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(54) Title: AN IMPROVED CONTACT ARRANGEMENT FOR HIGH FAULT CURRENT WITHSTAND IN A LOW VOLTAGE SWITCHING DEVICE

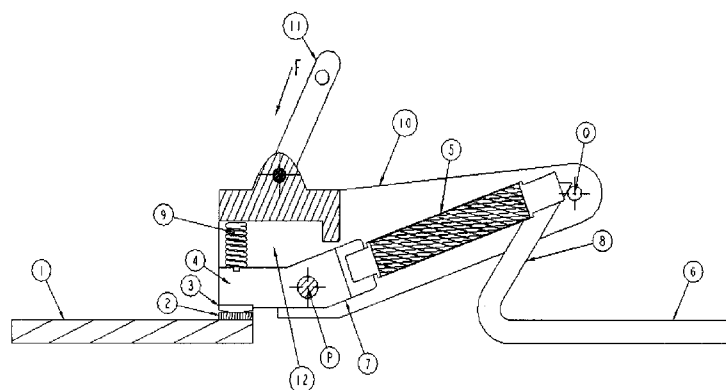


Figure 4

(57) Abstract: The present invention relates to an improved contact arrangement in a low voltage switching device to withstand high fault currents. The improved contact arrangement in a low voltage Switching device, preferably a power circuit breaker comprising of at least a pair of stationary conductors (1, 6) joined by moving conductor (4), a portion of which is a flexible conductor (5) with appropriate ratio/geometry comprising a dynamic compensation loop to compensate constriction forces generated on account of fault currents of high magnitude flowing through the contacts.

**AN IMPROVED CONTACT ARRANGEMENT FOR HIGH FAULT CURRENT
WITHSTAND IN A LOW VOLTAGE SWITCHING DEVICE**

FIELD OF THE INVENTION

The present invention relates to an improved arrangement in a low voltage switching device to withstand high fault currents. More particularly, the invention relates to a contact arrangement in a low voltage Switching device, preferably a power circuit breaker comprising of atleast a pair of stationary contacts joined by moving contact arm, a portion of which is a flexible conductor with favourable geometry comprising a dynamic compensation loop to compensate electrodynamic forces/constriction forces generated on account of fault currents of high magnitude flowing through the contacts.

BACKGROUND OF THE INVENTION

Electrical switching devices are conventionally employed to protect electrical equipment from overcurrent situations arising from short circuits and ground faults that can potentially damage the equipment and/or power conductors leading the same.

In a conventional switching device, the overcurrent causes the switching contacts to repel because of the electrodynamic forces generated.

Under high fault current conditions, contacts experience high forces due to current constriction at the mating surfaces, which force being proportional to the square of the current through the constriction point, tends to force the contacts apart. In order to counteract this contact separation force spring loaded mechanisms are used in prior art inventions.

US 5,030,804 relates to a contact arrangement, particularly intended for current-limiting low-voltage circuit breakers, with a double-break movable contact arm, the central part of which is attached to an insulating shaft which is rotatably journaled in elongated holes in stand parts on each side of the contact arm. In the closed position of the arrangement, the movable contact arm is pressed against two U-shaped fixed contact arms with the aid of two torsion springs. The contact arms have flat shape and are arranged with their broad sides facing each other. The shaft consists of two sleeve-formed holders surrounding the torsion springs. One

holder exhibits a stop face for a latching member for arresting the movable contact arm in the open position.

