

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
11 October 2007 (11.10.2007)

PCT

(10) International Publication Number
WO 2007/112507 A1

(51) International Patent Classification:
H04B 3/56 (2006.01)

(21) International Application Number:
PCT/AU2007/000450

(22) International Filing Date: 4 April 2007 (04.04.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2006901735 4 April 2006 (04.04.2006) AU

(71) Applicant (for all designated States except US): **ADC GMBH** [DE/DE]; Beeskowdamm 3-11, 14167 Berlin (DE).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **YELLAND, Donald Malcolm Ross** [AU/AU]; 27 Greenvale Grove, Hornsby, New South Wales 2077 (AU). **ALLWOOD, Brent David** [AU/AU]; 8 Pangela Street, Buttaba, New South Wales 2283 (AU).

(74) Agents: **CLARK, Ross James** et al.; Davies Collison Cave, 1 Nicholson Street, Melbourne, Victoria 3000 (AU).

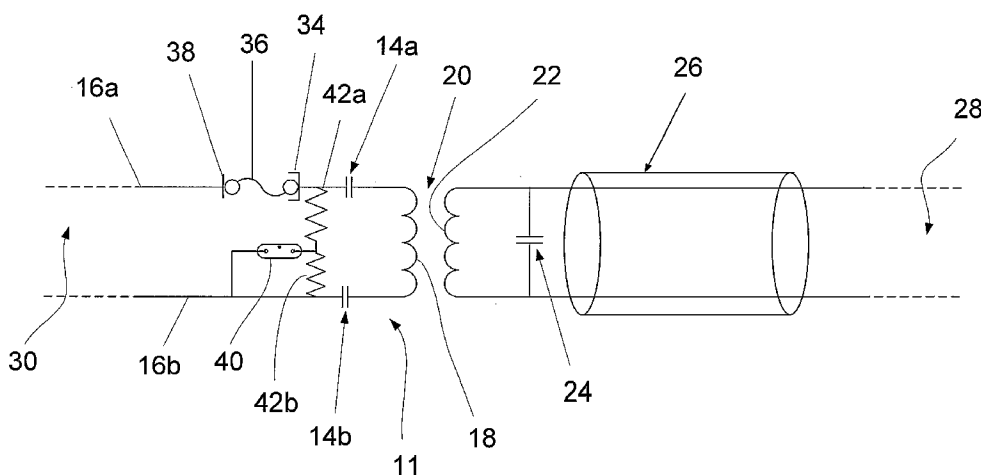
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: POWER LINE COMMUNICATIONS COUPLER



(57) Abstract: A power line communications coupler for effecting signal coupling between electric signalling equipment and an electric power system, said coupler including a fuse coupleable to a power line of said electric power system; and a signal coupler in electrical communication with said fuse and being coupleable to said signalling equipment.

WO 2007/112507 A1

POWER LINE COMMUNICATIONS COUPLER

Technical Field of the Invention

5

The present invention relates to a power line communications coupler.

Background of the Invention

10 Power line communication involves sending electric data signals through electrically
conductive power cables together with electric power signals. Networks for distributing
electric power signals constitute the largest deployed networks in the world. Such
networks can be used for electric data signal transmission. Numerous protocols have been
developed into standards governing transmission of electric data signals through power
15 lines. The coupling of these electric data signals to and from electrically conductive power
cables safely and in compliance with government regulations while maintaining low signal
loss is key to the successful deployment of these power line communications systems.

US 7,145,440, for example, discloses a broadband coupler capable of direct electrical
20 connection to an energised power line. The coupler includes a conductive portion movable
by an adjustable member from a non-conducting retracted position spaced apart from the
power transmission line to a forward conducting position in electrical contact with the
power line. An insulated arm supports the coupler on the power line. A base on the
coupler is engageable with a remotely activated tool in order to accomplish the electrical
25 connection in a safe and secure manner.

In US 7,145,440, broadband data signals are sent to and from customer premises along the
shared energized power lines. New coupler connections to the energized power lines allow
the additional broadband customers and/or repeaters to join the communication system.
30 Also couplers taught by US 7,145,440 may provide connections to control electronics,
routers, wireless transceivers, and may allow the broadband signals to bypass transformers

- 2 -

on the power lines.

To minimise signal loss this coupling normally takes place directly on high power cables these being the core electricity conductors within an electrical network thus requiring
5 bulky high current rupturing fuses and fuse holders and a direct physical connection to the electrical system with no way to easily determine or maintain the efficiency of this physical connection for the disproportionately small power line communications signals compared to the electrical power.

10 It is generally desirable to overcome or ameliorate one or more of the above mentioned difficulties, or at least provide a useful alternative.

Summary of the Invention

15 In accordance with one aspect of the invention, there is provided a power line communications coupler for effecting signal coupling between electric signalling equipment and an electric power system, said coupler including a fuse coupleable to a power line of said electric power system; and a signal coupler in electrical communication with said fuse and being coupleable to said signalling equipment.

20

Preferably, the fuse and the signal coupler are substantially arranged within a housing.

Preferably, the housing includes a host fuse holder.

25 Brief Description of the Drawings

Preferred embodiments of the present invention are hereafter described, by way of non-limiting example only, with reference to the accompanying drawing in which:

30 Figure 1 is a circuit diagram of a preferred embodiment of the invention;
Figure 2 is a diagrammatic illustration showing the components of the embodiment of the

- 3 -

invention shown in Figure 1;

Figure 3 is a schematic diagram showing electric signalling equipment in electrical communication with an electric power system by way of a power line communications coupler;

5 Figure 4 is a diagrammatic illustration of a perspective view of the power line communications coupler shown in Figure 3;

Figure 5 is a diagrammatic illustration of another perspective view of the power line communications coupler shown in Figure 3;

Figure 6 is a diagrammatic illustration of an exploded view of the power line
10 communications coupler shown in Figure 3;

Figure 7 is a circuit diagram of a signal coupler of the power line communications coupler shown in Figure 3;

Figure 8 is a diagrammatic illustration of a perspective view of a top side of the signal coupler shown in Figure 7;

15 Figure 9 is a diagrammatic illustration of a perspective view of a bottom side of the signal coupler shown in Figure 7;

Figure 10 is a diagrammatic illustration of a bottom view of the signal coupler shown in Figure 7;

Figure 11 is a diagrammatic illustration of a side view of the signal coupler shown in
20 Figure 7;

Figure 12 is a diagrammatic illustration of a top view of the signal coupler shown in Figure 7;

Figure 13 is a diagrammatic illustration of a bottom view of a printed circuit board of the signal coupler shown in Figure 7;

25 Figure 14 is a diagrammatic illustration of a side view of a printed circuit board of the signal coupler shown in Figure 7; and

Figure 15 is a diagrammatic illustration of a top view of a printed circuit board of the signal coupler shown in Figure 7.

