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UV-LED/TiO_2 Photocatalytic Filter with Sterilizing Function for Air Conditioning System

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ABSTRACT

We hereby introduce an air-conditioning system which uses a nano-photocatalyst sterilization device. The system consists of a base, a cover, a photocatalyst filter, a kit, a packing piece and a number of lighting devices. This assembles into a sterilization device which installs into an air conditioning system. The lighting device is composed of a circuit base with a bowl-shaped casing and a high-powered LED light source, the inner wall of the bowl casing is shaped into a hood-like projection area. By the use of high-powered LED light source and a bowl-shaped casing, a varnish design is formed. This results in the light projections from the LED light source to refract and collide inside the projection area of the bowl-casing to achieve even exposure of the photocatalyst filter, enhancing lighting density, illumination and utilization to remove toxic bacteria, toxic gases, odors and pollutants further improving indoor air quality.

***Keywords:* Nano-photocatalyst, LED, Air quality.**

1. Introduction

Indoor air quality (IAQ) has various different levels of impact to the human health. Many diseases such as Legionnaire's disease (caused by microbial infections), allergic diseases (caused by allergens), diseases and cancers (caused by prolonged exposure to various irritant and carcinogenic chemicals in the environment) all show that indoor air quality and the human health are closely related [1]. Therefore, how air pollution factors can be controlled or adequately handled has become a topic that can not be ignored. In the field of actual research and application of photocatalytic oxidation processes which consists mainly of the handling of air pollutants [2~6], the UV/titanium dioxide photocatalyst procedure (UV/TiO2 process) is more developed in terms of basic reaction mechanism, reaction system design and other operational aspects.

The SARS outbreak in 2003 highlighted airborne infections in hospital [7], seriously affected the normal health care services of the hospital. As the patients are infectors of the pathogens, the hospital became a gathering place for various different pathogen infectors.

A currently well-known air purified sterilization apparatus is the No. I231355 "Energy-saving Nano-photocatalyst sterilizing device" approved by Intellectual Property Office, Ministry of Economic Affairs, R.O.C., Publication Date: April 2005 [8]. But a content analysis of the patent application shows that it lacks the following.

1. A square hood shaped body as the carrier, meaning when assembling the carrier, the photocatalyst filter must be assembled separately on the four sidewalls, making it costly and with limited space to install.
2. When installing, the top and bottom peripheral walls have to be tilted and the exit hole set. So it can cooperate with the LED installations and reflective flake pieces to increase the range of light exposure. It is very inconvenient and space consuming when assembling.
3. Reflective pieces are used to increase the range of light exposure from the LED to the photocatalyst layer of the photocatalyst filter, but it is unable to increase the projected light density and illumination. Efficiency of sterilization and decontamination of the air is limited with low overall reaction efficiency.

In order to prevent the spread of viruses through the air flow and given the lacks of the above-mentioned, with creative ideas based on many years of experience and various exploration in designs and tests to correct and improve; we have this creation [9]. The major design points are listed below.

1. Top and bottom circular connectors with built in filter and UV LED light module which uses a circumferential projection to refract and collide to

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achieve even exposure to the filter. Enhances light density, illumination and utilization.

2. The titanium dioxide on the filter under irradiation of UV LED photocatalytic reation; purifies air, is antibacterial, deodorizes, disinfects and anti-mildew.
3. Filter consists of a non-woven filter net, paper honeycomb-shaped filter and honeycomb-shaped active carbon filter.
4. Use of carefully developed photocatalysts.
5. Applies to the fields of air supply and air return duct systems in engineering.

In section 2, the idea point our innovation is presented. Section 3 is the achievement of our innovation. The final section of this study consists of a conclusion and recommendations for future research.

2. The New Idea Point

Figure 1 shows a 3-dimensional exploded view of the creation. It mainly consists of a base and a cover with a photocatalyst filter, packing piece, and a number of lighting fixtures in between. This is a sterilization device to be installed in air conditioning systems. The base and the cover have a flange in relative positions, with a vent in the center to make sure of the flow of air intake in the ventilation pipe of the air conditioning system. In addition, there is a convex section around the inner edge of the base to form a seating surface. The photocatalyst filter structure is made up of cotton pieces or woven filters which contain titanium dioxide. The kit contains a hollow flange ring which is slight smaller than the diameter of the base. The packing piece is a sheet plug article with pieces accompanied for setting the photocatalyst filter. The lighting fixture is a circuit base set in a bowl-shaped casing coupled with a high-powered LED light source (Fig. 2); the casing is oval shaped to form a parabolic projection area.

