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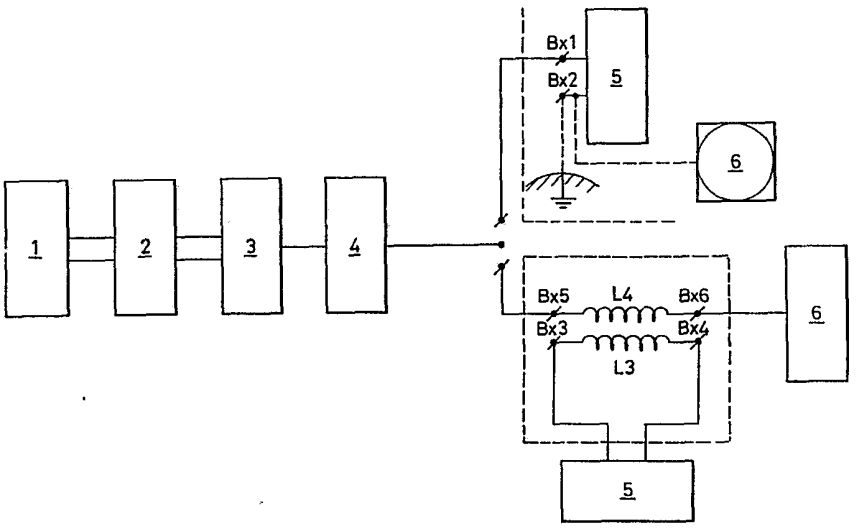
(54) Title: APPARATUS AND METHOD FOR SINGLE LINE ELECTRICAL TRANSMISSION



(57) Abstract

This invention is in the area of electrical technology, of a means for the continuous transformation of electrical energy with its subsequent transmission from the initial source to a consuming device via a single-wire transmission line. The purpose of the invention is the creation of a highly efficient means for the transformation and transmission of electrical energy, employing both fixed and mobile devices which transform the electrical energy of initial sources and transmit it to consuming devices in a manner involving significantly reduced losses of Joulean heat resulting from the ohmic resistance of the transmission lines, and also the reduction of the metal content of such line. The invention may be used in conjunction with various power-generating and technological processes based on the use of super-high voltage electrical and electromagnetic fields, electron beams and long-wave radio links. The purpose of the invention is achieved by means of the transformation of the electrical energy from the initial source into the energy of oscillation of a field of free electrical charges (the displacement current or longitudinal wave of an electrical field), which energy is transmitted to the consuming device via a single-wire transmission line and, where necessary, transformed into the electrical energy of the conductive currents of a closed circuit.

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APPARATUS AND METHOD FOR SINGLE LINE ELECTRICAL TRANSMISSION

Area of Technology

This invention is in the area of electrical technology, and relates to a means (method) for the continuous transformation of electrical energy with its subsequent transmission from the initial source (transformer) to a consuming device, and also to an apparatus for the implementation of this method of transformation and the supplying of power to electrical devices through a transmission line consisting of a single conducting wire.

Background Art

There exists a means for the transmission of electrical energy along a single conducting wire which does not form a closed circuit. It is based on the discovery in 1729 by the English physicist Stephen Grey of the phenomenon of electrical conductivity. The essence of this phenomenon consists in the fact that electricity may be transmitted from one body to another along a metal conductor or a length of yarn, and that the electrical charge is distributed over the surface of the conductor.

Yu. A. Khramov, Physicists: A Biographical Reference Book. Moscow, "Nauka", 1983 (in Russian); Dictionary of Scientific Biography. New York, Charles Scribener's Sons, 1970-1978.

A well known means for the supplying of power to electrical devices has existed since the creation in 1799 by the Italian scientist Alessandro Volta of the first source of prolonged electrical current (Volta's column). This means is based on the transmission of electrical energy generated in the initial source to the consuming device directly through a transmission line consisting of two conducting wires which together with the source and the load form a closed circuit.

Yu A Khramov, Physicists: A Biographical Reference Book. Moscow, "Nauka", 1983 (in Russian); M I Radovsky. Galvani and Volta, Moscow-Leningrad, 1941 (in Russian); G. Polvani. Alessandro Volta, Pisa, 1942.

There exists a means for the supply of power to electrical devices based on the discovery made by M Faraday and J Henry of the phenomenon of electromagnetic induction (published by M Faraday in 18310, and on the invention by P N Yablochkov in 1876 of the electrical transformer. The essence of this means consists in the transformation of the current or the voltage of electrical energy generated in the initial source and the transmission line to the consuming device.

M Faraday Experimental Research in Electricity, Moscow-Leningrad, Publishing House of the Academy of Sciences of the USSR, 1947-1959 (in Russian); Yu A Khramov, Physicists: A Biographical Reference Book. Moscow, "Nauka", 1983 (in Russian); The Large Soviet Encyclopedia, Third Edition, Bol 26 Moscow, "Soviet Encyclopedia", 1977 (in Russian).

