Design and Fabrication of Automatic Uv Sterilization Equipment with Idle Laboratory Metal Cabinet During the Covid-19 Pandamic

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Abstract

Design and fabrication of PPE, including N95 masks and filtering face piece respirators such as goggles and face shields, played a crucial role in ensuring the safety of both virus-affected individuals and medical staff, health workers. As the corona virus (Covid-19) spread exponentially across the globe, the demand for this basic equipment, particularly face protection shields, has risen significantly. There have been efforts to determine the various methods for preserving PPE kits for use after sterilisation. The focus of the present work was the fabrication of a model portable PPE kit steriliserutilising the UV ozone sanitization process for the recycling of N95 masks and goggles. Due to its compact size, can be utilised in public health settings such as hospitals, research facilities, schools, and laboratories. The adopted method was inexpensive, reusable, and well-suited for mass sanitation. The effectiveness of the sterilisation will be evaluated using a Microbe content detection device associated with the conventional sterilisation procedure and a cabinet made of metal with a complete finish. The first of its kind, the successful implementation of sterilisation for a wide variety of everyday items aided by a microbe content detection technique should be an effective tool for use in large communities, offices, and public spaces to combat the spread of infectious diseases.

Key Words : Design Metal cabinet, UV Sterilization, Covid-19, Ultraviolet germicidal lamp, Fabrication UV Sterilize.

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1. Introduction:

In 2019, Covid19 took humanity by surprise. Due to its rapid and efficient spread, we were required to wear face masks and gloves in order to protect ourselves from everything we touch. Now SARS-COV-2 is just one of the viruses in the Corona virus family; many other viruses in this family have not yet jumped to humans. This pandemic has shown us the importance of being prepared for future pandemics.

Well, we can use masks to protect ourselves outside, but what about the items we bring home from the market or trade with others? For instance, we cannot apply sanitizers to cell phones, cash, or paperwork that doctors and patients exchange or that employees exchange with one another.

In addition, the use of sanitizers involves the use of chemicals that are harmful to humans and the environment, as well as the recurring expense of purchasing sanitizers. The solution to this enormous problem is an intelligent electronic system powered by a microcontroller. We design a compact, ultraviolet-sterilized, 360-degree disinfection box to solve the problem. The system employs ultraviolet-c tubes for this purpose. Now it has been demonstrated that UV C can eliminate all viruses within seconds.

Using 3D design software, the proposed sterilisation unit will have a cuboid-shaped metal chamber with a front-hinged door. The sterilisation chamber for household use should not be so large that it must be kept in a stationary position, but it should be large enough to sterilise most items of daily use, including masks, mobile phones, jewellery, wallets, and even food. Instead of expending energy and time on daily laundry, clothes can be sterilised in a short amount of time. The proposed dimensions of the metal chamber for use in a single dwelling are 60 40 60 cm (length width depth). For the version of the device intended for use by an entire community, however, larger sterilisation chambers can be fabricated. The case will include two ultraviolet (UV) light sources, a laser head, and a CCD camera for microbe detection (detailed in the next section). The UV lamps will be installed on the chamber's upper and lower surfaces. The items to be sterilised will be contained on a glass plate positioned above the UV lamp. The laser head will be mounted in the chamber's upper corner, and the CCD camera will be mounted on the chamber's upper face. Figure 1 is a schematic diagram of the sterilisation chamber. 20–25 minutes of UV light exposure is recommended for sterilising the items. Using the results of the microbe detection system, the exposure time for each individual item can be calibrated. The UV lamps and laser head will be electrically powered, and there will also be a battery backup for use in areas where an electrical outlet is not readily available.

• 360 Degree Disinfection • Proven to Deactivate All Corona Viruses • Automatic Timer-based Shutoff and Alerting • Can Sterilize Mask, Packed Food, Electronics, etc. • Variable Sterilization Timer Setting • Automatic Safety Shutoff • Easy To Use • No Water, No Chemicals | Eco-Friendly

When the start button is pressed, the Atmega controller accepts user input for time setting and initiates sterilisation. It turns off automatically when the sterilisation time has expired. Also, an automatic shutoff system stops the sterilisation if the lid is opened during the sterilisation process.

