

**PCT**

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>6</sup> :</b> <b>H02K 57/00</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 98/40960</b> <b>(43) International Publication Date:</b> 17 September 1998 (17.09.98)
<b>(21) International Application Number:</b> PCT/IT97/00054 <b>(22) International Filing Date:</b> 11 March 1997 (11.03.97) <b>(71) Applicant (for all designated States except US):</b> ENERGIA	<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD,	

*FOR THE PURPOSES OF INFORMATION ONLY*

## 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

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  
10 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  
15 often disfigure the landscape.

Generators for personal use, such as motor vehicle

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

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

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.  $V_L-V_L-V_H-V_H-V_H-V_L-V_L-V_L, V_H-V_H, \dots$ ).

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  
5 "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  
10 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.

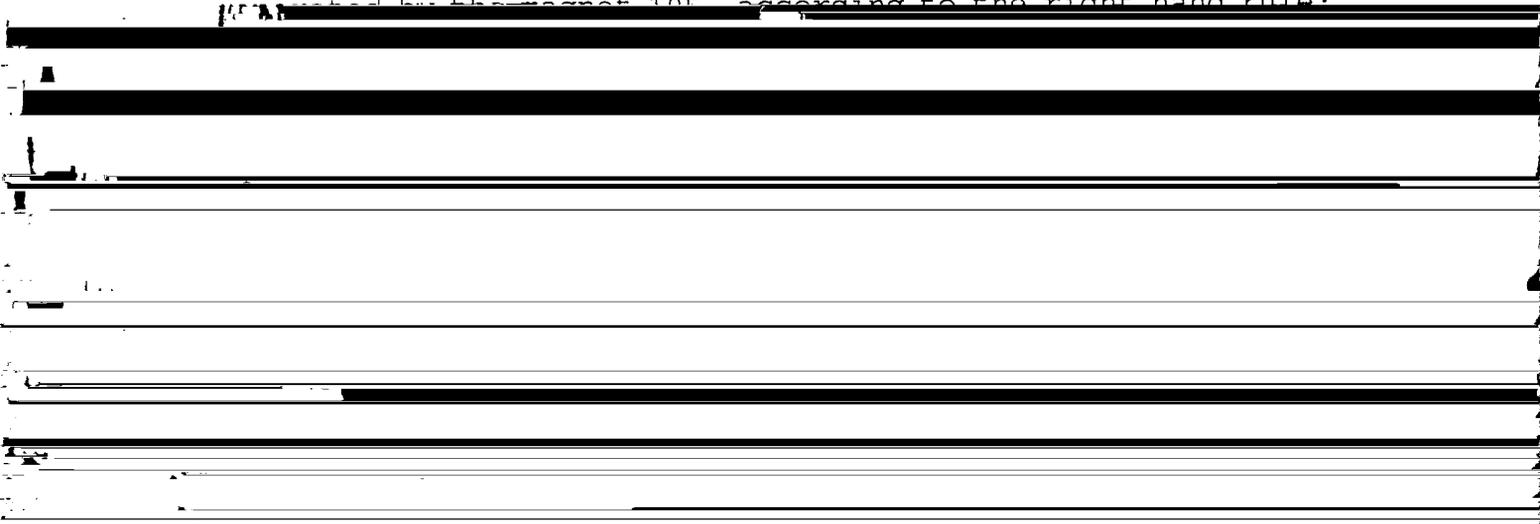
15 In an alternative embodiment of the present invention, the

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  
20 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  
25 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  
5 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  
10 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  
15 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  
20 suitable to be used in different applications, for example for

(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 5 307 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 10 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 15 (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 20 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 25 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  
5 electromagnetic unit 358 including a hollow cylindrical 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  
10 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  
15 (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  
20 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  
25 the winding 322 (on the magnet 316), and the windings 326-334,

