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FINECAUSE ENTERPRISE COMPANY LIMITED

Atmospheric Plasma Surface Treatment Machine

User's Guide

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A. Warning:

- Before starting this machine, it needs to be reliably grounded, externally connected to a stable air pressure source, and confirmed that the air source is free of oil and water.
- Please read this instruction carefully before installing, operating, or debugging this device.
- The operating environment, power level, working duration, and air quality may all have varying impacts on the gun barrel.

  Although the barrel is designed with a heat dissipation function, **it must not operate continuously under high temperatures**.

  Prolonged high-power operation can cause the gun barrel and motor body to overheat, so it is necessary to schedule regular shutdowns for cooling.

  Generally, when operating at maximum power, continuous use should not exceed 4 hours. However, adjustments should still be made based on actual conditions.

  If discoloration of the gun barrel is observed, the device should be shut down immediately to cool down. For future operations, the working time should be reduced accordingly.

  Note: A discolored barrel may continue to be used.
- During operating, users are advised to wear insulated gloves. If handlining with conductive products, it is mandatory to wear insulated gloves and place insulating material under the product as a barrier.

B. Introduction to Plasma 3D Surface Treatment Technology:

The energy of particles in low-temperature plasma is generally about several to more than ten Electronvolt, which is greater than the bonding energy of polymer materials (several to more than ten Electronvolt), which can completely break the Chemical bond of organic macromolecules to form new bonds; but far lower than high-energy radioactive rays, it only involves the surface of the material and does not affect the performance of the matrix. In the low-temperature plasma in the state of non-Thermodynamic equilibrium, electrons have high energy, can break the Chemical bond of molecules on the surface of materials, improve the chemical reaction activity of particles (greater than that of thermal plasma), and the temperature of neutral particles is close to room temperature. These advantages provide suitable conditions for the surface modification of thermosensitive polymer. Through low-temperature plasma surface treatment, the material surface undergoes various physical and chemical changes, or undergoes etching and roughness, or forms a dense cross-linked layer, or introduces oxygen-containing polar groups, resulting in improved hydrophilicity, adhesion, dyeability, biocompatibility, and electrical properties. The surface of the material is treated under the appropriate process conditions, so that the surface Morphogenesis of the material has changed significantly. A variety of oxygen containing groups have been introduced, which makes the surface change from non-polar, hard sticky to polar, easy sticky and hydrophilic, which is conducive to bonding, coating and printing.

Plasma has the following major effects on material surface treatment:

- Activation: Significantly improves the wetting performance of the surface, forming an active surface;
- Cleaning: Remove dust and oil stains, finely clean and remove static electricity;
- Coating: Provide a functional surface through surface coating treatment; Improve the adhesion ability of the surface, improve the reliability and durability of surface bonding.

After using atmospheric pressure plasma technology for treatment, surface energy can be improved for various materials such as polymer plastics, ceramics, glass, PVC, paper, or metals. Through this treatment process, the improvement and enhancement of surface tension characteristics of product materials can be more suitable for industrial coating, bonding and other treatment requirements.

For example, in electronic products, the coating treatment of LCD screens, the surface spray screen printing of structural components such as casings and buttons, the cleaning of PCB surfaces by removing glue and dirt, the treatment before adhesive bonding of lenses, the treatment before wire and cable coding, etc. Treatment before pasting the lampshade, brake pad, and door sealing strip of automotive industrial vehicles; fine harmless cleaning treatment for metal components in the mechanical industry, treatment before mirror coating, and treatment before sealing between various industrial materials, etc. The treatment before gluing the edge sealing position in printing, packaging, and box pasting machinery, etc. In the medical device industry, the treatment before adhesive bonding between needles and plastic catheters, etc.

The best solution for modifying the surface of three-dimensional objects is to use low-temperature plasma flow treatment technology. The principle is shown in Figure 1.1. Apply AC high-frequency high voltage to both ends of the electrode, causing the air between the two electrodes to generate a gas arc discharge and form a plasma zone. Plasma arrives under the blowing of airflow the purpose of modifying the 3D surface by processing the surface of the object.

