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(71) Applicant *(for all designated States except US)*: **PRESTOLITE ELECTRIC INC.** [US/US]; 46200 Port St., Plymouth, Michigan 48170 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **HRNJAK, Aleksander** [CA/CA]; 591 Lisa Cr., Windsor, Ontario N9G-2M6 (CA). **PLENZLER, James David** [US/US]; 6102 Holly Valley, Toledo, Ohio 43612 (US). **HALL, Robert David** [US/US]; 3144 Washburn Rd., Berkey, Ohio 43504 (US). **HARLEY, Clive** [US/US]; 308 Sedgewood Ln, Ann Arbor, Michigan 48103 (US).

(74) Agent: **Arnold, Jr., Patrick, J.**; McAndrews Held and Malloy, 500 W. Madison, Suite 3400, Chicago, Illinois 60661 (US).

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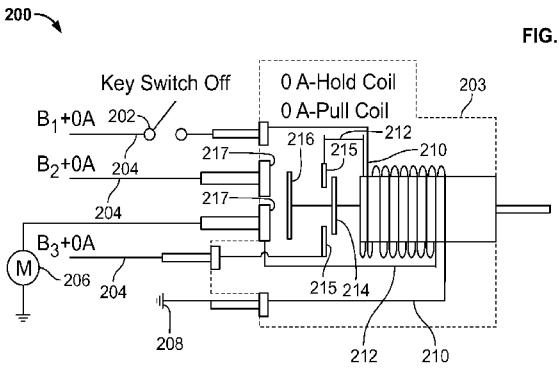
(54) **Title**: SOFT-START SYSTEMS AND METHODS FOR VEHICLE STARTERS

FIG. 2



(57) **Abstract**: Soft-start systems and methods for vehicle starters are provided. Embodiments provide a solenoid including: a first coil that receives power when an ignition switch is closed; a first plunger actuated when the first coil receives power; a first terminal configured to be abutted by a contact bar of the first plunger; a second coil that receives power when the contact bar of the first plunger abuts the first terminal; a second plunger actuated when the second coil receives power; and a second terminal configured to be abutted by a contact bar of the second plunger. Such a solenoid is configured to provide power at a first level to an attached motor when the contact bar of the first plunger abuts the first terminal and at a second level that is higher than the first level when the contact bar of the second plunger abuts the second terminal.

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SOFT-START SYSTEMS AND METHODS FOR VEHICLE STARTERS

Background of the Invention

[0001] During vehicle start-up, it has been found desirable to run the motor initially at reduced power. This practice is referred to as a "soft-start." One advantage of a soft start is to run the motor initially with reduced torque in the powertrain, which can allow the pinion to fully engage the ring gear prior to the motor being run at full power. In order to achieve a soft-start, present vehicle motors include a relay between the ignition switch and the solenoid that provides operating current to the motor. Examples of patent references that describe such configurations include US. Patent No. 5,475,270, US. Patent No. 5,892,422 and U.S. App. Pub. No. 2009/0002105.

[0002] A schematic of a prior art vehicle start system 100 that includes a relay 102 between the ignition switch 104 and the solenoid 106 is depicted in FIG. 1. The system 100 also includes a battery 108 and motor 110. In operation, when a vehicle operator turns the key, the ignition switch 104 allows power (about 1-5 amps, for example) to flow from battery 108 to relay 102. Relay 102 then allows power

(about 250 amps, for example) to flow from battery 108 to solenoid 106. Energizing solenoid 106 allows power (about 250 amps, for example) to flow to motor 110 and begins solenoid plunger moving toward contacts 114 and 116. When solenoid plunger 112 abuts contacts 114 and 116, higher power (about 2000 amps, for example) flows from battery 108 to motor 110 via solenoid 106. The initial period when the motor is supplied lower power (about 250 amps, for example) provides a soft start.

[0003] However, the extra relay takes up space, is a potential point of failure and adds cost to the vehicle starting system.

[0004] Thus, there is a need for improved soft-start systems and methods for vehicles.

Summary of the Invention

[0005] Embodiments of the present technology provide improved soft-start systems and methods.

Brief Description of the Drawing(s)

[0006] FIG. 1 is a schematic of a prior art vehicle start system.

[0007] FIG. 2 is a schematic of a vehicle start system used in accordance with an embodiment of the present technology in a first state.

[0008] FIG. 3 is a schematic of the vehicle start system of FIG. 2 in a second state.

[0009] FIG. 4 is a schematic of the vehicle start system of FIG. 2 in a third state.

[0010] FIG. 5 is a schematic of the vehicle start system of FIG. 2 in a fourth state.

[0011] FIG. 6 depicts a side-sectional view of a solenoid used in accordance with an embodiment of the present technology.

[0012] FIG. 7 depicts a perspective view of the solenoid of FIG. 6.

[0013] FIG. 8 depicts a side-sectional view of the solenoid of FIG. 6.

[0014] FIG. 9 depicts a side-sectional view of the solenoid of FIG. 6.

[0015] FIG. 10 depicts a side-sectional view of the solenoid of FIG. 6.

[0016] The foregoing summary, as well as the following detailed description of embodiments of the present invention, will be better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, certain embodiments are shown in the drawings. It should be understood, however, that the present invention is not limited to the arrangements and instrumentalities shown in the attached drawings.

Detailed Description of Preferred Embodiment(s)

[0017] Embodiments of the present technology provide improved soft-start systems and methods. In the figures, like elements are identified with like indicators.

[0018] FIG. 1 is a schematic of a prior art vehicle start system 100 that is described in the background section.

