DENTON VACUUM INC.

OPERATING INSTRUCTIONS
FOR
DENTON VACUUM
DV-502A HIGH-VACUUM EVAPORATOR
MANUAL OR AUTO SYSTEM WITH
3¼" OR 5¾" DIFFUSION PUMP

2 PIN OAK AVENUE • CHERRY HILL, NJ 08003 • (609)~~424-1012~~
FAX: (609)~~-424-0395~~

pump speed 120 l/min
ultra 5×10^-4 Torr

800 ml oil cap.

Called 3/10 re leaking lot. pump SINKU KIKO G100D
SN 29X131D

new/replacement arrived
~3/17/94 SN 912131D

8/26/94
Santovac 5 – non silicon based oil – doesn't crack as easy
(e.g. w/ DOW 704)

[illegible] vent → try turning mech. pump off, then vent
[illegible] does – means cord etc lodged under plate [illegible]
[illegible] chamber from mechanical pump

[illegible]: Turn off diff pump
With [illegible] valve open, vent mechan[illegible]
Let cool
Clean [illegible]
[illegible]

* [illegible] vacuum (≥50 mT) on Foreline probably because of poor
seal (o-ring) under Hi-Vac plate/gate

10/31/94
* Apparent problem w/ High Vacuum → Could be dirty
ionization gauge tube.

10/97 No arc → FILIGLOW 10 AMP FUSE (MDA10) blown (open front panel — far right, 2nd from top)
– check for continuity of current fuse
– replace if blown w/ one in top left drawer.

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Refer to Job No. 13793
when ordering spare parts.

3/1/93

TEL: 609-~~424-1012~~
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Fax 439-[illegible]

DENTON VACUUM, INC.
2 Pin Oak Avenue, Cherry Hill, NJ 08003

012793/502A

Jim Falco
(George Lutz)

INSTALLATION REQUIREMENTS

ELECTRICAL

- ✓ 120V AC, 60 Hz, 20 amps (AC cord included)
- ___ 120V AC, 60 Hz, 30 amps (AC cord included)
- ___ 208V AC, 60 Hz, 30 amps, single phase
- ___ 208V AC, 60 Hz, 20 amps, single phase
- ___ 230V AC, 50 Hz, 20 amps, single phase

WATER

___	Diffusion pumps:	approximately 1 to 3 gallons per minute
___	LV feedthroughs:	approximately 1.0 to 1.5 gallons per minute
___	Crystal monitor:	approximately .010 gallon per minute
___	DSM-300A:	approximately 1.0 gallon per minute
___	Minigun:	approximately .75 gallon per minute

PROCESS GAS

	Argon:	approximately 5 psi
✓	Nitrogen (vent):	approximately 5 to 20 psi
___	Oxygen (PE-120):	approximately .5 psi

UTILITY AIR (*auto system only*)

- ✓ Air valves: 80 to 100 psi clean and dry air

CAPACITIES

✓	3¼" Diffusion pump	100 cc	Dow Corning DC-704
___	5¾" Diffusion pump	250 cc	Dow Corning DC-704
✓	Mechanical pump	1 quart	Sunvis
✓	LN_2 trap	1 liter	

OPTIONS LIST

The items checked below are the optional accessories selected for this unit.

- [x] Auto System
- [ ] 12" x 18" Bell Jar
- [ ] 14" x 18" Bell Jar
- [ ] AC Glow Discharge
- [ ] Ballast Tank
- [x] Bell Jar Safety Guard ~~& Manual Lift~~
- [x] Carbon Evaporation Source; __ Yarn ✓ Rod
- [ ] Counterbalanced Hoist
- [ ] DTM-100
- [ ] DSM-5A Cold Sputter Module
- [ ] Auto Metal Evaporation
- [ ] DSM-300A Sputter Module
- [ ] Inverted Omni Rotary Fixture
- [ ] Omni Rotary Fixture
- [x] Tilting Omni Rotary Fixture
- [ ] 2 kva Evaporation Power Supply
- [ ] 2 kva Cooling
- [ ] Minigun (separate manual)
- [ ] 5¾" Diffusion Pump
- [ ] Adjustable Filament Holders
- [ ] Air-cooled diffusion pump

DRAWINGS

The drawings checked below pertain to a manual unit.

[ ]	Electrical Schematic (110V Manual Valve System)	A-0058-082-198-D
[ ]	Electrical Schematic DVG-6A (110V System)	A-0133-117-127
[ ]	Electrical Schematic DVG-6A Chassis (110V)	A-0133-117-139

The drawings checked below pertain to an automatic unit.

[x]	Auto Pump System Flow Chart	
[x]	Main Electrical Schematic (24V Auto System)	A/B-0133-103-002-B
[x]	Electrical Schematic (24V Auto Pump PC Board)	A-0058-082-219-E
[x]	Electrical Schematic DVG-6A (24V System)	A-0133-117-128-A
[x]	Electrical Schematic DVG-6A Chassis (110/24V)	A-0133-117-137

The drawings checked below pertain to options.

[ ]	Main Electrical Schematic (2 KV, 208V)	A-0058-082-300
[ ]	Main Electrical Schematic (208V)	A-0058-082-208
[ ]	Manual Bell Jar Lift	C-0058-076-018
[ ]	DSM-5A Sputter Module Installation	C-0108-014-001-A
[ ]	DSM-5A Cold Sputtering Module Assembly	C-0108-014-002-C
[ ]	DSM-5A/DSM-300A Electrical Schematic	B-0108-014-009-C
[ ]	DSM-300A Sputterhead Assembly (Internal)	C-0131-008-019-A
[ ]	DSM-300A Sputterhead Assembly (External)	C-0128-007-008
[x]	Carbon Rod Fixture	B-0084-039-003
[ ]	Carbon Yarn Fixture	B-0131-005-011
[ ]	Inverted Omni	D-0131-012-014-A
[ ]	Inverted Omni (with insert)	D-0131-014-064

MANUALS

The manuals checked below pertain to your unit.

- [x] Mechanical Pump - Ulvac G-100D
- [ ] Mechanical Pump - Alcatel 2010
- [ ] Omega Controller
- [x] Control Concepts SCR
- [ ] DTM-100
- [ ] STC-200

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WARNING!

Do not attempt to operate this system until you have completely read this Operations Manual. Failure to operate the system properly may result in damage to the system.

This unit has been shipped with the high-vacuum pump section under vacuum. **DO NOT** open any vacuum valves until the procedure outlined in the "Set Up Instructions" section has been followed. Failure to heed this warning may result in damage to the equipment. If the backing valve is opened before starting the mechanical pump, the diffusion pump may be damaged. If opening of the "main vacuum" valve is attempted, the valve operating mechanism may be damaged.

Air used for automatic valves **MUST** be dry and clean to ensure proper operation of the valves. Failure to comply may result in voiding the warranty.

1. INTRODUCTION

1.1 GENERAL

The Denton DV-502A is a complete, heavy duty laboratory evaporator using Denton's economical diffusion pump design. By using state-of-the-art electronic components and an advanced mechanical vacuum design, the DV-502A can rapidly and repeatedly cycle from atmosphere to high vacuum.

The unit will reach 10^{-4} Torr in the clean and outgassed system within three minutes, and 2×10^{-5} Torr within four minutes in the standard 12" diameter x 12" high bell jar. The system will blank off at approximately 2×10^{-6} Torr with water cooling of the diffusion pump, and in the 10^{-7} Torr scale using liquid nitrogen in the trap.

The DV-502A features a manual evaporation control with the capability for upgrading to automatic evaporation. Its standard 1 kva filament supply permits evaporation of most materials used in electron microscope specimen preparation including carbon, palladium, platinum, etc., and can handle many of the evaporations required in various metallizing, optical coating, and other applications.

1.2 DV-502A AUTO VACUUM SYSTEM

*(This section is for AN AUTO SYSTEM ONLY. If the system is a manual system go directly to **Section 1.3 Set Up Instructions** on page 1-3.)*

The Auto DV-502A allows automatic pumpdown and venting with manual valve overrides. The autopumping feature prevents system contamination due to prolonged rough pumping of the chamber below the crossover pressure (100 millitorr) if the system is left unattended.

With the Auto DV-502A, indicating lamps will light to show that each valve is open. Rocker switches are provided to control each valve in the MANUAL mode. A mode selection switch allows selection of AUTO PUMP, MANUAL VALVES, or AUTO VENT modes. With the diffusion and mechanical pumps running after initial start up, the bell jar may be vented, raised, loaded, lowered, and pumped to high vacuum automatically in the auto mode.

> **NOTE**
>
> **BEFORE THE DV-502A CAN BE OPERATED IN THE "AUTO PUMP" OR "AUTO VENT" MODES, THE DIFFUSION PUMP MUST BE ON AND PUMPING TO HIGH-VACUUM.**

To start up the DV-502A from a "cold" condition, follow the sequence in Section 2 of this operating manual. To open/close the valves, rotate the knob to the MANUAL VALVE position at the top left hand section of the control panel.

> **NOTE**
>
> **BEFORE ENTERING/LEAVING THE "MANUAL" MODE, ALL VALVE ROCKER SWITCHES SHOULD BE TURNED OFF.**

AUTO PUMP

1. With the mechanical and diffusion pumps running, and the backing valve open, turn all switches but the backing valve switch to OFF. Place the bell jar on the baseplate, rotate mode selector switch from MANUAL position to AUTO PUMP.

2. The system will automatically pump down to high-vacuum. Crossover pressure in the CHAMBER has been factory set at 100 millitorr. The pilot lights on the panel indicate the position of each valve. Light on means the valve is open.

3. When the CHAMBER TC gauge indicates that the pressure has fallen to zero (BACKING and HIVAC valves open), the high-vacuum gauge can be turned on. Turn it to the ZERO position and allow 30 seconds for it to warm up. Then push METER READ to light off the gauge. Rotate the gauge selector switch to the appropriate vacuum scale as required (10^{-4} to 10^{-7} Torr).

AUTO VENT

To vent the system, rotate mode selector switch to AUTO VENT position. The valves will automatically sequence and the bell jar will vent. The mechanical pump and diffusion pump will remain on and the backing valve will remain open. The bell jar can now be raised and the chamber unloaded/reloaded.

1.3 SET UP INSTRUCTIONS

1. Remove the back cover. A pair of magnets are shipped taped to the inside of the cabinet. Position them around the flattened part of the cold cathode tube. (Figure 1). The tube is mounted in the cylinder below the baseplate at about two o'clock. Check to see that the cable is pushed onto the end of the cold cathode tube and that the electrical spade connector is pushed onto the spade lug protruding from the cold cathode tube. This connection is the ground wire and must complete the circuit.

2. The evaporator's diffusion pump is water cooled. The water connections are located in the lower right hand corner of the rear of the unit (Figure 1). The unit is equipped with an "in" line and an "out" line, each designed for ¼" lines. Each unit is also equipped with a waterflow control valve. This valve is at the uppermost position of the water connection area, with the "in" line just below the valve, and the "out" line just below the "in" line. After making the water connections, open the flow control valve approximately a half turn. After the diffusion pump is hot, the discharge water should be warm, (approximately 100° F.) which is controlled via the flow control valve.

3. Air Hook-up ***(FOR AUTO SYSTEMS ONLY)***

   An external air supply of 80 to 90 psi is required to operate the air valves. The connections are located in the right side rear corner of the unit.