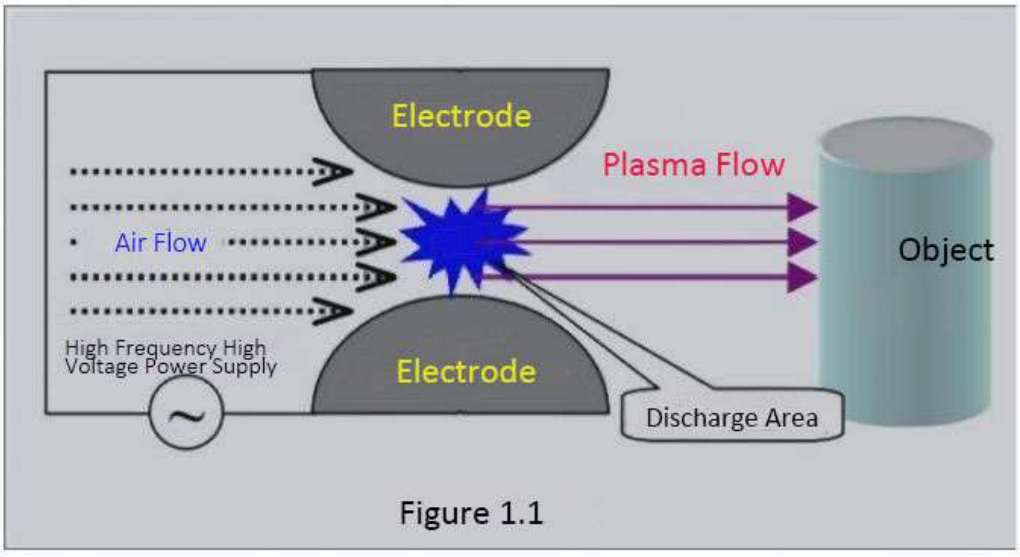


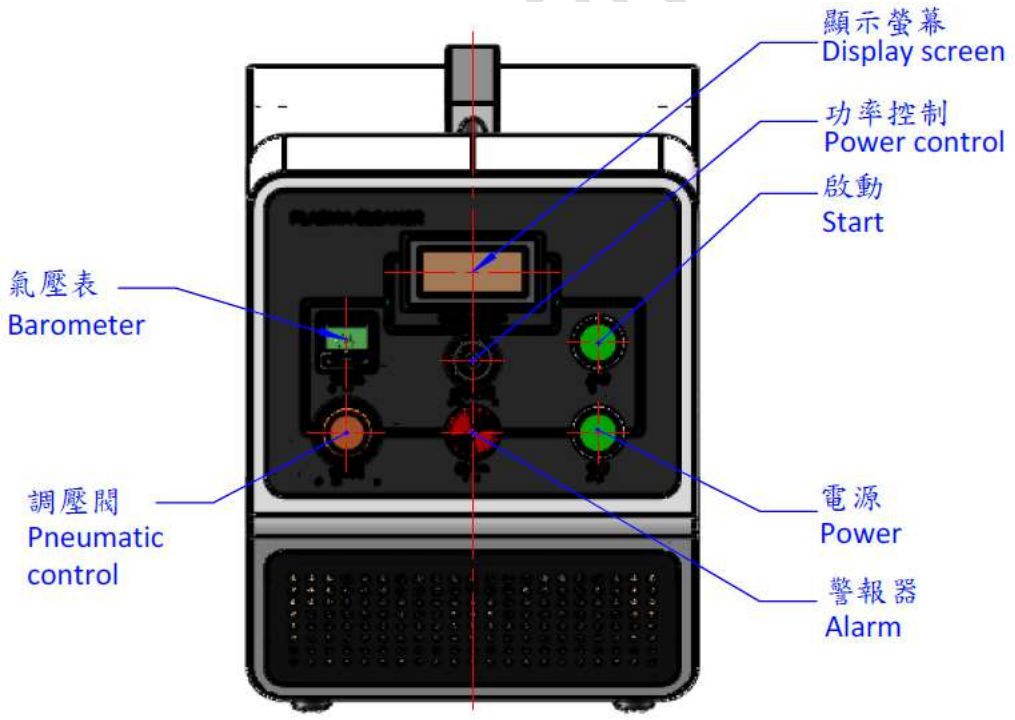
Figure 1.1

C. Specifications:

Supply Voltage	220(±10%) VAC,50/60Hz
Power Input Fuse	10A/250V
Operating Frequency	18KHz ~ 60KHz
Working High Voltage	2KV ~ 10KV
Maximum Practical Output Power	1000W (Based on actual situation)
Working Pressure Range	About 0.2MPa ~ 0.3MPa(2Kg ~ 3Kg)
Air Source Requirements	≥0.3Mpa(3Kg), <1MPa (10Kg), Oil free and water free
Host Size	580*260*320mm
Rotating Gun Nozzle Diameter	Ø30mm ~ 100mm (The nozzle comes with a choice of Ø50mm, 70mm, 80mm, or 100mm)
Weight	15kg

