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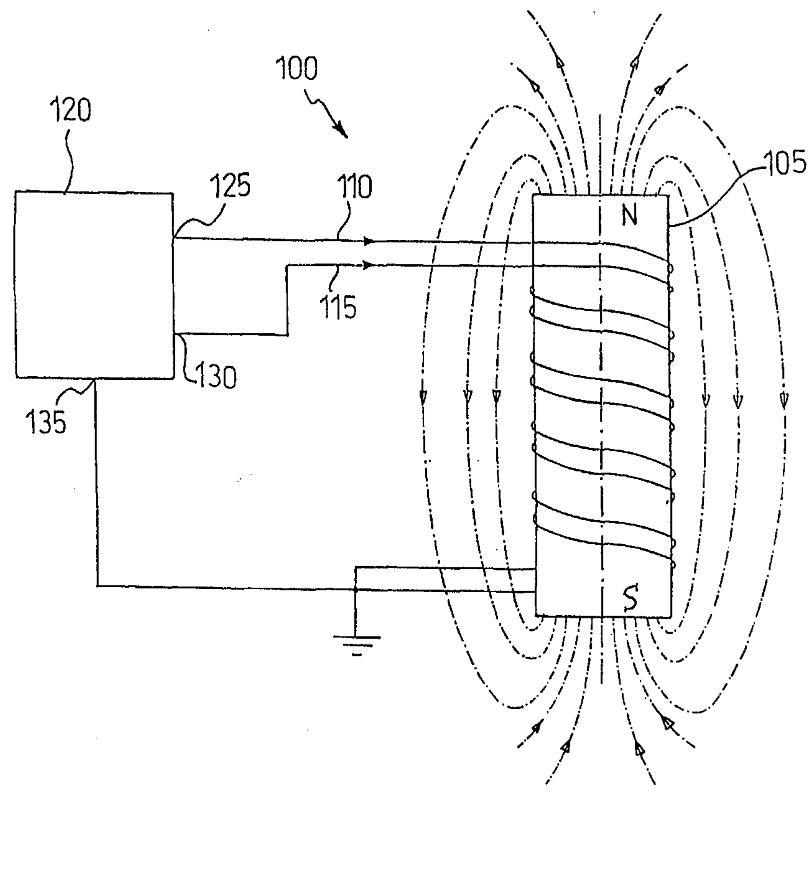
(57) Abstract

Electromagnetic device (100), particularly to be used as a generator, for example of mechanical energy, comprising means (105) for generating a magnetic field, at least one electric conductor (110, 115) arranged inside said magnetic field, means (120) for generating at least one sequence of electric pulses having amplitudes variable in time, said means for generating pulses (120) being connected to the electric conductors (110, 115) for applying a corresponding pulse sequence to each electric conductor (110, 115).



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ELECTROMAGNETIC DEVICE

The present invention relates to an electromagnetic device, and particularly to an electromagnetic device suitable to be used as a generator, for example of mechanical energy or heat.

A generator is in general a machine for transforming energy of a type into energy of a different type; generators are also commonly indicated with the improper expression of devices for producing energy, which always implicates a transformation or a conversion of energy into different form.

Known generators, which differ because of the nature of the used energy, because of the nature of the produced energy and in the way they work, have several drawbacks. Most of traditional generators, such as thermoelectric generators (which generate electric energy exploiting thermic energy produced by a fuel) or nuclear generators (which generate electric energy exploiting the energy released by fission of nuclear fuels), need to be fed with a source of energy (such as oil, gas, coal, uranium) available in nature in scarce quantity and therefore expensive. Moreover, the energy conversion process used in these generators produces polluting exhaust or waste which is dangerous and difficult to be disposed.

Several known generators, including generators using clean (not polluting) and renewable (not subject to exhaustion) sources of energy, such as hydroelectric generators (exploiting hydraulic energy, for example from rivers), geothermal generators (exploiting thermal energy of natural steam within the earth), eolian generators (exploiting energy of wind) and solar generators (exploiting energy sent out by the sun as radiant energy), need complex machineries and equipment. Generally, they are used in plants (power stations) producing energy on an industrial scale; the energy is then delivered to the final users by means of delivery networks (typically electric networks). This process however implies relevant losses of energy during the transfer. In addition, these power stations and related delivery networks involve high construction and management expenses and they often disfigure the landscape.

Generators for personal use, such as motor vehicle internal combustion engines and home heat generators (boilers), use fuels (petrol, diesel fuel or gas) which are expensive and polluting; electric motors (for example motors used in appliances) use on the contrary energy provided by the electric delivery network, with the above mentioned drawbacks, or small batteries (exploiting a chemical reaction) which provide a reduced power, have a short life, and are difficult to dispose once they are flat.

It is an object of the present invention to overcome the above drawbacks. This object is achieved by means of an electromagnetic device as set out in the first claim.

The electromagnetic device of the present invention exploits a practically unlimited source of energy and it is thus very cheap; it produces no harmful waste and therefore it is safe and not polluting.

This electromagnetic device is very easy to manufacture and it employs very cheap components; it is suitable in particular for domestic use, since it is noiseless and small, even if it is not excluded its use for producing energy on an industrial scale.

In addition, the electromagnetic device according to the present invention does not need to be connected to an external electric network and it is therefore particularly practical.

Further features and advantages of the electromagnetic device according to the present invention will appear in the following description of several preferred embodiments of the same, given purely by way of a non-restrictive indication, with reference to the attached drawings where:

Fig.1 shows a schematic block diagram of an electromagnetic device according to the present invention;

Fig.2 depicts time diagrams of the pulse sequences generated in the electromagnetic device of Fig.1;

Fig.3a schematically shows a motor embodying the electromagnetic device of the present invention;

Fig.3b is an exploded view of a particular of the motor of Fig.3a.

With reference in particular to Fig.1, an electromagnetic device 100 according to the present invention includes a permanent magnet 105 (made up for example of an iron-cobalt alloy), whose North and South poles are denoted by the letters N and S, respectively. The permanent magnet 105 generates a magnetic field in the surrounding space; this field is schematically depicted by its lines of force which come out from the North pole and enter the South pole. However, the electromagnetic device in this embodiment of the present invention lends itself to be implemented even with an electromagnet or different equivalent means for generating a magnetic field, or even without the magnet 105, for example exploiting the universal magnetic field.