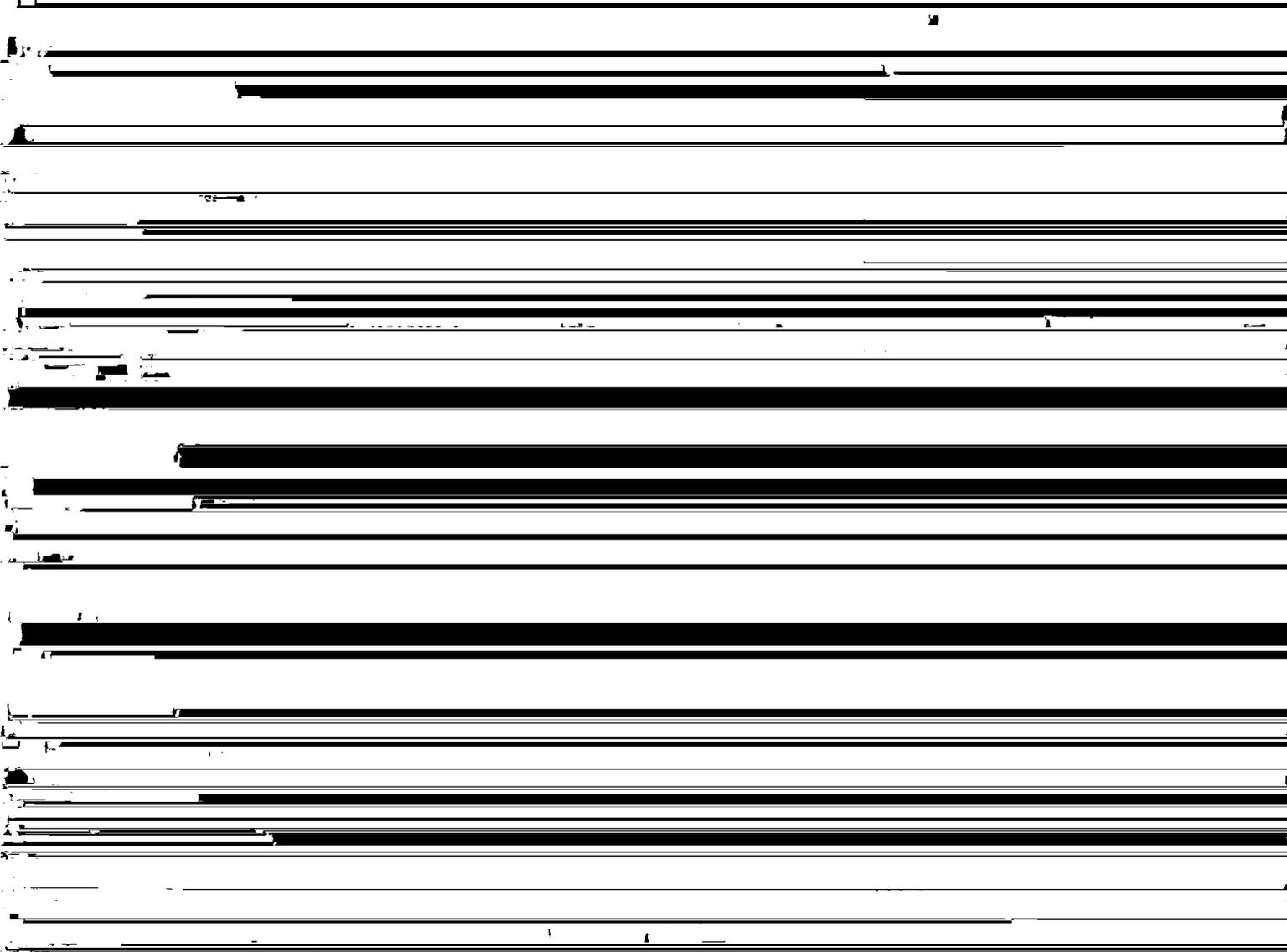
328-336 and 330-338 are likewise connected. Preferably, a capacitive element 381, typically a capacitor having a capacity smaller than 40nF, is connected in series to a pair of windings, e.g. the pair 324-332, and it is useful to increase the starting couple in load operation. The motor 300 further includes 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

