EVAPORADOR

AUTO 306 Vacuum Coater
With Diffusion Pumping
System

Installation and Operation Manual

EDWARDS

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EDWARDS

INSTRUCTION
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MASTER PASSWORD

The master password for the controller fitted in this unit is:

3 9 2 7

This password enables operator access to all levels of menu operation, including the setting of lower level passwords.

Please remove this page and store it in a safe location if you do not wish your operators to have access to the set points and manual control which can be hazardous if used incorrectly.

SAFETY PRECAUTIONS

General Notes on Safety Precautions

Throughout this manual a policy of highlighting special safety precautions has been adopted in the form of WARNING and CAUTION notes, which must be observed during installation, operation and servicing of the equipment.

WARNINGS

Are given when failure to observe the instruction could result in injury or death to personnel.

CAUTIONS

Are given where failure to observe the instruction could result in damage to the equipment.

List of Warnings and Cautions

The following list of warnings and cautions are extracts from the main text of the manual and are highlighted here to bring them to the reader's attention.

List of Warnings

WARNING

The unit is not fitted with facilities for crane lifting and should be carried to its installation location on a pallet.

WARNING

Always replace the earth wires (removed in step 2) when re-assembling the covers.

WARNING

All electrical work performed on this unit must be carried out by a qualified electrician.

WARNING

Rotary pump exhaust fumes can be dangerous if hazardous materials are being processed. Ensure that the rotary pump exhaust is discharged to a well ventilated area outside of the building.

WARNING

High voltages may be generated within the auto 306. Switch off and disconnect the electrical supply before fitting accessories. Electrical connections to components should be performed by a qualified electrician.

WARNING

Surfaces within the auto 306 can exhibit extremes of temperature. Ensure that adequate precautions are taken to avoid touching hot or cold surfaces such as the diffusion pump body, source holders, targets and components associated with Plasmaglo and other HT discharge processes.

WARNING

Use only liquid nitrogen for filling the trap, other liquid gasses are not suitable. Read the safety instructions for the handling and use of liquid nitrogen (Publication No. K100-00-88) before proceeding.

WARNING

Ensure that any pressurised gas supply connected to the vacuum coater is adequately pressure regulated (0.1 bar max.) and vented.

WARNING

An implosion guard must be used when a glass process chamber is employed (see Publication No. 11-E090-27-880 supplied with this manual).

WARNING

Overriding the software that is pre-programmed into the Controller can cause hazardous high vacuum valve closure.

WARNING

Intense light can be emitted from evaporation sources or ion gauges. Always use dark safety glasses when viewing hot sources.

WARNING

Surfaces within the auto 306 can exhibit extremes of temperature. Ensure that adequate precautions are taken to avoid touching hot or cold surfaces such as the diffusion pump body, source holders, targets and components associated with Plasmaglo and other HT discharge processes.

WARNING

High voltages may be generated within the auto 306. Switch off and disconnect the electrical supply before fitting accessories. Electrical connections to components should be performed by a qualified electrician.

WARNING

Ensure that the unit is electrically isolated before commencing maintenance work. All electrical maintenance must be performed by a competent electrician

WARNING

Adequate precautions should be taken when cleaning the work chamber if dangerous substances have been processed. Ensure that suitable protective clothing is worn including gloves and goggles.

WARNING

Alcohol based solvents are highly flammable, avoid contact with the skin. Smoking must be prohibited.

WARNING

Ensure that the HT and LT supplies are switched off during the valve adjustment procedure.

WARNING

This procedure must be performed by a qualified electrician

List of Cautions

CAUTION

Follow the Controller operation procedure carefully to avoid incorrect operation which could damage the coater.

CAUTION

Do not use excessive force to close the needle valve

CAUTION

Surfaces within the coater may remain cold for several hours due to the liquid nitrogen that is present in the trap.

CAUTION

Do not wipe the 'L' section gasket around the chamber with an organic solvent. Use only dry, lint-free cloth or paper tissue.

CAUTION

Do not use wire wool to clean accessories as the fine wires break away and can cause damage to 'O' rings and the seal on the high vacuum valve.

Contents

List of Illustrations

List of Associated Publications

Publication Number	Title
05-B304-09-880	EO2K, EO4/160K and EO6K Diffusion Pump Manual
03-A360-01-882	E2M8 Rotary Pump Manual
08-C311-07-881	PVEK Series, Solenoid Operated Pipeline Valves
04-A133-05-882	Foreline Trap
11-E090-27-880	Safety Operating Instructions for Glass Bell Jars and Cylinders
07-D024-22-883	Pirani Gauge Heads
07-D145-37-882	Penning Gauge Head
K100-00-88	Instructions for the Use and Handling of Liquid Nitrogen
17-D154-31-895	Mass Spectrometer Leak Detectors
04-A462-20-880	EMF Filters
21-E100-00-880	Vacuum Leadthroughs

1 INTRODUCTION

1.1 Scope of Manual

This manual has been produced to provide installation, operation and maintenance instructions for the Edwards AUTO 306 vacuum coater. Instructions for installing and operating the range of accessories that are available for use with this unit are given in the working instructions supplied with the accessory.

1.2 General Description

The AUTO 306 is a microprocessor controlled vacuum coater that can be configured to perform a variety of coating tasks. The flexibility is achieved by adding a wide range of functional accessories to a standard base unit, the main elements of which comprise the following:

- A vacuum pumping system
- A microprocessor control system and control panel
- A baseplate
- An electrical system
- Cabinet

A schematic arrangement of the system is shown in Figure 1 and a brief description of the function of each element of the system is shown in the following sections.

1.2.1 Pumping System

Refer to Figure 1 for the location of the numbered items listed in the following description. The vacuum pumping system for the coater consists of an oil vapour diffusion pump (4), backed by a rotary pump (12).

The diffusion pump is an Edwards EO4/160K and is mounted vertically beneath the baseplate. It is capable of pumping the process chamber down to a pressure below 2×10^{-7} mbar.

Mounted between the baseplate and diffusion pump are an electrically operated high vacuum isolating valve (3) and a liquid nitrogen trap (5). The outlet of the diffusion pump is connected via a flexible coupling (6) and an electrically operated 'backing' valve (8) to a roughing/backing manifold. A second vacuum line from the baseplate connects to the same roughing/backing manifold via an electrically operated 'roughing' valve (10). The control system operates each of the electrically operated valves in sequence to switch the rotary pump between roughing and backing duties as required. A connection from the roughing/backing line is taken via an Edwards FL20K foreline trap (9) and flexible coupling (11) to the rotary backing pump (12).

1. Vacuum Chamber
2. Penning Gauge
3. High Vacuum Valve
4. Diffusion Pump
5. Liquid Nitrogen Trap
6. Flexible Coupling
7. Pirani Gauge - PRM10K
8. Backing Valve
9. Foreline Trap
10. Roughing Valve
11. Flexible Coupling
12. Rotary Pump
13. Oil Mist Filter Filter
14. Air Admit Filter (Sintered)
15. Air Admit Valve
16. Gas Admit Valve
17. Vacuum Interlock Switch
18. Pirani Gauge PRL10K

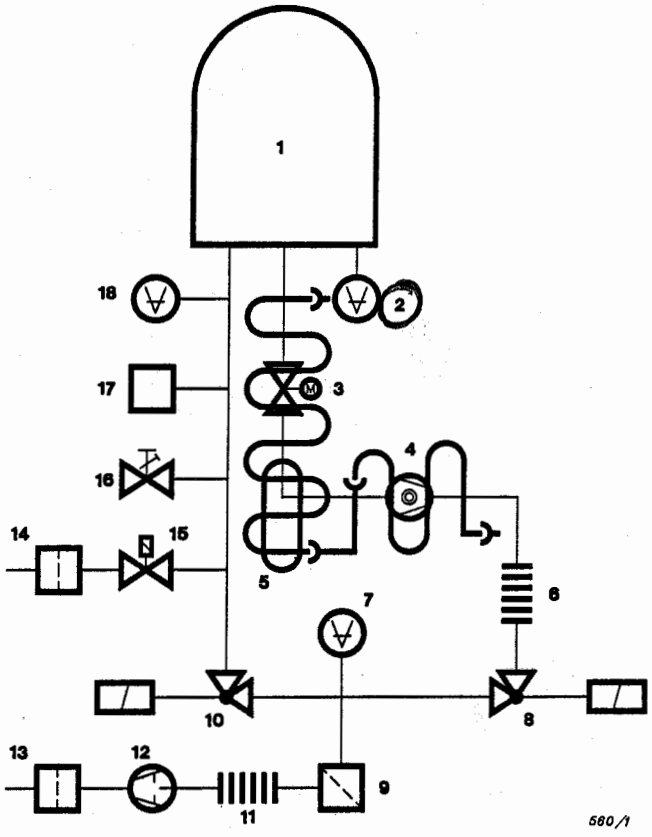


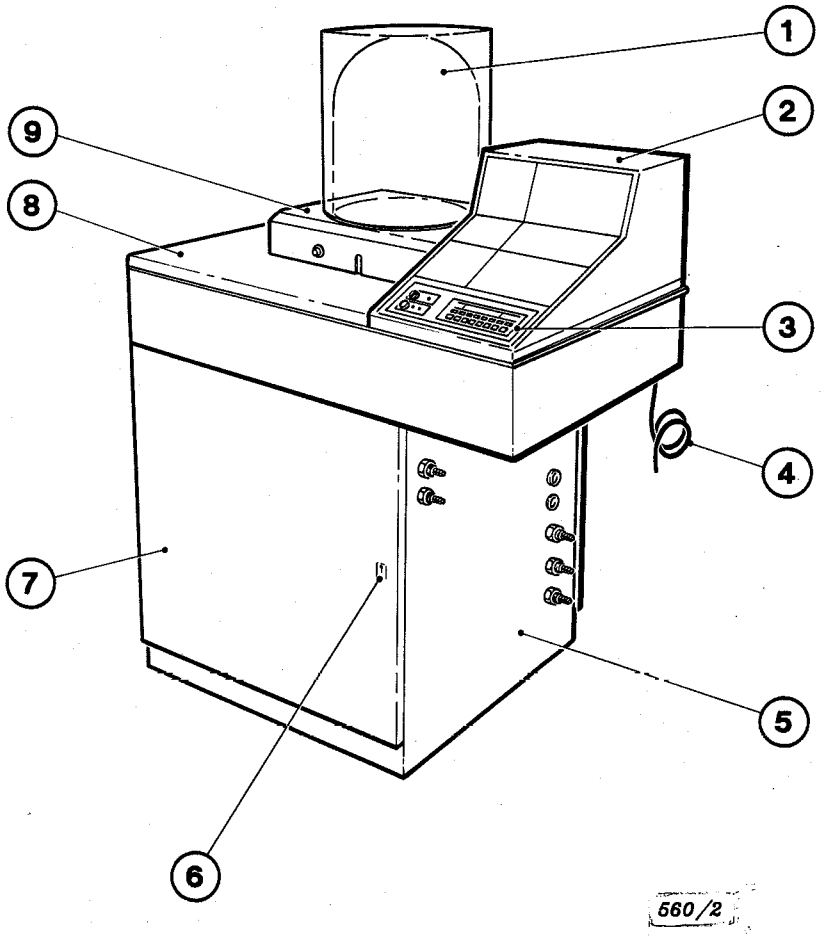
Figure 1 - System Schematic

The backing pump is an Edwards model E2M8, two stage, oil sealed rotary vacuum pump. An Edwards EMF10 filter (13) is fitted to the outlet of the pump to remove odours and oil mist from the pump exhaust.

1.2.2 Control System

To simplify the operation of the vacuum coater, an automatic microprocessor control system is employed. The Controller is pushbutton operated and is fitted with a two line fluorescent display to show system status and pressure. It is pre-programed to provide an automatic pump-down sequence and a plasma sequence.

A dual head Pirani module and a single head Penning module are incorporated within the unit to allow a choice of gauge heads to be used covering the range of 5×10^{-8} to 1000 mbar. The gauge heads are located as shown in Figure 1; the Penning and PRL10K Pirani gauge are used to measure the pressure within the coating chamber and the PRM10K Pirani gauge is used to measure the backing pressure in the backing/roughing line. Relay outputs are provided to control pumps, valves and process related accessories.



1. Bell Jar and Implosion Guard
2. Electrical Control Cabinet
3. Controller
4. Mains Lead
5. Services Panel
6. Lock
7. Front Door Panel
8. Work Top
9. Baseplate Shroud

Figure 2 - Location of Main Components

To ensure that the pumping sequence is not tampered with, the Controller is provided with a password protection system which prevents unauthorised changes being made to the Controllers programing.

The Controller is built into the electrical control cabinet, the location of which is shown in Figure 2. Individual controls for the accessories can be added to the control panel by removing the appropriate blanking plates.

1.2.3 Baseplate

The baseplate of the coater provides an interface between the process chamber and the system. It is manufactured from stainless steel and is machined with a number of holes to enable the mounting of vacuum electrodes, gauge heads and accessories such as workholders and sources.

Instructions are provided with each accessory for fitting to the baseplate and it is important that the correct sequence of assembly is used for each item.

1.2.4 Electrical System

The electrical system of the coater is designed to allow the addition of supplementary transformers and power supplies to suit the applications that are required by individual customers. The baseplate of the cabinet is pre-drilled to accept the transformer accessory kits and cutaways in the internal walls are provided to receive the associated cable runs.

1.2.5 Cabinet

The component parts of the vacuum coater are fully enclosed in a cabinet as shown in Figure 2. Mounted adjacent to the baseplate is the control panel section which is hinged, thus allowing it to be opened to give access to the underside when fitting accessories.

Lockable, hinged sheet steel door panels allow free access to the front and rear of the cabinet. Positive break safety switches on the baseplate shroud and cabinet doors are interlocked with the coater accessories electrical supply to prevent operation of the chamber accessories (e.g. HT/LT supplies, etc.) with the interior exposed. The unit is built to IP20 classification.

Four castors are fitted to the underside of the unit to facilitate ease of movement; four 'O' rings are provided for positioning beneath the castors once the unit is installed in its operating position to prevent it from rolling.

2 TECHNICAL AND PLANT DATA

2.1 Dimensional Data

Overall width	880 mm
Overall depth	595 mm
Overall height	1450 mm
Working area, minimum	1000 x 1600 mm
Weight approximate, basic	158 kg approx.

2.2 Electrical Data

Supply required	220/240V 1ph 50Hz or 210/220V 1ph 60Hz
Supply cable (supplied)	2 metres long x 3 core
Power consumption	3 kVA max
IP Rating	IP20

2.3 System Data

Water cooling requirements	75 $l.h^{-1}$ at 20°C
Liquid nitrogen trap capacity	1.4 litres
Oil capacity (vacuum pumps)	
Rotary pump E2M8	550 ml per charge, Edwards No. 15
Diffusion pump E04/160K	175 ml per charge, Silicone 704 or Santovac 5
Vacuum performance	
Ultimate vacuum (better than)	2×10^{-7} mbar
Pump-down time (typical)	Better than 4 minutes to 10^{-5} mbar Better than 25 minutes to 10^{-6} mbar
Leak rate	Tested to better than 10^{-5} mbar ls^{-1}

Note: All vacuum measurements are given using Santovac 5 fluid in the diffusion pump and for a clean, empty, degassed chamber vented with normal air and with the chamber lifted for 2 minutes.

