(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 906 427 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
02.04.2008 Bulletin 2008/14

(51) Int Cl.:
H01H 71/24 *(2006.01)* ***H01H 50/10*** *(2006.01)*

(21) Application number: **06020548.1**

(22) Date of filing: **29.09.2006**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(71) Applicant: **SIEMENS AKTIENGESELLSCHAFT**
80333 München (DE)

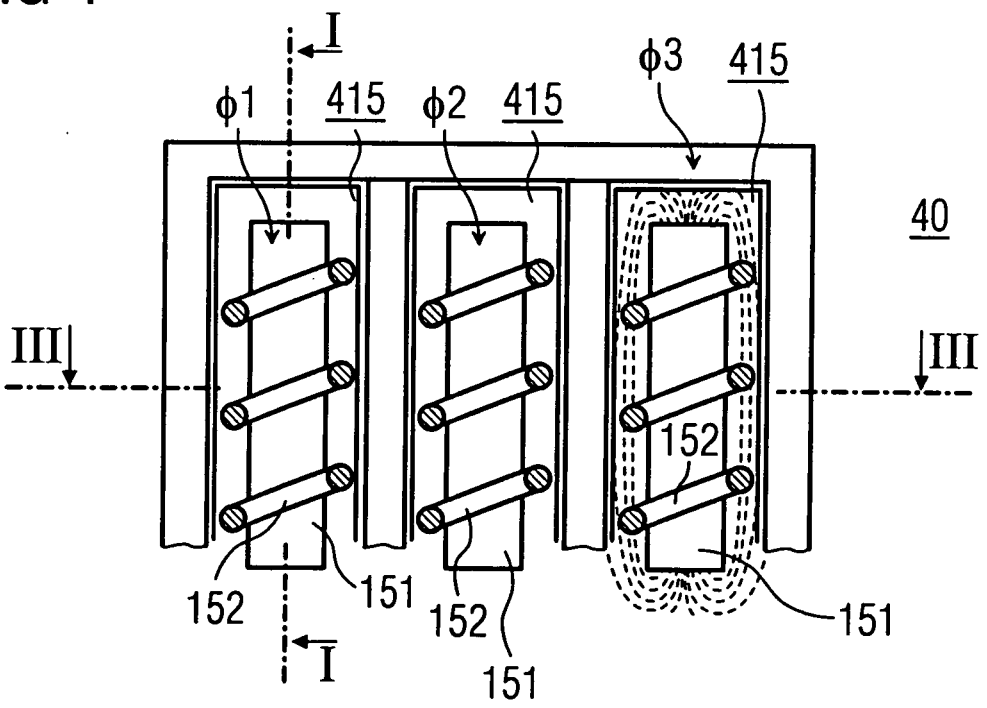
(72) Inventor: **Krätzschmar, Andreas Dr.**
92260 Ammerthal (DE)

(54) **An electromagnetic drive unit and an electromechanical switching device**

(57) An electromagnetic drive unit (415) comprises a yoke (153), a coil (152) around said yoke (153), and a movable armature (151). Said coil (152) and said yoke (153) are at least partly surrounded by a magnetic layer (400).

An electromechanical switching device (40) comprises a housing (18); at least one input terminal (11) and a responsive output terminal (12) for connecting the electromechanical switching device (40) to at least one current phase; and at least one electromagnetic drive unit (415) according to the first aspect of the invention. The coil (152) is adapted to receive a current responsive to the current of the responsive current phase (ϕ1, ϕ2, ϕ3), and the movable armature (151) is adapted to break or limit at least the responsive current phase (ϕ1, ϕ2, ϕ3) if the responsive current phase (ϕ1, ϕ2, ϕ3) carries an excessive current.