There exists a means for the supplying of power to electrical and radio devices by using an electromagnetic field. This means is based on G Herz;s experimental proof in 1888 of the existence of electromagnetic waves, the discovery of which was forecast by J Maxwell in 1865. the means essentially consists in the tansformation of electrical energy from the initial source into an electromagnetic field which is radiated in to space and received by the consuming device.

Dictionary of Scientific Biography. New York, Charles Scribener's Sons, 1970-1978. Yu A Khramov, Physicists: A Biographical Reference Book. Moscow, "Nauka", 1983 (in Russian); J K Maxwell, Selected Works on Electromagnetic Field Theory, Moscow "Gosizdat", 1954 (in Russian).

It is believed to have been proposed to provide a means for the supply of power to electrical devices via a

single-wire transmission line, demonstrated by N Tesla in the late nineteenth century.

Nikola Tesla, 1865-1943. Lectures, Patents, Articles. Belgrade, 1956; John O'Neill: Electrical Prometheus. Moscow*, "History of Technology" 1944 (in Russian)); B N Rzhonsnitsky. Nikola Tesla Moscow "Molodaya Gvardiya", 1959 (in Russian); G K Tsverava. Nikola Tesla. Leningrad, "Nauka" 1974 (in Russia).

There also exists an electrical device for the transmission of the energy of free electrical charges from the initial source by means of a non-conducting ribbon. This is the so-called high voltage electrostatic generator, which was designed and constructed by the American physicist Van de Graaf between 1929 and 1933. In this device electrical charges are sprayed from needles under high voltage on to a moving ribbon and transferred to an insulated metal dome, where they accumulate. The charges may be sprayed on to the ribbon and collected from it; the ribbon and the dome may be negatively or positively charged.

K E Swarts. The Uncommon Physics of Common Phenomena, Vol 2. Translated from the English by E I Butikov and A S Kondratiev, Moscow, 1987 (in Russian); Yu. A. Khramov, Physicists: A Biographical Reference Book. Moscow, "Nauka", 1983 (in Russian).

Objects of The Invention

The primary goal of the invention is a significant reduction in the losses of Joulean heat resulting from the ohmic resistance of a power transmission line in the process of transmitting electrical energy from the initial source to a consuming device, and also a simultaneous reduction int eh metal content of the transmission line.

Summary of The Invention

In part of the means this object is at least particularly achieved by the transformation of the

electrical energy generated in the initial source into the energy of oscillation of a field of free electrical charges (the displacement current or longitudinal wave of the electrical field), which energy is transmitted to the consuming device via a single wire transmission line and, where necessary, transformed into the electromagnetic energy of closed circuit conductive currents.

The oscillations of the field of free electrical particles occur either by means of the reciprocating (cyclical) displacement of a concentrated electrical charge in space, or by means of a periodical change in density (and/or polarity) of the free electrical charges on a particular surface (in a particular volume).

In part of the apparatus the goal is achieved by including in the apparatus an alternating density generator of free electrical charges, which flow under the influence of coulomb forces along a single-wire transmission line to the site of a device which consumes electrical energy. A possible variant of the generator is a generator at the outlet of which not only the density of the free electrical energy charges, but also their polarity, may be varied. The outlet of the generator is connected to a single-wire transmission line either directly or via a blocking capacitor.

In addition, the generator of oscillations of the electrical field of free charges may be constructed in a similar fashion to a generator of displacement current (travelling longitudinal waves of an electrical field), by using a sequential resonance circuit in the form of two interconnected inductors such that the equivalent inductivity of the resonance circuit is provided by their resultant inductivity, and the equivalent capacity of the resonance circuit is provided by the equivalent (natural) capacity of the interconnected inductors.

To supply power to electrical devices which consume alternating current, the output of the single-wire transmission line is connected:

a) to one of the input terminals of the receiving devices, while the device's other input terminal is either earthed or connected to any conductor possessing a natural (equivalent) capacity adequate to provide for the normal working of the receiving (consuming) device.

b) to an accommodating device employing a conversion circuit consisting of two interconnected inductors, such that the receiving device (load) is connected to the two ends of the first inductor, the output of the single-wire transmission line is connected to one end of the second inductor, and the other end of the second inductor is connected to any conductor with an equivalent (natural) capacity and inductance selected in order to provide for the nominal power consumption of the receiving device (load).

To supply power to devices consuming direct current, the single-wire transmission line is connected to an adjustment circuit in the form of:

c) a diode system, such that the output of the single-wire transmission line is connected to the common point of the anode of the first diode and the cathode of the second diode, while the cathode of the first diode and the anode of the second diode are the output points for connection to the receiving device, either directly or with a capacitor connected in parallel.

d) a transformer circuit consisting of two interconnected inductors such as to rectify alternating current (voltage) directed to the receiving device from the first inductor.

Brief Description of the Drawings

In order to provide a better understanding of the invention, there follow specific examples of its construction with references to the drawings attached, in which:

Fig 1 shows a block diagram of the proposed device in a first construction variant (embodiment);

Fig 2 shows a second construction variant of the present invention, employing a sequential resonance circuit;

Fig 3 shows a power supply diagram for receiving devices operating on alternating current; and

Fig 4 shows the power supply diagram for receiving devices operating on direct current.

