

## **TECHNICAL FIELD OF THE INVENTION**

This invention relates generally to an emission control device and more particularly to an exhaust emission control device and a method of emission control for filtering particulate matter contained in the exhaust gases.

## **BACKGROUND AND THE PRIOR ART**

The gaseous pollutants emitted by an increasing number of combustion engine based automobiles, industries and households pose a real threat to world environment and public health. The particulate matter (PM) contained in vehicle exhaust is known to cause multiple health problems including respiratory diseases, nasal congestion and eye irritation, apart from being responsible for green-house effect. Not only combustion engines, but industries involving procedures like manufacturing, burning of hazardous waste, and plants based on fossil fuels also emit large volume of gaseous effluents which needs to be adequately treated before it can be safely released into the environment.

Since the Clean Act of 1977 which sets the limits on the amount of each pollutant that could be emitted from an automobile, researchers all over the globe have come up with better combustion technologies that have undoubtedly reduced the toxicity of the exhaust leaving the combustion unit. But that alone is insufficient to meet the emission standards. Therefore, additional technologies to detoxify the exhaust are an essential part of emission control.

Most of the existing technologies for emission control prove to be very expensive for installation in automobiles, small-scale industries and household applications like kitchen ventilation.

Existing emission control methods such as Positive Crankcase Ventilation (PCV) system, Exhaust Gas Recirculation (EGR) valve and Air Injection do not remove the particulate matter. Moreover, they often suffer from various mechanical problems causing possible engine oil leaks, system clogging, adverse affect on engine performance and even possible breakdown of the vehicle if operated in high traffic areas.

Catalytic converter is popularly being used in automobiles for reduction of hydrocarbons, carbon monoxide and oxides of nitrogen, but are very expensive because of the use of noble metals like Platinum, Palladium and Rhodium as catalysts. Moreover, they do not filter out the particulate matter, soot, smoke and dust particles contained in the exhaust stream. Burners and activated carbon (charcoal) based devices are impractical for use on automobiles and require regular maintenance and replacement of filtering agent which adds to the effective cost of the device.

Recently there has been some development towards reducing emission from exhaust stream based on electrostatic precipitation of exhaust gases. *Masters, U.S., Patent No. 5,419,123 and Keppel, U.S., Patent No. 6,508,991 B2* discloses such an emission control device. They either use induction coil or a transformer-rectifier in conjugation with a high power battery to achieve very high voltages of the order of tens of thousands of volts required for electrostatic precipitation and ionisation.

However, the devices based on Masters and Keppel invention suffer from some serious technical glitches. In Masters' invention, as high voltage is delivered through standard wiring, there is significant loss of voltage (upto 70%). It means that for 15KV to be delivered to the ESP electrode, about 50KV must be supplied, causing much faster depletion of the battery strength. Movement of electrical charges at such a high voltage in turn creates radio frequency interference (induction of random cycling frequencies) in adjacent wires. When used in automobiles, these random cycling frequencies can be sufficiently large to set false codes in automobiles computers or even damage them altogether. So these devices are often accompanied by a damper circuit to dampen the random cycling fields. A plug is used in Masters' patent to deliver the spark for ionisation. As a result, spark gets concentrated to a particular region and does not ensure uniform ionisation of the entire exhaust stream. It has been experimentally found that uniform ionisation of the exhaust stream greatly enhances the pollution removal efficiency of the device.

The present invention therefore presents a highly efficient and low cost solution for filtering the gaseous exhausts based on the principles of Electrostatic Precipitator and Van de Graaff generator. The Van de Graaff generator is used for delivering very high voltages (tens of Kilo Volts) required by the electrostatic precipitator (ESP) electrodes to cause precipitation of the particulate matter. The present invention relates to a device or method for removing and/or reducing the particulate matter (PM), dust, soot etc. contained in exhaust of combustion engine in automobiles like cars, trucks etc. Though the focus of the work presented here is in the automobile sector, the invention can also be applied to filter the exhaust emitted by industries during various manufacturing processes or to residential effluents like chimney smoke, with some minor modifications without departing from the scope of the invention.

Additionally, the invention encompasses a variable gap gas-discharge voltage regulator to regulate the voltage generated by Van de Graaff generator. It further provides an automated cleaning unit comprising of a scrubbing brush/wiper for cleaning off the accumulated particulate matter on the ESP electrodes and storing it in a hopper for safe disposal.

## **OBJECTS OF THE INVENTION**

A basic object of the present invention is to overcome the disadvantages/drawbacks of the known art.

Another object of the present invention is to provide a technique of driving the Van de Graaff generator rollers using the rotational motion of vehicle axle. The rollers, however, can be rotated through other means as well.

Another object of the present invention is to provide Van de graaff generator for generating high voltages required in electrostatic smoke precipitators

Another object of the present invention is to provide an emission control device for filtering particulate matter contained in the exhaust gases.

The principle object of the invention is to provide an exhaust emission control device and method for filtering particulate matter contained in the exhaust gases.

Another object of the invention is to provide a method for regulating of the voltage generated by a Van de Graaff generator.

Yet another object of the invention is to provide a cleaning unit comprising a cleaning means and a hopper for automated cleaning and safe storage of the accumulated particulate matter.

