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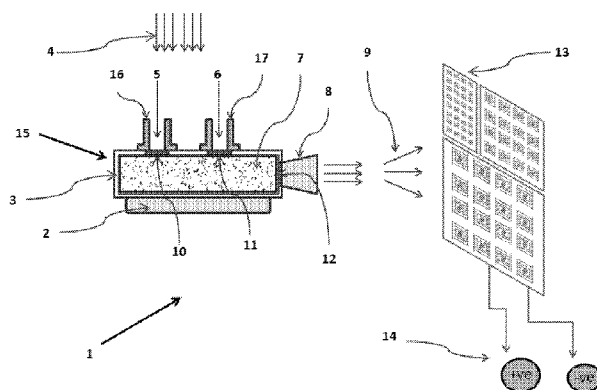
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(54) Title: WIRELESS TRANSMISSION OF ELECTRICITY



- (57) Abstract: This invention is related to transfer of electrical energy without wires in any transmission medium. A wireless electric power transfer system works by converting electrical energy to large wavelength photons such as microwave/radio-wave photons using a photon beam generator and directing the beam to a rectifier antenna array which reconverts the photons into electricity. The wireless electric power transfer system 1 is comprised of a photon beam generator 15, a source of electromagnetic waves 4 to pump the photon beam generator 15 and a rectifying antenna array 13 that captures and converts the generated photons into electricity. The photon beam generator 15 is further comprised of a cavity 3 that contains a medium of molecules 7 that have a dipole moment and are pumped to their higher rotational or vibrational or ro-vibrational energy levels. The de-excited molecules emit microwave/radio-wave photons out of the aperture 12 to form a photon beam 9 striking a rectifier antenna array 13 which converts the microwave/radio-wave photons into electricity.



WIRELESS TRANSMISSION OF ELECTRICITY

TECHNICAL FIELD:

This invention is related to the transmission of electrical power wirelessly through the earth's atmosphere, where air is the main medium. The disclosed system could also be adapted to space where there is void. The disclosed new system could also be used when the transmission medium is water. The disclosed system could also be used on other planets where the atmospheres are different than earth's atmosphere. The same disclosed system could be used as a communication system that works in all of the transmission media as stated above. The disclosed system is mainly intended to transfer energy at larger distances, but it could also be used in applications where energy transfer is required at near distances.

DESCRIPTION OF THE RELATED ART:

Various methods exist today to transmit electricity without wires. Basically all of them use a combination of an emitter device that emits electromagnetic energy & a receiving device that captures the electromagnetic energy. The emitters could emit electromagnetic energy in the form of light using lasers or in the form of microwaves using microwave transmitters. The receptors could be photo voltaic cells that captures the laser light and reconverts it into electricity or an antenna that captures the electromagnetic energy and reconverts the captured energy into electricity.

Direct induction & resonant magnetic induction are the most efficient means to transfer wireless power, but only at near distances. Transmission of electromagnetic energy can take place by coupling two induction coils through a process known as mutual induction. With this method it is possible to transmit and receive significant amounts of energy but the two inductors must be placed close to each other. There exists a certain frequency for a coupled system of inductors

having a matched inductance at which the transfer of energy is maximum. This is known as the resonant frequency. If resonant coupling is used, where inductors are matched to a mutual frequency, significant power may be transmitted over even greater distances in range of meters.

Described below are various methods to achieve wireless electrical energy transfer and their limitations.

ENERGY TRANSFER USING LIGHT:

Light is an electromagnetic wave at extremely short wavelengths and therefore can be used to transmit electromagnetic energy, but due to its high frequency it has its limitations. Power can be transmitted by converting electricity into a light beam or a laser beam which is focused at a photovoltaic panel receiver. This is generally known as "power beaming". Lasers are mostly used to transmit at light frequencies as their beams have high coherence and thus high directionality. At NASA Marshall Space Flight Center, NASA conducted experiments with lightweight model aircrafts powered by laser beams. They focused a laser beam on a panel of photovoltaic cells embedded on the model aircraft to achieve the first flight of an aircraft powered by a laser beam.

The mains drawbacks of power beaming using light are:

- The inefficient conversion of electricity into light and vice versa, light into electricity. A few years back inefficient conversion of electricity to light was a major problem , incandescent lamps emit 98% of the energy input as heat , but with latest LED technologies efficiencies of upto 100% have been claimed , LED lamps lack coherence and hence lack high beam directionality but with a laser high beam directionality can be obtained, but lasers to date are highly inefficient, even the latest Free Electron Lasers are inefficient .The most

efficient lasers , laser diode arrays, can achieve more than 50% efficiency, but such lasers do not have mutual coherence .

- Considering that both conversion efficiencies and directionality have improved to an acceptable extent, one major problem still remains: the reconversion of light back into electricity, photovoltaic cells are inefficient, with photovoltaic cells achieving a maximum of 40%-50% efficiency under certain conditions.
- Although laser power beaming can be optimised to the wavelength of the laser at which the photovoltaic conversion efficiencies are higher, there are still problems in choosing the right frequency with respect to atmospheric absorption & especially absorption, reflection and diffraction due to clouds.

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ENERGY TRANSFER USING MICROWAVES:

Power beaming can be achieved using microwaves. Microwaves are electromagnetic waves at much longer wavelengths than that of light, conversion efficiencies are higher than lasers, and are less prone to atmospheric attenuation. However microwaves have far longer wavelengths than visible light, and require proportionately larger transmitters and receivers to deal with diffraction over long distances. Ever since the discovery of electromagnetism, efforts were being made

to find more efficient methods & devices to transmit electromagnetic energy at long distances.

Early contributions to wireless transmission via radio waves were largely due to Heinrich Rudolf Hertz , Guglielmo Marconi and Nikola Tesla. Hidetsugu Yagi and Uda later contributed to wireless energy transmission using a directional array antenna that he designed. Although it was not practical for power transmission, their directional array beam antenna has been successfully used in wireless telecommunications.

When considering RF energy transmission, the laws of physics related to beam propagation come into effect. Laws of divergence of electromagnetic beams state that an electromagnetic beam will spread and become weaker as distance increases. Beam divergence is directly related to the efficiency of RF energy transmission. The more the divergence the bigger the receiving device becomes, where at a certain point it becomes impractical to harness the transmitted energy. Divergence depends on the wavelength of the electromagnetic wave. The shorter the wavelength the lesser the divergence. Power transmission using radio waves can be made more directional using shorter wavelengths of electromagnetic radiation, typically in the microwave range. This allows power to be beamed at longer distances.

Divergence also depends on the coherent nature of the electromagnetic waves, with a high coherence beam divergence decreases. Coherence here means with respect to frequency (monochromaticity), phase and polarisation of the output beam .

Beam divergence is also affected by diffraction at the transmitting antenna. Until now efficient wireless electromagnetic energy transfer has been achieved only at short distances and in general long distance energy transfer requires large devices.

While Phased array technology has been used to increase beam directionality, it has its limitations due to a phenomenon called the thinned array

curse; gaps in the array act as a diffraction grating and cause side lobes that lose energy.

A rectenna (Rectifying Antenna) array may be used to reconvert the microwave energy back into electricity. Rectenna conversion efficiencies are generally high .

Several applications of power beaming are currently being studied.

- Harnessing the Sun: Solar Power Satellites orbiting the earth could transmit the captured solar energy by converting it into microwaves and beaming the microwaves to Earth.
- Providing power to a spacecraft from the earth using microwaves is being considered .
- Terrestrial Point to Point Line of Sight Energy transfer.

However power beaming by microwaves for most space applications face a major problem : they require large aperture sizes both for the transmitter and the rectenna . A NASA Study of solar power satellites required a 1-km diameter transmitting antenna, and a 10 km diameter receiving rectenna, for a microwave beam at 2.45 GHz. The apertures could be made smaller by using shorter wavelengths, but the atmosphere is opaque to most of the shorter wavelengths because of atmospheric absorption and absorption by rain or water droplets.

We could combine several smaller satellites to make the microwave beam more directional but the problem of the Thinned array curse still remains.

Successful experiments in High power Wireless Power Transmission using microwaves have been conducted. Experiments to transfer energy in the range of tens of kilowatts have been performed at Goldstone in California in 1975 and in 1997 at Gand Bassin on Reunion Island.

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ENERGY TRANSFER USING INDUCTION

Power Transfer through induction can be achieved only for short distances. Direct induction & resonant magnetic induction are the most efficient means to transfer wireless power, but only at near distances. Transmission of electromagnetic energy can take place by coupling two induction coils through a process known as mutual induction. With this method it is possible to transmit and receive significant amounts of energy but the two inductors must be placed close to each other. An electrical transformer is a good example for wireless energy transfer through mutual induction. The primary and secondary circuits of a transformer are electrically isolated from each other. The transfer of energy takes place through mutual induction.

The principle is used in charging household items like electric toothbrush, consumer electronic devices such as cell phones. It is also used to transfer energy in Transcutaneous energy transfer (TET) systems in artificial hearts and medical implants.

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ENERGY TRANSFER USING LOW POWER

Wireless power transfer technology using RF energy can also be used to power devices with low power requirements. Low energy devices such as computer peripherals, wireless sensors, and medical implants could be powered using RF energy. The amount of power that can be transmitted is very limited.

ENERGY TRANSFER USING EVANESCENT WAVE COUPLING

A new wireless power transfer concept called Evanescent wave coupling was introduced by Marin Soljacic, and his colleagues at the Massachusetts Institute of Technology in 2007. They applied the near field behaviour of electromagnetic fields to a wireless power transfer concept based on coupled resonators. By using evanescent coupling the energy receiving device (the device to be charged) can receive energy from the emitter device only if it has a resonant frequency that is close to the emitter device. Until then the electromagnetic energy is trapped in the Emitter/ Charger device.

The theory behind this is that when electromagnetic waves are sent through a highly angular waveguide, evanescent waves are produced which carry no energy and when another compatible resonant waveguide is brought close to the transmitter, the evanescent waves can allow the energy to tunnel through and deliver power to the receiving resonant waveguide. This is known as evanescent wave coupling. By tunnelling the electromagnetic waves, energy does not radiate outside of the waveguide.

