M.E.G.

(MOTIONLESS ELECTROMAGNETIC GENERATOR)

Contents

Background definitions :

The idle state is the state where the magnetic field of the permanent magnet is not interacting with the induction coil and therefore is not inducing any voltage.

The inducing state is the state where the magnetic field of the permanent magnet is interacting with the induction coil and therefore inducing a voltage that can be supplied toan electrical load.

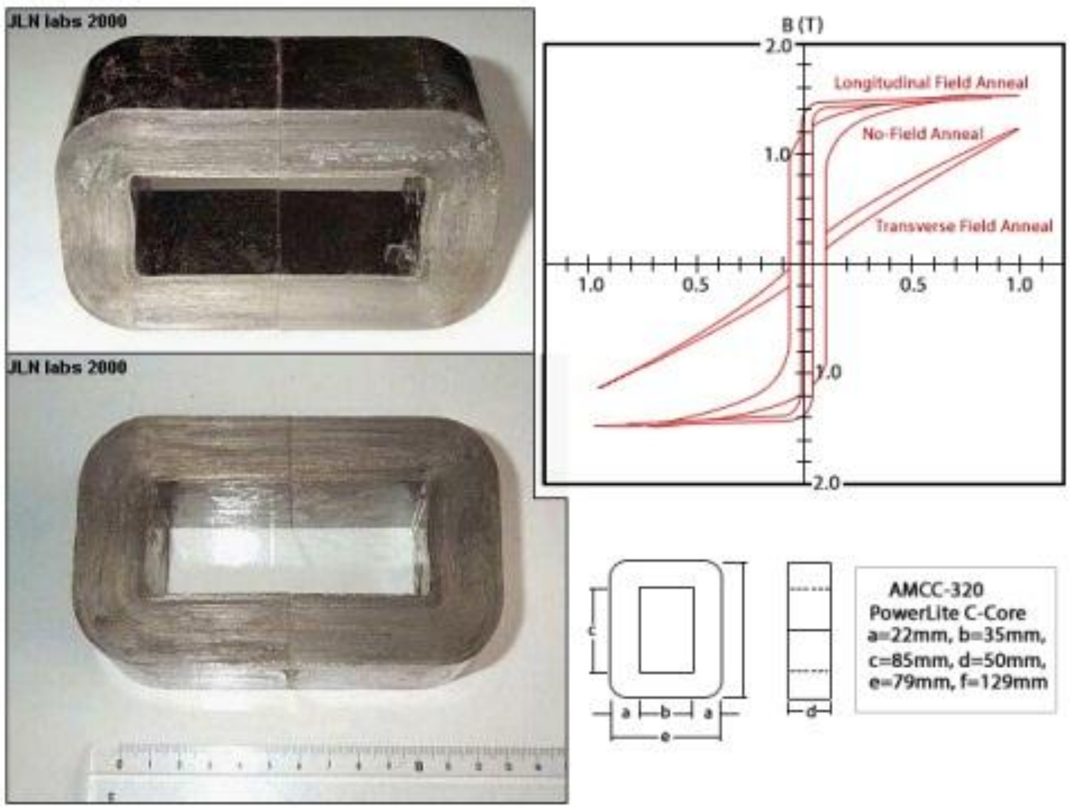
Summary :

The proposed magnetic device is a motionless electric generator capable of providing electrical power by converting the stored energy in the magnetic field of a permanent magnet into electrical energy without any applied input electrical power or energy. The waveform of the generated voltage can be periodic and of any shape such as sinusoidal, triangular, square, etc. The motionless electric generator comprises at least a permanent magnet, control coils, an induction coil, a ferromagnetic core providing a magnetic path between the induction coil and the permanent magnet, and a control circuit for driving the control coils. The motionless electric generator is capable of operating in two states – the idle state and the induction state. The inventive concept comprises the generation of alternating periodic voltages by changing the state of the generator. A half-cycle voltage is induced in the induction coil when the generator state changes from the idle state to the induction state and back to the idle state. The magnetic path of the magnetic field of the permanent magnet is controlled by energizing and de-energizing the control coils. Furthermore, when the control coils are energized and de-energized following a sinusoidal function, a sinusoidal voltage is induced in the induction coil.

Step 1 : Build the current transformer.

Hi, in this guide I will show you how to produce free electricity using a diy system wich you can build by yourself in less than 2 hours.

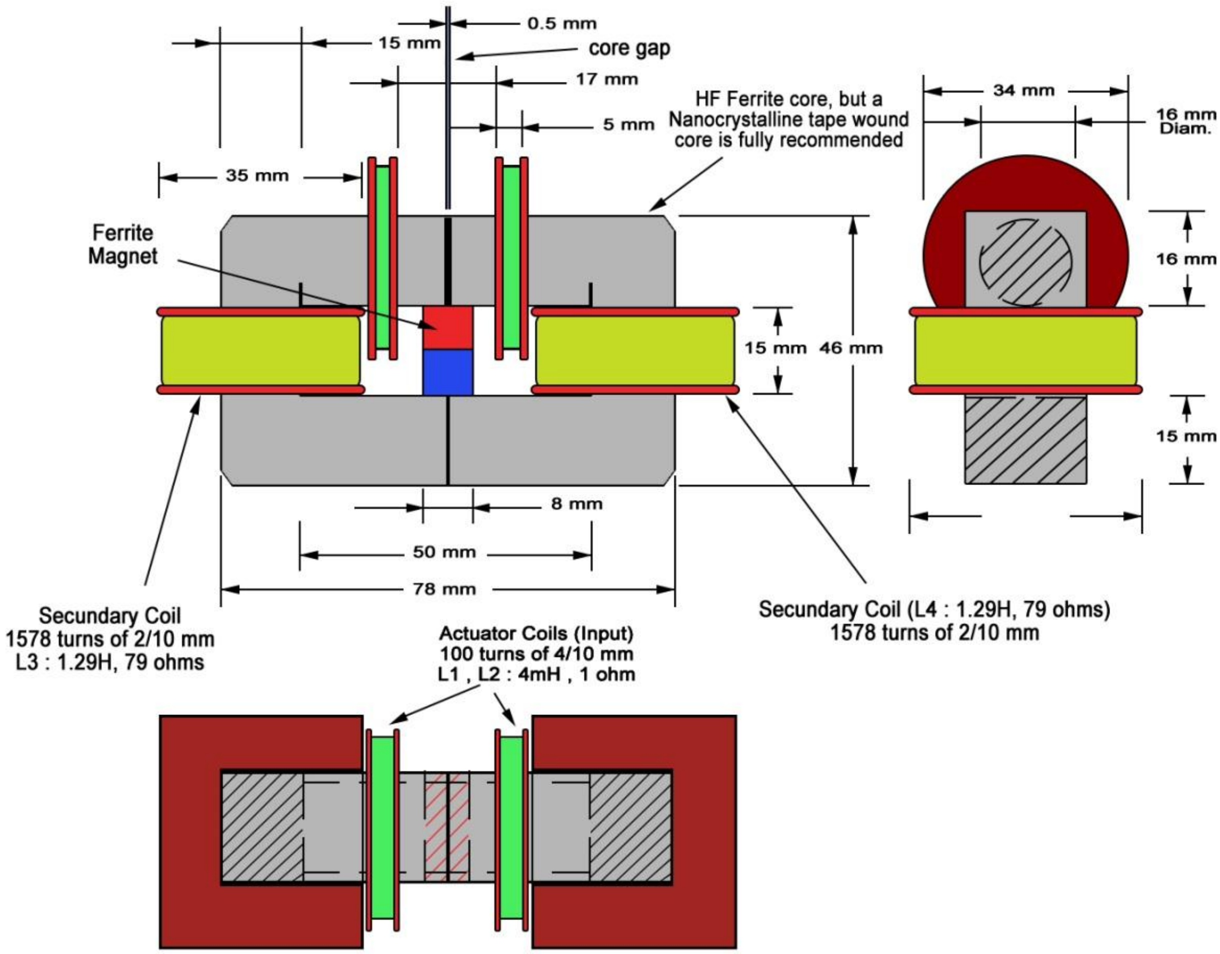
I am starting by building the current transformer.



The current transformer requires the following materials:

- Magnetic core with rectangular U-shape;
- enamelled copper wire to achieve 2 coils (L1 & L2) with a diameter of 0,5mm in total length of 60m, 110g weight apx;
- enamelled copper wire to achieve 2 coils (L3 & L4) with a diameter of 0,5mm in total length of 900m, 1,1kg weight apx;
- rectangular permanent magnet, dimensions 35 * 40 * 40;
- pressboard cardboard for the four coils.

Here is a short diagram which you can follow to build the current transformer.



There are going to be 4 cooper coils : 2 collector coils and 2 actuator (input) coils.

From the pressboard papel we cut 4 rectangular pieces, then cut the pieces in C-shapes so can be inserted on the magnetic core.

Measure and cut form a thin pressboard papel , 2 pressboard papel ribbons.

Insert the pressboard papel ribbon in the middle of the U-shape magnetic core, and then insert the the first pressboard papel C-shape.

The second one, use it to measure and cut a little piece of pressboard papel which will close the C-shape.

Use a strong glue to stick the little pressboard papel to the C-shaped pressboard papel to close it. Do the same with the second one.

Do the same with the other U-shaped magnetic core.

Drill a hole in the pressboard papel where it will exit one of the cooper thread end.

Position a plier on a vice, and then fix in place the U-shaped magnetic core because it is easier to rap the cooper thread. Make for about 1500 rounds then drill another hole in the pressboard papel where the other end of the cooper thread it will be exit.

Do the same with the second coil.

After you've finished the first 2 coils start making the other 2.

Use the same method as you used at the first 2. The only difference is that the pressboard papel will not be cut in C shape, the middle of the piece will be cut with an office knife, and I will have 500 rounds of cooper thread each. The distance between the pressboard papel is 5 mm.

After the current transformer is done, take the cooper thread end's from the actuator coil and connect it to a cable connector.

I am taking the cooper thread end's from the actuator coil and I am going to connect it to a cable connector.

Step 2 : Assemble the electronic control .