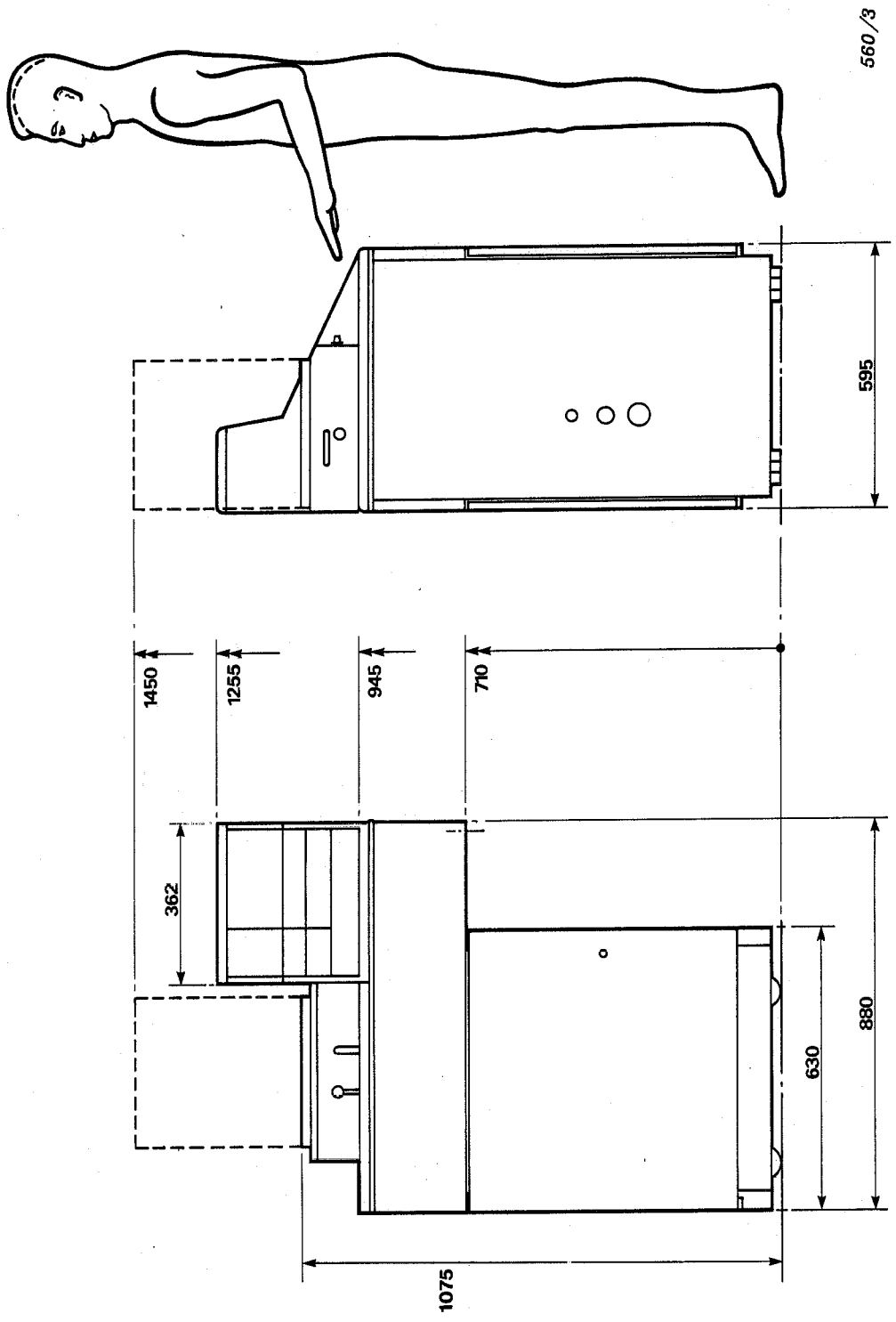


Figure 3 - Dimensional Details and Normal Operating Position

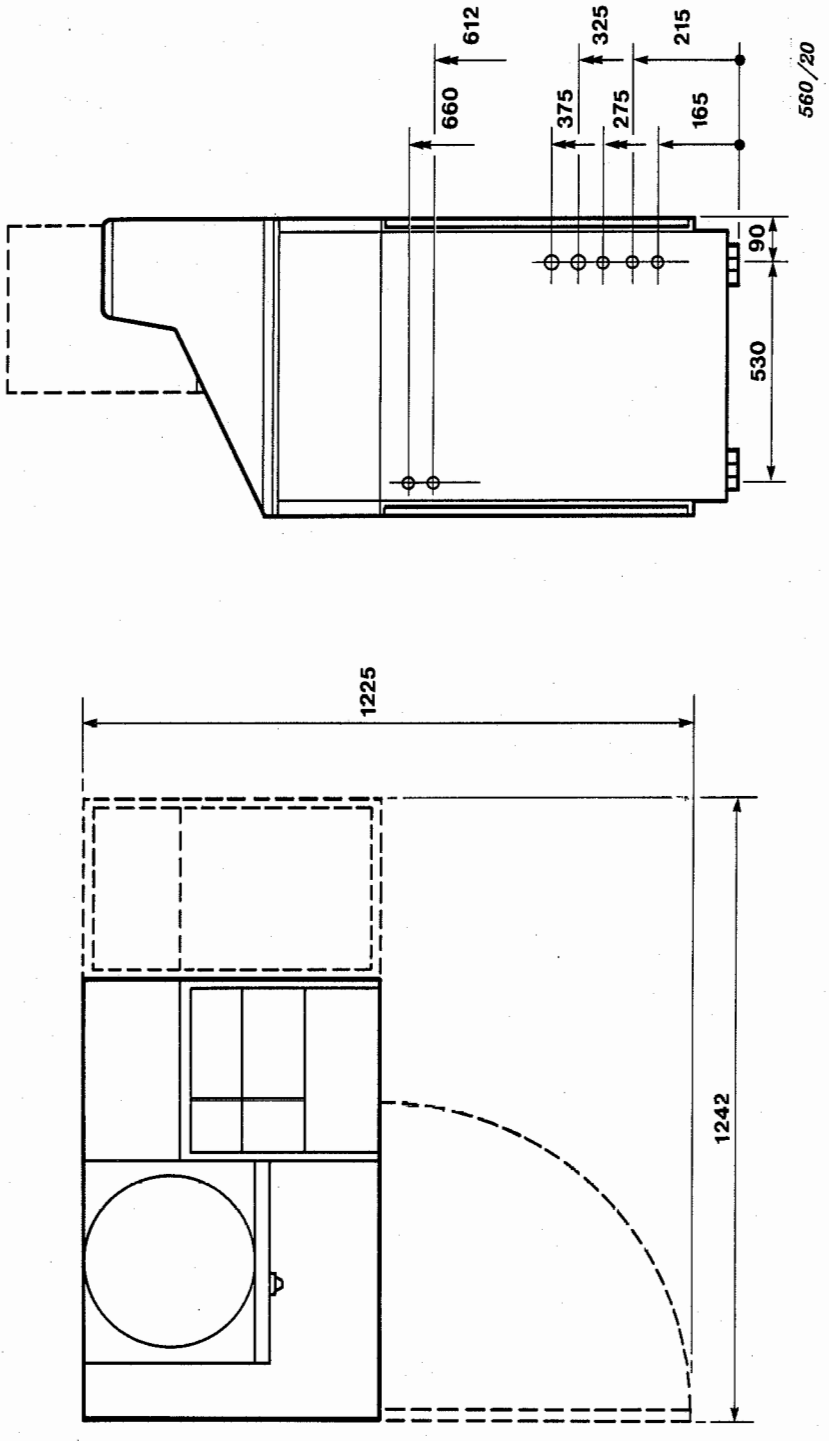


Figure 4 - Dimensional Details

2.4 Services Connections

Cooling water	8 mm o/d tubing for direct connection 6 mm i/d for riffled nozzle connection
Electrical supply	Three core (wire) mains cable supplied with the unit
Vent	
Connection	6 mm o/d tubing for direct connection 4 mm i/d for riffled nozzle connection
Supply pressure	0.1 bar maximum
Needle valve	
Inlet	6 mm o/d tubing for direct connection 4 mm i/d for riffled nozzle connection
Supply pressure	0.1 bar maximum
Rotary pump discharge outlet	16mm i/d for riffled nozzle connection

Note: All nozzle connections should be secured using suitably sized hose clips.

3 INSTALLATION

3.1 Unpacking

Upon receipt of the unit, remove the packing materials and check the unit for any damage that may have occurred in transit. The unit is supplied with a packing list and certain items are contained in an installation kit supplied in a separate carton. The packing list for the installation kit is reproduced below for convenience; check each item against the packing list and notify the suppliers immediately of any damage, loss or shortfall (refer to Section 7 - COMMUNICATION WITH EDWARDS for the procedure).

Item	Description	Code No.	Qty	Check (✓)
1	Carton	B21002005	1	❑
2	'O' ring (VOR)	H02125040	4	❑
3	32 A/F wrench	29415-023	1	❑
4	19 A/F wrench	29415-022	1	❑
5	Baseplate leadthrough shield	E100004042	2	❑
6	Door key	E09000256	2	❑
7	8 mm diam. tube to hose stem	H03532012	2	❑
8	6 mm diam. tube to hose stem	H03532004	2	❑
9	Rotary pump oil No. 15 (1 litre)	H11002015	1	❑
10	Rotary pump fitting pack	A34001026	1	❑
11	Activated alumina (14 ozs)	H02600055	1	❑
12	AUTO 306 Controller fuses (1 pack)	-	1	❑
13	Working Instructions	E09000880	1	❑
14	LN_2 filler	E09059000	1	❑
15	Silicone fluid 704EU (500 ml)	H11201040	1	❑

3.2 Preparation

3.2.1 Locating the Unit

A suitable site should be selected and prepared for the unit. It should have a level foundation with a surface suitable to support the weight of the unit (approximately 158 kg). Check also that there is an adequate water supply (75 $l.h^{-1}$ at 20°C), drain facilities and an electrical supply rated at 3 kVA minimum.

WARNING

The unit is not fitted with facilities for crane lifting and should be carried to its installation location on a pallet.

For final positioning the coater can be moved on its castors. In order to restrict rolling movement of the unit, use a lever to raise the right-hand side and sit the castors into the O-rings supplied. The castors on the left hand side of the unit are designed to allow movement in one plane (along the length of the machine and should not, therefore, require locking although additional 'O' rings are supplied if this is found to be necessary.

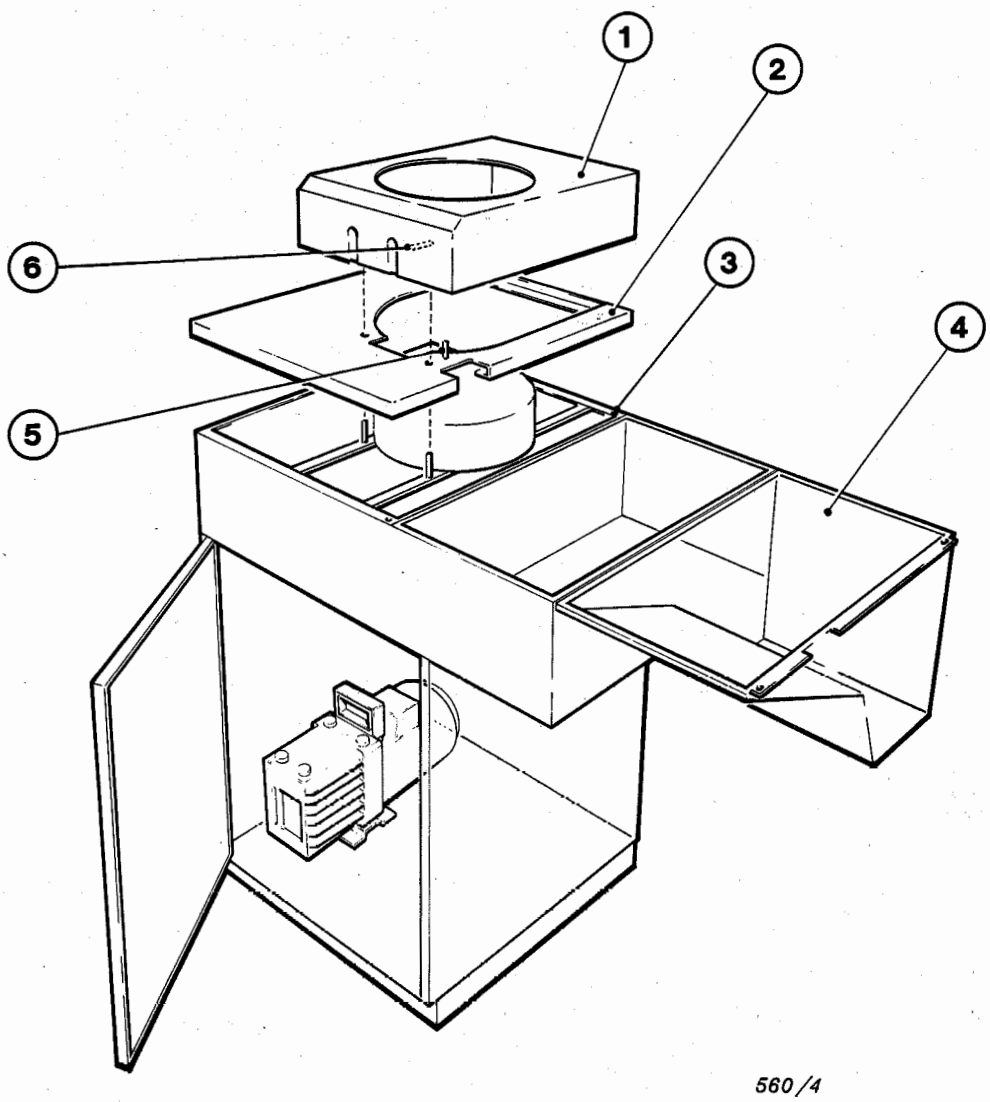
3.2.2 Setting-up

Before connecting the electrical supply to the unit, ensure that the supply voltage matches the voltage stamped on the side of the unit. If the voltage does not match it is necessary to open the coater to make adjustments. Refer to Figure 5 and use the following procedure:

1. Lift the baseplate shroud squarely from the securing pins and carefully manoeuver it past the needle valve.
2. Disconnect the earth wires from the shroud and work top weld studs.
3. Carefully lift the worktop, moving it to the front of the unit to avoid the needle valve.
4. Undo the retaining screws securing the electrical control cabinet to the frame.
5. Lift the hinged top of the electrical control cabinet to the right of the unit, taking care to support the weight as it is lowered.
6. Adjust the push on connectors to the transformer tappings (see Figure 5) to suit the supply voltage.
7. Adjust the selector switch on the rear of the Controller unit (see Figure 6) to suit the supply voltage.
8. Check the voltage rating on the diffusion pump terminal box. If the voltage is incorrect it may be necessary to change the heater element (see Publication No. 05-B304-09-880).
9. Refit the covers in the reverse order when complete.

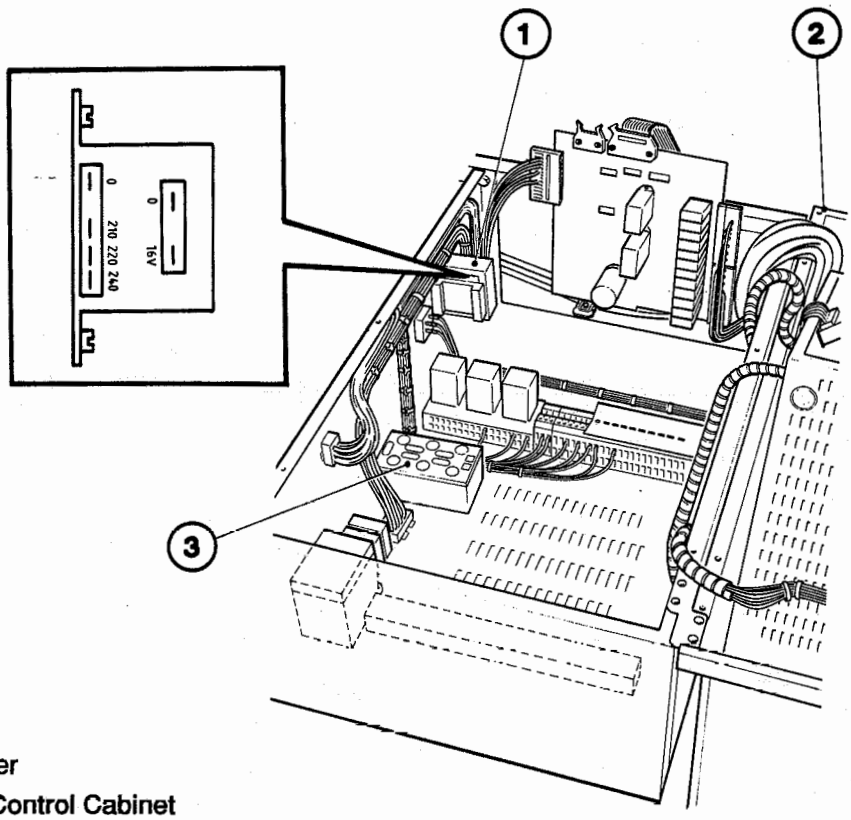
WARNING

Always replace the earth wires (removed in step 2) when re-assembling the covers.



1. Baseplate Shroud
2. Work Top
3. Electrical Control Cabinet Fixing Screws
4. Electrical Control Cabinet
5. Earth Stud
6. Earth Stud

Figure 5 - Removing the Covers



1. Transformer
2. Electrical Control Cabinet
3. HVV Back-up battery

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Figure 6 - Transformer Tap Locations

1. Mains Voltage Selector Switch

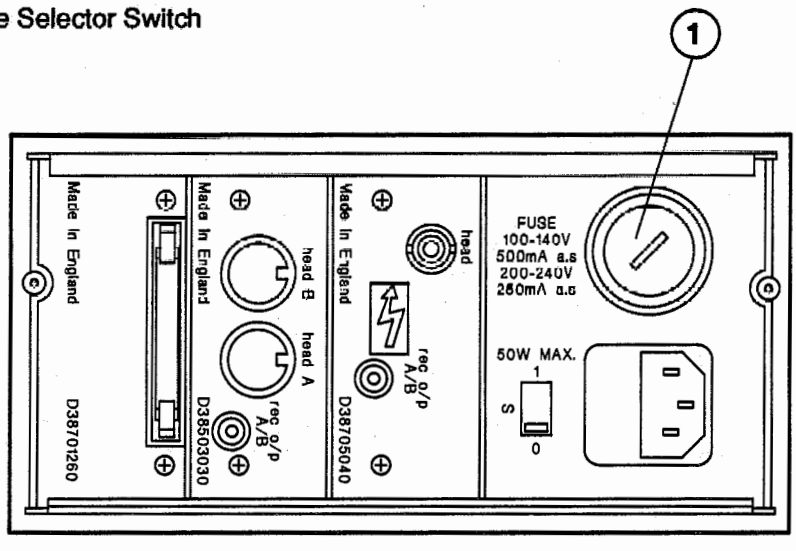

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Figure 7 - Rear of the Controller

3.3 Electrical Connection

Reference should be made to the circuit diagrams (see Figures 8 to 12) whilst carrying out the installation work.

WARNING

All electrical work performed on this unit must be carried out by a qualified electrician.

The coating unit must be directly connected to a correctly rated electricity supply of 3kVA capacity.

A three-core (wire) mains lead is supplied with the unit and must be connected to a fused 3-pin plug or terminal box (with a maximum fuse or trip rating of 16 amps) in the accepted standard form as follows:

BROWN	LIVE or LINE 1
BLUE	NEUTRAL or LINE 2
GREEN/YELLOW	EARTH

3.4 Rotary Pump Discharge Connections

An oil mist filter is installed on the rotary pump discharge outlet to remove oil vapour and odour. However, it is recommended that an exhaust line is connected between the riffled nozzle outlet marked ROTARY PUMP EXHAUST and the outside of the building.

It is recommended that a catchpot is fitted into the exhaust pipeline to prevent condensed vapours from draining back into the rotary pump. The pipeline should be inclined downwards to the catchpot and then rise to its ejection level (see the rotary pump working instructions for further details).

WARNING

Rotary pump exhaust fumes can be dangerous if hazardous materials are being processed. Ensure that the rotary pump exhaust is discharged to a well ventilated area outside of the building.

