Diffusion cloud chamber PJ45

09046-90 / -93

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Operating instructions

CE This unit complies with the applicable EU regulations.

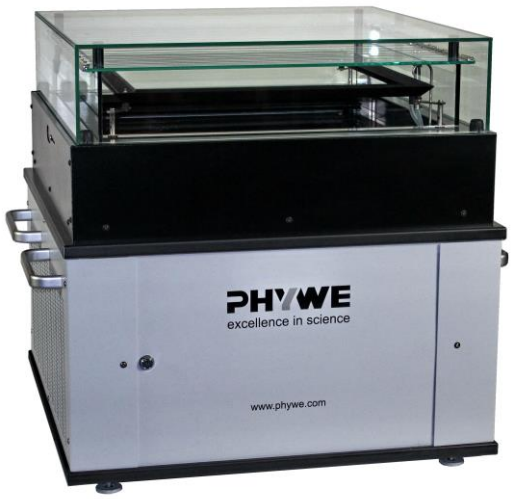


Fig. 1: 09046-93 Diffusion cloud chamber PJ45

TABLE OF CONTENTS

1 SAFETY INSTRUCTIONS

- Read the operating instructions thoroughly and completely prior to starting the unit. This is important for your own protection and for avoiding damage to the unit.
- Only use the unit for its intended purpose.
- Ensure that the mains voltage that is stated on the type plate of the unit corresponds to the voltage of your mains power network.
- The unit is solely intended for use in dry rooms where there is no risk of explosion.
- Do not use the unit if you notice signs of damage or leaks.
- When setting the unit up, ensure that the mains power switch or the device connector is freely accessible. Ensure that the venting slots of the unit are not blocked or covered.
- If possible, do not use any extension cords or multiple socket-outlets.
- Prior to starting the cloud chamber, wait at least two hours in order to exclude any problems with the refrigeration system, which might have occurred during the transport.
- Disconnect the power supply prior to performing any maintenance or cleaning tasks.
- Non-stop operation should be limited to exceptional cases.
- Optimum operation can only be guaranteed at a humidity of less than 50 %, as reliable visualisation of particle traces is only possible under these conditions.