FIG 4



EP 1 906 427 A1

Description

Field of the invention

[0001] The invention relates to the art of design of electromagnetic drive units, and further also to electromechanical switching devices

Background art

[0002] Circuit breakers and current limiters are devices that are used to break a current circuit or limit current in a current circuit in the low voltage range which usually is understood to cover voltages from 100 V up to 1000 V. Typically, circuit breakers and current limiters are adapted to break a current circuit or limit current therein for a three-phase current, but it is also possible that the current circuit is a one-phase current circuit only. Breaking a current circuit may be necessary in the case of short-circuit, phase fault or an overload condition. Limiting a current in a current circuit can be used to avoid adverse effects of an overload condition, for example.

[0003] Circuit breakers and current limiters are electromechanical switching devices that comprise at least one electromagnetic drive unit, typically one for each phase. Such an electromagnetic drive unit follows the current in the at least one current phase and is adapted to break the current phase or phases upon detecting an excessive current by releasing the lock of the circuit breaker or current limiter or by displacing the contact pieces of such devices. Typically, a coil is used for monitoring the current.

[0004] In order to reduce the manufacturing costs and to make the electromagnetic drive unit smaller, the electromagnetic drive units typically comprises a yoke and an armature that are relatively simple and cheap parts and thus tend to generate a magnetic field very inefficiently. This magnetic field must at least partly be compensated by increasing the number of windings in the coil, which tends to lead to increased electrical losses and to excessive heat dissipation, thus increasing the complexity of design of electromechanical switching devices in which electromagnetic drive units are used.

Summary of the invention

[0005] A first object of the invention is to improve the efficiency of an electromagnetic drive unit that is preferably suitable for use in a short-circuit release. This object can be achieved with an electromagnetic drive unit as set out in claim 1.

[0006] A second object of the invention is to reduce the sensitivity of a short-circuit release of an electromechanical switching device against cross-phase interference. This object can be achieved with an electromechanical switching device as set out in claim 6.

[0007] The dependent claims describe various advantageous aspects for both objects of the invention.

Advantages of the invention

[0008] If the yoke and the coil of an electromagnetic drive unit comprising a yoke, a coil around said yoke, and a movable armature are at least partly surrounded by a magnetic layer, the magnetic field lines caused by a current flow through the coil may penetrate into the magnetic layer that can thus form an outer boundary for the magnetic field lines. This is suspected to improve the magnetic coupling between the yoke and the armature and thus also to improve the efficiency of the electromagnetic drive unit.

[0009] If the magnetic layer comprises a synthetic material, especially a polymer, the electromagnetic drive unit can be manufactured in a particularly easy manner.

[0010] If the synthetic material further comprises ferromagnetic powder or ferromagnetic fibers, the magnetic properties of the magnetic layer may be improved.

[0011] Preferably, the magnetic layer has a relative magnetic permeability $\mu_r \in [30, 100]$.

[0012] The magnetic layer can also be a partial magnetic coating of a housing of the electromagnetic drive unit. In this manner, the cost of material may be reduced, since the magnetic layer does not need to be strong enough to form a supporting wall.

[0013] By an improved magnetic behavior due to magnetic layers inside or on the surface of the housing, it is also possible to reduce the number or windings of the coil. Hence the electric losses of the coil and the constructed space can be reduced as well.

[0014] If the electromechanical switching device comprises at least two input terminals and responsive output terminals for connecting the electromechanical switching device to at least two current phases, and a coil for each of the responsive current phases, and if the magnetic layer is located between said coils, cross-phase interference to the coil can be reduced and the accuracy of the electromechanical switching device for excess currents may be improved.

List of drawings

[0015] In the following, the preferred embodiment of the invention is described in more detail with reference to the examples shown in Figures 3 and 4 of the appended drawings, of which:

Figure 1 is a section of a current limiter of prior art;

Figure 2 is a second section of the current limiter of Figure 1 in direction III-III illustrating magnetic field lines;

Figure 3 is a section of a current limiter according to a first aspect of the present invention; and

Figure 4 is a second section of a current limiter of Figure 3 in direction III-III illustrating magnetic field

lines.

[0016] Same reference numerals refer to similar structural elements throughout the Figures.