Fig 5 illustrates the distribution of amplitudes of voltage and electric current for a short length of line equal to a 1/4 wavelength;

Fig 6 illustrates the distribution of voltage and current for an unclosed line having a 1/8 wavelength.

Description of First Embodiment

A means for supplying power to electrical devices, including the generation and transformation of electrical energy with its subsequent transmission to a receiving device via a transmission line, this means being distinguished by the fact that the electrical energy generated is transformed into the energy of oscillation of a field of free electrical charges (the displacement current or longitudinal wave of an electrical field), the density of which charges varies in time, and this energy is transmitted via a single-wire transmission line and, where necessary, transformed into the electromagnetic energy of conductive currents.

Referring to Fig 1, in illustrated an apparatus for initial source of electrical energy 1, a transformer (of current, voltage or frequency) 2, an alternating density generator of free electrical charges 3, which charges flow under the influence of coulomb forces along a transmission line 4, through a consuming device 5, to any conductive body 6, which has an equivalent (natural) capacity sufficient to provide for the normal working of the consuming device 5.

Description of Second Embodiment

Referring to Fig 2, in addition, the apparatus may be constructed on the basis of a generator of displacement current (longitudinal wave of an electrical field), using a sequential resonance circuit (Fig 2) in the form of two interconnected inductors L1 and L2 such that the equivalent inductivity Leq of the resonance circuit is provided, in the simplest case of idle running, by the resultant inductivity L1,2, and the equivalent capacity is provided by the resultant (natural) capacity of the resonance circuit.

To supply power to electrical devices operating on alternating (variable) current, the output of the single-wire transmission line 4 is connected:

to one of the input terminals Bx 1 of the receiving device 5 (Fig 3), and the other input terminal Bx 3 of the receiving device is either earthed or connected to any conductive body 6 possessing an equivalent (natural) capacity adequate to ensure the normal working of the receiving device 5.

to an accommodating device, employing a transformer circuit (Fig 3) consisting of two interconnected inductors L3 and L4, such that the two ends Bx3 and Bx 4 of the inductor L3 are connected to the receiving device 5, while one end of the ends Bx 5 of the second inductor L4 is connected to the output of the single-wire transmission line 4, and the other end Bx6 of the inductor L4 is connected to any conductive body 6, with

an equivalent (natural) capacity selected in order to provide the nominal power consumption of the receiving device 5.

To supply power to electrical devices operating on direct current, the output of the single-wire transmission line 4 is connected to an accommodation circuit in the form of:

a diode circuit (Fig 4) such that output of the single-wire transmission line 4 is connected to the common point of the anode of the first diode VD1 and the cathode of the second diode VD2, while the cathode of the first diode VD1 and the anode of the second diode VD2 are the outlets 01 and 02 to be connected to the receiving device 5, either directly or with a capacitor connected in parallel;

a transformer circuit (Fig 4) employing two interconnected inductors L5, L6, such that the receiving device 5 is connected to the inductor L5 via the rectifying circuit.

According to the invention, the proposed means for the supply of power to electrical devices and the apparatus for the implementation of this means possess a high degree of reliability due to the absence of complex electronic or mechanical assemblies, they permit the use of inexpensive mass-produced radio-electronic components and their working cycle is automatically regulated to a high degree.

The production of the invention will make possible a sharp reduction in the costs involved in transmitting electrical energy over long distances, and a sharp reduction in the losses of Joulean heat from transmission lines.

The invention is intended for the creation of a highly efficient means for the transformation and transmission of electrical energy, and also for the creation of both permanent and mobile devices for the transmission of electrical energy from an initial source

to a consuming device via a single-wire transmission line.

The invention may be used conjointly with various power-engineering and technological processes which involve the use of super-high voltage electrical and electromagnetic fields, electron beams and super-long wave radio communications, when it will make possible a sharp reduction in the dimensions and weight of equipment as compared with the means traditionally employed.

Devices constructed in full compliance with Tesla's patents have a very low C.O.P. (coefficient of efficiency). This can be explained on the one side by the absence of technology for construction of such systems, which in fact had been worked out by Tesla himself and on the other side by the absence of the strictly outlined theory of electromagnetic wave generation, as the radio science was only about to be born. The founder of this science was N Tesla with his resonance transformer, patented on the 25th of April 1891 under number 390414. This transformer could generate high voltage oscillations of high frequency.