D. External structure and description of the host:

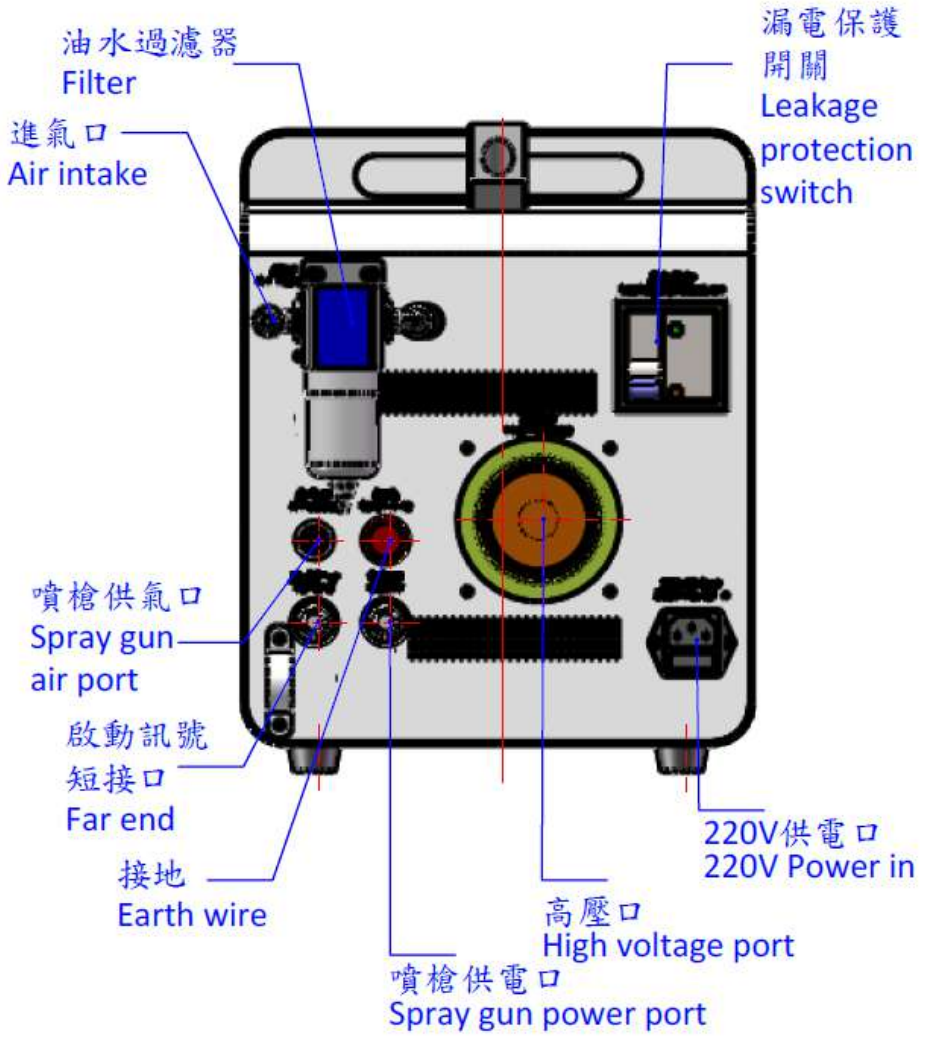
- Equipment structure (Front side)