To operate this machine, the system consists of an LCD display with push buttons. The buttons are used to set the sterilisation duration. After initialization, the Atmega controller uses proximity sensors to determine if the lid is closed. After detecting a closed lid, the controller activates the UV tubes for the predetermined amount of time to ensure proper sterilisation. Once sterilisation is

complete, the controller deactivates the UV tubes and emits a buzzer to signify completion of the process.

Since direct exposure to UV can be hazardous, the controller also turns off the UV tubes if the box is opened during the sterilisation process. This ensures a water-free and chemical-free sterilisation procedure that can aid in preventing the spread of COVID 19.

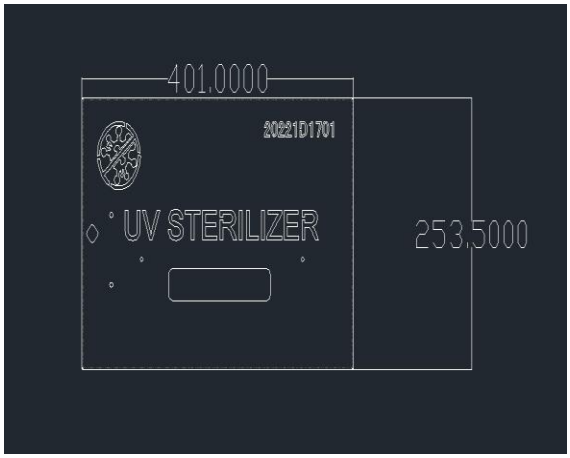
Design & Fabrication of Metal Cabinet The Metal Cabinet's design is one of the most crucial aspects of product development. Metal Cabinet are the product's exterior and the part with which we typically interact. They must be highly functional, aesthetically pleasing, and user-friendly.

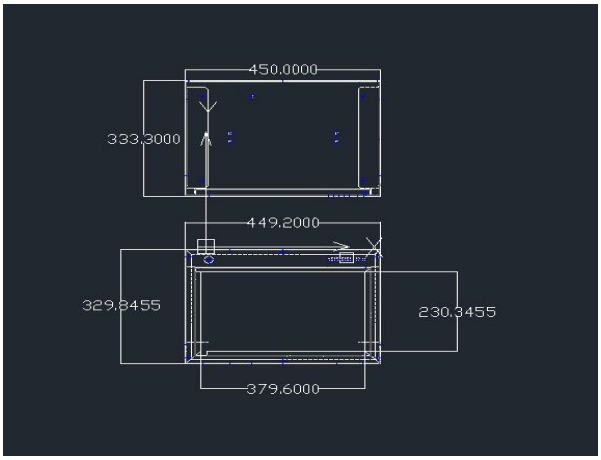
Solid Works is a solid modeller and uses a parametric feature-based approach that was developed by PTC (Creo/Pro-Engineer) to create models and assemblies. The student version of Solid Works has been used for model development and simulation. The software employs the Para solid modelling core.

Parameters are constraints whose values determine the model or assembly's shape or geometry. Parameters can be numeric, such as line lengths or circle diameters, or geometric, such as tangent, parallel, concentric, horizontal or vertical, etc. Through the use of relations, numerical parameters can be associated, allowing them to capture design intent.

The designer's intent for a component's response to modifications and updates. For instance, the hole at the top of a beverage can should remain at the top surface regardless of the can's height or size. Solid Works enables the user to specify that the hole is a feature on the top surface, and will then respect the user's design intent regardless of the height later assigned to the can.

Features are the constituent elements of a part. These are the forms and operations that compose the component. Typically, shape-based features start with a 2D or 3D sketch of shapes like bosses, holes, slots, etc. Then, this shape is extruded to add or remove material from the component. Not based on a sketch, operation-based features include fillets, chamfers, shells, applying draught to the faces of a part, etc.





Design Development using the solid works tool is the first step in the fabrication procedure.

(B) Required Material Procurement (Metal+Electrical).

(C)Laser Cutting, Bending, Welding, and Powder Coating for Metal Enclosures

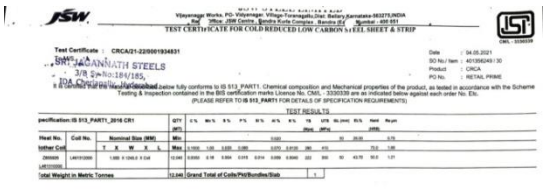
(D) UV Lights, Control Panel Fitting in Metal Enclosure. (E) UV Lights, Control Panel Fitting in Metal Enclosure.