Carrying out experiments with his resonance transformer Tesla came to what modern radio science calls "resonant line" or "1/4 wavelength transformer", which is used to coordinate lines. Line coordination is transformation of the loads resistance into active resistance which equals to the wave resistance of the line. A short length of an unclosed line with the length of 1/4 or full number of wave quarters is equal to a step-up or a step-down voltage (current) transformer. Distribution of the amplitudes of voltage and electric current for a short length of the line which is equal to the 1/4 of the ware length is shown in Fig 1. This distribution derives from combination of falling and reflecting waves. As is shown in the Fig 5(a) with Rh > , where - wave resistance of the line, the line works as a step-up transformer: its outcoming voltage is higher in magnitude than the incoming one as well as its

outcoming currents less in magnitude compared to the incoming one. So the coefficient of transformation in this case equals to the magnitude of the outcoming voltage divided by the magnitude of the incoming voltage. The higher is the magnitude of the loads resistance the higher is the coefficient of transformation. The highest coefficient of transformation had an unclosed 1/4 wavelength line (Rh =). As is shown in Fig 5(b) with RH < the line acts as a step-down transformer: its outcoming potential is lower than the incoming one as well as its outcoming current is higher than the incoming one.

Distribution of amplitudes of voltage and current for an unclosed line the wavelength /8 is shown in Fig 2:

a) distribution of amplitude of current and voltage;

b) graphics of incoming current and voltage;

Im bx - max amp of the incoming current;

Vm bx - max amp of the incoming voltage;

Vm st - max amp of the standing wave voltage;

Im st - max amp of the standing wave current.

There are some points on the line where voltage always equals to zero, while the current has max amplitude which is equal to the double amplitude of the falling wave. In these points both falling and reflective waves of the potential are always equal in magnitude but opposite in sign while falling and reflecting waves of the current are equal in magnitude and coincide in direction. These points are called voltage nodes.

Along with the abovementioned points there some other points on an unclosed line with the max amplitude of voltage which is equal to the double amplitude of the falling wave and the current is always equal to zero. In these points both falling and reflecting waves of the voltage are equal in magnitude and in sign, while those

of the current are equal in magnitude but opposite in direction. These points are called current nodes. Taking into consideration the above stated we, hereby, claim that Tesla's resonance transformer was nothing else but a kind of common transformer with a 1/4 wavelength unclosed line. Tesla's patent entitled "Apparatus For Transmitting Electrical Energy" 1,119,732 (patented Dec 1st, 1914) mentioned in the report "Modern Resonance Transformer Design Theory" by D C Cox, convincingly proves this claim. in the figure of this patent (counter to the electric circuit by R A Ford in his article "Tesla Coil Secrets") the construction of Tesla's resonance transformer combined with 1/4 wavelength unclosed line is vividly presented. As one can see in the figure of this patent Tesla's transformer consists of two single layed coaxial coils A and C, which in fact are a step-up transformer with an empty core and a 1/4 wavelength unclosed line in the form of single layed coil B, with another conductors of the construction attached to it. The two coils A and B should compulsory be singled layed, otherwise they will fail to provide favourable conditions for generating standing waves. But if you draw the coil C above the coil B, but not the coil A, while everything else remains unchanged in Tesla's figure of his patent, on equal distances from the terminals of the coil C, the conditions of work of this system will change completely. The outcoming voltage on terminals D and P will be greatly reduced, the efficiency of the system will decrease because we "deprive" it of the 1/4 wavelength unclosed line which does actually generate high outcome voltage. Beside these technological aspects it should be noted that the coil A which is connected in series to the coil B, plays the role of a 1/4 wavelength transformer for the coil B, thus, providing a zero potential for the secondary coil A, placed close to the primary coil C, or in other words - provides for the coil A zero voltage and max current. At the same time coil A is having a bigger diameter compared to the one of the coil B besides being

a step-up coil for the voltage of the secondary coil of the air transformer, ie. playing the role of a generator, feeding a 1/4 wavelength line (which is represented in form of the coil B). The fact that scientists and researches are not aware of these technological peculiarities dooms to failure their attempts to repeat construction of this device using Tesla's resonance transformer as their calculations are based on electric scheme published in the scientific press similar to the one, given by R A Ford, which does not contain correspondent technological peculiarites. To our opinion, the main drawbacks of Tesla's patent entitled "Apparatus For Transmitting Electrical Energy" are as follows:

Single layer's construction of secondary coils of the transformer in between the primary and secondary coils, and brings the necessity to increase the incoming voltage for the primary coil up to hundred and thousands of volts, augmenting simultaneously diameters of the primary and secondary coils up to a couple meters with working frequencies up to some dozens of kHz.

possibility of effective work only for the unclosed line (antenna) that is in the regime of radio frequency radiation.

possibility to transmit electric energy to other consumers only due to electromagnetic radiation, which leads to a very low C.O.P. of transmission.

dimensions of the apparatus are acceptable for work on high frequencies only (hundreds of kHz).

The method and apparatus of the present invention does not have the drawbacks of previously know single line systems. The proposed device which may be termed a "monovibrator" consists of two inductively connected much layed coils in accordance with the scheme of a consecutive resonance circuit. As a rule, the secondary coil consists of up to some tens of thousands of winds (turns) of thin isolated wire with the winds wound one to another in many layers on a dialectic carcass (former).

Disposition of the primary coil in respect to the secondary one doesn't matter much. What does matter is an inductive link which determines potential transmitted from the primary to the secondary coil. Monovibrator can have a ferromagnetic core, as well as it may not have on. The ferromagnetic core influences the width of working frequencies lane (bandwidth) - it broadens it.