Detailed description

[0017] Figure 1 is a section of a current limiter 10 known from prior art. The current limiter 10 comprises a housing 18, three input terminals 11 and responsive output terminals 12 for connecting the current limiter 10 to three phases of a current circuit.

[0018] The current limiter 10 comprises three electromagnetic drive units 15. In an electromagnetic drive unit 15, coil 152 is adapted to receive a current responsive to the current of the responsive current phase $\phi 1$, $\phi 2$, $\phi 3$, and the movable armature 151 is adapted to break at least the responsive current phase $\phi 1$, $\phi 2$, $\phi 3$ if the responsive current phase $\phi 1$, $\phi 2$, $\phi 3$ carries an excessive current.

[0019] In the case of short circuit, the striker armature 151 will be attracted to the yoke 153 due to a rapidly increasing magnetic field caused by the excessive short circuit current. The plunger 155 that is connected with the striker armature 151 transfers the motion of the striker armature 151 to the contact bridge 16 carrying the movable contact pieces 14, displacing the movable contacts pieces 14 from the respective stationary contact pieces 13 and thus disconnecting the current path.

[0020] Advantageously, there is a mechanical spring 180 located between the yoke 153 and the striker armature 151. With the help of the spring 180, the operating point and thus also the current threshold required to open the contact pieces 13, 14 can be adjusted. Furthermore, the spring 180 resets the position of the striker armature 151 by returning it back to its initial position after the current flow has been disrupted.

[0021] A contact spring 17 can be used to adjust the limit current which causes the current circuit to be limited.

[0022] A contact breaker of the prior art is in principle very similar to the current limiter 10, except that a contact breaker further comprises a locking mechanism that, after being activated, is adapted to keep the broken current phase or phases $\phi 1$, $\phi 2$, $\phi 3$ broken until the locking mechanism being manually deactivated. The simplest way to achieve this is to supply the contact breaker with a latching mechanism L which can latch a plunger 154 down to a displaced position so that it prevents with its shoulders 182 the contact bridge 16 from returning to make contact between the movable contact pieces 14 and the stationary contact pieces 13.

[0023] Current limiters and contact breakers are known as such in the prior art, and the skilled person appreciates that understanding the operating principles of these devices in more detail is not relevant for understanding the principles underlying the present invention.

[0024] Figure 2 is a section of the current limiter of Figure 1 in direction III-III illustrating magnetic field lines for phase $\phi 3$. As can be seen, the magnetic field lines of the coil 152 used to measure the current in phase $\phi 3$ penetrate into the next block where a similar coil 152 is used to measure the current in phase $\phi 2$. The magnetic field lines that would be caused by the coil 152 used to measure the current in phase $\phi 2$ would, similarly, penetrate into the blocks for measuring currents in phases $\phi 1$ and $\phi 3$, and the magnetic field lines that would be caused by the coil 152 used to measure the current in phase $\phi 1$ would penetrate into the block for measuring currents in phases $\phi 2$.

[0025] Cross-phase interference of the above kind may make the short-circuit release of a current limiter or of a circuit breaker to function improperly, or at least reduce the operational accuracy of the circuit breaker. A possible consequence is that a current circuit will be not limited or broken despite it carrying an excessive current, or that a current circuit is limited or broken too early, i.e. despite it is not carrying an excessive current.

[0026] Figure 3 is a section of a current limiter 40 according to a first aspect of the present invention. The operating principle of the current limiter 40 is the same as that of the current limiter 10 shown in Figure 1.

[0027] The electromagnetic drive unit 15 has been replaced with an improved electromagnetic drive unit 415 that comprises in addition to the components shown in Figure 1 also a magnetic layer 400 that at least partly surrounds the coil 152 and the yoke 153. Optionally, the magnetic layer 400 may also at least partly cover the striker armature 151. The magnetic layer 400 may show at least one opening O for the conductor wire W that is used to feed the coil 152. Preferably, the opening is matched to the size of the conductor wire W to reduce magnetic losses.

[0028] The magnetic layer 400 may comprise a synthetic material, especially a polymer. The synthetic material may further comprise ferromagnetic powder or ferromagnetic fibers.