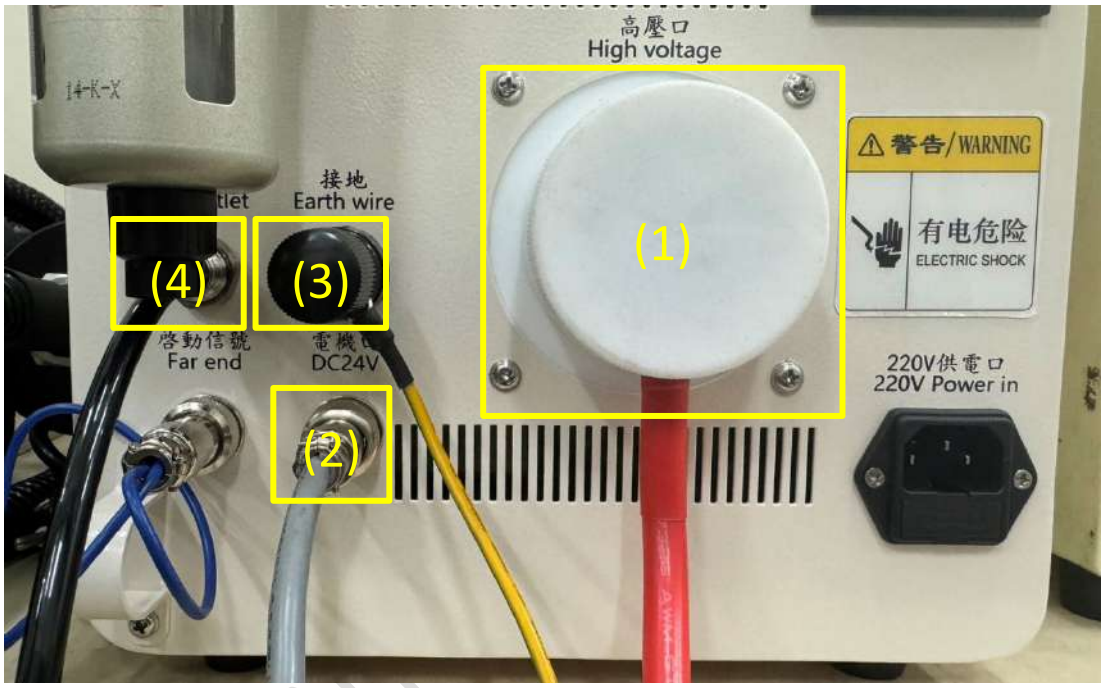
1. Alarm: If the air pressure does not reach 0.05Mpa, the air pressure is over 0.3MPa, the working current is too high, and the temperature is too high, an alarm sound will be emitted.
2. Power: This is the main switch of the equipment; when the switch is in a raised and no light state, the host is in a power off state, and when the switch is in a light state, the host is in a power on state. Lock the air pressure regulating valve.

3. Start: After the device power switch is turned on, the nozzle will be in standby mode for spraying plasma. Press the start button to start the spraying work.
4. Barometer: After the power switch is turned on, the gas display screen displays the current working air pressure value.
5. Pneumatic control: Adjust the knob clockwise to increase the air pressure and counterclockwise to decrease it (it is more commonly used to adjust the working air pressure to between 40KPA and 60KPA).
6. Display screen: Display device, displaying the operating status of the device, providing power supply voltage, current, real-time power, and cumulative energy usage. (About 10W in standby mode.)
7. Power control: Users can adjust the power through the potentiometer knob to get the appropriate power. (Slight adjustment, do not use excessive force to avoid damaging the potentiometer.)

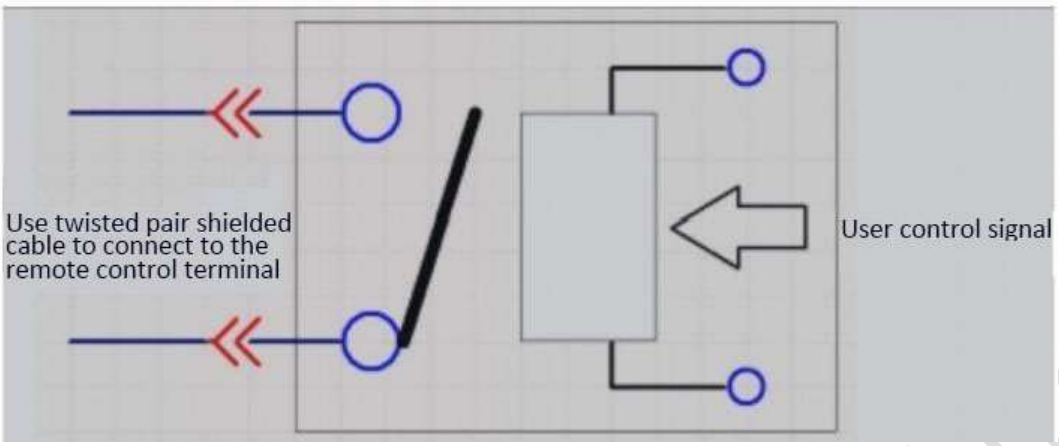
- Equipment structure (Back side)



1. Link gun head: Need to connect the (1) high voltage port, (2) spray gun power port, (3) earth wire, and (4) spray gun air port. Each one cannot be missing.
   (Generally, the factory will connect it properly. If it falls off or is unplugged, please install it under technical guidance. It must be powered off for operation. There is high voltage here and be careful of safety.)
   - The following is a picture of the gun head cable connect to equipment:



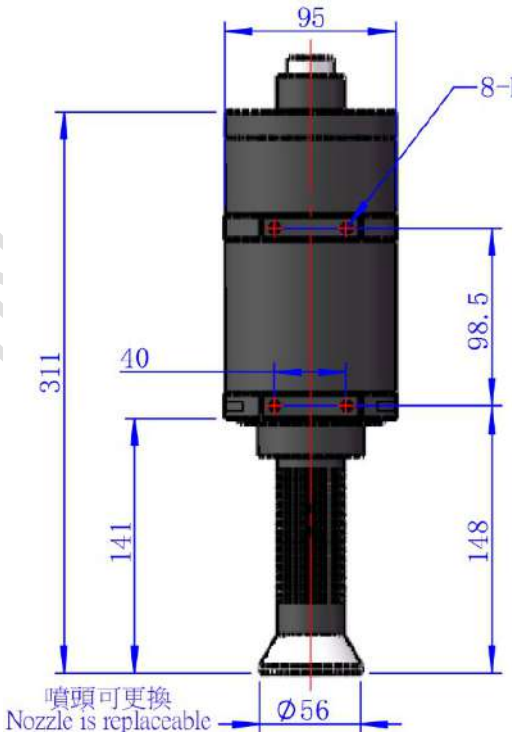
2. Leakage protection switch: If the input current is too high, or when the voltage is unstable, the device will automatically power off for protection, and wait for the voltage to stabilize, switch on again.
3. The required range of air source pressure: ≥ 0.3MPa. If the air source pressure exceeds 1MPa 10Kg, an external pressure limiting valve needs to be installed. The air source can use ordinary air.
   When required by special process technology, nitrogen or other specific gases can be used. If there is no compressed air or the pressure is below 0.05 MPa 0.5Kg, the machine will automatically stop working and give an alarm.
   Warning: The requirement must be no oil, no water source.
4. Earth wire: When connecting the ground wire of the host, the power must be cut off during operation. When installing, unscrew the nut, press on the ground wire, and tighten the nut.
5. Far end: The upper computer is used to control the interface of plasma equipment, and the control line uses twisted pair shielded wire. Passive connection must be used for connection.



6. Power in port: Single phase 220VAC power input

Warning: The supporting power supply must use single-phase three wire, which must ensure a reliable grounding wire connection. (It is not possible to simply use other machine equipment casings as ground wires. Without a reliable ground wire connection, it may cause damage to the equipment or electric shock to personnel.)

- Introduction of plasma spray gun



＊ The spray gun size is for reference only. Actual assembly dimensions may vary slightly.

The plasma spray gun is an important component of the atmospheric pressure plasma jet formed.

The surface of the processed material usually passes through the plasma jet zone between 5 and 15mm from the plasma nozzle.

When working, the plasma spray gun will generate a certain temperature. When installing the plasma spray gun, it can be combined with a metal bracket as much as possible to facilitate heat dissipation. The processed materials and items generally pass through the plasma nozzle in a mobile form.

Warning: During work, the materials and items being processed must not be left in the plasma jet area for a long time to avoid high temperature damage or potential combustion hazards! During operation, it is important to prevent human hands from touching and causing burns!

Warning: There is high voltage inside the plasma gun and its cables. Be careful to prevent accidental damage and electric shock danger! Before opening the chassis casing, it must be cut off!

Pay attention to the ceramic material inside the plasma gun, and avoid damage caused by impact during movement, installation, and use. After long-term use, there will be some accumulation of dirt in the plasma gun body, which requires regular maintenance and cleaning, and timely replacement of worn parts.

E. Equipment installation:

1. Prepare a 10A three hole power socket and connect it to the power input socket of the host using the power cord provided with the equipment.
2. A standardized grounding wire connected to the grounding terminal at the rear of the host; this is very important.
3. A stable air source of no less than 3Kg (recommended to be greater than 5Kg) without oil and water, connected to the compressed air input interface of the host.
4. Choose a ventilated place to place the host and ensure its heat dissipation.
5. Fix the plasma spray gun/rotating gun according to the position of the target being processed.
6. Carefully read the user manual, determine the control method, and prepare external control cables according to the requirements of the manual. Connect the control cables to the corresponding control input ports at the back of the host.

F. Equipment operation:

1. Preparation:

   Please refer to the 4th chapter of this manual and make necessary connections according to actual needs.

   Attention: Before connecting to the power supply, please ensure that the power switch remains in the off state; and point the plasma spray gun to a safe position.

