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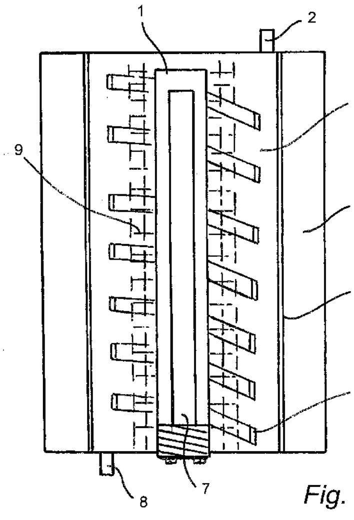

Fig. 1

(57) Abstract: Apparatus for treating fuel prior to combustion comprises a channel (3) for fuel to be treated, a photo catalyst (5) situated within the channel (3) so as to be in contact with the fuel passing therethrough, electromagnetic radiation source means (7) for irradiating the catalyst (5) and magnetic field source means (4) for providing a magnetic field to which the fuel is exposed. The apparatus enables the engine to develop greater torque at lower rotating speeds as well as improve power.

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Title. Fuel tieatment apparatus

Field of the invention

This invention relates to apparatus for treating a fuel, for example fuel oil, prior to combustion of the fuel.

Background to the invention

The invention is particularly applicable to the treatment of hydiocarbon based fuel such as gasolene or diesel oil, prior to the consumption of the fuel in an internal combustion engine. However, the invention is also applicable to the treatment of fuels for other uses, for example for external combustion engines or boilers

Calculations suggest that only about 38% of the chemical energy in a fuel supplied to an internal combustion engine is converted into mechanical output energy. This is partly due to the thermodynamic constraints that apply when high entropy thermal energy from burning fuel is converted into a mechanical output drive of the engine. However, the efficiency of the engine can be further reduced by inefficient combustion of the fuel. It is believed that, in fact, 33% of the energy in the fuel supplied to the engine is lost as exhaust loss, whilst 29% of the energy is lost as thermodynamic, or cooling loss

A significant proportion of the exhaust losses is constituted by products of incomplete combustion, or products which have otherwise been detrimental to the burning process. Examples of either type of such product include carbon monoxide, hydrocarbons, nitrogen oxide, sulphur dioxide, smoke particles (certain heavy metal compounds, lead compounds, dark smoke and oil mists) and methanal. As well as being related to energy release, those products can be a source of environmental pollution. Thus effective reduction of the products in internal combustion engine combustion can boost fuel efficiency considerably and cut toxic emissions into the environment

In general, previously proposed and used technologies for reducing harmful/incomplete internal combustion engine combustion products and boosting fuel-to-power efficiency either alter fuel molecular structures to boost combustion efficiency or raise oxygen density in the air that enters the engine so as to boost combustion efficiency.

Examples of the first category of technology include magnetic fuel economisers and nanofuel economisers, whilst rare earth oxygen boosters or turbochargers are examples of systems that raise oxygen density.

It has been proposed to use far infrared electromagnetic radiation to pretreat fuel. A far infrared radiator is installed on a fuel pipeline and generally emits electromagnetic radiation at 3-20 μm. The theory is that the energy from this radiation acts on the hydrocarbon molecules in the fuels causing resonance in the molecular bonds and absorption of the kinetic energy of the fire infrared photons. The absorption of energy is thought to cause transitions at the molecular and even atomic level, as a result of which saturated molecular chains in the fuels are forced to break and release free electrons to generate a large number of free radicals and enhance combustion efficiency. In practice, however, there is a body of evidence that suggests that almost none of these types of approach improves combustion of the fuels.

Summary of the invention

According to a first aspect of the invention, there is provided apparatus for treating a fuel prior to combustion, the apparatus comprising a channel for fuel to be treated, a photocatalyst situated within the channel so as to be in contact with the fuel passing therethrough, electromagnetic radiation source means for irradiating the catalyst and magnetic field source means for providing a magnetic field to which the fuel is exposed.

Preferably, the electromagnetic radiation source means is so arranged, relative to the channel, also to irradiate, in use, fuel travelling through the channel.

Preferably, the electromagnetic radiation source means is operable to emit electromagnetic radiation comprising ultraviolet light, preferably having a wave length in the range 175-400 nm.

Thus fuel oil being treated in the apparatus flows through a magnetic field in the channel while being catalised unter ultraviolet light by the photocatalyst. It is believed that during this process branched chains of macromolecules of fuel are broken up and photodecomposed whilst saturated molecular chains are opened up, releasing some ions and generating a large amount of free radicals. Alcohols and phenols in the fuel can also be reduced to hydrogen and hydroxyl ions, generating inorganic salts such as sulphide. It is thought that the inorganic salts generated above reduce the amount of negative burning products from the subsequent combustion of the fuel. The applicants also believe that the apparatus can both improve fuel quality and protect an engine supplied with the fuel. The fuel oil that has been photodecomposed by the apparatus delivers better antiknock performance and greater energy output. The fuel processed by the apparatus may also dampen engine noise and undermine modular stability of poor quality fuel oil. Some impurities are mineralised to inorganic salts that are emitted naturally, without participating in any of the combustion reactions. The apparatus is thought to be particularly significant in photodecomposing methanol and other substances that can damage a three way catalytic converter on an automobile, and thus reducing the chance of the converter being damaged by pollutants from the burnt fuel. The problem of frequent engine damage caused by poor quality fuel oil that contains ethanol is also greatly reduced or obviated.

It is believed that the apparatus produces fuel that, when consumed in an engine, produces greater and more intensive energy of external combustion, due to an increased burning rate, thus enabling the engine to develop greater torque at lower rotating speeds as well as improved power (possibly by up to 10%).

Tests show that gasolene that has been processed by the apparatus, when consumed in a spark combustion engine, emits 45% less CO, 7.2% less NxO and 25% less HC, and generates fewer PM 2.5 size range particles (i e. smaller than 2.5 micrometers).

The fuel oil processed by the apparatus may also be useful in clearing up carbon deposition in engine cylinders, whilst a greater combustion efficiency of the fuel helps with the dissolution of coke deposits.

In the case of carbon based fuel, for example oil, diesel or gasolene, the 175-253 7 nm ultraviolet light has been found to decompose organic molecules, whilst the ultraviolet light of the wavelength 253.7-380 nm has been found to activate the photocatalyst, thereby releasing reactive oxygen and hydroxyl ions.

The electromagnetic radiation source means may, for example, comprise a mercury vapour gas discharge lamp, an excimer laser, an LED (light emitting diode) or an array of LEDs.

In any case, the electromagnetic radiation source means preferably extends along the channel and preferably along its whole length.

This facilitates an arrangement in which the treatment of the fuel by the electromagnetic radiation occurs at least for substantially the whole time that the fuel is travelling through the channel.

Preferably, the channel encircles the electgromagnetic radiation source means.

Preferably, the magnetic field source means is so arranged, relative to the channel, that the magnetic field from the magnetic field source means extends into the channel.

Thus fuel in the channel is simultaneously treated by the magnetic field, the electromagnetic radiation and the photocatalyst.

The magnetic field source means may to advantage be situated outside the channel.

Preferably, the magnetic field source means encircles the channel

The magnetic field source means may comprise one or more permanent magnets, but preferably comprises an electromagnetic coil which encircles the channel

The use of an electromagnetic coil as the source of magnetic field enables a time varying magnetic field to be readily generated, and it is believed that this can result in the fuel being more effectively treated.

To that end, the electromagnetic coil may to advantage be connected to coil driver circuitry operable to supply a time varying current to the coil, the current being in the form of a square wave signal having a frequency of 100-500 Hz.

Preferably the square wave current generated by the driver circuitry flows in alternating senses around the coil.

It is believed that the magnetic fields generated by such a current will have a beneficial stirring effect on hydrocarbon fuel molecules being treated in the apparatus.

The electromagnetic coil may to advantage be one of two such coils, which are preferably coaxial, the arrangement of coils and driving circuitry being such that current flowing through the coils at any one time travels in opposite senses around the coils. For example, while the current is flowing in a clockwise direction through the first coil, the current in the second coil, when viewed in the same direction as the first coil, will be flowing in an anticlockwise direction.

Preferably, the coils are wound in opposite senses. This enables these current flow characteristics to be achieved simply by connecting the coils in series to the output from the coil driver circuitry

Preferably, the apparatus includes an electrically conductive member which extends into the channel and which, in use, conducts an electric current.

This current causes a magnetic field which is believed to assist in the separation of minerals from the fuel and/or to vary the direction and/or magnitude of the net flux of magnetic field within the channel.

Preferably, the conductive member is so arranged that said current is induced by the magnetic field generated in the channel by the magnetic field generating means.

Preferably, the conductive member is helical and is preferably substantially coaxial with the coils.

The helical member is preferably rotatably mounted, for rotation about its axis within the channel, the apparatus including rotational drive means for rotating the helical member.

The rotational drive means may conveniently include a motor which drives the helical member through a magnetic linkage comprising a first coupling member outside the channel and a second coupling member carried on the helical member, the coupling members being magnetically coupled to each other so that rotation of the first coupling member by the motor results in a corresponding rotation of the second coupling member.

Preferably, the first coupling member comprises a gear ring which encircles the channel and meshes with an output gear attached to the motor.

The photocatalyst may conveniently comprise a coating on the inner surface of the channel.