Two electric conductors 110 and 115 are wound around the magnet 105 and they are parallel and arranged in the shape of a solenoid, with a number of turns (for example several hundreds) variable according to the application and the structure of the electromagnetic device 100. Alternatively, the conductors 110 and 115 are arranged with a different shape and possibly they are not parallel, or they are not wound around the magnet 105 but they are close to the same, in any case in a region where the strength of the magnetic field generated by the magnet 105 is not negligible.

In addition, the electromagnetic device 100 includes a unit 120 for generating electric (voltage or current) pulse sequences, i.e. wave forms where the time during which the electric quantity maintains a high (absolute) value is far shorter, e.g. less than 1/10, than the time during which it maintains a null (or anyway low) value. Particularly, the unit 120 has two output terminals 125 and 130 connected to a terminal of the windings 110 and 115, respectively; a third output terminal 135 is connected to the other terminal of the windings 110 and 115 and is a reference terminal (earth) of the whole device.

In a preferred embodiment of the present invention, the unit 120 generates a first voltage pulse sequence at its output terminals 125 and 135; the time interval (in the following indicated as "period") between two contiguous pulses (considering negligible their length) is fixed, and has a value related to the application and the structure of the electromagnetic device 100. Tests have been carried out with different fixed values of the period up to a minimum value about 10^{-12}s, but the present invention lends itself to be implemented also with not fixed periods. The voltage pulses generated at the output terminals 125 and 135 have an amplitude (with regard to a reference value of the earth terminal) which takes alternatively a "low" type value V_L and a "high" type value V_H, where the difference between the amplitude of a high type pulse and the amplitude of an immediately preceding low type pulse is greater or equal to a predetermined minimum value, preferably 50V. Advantageously, the amplitude of these voltage pulses changes continuously, and it is preferably random. For example, the amplitude of the voltage pulses takes discrete values spaced from each other by a multiple of 1V in a range of defined values, e.g. from a minimum value of 380V to a maximum value of 450V, as in the sequence depicted in the first time diagram of Fig.2 (denoted with the letter a). The voltage pulse sequence is, in turn, constituted by several pulses of the same type (which means that the amplitude differs less than 50V), alternated to several pulses of the other type, eventually in number which is not fixed in time, for example random (e.g. V_L-V_L-V_H-V_H-V_H-V_L-V_L-V_L,V_H-V_H,...).

The unit 120 generates in addition a second voltage pulse sequence at its output terminals 130 and 135, with a period equal to the period of the first sequence generated at the output terminals 125 and 135. The voltage pulses of the second sequence are shifted, with respect to the corresponding pulses of the first sequence, of a time interval which is fixed and shorter than this period. However, the present invention lends itself to be implemented with periods of the two pulse sequences which are not equal from each other and with a shifting of different and even not fixed length. The voltage pulses of the second sequence have an amplitude which is multiple of the amplitude of the corresponding pulses of the first sequence; particularly, the amplitude of these voltage pulses takes a "multiplied low" type value V_{Lm} and a "multiplied high" type value V_{Hm} corresponding to a low type pulse V_L and a high type pulse V_H of the first sequence, respectively. Preferably, the amplitude of each pulse of the second sequence is equal to 2,5 times the amplitude of the corresponding pulse of the first sequence, as depicted in the second time diagram of Fig.2 (denoted with the letter b); in alternative embodiments, a different and even not fixed multiplicative factor is used.

The first and second voltage pulse sequences described above are applied to the winding 110 and 115, respectively. In an alternative embodiment of the present invention, the electromagnetic device 100 has a single winding and a total voltage pulse sequence corresponding to the superimposition of the first and second sequence, as depicted in the third time diagram of Fig.2 (denoted with the letter c), is applied to its terminals. It should be noted that the use of two different windings is particularly useful when the period of the pulse sequences is very short, since it avoids interference phenomena between consecutive pulses of the first and second sequence. As described in detail above with reference to the pulses of the first and second sequence, the present invention lends itself to be implemented even with a total pulse sequence different from the depicted sequence. For example, in alternative embodiments, the different type pulses follow one another in the total sequence in any order, there are only one, two, three or more than four pulse types with different amplitude, the total sequence includes two or more consecutive pulses of one same type, and so on. Moreover, it should be noted that the electromagnetic device 100 of the present invention lends itself to be implemented even with a single winding 110 and only the described first pulse sequence applied to this winding.

In a different embodiment of the present invention, the electromagnetic device 100 includes several winding pairs (or several single windings as described above), and pulse sequences similar to the ones described above are applied thereto; advantageously, it is possible to increase the period of the pulse sequences applied to the different windings by using several windings, obtaining the same performance of the electromagnetic device 100. These pulse sequences can be arranged in several manners; for example, the pulse sequences are of the same type or different type, they have pulse amplitude values which are equal or different, they have equal or different period, they are phased or shifted between one another, either of a time interval which is multiple of a period or of a different value.

Preferably, as shown in the drawing, the windings 110 and 115 are wound around the magnet 105 in a way that the current flowing therethrough and corresponding to the described voltage pulses generates a magnetic field which is substantially parallel and concordant with the magnetic field generated by the magnet 105, according to the right hand rule; however, the present invention lends itself to be implemented even with a different arrangement of the windings 110,115. The pulses applied to the windings 110 and 115 perturb the magnetic field generated by the magnet 105 and produce a total magnetic field having an amplitude which is extremely higher than the amplitude of the magnetic field generated by the magnet 105. Experimental tests have shown that the resulting magnetic field has an amplitude far higher (e.g. several thousands times) than the field produced by the magnet 105 and that the energy generated by the electromagnetic device 100 is extremely higher than the energy absorbed by the unit 120 for generating the pulse sequences.