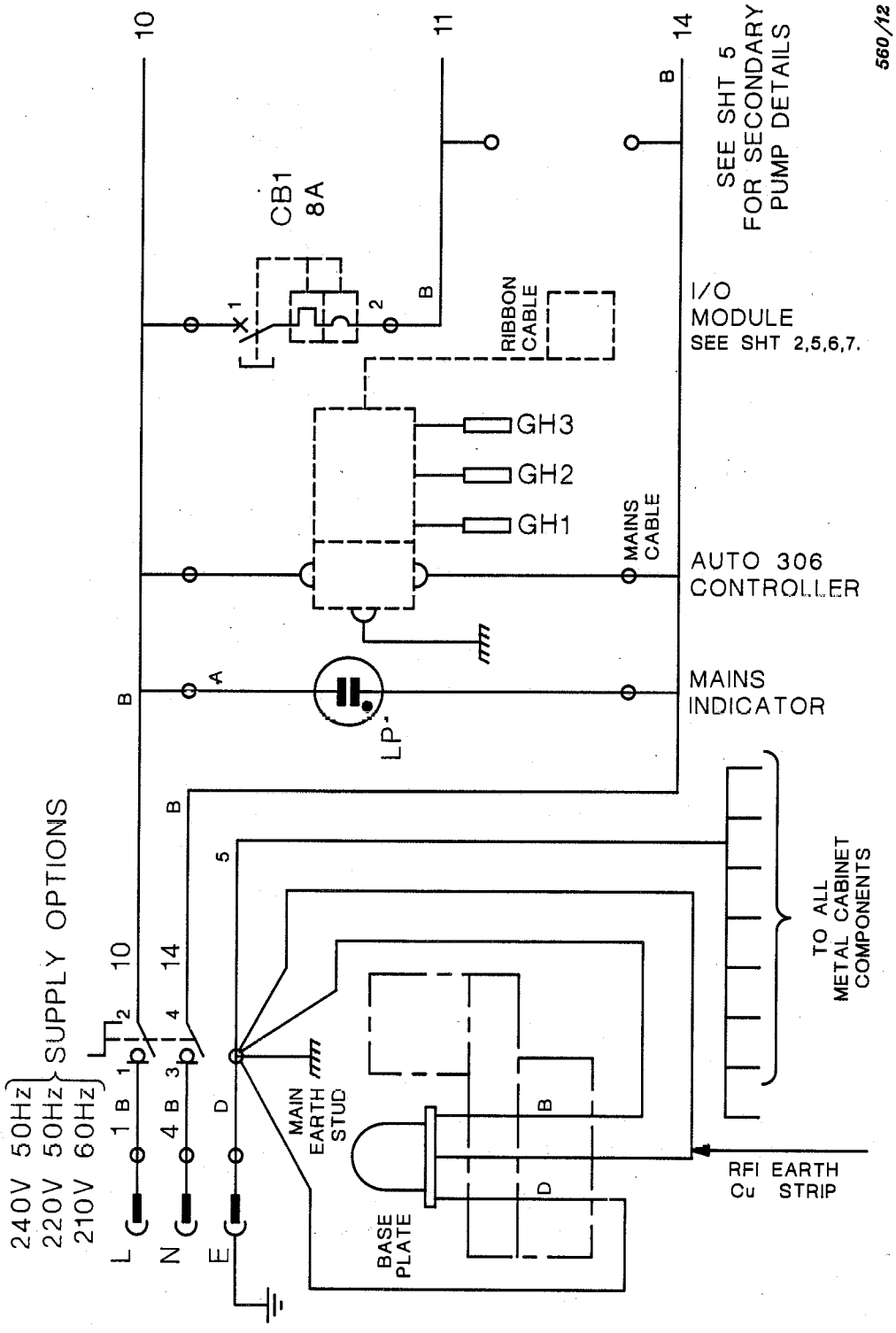


Figure 8 - Circuit Diagram (sheet 1)

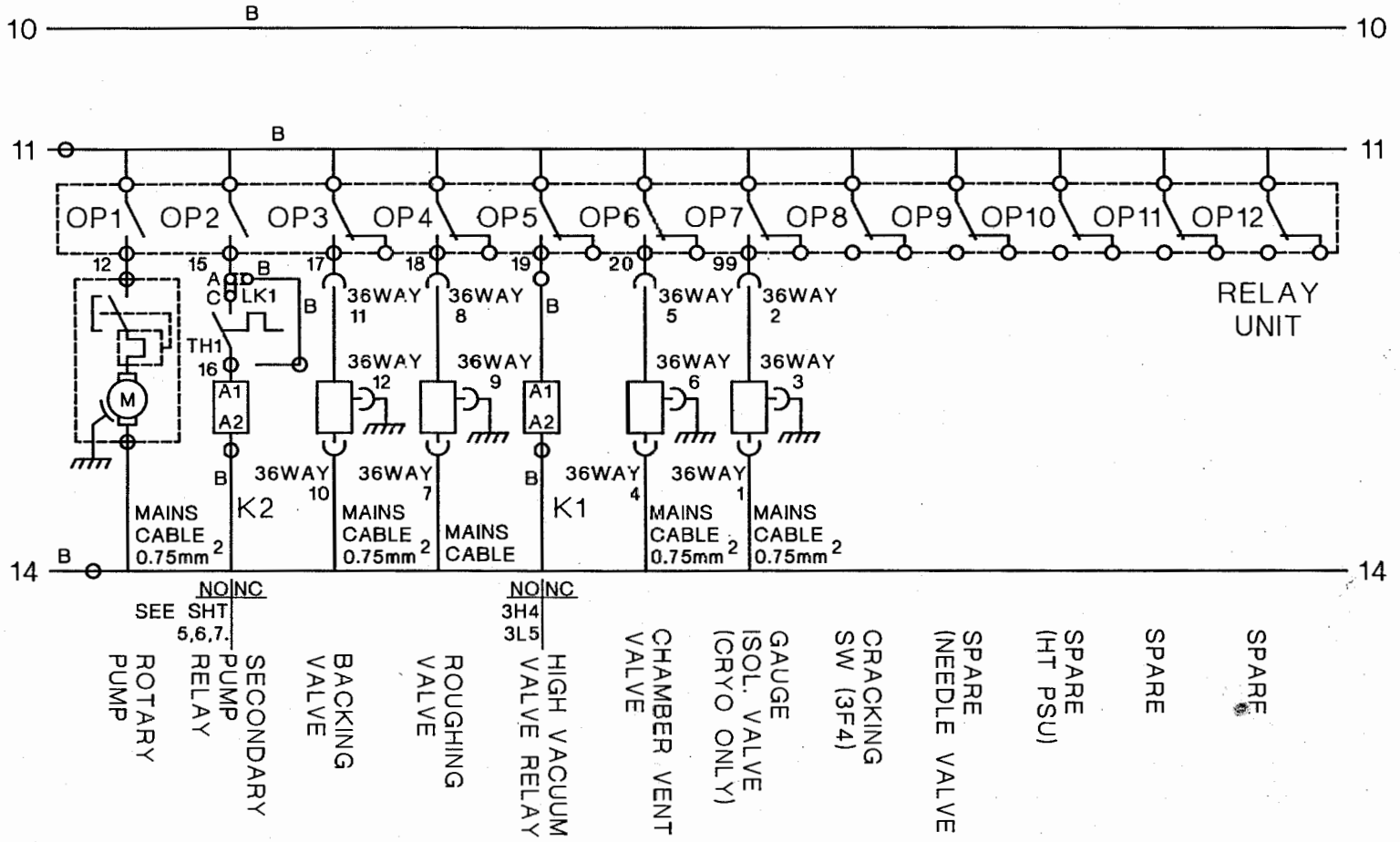


Figure 9 - Circuit Diagram (sheet 2)

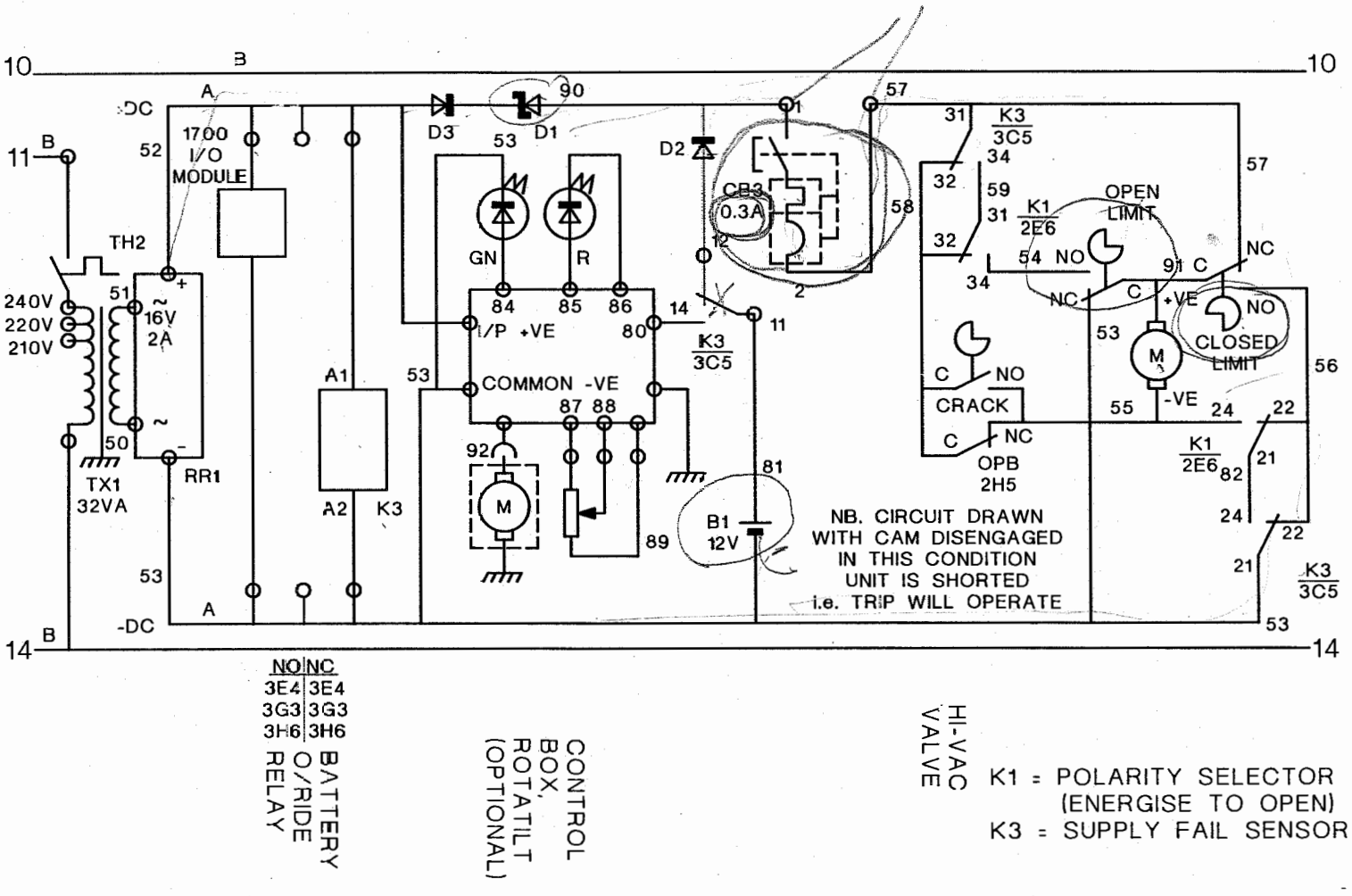


Figure 10 - Circuit Diagram (sheet 3)

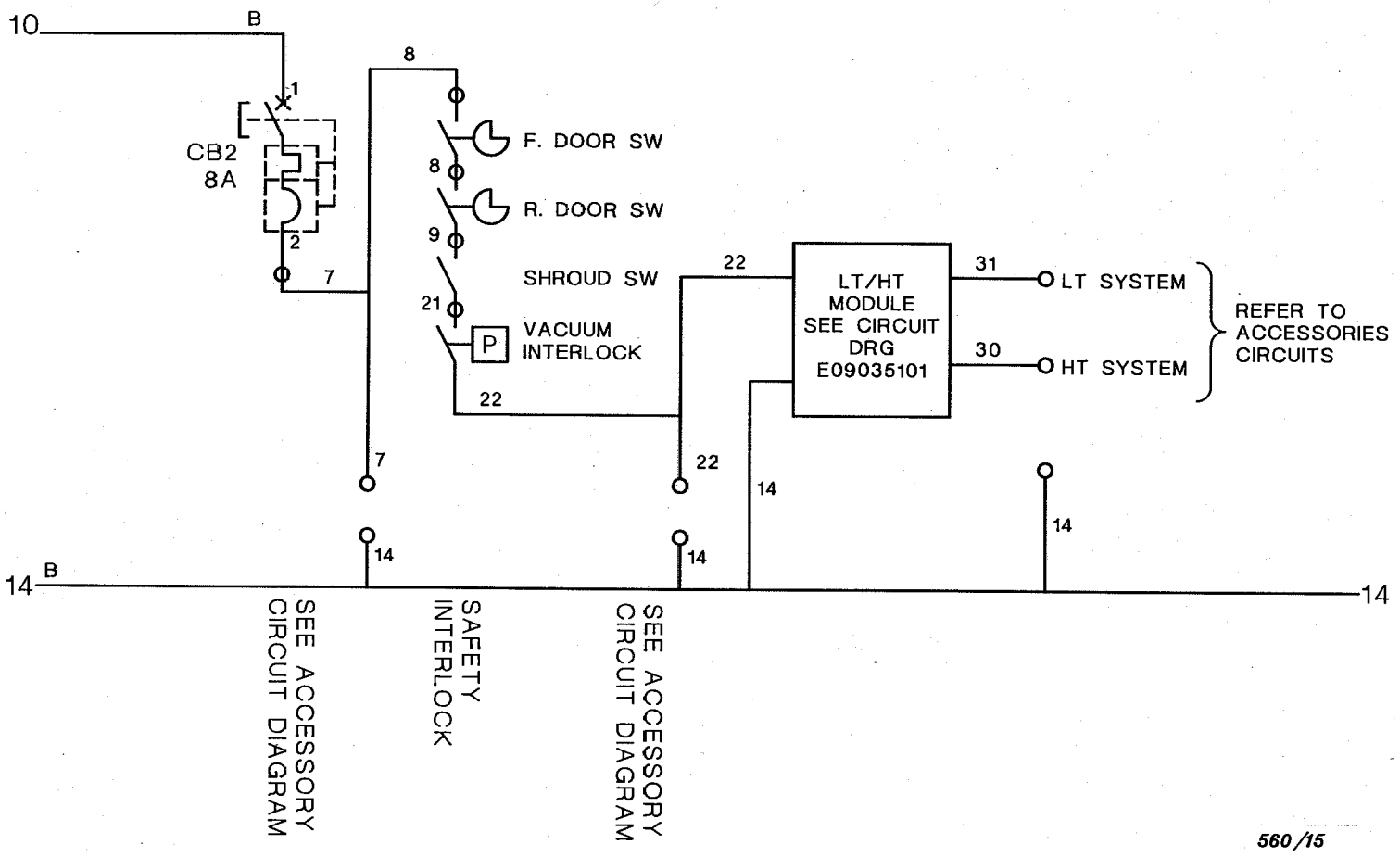


Figure 11 - Circuit Diagram (sheet 4)

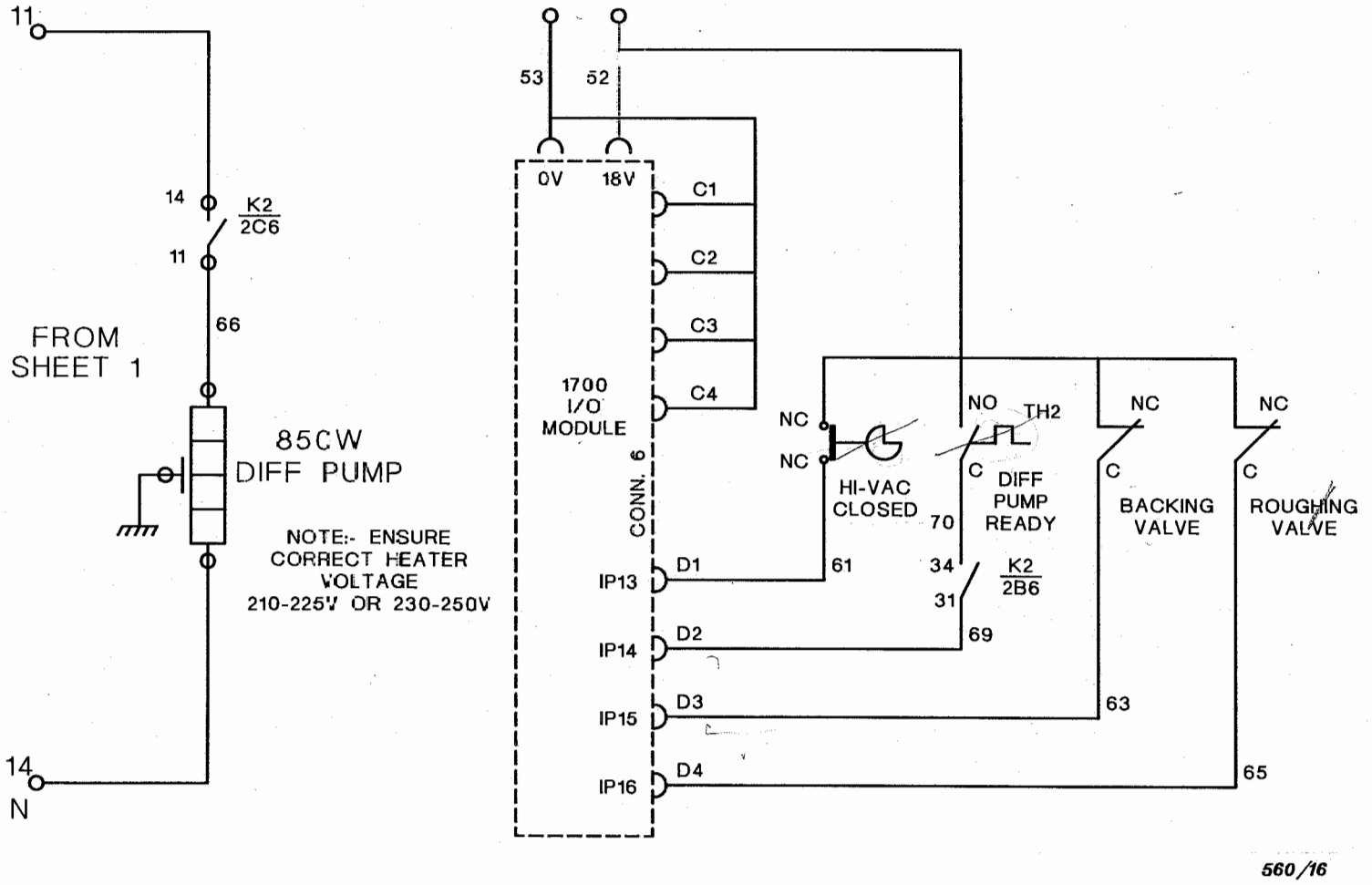
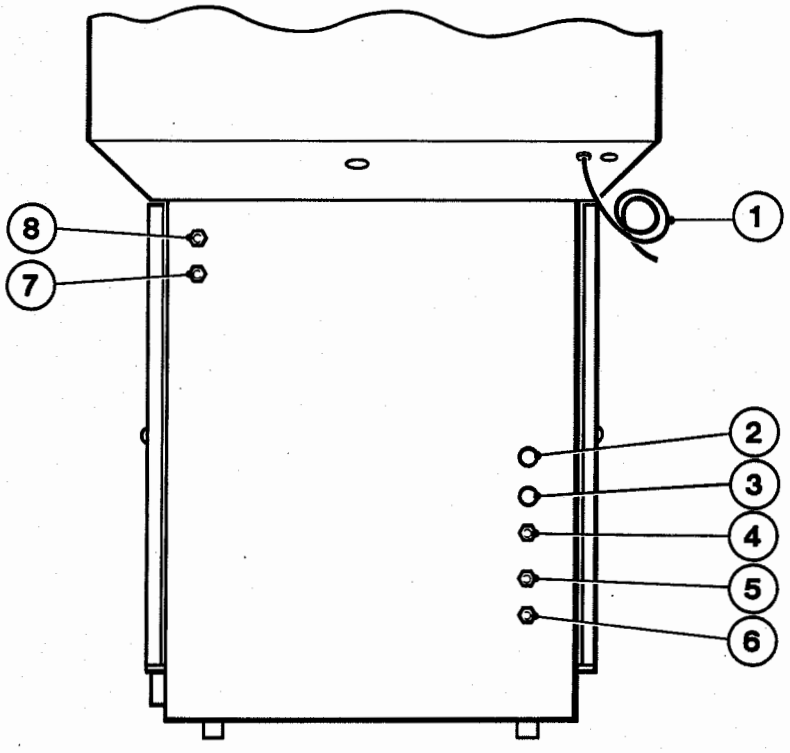


Figure 12 - Circuit Diagram (sheet 5)



1. Mains Lead
2. Cryopump Helium In (not used)
3. Cryopump Helium Out (not used)
4. Rotary Pump Exhaust
5. Cooling Water In
6. Cooling Water Out
7. Needle Valve Inlet
8. Vent Valve Inlet

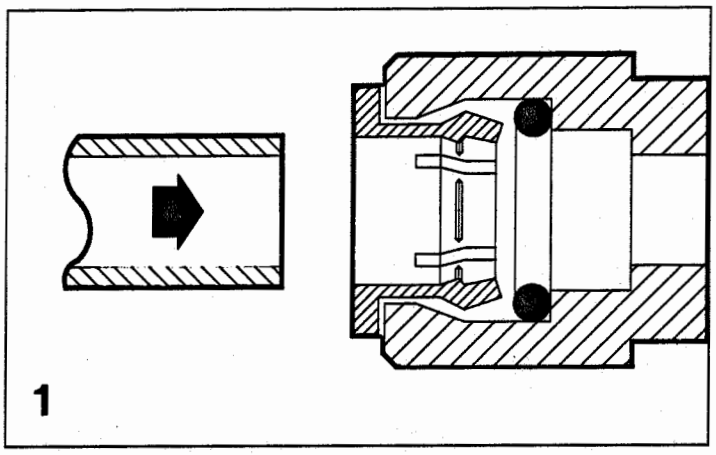
Figure 13 - Services Connection Details

3.5 Water Connections

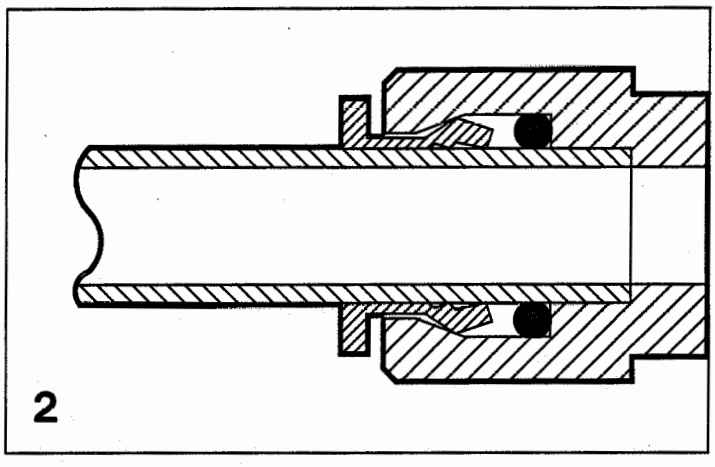
A cooling water supply is required for the diffusion pump. The flow and return connections are made via connectors located on the right-hand side panel of the coating unit, as shown in Figure 13. The connectors are of the 'quick fit' type and are designed to accept a nozzle (supplied) or directly inserted rigid tubing; the method of use is illustrated in Figure 13. Reinforced plastic tubing can be used but rubber is not recommended. When the nozzles are used, the tubing must be secured using suitable hose clips.