4. To prevent any damage from occuring to your Denton Vacuum system during shipment, the bell jar/guard has been removed and packed separately. To install the bell jar/guard, follow this procedure:

   A. Unpack the bell jar/guard from shipping carton. The bell jar is shipped with the guard attached.

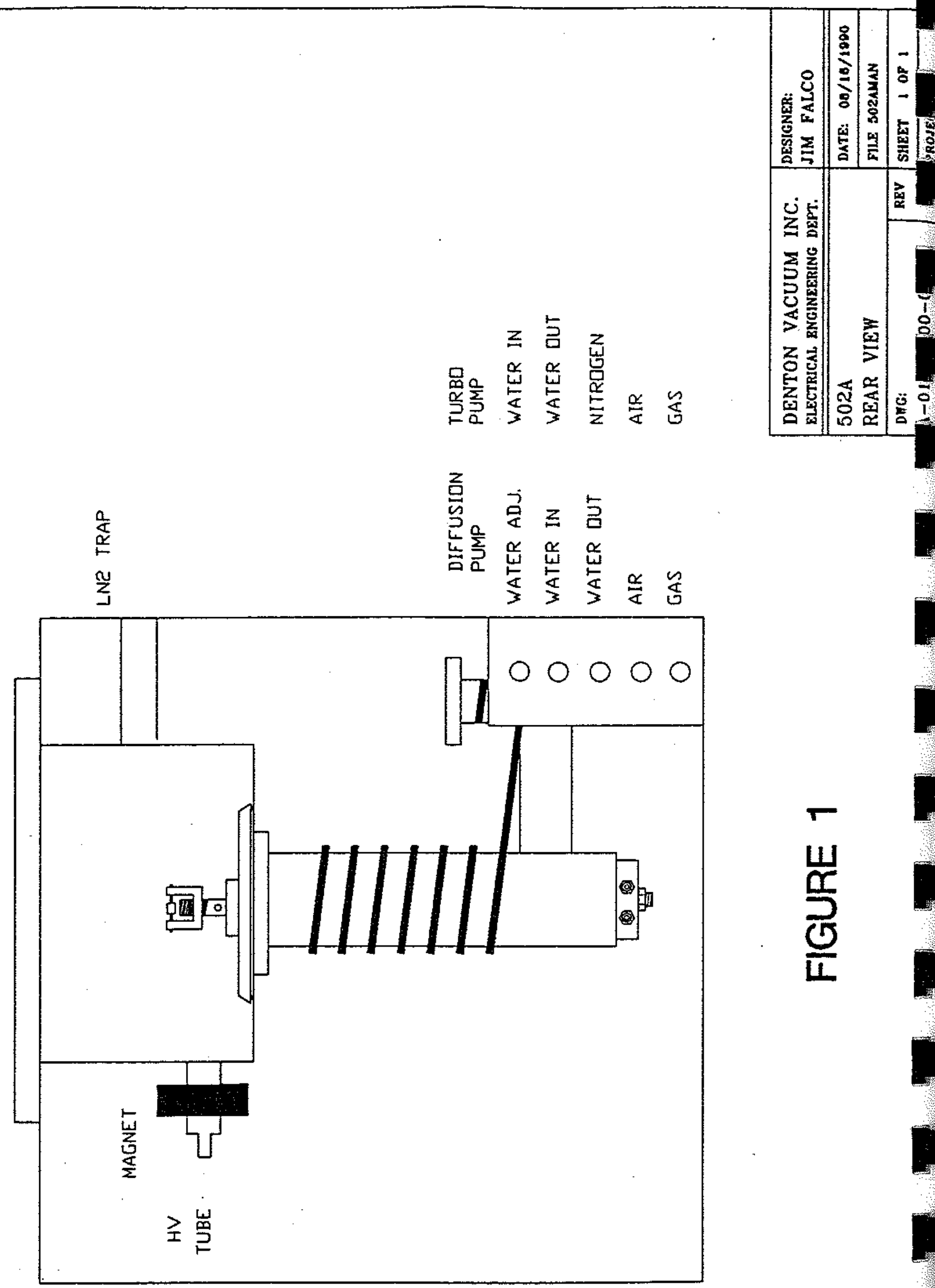


FIGURE 1

B. Remove all tape from the baseplate. Thoroughly clean the baseplate surface.

C. The lift rod assembly is secured into the lift rod base with three set screws. Loosen these three set screws and remove the lift rod assembly from the lift rod base.

Note: This is a common option which may or may not apply to your system.

D. Place the bell jar on the baseplate. The bell jar should sit flush on the baseplate. Align the bell jar so that the bushing assembly is aligned with the lift rod base. Insert the lift rod assembly through the bushing assembly and into the lift rod base.

E. Be certain that the bell jar is centered on the baseplate and that the bell jar does not make contact with any of the fixturing in the chamber.

F. Secure the lift rod assembly to the lift rod base by tightening the three set screws.

G. The bell jar/guard should now slide easily up and down the lift rod assembly.

5. The mechanical pump is shipped pre-filled with oil. Check the oil level in the mechanical pump only after it has been running. The level is misleading when pump is idle.

A DV-502A equipped with a counterbalanced hoist will be shipped with the hoist unmounted. To mount the hoist, see the installation instructions in the operating manual.

1.4 INSTALLATION OF COMMON OPTIONS

Some of the more common fixtures purchased with the DV-502A units also need to be installed. Your unit may or may not have these accessories:

1. The Tilting Omni Rotary Motion is shipped mounted on the pumpout cover. The three support legs for the cover are slotted. The chain drive for the tilt cam should be adjusted properly. Move the cover away from the rotary

feedthrough to adjust the chain. The rotary drive is a rubber o-ring to provide flexibility.

> **WARNING!**
>
> All drive mechanisms, whether chain or o-ring driven, must be properly adjusted to prevent excessive wear and binding of rotating parts. After installing the chain, snug fixture until chain is tight then loosen until a slight sag is evident. This allows the bearings to rotate freely and the sprockets to function properly. Check rotation to ensure smooth operation without jerky or noisy indications.

2. The filament holders screw directly onto the threaded 3/8" low voltage feedthroughs, which are mounted in pairs at the left and right of the baseplate. Filaments can be positioned low for low angle rotary shadowing or well over the Tilting Omni for conductive coatings. Make all connections snug for good electrical contact.

3. The Carbon Evaporation Source also screws directly on a low voltage feedthrough. The shielded braided wire from the fixed rod holder should be held between washers on the other low voltage feedthrough. The source should be positioned above the Tilting Omni 4" to 5" and offset about 15 degrees for conductive coatings. The source is about 4" above the pumpout cover to deposit support films. Again, make all connections snug for good electrical contact.

Both the filament holders and carbon source are adjustable up and down; in or out. When positioning the sources do not permit any rod to touch the pumpout cover, which is at baseplate ground and would short circuit the evaporation current.

> The light from either source can damage the optic nerve. **NEVER** look at a heated source without eye protection such as welder's glasses or a coated piece of glass as you might use to watch a solar eclipse.

1.5 SYSTEM DESCRIPTION

This vacuum evaporator utilizes mechanical, electrical, and physical principles and should be operated only by personnel who have had suitable scientific training or experience.

The evaporator consists of four main sections: the vacuum chamber, the pumping system, the vacuum gauges, and the electrical controls and filament supply.

VACUUM CHAMBER

The vacuum chamber is a pyrex bell jar and gasket resting on a stainless steel baseplate assembly. The stainless steel baseplate has a cylinder welded below it which contains the poppet valve and an LN_2 baffle. Welded to the bottom of the cylinder is a plate to which the diffusion pump is bolted. Four low voltage, high-current feedthroughs are sealed through holes in the baseplate. Six additional holes are provided for accessories.

PUMPING SYSTEM
(Figure 2)

The standard system consists of a 3¾" high speed oil diffusion pump (if you have a 5¾" pump it will be noted on the Options List on page ii.) and an Alcatel 2010 (7 cfm), or Ulvac G100D (5 cfm) two-stage, direct-drive mechanical pump, together with manually operated 1" roughing and backing valves, and a main valve plus LN_2 baffle.

The plate in the poppet valve seals off a 5¾" diameter hole to the trap and is actuated by the lever on the front. Depressing the lever closes the valve. When opening or closing the main valve, grasp the lever firmly and move up or down. The valve action is spring loaded. **NEVER** attempt to open the main valve with the chamber at atmosphere and the diffusion pump at high-vacuum.

The LN_2 trap with its stainless steel multi-coolant drum and non-creep outer shield is welded directly to the upper cylindrical housing. A coaxial low heat loss feedthrough is attached to the drum and extends to the opening in the cabinet frame on the left side. An optional funnel assembly is available that screws directly into the LN_2 fill line.

DENTON 502A
HIGH VACUUM EVAPORATOR

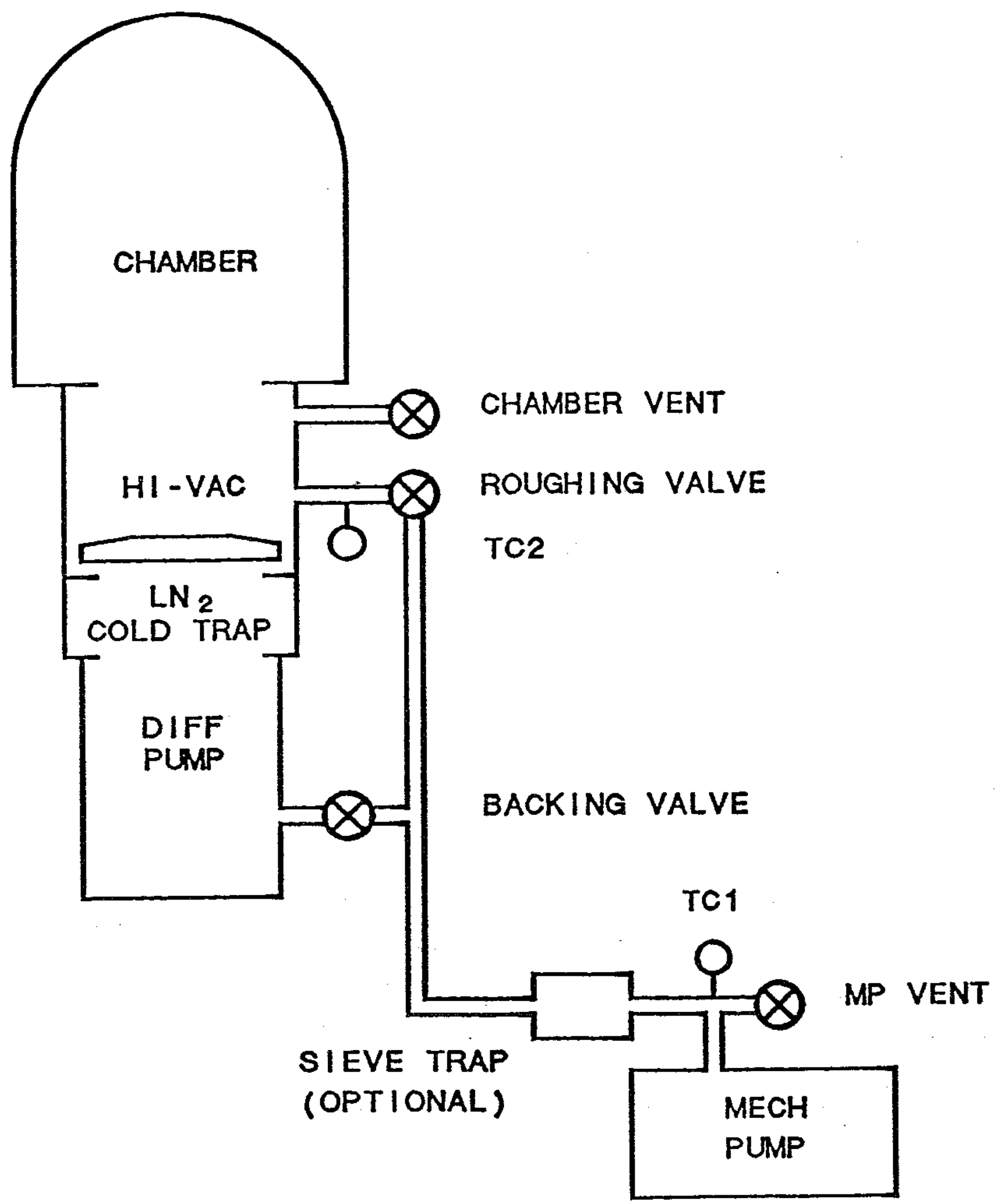


FIGURE 2

At the right of the upper cylinder is a flange which connects to the internal volume. The flange is attached to piping, which leads through the roughing valve to the mechanical pump. Another bellows sealed valve makes the direct connection between the mechanical pump and the diffusion pump exhaust. A compression fitting for the cold cathode discharge gauge tube is also welded in this area.

The main valve in the upper cylindrical housing is bellows sealed. For any maintenance, cleaning, replacement of gaskets, etc. on this valve, the diffusion pump should be cooled and the valve left open as the system is brought up to atmospheric pressure (by venting through the chamber). The operating mechanism is removed by unbolting the cap screws holding the operator flange to the mating flange. Remove the round retainer and four screws on the valve plate. The valve operating mechanism is removed through the flange. The valve plate lifts out through the baseplate.

The chamber vent is a toggle valve located at the front left center above the control panel. It is piped to a "Tee" located on the chamber side of the roughing valve. The No. 2 position thermocouple gauge is located in the other side of the "T" to measure pressure in the chamber.