[0019] FIG. 2 is a schematic of a vehicle start system 200 used in accordance with an embodiment of the present technology in a first state. The vehicle start system 200 includes key switch 202, solenoid 203, battery 204, motor 206 and ground 208. Solenoid 203 includes hold coil 210, pull coil 212, first plunger with contact bar 214, first

terminal 215, second plunger with contact bar 216, and second terminal 217. In the first state depicted in FIG. 2, key switch 202 is open/off such that: (1) power does not flow to solenoid 203 from battery 204 via connection B_1; (2) power does not flow to solenoid 203 from battery 204 via connection B_2; and (3) power does not flow to solenoid 203 from battery 204 via connection B_3. This is the state of the vehicle start system 200 when motor 206 is not running and vehicle ignition has not been triggered, for example, by an operator of the vehicle turning a key in the ignition.

[0020] FIG. 3 is a schematic of the vehicle start system 200 in a second state. This is the state of the vehicle start system 200 immediately after a vehicle ignition is triggered, for example, by an operator of the vehicle turning a key in the ignition. In the second state depicted in FIG. 3, key switch 202 is closed/on such that power (about 1-10 amps, for example) is allowed to flow to solenoid 203 from battery 204 via connection B_1. Supplying power to solenoid 203 via connection B_1 energizes hold coil 210 causing first plunger with contact bar 214 to move laterally toward first terminal 215. Motor 206 is not running in this state.

[0021] FIG. 4 is a schematic of the vehicle start system 200 in a third state. This is the state of the vehicle start system 200 immediately after contact bar 214 of first plunger abuts first terminal 215. Abutting contact bar 214 to first terminal 215 energizes pull coil 212 via connection B_3, thereby allowing power (about 200 amps, for example) to flow to motor 206 from battery 204 via solenoid 203 and connection B_3, and causing second plunger with contact bar 216 to move laterally toward second terminal 217. Motor 206 is running in this state at lower power (about 200 amps, for example) providing a soft-start.

[0022] FIG. 5 is a schematic of the vehicle start system 200 in a fourth state. This is the state of the vehicle start system 200 immediately after second plunger with contact bar 216 abuts second terminal 217. Abutting contact bar 216 of second plunger to second terminal 217 allows higher power (about 2000 amps, for example) to flow to motor 206 from battery 204 via solenoid 203 and connection B_2. Motor 206 is running in this state at higher power (about 2000 amps, for example).

[0023] When the motor is stopped, for example by an operator of the vehicle turning a key in the ignition, the vehicle start system 200 will return to the first state depicted in FIG. 2.

[0024] FIG. 6 depicts a side-sectional view of a solenoid 600 used in accordance with an embodiment of the present technology. Solenoid 600 includes the elements of solenoid 203 described above in connection with FIGs. 2-5. Solenoid 600 also includes body 602, bobbin 604 and anvil 606, and depicts the first plunger 608 with contact bar 214 and the second plunger 610 with contact bar 216. FIG. 7 depicts a perspective view of the solenoid of FIG. 6.

[0025] FIGs. 8-10 depict side-sectional views of the solenoid of FIG. 6. FIG. 8 depicts solenoid 600 in the first state described above in connection with FIG. 2. In the first state, there is a first gap 802 that first plunger 608 with contact bar 214 can traverse prior to contact bar abutting first terminal 215. There is also a second gap 804 that second plunger 610 with contact bar 216 can traverse prior to contact bar abutting first terminal 217.

[0026] FIG. 9 depicts solenoid 600 in the third state described above in connection with FIG. 4. In the third state, first plunger 608

with contact bar 214 abuts first terminal 215, but second plunger 610 with contact bar 216 does not abut second terminal 217. In this state, an attached motor would be running at lower power (about 200 amps, for example) providing a soft-start.

[0027] FIG. 10 depicts solenoid 600 in the fourth state described above in connection with FIG. 5. In the fourth state, first plunger 608 with contact bar 214 abuts first terminal 215, and second plunger 610 with contact bar 216 abuts second terminal 217. In this state, an attached motor would be running at higher power (about 2000 amps, for example).

[0028] FIGs. 9-10 also depict the magnetic path 902 of the solenoid coils 210, 212.

[0029] In operation, a solenoid and/or vehicle start system as described herein can provide a soft-start for a motor without requiring an additional relay. Certain embodiments of the present invention include methods of starting an engine using a solenoid and/or vehicle start system as described herein. Certain embodiments of the present invention include methods of making a solenoid and/or vehicle start system as described herein.

[0030] Certain embodiments of the inventive solenoids and/or vehicle start systems can provide for: (1) improved use of space by eliminating the additional relay; (2) removal of a potential point of failure; and/or (3) lower cost.

[0031] While particular elements, embodiments and applications of the present invention have been shown and described, it will be understood that the invention is not limited thereto since modifications can be made by those skilled in the art without departing from the scope of the present disclosure, particularly in light of the foregoing teachings.

What is claimed is:

1. A solenoid for use in a vehicle starting system comprising:

a first coil configured to receive power when an ignition switch is closed;

a first plunger comprising a contact bar operatively connected to the first coil such that the first plunger is actuated when the first coil receives power;

a first terminal configured to be abutted by the contact bar of the first plunger after the first plunger is actuated;

a second coil configured to receive power when the contact bar of the first plunger abuts the first terminal;

a second plunger comprising a contact bar operatively connected to the second coil such that the second plunger is actuated when the second coil receives power; and

a second terminal configured to be abutted by the contact bar of the second plunger after the second plunger is actuated,

the solenoid configured to provide power at a first level to an attached motor when the contact bar of the first plunger abuts the first

terminal and the contact bar of the second plunger does not abut the second terminal, and

the solenoid configured to provide power to an attached motor at a second level that is higher than the first level when the contact bar of the second plunger abuts the second terminal.