30

Detailed Description of Preferred Embodiments of the Invention

An embodiment of the invention 10 is a combined fuse holder and signal coupler between a signal system and an electrical power system as illustrated in Figure 1 and Figure 2
5 comprising:

a typical power line communications coupling circuit 11 built on a potted Printed Circuit Board insert 12 comprising of an isolation capacitor 14a, 14b on each phase 16a, 16b connecting across the primary winding 18 of an isolation/ matching transformer 20 with the secondary winding 22 terminating at a small impedance matching capacitor 24.
10 Only low voltage signals are transferred via the isolation transformer 20 and a screened signal cable 26 (rated for use in an electrical environment that could be a Belden 8762 single pair screened cable) to and from the signal equipment 28. The capacitor 24 and transformer 20 have been selected and laid out on a printed circuit board 12 to ensure good frequency coupling response and matching impedance between the electrical system 30
15 and the signal system 28;

an integrated fuse holder 44 consisting of a guide tube 32 open at both ends to permit moisture to drain out freely and sprung contact 34 for a high current rupturing fuse 36 likely to be accepted by most electrical authorities globally where one end of the fuse 36 is in contact via the existing host fuse holder contact 38 with active phase 16a of the
20 high current electrical system 30 and the other end feeds the first capacitor 14a via an integrated sprung contact 34;

an integrated indicator light 40 to directly indicate when the physical coupling to the electrical system 30 is of a low impedance with a specific pull down resistor 42b to ensure a contact but high impedance connection is not indicated as good;

25 an integrated indicator light 40 to expire after approximately two years or when the isolation capacitors 14a, 14b have eventually sustained sufficient damage from ongoing power spikes to no longer be effective conductors or isolation capacitors;

a standard heavy duty host fuse holder 44 that could be manufactured by Cavanna and could be of model DPA likely be accepted by most electrical authorities globally, encapsulating the Potted Printed Circuit Board insert 12 holding all the circuitry described
30 in this specification, the integrated fuse 36 and the indicator light 40;

an integrated resistor network 46 located near the integrated fuse holder 44 sprung contact 34 able to generate sufficient heat to dry out contacts 46 normally dried out by the normal high current use of the host fuse holder 44 and also ensuring a small whetting
35 current continually circulates though the high current fuse 36, heavy duty fuse holder

- 5 -

assembly 12, 44 and physical connections 16a, 16b to the electrical system 30 to stimulate low impedance contact through the chain of contacts for the power line signal.

The power line communications coupler 100 shown in Figure 1 functions in an analogous manner to that of the embodiment of the invention shown in Figures 1 and 2. That is, the coupler 100 is used to effect signal coupling between electric signalling equipment 102 and an electric power system 104. The power line communications coupler 100 is adapted to receive electric data signals from said signalling equipment 102 and send said electric data signals to one or more power line communication equipment end points of the electric power system 104. Further, the power line communications coupler 100 is adapted to receive electric data signals from the signalling equipment 102 and send the electric data signals to one or more intermediate power line communication equipment repeater systems that form part of the electric power system 104.

As particularly shown in Figures 4 to 6, the coupler 100 includes a fuse 106 coupleable to a power line 108a, 108b of the electric power system 104. The coupler 100 also includes a signal coupler 110 in electrical communication with the fuse and coupleable to the signalling equipment 102. The coupler 100 includes a generally hollow cylindrical housing 112 that is formed in the following two intermatable parts:

20

- a. The fuse holder 114; and
- b. The coupling head 116.

The fuse holder 114 is generally cylindrical and includes a right angle active phase contact 118 at a first end 117. The right angled active phase contact 118 is used to electrically connect the coupler 100 to an insulation piercing probe (not shown) coupled to an active phase power line 108a of the electric system 104. Alternatively, the fuse holder 114 includes an in-line active phase contact (not shown) for electrically connecting to the insulation piercing probe (not shown) coupled to the active phase power line 108a of the electric system 104. An open end 119 of the cylindrical fuse holder 114 is shaped to receive, and securely seat therein, the fuse 106.

- 6 -

The coupler 100 includes an annular spacer 124 seated in the fuse holder 114. The fuse 106 extends through the spacer 124 when seated in the fuse housing 114. The spacer 124 preferably locates the fuse 106 in position for electrical connection to the signal coupler
5 110 and electrically isolates the fuse 106 from the internal peripheral walls of the housing 112. The fuse 106 is preferably a high rupture current fuse.

A first end 121 of the generally cylindrical coupling head 116 includes a socket 120 that is shaped to receive a screened mains rated signal cable (not shown). Another open end 122
10 of the coupling head 116 is shaped to receive, and securely seat therein, the signal coupler 110 (the operation of the signal coupler is described in further detail below).

The open ends 117, 122 of the fuse holder 114 and the coupler head 116 include interlocking parts. For example, the open ends 117, 122 are coupled together by way of
15 respective snap lock male and female interlocking parts. Alternatively, the open ends 117, 122 are secured together by way of corresponding helical threads. Otherwise, the open ends 117, 122 of the fuse holder 114 and the coupler head 116 can be coupled together by way of any other suitable means. The fuse 106 and the signal coupler 110 are substantially arranged within the housing 112 when the fuse holder 114 and the coupling head 116 are
20 coupled together in the described manner.

As particularly shown in Figures 7 to 12, the signal coupler 110 includes a typical power line communications coupling circuit built on a potted printed circuit board 130. The signal coupler 110 includes parallel isolation capacitors 132a, 132b and 134a, 134b on
25 each phase 108a, 108b connecting across the primary winding 138 of the isolation/matching transformer 140 (preferably PE-68629). The capacitors 132a and 132b are preferably 10nF and 1.5nF. The capacitors 134a and 134b are preferably 4.7nF and 1.5nF. The capacitors of each pair are disposed on opposite sides of the printed circuit board 130. The capacitors of each pair are not arranged in parallel on opposite sides of the board to
30 reduce interference therebetween. The secondary winding 142 terminating at diodes 144a, 144b (preferably TVS 0603 30V). Only low voltage signals are transferred via the

- 7 -

isolation transformer 140 and a screened signal cable 146 (rated for use in an electrical environment that could be a Belden 8762 single pair screened cable) to and from the electric signalling equipment 102. The transformer 140 has been selected and laid out on a printed circuit board 130 to ensure good frequency coupling response and matching
5 impedance between the electric power system 104 and the electric signalling system 102.

The integrated fuse holder 114 includes a guide tube (not shown) open at both ends to permit moisture to drain out freely and a sprung contact 150 for the high current rupturing fuse 106. The fuse 106 is likely to be accepted by most electrical authorities globally. One
10 end of the fuse 106 is in electrical contact, via the existing host fuse holder contact 118, with active phase 108a of the high current electric power system 104. The other end of the fuse 106 feeds the parallel pair of isolation capacitors 132a, 132b via an integrated sprung contact 150. The parallel capacitors 132a, 132b address high end and low end frequencies.

15 The signal coupler 110 includes an integrated indicator light 152 to directly indicate when the physical coupling to the electric power system 104 is of a low impedance with a specific pull down resistor 154b (100KOhms) to ensure a contact but high impedance connection is not indicated as good. The integrated indicator light 152 may expire after approximately two years, or when the isolation capacitors 132a, 132b and 134a, 134b have
20 eventually sustained sufficient damage from ongoing power spikes to no longer be effective conductors or isolation capacitors. The housing 112 includes an aperture 158 through which the indicator can be viewed.