[0029] Advantageously, the magnetic layer 400 has a relative magnetic permeability $\mu_r \in [30, 100]$.

[0030] The magnetic layer 400 can be a partial magnetic coating of a housing of the electromagnetic drive unit 415. If the electromagnetic drive unit 415 is comprised in the housing 18 of a current limiter 40, the housing of the electromagnetic drive unit 415 can be the housing of the current limiter 40.

[0031] Figure 4 shows sections of the current limiter of Figure 3 in direction III-III illustrating magnetic field lines. An effect of the magnetic layer 400 is that the magnetic field lines penetrate into the magnetic layer which then forms an outer boundary for the magnetic field lines. This is suspected to improve the magnetic coupling between the yoke 153 and the striker armature 151.

[0032] To reduce the cross-phase interference, the magnetic layer 400 may be located between the coils 152 that are used to measure the currents carried by different phases $\phi 1$, $\phi 2$, $\phi 3$.

[0033] According to a further embodiment of the inven-

tion, the magnetic layers 400 are located only between the coils 152 for different $\phi 1$, $\phi 2$, $\phi 3$.

[0034] Even though the invention was described by way of examples relating to a three-phase current limiter, the skilled person appreciates that the invention is not limited to such a limiter but can be extended to any electromagnetic drive unit and to any electromechanical switching device comprising an electromagnetic drive unit. A particular example of such an electromechanical switching device is a circuit breaker.

Claims

1. An electromagnetic drive unit (415), preferably for a short-circuit release, comprising a yoke (153), a coil (152) around said yoke (153), and a movable armature (151), **characterized in that**: said coil (152) and said yoke (153) are at least partly surrounded by a magnetic layer (400).

2. An electromagnetic drive unit (415) according to claim 1, **wherein:** said magnetic layer (400) comprises a synthetic material, especially a polymer.

3. An electromagnetic drive unit (415) according to claim 2, **wherein:** said synthetic material further comprises ferromagnetic powder or ferromagnetic fibers.

4. An electromagnetic drive unit (415) according to any one of the preceding claims, **wherein**: said magnetic layer (400) has a relative magnetic permeability $\mu_r \in [30, 100]$.

5. An electromagnetic drive unit (415) according to any one of the preceding claims, **wherein:** said magnetic layer (400) is partial magnetic coating of a housing (18) of the electromagnetic drive unit (415).

6. An electromechanical switching device (40), **comprising:**

   i) a housing (18);
   ii) at least one input terminal (11) and a responsive output terminal (12) for connecting the electromechanical switching device (40) to at least one current phase;
   iii) a short-circuit release with at least one electromagnetic drive unit (415) according to any one of the preceding claims, wherein: the coil (152) is adapted to receive a current responsive to the current of the responsive current phase ($\phi 1$, $\phi 2$, $\phi 3$), and the movable armature (151) is adapted to break or limit at least the responsive current phase ($\phi 1$, $\phi 2$, $\phi 3$) if the responsive current phase ($\phi 1$, $\phi 2$, $\phi 3$) carries an excessive current.

7. An electromechanical switching device (40) according to claim 6, **wherein:** said armature (151) is a striker armature adapted to break the contact between at least one movable contact piece (14) and a responsive stationary contact piece (13) by displacing said at least one movable contact piece (14).

8. An electromechanical switching device (40) according to claim 6 or 7, **wherein:** said magnetic layer (400) is a part of said housing (18) of the electromechanical switching device (40).

9. An electromechanical switching device (40) according to any one of claims 6 to 8, **wherein:** said electromechanical switching device (40) comprises at least two input terminals (11) and responsive output terminals (12) for connecting the electromechanical switching device () to at least two current phases ($\phi 1$, $\phi 2$, $\phi 3$), and a coil (152) for each of the responsive current phases ($\phi 1$, $\phi 2$, $\phi 3$); and wherein the magnetic layer (400) is located between said coils (152).

10. An electromechanical switching device (40) according to any one of the preceding claims 6 to 9, **wherein:** said electromechanical switching device (40) is a current limiter.