High working outcoming voltage is the result of a high coefficient of transformation, as the primary coil usually contains a couple of dozens of winds for working frequencies ranging from 1kHz to a couple of hundred kHz. A preferred working frequency is 5kHz.

With the characteristics, specified in claim 3, the load of monovibrator when running idle acquires capacitance character that means that it is reactive. The magnitude of an active constituent of a monoconductive line with the consecutive resonance is rather low and its incoming resistance is approaching zero. That is why with rather a powerful primary source the consecutive resonance makes it possible to transmit more power through the monoconductive line in case there is an outtake of this power at the other line terminal, which is opposite to the primary source of power.

Reaction of the monoconductive line of any length can always be compensated by regulated within frequency range primary source (generator, converting devices), thus providing consecutive resonance in the line itself with all the magnitudes of incoming and outgoing characteristics arising therefrom.

Currently there are different schemes of automatic frequency regulation of generators of alternating electromotive power depending on changing inductive-capacitant parameters of conductive lines.

Claims

1. A method of supplying power to electrical devices, including a process for the generation and transformation of electrical energy with its subsequent transmission to a receiving device via a transmission line, the means being **characterised by** the transformation of the electrical power which is generated into the energy of oscillation of a field of free electrical charges such as the displacement current or longitudinal wave of an electrical field, the density of which charges varies in time, and the transmission of this energy via a single-wire transmission line and, where necessary, its transformation into the electromagnetic energy of conduction currents.

2. An apparatus for the implementation of the method of claim 1, the apparatus is providing an initial source of electrical energy, a transforming device, a transmission line and a receiving device, the apparatus being **characterised by** the including of a variable density generator of free electrical charges, the output of which is connected by means of a single-wire transmission line to a receiving device, either directly or via a blocking capacitor, and further to any conductive body possessing an equivalent (natural) capacity adequate to ensure the normal functioning of the receiving device.

3. An apparatus as claimed in claim 3, **characterised in that** the generator of oscillations of the field of free electrical charges, such as displacement current or longitudinal wave of an electrical field, employs a sequential resonance circuit in the form of two interconnected inductors (L1) and (L2), such that the equivalent inductance (Leq) of the resonance circuit is provided, in the simplest case, by the resultant inductivity (L1 + L2), and the equivalent capacity adequate to ensure the normal functioning of the receiving device.

4. An apparatus as claimed in claim 3, **characterised in that** the supply of power to electrical devices operating on alternating current, the output of the single-wire transmission line is connected to an accommodating device which employs a transformer circuit consisting of two or more interconnected inductors, such that the two ends of one of these inductors are connected to the receiving device, while one of the ends of the other inductor is connected to the output of the single-wire transmission line, and the other end of this inductor is connected to any conductive body possessing an equivalent (natural) capacity adequate to ensure the normal functioning of the receiving device.

5. An apparatus as claimed in claim 4, **characterised in that** the fact that for the supply of power to receiving devices operating on direct current, such devices are connected to the output of the single-wire transmission line by means of accommodating devices in the form of:

a) a diode circuit such that the common point of the anode of the first diode and the cathode of the second diode is connected to the output of the single-wire transmission line, while the cathode of the first diode and the anode of the second diode are the outlets to be connected to the receiving device, either directly or with a capacitor connected in parallel;

b) a transformer circuit employing two interconnected inductors, such that the receiving device is connected to one of the inductors via a rectifying circuit.

6. An apparatus as claimed in claim 3, **characterised in that** the two interconnected inductors (L1, L2) comprise two inductively connected coils in accordance with the scheme of a consecutive resonance contour, the second coil (L2) comprising a plurality of turns of isolated wire with the turns wound round a dielectric former.