The fuse holder 114 is, for example, a standard heavy duty host fuse holder 114 that is by
25 Cavanna and could be of model DPA likely be accepted by most electrical authorities globally. The fuse holder 114 preferably encapsulates the potted printed circuit board 130 holding all the circuitry described in this embodiment of the invention, the integrated fuse 106 and the indicator light 152.

30 The resistors 154a, 154b (68KOhms, 100KOhms), located near the integrated fuse holder 114, the sprung contact 150 are able to generate sufficient heat to dry out contacts normally dried out by the normal high current use of the host fuse holder 114 and also ensuring a small whetting current continually circulates though the high current fuse 106, heavy duty fuse holder assembly and physical connections 108a, 108b to the electric power

- 8 -

system 104 to stimulate low impedance contact through the chain of contacts for the power line signal.

The signal coupler 110 also includes a fuse 160 (preferably MOV V300LA4) to protect the circuit from spikes. The fuse 110 is preferably a quick acting 125 Volt, 2 Amp fuse.

The arrangement of the tracks of the printed circuit board 130 of the signal coupler 110 are shown in Figures 13 to 15. Tracks are laid on both sides of the board 130. The board 130 is of sufficient size for installation within the fuse holder 114.

10

While we have shown and described specific embodiments of the present invention, further modifications and improvements will occur to those skilled in the art. We desire it to be understood, therefore, that this invention is not limited to the particular forms shown and we intend in the append claims to cover all modifications that do not depart from the spirit and scope of this invention.

15

Throughout this specification, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

20

The reference to any prior art in this specification is not, and should not be taken as, an acknowledgment or any form of suggestion that the prior art forms part of the common general knowledge in Australia.

Claims Defining the Invention

1. A power line communications coupler for effecting signal coupling between
5 electric signalling equipment and an electric power system, said coupler including a fuse coupleable to a power line of said electric power system; and a signal coupler in electrical communication with said fuse and being coupleable to said signalling equipment.
- 10 2. The coupler claimed in claim 1, wherein the fuse and the signal coupler are substantially arranged within a housing.
3. The coupler claimed in claim 2, wherein the housing includes a host fuse holder.
- 15 4. The coupler claimed in any one of claims 1 to 3, including circuitry for effecting a whetting current through the fuse.
5. The coupler claimed in any one of the preceding claims, including an indicator for indicating the status of electrical coupling to the electric power system.
- 20 6. The coupler claimed in claim 5, wherein the indicator indicates when physical coupling to the electric power system is of low impedance.
7. The coupler claimed in claim 5 or claim 6, wherein the indicator is a light.
- 25 8. The coupler claimed in claim 7, wherein the light is visible externally from the coupler.
9. The coupler claimed in any one of the preceding claims, including circuitry for
30 heating internal components of the coupler.

- 10 -

10. The coupler claimed in claim 10, wherein the circuitry for heating includes one or more resistors.
- 5 11. The coupler claimed in any one of the preceding claims, wherein, in use, the coupler receives electric data signals from said signalling equipment and sends said electric data signals to one or more power line communication equipment end points of the electric power system.
- 10 12. The coupler claimed in any one of claims 1 to 10, wherein, in use, the coupler receives electric data signals from said signalling equipment and sends said electric data signals to one or more intermediate power line communication equipment repeater systems of said electric power system.
- 15 13. The coupler claimed in any one of the preceding claims, wherein the fuse is a high rupture current fuse.
14. A power line electrical communications coupler substantially as herein before described with reference to the accompanying drawings.