In 2007 the MIT researchers successfully demonstrated the ability to power a 60 watt light bulb from a power source that was several meters away at roughly 40% efficiency.

The major drawback with this method is that energy transfer can take place only at near distances, and it may not work in other types of transmission media like water, and other atmospheres.

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ELECTRICAL CONDUCTION

Some natural conductors of electricity like the earth and oceans can be used as a medium and electrical currents can be propagated through these naturally existing conductors. A natural medium like the atmosphere can be made conducting by ionising the air. Ionisation occurs when the breakdown voltage of the medium is exceeded, thus making it to conduct electricity. For example a high-power ultraviolet beam could be used to ionise the air thus creating a conducting column between the transmitter and the receiver. The major technical drawback with this system is that huge energies are required to ionise the columns of air and is very inefficient.

EVALUATION OF ABOVE LISTED METHODS

In the above listed prior art methods of transmission of electrical energy using light , microwaves , induction and evanescent wave coupling we find that there is no technology that has completely solved the main problem of wireless energy transfer, that is transmitting large amounts of electrical energy at long distances very efficiently in different types of transmission media. There are three major technical problems that have not been solved, that of efficiency, long distance transmission and transmission through media other than air, such as water and other extraterrestrial atmospheres. Following is a summary of the drawbacks of prior art methods cited above.

With light, efficiency has been a major issue due to laser efficiencies not crossing 50% and photovoltaic conversion efficiencies not exceeding 40%. LEDs operating at 99% efficiency could substitute lasers but lack beam directionality. Another major issue with light is atmospheric absorption & especially absorption, reflection and diffraction due to clouds.

With microwaves, electromagnetic waves are at much longer wavelengths, conversion efficiencies are higher than lasers, and are less prone to atmospheric attenuation. However microwaves have far longer wavelengths than visible light, and require proportionately larger transmitters and receivers to deal with diffraction and divergence over long distances. They also suffer from interference.

With Induction Power Transfer can be achieved only for short distances. Direct induction & resonant magnetic induction are the most efficient means to transfer wireless power, but only at near distances.

With Evanescent wave coupling wireless power transfer takes place between coupled resonators. But there is a requirement that the energy receiving device (the device to be charged) should be close to the emitter device.

There are three major problems that one encounters when designing such a wireless power transmission system that functions in the earth's atmosphere.

a) Problems linked to AC to DC Conversion technology at high frequencies:

This poses a considerable technological challenge to design converters that function at optical frequencies or infrared frequencies (wavelengths of 2 – 0.3 μm). The rectifying diodes and antenna would have to be extremely small, typically in the range of micro/nanometres and their real efficiencies would be between 0.1 – 1%. It is practically not feasible to construct them; even if it were constructed they would be very inefficient. One may argue that an alternative to wireless power transfer could be achieved using light by transmitting light and use a photovoltaic panel to convert the light into electricity, but the photovoltaic panel conversion efficiencies are quite low and the atmosphere is not transparent for all wavelengths in the optical spectrum.

b) The transmission medium:

Transmission in earth's atmosphere. Atmospheric opacity to the entire electromagnetic spectrum depends on the wavelength of the electromagnetic waves. There are certain frequencies at which the atmosphere is completely transparent. The regions of the spectrum in which these frequencies are found are also called atmospheric windows. According to FIG. 5 & FIG. 6, we see that in the microwave/radiowave region of the absorption spectrum of air we can transmit electrical energy between wavelengths of 5 cm to 10 Meters at good efficiencies. Thus transmitting electrical energy in the atmosphere is limited to only those frequencies that pass through the atmosphere, thus limiting the prior art devices' capabilities to transfer energy.

Transmission in water: Water has its own absorption spectrum, it absorbs strongly in the ultraviolet, Infrared and microwave regions, but

is mostly transparent to the visible region of the electromagnetic spectrum.

Transmission in extra terrestrial atmospheres: Each planet has its own characteristic atmospheric composition, and the constituents of the atmosphere may vary so the absorption spectrum may vary.

c) Problems linked to Interference and divergence :

Transmission using ordinary microwaves and radio waves can be affected due to interference from other electromagnetic noise or radiation present in the transmission medium.

For transmission using ordinary microwaves and radio waves, beam divergence is influenced by diffraction at the transmitting antenna. Until now efficient wireless electromagnetic energy transfer has been achieved only at short distances and in general long distance energy transfer requires large devices. While Phased array technology has been used to increase beam directionality, it has its limitations due to a phenomenon called the thinned array curse; gaps in the array act as a diffraction grating and cause side lobes that lose energy.

OBJECTS OF THE INVENTION

Considering the previously mentioned problems of the related art regarding wireless electric power transfer , the object of the present invention is to provide a solution to the problems of the prior art . In particular the present invention aims at solving the problems of the prior art through several embodiments.

The solution lies in the production of electromagnetic waves that have both the directional properties of light and conversion efficiency levels of microwaves, which means we need to generate photons in the range of microwave/radio

wavelengths and transmit them to a receptor consisting of a Rectifier Antenna Array (Rectenna) that reconverts the captured photons into electricity.

There is a major technical challenge in generating these microwave/radio-wave photons in a large quantity. The present invention addresses the above challenge. It consists of a photon beam generator which is the main component of the wireless electric power transfer system, and uses a new inventive method to generate large quantities of large wavelength microwave/radio-wave photons at several required wavelengths.

Electromagnetic energy emitted could be described either in the form of electromagnetic field variations or in the form of photons; we need to clearly differentiate these two descriptions regarding electromagnetic emission and to get a clear idea about this;

Consider radio waves or microwaves generated using available devices like klystron, magnetron etc. When these devices vary the electromagnetic fields at a particular frequency, they transmit electromagnetic field variations at that frequency but they generally do not emit or transmit photons at that frequency, the photons associated could have other frequencies that do not correspond to the frequency of the oscillator. To be able to generate photons at that particular radio frequency, let us say 2.45 GHz, (typical microwave oven frequency), we need to construct a different device that is capable of emitting these 2.45 GHz photons and not just electromagnetic waves having 2.45 GHz frequency. Typically a magnetron would emit radio waves having a frequency of 2.45 GHz but not photons having a 2.45 GHz frequency.

Consider on the other hand devices like MASER, LASER or a FREE ELECTRON LASER, these devices emit photons at a particular frequency. For example when the ammonia maser generates a maser beam that has a frequency of 24 GHz, it actually emits photons having frequency of 24 GHz. These devices emit coherent radiation of photons in the visible & microwave range, but very few devices emit photons having frequencies below the Infrared frequencies. Masers exist that operate at microwave frequency that do generate microwave photons,

but they do so at very low intensities, and thus may not be practical for building wireless electrical energy transfer systems.

Main drawbacks of MASERS that exist today are

- They are not capable of producing large quantity of photons, most MASERS having a power output in the range of picowatts and milliwatts. These kinds of outputs are not suitable for energy transfer but may be useful for telecommunications.
- The range of maser wavelengths available is very limited, and moreover they are not available for the radiowaves wavelength region starting from 10 cm onwards.

The present new photon beam generator device that forms a central part of the disclosed wireless electric power transfer system does not have the drawbacks mentioned above associated with that of laser and masers. The disclosed photon beam generator device is

- Capable of producing high power outputs which is limited only by the size of its cavity
- Capable of producing outputs at different wavelengths that is only limited by the type of medium in the cavity. The range of wavelengths available is much larger than masers, so that they can operate in the windows of radiowave and microwave regions of the atmosphere.

SUMMARY OF THE INVENTION

A new system, device and method for the transmission of electrical power wirelessly are disclosed. The system works by converting electrical energy to large wavelength photons such as microwave photons or radiowave photons using a photon beam generator and directs the beam to a rectifier antenna array which reconverts the photons into electricity.

There is a major technical challenge in generating large quantities of microwave/radio-wave photons. The principal innovation lies in the photon beam generator which is the main component of the wireless electric power transfer system, which uses a new inventive method to generate large quantities of large wavelength photons.

The disclosed system is primarily meant for use in the earth's atmosphere, where air is the main medium, this disclosed system could however be adapted to space where there is void. This disclosed system could also be used when the transmission medium is water or on other planets where the atmospheres are different than earth's. It could also be used as a communication system that works in all of the transmission media as stated above.

The proposed wireless electric power transfer system is comprised of a photon beam generator, a source of electromagnetic waves to pump the photon beam generator and a rectifying antenna array that captures and converts the photons into electricity. The photon beam generator is further comprised of a cavity that contains a medium of molecules that have a dipole moment which are pumped using the electromagnetic wave source that generates electromagnetic waves that are directed through waveguides to excite the medium of molecules to their higher rotational energy levels or higher vibrational energy levels or higher ro-vibrational energy levels. The de-excited molecules emit microwave photons out of the cavity's aperture to form a photon beam that strikes a rectifier antenna array which converts the microwave photons into electricity.

DETAILED DESCRIPTION OF THE INVENTION

Following is the description of this invention divided into four parts

- Description of the presently disclosed Complete Wireless Electrical Power Transfer System
- Theory of the photon beam generator device of the present wireless electric power transfer system. The photon beam generator device is used to produce a beam of the microwave or radio wave photons.
- Description of the receiver of the present wireless electric power transfer system. The receiver is a rectifying antenna array that captures and converts the photons into electricity.
- Main advantages of the present new system of transfer of electrical energy without wire above other current systems of the state of art.

DESCRIPTION OF THE PRESENT COMPLETE WIRELESS ELECTRICAL POWER TRANSFER SYSTEM

A new wireless electric power transfer system transmits energy at a distance by converting electrical energy to large wavelength photons such as microwave photons using a new concept photon beam generator and directing the beam to a rectifier antenna array incident to it and positioned at distance which reconverts the captured photons into electricity. The main innovation lies in the photon beam generator.

FIG. 1 shows a schematic diagram of the complete Wireless Electric Power Transfer System according to the present disclosed system.