- US 3,800,252 discloses Contact arrangement for electrical switching device and electromagnet and armature for alternately moving two switch arms into contact-making and contact-breaking positions. Two spaced contact springs insulated from each other are clamped in a switch housing. A stationary center contact is disposed between the contact springs and has a bifurcated contact end in the form of two legs, one bent tong-like toward one contact spring and the other bent tong-like toward the other contact spring. The two contact springs are biased to engage the stationary contacts and are operated to accommodate one contact spring to engage one stationary contact as the other contact spring is disengaged from the other stationary contact, by a card-like operating member of insulating material carried on the end of the armature. The operating member has a slot intermediate its ends through which one contact spring extends and forms a support at its end opposite the armature for the other contact spring.
- US 5,097,104 discloses a contact arrangement provided for an electrical switching device, particularly for a contactor or protective relay, includes a stationary contact element and a movable contact element. The stationary contact element essentially consists of an elongated current lead-in member, at the end region of which there is affixed a contact member. At this contact member there is adjacently arranged an arc guiding element which is supported at the elongated current lead-in member, but is electrically conductively connected to the current lead-in member solely at an end portion thereof. At the surface or side facing away from the elongated current lead-in member, the arc guiding element is provided on an end surface area confronting the contact member with a projection which is formed of ferromagnetic material and symmetrically arranged in the center of the arc guiding element. The shortest distance between the contact member and the projection is, at most, one half of the extent of the projection in the lengthwise direction of the arc guiding element. The contactor equipped with this contact arrangement can interrupt relatively high short-circuit currents and possesses a sufficiently long service life.

The disadvantage of the above mentioned prior art methods is that the high fault current /over current causes the low voltage switching contacts to repel because of the electrodynamic/constriction forces generated . The low voltage switching devices designed could not withstand the high short circuit currents generated. Moreover the prior art devices
5 did not provide the ability to withstand high thermal and mechanical stresses developed by the short circuit currents through the duration of flow of fault current. The high fault electrodynamic ~~currents~~ forces generated tend to force the prior art low voltage switching device contacts apart , where in order to counteract the contact separation spring loaded mechanism were used. The large spring loaded mechanisms were complex, cumbersome and
10 requires higher space to accommodate the same.

Thus there is a need to provide an improved contact arrangement for high fault current withstand in a low voltage switching device such that the said switching device can withstand high short circuit conditions. Further to provide with a compensation loop, where the electrodynamic force generated by the favourable dispositions of the said conductors
15 compensates other electrodynamic/ constriction forces and keep the switching contacts in static equilibrium while maintaining the device in “ON” condition.

Further there is a need to design a switching device to withstand high short circuit current, for achieving selectivity or coordination between the switching devices so that the closest switching device upstream of the fault location will isolate the faulted section from the
20 healthy section of the power network. This results in increased availability of the system. One of the main requirements of such a switching device is its ability to withstand high thermal and mechanical stresses developed by the short circuit currents through the duration of flow of fault current.

OBJECTS OF THE INVENTION

25 The main object of the present invention is to overcome the disadvantages of the prior art.

Another object of the present invention is to provide an improved contact arrangement for high fault current withstandability in a low voltage switching device.

Yet another object of the present invention is to provide an improved contact arrangement with a dynamic compensation loop to compensate electrodynamic/constriction forces generated on account of high fault currents.

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Yet another object of the present invention is to provide an improved contact arrangement that aids in maintaining dynamic stability of the contact arrangement in “ON” condition of switching device.

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Yet another object of the present invention is to provide an improved contact arrangement such that the switching device has the ability to withstand high thermal and mechanical stresses developed by the short circuit currents.

SUMMARY OF THE INVENTION

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According to one aspect of the present invention there is provided an improved contact arrangement housed within a cage assembly for withstanding high fault current in a low voltage switching device , said arrangement comprising

plurality of contact strips;

a stationary conductor rigidly fixed with one of the said contact strip;

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a movable conductor comprising a tail part structurally fixed with one of the said contact strip;

a flexible conductor operatively associated/connected with said tail part of movable conductor at one end and a horn type stationary conductor at another end;

a contact spring operatively mounted on said movable conductor;

a pin around which said movable conductor is pivoted;

wherein length of said movable conductor bears an appropriate ratio /geometry with said flexible conductor adapted to generate a dynamic compensation force to counteract other electrodynamic/constriction forces generated on account of fault currents of high magnitude flowing through said contact strips.

5 **DETAILED DESCRIPTION OF THE INVENTION**

The present invention relates to a contact arrangement in a low voltage Switching device, preferably a power circuit breaker comprising of at least a pair of stationary contacts joined by moving contact arm, a portion of which is a flexible conductor with favorable geometry comprising a dynamic compensation loop to compensate electrodynamic/constriction forces
10 generated on account of fault currents of high magnitude flowing through the contacts. The said arrangement aids in maintaining dynamic stability of the contact arrangement in “ON” condition of the switching device.