Connect a length of tubing (8 mm o/d for direct connection or 6 mm i/d for nozzle connection) from the water supply to the connector marked COOLING WATER IN and another length from the connector marked COOLING WATER OUT to a suitable drain.

1. Insertion



2. In-Situ



3. Removal

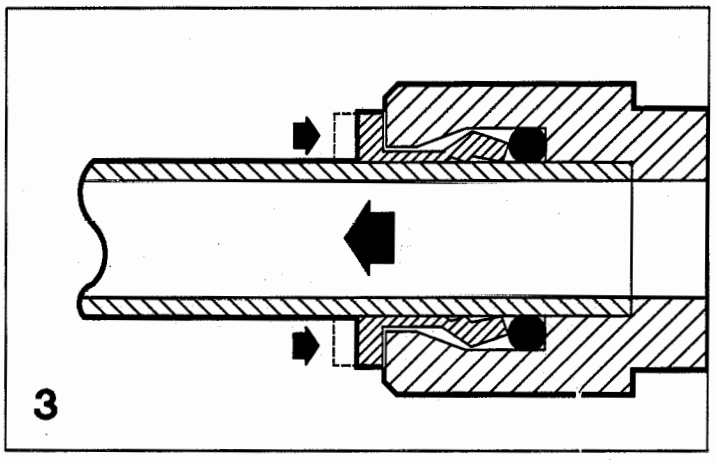


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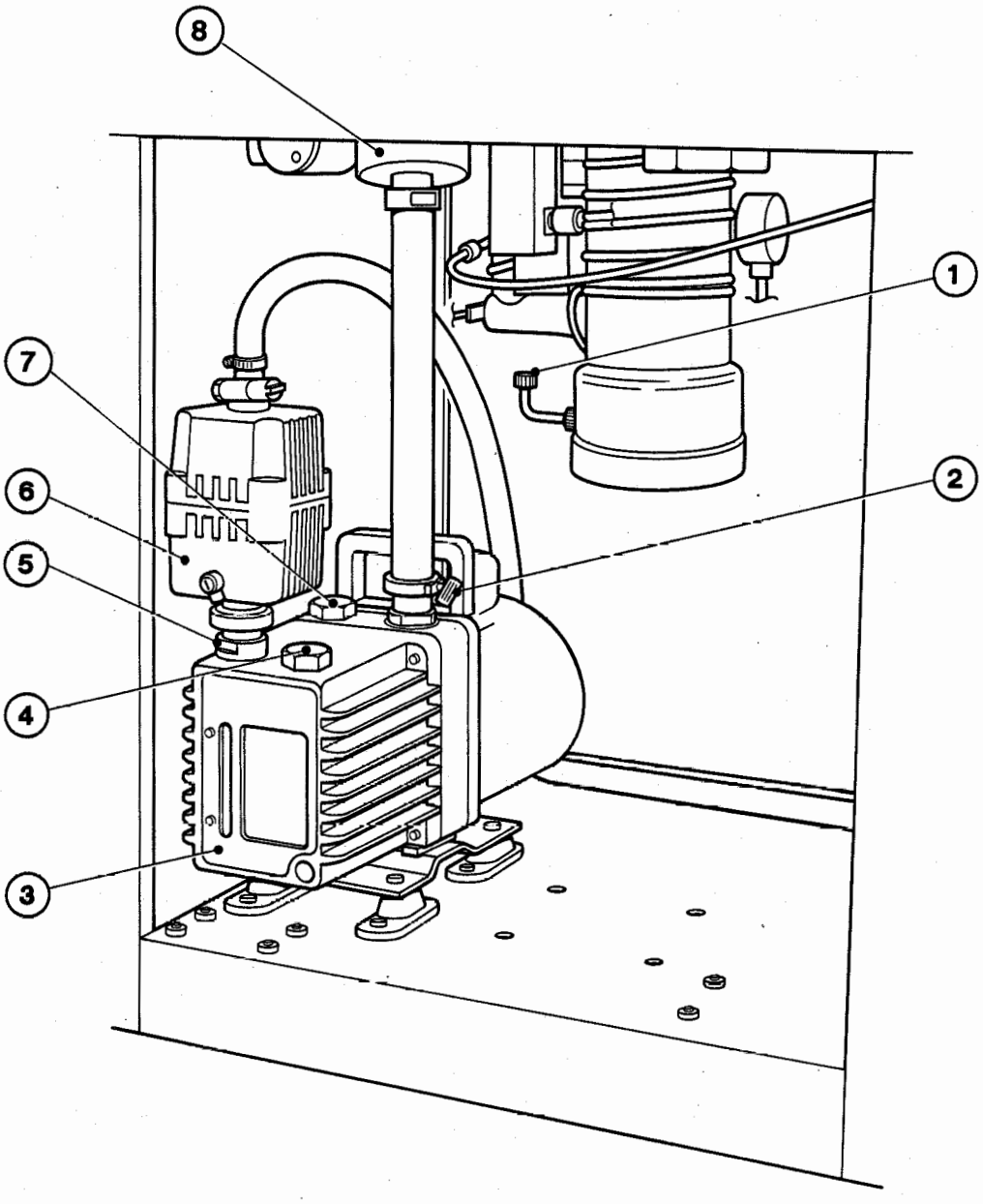
Figure 14 - Quick Fit Water Connector



1. Diffusion Pump Oil Filler Tube
2. Foreline Trap Bottom Coupling
3. Rotary Pump
4. Oil Filler Plug
5. Oil Mist Filter Coupling
6. Oil Mist Filter
7. Gas Ballast Valve
8. Foreline Trap

Figure 15 - Component Location

3.6 Foreline Trap

1. Unscrew the top of the foreline trap and remove the basket; this process may be made easier if the covers are removed as detailed in Section 3.2.2. Refer to the working instructions supplied with this manual relating to foreline traps for further information on removing the basket.

Note: The unit is dispatched with the system under vacuum which may make the removal of the cap on the foreline trap difficult. To release the vacuum and thus facilitate the removal of the cap, it may be necessary to release the lower coupling (see Figure 14) to vent it to atmosphere.

2. Fill the basket with the desiccant supplied in the installation kit and refit it into the trap.

3. Refit the cap onto the trap and ensure that the lower coupling is secured.

3.7 Rotary Vacuum Pump

1. Remove the red transit clamping plate which secures the pump to the base of the cabinet (see Figure 14 for the location of the rotary pump).

2. Remove the oil filler plug from the top of the pump and pour 0.55 litres of pump oil (provided in the installation kit) into the filler hole using a funnel if necessary. Replace the plug.

3. Remove the bungs from baseplate positions RP and 7 (see Figure 16 for locations) and replace with the two stainless steel shrouds from the installation kit.

3.8 Diffusion Pump

The diffusion pump is emptied of fluid before despatch and therefore requires to be charged with the oil provided in the installation kit. The Auto 306 is tested with Santovac 5 diffusion fluid before dispatch and the diffusion pump does not, therefore, require cleaning if refilling with either Santovac 5 or Silicone 704. If the pump is filled with the Silicone 704 supplied in the installation kit and a subsequent change is made to Santovac 5, the pump will require draining and cleaning of all traces of Silicone 704 before filling with Santovac 5.

The procedure for filling the pump is as follows:

1. Remove the backing line from the diffusion pump by carefully releasing the securing clamp.

2. Fill the pump with the correct quantity of oil (see Section 2 - TECHNICAL AND PLANT DATA), using a suitable funnel if necessary.

3. Refit the backing connection to the pump and tighten the securing clamp.

3.9 Fitting Accessories

Any accessories that have been ordered with the unit should now be fitted in accordance with the instructions supplied with the accessory. Figure 16 shows the arrangement of baseplate holes and details the location for the fitting of the accessories.

When fitting accessories the following points should be observed:

WARNING

High voltages may be generated within the auto 306. Switch off and disconnect the electrical supply before fitting accessories. Electrical connections to components should be performed by a qualified electrician.

WARNING

Surfaces within the auto 306 can exhibit extremes of temperature. Ensure that adequate precautions are taken to avoid touching hot or cold surfaces such as the diffusion pump body, source holders, targets and components associated with Plasmaglo and other HT discharge processes.

Details of the accessories available for the AUTO 306 are given in the following table:

Product Code	Description	Publication No.
E09062000	Top Plate Counter Balance	11-E090-62-880
E09022000 E09023000	Tripod Baffle Plate	11-E090-22-880
E09032000 E09045000 E09044000	Manual Source Shutter Electromagnetic Source Shutter - Panel Accessory Electromagnetic Source Shutter - Baseplate Acc.	11-E090-32-880
E09033000 E09035000 E09063000 E09064000 E09070000 E09052000	Selector Switch HT/LT Controller LT Transformer Kit (10V, 100A/5V, 200A) LT Transformer Kit (10V, 100A/30V, 30A) LT Transformer Kit (3V, 350A) HT Power Supply	11-E090-52-880
E09028000	Filament Holder	11-E090-28-880

Product Code	Description	Publication No.
E09029000 E08572000 E08573000 E08571000 E08535000	Rotatilt 3 Planetary Workholder for Rotatilt 3 Plane Workholder for Rotatilt 3 Grid Holder for Rotatilt 3 Magnetic Grid Holder for Rotatilt 3	11-E090-29-880
E09039000	Single Carbon Evaporation Source for 3mm or 6.35mm Carbon Rod	11-E090-39-880
E09036000 E08507091 E08507092	Ion Etching Accessory with Movable Ion Source and HT Power Supply Cathodes for Ion Etching Accessory Gun Insulators for use with IBT200 and Ion Etching Accessories, PK10	11-E090-36-880
E09040000 E08512000 E08511023 E08511030	Twin Electron Beam Source Twin Electron Beam Power Unit Twin Electron Beam Source Filaments, Pk5 High Purity Tungsten Rod, 2mm Dia. x 50mm, Pk5	11-E090-40-880
E05201000	Specimen Cooling Finger (use with Cylinder Chamber Kit)	11-E052-01-880
E09038000	Four Position Turret Source	11-E090-38-880
E09058000 E09066000 E09026000 E09024000	Workholder Ring Spherical Workholder Dome Radiant Heater Quartz Heater	11-E090-26-880
E09037000 D32501000	Six Position Electron Beam Source Power Supply for 6 Position Electron Beam Source	11-E090-37-880
E09025000 E09050000 E09021000	Single Bar Glow Discharge DC Sputtering Accessory (use with HT Power Supply) Plasmaglo Ion Bombardment	11-E090-21-880

Product Code	Description	Publication No.
E09053000	Rotary Work Holder	11-E090-53-880
E02512000 E09027000	Domed Bell Jar Kit Cylindrical Chamber Kit	11-E090-27-880

1. Read the entire instruction before attempting assembly in order to fully understand each step.

2. During accessory assembly or maintenance ensure that all electrical and water supplies to the coating unit are isolated.

3. Ensure that all electrical and water connections are secure.

4. HT connections should be made only with the HT cable supplied.

5. The wiring of the coating unit is numbered and colour coded for easy reference.

6. Clean all parts before assembly.

7. Do not use undue force during assembly.

8. Do not oil or grease chains and bearings to be fitted in the vacuum chamber.

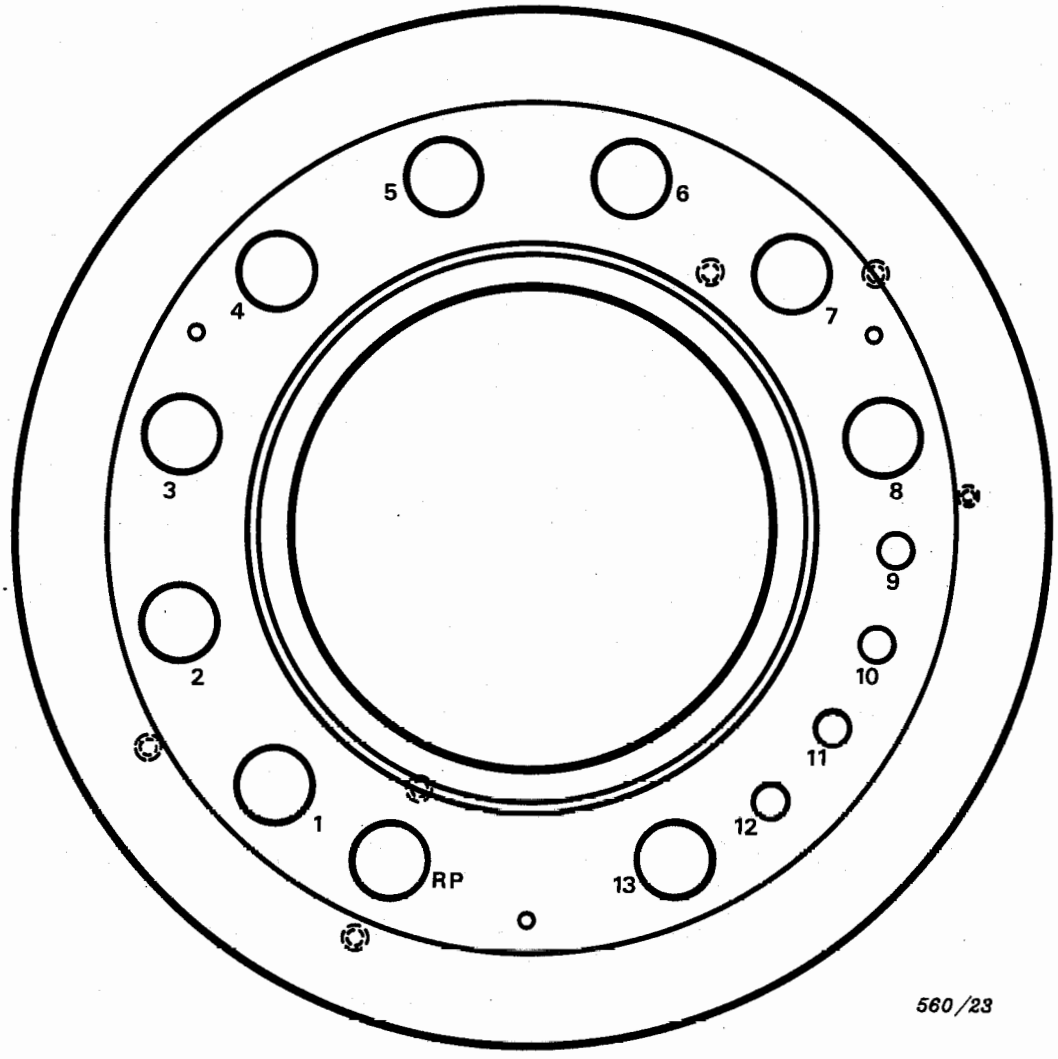
9. Ensure that O-rings and seals are free from contamination.

10. Check the leak tightness of all vacuum joints before operating the vacuum coater.

11. Parts removed from the unit to enable the fitting of an accessory should be stored for future use.

12. For improved access to the underside of the baseplate, remove the baseplate shroud and the worktop from the unit (see Section 3.2.2 - steps 1 to 5 for method). These should be replaced when the accessories have been installed.

13. The coating unit is fitted with safety and protective devices (i.e. overload trips and vacuum switches) to prevent damage to the equipment or injury to an operator. These devices must not be tampered with or modified.



Front of Unit

Position	Function/Type	Position	Function/Type
RP	Roughing Line (Fixed)	7	Penning Head (Fixed)
1	LT Type 6 Leadthrough	8	LT Type 6 Leadthrough
2	LT Type 6 Leadthrough	9	Radiant Heater
3	Shutter Accessory	10	Radiant Heater
4	Thermocouple	11	HT (Plasmaglo)
5	LT Type 6 Leadthrough	12	HT (Plasmaglo)
6	LT Type 6 Leadthrough	13	Rotary Drive

Figure 16 - Baseplate Details

4 OPERATION

4.1 Introduction

The operating procedures detailed in this section are divided into two parts; the first part (Section 4.2) is intended to familiarise the operator with the use of the Controller, the second part (Section 4.3 onwards) details the procedures necessary to prepare the unit for operation.

4.2 Using the Controller

4.2.1 Function of the Switches

The front panel of the Controller is illustrated in Figure 17. A fluorescent display gives details of the system status on the top line and information relating to system pressure on the second line. A schematic view of the Controller menus is shown in Figure 18. All of the functions that are programable by operator are entered via the menus using the switches on the front panel of the Controller.

The function of each of the switches is as follows:

▲ Scroll up key: this key allows the operator to scroll through all of the options that are available at the current location in the program.

▼ Scroll down key: this key has the same function as the scroll up key but moves through the menu in the reverse order.

The scroll keys can also be used to change the pressure reading displayed on the Controller by selecting a different gauge head, i.e. chamber pressure (which is the default display) to backing pressure.

