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(54) **CDI-PIEZOELECTRIC SYSTEM FOR USE IN SCOOTERS AND MOPEDS**

(57) A feed system with CDI technology with piezoelectric injector is described, similar to those used in the engines of conventional motor vehicles, designed for use in scooters and mopeds with a cubic capacity of 100 to 400 cc, both single-cylinder and two-cylinder, wherein the elements and mechanisms that integrate said system are manufactured from a material composed of a reinforced aluminium alloy compound, having pistons with a pre-chamber, four valves per cylinder, dual intake manifolds and a higher compression ratio, affording advantages over conventional engines such as increased performance, significant difference in high pressure of the fuel, with variable injection momentum and pressure, a particularly fine spray of fuel, very moderate fuel consumption, a low environmental pollution index and other similar advantages.

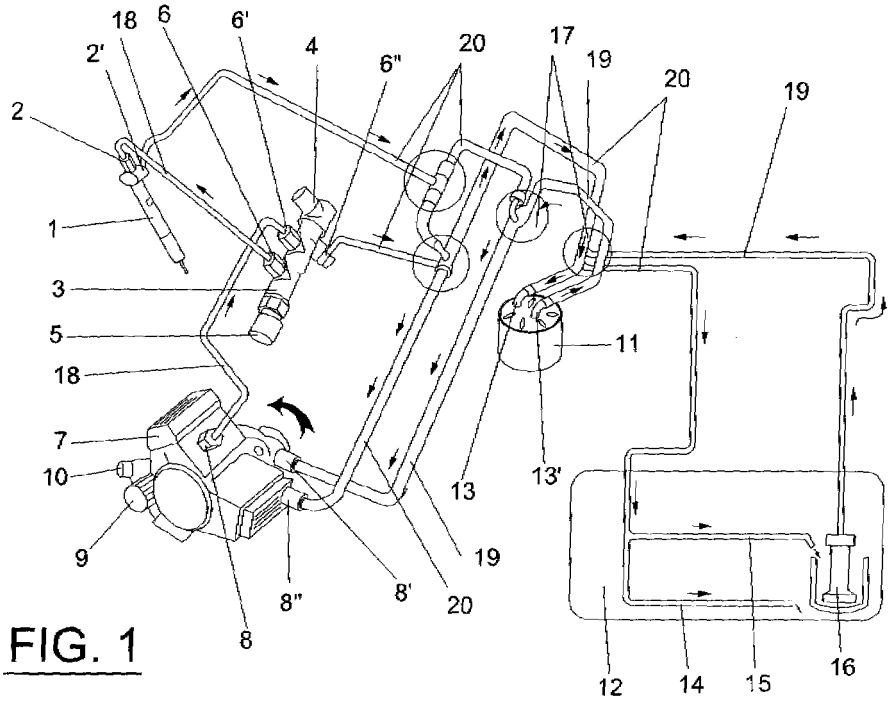


FIG. 1

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Description

Object of the Invention

[0001] The present invention relates to a CDI-piezoelectric system for use in scooters and mopeds, which offers substantial advantages and evident novelty characteristics compared to known means used for the same purposes in the current state of the art.

[0002] More specifically, the present invention proposes a set of modifications in relation to certain elements that compose the known CDI system (common-rail diesel turbo injection) with piezoelectric injector, used in the diesel engines of motor vehicles, in such a manner that said elements, conveniently adapted, determine the correct installation and application thereof in scooters and mopeds, which would achieve such characteristics in their engines as to considerably increase their performance, compared to the currently applied technique. The creativity of the invention of the design in the modifications proposed herein is specifically destined for use in single-cylinder and two-cylinder engines of the aforementioned vehicles, affording them the same and additional advantages over motor vehicles equipped with a CDI system, essentially in terms of savings in fuel consumption, environmental pollution and other advantages.

[0003] The field of application of the invention falls within the industrial sector dedicated to engine manufacturing, specifically for scooters and mopeds.