11. An electromechanical switching device (40) according to any one of the preceding claims 6 to 9, **wherein:** said electromechanical switching device (40) is a circuit breaker.

12. An electromechanical switching device (40) according to claim 11, further **comprising:** a locking mechanism that, after being activated, is adapted to keep the broken current phase or phases ($\phi 1$, $\phi 2$, $\phi 3$) broken until the locking mechanism being manually deactivated.

FIG 1
(PRIOR ART)

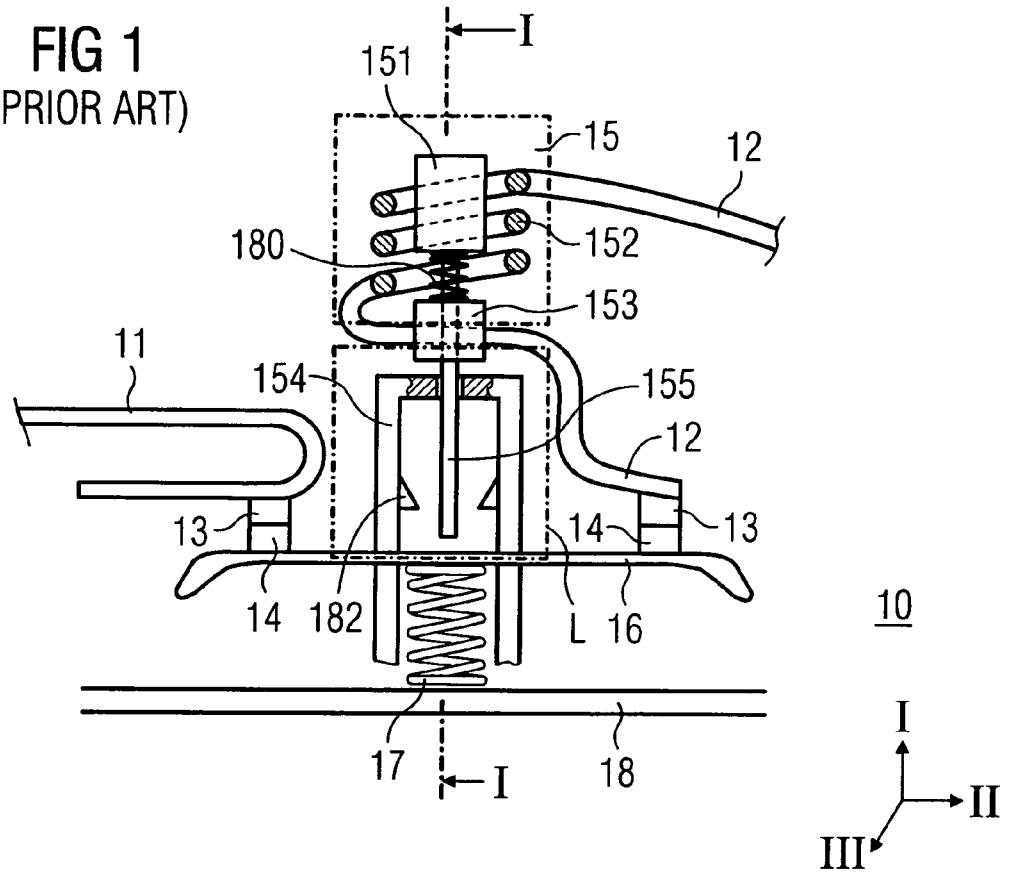


FIG 2
(PRIOR ART)