A Wireless Electric Power Transfer System 1 is comprised of a photon beam generator 15, a source of electromagnetic waves 4, and a rectifier antenna array 13. The photon beam generator 15 is further comprised of a cavity 3 that contains a medium of molecules 7 that have a dipole moment.

In order for the system to work the photon beam generator 15 is pumped using an electromagnetic wave source which generates electromagnetic waves 4 that are directed through the waveguides 16 & 17 to excite the medium of

molecules 7 to their higher rotational energy levels or higher vibrational energy levels or higher ro-vibrational energy levels. The de-excited molecules emit microwave photons out of the aperture 12 to form a photon beam 9 and the photon beam 9 is focused through a focusing hood 8 to be incident on a rectifier antenna array 13. The rectifier antenna array 13 converts the microwave photons into electricity.

As shown in FIG. 3 the photon beam generator 55 could also be pumped using a Radio Frequency Generator 60. Instead of waveguides the electromagnetic energy is conveyed through electrode plates 65 & 66 that are coupled to the Radio Frequency Generator 60. The pair of electrode plates 65 and 66 coupled to the RF generator 60 generates an oscillating electrical field.

A practical example of using the system 1 would be to transmit electric power from point A to point B in our earth's atmosphere. We assume that A & B are in line of sight distance to each other.

To determine the operating frequency range of the system 1, we need to consider in the first place the absorption spectrum of air and find the transparent windows available in the microwave or radiowave region, because it is in these regions that it is practical to construct converters such as receiving antennas and rectifier diodes. And also because at these microwave or radiowave frequencies conversion efficiencies are high.

According to FIG. 5 & FIG. 6, we see that in the microwave/radiowave region of the absorption spectrum of air we can transmit electrical energy between wavelengths of 5 cm to 10 Meters at good efficiencies. This gives us the operating frequency range of the system. In case we need to transmit electrical energy at microwave frequencies outside of this band of 5cm to 10 Meters then we need to transmit at frequencies that are not found in the rotational spectra of the major constituents of the atmosphere as shown in the FIG. 9.

The next process would be to choose the molecules that go into the cavity 3 and that have emission spectra at these wavelengths.

The molecular composition of the medium is chosen in a manner such that

1 . At least one frequency from the band of frequencies consisting of the rotational spectrum , vibrational spectrum and ro-vibrational spectrum of the collection of molecules of the cavity is not present in the absorption spectra of the different types of molecules present in the transmission medium.

2. The types of molecules chosen for the medium are chosen in a manner that they form a homogeneous collection of molecules. Homogeneous collection means that the different types of molecules do not interact with other chemically. Different types of molecules could make up the medium. The collection could also be a mixture of atoms and molecules, but it is important that they form a homogeneous collection of at least one type of molecule, which means that there should be at least one type of molecule present in the collection. This is because only molecules have rotational and vibrational spectra and the photon beam generator of the present disclosed system generates photons having energies that correspond to the rotational energy level transitions and the vibrational energy level transitions of the molecules. Atoms present in the medium do not contribute to the photon generation, but may serve to maintain the pressure inside the cavity, or used to conduct heat from the cavity. The molecules could be composed of more than two atoms. A molecule is a compound consisting of at least two atoms.

3. The types of molecules chosen for the medium are also chosen in a manner that they have a dipole moment.

In a molecule, energies associated with rotational energy level transitions are generally small compared to the vibrational energy level transitions. In general, transitions among various vibrational energy levels involve energies in the infrared region and transitions among various rotational energy levels involve energies in the microwave and far infrared region. FIG. 8 shows different molecular processes and their respective energy transition frequency bands. So, if we need to transmit energy at microwave/radiowave frequencies we need to look for molecules that have rotational spectra or ro-vibrational spectra that fall in the microwave/radiowave region. One could refer the molecular spectral databases published by several research institutions to find the needed molecules. One such database is the NIST (National Institute of Standards and Technology) database where a search for molecules with particular spectra could be conducted. Their latest web link is <http://physics.nist.gov/PhysRefData/MolSpec/freqsearch.html>, where a spectral frequency range could be entered as a search parameter and the tool lists all molecules having the desired spectral frequency range.

Rotational spectra arise only when molecules are polar in nature and have a permanent dipole moment. The molecules contained in the cavity should be polar molecules. Polar molecules are molecules having a permanent electric dipole moment. The permanent dipole moment is due to the various asymmetries in their structure and the presence of partial charges on the atoms in the molecule that arise from differences in electro-negativity or other features of bonding. So, in order for a molecule to interact with an electromagnetic wave via rotational transitions, it must possess either a magnetic or electric dipole moment. Without it no externally applied magnetic or electric field can exert torque.

Molecules that have a permanent dipole moment can generate a strong pure rotational spectrum when excited to a higher rotational energy level by pumping them with electromagnetic waves at the right frequencies. Symmetric molecules like H_2 , O_2 , C_2 , CH_4 have weak rotational spectra generated by the electric quadrupole moment. These symmetric molecules could also acquire a

temporary dipole moment due to anti-symmetric stretching modes. During these conditions the rotational energy level transitions could be achieved also by pumping them with electromagnetic waves. It becomes obvious that when a molecule has rotational spectrum it possesses a permanent dipole moment.

After having shortlisted the molecules capable of interacting with electromagnetic waves via rotational transitions, as a next step we need to exclude the use of molecules present in the transmission medium (Earth's atmosphere for example) that attenuate considerably the electromagnetic waves at the desired transmission frequency or frequencies. FIG. 7 shows the earth's atmospheric composition. The earth's atmosphere mainly consists of N_2 (Nitrogen) and O_2 (Oxygen). FIG. 9 shows the Molecular Structure of key atmospheric constituents that indicate the dipole nature of the molecules, thus showing which molecules are capable of having rotational absorption spectra.

For example imagine we need to transmit energy at frequencies around 60 GHz (wavelengths around 5 mm), and we find that O_2 (Oxygen) has a peak absorption in this frequency range then we need to avoid using O_2 as a medium for the cavity. O_2 has no electric dipole moment but unlike other diatomic gases it does have a permanent magnetic dipole. Nitrogen has neither electric nor magnetic dipole moment and therefore no rotational absorption spectrum. So it cannot be used in the cavity's medium when we need to operate at rotational energy transition frequencies. On the other hand, we could use O_2 as a medium for the cavity, when we need to transmit energy in a planet's atmosphere different from the earth's, where O_2 is not a major constituent of the planet's atmosphere. Once we have the list of molecules that have the desired spectra we can fill the cavity 3 with these molecules that form the medium 7 & pump them using electromagnetic waves 4 at the corresponding excitation frequencies. Here in this disclosed system we could use for example Nitrous Oxide as the medium that goes into the cavity of the photon beam generator.

The electromagnetic wave source used in this disclosed system is a Magnetron 41 that serves as a hi-power microwave source. Several devices like

hi-power special vacuum tubes can also be used to generate microwaves. These tubes are different from low-frequency vacuum tubes, they use the ballistic motion of electrons in vacuum controlled by electrical or magnetic fields. They include Magnetron, Klystron, Travelling Wave Tube, Gyrotron.

Low power microwave sources use solid state devices such as Field effect transistor, tunnel diodes, Gunn Diodes, IMPATT diodes

As in FIG 1 , the molecules of the medium 7 contained in the cavity 3 are excited by a band of low frequency electromagnetic waves 4 generated by the Magnetron 41 or several Magnetrons that functions as a hi-power electromagnetic waves source. The source of electromagnetic waves should consist a frequency or a band of frequencies that is found in the rotational spectrum, vibrational spectrum and ro-vibrational spectrum of the said molecules.

In the present disclosed system we use only a single magnetron 41 , but when we need an electromagnetic waves source that contains a band of several frequencies , several magnetrons could be used so that the electromagnetic waves 4 generated by it contain frequencies that excite the molecules to several different higher rotational or vibrational or ro-vibrational energy levels.

The electromagnetic waves 4 generated by the source are guided into the cavity 3 through at least one waveguide. Several waveguides could be used. It depends on the frequency composition of the generated electromagnetic waves, which in turn depends on the different frequencies of photons that need to be generated. Here in this example of the disclosed system, the electromagnetic waves 4 generated by the source are guided into the cavity 3 through the two waveguides 16 & 17. Waveguide covers 10 & 11 allow the electromagnetic waves to pass through but do not allow the medium of molecules 7 from escaping outside the cavity 3.

The molecules of the medium 7 are pumped by the electromagnetic waves 4 to higher energy levels which could be either higher rotational energy levels , higher vibrational energy levels or higher ro-vibrational energy levels or a combination of the mentioned energy levels , and return to their ground state

either spontaneously or through stimulated emission, thus emitting photons that have energies corresponding to transitions of rotational or vibrational or ro-vibrational energy levels which normally correspond to microwave photons .

The molecules of a medium contained in a cavity could also be excited using an oscillating electrical field. As shown in FIG. 3 a photon beam generator 55 is pumped using a Radio Frequency generator 60. Instead of waveguides the electromagnetic energy is conveyed through a pair of electrodes or electrode plates 65 & 66 that are coupled to the Radio Frequency Generator 60. The pair of electrode plates coupled to the RF generator 60 generate an oscillating electrical field. The radio frequency generator 60 is placed on the outside of the cavity 68, The pair of electrode plates 65 & 66 are placed on the inside of the cavity 68 and placed opposite to each other. By electrically coupling the radio frequency generator 60 to the pair of electrode plates 65 & 66 , a radio frequency signal is generated thereby creating an alternating electrical field that excites the molecules of the medium 59 to higher energy levels which could be either higher rotational energy levels , higher vibrational energy levels or higher ro-vibrational energy levels or a combination of the mentioned energy levels.

Referring to FIG 1. the generated microwave photons that pass through the aperture 12 are focused by the reflective hood 8 to form a photon beam 9. The reflective hood disposed outside of the cavity 3 is attached to the aperture 12. The aperture 12 is covered by a transparent material that is transparent to the photons but prevents the medium 7 from leaking out of the cavity 3.