7. An apparatus as claimed in claim 6, **characterised in that** the inductors have a ferromagnetic core.

8. An (electrostatic) generator for use in the apparatus of any of claimed 3 to 7.

9. A receiving device for use in the apparatus of any of claims 2 to 8.

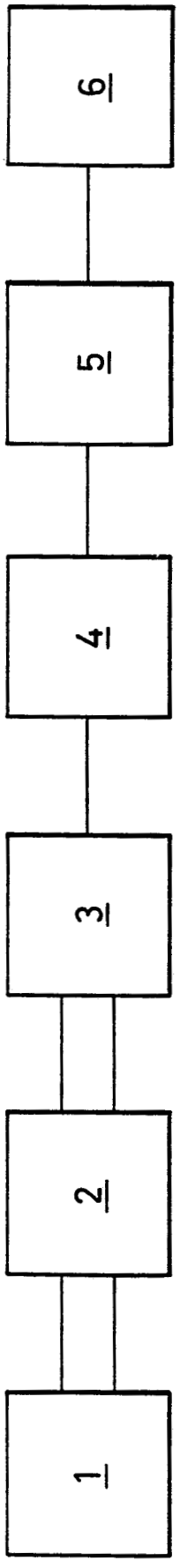

Fig.1

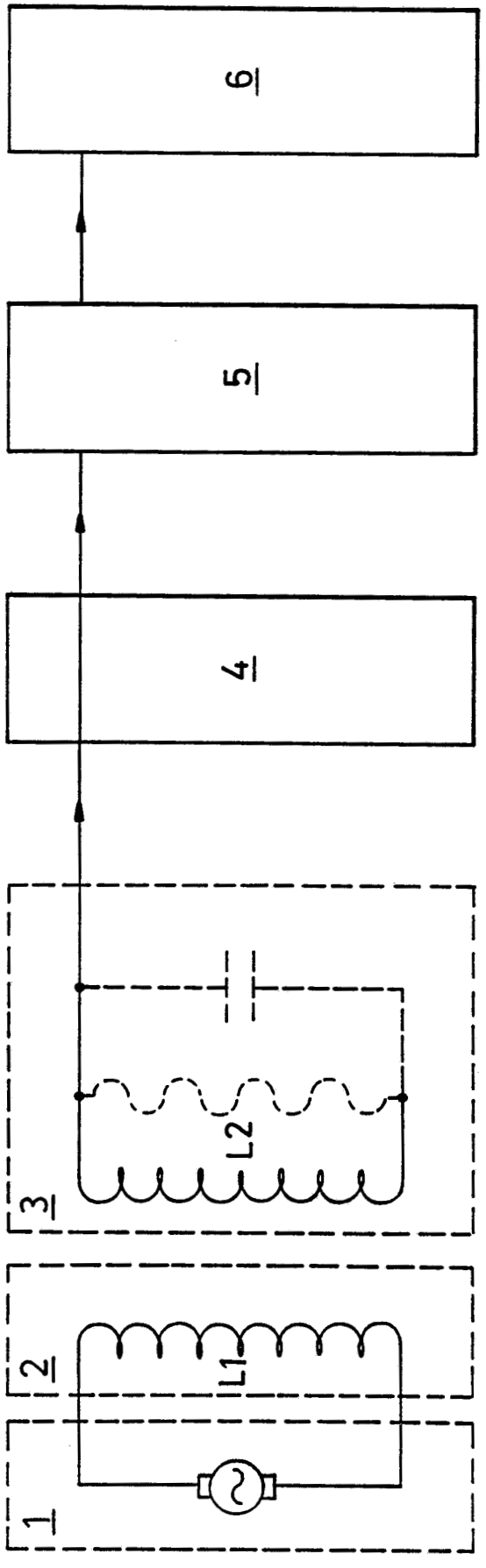

Fig.2

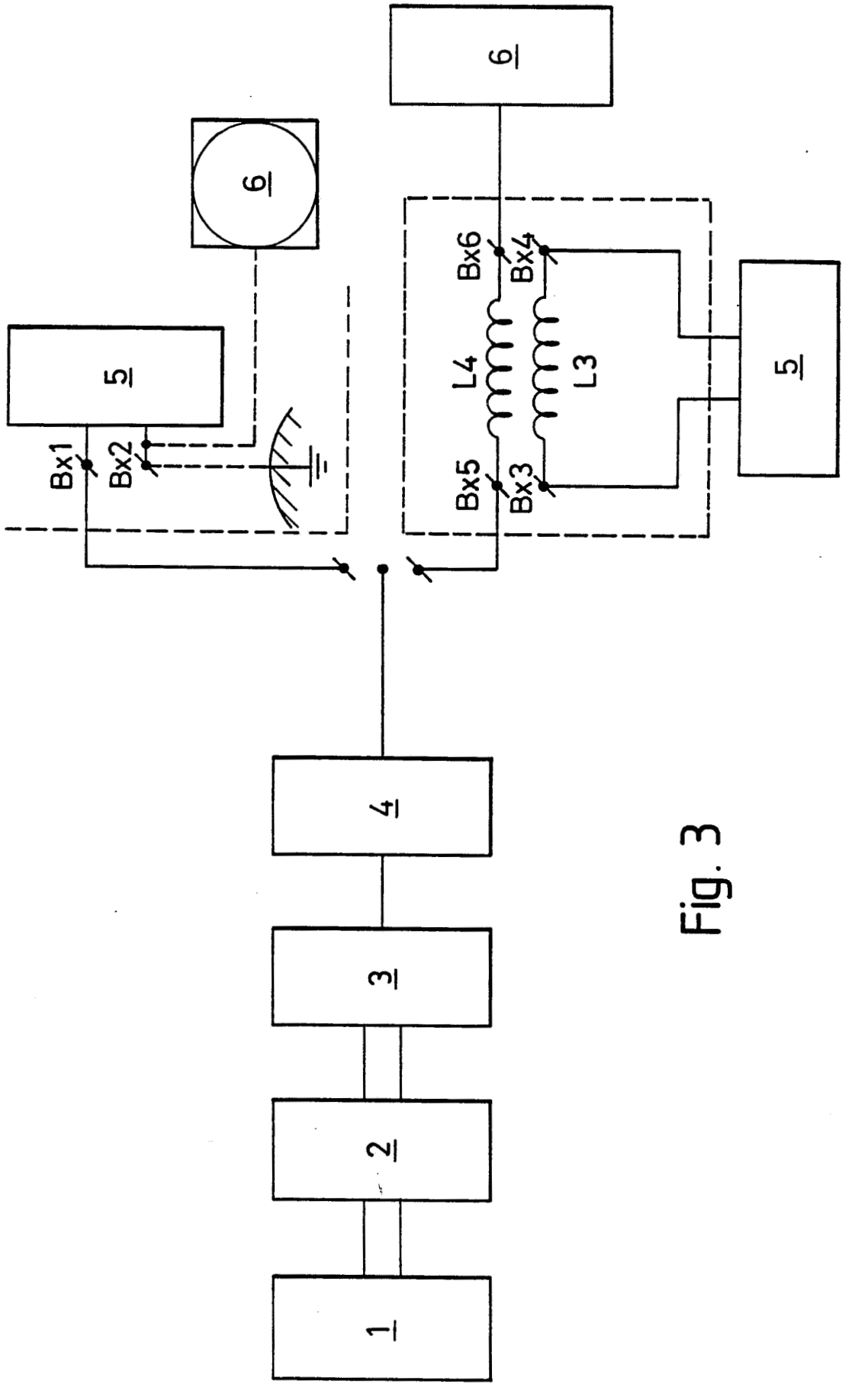

Fig. 3

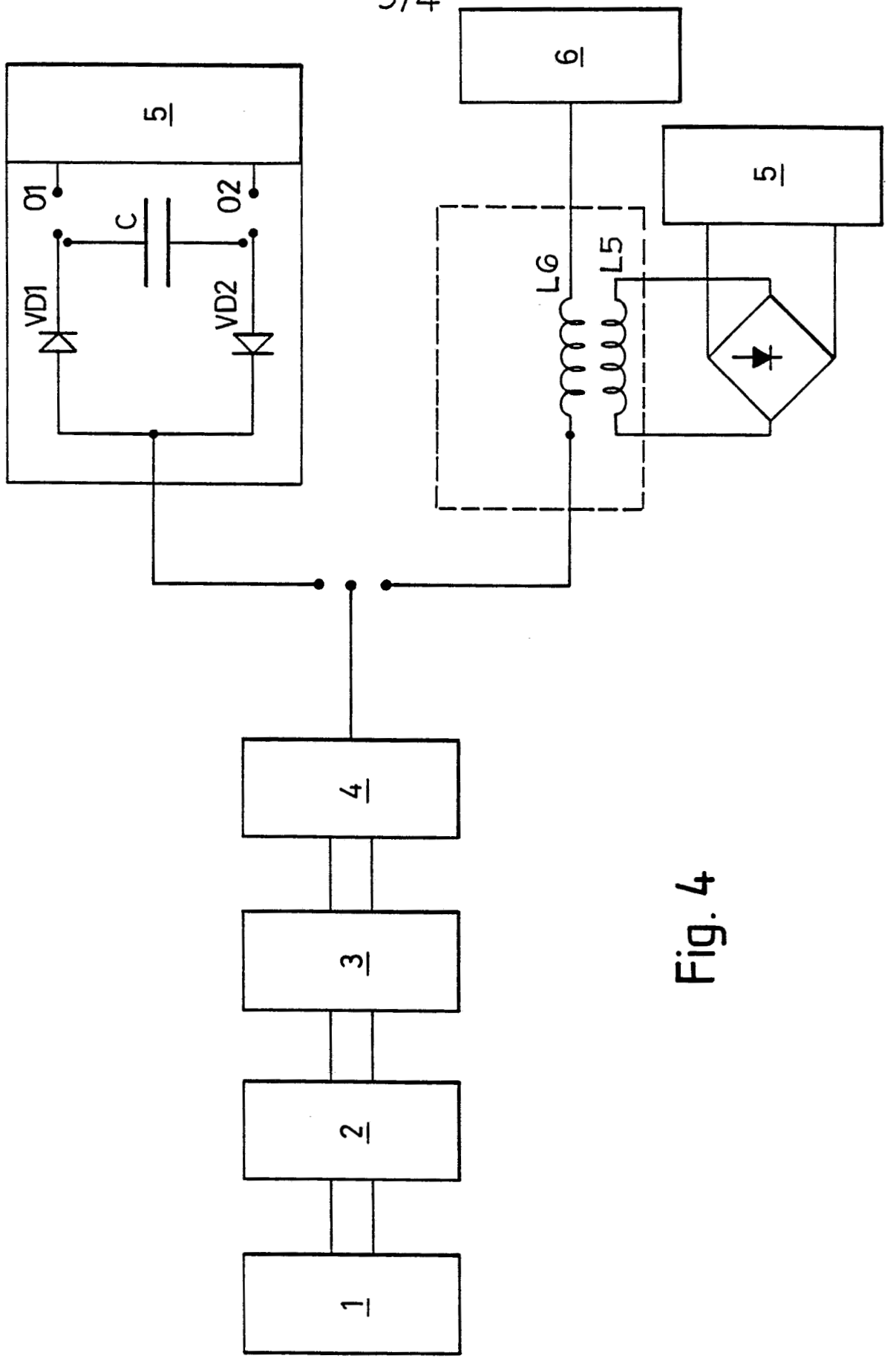