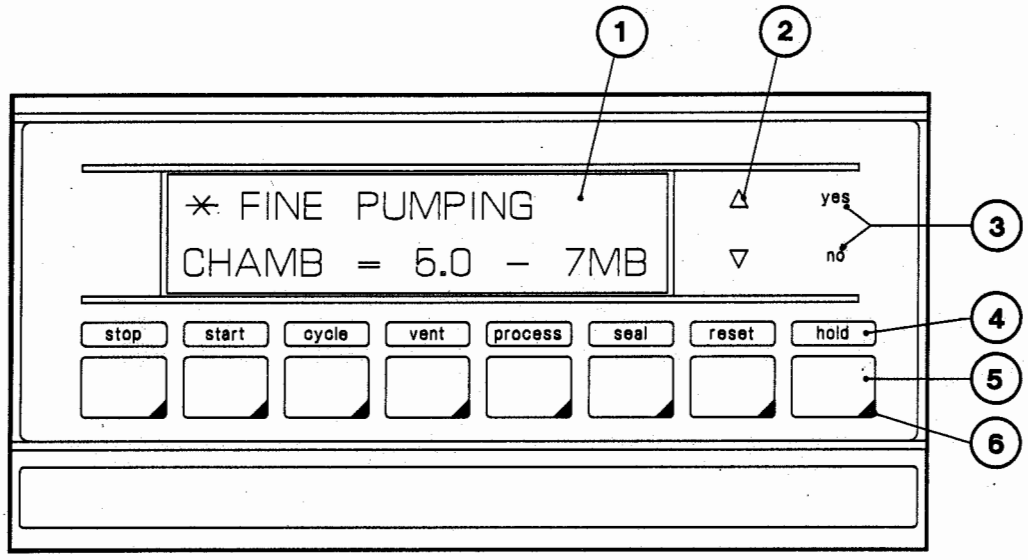
yes Pressing the 'yes' key accepts or enters the option displayed on the top line of the fluorescent display.

no Pressing the 'no' key changes the display to the next highest menu level.

stop The 'stop' button closes down the pumping system.

start The 'start' button starts or restarts the pumps running and puts them in the 'ready' mode.

cycle Pressing 'cycle' initiates the pumping cycle and opens the high vacuum valve but does not activate the process relays.



1. Two Line Fluorescent Display
2. Scroll Button
3. 'yes' and 'no' Switches
4. Switch Annotation
5. Switch
6. LED Indicator

Figure 17 - Controller Front Panel

vent — Pressing 'vent' closes the high vacuum valve and returns the pumping system to the backing condition. It also switches off the process relays and vents the chamber to atmosphere.

process — Pressing the 'process' button initiates the same pump down sequence as 'cycle' and then moves the coater into the 'plasma process' mode, during which, process operations such as HT cleaning are performed.

seal — Pressing 'seal' closes the high vacuum valve, returns the system to the backing condition and switches off the process relays.

reset — Pressing 'reset' resumes a normal pump down sequence at a safe point following an error condition.

hold — Pressing 'hold' suspends the system in its current state of operation thus enabling, for example, longer roughing or process times.

Each of the switches on the bottom row is fitted with an LED in the bottom right hand corner; the switch can only be operated when the indicator is illuminated, thus providing protection from improper operating sequences.

4.2.2 Password Operation

Password protection provides three levels of security to the system, thus preventing alterations to the pumping configuration which could prove harmful to the system. The password control applied to each level of the system is shown in Figure 18.

The passwords are created using the master password supplied at the front of this manual and can be changed if required. To prevent unauthorised operation in the wrong mode, some levels of menu require a password to exit to the next highest level.

To carry out the following procedure the system master password must be known. If the password system is to be used, it is first necessary to enter the passwords for each of the three levels before the initial settings can be made. Alternatively the password system may be switched off altogether using the master password.

To set the system passwords, select ADJUST MODE from the MODE SELECT menu and then select PASSWORD CONTROL. The prompt will be:

Press	Display Reads	Function
	PASSWORD CONTROL	
yes	PASSWORD ENTRY MASTER = #	Flashing #, prompting the entry of the first digit
▲ or ▼	MASTER = 1	To enter first master digit
yes	MASTER = 1#	To accept the choice and move on to the next digit. Repeat for all four digits
yes	PASSWORD OFF	This display will show the current password status (either on or off)
▲ or ▼	PASSWORD ON	To change the status, if necessary, to on
yes	LEVEL 1 = #	Prompting the entry of the first digit
▲ or ▼	LEVEL 1 = 2	To select first digit (in this example '2')

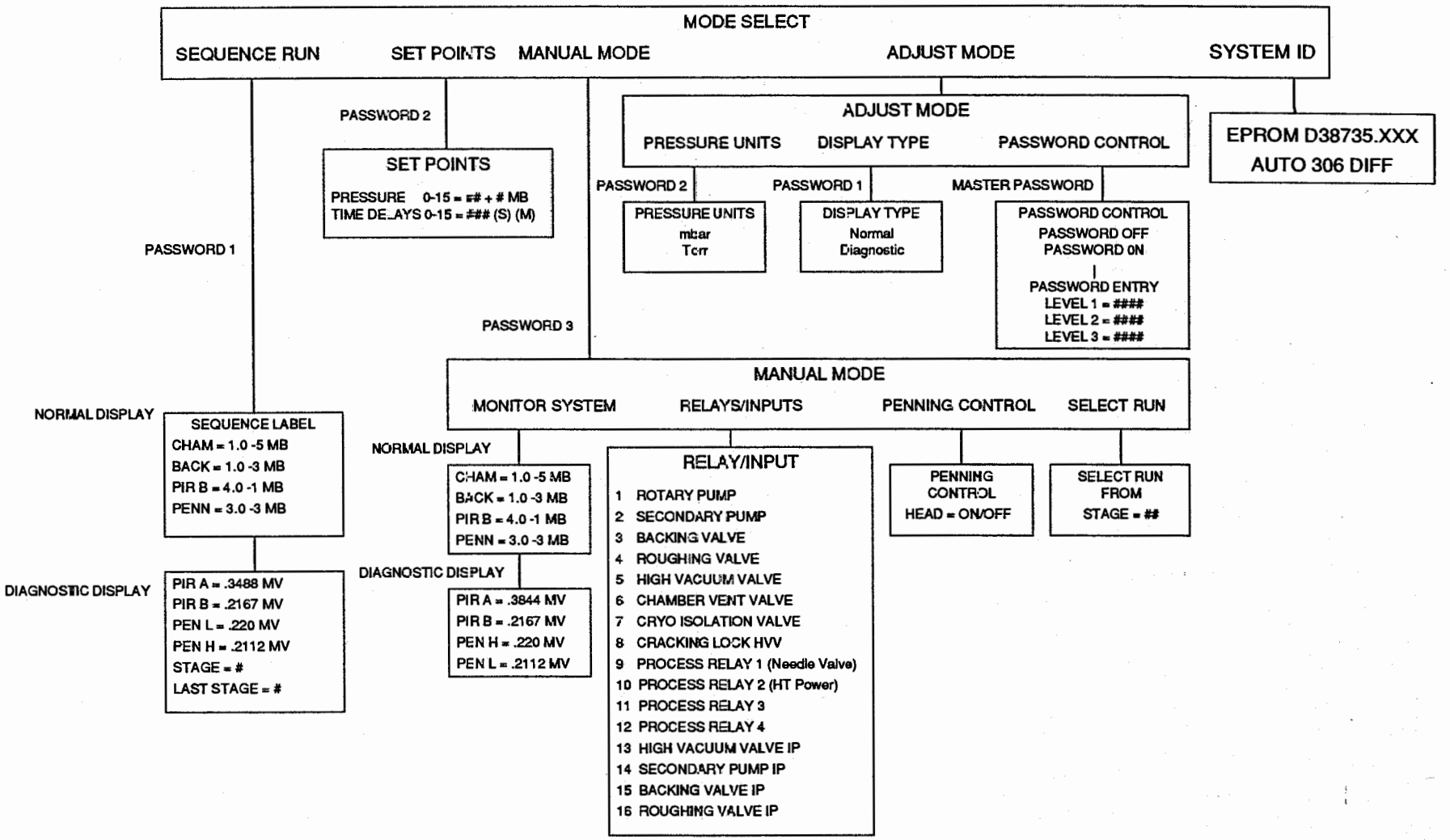


Figure 18 - Controller Menu Configuration

Press	Display Reads	Function
yes	LEVEL 1 = 2#	Prompting the entry of the second digit
▲ or ▼	LEVEL 1 = 23	To select the second digit

Repeat these steps to select up to four digits then press 'yes' twice. If less than four digits are required, press 'yes' twice after selecting the last required digit. The controller will now promt the selection of the second password which may be entered in the same manor as password one. If the password is not required, press 'yes' twice to move on to the next password.

Once the passwords have been set and the PASSWORD menu is left, the master password will be required to alter the passwords.

4.2.3 Manual Control

CAUTION

Follow the Controller operation procedure carefully to avoid incorrect operation which could damage the coater.

The Controller can be operated in the manual mode which provides direct control of the relays. It should be noted, however, that this should only be performed by an experienced operator, such as a service engineer as in the manual mode, the normal interlocks are inoperable such as venting the chamber with the high vacuum valve open and the secondary pump operating. Such procedures, if not carefully controlled, can cause harm to the vacuum system.

4.2.4 Customer Set Points

The primary function of the Controller is to provide automatic control to the pumping system by monitoring the system and timing events to provide appropriate control functions (i.e. relay operations) at given points throughout the program. Although it is not possible for the operator to alter the sequence of events in the program, it is possible to alter a number of the key time and pressure values to suit the process application. These values are set in accordance with the following examples:

1. To set time store 7 to 20 seconds

Press	Display Reads	Function
	MODE SELECT	
▲ or ▼	SET POINTS	
yes	PRESSURE	
▲ or ▼	TIME DELAYS	
yes	# = # SEC (MIN)	To select time store
▲ or ▼	# = # SEC (MIN)	To scroll through store number and set points
yes	7 = ### SEC	To display value in time store 7
yes	7 = #	Prompting the entry of a number
▲ or ▼	7 = 2	Alters the prompt to a digit, scroll to select the correct value
yes	7 = 2#	To accept the value and proceed to the next digit. Repeat selection for the next digit
	7 = 20#	Pressing yes without pressing ▲ or ▼ will move the prompt onto the next item to be selected (i.e. minute or seconds) ignoring the 3rd digit
yes	7 = 20 #	Flashing prompt to select seconds or minutes
▲ or ▼	7 = 20 S	At this point the 'S' will be flashing

Press	Display Reads	Function
yes	7 = 20 SEC	The display will stop flashing denoting that the value has been entered into the store

2. To set pressure store 13 to 1.0×10^{-5} mbar

Press	Display Reads	Function
	MODE SELECT	
▲ or ▼	SET POINTS	
yes	TIME DELAYS	
▲ or ▼	PRESSURE	
yes	# = ## ± # MB	To select pressure store
▲ or ▼	# = ## ± # MB	To scroll through store number and set points
	13 = 2.0 ± 5 MB	To display pressure in store 13 (for example)
yes	13 = #.# ± #	Clears the existing value and leaves a flashing #, prompting the entry of a number
▲ or ▼	13 = 1.# ± #	Alters the prompt to a digit, scroll to select the correct value
yes	13 = 1.0 #	To accept the value and proceed to the next digit. Repeat the selection for the next digit. Pressing yes without pressing ▲ or ▼ will move the prompt onto the next item to be selected (i.e. the exponent)

Press	Display Reads	Function
yes	13 = 1.0 ± #	Flashing # prompting the selection of the exponent. Select as per other digits, using the ▲ switch to display negative exponent values
yes	13 = 1.0 -5	At this stage the exponent will be flashing
yes	13 = 1.0 -5 MB	The display will stop flashing, denoting that the value has been entered into the store. Check the value - if an error has been made, press yes to clear the value and then re-enter as detailed above
no		To take the controller back up the menu (i.e. to set another store value or, if pressed repeatedly, back to the mode select menu

The function of each set point is as follows:

Delay 0: Diffusion pump cooling time (rotary pump running)

Delay 1: Diffusion pump warm-up time. This is usually set to zero minutes and is overridden by the thermal snap switch.

Delay 2: High vacuum valve closure time, i.e. the time taken for the high vacuum valve to fully open or fully close.

Delay 3: Other valve closure time, e.g. the time taken for the backing and roughing valves to fully open or fully close.

Delay 4:	Roughing limit - If the system remains in roughing for more than the limit period, an error condition is indicated. The 'hold' function does not disable this error check.
Delay 5:	Pump down limit - If the system remains in the pump down stage for more than the limit period, an error condition is indicated. The 'hold' function does not disable this error check.
Delay 6:	Fine pumping limit - If plasma process is operational and the pressure set point in pressure store 13 is not achieved during the period set by this limit, an error condition is indicated. The 'hold' function disables this error check.
Delay 7:	HT time - If plasma process is operational (i.e. 'process' selected instead of 'cycle'), this is the plasma process time. The 'hold' function will extend this time. If this time is set to zero seconds, the Controller by-passes this function (i.e. assumes that the function is not required).
Delay 8:	Delay to close vent valve - vent valve closes after this time and system reverts to 'sealed' (to avoid continuous gas loss from cylinders, etc.)
Delay 9:	Backing error limit - If the backing pressure rises above the value stored in Pressure Store 5 for longer than this period a backing error will be displayed.
Delay 10:	Foreline pumping limit - If the backing pressure remains above Pressure Store 6 for longer than this period with both roughing and backing valves shut a backing error will be displayed.
Delay 11:	Spare
Delay 12:	Spare
Delay 13:	Spare
Delay 14:	Delay to start process relay 3
Delay 15:	Spare

Each of the delays is adjustable within set limits and the Controller will not accept attempts to enter values outside the specified range.

Delay Number	Minimum Value	Default Value	Maximum Value
0	1 minute	10 minutes	30 minutes
1	0 minute	0 minutes	30 minutes
2	5 seconds	10 seconds	20 seconds
3	2 seconds	4 seconds	8 seconds
4	1 minute	3 minutes	20 minutes
5	30 seconds	2 minutes	255 minutes
6	0 seconds	10 minutes	255 minutes
7	0 seconds	0 seconds	255 minutes
8	2 minutes	3 minutes	255 minutes
9	5 seconds	10 seconds	20 seconds
10	1 minute	1 minute	1 minute
11	0 seconds	0 seconds	255 minutes
12	0 seconds	0 seconds	255 minutes
13	0 seconds	0 seconds	255 minutes
14	0 seconds	0 seconds	255 minutes
15	0 seconds	0 seconds	255 minutes

Pressure Store 0: Diffusion pump start - Pressure for the transition from backing pump to warm-up

Pressure Store 1: Roughing to pump-down changeover - The pressure at which the system changes from roughing to pump-down. The 'hold' function disables this facility.

Pressure Store 2: Spare

Pressure Store 3: Penning gauge on - The Penning gauge is turned on when the pressure measured by the chamber Pirani head falls below this value. The Penning gauge head switches off when the pressure rises to 10% above this set point.

Pressure Store 4: High vacuum fail - If the chamber pressure exceeds this value when the high vacuum valve is open, an error condition is indicated.

Pressure Store 5: Backing error - If the backing pressure rises above this value for a period longer than that stored in Delay 9, a backing error will be displayed.

Pressure Store 6: Backing valve open - The backing valve will open when the pressure measured on the backing Pirani head is less than this value unless the system is in the roughing state.

Pressure Store 7: High vacuum valve shut - If the pressure on backing Pirani head exceeds this pressure during the transition from roughing to fine pumping (i.e. pump-down stage), the high vacuum valve will shut to prevent backing errors and/or the stalling of the diffusion pump.

Pressure Store 8: Process abort - If the pressure on the chamber Pirani head exceeds this set point during plasma process, an error condition is indicated.

Pressure Store 9: Spare

Pressure Store 10: Spare

Pressure Store 11: Spare

Pressure Store 12: Spare

Pressure Store 13: Plasma process - If the system is in the process mode it will switch from fine pumping to plasma process at this set pressure. The 'hold' function disables this process.

Pressure Store 14: Spare

Pressure Store 15: Spare

Each of the pressure settings is adjustable within set limits and the Controller will not accept attempts to enter values outside the specified range.

Pressure Setting	Minimum Value	Default Value	Maximum Value
0	1×10^{-2}	1×10^{-1}	6×10^{-1}
1	5×10^{-2}	2×10^{-1}	6×10^{-1}
2	0×10^{0}	0×10^{0}	1×10^{3}
3	5×10^{-2}	2×10^{-1}	6×10^{-1}
4	8×10^{-4}	1×10^{-3}	3×10^{-3}
5	3×10^{-1}	6×10^{-1}	1×10^{0}
6	8×10^{-1}	1×10^{0}	2×10^{0}
7	2×10^{-1}	4×10^{-1}	8×10^{-1}
8	5×10^{-3}	5×10^{-1}	1×10^{0}
9	0×10^{0}	0×10^{0}	1×10^{3}
10	0×10^{0}	0×10^{0}	1×10^{3}
11	0×10^{0}	0×10^{0}	1×10^{3}
12	0×10^{0}	0×10^{0}	1×10^{3}
13	0×10^{0}	1×10^{-4}	5×10^{-3}
14	0×10^{0}	0×10^{0}	1×10^{3}
15	0×10^{0}	0×10^{0}	1×10^{3}

4.2.5 Stages and Error Readings

The Controller program is divided into stages which are operated in pre-determined sequences in accordance with the application and operator requirements. Each stage has a label to inform the operator, via the Controller's display, of the status of the system. If an error condition is displayed, pressing the 'reset' button will return the display to the fail safe system condition from where the appropriate action can be taken to clear the fault (e.g. 'DIFF PUMP FAIL' - check cooling water supply.

The following list details all of the programmed stages that are employed by the Controller that have display and error labels associated with them:

Stage No.	Function	Stage Label
1	Power fail	POWER FAIL
9	Standby	STANDBY
10	Backing	BACKING
11	Pump warm up	PUMP WARM UP
12	Pump cool down	DIFF PUMP OFF
13	Sealed	SEALED
14	Chamber vent	CHAMBER VENT
16	Roughing	ROUGHING
17	Pump down	PUMPDOWN
18	Fine pumping	FINEPUMPING
20	Plasma process	PROCESS

Stage No.	Function	Error Label
58	Plasma process aborted	PROCESS ABORT
59	Gauge error head 2	HD2 GAUGE ERROR
61	High vacuum fail	HIGH VAC FAIL
62	Fine pumping limit (plasma process)	LIM FINEPUMPING
64	Roughing fail	ROUGHING FAIL
65	Rotary pump fail	ROT.PUMP FAIL
67	Backing error	BACKING ERROR
68	Cooling Fail	DIFF PUMP FAIL
70	Roughing valve error	R VALVE ERROR
71	Backing valve	B VALVE ERROR
72	High vacuum valve error	HV VALVE ERROR
76	Diffusion pump error	DIFF PUMP BACKING ERROR
77	Gauge error, head 1	HD1 GAUGE ERROR
90	Process time not set	PROCESS TIME ??