The electromagnetic device of the present invention is suitable to be used in different applications, for example for producing thermal, electric, mechanical energy, and so on. An example of motor for transforming the energy provided by the electromagnetic device of the present invention into mechanical energy (particularly kinetic energy) is depicted in Fig.3a. The motor 300 includes a stationary element (stator) 302 and a moving element (rotor) 304 joined together by means of bearings (which are not shown in the drawing) in a way that the only possible relative movement is a rotation around a common axis 306. A short circuit electric conductor 307 is wound longitudinally in the shape of a spiral on the rotor 304. The stator 302 includes a permanent magnet in the shape of a hollow cylinder with the North (N) and South (S) poles arranged at the longitudinal ends; preferably, the magnet of the stator 302 is split longitudinally into several portions 308-322 (eight in this example) in order to reduce stray currents.

Referring now to Fig.3b (elements in common with Fig.3a are denoted with the same reference numbers) a detailed exploded view of the structure of the magnet 308 is shown (similar considerations apply to the other magnets 310-322). Grooves (or slots) which accommodate an electric conductor 324 (324-338 in Fig.3a), for example a copper wire with a cross-section of 1mm, are drawn on the surface of the magnet 308; the electric conductor 324 is wound around the magnet 308 in the shape of a spiral spreading out longitudinally in both directions and forming for example a hundred of turns. Further grooves accommodate another electric conductor 340, insulated from the winding 324; the conductor 340 is likewise wound longitudinally around the magnet 308 in the shape of a spiral forming for example a hundred of turns.

A transversal hollow 356, preferably perpendicular to the common axis 306 and therefore also to the lines of force of the field generated by the magnet 308, is provided in the magnet 308. The hollow 356 accommodates at least one electromagnetic unit 358 including a hollow cylindric stator 360 of ferromagnetic material on which an electric conductor 362 wound longitudinally as a spiral is arranged. A rotor 378 rotationally movable (with regard to the stator 360) around a common axis, is accommodated inside the stator 360; an electric conductor 380, likewise wound in the shape of a spiral, is provided on the rotor 378 and it is connected to the outside by means of wiping contacts, e.g. brushes. The winding 362 (primary winding) defines a number of turns, e.g. 100, smaller than the number defined by the winding 380 (secondary winding), e.g. 250. The secondary winding 380 and the winding 340 are parallel connected, with a terminal in common and the other terminal connected to the earth terminal; the primary winding 362 and the winding 324 are likewise parallel connected, with a terminal in common and the other terminal connected to the earth terminal.

Referring back to Fig.3a, each winding 324-338 is parallel connected to the winding opposite to the axis 306; particularly, the not grounded terminal of the winding 324 (on the magnet 308) is connected to the corresponding terminal of the winding 322 (on the magnet 316), and the windings 326-334, 328-336 and 330-338 are likewise connected. Preferably, a capacitive element 381, typically a capacitor having a capacity smaller than 40nF, is connected in series to a pair of windings, e.g. the pair 324-332, and it is useful to increase the starting couple in load operation. The motor 300 further includes a signal processing electronic unit 382 (e.g. an ORION type processor for power audio signal processing) having a number of output terminals equal to the number of winding pairs 324-338 (four in this example) and a further output terminal connected to the earth terminal; each output terminal of the unit 382 is connected to the not grounded terminal of a corresponding pair of the windings 324-338. The signal processing unit 382 is operated, by means of control signals, by a logic unit 383, e.g. a DSP (Digital Signal Processing) electronic card, possibly connected to a Personal Computer (PC).

The motor 300 comprises a further electromagnetic unit 384 including a hollow cylindric stator 386 of ferromagnetic material on which an electric conductor 388, wound longitudinally as a spiral, is arranged. A rotor 390 rotationally movable (with regard to the stator 386) around a common axis is accommodated inside the stator 386; an electric conductor 392 likewise wound in the shape of a spiral is provided on the rotor 390 and it is connected to the outside by means of wiping contacts, e.g. brushes. The winding 388 (primary winding) defines a low number of turns, e.g. a hundred, while the winding 392 (secondary winding) defines a high number of turns, e.g. a thousand. A terminal of the secondary winding 392 is connected to the earth terminal, while the other terminal is connected to an input terminal of the unit 382. The primary winding 388 is parallel connected, by means of an electromagnetic switch 394 or any equivalent means (operated by the logic unit 383), to an electric generator 396, e.g. a storage battery which provides a voltage of 12V at its positive (+) and negative (-) terminals and which has an ampere-hour capacity of 1,9Ah. Particularly, a terminal of the primary winding 388 is connected to the earth terminal, while the other terminal is connected (through the switch 394) to the positive terminal of the electric generator 396; the negative terminal of the electric generator 396 is connected to the earth terminal.

The logic unit 383 periodically switches on the switch 394 for a short time interval in order to apply a base pulse sequence to the primary winding 388. The length of this period is inversely proportional (with the same performance of the motor 300) to the number of winding pairs 324-338 arranged on the stator 302; in this example, the switch 394 is on every 10^{-6}s, for a time interval lasting about 10^{-7}s. The fast variation of the current applied to the primary winding 388 produces a magnetic field with a variable amplitude; the corresponding variations of flux linkage through the secondary winding 392 generates a sequence of multiplied base pulses at the ends of the winding 392, whose amplitude (defining the minimum low type value V_L) is related to the ratio of the number of turns of the windings 392 and 388. This sequence of multiplied base pulses, having a fixed amplitude (e.g. 380V), is provided to the input terminal of the signal processing unit 382. Preferably, at least one further electromagnetic unit (which is not shown in the drawing), similar to the unit 358 described with reference to Fig.3b, or other equivalent means for generating a magnetic field having a direction preferably perpendicular to the axis of the rotor 390, is provided in the stator 386. An induced current having opposite directions corresponding to each leading and trailing edge of the base pulses is generated in the winding 390. The described induced current flows in the winding 390 which is inside the magnetic field created by the further electromagnetic unit; the winding 390 is then subject to a force alternatively rotating clockwise and counterclockwise the rotor 390. Advantageously, with the described structure it is possible to obtain a voltage pulse sequence having a very short period; alternatively, the same pulse sequence is obtained with conventional means.