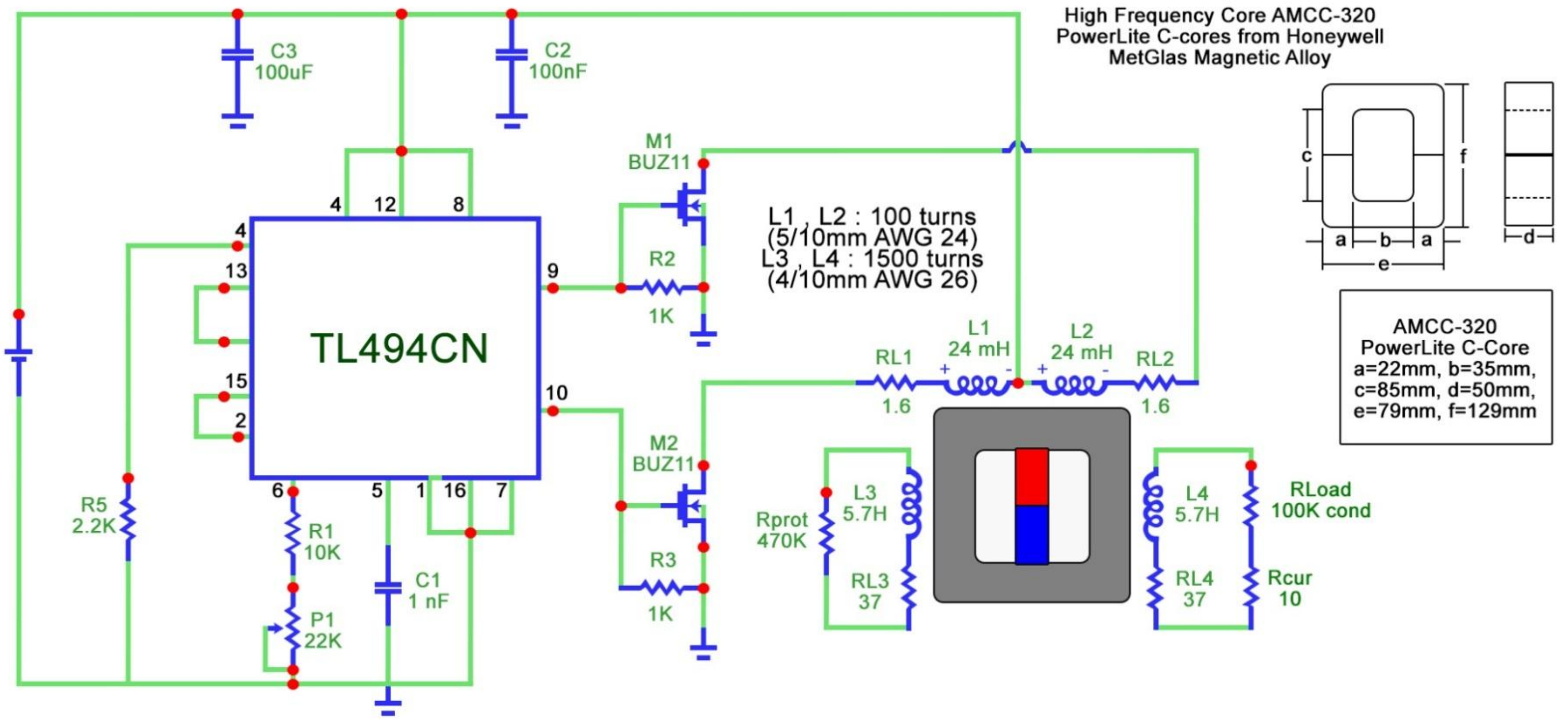
Start to assemble the electronic control.

The electronic components you will need are :

- circuit board with the size of 10*10cm;
- integrated circuit TL494CN;
- transistor BUZ11 – 2pcs;
- capacitors with the following values :
  - 100 uF/35 V – 1 pcs;
  - 100 Nf ceramic – 1 pcs;
  - 1 nF ceramic – 1 pcs.
- resistant with the following values:
  - 1 kohm/0.5 W – 2 pcs;
  - 2,2 kohm/0.5 W – 1pcs;
  - 10 kohm/0,5 W – 1pcs;
  - 100 kohm/3W – 2pcs.
- potentiometer 22 kohm.

The electronic installation on the circuit board is done according to the following diagram:

The installation is powered by a voltage of 25V DC, supplied by a stabilized power supply.



This is the diagram i have used to complete this project.

The control board for the M.E.G. device.

To establish the input power measure the voltage and the current supplied by the power suply:

- voltage VIN = 25 V;
- smoothly current intensity = 0.15 A,
- result Pin = Uin x smoothly = 3.75

Then measure the output voltage and current and calculate the output power.

Pout = Uout x lout.

Then calculate COP coefficient as the ratio between the power output and the input.

COP = Pout / Pin.

Add on the circuit board the integrated circuit, after that add the 2 transistors, then add the resistant’s, after this add the capacitors.

After these components are added to the circuit board, add a plug-in cable which will connect to the batteries.

Add two wires to make the connection with the potentiometer.

Another 2 wires added will make the connection with the switch.

Step 3 : Build the panel box.

Now start to build the panel box.

Mount the banana socket jack on the front of the panel.

Add 4 wires to the circuit board which will make the connection between the circuit board and the banana socket jack.

Add 2 wires to connect the led.

Mount the potentiometer, the led, and the switch.

Drill a hole in the box to hold in place the circuit board.

After the control box panel is finished, mount at the end of the plug-in cable connectors.

To make hole the current transformer add 4 or 2 rectangular magnets.

Cut a cable in 2 and mount the banana jack plug-in, then connect it to the wire connectors.

Connect the collector coils to a wire connector and add 2 resistant's.

Connect 2 scoter batteries in parallel.

Connect the banana jack plug-ins and switch-on. Then measure with an ammeter, then switch-off and measure again.

Step 4 : Put the system together.

Mount the current transformer and the box panel to a wooden board.

Drill 2 holes on 2 L-steel pieces and place them on the wooden board to be the support for the car outlet.

Cut the plug-in cable and make the connection to the car outlet adding 2 electric connectors.\add 2 electric connectors to 2 cables and connect it to the batteries. At the other end connect a car phone battery charger, which will plug-in the car outlet.

On another wooden board make holes at a distance of 5 cm and mount in place the socket bulbs, then connect the sockets in parallel.

Connect the bulbs to the electric connector, which are connected to the collector coils.

Now measure the amperage.

You can see that is working.

Drawings – Figures

FIG. 1 is a perspective view of a double induction coil - single magnet electric generator.

FIG. 2 is a top view of the generator shown in FIG. 1 during the idle state.

FIG. 3 is a top view of the generator shown in FIG. 1 during the positive induction state.

FIG. 4 is a top view of the generator shown in FIG. 1 during the negative induction state.

FIG. 5 is a perspective view of another embodiment of a double induction coil - single magnet electric generator.

FIG. 6 is a cross-sectional view of the generator shown in FIG. 5 with all coils deenergized.

FIG. 7 is a cross-sectional view of the generator shown in FIG. 5 during the idle state.

FIG. 8 is a cross-sectional view of the generator shown in FIG. 5 during the induction state.

FIG. 9 is a cross-sectional view of the generator shown in FIG. 5 with a split blocking coil.

FIG. 10 represents the positive half-cycle of an induced sinusoidal voltage.

FIG. 11 represents the negative half-cycle of an induced sinusoidal voltage.

FIG. 12 represents a complete cycle of an induced sinusoidal voltage.

FIG. 13 represents a 180º out-of-phase complete cycle of an induced sinusoidal voltage.

FIG. 14 represents an embodiment of the connection diagram of a double induction coil generator.

FIG. 15 represents another embodiment of the connection diagram of a double induction coil generator.

FIG. 16 is a perspective view of a single induction coil - double magnet electric generator.

FIG. 17 is a cross-sectional view of the generator shown in FIG. 16 during the idle state.

FIG. 18 is a cross-sectional view of the generator shown in FIG. 16 during the positive induction state.

FIG. 19 is a cross-sectional view of the generator shown in FIG. 16 during the negative induction state.

FIG. 20 is a perspective view of another embodiment of a single induction coil - double magnet electric generator.

FIG. 21 is a cross-sectional view of the generator shown in FIG. 20 during the idle state.

FIG. 22 is a cross-sectional view of the generator shown in FIG. 20 during the positive induction state.

FIG. 23 is a cross-sectional view of the generator shown in FIG. 20 during the negative induction state.

FIG. 24 is a perspective view of a single induction coil - single magnet electric generator.

FIG. 25 is a cross-sectional view of the generator shown in FIG. 24 as seen in front of the induction coil during the idle state.

FIG. 26 is a cross-sectional view of the generator shown in FIG. 25 along axis FIG. 26 – FIG. 26.

FIG. 27 is a cross-sectional view of the generator shown in FIG. 25 along axis FIG. 27 – FIG. 27.

FIG. 28 represents the same view as shown in FIG. 25 but during the positive induction state.

FIG. 29 represents the same view as shown in FIG. 25 but during the negative induction state.

FIG. 30 is a top view of a triple induction coil – double magnet – three phase electric generator during the idle state.

[FIG. 31 is a cross-sectional view of the generator shown in FIG. 30 along axis FIG. 31 – FIG. 31 during the idle state.

FIG. 32 is a cross-sectional view of the generator shown in FIG. 30 along axis FIG. 32 – FIG. 32 during the idle state.

FIG. 33 represents the same view as shown in FIG. 32 but during the positive induction state.

FIG. 34 represents the same view as shown in FIG. 32 but during the negative induction state.

FIG. 35 represents an embodiment of the generator shown in FIG. 34 provided with two shunt coils.

Drawings – Reference Numerals.

100 – double induction coil - single magnet electric generator

102 – magnetic field

104, 104a, 104b – induction coils

106 – ferromagnetic core

108, 108a, 108b – permanent magnets

110, 110a, 110b – shunting coils

112, 112a, 112b – blocking coils

114 – magnetic flow direction arrowhead

116 – control circuit

118a, 118b, 118c, 118d – insulated gate bipolar transistor (IGBT)

200 – double induction coil – single magnet electric generator

300 – single induction coil – double magnet electric generator

400 – single induction coil – double magnet electric generator (with two shunt coils)

500 – single induction coil – single magnet electric generator

600 – triple induction coil – double magnet electric generator

Detailed Description.

FIG. 1 represents a perspective view of an embodiment of a single phase double induction coil - single magnet electric generator 100. As shown on FIG. 1, the ferromagnetic core 106 of the generator 100 has three columns magnetically connected by a top and bottom ferromagnetic bases shaped in a star configuration. The permanent magnet 108 is in contact with the center of the ferromagnetic bases. As shown in FIG. 1, when all control coils are deenergized, the magnetic field of the permanent magnet 108 is distributed among the three ferromagnetic core columns 106. The ferromagnetic core 106 can be constructed of a laminated ferromagnetic material with high permeability factor such as silicon sheet steel. The laminated ferromagnetic core minimizes the Eddy current losses. Each control coil – the shunting coil 110 and the blocking coils 112a, 112b, is wound around one of the three ferromagnetic core 106 columns. The blocking coils 112a, 112b can be energized to create a counter magneto-motive force that substantially eliminate the magnetic field 102 of the permanent magnet 108 passing through the columns where the induction coils 104a, 104b are wound as shown in FIG 2, FIG. 3, and FIG. 4. Similarly, the shunting coil 110 can be energized to create a counter magneto-motive force that substantially eliminate the magnetic field 102 of the permanent magnet 108 passing through its corresponding ferromagnetic column as shown in FIG. 3 and FIG. 4. Each control coil 104a, 104b, 110, 112a, and 112b can be a magnet wire type made of copper.