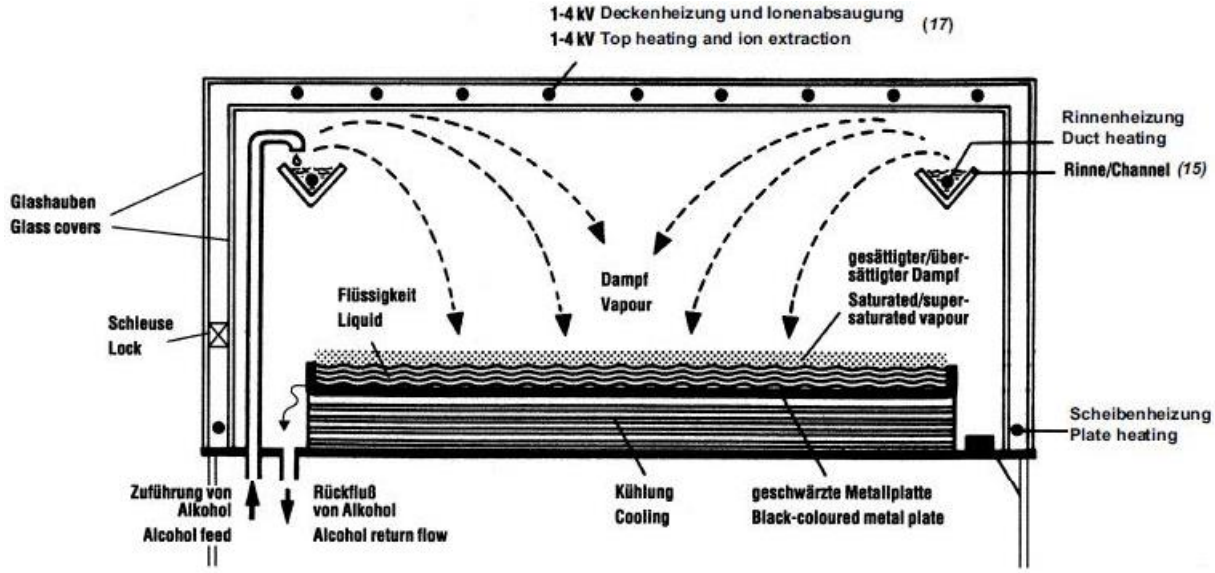
2 INTRODUCTION

Radioactivity as a hot topic of our society has played an important role in politics, economy, and media for many years. The fact that this radiation cannot be perceived with the natural human senses causes emotions like no other science topic before.
With the diffusion cloud chamber by Phywe Systeme GmbH & Co. KG, you have purchased a unit that can make the tracks of cosmic and terrestrial radiation visible.
These tracks enable the identification of various types of natural radiation. In addition, physics experiments can be performed with the aid of artificial radiation sources.

3 LAYOUT AND MODE OF OPERATION

The cloud chamber consists of a chamber base and observation chamber. The chamber base holds the refrigeration unit, power supply, alcohol tank, alcohol pump, and timer. The observation chamber is located on top of the chamber base.
The bottom of the observation chamber is a massive, black metal plate (45 cm x 45 cm), which is cooled evenly over the entire surface by the refrigeration unit (approx. −30 °C).
The top plate and the side walls of the observation chamber are formed by two glass covers, one inside the other. Thin heating wires (*17*) between the two upper glass plates heat this area of the chamber and prevent condensation. This grid is also used as a high voltage grid for ion extraction.
The upper part under the glass cover is equipped with an electrically heated channel (*15*) that runs around the entire circumference. Isopropyl alcohol drips into this channel from a bent tube (*14*).
The alcohol evaporates and diffuses from the upper, warmer area of the chamber to the cold chamber bottom. Here, the alcohol vapour condenses and flows back into the storage tank.
A zone of supersaturated alcohol vapour forms above the thin liquid layer that covers the bottom plate. In this area, and only in this area, charged particles of matter, which come from inside or outside the chamber, produce ions along their flight path. Droplets of isopropyl alcohol have a tendency to attach themselves to these ions, thereby producing visible cloud tracks. The length and nature of the particle track enables conclusions to be drawn concerning the type of ionising particle.

Fig. 2: Diffusion cloud chamber (cutaway view)



4 TRANSPORT OF THE UNIT

Attention!

Ensure that the cloud chamber is not tilted during the transport (< 10° referred to the perpendicular). Otherwise, the refrigeration system will be damaged beyond repair.

Do not transport the cloud chamber (e.g. to another location for presentation) when the evaporation channel is filled with alcohol. In order to drain the alcohol from the evaporation channel, the cloud chamber is now equipped with a drain valve. This valve can be actuated by way of an adjusting knob that is located above the knurled nut (*11*) for controlling the alcohol supply. When the drain valve is opened, the alcohol flows back into the alcohol tank (*12*). Close the drain valve after the evaporation channel has been drained.

5 SET-UP OF THE UNIT

In order to ensure a good view of the observation chamber, we recommend placing the unit on a square table with an edge length of 90 to 100 cm. Since the unit weighs 80 kg, the table must have a corresponding load bearing capacity. The table should be approximately 60 cm high.
Ensure that the ventilation slots (*20*) are free and that the unit is not excessively subjected to light from above. A slightly darkened room would be ideal.
Connect the cloud chamber to the power supply by way of the supplied mains power connecting cable. The mains power connector (*1*) is located down at the back of the unit. The corresponding mains power outlet should be protected with 16 A maximum.
Align the cloud chamber horizontally by way of the adjustable feet (*16*) in order to ensure an even alcohol level in the channel (*15*) and, thereby, a clear image.