The signal processing unit 382 (operated by the logic unit 383) changes the amplitude of each received voltage pulse, generating voltage pulses having an amplitude between the input minimum value and a set maximum value, e.g. 450V (defining the maximum high type value V_H). Particularly, a low type voltage pulse V_L having an amplitude with a random value higher or equal to 380V is provided at a certain moment to a first output terminal connected to the winding pair 324-332; a high type voltage pulse V_H having an amplitude with a random value lower or equal to 450V and at least 50V higher than the amplitude of the preceding pulse is provided at the next period to this terminal, and so on as described above in detail. A similar voltage pulse sequence but with different values is provided to a second output terminal connected to the adjacent winding pair 326-334; this pulse sequence is one period shifted with regard to the one applied to the winding pair 324-332, so that when a low type pulse V_L is on the first output terminal a high type pulse V_H is on the second output terminal, and vice versa. In a similar manner, a pulse sequence, shifted with regard to the one applied to the winding pair 326-334, is provided to a third output terminal connected to the winding pair 328-336 and a pulse sequence, shifted with regard to the preceding one, is provided to a fourth output terminal connected to the winding pair 330-338. An example of the pulse sequences generated by the signal processing unit 382 is:

1) 380V 448V 381V 447V 383V 450V 382V ...

2) 449V 380V 450V 381V 448V 382V 447V ...

3) 384V 449V 383V 448V 380V 446V 383V ...

4) 450V 382V 448V 385V 449V 381V 446V ...

As can be seen, the amplitude of the voltage pulses applied in a certain moment to the several winding pairs 324-338 changes spatially likewise the amplitude of the voltage pulses applied to each winding pairs changes in time.

This preferred embodiment (with the low and high type voltage pulses alternated spatially and in time and with an amplitude not less than 380V and random) allows obtaining a regular motion without leaps of the rotor 304. However, the motor 300 lends itself to be operated even with different pulse sequences, as described above.

The pulse sequence applied to each winding 324-338 is applied at the same time also to the primary winding 362 of the corresponding electromagnetic unit 358 (see Fig.3b), and to the similar windings which are not shown in the drawings. As described with reference to the electromagnetic unit 384, a pulse corresponding to each voltage pulse applied to the primary winding 362 and having an amplitude multiple of the input pulse, according to the ratio of the number of turns of the windings 362 and 380, is generated on the secondary winding 380 with some delay (about 10^{-13}s). In this example, each pulse on the secondary winding 380 has an amplitude equal to 2,5 times the amplitude of the corresponding input pulse. The pulse sequence generated in this way on the secondary winding 380 is applied to the winding 340 and it is slightly shifted, or delayed, with respect to the input pulse sequence (directly applied to the winding 324).

The pulses applied to the windings on the magnets 308-322 produce, as described above, a very high amplitude variation of the magnetic field generating a corresponding variation of flux linkage through the winding 307; an induced electromotive force results on the same and it causes a current flow. At the same time, the pulses applied to the winding 362 and the other similar windings produce a magnetic field having a direction perpendicular to the common axis 306. The induced current described above flows in the winding 307 which is inside the magnetic field created by these windings and it is then subject to an electromagnetic force having a direction given by the left hand rule. This force rotates the rotor 304 and the shorter the pulse period is the higher the rotation speed is. It should be appreciated that it is possible to modify readily the rotation direction of the rotor 304 by changing the direction of the current in the windings by means of switches (which are not shown in the drawings). Test results have shown that a very high shaft horsepower (e.g. 20kW), with an idle speed about 3000rpm (revolutions per minute), is obtained by absorbing a negligible power from the electric generator 396 (e.g. 0,07A per 12V, that is 0,84W). In a different embodiment, the motor shaft is coupled to an alternator or a direct-current generator (not shown in the drawing) for producing electric energy. Preferably, a very small part of the produced energy is used for recharging the generator 396.

It should be noted that the motor described above lends itself to be constructed in alternative manners, for example by arranging the short circuit winding on the stator and the permanent magnets with the related windings (connected to the signal processing unit by means of wiping brushes) on the rotor, or by using a different number of conductors wound around the permanent magnets (up to a single winding with a single permanent magnet), or by arranging the electromagnetic units inside the magnets on the stator not perpendicularly to the common axis, or by feeding the winding on the rotor with a direct current, or by replacing the same winding with conductive bars joined at their ends by two connecting rings, or by implementing the pulse generation unit with a custom electronic circuit, and so on.

In a preferred embodiment, the motor 300 further includes position sensors (not shown in the drawing) detecting the rotation speed of the rotor 304 (and possibly the one of the rotors 378 and 390 as well). The sensed values are provided to the logic unit 383 which consequently modifies the operation of the motor 300. Particularly, if the rotation speed is higher than a predetermined value, the logic unit 383 increases the period of the pulse sequences, whilst if the speed is lower than that value it reduces this period; when the rotation speed is not regular, the logic unit 383 increases the minimum amplitude value of the voltage pulses.

The motor 300 in operation warms up owing to the energy transformation process; it has been verified by tests that if the temperature inside the stator 302 raises up to a critical value, about 100°, the motion of the rotor 304 stops and it starts again as soon as the temperature falls under this critical value. The temperature of the motor 300 increases by going on feeding the same with the voltage pulses described above (even without motion of the rotor 304), so that this feature can be advantageously used when the device is intended to be used as thermal generator. On the contrary, when the device works as a motor it needs to be cooled, for example by self ventilation, where cool air is conveyed onto the inner surface of the stator 302 by means of a fan fastened to the motor shaft.

In a preferred embodiment, the motor 300 works in a controlled atmosphere. Particularly, the stator 302 and the rotor 304 are enclosed in a container (not shown in the drawing) at a pressure lower than the atmospheric pressure, e.g. lower than 100mbar (preferably 70mbar). In this situation, it has been shown that the heat production is practically negligible and that the yield of the motor 300 improves considerably.

The structure described above lends itself to be used with simple changes as electric generator as well. It is enough to replace the rotor 304 with a stationary electric conductor (induced conductor), typically wound longitudinally in the shape of a coil, which is then connected to an external load circuit.

Advantageously, in this case the electromagnetic units (358 in Fig.3b) accommodated in the transversal hollows provided in the permanent magnets and the further windings (340 in Fig.3b) arranged around the permanent magnets are not used. In a preferred embodiment, each pulse sequence generated by the signal processing unit (382 in Fig.3a) and applied to a pair of opposite windings (324-338 in Fig.3a), arranged around the permanent magnets, is constituted by one or more pulses of a same type alternated to one or more pulses of a different type, wherein the number of consecutive pulses of the same type is random. In practice, the signal processing unit provides random the different type of generated pulses to its output terminals.