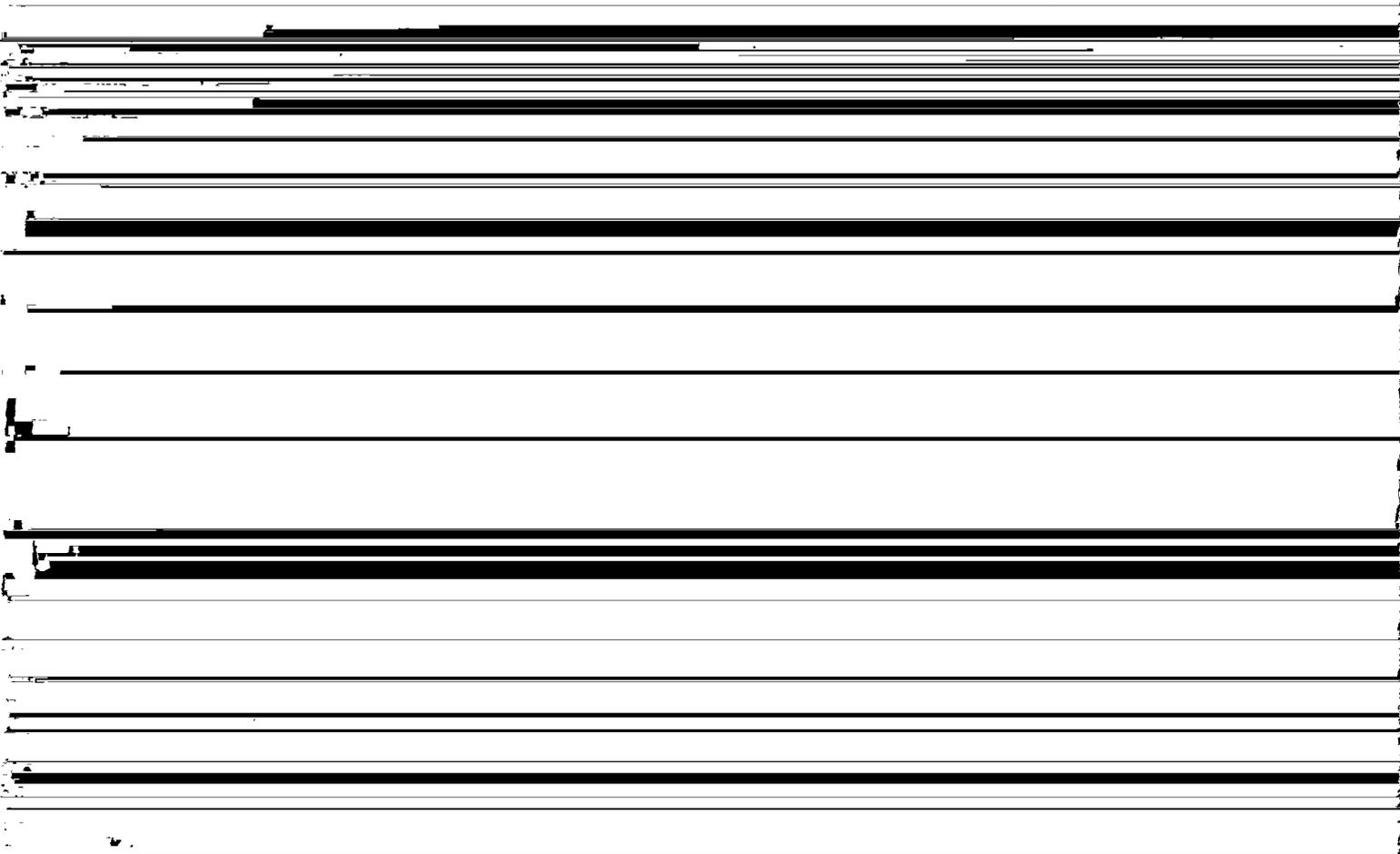
connected to the lead unit 382 to an



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



5 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  
10 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

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 ...
- 5 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.

10 This preferred embodiment (with the low and high type voltage pulses alternated spatially and in time and with an

~~each pulse on the secondary winding 380 has an amplitude equal~~

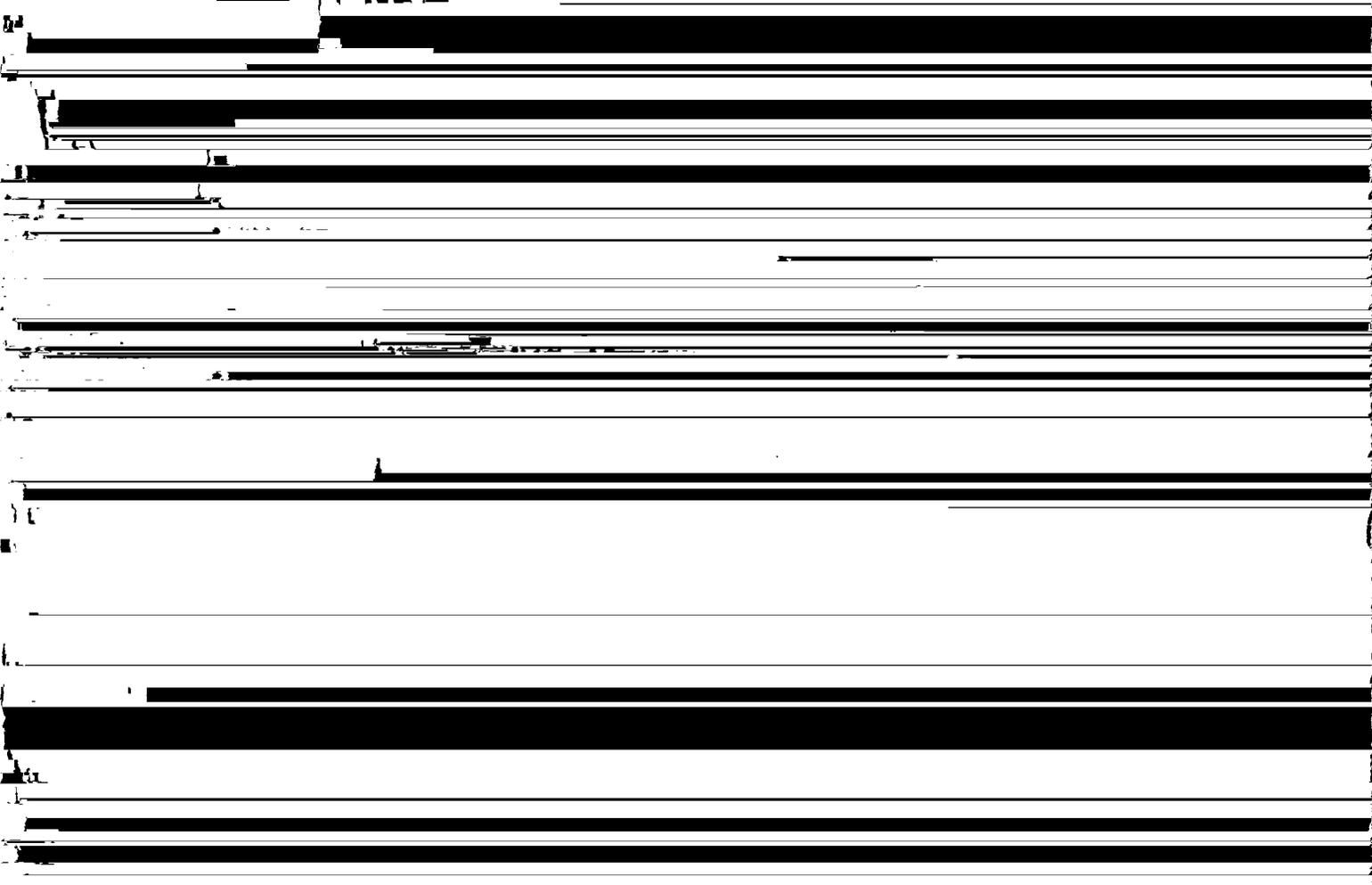
to 2,5 times the amplitude of the corresponding input pulse. The pulse sequence generated in this way on the secondary winding 380 is applied to the winding 340 and it is slightly shifted, or delayed, with respect to the input pulse sequence (directly applied to the winding 324).