The cooling water control valve for the diffusion pump is at the left rear of the cabinet (Figure 1 Water Adjustment). The best operation is obtained when water at 70° F., or cooler, is run through the system at a rate such that the discharge water is only slightly warm to the touch. Adjust the water flow rate until the proper exit temperature (100° F.) is obtained. The cooling water should enter at the top of the diffusion pump and exit at the foreline.

The standard 3¼" diffusion pump is charged with 100 cc of Dow Corning silicon oil No. DC-704, while the 5¾" diffusion pump is charged with 250 cc of the same oil.

The toggle valve above the front panel can be used to vent the mechanical pump; however, it is only necessary to vent the two-stage mechanical pump when the system will be shut down for more than a couple of hours. **ONLY** open this valve when both the roughing and backing valves are **CLOSED**.

VACUUM GAUGES

The vacuum gauging includes a two-position thermocouple gauge a selector switch to read pressures down to one millitorr at the mechanical pump FORELINE or in the CHAMBER.

The Denton cold cathode discharge gauge is an improved linear type with decade scales covering the pressure range from 5 x 10^{-4} to 10^{-7} Torr.

COLD CATHODE IONIZATION GAUGE - DVG-6A

The Denton DVG-6A Cold Cathode Ionization Gauge provides reliable pressure measurement in the high-vacuum range 10^{-3} to 10^{-7} torr.

10^{-3} torr = 10^{-3} mm Hg = 1 micron Hg = 1.33 dynes per sq. cm = 0.133 newton per square meter.

The cold cathode ionization gauge is also called Phillips gauge, Penning gauge, or discharge gauge. Pressure is determined by measuring the ion current caused by collisions between gas molecules and electrons. A magnet causes the electrons to follow long helical paths which increase the probability of gas collisions and result in greater sensitivity at low pressures. The Denton gauge has a stainless steel body which is rugged and easily cleaned.

The discharge gauge tube is mounted in the cylinder just below the baseplate through an o-ring sealed quick disconnect. The two-piece magnet fits together on the flattened section of the tube. Two connections are made to the tube. The center wire plugs over the center post; the ground wire clips to the lip of the ⅞" diameter body.

The magnet is shipped demounted. When positioning the magnet, check the wire connections to the tube.

The controls include a range selector switch marked "OFF," "ZERO," 10^{-4}, 10^{-5}, 10^{-6}, and 10^{-7}. These ranges are multiplied times the meter reading to indicate pressure in torr. Moving the selector to "ZERO" turns the power on without a pressure reading to set the meter to zero with the zero set control. It takes twenty seconds for the gauge to reach initial operating temperature. When the vacuum system has pumped to below 10^{-3} torr, move the range selector switch to 10^{-4}, then depress "METER READ" switch.

The gauge is protected by an over-pressure limit circuit which shuts off the high-voltage if the pressure rises to approximately 10^{-3} torr (1 micron). The high voltage is reactivated by depressing the "METER READ" switch, only if the pressure is lower than 10^{-3} torr.

A contaminated discharge tube will outgas, causing the pressure indication to fluctuate. You may try to clean up the tube by running the vacuum system for three

to four hours with the gauge operating. A quicker cleanup can be attempted by roughing out the system to about fifty microns, turn the range selector to "ZERO" position, and then depressing the "METER READ" switch, and hold for thirty seconds. A vigorous glow discharge will form in the ion tube. Continued pumping to below 10^{-3} torr. Depress the "METER READ" switch, then move the range selector to 10^{-4}. If the glow discharge has cleaned the tube, the pressure reading will be steady - not fluctuating.

The gauge tube is easily removed for cleaning. Half fill with acetone and shake vigorously to remove oil film or loose debris. Liquid hone or glass beading will remove oxide coatings. Rinse well in clean water, acetone, alcohol, and dry well under mild heat.

Check the ZERO setting of the needle when the gauge circuit is fully warmed by switching the range selector back to ZERO. The needle should point to zero. If not, adjust with ZERO SET knob.

The high-voltage is factory set by R6 (Cal. Adj.) to trip off between 9 and 10 on the 10^{-4} scale. Check by closing main valve with discharge gauge on 10^{-4} scale. As pressure rises, the high-voltage should cut off at 9 to 10.

ELECTRICAL CONTROLS AND FILAMENT SUPPLY

The main power circuit breaker is mounted on the left hand side of the hinged control panel. There are also switches to turn on the mechanical pump, the diffusion pump, the filament supply, the filament/glow selector, and the rotary fixture (the glow and rotary are options that can be retrofitted). The standard filament supply is of 1 kva capacity and is operated by manipulating the filament adjust at the upper left center of the control panel. This will supply voltage from the 1 kva stepdown transformer to the electrodes in the baseplate.

Fuses for the diffusion pump heater, mechanical pump and filament power are located inside the front hinged panel on a bracket on the right hand side. These should be the first things checked if lack of power to any subsystem is suspected. If any fuse continues to blow, the appropriate circuit should be checked for an electrical short.

Current passing through the electrodes is measured by the 0-60 amp ammeter on the instrument panel. To the right of the ammeter is a selector switch. The output of the filament supply can be switched to the left or right sets of electrodes.

Depending on the resistance of the carbon rod or filament wire used, different power levels will be drawn. If you are unable to draw 40 amps with the SCR on full scale, you must use a wire of larger diameter. If you can draw 55 amps, but nothing is evaporating, then:

1. FOR FILAMENT WIRE:

   a. Use smaller diameter wire.
   b. Check melting point of material.
   c. You may require an evaporation power supply with lower voltage and higher amp output.

2. FOR CARBON RODS:

   a. Check purity of carbon rods. Use only highest purity rods that have the highest resistance.
   b. Check diameter of reduced section. It MUST be .040" or less to have appropriate resistance.

1.6 OPTIONS DESCRIPTION

AC GLOW DISCHARGE

All materials exposed to our atmosphere tend to accumulate molecular layers of oil and water on the surface. These few molecular layers cause the surface to repel water. Carbon films so contaminated will cause aqueous solutions to bead rather than to spread over the surface. Contaminated grids will not pick up replicas readily. The AC Glow Discharge will clean the carbon support films and grids in vacuum of the molecular layers of oil and water.

BALLAST TANK

When shadowing, it is good to reduce mechanical vibration to a minimum. The ballast tank provides backing vacuum for the diffusion pump so the backing valve may be closed and the mechanical pump turned off during the time of evaporating. This eliminates vibration from the mechanical pump and the electric motor.

CARBON EVAPORATION SOURCE

The Carbon Evaporation Source is adjustable and is designed to provide carbon films for support, replication, or conduction.

DSM-5A COLD SPUTTER MODULE

The DSM-5A Cold Sputter Module consists of an adjustable height cathode and anode assembly, and a specimen table mounted on a sturdy support stand. Included is one shielded high-voltage feedthrough, a micrometer bleed valve, a bellows safety switch, a DC power supply, and all interconnecting wiring.

The cathode assembly adjusts vertically to accommodate specimen height. It can swing horizontally to be moved over a rotating, tilting work holder such as our Tilting Omni. The cathode disc is electrically isolated from its shield and support stand. The target is clamped to the disc so it can be readily changed. A gold target, 2⅜" diameter by .0015" thick, is standard, with a 60 percent gold/40 percent palladium target optional.

The control cabinet contains a DC power supply, providing 0-1200 volts at up to 50 milliamps. A 2½ amp line fuse is located at the back of the cabinet. A ½ amp fuse mounted inside protects against a high-voltage short. A bellows safety switch vacuum interlock mounts in the bell jar baseplate. This provides protection for personnel as power can be applied to the sputter module only when the system is under vacuum.

OMNI ROTARY FIXTURE

The Denton Omni Rotary Fixture permits rotary shadowing with a wide variety of angle adjustment. The sample is mounted on a microscope slide, then placed in the slide holder on the rotary table. The slide may be set at any angle to the axis of rotation from normal to 90 degrees. Tremendous versatility of multiple shadowing is possible with various angular settings and source heights. The speed of rotation is adjustable up to about 60 rpm.

TILTING OMNI ROTARY FIXTURE

The Denton Tilting Omni Rotary Fixture permits rotary shadow casting with continuously varying incident angle. The sample is mounted horizontally and tilts to a 45° angle and back to the horizontal continuously as the specimen rotates. The tilting motion is considerably more rapid than the rotation so that, with a properly located source, the evaporant is distributed in an essentially random manner over the contours of the sample surface. A tremendous versatility of distribution is possible since the location of the source may be varied and more than one source may be employed.

2 KVA EVAPORATION POWER SUPPLY

The 2 kva Evaporation Power Supply can provide power to two sets of filaments. It supplies 200 amps at 10 volts or 400 amps at 5 volts. The voltage can be easily changed by switching a wire between terminals on the primary side of the 2 kva transformers. (H.1 and H.2 primary yields 10 volts on the secondary; H.1 and H.3 primary yields 5 volts on the secondary.)

MINIGUN (See separate manual)

2. INITIAL START UP

2.1 INSPECTION

Before the initial start up of the system, make sure that all the required utilities are provided. Make sure all lines are connected and that there are no loose wires, hoses, or hardware.

Check the mechanical pump oil level only after it has been running for a few minutes. The oil level indication of an idle pump can be misleading. During shipping, oil drains down from the internal pump parts and may show an adequate oil level. However, after the pump has been running for a short period of time, the oil is distributed throughout the pump and the oil level may not be sufficient for proper operation.

2.2 START UP PROCEDURE

BRING SYSTEM UP FROM A "COLD" CONDITION

ALL valves are closed; ALL switches are off.

1. Turn on system power. The SYSTEM READY light should come **ON.**
2. Turn on mechanical pump.
3. Turn thermocouple gauge selector switch to the FORELINE position.
4. Thermocouple needle should indicate 50 millitorr very quickly. When it does, open backing valve.
5. Turn on diffusion pump cooling water.
6. When FORELINE reads below 50 millitorr,turn on diffusion pump. Wait 20 minutes for the diffusion pump to reach operating temperature. FORELINE pressure should go to less than 50 millitorr.
7. Adjust water flow to the diffusion pump so the exit temperature is approximately 100° F.
8. If you are using LN_2, it can be added at this time. A pressurized Dewar is usually connected directly into the opening on the left side of the cabinet. Alternatively, the optional LN_2 funnel can be used to add about a quart of LN_2. The reservoir should be filled until LN_2 spills out onto the floor on the inside of the cabinet. One charge should last two to three hours. Once filled, do not allow the LN_2 trap to warm up while operating or the condensed

contaminates will vaporize and re-emitted into the bell jar. This can be detected as a rise in pressure on the cold cathode (High-Vacuum) gauge.

9. Bell jar should be on baseplate at this time.
10. Close backing valve.
11. Open roughing valve.
12. Turn thermocouple gauge selector to CHAMBER position.
13. When CHAMBER reads between 100 and 150 millitorr, close roughing valve.
14. Open backing valve.
15. Open main valve by lifting ball handle on left of unit.
16. Thermocouple gauge should now read below 5 millitorr on CHAMBER position.
17. Turn "High-Vacuum Gauge" range selector knob to the "ON" position. Allow one minute for cold cathode tube to activate. Use zero set knob to calibrate gauge.
18. Turn range selector knob to " 10^{-4} " position.
19. Press "meter read" button. Button should remain illuminated at this time. When gauge reads below 1, turn range selector knob to the next highest scale (10^{-5}, 10^{-6}, 10^{-7}).

> **NOTE**
>
> **If the unit has just been delivered, or if the chamber has been open to atmosphere for several days and has picked up water vapor on the surfaces, it will be necessary to pump the system for many hours (even overnight) to fully clean it out.**

TO VENT CHAMBER

1. Turn off high-vacuum gauge.
2. Close hi-vac (main) valve by lowering ball handle.
3. Vent chamber via "chamber vent" on front panel.

3. OPERATING PROCEDURE

3.1 BELL JAR LOADING

1. Open the CHAMBER vent valve and bring the bell jar to atmosphere. (Necessary only if bell jar was left under vacuum previously.)
2. Lift off bell jar.
3. Load filament and/or carbon sources. Adjust sources to desired position.
4. Position samples in bell jar.
5. Replace bell jar being careful not to hit baseplate fittings.