In a manner similar to the one described in the preceding case, the pulse sequences cause a variation of magnetic flux linkage through this coil and an induced electromotive force with a very high power (e.g. some tens kW) results at the ends of the coil itself. Test results have shown that the voltage value at the ends of the induced winding is related to the difference between the amplitude of the low type pulses V_L and the amplitude of the high type pulses V_H; for example, a difference of about 60V has been used in order to get a 220V voltage. Moreover, it should be noted that the electric generator described above does not warm up, so that it is preferably used at atmospheric pressure without any cooling system.

A person skilled in the art will of course be able to make many modifications and alterations to the electromagnetic device described above in order to satisfy local and specific requirements, all such changes remaining, however, within the scope of protection of the invention as defined by the following claims.

CLAIMS

1. Electromagnetic device (100) comprising means (105) for generating a magnetic field, at least one electric conductor (110,115) arranged for being inside said magnetic field,

characterized in that

the electromagnetic device (100) includes means (120) for generating at least one sequence of electric pulses having amplitudes variable in time, said means for generating pulses (120) being connected to the electric conductor (110,115), or to the electric conductors, for applying the pulse sequence, or a corresponding one of the pulse sequences, to the electric conductor (110,115), or to each one of the electric conductors.

2. Electromagnetic device (100) according to claim 1, wherein the means for generating the magnetic field is constituted by at least one permanent magnet (105).

3. Electromagnetic device (100) according to claim 2, wherein each electric conductor (110,115) is wound around the permanent magnet (105).

4. Electromagnetic device (100) according to any claim from 1 to 3, wherein the pulses of the sequence, or of each one of the sequences, are separated by a fixed period.

5. Electromagnetic device (100) according to any claim

from 1 to 4, wherein the electric pulses are voltage pulses.

6. Electromagnetic device (100) according to claim 5, wherein the pulse sequence, or each one of the pulse sequences, includes at least a pulse of a first type (V_L) alternated with at least a pulse of a second type (V_H), the difference between the amplitude of each pulse of the second type (V_H) and the amplitude of an immediately preceding pulse of the first type (V_L) being not less than a predetermined value.

7. Electromagnetic device (100) according to claim 6, wherein the predetermined value is 50V.

8. Electromagnetic device (100) according to claim 6 or 7, wherein the amplitude of each pulse of the first type (V_L) is at least 380V.

9. Electromagnetic device (100) according to any claim from 6 to 8, wherein the amplitude of the pulses is random.

10. Electromagnetic device (100) according to any claim from 6 to 9, wherein the pulse sequence, or each one of the pulse sequences, includes a pulse of a third type (V_{Lm}) and a pulse of a fourth type (V_{Hm}) corresponding to each pulse of the first type (V_L) and the second type (V_H), respectively, each pulse of the third (V_{Lm}) and fourth (V_{Hm}) type having an amplitude multiple of the amplitude of the corresponding pulse.

11. Electromagnetic device (100) according to claim 10,

wherein the amplitude of each pulse of the third (V_{Lm}) and fourth (V_{Hm}) type is 2,5 times the amplitude of the corresponding pulse.

12. Electromagnetic device (100) according to claim 10 or 11, wherein each pulse of the third (V_{Lm}) and fourth (V_{Hm}) type is separated from the corresponding pulse by a time interval shorter than said period.

13. Electromagnetic device (100) according to any claim from 10 to 12 including at least one pair of said electric conductors (110,115), wherein the pulse sequence, or each one of the pulse sequences, is constituted by a corresponding first and second pulse sequence including only the pulses of the first (V_L) and second (V_H) type and only the pulses of the third (V_{Lm}) and fourth (V_{Hm}) type, respectively, the first and second sequence being applied to a first (110) and a second (115) electric conductor of the pair (110,115), respectively.

14. Heat generator including the electromagnetic device (100) according to any claim from 1 to 13.

15. Motor (300) including the electromagnetic device according to any claim from 1 to 13, a first (304) and a second (302) element rotationally movable between each other around a common axis (306), wherein the first element (304) includes at least one electric conductor circuit (307) and the second element (302) includes the means (308-322) for generating the magnetic field.

16. Motor (300) according to claim 15, wherein the first element is a rotor (304) and the second element is a stator (302), the electric conductor circuit (307) being wound longitudinally around the rotor (304) in the shape of a spiral.

17. Motor (300) according to claim 16, wherein the stator (302) and the rotor (304) are enclosed in a container at a pressure lower than atmospheric pressure.

18. Motor (300) according to claim 17, wherein said pressure is lower than 100mbar.

19. Motor (300) according to any claim from 15 to 18, wherein the means for generating the magnetic field is constituted by a plurality of said permanent magnets (308-322) insulated therebetween, a corresponding one of the first (324-338) and second (340) electric conductor being wound around each one of the magnets (308-322).

20. Motor (300) according to claim 19, wherein the first electric conductors (324-338) are in even number, each one of the first electric conductors (324-330) being parallel connected to a first electric conductor (332-338) opposite to the common axis (306) for being applied a same first pulse sequence.

21. Motor (300) according to claim 20, wherein the first pulse sequence applied to each one of the first electric conductors (324-338) is shifted with respect to the first

pulse sequence applied to at least one adjacent first electric conductor (324-388) by said period.

22. Motor (300) according to any claim from 15 to 21, further comprising a first electromagnetic unit (358) corresponding to each one of the first (324-338) and second (340) electric conductors, each first electromagnetic unit (358) including a first primary winding (362) and a first secondary winding (380) for producing a voltage multiple of the voltage applied to the first primary winding (362) on the first secondary winding (380) with a delay equal to said time interval, the first primary winding (362) being parallel connected to the corresponding first electric conductor (324-338) for being input the corresponding first pulse sequence and the first secondary winding (380) being parallel connected to the corresponding second electric conductor (340) for applying the corresponding second pulse sequence.

23. Motor (300) according to claim 22, wherein each one of the first primary windings (362) and each one of the first secondary windings (380) is arranged on a first stator (360) and a first rotor (378), respectively.