2. Equipment self-inspection:

   Turn on the power switch, and the device enters a self-check state. The LCD display screen displays the system power on self-test interface, and the system self-test time is approximately 3 seconds.

3. Operate:

   Turn on the power switch and confirm that the pressure is displayed between 0.2MPa and 0.3MPa. If you need to start locally, you can directly press the start button. If you need to connect the control line remotely, you can directly start the upper computer.

G. Fault diagnosis:

During the operation of the system, if fault information is detected, the system will stop working. common faults include the following:

1. No plasma spraying or failure to spray during spraying.
   - Air pressure failure: Air source pressure or significant fluctuations in the air source result in non-spraying or uneven ion spraying during spraying.

     Countermeasures: Check the air source and input the air pressure to ensure it meet the equipment requirements; adjust the air pressure knob, observe if there is any change in the display of the air pressure gauge, and check the air circuit such as the solenoid valve.
   - The plasma ejected is abnormal, and in severe cases, there is no plasma output.

     Countermeasure: The spray gun components are routine maintenance components and should be inspected regularly. Long term use, especially continuous use, can easily cause erosion of high-voltage electrodes, resulting in abnormal jet flow, and in severe cases, no jet output. High voltage electrodes are consumables and require regular inspection. In case of severe wear and tear, they should be replaced in a timely manner.
2. Stop spraying plasma
   - Power supply undervoltage (low 198V).

     Countermeasure: Check the input AC voltage.
   - System overvoltage. (above 255V)

     Countermeasure for power overvoltage: Check the input AC voltage.

- High voltage output open circuit.
  Countermeasure: Check if there is an open circuit in the high-voltage electrode connection between the high-voltage output and the interior of the spray gun; check the connection of the high-voltage detection line; check if the set power matches the air pressure, and if there are situations of low power or excessive air pressure.
- High voltage output short circuit.
  Countermeasure: Check if there is a short circuit in the high-voltage electrode connection between the high-voltage output and the interior of the spray gun; check the connection of the high-voltage detection line; check whether the set power matches the air pressure, and whether there are situations of high power and low air pressure.

3. No power display fault:
   - When starting up, the fuse is burnt out, and the front switch trips. The power component is faulty when turning on the power switch, the fuse is burnt out, or the front switch trips.
     Countermeasure: Check if the IGBT tube on the main radiator is damaged or if the transformer coil is broken, and replace the damaged IGBT.

H. Safety regulations:

In order to ensure the safety of operators and avoid harm to the plasma machine control system and the environment, it is necessary to strictly comply with the safety precautions described in this section and subsequent chapters whenever starting plasma mechanical equipment.

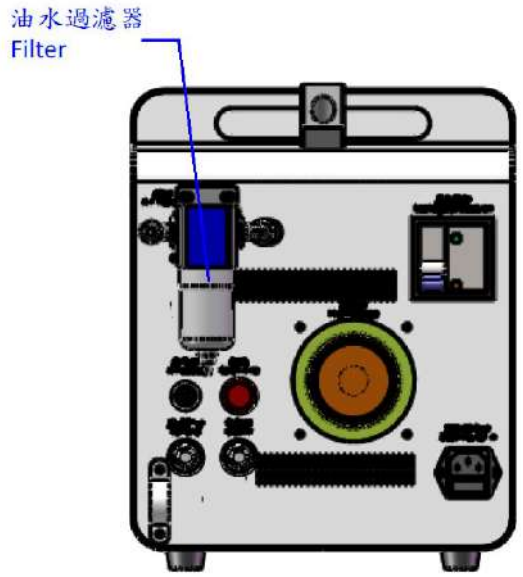
Please note that there is high-frequency and high voltage inside the plasma system. Please do not open the back cover of the chassis during machine operation for debugging and maintenance. Please do not touch the plasma flame with your hands to avoid being electrocuted or burned.

When the plasma machine is moving and running, it is strictly prohibited to put your body and other objects into the protective case to avoid unnecessary losses.

I. Maintenance and consumables instructions:

- Filter:

  It needs to be checked regularly. If the water is almost full, please pour it out.



- Inner wall of the spray gun:

  The inner wall of the spray gun will carbonize over time. A sandpaper can be used to grind the inner wall.

- Consumables:

  The electrodes and gun nozzles are consumables and need to be checked regularly. The usage environment and duration of use will affect the lifespan. Generally, they can be used for 8 to 12 months under normal use. If the wear and tear is serious, they need to be replaced in time.