When the control coils 110, 112a, 112b are energized, their magnetic fields create the effect of lowering the permeability of the ferromagnetic core columns 106. This apparent decrease in permeability increases the reluctance of the ferromagnetic core 106, and therefore, forces the magnetic field 102 from the permanent magnet 108 to move to a core path with lower reluctance.

The dynamic of changing the magnetic field 102 paths by using low power control coils – shunting coil 110 and blocking coils 112a, 112b is optimized to obtain the maximum efficiency. The efficiency can be defined as the ratio of the power supplied by the induction coil to a load by the total power consumed by the control coils. The total power of the control coils is equal to $Vdc_{110} x\ Idc_{110} + Vdc_{112a} x\ Idc_{112a} + Vdc_{112b} x\ Idc_{112b}$. The power required by the shunting and blocking coils to control the path of the magnetic field 102 of the permanent magnet 108 and therefore to change the state of the generator is governed by the ampere-turn relationship known as the magneto-motive force (mmf). The mmf of a coil required to created a given magnetic field can be designed with different levels of currents and turns, and therefore, different levels of power. The heat loses can be minimized by minimizing the Joules effect (R x I) due to the resistance of the shunting and blocking coils.

The operation of the generator 100 comprises an idle state and two induction states. As shown in FIG. 2, during the idle state, the two blocking coils 112a, 112b are energized and the shunting coil 110 is de-energized. That is, the magnetic field 102 in the ferromagnetic core columns 106 supporting the induction coils 104a, 104b is negligible or zero. During the idle state, all magnetic flux of the magnetic field 102 coming out of the permanent magnet 108 is located in the ferromagnetic core column 106 supporting the shunting coil 110. During the induction state, there is a transfer of the magnetic field 102 between the ferromagnetic core column 106 supporting the shunting coil 110 and one of the ferromagnetic core column 106 supporting the induction coils 112a, 112b.

The induction states are created by energizing the shunting coil 110 while deenergizing one of the blocking coils 112a, 112b. If sinusoidal currents drive the shunting coil 110 and the blocking coils 112a, 112b, the generated magnetic fields are also of sinusoidal forms. Then, the magnetic field transferred between the idle and induction states is also sinusoidal. As a result, the induced voltages in the induction coils 104a, 104b are in term sinusoidal. FIG. 10 and FIG. 11 can represent the voltages generated during the positive and negative inducing states respectively. The 180º phase difference between the waveforms of FIG. 10 and FIG. 11 is obtained by winding the induction coil 104a clockwise and coil 104b counterclockwise to provide each induction coil with the correct voltage polarity. The voltage waveforms of FIG. 10 and FIG. 11 can be combined to form a complete sinusoidal waveform as shown in FIG. 12. The circuit of FIG. 14 can be used to superimpose the positive and negative induced voltages of FIG. 10 and FIG. 11, respectively. The control circuit 116 operates the transistors 118a, 118b, 118c, 118d that work in a push-pull configuration; only a transistor is on at one time. The control circuit 116 is provided with a feedback (not shown) to know the state of the control coils - shunting coil 110 and blocking coils 112a, 112b. The plus sign represents the instantaneous positive polarity of the voltage induced at each coil 104a, 104b. When the two induction coils 104a, 104b are connected as indicated on FIG. 14, the load can be supplied with a complete sinusoidal voltage as shown on FIG. 12.

FIG. 3 and FIG. 4 show the generator 100 under the positive and negative induction states, and they represent the induction states at their maximum where all the magnetic field 102 is linked with the induction coils 104a, 104b.

The induced voltage (~Vac) at each induction coil 104a, 104b is a function of the control currents circulating through the control coils - shunting 110 and blocking 112a, 112b coils. If the currents passing through the control coils 110, 112a, 112b are increased and decreased following a sinusoidal function, the magnetic flux changes following a sinusoidal waveform. Because the electric generator 100 can only be in one induction state at a time, a mathematical relationship for the flux created by the shunting coil 110 and the blocking coils can be written $\frac{d\varphi 110}{dt} + \frac{d\varphi 112\text{a,b}}{dt} = 0$ (1). In other words, an increase (or decrease) of the magnetic flux in the ferromagnetic shunting column shall equal the decrease (or increase) of the magnetic flux in the corresponding ferromagnetic induction column. Equation 1 is derived from the conservation of total magnetic flux provided by the permanent magnet 108.

Each of the voltage waveforms shown in FIG. 10 and FIG. 11 is obtained by moving the magnetic field 102 of the permanent magnet 108 from the idle state shown in FIG. 2 to the induction states shown in FIG. 3 and FIG. 4 and back to the idle state of FIG. 2.

FIG. 5 represents another embodiment of a single phase, double induction coil – single magnet electric generator 200. The generator 200 is provided with two control coils – the shunting coil 110 and the blocking coil 112. The induction coils 104a, 104b share the same magnetic field 102 because they are wound around the same ferromagnetic core column 106.

FIG. 6 shows the magnetic field 102 distributions of the permanent magnet 108 when all control coils are de-energized. Due to magnetic symmetry, the magnetic field 102 is divided into two paths – the ferromagnetic core column of the shunting coil 110 and the ferromagnetic core column of the blocking coil 112.

FIG. 7 shows the generator 200 in the idle state. During the idle state, the magnetic field 102 passing through the ferromagnetic core column 106 of the induction coils 104a, 104b is substantially zero. The idle state is obtained by energizing the blocking coil 112 and de-energizing the shunting coil 110.

FIG. 8 shows the generator 200 during the induction state. As the generator 200 changes from the idle state of FIG. 7 to the induction state to FIG. 8 and back to the idle state of FIG. 7, a voltage is induced at the induction coils 104a, 104b. If the blocking coil 112 is driven by sinusoidal voltage and current, a sinusoidal voltage can be induced at each induction coil 104a, 104b. The waveforms induced at each induction coil 104a, 104b are similar to the half-cycle voltages shown in FIG. 10 and FIG. 11, respectively. The induction coils 104a, 104b of generator 200 can be wound counterclockwise to induce voltages of opposite polarities - 180º out of phase.

Because a voltage is induced at each induction coil 104a, 104b simultaneously, the generator 200 is capable of feeding two independent loads at the same time. FIG. 15 represents a typical connection diagram that can provide power to two loads simultaneously. The operation of the control circuit 116 is such that only two transistors are on at one time. For instance, in order to generate the voltages ~Vac1 and ~Vac2, the sequence of operation can be made to alternately turn on transistors 118a, 118d and then to turn on transistors 118b, 118c. The voltage waveform of ~Vac1 can be similar to the voltage shown in FIG. 12, and the voltage waveform of ~Vac2 can be represented by the voltage shown in FIG. 13.

Even though FIG.14 and FIG. 15 show embodiments with Isolated Gate Bipolar Transistors (IGBT), other electronic switching devices can also be used such as thyristors, Mosfets, Fets, etc.

As the generator 200 changes states, a changing magnetic field 102 passes through the blocking coil 112 inducing a voltage in the blocking coil that interfere with the control voltage driven the blocking coil 112. FIG. 9 represents an embodiment for minimizing this effect. The blocking coil 112 is split in two parts, a half is located at the ferromagnetic core column 106 where the shunting coil 110 is wound and the other half is located at the ferromagnetic core column 106 where the induction coils 104a, 104b are wound. As the magnetic field 102 of the permanent magnet 108 increases in one column and decreases at the other column, and vice versa, a voltage of equal magnitude and opposite polarities is induced at each half of the blocking coil 112 and substantially cancelling each other out. The split control coil technique can be used with any control coil and any embodiment of the electric generator presented in this document.

FIG. 16 shows a single phase, single induction coil – double magnet electric generator 300. The control coils consist of two shunting coils 110a, 110b. The idle state for generator 300 is shown on FIG. 17. Under the idle state both shunting coils 110a, 110b are de-energized and no magnetic field 102 crosses through the induction coil 104.

FIG. 18 shows the positive induction state in which the shunting coil 110a is energized and 110b is de-energized. As the magnetic field 102 through the induction coil 104 increases, reaches a maximum, and decreases to zero, a voltage of the form shown in FIG. 10 is induced in the induction coil 104. FIG. 19 shows the negative induction state in which the shunting coil 110b is energized and 110a is de-energized. As the magnetic field 102 through the induction coil 104 increases, reaches a maximum, and decreases to zero, a voltage of the form shown in FIG. 11 is induced in the induction coil 104.

The ferromagnetic core 106 of generator 300 is designed to provide a magnetic path for the idle state of each permanent magnet 108a, 108b. When the generator 300 is in one of the induction states as shown on FIG. 18 and FIG. 19, the center columns carry the magnetic field of both permanent magnets 108a, 108b. As a consequence, these center columns can be provided with a larger cross-sectional area in order to accommodate the increased magnetic field.

FIG. 20 is another embodiment of a single phase, single induction coil – double magnet generator 400. Generator 400 is similar to generator 300 but with the magnets 108a, 108b closer to the induction coil 104. The control coils consist of four coils – two blocking coils 112a, 112b and two shunting coils 110a, 110b. Generator 400 also exhibits two idle state paths as shown in FIG. 21. The idle state is obtained by de-energizing the shunting coils 110a, 110b and energizing the blocking coils 112a, 112b. The two permanent magnets 108a, 108b are oriented to induce voltages in the induction coil 104 of opposite polarities as shown in FIG. 22 and FIG. 23. The induction states shown in FIG. 22 and FIG. 23 generate voltages as shown in FIG. 10 and FIG. 11, respectively. The positive induction state of FIG. 22 is obtained by energizing the shunting coil 110a and the blocking coil 112b. While, the negative induction state of FIG. 23 is obtained by energizing the shunting coil 110b and the blocking coil 112a.

FIG. 24 is a perspective view of a single phase electric generator 500 consisting of a single induction coil 104 and a single permanent magnet 108. The ferromagnetic core 106 is configured to allow the magnetic field 102 from the permanent magnet 108 to enter the induction coil 104 from two different directions, and therefore, inducing voltages of opposite polarities. FIG. 25 corresponds to the idle state of generator 500 and it is obtained when all control coils – the blocking coils 112a, 112b are de-energized.

FIG. 28 shows the generator 500 during the positive induction state. This state is obtained by energizing the blocking coil 112b and de-energizing 112a. The voltage induced in the inducing coil 104 has a polarity (not shown) corresponding to the magnetic path where the north pole of the permanent magnet 108 is magnetically connected with the left side of the induction coil 104. As the magnetic field increases, reaches a maximum, and decreases to zero a sinusoidal voltage is induced similar to the voltage waveform as shown in FIG. 10. On the other hand, FIG. 29 shows the generator 500 during the negative induction state. This state is obtained by energizing the blocking coil 112a and de-energizing 112b. The voltage induced in the induction coil 104 has a polarity (not shown) corresponding to the magnetic path where the north pole of the permanent magnet 108 is magnetically connected with the right side of the induction coil 104. The voltage induced during this state is shown in FIG. 11. As before, the generation of alternating voltages requires the device 500 to have an idle state shown in FIG. 25 which forces the magnetic field 102 to move out of the induction coil 104 and allow the induced voltage to go to zero.