20

1/9

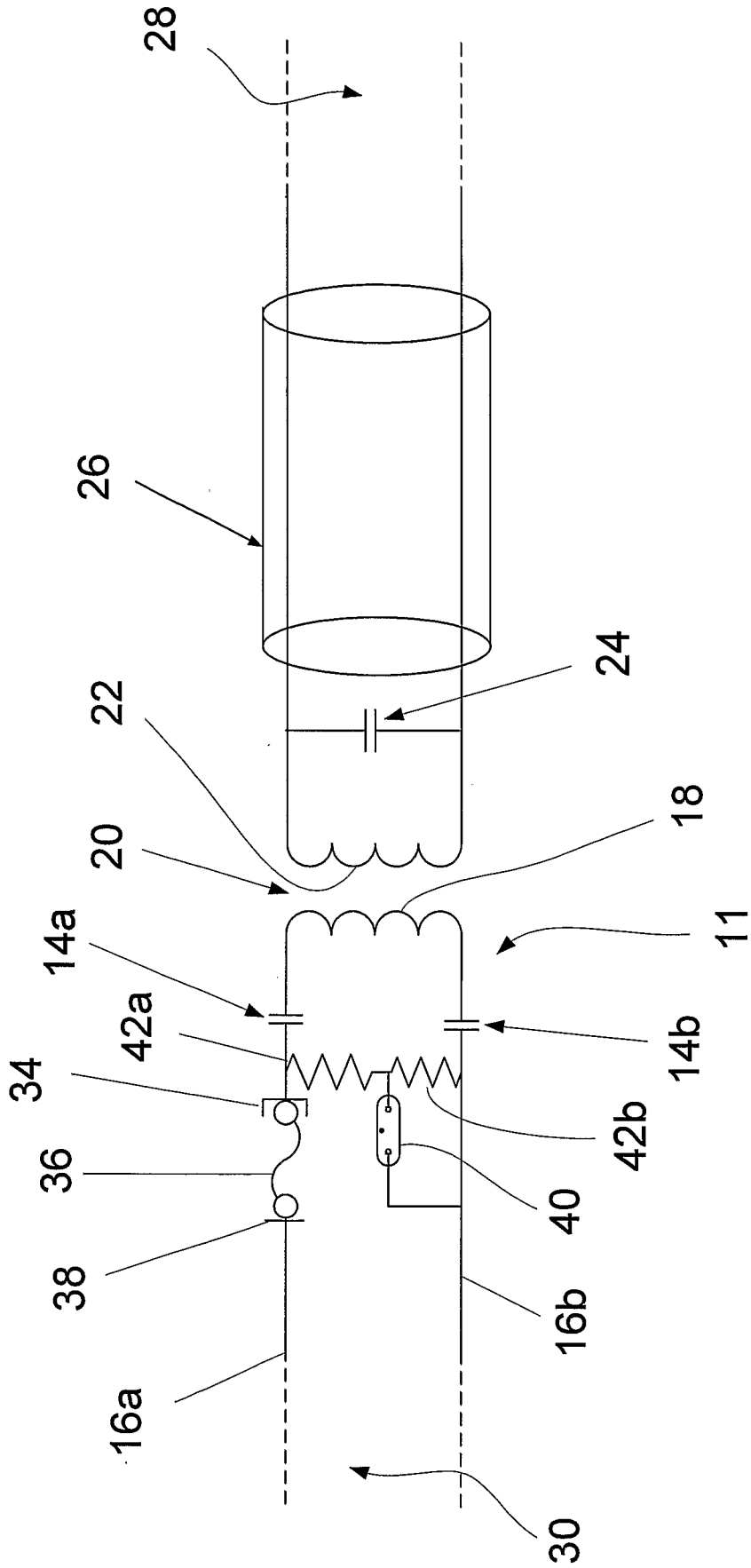


Figure 1

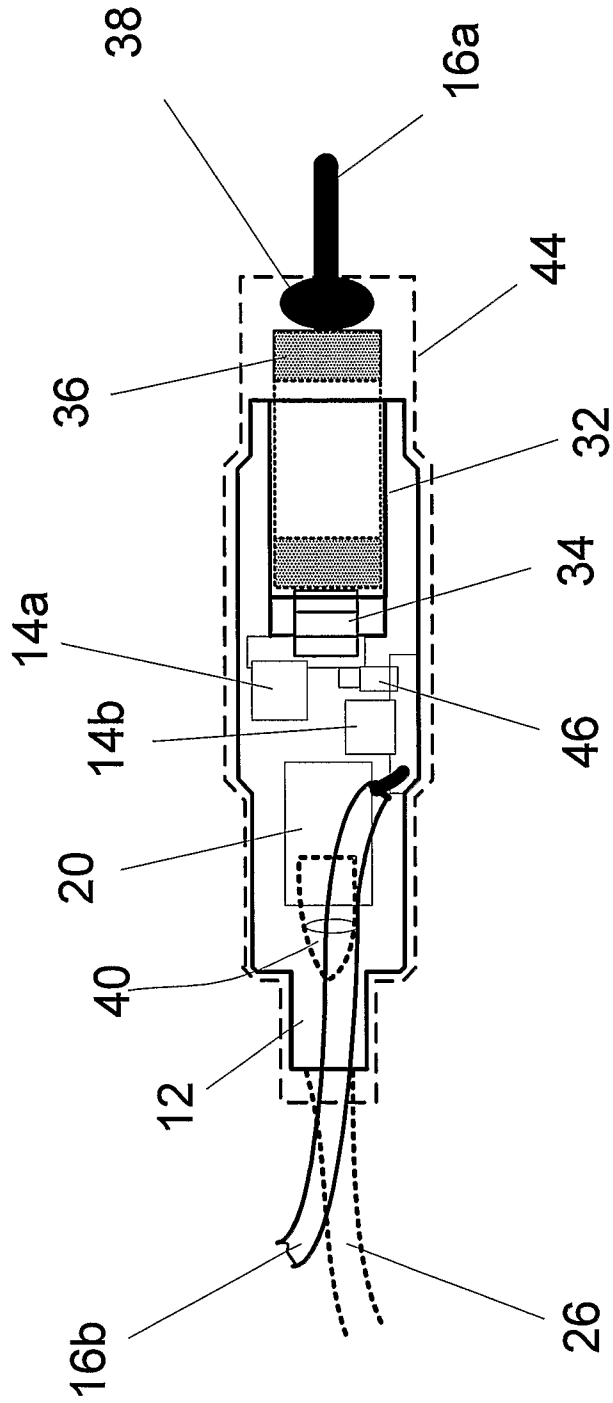


Figure 2

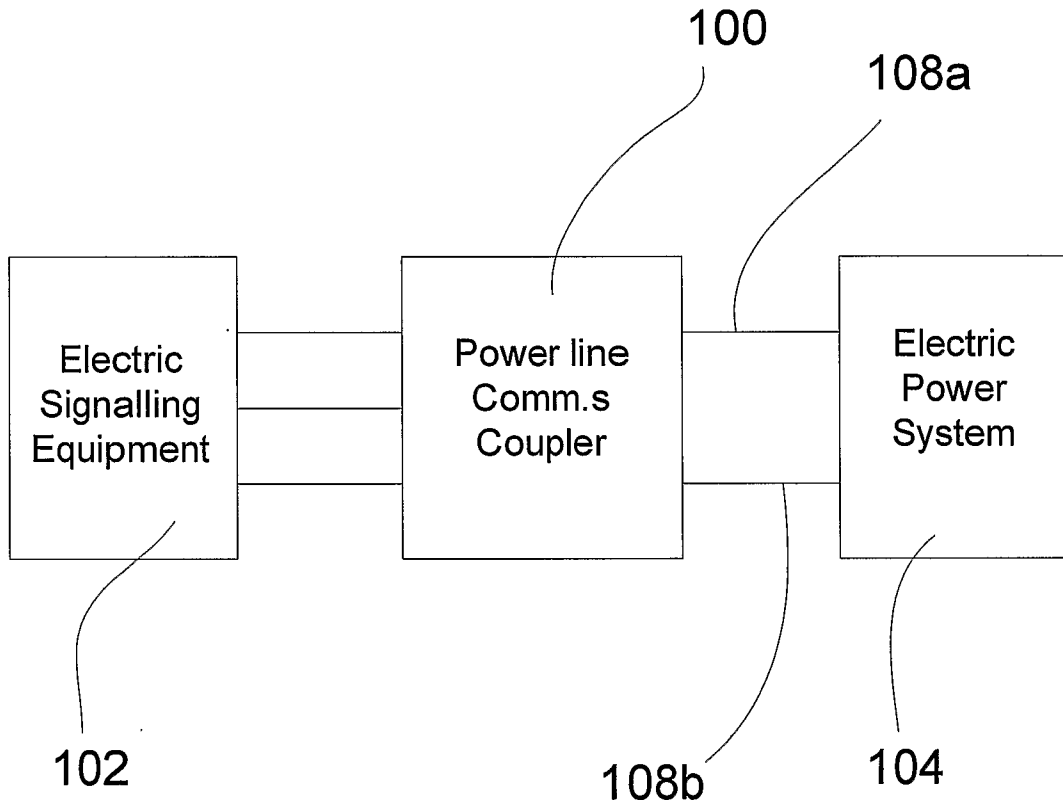


Figure 3

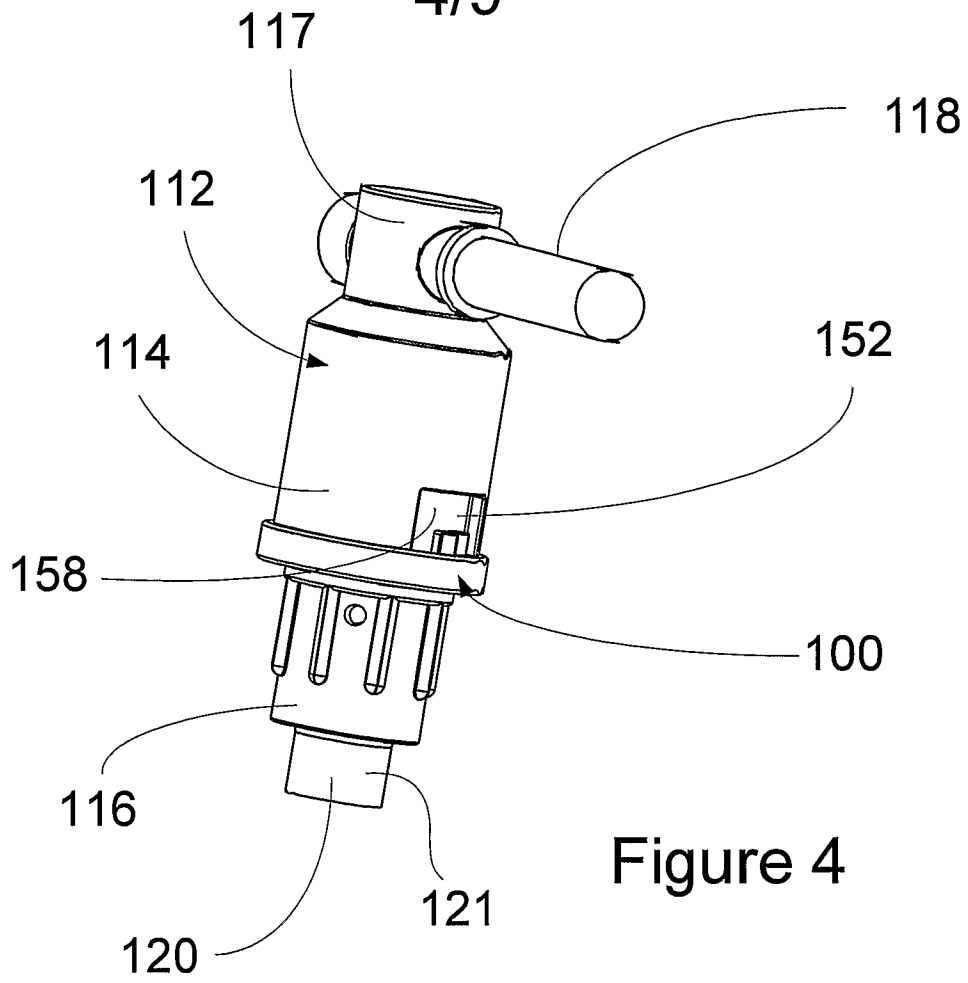


Figure 4

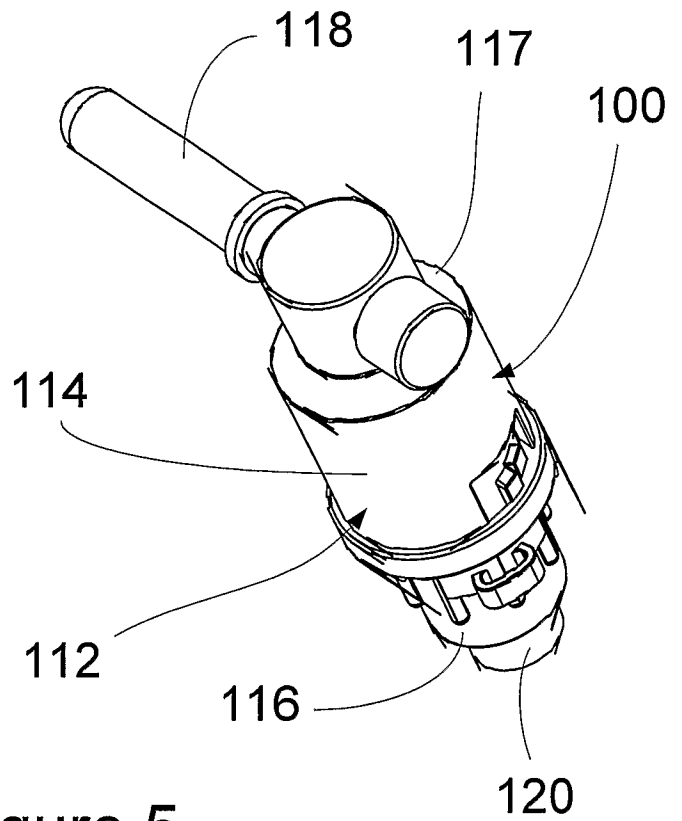


Figure 5

5/9

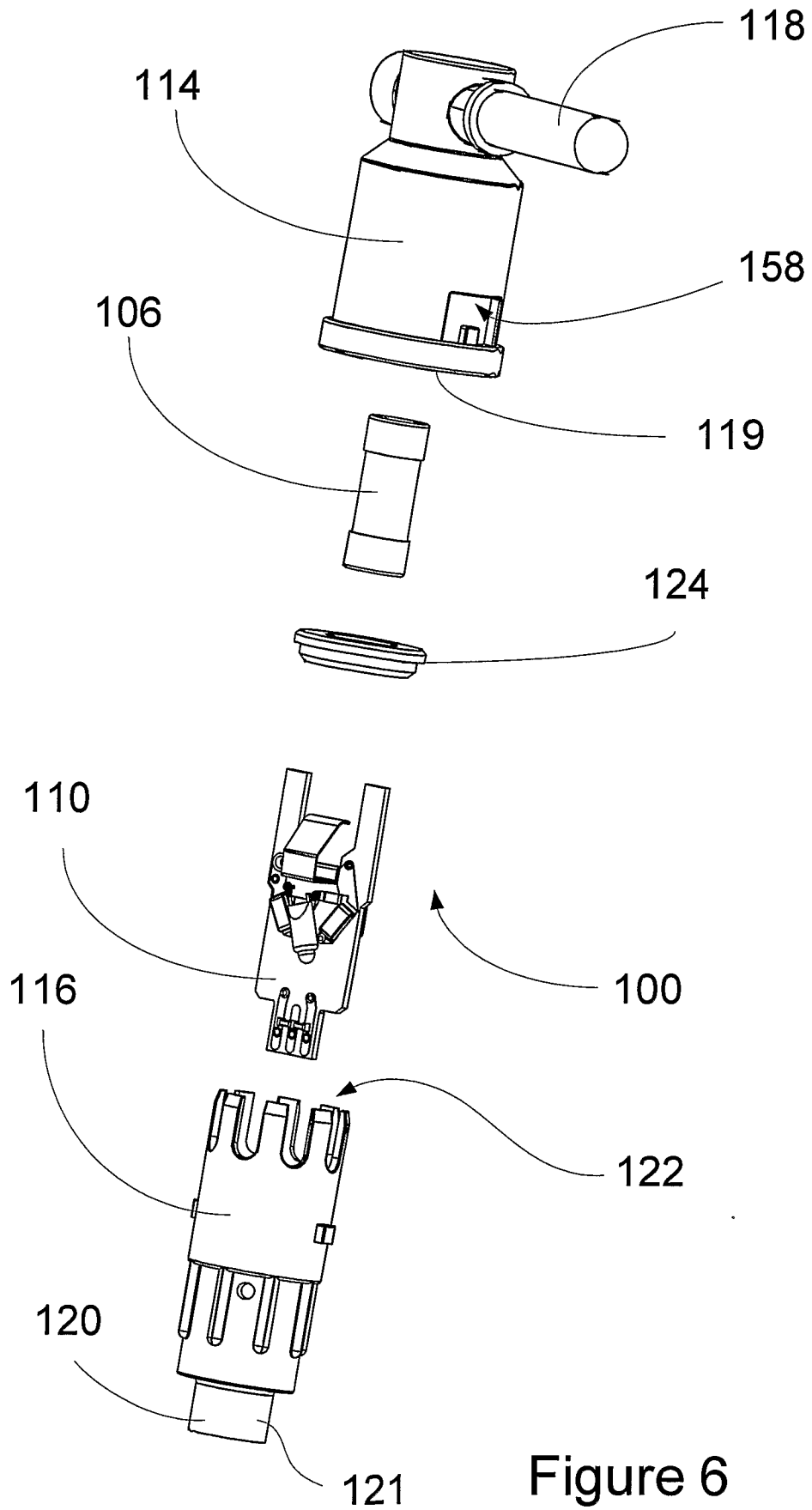


Figure 6

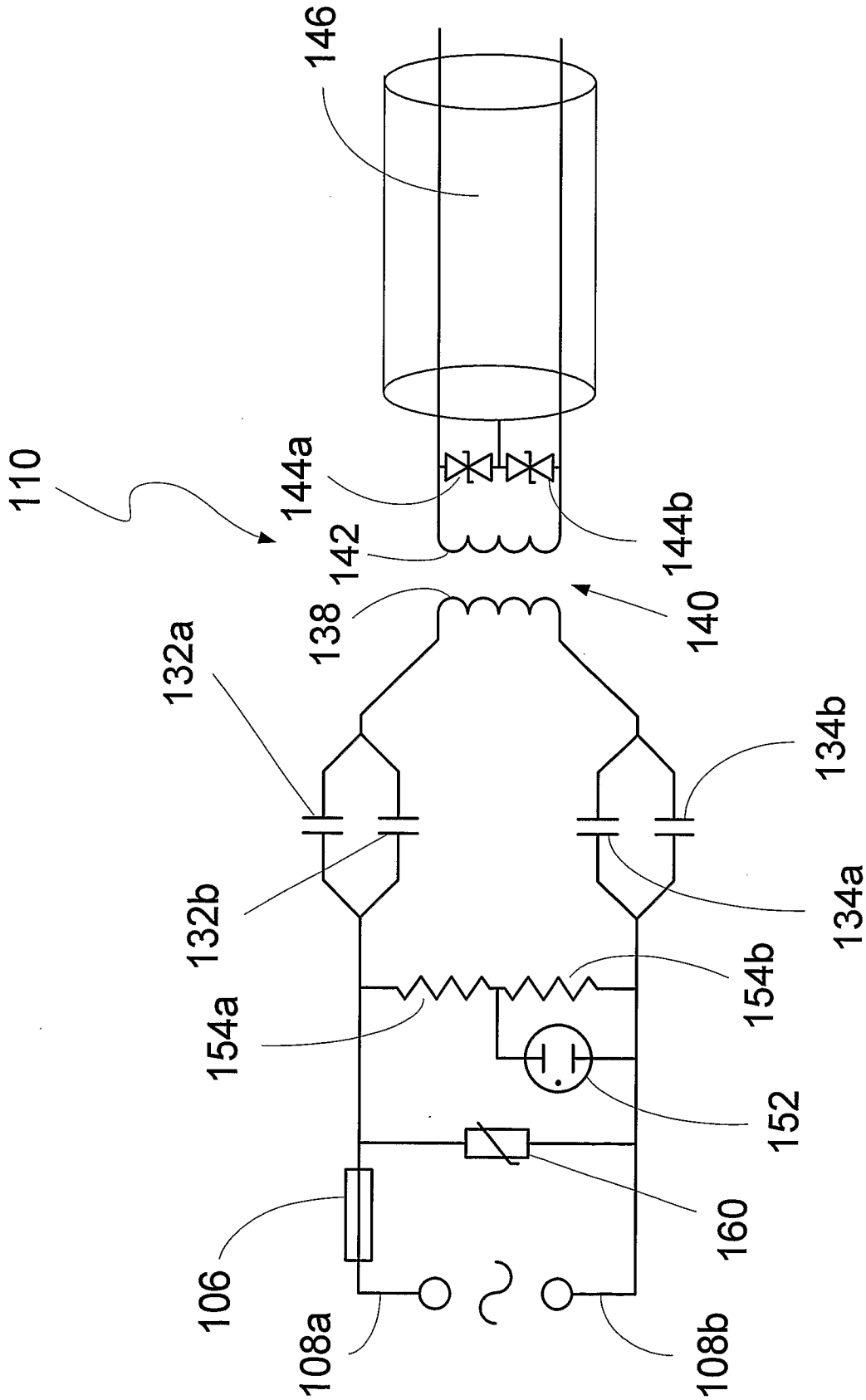


Figure 7

7/9

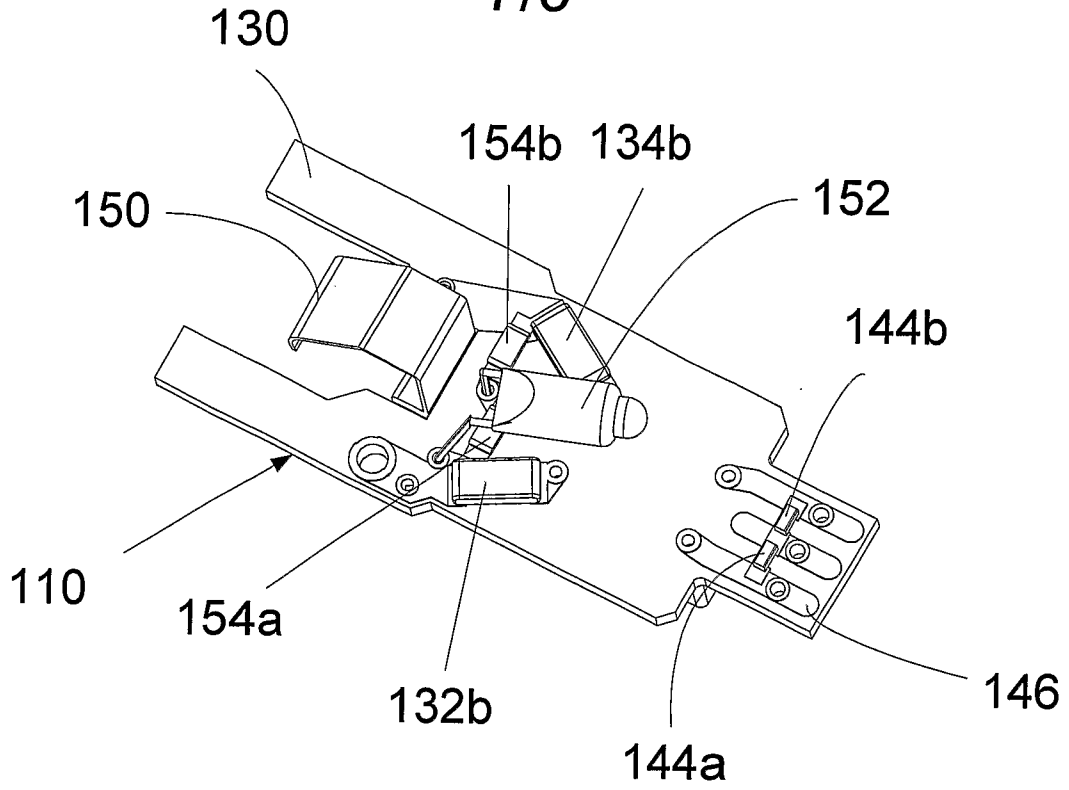


Figure 8

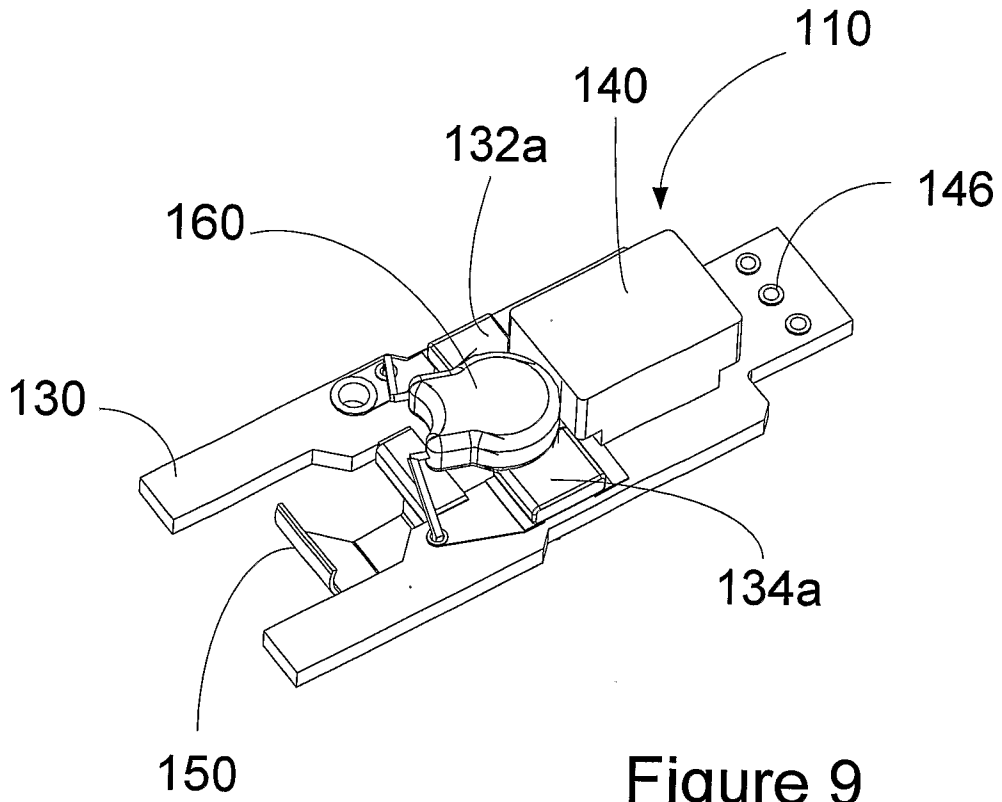


Figure 9

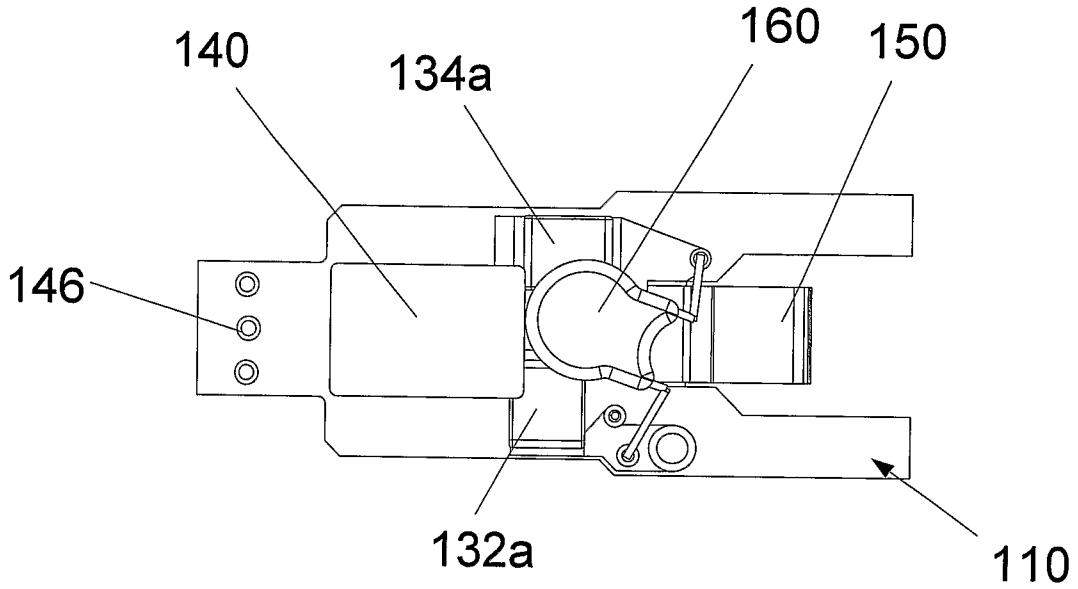


Figure 10

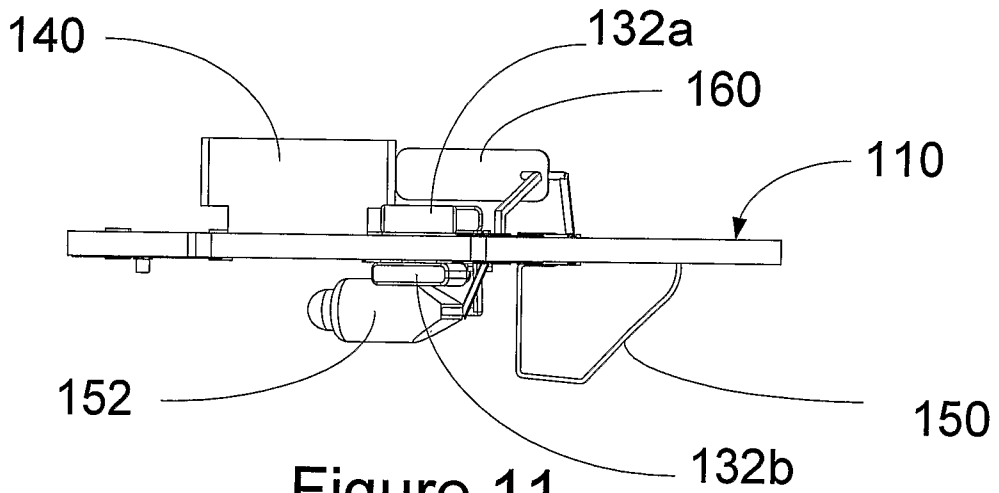