2. A method of starting a vehicle using a solenoid comprising:

providing power to a first coil of a solenoid when an ignition switch is closed;

actuating a first plunger comprising a contact bar operatively connected to the first coil when the first coil receives power;

abutting the contact bar of the first plunger with a first terminal;

providing power to a second coil when the contact bar of the first plunger abuts the first terminal;

providing power to a motor at a first level when the contact bar of the first plunger abuts the first terminal;

actuating a second plunger comprising a contact bar operatively connected to the second coil when the second coil receives power;

abutting the contact bar of the second plunger with a second terminal; and

providing power to a motor at a second level that is higher than the first level when the contact bar of the second plunger abuts the second terminal.

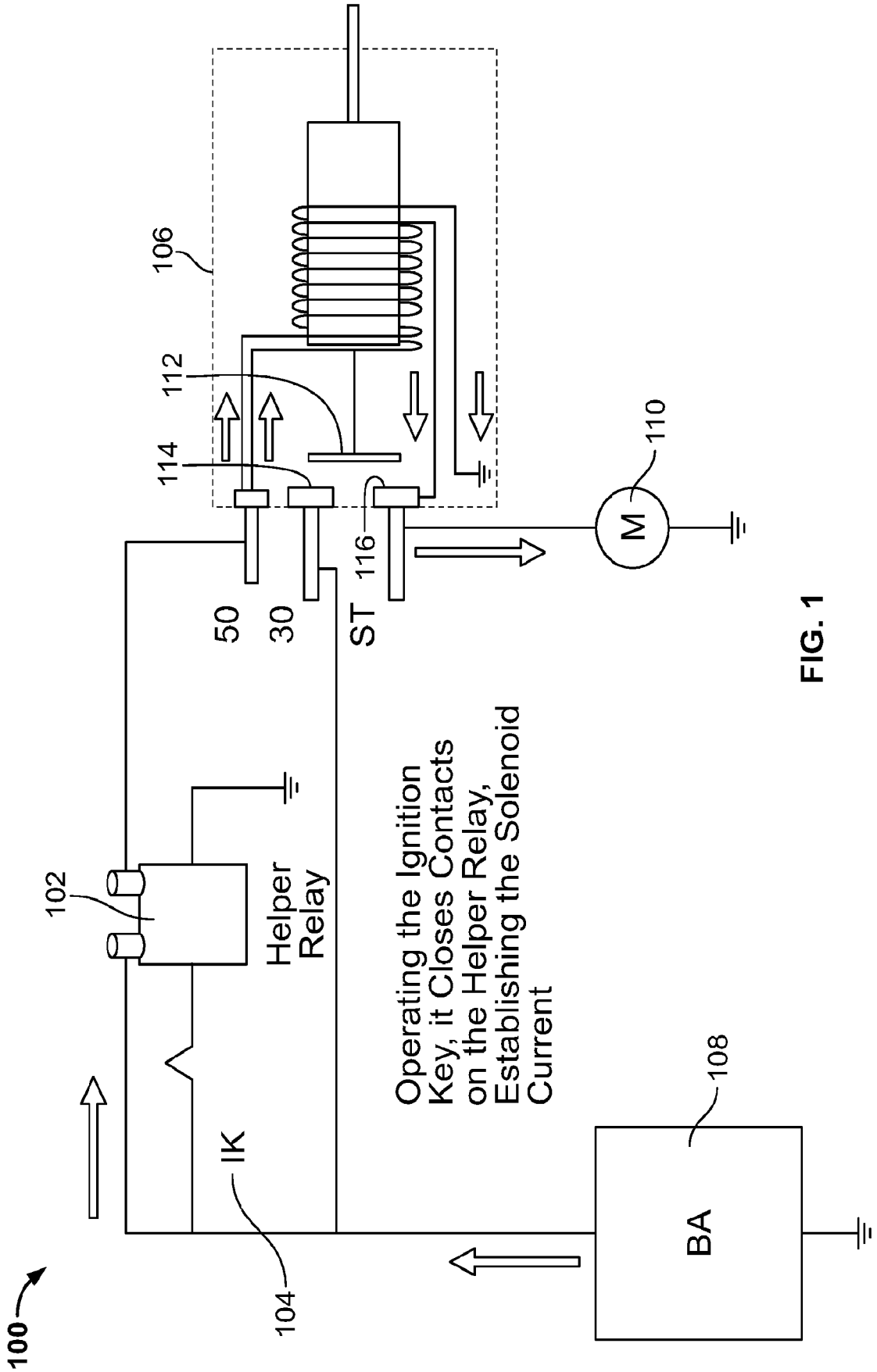
100
102
104
106
108
110
112
114
116
50
30
ST
M
BA
IK
Helper Relay
Operating the Ignition Key, it Closes Contacts on the Helper Relay, Establishing the Solenoid Current