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

~~stator~~ ~~power circuit~~ by means of wiring brushes) on the



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

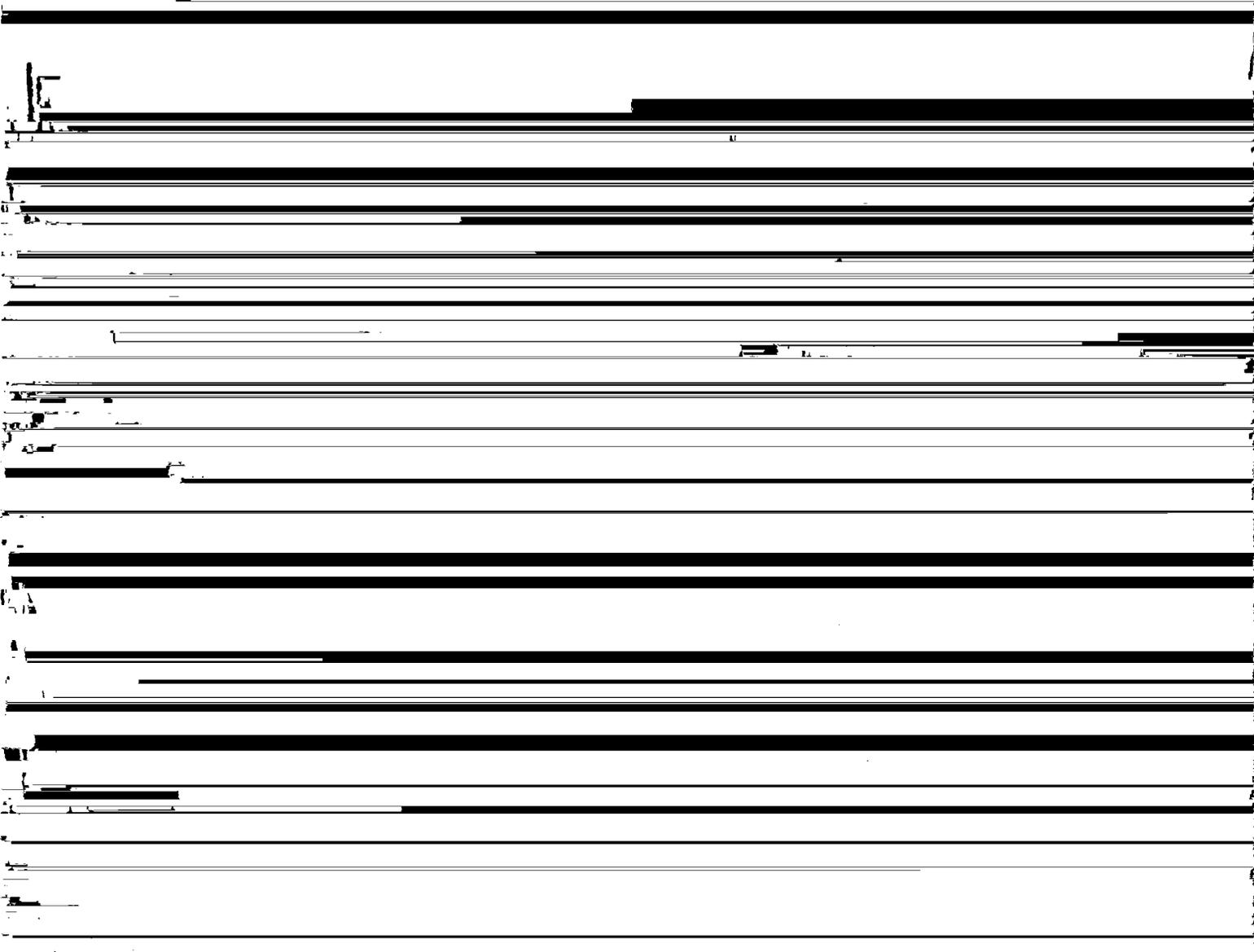
e.g. lower than 100mbar (preferably 70mbar). In this situation, it has been shown that the heat production is practically negligible and that the yield of the motor 300 improves considerably.

5           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  
10 load circuit.