The voltage generated by the electric generators 100, 200, 300, and 400 is single phase. A three phase electrical generator can be constructed by using a single phase generator 100, 200, 300, 400 per phase A, B, and C. The construction of a three phase generator is similar to the construction of a three phase transformer bank using three single phase transformers. A condition for this three phase configuration is that the controlled signals applied to each electric generator 100, 200, 300, 400 shall generate an induced voltage with a 120º phase shift.

FIG. 30 represents a three-phase, triple induction coil – double magnet electric generator 600. The ferromagnetic core 106 is designed to allow the magnetic field 102 of each magnet 108a, 108b to reach each induction coil 104a, 104b, 104c. The two permanent magnets 108a, 108b are oriented with opposite polarities to generate the positive and negative induced voltages. The control coils consist of six blocking coils 112a-A, 112a-B, 112a-C, 112b-A, 112b-B, 112b-C.

FIG. 30, FIG. 31, and FIG. 32 show the generator 600 in the idle state. The idle states for phases C and B are shown in FIG. 31 and FIG. 32 respectively. FIG. 33 and FIG. 34 show the positive and negative induction states of phase B, which is also typical of phases A and C. The voltages and currents driving the blocking coils for phases A, B, C shall be 120º out of phase in order to induce voltages in the induction coils 104a, 104b, 104c with 120º phase difference.

FIG. 35 is another embodiment of the generator 600 with two shunting core columns and coils 110a, 110b. FIG. 35 shows the condition during the idle state obtained by energizing the blocking coils 112a-A, 112a-B, 112a-C, 112b-A, 112b-B, 112b-C and deenergizing the shunting coils 110a, 110b.

Drawings :

