. 2

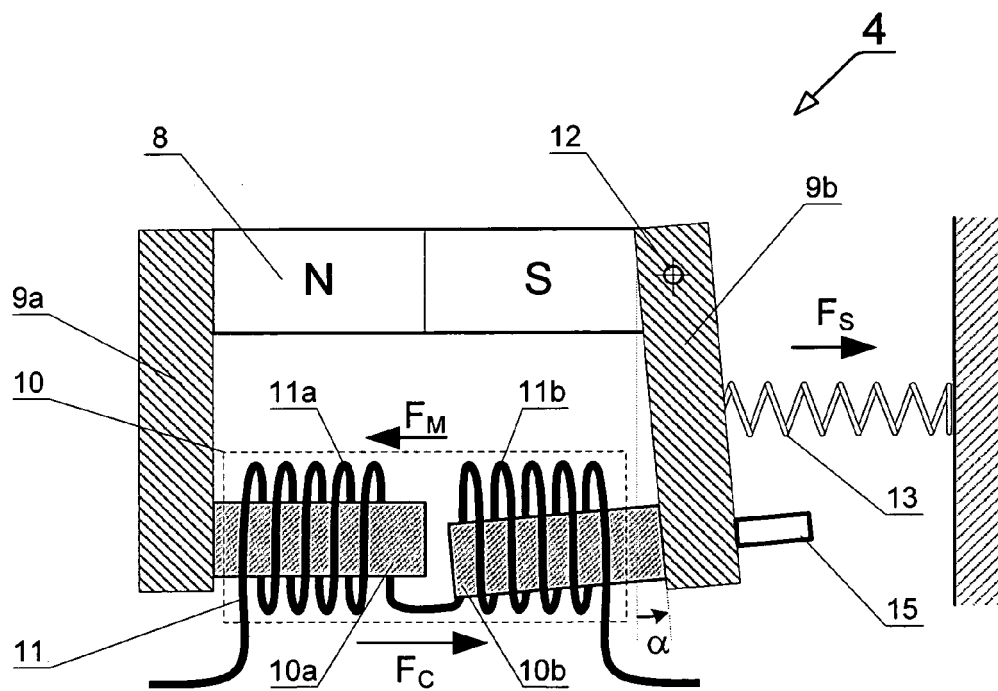


Fig. 3

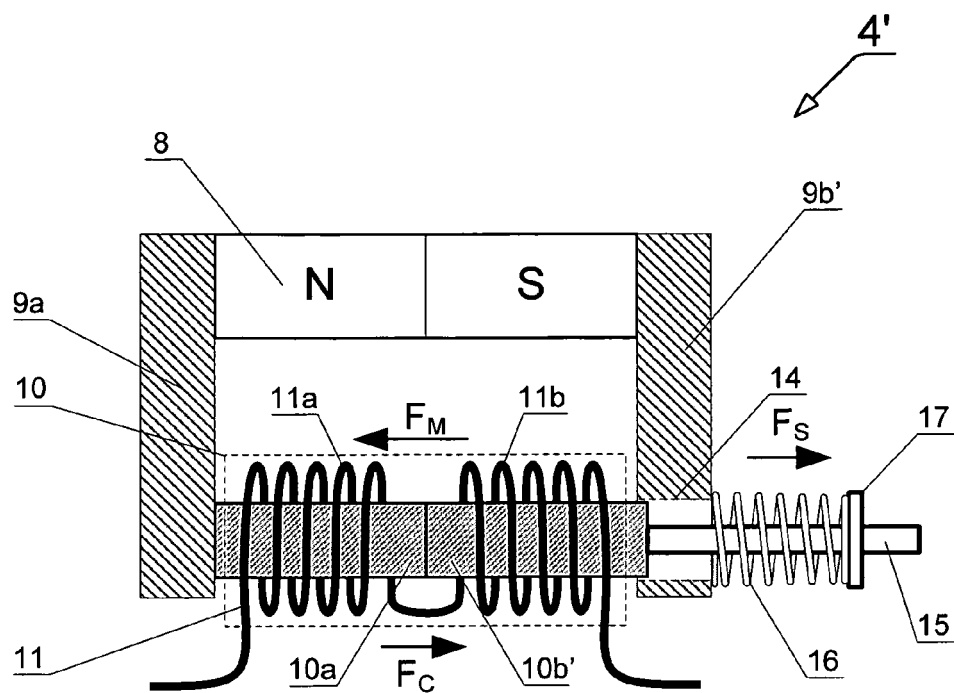


Fig. 4

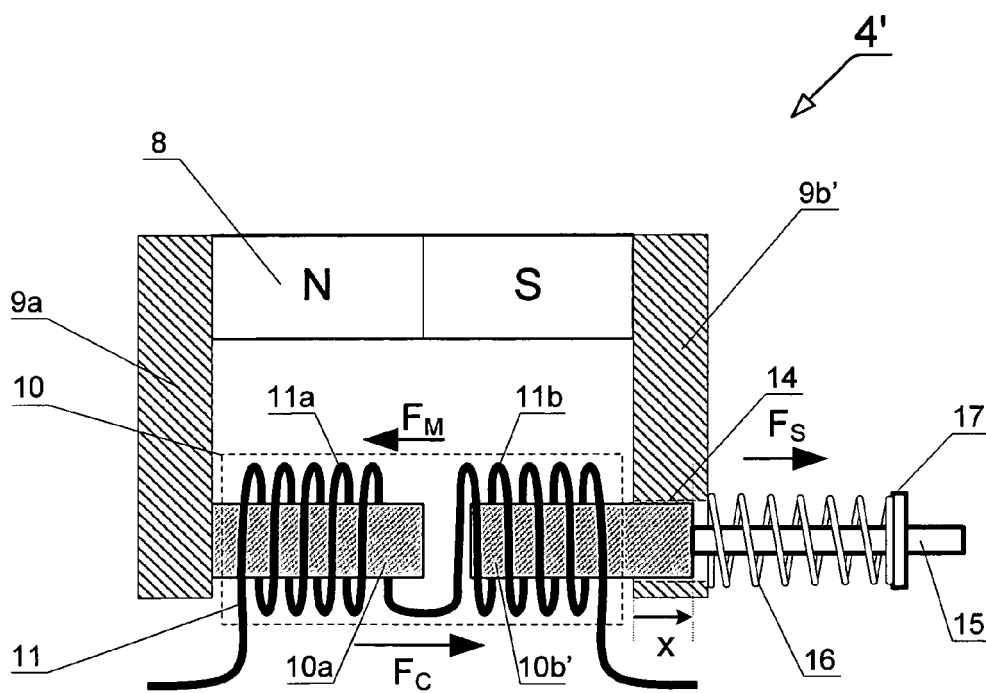


Fig. 5



EUROPEAN SEARCH REPORT

Application Number
EP 11 46 0056

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 02/43095 A1 (ABB PATENT GMBH [DE]; SIEDELHOFER BERND [DE]; HABEDANK WINRICH [DE]; P) 30 May 2002 (2002-05-30) * abstract; figure 1 * * page 2, line 4 - page 5, line 23 * -----	1	INV. H01H71/14 H01H71/40
A	DE 102 22 552 A1 (ABB PATENT GMBH [DE]) 27 November 2003 (2003-11-27) * abstract; figures 1-4 * * column 5, line 1 - column 6, line 28 * -----	1	
A	DE 102 20 665 A1 (ABB PATENT GMBH [DE]) 20 November 2003 (2003-11-20) * abstract; figure 1 * * paragraph [0023] - paragraph [0029] * -----	1	
A	EP 1 526 560 A2 (ABB PATENT GMBH [DE]) 27 April 2005 (2005-04-27) * abstract; figures 1-8 * * paragraph [0023] - paragraph [0042] * -----	1	
			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 5 April 2012	Examiner Serrano Funcia, J
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 46 0056

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.

05-04-2012

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 0243095	A1	30-05-2002	DE	10058075 A1	06-06-2002
			EP	1336185 A1	20-08-2003
			US	2003235021 A1	25-12-2003
			WO	0243095 A1	30-05-2002

DE 10222552	A1	27-11-2003	NONE		

DE 10220665	A1	20-11-2003	NONE		

EP 1526560	A2	27-04-2005	DE	10349907 A1	25-05-2005
			EP	1526560 A2	27-04-2005

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 1526560 A [0003]