> **NOTE**
>
> **SUBSECTIONS 3.2 THROUGH 3.6 PERTAIN TO MANUAL PUMPING AND VENTING.**

3.2 BELL JAR ROUGHING

1. Check that both vent valves are closed.
2. Close backing valve.
3. Open roughing valve.
4. Turn "TC Select" knob to CHAMBER.
5. Turn discharge gauge selector switch to ON position. Allow one minute for the gauge to warm up and then zero it.

It should take from two to four minutes to rough-pump the bell jar to 100 millitorr.

3.3 PUMPING BELL JAR TO HIGH-VACUUM

Check that CHAMBER pressure has been roughed to between 100 and 150 millitorr. ONLY then:

1. Close roughing valve.

2. Open backing valve.

3. Open main valve by grasping ball handle and raising it upward. The bell jar is now pumping to vacuum.

4. When the CHAMBER pressure drops below 5 millitorr, turn the high-vacuum gauge selector switch to the "10^{-4}" position and push the METER READ button. If the bell jar pressure is too high, the gauge needle will swing full right then drop back to zero, and the pilot light will go off. Wait a few seconds and again push "Meter Read." When the gauge needle drops below 1 on the scale, switch to the next higher scale.

> **NOTE**
>
> **If the unit has just been delivered, or if the chamber has been open to atmosphere for several days and has picked up water vapor on the surfaces, it will be necessary to pump the system for many hours (even overnight) to fully clean it out.**

3.4 EVAPORATING

When the bell jar reaches the necessary vacuum:

1. Move filament selector switch to direct power to the appropriate filament holder electrode.

2. Place FILAMENT/GLOW switch in FILAMENT position.

3. Check that FILAMENT ADJUST knob is in OFF position (fully counterclockwise).

4. Turn on FILAMENT/GLOW POWER switch.

5. Turn FILAMENT ADJUST knob clockwise to bring filament to red color (perhaps 15 amps). Hold at this power level. Check HIGH-VACUUM gauge to see if vacuum is holding. Check ammeter to obtain ampere reading. This is outgassing the filament and the evaporant. Do this for about 20 seconds or until the pressure starts dropping again. Raise power to the appropriate level to complete the evaporation.

For helpful hints on metal or carbon evaporation see Section 4.

3.5 BELL JAR VENTING

1. Turn off the HIGH-VACUUM gauge.

2. Close the main valve.

3. Open the CHAMBER vent valve. Check vacuum on FORELINE. It should remain stable. A rise in reading indicates the main valve is leaking through. If the FORELINE pressure refuses to go back to zero, contact the factory for recommendations.

> **NOTE**
>
> **To improve cycle times, you can connect the chamber vent line to a 3 psig dry N_2 line. This will reduce the potential for water vapor buildup in the chamber.**

3.6 CONTINUING OPERATION WITH A HOT DIFFUSION PUMP

1. Place the bell jar on the baseplate, making certain that the gasket and plate are both clean and free of debris. Close the chamber vent valve.

2. Close the backing valve.

3. Open the roughing valve, turn HIGH-VACUUM gauge selector to ON position, and allow the system to pump to between 100 to 150 millitorr.

4. Close the roughing valve.

5. Open the backing valve.

6. Open the main valve (Hivac Valve), turn HIGH-VACUUM gauge selector switch to " 10^{-4} " position, and push METER READ button.

3.7 SHUTTING SYSTEM DOWN

1. If the system is open to air, place the bell jar on the baseplate and rough down to 100 microns. Pump to high-vacuum as above if time permits. (The bell jar should always be left under vacuum when not in use.)

2. Close the main valve (Hivac Valve) if open.

3. Turn off the diffusion pump. Allow 10 to 20 minutes for the diffusion pump to cool.

4. Close the backing valve.

5. Turn off mechanical pump.

6. Vent the mechanical pump.

7. Turn off system power.

8. Close the diffusion pump cooling water valve.

9. REMEMBER THAT WHEN CLOSED DOWN, THE BELL JAR SHOULD BE IN PLACE AND UNDER VACUUM. ALL VALVES SHOULD BE CLOSED AND SWITCHES OFF.

Your DV-502A diffusion pumped system can give you over 10 years of reliable operation if treated properly. Eighty percent of all operating problems are caused because one of the following "Operating Rules" was broken:

1. **NEVER** have both the backing and roughing valves open at the same time. Always close one before opening the other.

2. **NEVER** open the main valve unless:

   a. The CHAMBER pressure is between 100 and 150 millitorr or less;
   b. The backing valve is open.

3. **NEVER** open chamber vent with main valve open **and** the diffusion pump hot.

4. **NEVER** open mechanical pump vent with the backing valve open.

3.8 OPTIONS

AC GLOW DISCHARGE

When a bell jar high-vacuum evaporator is equipped with a glow discharge cleaning circuit, carbon support films and grids may be cleaned in vacuum to remove the molecular layers of oil and water.

The Denton AC Glow Discharge apparatus consists of a 4000V, 30MA high-voltage transformer, a high-voltage baseplate feedthrough, and a bellows activated safety switch. This apparatus should be installed in the evaporator when being built, but it can be added in the field by using a spare baseplate hole for the safety switch.

To set up for glow cleaning, a pure aluminum wire, connected to the high-voltage feedthrough, is brought about 1½" above the port cover, then looped over the area of the cover to be used.

WARNING!

MAKE SURE GLOW WIRE IS COMPLETELY ISOLATED FROM FIXTURING (FOIL SHUTTERS, ETC.) TO PREVENT IT FROM SHORTING.

Rough out the bell jar to 30 to 70 microns. Move the FILAMENT/GLOW switch to "Glow." Turn on FILAMENT POWER switch. Rotate POWER ADJUST knob clockwise to about 50. (No reading will register on the current meter.) A glow or plasma should be visible along the aluminum wire. The material to be cleaned should be just below the visible glow. Little or no glow should be evident below the port cover. Vary the power to get a steady lavender glow. (To see the glow it may be necessary to shadow the bell jar from bright room lighting.) Hold for 2 to 15 minutes. All surfaces are being bombarded with ions formed in the high-voltage field.

Reducing the pressure results in less gas to be ionized. Visible glow is not evident below 10 to 25 microns. At this pressure the rate of cleaning is very slow. At pressures much above two hundred microns, the glow fills the bell jar and the cleaning rate is diminished. The most vigorous cleaning is in the dark space just beyond the visible glow.

After cleaning, turn the POWER ADJUST counterclockwise to "off." Turn FILAMENT POWER off. Close roughing valve. Open chamber vent. Remove cleaned material. It should stay visibly clean for a day or so.

BALLAST TANK

The 10 liter ballast tank will provide backing vacuum for at least 10 minutes when the bell jar is in 10^{-5} Torr range. To use the ballast tank, you proceed as with normal pumpdown until you are ready to evaporate metal for shadowing.

1. Close backing valve.
2. Turn off mechanical pump.
3. Evaporate.
4. Turn on mechanical pump.
5. Open backing valve.

BELL JAR SAFETY GUARD, MOUNTING INSTRUCTIONS

We supply the guard separate and unmounted so the bell jar may be shipped in a fitted carton.

The black rubber strip is fitted to the bell jar ⅛" above the gasket. We use plastic electrician's tape to hold the rubber strip in place. The tape usually overlaps the gasket a small amount.

The metal belly band mounts on the rubber strip. Tighten the nut and bolt so the band seats firmly.

Place the bell jar on a flat surface and lower the guard over it. Align the threaded bosses, insert the mounting screws, and tighten.

MANUAL LIFT

1. Install the guard around the bell jar and center the bell jar on the baseplate. Rotate the bell jar so that the opening in the band is towards the rear of the unit.

2. Preassemble the lifting mechanism according to Drawing No. C-0058-076-018. (Slide Item 1 onto Shaft 2 then insert both Shafts 2 and 5 onto Mounting Block 6/4.)

3. Set the lifting mechanism assembly onto three mounting holes on top of the unit. Slide the bell jar assembly so that it is perpendicular and that Vertical Block 10 is touching the top and bottom band of the bell jar guard.

   The lifting mechanism is typically located behind the bell jar, based on user preference of where the bell jar will eventually swing when it is at the top of the lift.

4. Secure the bell jar guard to Vertical Bar 10 using 10-32 x ½" bolts with lock washer and nut.

5. Bolt lift mounting plate to top using three ⅜" bolts with a flat washer, a lock washer and a nut on the underside of the top.

6. Slide cage assembly onto Shaft 2 and insert Shafts 2 and 5 into Mounting Block 6/4.

7. Looking from the rear and twisting from the top of the lift mechanism, make sure that Shafts 2 and 5 are parallel (otherwise, the lift mechanism might bind during raising and lowering).

8. Secure the locking Allen bolt at the base of the mounting block.

9. Attach the "belly band" around the bell jar.

10. Attach the guard to the "belly band".

11. Check the bell jar for easy raising/lowering. If it is binding, check the alignment of the two shafts.

CARBON ROD EVAPORATION SOURCE

The carbon evaporation unit is designed to use high-purity nominal ⅛" (.120") diameter carbon rods. It will fire the .040" reduced diameter, as supplied. The fixed carbon must have the contact end flat, smooth, and square to the moving carbon. The height is adjustable by loosening a screw holding the unit to the mounting post.

> **NOTE**
>
> **DO NOT permit the mounting post to touch the pumpout cover, which is at baseplate ground. This would short the filament current directly to ground.**

LOADING CARBON

Two carbon rods are positioned in the center of the "yoke" to do the coating. One rod will have a reduced section; the other will have a full diameter section that has been carefully flattened on the end touching the point (or reduced section) of the other rod. A metal or emery board nail file is useful for this task.

Both carbon rods should be inserted, one after another, through the outside end of the fixed rod holder. First, the flattened rod should be inserted and pushed through with another rod or a 1/16" wooden stick into the moving rod holder. Tighten the rod when the flat end is exposed approximately ¼" from the holder. Push the holder against the spring and deflect approximately ⅜" by hand. Insert the second rod (point first) and push it up against the fattened rod. Tighten the thumb screw holding the pointed carbon in the fixed holder. When using a reduced section carbon rod, the spring should be moved out a little more than the length of the reduced section.

When properly loaded, the reduced section goes from a solid to a gas (sublimes) with no liquid phase. When unloading, allow time for mandrels to cool as they get quite hot, especially when firing carbon for 30 seconds or longer. The screws holding the guide sleeve and the carbon rod need only be finger tight. The screw for the power lead should be tightened snugly. **NOTE: EXCESSIVE TIGHTENING OF CARBON LOCKING SCREW WILL BREAK THE ROD.**

EVAPORATION

The chamber should first be pumped to 2 x 10^{-5} Torr or less. Denton Vacuum supplies a hard carbon rod of excellent quality. With the reduced diameter (.040") section, we suggest using a filament power setting of about 15 amps to degas the carbon; about 40 to 45 amps to evaporate. Degas the carbon (bright red) for 5 to 10 seconds. (Watch the chamber pressure rise and then start to fall back.) Carbon should be evaporated slowly. Normally, after degassing, the filament power is increased to where the carbon starts lightly sparking, then backing off 5 percent on the power setting. Length of evaporation time will depend on desired thickness of carbon film. It should take from 30 seconds to two minutes to totally evaporate the carbon rod.

A carbon rod with a .040" reduced section heats up and stabilizes more quickly. The rate of evaporation remains fairly constant. Thickness of the deposited film may be controlled by the length of the reduced section.

To check the carbon evaporation technique before coating samples, do the following: Coat a glass cover slip with gold. The gold color will change to copper when the cover slip is overcoated with 100 angstroms of carbon, to orange with 150 angstroms of carbon, and to purple with 200 angstroms.

> **WARNING!**
>
> **USE DARK GLASS TO OBSERVE CARBON EVAPORATION. INTENSE BRIGHTNESS IS HARMFUL TO EYES WHEN VIEWED DIRECTLY.**

EVAPORATION TIPS

If you cannot evaporate your carbon at 40 amps in one minute, then you need to:

1. Check your carbon's purity. Use only the highest purity carbon with high internal resistance.

2. Check the diameter of the reduced section. It should be .040 or less. Current required to evaporate is dependent on the square of the diameter. A small difference in diameter can make a big difference in power required.