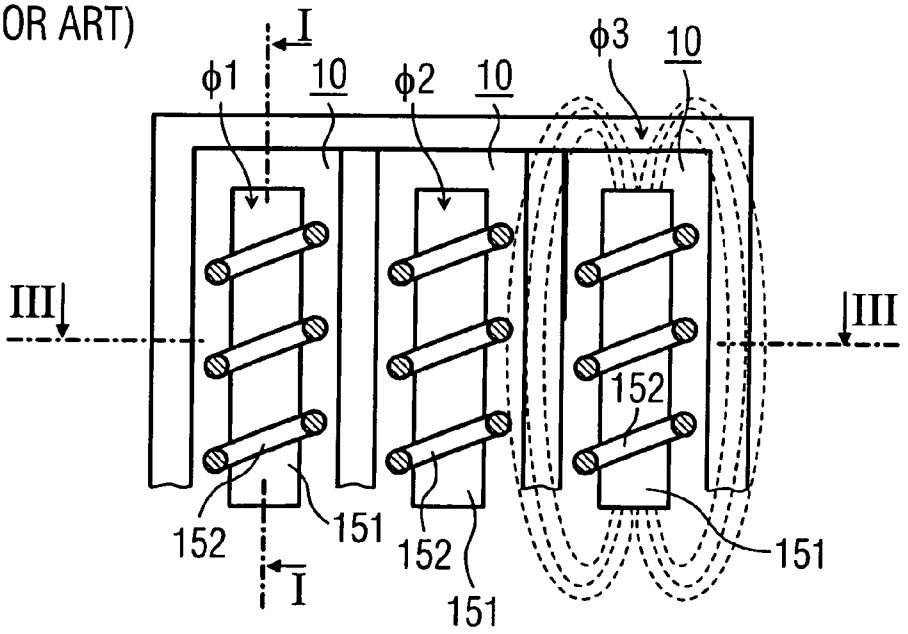


FIG 3

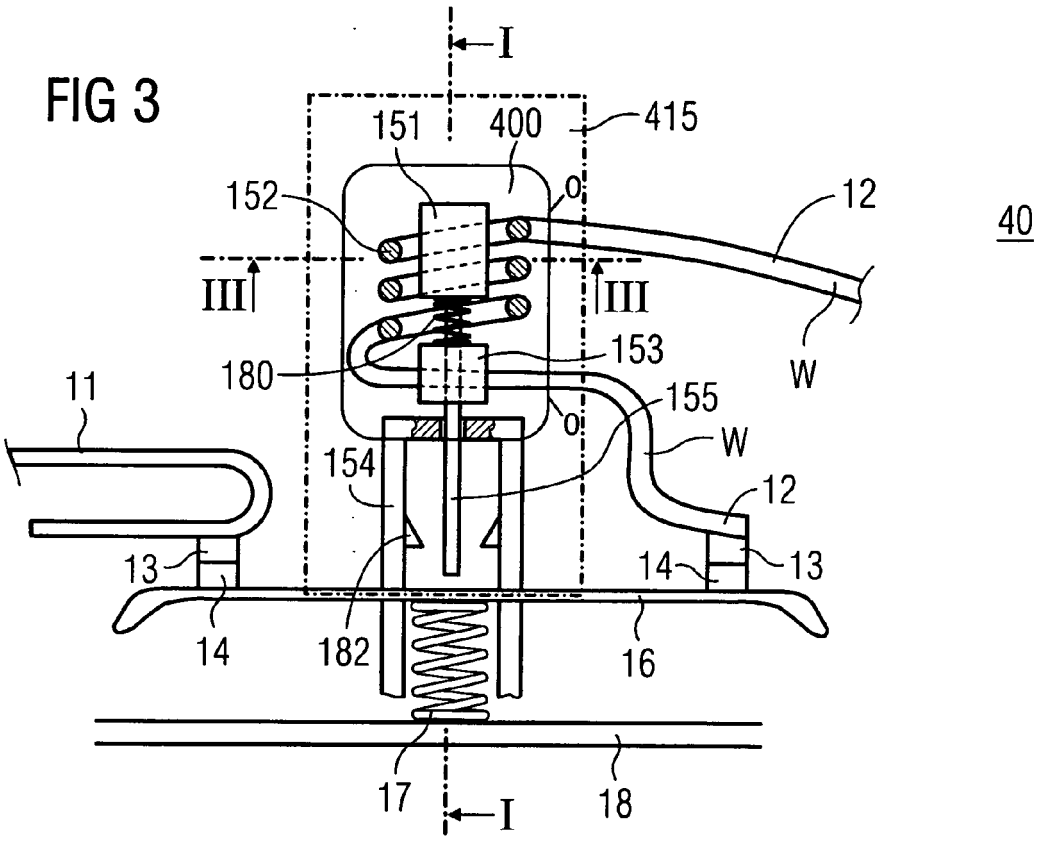
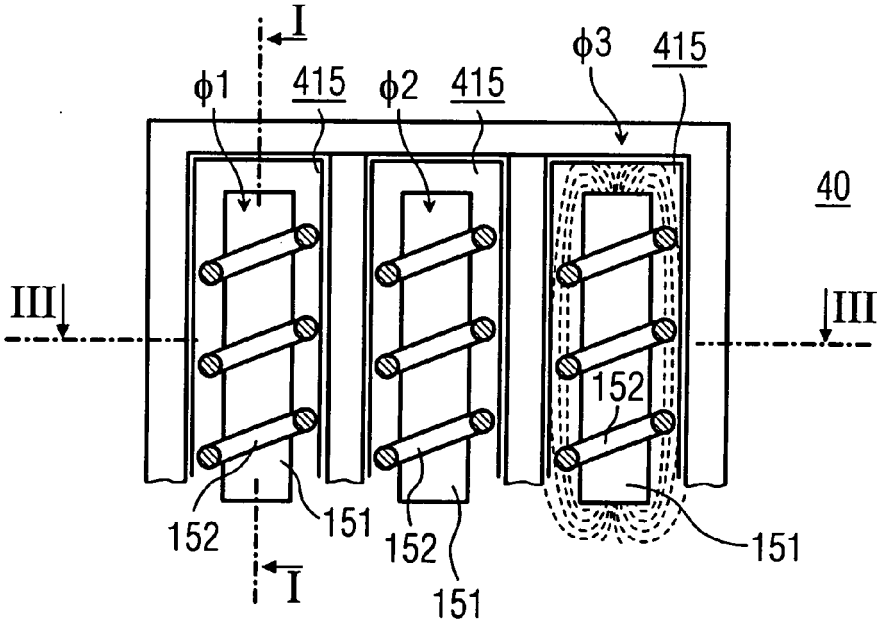