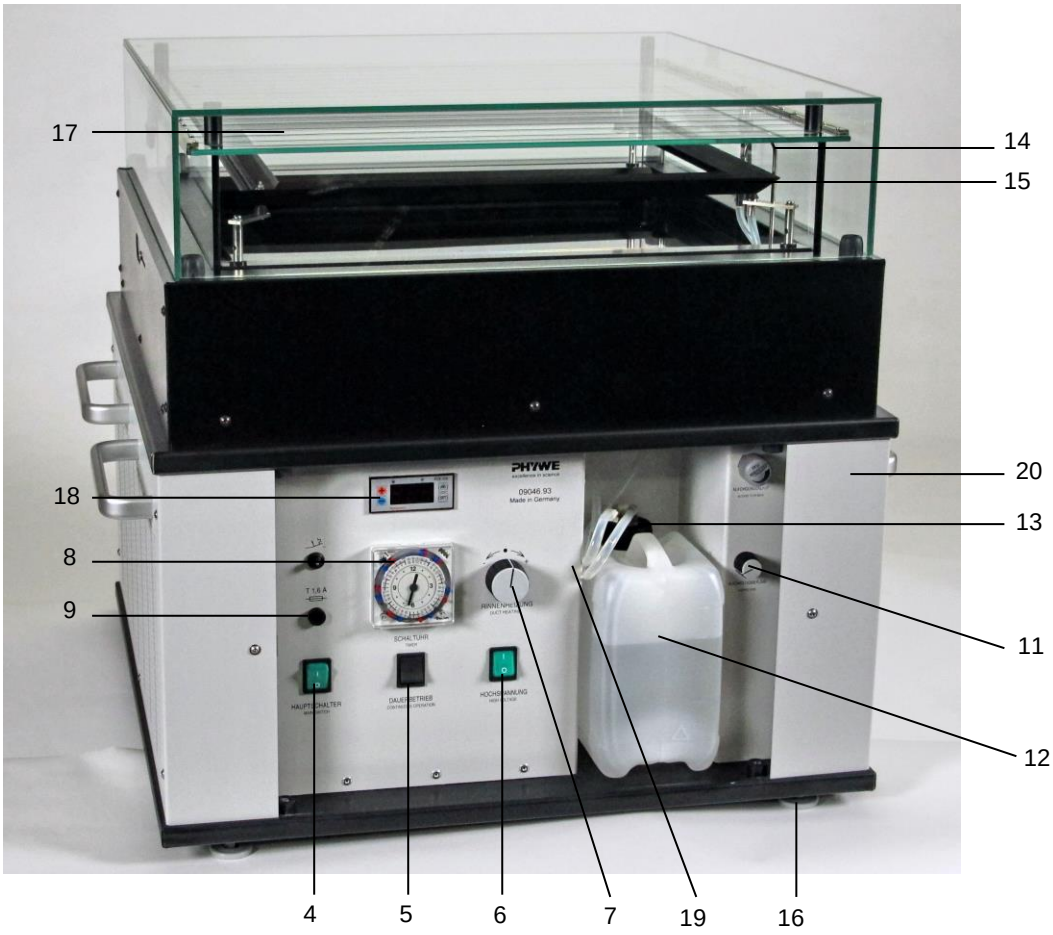


Fig. 3: Front view

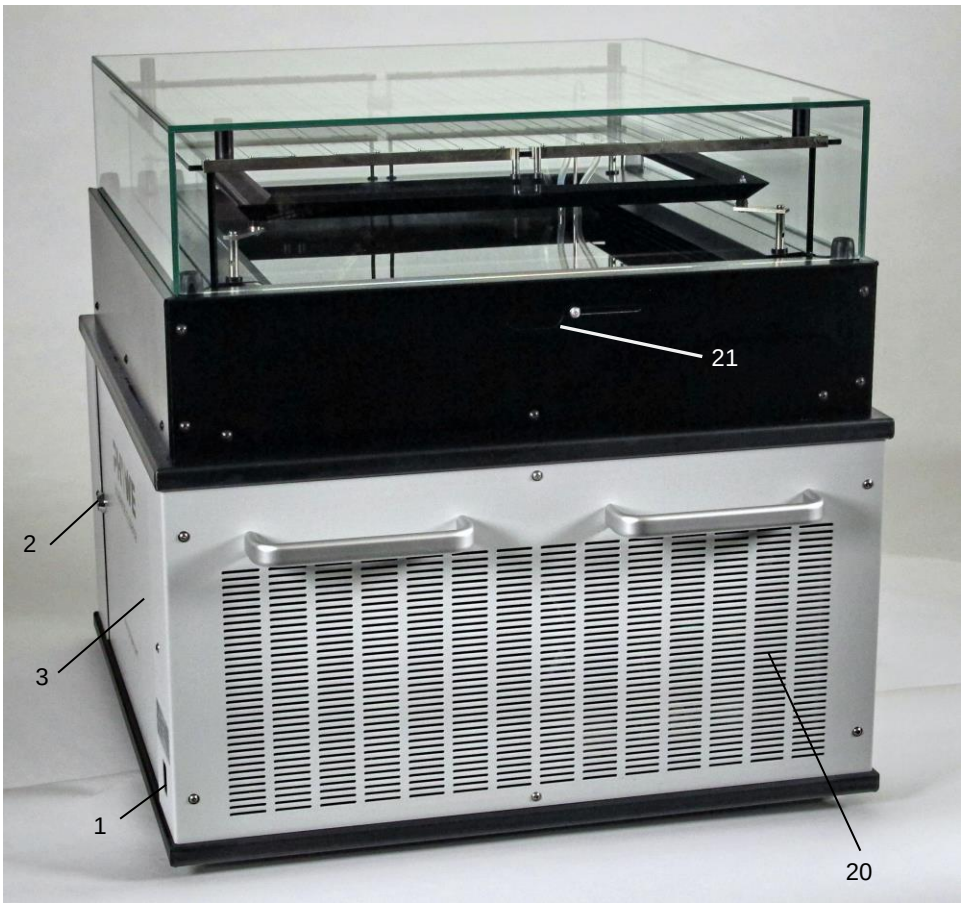


Fig. 4: Rear view

6 START-UP

The chamber base of the unit can be accessed from two sides. In order to open the two sides, unlock the respective lock (*2*), push the side plate with the lock a few centimetres to the right, and lift the plate out towards the front.
At the front, you can now see a control panel with the following components and operating elements:

– Alcohol tank (removable) with a double tube that can be unscrewed and removed (*12*)
– Main switch (*4*)
– Switch "continuous operation – timer" (*5*)
– Switch "high voltage" (*6*)
– Knurled nut for the alcohol supply (*11*)
– Control knob for the channel heater (*7*)
– Timer (*8*)
– Automatic circuit breaker (*9*)
– Thermostat (*18*)
– Filter (*19*)
– Side plate (*20*)

After you have connected the unit to the mains power supply and after you have opened the front, remove the alcohol tank (*12*) from its compartment and unscrew the union nut (*13*) of the double tube.
Fill the alcohol tank by three quarters (see section 7 "Handling instructions for isopropyl alcohol"), reconnect the tubes by way of the union nut, and place the alcohol tank into its compartment.
Then, adjust the switches as follows:

Main switch (*4*):	ON
Mode (*5*):	continuous operation
High Voltage (*6*):	ON

Then, adjust the amount of alcohol that drips into the evaporation channel (*15*) by way of the knurled nut (*11*). Turn the knurled nut to the left and observe the alcohol that flows through the bent tube (*14*) into the channel.
When the channel is filled by approximately 1 cm, reduce the inflow to approximately 6 to 8 drops per second. During the operation of the cloud chamber, the alcohol level in the channel should remain constant.
After approximately 15 minutes, the first white tracks should be visible on the black observation surface.
If, after a runtime of approximately 1 hour, the tracks become slightly milky and fuzzy, you can reduce the channel heater power by way of the control knob (*7*).
If the tracks are too weak, you can increase the heating power.
Optimum operation can only be guaranteed at a humidity of less than 50 %, as reliable visualisation of particle traces is only possible under these conditions.
If you want to run the cloud chamber in automatic mode, set the markers of the timer to the desired daily switching times (red marker for switching the cloud chamber on, blue marker for switching it off) and set the mode switch (5) to "timer". Details concerning the timer can be found in the instruction manual of the timer.