FIG. 1

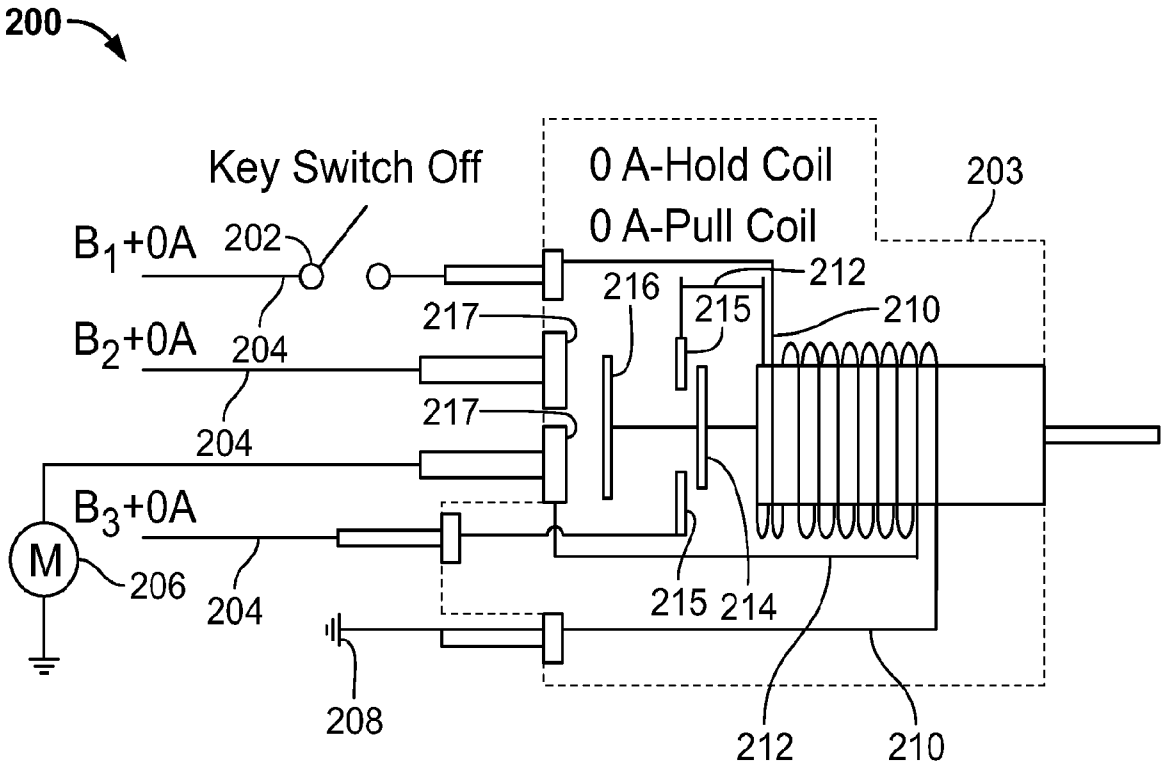
200
Key Switch Off
0 A-Hold Coil
0 A-Pull Coil
203
B1+0A
202
B2+0A
204
204
B3+0A
M
206
204
208
216
215
212
210
217
217
215
214
212
210

FIG. 2

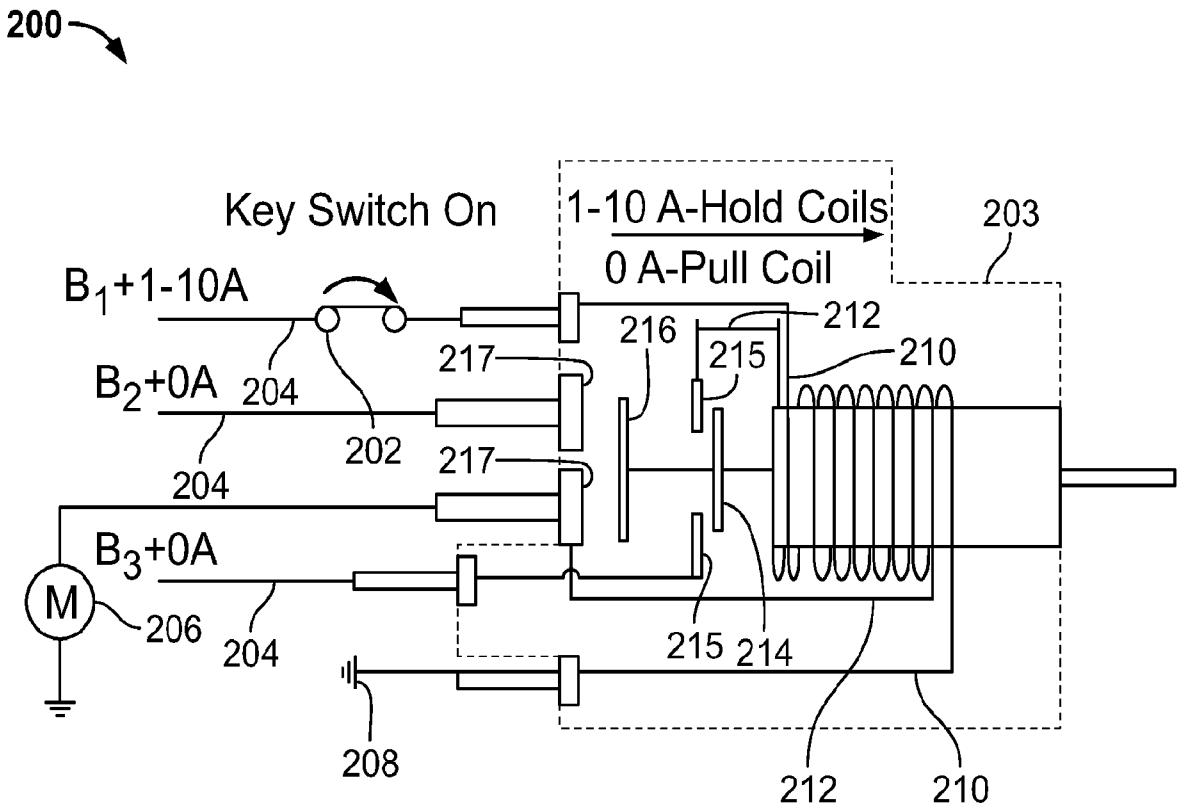
200
Key Switch On
1-10 A-Hold Coils
0 A-Pull Coil
203
B1+1-10A
B2+0A
204
204
202
B3+0A
M
206
204
208
216
215
212
210
217
217
215
214
212
210