I
151
400
415
152
12
40
III
III
153
180
W
11
155
W
154
12
13
14
13
14
182
16
17
I
18

FIG 4


I
ϕ3
415
ϕ1
415
ϕ2
415
40
III
III
152
152
151
152
151
151
I

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 02 0548

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	EP 0 515 292 A1 (MERLIN GERIN [FR]) 25 November 1992 (1992-11-25) * the whole document *	1,6,7, 9-12	INV. H01H71/24 H01H50/10
X	EP 1 083 585 A2 (ABB PATENT GMBH [DE]) 14 March 2001 (2001-03-14) * the whole document *	1,6,7, 10-12	
X	DE 626 424 C (STOTZ KONTAKT GMBH) 26 February 1936 (1936-02-26) * the whole document *	1,6,8-11	
X	JP 05 314883 A (NIPPON ELECTRIC CO) 26 November 1993 (1993-11-26) * the whole document *	1-5	
X	JP 06 103873 A (MATSUSHITA ELECTRIC WORKS LTD) 15 April 1994 (1994-04-15) * the whole document *	1-5	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	6 February 2007	RAMIREZ FUEYO, M

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

EPO FORM 1503 03.82 (P04C01)

2

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 02 0548

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.

06-02-2007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0515292 A1	25-11-1992	DE 69201999 D1	18-05-1995
		DE 69201999 T2	23-11-1995
		ES 2073896 T3	16-08-1995
		FR 2676860 A1	27-11-1992
EP 1083585 A2	14-03-2001	DE 29915698 U1	11-05-2000
DE 626424 C	26-02-1936	NONE	
JP 5314883 A	26-11-1993	NONE	
JP 6103873 A	15-04-1994	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82