4.2.6 Relays and Inputs

The relay and input information for the Controller are summarised in the following table:

Input/Relay Number	Function	Display
1	Rotary pump	1 ROTARY P. OFF/ON
2	Diffusion pump	2 SEC. PUMP OFF/ON
3	Backing valve	3 BACKING V OFF/ON
4	Roughing valve	4 ROUGH V OFF/ON
5	High vacuum valve	5 HI VAC V OFF/ON
6	Air admit valve	6 VENT V OFF/ON
7	Spare	7 CRYO ISOL V OFF/ON
8	Cracking lock (high vacuum valve)	8 CRACKING OFF/ON
9	Process Relay P1 (Needle valve)	9 NEEDLE/P1 OFF/ON
10	Process Relay P2 (HT power supply)	10 HT PWR/P2 OFF/ON
11	Process Relay P3	11 RELAY P3 OFF/ON
12	Process Relay P4	12 RELAY P4 OFF/ON
13	High Vacuum Valve	13 HI VAC IP OFF/ON
14	Diffusion pump IP	14 SEC PUMP IP OFF/ON
15	Backing Valve IP	15 BACK V IP OFF/ON
16	Roughing valve IP	16 ROUGH V IP OFF/ON

4.3 Preparing the Coater for Operation

4.3.1 Charging with Liquid Nitrogen

Liquid nitrogen is required for use in the liquid nitrogen trap on the inlet of the diffusion pump.

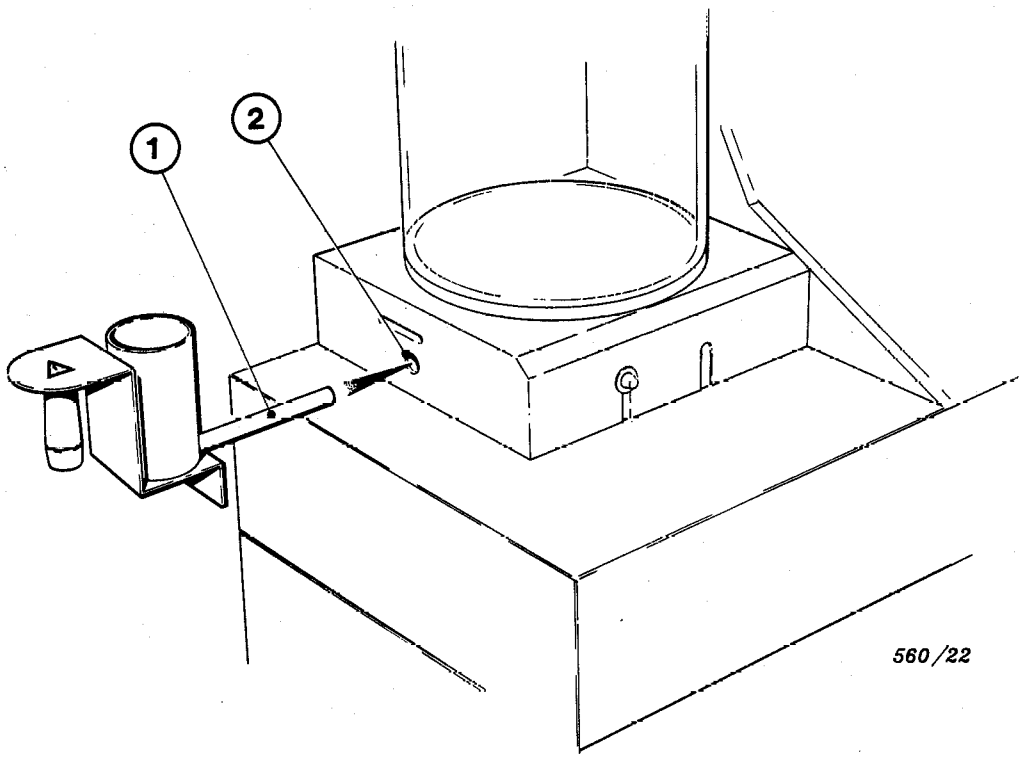
WARNING

Use only liquid nitrogen for filling the trap, other liquid gasses are not suitable. Read the safety instructions for the handling and use of liquid nitrogen (Publication No. K100-00-88) before proceeding.

The entry port for the liquid nitrogen trap is located at the left-hand side of the chamber and under the baseplate (see Figure 19). The reservoir has a liquid capacity of 1.4 litres which is sufficient for about eight hours use under normal operating conditions.

The liquid nitrogen filler fits into the liquid nitrogen trap entry tube on the baseplate shroud. Liquid nitrogen should be carefully poured into the trap from a suitable container, observing the normal safety precautions such as gloves and face protection.

The liquid nitrogen trap can also be filled using large, freestanding pressurised liquid nitrogen vessels via a pipe, no larger than 12 mm diameter, inserted into the filler tube. Ensure that the "boil off gasses" are freely vented during this process to avoid pressure build up within the trap which could forcibly eject the filler tube.



1. Liquid Nitrogen Filler
2. Trap Entry Tube

Figure 19 - Filling with Liquid Nitrogen

NOTE: During the initial fill from ambient temperature, nitrogen will boil from the trap and a quantity greater than the capacity of the trap will be required.

4.3.2 Connection of Gas Supplies

When the process application requires a supply of gas (such as argon or helium) the supply must be connected to GAS ADMIT inlet (see Figure 13) using a length of suitable tubing.

> **WARNING**
>
> **Ensure that any pressurised gas supply connected to the vacuum coater is adequately pressure regulated (0.1 bar max.) and vented.**

4.4 Start-up

The following procedure should be used for starting-up the vacuum coater unit when preparing it for use (refer to Figure 17 for details of the Controller switch positions and Figure 20 for the location of the mains switch):

> **WARNING**
>
> **An implosion guard must be used when a glass process chamber is employed (see Publication No. 11-E090-27-880 supplied with this manual).**

> **WARNING**
>
> **Overriding the software that is pre-programmed into the Controller can cause hazardous high vacuum valve closure.**

1. Turn on the cooling water supply; ensure that a minimum flow rate of 75 litres per hour at 20°C is available.
2. Switch on the electricity supply to the unit.
3. Switch on the electrical power at the coater control panel and check that the reset button on the Controller is illuminated.

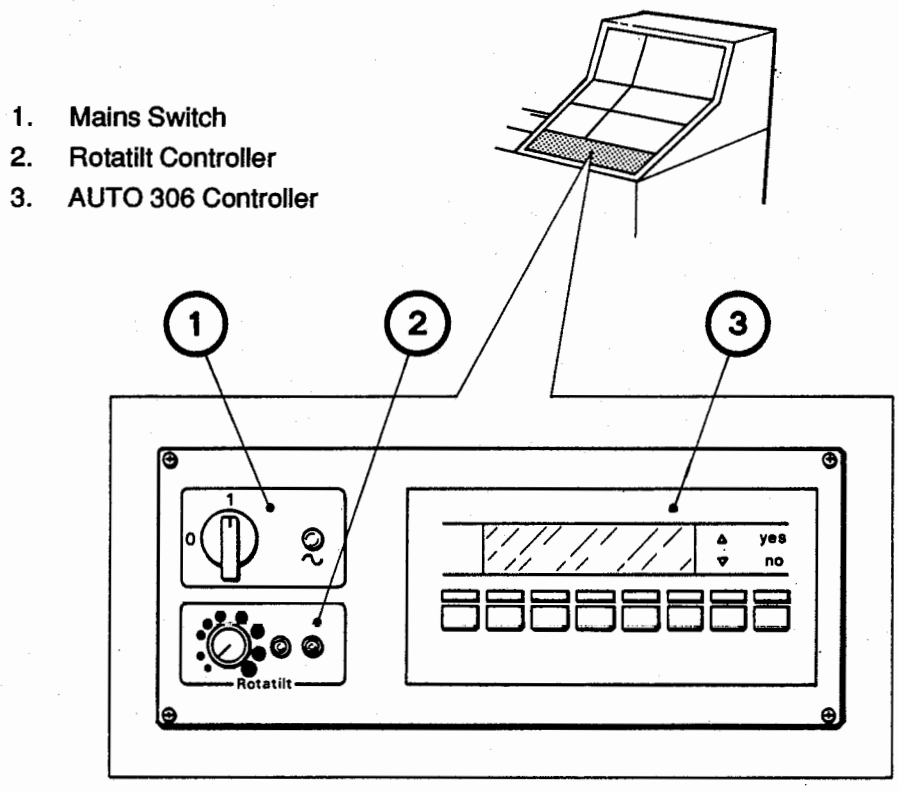


Figure 20 - Location of Mains Switch

4. Using the Controller, prepare the coater for use as follows:

Note: If the unit is switched off during operation, the controller will memorise the last stage and attempt to recover the process from that point. If this is the case * POWER FAIL *may not be the display label.*

Press	Display Reads	Notes
	* POWER FAIL	Reset button will illuminate
reset	* STANDBY	
start	* PUMPS ON	
	* BACKING	Rotary pump running and diffusion pump will start its warm-up period
	* PUMP WARM UP	After approximately 20 minutes the display will change to -

Press	Display Reads	Notes
	* SEALED	

At this point the coater is ready for use. If the trap is not already charged with liquid nitrogen refer to Section 4.3.1 and then the process chamber can be prepared for use as follows:

Press	Display Reads	Notes
vent	* CHAMBER VENT	

When the chamber reaches atmospheric pressure, open it and load with the substrates and materials for evaporation

Press	Display Reads	Notes
cycle or process (as applicable)	* ROUGHING	Pump down sequence commences
	* PUMP DOWN	
	* FINE PUMPING	
process	* PLASMA PROCESS	

5. Carry out the required process operations.

6. Close down the system in accordance with the instructions contained in the Section 4.6 - Closing Down.

4.5 Plasmaglo Cleaning and Related Plasma Processes

Plasmaglo cleaning is used to prepare surfaces such as glass prior to coating to ensure adherent films. The process will not clean heavy contamination, but will remove the mono-layers of hydrocarbon and water radicals left after normal cleaning processes.

In electron microscopy applications, difficulty sometimes occurs when using negative stains on carbon coated grids because the stains do not wet the film surface evenly and cause the specimens to dry unevenly and agglomerate. Carbon films exposed to a low power glow discharge will develop a hydrophyllic surface so that negative stains wet the surface evenly.

The Edwards patented 'Plasmaglo' systems employs an electrode shield so that high energy electrons from the cathode dark space are unable to impinge directly on the carbon film or specimen. This prevents undesirable decomposition of any hydrocarbon molecules but does ensure their removal from the film or specimen surface.

The following instructions assume that the coater is switched on and prepared for operation and that the accessories required for glow discharge cleaning are fitted and that time delay 7 is set. The procedure is also applicable when using the DC sputtering accessory E090 50 000.

1. Using the Controller, prepare the coater for use as detailed in Section 4.3 and 4.4, then proceed as follows:

Press	Display Reads	Notes
process	* ROUGHING	Pump down sequence commences
	* PUMP DOWN	
	* FINE PUMPING	
	* PLASMA PROCESS	

2. Ensure that the variable transformer is in the zero position (fully anticlockwise).

3. Switch the LT/HT selector switch to HT.

4. Slowly increase the setting of the variable transformer until the expected current for Plasmaglo cleaning is reached (about 1.3A). It will be necessary to adjust the needle valve for optimum discharge (i.e. when the plasma extends over the maximum volume).

It will be useful to note the needle valve setting, the current and variable transformer settings and the chamber pressure for future use.

5. Plasmaglo clean for the required time and note this time. As a general guide 10 minutes is typical. However, this varies greatly depending on many parameters, the material being cleaned is an example. It is recommended that a range of times is tried and a suitable cleaning time judged from subsequent coating results.

6. Close the needle valve

CAUTION

Do not use excessive force to close the needle valve

7. Return the variable transformer to zero and switch the HT/LT selector switch to off.

8. At the end of the process, the high vacuum valve will automatically open and the system will continue to pump in preparation for further processes.

4.6 Closing Down

4.6.1 To Unload the Chamber

1. Press 'vent' on the Controller and wait until the chamber is at atmospheric pressure (approximately one minute).

2. Remove the implosion guard and bell jar

3. Unload the chamber

4. The chamber can then be reloaded ready for the next evaporation cycle if required.

4.6.2 To Close Down the Unit Completely

1. Unload the chamber as described above.

2. Reposition the bell jar and implosion guard.

3. Press ' cycle' on the Controller

4. Allow the chamber pressure to fall to 3×10^{-4} mbar or lower.

5. Press 'seal' and then 'stop' on the Controller; the system will close down and the display will read * DIFF PUMP OFF and then * STANDBY.

6. After about 20 to 30 minutes the diffusion pump will be cold.

7. Switch off the mains isolator on the front panel.

8. Turn off the cooling water.

CAUTION

Surfaces within the coater may remain cold for several hours due to the liquid nitrogen that is present in the trap.

Note: It is recommended that the unit is left under vacuum when not in use. Weekly checks should be made to maintain the vacuum when the unit is not in use for long periods.

5 OPERATING TECHNIQUES

The following information on the techniques used in vacuum coating is intended as a guide only as each process is dependant on a number of factors, including the materials being processed and the accessories that are fitted. In addition a number of the processes may be used together or sequentially (e.g. evaporation from carbon source and filament source) to obtain different results.

Coating and electron microscopy techniques and theories are dealt with in a number of standard text books, the following two being particularly recommended:

Handbook of Thin Film Technology - L. I. Maisel and R. Glang	Published by McGraw Hill New York
*Vacuum Deposition of Thin Films - L. Holland,	Published by Chapman and Hall
*Techniques for Electron Microscopy - D. H. Kay,	Published by Blackwell Scientific Publications - Oxford.
Replica, Shadowing and Freeze Etching Techniques - J. H. M. Willison and A.J. Rowe	Published by North-Holland

* Out of print

WARNING

Intense light can be emitted from evaporation sources or ion gauges. Always use dark safety glasses when viewing hot sources.

WARNING

Surfaces within the auto 306 can exhibit extremes of temperature. Ensure that adequate precautions are taken to avoid touching hot or cold surfaces such as the diffusion pump body, source holders, targets and components associated with Plasmaglo and other HT discharge processes.

WARNING

High voltages may be generated within the auto 306. Switch off and disconnect the electrical supply before fitting accessories. Electrical connections to components should be performed by a qualified electrician.

5.1 General Evaporation from a Filament Holder or Turret Source (Static Work)

This process assumes the use of one or more of the following accessories:

- Filament holder or turret source
- Plasmaglo bombarding rings
- Radiant heater
- Source shutter
- Selector switch (if using two or more filament holders)
- LT/HT controller
- HT power supply
- LT transformer kit
- Baffle Plate and Tripod
- Work holder

1. Load the substrates and evaporation materials into the chamber.
2. Close the chamber by repositioning it on the baseplate and fitting the implosion guard.
3. Press the 'cycle' button, or the 'process' button if the Plasmaglo accessory is fitted.
4. The system will pump down and go into the plasma process if 'process' was selected.
5. Adjust the needle valve and chamber pressure to read 8×10^{-2} (approximately) on the second line of the Controllers display. The backing pressure can be checked by using the scroll keys to alter the information displayed on the second line of the Controller display. Backing pressure should not be allowed to approach the error value set in pressure store 6.
6. Select HT on the HT/LT controller
7. Slowly increase the setting of the variable transformer until the expected current for Plasmaglo cleaning is reached. If necessary, adjust the high vacuum valve and needle valve for optimum discharge (i.e. when the plasma extends over the maximum volume). The high vacuum valve will open at the end of the process time as set in time delay 7 (see Section 4.2 - Using the Controller).
8. Plasmaglo clean for the required time and note this time. As a general guide 10 minutes is typical. However, this varies greatly depending on many parameters, (e.g. the material being cleaned). It is recommended that a range of times is tried and a suitable cleaning time judged from subsequent coating results.

9. Gently close the needle valve and return the variable transformer to zero and turn off the LT/HT switch.

10. Switch on the radiant heater and set the required substrate temperature on the digital temperature controller.

11. Ensure that the source shutter is covering the source.

12. Ensure that the variable transformer is in the zero position.

13. Select LT on the LT/HT switch

14. Slowly rotate the variable transformer to a setting to give a current below evaporation current but sufficiently high to degass the source (and evaporant). Note the current and variable transformer settings for future use.

15. Slowly increase the current to the evaporation level. Open the source shutter and deposit the evaporant to the required thickness. Note the current and variable transformer setting for future use.

16. Return the variable transformer to zero and the LT/HT switch to off. Switch off the radiant heater.

17. If further source positions are to be used repeat steps 10 to 16 using the LT selector switch.

18. If a four position turret source is used, rotate the sources into position and repeat steps 10 to 16. Ensure that the variable transformer is at the Zero setting before rotating the source turret.

Electron beam evaporation sources may be used instead of thermal sources - see the separate instructions supplied with the electron beam source accessory for further details.

5.2 Sputtering

This process assumes the use of the d.c. Sputtering Accessory (E09050000)

1. Prepare the coater for operation and pump down using the 'process' sequence on the Controller.

2. Connect a suitable gas supply (e.g. air, argon, argon/oxygen) regulated at a low pressure (0.1 bar) to the needle valve nozzle on the side of the cabinet - see Section 4.3.2 for details.

3. The coater will go into the plasma process and the high vacuum valve will be throttled.

4. Adjust the needle valve until the chamber pressure is about 10^{-2} mbar. The backing pressure can be checked by using the scroll keys to alter the information displayed on the second line of the Controller display. Backing pressure must not be allowed to approach the error value set in pressure store 6.

5. Ensure that the variable transformer is in the zero position (fully anticlockwise).

6. Select HT on the LT/HT switch.

7. Slowly increase the variable transformer setting until the expected sputtering current and voltage are reached. It may be necessary to adjust the needle valve setting and the current to obtain the required sputtering characteristics. It will be useful to note the needle valve setting, the variable transformer setting and the sputtering current and voltage for future use.

8. Sputter for the required time to deposit the required thickness. Note the time.

9. Return the variable transformer to zero and cancel the HT switch.

10. Close the needle valve.

11. Press 'cycle' on the Controller unless the time set for process is near to completion, in which case the system will complete the process automatically; at the end of the process the system will go into fine pumping and the chamber can be vented by pressing the 'vent' button if required.

5.3 Coating for Electron Microscopy

The following processes can be carried out with the Edwards AUTO 306 coater depending on the accessories that are fitted:

- Manufacture of support films - using carbon or silicon monoxide.
- Manufacture of replicas - using carbon, platinum/carbon, silicon monoxide, etc.
- Shadow casting - using platinum/carbon or high density metals.
- Cone shadowing.
- SEM coating

5.3.1 Carbon Support Films and Replicas

Support films are used to hold small specimens in place on microscope grids. Generally a support film is used to stop the sagging of thin section specimens when these are mounted on the specimen grids.

The use of plastic films, although easy to manufacture down to about 200Å thickness, is not favoured because they distort and are degraded in the microscope electron beam. They also have an inherently high background structure. For this reason evaporated carbon films are used which are almost structureless and conduct heat, generated by the electron beam, away from the specimen. It is easy to make thin carbon films between 20 and 100Å thickness by evaporation techniques and their strength and opaqueness facilitate their handling.

It is not always possible to place the specimen on an electron microscope grid and therefore a replica is sometimes made of the surface features of the specimen.

Replicating materials are usually plastic films, but these have a high background structure, giving rise to misinterpretation of results, and do not always follow closely the surface topography.

The use of carbon deposited directly on the specimen to form a replica gives the best results, but it is not always possible to remove the carbon film from the specimen other than by destroying the specimen. An alternative technique to overcome this is to make a plastic replica of such a specimen and then deposit carbon on this plastic replica. It is easy to remove the carbon replica which has better resolution and is more stable in the electron beam than the primary plastic replica.