24. Motor (300) according to claim 22 or 23, wherein each first electromagnetic unit (358) is accommodated in a hollow (356) provided transversally in the corresponding magnet (308).

25. Motor (300) according to any claim from 15 to 24,

wherein the means for generating pulses include a second electromagnetic unit (384) comprising a second primary winding (388) and a second secondary winding (392) for producing a voltage multiple of the voltage applied to the second primary winding (388) on the second secondary winding (392), the second primary winding (388) being parallel connected to an electric generator (396) through switching means (394) for being input a base pulse sequence and the second secondary winding (392) being connected to a signal processing unit (382) for applying a multiplied base pulse sequence, the signal processing unit (382) changing the amplitude of each multiplied base pulse for generating the first pulse sequences at its output terminals.

26. Motor (300) according to claim 25, wherein the second primary winding (388) and the second secondary winding (392) are arranged on a second stator (386) and a second rotor (390), respectively, the second electromagnetic unit (384) including means for generating a further magnetic field perpendicular to an axis of the second rotor (390).

27. Motor (300) according to claim 25 or 26, further comprising a logic unit (383) for operating the signal processing unit (382) and the switching means (394).

28. Motor (300) according to claim 27, further comprising a sensor for detecting an indication of a rotation speed of the rotor (304), the logic unit (383) changing said period

and/or the amplitude of the pulses of the first sequences depending on said indication.

29. Motor (300) according to any claim from 15 to 28, further comprising capacitive means (381) connected in series to at least one of the first electric conductors (324-338).

30. Electric generator comprising the electromagnetic device according to any claim from 1 to 13 and an induced electric conductor arranged for being inside said magnetic field.

31. Electric generator according to claim 30, wherein the number of consecutive pulses of a same type in each pulse sequence is random.

32. Method for producing energy comprising the steps of:

generating a magnetic field,

generating at least one sequence of electric pulses having amplitudes variable in time,

applying a corresponding pulse sequence to at least one electric conductor arranged inside said magnetic field.

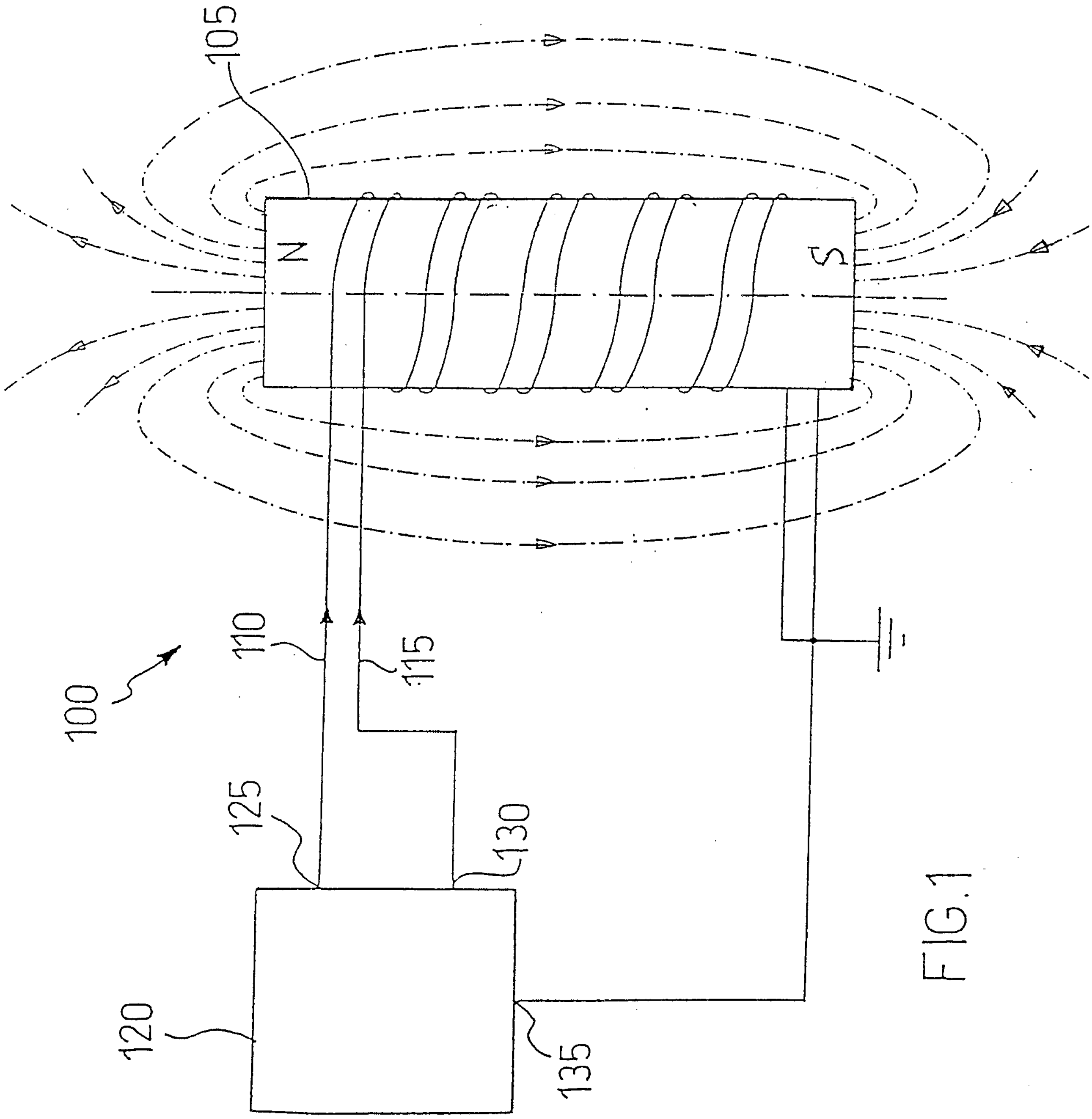
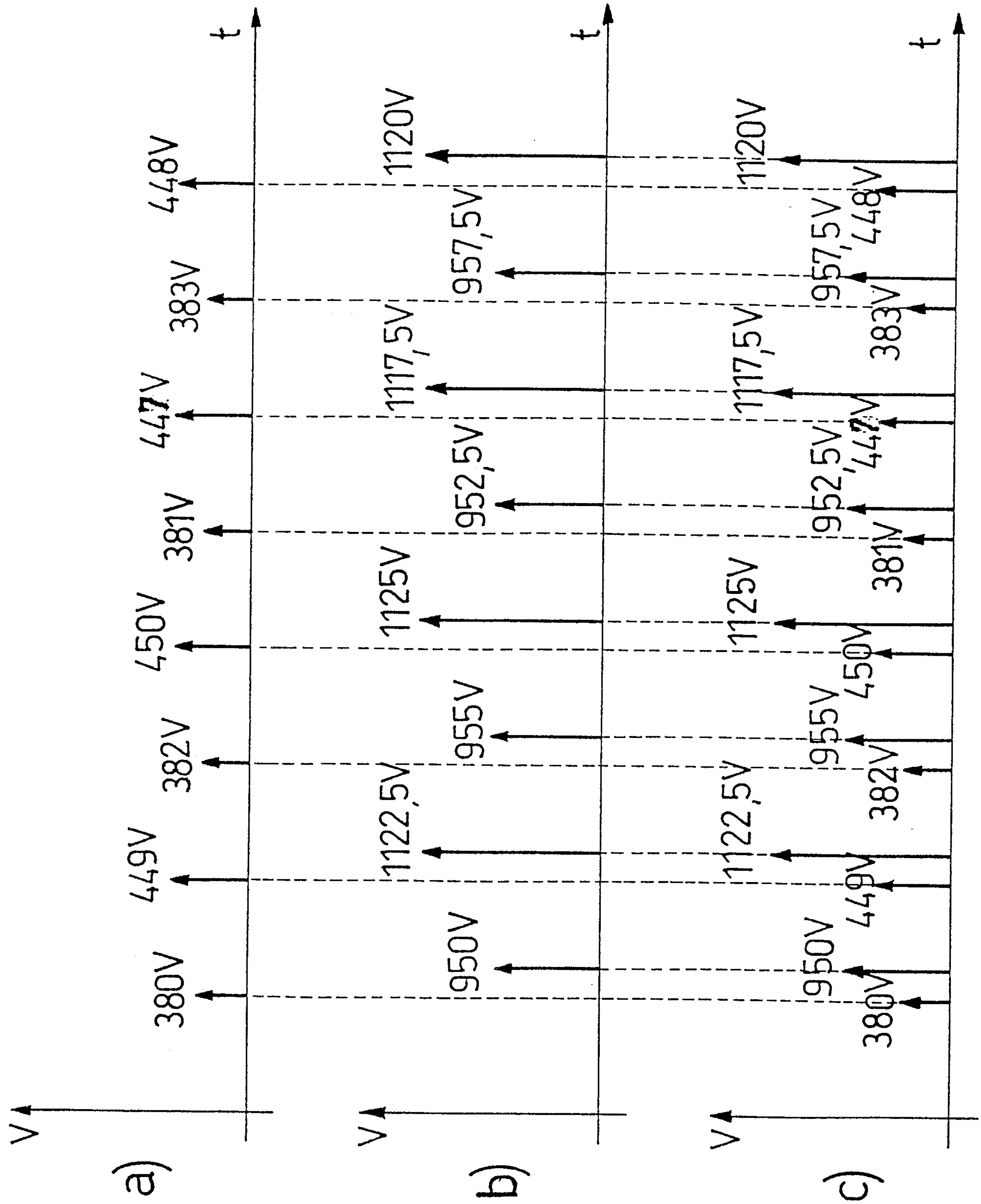