The counter balancing force is generated by the interaction of the magnetic fields produced by the conductors carrying current in opposite directions. The counter electrodynamic force
15 so generated is proportional to the square of the current through the conductors and such other parameters as the length of the conductors, their distance of separation, etc. The dynamic force generated by the favorable dispositions of the said conductors in this arrangement compensates for the electrodynamic/constriction forces and keep the switching contacts in static equilibrium while maintaining the device in “ON” condition.

20 The present invention there is provided an improved contact arrangement housed within a cage assembly for withstanding high fault current in a low voltage switching device, said arrangement comprising plurality of contact strips; a stationary conductor rigidly fixed with one of the said contact strip, a movable conductor comprising a tail part structurally fixed with one of the said contact strip, a flexible conductor operatively associated/connected with
25 said tail part of movable conductor at one end and a horn type stationary conductor at another end, a contact spring operatively mounted on said movable conductor; a pin around which said movable conductor is pivoted. The length of the movable conductor bears an

appropriate ratio /geometry with flexible conductor adapted to generate a electrodynamic compensation force to compensate other electrodynamic/ constriction forces generated on account of fault currents of high magnitude flowing through said contact strips.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

5 Figure 1 illustrates the contact arrangement of the in a low voltage switching device.

Figure 2 illustrates the current path of the contact arrangement in a low voltage switching device.

Figure 3 illustrates the multi finger arrangement of the contact arrangement in a low voltage switching device.

10 Figure 4 illustrates the contact arrangement in the cage assembly in a low voltage switching device.

DETAILED DESCRIPTION OF THE ACCOMPANYING DRAWINGS

Referring to fig 1, the contact arrangement comprises of a stationary conductor 1, a contact strip 2 rigidly fixed with stationary conductor 1, a contact 3 is structurally fixed to the
15 movable conductor 4. The movable conductor 4 is pivoted and capable of rotating around a pin P. The pin P is held stable by the cage assembly 12 (shown in fig 4). A stationary conductor 6 shall have a portion bent to form a horn 8. The tail part 7 of movable conductor 4 is attached to horn 8 of stationary conductor 6 by means of a flexible conductor 5. Alternately, horn 8 may be a second flexible conductor joined to stationary conductor 6 at
20 one end.

Fig 2 shows the Current path 14 of the contact arrangement. A contact spring 9 of force FS (in fig. 4) mounted on movable conductor 4, creates an anti-clockwise torque on the movable conductor 4 about pin P. When high fault currents pass through the contact system shown in fig 2, constriction forces FH are developed at the mating surface of the contact strip 2 and
25 contact 3, which tends to rotate the movable conductor 4 in clockwise direction. Lengths L1 and L2 (shown in fig 1) may be chosen in the ratio, preferably 1:5, more preferably 1:4 and

most preferably in the ratio of 1:3 such that the dynamic force developed is adequate to maintain circuit continuity during high fault current condition. The dynamic compensation loop is formed by the tail part 7 of the movable conductor 4, the flexible conductor 5, and the horn 8 of the stationary conductor 6. A repulsive force **FC** generated on account of anti parallel current flow in Flexible conductor 5 and horn 8 creates an anti-clockwise torque on movable conductor 4 about pin **P**, thus compensating the constriction forces **FH**.

Fig 3 shows a multi finger arrangement of the contact arrangement. For higher withstandability, multiple parallel paths of similar geometry and length may be provided such that pin **P** is common to all parallel paths. The scope of the design may be extended by increasing to any number of parallel paths.

Fig 4 shows the contact arrangement housed in the cage assembly 12. The pin **P** is anchored in the cage 10 to avoid any motion relative to the cage 10. Thus the forces on the pin **P** during high fault current conditions is transferred to the cage 10, which is in turn held stable by force **F** applied on it by an operating mechanism through a transmission link 11. The cage assembly 12 is structurally coupled to the operating mechanism by means of a transmission rod 11. The operating mechanism is able to hold the cage assembly 13 in equilibrium position, while the stationary contact strip 2 and the arcing contact 3 are in contact even during high fault current flow, until any motion of the cage is initiated by the operating mechanism.