CARBON YARN EVAPORATION SOURCE

The Carbon Yarn Evaporation Source is adjustable and is designed to provide carbon films for support, replication or conduction. The mounting posts are drilled and tapped to screw onto one of a pair of low-voltage feedthroughs. The rectangular extension block connects the upper post to the lower post. Two blocks clamp the carbon evaporation unit to the upper post. This arrangement gives flexibility to locate the source as desired.

> **NOTE**
>
> **DO NOT** permit the mounting post to touch the pumpout cover which is at baseplate ground. This would short the filament current directly to ground.

The carbon yarn evaporation unit is designed to use high-purity carbon yarn. The height is adjustable by loosening the screw holding the unit to the mounting post.

LOADING CARBON

The carbon yarn is placed across two spring loaded electrode posts. Carbon sublimes, i.e., it goes from solid to a gas with no liquid phase). When reloading, allow time for mandrels to cool as they get quite hot, especially when firing carbon for 30 seconds or longer.

EVAPORATION

The chamber should first be pumped to 2 x 10^{-5} torr or less.

Denton Vacuum supplies a carbon yarn of excellent quality. It is suggested that a low power setting, to degas the carbon, be used; slowly raise to evaporate. Degas the carbon (bright red) for 5 to 10 seconds. (Watch the chamber pressure rise, and then start to fall back.)

Carbon may be evaporated slowly or rapidly. Normally, after degassing, the

power is increased to where the carbon starts depositing. Length of evaporation time will depend on the desired thickness of carbon film. It should take from 30 seconds to totally evaporate the carbon. **DO NOT** take power too high for more than one minute. **NEVER EXCEED 50 AMPS.**

A rapid evaporation (flashing) may be utilized by presetting the control to 75 percent of dial rotation and then turning on the power. The flash will last from 1 to 2 seconds and help reduce heat damage.

Carbon vaporizes due to localized heat caused by resistance to flow of electric current. Carbon resistance lowers as carbon heats up, but will stabilize.

To check the carbon evaporation technique before coating samples, do the following: Coat a glass cover slip with gold. The gold color will change to copper when the cover slip is overcoated with 100 angstroms of carbon; to orange with 150 angstroms of carbon; and to purple with 200 angstroms.

> **WARNING!**
>
> **USE DARK GLASS TO OBSERVE CARBON EVAPORATION. INTENSE BRIGHTNESS IS HARMFUL TO EYES WHEN VIEWED DIRECTLY.**

COUNTERBALANCED HOIST INSTALLATION

A DV-502A unit equipped with a counterbalanced hoist can be installed as follows:

a. Clean off the baseplate.

b. Position the bell jar and guard on the baseplate.

c. Mount the hoist to the unit using four bolts (supplied).

d. Connect the main cable to the top of the bell jar using the two cable clamps. Ensure that the wire goes on both pulleys inside the hoist.

e. While one person keeps tension on the main cable line, a second person should remove the bolt underneath the counterweight. Then, slowly transfer the pulling weight to the bell jar and guard assembly.

f. Install the hoist guide rods if they are not already installed.

g. Before using the hoist, remove the bolt located near the bottom of the upright section.

The bell jar should sit flush on the baseplate. Seating can be adjusted by loosening the band clamp and moving the bell jar up or down slightly.

DSM-5A COLD SPUTTER MODULE

Assembly:

The sputtering module stands on the baseplate or the raised cover plate of the bell jar evaporator. (See drawing C-0108-014-001 for installation.) Three ½" diameter holes are required in the baseplate. One is for the positive high-voltage feedthrough, one for the gas bleed, and one for the bellows safety switch. The high-voltage feedthroughs and leads in the bell jar are shielded to prevent sputtering except from the cathode target.

Two coaxial cables are provided for high-voltage connection to the power supply. Connect cable marked "POS" to the high-voltage feedthrough marked "POS." Inside the bell jar connect lead from lower ring on sputtering module (anode) to "POS" high-voltage feedthrough. Connect cable marked "NEG" to the base plate mounting bolt. Inside the bell jar connect lead from top of sputtering module (cathode) to "NEG" connector.

The sputtering module removes from the bell jar by unplugging leads at the high-voltage feedthroughs and lifting out.

Although sputtering is possible using room air as the bleed gas, it is not recommended. The composition of room air varies with water and oil vapor as contaminants. Argon is recommended as the ionized gas is an efficient, repeatable sputter medium. Connect a cylinder of argon equipped with pressure reducing valves to the micrometer bleed valve using plastic tubing. The cylinder should be chained upright.

OPERATION

When the sputtering module is in position and all the connections are made, it is ready to operate. Use the following procedure:

a. Before pumping the bell jar, open the argon cylinder shutoff valve, open the toggle valve behind the micrometer valve, and open the micrometer valve. Adjust the gas cylinder pressure regulator valve to approximately one psi reading on the low pressure gauge and purge the gas line. Shut off the gas flow by closing the toggle valve.

b. Be sure the cathode is centered over the specimen holder with 1½" between cathode and specimens. Lower bell jar and pump to 10^{-5} torr to outgas specimens and remove moisture.

c. Turn off high-vacuum gauge. Open gas toggle valve. Adjust micrometer valve to obtain 10 to 15 microns in bell jar as read on TC2 position.

NOTE: A STABLE GAS FLOW IS ESSENTIAL TO PRODUCE REPEATABLE COATINGS.

d. Turn on power supply. Adjust powerstat clockwise to obtain glow. At 45 on the powerstat about 500 volts is applied to the cathode; at 90 the cathode receives approximately 1000 volts. **Do not** exceed 50 milliamps current. The rate of deposition relates to the distance from the cathode to the substrate, gas pressure, target material, and voltage. With 10 microns argon gas pressure, 1½" distance to target, and 40 milliamps current, the DSM-5A deposits 100Å of gold in 30 seconds.

e. With desired coating deposited, turn powerstat counterclockwise to zero. Turn off power supply switch. Close toggle valve. Close main valve of vacuum system. Vent the bell jar and remove specimens.

A casual check of the thickness of the gold coating can be made by placing a glass cover slip at the same level as the specimen. With about 50Å of gold, glass will transmit a light blue-gray coloring agent against a piece of white paper. A 100Å gold coating is blue-green against white and has a faint gold reflection. At 200Å the green is deeper and the gold reflection is obvious.

> **NOTE**
>
> THE DSM-5A AND THE DSM-300A SPUTTER UNITS ARE SAFETY INTERLOCKED. THEY WILL NOT OPERATE IF THE BELL JAR IS AT ATMOSPHERE.

DSM-300A AND ADJUSTABLE SPUTTER MODULE OPERATION

Setup

> **NOTE**
>
> THE SPUTTER UNITS ARE SAFETY INTER-LOCKED. THEY WILL NOT OPERATE IF THE BELL JAR IS AT ATMOSPHERE.

To be able to sputter aluminum, chromium or other metals that form oxides, it is necessary to eliminate virtually all oxygen from the system. Therefore, the vacuum chamber as well as the gas inlet line must be fully leak checked. This can be done in the following manner:

a. The sputtering gas (typically argon) must be supplied from a tank, **not** a house line. The tank should be connected to a two-stage regulator, with the final pressure into the system being 3-10 psig.

b. There must be a positive cutoff valve (customer supplied) after the regulator. This is normally a ball valve or a toggle valve.

c. With the toggle valve closed, open the tank valve to pressurize the line to full tank pressure and then close it. Observe the pressure reading. Allow the

system to sit for several hours and observe the pressure again. If it has not dropped, then the system is leak tight from the tank to the cutoff valve.

d. Leaving the toggle valve closed, open the gas inlet valve and needle valve completely. Pump your vacuum system to high-vacuum and observe how low the ultimate pressure goes. It SHOULD go to the same ultimate as with the gas inlet valves closed (although slower). It MUST go lower than 1×10^{-5} torr if you are to have any hope of sputtering aluminum.

Having ensured that your gas inlet line is leak tight, you can proceed to operation of the DSM-300A.

OPERATION

1. Pump system down to less than 1×10^{-5} torr. If this is the first time you have run system (or sputterhead), allow at least a two hour period to pump out contaminants from the sputterhead.

2. Use bypass option if available.

3. Turn off hi-vac gauge.

4. Open gas solenoid. Allow thirty seconds for a pulse of gas to work its way through system, and for pressure to stabilize.

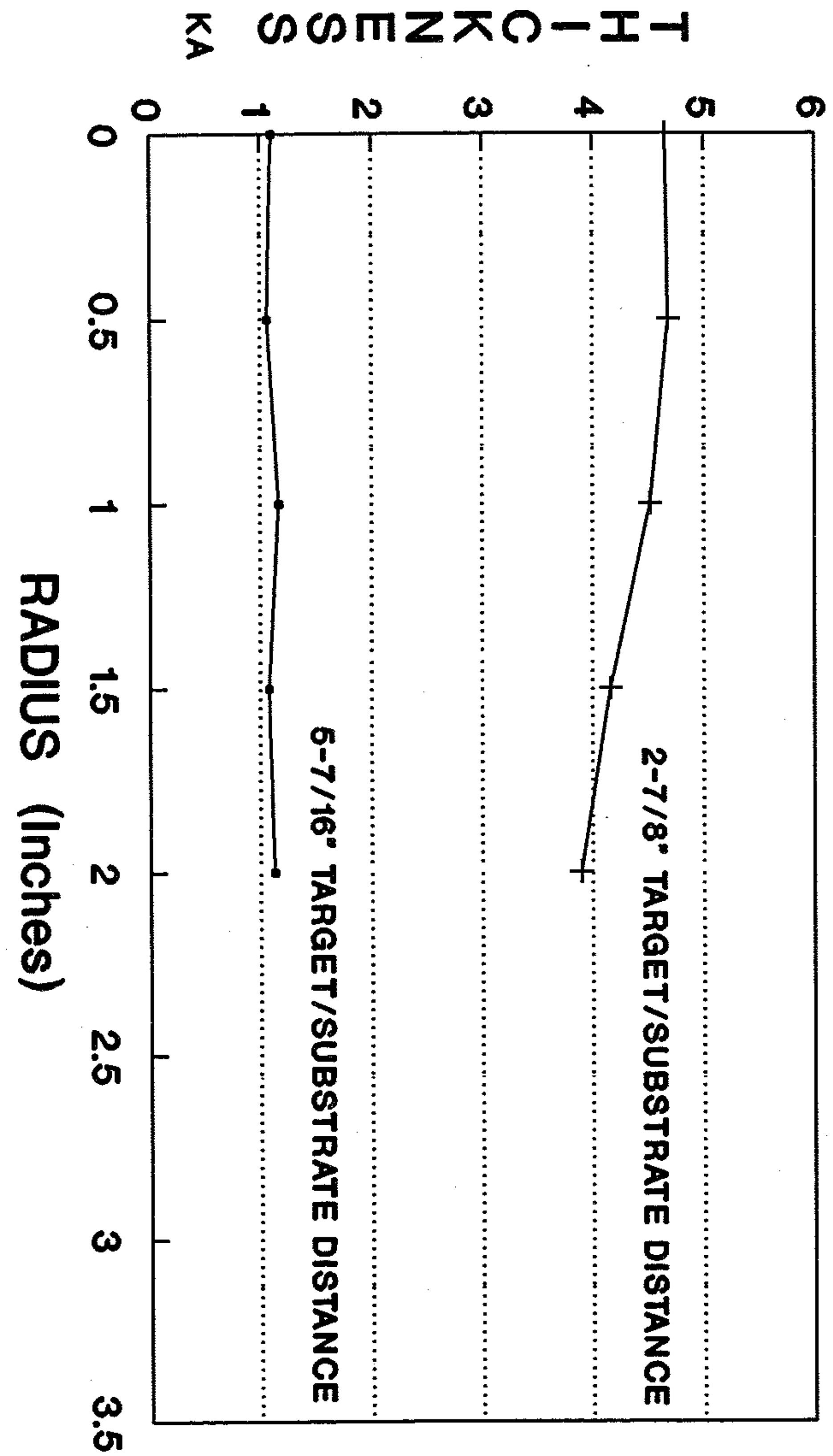
5. Adjust needle valve to bring pressure to desired setting (generally 5 m. torr). The DSM-300A sputterhead is capable of sputtering between 6×10^{-4} torr and 1×10^{-2} torr (10 millitorr) pressure in the chamber. (The lower the pressure, the less scattering losses there will be. The higher the pressure, the easier it is to develop a plasma.) A recommended starting pressure is 10×10^{-3} torr (or ten millitorr). If you have a turbo or diffusion pumped system, you can estimate a low millitorr reading in the chamber by having a 100 - 150 millitorr pressure on the foreline TC reading. If in doubt as to exact pressure, go to a higher pressure before trying to light off the sputterhead.

6. **After ensuring that water flow to the sputterhead is on,** turn on sputter power and bring up to desired setting. 300 milliamps is sufficient to sputter Al, Cr, Ta, W. Ni and any other DC Magnetron sputterable material.

For DSM-300A Systems Using the 1 kW Power Supply

Typical Uniformity Curves

(Test Run with Copper Targets)



2-7/8" TARGET
POWER: 400V, 0.151A
PRESSURE: 10μ ARGON

5-7/16" TARGET
POWER: 400V, .08A
PRESSURE: 5μ ARGON

TIME: 1200 SECONDS
CU RATE: 282Å PER MINUTE
AT 2-7/8" DISTANCE

- Ensure that all power knobs are rotated fully counterclockwise.
- Ensure that the shutter is closed.
- Turn on Sputter Power.
- Rotate the VOLTAGE COARSE ADJUST knob fully counterclockwise.
- Slowly rotate the AMPERAGE COARSE ADJUST knob clockwise until the voltage light comes on. This should occur at 30 to 40 percent of the full scale knob rotation.
- Bring up voltage power slowly until the desired power level is attained. (Remember to condition the target if arcing occurs.)
- After a suitable presputter, open the shutter to deposit the coatings.

Final deposition rate will be dependent on material being sputtered, power setting, pressure, distance and time.

6. When you have reached the desired thickness on your substrate, the power should be turned off, the argon turned off and the chamber vented.

NOTE

TARGET CONDITIONING

When starting to sputter a new target, or if the vacuum system has not been operated for a long time, power to the sputterhead must be brought on at a low power level, and then gradually raised to higher power levels as the target arcing decreases over the course of several minutes. This will allow contaminants to outgas and for the target to properly prepare itself for sputtering good quality films.

NOTE

ORIENTATION OF MAGNETS

Position of the magnets inside of the sputterhead is critical to achieve the sputtering plasma ring. The center magnet should be positioned with the "North" pole facing outward and the outside magnets with the "South" poles facing outward. If you have any questions/concerns about the orientation of the magnets when removing/installing them, CALL THE FACTORY.

Maximum Power Settings:

a. For DSM-300A systems with 300 milliamp meter:
   - **Do not** exceed 300 milliamps.
   - Supply water if sputtering for a period longer than two minutes.

b. For DSM-300A systems with 1.5 amp meter:
   - **Do not** exceed 1.0 amps.
   - Supply water if sputtering above 300 milliamps or if longer than two minutes at less than 300 milliamps.

DSM-300A EXTERNAL SPUTTERHEAD

Clamped Target Changeout

The DSM-300A sputterhead is externally mounted on top of the cylindrical chamber and is protected by a cylindrical aluminum guard.

To remove the sputterhead:

1. The guard must first be removed by the four screws fastening it to the lower band clamping the glass cylinder.
2. The guard may then be raised to clear the top plate exposing the sputter- head assembly.

3. Three screws which hold the top aluminum outer shield are removed. Then by raising the aluminum shield, the target assembly is visible.
4. The target assembly is released by loosening the six socket head screws in the teflon ring.
5. The target assembly may now be lifted (without disconnecting the water lines) and positioned to gain access to the target supporting ring. The ring is held by three horizontally positioned flat head screws.
6. The ring is loosened or clamped to the target by rotating the slotted sections. To change targets the screws must be removed and then replaced. If using a foil target, a 1/8" thick backing plate of copper or aluminum must be used to give a good thermal and electrical connection.

OMNI & TILTING OMNI ROTARY FIXTURES

These rotary fixtures provide variable speed rotation for specimens under high-vacuum. The Tilting Omni causes the angle between the source and the specimen to vary continuously during rotation. The Tilting Omni can also rotate at a fixed angle for cone shadowing simply by substituting a sleeve and screw, provided with the fixture, in place of the teflon pin. The Omni Rotary Fixture remains in a fixed horizontal position.

A 0-60 rpm gear motor mounts in a "C" bracket below the baseplate. Power is driven through a flexible coupling to a ¼" rotary motion feedthrough, which is also the vacuum seal at the baseplate. The gear motor is shipped mounted to the bracket. The ¼" rotary motion device installs through the baseplate from the vacuum side. The long threaded end under the large hex nut clamps the bracket firmly to the baseplate; the open side of the bracket faces out.

The ¼" rod should move freely in the rotary motion feedthrough. Install the teflon washer, the thrust clamp, and the upper part of the flexible coupling on the ¼" rod. Lower the rod assembly so the bar on the motor shaft and the bar on the rod fit snugly into the nylon insert. Tighten the rod thrust clamp and the upper and lower part of the flexible connector.

Plug in the gear motor and test the rotation. The vacuum end of the rotary motion device should rotate smoothly and the nylon insert should turn evenly with no play where it meshes with the drive and driven bars.

The rotating table assembly mounts through a 25/32" hole in the port cover with two 6/32" x ⅜" long flat head screws, which thread into holes with centers 19/32" from mounting hole center. The cover port must be firmly positioned. The table is drilled to accept 12 specimen mounts with .128" pins or 8 mounts 13/32" in diameter. The standard table is 2½" in diameter, but larger tables may be used. The Omni Rotary Fixture is also available with a microscope slide.

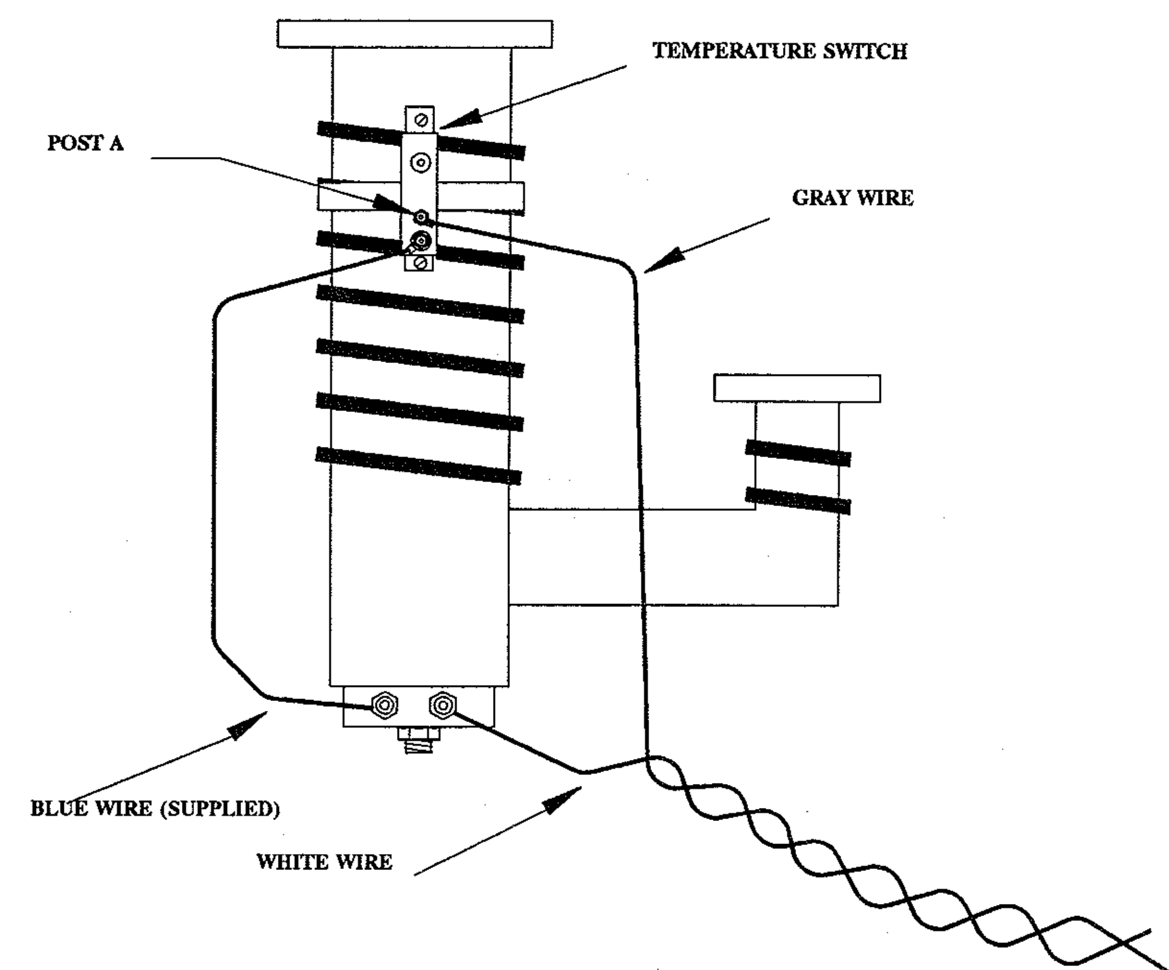
The pulley ratio for rotation is 1:1. Mount the driving pulley on the ¼" rod in the same plane as the driven pulley. The small gear drives the tilting cam. The chain drive for the tilt cam is fitted after the table assembly and the rotary motion feedthrough are installed.

Wrap the chain around the driving and driven gear. Mark the length carefully. Use long-nosed pliers to open the chain. Make certain that the link ends are bent evenly. Properly assembled, the joined links will look exactly like the rest of the chain. The Omni Rotary Fixture uses a rubber belt in lieu of a chain. Wrap the belt around the pulley on the drive shaft and the pulley on the rotary motion shaft. All bearings in the vacuum space run dry. The rotary motion feedthrough uses a lubricated sleeve plus two spring loaded o-rings for a vacuum seal. Use a high quality lubricating vacuum grease such as our Moly-lube. Do not use silicon based grease.

To lubricate the rotary motion feedthrough, loosen the upper end of the flexible connector, loosen the thrust clamp, and remove the hex nut. All these parts are within the "C" bracket below the baseplate. The motion feedthrough will now lift from the baseplate. Loosen the hex nut on the vacuum side of the motion feedthrough. Inspect lower end of ¼" rod for burns. Rod should lift out easily bringing the o-ring, spring, and o-ring assembly with it. Wipe spacers, o-rings, and spring clean. Lubricate o-rings lightly. Lubricate ¼" rod lightly. As you reassemble, pack grease into the spring area. This will act as a lubricant reservoir.

The Omni and Tilting Omni may be adapted to any evaporator with a 10" diameter or larger bell jar. At additional cost we can supply a mounting plate or a motion feedthrough flanged for baseplate holes larger than 33/64" diameter.

TEMPERATURE SWITCH INSTALLATION INSTRUCTIONS



1. Turn off all system power and unplug the DV-502A.
2. Remove front access panel.
3. Attach temperature switch to diffusion pump as shown.
4. Locate gray and white wires attached to the bottom of the diffusion pump and remove the gray wire.
5. Attach gray wire to Post A of temperature switch using hardware supplied (hardware already on temperature switch).
6. Attach the blue wire from the temperature switch to the bottom of the diffusion pump (where the gray wire was previously).
7. Reinstall front access panel, this completes installation.

4. EVAPORATION PROCESSES

4.1 METAL EVAPORATION

For shadowing, increase the filament power sufficient to melt the evaporant. Platinum melts at 1769° C. and evaporates readily at 1800° C. Watch the evaporant through dark glasses to avoid eye damage. Increase power to evaporate quickly without causing evaporant to fly off in chunks. Molten platinum dissolves tungsten. A slow platinum evaporation usually will stop due to the filament breaking. The diameter of filament wire is limited to a size that will heat above 1800° C. with not more than 50 amperes current. We suggest MULTISTRAND .015" filament wire for maximum heat surface. Do not operate above 40 amps for more than one minute as this will exceed 1 kva.

For low angle rotary shadowing, use a straight length of multistrand .015" filament with a 1" length of .005" diameter platinum wrapped along the filament. Position the source out from the sample 10 cm. and up 1 cm. above the plane of the sample for the shadow angle of 9 degrees. Rotate sample 100 rpm while evaporating platinum vapor evenly for a period of 10 to 15 seconds. Shadowing is usually done at 1 or 2 x 10^{-5} torr.