Background and Summary of the Invention

[0004] At present, the highly practical nature of scooter motorcycles is widely known, essentially due to their ease of driving and mobility in cities, where they are becoming increasingly used as a means of locomotion. These types of motorcycles are currently powered by petrol engines, lacking an intake manifold or overfeeding aid, said overfeeding taking place by means of direct petrol injection, in two or four strokes, with a compression ratio of 7:1 to 12.5:1, a crankshaft having unreinforced needle roller bearings with a simple connecting rod, of the type generally used in petrol engines, conventional pistons without a chamber and made of aluminium and a cylinder head manufactured from the same material. Said engines have two or four valves per cylinder and a cubic capacity of 50 to 500 cc.

[0005] Taking the values represented in the preceding section into account, the considerable advantages afforded to scooters by diesel-powered engines could be evaluated in a similar manner to the considerable advantages afforded to motor vehicles by the change in fuel (from petrol to diesel), mainly in terms of consumption and price, which would evidently be increased if a technology based on a system known as CDI with piezoelectric injector were applied to said engine change. The use of this system is widely accredited in motor vehicle engines, wherein not only has it stood out for its lower consumption and price but also for contributing to optimising their performance in general. To this end, the present invention has considered the possibility that both scooter motorcycles and mopeds can benefit from the general advantages afforded by diesel engines, having the ingenious creativity of adapting certain constituent elements of said CDI-piezoelectric system for correct application thereof to scooter and moped engines, mainly in those having a cubic capacity of 100 to 400 cc.

[0006] With the design proposed, scooters would achieve greater autonomy, lighter weight on reducing some components such as injectors, emit less environmental pollution both from exhaust gases and noise and have a greater possibility of reaching high engine revolution speeds (5,000 to 6,000 rpm) due to lower injector inertia, as well as reduce vibrations, achieve higher fuel pressure, which favours ignition, greater operating ease for mechanics in the event of failures and reduced cost of spare parts, as these are currently available at commercial establishments that sell spare parts for motor vehicles.

[0007] The CDI-piezoelectric system proposed by the invention for incorporation in scooters is **characterised in that** it has different indispensable components conveniently installed so that said system can provide the advantages estimated by the applicant of this invention, in a manner similar to that provided by the same system to motor vehicles.

[0008] Said system has a technique which provides four valves per cylinder head, with dual intake manifolds, manufactured from a material basically composed of reinforced aluminium alloys for diesel, the cylinder head cap being manufactured from the same material and having sufficient space for the piezoelectric injector, with the fixation centred by means of screws in its own cavity. Where said cylinder head contains intake and exhaust camshafts, which actuate the valves by means of a hydraulic thruster. In turn, the injector used in the proposed system does not have an electromagnet, as the 200 volt current incident upon the piezoelectric crystals causes these to contract or dilate to allow or block the passage of the fuel, as opposed to current piezoelectric injectors, which are equipped with electromagnets. Therefore, ignition pressure projection is higher, the intake channel has a different shape to guarantee greater optimisation, and the orifice that positions the injector has a smaller diameter (17 mm) than that of current injectors.

[0009] The engine block may be composed of grey cast iron and built in two variants, according to the type of construction of the motorcycle in question. Where a variant may be built in the same manner as the engine block, defined by two parts which support the transmission system, wherein the transmission and variator assembly act in turn as rear swingarm and suspension, and the other variant may be an engine disposed independently, associated with the chassis by means of screws and transmitting force or movement by means of a toothed belt or similar.

[0010] The high-pressure pump of the system has three compact radial pistons, reaching maximum pressures of 1,800 to 2,000 bar, with a spinning regime of around 5,000 rpm. Said pump houses the thermal fuel probe, the flow regulator valve and the overpressure limit valve. Fuel influx is carried out by means of independent valves on the pump heads, in such a manner that said fuel actuates a conical cotter pin disposed on the influx valve, leaving a section of the opening free. When the pump piston compresses the fuel, the valve exerts pressure onto the base, obstructing it. In this manner, the fuel outflow valve remains closed due to the resistance of a spring and the pressure exerted by the high pressure stemming from the distribution pipe.