Figure 11

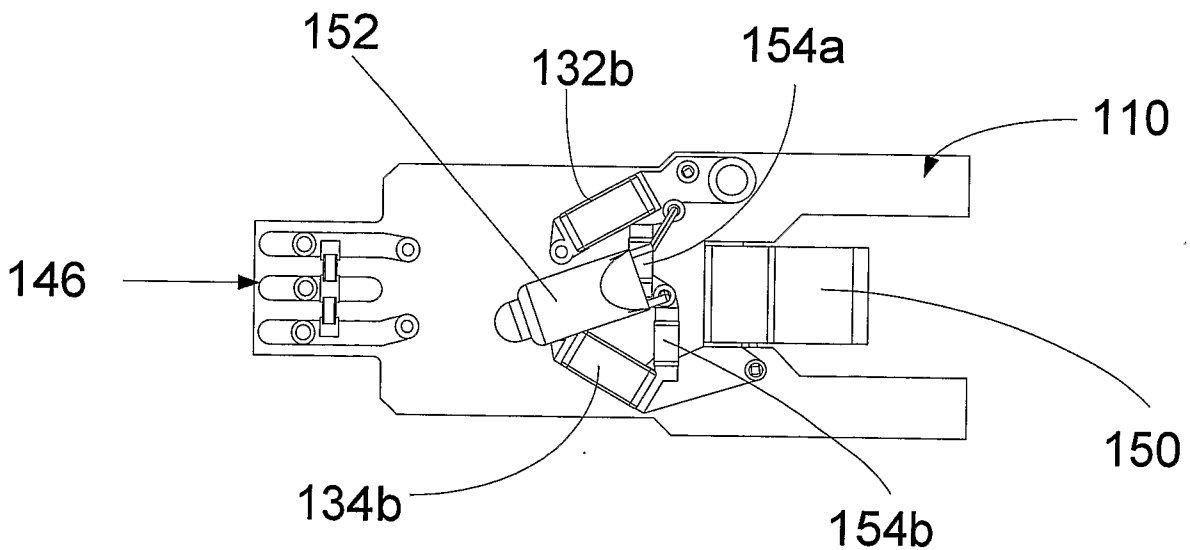


Figure 12

9/9

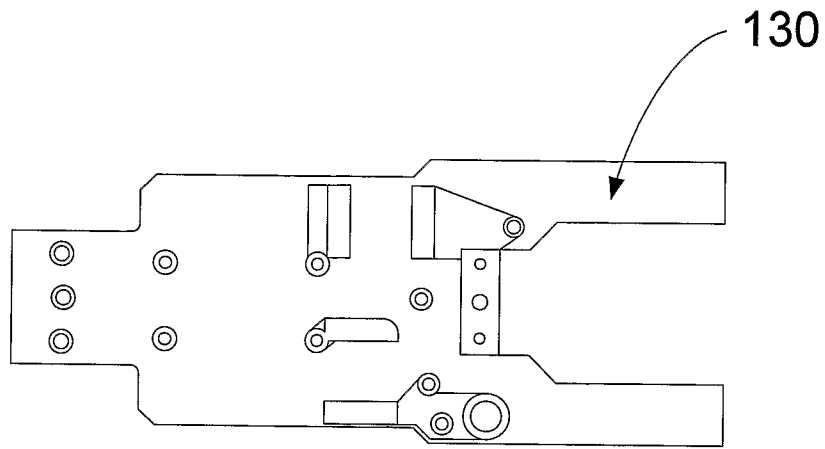


Figure 13



Figure 14

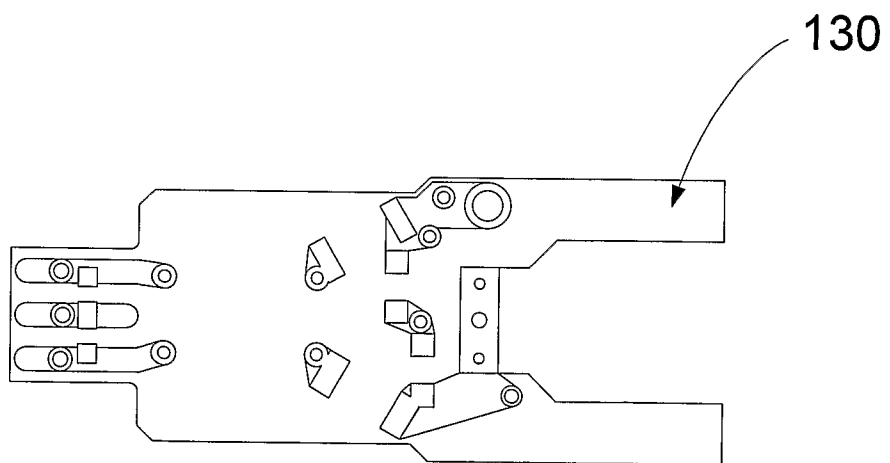


Figure 15

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2007/000450

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

H04B 3/56 (2006.01)

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)

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 practicable, search terms used)

WPAT, USPTO, ESPACE Keywords: power line; mains; communicat; data; signal; coupl; interfac; fuse; circuit breaker and like keywords