To shadow without rotation the V-shaped filament is often used with the platinum wire wrapped at the point of the "V". It melts to form a drop. Evaporate rapidly just below the temperature causing spitting. It is a race between evaporation and dissolution. Seldom can a "V" filament be used a second time as it will show thinning from the first use. Shadowing is done at a 45° angle to provide a height to shadow length of one to one. Smoother samples require a more shallow angle for the shadow to be discernable. As low as 6° has been used with careful setup.

Conductive coating uses the same techniques with differences. A conductive coating provides an electrical path to dissipate electrons from the beam. A gold coating of 100Å will increase secondary emission, provide a measure of heat dissipation, and, to a degree, provide radiation protection for the sample. To aid in making the coating continuous, the samples are rotated and tilted during deposition. This gets a conductive coating into the hills and valleys avoiding shadows.

If sufficient gold is evaporated to deposit 100Å on a smooth surface, the exposure determines how much deposits on any given spot. If the bottom of a depression is exposed 10 percent of the time, it will receive only 10Å of gold. The sample may need extra coating to become conductive. Use only the coating needed to prevent charging.

If gold wire .008" diameter of a measured length is used and the wire is completely evaporated, the conductive coating is repeatable; however, for each sample, the thickness of the coating for an area is determined by its exposure to the metal vapor.

When evaporating metals that do not dissolve the tungsten filament, at the completion of the evaporation allow the filament to cool for several minutes before venting. With care, a filament will last for 15 to 20 evaporations. Venting immediately will cause the tungsten to oxidize.

4.2 CARBON EVAPORATION

Carbon is used in a thin film to support samples as they stretch over the grid openings. This supporting film can be as thin as 30Å to 35Å. A drop of diffusion pump oil placed on a piece of white porcelain and carbon coated will show a discernable grey at about 30Å carbon. The porcelain stays white under the oil and is carbon coated elsewhere. Thicker carbon films are used for replicas. Replicas usually are 100Å to 150Å. Carbon is used for conductive coatings ranging in thickness from 50Å to several hundred angstroms.

A useful carbon thickness monitor can be made by gold coating cover slips. Place the gold cover slip with the samples to be carbon coated. The gold will change to a copper color when 100Å of carbon is deposited, to orange with 150Å carbon, to purple with 200Å carbon.

The Denton Carbon Evaporation Source uses a nominal ⅛" carbon rod that is .120" in diameter. A fixed rod holder and a spring loaded moving rod holder combine to maintain contact during evaporation. The current is adjusted to approximately 40 amps to achieve the sublimation temperature of the carbon.

Three millimeters of reduced section can be evaporated when a rod is reduced in cross section to .040" diameter. The carbon rods are supplied with reduced sections. A reduced section will continue to evaporate at a given power level. Reduced sections are used when carbon deposits of 150Å to 200Å are desirable. Automatic carbon evaporation is easier to control using reduced sections instead of points. Incidently, evaporation is not the proper description for carbon going from solid to vapor. Carbon sublimes when heated.

The Denton Carbon Evaporation Source also uses carbon yarn for quick loading and easy evaporation.

High pressure (1 to 10 millitorr) evaporation of gold, gold palladium, or carbon can improve conductivity of coatings on SEM specimens having very irregular or porous surfaces difficult to penetrate with straight line (2 x 10^{-5} Torr) evaporation pressures. High pressure evaporation will produce somewhat larger grain size, but only rarely will this increase be objectionable.

This high-pressure technique may also be adapted to protect heat sensitive specimens from filament or carbon source thermal radiation. Because thermal radiation is essentially straight line at all pressures, inserting a shield 25 mm. to 30 mm. diameter between the filament and specimen about 2.5 cm. from the filament will block the radiant heat, but will permit the evaporant to diffuse around the shield and coat the specimen.

At 10 millitorr some coating thickness is lost, but the diffuse nature of the coating permits conductivity and penetration to remain excellent. If evaporating carbon by this method, expect some loss to oxygen when bleeding air. Bleeding an inert gas would eliminate this loss.

5. SERVICING VACUUM PROBLEMS

Occasionally, a problem may arise in the vacuum system. Leaks may occur through bad seals, loose welds, or through the malfunction of a component. The following is presented as a guideline for servicing vacuum problems when they occur.

5.1 MECHANICAL PUMP

When starting up, leave both roughing and backing valves closed and check the mechanical pump vacuum on the TC gauge position. Since the pump is exhausting only a short section of copper tubing, the indicated vacuum should drop quickly below 50 microns. If not:

1. Check the oil level. It should be visible in the bull's eye between the high and low marks on the glass.

2. Check oil condition. The oil may be dark, but it should be reasonably clear. A milky color indicates water contamination. Check further by sampling a few drops from the oil drain. Presence of water calls for an oil change. Smell the oil. Aromas foreign to oil indicate contamination.

   Mild contamination from water and some solvents may be cleared up using gas ballast. Run the pump with the system valves closed. Open the knurled ballast valve until the exhaust is gurgling. Continue for an hour or so, then close the ballast valve and check TC1 reading for improvement. If the oil contamination is not relieved by ballasting, the oil should be changed.

   Contaminated oil is changed as follows: Drain pump thoroughly. Install drain plug and run pump 5 to 10 seconds. Drain accumulated oil. Install drain plug, remove hose on the pump inlet, and pour half of a normal fill of fresh oil into the inlet with the pump running. This tends to flush both stages of the pump. Drain flushing oil and fill pump with fresh oil. Check level after pump has been running a few minutes. Add or drain oil to bring level between lines in the bull's eye. Low oil level may not provide a continuous flow to the pump for sealing and lubricating. High oil level may cause oil to be blown from the exhaust onto the floor.

3. Air leaks may occur at the threaded connection for the thermocouple tube. A drop of acetone or alcohol on a leaky connection will cause a change in

reading in FORELINE TC. A small leak may be sealed temporarily resulting in an improved vacuum. A larger leak will allow liquid acetone to enter and vaporize resulting in pressure rise in FORELINE TC. Even a small leak may degrade the vacuum considerably when the leak is right at the tube. The leak is sensed before it has a chance to expand and be pumped away. Use teflon tape on the thermocouple tube threads when installing. If small leaks are then detected, a small drop of nail polish can seal them.

4. The roughing and backing valves are bellows sealed with the bellows being on the mechanical pump side when the valves are closed. Bellows eventually will develop hairline cracks due to work hardening the copper alloy at the inner or outer convolution.

   Usually a hairline crack in the bellows will leak more with the valve completely open (bellows is compressed) than with the valve nearly closed (bellows in normal condition). Variations in TC1 reading as the valve is moved from nearly full open to nearly closed indicate trouble in this area. Squirt acetone in the bellows vent hole in the stem flange to check.

   The bellows is replaceable with static o-rings forming the vacuum seal. To replace, remove stem assembly from valve body. Four allen head screws hold the stem assembly. Spin the flange from the threaded stem. Slide a 6" length of ¾" i.d. copper tubing with opposing ears 3/16" wide by ½" long at the forward end down over the threaded stem to fit slots in the nylon valve stem nut. Remove stem nut. Bellows is free to be inspected. You should replace both the bellows and the nylon stem nut. When reassembling, a drop of thread seal on the stem nut will prevent the nut subsequently loosening.

   Normally the o-rings are reusable; however, all seals should be inspected and cleansed if necessary. Wipe the o-ring grooves. If vacuum grease is used, apply a thin coating and wipe it off with a clean rag. Sufficient grease will remain to lubricate the o-ring.

5. Many evaporators are equipped with a mechanical pump line vent. Check to see if it is closed.

5.2 AREA BETWEEN MAIN VALVE & BACKING VALVE (Figure 3)

Vacuum problems can occur in the area between the main valve and the backing valve. Assume we have adequate vacuum with all valves closed, but the vacuum

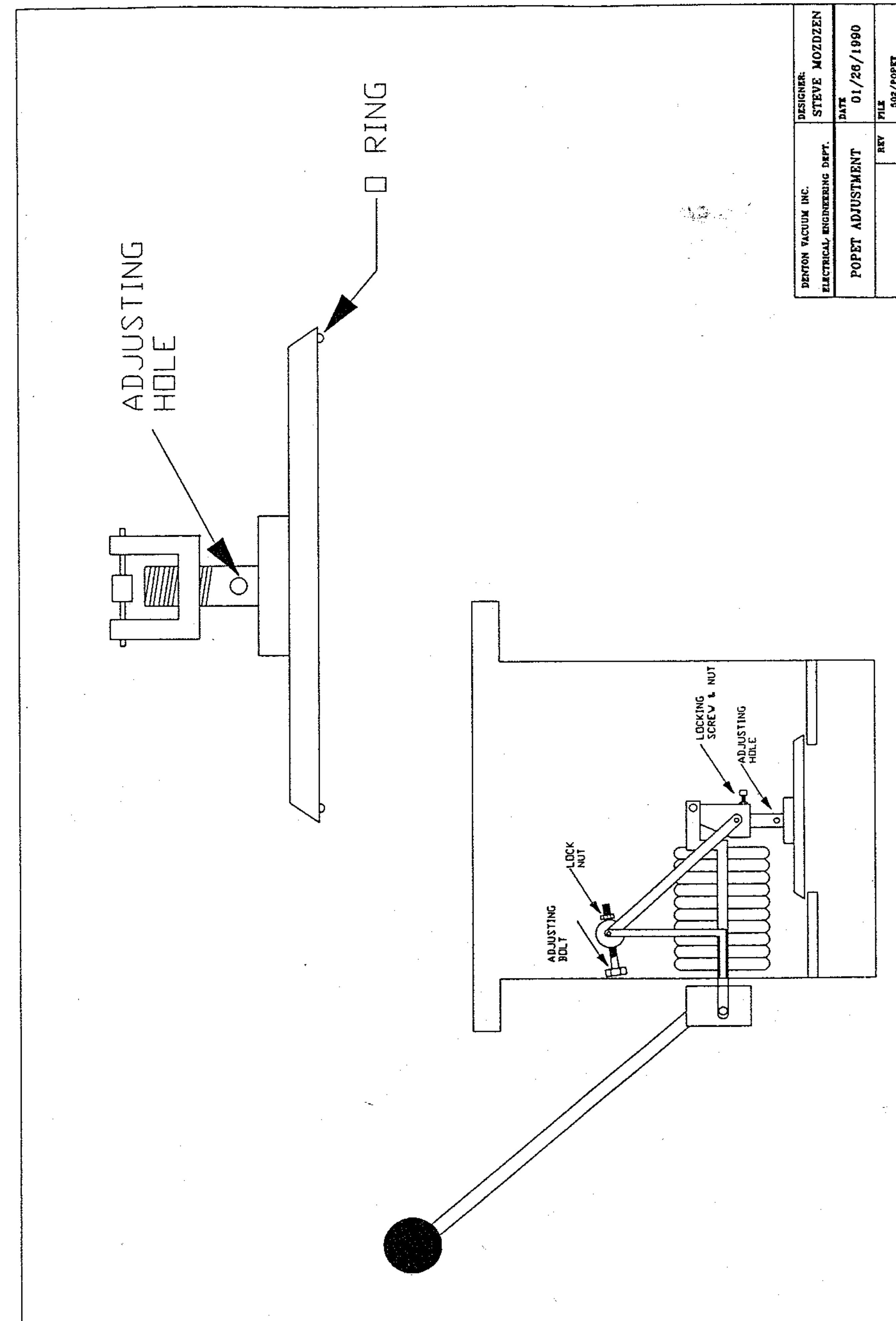


FIGURE 3

attainable with the backing valve closed is considerably better than with the backing valve open. A few microns difference is acceptable.

1. Debris may prevent the main valve from closing completely. To check, pump down the diffusion pump with the backing valve open.

   With the main valve closed, vent the bell jar. This will have no effect on the TC1 reading providing the main valve is sealing. If the pressure does rise, check the main valve seal. Debris may prevent the valve plate from closing. Check the o-ring. A piece of filament wire may be in or across the o-ring. Check the valve plate action. It should lower into place, than clamp lightly. Venting the diffusion pump to atmosphere with the bell jar under vacuum or exhausting the bell jar with the diffusion pump at atmosphere puts a great force on the valve mechanism. Neither condition should happen in normal operating procedures.

   Valve plate seating may be adjusted if maloperation has caused it to change. This can be done by rotating the poppet plate downward and the re-tightening the set screw.

   Many diffusion pumps have a drain fitting. Some have an oil level fitting. Either may leak when loose. The leak may be apparent only with the diffusion pump hot when it is difficult to check with acetone.