By focusing the generated photons that form the photon beam 9 to be incident on the rectifier antenna array 13 the beam is received by the rectifier antenna array 13 which reconverts the photons of the photon beam 9 into electricity.

In the event of photon beam generator (transmitter) and the rectifier antenna array (receiver) not being in line of sight to each other, which means there

is an obstacle in the path of the photon beam then the photon beam could be directed to a mirror and reflected to the rectifier antenna array.

In FIG. 10 the photon beam generator 151 is pumped using an electromagnetic wave source 152 through waveguides 153 and 154 to give an output photon beam 155 that is reflected off a mirror 156. The reflected beam 157 is incident on the rectifier antenna array 158. The captured photon beam is reconverted into DC electricity and output at the DC terminals 159.

THEORY OF THE PHOTON BEAM GENERATOR 15 DEVICE OF THE PRESENT WIRELESS ELECTRIC POWER TRANSFER SYSTEM

The central part of this disclosed wireless electric power transfer system is a new kind of photon beam generator device that generates low energy photons or large wavelength photons.

The working principle of this device is as follows:

Molecules having a dipole moment are contained in the cavity and are excited by a band of low frequency electromagnetic waves generated by an electromagnetic wave generator or RF devices such as a Magnetron, Klystron or other radiowave emitting devices. The electromagnetic waves emitted by the generator contain frequencies that excite the molecules to higher rotational or vibrational or ro-vibrational energy levels. The molecules return to their ground state either spontaneously or through stimulated emission, thus emitting photons that have energies corresponding to transitions of rotational or vibrational or ro-vibrational energy levels. The types of molecules in the cavity are chosen in such a way that their emission spectra when pumped using microwaves corresponds to the desired output frequencies of the photon beam generator device.

Thus the photon beam generator device acts like an energy converter device. It converts electrical energy into low frequency photons. This device in

comparison with a maser would be a device that is pumped electromagnetically but generates non coherent photons.

Although the molecules in the photon beam generator device are used as a two level system and that there would not be amplification of the input signal because there are only 50% of the molecules populated in the excited state at any given instant, which means there is no population inversion, we are still left with 50% percent of the molecules that generate the photons that are output from this device. Thus we have 50% of the electrical energy input converted into usable photons . It acts like a device that absorbs the input electrical energy and outputs photons in the radiowave and microwave range.

The photons emitted are in the microwave frequency range and in the far infrared range, as energies associated with rotational or vibrational or ro-vibrational transitions are generally small compared to the electronic transitions. Such low frequencies are preferred from the point of view of constructing practical conversion devices.

For a better understanding of the photon beam generator device, we could compare it with a LASER with respect to the following

- LASERs produce a highly coherent output beam, with respect to frequency (monochromaticity), phase and polarisation of the output beam, whereas the new photon beam generator device of this disclosed system does not produce a coherent output beam. It produces a beam containing several chosen frequencies which could be out of phase and polarised at all angles.
- The cavity used in a LASER is resonant whereas the new photon beam generator device of this disclosed system uses a cavity that is not resonant, that is there are no reflecting mirrors.
- The LASER generates a beam with only a single frequency, whereas the new photon beam generator device of this disclosed system can generate a beam containing multiple frequencies.

- In a LASER amplification of the input signal can be achieved due to population inversion whereas in the new photon beam generator device of this disclosed system amplification cannot be achieved because there is no population inversion, because the molecules of the medium of the new photon beam generator device of this disclosed system are used as a two level system. In a LASER the atoms or molecules of the medium are used as a three level or plus system.
- In a laser atoms can be used in the medium to generate photons. In the disclosed photon beam generator device only molecules are used to generate the large wavelength photons, because atoms do not possess neither rotational nor vibrational spectra and thus cannot generate large wavelength photons. Atoms can only be excited to their electronic energy levels.

DESCRIPTION OF THE RECEIVER OF THE PRESENT WIRELESS ELECTRIC POWER TRANSFER SYSTEM

The rectifier antenna array 13 is an array of rectifier antenna modules, each of the rectifier antenna modules further comprised of a semiconductor rectifier diode and a pair of antenna elements connected for supplying an electrical signal to the semiconductor rectifier diode. The rectifier antenna modules are further grouped into sub arrays, each sub array containing rectifier antenna modules that are dimensioned to receive a particular frequency component of the photon beam 9 coming out of the new photon beam generator device 15 of this disclosed system. FIG. 4 shows a detailed view of the rectifier antenna array 13.

As per FIG. 4 a magnified view of a rectifier antenna module is shown at the extreme left of FIG. 4 where 88 and 87 are antenna elements that are configured in a square spiral shape, the ends of which are connected to the rectifying semiconductor diode 86. The diode 86 is a full bridge rectifier circuit that converts the AC signal of the photon into a DC signal, thus producing DC electrical current. DC outputs of these modules are paralleled to give a final output at terminals 14.

The antenna elements used in the rectenna array of this presently disclosed system are Square Spiral in shape, but one could also use shapes such as Dipole, Bowtie and Spiral.

ADVANTAGES OF THE PRESENT WIRELESS ELECTRIC POWER TRANSFER SYSTEM

The main advantages of this disclosed system over other existing systems are

1. The system can transmit power through almost any medium including water, cloudy atmosphere, extraterrestrial atmosphere, etc. provided the composition of the mixture of molecules in the photon beam generator system is chosen such that the frequencies of the photon beam emitted are not present in the absorption spectra of the different types of molecules present in the transmission medium.
2. Interference: Because the wireless energy beam is made up of photons it is less prone to Interference from other electromagnetic noise or radiation present in the transmission medium, unlike other ordinary radiowave communications where photons are not used.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 shows a schematic diagram of the complete Wireless Electric Power Transfer System according to the present disclosed system.

FIG. 2 shows a schematic diagram of the Photon beam generator Device, wherein the Photon beam generator Device is pumped using electromagnetic waves generated by a magnetron, the Photon beam generator Device is a central and important part in the disclosed Wireless Electric Power Transfer System which converts electrical energy into photons.

FIG. 3 shows a schematic diagram of another version of the Photon beam generator Device according to the present disclosed system, wherein the Photon beam generator Device is pumped using Radio Frequency Generator.

FIG. 4 shows a schematic diagram of the Rectifier Antenna Array (RECTENNA Array) in the disclosed Wireless Electric Power Transfer System that serves to receive the photon beam generated by the photon beam generator device and convert it to electricity.

FIG. 5 is a chart that shows Atmospheric transmission windows for the electromagnetic spectrum.

FIG. 6 shows an Atmospheric transmission chart indicating the major absorption bands of the atmosphere with respect to the electromagnetic spectrum.

FIG. 7 is a chart of Atmospheric composition.

FIG. 8 shows different Molecular processes and their respective energy transition frequency bands.

FIG. 9 shows the Molecular Structure of key atmospheric constituents that indicate the dipole nature of the molecule, thus showing which molecules are capable of having rotational absorption spectra.

FIG. 10 shows a schematic diagram of the complete Wireless Electric Power Transfer System according to the present disclosed system with an additional mirror included in the optical path formed between the photon beam generator and the rectifier antenna array (RECTENNA array).

DRAWINGS - REFERENCE NUMERALS

FIG 1.

1. Wireless electrical power transfer system
2. Cooling unit of the photon beam generator 15
3. Cavity of the photon beam generator 15
4. Source of electromagnetic waves for the photon beam generator 15
5. Passage of waveguide 16
6. Passage of waveguide 17

- 7. Medium of molecules in the cavity 3 of the photon beam generator 15
- 8. Reflective focusing hood attached to the aperture 12 of the cavity 3
- 9. Photon beam coming out of the photon beam generator 15
- 10. Waveguide cover for the waveguide 16
- 11. Waveguide cover for the waveguide 17
- 12. Aperture of the cavity 3
- 13. Rectifier Antenna Array (RECTENNA)
- 14. Output terminals from the Rectifier Antenna Array (RECTENNA) 13
- 15. Photon beam generator
- 16. Waveguide
- 17. Waveguide

FIG 2.

- 25. Photon beam generator in detail
- 29. Medium of molecules
- 30. Waveguide
- 31. Waveguide
- 32. Passage into waveguide
- 33. Passage into waveguide
- 34. Reflective focusing hood
- 35. Waveguide cover
- 36. Waveguide cover
- 37. Aperture for the cavity 38 of the photon beam generator 25
- 38. Cavity of the photon beam generator 25
- 39. Cooling unit of the photon beam generator 25
- 40. Photon beam coming out of the photon beam generator 25
- 41. Magnetron to produce electromagnetic waves which pumps the molecules of the medium 29

FIG 3.

- 55. Photon beam generator with Radio Frequency generator as a source of electromagnetic energy to excite the medium 59
- 59. Medium of molecules of the cavity 68 of the photon beam generator 55
- 60. Radio Frequency (RF) generator used to pump the molecules of the medium 59
- 61. Output terminal from the RF generator 60 that connects to the electrode plate 65
- 62. Output terminal from the RF generator 60 that connects to the electrode plate 66
- 64. Reflective focusing hood attached to the aperture 67 of the cavity 68
- 65. One of the pair of electrode plates coupled to the RF generator 60 that generates an oscillating electrical field.
- 66. One of the pair of electrode plates coupled to the RF generator 60 that generates an oscillating electrical field.
- 67. Aperture of the cavity 68 of the photon beam generator 55
- 68. Cavity of the photon beam generator 55
- 69. Cooling unit for the photon beam generator 55

- 70. Photon beam coming out of the photon beam generator 55 FIG 4.
- 80. Sub-array of rectifier antenna modules dimensioned to capture photons of a particular wavelength
- 81. Rectifier antenna module, each module consisting of a semiconductor diode coupled to a pair of antenna elements.
- 82. Sub-array of rectifier antenna modules dimensioned to capture photons of a particular wavelength
- 83. Rectifier antenna module, each module consisting of a semiconductor diode coupled to a pair of antenna elements.
- 84. Sub-array of rectifier antenna modules dimensioned to capture photons of a particular wavelength
- 85. Rectifier antenna module, each module consisting of a semiconductor diode coupled to a pair of antenna elements.
- 86. Rectifying semiconductor diode coupled to pair of antenna elements 87 & 88.
- 87. One of the pair of antenna elements coupled to the rectifying diode 86
- 88. One of the pair of antenna elements coupled to the rectifying diode 86
- 90. Complete Rectifier Antenna Array (RECTENNA Array)

FIG 5.