FIG.1

FIG. 2


a)
b)
c)
V
t
380V
449V
382V
450V
381V
447V
383V
448V
950V
1122,5V
955V
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952,5V
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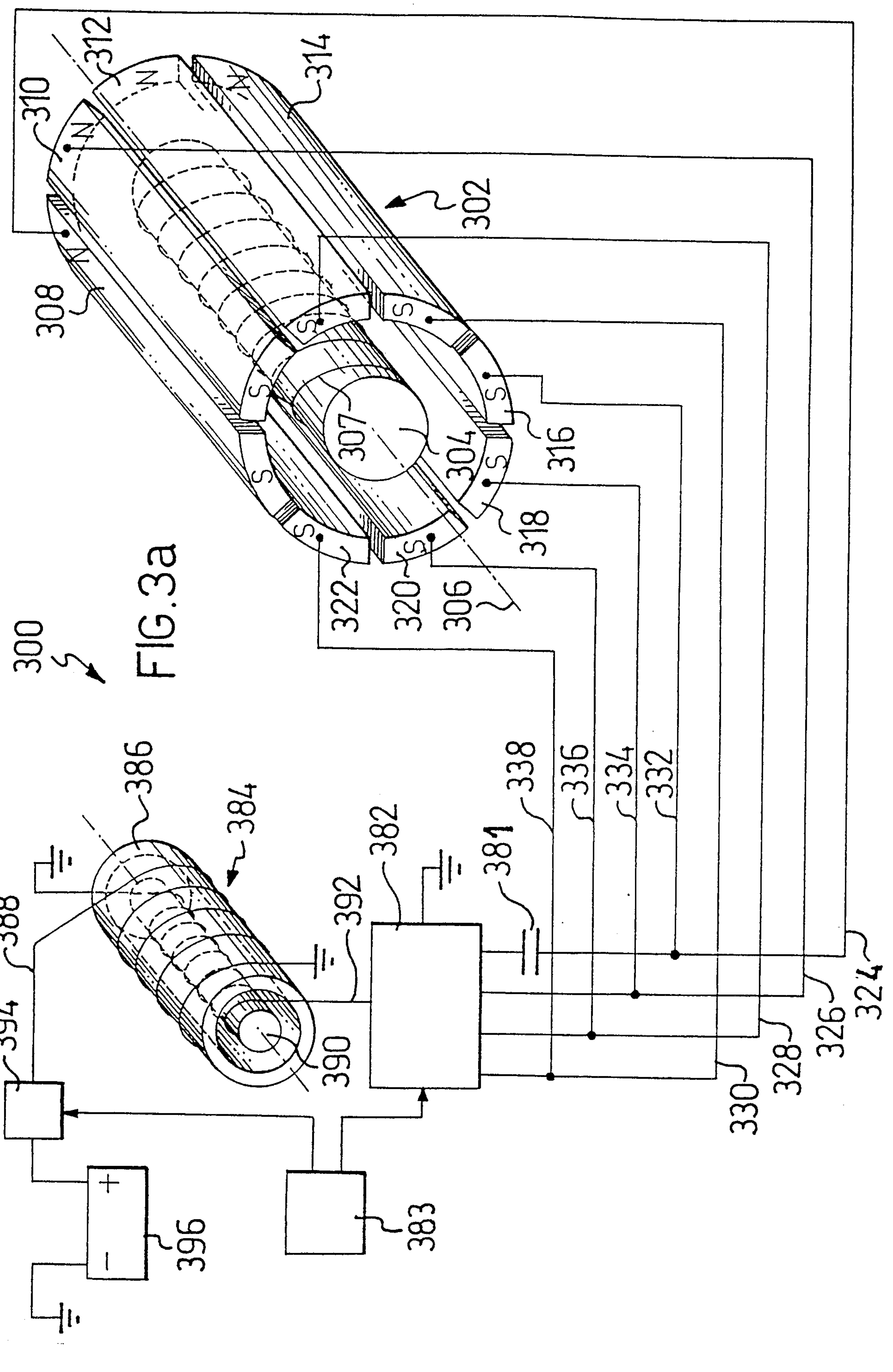
957,5V
1120V