Advantageously, in this case the electromagnetic units  
(see in Fig. 2b) accommodated in the transversal hollow

provided in the permanent magnets and the further windings  
(see in Fig. 2b) arranged around the permanent magnets are not

linkage through this coil and an induced electromotive force



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

CLAIMS

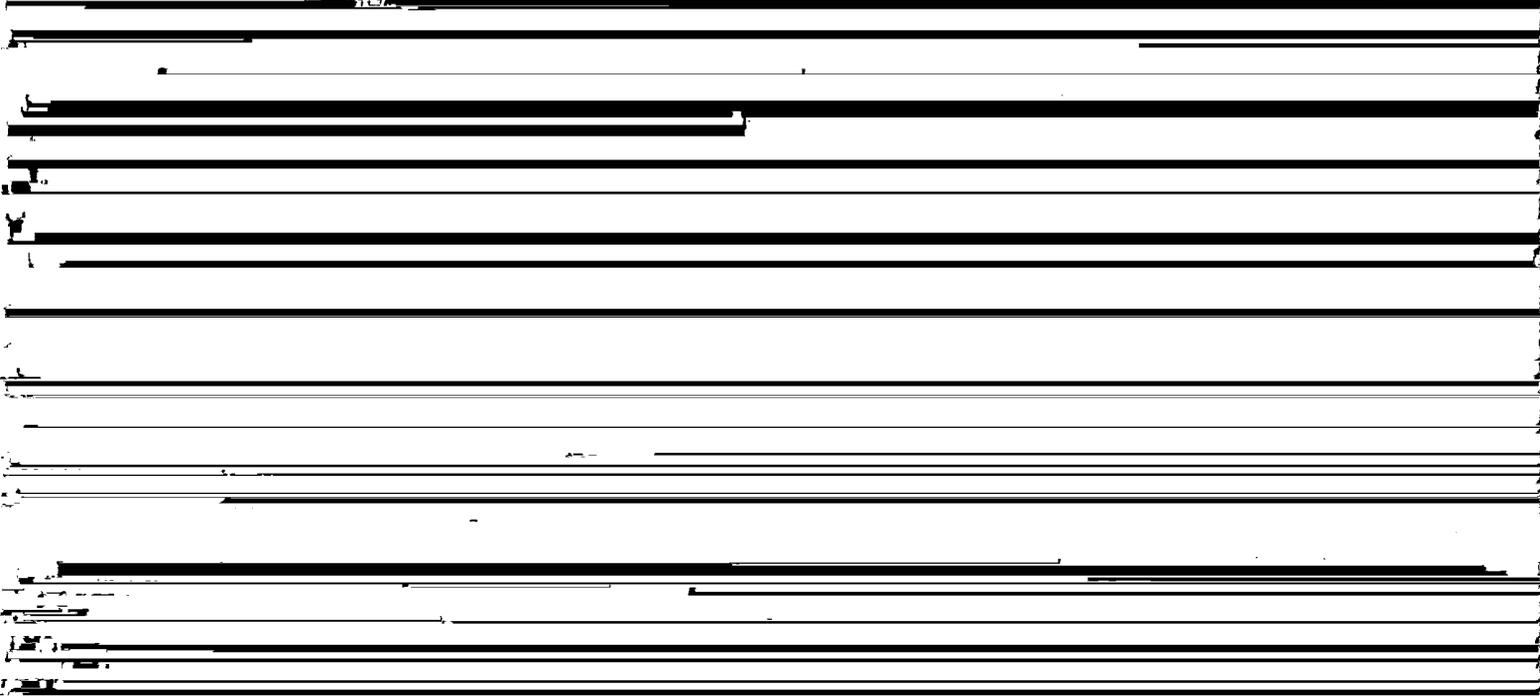
1. Electromagnetic device (100) comprising means (105)  
for generating a magnetic field, at least one electric  
conductor (110,115) arranged for being inside said magnetic  
5 field,

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  
10 (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.

15 2. Electromagnetic device (100) according to claim 1,  
wherein the means for generating the magnetic field is

provided by at least one permanent magnet (105)



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.

10 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.

15 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.

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



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).