- 100. Chart that shows Atmospheric transmission windows for the electromagnetic spectrum.

FIG 6.

- 110. Atmospheric transmission chart indicating the major absorption bands of the atmosphere with respect to the electromagnetic spectrum.

FIG 7.

- 120. Chart of Atmospheric composition.

FIG 8.

130. Table that shows different Molecular processes and their respective energy transition frequency bands.

FIG 9.

140. Table that shows the Molecular Structure of key atmospheric constituents that indicate the dipole nature of the molecule, thus showing which molecules are capable of having rotational absorption spectra.

FIG 10.

150. Complete Wireless Electric Power Transfer System according to the present disclosed system with an additional mirror included in the optical path formed between the photon beam generator and the rectifier antenna array (RECTENNA array).

151. Photon beam generator

152. Electromagnetic waves source

153. Waveguide

154. Waveguide

155. Photon beam coming out of the Photon beam generator 151

156. Mirror to reflect and direct the photon beam 155.

157. Reflected photon beam incident on the rectifier antenna array 158

158. Rectifier antenna array (RECTENNA Array)

159. Direct Current (D.C) output terminals from the rectifier antenna array (RECTENNA Array) 158

PRACTICAL EXAMPLE OF CONSTRUCTING THE PRESENT DISCLOSED WIRELESS ELECTRICAL POWER TRANSFER SYSTEM

Construction of the cavity:

According to FIG 1 the cavity 3 is a metallic cuboid chamber made of galvanised or stainless steel and is coated on the inside with a material such as enamel that is inert to the medium of molecules, which means that it does not react with the medium. The coating could also be material like fused silica.

The metallic body of the cavity 3 makes the cavity 3 like a faraday's cage inside out, so that the electromagnetic waves entering into the cavity from the coupled waveguides 16 & 17 is reflected from the walls of the cavity 3 and trapped inside the cavity 3. The inner surface or the walls of the cavity 3 should also be capable of reflecting the photons emitted from the molecules. The inner surface or the walls of the cavity 3 should also be inert to the molecules of the medium 7.

The cavity 3 could equally have a cylindrical shape. The cavity 3 could be coupled to several waveguides, in this presently disclosed system there are two waveguides 16 & 17 as shown in the FIG. 1. The wave guides 16 & 17 guide the electromagnetic waves 4 generated by a source through 5 & 6 into the cavity 3.

Selection of the medium of the cavity:

In this preferred embodiment of the disclosed system 1 of this invention we can choose Nitrous Oxide (N_2O) as the medium 7 that goes into the cavity 3 of the Photon beam generator 15. According to FIG 9 we see that Nitrous Oxide (N_2O) can be excited at a frequency of 25 GHz. Therefore all device components of this system 1 dependent on the excitation frequency of the medium have to sized accordingly.

Source of electromagnetic waves:

We can use a magnetron 41 as shown in the FIG 2 which is tuned to a frequency of 25 GHz in order to pump the medium 29.

Waveguides:

A waveguide is a hollow conductive metal rectangular or circular pipe that guides electromagnetic waves. They propagate signals above a certain frequency. The cut off frequency depends upon its dimensions. A very rough calculation of dimensions required for a waveguide would be to follow a rule of keeping the width of the waveguide in the same order of magnitude as the wavelength of the signal being carried. Therefore an electromagnetic wave having a wavelength of 12.2 cm (Approximately 2.45 GHz) would require at least one inner dimension larger than 6.1 cm.

Waveguides used are rectangular pipes made of alloys like Aluminium, Copper, Bronze, Invar, Stainless Steel, Coin Silver. A typical waveguide that works between 50 GHz & 70 GHz is made of stainless steel and the inside dimensions in inches would be 0.148 x .074. The wall thickness could vary from .04 to .01 inches. Waveguides and waveguide components are readily available in the market and also could be made to order.

Waveguide Covers:

Waveguide covers 10 & 11 are required at the entrances of the waveguides 16 & 17 into the cavity 3. They prevent the leaking of the cavity's medium 7 into the waveguides. They however allow electromagnetic waves to pass through. They are generally constructed out of mica sheets.

Aperture:

The cavity 3 has an aperture 12 to allow the emitted photons by the medium 7 to pass through and has an area large enough to allow the photons having the largest wavelength. It also has a transparent hermetic cover that is transparent to the photons but does not allow the medium 7 to leak out of the cavity 3.

Cooling Unit:

Cooling the cavity 3 using a cooling system 2 is necessary to maintain the medium at a temperature where the thermal distribution of the different rotational levels has to be taken into consideration. The number of molecules in a rotational level J depends on the temperature of the medium. There exists a temperature where the number of molecules in rotational level J is maximum, which is desired for maximum conversion efficiency of the photon beam generator. So this particular temperature needs to be maintained. It is also required to dissipate the unused electromagnetic energy. As far as possible the entire outer surface of the cavity is thermally connected to the cooling unit. The cooling unit could be a heat exchanger using water as the working medium. The heat exchange medium could be circulated in a spiral tube that encompasses the outside of the cavity 3. Here in the figures accompanying the description, the cooling system 2 is represented as a block.

Construction of Rectifier Antenna Array (RECTENNA Array):

The rectifier antenna array 13 is an array of rectifier antenna modules, each of the rectifier antenna modules further comprised of a semiconductor rectifier diode and a pair of antenna elements connected for supplying an electrical signal to the semiconductor rectifier diode. The rectifier antenna modules are further grouped into sub arrays, each sub array containing rectifier antenna modules that are dimensioned to receive a particular frequency component of the photon beam 9 coming out of the new photon beam generator device 15 of this disclosed system. FIG. 4 shows a detailed view of the rectifier antenna array 13.

As per FIG. 4 a magnified view of a rectifier antenna module is shown at the extreme left of FIG. 4 where 88 and 87 are antenna elements that are configured in a square spiral shape, the ends of which are connected to the rectifying semiconductor diode 86. The diode 86 is a full bridge rectifier circuit that converts the AC signal of the photon into a DC signal, thus producing DC electrical current. DC outputs of these modules are paralleled to give a final output at terminals 14.

The antenna elements used in the rectenna array of this presently disclosed system are Square Spiral in shape, but one could also use shapes such as Dipole, Bowtie and Spiral.

INDUSTRIAL APPLICABILITY

- The system can transmit power through any medium provided the composition of the medium is known; this includes water, so one of the applications could be to transmit power to undersea installations.
- Solar Energy: Energy harnessed from solar satellites in space can be relayed back to earth in a much efficient way than other methods.

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CLAIMS

I Claim

1) Wireless electric power transfer system, comprising:

a photon beam generator to generate a photon beam;
means to capture and convert the said photon beam to electricity;
said photon beam generator comprising:

a cavity, said cavity provided with an aperture, a medium contained in the said cavity, said medium consisting of molecules, said molecules being a homogeneous collection of molecules, said homogeneous collection of molecules consisting of at least one type of molecule, said molecules having a dipole moment, each of the said molecules being composed of at least two atoms, a pumping means, said pumping means being either a source of electromagnetic waves or a radio frequency generator, said source of electromagnetic waves having a frequency or a band of frequencies that is selected or are selected from a group consisting of rotational spectrum, vibrational spectrum and ro-vibrational spectrum of the said molecules, said radio frequency generator having a frequency or a band of frequencies that is selected or are selected from a group consisting of rotational spectrum, vibrational spectrum and ro-vibrational spectrum of the said molecules.

2) The system of claim 1 wherein the said source of electromagnetic waves is disposed on the outside of the said cavity, wherein the said source of electromagnetic waves is coupled to the said cavity via at least one waveguide.

- 3) The system of claim 1 or claim 2 wherein the said at least one waveguide is provided with a cover, said cover placed between the said at least one waveguide and the said cavity, said cover being transparent to the said source of electromagnetic waves, said cover preventing the said medium contained in the said cavity to leak into the said at least one waveguide.
- 4) The system of claim 1 wherein the said radio frequency generator is disposed on the outside of the said cavity , the said radio frequency generator being electrically coupled to a pair of electrode plates , the said pair of electrode plates disposed on the inside of the said cavity.
- 5) The system of claim 1 wherein the said aperture is provided with a reflective focusing hood , said reflective focusing hood attached to the said aperture on the outside of the said cavity.
- 6) The system of claim 1 wherein the said aperture is covered with a transparent material, the said transparent material being transparent to the photons emitted by the said molecules.
- 7) The system of claim 1 wherein the said aperture has a diameter larger than the wavelength of the photon having the largest wavelength emitted by the said molecules in order to allow the photons having the largest wavelength emitted by the said molecules to pass through.
- 8) The system of claim 1 wherein the inner surface of the said cavity is reflecting for the photons emitted by the said molecules.