Additionally, or alternatively, the photocatalyst may be carried by a rack within the channel, the rack being attached to the helical member

The apparatus may to advantage include a cleaning member situated within the channel in contact with the electromagnetic radiation source means, the cleaning member being movable relative to the electromagnetic radiation source means to clean the latter.

The cleaning member may conveniently be constituted by the helical member or the rack.

Preferably, the photocatalyst comprises titanium dioxide.

According to a second aspect of the invention, there is provided a device designed to improve ICE fuel effeciency via magnetic force, photocatalysts and photodecomposition. The device having a main body which defines a photocatalyst channel which is located in a magnetic field and stationed on the fuel pipeline for the ICE along which pipeline fuel is transported to the ICE, the channel also encircling a light source which radiates electromagnetic radiation at a wavelength of 175-400 nm, the device further comprising photocatalysts situated in the channel and a magnetic field generator on the outer side of the channel operable to expose the channel to magnetic field, the channel having an inlet and outlet which have both connected to the fuel pipeline and sealed.

Preferably, the device further comprises spirals (or a helical member) that are used to even out magnetic distribution and are deployed in the photocatalyst channel

Preferably, the photocatalyst channel is circular, spiral or bulbous.

Preferably, the light source is a source of nano light or black light.

Preferably, the photocatalysts are located on the inner wall of the photocatalyst channel, towards which walls the light source radiates.

Preferably, the photocatalysts are located inside the photocatalyst channel, or are located both inside the channel and on an inner wall of the channel to which the light source radiates.

Preferably, the photocatalysts are formed as coatings containing titanium dioxide on the inner wall of the photocatalyst channel, or are cylindrical racks containing titanium dioxide when located inside the channel.

Preferably, the magnetic field generator is a permanent magnet, or the magnetic field is an electromagnetic field.

Preferably, the helical members (spirals) that are used to even out magnetic distribution consist of 1-2 parallel iron plates clad in a thin aluminium sheet and formed or moulded into a spiral/helical shape.

Brief description of the drawings

The invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

Figure 1 is a cross-sectional view of a first embodiment of apparatus in accordance with the invention;

Figure 2 is an isometric view of a rack which supports a photocatalyst, and which forms part of the apparatus shown in Figure 1;

Figure 3 is a side elevation of a helical member, also forming part of the apparatus shown in Figure 1;

Figure 4 is a sectional side view of a second embodiment of apparatus in accordance with the invention;

Figure 5 is a sectional side view of a third embodiment of apparatus in accordance with the invention;

Figure 6 is a circuit diagram showing the circuitry that controls the operation of the third embodiment and also supplies the energising current for electromagnetic coils on the third embodiment; and

Figure 7 is a circuit diagram of circuitry for powering the electric motor and the lamp of the third embodiment of apparatus.

Detailed description

Each embodiment of apparatus comprises a device which is intended to improve ICE (internal combination engine) fuel combustion efficiency through magnetic force, photo catalysts and photo-decomposition. It allows fuels to be processed concurrently through a magnetic field, a light source and photo catalysts, before the fuel is fed into the engine cylinder for a complete combustion. It is believed to have the benefits of lowering carbon emissions, mitigating environmental pollution and improving engine efficiency.

The device mainly consists of a photo catalyst channel The channel is located to a magnetic field and stationed on the fuel pipeline, transporting fuels from one end of the pipeline to the other. It also encircles electromagnetic radiation sourse means comprising a light source which radiates electromagnetic radiation at wavelength of 175-400 nm. Photo catalysts are deployed in the channel. There is a magnetic field generator on the outer side of the channel to expose the channel to the magnetic field. The inlet and outlet of the channel are both connected to the fuel pipeline and sealed. Spirals that are used to even out magnetic distribution are deployed in the described photo catalyst channel The described photo catalyst channel is circular, spiral, or bulbous. Nano light or black light are terms used to describe the emissions from the 175-400 nm light source The photo catalysts are located on the inner wall of the channel towards which the light source radiates. The photo catalysts may also be located inside the photo catalyst channel, or located both inside the channel and on the inner wall of the channel towards which the light source radiates The photo catalysts are coatings containing titanium dioxide when located on the inner wall of the photo catalyst channel. The photo catalysts are also on cylindrical racks containing titanium dioxide when located inside the channel The magnetic field is generated by a permanent magnet, or is an electromagnetic field. The spirals that are used to even out magnetic distribution consist of 1-2 paralleled iron plates. The pair of plates are clad in a thin aluminium sheet and molded into a spiral shape, to constitute a helical member.

The embodiments allow fuels to be processed concurrently through a magnetic field, a light source and photo catalysts, before being fed into the engine cylinder for a complete combustion. They can reduce carbon emissions, mitigate environmental pollution and improve engine efficiency.

The fuels can be concurrently exposed to a magnetic field, a 175-400 nm light source, and photo catalysts before being fed into the engine for deflagration The magnetic field, the 175-400 nm light source and photo catalysts act on the fuels at the same time.

ICE fuels generally refer to organic liquids like petrol, diesel, kerosene, ethanol, gasoline and methanol, and organic gases like liquefied gas, natural gas and alcohol. They are mainly a mix of organic compounds, for instance, alkanes, aromatic hydrocarbons, benzene and hydroxyl. All the fuels are organic mixtures with long carbon chains and heavy molecules. The heavier the molecules are, the stickier they are; the lighter the molecules are, the higher heat value they contain and the better is their atomization combustion. Hydroxyl free radicals are high energy fuels. Modern combustion theories suggest oxidation of organic compounds is in nature a series of chain reactions by free radicals The speed of combustion and the generation of negative burning products are affected by the status of molecular chains that free radicals polymerize into. The length of molecular chains of organic compounds dictates the level of energy in combustion reactions Compounds like phenol and alcohol can decompose into hydric and hydroxyl ions that propel combustion Organic fuels free from metal ions burn faster and fuller. It is difficult for inorganic salts to generate oxides that pollute the environment. Fuels going through a magnetic field are catalysed and oxidised. Fuel gas molecular chains break and release hydroxyl free radicals. Thiol and thiophene in the radicals decompose into hydrogen and generate a large amount of free radicals and hydrogen When free radicals polymerize, the Brownian motion – which drives polymer molecular motions – turns into a hollow tubular motion which accelerates the combustion speed. In the meantime, the photo catalysts in the fuels of this utility model are exposed to 175-400 nm light waves. The catalysts absorb energy from the light and form electron-hole pairs. Those pairs (photo carriers) quickly move to the surface and activate H_2O and O_2 attached to the surface. Hydroxyl (-OH) and Reactive oxygen (-O) are then generated to speed up combustion. Petrol has a combustion value of 10,500 kcal/litre while hydrogen has that of 20,000 kcal/litre. Hydrogen only requires a small amount of energy to ignite, at 1/6 of what petrol requires. The travel speed of flames in burning hydrogen is nine times as fast as that in burning petrol. The addition of hydrogen to fuels accelerates the speed of flames and enhances the energy release base of heat values. Hybrid gas then ignites more quickly and burns faster to avoid energy waste and negative reactants generated from fire accidents. Inorganic salts generated can reduce the generation of oxides and save energy while cutting pollution.

Without changing the ICE structural designs, each embodiment enhances energy release base, speeds up fuel combustion, and bends the burning curve to complete the energy release process in an earlier and intensified manner in the meantime, inorganic compounds like sulphides are turned into salts in the process and environmental pollution is thus mitigated. Experiments suggest that application of this solution bends burning curves and completes the energy release process in an earlier and intensified manner. Engine noise is significantly dampened and torque is greatly enhanced. Engine efficiency is considerably boosted and negative burning products are effectively reduced.

Figures 1-4 illustrate a device designed to improve ICE fuel combustion efficiency through magnet force, photo catalysts and photo-decomposition. The device mainly consists of a photo catalyst channel 3 in which in use, fuel is concurrently exposed to a magnetic field, a 175-400 nm light source, and photo catalysts before being fed into an engine for deflagration.

The photo catalyst channel is located in a magnetic field and stationed on the fuel pipeline, transporting fuels from one end of the pipeline to the other. It also encircles a light source which radiates at 175-400 nm. Photo catalysts are deployed in the channel 3. There is a magnetic field generator 4 on the outer side of the channel 3 to expose the channel 3 to the magnetic field. The inlet 8 and outlet 2 of the channel 3 are both connected to the fuel pipeline and sealed.

With reference to Figure 3, spirals constituting a helical member 6 are used to even out magnetic distribution and are deployed in the photo catalyst channel 3. Those spirals are formed from two parallel iron plates 10. The pair of plates 10 are clad in a thin aluminium sheet and molded into a spiral shape. They play a role of evenly distributing the magnetic field in the catalyst channel, and facilitate catalysis and oxidation of fuel in the channel 3 under the magnetic force.

The described catalyst channel is cylindrical, but in other embodiments may be circular, spiral, or bulbous. Nano light or black light is the electromagnetic radiation emitted by 175-400 nm light source 7. The described photo catalysts are located on the inner wall of the channel 3 towards which the light source 7 radiates, and are also provided inside the photo catalyst channel 3. More specifically, the photo catalysts are included in coating 5 containing titanium dioxide on the inner wall of the photo catalyst channel 3. The photo catalysts are also applied to a cylindrical rack 9 containing titanium dioxide when located inside the channel.