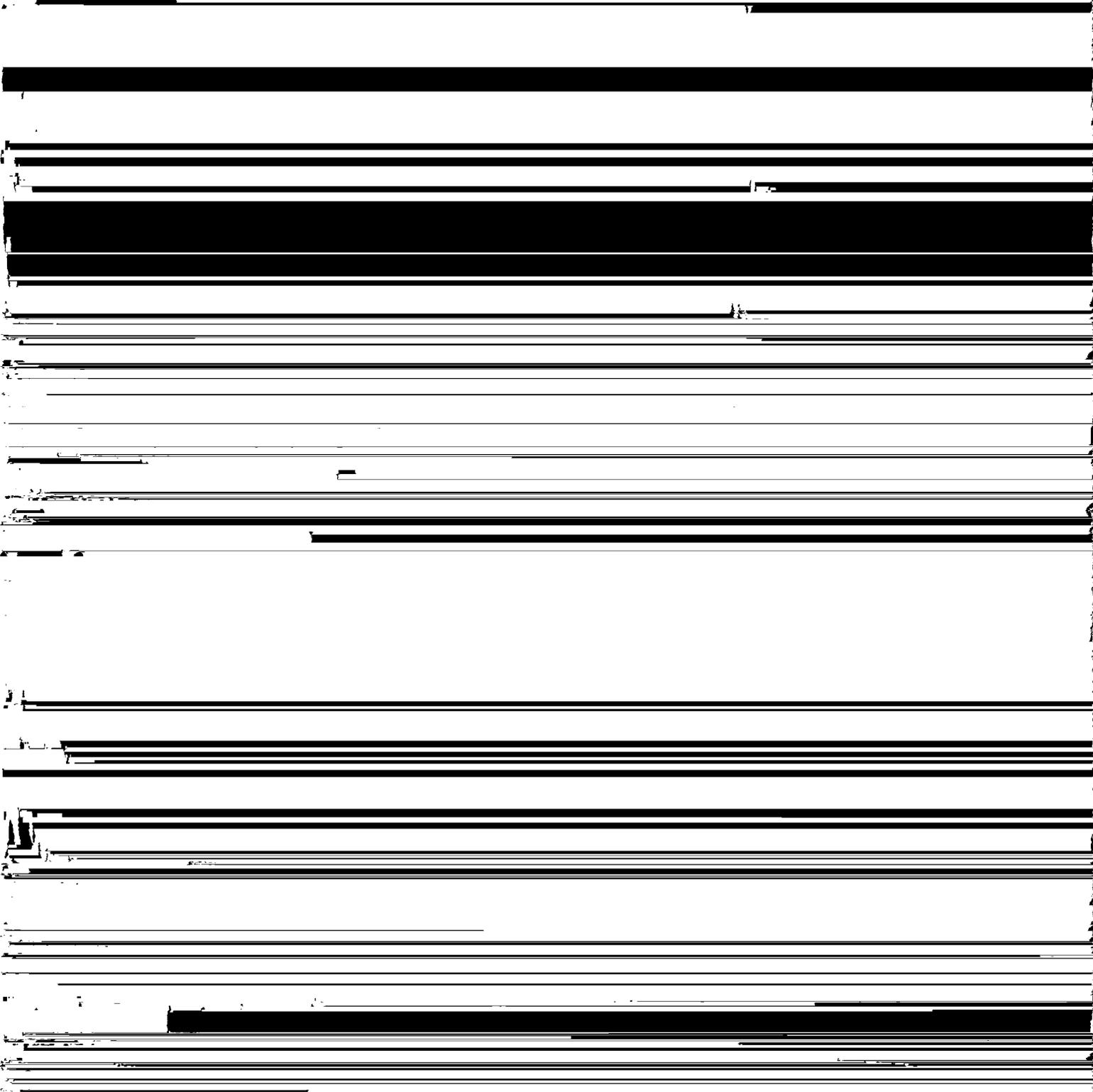
20. Motor (300) according to claim 19, wherein the first electric conductors (324-338) are in even number, each one of the first electric conductors (324-330) being parallel connected to a first electric conductor (332-338) opposite to the common axis (306) for being applied a same first pulse sequence.

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 (350)



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  
5 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  
10 (382) for applying a multiplied base pulse sequence, the

multiplied base pulse for generating the first pulse sequences at its output terminals.

26. Motor (300) according to claim 25, wherein the second  
15 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).

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  
5 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.

10 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,  
15 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.