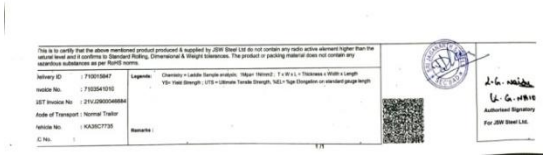
(E) Verifying Prototype part.

Fabrication is the process of constructing products by combining typically standard parts through one or more separate processes. For instance, steel fabrication is the production of metal structures using a variety of techniques, including cutting, bending, and assembly.

Selection Criteria for Raw Materials The selection criteria for the raw materials chosen for a particular product should include characteristics that are significant in determining both its process performance and its "organoleptic" properties. Organoleptic refers to a product's taste, colour, odour, and mouthfeel.

We have selected 1mm-thick mild steel sheets, which are inexpensive and simple to manipulate.





Laser Cutting:
Laser cutting is the first process of metal fabrication. During this step, the metal fabrication company cuts one or more raw metal pieces to be used in the creation of a new metal structure or product. Despite this, cutting steel, aluminium, iron, or any other common metal requires specialised equipment. Some metal fabrication companies cut metal with torches, while others use numerical control (CNC) machines with lasers or water jets. When the process is complete, the company will have clean, properly sized sheets or sections of metal to work with.

CNC Bending:
After cutting unfinished metal, metal fabricators must bend it. Again, there are numerous methods for bending metal after it has been cut. Some metal fabrication companies create the desired shape by hammering metal sheets or sections. Hammering can be performed manually or using a machine (power hammering). Recently, however, many metal fabrication companies have begun bending their metal with press brakes. When activated, this heavy industrial machine automatically presses metal sheets and sections into a predetermined shape. It essentially presses the metal into the desired shape by clamping it between a punch die.

Assembling:

Assembly is the third and final step in metal fabrication. This process, as its name suggests, involves assembling metal sheets or sections into the desired end product. Welding is the most common method of assembly, though other techniques may also be utilised. Besides welding, metal fabrication companies may also crimp seams, apply screws or other fasteners, and apply glue.

Following metal assembly, the company will complete the product before shipping and selling it to customers.

Fabrication of metal is the driving force behind the expansion of the nation's manufacturing sector. Metal fabrication companies rely on a three-step process consisting of cutting, bending, and assembling, despite having access to a vast array of machines and techniques. These three processes enable metal fabrication companies to create new products from raw metal materials.

UV Disinfection Method:

We design a UV system with variable frequency using a low-pressure UV lamp.

The pulse frequency influences the germicidal effectiveness of pulsed UV light.

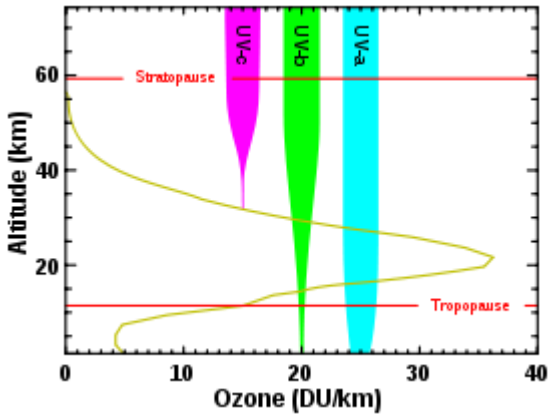
Pulsed UV light at particular frequencies is more bactericidal than continuous UV light.

UV sterilisation, also known as UV disinfection or ultraviolet germicidal irradiation (UVGI), prevents the multiplication of microorganisms by destroying certain chemical bonds and scrambling the structure of DNA, RNA, and proteins.

What is the efficacy of UV sterilisation? Does it work against viruses and bacteria? What are the merits and demerits? As a microbiologist, I hear these questions frequently, especially when people consider how dirty their cell phone gets. As more UV sterilisation products are introduced to the market, you may wonder if they are worthwhile. So, let's dig in!