Attention!

Non-stop operation should be limited to exceptional cases.

Now, close the front by inserting the plate (*3*) into the right side of the opening and by pushing it to the left until it reaches the stop. Then, lock it.

The filter *(19)* should be checked for soiling every month. In addition, the side plate *(20)* should be removed once per year in order to clean the heat exchanger.

Attention!

Fig. 5: Opened rear panel with cooling unit

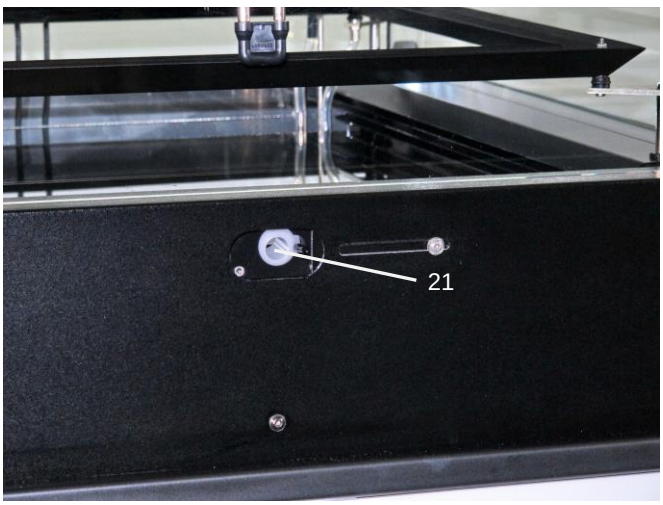


Fig. 6: Insertion for radiation sources

Opening the back panel

Only employees of PHYWE Systeme GmbH & Co. KG or specialised persons who are authorised by PHYWE in writing are authorised to open the back panel. The back panel can be opened and closed in the same manner as the front. When the back panel is opened, you can see the refrigeration unit and the sight glass (*22*) for the refrigerant.

During the operation of the cloud chamber, the sight glass should always be filled with liquid, and there should be no bubbles.

The thermostat is factory-set to the ideal value. In the case of extreme room temperatures, it may be necessary to readjust it slightly (see the table "Using the controller"). **Only employees of PHYWE Systeme GmbH & Co. KG or specialised persons who are authorised by PHYWE in writing are authorised to perform adjustments of the refrigeration unit.**

Artificial sources of radiation

The left side of the chamber base has an opening (*21*) through which artificial sources of radiation can be inserted. The cover plate can be pushed open to the right by way of the screw head. The ball with a pin, which is located behind the plate, can be turned via the pin until the opening to the inside becomes visible.

General information

A: General

In order to avoid deposits or condensation on the inside of the inner glass cover, the chamber should not be disconnected from the power supply nor should it be switched off via the main switch. This ensures that the heating circuit for the glass cover heater remains active even when the chamber itself—controlled by the timer—is inactive at night or over the weekend. This prevents the alcohol from condensing on the inner surface of the glass cover and, thereby, the formation of deposits.

Please read the enclosed thermostat description thoroughly.

Do not let the cloud chamber run 24/7 in order to prevent it from freezing. The night setback ensures an air exchange, thereby increasing the visibility of the α-particles.

B: Maintenance and care

Viewed from the outside, the machine-cooled diffusion cloud chamber has a simple, clear, and robust design. Nevertheless, it is a highly sensitive thermodynamic system that is finely tuned during continuous tests over several weeks before it is handed over to the customer. Its functional components and their interaction are the result of several years of technological development and a high level of experience. This is why only employees of PHYWE Systeme GmbH & Co. KG or specialised persons who are authorised by PHYWE in writing are authorised to manipulate, modify, or repair the unit.