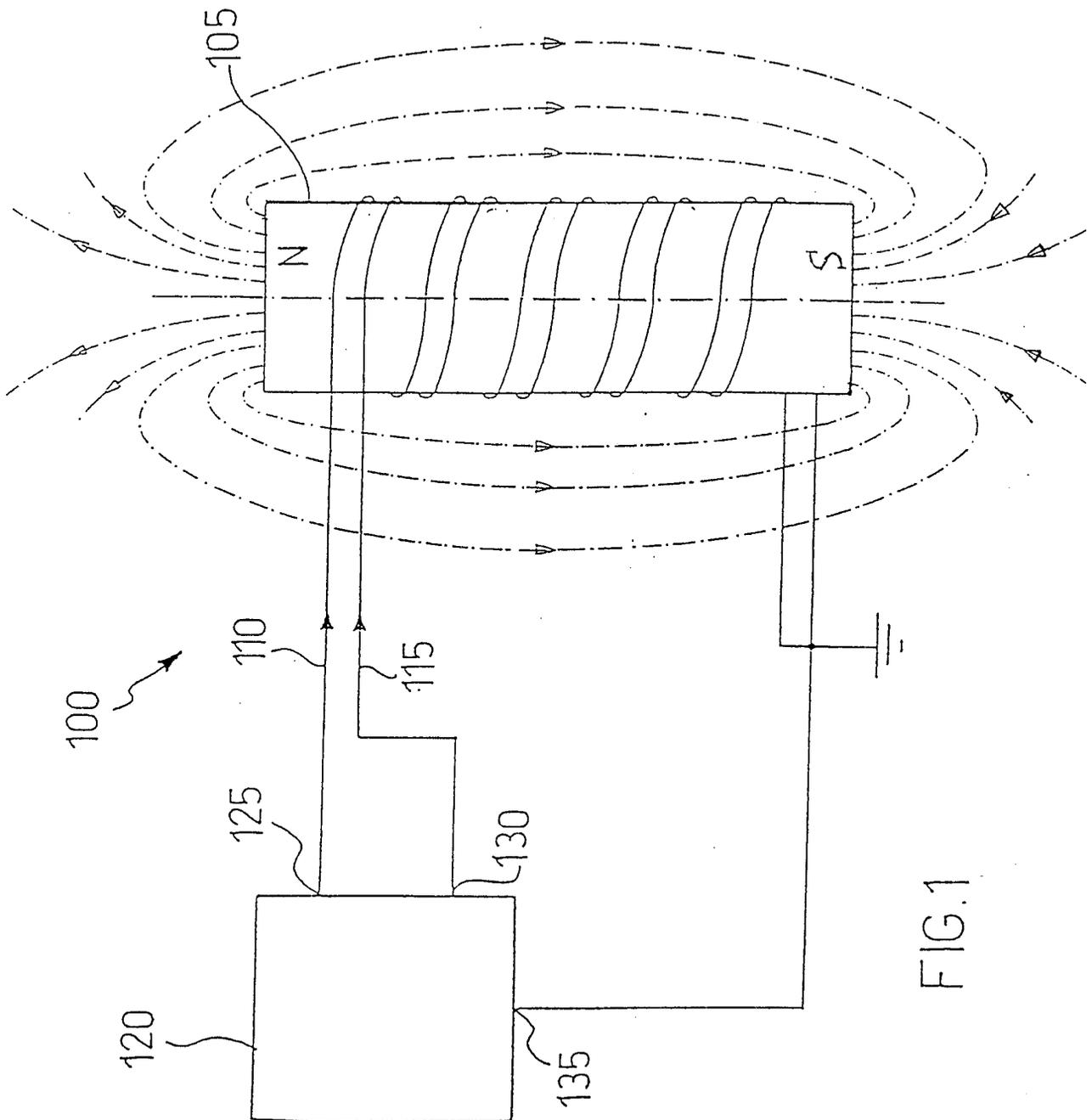


FIG.1

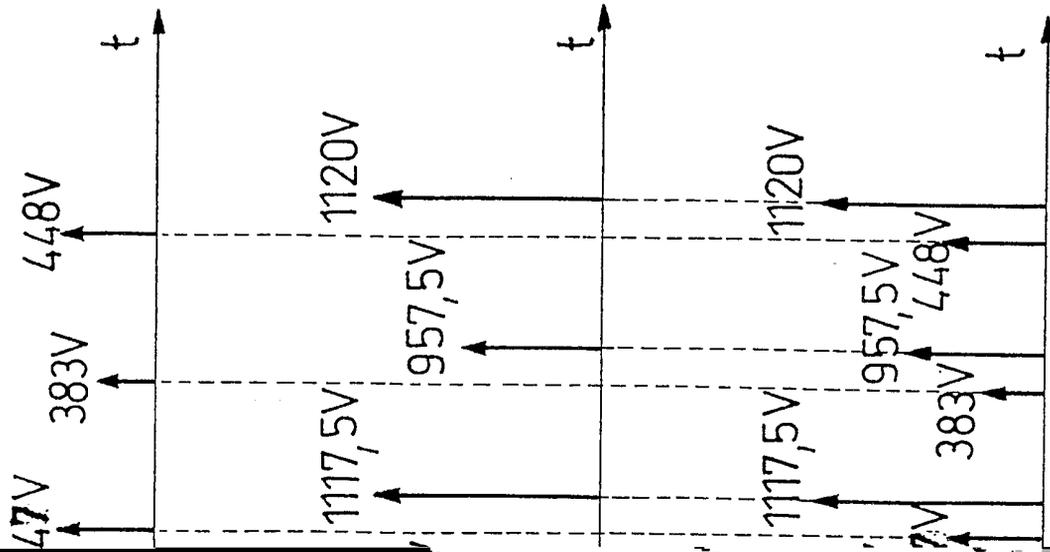
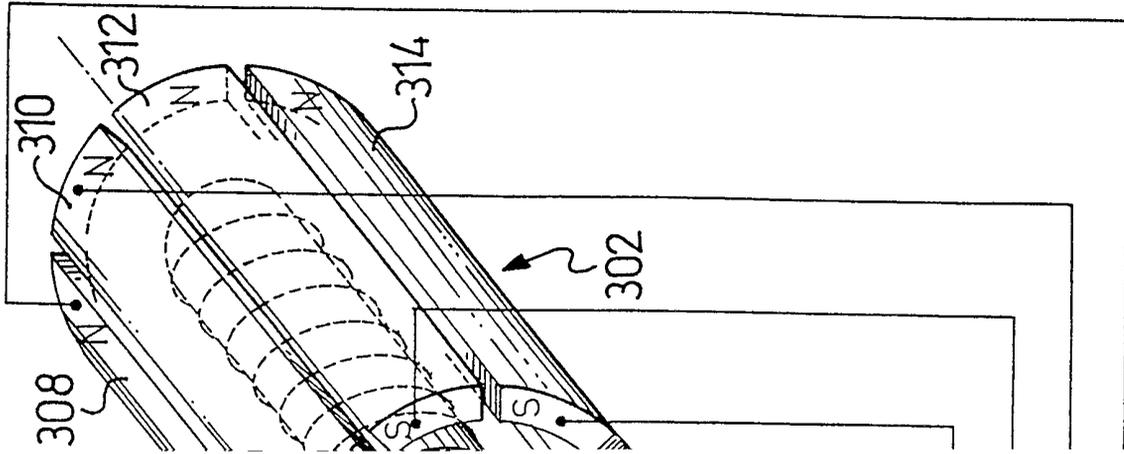