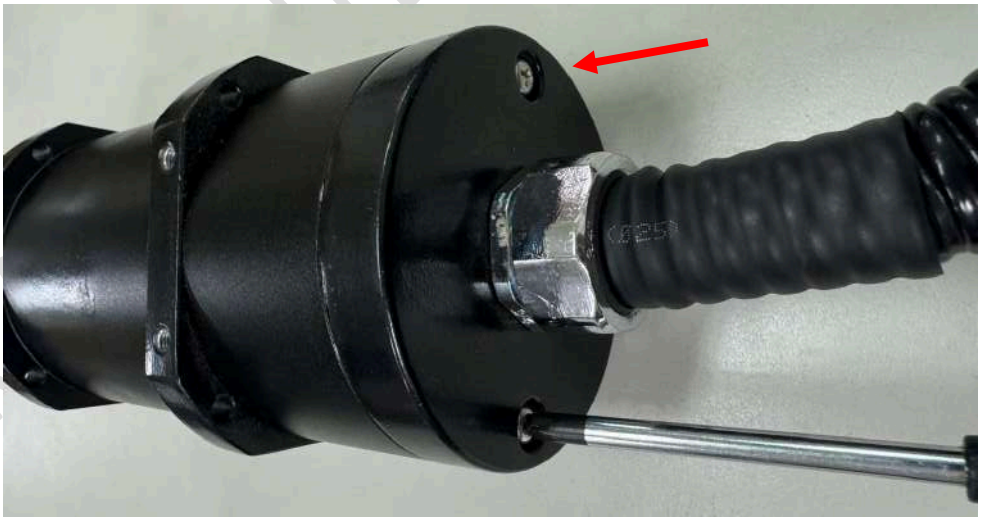
  - When the effect of plasma with the same parameters weakens and cannot reach the original effect, it is necessary to replace the electrode or try to increase the power. It is recommended that users record not only the machine purchase date, but also the

parameters of each plasma treatment; then after half a year of use, users should do first article inspection during each times operation to confirm if the adhesion meets the requirements. If not, increase the power to see the effect. If it still fails, it can be determined that the plasma effect has weakened and new electrode needs to be replaced.

- Electrode replacement method:

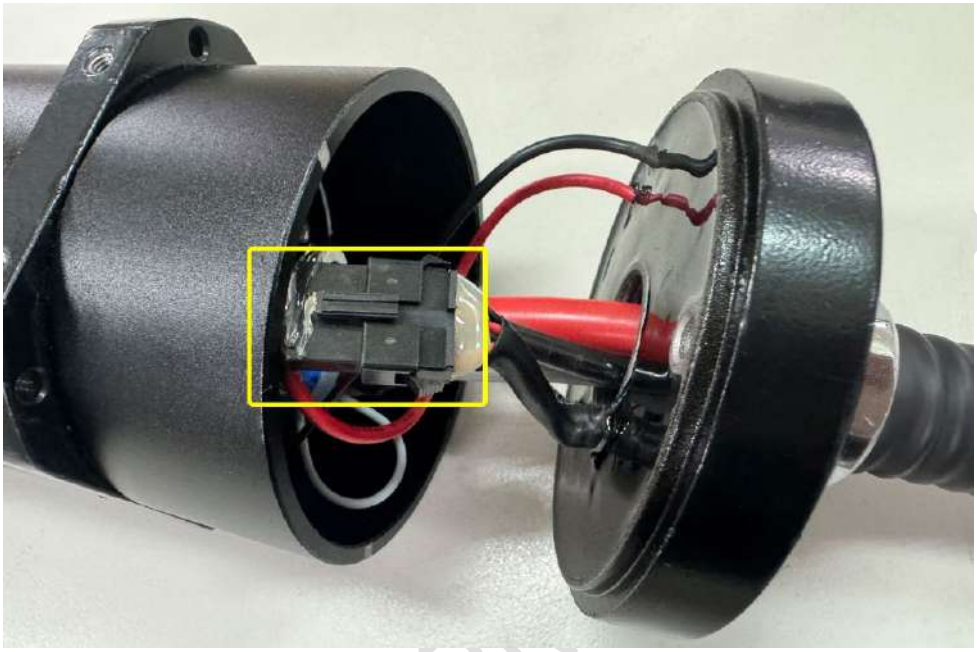
(1) Remove the nozzle from the spray gun.

(2) Remove the 2 long screws at the rear end of the spray gun.