These and other advantages of the present invention will become readily apparent from the following detailed description read in conjunction with the accompanying drawings.

## **SUMMARY OF THE INVENTION**

The following presents a simplified summary of the invention in order to provide a basic understanding of some aspects of the invention. This summary is not an extensive overview of the present invention. It is not intended to identify the key/critical elements of the invention or to delineate the scope of the invention. Its sole purpose is to present some concept of the invention in a simplified form as a prelude to a more detailed description of the invention presented later.

According to one embodiment of the present invention, there is provided an exhaust emission control device comprising: an inlet means adapted to receive exhaust gas; a sieve filter for separating heavy particles from said exhaust gases; a treatment plant connected to said inlet; means comprising an electrostatic precipitator for removing said particulate matter, said electrostatic precipitator further comprising duality of electrodes for corona generation, duality of rollers with a belt mounted over said rollers, duality of metallic brushes for transferring charges, a van-de-graaff generator for providing high voltage to said electrodes.

Another embodiment of the present invention provides a voltage regulator to regulate the voltage generated by said van-de-graaff generator.

Yet other embodiment of the present invention provides a cleaning unit comprising a cleaning means for cleaning off said particulate matter accumulated on said electrodes and a hopper placed at the bottom of said treatment plant for safe disposal of said particulate matter; an outlet means connected to said treatment plant for expelling the filtered gas.

## **BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS**

In the appended drawings:

Fig 1 illustrates the diagrammatic view of the embodiment of the present invention showing its use as an emission control device.

FIG. 2 illustrates the longitudinal section view of the complete embodiment of the present invention showing the inner modules of the device.

FIG. 3 illustrates the front view of the emission control device described in the invention.

FIG. 4 illustrates the perspective view of the Van de Graaff generator, showing the embodiment of the voltage regulator described in the present work.

FIG. 5 illustrates the perspective view of the scrubbing brush/wiper that constitutes the cleaning mechanism in a cylindrical precipitator.

## **DETAILED DESCRIPTION OF THE ACCOMPANYING DRAWINGS**

The following drawings are illustrative of particular examples for enabling methods of the present invention, are descriptive of some of the methods, and are not intended to limit the scope of the invention. The drawings are not to scale (unless so stated) and are intended for use in conjunction with the explanations in the following detailed description.

Reference is first invited to Fig 1 where the inlet means, outlet means, treatment unit, hopper, van de graaff generator, electrostatic precipitator etc. is shown.

Fig. 2 shows sectional view of the present invention where arrangement of each element is shown.

Fig. 3 shows the arrangement of metallic rings, rollers, strip, electrostatic precipitator, van de graaff generator, hopper etc. it forms the core of the present invention.

Fig. 4 shows the arrangement of cleaning unit and voltage regulator. It also shows position of the lower roller adapted to rotate the strip.

Fig. 5 illustrates the frame that provides support to the treatment plant.

The invented system is thus an emission control device for filtering particulate matter contained in the exhaust gases.

## **DETAILED DESCRIPTION OF THE INVENTION**

Accordingly the present invention uses a Van de Graaff generator for generating very high voltages which are delivered to the electrodes of an electrostatic precipitator (ESP) through a mechanism described in detail in the further paragraphs. An electric corona field is set up in the space around the charged electrode, and the exhaust stream is allowed to flow this field. As a result, the pollutants contained therein get ionised and start experiencing electrostatic force of attraction towards the oppositely charged electrode (collecting plate), where they finally get precipitated. Thus the air that finally comes out of this treatment chamber is free from suspended particulate matter and other pollutants.

A general Van de Graaff generator consists of two rollers, a belt mounted over them, two brushes and a charging sphere. However there are several designs of Van de Graaff generator possible each having some minor differences in the design. Though we have described the triboelectric

effect based Van de Graaff design here, any other suitable design of the Van de Graaff generator may also be adopted for generating the high potentials, and is covered within the scope of the invention.

In the triboelectric effect based design, the lower brush is grounded while the upper brush is connected to a metallic cylinder, which is used as an electrode in the described Electrostatic Precipitator. The belt gets charged with respect to the lower roller by triboelectric effect. Due to the resulting field generated, the lower brush transfers charge from the ground to the belt by induction. The belt transfers the charge to the upper roller. The upper brush then picks up this charge and transfers it to the charging cylinder. The material for the rollers and the belt is to be chosen in accord with the triboelectric series, since it directly influences the nature and the tendency of the charge being generated. The material of the lower roller, belt and the upper roller are in ascending (or descending) order of their electro-negativity for generation of negative (or positive) charge on the outer cylinder.

An electrostatic precipitator (ESP) is a very efficient particulate collection device (efficiency above 99%) that removes particles such as dust, soot, particulate matter etc. from a flowing gas stream. There are several designs of an electrostatic precipitator (ESP) e.g. plate type design, wire-cylinder design etc. Though the cylindrical design is explained in this invention, other designs can also be adopted in the system, and is covered within the scope of the invention. In the cylindrical design, the inner cylinder is charged to a high voltage by the Van de Graaff generator and is used as an ESP electrode while the outer cylinder is grounded. The high potential difference between the inner and outer cylinder generates an electric corona field in the space between them. The exhaust stream is allowed to pass through this corona field. In the process, the particulate matter gets ionized and consequently gets precipitated on the outer cylinder.