FIG.2



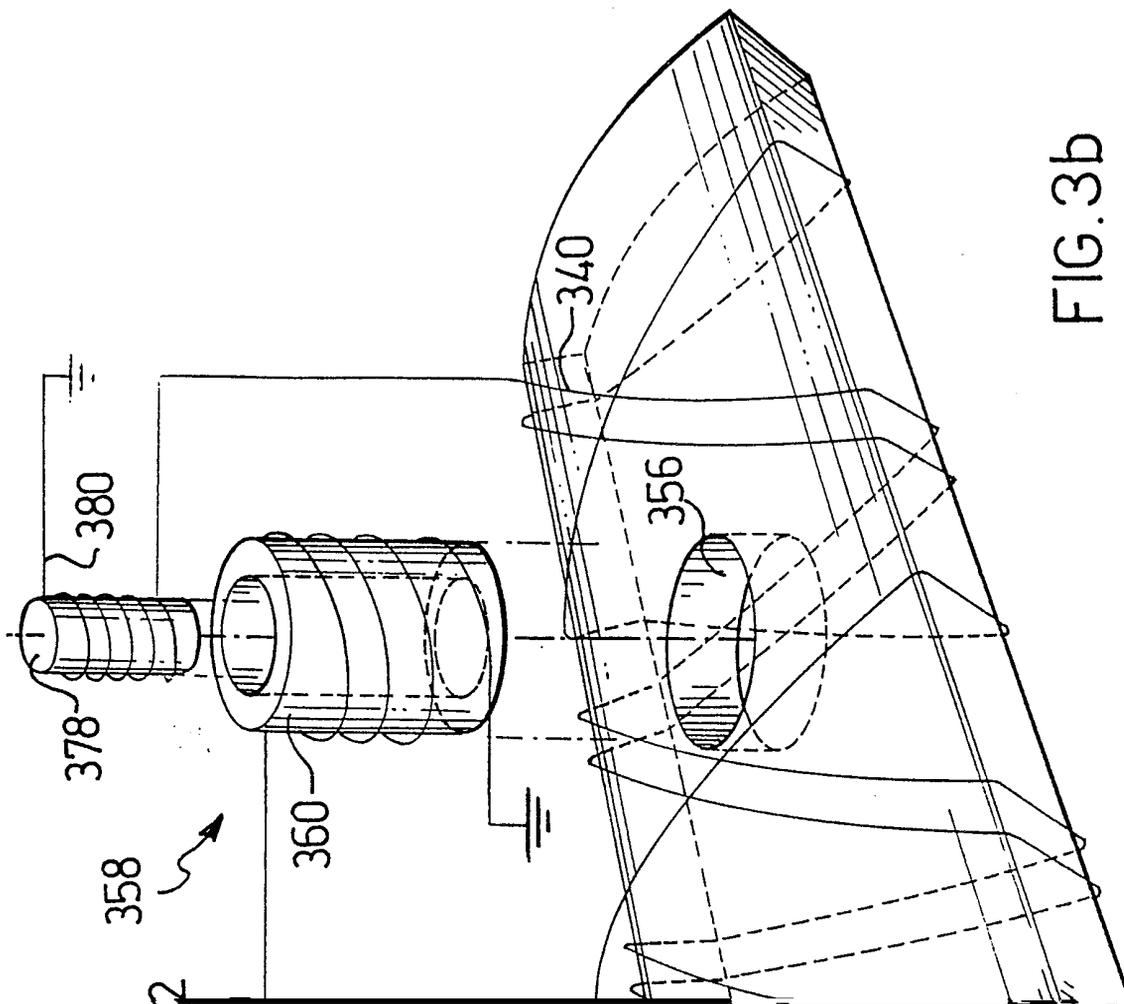


FIG. 3b

# 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.

° Special categories of cited documents :

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

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 European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer  Leouffre, M
--	---------------------------------------

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/IT 97/00054

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 4039236 C	27-05-92	DE 4002883 A	08-08-91
-----			
EP 0162966 A	04-12-85	DE 3420034 A	05-12-85
-----			
US 3999090 A	21-12-76	AU 497791 B	11-01-79
		AU 1725276 A	02-03-78
		CA 1050600 A	13-03-79
		CH 600661 A	30-06-78
		DE 2644238 A	07-04-77
		FR 2326798 A	29-04-77
		GB 1557071 A	05-12-79
		JP 52066906 A	02-06-77
		JP 52042809 A	04-04-77
		SE 7610666 A	31-03-77
-----			
WO 9637944 A	28-11-96	AU 5923696 A	11-12-96
-----			