As shown in Figure 1, the photo catalyst channel 3 encircles the light source 7 and allows fuels to flow through. A transparent circular shield is centrally housed in the channel 3 and corresponds to the shape of the light source. The shield defines a chamber 1 which accommodates the light source at the center of the transparent circular shield. The inner wall of the channel 3 has coatings containing titanium dioxide 5 Inside the channel 3, the cylindrical rack 9 carrying titanium dioxide is installed. With reference to Figure 2, the titanium dioxide is applied as a coating to the outer surface of the cylindrical rack 9. This is to extend the interface where fuels meet photo catalysts for conversation. Reflective coatings can be applied to the outer surface of the transparent channel 3 to a magnetic generator 4 (which encircles the channel 3) to allow both direct and reflected light to act on the fuels flowing through the channel. The photo-decomposition results will then be enhanced The transparent shield is made of heatproof transparent materials, for example, heatproof glass.

With reference to Figure 2, the rack 9 is generally cylindrical, and is formed from six coaxial rings 12-17 which are parallel and are spaced apart in the direction of the axis of the cylinder defined by the rack 9. The rings are held together by means of straight, parallel tie bars 18-27 which extend parallel to the axis of the cylinder defined by the rack 9. The tie bars 18-27 and rings can be formed of a wire of a suitable metal, and the tie bars and rings can be held together by any suitable means, for example by being welded together. The whole of the rack 9 is coated with the titanium dark side photo catalyst The tie bars 18-27 are regularly arranged around the rings so that the angular spacing between any adjacent pair of tie bars is constant.

In the embodiment shown in Figure 4, various components correspond to the components of the first embodiment, and these are indicated by the reference numerals of Figures 1-3 raised by 50. In Figure 4, the light source and rack have been omitted for the sake of clarity. The second embodiment does not have a component corresponding to the helical member 6, but instead includes a helical arrangement of vanes 11 which define a helical path between the inlet 52 and outlet 58.

Thus the channel which encircles the light source and allows fuels to flow through is a spiral channel surrounding the light source Spiral vanes or separators 11 are positioned in the transparent circular shield, to form a spiral channel where fuels can only enter from the inlet sitting at the top, and then flow to the shape of the spiral channel, before finally heading for the outlet at the bottom. This type of channel helps prolong contacts between magnetic, light, photo catalyst materials and fuels to extend conversion time. Coatings with titanium dioxide are applied to the inner wall of the spiral channel. Cylindrical racks are installed within the channel (between the shield 1 and radial inner edges of vanes 11).

In either embodiment the magnetic field is generated by a magnetic generator (4, 54). The generator can be either a permanent magnet or an electromagnetic generator as the latter also generates a magnetic field. In these examples the field provided by magnet-field-generating coils driven by electric controllers which feature positive and negative square wave generators, power amplifiers and voltage stabilizers. Car batteries charge the controllers, and when electricity runs through the positive square wave generators, positive and negative square waves at 100-500 Hz are generated. After being amplified by the power amplifiers, the waves are fed into the magnet-field-generating coils and a magnetic field occurs within the coils. The power source provides electricity via voltage stabilisers to the light source in the transparent shield. Positive square wave generators, power amplifiers and voltage stabilisers are all available from the market. They can be replaced by traditional circuits, but it is preferable for the circuits used to have positive square wave generators that generate 100-500 Hz positive and negative square waves. After being amplified by power amplifiers and fed into the magnet-field-generating coils, the waves can generate magnetic force equivalent to a magnetic flux density of 100-500 Gs. The magnetic generator sits on the outer side the photo catalyst channel, and the catalyst channel sits in the magnetic field generated by the generator.

A programmed unit can also provide the light source and magnetic generator of this utility model with conversion-support power circuits, just like storage batteries. The unit controls the light source and generates a modulated magnetic field. An electromagnetic generator can also generate a modulated magnetic field. Such a field is formed of magnet-field-generating coils. Car storage batteries produce 100-500 Hz positive and negative square waves via the programmed unit, and feed them into magnet-field-generating coils. A modulated magnetic field is then induced in the coils. The power source provides electricity via the programmed unit to the light source in the transparent shield. Program-controlled IC circuit components of the programmed unit are all available from the market, therefore no such details will be repeated. The magnetic generator sits on the outer side the photo catalyst channel, and the catalyst channel sits in the modulated magnetic field generated by the generator.

Each embodiment is for installation near the engine fuel inlet and would be mounted on the corresponding engine or vehicle and connected to the car storage batteries to help magnet-field-generating coils generate the magnetic field. Through the inlet, fuels first enter the photo catalyst channel that encircles the light source and conveys fuels. The fuels are concurrently exposed to the magnetic field, the 175-400 nm light source and the photo catalysts, before feeding into the engine for deflagration, to achieve better engine efficiency and fuel savings.

A device in accordance with the invention allows fuels to be processed concurrently through a magnetic field, a light source and photo catalysts, before being fed into the engine cylinder for a complete combustion. It has the benefits of reducing carbon emissions, mitigating environmental pollution and improving engine efficiency.

The third embodiment of apparatus in accordance with the invention will now be described with reference to Figures 5-7.

In this case, an elongate, low pressure mercury discharge lamp 30 is contained within a hollow cylindrical housing 32 which is formed from metal or any other suitable material and is of a three part construction, having a cylindrical body portion 34 attached at either end to two end caps 36 and 38 attached to the body at screw threaded connectors 40 and 42 provided between the body and each end cap

The cap 36 carries a hose connector 44 which acts as the inlet for the apparatus. The connector 44 is attached to the cap by any suitable means, and sealed thereto, again by any suitable means. The connector 44 defined one end of a passage 46 which extends through the cap 36 and into the interior of the housing 32.

The housing 32 accommodates a hollow cylindrical core piece which is coaxial with the housing 32 and light source 30 and extends along the housing from the end cap 36 to the end cap 38. The core piece 38 is formed from a non-ferromagnetic material, and is attached to the housing 32 at the caps 36 and 38 by any suitable means, for example a screw threaded connector or by being welded

A liquid tight seal between the core piece 48 and the end caps 36 and 38 is provided by O ring seals 50 and 52.

The cap 36 includes a cylindrical end wall 37 which defines a blind socket for locating the adjacent end of the lamp 30.

The core 48 includes three outwardly directed annular flanges 54, 56 and 58 which define, with the portion 34 of the housing 32, a pair of axially spaced cylindrical racks 60 and 62 which are coaxial with the core 48 and the lamp 30, and which accommodate corresponding coaxial coils 64 and 66, each of which is wound onto a respective one of the racks 60 and 62.

The coils 64 and 66 are of a suitable conductor, and act as electromagnetic coils The coils have the same number of turns as each other, but are wound onto the rack 60 and rack 62 in opposite senses and are connected to driving circuitry in series with each other, so that the current from the driving circuitry passes through the coils in opposite senses. The core 54 thus acts as a rack for supporting the coils 64 and 66

The end cap 38 includes an outlet hose connector 68 through which fuel exits the apparatus after having been processed.

The outboard end of the cap 38 includes a screw threaded connector 70 on which a further end cap 72 is mounted. As can be seen from Figure 5, the cap 72 is open ended to allow access to terminals 74 of the lamp 30. Leakage of fuel between the lamp 30 and the cap 72 is prevented by an annular O ring seal 76. A further, upstream annular O ring seal 78 is also provided between the main body of the lamp 30 and the cap 38, and also helps to prevent leakage of oil out of the cap 38.

The cap 48 is also provided with a mounting lug 80 which is generally circular (when viewed end on) and via which a DC electric motor 82 is attached to the apparatus. The lug 80 has an aperture 84 through which the motor extends, the motor having an output shaft 86 which extends to the opposite side of the lug 80 from the rest of the motor, and which is attached to an externally toothed gear wheel 88 held on the shaft 86 by a fastening nut 90. A part cylindrical cowell 92 defines, with the lug 80, a cylindrical chamber 94 for accommodating the gear wheel 88.

The chamber 92 is open at its upper region, with the apparatus viewed as shown in Figure 5, so that the gear wheel 88 can mesh with an externally toothed annular ring 94 which is rotatably mounted on the cap 38, is disposed coaxially with the lamp 30 and core 48 and provides the first magnetic coupling member of a magnetic linkage through which the motor 82 can rotate a rack and helical member assembly 96 around the lamp 30.

To that end, the annular ring 94 contains a number of radially positioned permanent magnets (not shown) which are equi-angularly arranged within the ring with alternating polarities. Thus, for example, one of those magnets positioned with the north pole as its radially inner pole will be flanked by two other magnets in each of which the south pole will be radially innermost. The second coupling member of the magnetic linkage comprises an inner annular ring 98 which contains a similar arrangement of magnets (not shown), and is mounted within the housing 32. In use, the operation of the motor 82 rotates the gear wheel 88 which, in turn, rotates the ring 94. This, in turn, causes a corresponding rotation of the ring 98, by virtue of the magnetic coupling between the rings, so that drive can be transmitted to the ring 98 without the need for a transmission which directly contacts the ring 98.