This process assumes the use of the following accessories:

- Carbon evaporation source
- Filament holder
- Selector switch
- LT/HT control unit
- LT transformer (10V 90A, 30V 30A)
- Baffle plate and tripod

The process given in the following steps is for downward evaporation.

1. Place the substrate (mica sheet or glass slide) on the baffle plate.

2. Set the carbon evaporation source in the upper position and close the work chamber.

Note: For evaporation using pure carbon the electrodes are attached to the leadthroughs in positions 5 and 6 of the baseplate - See the appropriate accessory manual for full details.

3. Pump the system down to a pressure of 10^{-4} mbar or lower.

4. Select LT on the LT/HT selector switch and slowly increase the variable transformer until the source glows.

5. Increase the variable transformer setting to evaporate the carbon until the required thickness is achieved.

Some operators may prefer upward evaporation onto samples in a grid holder mounted in the Rotatilt. Replicas of 'rough' surfaces may be more easily covered if the sample is mounted on a suitable sample holder, fixed to the Rotatilt which is rotated during evaporation.

To produce hydrophyllic support films, glow discharge cleaning (or ion bombardment) is used. The support films are placed on the baffle plate and a glow discharge is generated by the Plasmaglo ion bombardment rings (See Section 4.5 for further details). This is operated for about 10 seconds.

5.3.2 Shadow Casting

This process involves the deposition of materials on to samples to increase their contrast when viewed in an electron microscope. Deposition material is vacuum evaporated at an angle to the surface of the substrate to form shadows which are less electron dense than the coated parts. The shadow can also be used to determine dimensions of surface features provided the shadow angle is known. Shadow casting may be combined with carbon coating to produce shadow replicas.

This process assumes the use of the following accessories:

- Carbon evaporation source
- Filament holder
- LT Selector switch
- LT/HT control unit
- LT transformer (30V 30A, 10V 90A)
- Manual source shutter
- Baffle plate and tripod
- Rotatilt 3 used in conjunction with:
  - Grid holder
  - Plane workholder
  - SEM planetary workholder

1. Follow steps 1 to 3 as detailed in Section 5.3.1.

2. For the manufacture of replicas and cone shadowing switch on the Rotatilt motor; for scanning electron microscope specimen preparation switch on the SEM planetary work-holder motor.

3. Select LT on the LT/HT selector switch and slowly increase the variable transformer until the source glows.

4. Slowly increase the variable transformer setting until the evaporation current is reached. It will be useful to note the current and variable transformer setting for future use.

5. Open the source shutter and evaporate to the required thickness.

Note: If excessive heat is likely to damage the specimen the evaporation can be carried out in steps - for example, one second evaporation followed by one minute waiting time with the source shutter closed to allow the specimen to cool then repeat the process.

6. Close the source shutter, and reduce the variable transformer setting to zero.

7. Switch off the Rotatilt if fitted.

8. Press 'vent' on the Controller.

Some evaporation processes are carried out using the twin electron beam source. Further details on such processes are contained in the instructions supplied with the electron beam source.

5.3.3 Aperture Cleaning

Electron microscope apertures can be vacuum baked and degassed in the coater using a molybdenum boat supported by the filament holder. The procedure is as follows:

1. Place the aperture in a suitably sized molybdenum boat.

2. Pump down the system by pressing 'cycle' on the Controller.

3. Increase the LT variable transformer setting, observing the aperture to ensure that it becomes hot without melting; maintain the temperature for a few seconds then reduce the variable transformer to zero.

4. Shut down the system by pressing 'vent' on the Controller.

5.3.4 Carbon 'String' Evaporation

Some operators prefer to use carbon 'string' to produce carbon support films and replicas.

1. Clamp the carbon string in a filament holder with the posts adjusted to provide a gap of 1 - 1.5 cm and connected to the 30 volt transformer supply (see the filament holder accessory instructions for details).

2. Follow steps 1 to 3 detailed in Section 5.3.1

3. Slowly increase the power on the variable transformer until the string glows red hot to degass it.

4. Open the shutter, then rapidly increase the variable transformer setting to evaporate the string and deposit carbon. Return the variable transformer to zero.

6 MAINTENANCE

6.1 Work Chamber

The workchamber and baseplate must be kept clean of coated deposits. Debris should be removed from the high vacuum valve plate. Soft deposits can be removed by wiping away with a soft rag damped in iso-propyl or ethyl alcohol. For harder deposits a fine grade of emery cloth is recommended. Do not use wire wool since the fine wires break away and can cause damage to O-rings etc. Occasionally dismantle the leadthroughs and clean with iso-propyl or ethyl alcohol.

WARNING

Ensure that the unit is electrically isolated before commencing maintenance work. All electrical maintenance must be performed by a competent electrician

CAUTION

Do not wipe the 'L' section gasket around the chamber with an organic solvent. Use only dry, lint-free cloth or paper tissue.

WARNING

Adequate precautions should be taken when cleaning the work chamber if dangerous substances have been processed. Ensure that suitable protective clothing is worn including gloves and goggles.

WARNING

Alcohol based solvents are highly flammable, avoid contact with the skin. Smoking must be prohibited.

6.2 Backing and Roughing Valves

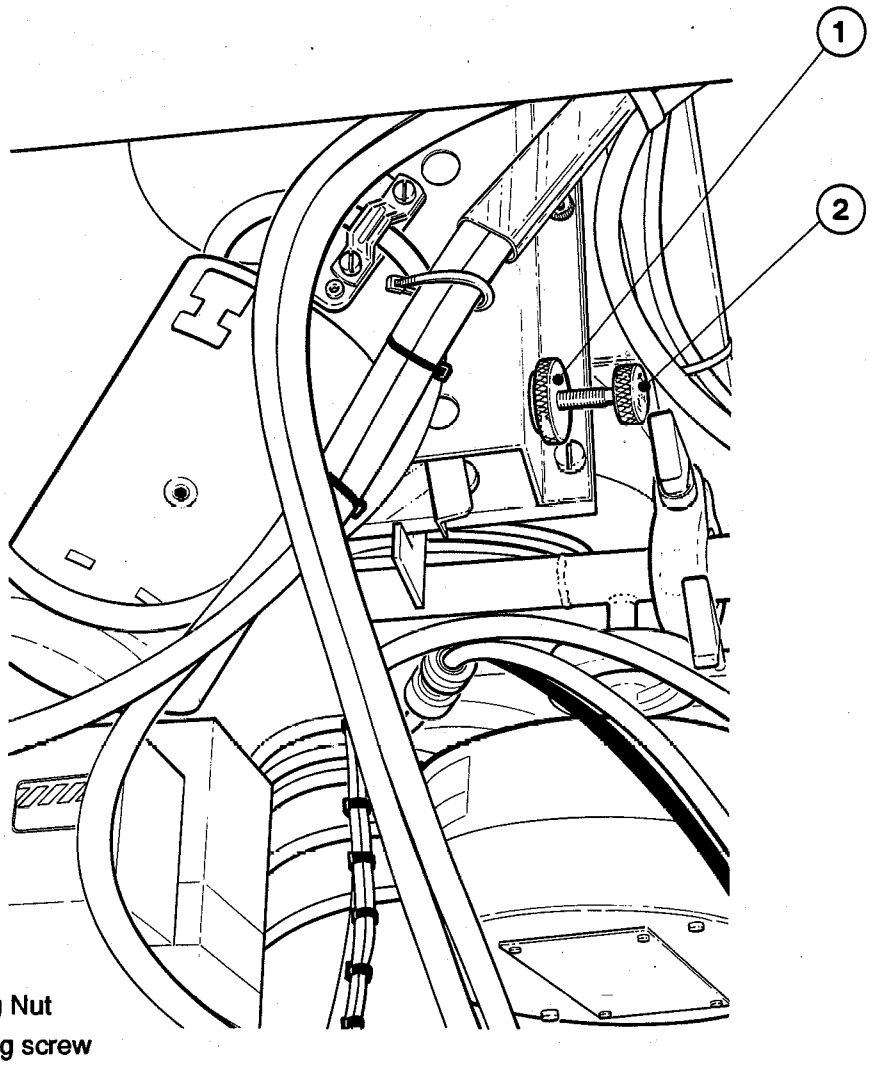
Should leakage across the valve seat be suspected, the seat O-ring seal should be examined for damage and deterioration and must be renewed, if defective. To renew the O-ring seal, refer to the valves own working instructions supplied with this manual (Publication No. 08-C311-07-881).

6.3 Adjusting the High Vacuum Valve

During manufacture the position of the high vacuum valve in its throttled (cracking) position is carefully set so that the chamber pressure, over a wide operating range, when adjusted by the needle valve, does not cause the backing pressure to rise above the limits set in the Controller. It may be necessary to change this setting for particular applications.

WARNING

Ensure that the HT and LT supplies are switched off during the valve adjustment procedure.



1. Locking Nut
2. Adusting screw

560/19

Figure 21 - High Vacuum Valve Throttling Adjustment

1. Pump down the system by pressing 'process' on the Controller and wait for the display to read * PLASMA PROCESS, (i.e. with the high vacuum valve throttled).

2. Adjust the chamber pressure to the required value using the needle valve. If the backing pressure is too high, the high vacuum valve needs to be throttled more by unscrewing (anti-clockwise) the adjustment screw on the side of the high vacuum valve drive mechanism (see Figure 21). If the backing pressure is too low, the valve requires less throttling; tighten (clockwise) the adjusting screw and press 'seal' to close the high vacuum valve and then 'process' to check the adjustment.

3. Lock the adjusting screw by tightening the locking nut.

Leakage across the high vacuum valve is detectable when the high vacuum valve is closed and a backing pressure rise is measured when the chamber is vented. A small rise followed by a recovery is not serious. A larger rise will cause the backing pressure alarm to be initiated, resulting in the switching off of the diffusion pump. In this situation the valve seat and 'O' ring face must be cleaned of deposits. This is performed as follows:

1. Turn off the pumps and allow to cool down (twenty to thirty minutes).

2. Disconnect the unit from the mains.

3. Disconnect one of the battery terminals - See Figure 6

4. Switch on the mains and operate the system in manual mode, with caution.

5. Open all valves to admit air to the whole pumping system and switch off the mains supply.

6. Remove the chamber and wipe away deposits on the 'O' ring and seating area using a lint free cloth moistened with iso-propyl or ethyl alcohol.

7. Reconnect the battery terminal disconnected in step 3.

8. Re-initiate the system and check the operation of the high vacuum valve.

WARNING

In the case of mains failure the system closes down safely and the high vacuum valve is closed by means of a 12 volt battery. If, during maintenance, it is necessary to have the valve lifted for cleaning, etc. at atmospheric pressure, the battery must be disconnected as described above.

The valve mechanism must not be dismantled. If a fault occurs, notify Edwards High Vacuum or your nearest Edwards distributor who will arrange to service the valve.

6.4 Accessories

Glass bead blasting is recommended for cleaning chamber accessories if available. The use of 3M 'Scotchbrite' is also recommended in preference to more abrasive cleaners.

CAUTION

Do not use wire wool to clean accessories as the fine wires break away and can cause damage to 'O' rings and the seal on the high vacuum valve.

6.4.1 Tripod and Baffle Plate

These accessories should be cleaned occasionally as detailed in Section 6.4.

6.4.2 Four Position Turret Source

Occasionally dismantle the turret and clean with a fine grade of emery cloth. Do not grease the chain or bearings of the turret. Check the insulators and clean or replace as necessary. Ensure that there is sufficient grease in the rotary shaft seal (see accessory manual for full details). Occasionally put graphite suspension on moving contacts.

6.4.3 Six Position Electron Bombarded Source

Occasionally dismantle the unit and clean with fine grade emery cloth. Do not grease the chain or bearings of the source. Check the insulators and clean or replace as necessary. Check the hearths and replace as necessary. Check the filament and replace as necessary. Ensure that there is sufficient grease in the rotary shaft seal (see accessory manual for full details).

Further details on the maintenance of the six position electron bombardment source are contained in separate instructions for the accessory.

6.4.4 Filament Holder

Occasionally clean the filament holder with fine grade emery cloth. Clean the leadthrough with fine grade emery cloth.

6.4.5 Source Shutter

Occasionally clean the source shutter with fine grade emery cloth. Ensure that there is sufficient grease in the rotary shaft seal (see accessory manual for full details).

6.4.6 HT Power Supply

Occasionally clean the HT leads and check for signs of cracking, replace as necessary. Clean the leadthroughs. It may be necessary to remove the leadthrough to accomplish this. Check the individual parts of the accessory for HT tracking and replace as necessary.

6.4.7 Plasmaglo Accessory

Occasionally clean the HT shields and insulators with fine grade emery cloth. Check the insulators for cracking and HT tracking and replace as necessary.

6.4.8 D.C. Sputtering Accessory

Clean all parts of the accessory with fine grade emery cloth. Do not use wire wool. Clean the insulators and check them for any cracking or HT tracking and replace as necessary. Clean or renew the cathode as necessary.

6.4.9 Workholder ring

Occasionally clean the workholder ring with fine grade emery cloth.

6.4.10 Radiant Heater

Occasionally clean the radiant heater with a soft to medium grade wire brush. Check the thermocouple leads and insulation and replace as necessary. Polish the reflector with metal polish and wipe clean using a lint free cloth moistened with iso-propyl or ethyl alcohol.

6.4.11 Spherical Workholder

Occasionally clean the spherical workholder with fine grade emery cloth.

6.4.12 Carbon Evaporation Source

Frequently clean the accessory with a fine grade emery cloth or a soft wire brush. Check the carbon rods and sharpen or renew as necessary. Check the insulators and particularly the mica insulators for cracking and renew as necessary. Frequently clean the leadthroughs with a fine grade emery cloth.

6.4.13 Rotatilt Accessory

Carefully clean the accessory with metal polish. Check the drive spring for stretch and replace as necessary; do not spin the drive by hand. Do not oil or grease the bearings inside the chamber. Ensure that there is sufficient grease in the rotary shaft seal. Check the accuracy of the angle setting on the protractor.

6.4.14 SEM Planetary Workholder

Occasionally dismantle the unit and clean with a fine grade emery cloth.

6.4.15 Specimen Holders

Including planetary work holders, grid holders, etc. - clean the entire accessory with metal polish.

6.4.16 Top Plate Counter Balance Accessory

Clean the accessory with a damp cloth. Lightly oil the chain.

6.4.17 Specimen Cooling Accessory

Clean the accessory with fine grade emery cloth. Occasionally check the gasket and replace as necessary.

6.5 Fault Finding

The faults set out below cover most faults that could occur during the normal life of the equipment. Other possible faults are rare or due to mal-operation of the equipment. A list of error messages for the Controller is given in Section 4.2.4.

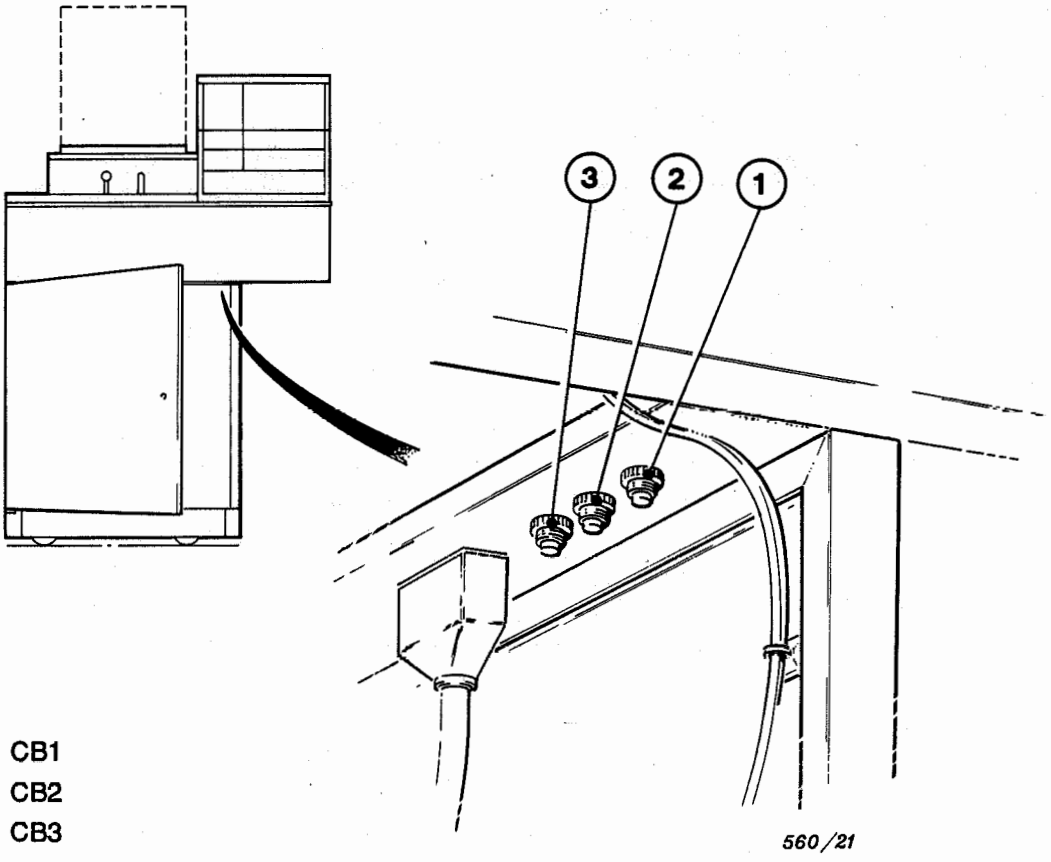
6.5.1 General

If a circuit breaker trips, it should be reset after attempting to determine the cause of the fault. The location of the circuit breaker switches is shown in Figure 22.

No.	Rating	System Protected
CB1	8A	Pumping system
CB2	8A	Accessories (LT/HT supplies etc.)
CB3	0.5A	High vacuum valve

Only the recognised spares supplied by Edwards High Vacuum should be used to replace faulty parts. Certain parts should be replaced only by Edwards High Vacuum International or their

accredited distributors. An indication is given in the following sections as to which parts should be returned to the manufacturer or distributors.



1. CB1
2. CB2
3. CB3

Figure 22 - Location of Circuit Breakers

6.5.2 Rotary Pump Fails To Start

Three main causes of failure to start are possible:

- The rotary pump oil is too viscous (because of low temperature) for the motor to run the pump.
- Because of a faulty connection or open circuit breaker, no voltage is applied to the motor.
- The windings of the motor itself are damaged.

The fault finding procedure is as follows:

WARNING

This procedure must be performed by a qualified electrician

1. Press the red reset button on the motor and start the pump. If the pump does not start proceed with step 2.
2. Switch off the mains supply and remove the rotary pump connection plate.

Note: This is located on the end of the motor and holds the reset button.

3. Connect a multimeter between points A1 and A2 on the motor and set the meter to read the mains voltage on the unit.
4. Switch on the rotary pump.
5. If the meter indicates that the mains voltage is connected then switch off the rotary pump and disconnect the pump from the mains supply.
6. Set the meter to read resistance. If the meter reads approximately 5Ω for a 240V motor then the fault is that the rotary pump oil is too viscous (because of low temperature) for the motor to run the pump; if not the fault is probably due to damaged motor windings.
7. If the meter indicates that the mains voltage is not connected a circuit fault (i.e. a faulty connection or open circuit breaker) is apparent.