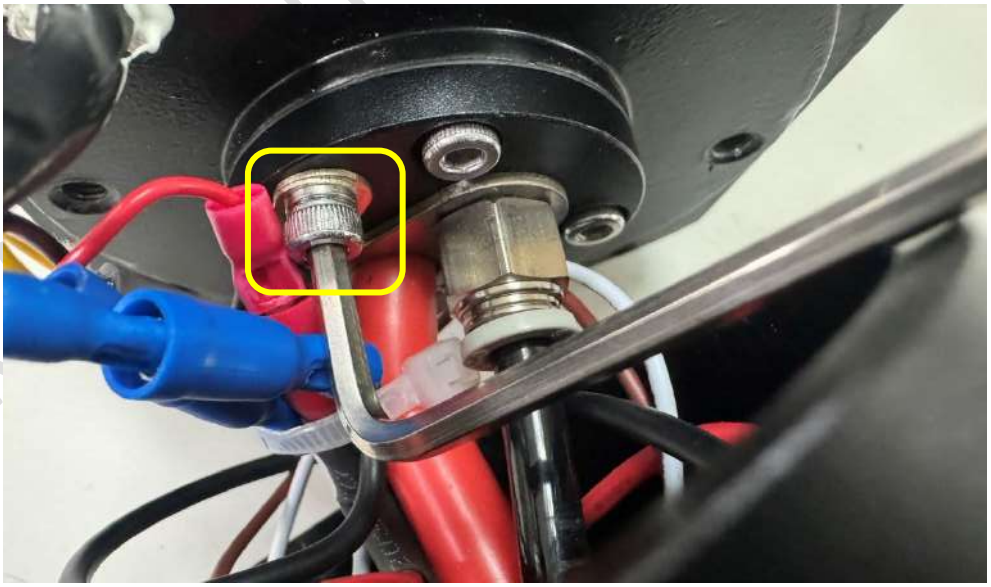
(3) Disassemble the 6-pin connector.

Note: When reassembling, be sure to align the pins and holes properly; do not insert them incorrectly.

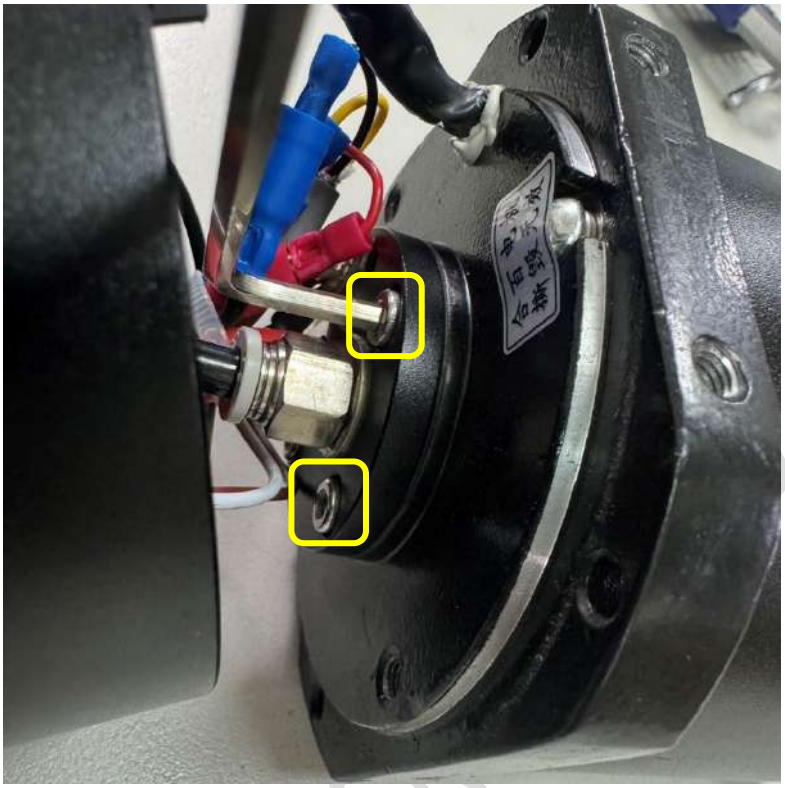


(4) Remove the screw for ground.

Note: When reassembling, be sure to tighten the screws to ensure sufficient ground wire contact.



(5) After removing the 4 screws from the electrical tube, pull the electrical tube and wires out from the back together.



After pulling it out, it appears as follows:

(6) Loosen the screw on the electrode, turn the electrode counterclockwise to remove it from the ceramic thread, and after replacing it with a new electrode, tighten the screw to ensure proper contact.