The rack and helical member assembly extends along a substantial portion of the length of the interior of the housing 32, and comprises a rack 100 which is attached at one end to the ring 98, bears against the lamp 30 and is also rotatable about the lamp 30. The general structure of the rack is similar in many respects to the rack shown in Figure 2. Thus the rack 100 has eight coaxial rings (for example ring 102) In this case, however, each of these rings is generally cylindrical. Instead of the tie bars of the Figure 2 rack, each of the rings is attached to its neighbouring rings through a number of equi-angularly spaced, blade like connectors such as the connector 104 which also bears against the lamp 30. Each of these connectors bears against the lamp 30 so that, as the rack 100 rotates about the lamp 30, it cleans the surface of the latter. The rings, such as ring 102, of the rack 100 can also have a cleaning effect during this rotation. A helical member 106, formed from silicon steel sheet that has been cut and shaped into a helical form, is attached to the rack 100 at the outer surfaces of a number of its rings, and is thus also arranged coaxially with the rings, and hence with the lamp 30 and housing 32.

Titanium dioxide catalyst may also be coated on the exposed outer surfaces of the rings of the rack 100, but in this particular case, the titanium dioxide photo catalyst is applied just as a coating 108 to the inner surface of the core 48.

As can be seen from Figure 5, the spacing between the coating 108 and the radial outer faces of the helical member 106, the exposed portions of the rack 100 and the exposed portions of the lamp (i.e. those not covered by the rack at any one time) provide a channel through which fuel introduced through the connector 44 can flow through the apparatus and exit through the connector 68.

During its passage through the apparatus, the fuel is exposed to ultra violet radiation from the lamp 30, to the magnetic field generated by the coils 64 and 66 and to the photo catalyst coating 108 which is activated by the light from the lamp 30. In addition, the magnetic field generated by the coils 64 and 66 induces in the helical member 106 a current which itself creates a magnetic field. It is believed that the magnetic field to which the fuel is subjected helps to separate mineral components so that these do not interfere with the subsequent combustion process. During the operation of the device, the motor 82 rotates the rack 100 and helical member 106 This rotation is believed to assist in the processing of the fuel, and causes the rack 100 to clean the outer surface of the lamp 30, as discussed above.

The lamp 30 has a power output of between 8 watts and 14 watts in the current models (higher power output lamp can also be adopted), and is of a length between 10 and 20 cm in the current model. The actual power output and dimensions of the lamp (and the associated dimensions of the rest of the apparatus) may differ from one embodiment to the next, depending upon the nature of the fuel to be processed, and the size of engine to which the processed fuel is to be supplied

In use, the coils 64 and 66 are supplied with an alternating square wave current of a frequency of 100-500 Hz (as with the apparatus of the first embodiment). This current is supplied by the circuit shown in Figure 6. That circuit is based around two integrated circuits, IC2 and IC3. Integrated circuit IC2 may be of the type designated by the reference MM358 8-DIP, whilst IC3 may be of the type designated by the reference LM2525A16-DIP.

The circuit shown in Figure 6 includes an input for receiving a signal indicative of the activation of the engine, and is arranged so that the activation of the engine will automatically trigger the circuit of Figure 6 into activating the lamp 30 and the motor 82, as well as triggering the supply of the energising current to the coils 64 and 66.

The skilled addressee will appreciate the system to which the input needs to be connected to achieve this, but an example would be the vehicle's fuel pump control system.

The input on the circuit of Figure 6 for the activation signal is the input A, in the top left hand corner, via which the circuit of Figure 6 is connected to the input A of the circuit of Figure 7 The circuit of Figure 7 includes DC V+ and DC V- terminals which receive the signal indicative of activation, causing the circuit of Figure 7 to provide an activation signal at the input A of the Figure 6 circuit.

The output for the alternating current for energising the coils 64 and 66 is provided by terminals B2-AC 25 Hz and AC 25 Hz on the right hand size of the circuit.

The circuit shown in Figure 6 includes a terminal A which is connected to terminal A of the circuit of Figure 7. The circuit of Figure 7 is based around integrated circuit IC4, which may be of the type designated by the reference IR2520D Figure 8 PIN. When power is received to the terminal A of the circuit of Figure 7, the latter starts up and then drives the lamp 30 by causing the latter to emit ultraviolet radiation as described above.

The table Annexed to this description sets out the details of various compomnents of the circuits.

It will be appreciated that there are other ways of activating and driving the lamp 30, the motor 82 and the coils 64 and 66, and suitable circuits for achieving this will be readily apparent to the skilled addressee.

第 2 页，共 5 页

产品型号Model		ESCC-60					
版本 Version		REVB					
发行时间 Date		2013-8-20					
项目Item	物料编码 PART NO	名称 NAME	规格DESCRIPTION (part no from the supplier or desciption	供货商 supplier (brand)	数量 Quantity	单位Unit	位置LOCATION
14	3-11006	贴片电阻 resistor	754/1206 +/-5%	国巨 Yageo	1	PCS	R12
15	3-11007	贴片电阻 resistor	32 4K/1206 +/-5%	国巨 Yageo	1	PCS	R13
16	3-11008	贴片电阻 resistor	202/1206 +/-5%	国巨 Yageo	7	PCS	R16, R22, R23, R26; R27, R33, R34,
17	3-11009	贴片电阻 resistor	302/1206 +/-5%	国巨 Yageo	1	PCS	R17
18	3-11010	贴片电阻 resistor	104/1206 +/-5%	国巨 Yageo	3	PCS	R18, R19, R21,R3
19	3-11011	贴片电阻 resistor	623/1206 +/-5%	国巨 Yageo	1	PCS	R20
20	3-11012	贴片电阻 resistor	76 8K/1206 +/-5%	国巨 Yageo	1	PCS	R24
21	3-11013	贴片电阻 resistor	10欧/1206 +/-5%	国巨 Yageo	1	PCS	R25
22	3-11014	贴片电阻 resistor	272/1206 +/-5%	国巨 Yageo	2	PCS	R41,R38
23	7-20012	贴片431 431 module	431 SO-23	ST	1	PCS	IC1
24	5-20013	贴片二极管 diode	BAV99LT1 SOT-23	ST	1	PCS	D4
25	8-50011	贴片三极管 audion	MMB2222A SOT-23 NPN[1P]	ST	2	PCS	Q8,Q9
26	5-20014	贴片二极管 diode	IN4148	ST	4	PCS	D5,D6,D7,D8
27	5-20015	贴片稳压二极管 regulator diode	24VDC SMT	ST	1	PCS	ZD1
28	5-20016	稳压二极管 regulator diode	30VDC 1W 插件 plug	ST	1	PCS	ZD2
29	5-20017	稳压二极管 regulator diode	18VDC 1W 插件 plug	ST	1	PCS	ZD3

产品型号 Model	ESCC-60						
版本 Version	REVB						
发行时间 Date	2013-8-20						
项目Item	物料编码 PART NO	名称 NAME	规格DESCRIPTION (part no from the supplier or desciption	供货商 Supplier brand	数量 Quantity	单位Unit	位置LOCATION
30	4-21025	金属膜电阻 resistor	1W 10欧 +/-5% 10 ohm	康鼎 Kangding	2	PCS	R9, R10
31	11-10011	CL21电容 capacitor	104/400V P=10mm 105度 105 c	易杰 Yijie	1	PCS	C3
32	11-10012	CL21电容 capacitor	474/100V P=5mm 105度 105c	易杰 Yijie	1	PCS	C9
33	11-10013	高压瓷片电容capacitor	681/1000V	易杰 Yijie	1	PCS	C5
34	11-10014	CBB81电容 capacitor	CBB81 103/1600V 105度 105c	易杰 Yijie	1	PCS	C6
35	12-10010	电解电容 capacitor	50V 100UF D8mm*L12mm P=3 5mm 10000H	米田电 Mitiandian	2	PCS	C10, C11
36	41-10001	IC	IR2520D 8PIN	IR	1	PCS	IC4
37	42-10012	MOSFET	TO-220 IR540N	IR	2	PCS	Q1,Q2
38	43-10011	保险管 fuse	4A/250V AC 慢速延迟性 slow delay	华电 xyhuadian	1	PCS	F1
39	5-20111	二极管 diode	MBR20100 TO-220	MBR	2	PCS	D1,D2
40	5-20112	二极管 diode	IN4007 DO-41	MIC	1	PCS	D3
41	13-10001	变压器 transformer	EFD-19 1mH+/-5%	力能达 linengda	1	PCS	T1
42	13-10002	变压器 transformer	EFD-25 7mH+/-8%	力能达 linengda	1	PCS	T2
43	42-10013	MOSFED	B40NF10L	IR	5	PCS	Q3, Q4, Q5, Q6, Q7
44	41-10002	集成电路 IC	LM2525A 16-DIP	ST	1	PCS	IC3
45	41-10003	集成电路 IC	LM358 8-DIP	LM	1	PCS	IC2