[0011] The piezoelectric injector of the system proposed by the invention fulfils the appropriate requirements for use thereof in both scooters and mopeds, which generally have a cubic capacity of 100 to 400 cc. Where said injector carries out its function (injection) through a nozzle with seven orifices, directly in the combustion chamber, which is indirectly activated by an electromagnetic valve that activates the application and discharge of pressure from the control chamber by means of the injection needle. Therefore, when the injector needle is raised (start of injection), the valve opens so that the fuel in the control chamber returns, and when said injection needle is closed (end of injection) the valve is shut off, supplying the adequate pressure to the control chamber. The system is equipped with a venturi nozzle, which functions under the same principle as an aspiration pump wherein, on producing a depression in the recovery connection of the injectors, allows fuel return to increase with the volume of the recovery fuel. This process has a high-precision flow compared to the established pressure.

[0012] The regulator valve installed in the high-pressure pump functions under the principle of electromagnetism and consists of three main parts, the first, in order, being an electric coil which, on applying current stemming from the engine control unit, according to its operating needs, modifies the magnetic intensity thereof; another part consists of a valve piston which acts while reactuating the modification in electromagnet field intensity, modifying the position of the valve and allowing the passage of fuel; the third part is comprised in that the valve box which houses the valve piston contains the inflow and outflow orifices, which are connected inside the high-pressure pump. Therefore, based on the magnetic force, this valve opens or closes the by-pass channel between the common-rail pressure field and the return.

[0013] The common-rail pressure sensor is disposed at one end thereof, where it can detect the pressure and, by transforming the mechanical impulse in the sensor electronics, a signal voltage is created which corresponds to the current common-rail pressure, which is automatically transferred to the engine control unit. The opposite end of the common-rail, that opposite the end where the pressure sensor is installed, is equipped with a flow regulator valve, associated therewith by means of threads, which functions in a similar manner to the aforementioned regulator valve, i.e. under the principal of electromagnetism.

[0014] The thermal fuel probe of the system is integrated in the high-pressure pump, forming part of the low-pressure circuit. Said probe is built according to a negative temperature coefficient, i.e. electrical resistance decreases as the temperature increases, sending the information to the control unit.

[0015] The knock sensor is housed within the engine block and functions under the piezoceramic principle, being capable of recognising internal engine combustions by means of acoustic signals. The knock sensor has three specific functions, which consist of recognising mechanical engine ageing and transmitting it to the engine unit so that it can act accordingly, modifying the minimum injection adjustment, facilitating the recognition of injector needles in poor condition or stagnant and enabling adequate self-diagnosis.

[0016] The crankshaft position sensor functions under the induction principle, producing sinusoidal signal voltage which, on crossing a photoelectric barrier (an incremental wheel), sends the signal to the engine control unit. On missing two incremental teeth in the crown the signal varies, said unit being capable of recognising the position of the crankshaft with the missing teeth and change in respective signal.

[0017] The engine control unit can be associated by means of a floating screw at any point of the scooter or motorcycle, in such a manner as to absorb the vibrations, provided that said location is a refrigerated zone or has an air current. Said unit has multiple functionalities, of which some could be mentioned, such as identification of engine load, regulation of engine idle with a minimum work pressure comprised between 280 and 300 bar, common-rail speed and pressure stability, activation of the electric low-pressure fuel pump, control of the high-pressure pump, limitation of the number of revolutions and injection cutoff under retention regime, etc.

[0018] The low-pressure circuit is in charge of supplying the injection system with the sufficient amount of filtered fuel with the necessary pressure for the proper functioning thereof. The electric pump is in charge of transporting the fuel from the tank through the internal pressure limit valve, which can restrict the pressure to a maximum of 8.5 bar in the event of obstruction. The fuel is impelled by means of the high-pressure pump, being regulated at a pressure of approximately 3 to 3.5 bar by the overpressure valve installed in the high-pressure pump. The amount of fuel not consumed during high pressure is returned to the tank by means of return.