FIG. 3

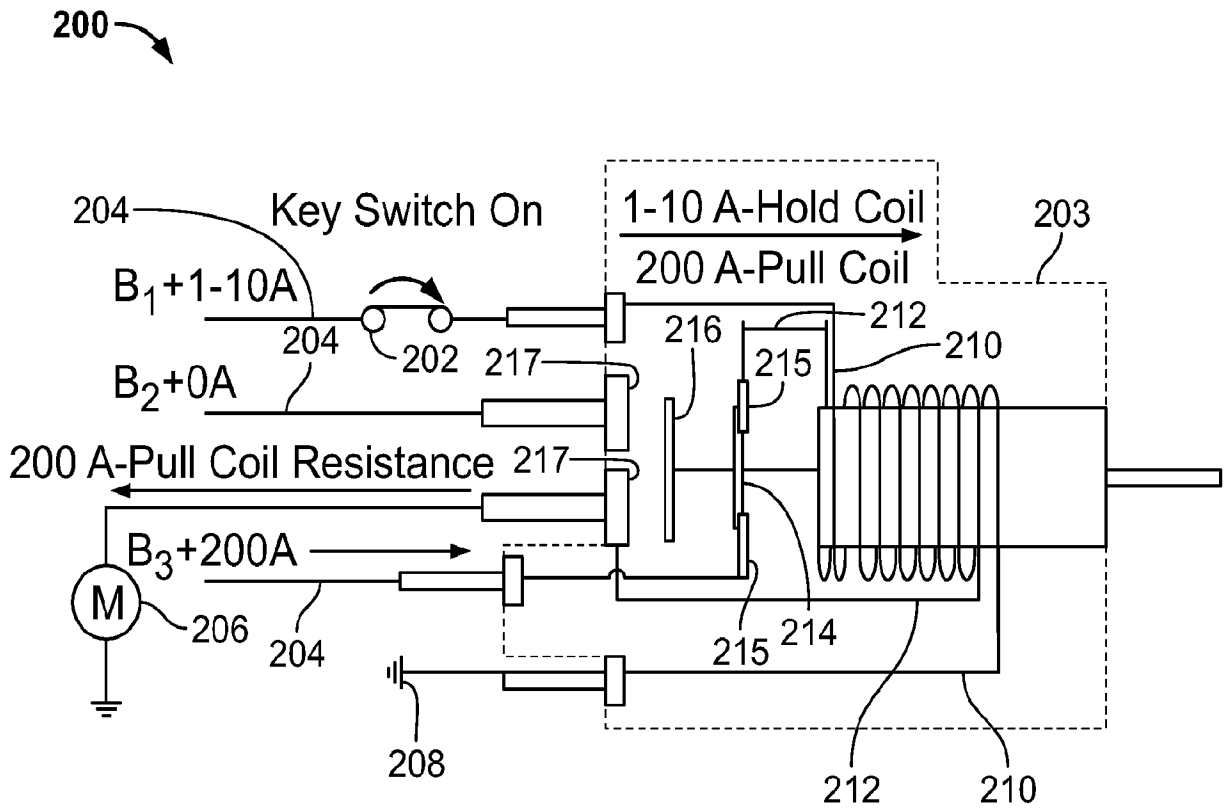
200
204
Key Switch On
1-10 A-Hold Coil
200 A-Pull Coil
203
B1+1-10A
204
202
216
212
210
217
215
B2+0A
200 A-Pull Coil Resistance
217
B3+200A
M
206
204
215
214
208
212
210