The polarity of the corona generated depends on the nature of the charge generated by the Van de Graaff generator. A negative corona is however preferred over positive corona because the former is more stable than the later in the sense that it can support a much higher voltage before sparking occurs. For setting up a negative corona, the material for lower roller, belt and upper

roller have to be in the ascending order of their electro-negativity. However, in some applications of ESP, positive corona is desired, and can easily be obtained by simply interchanging the connection of the two rollers. Such minor modifications and additions may be made to the device without departing from the spirit of the invention.

The invention also describes the embodiment of an automated cleaning mechanism for the cylindrical precipitator. However, the user may resort to manual cleaning as well. Inside the outer cylinder, a scrubbing brush or a wiper that runs along the length of the cylinder is provided. The scrubbing brush/wiper rotates about the central axis of the two cylinders. This brush may be rotated by an electric motor or any other suitable arrangement depending upon the resources available. The rotation of the brush/wiper would scoop out the precipitated matter from the walls of the inner and/or outer cylinder. The scooped out precipitate gets collected into a hopper through an opening provided in the outer cylinder. We have provided only one preferred design of such a cleaning unit. However, other suitable designs may also be adopted.

The invention further describes the embodiment of a voltage regulator to regulate the voltage generated by Van de Graaff generator. An upper limit has to be imposed on the voltage generated by the Van de Graaff generator otherwise it may eventually lead to complete breakdown of the air and may cause accidents. Such a constant and regulated voltage supply greatly increases the working efficiency of the ESP.

The voltage regulation is achieved through a variable gap gas-discharge voltage regulator. In this, a sharp pointed grounded metal piece or a thin ring is kept in the vicinity of the electrode being charged by Van de Graaff generator (inner cylinder in our case). The maximum achievable potential by this electrode can be varied by varying the gap between the grounded metal/ring and the electrode. As the distance between grounded metal/ring and the electrode is varied, the rate of corona discharge at the metal/ring tip as well as the total current in the air path remains constant, while the resistance of the air path and the potential on the electrode go up or down. The smaller the gap, the lower is the maximum achievable potential difference by the electrode.



The mechanism to be employed for realising the rotation of the Van de Graaff generator belt over the rollers can be anything depending upon the availability of resources and the area of application of the invention. It must be noted that Van de Graaff generator belt requires very small rotational torque which can easily be supplied. Some of the preferred mechanisms for the same are employing rotational motion of vehicle axle in case of automobiles, use of an electric motor or a dynamo of suitable characteristics or a blade-turbine based design in scenarios like kitchen ventilation, industrial chimneys etc. Higher is the speed of the rotation of the belt, greater is the rate of charging.

An illustrative embodiment of the device is shown in **Fig 1**. The system involves an inlet **1** through which the exhaust gases from combustion chamber or chimney enter the system, a sieve filter **2** used for separation of heavy particles from the exhaust, a treatment plant **3** for precipitation of fine particles (like SPM), a cleaning unit **4** for removal of the precipitated material, a hopper **5** for collection of the precipitated particulate, a voltage regulator **6** to control voltage developed and an outlet **7** for expelling the cleaned gas.

Inlet **1** for the system is designed to be of an adjustable dimension so that it is versatile for different applications. The sieve filter **2** is provided to trap any heavy particulate (for which a detailed treatment is unnecessary) from the emission gases which enter the system through the inlet.

After physical separation, the gases pass through the treatment plant **3** which consists of an electrostatic precipitator and a Van de Graaff generator (**Fig4**). This plant is supported by a rigid frame **8**. An electrostatic precipitator (ESP) is a particulate collection device that removes particles from a flowing gas (such as air) using the force of an induced electrostatic charge. Electrostatic precipitators are highly efficient (above 99%) filtration devices and can easily remove fine particulate matter such as dust and smoke from the air stream.

The electrostatic precipitator considered in this embodiment is of a tubular design (**Fig5**) with the inner cylinder **9** acting as the charged electrode and the outer cylinder **10** being grounded. A high voltage is developed between the two cylinders **9, 10** using the Van de Graaff generator (**Fig.4**),

causing a corona formation between the two cylinders **9, 10**. The exhaust stream is allowed to pass through this corona field. The ions generated by the corona induce charge onto the precipitate matter causing them drift along the field between the cylinders **9, 10** and get precipitated on the outer one **10**. Though not shown explicitly in the figures for the sake of clarity, the space between the ESP electrodes (like the two concentric cylinders in this embodiment) may be occupied by structures such as grid or plates coated with suitable catalysts and/or chemicals to perform additional functions like oxidation etc on the exhaust gas stream.

The current embodiment also describes an automatic cleaning unit (**Fig5**) for removal of the particulate precipitated on the outer cylinder **10** periodically. The cleaning system includes a scrubbing brush/wiper **11** to scoop out the precipitated material from the inner **9** and outer cylinder **10** into a hopper **12** present at the lower end of the cleaning unit **4**. The brush/wiper **11** runs along the length of the cleaning unit **4** and rotates about the axis **13** of the cleaning unit **4**. This brush **11** may be rotated by an electric motor or any other suitable arrangement depending upon the resources available. The hopper **12** stores the precipitate so that it can be discarded safely later.

A Van de Graaff generator (**Fig4**) is a high voltage constant current source which uses mechanical energy (rotary motion) for transfer of charges against such high fields. The Van de Graaff generator in the present embodiment is a triboelectric effect based system. It consists of two rollers **14, 15**, a belt **16** running over them; metallic brushes **17, 18** and a charging sphere **19**. In this design, the lower metallic brush **17** is grounded while the upper metallic brush **18** is connected to the charging cylinder **19** which is also used as the electrode **9** of the Electrostatic Smoke Precipitator.

The belt gets charged with respect to the lower roller by triboelectric effect. Due to the resulting field generated, the lower brush **17** transfers charge from the ground to the belt **16** by induction. The belt **16** transfers the charge to the upper roller **15**. The upper brush **18** picks up this charge and transfers it to the charging cylinder **19**. The material for the rollers **14, 15** and the belt **16** is to be chosen in accord with the triboelectric series, since it directly influences the nature and the tendency of the charge being generated. The material of the lower roller **14**, belt **16** and the upper

roller **15** are either in ascending order (or descending order) of their electro-negativity for generation of negative (or positive) charge on the outer cylinder. It is contemplated that the Van de Graaff generator can also be housed outside the electrostatic precipitator (the treatment chamber), in which case, the charges are transferred from the van de Graaff rollers to the electrodes through a connecting wire.

To regulate the voltage generated by Van de Graaff generator (**Fig 4**), a variable gap gas-discharge voltage regulator is used. An upper limit has to be imposed on the voltage generated by the Van de Graaff generator otherwise it may eventually lead to complete breakdown of the air and may cause accidents. The voltage regulation is achieved by using a thin ring **20** kept in the vicinity of the electrode **19** being charged by Van de Graaff generator (inner cylinder in our case). The maximum achievable potential by this electrode can be varied by varying the gap between the grounded metal/ring **20** and the electrode. As the distance between grounded metal/ring **20** and the electrode is varied, the rate of corona discharge at the metal/ring **20** as well as the total current in the air path remains constant, while the resistance of the air path and the potential on the electrode go up or down. The smaller the gap, the lower is the maximum achievable potential difference by the electrode. Here the thin ring **20** acts as a variable gap gas-discharge voltage regulator.

### **Calculations when VDG is housed within the wire-type ESP chamber**

*Voltage to be applied between cylinders:*

- Voltage between two concentric cylinders in wire cylinder ESP is given by the following equation:

$$V = C \cdot \ln(R_2/R_1)$$

Where  $R_1$  is the inner radius of the cylinder,  $R_2$  is the outer radius of the cylinder.

Calculations shown below are for  $R_1 = 3\text{cm}$ ,  $R_2 = 6\text{cm}$

- For concentric cylinders, the critical voltage for formation of corona is given by

$$E_c = 31 \times 10^5 \times m \frac{\rho}{\rho_s} \left( 1 + \frac{0.308}{\sqrt{\rho R_1 / \rho_s}} \right) V / m$$

Taking m (irregularity factor) = 1 for polished surface and  $\rho/\rho_s$  (relative air density) = 1 at Standard Temperature and Pressure, we get,  $E_c = 8.61 \text{ MV/m}$ .

- Corona starting voltage is given by the relation:  $V_c = E_c \times R / \ln(R_2/R_1)$

For decreasing the corona starting voltage ( $V_c$ ) and also to increase its gap from spark over voltage, high curvature ( $R = 1 \text{ mm}$ ) perturbations are provided on the inner cylinder. Substituting the dimensions in above equation, we get,  $V_c = 12.42 \text{ KV}$ .

- Spark-Over Voltage ( $V_s$ ) = 745 KV (Voltage at which complete breakdown of air between cylinders takes place). Voltage around 13.5 KV can be chosen to maintain a negative corona and also be far away from spark over voltage.

#### Length of the cylinders:

$$\text{Area of cross section between cylinders } A = \pi (R_1^2 - R_2^2) = 84.8 \text{ cm}^2$$

Each dust particle would require around, say, 0.5 sec ( $\tau$ ) of travel time through the corona region for it to get sufficiently charged up and get precipitated.

Also, taking the average exhaust flow rate from a car  $F = 70 \text{ liters/min} = 1.167 \times 10^{-3} \text{ m}^3/\text{sec}$

Hence minimum length of the cylinder required =  $F\tau / A = 13.72 \text{ cm}$ .

We choose the cylinder length = 20cm

#### Charging Current of Vann de Graff Generator:

$$\text{Corona Current (I)} = \beta \cdot (V - V_c)^\alpha$$

For air as medium,  $\beta = 45 \text{ } \mu\text{A/cm}$  and  $\alpha = 4.2$

Charging Current,  $I = 1.24 \text{ mA/20cm}$

Hence the Vann de Graff generator to be used should have a charging current around 1.5 mA.

### **Advantages**

1. **High Efficiency:** The emission control device described in our invention employs ESP technology which has a very high efficiency (above 99%) in removing the particulate matter, dust, soot etc. Other devices for removing the particulate matter like Diesel Particulate Filter usually have efficiency of around 85%.
2. **Removes Suspended Particulate Matter and is Free from Mechanical Failures:** Existing emission control methods such as Positive Crankcase Ventilation (PCV) system, Exhaust Gas Recirculation (EGR) valve and Air Injection do not remove the particulate matter. Moreover, they often suffer from various mechanical problems causing possible engine oil leaks, system clogging, adverse affect on engine performance and even possible breakdown of the vehicle if operated in high traffic areas.
3. **Does not Require any External Electric Source:** Unlike other electrostatic precipitator based devices, the ESP described in our invention does not require any external source of electric energy for generating high voltages. It saves the high cost associated with the batteries and electric circuitry, which together amount for a large percentage of the operational cost of an ESP. In this sense, our product requires only one time investment, and hence is very cheap and affordable.
4. **Provides an Automated Cleaning Mechanism:** Our invention includes embodiment of an automated cleaning mechanism which is not available in most of the emission control devices used in automobiles.
5. **Negligible Maintenance Cost:** Product based on our invention does not require regular maintenance, refilling of any cleaning agent and recharging of batteries nether does it consume additional fuel for complete combustion of unburned particles. It has virtually negligible maintenance cost.

6. **Easily Implantable without Requiring Major Modifications:** Unlike other vehicle emission control devices that either cannot be installed in all range of vehicles or require major modifications in the vehicle's exhaust system before installation, our invention can easily be retro-fitted in a wide range of vehicles without introducing any significant change in their exhaust system. Hence, the product will have applications not only in new vehicles, but can also be used in existing vehicles.
  
7. **Does not use expensive cleaning agents or sophisticated electronics:** Catalytic converters used nowadays for controlling vehicle emission are very expensive because of the use of noble metals like Platinum, palladium and Rhodium. Moreover, the stratum of such converters often gets clogged after some time and requires refilling of the cleaning agent. Our invention neither uses expensive chemicals nor does require regular refilling of the cleaning agent. Moreover, it does not use sophisticated electronics that are used in Computer Controlled emission reduction devices, and hence, is more robust and cheaper.
  
8. **Free from electric power losses and other technical problems often encountered in very high voltage devices:** Electrostatic precipitators till date use induction coil or transformer-rectifier based electric circuits to generate high voltages from a low voltage battery. These methods have poor electric efficiency (less than 80%) and induce unwanted random magnetic fields that may damage the nearby electric circuitry. Our invention based on Van de Graaff generator does not use any external source of electric energy, and hence is free from such power losses and unwanted magnetic fields.
  
9. **Minimal Operational Requirements:** Van de Graaff generator used in our invention requires very small power for operation which can easily be supplied either mechanically or by a simple electric motor. It does not add much to the cost of the unit.

## Application

1. Automobile manufacturers for emission control in vehicles

2. Industrial plants for chimney exhaust cleaning
  
3. Households for use at fireplace, kitchen ventilation etc.

Although the embodiments herein are described with various specific embodiments, it will be obvious for a person skilled in the art to practice the embodiments herein with modifications. However, all such modifications are deemed to be within the scope of the claims.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the embodiments described herein and all the statements of the scope of the embodiments which as a matter of language might be said to fall there between.

## WE CLAIM

1. An exhaust emission control device for filtering particulate matter contained in the exhaust gases, said device comprising:
  - an inlet means adapted to receive exhaust gas;
  - a sieve filter for separating heavy particles from said exhaust gases;
  - a treatment plant connected to said inlet means comprising an electrostatic precipitator for removing said particulate matter, said electrostatic precipitator further comprising duality of electrodes for corona generation,
  - a van-de-graaff generator for providing high voltage to said electrodes, said van-de-graaff generator comprising duality of rollers with a belt mounted over said rollers, duality of metallic brushes for transferring charges whereby one of the brushes being grounded and the other being connected to said electrodes, wherein the said rollers are driven through rotational motion of vehicle axle or other alternate means,
  - a voltage regulator to regulate the voltage generated by said van-de-graaff generator,
  - a cleaning unit comprising a cleaning means for cleaning off said particulate matter accumulated on said electrodes wherein said cleaning means run across the length of said electrodes and configured to either rotate about the central axis of said electrodes or swipe longitudinally through the treatment plant
  - a hopper placed at the bottom of said treatment plant for safe disposal of said particulate matter; and
  - an outlet means connected to said treatment plant for expelling the filtered gas.
2. Device as claimed in claim 1 wherein one electrode of the said electrodes is charged through said van-de-graaff generator and the other electrode is grounded.



3. Device as claimed in claim 1 wherein the space between said duality of electrodes forms a corona field.
4. Device as claimed in claim 1 wherein said electrostatic precipitator optionally comprising grid or plates coated with suitable catalysts and/or chemicals for performing oxidation and the like.
5. Device as claimed in claim 1 wherein materials of the said rollers are chosen to set up desired polarity of said corona field.
6. Device as claimed in claim 1 wherein said voltage regulator is a variable gap gas discharge voltage regulator.
7. Device as claimed in claim 1 wherein said treatment plant further comprising a rigid frame to support said treatment plant.
8. Device as claimed in claim 1 wherein said cleaning means comprising a scrubbing brush means and /or wiper means adapted to be rotated about the central axis of the electrodes.
9. Device as claimed in any of the preceding claims wherein said van-de-graaff generator is optionally located outside the electrostatic precipitator.
10. Device as claimed in claim 1 wherein said electrostatic precipitator is substantially cylindrical type.
11. Device as claimed in claim 1 wherein said electrostatic precipitator is optionally plate type.

**12.** Device as claimed in claim 1 wherein said electrostatic precipitator is optionally wire cylinder type.

**13.** An exhaust emission control method for filtering particulate matter contained in the exhaust gases comprising steps of:

receiving exhaust gases at the inlet;

separating heavy particles from said exhaust gases using a sieve filter;

precipitation of fine particles present in said exhaust gases in a treatment plant wherein a high voltage developed between the electrodes of electrostatic precipitator using a van-de-graaff generator, where the duality of rollers of the said van de graaff generator are driven through rotational motion of vehicle axle or other alternate means, causing a corona field formation between said electrodes, allowing exhaust gases to pass through said corona field, ions generated by corona further inducing charge onto the precipitate matter causing them to drift along the fields between the electrodes and get precipitated on the oppositely charged electrode; controlling the voltage developed on electrodes using a voltage regulator; removal of said precipitated material using a cleaning means and collecting said precipitated matter in a hopper; wherein said cleaning means is configured to rotate about the central axis or longitudinally across the said treatment plant to clean the precipitated matter from the said electrode surface;

expelling the filtered gas from the outlet.

**14.** Method as claimed in claim 13 wherein said voltage is regulated by varying the distance between said grounded metal ring and said electrode charged by said van-de-graaff generator.

**15.** Method as claimed in claim 13 wherein one electrode out of the said electrodes is charged through said van-de-graaff generator and the other electrode is grounded.

**16.** Method as claimed in claim 13 wherein materials of the said rollers are chosen to set up desired polarity of said corona field.

## **ABSTRACT**

### **EMISSION CONTROL DEVICE FOR FILTERING PARTICULATE MATTER CONTAINED IN EXHAUST GASES AND A METHOD THEREOF**

This invention relates generally to an emission control device and more particularly to an exhaust emission control device and a method of emission control for filtering particulate matter contained in the exhaust gases. It comprises of an inlet means adapted to receive exhaust gas; a sieve filter for separating heavy particles from said exhaust gases; a treatment plant connected to said inlet means comprising an electrostatic precipitator for removing said particulate matter, said electrostatic precipitator further comprising duality of electrodes for corona generation; a van-de-graaff generator for providing high voltage to said electrodes, the said van de graaff generator further comprising of duality of rollers with a belt mounted over said rollers whereby the said rollers are driven using motion of vehicle axle or other alternate means, duality of metallic brushes for transferring charges to the said electrodes; a voltage regulator to regulate the voltage generated by said van-de-graaff generator; a cleaning unit for cleaning off said particulate matter accumulated on the said electrodes, etc.

Fig. 1

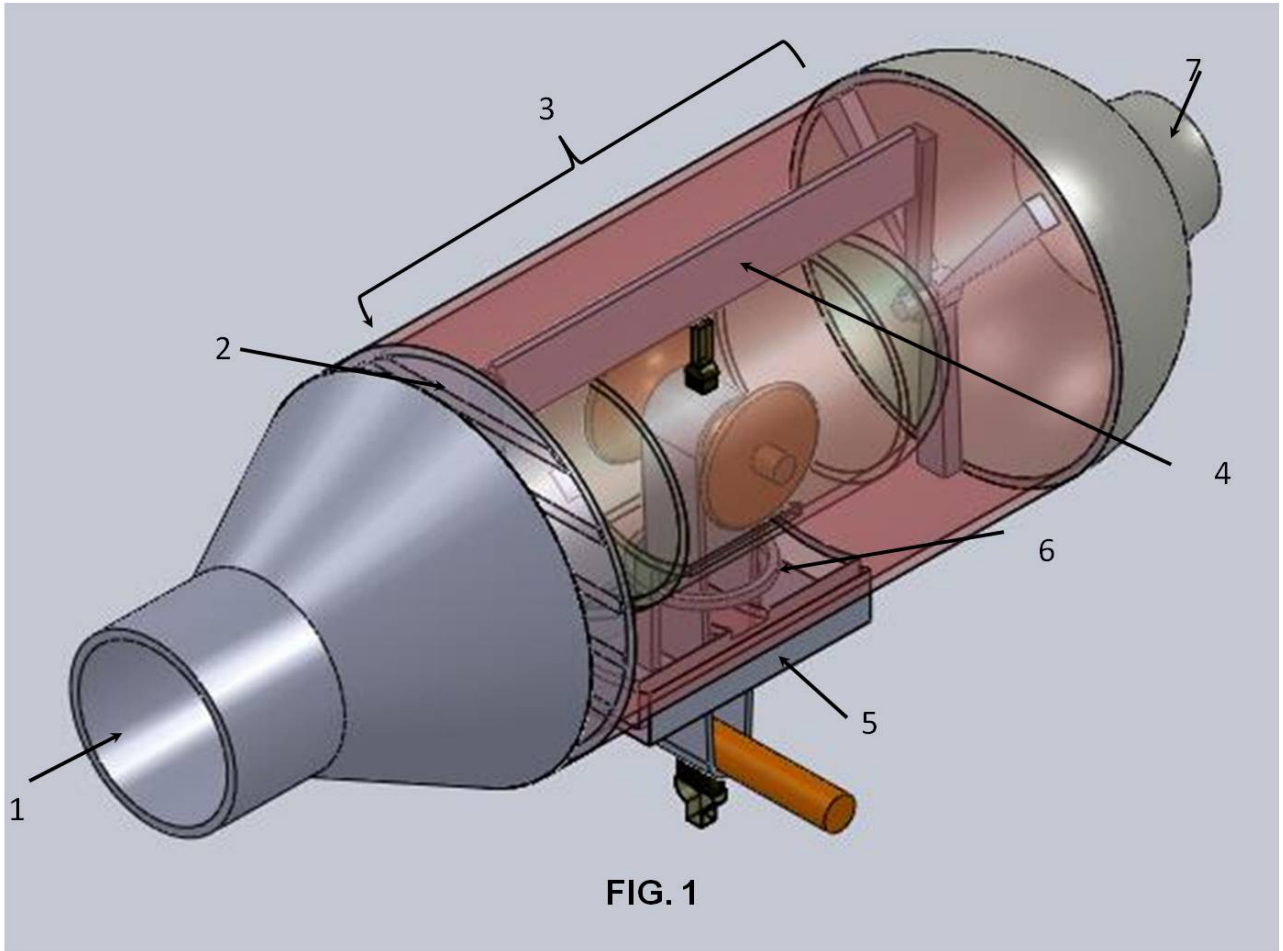


FIG. 1

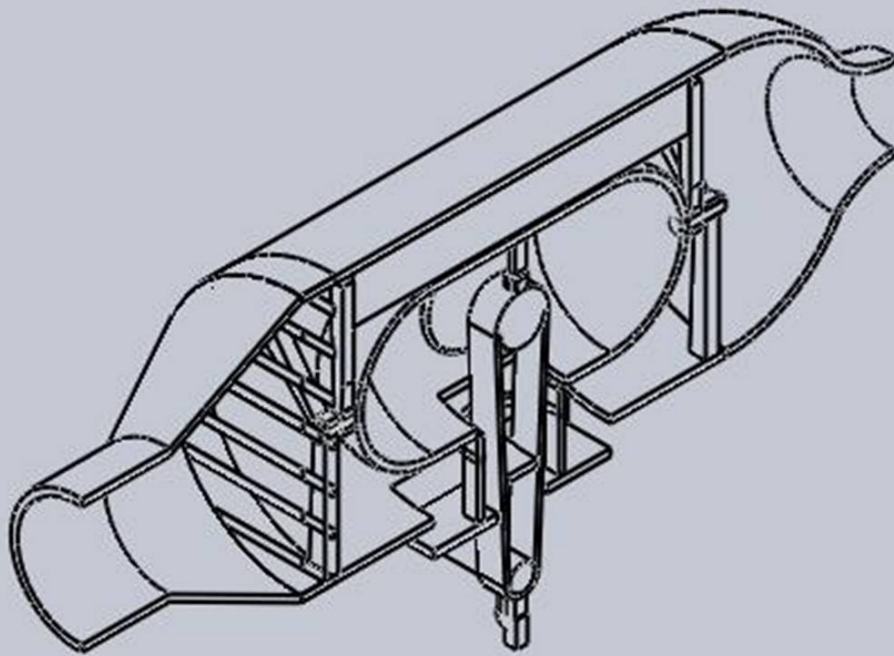


FIG. 2

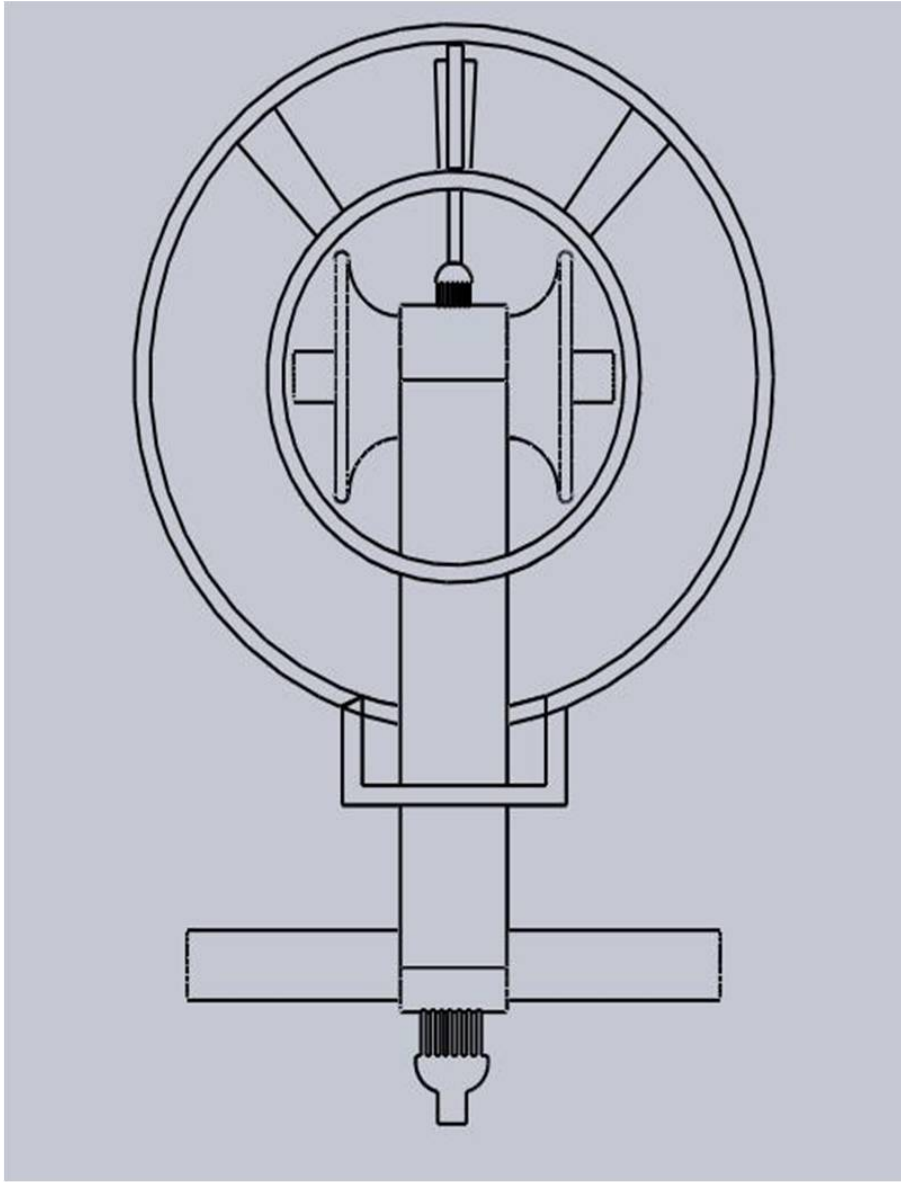
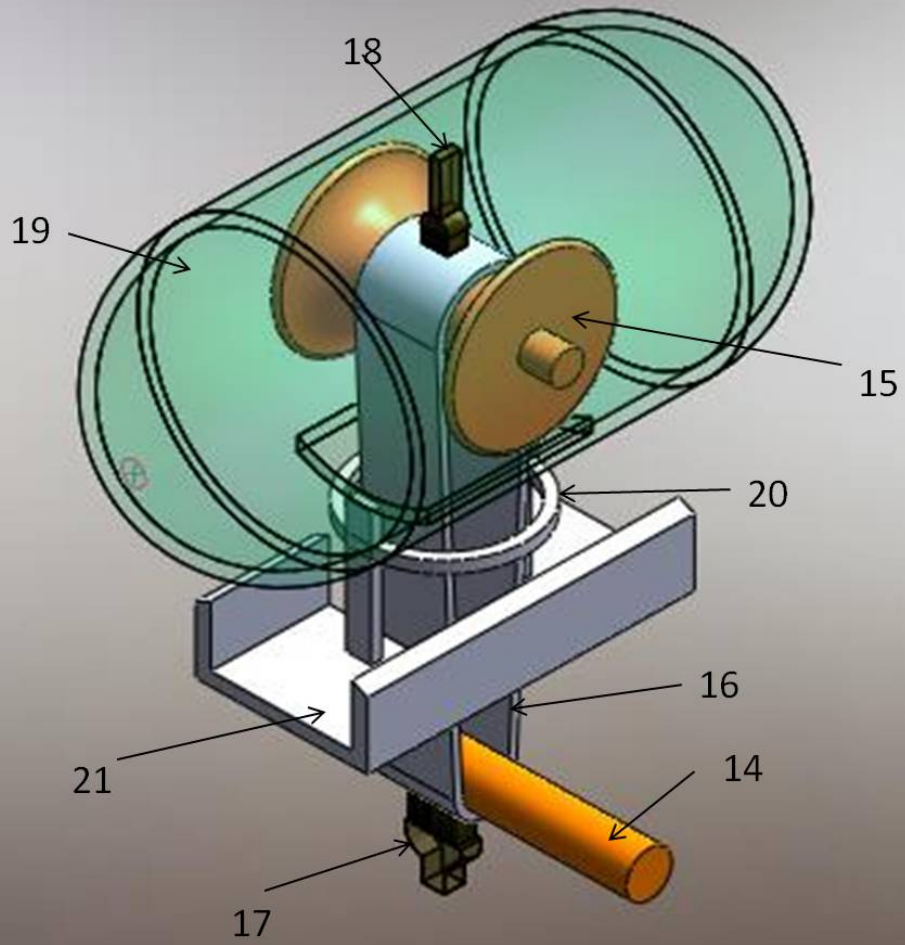


FIG. 3



**FIG. 4**