第 4 页，共 5 页

产品型号Model	ESCC-60						
版本 Version	REVB						
发行时间Date	2013-8-20						
项目Item	物料编码 PART NO	名称 NAME	规格DESCRIPTION (part no from the supplier or desciption	供货商 supplier (brand)	数量 Quantity	单位Unit	位置LOCATION
46	19-10001	红色输入线 input cable	18# UL 1015 600V 105度 c 670mm	新成电子 XinCheng	1	PCS	VDC+
47	19-10002	黑色输入线 input cable	18# UL 1015 600V 105度 c 670mm	新成电子 XinCheng	1	PCS	VDC-
48	19-10003	U型端子[输入线) U shape connector (input)	PVC绝缘套叉形端子/端子开口6mm [TDK SNYDL1-6/SVS1 25-6]	TDK	2	PCS	
49	20-10001	透明灯冒 transparent cap	无冒凸透明灯冒 lead-free transparent cap	新成电子 XinCheng	1	PCS	
50	22-10001	小护线圈 protection wrap small	黑色护线圈[直径3MM]	新成电子 XinCheng	2	PCS	
51	22-10002	大护线圈 protection wrap large	黑色护线圈[直径6MM]	新成电子 XinCheng	2	PCS	
52	31-10001	LED	长引脚/白发蓝/直径5mmLED	新成电子 XinCheng	1	PCS	LED1
53	19-10004	LED双线 LED dual connectors	22# UL 300V 80度 c 140mm [带母座]	新成电子 XinCheng	1	PCS	LED1
54	19-10005	LED公座 LED socket	2PIN[间距离2 5mm]	新成电子 XinCheng	1	PCS	CN1
55	24-10001	矽胶套管 silica gel tube	TO-220A [L 22mm]	通达电子 Tongda	7	PCS	D1/D2/Q3/4/5/6/7
56	47-10001	导热密封硅胶 silica gel seal	XJA-HG05 1 1	欧特电子 Oute	140	PCS	
57	19-10006	UV-2芯18#输出线 output cable	1050mm[2PIN灯座G5（5mm)]自己开模生产。耐温200度 200c	力能达 linengda	1	PCS	R/R
58	40-10001	尼龙波纹管 nylon rippled tube	黑色尼龙波纹管内¢ 12mm/外¢ 15 8mm L 0 8M	正尼 zhengni	0 8	m	
59	51-10001	铝外壳上盖 aluminum cap	L132mmW68mmH33mm	金科利 jinkeli	1	PCS	
60	51-10002	铝外壳底盖 aluminum cap	L117 4mmW55 2mmH2 5mm	金科利 jinkeli	1	PCS	

产品型号model		ESCC-60					
版本 version		REVB					
发行时间 date		2013-8-20					
项目Item	物料编码 PART NO	名称 NAME	规格DESCRIPTION	供货商	数量 Quantity	单位Unit	位置LOCATION
61	52-10001	高温热缩管 heat thrinkable tube	155度/耐高温/耐油/铁氟龙套管¢19 1mm	广州市熙晓绝缘材料	0 045	m	
62	19-10007	电机线2芯输出线[母] output cable	外径 3 5mm 24#红黑线 长1070mm outter diameter length	华通电子 Huatong	1	PCS	V+
63	19-10008	电机线2芯输出线[公] output cable	外径 3 5mm 24#红黑线 长150mm outter diameter length	华通电子 Huatong	1	PCS	V-
64	19-10009	AC-2芯输出线 output cable	1050mm[快速连接头（母）] length	华通电子 Huatong	1	PCS	B
65	19-100010	AC-2芯输出线 output cable	200mm[快速连接头（公）] length	华通电子 Huatong	1	PCS	B
66	60-00001	包装箱 packaging	500*400*300 [30/1PCS]	金伟 jinwei	1	PCS	

备注

审核

日期

Claims

1 Apparatus for treating a fuel prior to combustion, the apparatus comprising a channel for fuel to be treated, a photocatalyst situated within the channel so as to be in contact with the fuel passing therethrough, electromagnetic radiation source means for irradiating the catalyst and magnetic field source means for providing a magnetic field to which the fuel is exposed.

2. Apparatus according to claim 1, in which the electromagnetic radiation source means is so arranged, relative to the channel, also to irradiate, in use, fuel travelling through the channel.

3. Apparatus according to claim 1 or claim 2, in which the electromagnetic radiation source means is operable to emit electromagnetic, radiation comprising ultraviolet light

4. Apparatus according to claim 3, in which said ultraviolet light has a wave length in the range 175-400 nm.

5. Apparatus according to any of the preceding claims, in which the electromagnetic radiation source means comprises a mercury vapour gas discharge lamp, an excimer laser, an LED (light emitting diode) or an array of LEDs.

6. Apparatus according to any of the preceding claims, in which the electromagnetic radiation source means extends along the channel.

7. Apparatus according to claim 6, in which the electromagnetic radiation source means extends along the whole length of the channel.

8. Apparatus according to any of the preceding claims, in which the channel encircles the electromagnetic radiation source means

9. Apparatus according to any of the preceding claims, in which the magnetic field source means is so arranged, relative to the channel, that the magnetic field from the magnetic field source means extends into the channel.

10. Apparatus according to any of the preceding claims, in which the magnetic field source is situated outside the channel. -

11. Apparatus according to claim 10, in which the magnetic field source means encircles the channel.

12 Apparatus according to any of the preceding claims, in which the magnetic field source means comprises an electromagnetic coil which encircles the channel.

13. Apparatus according to claim 12, in which the electromagnetic coil is connected to coil driver circuitry operable to supply a time varying current to the coil, the current being in the form of a square wave signal having a frequency of 100-500 Hz

14. Apparatus according to claim 13, in which the square wave current generated by the driver circuitry flows in alternating senses around the coil

15. Apparatus according to any of claims 12 to 14, in which the electromagnetic coil is one of two such coils, which are coaxial, the arrangement of coils and driving circuitry being such that current flowing through the coils at any one time travels in opposite senses around the coils.

16. Apparatus according to claim 15, in which the coils are wound in opposite senses.

17. Apparatus according to any of the preceding claims, in which the apparatus includes an electrically conductive member which extends into the channel and which in use, conducts an electric current

18. Apparatus according to claim 17, in which the conductive member is so arranged that said current is induced by the magnetic field generated in the channel by the magnetic field generating means.

19. Apparatus according to claim 17 or claim 18, in which the conductive member is helical and is substantially coaxial with the coils.

20. Apparatus according to any of claims 17 to 19, in which the helical member is rotatably mounted, for rotation about its axis within the channel, the apparatus including rotational drive means for rotating the electrically conductive member.

21. Apparatus according to claim 20, in which the rotational drive means may conveniently include a motor which drives the helical member through a magnetic linkage comprising a first coupling member outside the channel and a second coupling member attached to an electrically conductive member, the coupling members being magnetically coupled to each other so that rotation of the first coupling member by the motor results in a corresponding rotation of the second coupling member.

22. Apparatus according to claim 21, in which the first coupling member comprises a gear ring which encircles the channel and meshes with an output gear attached to the motor.

23 Apparatus according to any of the preceding claims, in which the photocatalyst comprises a coating on the inner surface of the channel.

24. Apparatus according to any of the preceding claims, in which the photocatalyst is provided on a rack within the channel, the rack being attached to the helical member.

25. Apparatus according to any of the preceding claims, in which the apparatus includes a cleaning member situated within the channel in contact with the

electromagnetic radiation source means, the cleaning member being movable relative to the electromagnetic radiation source means to clean the latter.