Fig. 4

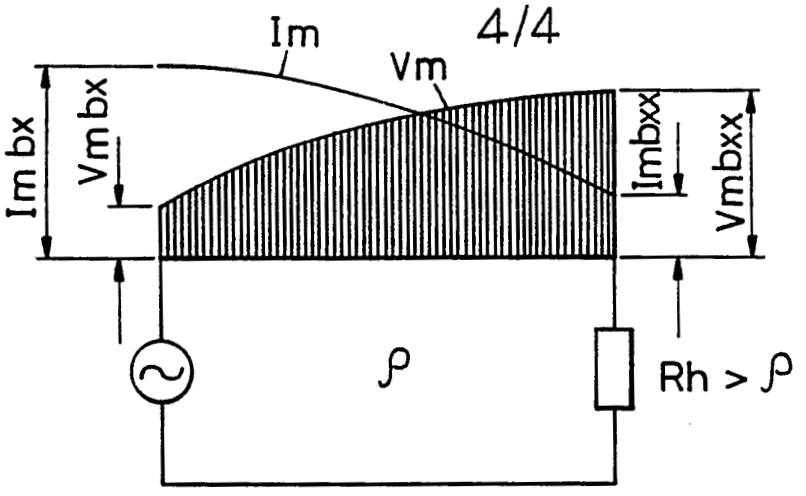

Fig. 5(a)

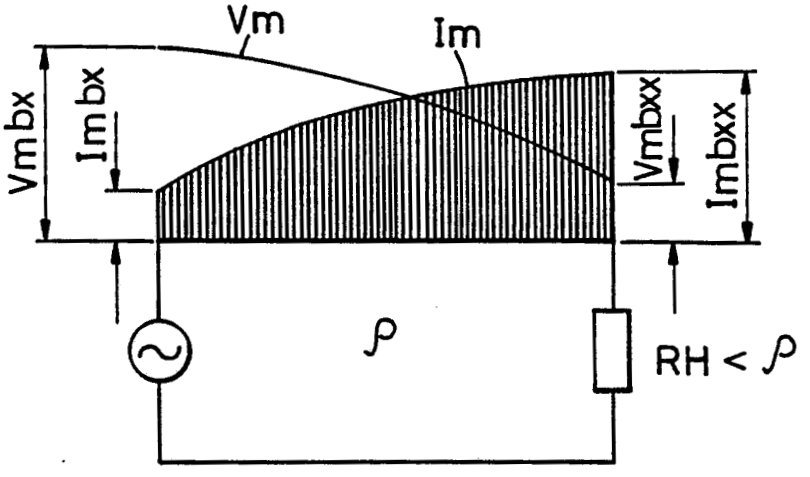

Fig. 5(b)

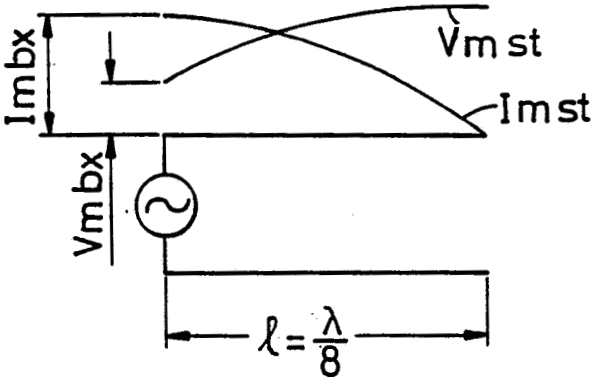

Fig. 6(a)

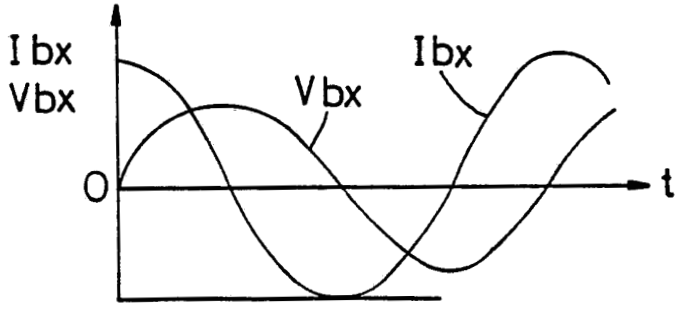

Fig. 6(b)

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 93/00960

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 H02J17/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	H02J ; H04B ; H01P

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	IECEC-91 4 August 1991, BOSTON pages 404 - 409 , XP312837 GROTZ 'wireless transmission of power,an attempt to verify nikola tesla's 1899 colorado springs experiments,results of research and experimentation' see the whole document	1-3

° Special categories of cited documents :[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
17 AUGUST 1993	25. 08. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	CALARASANU