The fault correction procedure is as follows:

WARNING

This procedure must be performed by a qualified electrician

1. Check that the mains supply to the unit is healthy.
2. Check the continuity of the supply circuit fuse (or operation of the supply circuit breaker).
3. Check the wiring for loose connections and continuity.
4. If the fault cannot be found notify Edwards High Vacuum.

6.5.3 Rotary Pump Performance Poor

The performance of the rotary pump may be poor during either backing operations only or all operations and can be caused through:

- A leak in the system
- The rotary pump oil being contaminated
- The foreline trap being contaminated

If the rotary pump oil is contaminated, open the gas ballast valve on the rotary pump and run the pump for 30 minutes. If the pressure does not improve check the condition of the rotary pump oil and change if necessary. If this fails, check the system for leaks (See Section 6.6 - Leak Detection) and effect the necessary repairs.

If the fault lies in a contaminated foreline trap see the separate working instructions relating to Foreline Traps supplied with this manual.

6.5.4 Diffusion Pump not Operating

Three main causes of failure of the diffusion pump are possible:

- Because of a faulty connection or tripped circuit breaker, no voltage is applied to the pump heater.
- Pump heater failure.
- Thermal snap switch operating due to low water supply.

The fault finding procedure is as follows:

> **WARNING**
>
> **This procedure must be performed by a qualified electrician.**

1. Turn on the water, and pump down the system (see Section 4.4)
2. Connect a multimeter set to read the mains voltage of the unit across the heater of the vapour pump; re-set the trip switch (CB1) if necessary.
3. Switch on the diffusion pump and check that mains voltage is connected across the heater. If meter does not indicate mains voltage, a circuit fault is apparent. Check circuit for loose or broken wires.

4. If the meter shows that mains voltage is connected to the pump, switch off the diffusion pump, disconnect the heater connections from the mains supply and set the meter to read resistance.

5. If the meter does not indicate a heater resistance of 60-70 Ω then the heater is damaged. The procedure for renewing the diffusion pump heater is described in the supplementary instructions supplied with this manual.

6.5.5 Diffusion Pump Performance Poor

The performance of the diffusion pump may be poor for the following reasons:

- Contaminated system
- Leaking system
- High backing pressure
- Water flow not sufficient
- Pump not warmed up
- Low diffusion pump level

Fault finding procedure

1. The first three reasons for poor performance usually coincide with a drop in performance of the rotary pump and hence are corrected in the same way.

2. Always allow the required time for warming up.

3. Check that the water supply is sufficient. The temperature at the outlet should not rise above 35°C. Check the water line system for a blockage. If a blockage is found, blow compressed air through the system via the cooling water inlet connection.

6.5.6 HT and LT Power Failure

There are four possible reasons for HT or LT failure:

- Circuit breaker (CB2) tripped - press to reset
- LT selector switch in wrong position
- Wire in the circuit loose or broken
- Pressure in system too high

The fault finding procedure is as follows:

1. Pump down the chamber in accordance with the instructions contained in Section 4.4)

2. Check that the LT/HT selector switch is in the correct position.

3. Check the circuit wiring.

4. Continue pumping until the pressure is below 10^{-4} mbar.

Note: The HT and LT circuits have a vacuum operated switch in series and this will prevent the HT and LT from operating until the pressure is low enough (see Section 6.5.7).

6.5.7 Vacuum Interlock Switch

A vacuum operated switch is situated between the secondary pump and the chamber and provides the switching contacts which prevent the operation of the accessories, such as the LT/HT supplies, when the chamber is removed. The switch is sealed for safety reasons and cannot be adjusted. If a fault is suspected, please contact Edwards High Vacuum International or your nearest Edwards distributor.

6.5.8 Penning Gauge Head Faulty

Three possible reasons for the gauge head being faulty are:

- Leak.
- Gauge head dirty.
- Gauge head magnets out of alignment.

The fault finding and correction procedure is as follows:

The first of the reasons stated above is usually coincident with a drop in performance of the diffusion pump and is found in the Section 6.5.5. Diffusion Pump Performance Poor.

Correction of the other two faults is covered in the supplementary instructions relating to Penning Gauge Heads.

6.5.9 Pirani Gauge Head Faulty

Two possible reasons for the gauge head being faulty are:

- Leak.
- Gauge head dirty.

The fault finding and correction procedure is as follows:

The first of the reasons stated above is usually coincident with a drop in performance of the diffusion pump and is found in the Section 6.5.5. Diffusion Pump Performance Poor.

If the function of the gauge head becomes impaired due to exposure to contamination, it should be removed from the unit and either cleaned or returned to Edwards under the exchange/replacement service. Information on the exchange/replacement service together with the cleaning and recalibration details can be found in the supplementary instructions relating to Pirani Gauge Heads.

6.6 Leak Detection

Leak detection is a subject normally covered in text books on vacuum physics and is fairly comprehensive. The following section is for guidance only and the method set out is adequate for most leaks. If, however, small leaks occur in the unit, alternative methods of leak detection may be necessary and reference should be made to the standard works on the subject; a booklet entitled "Mass Spectrometer Leak Detectors", Publication No. 17-D154-31-895 is supplied with this manual.

It is unlikely that fabricated parts of the plant will leak as they undergo stringent leak testing both before and after assembly. These parts may suffer damage in transit, but should only be suspected after all other tests have failed. In general leakage is most likely to occur between sealing faces such as O-ring joints and rubber diaphragms.

6.6.1 Real and Virtual Leaks

It is necessary to establish whether the 'leak' is in fact a true leak or an apparent leak caused through outgassing inside the system. It is necessary to pump the system to its best obtainable vacuum and then seal it and plot a graph of system pressure against time. If this graph is a straight line then it is likely that the leak is a real leak. If the graph reaches an equilibrium pressure, (that is, not a straight line), then it is likely that the leak is apparent and caused through outgassing. The source of outgassing must be sought and removed to correct the apparent leak. Further tests are necessary to find a real leak.

6.6.2 Principle of Leak Detection

When helium or some other suitable search gas replaces air through a leak, the search gas diffuses through the leak at a much greater rate than air. In addition, the sensing element in the system usually has a much greater sensitivity to the search gas than to air.

This principle can be used very conveniently in a vacuum system which utilises a Pirani type gauge head for vacuum measurement since the measuring gauge head can be used as the sensing element. The thermal conductivity of helium for example is nearly twice that of air, hence if helium is present at the Pirani gauge head the apparent pressure reading will increase considerably.

6.6.3 Suggested Method of Leak Detection

Using the Controller as detailed in Section 4.4, pump down the system to its best ultimate pressure. Use the ▲ and ▼ buttons on the Controller to select between backing gauge heads as required and while watching the Controller display, pass a jet of helium or other suitable search gas over the suspected area; as helium is considerably lighter than air it is preferable to start at the top of the system when leak testing.

If a leak is present the display will indicate a sharp rise in pressure. Remove the search gas probe and allow the display to return to the original reading. Repeat the procedure to check the result.

It is necessary to probe the suspected area more than once to avoid false readings caused by transient changes in system pressure which, although unlikely, can occur. Having located the suspected area, the probe can be replaced by a very fine one and the above procedure repeated to pinpoint the leak. Any leak occurring should be cured in the normal way.

7 LIST OF SPARES

Item	Code Number	Description
Rotary Pump		
E2M8	A362-01-800	Spares kit
EMF10 Filter	A223-04-078	Element
Diffusion Pump		
EO4/160K	H017-00-137	Heater 210-225V
	H017-00-134	Heater 230-250V
Control System		
Gauge Heads	D021-58-000	PRL10K
	D021-66-000	PRM10K
	D145-41-000	CP25EK
Solenoid Valves		
Backing and Roughing	D111-23-010	PCB Assy PV10-40EK
Vent	D154-05-761	Coil 220V 60Hz
	D154-05-760	Coil 240V 50Hz
'O' Rings & Seals		
	B271-58-075	ISO 160 Viton-Flange Seal
	B271-58-427	Co-seal NW10/16
	B271-58-448	Co-seal NW20/25
	H021-06-115	'O' Ring 2A Viton
	H021-06-010	'O' Ring 0012
	H021-06-262	PV25EK Body Seal
	H021-24-024	PV25EK Valve Seat
	H021-22-027	'O' Ring Viton
	H021-24-032	'O' Ring 5 x 15 mm, NW10
	H021-24-035	'O' Ring 5 x 28 mm, NW25
	H021-06-226	'O' Ring Viton

If a fault occurs on the AUTO 306 Controller which requires it to be returned for service or repair, it is important that the serial number of the AUTO 306 and the type of secondary pump (i.e. Turbo, Cryo or Diffusion) are notified. This will ensure that the Controller will be correctly configured when it is returned.

COMMUNICATION WITH EDWARDS HIGH VACUUM INTERNATIONAL

Any communication relating to this instruction or the product should be directed to Edwards High Vacuum International or to your supplier.

Please specify:

1. the model, serial number and code

2. the date of purchase

3. your order number and the suppliers' invoice number

EQUIPMENT MUST NOT BE RETURNED WITHOUT PRIOR NOTIFICATION

Health and Safety

Health and Safety at Work Legislation requires every employer to conduct his business so as not to expose persons, not in his employment, to risks to their health and safety. When goods are returned to the supplier, therefore, warning must be given if their usage is likely to render the equipment hazardous in any way. Your attention is drawn to FORMS HS1 and HS2.

Edwards High Vacuum International and its distributors reserve the right to refuse to accept any equipment returned which they have reason to believe may be hazardous.

Damage in Transit

If any damage has occurred in transit, it is important to inform both the carrier and supplier within three days of delivery.

Further advice regarding the return of Edwards' products, or the completion of forms HS1 and HS2 can be obtained from the Warranty or Service departments or the appropriate service centre. A list of appropriate service centres appears overleaf.

EDWARDS SERVICE CENTRES

EUROPE

UNITED KINGDOM

Edwards High Vacuum International
Manor Royal
Crawley
West Sussex RH10 2LW
Tel: (0293) 528844
Fax: (0293) 533453

Edwards High Vacuum International
3 Deerdykes Court South
Deerdykes Road
Westfield
Cumbernauld
Strathclyde G68 9HW
Tel: (0236) 730575
Fax: (0236) 720156

WEST GERMANY

Edwards Kniese & Co
Hochvakuum GmbH
Geschaftsbereich Komponenten
Postfach 1409
D-3550 Marburg
Tel: 49 6421 8030
Fax: 49 6421 80388

ITALY

Edwards Alto Vuoto SpA
Via Carpaccio 35
20090 Trezzano s/n (Milano)
Tel: 2 4840 2258
Fax: 2 4840 1638

USA

EASTERN REGION

Edwards High Vacuum International
2175 Military Road
Tonawanda
New York 14150
Tel: 716 695 6354
Fax: 716 695 6367

Edwards High Vacuum International
1300 East Arapaho Road
Suite 114
Richardson TX 75081
Tel: 214 669 9030
Fax: 215 669 8054

Edwards High Vacuum International
Noxon Business Park
8 D Noxon Road
RR2
Poughkeepsie NY 12603
Tel: 914 471 3152
Fax: 914 471 3253

WESTERN REGION

Edwards High Vacuum International
374 South Milpitas Boulevard
Milpitas
CA 95035
Tel: 408 946 4707
Fax: 408 946 8510

SOUTHERN REGION

Edwards High Vacuum International
2204 Forbes Drive
Austin
TX 78754
Tel: 512 834 8833
Fax: 512 834 1235

PACIFIC

JAPAN

Nissan Edwards Shinku KK
12-15 Shimomaruko 2-chome
Ota-Ku
Tokyo 146
Tel: 3 756 4026
Fax: 3 756 4509

HONG KONG

Edwards High Vacuum (Pacific)
(Part of BOC Limited)
Unit 5, 4/F Kingsford Industrial Centre
13 Wang Hoi Road
Kowloon Bay
Kowloon
Hong Kong
Tel: 3 796 9111
Fax: 3 796 9095

REPUBLIC OF KOREA

Song Won International Co Ltd
Sun In Building
738-41 Panpo-Dong
Seoul
Korea
Tel: 2 515 18115
Fax 2 515 1818

TAIWAN

Zimmerman Scientific Co Ltd
Golden Dragon Building
8FL No. 127
Fu-Shin South Road
Section 1, Taipei
Taiwan
Tel: 2 752 7075
Fax: 2 771 9415

HEALTH AND SAFETY FORM HS1

GUIDANCE NOTE

PROCEDURE FOR RETURNING ALL EQUIPMENT TO EDWARDS HIGH VACUUM INTERNATIONAL OR OUR AUTHORISED DISTRIBUTORS

Our aim is to deal expediently with your product and we therefore seek your co-operation in complying with this Guidance Note and completing form HS2. Its purpose is to enhance health and safety and minimise risk. Adherence to this Guidance Note will assist you in fulfilling your legal obligation.

When returning equipment to us, or our authorised distributor, the following procedure must be followed:-

1. Any fluid or lubricant or gases in the equipment or accessories must be drained or purged by yourselves and disposed of safely.
2. All accessories must be removed and, if contaminated and requiring our attention, sealed in heavy gauge polythene and secured to the pallets with the other equipment.
3. All filter elements must be removed and disposed of by yourselves as contaminated waste, if applicable.
4. All outlets, including those resulting from the removal of accessories, must be sealed with suitable blanking covers or heavy gauge PVC tape.
5. All contaminated equipment must be sealed in heavy gauge polythene, preferably a bag. Large equipment should be securely strapped to a suitable pallet which must be no larger than 510mm x 915mm (20" x 35"). If you have difficulty in complying with this requirement or are returning a product which will not fit onto the specified pallet. please make contact with the service centre prior to despatch.
6. The pallet must be labelled in accordance with the appropriate regulations which cover the Packaging, Transportation and Labelling of Dangerous Substances.
7. You must notify the anticipated delivery date of the equipment in writing by completing Form HS2. This communication must be faxed or mailed first class to our Service or Warranty departments or to our authorised distributor. HS2 forms need to be received before the equipment arrives.
8. A copy of form HS2 must be handed to the carrier who must be informed if the consignment is hazardous. The original HS2 form must be securely fixed to the exterior of the consignment packaging in a suitable envelope.
9. It is recommended that contaminated equipment is transported only in vehicles where the driver is in a separate cab, not sharing the same air space as the load.
10. We want to deal with your equipment as quickly as possible, but failure to comply with the procedure will lead to delay. This could affect the repair, refurbishment, or the issue of credit where appropriate.

NOW PLEASE COMPLETE FORM HS2 IF YOU INTEND TO RETURN EQUIPMENT

HEALTH AND SAFETY FORM HS2

PLEASE READ GUIDANCE NOTE HS1 BEFORE COMPLETING THIS FORM.

INTRODUCTION

The person who completes this document must be personally satisfied that they know of all the types of processes in which the equipment has been used.

Non-completion or incomplete answers will regrettably result in delay. Correct completion of this form will assist you in meeting both your civil and statutory obligations. (Please tick the appropriate boxes)

SECTION ONE

a. Equipment type/model _____

b. Serial No. (if any) _____

c. Has the equipment been used ?

yes ❑ Go straight to Section 2

no ❑ Go straight to Section 4

SECTION TWO

Does the process(es) produce any of the following ?

a. Radioactive hazard yes ❑ no ❑

b. Biological hazard yes ❑ no ❑

c. Potentially harmful substances or gases?

yes ❑ no ❑

d. Any other known substance ?

yes ❑ no ❑

If YES to any of the above complete Section 3, if NO go straight to Section 4.

We will not accept delivery of any equipment that has been radioactively or biologically contaminated, without written evidence of decontamination, e.g. specialist decontamination or laboratory analysis. Alternatively, we will require evidence that the biological process is not harmful. **DO NOT DESPATCH EQUIPMENT**. Phone us first for advice.

SECTION THREE

a. Please list all substances, gases or by-products which may have come into contact with the equipment:

Chemical / Substance Name	Chemical Symbol	Precautions Associated With Substance, e.g. Personal Protective Equipment Required	Action If Spillage Or Human Contact
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

SECTION FOUR

To assist us in quickly meeting your service and warranty requirements, please also complete the following:

Reason for return and/or symptoms of malfunction:

_____

_____

_____

If you have a warranty claim please state our invoice number or that of our authorised distributor:

_____

Name of distributor:

_____

NOW COMPLETE SECTION FIVE

SECTION FIVE: DECLARATION

I have made reasonable enquiry and I believe the information supplied on this form is accurate. No information has been withheld. Procedures stated on form HS2 have been followed.

Please Sign _____

Print Name _____

Your Job Title _____

Name of Organisation _____

Complete Phone Number _____

Date of Signature _____

Anticipated Delivery Date _____

International Sales and Service

United Kingdom
Edwards High Vacuum International
Manor Royal, Crawley
West Sussex RH10 2LW
Tel. (National) Crawley (0293) 528844
(International) +44 293 528844
Telex 87123 EDIVAC G
Fax 0293 533453
Edwards High Vacuum International
is part of The BOC Group plc

Brazil
Edwards Alto Vacuo
(Part of BOC do Brasil Ltda)
Rua Bernardo Wrona 222
02710 – Sao Paulo-SP
Telephone 11 858 0377
Telex 11 30772 EDRS BR
Fax 11 265 2766

Canada
Edwards High Vacuum
(Part of Canadian Oxygen Ltd)
430 South Service Road West
Oakville, Ontario L6K 2H1
Telephone 416 845 3437
Fax 416 845 4924

France
Temescal
An operating unit of
Edwards High Vacuum International
16 Rue Champ Lagarde
78000 Versailles
Telephone 331 39534823
Telex 696715 HUC PROM F
Fax 331 39505416

Hong Kong
Edwards High Vacuum (Pacific)
(Part of BOC Limited)
Unit 5, 4/F Kingsford Industrial Centre
13 Wang Hoi Road, Kowloon Bay
Kowloon, Hong Kong
Telephone 3 7969111
Telex 43393 EHVP HX
Fax 3 7969095

Italy
Edwards Alto Vuoto SpA
Via Carpaccio 35
20090 Trezzano s/n (Milano)
Telephone 2 484 02258
Telex 311345 EDVAC I
Fax 2 484 01638

Japan
Nissan Edwards Shinku KK
12-15 Shimomaruko 2-chome
Ota-Ku, Tokyo 146
Telephone 3 756 4026
Telex 2466404 NES J
Fax 3 756 4509

USA
Edwards High Vacuum International
One Edwards Park
301 Ballardvale Street
Wilmington, MA 01887
Telephone 508 658 5410
Telex 710 347 7672
Fax 508 658 7969

Edwards High Vacuum International
2175 Military Road
Tonawanda
NY 14150
Telephone 716 695 6354
Fax 716 695 6367

Temescal
An operating unit of
Edwards High Vacuum International
2850 Seventh Street
Berkeley
CA 94710
Telephone 415 841 5720
Fax 415 540 6199

West Germany
Edwards, Kniese & Co
Hochvakuum GmbH
Geschaftsbereich Komponenten
Postfach 1409, D-3550 Marburg
Telephone 6421 8030
Telex 482732 EDVAK D
Fax 6421 80388

Edwards Kniese & Co
Hochvakuum GmbH
Industrial Division
Postfach 1569 D-3550 Marburg
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Telex 482375 EKVAK D
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