26. Apparatus according to claim 25, in which the cleaning member comprises the rack.

27. Apparatus according to any of the preceding claims, in which the photocatalyst comprises titanium dioxide.

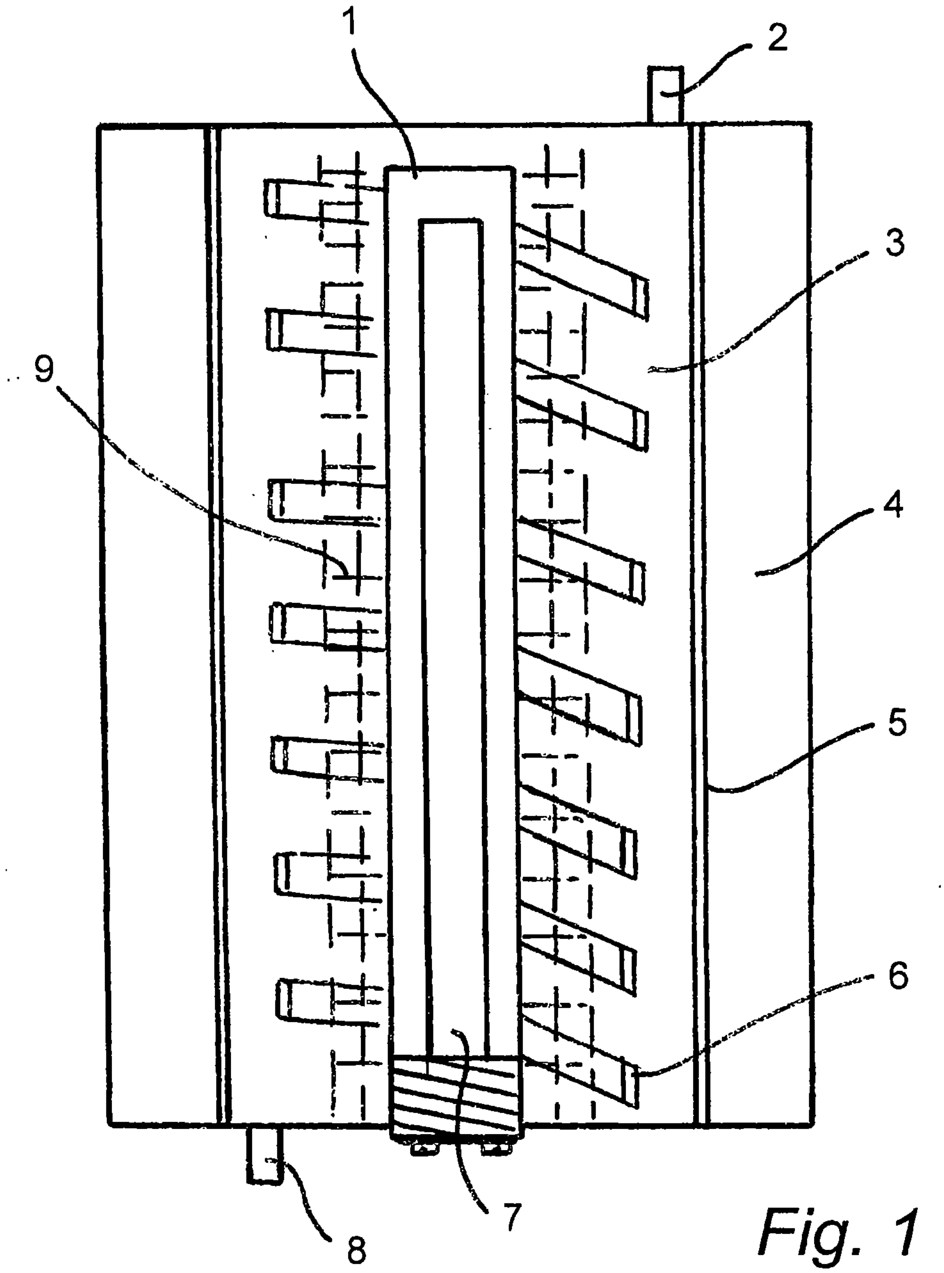

Fig. 1

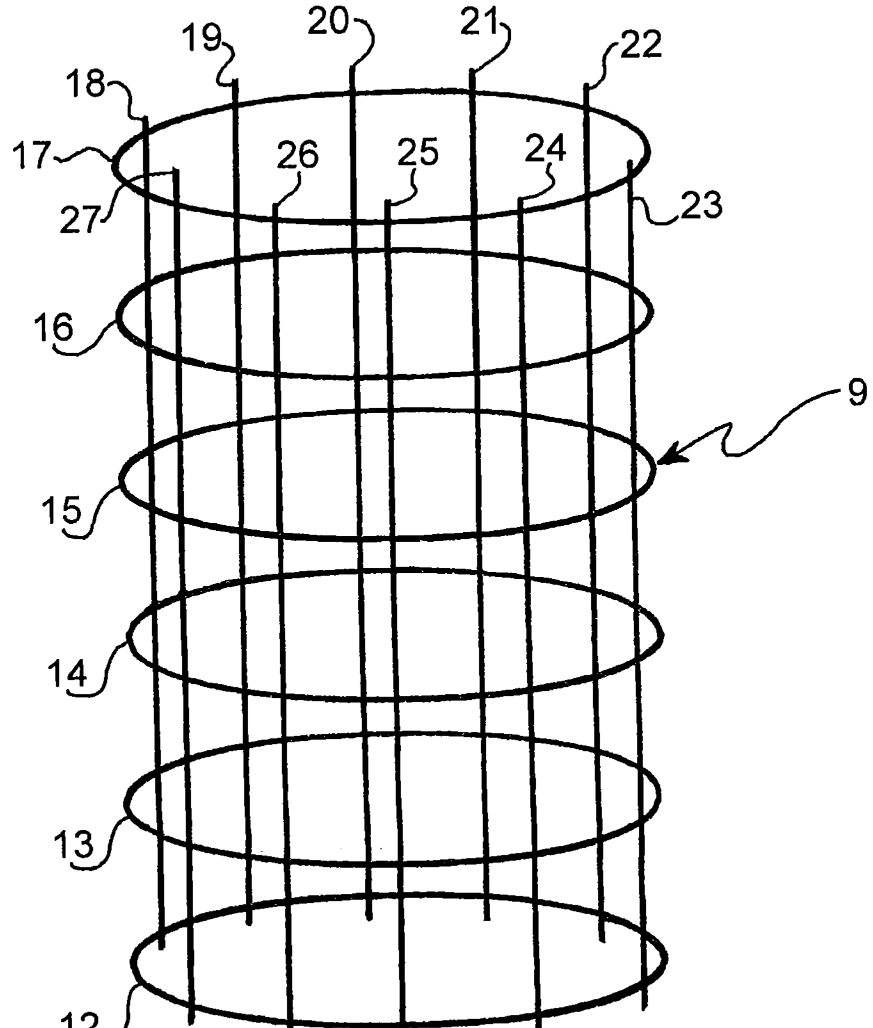