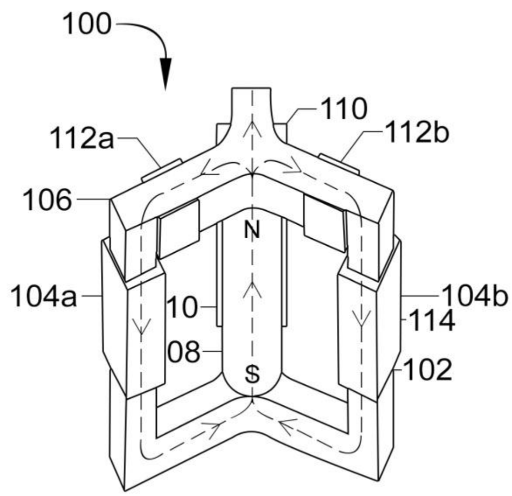


FIG. 1

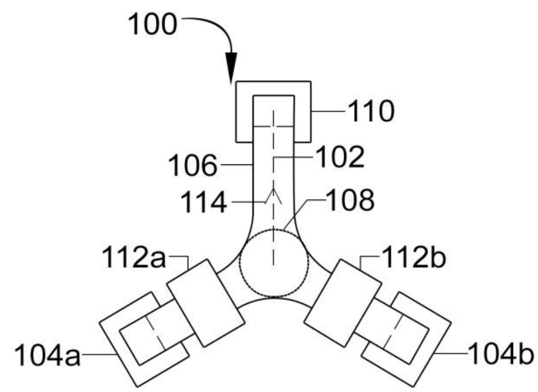


FIG. 2

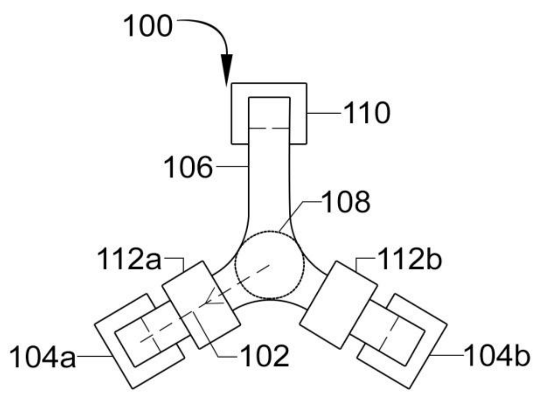


FIG. 3

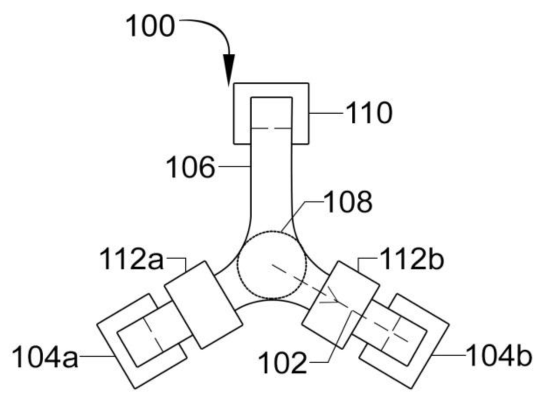


FIG. 4

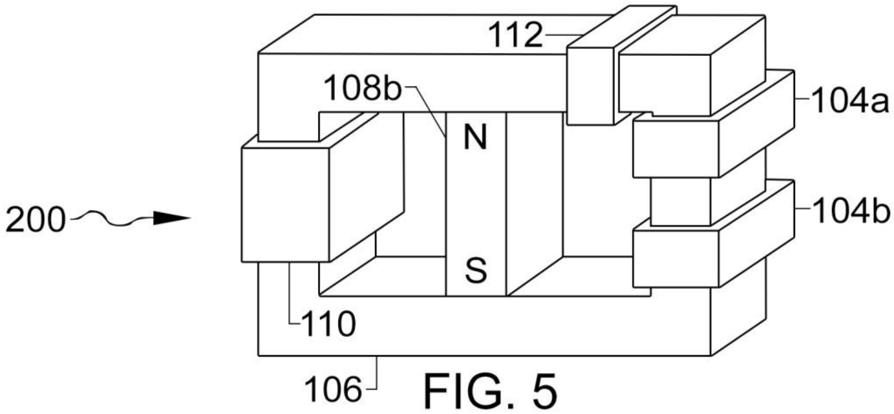


FIG. 5

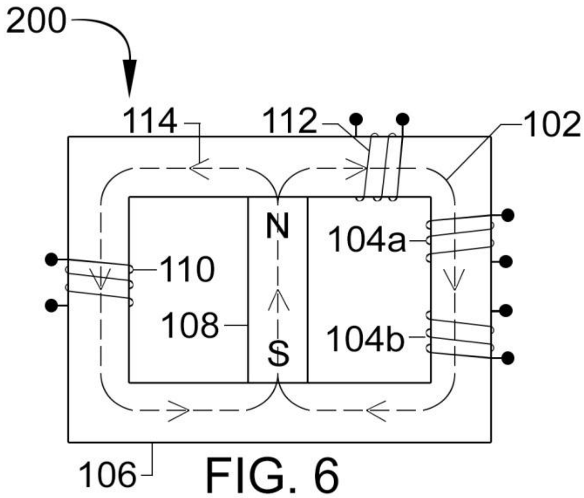


FIG. 6

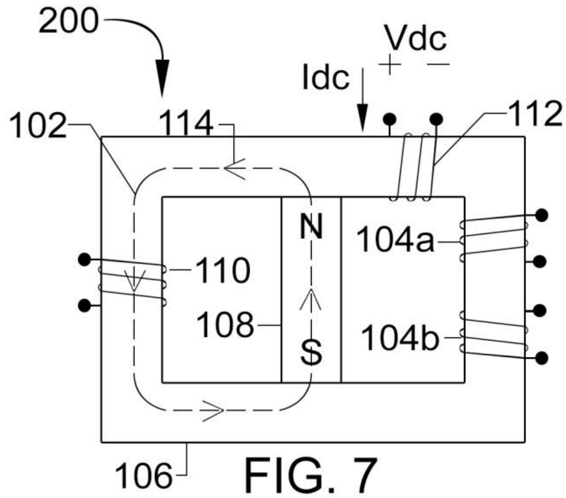


FIG. 7

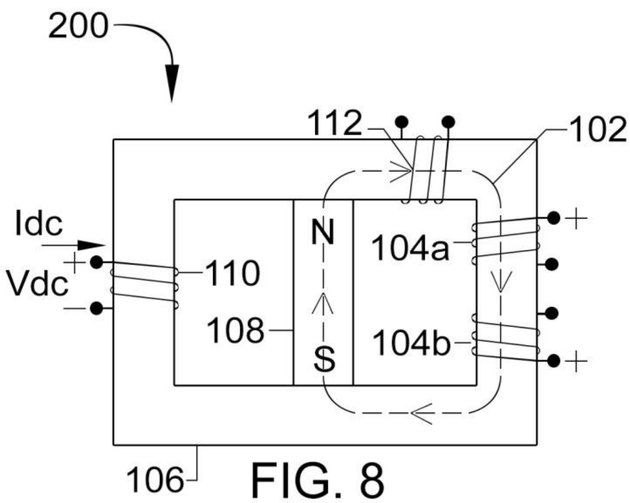


FIG. 8

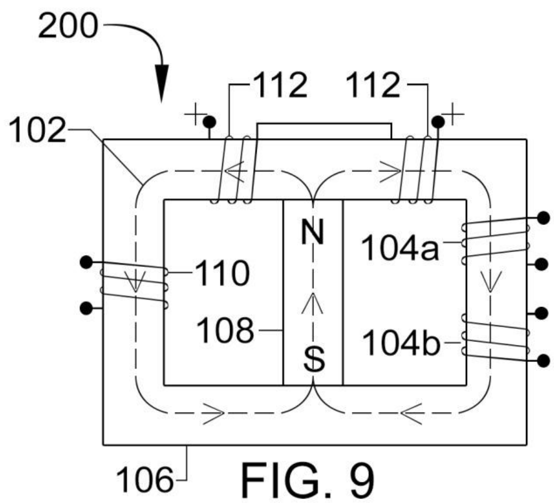


FIG. 9

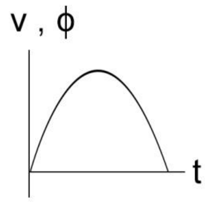


FIG. 10

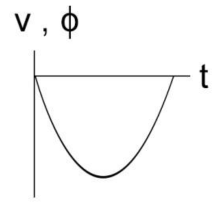


FIG. 11

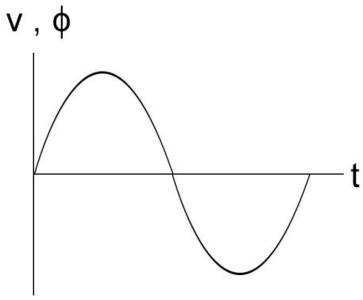


FIG. 12

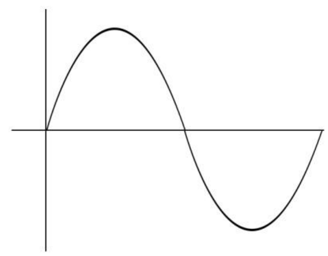


FIG. 13

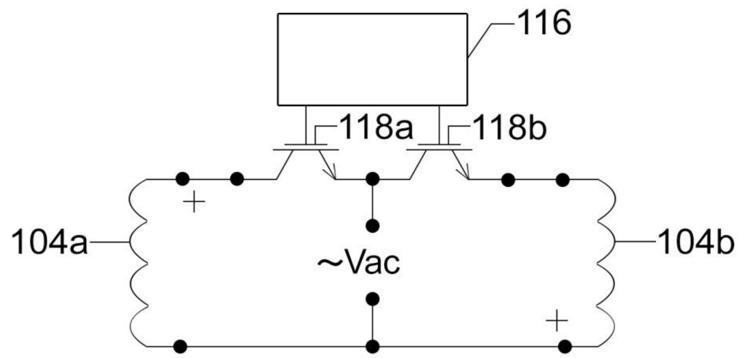


FIG. 14

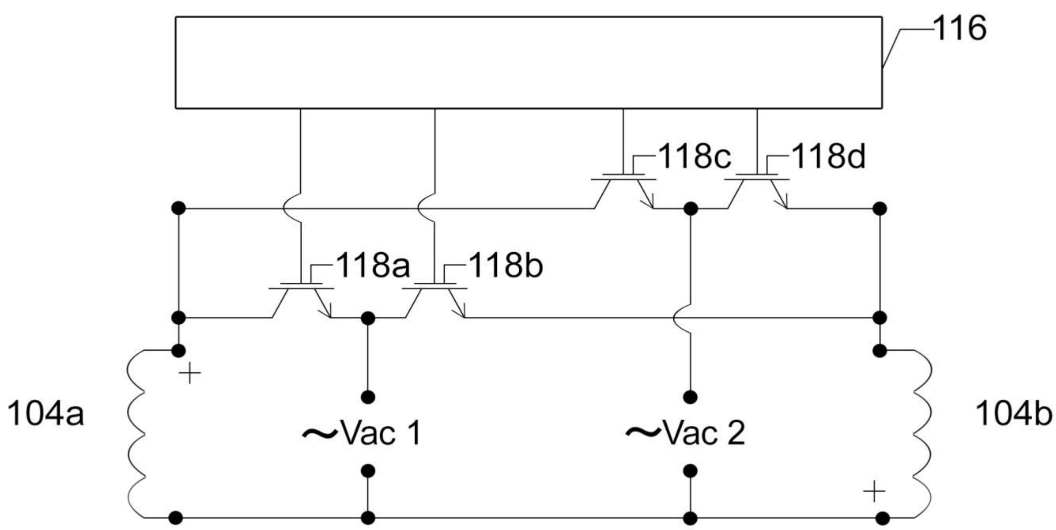


FIG. 15

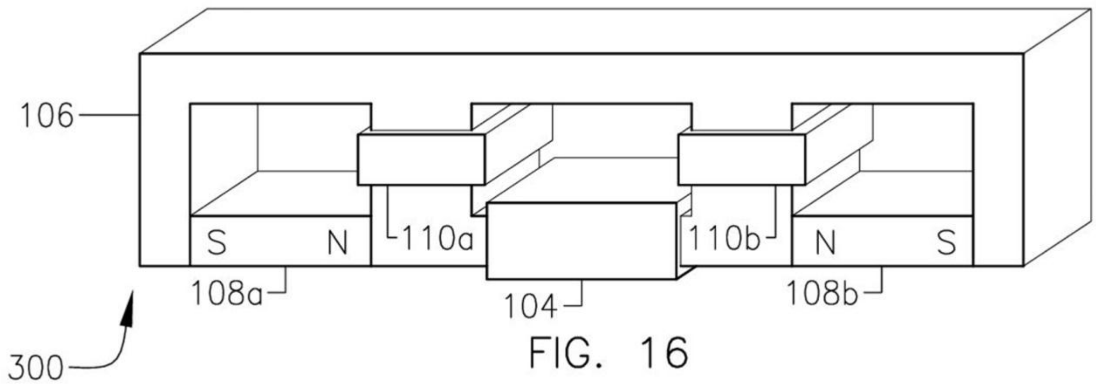


FIG. 16

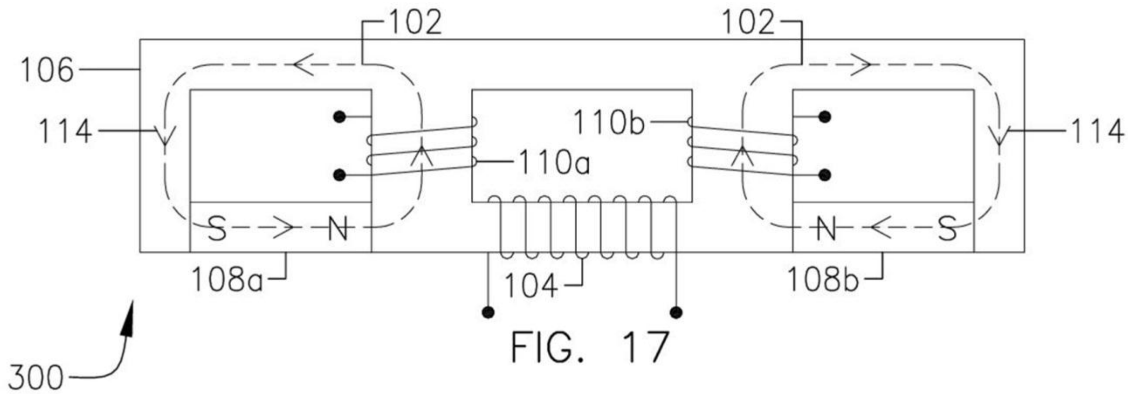