In the event of malfunctions of the refrigeration unit, RAPO with its headquarters in Germany located at Königsstieg 104, 37081 Göttingen (Tel.: +49 (0) 551-64442) can provide information concerning the competent service station. An insufficient supply of fresh air may reduce the cooling power of the refrigeration unit. In order to ensure a sufficient supply of fresh air, ensure that the chamber base is free. In addition, it is important to clean the cooling ribs of the heat exchanger and the air filter every year with the aid of a vacuum cleaner or brush. If it is very dirty, replace the air filter.

The cooling ribs can be cleaned when the left side plate is removed. In the case of a sufficient supply of fresh air, the internal temperature of the chamber should not be higher than 40 °C.

The outer glass cover should also be cleaned from time to time. This can be done with any type of commercially available glass cleaner.

Attention!

Prior to removing the glass covers for cleaning, disconnect the chamber from the mains power supply **(unplug the mains power plug!)**.

Cleaning the outer cover:

The outer glass cover can simply be lifted off for cleaning.

Only employees of PHYWE Systeme GmbH & Co. KG or specialised persons who are authorised by PHYWE in writing are authorised to perform the following tasks:

Cleaning the inner cover:

In order to clean the inner glass cover, proceed as follows:

- *Lift the outer cover off.*
- *Remove the spacer bolts between the outer and inner cover.*
- *Disconnect the connector for the cover heater by puling it downwards.*
- *Unscrew four black side plates with the aid of the supplied screwdriver.*
- *Disconnect the flat connector for the glass plate heater (on the side where the sources of radiation are inserted).*
- *Remove the inner cover.*

Removing and reinstalling the heating wires:

- *Disconnect the connector between the two heating segments.*
- *For the linear expansion of the heating wires, which are under mechanical tension, heat the two heating wire segments electrically one after the other with an external source of current with 4.5 V/12 A. After the heating wires have been slightly expanded in this way, pull the pair of rails of one of the heating segments carefully off the cover plate of the glass cover. Remove the flat springs between the rails and the glass plate.*
- *In order to reinstall the heating segments, push the rails that hold the heating segments back onto the glass plate. Then, expand the wires of the heating segments once again by way of an external voltage source (see above) so that the flat springs, which are required for maintaining the necessary mechanical tension of the heating wires, can be pushed back in place between the rails and the glass plate.*

Attention!

Because of the unavoidable dimensional tolerances of the glass cover plate, it is very important to ensure that each of the two heating circuits is reinstalled in its original position.

Assembly

After the glass covers have been cleaned, reassemble them in reverse order.

C: Lamp replacement

Attention!

Disconnect the chamber from the power supply **(unplug the mains power plug!)** prior to replacing a lamp. Remove the front and back panels by way of the supplied screwdriver. After the lamp replacement, ensure that the protective earth conductor is properly connected when reinstalling the housing panels.