Fig. 2

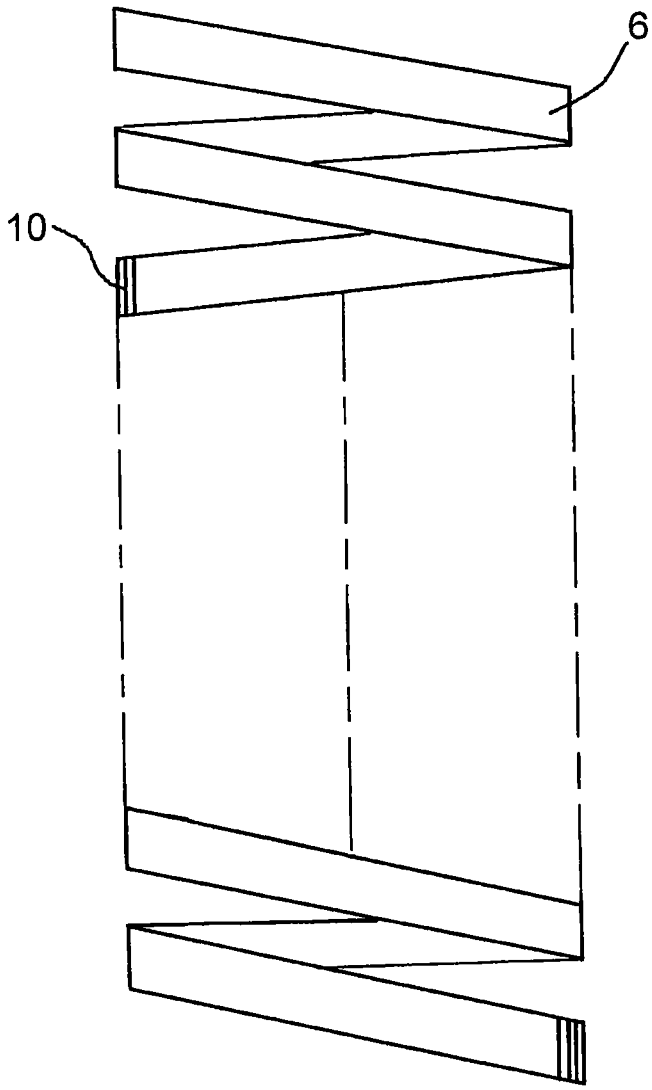

Fig. 3

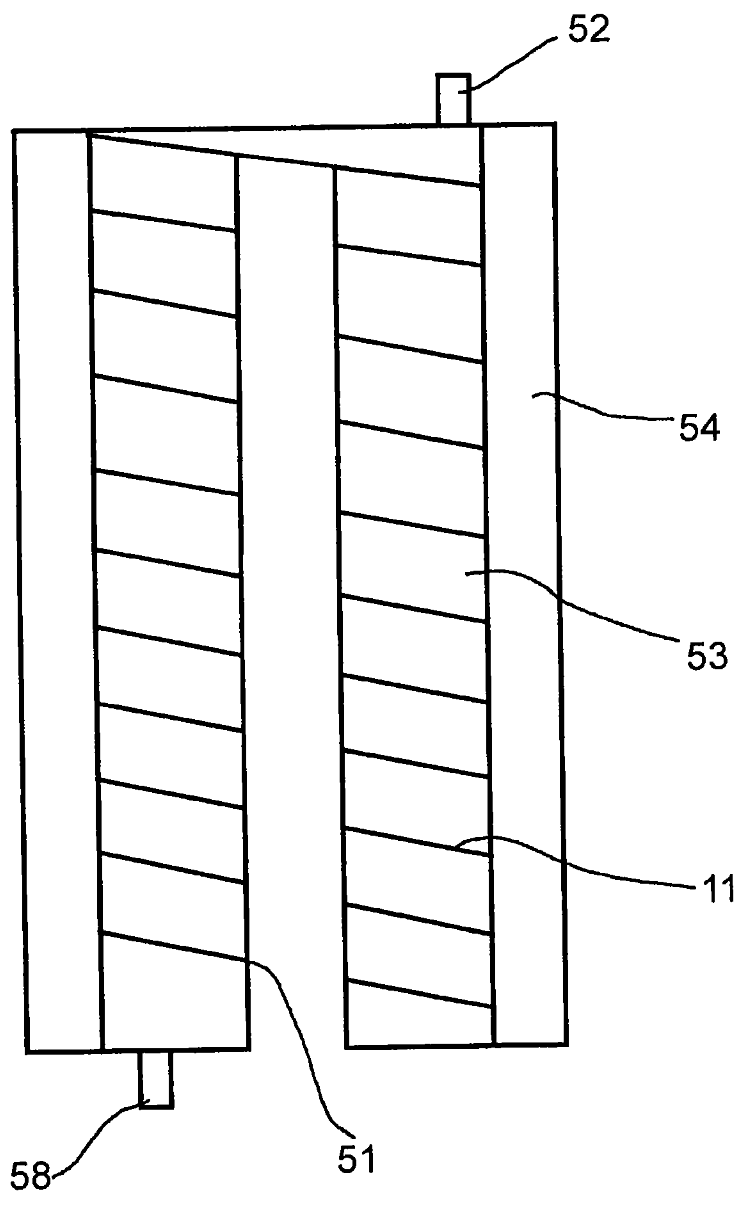

Fig. 4

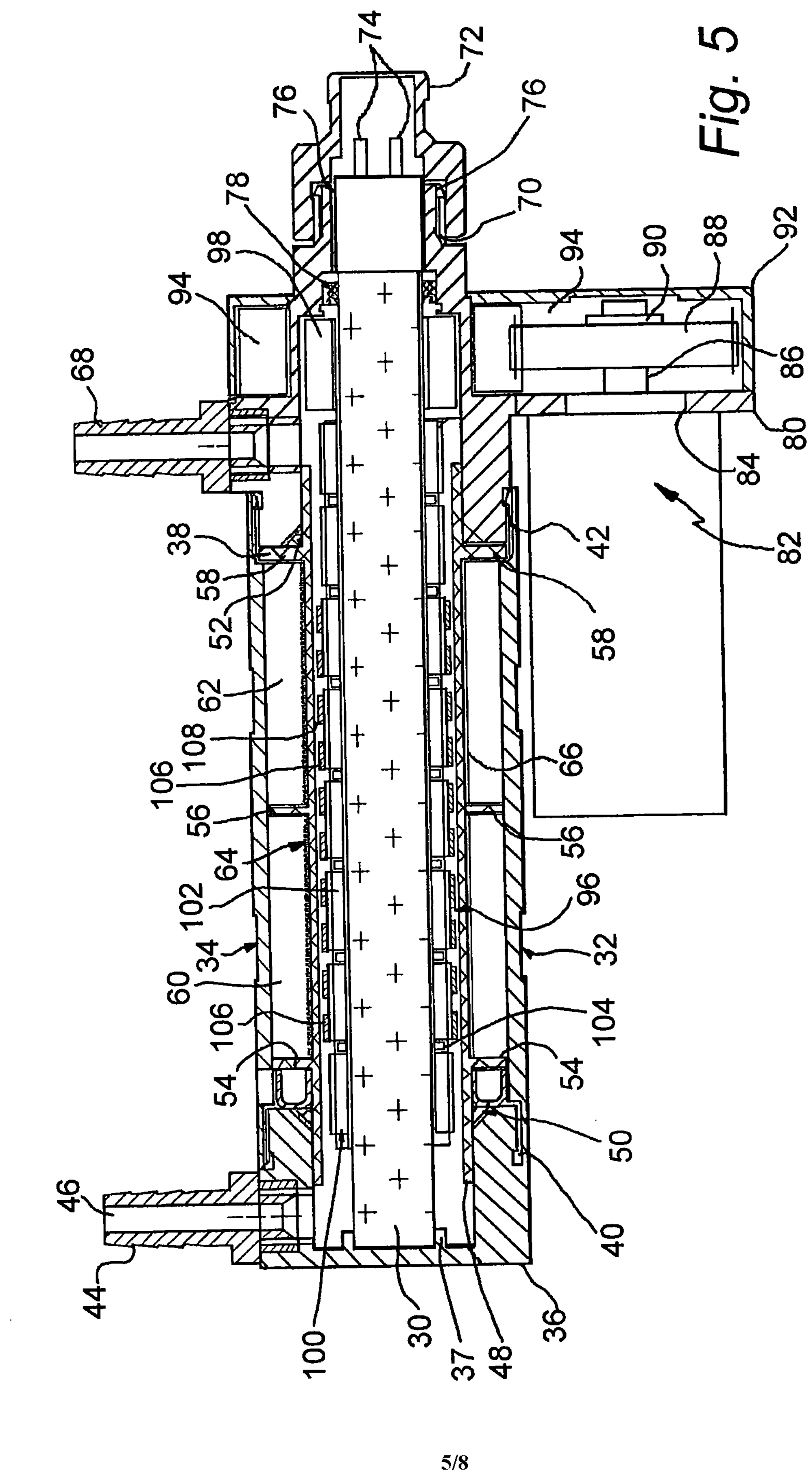
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Fig. 5

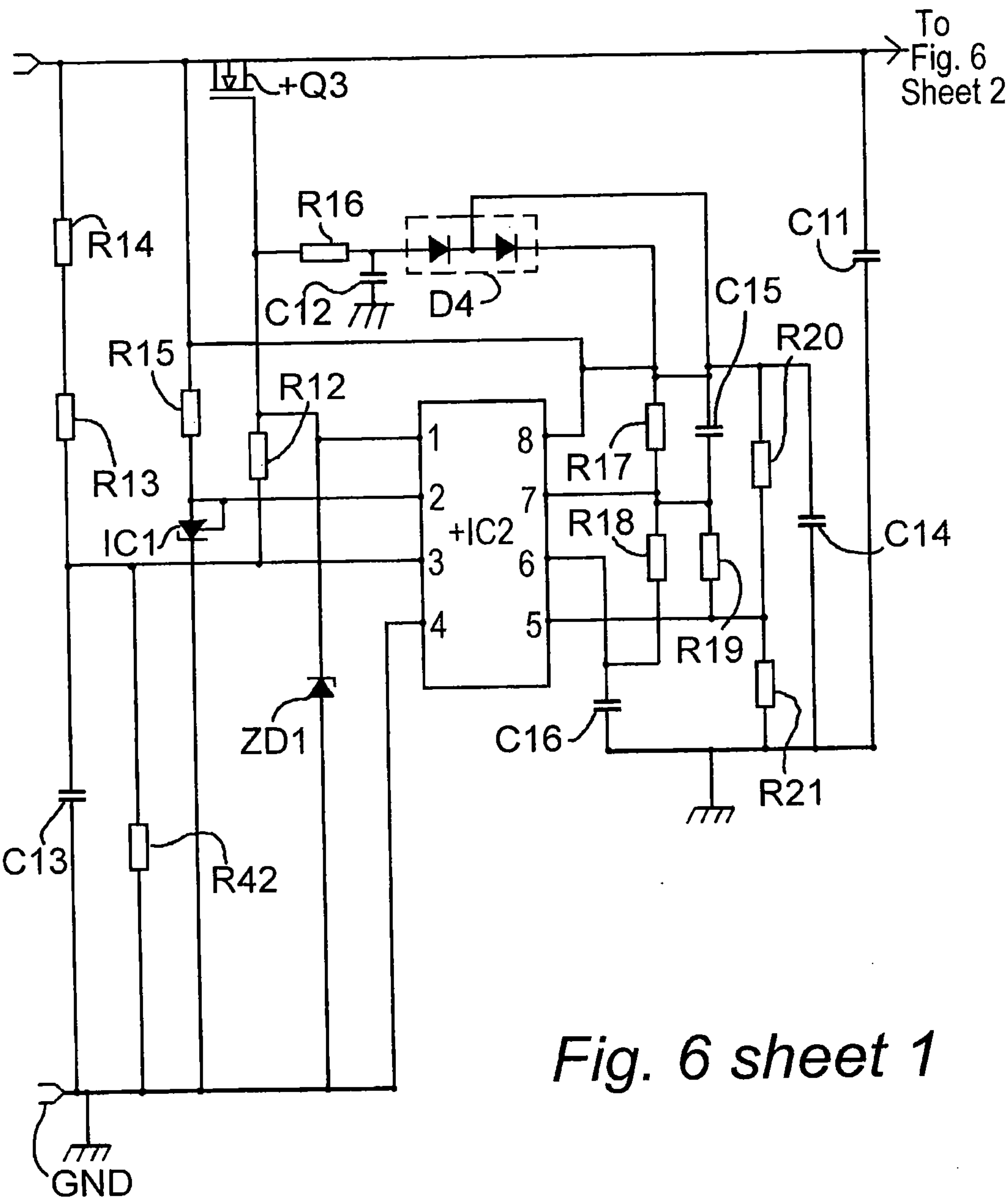
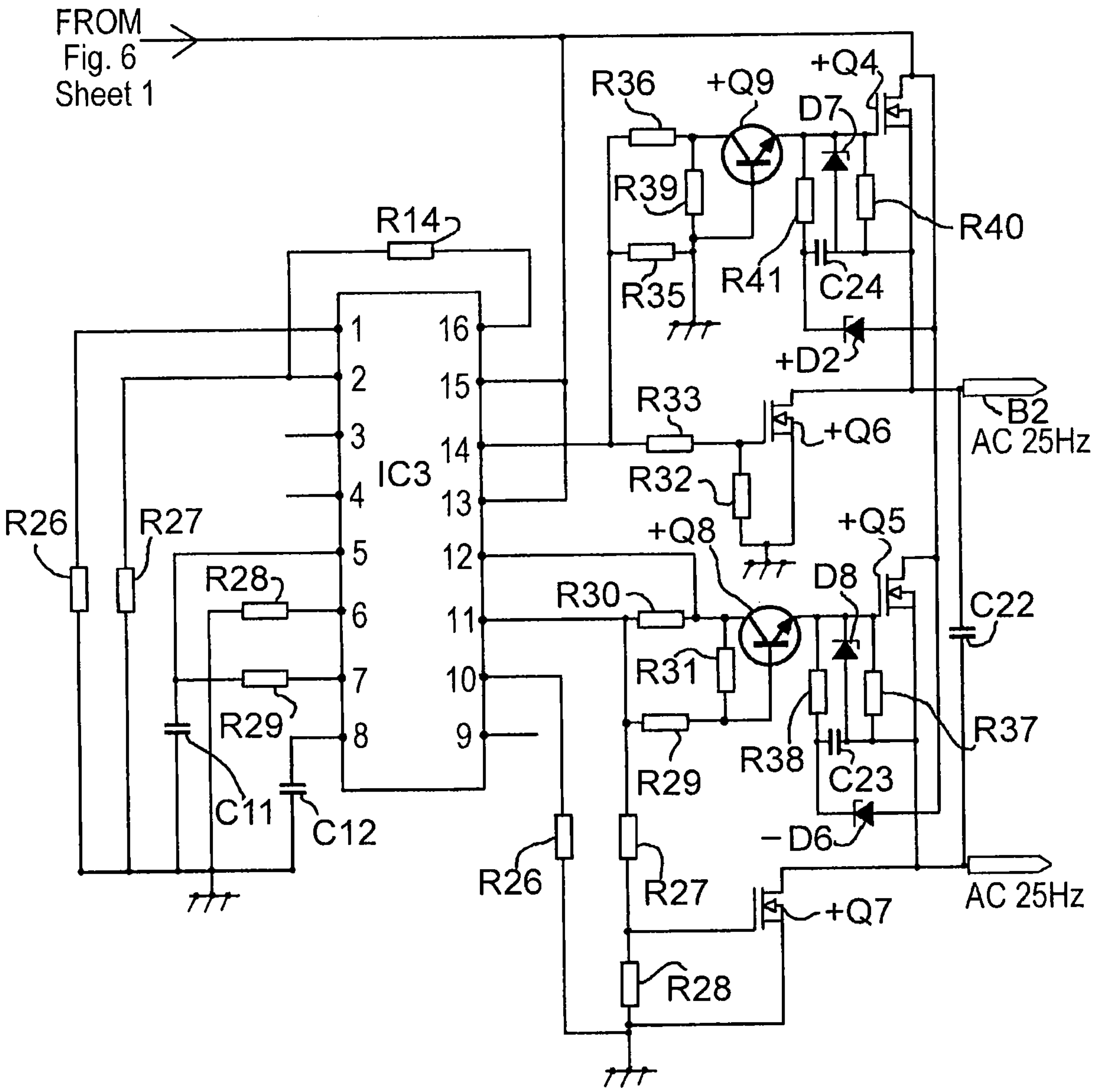