[0019] The common-rail is fixed to the engine lid by means of screws. It determines a high-resistance metal pipe having a predetermined mechanism and connections intended for the functioning of the injector or injectors (as needed) and a connection to the high-pressure valve. Said pipe has inner threads at both ends, which

serve to fix the pressure sensor and pressure regulator valve, also having a connection that serves as an outlet for the fuel to flow to the corresponding return. Said common-rail stores the fuel compressed by the high-pressure valve and sends it according to the need of the injectors. Its total volume must be calculated previously in order to compensate the pressure drops on carrying out injection.

[0020] The high-pressure circuit is in charge of creating and accumulating the high pressure required for injection, where the high-pressure pump compresses the fuel regulated according to the common-rail, sending said fuel to the injectors through the high-pressure pipes. The CDI control unit detects, via its incoming signals, engine status and the driver's needs at all times. In the event that fuel (diesel) temperature is less than 10°C, the common-rail pressure is regulated by the pressure regulator valve and raises its temperature as soon as possible. On compressing the fuel at high pressure, the high-pressure pump heats up and excess flow is discharged by means of return via the pressure regulator valve. In this manner, the cold fuel accumulated in the tank mixes with the incoming hot fuel via the return pipes. In the event that fuel temperature is higher than 10°C, the common-rail pressure is regulated by means of the high-pressure pump flow regulator valve. Therefore, the pressure regulator valve remains closed during the process and the high-pressure pump only receives the flow necessary for common-rail pressure. In this manner, excessive heat emission is reduced in order to maintain an optimal diesel-oil temperature.

[0021] System overfeeding is destined for generating pressures in the intake manifold of around 0.8 and 1.5 bar, in accordance with engine characteristics, cylinder capacities and needs. The current formed by the exhaust fumes is used to turn the turbo turbine. The regulation of said turbine may be varied electronically, modifying the position of the blades in its interior and, in turn, the leveraged flow of exhaust fumes, increasing or decreasing with the corresponding rotation of the turbine, in accordance with engine needs. The number of exhaust fume revolutions determines the compressed air current, i.e. overfeeding pressure. The overfeeding pressure transmitter constantly controls the pressure and transmits it to the CDI unit. In order to control overfeeding pressure, the engine control unit takes into account the information stemming from the cooling and overfeeding temperature, atmospheric pressure, number of engine revolutions and injection flow. The invention envisages another overfeeding alternative, which consists of a small-sized volumetric compressor which, mechanically receives constant movement from the engine through a toothed belt and, through the aforementioned sensors envisaged in the CDI engine unit, gradually acts on a butterfly valve, creating excess intake pressure or releasing it according to engine load needs.

[0022] The air distribution pipe may be composed of a high-resistance plastic material, designed with predetermined structural differences in the shape and length thereof, with the object of favouring the entrance of air at different revolutions, and may also have two filling channels per cylinder, one being straight and the other spiralled. Each filling channel can be shut off by means of an electronic butterfly valve, controlled by the CDI engine electronic unit, according to engine needs and work regime, thereby modifying the engine's intake capacity. In order to act on the intake manifold, the engine control unit takes into account certain values such as the air mass gauge, thermal overfeed air sensor and overfeed, feed and crankshaft transmitters, etc.

[0023] It must also be pointed out that pre-heating of the CDI-piezoelectric system is mainly aimed at fulfilling the EURO-4 and OBD-IV emission standards, due to the fact that, as the system has been designed to work at high pressure, it reaches the necessary optimal temperature for startup, due to which said pre-heating can be very brief, as well as a more stable engine idle and adjustable incandescence temperature.

[0024] The common-rail system proposed by the invention, for use in scooters and mopeds, affords multiple advantages which have in general always been associated with this type of technology applied to motor vehicles, such as: variable injection momentum and pressure, a particularly fine spray of fuel, high combustion pressure with richer combustion, less emission of contaminating agents, lower fuel consumption and greater rotation torque. The dosage of the injection flow is carried out with great precision, having several combustion stages: prior, main and subsequent, wherefrom additional advantages are obtained which comprise: longer maintenance of the process at a constant pressure (main injection), higher degree of thermal performance, smoother combustion process (prior injection) and the option of subsequently processing the exhaust fumes (subsequent injection). The crankshaft is composed of a more reinforced material with bushings and ball bearings, and the connecting rods are also reinforced with a pre-chamber having a different design, in the form of a flattened jar.