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6844810 B2 (CERN) 18 January 2005 Col 3 lines 19-63 Figs 3, 4	1-14
X	WO 2000/049726 A1 (SIEMENS AKTIENGESELLSCHAFT) 24 August 2000 Whole document	1-14
X	WO 1998/033258 A2 (NORTHERN TELECOM LTD, CA) 30 July 1998 Abstract Pg 3 lines 1-32 Pg 6 line 20 – Pg 7 line 32 Pg 8 lines 4-16, Pg 9 lines 9-23 Figs 3, 5-7	1-14



Further documents are listed in the continuation of Box C



See patent family annex

* Special categories of cited documents:		
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	
"P" document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

15 May 2007

Date of mailing of the international search report

22 MAY 2007

Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
E-mail address: pct@ipaustalia.gov.au
Facsimile No. (02) 6285 3929

Authorized officer

ATA MAQBOOL
AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
Telephone No : (02) 6283 7905

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU2007/000450

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
US 6844810	AU 2003277438	AU 2003277439	AU 2003301381		
	AU 2003301390	BR 0315307	BR 0315356		
	BR 0315364	BR 0315492	CA 2502104		
	CA 2502107	CA 2502122	CA 2502547		
	CN 1706013	CN 1706099	CN 1706175		
	CN 1706176	EP 1552677	EP 1552678		
	EP 1556947	EP 1561226	KR 2005004954		
	KR 2005005576	KR 2005006560	MX PA05003903		
	MX PA05004087	MX PA05004088	MX PA05004090		
	US 7005943	US 7109835	US 2004085171		
	US 2004085172	US 2004090284	US 2005020233		
	US 2006008204	WO 2004036601	WO 2004036772		
	WO 2004036813	WO 2004036879			
WO 0049726	AU 34173/00	EP 1079538	EP 1151552		
WO 9833258	AU 56730/98	CA 2278843	EP 0956631		

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX