Edwards

11-E085-91-881
September 1980

Edwards Marburg
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EDWARDS VACUUM COATING UNIT

MODEL E306A   Serial No. 1239

Code 11-E085-91-000

Glasglocke aus "Borosilikat"

Supplementary instructions

E306 accessory instructions	M11913
Recommended safety precautions for handling cryogenic liquids	59-K100-00-880
E2M8 rotary vacuum pump	03-A360-01-880
Foreline traps	M04632
E04 oil vapour diffusion pump	M05764
Pirani vacuum gauges	07-D035-23-880
Pirani gauge heads	07-D024-21-880
Penning 8 vacuum gauge	07-D043-14-880
CP25 Penning gauge head	07-D145-33-880
VSK1B vacuum switch	07-D059-11-880
PV10 solenoid operated pipeline valve	08-C311-03-880
LV5 leak valve	M08788
Vacuum leadthroughs	08-D072-19-912

Edwards High Vacuum
Manor Royal, Crawley, West Sussex RH10 2LW, England
Telephone: Crawley 28844 (std code 0293)   Telex: 87123 Edhivac G

Edwards

Instructions

11-E085-91-880
Amendment
October 1980

Edwards vacuum coating unit

Model E306A

The vacuum coating unit is fitted with casters for ease of positioning.

Caster cups are provided to prevent accidental movement of the unit when in its final location. Place one under each of the four casters.

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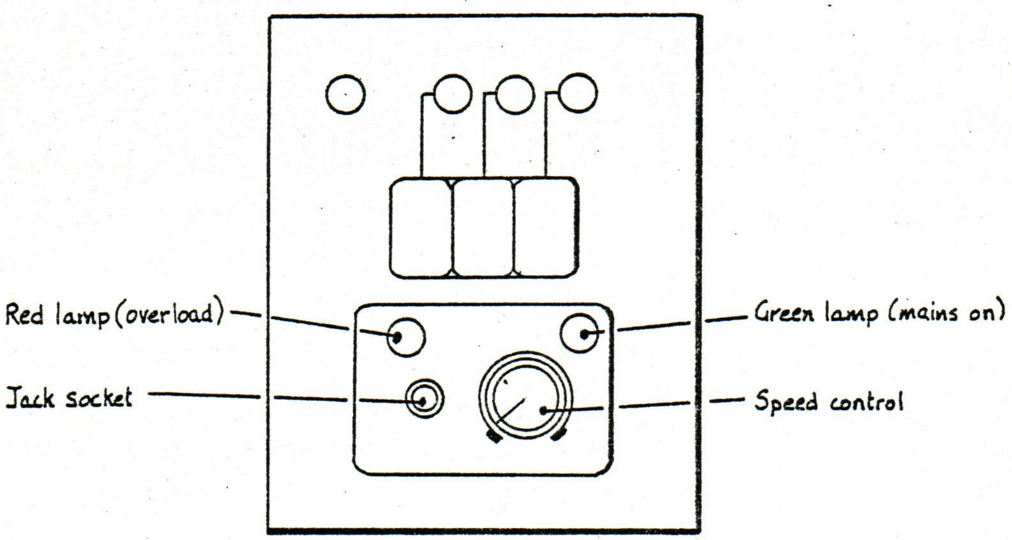
The pump-start module in the control panel is modified to include a power take-off socket and speed control, primarily for operation of a Rotatilt-3 accessory. The socket provides a 12V supply.



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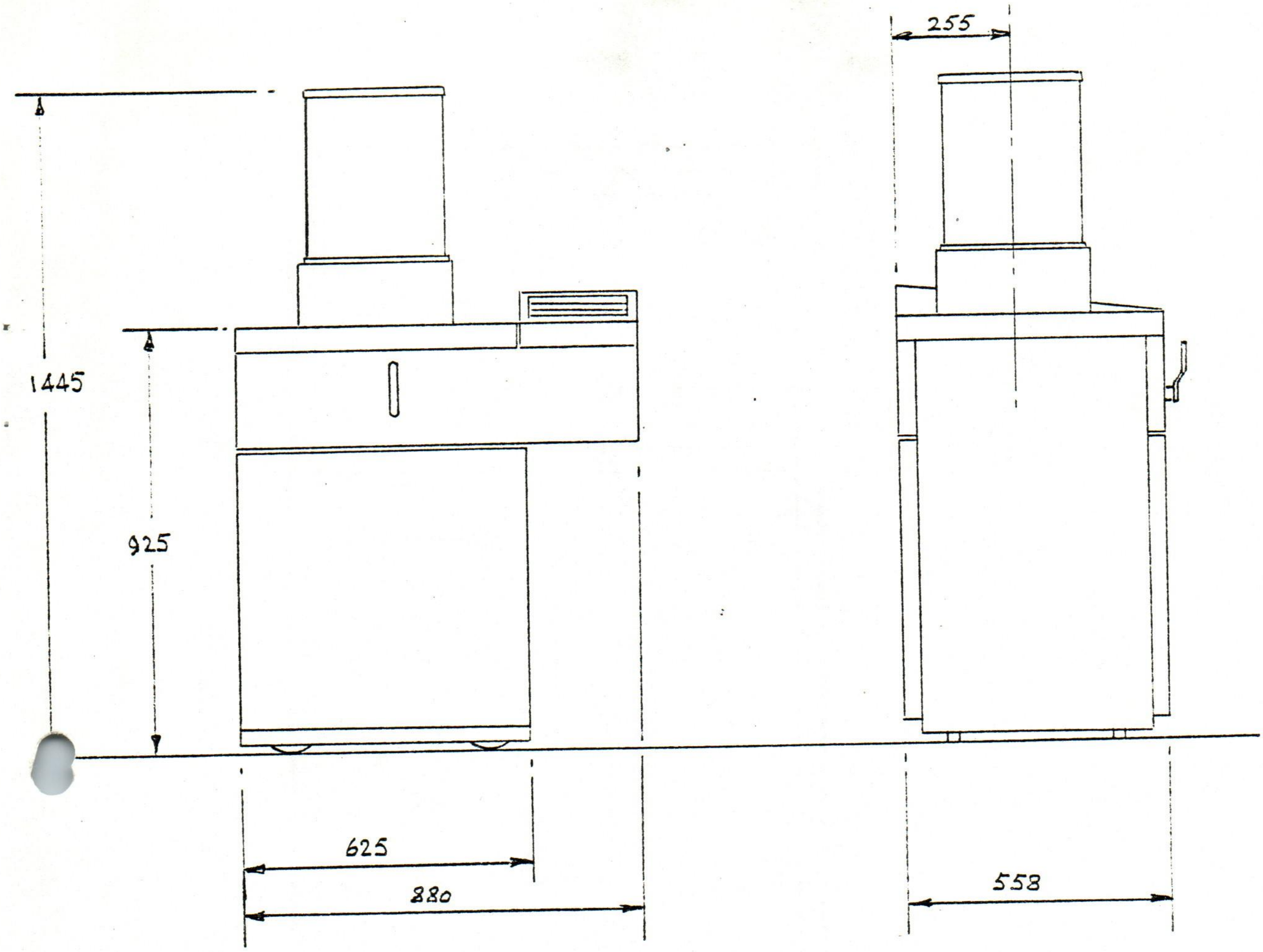
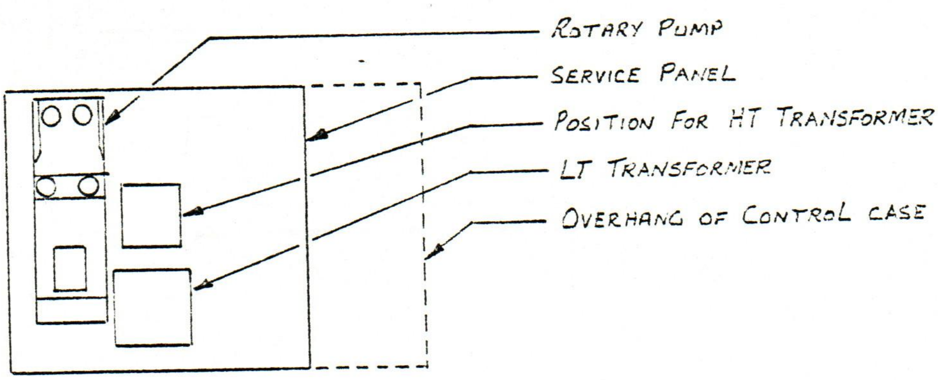
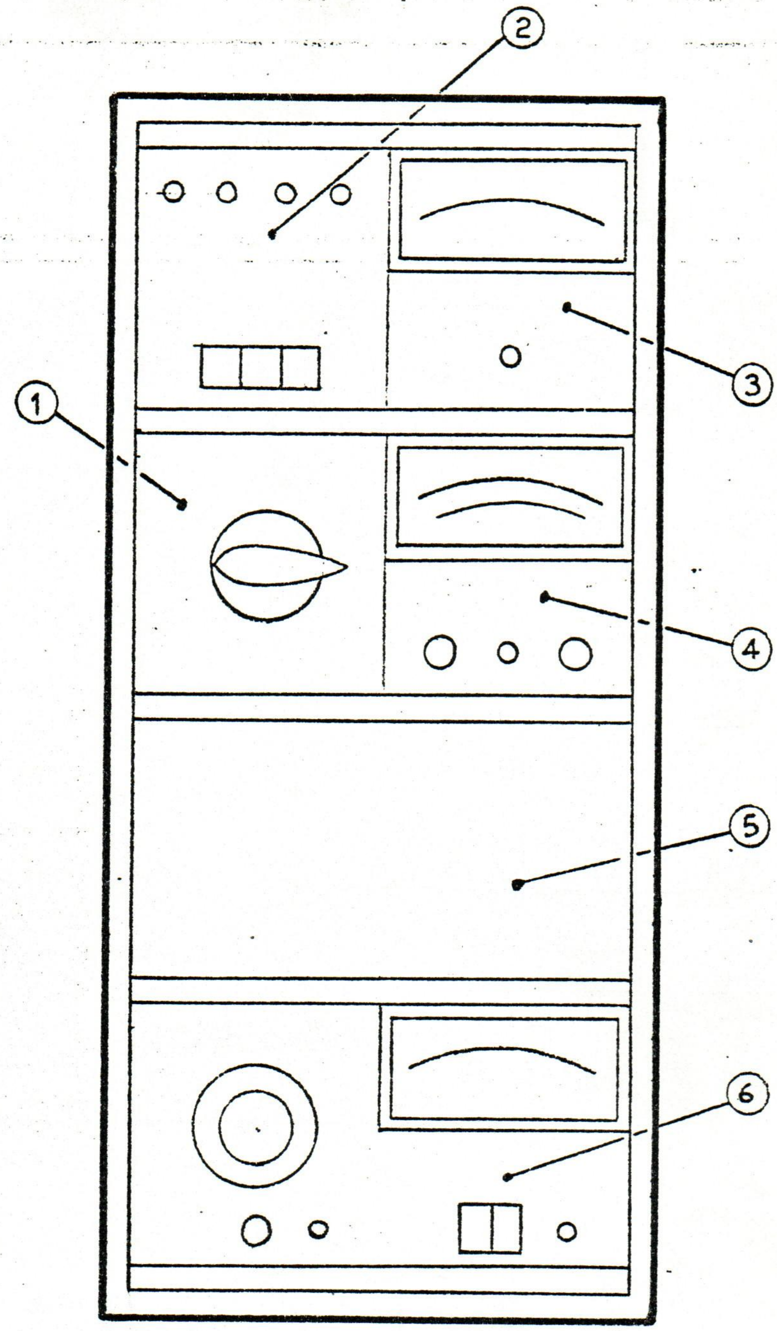


All dimensions in mm.

DIMENSIONS

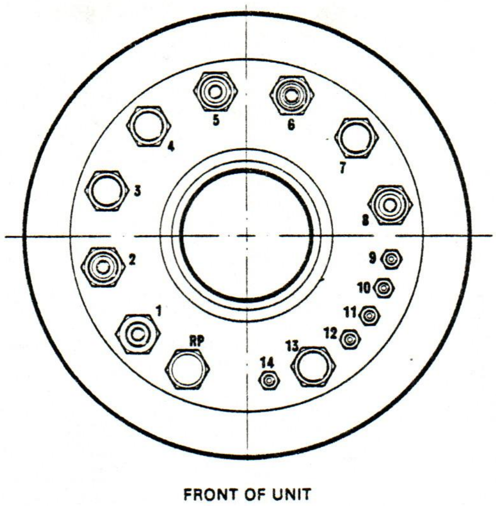


FLOOR PLAN

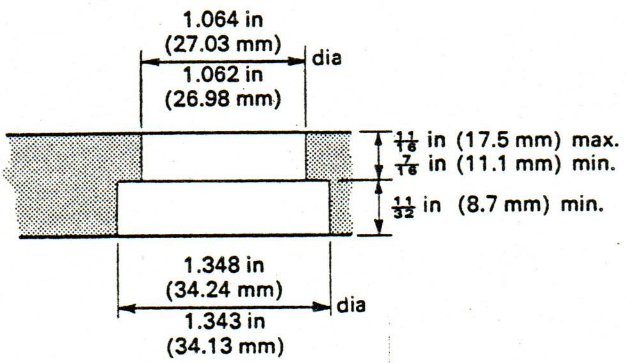


CONTROL PANEL

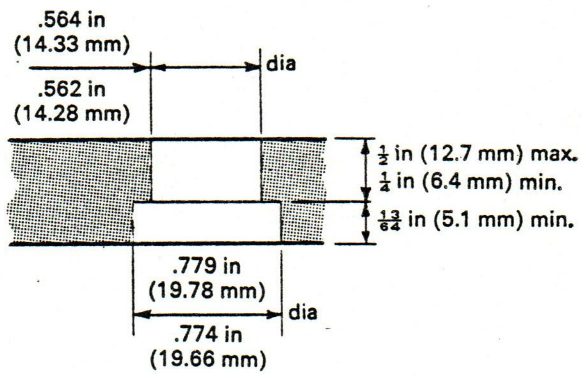
Key	Title
1	LT selector switch
2	Pump control panel
3	Pirani gauge control unit
4	Penning gauge control unit
5	Blank
6	HT/LT control unit



Chamber baseplate details



Hole size 'A'

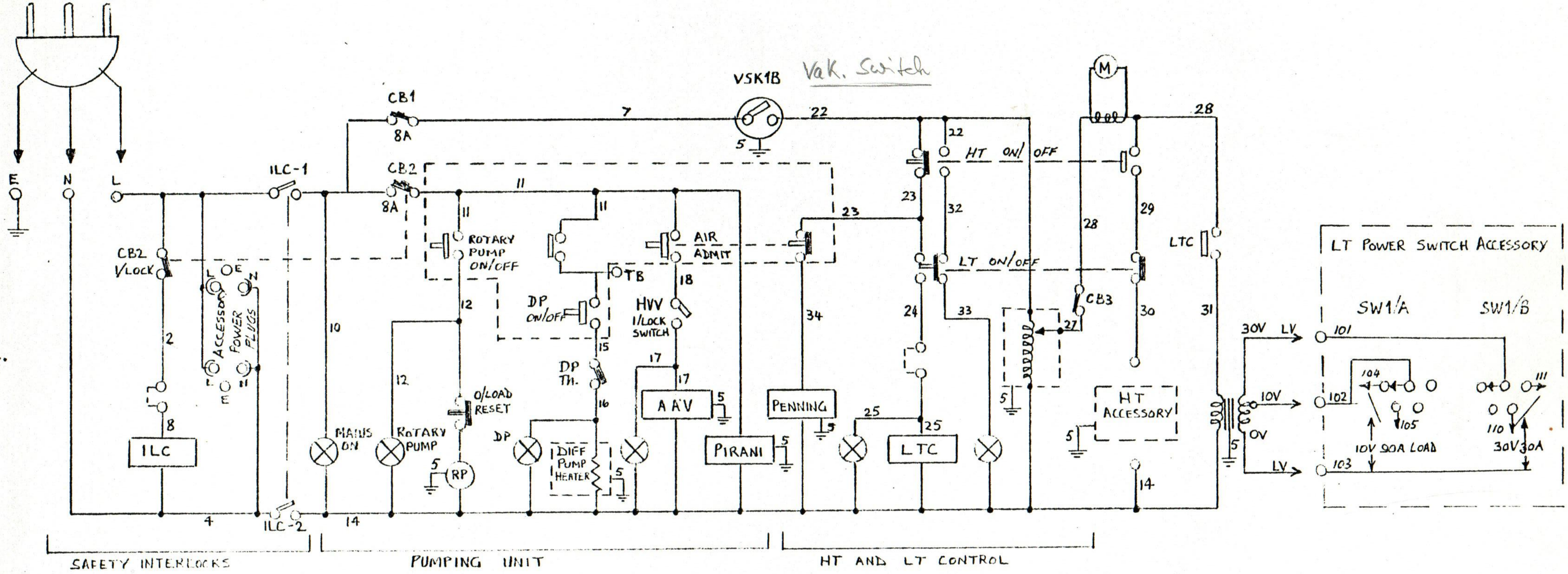


Hole size 'B'

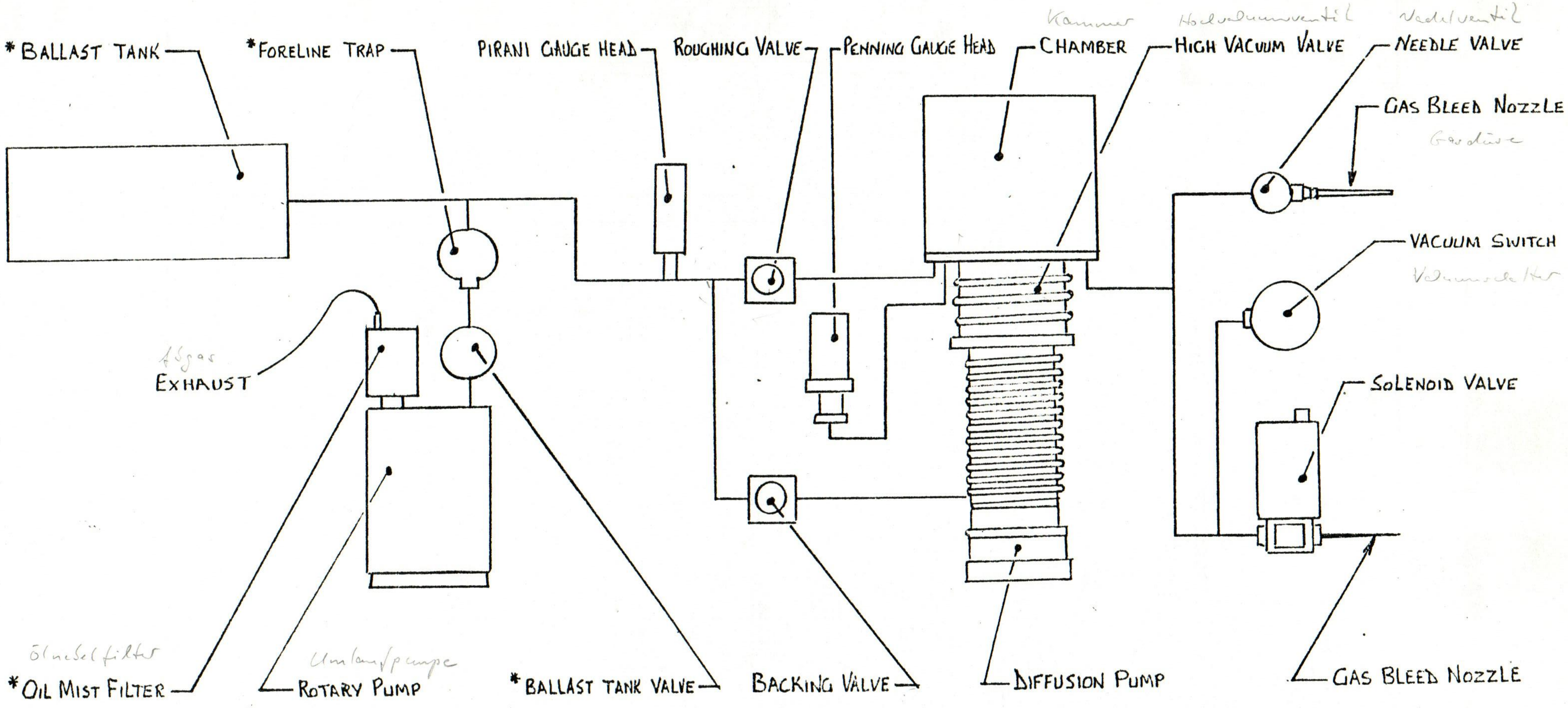
Basic unit baseplate configuration

Baseplate position	Hole size	Fitting
RP	A	Roughing port
1	A	Type 6 leadthrough
2	A	Earth pillar
3	A	Blank plug
4	A	Blank plug
5	A	Blank plug
6	A	Blank plug
7	A	Penning gauge head

Baseplate position	Hole size	Fitting
8	A	Blank plug
9	B	Blank plug
10	B	Blank plug
11	B	Blank plug
12	B	Blank plug
13	A	Blank plug
14	B	Chamber gas admittance port

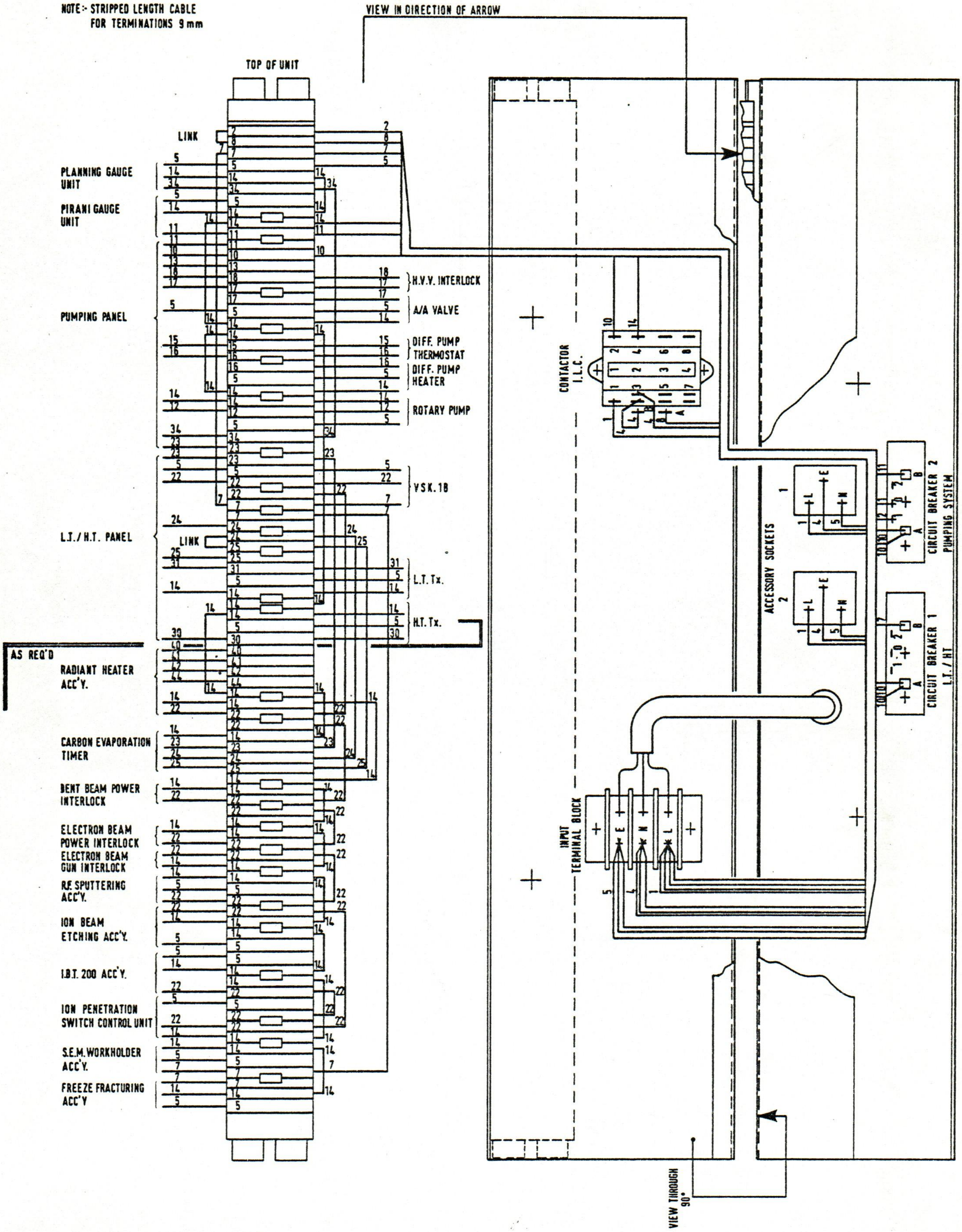


CIRCUIT DIAGRAM E306A COATER



*When fitted

E306A SCHEMATIC PUMPING DIAGRAM



E306A Terminal block connexions

DATA AND SPECIFICATION

All vacuum measurements are given for a clean, empty degassed chamber, using silicone 704 pump fluid.

Ultimate vacuum	better than 7 x 10^{-7} mbar
Pump down time	Typically (2½ min to 10^{-4} mbar (5 min to 10^{-5} mbar
Leak rate	tested to better than 10^{-5} mbar ls^{-1}
LT supply	10V at 90A or 30V at 30A (Selector switch available as accessory)
HT supply (available as accessory)	3.3 kV at 50 mA (5 kV open circuit)
Electricity supply required	220/240V single phase 50 Hz
Power consumption	3 kVA
Electricity supply cable (supplied)	2 m (3 core cable)
Water supply required	1.2 l min^{-1} at an inlet temperature of 15°C. The temperature increase at the outlet should not exceed 10°C above the inlet. The outlet temperature should not exceed 35°C.
Liquid nitrogen required	The liquid nitrogen reservoir has a capacity of 1.4 litres and under normal operating conditions this will last for 6 hours. It should be noted that during the initial fill from ambient temperature liquid nitrogen will boil from the trap and excess should be allowed, usually about 1 litre extra will be required.
Oil charges	
Rotary pump E2M8 One litre supplied with unit)	550 ml per charge
Diffusion pump E04 (200 ml supplied with unit)	175ml per charge
Weight	
Main unit	136 kg (300 lb)
Rotary pump including pump oil	22.8 kg (51 lb)

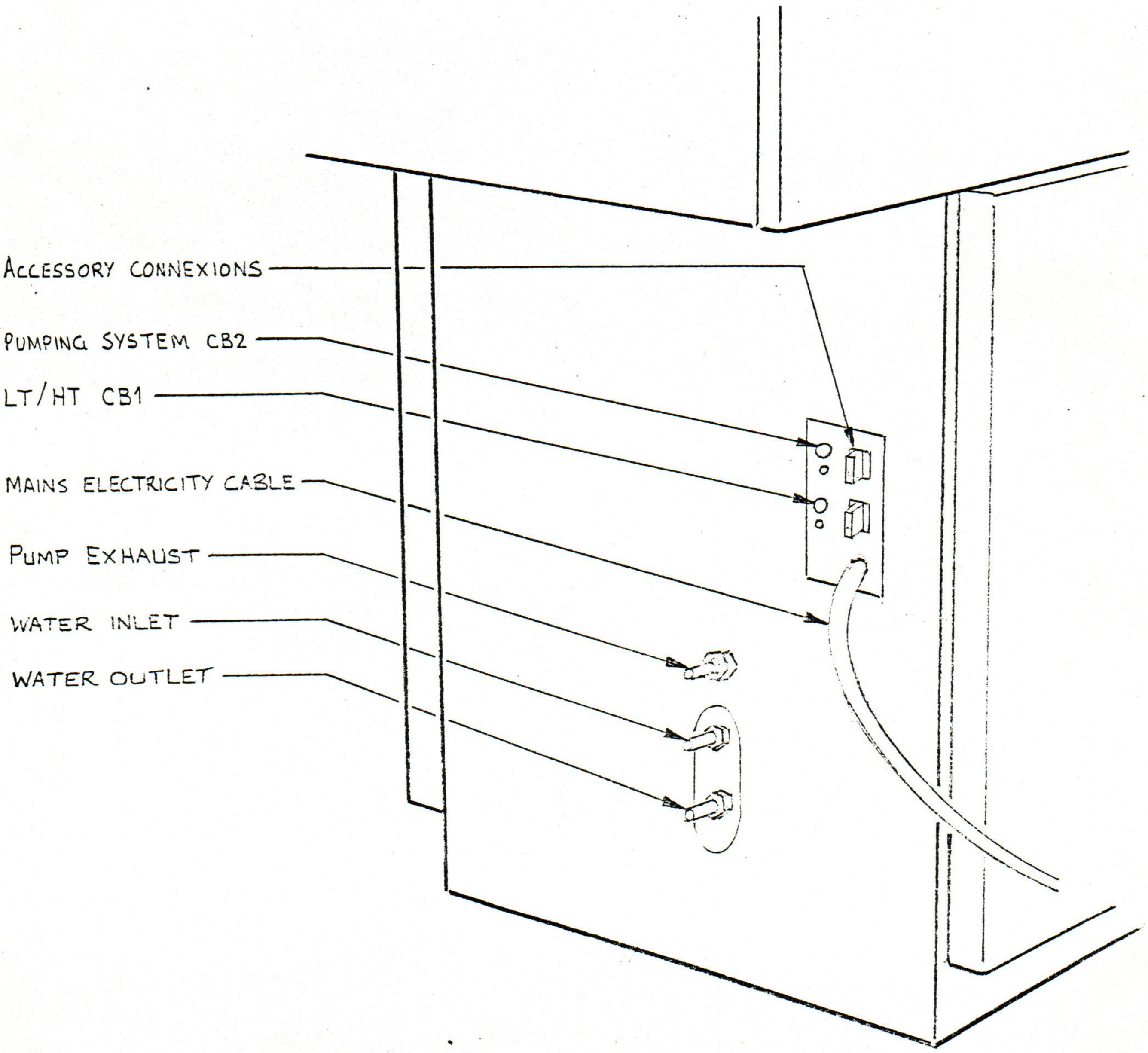
Unpacking

Upon receipt of the unit, remove the packing materials and check the unit for any damage that may have been incurred in transit. Notify Edwards High Vacuum immediately of any damage (see section Communication with Edwards.

Siting the unit

A suitable site should be selected and prepared for the unit. The site should have a level foundation with a surface suitable to support the weight of the unit, a water supply outlet and drain capable of passing 1.2 l min^{-1} and an electricity supply rated at a minimum power of 3 kVA.

Remove the worktops and the front and rear panels.



SERVICE PANEL

Cooling water connexions

Below the projection on the right hand side of the unit there is a service panel. On the service panel there are three riffled nozzles and a grommetted hole. The two lower riffled nozzles are the water inlet and outlet and are marked. The upper nozzle is the exhaust. Connect a length of tubing from the water supply to the upper nozzle and a further length of tubing from the lower nozzle to a drain.

It is recommended that the unit is connected to the water supply and drain using flexible but not rubber tubes. Experience has shown that even reinforced rubber hose is prone to cracking and perishing. However, nylon and reinforced polythene tubes have been used successfully. When using any type of flexible water lines, they should be pushed over the riffled nozzle and a hose clip fitted.

Rotary pump discharge connexions

To prevent vapour or oil mist being discharged into the building it is recommended that a discharge pipeline is installed between the upper riffled nozzle and the outside of the building. A catchpot should be included in this pipeline to prevent condensed vapours from draining back into the rotary pump. The pipeline should slope down to the catchpot and then rise to its ejection level. As with the water supply connexions, flexible (but not rubber) tubing fitted with a hose clip should be used. An oil mist filter model MF20 can be fitted to the pump and will eliminate oil mist without the necessity of piping the mist to the outside of the building.

Rotary pump

Remove the oil filler plug situated on the top of the rotary pump. Pour 0.55 litres of oil into the filler hole (a funnel may assist this operation). Screw the oil filler plug back into position.

Position the rotary pump subassembly inside the unit, so that it does not touch anything inside the cabinet, as this will cause vibration. Fit the length of black rubber tubing from the rotary pump inlet port to the 25 mm dia tube below the elbow.

Connect the three wires from the rotary pump motor to the adjacent terminal block, matching each cable number with that already in the block.

Diffusion pump

The diffusion pump is drained before despatch and has to be charged with the oil provided. To achieve this it is necessary to remove the vacuum nut on the modified drain tube on the diffusion pump. Fit the funnel to the port from which the vacuum nut was removed. Carefully pour 175 ml of silicone 704 fluid into the funnel and allow it to drain into the pump.

When the fluid is drained into the pump remove the funnel and refit the vacuum nut.

Electricity supply connexion

Connect a plug rated at 3 kVA capacity to the electricity supply cable. Connect the brown cable to the live contact, the blue cable to the neutral contact and the yellow/green cable to the earth contact.

Operation

The operation procedure enables the operator to achieve the required pressure for coating. Coating and electron microscopy techniques and theories are dealt with in a number of standard text books, the following two being particularly recommended:

Vacuum deposition of thin films, L.Holland, Chapman and Hall

Techniques for electron microscopy D.H.Kay.
Blackwell Scientific Publications - Oxford

PUMP DOWN (Abridged Pumping Sequence, Page 23)

1) Ensure that the valve lever is in the 'closed' position and that the needle valve and air admittance valves are closed. Check also that there are no other openings to atmosphere in the system, (for example - baseplate plugs removed).

2) Ensure that all switches are off and all controls are set in the zero position.

3) Open the front panel of the unit and open the rotary pump gas ballast valve. This valve is situated on the top of the rotary pump. Close the front panel of the unit. During the first pump down sequence it is essential to operate the pump under gas ballast conditions to degas the pump oil and the system, which has been exposed to atmosphere for a considerable time.

4) Turn on the water supply to the unit and check that the water flow is 1.2 $l\ min^{-1}$.

5) Switch on the mains electricity supply to the unit. The 'mains on' lamp will light.

6) Press the rotary pump 'on' switch, the rotary pump lamp will light.

7) Allow the rotary pump to operate for at least one hour and then open the front panel of the unit. Stop the rotary pump until the door is re-closed. Close the gas ballast valve and close and secure the front panel of the unit. Start the rotary pump.

8) Place the glass bell jar on the baseplate ensuring that the 'L' section gasket is in place and is clean and free from grit. Damage to this gasket will inevitably cause leakage.

9) Slowly open the backing valve - that is turn the valve lever through 90^o in a clockwise direction.

10) The pressure in the system will be indicated on the Pirani gauge meter. Allow the system pressure to fall to 3×10^{-1} mbar and press the 'diff' pump 'on' switch. The 'diff' pump lamp will light. The pump will take 20 mins to reach its operating temperature.

11) Fill the liquid nitrogen reservoir. Do this only after the system has been pumped down to prevent liquid oxygen condensing and creating a potential hazard.

12) Close the backing valve and open the roughing valve by moving the valve lever through 180° in an anti-clockwise direction.

13) Allow the chamber to be pumped until the pressure reading on the Pirani gauge is 3×10^{-1} mbar and then close the roughing valve and open the backing valve by moving the valve lever through 180° in a clockwise direction.

14) SLOWLY open the high vacuum valve by pulling the valve lever outwards and turning it through 180° in a clockwise direction.

15) Switch on the Penning gauge control unit and select range 1. Ranges 2 and 3 can be selected as the pressure in the chamber is reduced.

The unit is now in a condition to proceed with the deposition. Select the required deposition method from the following:

The sequences set out below follow general deposition techniques and will suit most processes. However, some operators may prefer to alter these techniques to suit their own process and the following is offered only as a guide in these instances. The operation of all accessories for a particular type of deposition is included and the relevant step should be omitted if a particular accessory is not fitted into the unit.

<u>General evaporation from a filament or boat</u>

1) Check that a suitable pressure (10^{-4} mbar or below) is achieved by reference to the Penning gauge.

2) Close the high vacuum valve fully and then reopen to the position marked 'glow discharge'.

3) Adjust the needle valve and high vacuum valve until the pressure in the chamber is about 10^{-2} mbar. Do NOT allow the backing pressure to exceed 3×10^{-1} mbar.

4) Switch off the Penning gauge.

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

6) Press the HT selector switch.

7) Slowly increase the setting of the variable transformer until the expected current for Plasmaglo cleaning is reached. It will be necessary to adjust the high vacuum valve and needle valve for optimum discharge, that is when the plasma extends over the maximum volume.

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

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, (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.

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

10) Open the high vacuum valve, close the needle valve and switch on the Penning gauge.

11) Allow the chamber pressure to reach 10^{-4} mbar or below.

12) Switch on the radiant heater and set the required substrate temperature on the variable control.

13) Ensure that the manual source shutter is covering the source.

14) Select the required source position by rotating the selector switch.

15) Ensure that the variable transformer is in the zero position.

16) Press the LT switch.

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

18) Slowly increase the current to the evaporation level. Open the source shutter. Note the current and variable transformer setting for future use.

19) Return the variable transformer to zero and the selector switch to off. Switch off the radiant heater.

20) If further source positions are to be used repeat steps 12 to 19.

21) If a four position turret source is used, rotate the sources into position instead of rotating the selector switch.

<u>Sputtering (d.c. sputtering accessory)</u>

1) Check that a suitable pressure in the system is achieved by reference to the Penning gauge control unit. Switch off the Penning gauge.

2) Connect a suitable gas supply (e.g. air, argon, argon/oxygen) regulated at a low pressure to the gas bleed nozzle situated below the baseplate in the shroud.

3) Close the high vacuum valve fully and then reopen to the position marked 'glow discharge'.

4) Adjust the needle valve and high vacuum valve until the chamber pressure is about 10^{-2} mbar. Do NOT allow the backing pressure to rise above 3×10^{-1} mbar.

5) Switch off the Penning gauge.

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

7) Press the HT selector switch.

8) Slowly increase the variable transformer setting until the expected sputtering current is reached. It will be necessary to adjust the high vacuum valve, needle valve settings and the current to obtain the required sputtering characteristics.

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

9) Sputter for the required time to deposit the required thickness. Note the time.

10) Return the variable transformer to zero and cancel the HT switch.

11) Close the needle valve and open the high vacuum valve.

12) Switch on the Penning gauge.

Coating for electron microscopy

The following processes can be carried out with the Edwards 306 coater.

1) Manufacture of support films - using carbon or silicone monoxide.

2) Manufacture of replicas - using carbon, platinum/carbon, silicon monoxide, etc.

3) Shadow casting - using platinum/carbon or high density metals.

4) Cone shadowing.

1. Support films

(i) Downward evaporation

(a) Place the substrate (usually a glass slide) on the baffle plate.

(b) Set the carbon electrodes in the upper position.

Note: For evaporation using pure carbon the electrodes are attached to the leadthroughs in positions 5 and 6 of the baseplate.

(c) Proceed with the evaporation as set out below.

(ii) Upward evaporation

(a) Load the grids (previously covered with Formvar) into the grid holder.

(b) Set the protractor for normal incidence by rotating the manual shaft seal of the rotatilt accessory.

(c) Fit either the filament holder and filament for metallic films or the carbon evaporation source for carbon films in the lower position.

(d) Load the evaporant into the filament holder, or the carbon in the carbon source.

(e) Proceed with the evaporation as set out below.

2. Replicas

(i) Downward evaporation

Proceed as in 1 but replacing the substrate with the specimen.

(ii) Upward evaporation

Proceed as in 1 but replacing the grid covered with Formvar by the grid carrying the specimen.

3 & 4. Shadow casting and cone shadowing

(a) Load the grids into the grid holder and set at the required angle.

(b) Set the plant for upward evaporation.

Evaporation to form support films, replicas or shadow casting using carbon or platinum/carbon

1) Check that the chamber pressure is below 10^{-4} mbar by reference to the Penning gauge control unit. Switch off the gauge.

* The process for Plasmaglo cleaning is included here (steps 1-10) but is considered unnecessary by some workers and hence can be omitted if required.

*2) Close the high vacuum valve and then reopen to the position marked 'glow discharge'.

*3) Switch off the Penning gauge.

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

*5) Press the HT selector switch.

*6) Slowly increase the setting of the variable transformer until the expected current for Plasmaglow cleaning is reached (about 1.3A). It will be necessary to adjust the high vacuum valve and needle valve for optimum discharge, that is when the plasma extends over the maximum volume.

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

*7) 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.

*8) Return the variable transformer to zero and cancel the HT switch.

*9) Open the high vacuum valve, close the needle valve and switch on the Penning gauge.

*10) Allow the chamber pressure to reach 10^{-4} mbar or below.

11) Press the LT selector switch.

12) Slowly increase the variable transformer setting until the ammeter shows about 0.5A to 1.0A to degas the source.

Note: These currents may have to be adjusted for the particular source used.

It will be useful to note the current and variable transformer setting for future use.

13) Allow the system pressure to stabilize.

14) Close the manual valve on the left hand side of the unit if the backing volume is fitted.

Note: This step is only necessary when shadow casting.

15) For the manufacture of replicas and cone shadowing switch on the Rotatilt motor; for scanning electron microscope specimen preparation switch on the SEM planetary workholder motor.

16) 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.

17) 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, 1 second evaporation followed by one minute to allow the specimen to cool then repeat the process.

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

19) Switch off the Rotatilt or SEM planetary workholder if fitted.

20) Cancel the LT switch.

21) Press the rotary pump switch and slowly open the manual valve on the side of the unit.

Specimen cooling accessory

1) Mount the specimen on the specimen carrier.

2) Proceed with the normal operation until the chamber is evacuated.

3) Charge the cooling accessory by inserting a suitable funnel into the filling hole and pouring in a suitable quantity of liquid nitrogen.

4) Proceed with the normal operation.

Note: Specimen cooling should be carried out rapidly to prevent the formation of ice crystals and hence it is recommended that the specimen is precooled in deep cooled petroleum ether or methyl alcohol. Precool the specimen carrier to avoid any warm up of the specimen.

Basic specimen preparation for electron microscopy on to rotary work using an electron bombarded source

When each accessory is fitted into the chamber and the protractor of the Rotatilt is set at the required angle evacuate the chamber.

1) Check that the chamber pressure is below 3×10^{-5} mbar by reference to the Penning gauge.

2) Ensure that the HT and LT regulators on the EBS power supply are in the zero position.

3) Press the centre switch on the EBS power supply to switch on the electricity supply to the unit.

4) Ensure that the source shutter is covering the source.

5) Press the right hand (LT) switch on the EBS power supply to switch on the filament.

6) SLOWLY increase the right hand (LT) control to the position where the filament will degas*, this is at about 60% on the control.

Note: This operation will be accompanied by a rise in pressure which may be quite large, dependent on the state of the filament. If this degassing rate is high reduce the setting of the LT control until the evolved gas has been pumped away.

7) Continue to degas the filament until the system pressure reaches a steady level and then reduce the LT control setting to zero.

8) Switch on the Rotatilt drive motor.

9) Press the left hand (HT) switch on the EBS power supply.

10) Increase the left hand (HT) control until the HT voltage indicated on the meter is 4kV.

11) Press the right hand (LT) switch on the EBS power supply.

12) SLOWLY increase the right hand (LT) control until an emission current of between 50 and 100 mA is indicated on the meter. The HT voltage will drop.

Note: If powder is being evaporated it will degas when the electron beam is slightly out of focus*. This should be achieved before the next step.

* The degassing of the filament and powder could be achieved at the same time but care should be taken since this will inevitably result in large quantities of gas being evolved.

13) SLOWLY raise the source, watching the emission current meter until the emission reaches a maximum.

14) Adjust the HT, LT and hearth height as in steps 11, 12, 13, to obtain the best operating conditions.

15) When the best operating conditions are reached open the source shutter.

16) When the required film thickness is reached close the shutter.

17) Lower the source.

18) Switch off the HT and LT and return the controllers to zero.

19) Rotate the source turret into the next position and repeat the process from step 4).

20) When all the sources have been used omit step 19 and release the centre switch on the EBS power supply.

General notes on the process

At high evaporation rates with some materials (eg chromium) a plasma discharge can occur. This can be minimised by reducing the emission current, by generally keeping the source clean and by thorough degassing of the source and evaporant.

CLOSING DOWN

To unload the chamber

1) Switch off the Penning gauge

2) Close the high vacuum valve

3) Open the air admittance valve

4) Remove the implosion guard and bell jar

5) Unload the chamber

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

To close down the unit completely

1) Unload the chamber as described above

2) Reposition the bell jar and implosion guard, and close the air admittance valve.

3) Close the backing valve and open the roughing valve.

4) Allow the chamber pressure to fall to 3×10^{-1} mbar or below.

5) Close the roughing valve and open the backing valve.

6) Open the high vacuum valve for five minutes and then close it again.

7) Switch off the diffusion pump.

8) Insert an ejection tube into the vapour trap and blow low pressure air into the trap and empty.

Warning Care must be taken during this operation to ensure that the coolant does not come into contact with the eyes and skin of the operator.

9) After about 30 minutes the diffusion pump will be cold.

10) Close the backing valve

11) Switch off the rotary pump

12) Switch off the mains isolator

13) Turn off the cooling water

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.

Maintenance

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.

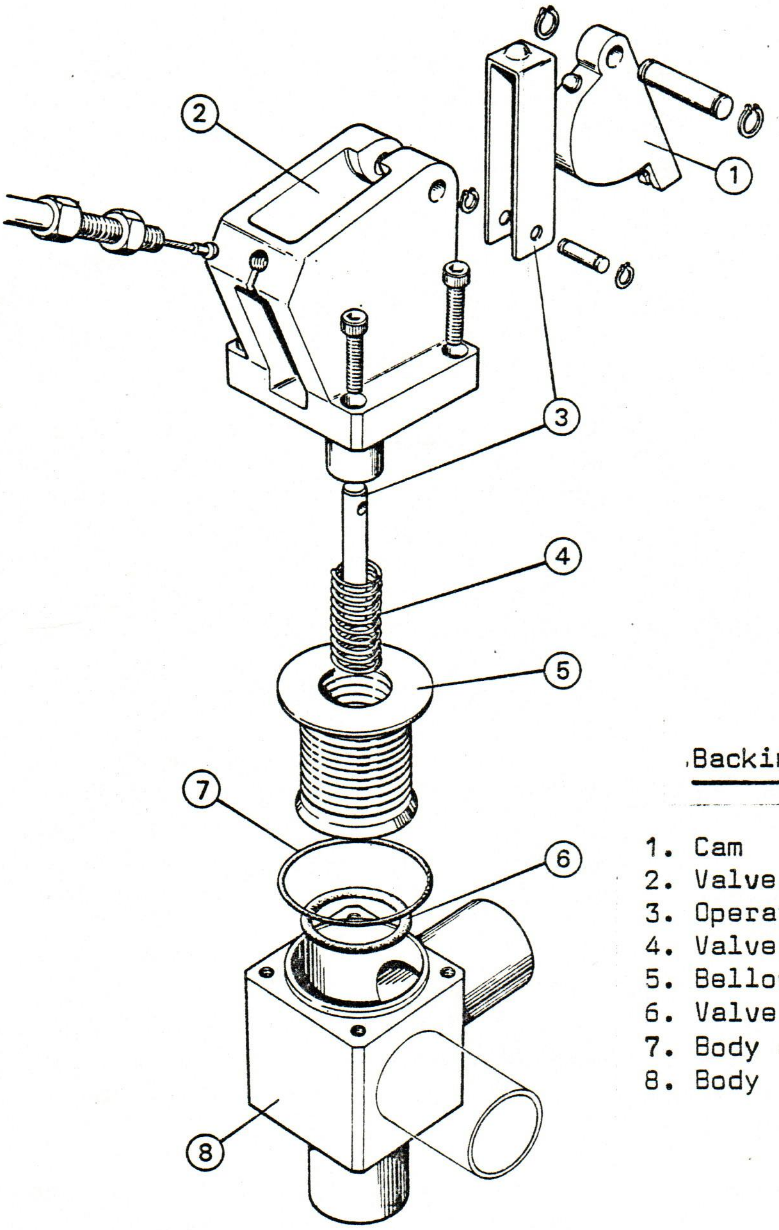
Do NOT wipe the 'L' section gasket around the chamber with an organic solvent. Use only dry, lint-free cloth or paper tissue.

debris = Trümmer
rag = Lumpen
emery cloth = Schmirgelleinen
dismantle = demontieren
gasket = Dichtung

BACKING AND ROUGHING VALVES (E085-00-068)

(1) 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 proceed as follows:

(a) Disconnect the cable from the valves. Remove the four socket head screws from the body then remove the cover complete with the actuating mechanism and bellows assembly.



Backing and roughing valves

1. Cam
2. Valve cover
3. Operating linkage
4. Valve spring
5. Bellows (C078-04-005)
6. Valve plate sealing ring (VIT0215)
7. Body sealing ring (H021-06-262)
8. Body

(b) Remove the defective O-ring seal then lightly lubricate the replacement seal with Apiezon 'M' grease and insert in the body groove.

(c) Re-assemble the cover complete with the valve actuating mechanism and bellows assembly then secure with the socket screws. Reconnect the cable.

(2) The bellows assembly should be replaced if damaged or if the seating is scored or defective. To renew the bellows assembly dismantle the valve as described above then unscrew the bellows assembly from the valve stem. Fit a replacement bellows assembly and re-assemble the valve as described above.

CHAMBER ISOLATION VALVE

The valve mechanism should not be dismantled. If a fault occurs, notify Edwards High Vacuum who will arrange to service the valve.

ACCESSORIES

Tripod and baffle plate. These accessories should be cleaned occasionally with a fine grade emery cloth. Do not use wire wool since the fine wires break away and can cause damage to the O-ring in the high vacuum valve and to the chamber seal.

Pour position turret source. Occasionally dismantle the turret and clean with a fine grade of emery cloth. Do not use wire wool. 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.

Six position electron bombarded source. Occasionally dismantle the unit and clean with fine grade emery cloth. Do not use wire wool. Do not grease the chain or bearings of the source. Check the insulators and clean or replace as necessary. Check the cermets and hearths and replace as necessary. Check the filament and replace as necessary. Ensure that there is sufficient grease in the rotary shaft seal.

Filament holder. Occasionally clean the filament holder with fine grade emery cloth. Clean the leadthrough with fine grade emery cloth. Do not use wire wool since the fine wires break away and can cause damage to O-rings and the chamber seal.

Source shutter. Occasionally clean the source shutter with fine grade emery cloth. Ensure that there is sufficient grease in the rotary shaft seal.

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.

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.

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.

Workholder ring. Occasionally clean the workholder ring with fine grade emery cloth.

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. Clean the TL4 occasionally, with fine grade emery cloth.

Spherical workholder. Occasionally clean the spherical workholder with fine grade emery cloth.

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.

SEM planetary workholder. Occasionally dismantle the unit and clean with a fine grade emery cloth. Do not use wire wool. Ensure that there is sufficient grease in the rotary shaft seal. Check the drive cord for stretch and replace as necessary. Sparingly oil the two universal joints on the drive shaft.

Rotatilt accessory. Carefully clean the accessory with fine grade emery cloth. Do not use wire wool. Check the drive spring for stretch and replace as necessary. 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.

Top plate counter balance accessory. Clean the accessory with a damp cloth. Lightly oil the chain.

Specimen holders. Clean the entire accessory with fine grade emery cloth.

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

Faultfinding

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.

GENERAL

Fuses Should a fuse become open circuit, it should be replaced with a fuse of the correct rating. Under no circumstances should the unit be operated with an incorrectly rated fuse.

Fuse	Location	Type	Rating
Penning	Rear of Penning gauge	RCS 261.1	500mA
Pirani	Rear of Pirani gauge	RCS 261.1	500mA

Spare parts Only the recognised spares supplied by Edwards High Vacuum should be used to replace faulty parts.

Leaks Leaks should be cured in the recognised manner. Specific problems on leak curing may require specialized knowledge and Edwards will be pleased to furnish any details required. Refer also to the section on 'Leak Detection'.

Special replacements Certain parts should be replaced only by Edwards High Vacuum or their accredited distributors. An indication is given in the following as to which parts should be returned to the manufacture, (or distributors).

ROTARY PUMP FAILS TO START

Three main causes of failure to start are possible:

(a) The rotary pump oil is too viscous (because of low temperature) for the motor to run the pump.

(b) Because of a faulty connexion or open circuit breaker, no voltage is applied to the motor.

(c) The windings of the motor itself are damaged.

Fault finding

(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 connexion 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 (a) above, if not the fault is (c) above.

(7) If the meter indicates that the mains voltage is not connected a circuit fault (b) above is apparent.

Fault correction

(1) Check that the mains supply to the unit is on and that any fuses in the supply are intact.

(2) Check the wiring for a loose or broken wire.

(3) If the fault cannot be found notify Edwards High Vacuum.

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:

(1) a leak in the system

(2) the rotary pump oil being contaminated

(3) the foreline trap (if fitted) being contaminated

If the fault occurs in (a) then a leak is present in the system.

If the fault occurs in (b) gas ballast the rotary pump for 30 min. If the pressure does not improve check the system for leaks. (See section 'Leak Detection').

Fault correction

If the fault is contaminated rotary pump oil, the fault can be corrected by prolonged gas ballast operation or in the worst conditions a change of oil.

If the fault is a contaminated foreline trap see 'Foreline trap' instructions.

Leaks can be cured in the normal way.

DIFFUSION PUMP NOT OPERATING

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

(a) Because of a faulty connexion or circuit breaker tripped (CB2) no voltage is applied to the pump heater.

(b) Pump heater failure.

(c) Thermal snap switch operating due to low water supply.

Fault finding

(1) Turn on the water, switch on the rotary pump and open the backing valve.

(2) Connect a multimeter set to read the mains voltage of the unit across the heater of the vapour pump.

(3) Switch on the diffusion pump and check that mains voltage is connected across the heater.

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

(5) If the meter does not indicate a heater resistance of 60-70 then the heater is damaged.

(6) If the meter did not indicate mains voltage in step 3 a circuit fault is apparent.

Fault correction

Diffusion pump heater renewal is described in the supplementary instructions.

Replace the fuse as necessary

Check circuit for loose or broken wires.

DIFFUSION PUMP PERFORMANCE POOR

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

(a) Contaminated system.

(b) Leaky system.

(c) High backing pressure.

(d) Water flow not sufficient.

(e) Pump not warmed up.

Fault finding

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.

Allow the required time for warming up.

Check that the water supply is sufficient. The temperature at the outlet should not rise above 35°C.

Fault correction

Check the water line system for a blockage. Blow compressed air through the section of water pipe in which a blockage is located.

HT and LT POWER FAILURE

There are four possible reasons for HT or LT failure:

(a) Circuit breaker (CB3) tripped - press to reset.

(b) LT selector switch in wrong position.

(c) Wire in the circuit loose or broken.

(d) Pressure in system too high.

Fault finding

With the chamber pumped down:

(1) Check that the switch is in the correct position.

(2) Check the circuit wiring.

(3) 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. If this is the reason why the circuits are inoperative reference should be made to the 'vapour pump performance poor' section.

PENNING GAUGE HEAD FAULTY

Three possible reasons for the gauge head being faulty are:

(a) Leak.

(b) Gauge head dirty.

(c) Gauge head magnets out of alignment.

Fault finding and correction

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 'diffusion pump performance poor'.

Correction of the other two faults is covered in the supplementary instructions

Recommended spares

Code No.	Description	Quantity
E085-00-800	Spares kit for Edwards 306 Coater comprising:	1
	BAFFLE VALVE AND PUMP LINES ASSEMBLY E04 DIFFUSION PUMP (B009-17-000)	
H021-06-213	Sealing ring VIT1213	1
H021-06-025	Sealing ring VIT0215	1
H021-06-115	Sealing ring VIT2A	2
*	Heater KB40 850W 240V	1
*H017-00-134	Heater KB40 850W 220V	
*H017-00-137	Heater KB40 850W 250V	

*Note: Please state exact voltage when ordering spares

Code No.	Description	Quantity
B016-09-035	Diaphragm, Moulded Viton 'A' for Baffle Valve	1
D024-21-000	Pirani gauge head	1
	LV5 NEEDLE VALVE (C370-01-000)	
C110-01-412	SC5 screwed body	5
C110-01-431	SC5 coupling nut	10
C110-01-105	SC5 O-ring carrier and O-ring	10
	PV10 SOLENOID VALVE (C311-03-000)	
C110-02-101	SC10 Pack	2

Code No.	Description	Quantity
E069-00-153	Microswitch	1
E069-00-038	Rubber tube for pump	1
H021-06-002	O-ring VIT0006	4
H021-06-013	O-ring VIT0113	1
H021-06-025	O-ring VIT0215	10
H021-06-079	O-ring VIT0437	1
H021-06-119	O-ring VIT1119	2

E085-00-205	Light grey plastic insert plug	2

INSTRUMENT CASE

D035-15-800	Spares kit for Pirani 10 gauge	1
D043-11-800	Spares kit for Penning 8 gauge	1
E085-00-154	Lamp miniature neon indicator 250V red	1
	2.5 x 12 long Posidrive screws	6

HT AND LT MODULE

	Spare brushes for variable transformer type V6H-U	1

ROTARY PUMP ASSEMBLY

14-A362-01-800	Spares kit for E2M8 rotary pump	1

ROUGHING AND BACKING VALVE ASSEMBLY E085-00-068

E085-00-079	Cable	2
H021-06-025	O-ring VIT0215	1
H021-06-262	O-ring VIT0347	1

MAIN CABINET ASSEMBLY AND DETAILS

E085-00-138	Bulgin 3 pin plug and socket	1
	Bolt, M6X x 16 hexagonal head	6
	Bolt, M8 x 20 hexagonal head	6
	M8 hexagonal full nut	6
	Shakeproof washer M6	6
	Shakeproof washer M8	6

CHAMBER ASSEMBLY

D012-19-000	Electrode type 6D	1
D145-33-000	Gauge head	1
E069-00-133	Electrode blank type 7	1
E069-00-134	Electrode nut type 7D	1
H021-06-013	O-ring VIT0113	5
H021-06-025	O-ring VIT0215	7
	Nut $\frac{7}{8}$ in BSF	4
	Nut $\frac{3}{8}$ in BSF	4
	Washer $\frac{3}{8}$ in	8

Code No.	Description	Quantity
E069-00-161	Electrode blank type 6	1
E069-00-162	Electrode nut type 6	1
	DIFFUSION PUMP FILLER ASSEMBLY	
H021-06-115	O-ring VIT2A	1

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.

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.

Real and virtual leaks

It is necessary to establish whether the 'leak' is in fact a true leak or an apparent leak caused through degassing 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 degassing. The source of degassing must be sought and removed to correct the apparent leak. Further tests are necessary to find a real leak.

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.

Suggested method of leak detection

Pump the system to its best ultimate in the normal way, switching on the Pirani gauge as a normal pressure reading instrument. Watching the Pirani gauge meter, pass a jet of helium or other suitable search gas over the suspected area.

Note: Since 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 Pirani gauge will indicate a sharp rise in pressure. Remove the search gas probe and allow the meter to return to the original reading. Once again subject the area to the search gas and watch the Pirani gauge meter. 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 ans the above procedure repeated to pinpoint the leak. Any leak occuring should be cured in the normal way.

Communication with Edwards

Any communication relating to the subject of this instruction should be addressed to Edwards High Vacuum or to the supplier from whom it was purchased.

Please specify:

1) The model, serial number and code etc.

2) The date of purchase.

3) Your order number and the suppliers sales reference.

Equipment should not be returned to the supplier without prior arrangement.

Damage in Transit

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

Supplementary instructions

The following instructions contain information to assist in the use and maintenance of the E306A coating unit:

E306 accessory instructions	M11913
Recommended safety precautions for handling cryogenic liquids	59-K100-00-880
E2M8 rotary vacuum pump	03-A360-01-880
Foreline traps	M04632
E04 oil vapour diffusion pump	M05764
Pirani vacuum gauges	07-D035-23-880
Pirani gauge heads	07-D024-21-880
Penning 8 vacuum gauge	07-D043-14-880
CP25 Penning gauge head	07-D145-33-880
VSK1B vacuum switch	07-D059-11-880
PV10 solenoid operated pipeline valve	08-C311-03-880
LV5 leak valve	M08788

Abridged pumping sequence

for 306 coater

(to be attached to the wall for easy reference)

Pump down

(a) Turn on the water supply.
(b) Ensure that all switches are off and all valves are closed.
(c) Switch on the mains electricity supply to the coater.
(d) Press the rotary pump switch.
(e) Open the backing valve.
(f) Switch on the Pirani gauge control unit and select head 1.
(g) Allow the pressure to fall to 3×10^{-1} mbar and press the diffusion pump switch.
(h) Wait 20 minutes for the diffusion pump to reach its working temperature.
(i) Fill the liquid nitrogen reservoir.
(j) Close the backing valve and open the roughing valve.
(k) Allow the pressure to fall to 3×10^{-1} mbar and close the roughing valve. SLOWLY open the roughing and high vacuum valves so that the pressure does not rise above 5×10^{-1} mbar.
(l) The system should now be below 10^{-4} mbar so that the Penning gauge can be switched on.

Closing down

(a) Switch off the Penning gauge.
(b) Close the high vacuum valve and open the chamber air admittance valve.
(c) Unload the chamber.
(d) Reposition the bell jar and implosion guard and close the air admittance valve.
(e) Close the backing valve and open the roughing valve and allow the pressure to fall to 3×10^{-1} mbar.
(f) Close the roughing valve and open the backing valve.
(g) Open the high vacuum valve for five minutes and then close again.
(h) Switch off the vapour pump.
(i) Empty the liquid nitrogen reservoir.
(j) After 30 mins close the backing valve and switch off the rotary pump.
(k) Switch off the mains electricity supply.
(l) Turn off the water supply.

Communication with Edwards

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Please specify:

1) the model, serial number and code.

2) the date of purchase.

3) your order number and the suppliers sales reference.

Equipment should not be returned to the supplier without prior arrangement.

IMPORTANT Health and Safety

Under Section 3 of the Health and Safety at Work Etc Act 1974 every employer has a duty 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.

Edwards High Vacuum and its distributors reserve the right to refuse acceptance of 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 the supplier within three days of delivery.