FIG. 4

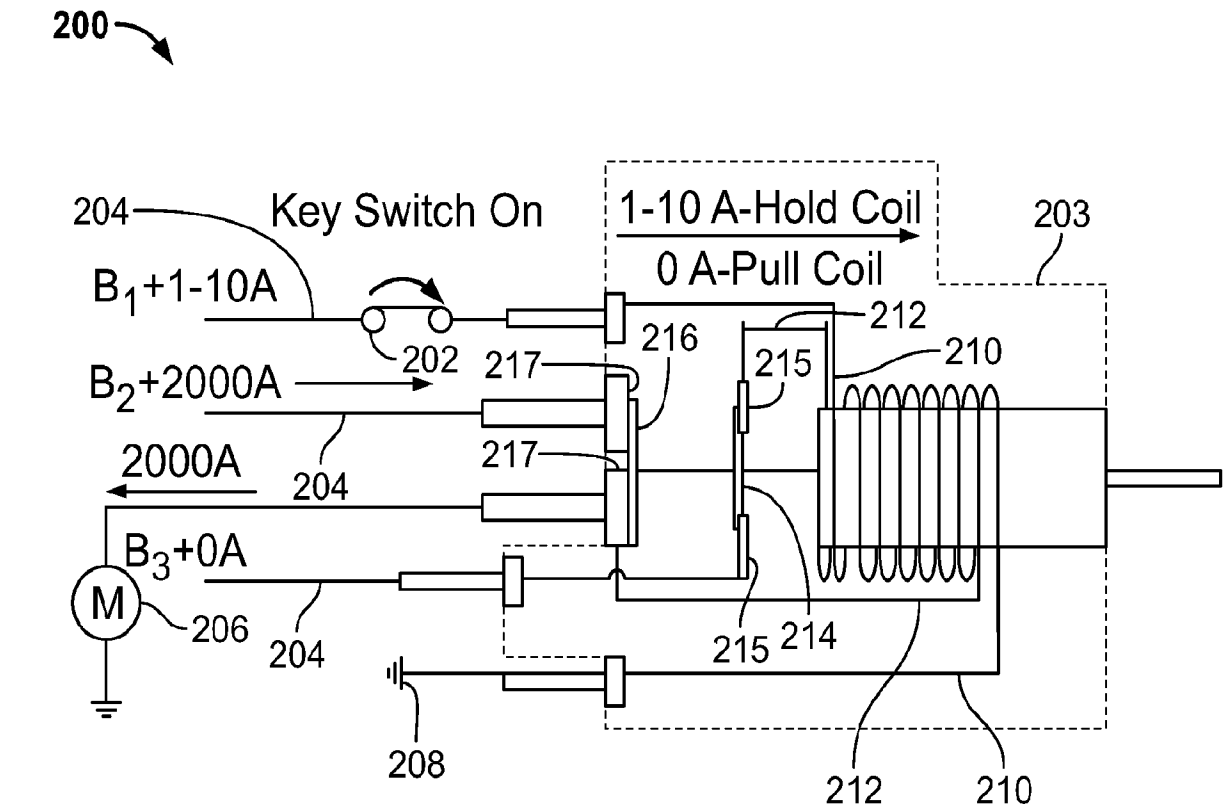
200
204
Key Switch On
1-10 A-Hold Coil
0 A-Pull Coil
203
B1+1-10A
202
216
212
210
217
215
B2+2000A
2000A
204
217
B3+0A
M
206
204
215
214
208
212
210

FIG. 5

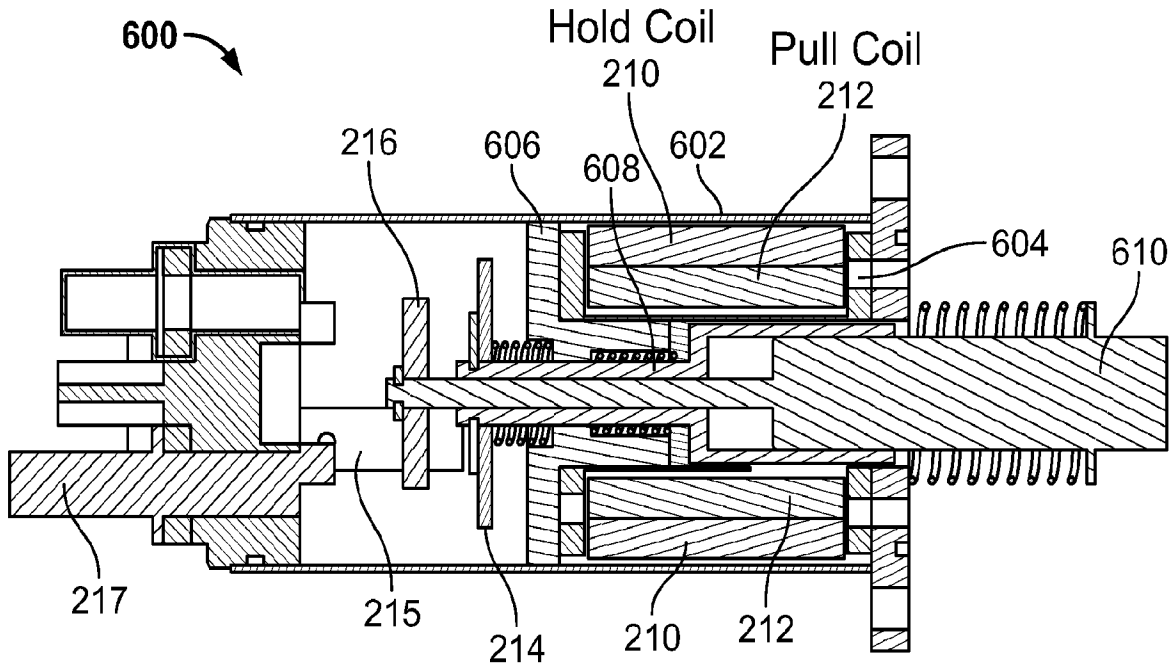
600
Hold Coil
210
Pull Coil
212
216
606
608
602
604
610
217
215
214
210
212

FIG. 6

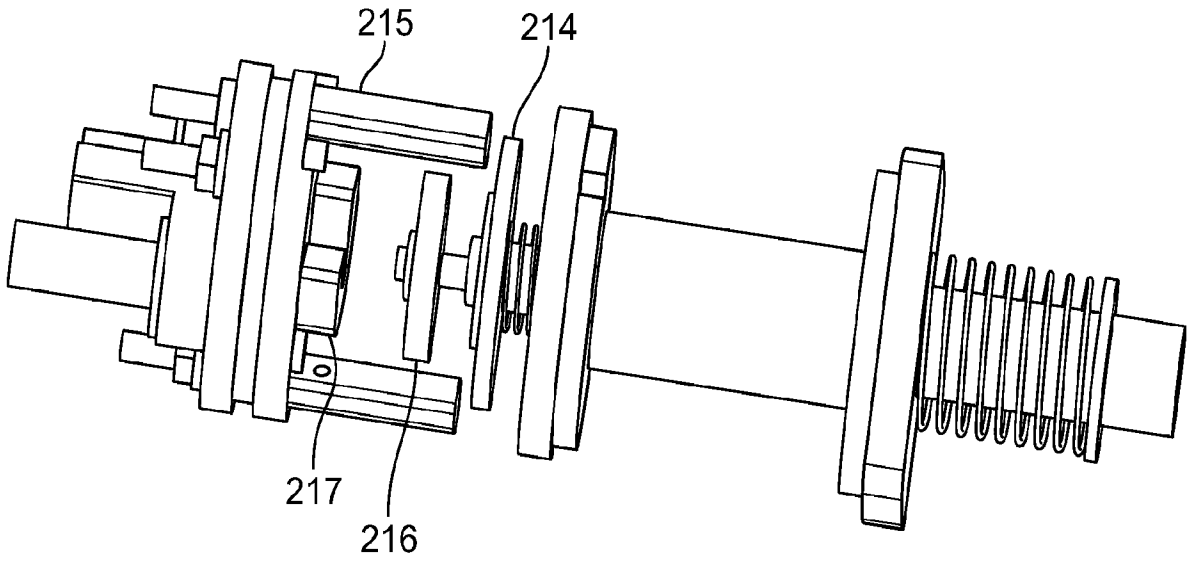
215
214
217
216

FIG. 7

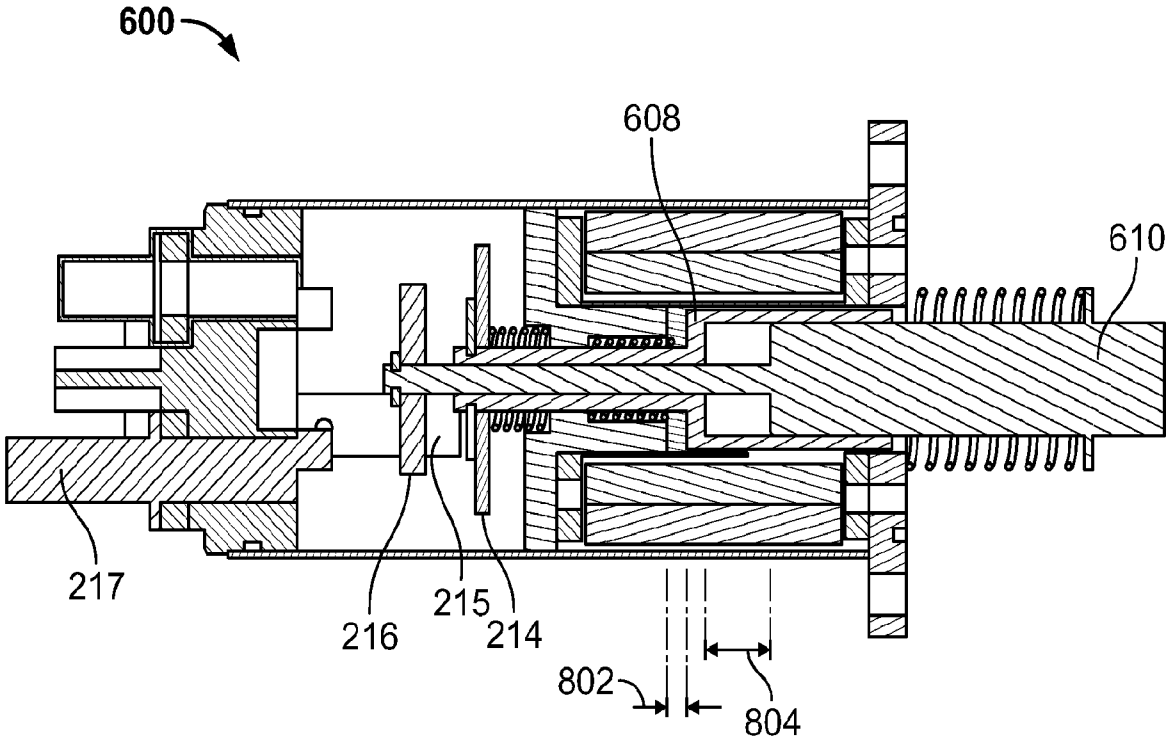
600
608
610
217
216
215
214
802
804

FIG. 8

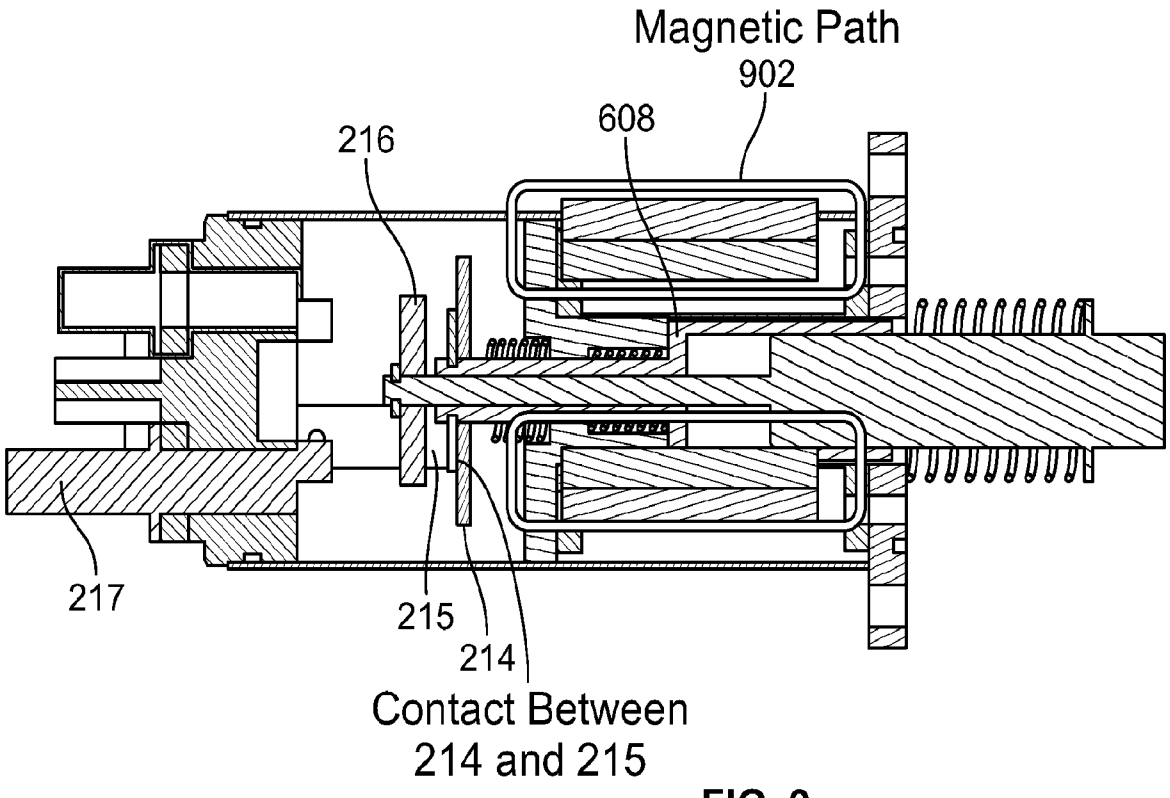
Magnetic Path
902
608
216
217
215
214
Contact Between
214 and 215

FIG. 9

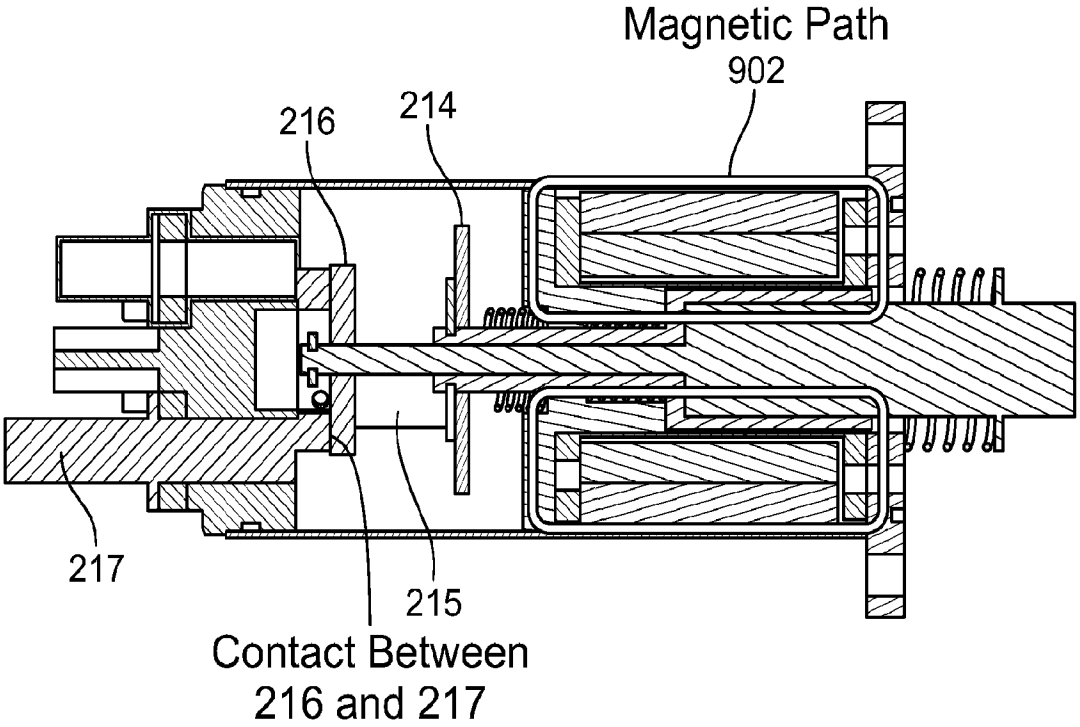
Magnetic Path
902
216
214
217
215
Contact Between
216 and 217

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/050312

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H01H 51/20 (2011.01)
USPC - 335/107
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)
IPC(8) - F02N 11/14; H01F 38/12; H01H 51/20, 67/00; H02P 1/00, 02, 16 (2011.01)
USPC - 318/778; 335/106, 107, 126

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)
PatBase, Google Patents, Google Scholar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009/0002105 A1 (BRADFIELD et al) 01 January 2009 (01.01.2009) entire document	1, 2
A	US 2002/0053961 A1 (KAJINO) 09 May 2002 (09.05.2002) entire document	1, 2
A	US 2002/0158519 A1 (FULTON et al) 31 October 2002 (31.10.2002) entire document	1, 2
A	US 2010/0033066 A1 (MURATA et al) 11 February 2010 (11.02.2010) entire document	1, 2
A	US 5,892,422 A (MONTAIGU et al) 06 April 1999 (06.04.1999) entire document	1, 2

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 December 2011	23 DEC 2011
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)