- 9) The system of claim 1 wherein the inner surface of the said cavity is reflecting for the electromagnetic waves generated by the said source of electromagnetic waves.
- 10) The system of claim 1 wherein the said cavity is provided with a cooling system, the said cooling system disposed on the outer surface of the said cavity.
- 11) The system of claim 1 wherein the said means to capture & convert the said photon beam is a rectifier antenna array, the said rectifier antenna array being an array of rectifier antenna modules, each of the said rectifier antenna modules further comprised of a semiconductor rectifier and a pair of antenna elements connected to the said semiconductor rectifier for supplying an electrical signal to the said semiconductor rectifier, the said rectifier antenna modules being further grouped into sub arrays, each of the said sub arrays containing rectifier antenna modules that are dimensioned to receive photons having a particular frequency.
- 12) Method to transmit electric power through a transmission medium comprising the steps of:
providing a photon beam generator for generating a photon beam, said photon beam generator comprised of a cavity,
providing the said cavity with an aperture,
selecting a type of medium to be contained in the said cavity, said medium consisting of molecules, said molecules being a homogeneous collection of

molecules, said homogeneous collection of molecules consisting of at least one type of molecule, said molecules having a dipole moment, each of the said molecules being composed of at least two atoms, filling the said cavity with the said medium, providing a source of electromagnetic waves or a radio frequency generator as a pumping means, the said source of electromagnetic waves having a frequency or a band of frequencies that is selected or are selected from a group consisting of rotational spectrum, vibrational spectrum and ro-vibrational spectrum of the said molecules, the said radio frequency generator having a frequency or a band of frequencies that is selected or are selected from a group consisting of rotational spectrum, vibrational spectrum and ro-vibrational spectrum of the said molecules, providing means to capture & convert the said photon beam to electrical current, pumping the molecules of the said medium to higher energy levels that is selected from a group consisting of higher rotational energy levels, higher vibrational energy levels and higher ro-vibrational energy levels of the said molecules, generating the said photon beam, focusing the said photon beam, providing means to capture & convert the said photon beam, capturing & converting the said photon beam to electrical current by using the provided said means to capture & convert the said photon beam.

- 13) Method of claim 12 wherein the said step of providing a source of electromagnetic waves or a radio frequency generator as a pumping means further comprises the steps of:
upon a condition in which the said source of electromagnetic waves has been provided as pumping means,

placing the said source of electromagnetic waves on the outside of the said cavity,
providing for at least one waveguide,
coupling the said source of electromagnetic waves to the said cavity via the at least one waveguide,
generating electromagnetic waves from the said source of electromagnetic waves,
guiding the said electromagnetic waves through the said at least one waveguide.

14) Method of claim 12 wherein the said step of providing a source of electromagnetic waves or a radio frequency generator as a pumping means further comprises the steps of:

upon a condition in which the said radio frequency generator has been provided as pumping means,
placing the said radio frequency generator on the outside of the said cavity ,
providing a pair of electrode plates,
placing the said pair of electrode plates on the inside of the said cavity,
placing the said pair of electrode plates opposite to each other,
electrically coupling the said radio frequency generator to the said pair of electrode plates ,
making the said radio frequency generator to generate a radio frequency signal.

15) Method of claim 12 wherein the said step of providing means to capture & convert the said photon beam to electrical current further comprises the steps of:

providing a rectifier antenna array, the said rectifier antenna array being an array of rectifier antenna modules , each of the said rectifier antenna modules

further comprised of a semiconductor rectifier and a pair of antenna elements connected for supplying an electrical signal to the said semiconductor rectifier , the said rectifier antenna modules being further grouped into sub arrays, each of the said sub arrays containing said rectifier antenna modules that are dimensioned to receive a particular frequency component of the said photon beam,

placing the said rectifier antenna array against to the photon beam generated by the said photon beam generator.

16) Method of claim 12 wherein the said step of providing the said cavity with an aperture further comprises the steps of:

providing a reflective hood,

attaching the said reflective hood to the said aperture on the outside of the said cavity for focusing the generated photons by the said photon beam generator.

17) Method of claim 12 wherein the said step of selecting a type of medium to be contained in the said cavity further comprises the step of:

selecting a molecular composition of the said medium in a manner such that at least one frequency from the band of frequencies that are selected from a group consisting of rotational spectrum, vibrational spectrum and ro-vibrational spectrum of the said homogeneous collection of molecules is not present in the absorption spectrum of the said transmission medium.

18) Method of claim 12 wherein the said step of capturing & converting the said photon beam to electrical current by using the provided said means to capture

& convert the said photon beam is preceded by the step of passing the said photon beam through an optical path consisting of at least one reflector.