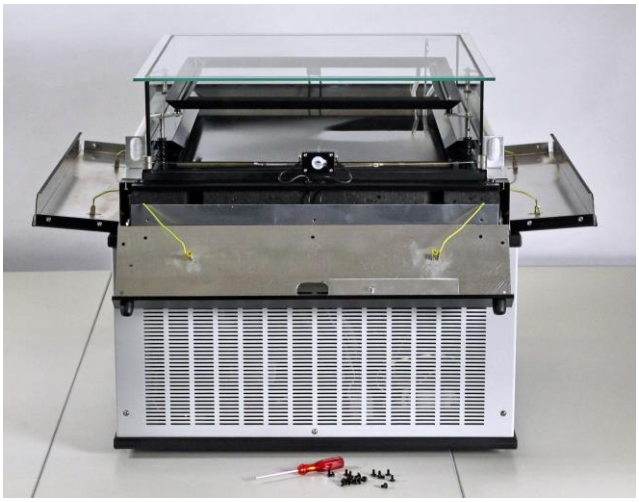


Fig. 7: Lamp change with opened cover plate

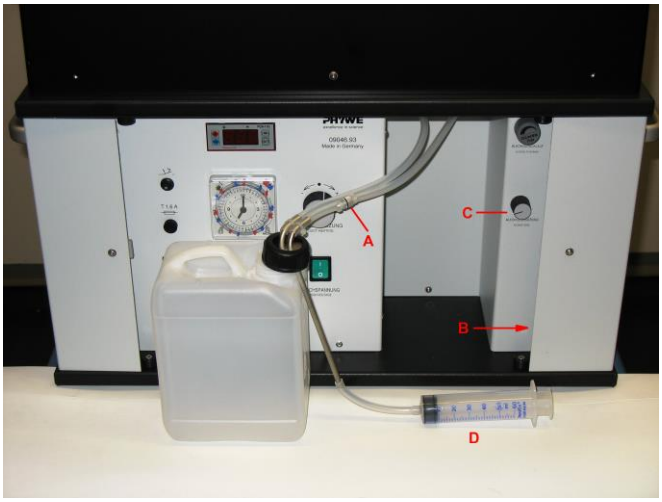


Fig. 8: Manually filling the pump

D: Alcohol consumption
The cloud chamber has a very low alcohol consumption. However, the dripping rate should be checked regularly, in particular if the cloud chamber is permanently in operation or if it is used continuously based on a week programme.
Ensure to use only isopropyl alcohol (PHYWE ref. no. 30092-70) when topping up. The alcohol must have a high level of purity (99% minimum).

E: Start-up after a longer downtime
If the alcohol pump should not pump anymore after a longer downtime, do as follows (see Fig. 8):
Check the filter (**A**) for contamination and clean it if necessary.

Attention!

Reinsert the filter sieve.
If the filter cannot be cleaned, it has to be replaced: *Filter sieve, fine, for alu fuel filter* (PHYWE order no. 171057).

Take out the disposable syringe (**D**) of the cavity behind the plate (**B**) and fill it with clean isopropyl alcohol. Then, remove the extraction probe from the tank. Connect the hose of the disposable syringe to the suction side of the extraction probe. Use the controller knob (**C**) to set the pump to maximum. With the aid of the disposable syringe, squeeze the isopropyl alcohol under moderate pressure into the line. The liquid should ascend visibly to the pump.
In case of any troubles during the filling, abort the process!
Do not excessively increase the pressure with the disposable syringe; otherwise the hoses will get leaky.

As soon as the pump starts to suck, and the isopropyl alcohol reaches the outlet in the chamber, turn the controller knob (**C**) to minimum.

Remove the disposable syringe and reinsert the extraction probe in the tank. Afterwards, the controller knob (**C**) can be set to the regular dripping speed.

7 POTENTIAL MALFUNCTIONS

Failure	potential cause	Solution
The cloud chamber cannot be started	No power	Activate the power supply.
	Main switch off	Set the main switch to “on”.
	Timer off	Set the timer or set the system to “manual“.
	Alcohol pump does not pump	See “6 E: Start-up after a longer downtime”
No visible tracks or clouds	No isopropyl alcohol in the channel	Open the alcohol supply, fill the channel, then reduce the alcohol supply until an even dripping rate is established.
	The channel is filled with isopropyl alcohol	Check the channel heater and refrigeration unit (approx. −32 °C).
Alcohol pump does not convey isopropyl alcohol to the channel	Cloud chamber has not been used for a longer period	Perform the steps listed in 6 E “Start-up after a longer downtime”.
Strong operating noise of the alcohol pump (clacking)	No isopropyl alcohol in the tank	Fill the tank with isopropyl alcohol.
Fuzzy tracks	No high voltage	Check the high voltage.
The refrigeration unit runs for a	Very high room temperature	Ensure the supply of fresh air. Clean the ventilation sys-