FIG. 17

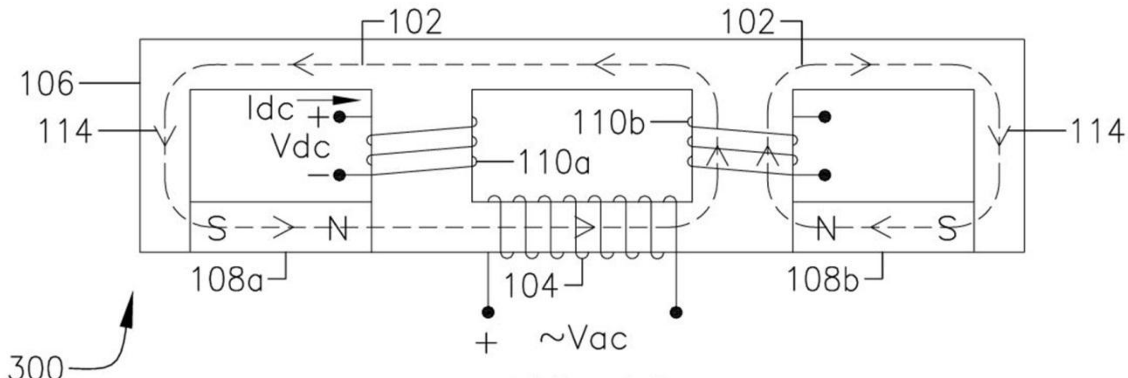


FIG. 18

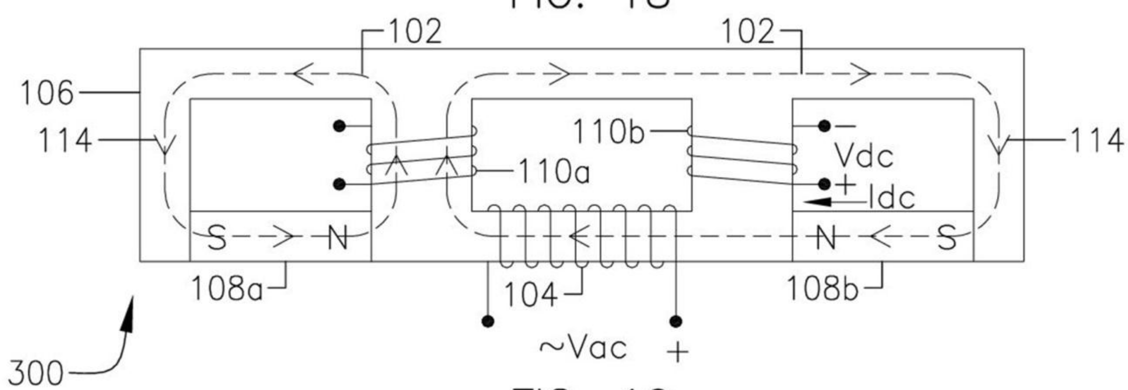


FIG. 19

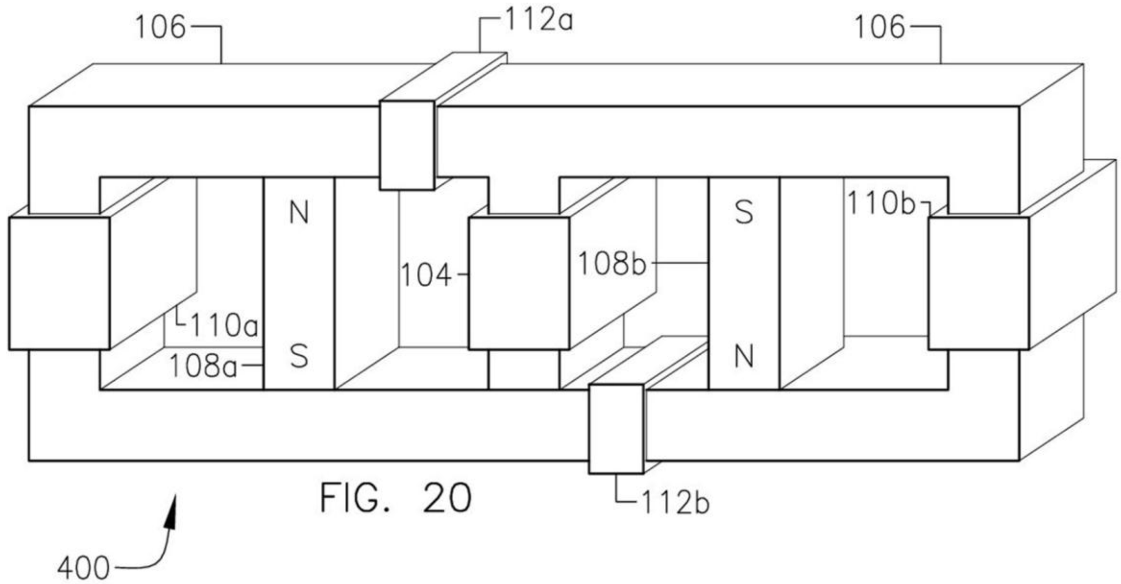

106
112a
106
N
S
110b
104
108b
110a
S
N
108a
112b
400

FIG. 20

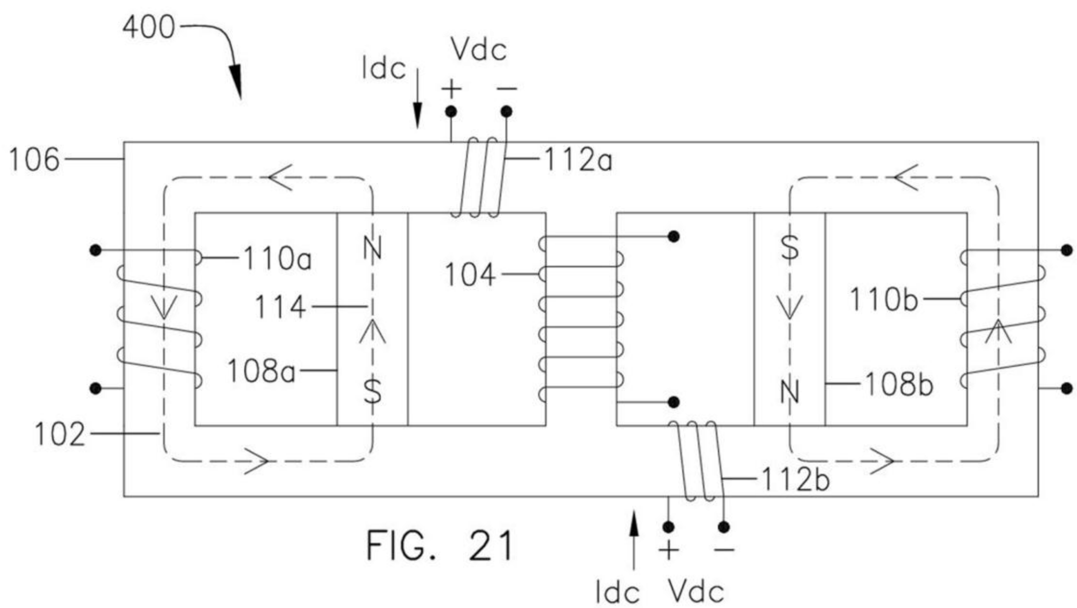

400
Idc
Vdc
+
−
106
112a
110a
N
104
S
114
110b
108a
S
N
108b
102
112b
+
−
Idc
Vdc

FIG. 21

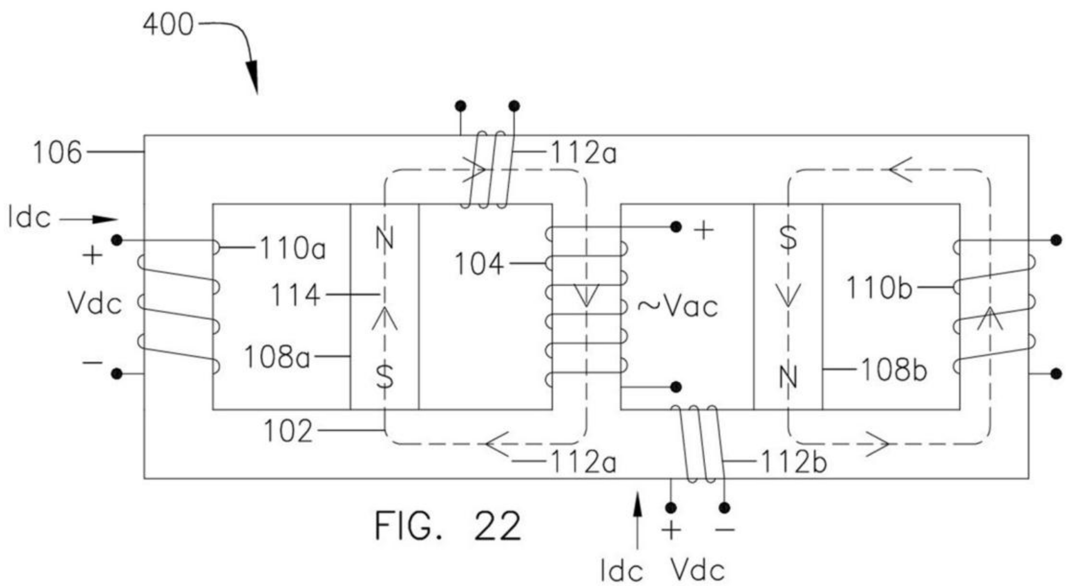

400
106
112a
Idc
+
Vdc
−
110a
114
108a
102
N
S
104
~Vac
+
S
N
110b
108b
112b
Idc
+
−
Vdc

FIG. 22

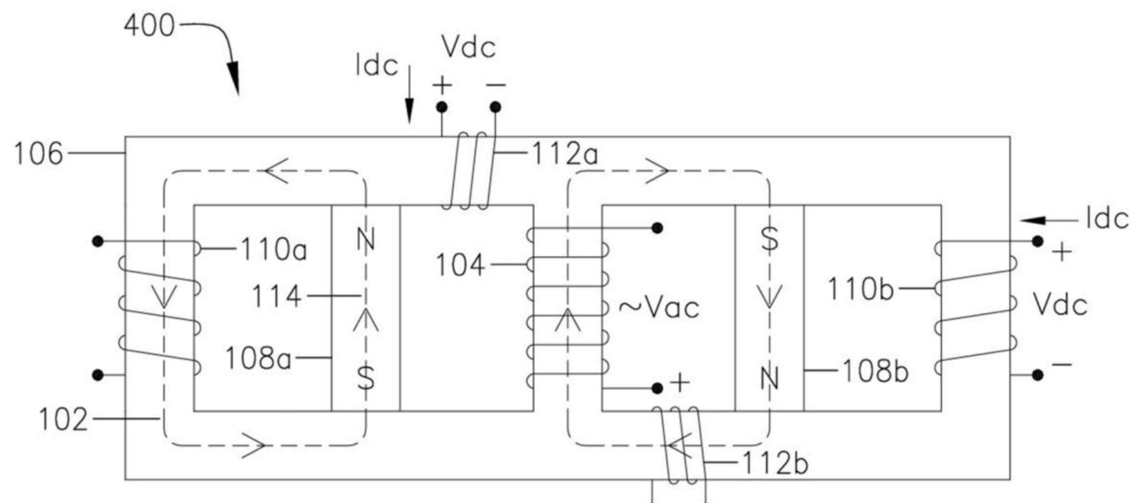

400
Idc
Vdc
+
−
106
112a
110a
114
108a
102
N
S
104
~Vac
+
S
N
110b
108b
Idc
+
Vdc
−
112b

FIG. 23

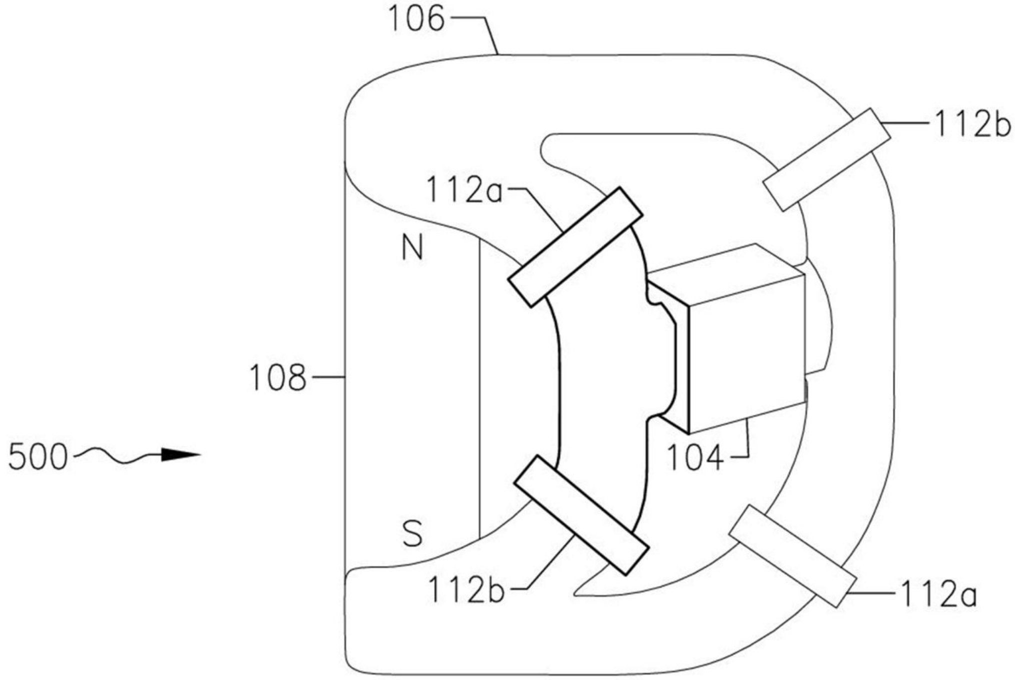

106
112b
112a
N
108
500
104
S
112b
112a

FIG. 24

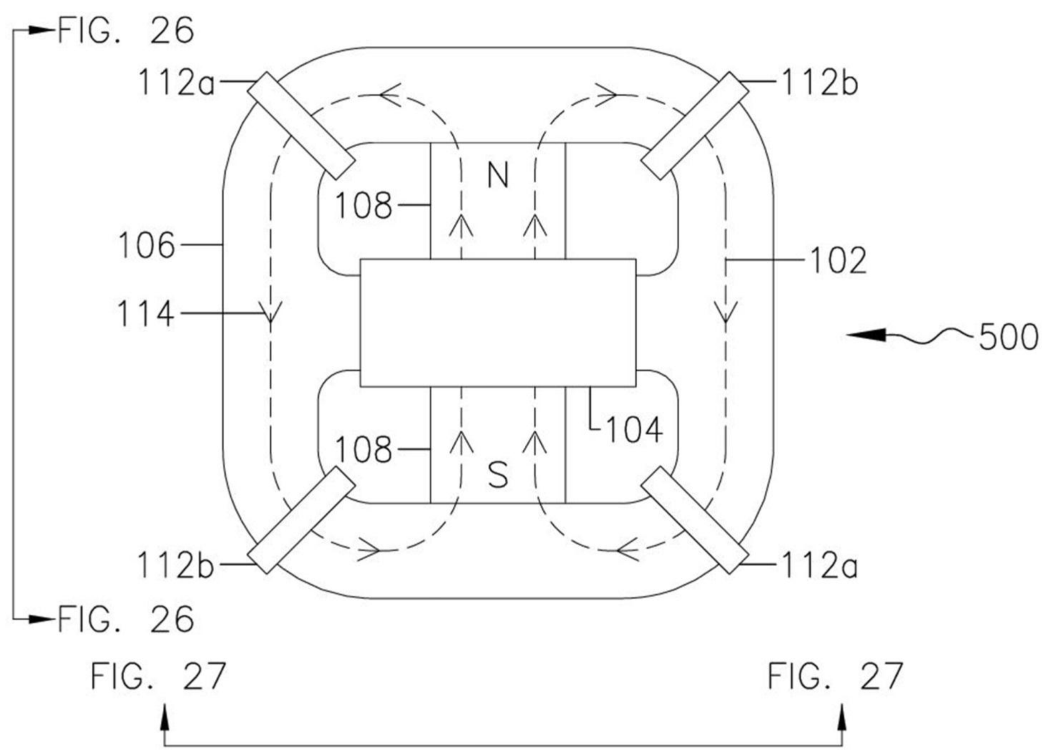


FIG. 26
112a
112b
N
108
106
102
114
500
104
108
S
112b
112a
FIG. 26
FIG. 27
FIG. 27