FIG. 1

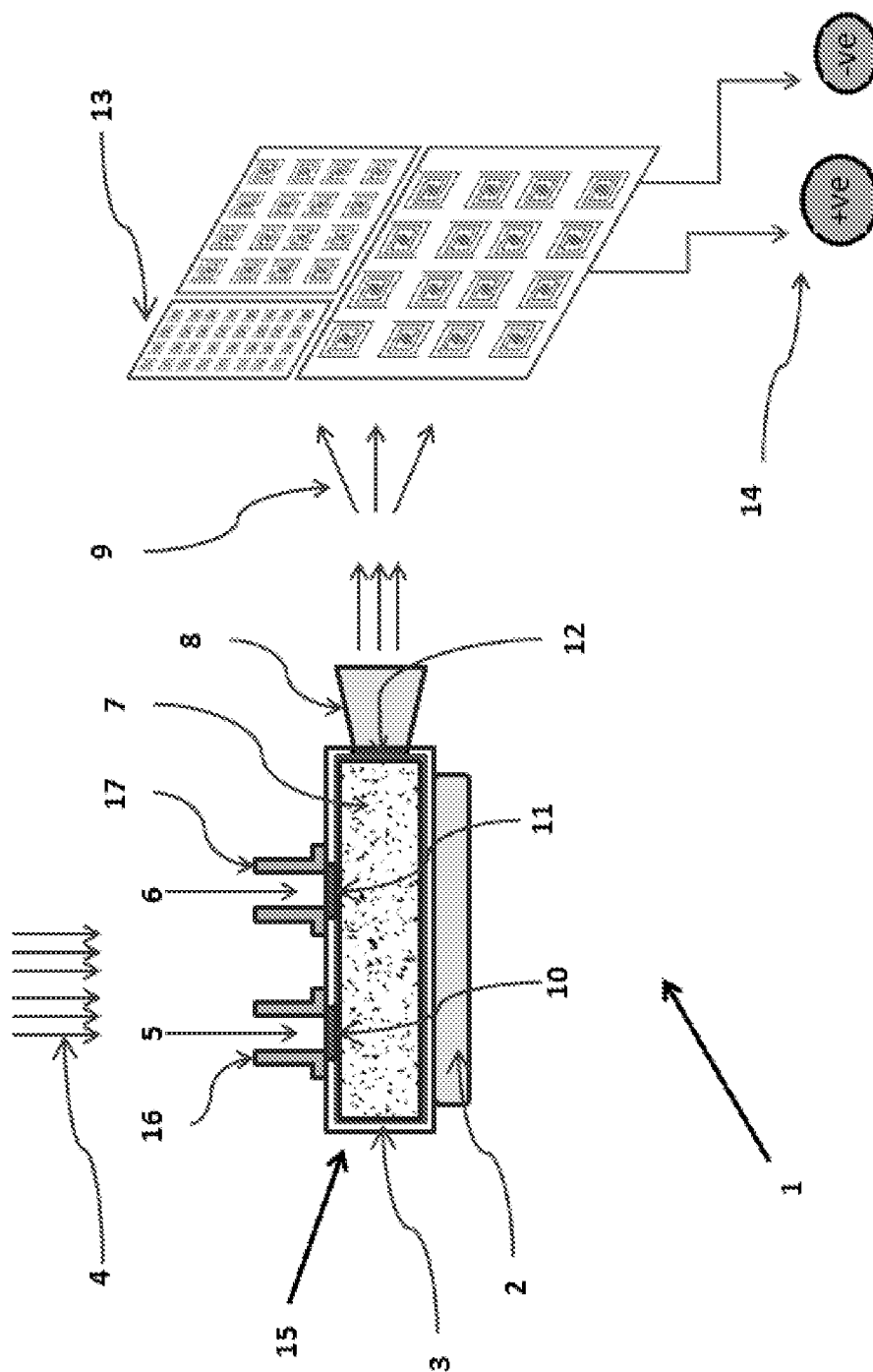


FIG. 2

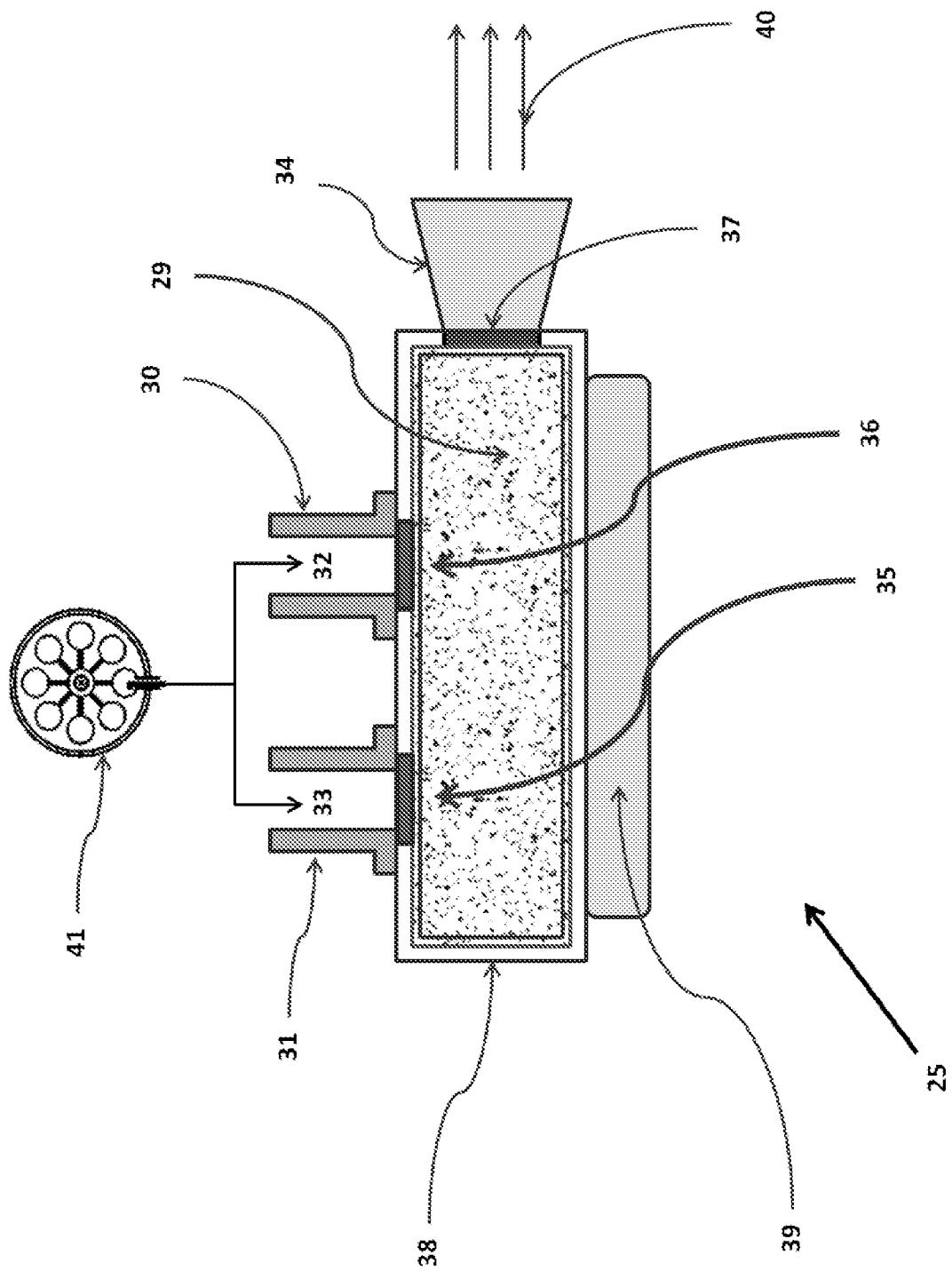


FIG. 3

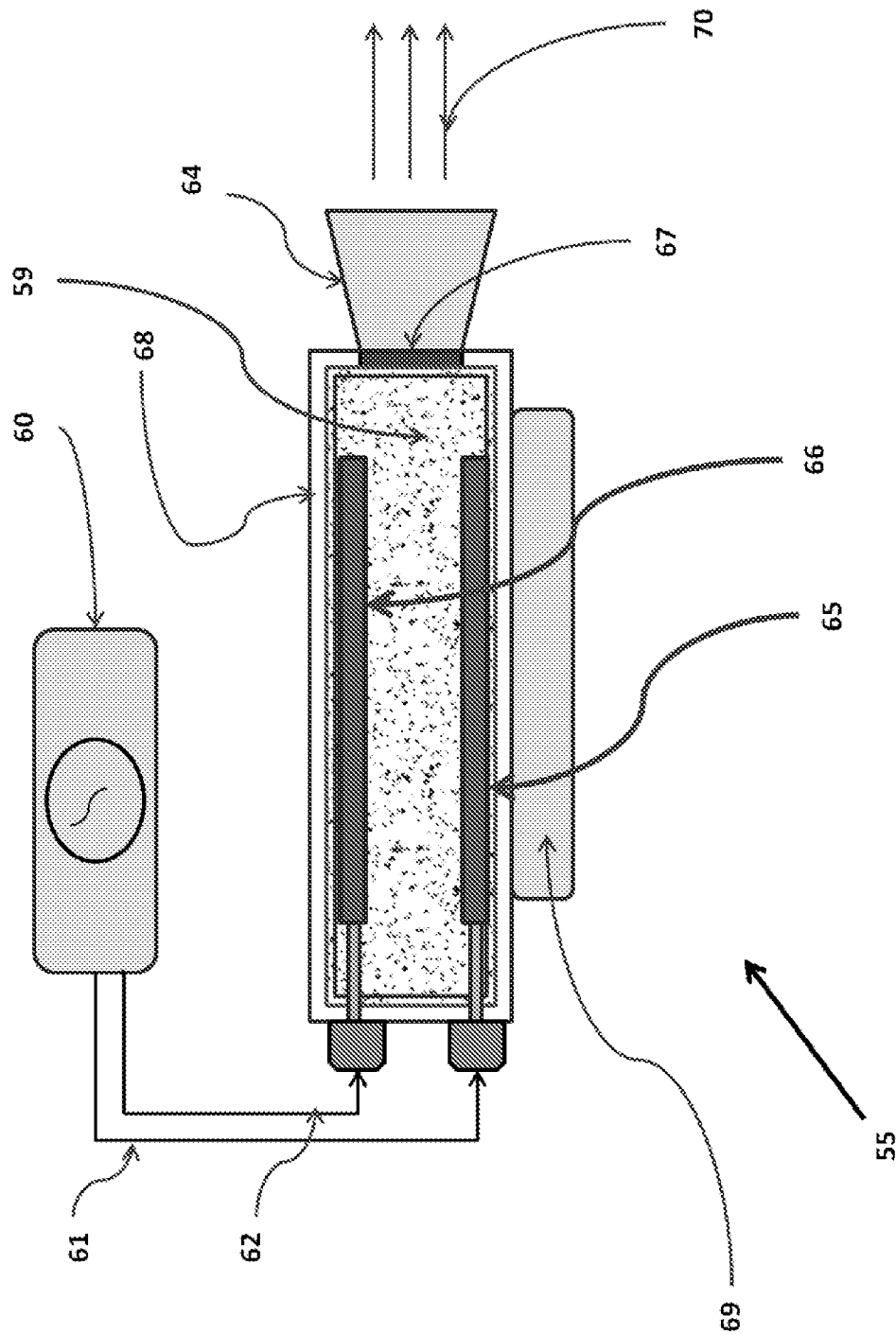


FIG. 4

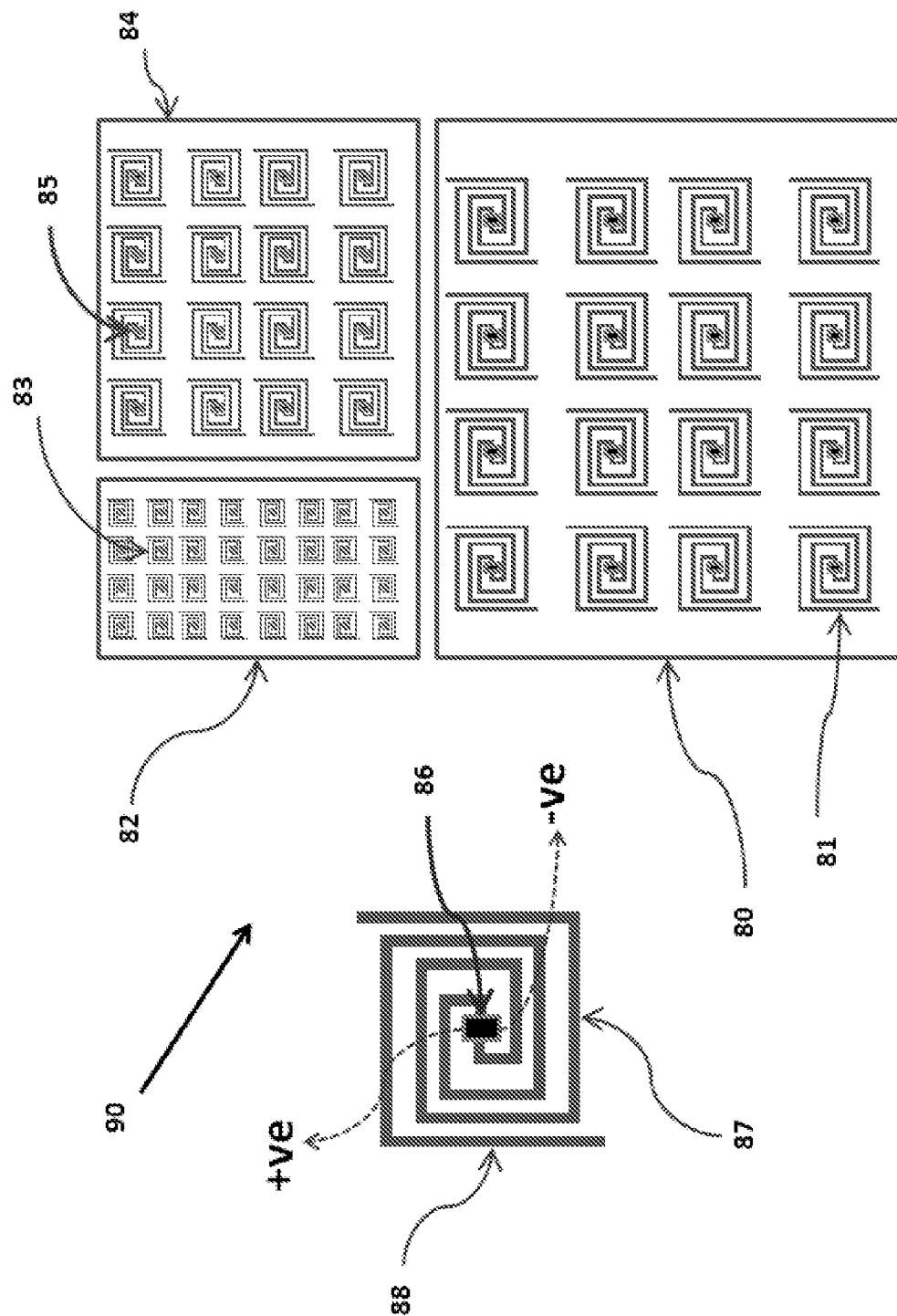


FIG. 5

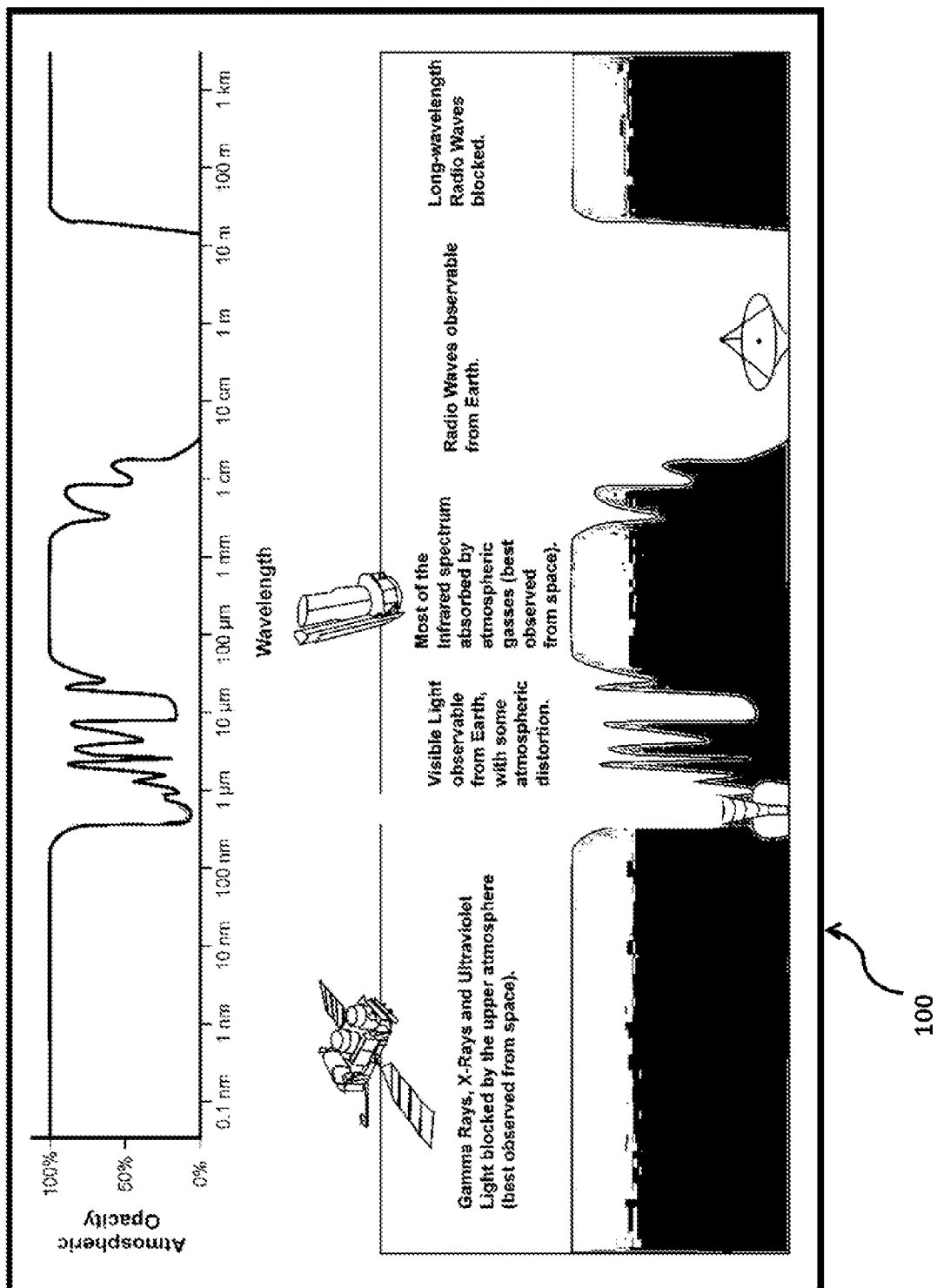


FIG. 6

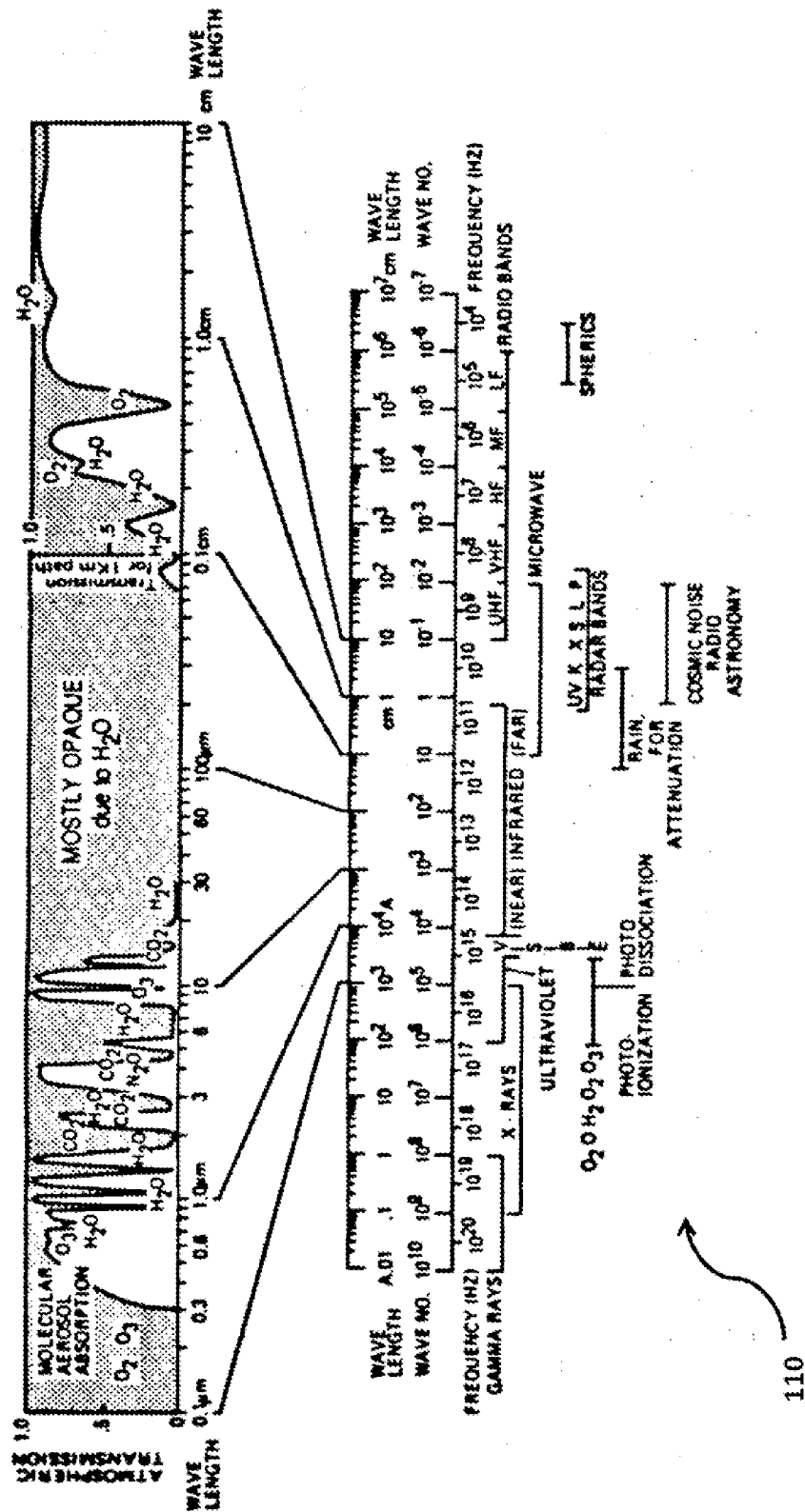


FIG. 7

Permanent Constituents of Earth's Atmosphere		Variable Constituents of Earth's Atmosphere	
Constituent	% by volume	Constituent	% by volume
Nitrogen (N ₂)	78.084	Water vapour (H ₂ O)	0-0.04
Oxygen (O ₂)	20.948	Ozone (O ₃)	0-12x10 ⁻⁴
Argon (Ar)	0.934	Sulphur dioxide (SO ₂) ¹	0.001x10 ⁻⁴
Carbon dioxide (CO ₂)	0.033	Nitrogen dioxide (NO ₂) ¹	0.001x10 ⁻⁴
Neon (Ne)	18.18x10 ⁻⁴	Ammonia (NH ₃) ¹	0.004x10 ⁻⁴
Helium (He)	5.24x10 ⁻⁴	Nitric oxide (NO) ¹	0.0005x10 ⁻⁴
Krypton (Kr)	1.14x10 ⁻⁴	Hydrogen sulphide (H ₂ S)	10.00005x10 ⁻⁴
Xenon (Xe)	0.089x10 ⁻⁴	Nitric acid vapour (HNO ₃)	Trace
Hydrogen (H ₂)	0.5x10 ⁻⁴		
Methane (CH ₄)	1.5x10 ⁻⁴		
Nitrous oxide (N ₂ O)	0.27x10 ⁻⁴		
Carbon monoxide (CO)	0.19x10 ⁻⁴		

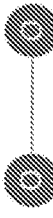
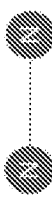
120

FIG. 8