very long time or even non-stop	Aeration blocked	tem. If these measures have no effect, i.e. if the chamber still does not run normally, consult a refrigeration/heating/air-conditioning specialist.
Excessive isopropyl alcohol consumption	Chamber leaking	Check the seal under the inner glass cover. Check the chamber for signs of leaking isopropyl alcohol. If you notice dripping or if the tubes are leaking, shut the cloud chamber down. Leaking isopropyl alcohol presents a fire hazard. If the leaks cannot be remedied, the cloud chamber **must be repaired by employees of PHYWE Systeme GmbH & Co. KG or by specialised persons who are authorised in writing by PHYWE.**

8 HANDLING INSTRUCTIONS FOR ISOPROPYL ALCOHOL

The handling of isopropyl alcohol (2-Propanol, Isopropanol, Propan-2-ol) is subject to the same hazard control rules that also apply to the handling of other chemicals, reagents, and dye solutions. It is clear that these types of substances must be handled with great caution and care so that neither the students and teachers nor other persons are exposed to unnecessary health hazards.
This is why the instructions on the relevant safety data sheets (in accordance with the REACH Regulation (EC) No 1907/2006) in their latest edition, the applicable accident prevention regulations, and workplace-related operating instructions must be complied with when handling isopropyl alcohol.
Some of the most important handling rules and general rules of conduct are stated below without any claim to completeness:

Isopropyl alcohol is a clear, highly flammable, and slightly oily liquid with an odour that is reminiscent of a mixture of ethanol and acetone. It is readily mixable with water and most organic solvents. Isopropyl alcohol vapours can form explosive mixtures with air.

Signal word
DANGER

Hazard information
H225: Highly flammable liquid and vapour.
H319: Causes serious eye irritation.
H336: May cause drowsiness or dizziness.

Safety information
P210: Keep away from heat/sparks/open flames/hot surfaces. No smoking.
P233: Keep container tightly closed.
P305 + P351 + P338:
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.
P501: Dispose of contents/container to a recognised waste management facility.

First aid
If inhaled:
Fresh air. If you feel unwell, seek medical advice.
After skin contact:
Rinse with plenty of water. Take off all contaminated clothing.
After contact with the eyes:
Rinse the eyes with the lid gap wide open (10 minutes minimum). Consult an ophthalmologist.
If swallowed:
Make the victim drink plenty of water; avoid vomiting (risk of perforation!). Seek medical advice immediately. In the case of spontaneous vomiting, risk of aspiration. Respiratory failure possible.

Disposal
Recommendation:
Must not be disposed of with normal household waste. Do not empty into drains.
Liquid residues must be recycled or taken to a suitable waste incineration plant.
Chemicals must be disposed of in compliance with the respective national regulations. You can find country- and substance-specific information and contact data at www.retrologistik.de.
Uncleaned packaging:
Recommendation: To be disposed of in accordance with the official local regulations.

9 TECHNICAL DATA

Active layer	45 cm x 45 cm x approx. 1 cm
Chamber (w x d x h)	64 cm x 64 cm x 60 cm
Working liquid	isopropyl alcohol, extra pure (2-Propanol)
Tank volume	2 litres
Illumination	integrated fluorescent lamps
Timer	7 x 24 hours (week programme)

Mains power supply
The unit is a class I unit and it may only be connected to power sockets with a protective earth conductor (PE).

Connection voltage	see the type plate (+6 %/−10 %)
Mains frequency	50/60 Hz
Power consumption	900 VA
Fuses	see the label
Weight	80 kg

10 CLOUD CHAMBER AND ACCESSORIES

Diffusion cloud chamber PJ45/1	09046-93
Isopropyl alcohol, extra pure, 1000 ml	30092-70

Subject to technical changes.

11 DISPOSAL

The packaging mainly consists of environmentally-friendly materials that should be returned to the local recycling stations.

Do not dispose of this product with normal household waste. If this unit needs to be disposed of, please return it to the address that is stated below for proper disposal.

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