CLAIMS

1. An improved contact arrangement housed within a cage assembly for withstanding high fault current in a low voltage switching device, said arrangement comprising
5 plurality of contact strips;

a stationary conductor rigidly fixed with one of the said contact strip;

a movable conductor comprising a tail part structurally fixed with one of the said contact strip;

a flexible conductor operatively associated/connected with said tail part of movable
10 conductor at one end and a horn type stationary conductor at another end;

a contact spring operatively mounted on said movable conductor;

a pin around which said movable conductor is pivoted;

wherein length of said movable conductor bears an appropriate ratio /geometry with said flexible conductor adapted to generate a dynamic compensation forces to
15 compensate other electrodynamic/constriction forces generated on account of fault currents of high magnitude flowing through said contact strips.
2. Arrangement as claimed in claim 1 wherein said ratio of movable conductor with flexible conductor are preferably 1:5, more preferably 1:4 and most preferably in the ratio 1:3.
- 20 3. Arrangement as claimed in claim 1 wherein said plurality of contact strips comprises of a stationary contact strip operatively connected with said stationary conductor.
4. Arrangement as claimed in claim 3 wherein said plurality of contact strips further comprises an arcing contact strip operatively connected with said movable conductor.

5. Arrangement as claimed in claim 1 wherein ~~said~~ the compensation loop is formed by said movable conductor, flexible conductor and said horn of stationary conductor.
6. Arrangement as claimed in claim 5 wherein said compensation loop is adapted to generate high electrodynamic force of repulsive nature FC on account of high fault
5 current flow through said loop so as to create an anti clockwise torque on said movable conductor about the said pin, assisting in compensating the said electrodynamic/constriction forces FH.
7. Arrangement as claimed in claim 1 wherein said contact spring is adapted to generate a force FS so as to create an anti clockwise torque on said movable conductor around
10 said pin that further aids in compensating the said electrodynamic/constriction forces FH.
8. Arrangement as claimed in claim 1 further comprising transmission link means adapted to hold said cage assembly is held in an equilibrium position.
9. An improved contact arrangement housed within a cage assembly for withstanding
15 high fault current in a low voltage switching device as substantially described hereinbefore with reference to accompanying drawings.