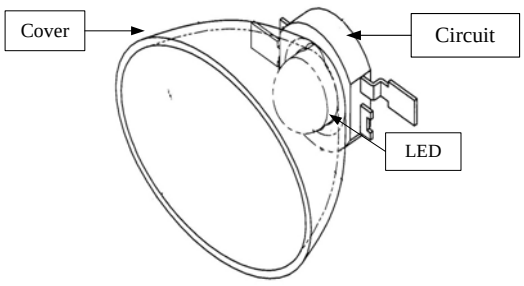

Fig. 2 LED light source

When assembling (Fig. 3), first place the outer edge of the photcatalyst filter onto the seat of the base then place the kit block at the outside edge of the photocatalyst filter surface. The gap between the inner flange and the framed outer wall can be fixed with the sheet plug article leaving the photocatalyst filter positioned between the seat surface and package, then assemble the 5 sets of lighting fixtures and place in the space located around the ring base to be connected to the power module (as shown in Fig. 4).

The photocatalyst should be placed below the lighting modules. Finally, secure the cover onto the base flange so that the base and cover vents are in line with the surface of the photocatalyst filter to complete assembly (as shown in Fig. 5).

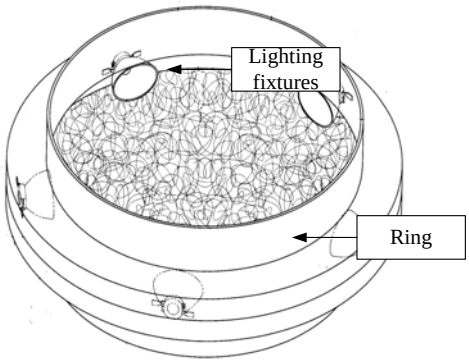

Fig. 3 The photocatalyst filter fixed in base

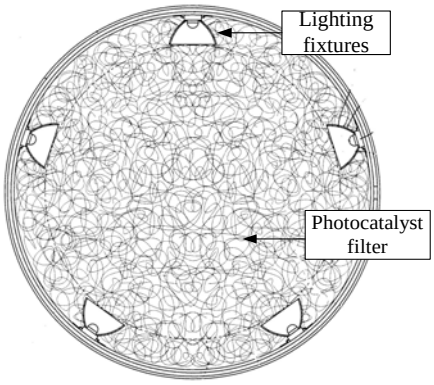

Fig. 4 The lighting fixtures fixed in base

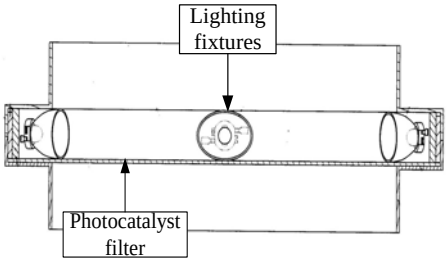

Fig. 5 The front view of photocatalyst filter in base

The sterilization device is installed in the air conditioning system in connection with the ventilation pipe (Fig. 6). The high-powered LED light source and bowl-casing are compatible in forming a varnish system, by using the light projected by the parabolic hood-like focus projection area, the photocatalyst containing titanium dioxide (TiO2) receives lighting evenly to increase efficiency of the LED. All harmful substances, allergens and other contaminants passed through the ventilation pipe, after being oxidized and decomposed by the photocatalyst filter achieves the removal of toxic bacteria, toxic gases, odors and pollutants which significantly increases the purpose of air sterilization, deodorization and purification; achieving practical value and market competitiveness.

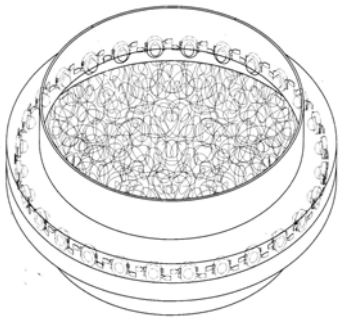

Fig. 6 Sterilization installment

3. The Achievement

According to the idea and design mentioned above, the product is achieved, and describe in below.

3.1 Characteristic and advantage

1. Provides good quality air.
2. The filter may be changed to reach requirements of actual demands of air quality.
3. Filter may easily be changed, just open the upper and lower covers. The same goes for the LED lighting.
4. Compare with traditional UV lamps, LED's have lower power consumption.
5. Honeycomb filters have an air rectification effect.
6. Does not produce material harmful to the human body, installation quick, simple & safe and can be installed on site.

3.2 The Photo of Real Product

Fig. 7 and Fig. 8 show the uncover sterilization device and completely assembled sterilization device, respectively. It can clearly be seen in the picture that the use of circumference projection and refraction collision of average exposure to the filter, can increase the light density, illumination and utilization.

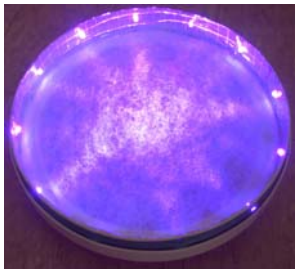

Fig. 7 The photo of sterilization installment (uncover state)

Fig. 8 The photo of sterilization installment (after constructed)

3.3 The Patent and Award

The new product had got the utility model patent in the R.O.C., and the number is M352010, from year 2009 to year 2018[10], and the international invention award in Italy and Poland (as shown in Fig. 9 and Fig. 10.

Fig. 9 2011 Inventeco International Invention Show (Italy)

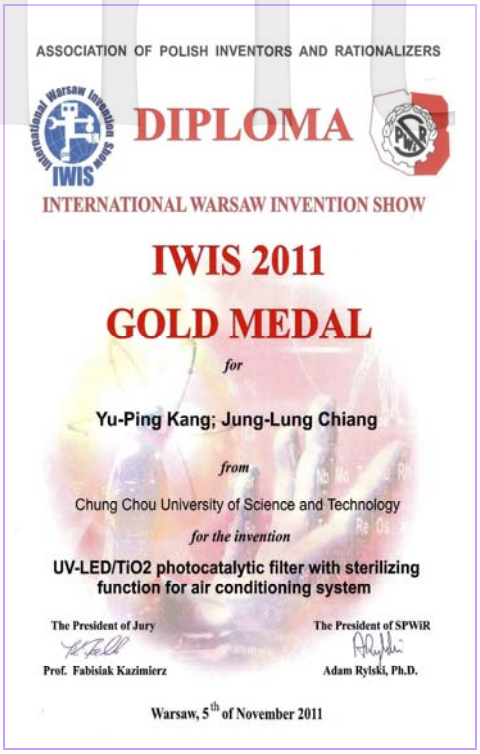

Fig. 10 2011 International Warsaw Invention Show (Poland)

4. Conclusions

The quality of indoor air has an effect on the health of the human body, how to control or properly dispose of air pollutants is a topic that can not be ignored. In 2003, the SARS outbreak highlighted the event of airborne infections that occurred in hospitals. This product uses the photocatalystic reaction of titanium dioxide (TiO2) filter under the irradiation of UV-LED lighting to purify air, antibacterial, deodorize, disinfects and anti-mildew to create a quality healthcare and home environment.

This invention is applicable to the fields of air supply and air return duct systems in engineering; it uses circular connectors for top and bottom. It also makes use of circumferential projection to refract and collide light to achieve an even exposure of light to the filter. In addition, all components in the device can be change to fulfill the needs. Changing filters is simple as you just have to open the top and bottom covers, the same goes for changing the LED modules. This device is also more energy-saving compared to traditional UV lamps as LED's are used.

When in use, it does not release any harmful materials to the human body. Assembly is quick, simple and safe and can be installed on site, an excellent air improving device. However, due to the additional power each light emitting devices consumes, there is still a shortcoming of extra electrical consumption. So how to improve it to become more energy-efficient shall be the focus for future studies.

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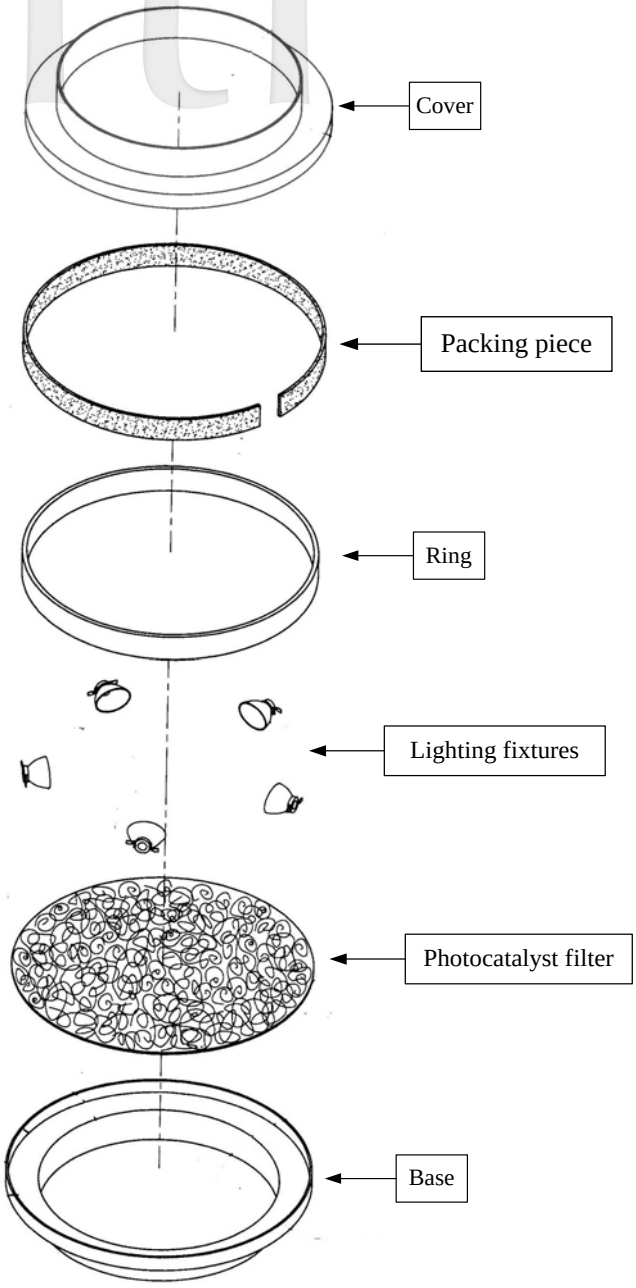

Fig. 1 The whole set of the invention

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