UV light has been utilised for sterilisation and disinfection since the middle of the twentieth century. With technological advancements, particularly in UV bulbs, its dependable long lifespan (thousands of hours) and smaller size (e.g. UV LED vs. traditional UV bulbs) have expanded its applications. It is used to disinfect water, air, fruits, vegetables, surgical instruments, tablet computers, toys, and an assortment of other surfaces.

Not all varieties of UV are effective for UV sterilisation. What does this entail? Ultraviolet (UV) refers to a range of electromagnetic waves with shorter wavelengths (higher frequency and energy) than violet visible light. UV is separated into three varieties with decreasing wavelengths and increasing energy.



Another limitation of UV sterilisation is that UVC damages proteins and DNA/RNA to such an extent that they cannot be used in biomedical products. UVC sterilisation of viruses, for instance, causes so much damage to the surface proteins of the viruses that they cannot be used as vaccines to induce appropriate immune responses. In biomedical products, a different type of "UV inactivation" is used to preserve viral surface proteins while effectively inactivating viruses. This is also the method we employ for our UV-inactivated, purified virus products, as we wish to use the intact viral proteins of the UV-treated viruses for biomedical applications, such as antibody production.

UV sterilisation is a great option whether you are looking for a bot to sterilise your countertops, a wand to wave over shady hotel sheets, or a device to sanitise your stinky shoes. Remember that it is essential to adhere to the manufacturer's instructions regarding light-source distance, exposure time, and safety precautions for any device you purchase.

It includes UVA, UVB, and UVC. Only UVC (100-280nm) has sufficient energy to effectively kill microorganisms during UV sterilisation. When purchasing a UV sterilisation product for use in your home or place of business, ensure that its UV wavelength falls within the UVC range (100-280 nm).

Is UV sterilisation effective against bacteria and viruses? Yes, and there are even more organisms than that. UVC at 254 nm is effective against all foodborne pathogens, natural microbiota, moulds, and yeasts, according to studies. Due to the different sizes and shapes of microorganisms, which affect their UV absorption, the time required to kill each species varies. 2

How does UV sterilisation work? I'm glad you asked! UV sterilisation, also known as UV disinfection or ultraviolet germicidal irradiation (UVGI), prevents the multiplication of microorganisms by destroying certain chemical bonds and scrambling the structure of DNA, RNA, and proteins. When a microorganism is incapable of multiplication, it is considered to be dead because it cannot reproduce within a host and is no longer contagious.

“Dead.” That sounds just right. How long does it take for this vile matter to reach the "dead" status? Let's discuss destruction in detail. Since UVC energy is used to destroy biomolecules, the effectiveness of UV sterilisation is dependent on the total energy applied, which is affected by exposure time and distance from the light source. For instance, if a petri dish containing E. coli is

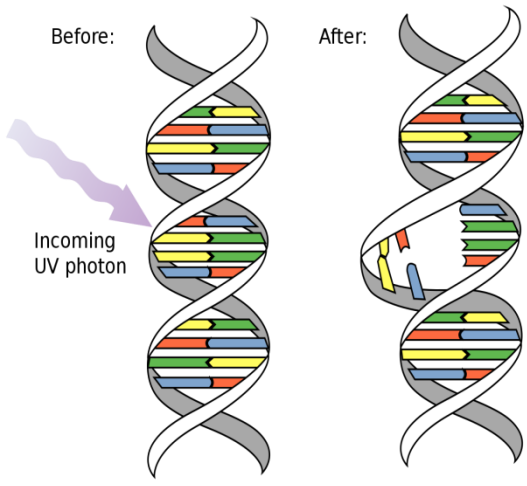
sterilised with a UV lamp held 1 cm above it for 1 to 2 minutes, the sterilisation will be complete. 1 In a medium UV box, sterilising surgical instruments could take between 5 and 10 minutes. A common recommendation for sterilising an 8-foot biosafety cabinet in a laboratory is 30 minutes.

Gas lasers, laser diodes, and solid-state lasers can be manufactured to emit ultraviolet light, and lasers covering the entire UV spectrum are available. The nitrogen gas laser emits a UV-dominated beam by electronically exciting nitrogen molecules. The ultraviolet lines with the greatest intensity are 337.1 nm and 357.6 nm in wavelength. Excimer lasers are a second type of high-power gas lasers. These lasers emit in the ultraviolet and vacuum ultraviolet wavelength ranges and are widely utilised. Presently, UV argon-fluoride excimer lasers operating at 193 nm are routinely used in the photolithographic fabrication of integrated circuits. The wavelength limit for the production of coherent ultraviolet light is approximately 126 nm, which is typical of the Ar2* excimer laser.