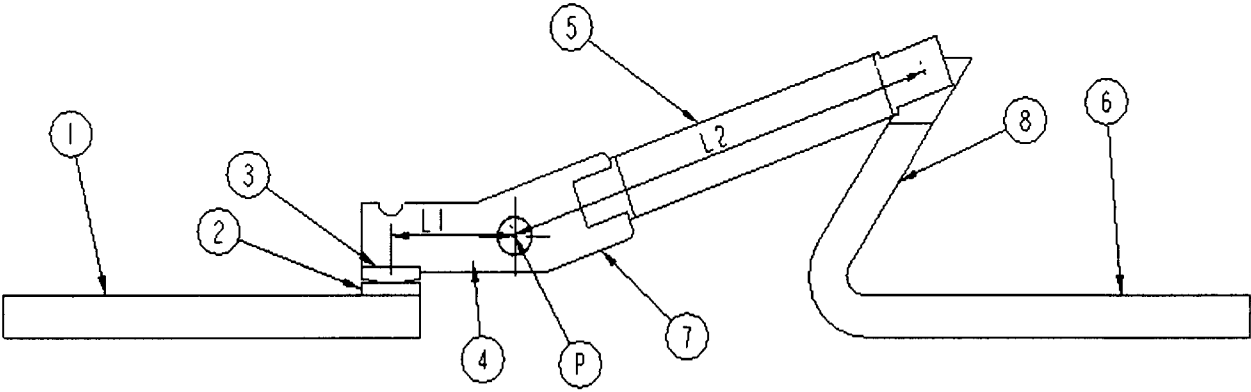


Figure 1

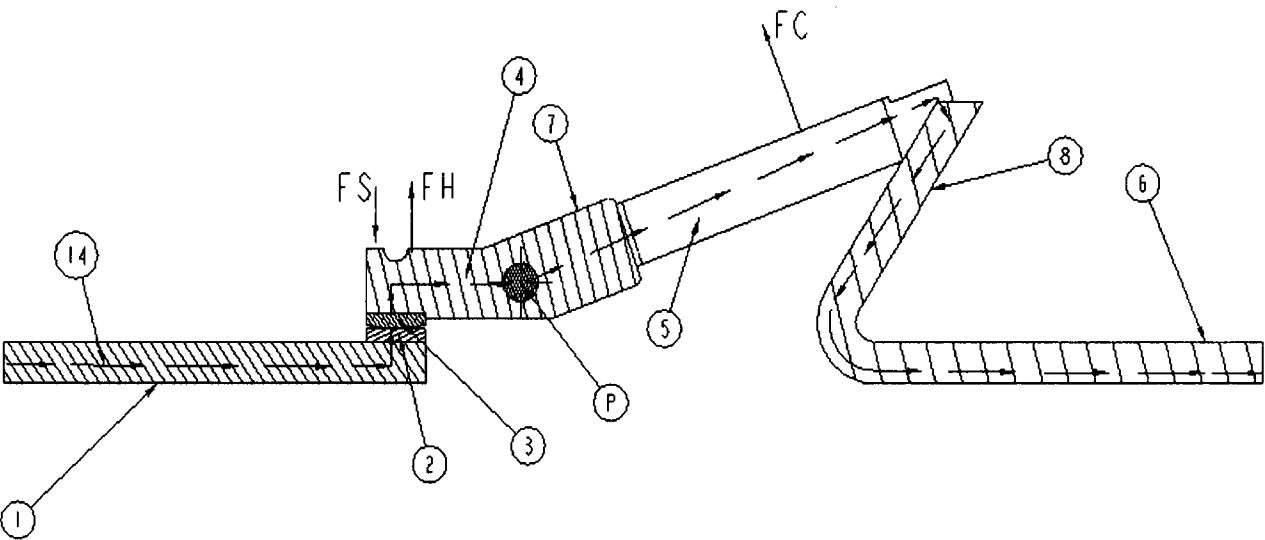
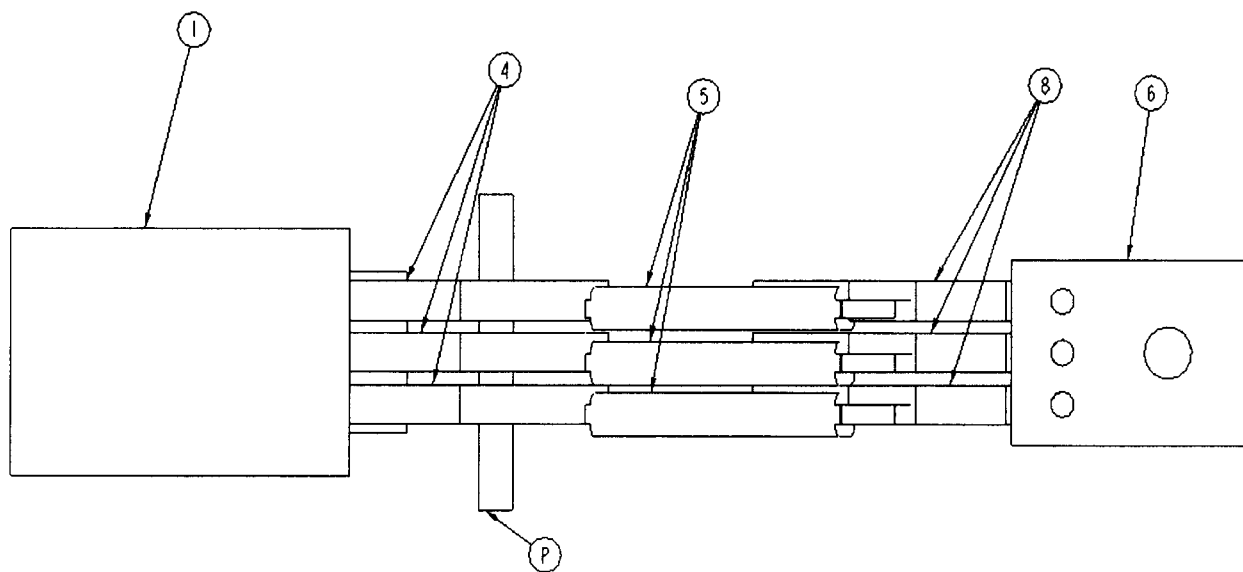