FIG. 25

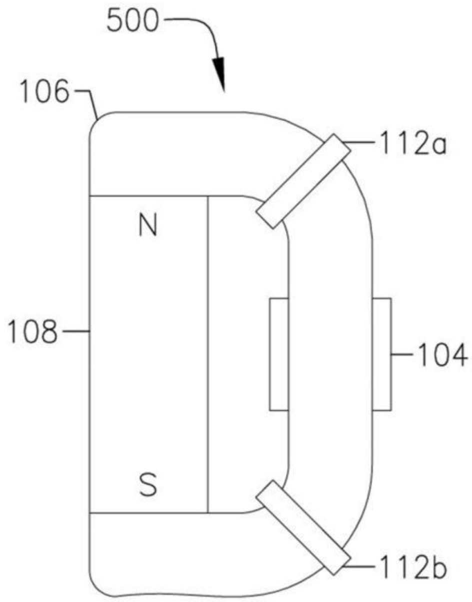


FIG. 26

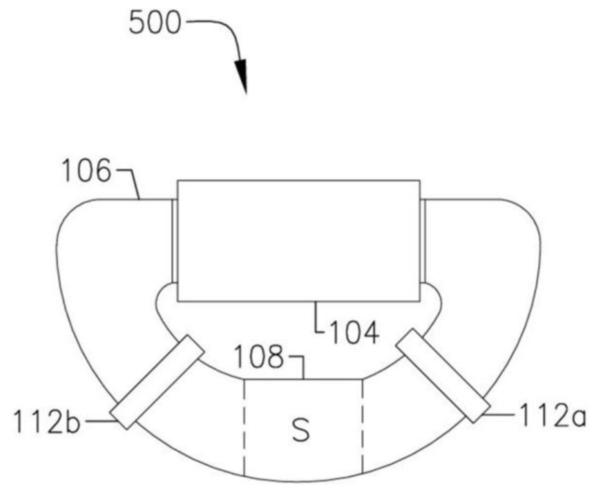


FIG. 27

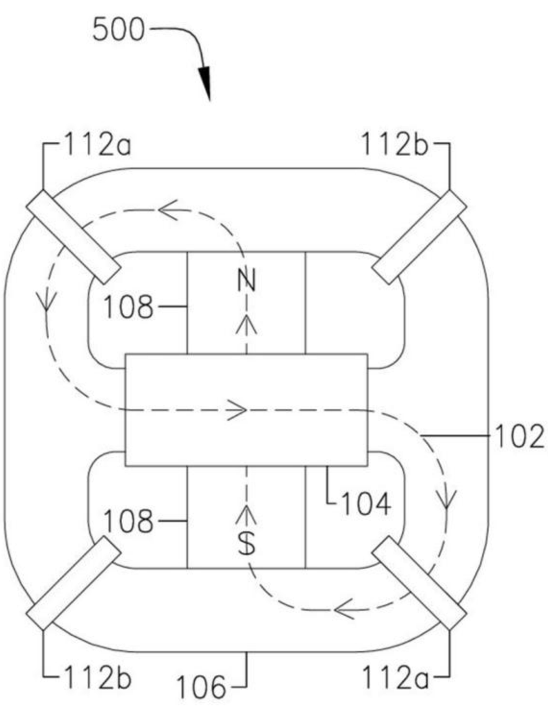


FIG. 28

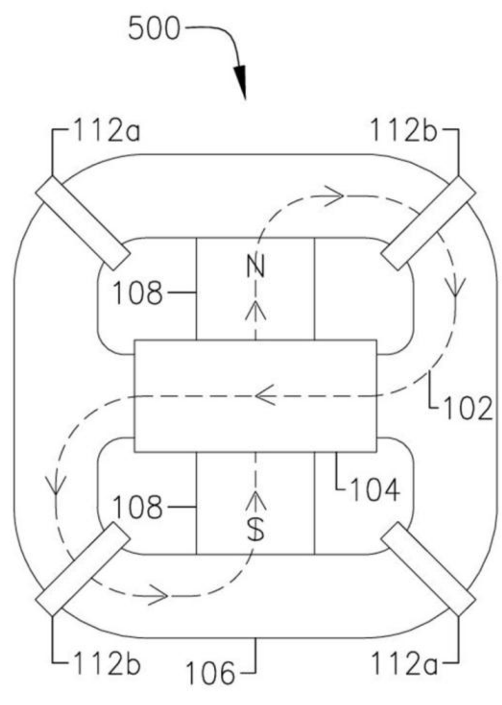


FIG. 29

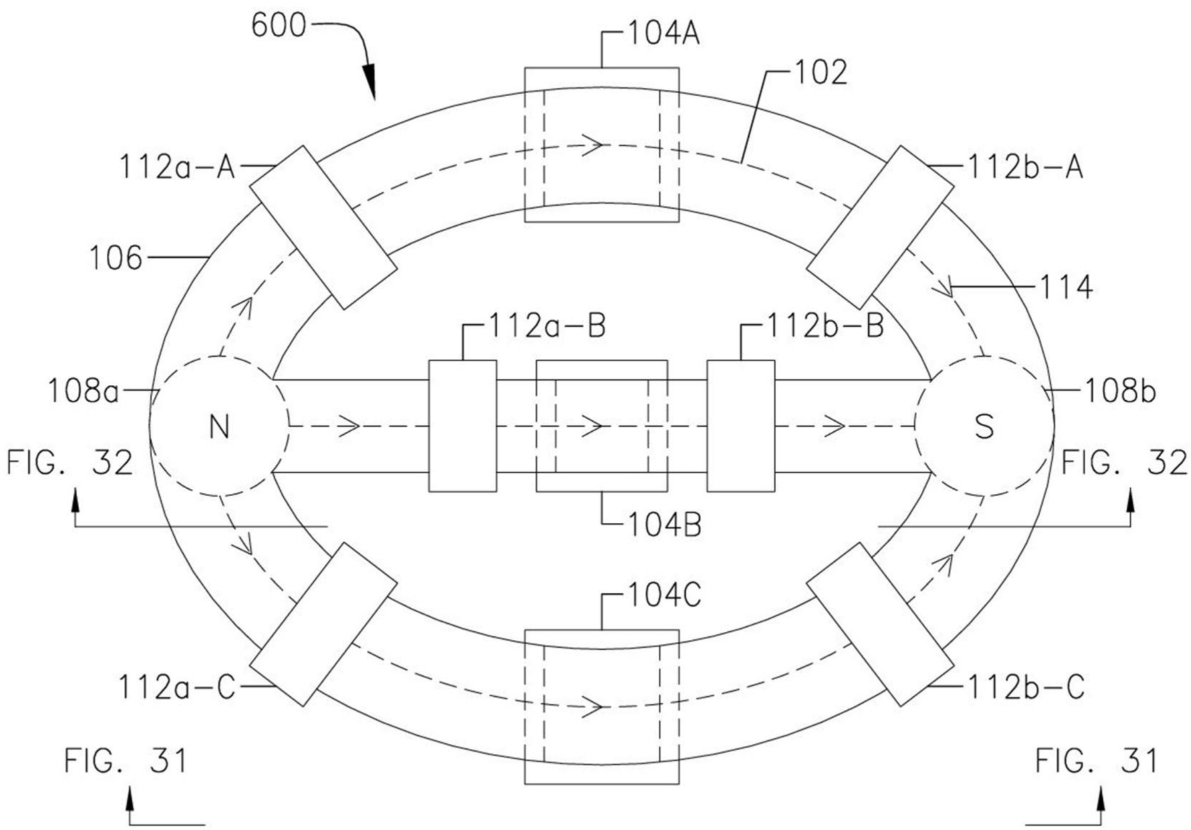

600
104A
102
112a–A
112b–A
106
114
112a–B
112b–B
108a
N
S
108b
FIG. 32
FIG. 32
104B
104C
112a–C
112b–C
FIG. 31
FIG. 31