At 375 nanometers, direct UV-emitting laser diodes are available.

[40] Using cerium-doped lithium strontium aluminium fluoride crystals (Ce:LiSAF), a technique developed in the 1990s at Lawrence Livermore National Laboratory, UV diode-pumped solid state lasers have been demonstrated. [41] Diode-pumped solid-state lasers commercially generate wavelengths shorter than 325 nm. It is also possible to create ultraviolet lasers by applying frequency conversion to lasers with lower frequencies.

Ultraviolet lasers find use in industry (laser engraving), medicine (dermatology and keratectomy), chemistry (MALDI), free-air secure communications, computing (optical storage), and the fabrication of integrated circuits.



COVID-19 (Coronavirus Disease 2019) is a disease caused by the novel coronavirus SARS-CoV-2, which caused a global pandemic. The world's public health systems and economies have been devastated by this virus, and many people are wondering, "Does UV light kill Covid?" As of December 31, 2021, the pandemic is experiencing a surge with the new Omicron variant and a total death toll of 5,439,895 worldwide, including more than 825,825 in the United States.

Effective UVC Lamp Types for Killing Covid

Ultraviolet (UV) radiation from the sun has less energy than X-rays and gamma rays, but more than visible light and radio waves. Sunlight emits natural UV rays in three spectral ranges: UVA, UVB, and UVC. Natural sunlight can expose humans to UVA and UVB rays, but the majority of UVC rays are absorbed by the ozone layer.

UVC light is replicated in germicidal UVC lamps, which have been demonstrated to be effective against numerous viruses and bacteria, including beta coronaviruses. SARS-CoV-2 is a member of the same beta coronavirus family as MERS (Middle East Respiratory Syndrome) and SARS (Severe Acute Respiratory Syndrome). UVC light has been shown to eradicate MERS and SARS, and recent research indicates that UVC lamps are also effective against the SARS-CoV-2 virus that causes COVID-19.

Does UV Light Kill Liquid Covid?

UV light is a proven disinfectant and steriliser, able to eliminate viruses from water, surfaces, and the air. UVC light effectively inactivates bacteria and viruses by causing damage to their nucleic acids, preventing them from replicating. A cell that is inactive and unable to replicate is considered harmless and incapable of spreading disease. UVC light is effective at killing the SARS-CoV-2 virus that causes COVID-19 in liquid cultures, according to a recent study published in the American Journal of Infection Control (AJIC), as "SARS-CoV-2 is highly susceptible to irradiation with ultraviolet light."

UV Light Cannibalizes COVID on Surfaces?

UVC Lamps Serve as Surface Sterilizers

Studies by the AJIC demonstrating a 99.7% efficacy rate for UVC germicidal lamps against the SARS-CoV-2 on laboratory surfaces have demonstrated their efficacy. To achieve this high rate of disinfection effectiveness, surfaces must be clean and exposed directly.

Depending on the surface, the temperature and humidity of the environment, and the quantity of virus deposited on the surface, cold and flu viruses can remain infectious on surfaces for several hours or even days. According to the Technical Report, 2020 COVID-19 Coronavirus Ultraviolet Susceptibility, the SARS-CoV-2 virus that causes COVID-19 respiratory disease is anticipated to live on surfaces for between six and nine days. Viruses tend to live longer on hard, nonporous surfaces such as stainless steel, plastic, and the like, as opposed to softer surfaces such as fabrics.

Using ultraviolet (UV) light to sterilise surfaces is also known as ultraviolet germicidal irradiation, or UVGI, and has been shown to be a highly effective method of disinfection when administered in sufficient doses from high-quality UV lamps. Germicidal lamps for disinfection are constructed differently than conventional fluorescent lamps, with UVC-emitting wavelengths.

Sun-emitted ultraviolet light is not visible to the human eye due to its higher frequency and shorter wavelength than visible light. UV light ranges from 10 nm (vacuum and extreme UV) to 400 nm, and is primarily subdivided into UVA (315-400 nm), UVB (280-315 nm), and UVC (100-280 nm), with UVC possessing the most potent germicidal properties.