Figure 2

**Figure 3**

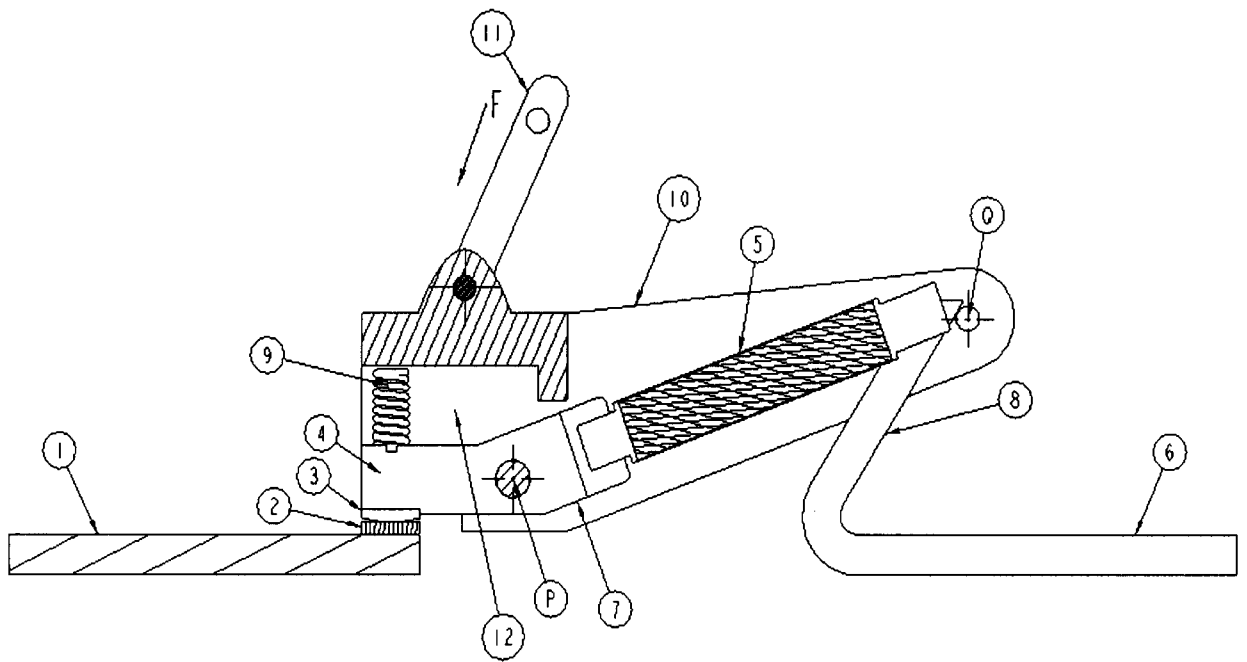


Figure 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2011/001716

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01H1/54 H01H1/58
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	JP 2003 217428 A (TERASAKI ELECTRIC CO LTD) 31 July 2003 (2003-07-31) abstract; figures 1-6	1-9
X	----- EP 1 732 098 A1 (MITSUBISHI ELECTRIC CORP [JP]) 13 December 2006 (2006-12-13) paragraph [0010] - paragraph [0024]; figures 1-3,5-7	1-9
X	----- EP 0 219 449 A1 (SIEMENS AG [DE]) 22 April 1987 (1987-04-22) column 2, line 44 - column 4, line 21; figure 1	1-9
X	----- DE 101 44 440 C1 (SIEMENS AG [DE]) 29 August 2002 (2002-08-29) figure 1	1-9
	----- -/-	

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2011/001716

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 6 089650 A (MITSUBISHI ELECTRIC CORP) 29 March 1994 (1994-03-29) figures 1,3,5 -----	1-9

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Information on patent family members

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