300
302
304
306
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381
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FIG.3a

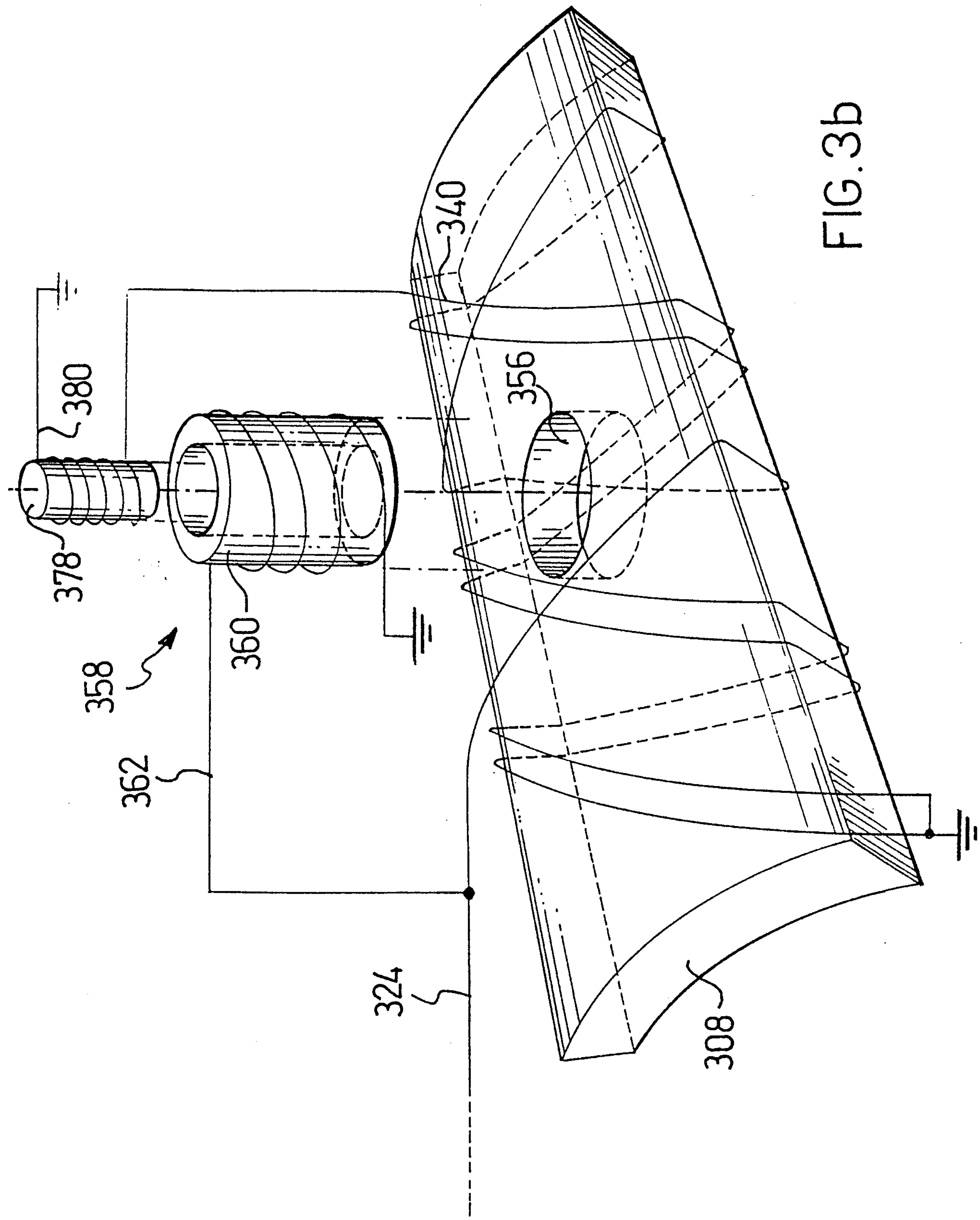

FIG.3b

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IT 97/00054

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H02K57/00

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 6 H02K

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 40 39 236 C (AUGUST BILSTEIN GMBH 6 CO. KG) 27 May 1992 see figures 1,2 ---	1-3,32
X	EP 0 162 966 A (VDO ADOLF SCHINDLING AG) 4 December 1985 see claim 1; figures 1-4 ---	1-3,32
X	US 3 999 090 A (R.C.SINNOTT) 21 December 1976 see column 12, line 34 - line 51; figures 1,2,5 ---	1-3,32
X	WO 96 37944 A (M.PINHEIRO) 28 November 1996 see claims 1-3 -----	1,32

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

☒ Patent family members are listed in annex.

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2

Date of the actual completion of the international search	Date of mailing of the international search report
13 November 1997	26.11.97

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/IT 97/00054

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