Region	Microwave	Far Infrared	Infrared	Visible and ultraviolet
Frequency (Hz)	$10^9 - 10^{11}$	$10^{11} - 10^{13}$	$10^{13} - 10^{14}$	$10^{14} - 10^{16}$
Wavelength (m)	$3 \times 10^{-1} - 3 \times 10^{-3}$	$3 \times 10^{-3} - 3 \times 10^{-5}$	$3 \times 10^{-5} - 6.9 \times 10^{-7}$	$6.9 \times 10^{-7} - 2 \times 10^{-7}$
Wave number (cm^{-1})	0.033 – 3.3	3.3 – 330	330 – 14500	14500 – 50000
Molecular process	Rotation of polyatomic molecules	Rotation of small molecules	Vibration of flexible bonds	Electronic transitions

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FIG. 9

Molecule	Structure	Structure Type	Permanent Electric Dipole Moment	May acquire dipole moment	Microwave (Rotational) absorption frequencies
Oxygen		Linear	No (Has magnetic dipole moment)	No	54-66 GHz & 118 GHz
Nitrogen		Linear	No	No	No rotational spectrum
Carbon Monoxide		Linear	Yes	Yes	115 GHz
Carbon Dioxide		Linear	No	Yes	13986 GHz
Nitrous Oxide		Linear	Yes	Yes	25 GHz
Water Vapour		Asymmetric Top	Yes	Yes	22 GHz, 184 GHz & 326 GHz
Ozone		Asymmetric Top	Yes	Yes	110 GHz
Methane		Spherical Top	Yes	Yes	10.32 GHz

140

FIG. 10