Brief Description of the Drawings

[0025] The main characteristics claimed by the invention herein shall be further explained in the detailed description below, alluding to the different modified and/or substituted parts in the corresponding mechanism of the scooter engine or in the case of the moped, which has been built according to the indications of the invention and, for greater explanatory clarity, reference is made to the attached drawing, which corresponds to a preferred embodiment, provided solely for illustrative and non-limiting purposes, where:

Figure 1, being the only attached figure, shows a general schematic view of the feed system of the engine proposed herein for use in a scooter or moped.

Description of a Preferred Embodiment

[0026] As mentioned earlier, a detailed description of the CDI system with piezoelectric injector for scooter engines, proposed by the invention, will be provided below with the help of the attached drawing, wherein numerical references have been used to designate its constituent parts.

[0027] Therefore, in accordance with the schematic drawing of figure 1, a piezoelectric injector 1 can be observed, envisaged for use in the system due to its high performance in direct diesel injection, which provides accurate control of the adequate dosage of fuel at intake, an important value to be taken into account in terms of fuel savings, in such a manner that said injector has two ports (2, 2') conveniently disposed next to one end, where one port 2 is for fuel flowing in from the common-rail at high pressure and the other port 2' is for return fuel flowing out via the return pipe, marked in the drawing by means of arrows that indicate the direction of the fuel. The integration of the common-rail (CDI) 3 ensures less noise emission during combustion, providing greater injection accuracy, being generally of cylindrical shape and having a pressure regulator valve 4 on one end and a pressure sensor 5 on the other end, while fuel inflow and outflow ports are disposed in the intermediate area, a first port 6 being for fuel flowing out towards the injector at high pressure, another similar port 6" separated by a distance of a few millimetres being for fuel flowing from by the pump 7 at high pressure and the third port 6" being diametrically opposed to the aforementioned ports (6, 6'), which serves as an outlet for the return pipe.

[0028] The high-pressure pump 7 has been represented in the drawing, which is in charge of sending the high-pressure fuel to the common-rail 3, flowing out via the port 8. The pump 7 has another two ports, one port 8' being for fuel flowing in via the return pipe from the common-rail 3 and another port 8" envisaged for supplying the fuel from the tank 12 to the pump. Additionally, it includes a flow regulator valve 9 and a thermal probe 10.

[0029] The circuit represented in the drawing has a filter unit 11 of cylindrical shape with two ports (13, 13') on one of its bases, one being for the fuel flowing 13 from the tank 12 and the other being for the fuel flowing 13' towards the pump 7. Part of the return fuel reaches the tank 12 via the return pipes and, once there, the pipe branches off (14, 15), in such a manner that one of these two pipes 14 discharges the return fuel into the tank, while the other 15 impels the return fuel directly towards an electric pump 16 installed in the tank, the latter being in charge of impelling the diesel flowing out from the tank towards the pump via the filter.

[0030] In the drawing shown in figure 1, four connections have also been represented, encircled 17 for greater clarity, which enable better distribution and use of the fuel throughout the feeding system. The different functions of the pipes have also been represented by means of numerical references for greater clarity, in such a manner that the pipes marked with the numerical reference 18 represent the high-pressure fluid, those marked with the numerical reference 19 represent the low-pressure fluid and, finally, the pipes marked with the numerical reference 20 represent the return fluid.

[0031] Further extension of the content of this description is not deemed necessary for a person skilled in the art to understand its scope and the advantages deriving from the invention, as well as for developing and implementing the object thereof.

[0032] Nevertheless, it should be understood that the invention has been described according to a preferred embodiment thereof, due to which it may be susceptible to modifications, particularly to its general shape, the size of the parts and/or the materials wherefrom said parts have been manufactured, provided that these fulfil the requirements imposed by the use for which they are destined.