To
Fig. 6
Sheet 2
+Q3
R16
R14
C12
D4
C11
C15
R15
R20
R12
1
8
R13
R17
2
7
IC1
+IC2
R18
3
6
C14
4
5
R19
ZD1
C16
R21
C13
R42
GND

Fig. 6 sheet 1


FROM
Fig. 6
Sheet 1
R36
+Q9
+Q4
D7
R39
R40
R14
R41
C24
R35
IC3
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3
4
5
6
7
8
9
10
11
12
13
14
15
16
+D2
R33
B2
+Q6
AC 25Hz
R32
R26
R27
+Q8
+Q5
R28
D8
R30
C22
R31
R29
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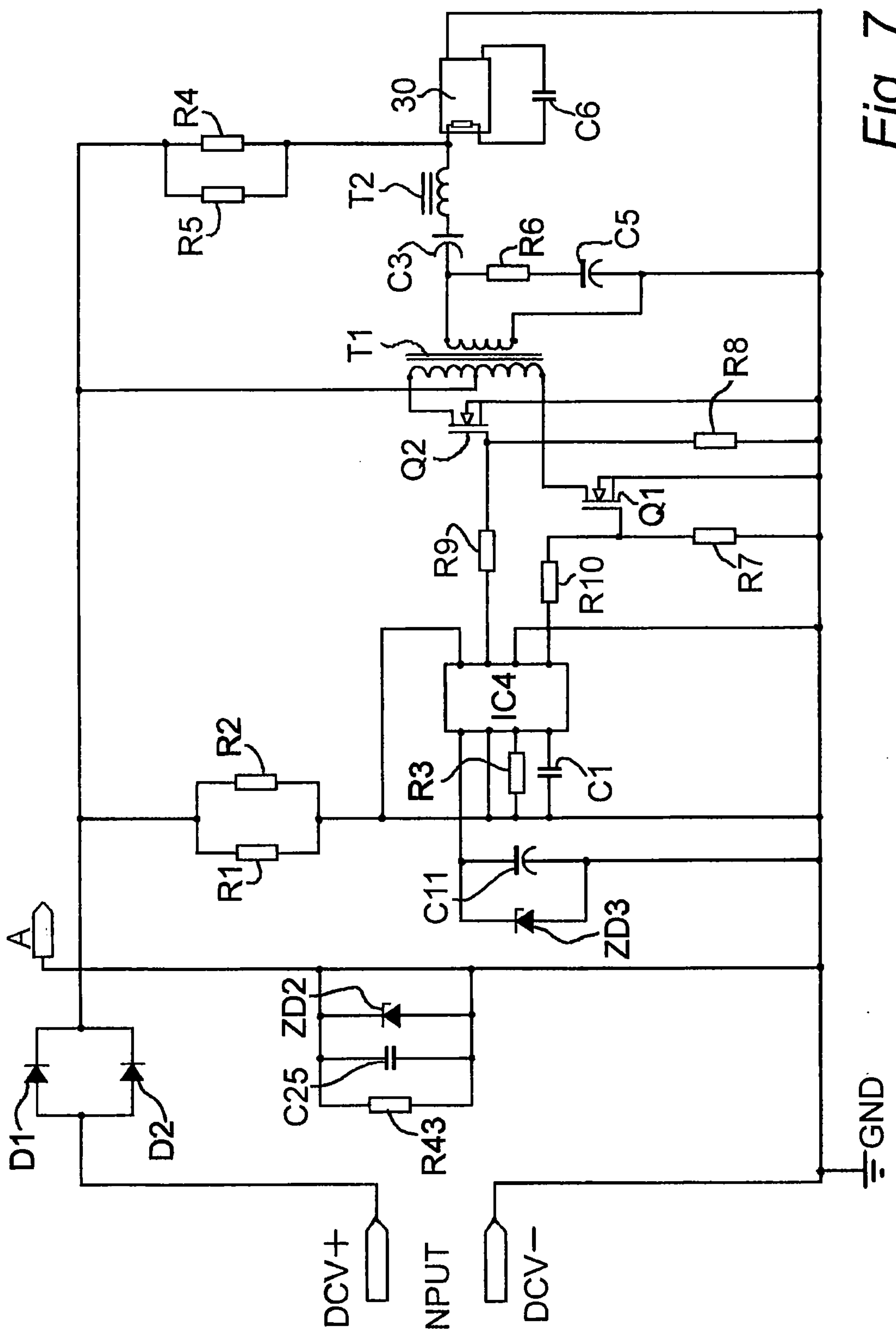
R27
AC 25Hz
+Q7
R28

Fig. 6 sheet 2


A
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D2
R43
C25
ZD2
R1
R2
C11
ZD3
R3
C1
IC4
R9
R10
Q2
Q1
R7
R8
T1
C3
R6
C5
T2
R5
R4
30
C6
GND
DCV+
INPUT
DCV−

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/071157

A. CLASSIFICATION OF SUBJECT MATTER

F02M 27/04(2006.01)i; F02M 27/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F02M27/+

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, CNPAT, CNKI:titanium w dioxide, magnetic+, electromagnetic+, lamp,photo w catalyst,

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 203130291U (DELI YANG ET AL.) 14 August 2013 (2013-08-14) See the whole document	1-2, 6-8, 10-11, 23-24, 27
PX	CN 103061925A (DELI YANG ET AL.) 24 April 2013 (2013-04-24) See the whole document	1-2, 6-8, 10-11, 23-24, 27
Y	CN 102383976A (DELI YANG ET AL.) 21 March 2012 (2012-03-21) description, paragraphs 14 to 23 and figure 1	1-27
Y	WO 2005011843A1 (PHILIPS INTELLECTUAL PROPERTYET AL.) 10 February 2005 (2005-02-10) description, pages 8 to 9 and figure 1	1-27
A	CN 201080872Y (HUIZHANG CHEN) 02 July 2008 (2008-07-02) See the whole document	1-27
A	WO 9964739A1 (GUITERREZ RICHARD NET AL.) 16 December 1999 (1999-12-16) See the whole document	1-27
A	CN 102374078A (XIANLI SONG) 14 March 2012 (2012-03-14) See the whole document	1-27

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:

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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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 when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 April 2014	**24 April 2014**

Name and mailing address of the ISA/	Authorized officer
STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA(ISA/CN) **6,Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China** **100088 China**	**SUN,Jinfeng**
Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)62085285**

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/CN2014/071157

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 203130291U	14 August 2013	None	
CN 103061925A	24 April 2013	None	
CN 102383976A	21 March 2012	CN 102606353A	25 July 2012
WO 2005011843A1	10 February 2005	EP 1656195A1	17 May 2006
		JP 2007501349A	25 January 2007
CN 201080872Y	02 July 2008	None	
WO 9964739A1	16 December 1999	AU 8567198A	30 December 1999
CN 102374078A	14 March 2012	CN 102588157A	18 July 2012