UV Surface Sterilization Benefits

In addition to a highly effective kill rate for viruses and bacteria, sterilising surfaces with UV light has many other advantages. Surfaces must still be cleaned manually to ensure they are free of organic compounds prior to UV exposure. However, by adding UV light disinfection to your

cleaning regimen, you can ensure a higher level of disease protection without the use of additional chemicals.

There is no need to expose food items to chemicals in order to prevent infestations and food-borne illnesses; UV radiation is sufficient. UV sterilisation is extraordinarily cost-effective, as it operates nonstop without requiring additional labour or maintenance. Utilizing high-quality UVC germicidal lamps makes surface sterilisation extremely efficient and cost-effective.

Light Sources provides a variety of germicidal UVC lamps for use in almost any surface, air, or water sterilisation application, including: • Low-pressure mercury germicidal lamps • Standard output • High output • Compact • Specialty
• Amalgam germicidal lamps • Spot and pellet technology • Medium-pressure germicidal lamps • Ozone lamps • Electronic ballasts • Lamp components

Table 1. Test for virus inactivation by irradiation using a built-in UVC lamp of Raycop RSC

	UV irradiation time (The amount of UV irradiation [a])			
	Before irradiation (0 mJ/cm²)	For 2 seconds (3.92 mJ/cm²)	For 5 seconds (9.8 mJ/cm²)	For 10 seconds (19.6 mJ/cm²)
Infectivity titer	1.3×10^7	1.7×10^3	$<1.3 \times 10^1$	$<1.3 \times 10^1$
Infectivity titer log reduction values [b] (decreasing rate) [c]		3.8 (> 99.98%)	>6.0 (>99.99%)	> 6.0 (> 99.99%)

Infectivity titer unit: $TCID_{50}$/mL
Detection limit: 1.3×10^1 $TCID_{50}$/mL
UV intensity in this test: 1.96 mW/cm²
a) The amount of UV irradiation: UV intensity (mW/cm²) × Irradiation time (seconds)
b) Infectivity titer log reduction values: $\log_{10}$ (Infectivity titer before irradiation/Infectivity titer after irradiation)
c) Decreasing rate: [1-1/10 (Infectivity titer log reduction values)] × 100 (%)

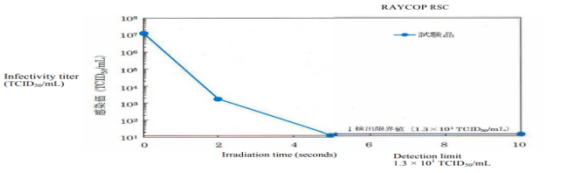


Figure 3. Test for virus inactivation by irradiation using a built-in UVC lamp of Raycop RSC

Advantages of UV Sterilization:

• Environmentally friendly, no hazardous or toxic chemicals to handle, no overdose problem (impossible), no need for specialised storage equipment, and no WHMIS requirements.
• Low initial capital expenditures and lower operating costs compared to comparable technologies such as ozone, chlorine, etc.
• Immediate treatment, no need for holding tanks, extended retention times, etc.
• Extremely cost-effective, treating hundreds of gallons for each penny of operating expense.
• No chemicals are added to the water supply; therefore, no chlorinated by-products are produced (chlorine plus organics = trihalomethanes).
• Taste, odour, pH, conductivity, and the general chemistry of the water remain unchanged; essential minerals and trace elements remain in the water
• Automatic operation requiring no special consideration or measurement; user-friendly.
• Simplicity and ease of maintenance, periodic cleaning (if applicable) and annual lamp replacement; no wearable moving parts.
• Installation is simple, requiring only two water connections and one power connection.
• Compatible with every other water treatment method (i.e. RO, filtration, ion exchange, water softeners and others)
Applications of UV Disinfection:

Water Purification and Wastewater Treatment
2. Surface Sanitization
3. Equipment Disinfection
Food and Drink Disinfection

Conclusion:

Automatic UV sterilisers Cabinet are a valuable component of any clean environment for regulating and destroying harmful bacteria, algae, and pathogens. They are excellent at purifying and maintaining a healthy environment, but they cannot replace a filter or medication. This is very inexpensive for the common man.

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