Claims

1. CDI-piezoelectric system for use in scooters and mopeds, particularly in engines comprised within a cubic capacity range of between 100 and 400 cc, with lower fuel consumption, lower environmental pollution indexes, significantly higher fuel pressure and other similar advantages, **characterised in that** it includes the following constructive and functional characteristics: a feed system specially adapted to this specific use with the incorporation of a piezoelectric injector (1), common-rail type injection technology (3) and a high-pressure pump (7).

2. System, according to claim 1, **characterised in that** the common-rail (3) element comprises a pressure sensor (5), a pressure regulator valve (4), a port (6) for fuel flowing out at high pressure towards the injector, another port (6') for fuel flowing in from the high-pressure pump and a third port (6'') for outflowing return fuel.

3. System, according to claims 1 and 2, **characterised in that** the high-pressure pump (7) has a flow valve (9), a thermal probe (10), a port (8) for fuel flowing out at high pressure and two inflow ports (8', 8").

4. System, according to one or more of claims 1 to 3, **characterised in that** it has different manifolds or pipes for the fuel fluid, of which some (18) are for the high-pressure fluid, others (19) are for the low-pressure fluid and the rest (20) are for the return fuel. It also has four connections (17) that determine the optimal use of the fuel.

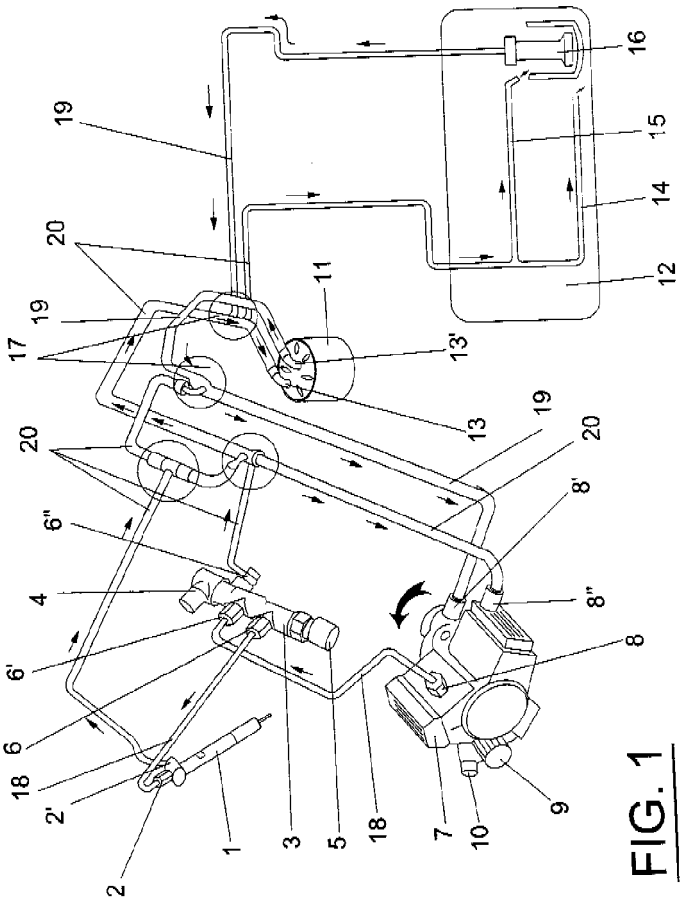


FIG. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ ES 2009/000037

A. CLASSIFICATION OF SUBJECT MATTER

see extra sheet
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)
F02M63, F02M55

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)

INVENES,EPODOC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 2003089332 A1 (YOMOGIDA et al.) 15.05.2003, paragraphs [6-9]; figure 5.	1-2
A		3-4
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A		2-4

☒ 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 document but published on or after the international filing date
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"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 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
01.June.2009 (01.06.2009)	**(09/06/2009)**
Name and mailing address of the ISA/ O.E.P.M. Paseo de la Castellana, 75 28071 Madrid, España. Facsimile No. 34 91 3495304	Authorized officer E. García Lozano Telephone No. +34 91 349 68 63

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES 2009/000037

C (continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of documents, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

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