FIG. 30

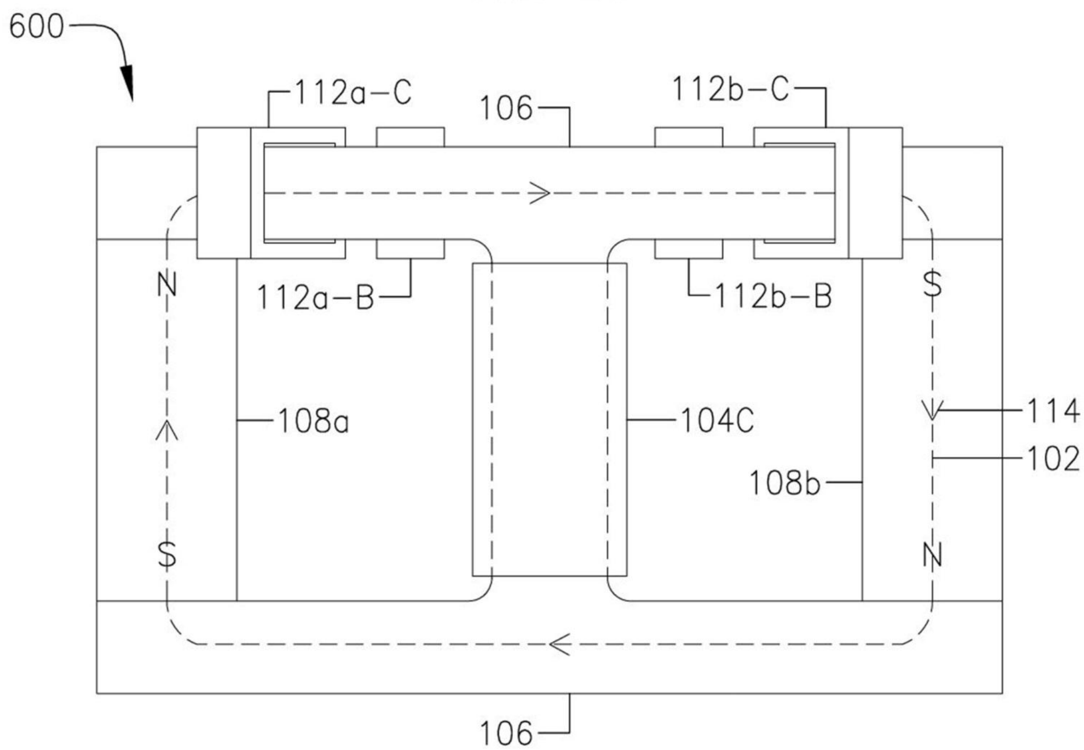

600
112a–C
106
112b–C
N
112a–B
112b–B
S
108a
104C
114
102
108b
S
N
106

FIG. 31

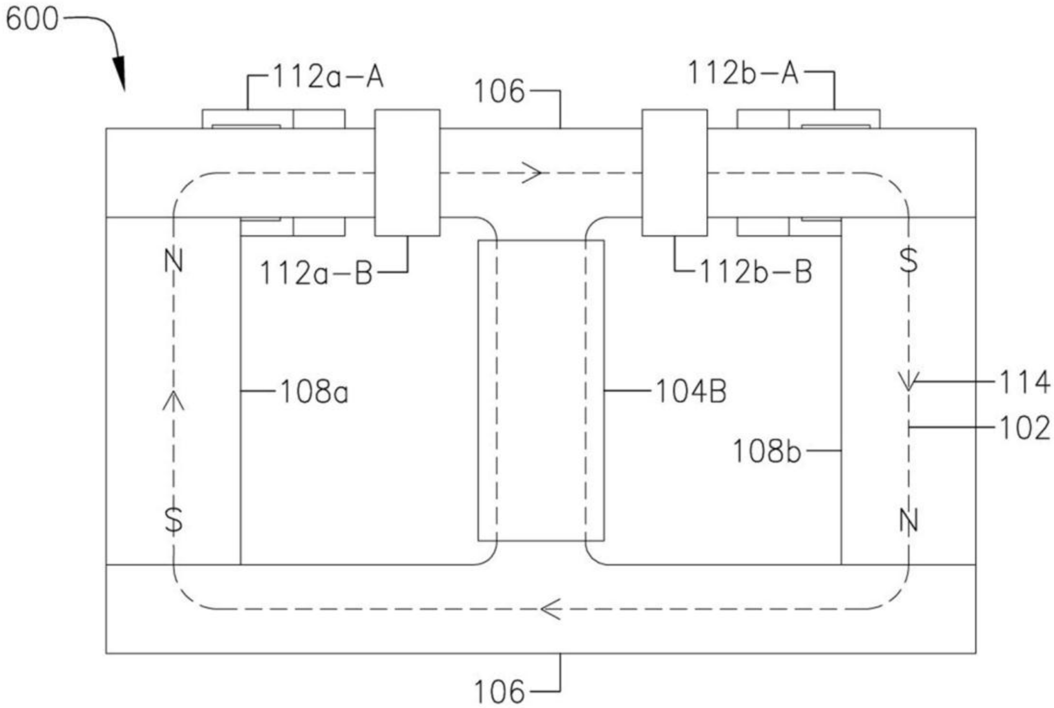

600
112a-A
106
112b-A
N
112a-B
112b-B
S
108a
104B
114
102
108b
S
N
106

FIG. 32

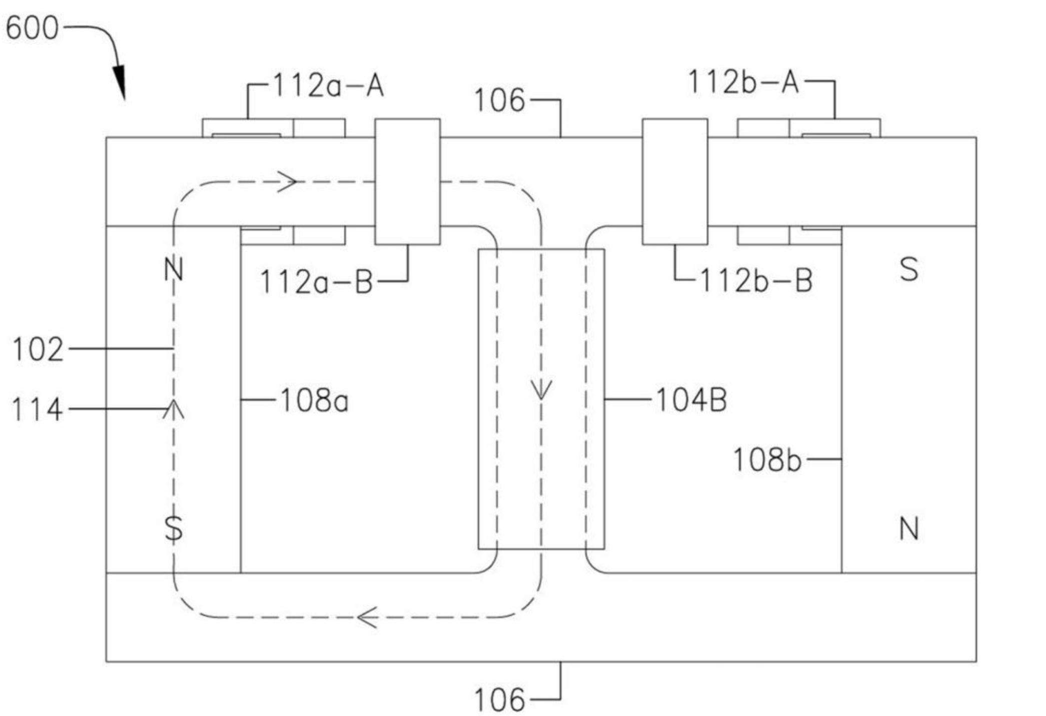

600
112a-A
106
112b-A
N
112a-B
112b-B
S
102
114
108a
104B
108b
S
N
106

FIG. 33

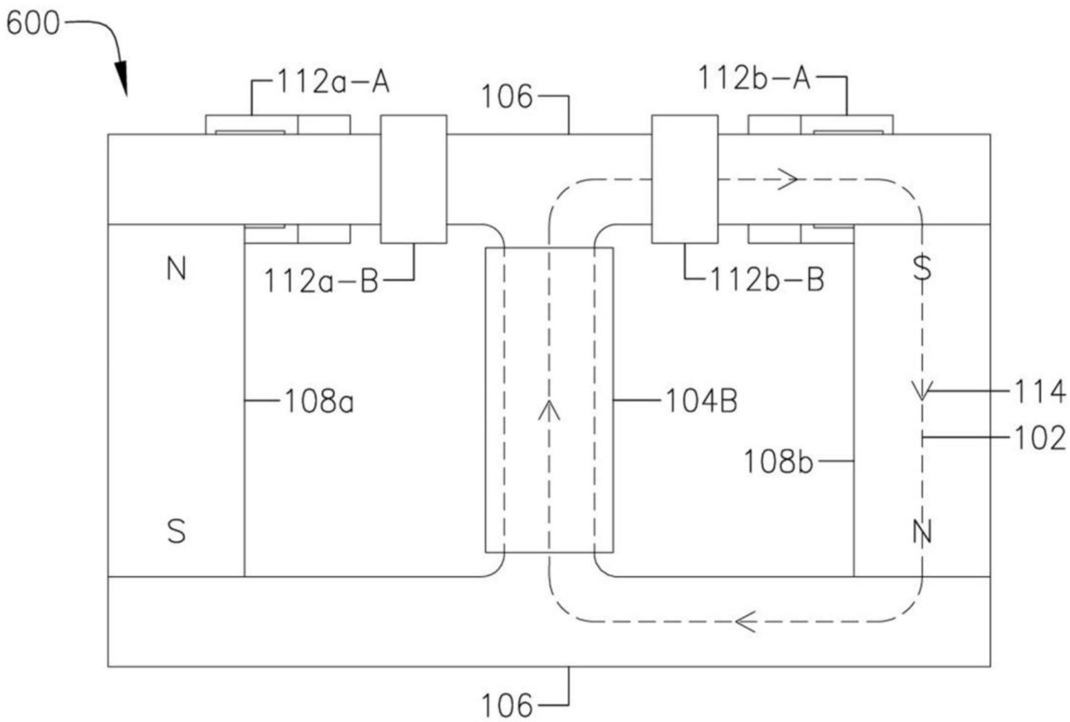

600
112a-A
106
112b-A
N
112a-B
112b-B
S
108a
104B
114
102
108b
S
N
106

FIG. 34

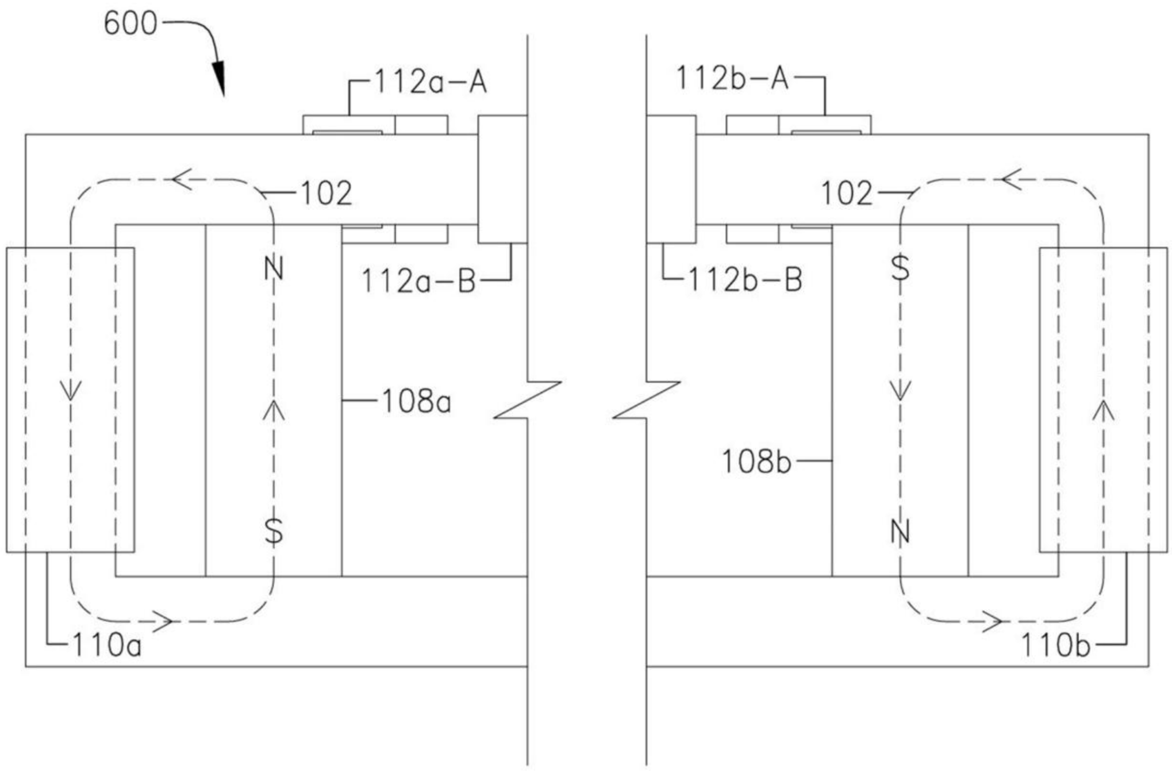

600
112a-A
112b-A
102
102
N
112a-B
112b-B
S
108a
108b
S
N
110a
110b

FIG. 35