   The trap baffle may leak especially where soldered or brazed connections are subject to wide temperature change. Usually such a leak can be found with acetone or with a helium mass spectrometer. Occasionally, the leak is happening only with the trap at liquid nitrogen temperature. If the system pumps down better without liquid nitrogen, the trap needs to be removed and corrected.

   The diffusion pump fluid can be oxidized if exposed to air while at operating temperature. Short exposures to air do not seriously affect DC-704, DC-705, or Santovac 5, but exposure is to be avoided with the diffusion pump heater on.

   Operation with the cooling water off, operation with a gross leak, or operation with the electric power being interrupted may result in diffusion pump fluid breakdown. When this happens, a complete system cleanup is recommended.

5.3 BELL JAR

The bell jar area may be the source of a vacuum problem. Assume we have good vacuum with all valves closed and with the backing valve open, but the bell jar area will not pump down:

1. First check the bell jar gasket and the bell jar. Wipe gasket and baseplate seal clean. Check gasket for cracks, slits, etc. Check glass edge for chips. A partial chip should not leak. A chip extending clear across should be ground out with flatness maintained. This can be done by contacting the factory. Sometimes an acceptable repair can be made with epoxy. Clean the glass with acetone. Apply epoxy in sufficient depth and allow to sit overnight. Keep epoxy from sides of bell jar using foil retainer. Carefully rub epoxy down to level of glass using abrasive such as crocus cloth. Properly finished, this repair will be effective and lasting.

   Occasionally, the bell jar will stick to the baseplate after venting. Position the bell jar with one hand and apply upward force with the other hand. Do not bang it or give it a hard blow with the heel of your hand. Sideways movement of the bell jar will contact a feedthrough and a chip may be the result. Loosen the bell jar only with upward force.

2. If the evaporator is equipped with a hoist, check the bell jar movement as it reaches the baseplate. It may need adjustment to seat fully.

3. Is the vent valve open?

4. The bellows for the main valve is located in the area above the valve. A bellows leak affects the bell jar vacuum. Check with acetone. The o-rings tend to maintain their static seal. Usually a leak is in a convolution of the bellows. Acetone can be squirted in the open end of the bellows through a hole in the flange. Start at the bottom and work up. The bellows is replaceable.

5. The quick disconnect for the ion tube is o-ring sealed. Acetone will usually disclose a leak. We use pyrex tubes for hot filament gauges and stainless steel tubes for cold cathode discharge gauges. On the cold cathode tube, the collector ring is sealed into the tube with a glass bead. A sharp blow may crack this bead. Check visually, then with acetone.

6. All power feedthroughs have o-ring seals. These static seals seldom leak once they are properly installed. Any "just installed seals" should be immediately

suspected when the vacuum failure occurs on the first subsequent pumpdown. Try to wiggle these feedthroughs from beneath the baseplate.

Rotary motion seals for simple shutters and for power driven work tables use twin o-rings. Vacuum grease is packed between the o-rings to lubricate and seal. These feedthroughs should be removed, cleaned, and regreased depending on the frequency of use. Some gas evolution is expected when the shaft moves in. Little or no leak should be expected when the shaft is rotated.

5.4 SMALL LEAKS

The preceding covers leaks of appreciable magnitude. Leaks of a size to prevent attaining less then 1 x 10^{-4} Torr will normally be found using acetone. At high vacuum actual leaks are likely to be small as to require a helium mass spectrometer to locate them. It is more common to have a problem with the diffusion pump not pumping very well than it is to have a 10^{-5} Torr leak suddenly appear.

Suppose your system will pump down to 2 x 10^{-4} Torr but no further. To diagnose the problem, do the following:

1. Close the main valve and watch the ~~hugh~~ high vacuum gauge needle. If the vacuum degrades quickly, then switch to TC2 (ROUGH (chamber)) and time the rise for 5 microns at two points; say from 10 to 15 microns and from 50 to 55 microns. If the time interval is the same, we are likely dealing with an air leak from outside. If the time interval is somewhat longer at the higher pressure, we may have a contaminated system, and the system is outgassing slowly.

   Open the main valve and pump down again. Repeat the pressure rise check. If the rise time is longer, contamination is a likely cause. A thorough cleaning of all surfaces in the vacuum space will correct the trouble.

2. When a tight, clean system does not pump down, the diffusion pump may be the cause. This can be determined by attempting to pump to high-vacuum, and then comparing the pressures on the CHAMBER and FORELINE TC. At chamber pressures greater then 1 x 10^{-4} Torr, the FORELINE pressure should be at least 20 millitorr greater than the CHAMBER. If it is, chances are that the high-vacuum reading is accurate and that the diffusion pump is doing its job by pumping contaminants or a leak out of the chamber. If the FORELINE TC is only 5 to 10 millitorr greater or even less then the CHAMBER TC, chances are that the diffusion pump is not operating properly. This could be due to one of the following:

a. Diffusion pump water exit temperature is too cold. It should be around 100° F. (or warm to the touch). Throttle down the needle valve (and the water flow) until the exit temperature rises.

b. Oil is low. The diffusion pump will have to be lowered to check this.

c. The jet assembly has raised up off the bottom of the diffusion pump. The diffusion pump will have to be lowered to check this.

d. The pump fluid may be oxidized or contaminated. Remove the pump, wipe all surfaces dry, clean with acetone, add proper type and amount of pump fluid, and reassemble.

Smaller diffusion pumps have a single heater. Usually a defective heater will not heat at all. On larger pumps one heater may burn out with the remaining heater not able to cause good pumping. Check the heater power. Check heater connections.

5.5 DISCHARGE GAUGE TUBE

Another problem area may be the discharge gauge tube. The evaporator seems to be working well, but the high-vacuum gauge reads at the low end in each scale. The ground clip may have been disconnected. Check the clips at the discharge tube. The discharge tube should be cleaned occasionally. A dirty tube may refuse to fire, or it may fire but give erratic readings. The needle will jump ¼ to ½ scale. This is to be expected when the unit has been idle for a long time or when the unit was shut down with the diffusion pump still hot. To clean the gauge, we use glass bead cleaning with an acetone rinse. If you do not have access to a glass beader, send the gauge tube to Denton Vacuum for cleaning.

5.6 CROSSOVER CALIBRATION FOR AUTO CYCLE (auto system only)

1. In Manual Mode, pump chamber to High-Vacuum.

2. Locate crossover controller (behind mechanical pump) and the two adjustment pots on the fact of the crossover controller. The set control on top is the percent input, and the one under that is time delay.

3. Set the (time delay set [button] control) full counterclockwise, and the ([top] percent input) full clockwise.

4. Locate thermocouple crossover sensor, just to the left of the crossover controller, and the adjust control on the round circuit board.

5. Using a voltmeter capable of reading up to 50 millivolts D.C. connect meter to crossover controller input, red to + (positive) and black to - (negative).

6. Adjust set control on thermocouple crossover sensor (round circuit board) until millivolt meter reads 30 millivolts, then detach meter.

7. Close high-vacuum valve and vent chamber.

8. Open roughing.

9. Close roughing when chamber is at 200 millitorr.

10. Turn percent input on crossover controller slowly counterclockwise until indicator lamp lights on face of controller.

11. Turn time delay on controller ~~full clockwise~~.

12. This completes crossover calibration. Unit will crossover at 100 millitorr in the auto pump mode.

6. GENERAL MAINTENANCE

A clean vacuum evaporator will more likely be a good operating evaporator. It is essential to keep the unit clean. A total system cleanup is recommended every six months. Scale build-up on the baseplate should be scraped off weekly and the surface cleaned with acetone or alcohol using a lint free cloth or paper and solvent. Be sure all debris is vacuumed away. Clean coating build-up from the bell jar with a metal polish. "Wenol" or "Pol" is recommended. These polishes clean off the coating deposit and polish the glass.

To ensure a proper vacuum seal, inspect the bell jar gasket for nicks, cracks, and other foreign material. Apply a thin coat of vacuum grease to the gasket. Immediately wipe off the grease to prevent excessive grease build-up. Inspect the sealing surface for nicks or scratches. These must be smoothed out with emery and polished with fine emery or Scotch Brite. Any deposit build-up must be similarly removed and the entire surface wiped clean with alcohol or acetone. Vacuum the baseplate to remove all debris and powder deposits.

A mechanical pump running with clean oil has an indefinite lifetime. Such pumps will be producing usable vacuum for ten or more years. On a monthly basis check the mechanical pump oil for level and contamination. Change oil if necessary.

If your unit has a counterbalanced hoist, visually inspect the horizontal support. Look for wear on the bearings and the wire rope.

NOTE

SHOULD THE WIRE ROPE SHOW EXCESSIVE WEAR OR THREADING, REPLACE IMMEDIATELY.

Should a need for spare parts occur, see the "Spare Parts" section of this manual. **BE SURE TO REFER TO THE JOB NUMBER WHEN ORDERING SPARE PARTS.**

Fuses in Machine 10/93

Dif Pump MDA 10A
Fil MDA 10A
Ac Amp MDX 4A
DC Pos MDL 5A
(Both) MDA 10A.

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DENTON VACUUM INC.

SPARE PARTS LIST

DV-502A

JOB #

PART NO.	DESCRIPTION	LOCATION	QTY.	PRICE EA.
5110-009	BELL JAR, 12" X 12"		1	$522.00
5110-010	BELL JAR, 12" X 18"		1	778.00
5110-015	BELL JAR, 14" X 18"		1	1,033.00
5091-001	BELL JAR GASKET BUNA N (12" DIA.)		1	27.30
5092-001	BELL JAR GASKET VITON A (12" DIA.)		1	87.10
5091-002	BELL JAR GASKET BUNA N (14" DIA.)		1	31.59
5092-002	BELL JAR GASKET VITON A (14" DIA.)		1	120.25
B-0062-001-004	GUARD, 12" X 12" B.J.		1	258.00
B-0062-001-002	GUARD, 12" X 18" B.J.		1	408.00
B-0062-001-003	GUARD, 14" X 18" B.J.		1	320.00
0024-001-002	⅜" LOW VOLTAGE FEEDTHROUGH		1	73.00
B-0030-018-001 (0030-002-012)	½" HIGH VOLTAGE FEEDTHROUGH		1	220.00
B-0041-001-002	¼" ROTARY MOTION		1	110.00
A-0092-001-031	½" BLANK PLUG		1	35.00
5094-009	SPRING	HIGH VACUUM VALVE LINKAGE	2	5.30
5000-237C	RETAINING RING	HIGH VACUUM VALVE FLANGE	1	8.80
0001-004-010	BELLOWS ASSEMBLY	HIGH VACUUM VALVE	1	201.00

DENTON VACUUM INC.

SPARE PARTS LIST

DV-502A

JOB #

PART NO.	DESCRIPTION	LOCATION	QTY.	PRICE EA.
0001-007-003	BONNET ASSEMBLY	MANUAL SYSTEM ROUGHING AND BACKING VALVES	2	$293.60
0001-007-006	BONNET ASSEMBLY	AUTO SYSTEM ROUGHING AND BACKING VALVES	2	365.00
B-0001-007-031	BELLOWS	ROUGHING AND BACKING VALVES	2	74.57
A-0001-007-036	BELLOWS NUT	ROUGHING AND BACKING VALVES	1	11.50
A-8027-001	TOOL, BELLOWS NUT	INSTALLATION OF BELLOWS NUT IN ROUGHING AND BACKING VALVES	1	27.90
5104-010	OIL	MECHANICAL PUMP		5.45/QT 14.60/GL
5104-002	OIL	STANDARD 3¼" DIFFUSION PUMP	100 CC	35.00
5104-002	OIL (DC-704)	OPTIONAL 5¾" DIFFUSION PUMP	250 CC	87.00
5085-002	HEATER (120V)	STANDARD 3¼" DIFFUSION PUMP	1	198.90
5085-004	HEATER (120V)	OPTIONAL 5¾" DIFFUSION PUMP	1	225.00
B-0052-002-003	COLD CATHODE GAUGE METAL TUBE	HIGH VACUUM VALVE COMPRESSION SEAL	1	135.00
0093-002-001* 96C91A	COLD CATHODE GAUGE MAGNET	HIGH VACUUM VALVE GAUGE TUBE *Units prior to 1989 need 1 set Magnetic Housing Assembly	2	16.87
B-0053-006-041	MAGNETIC HOUSING ASSEMBLY	MAGNETS Units prior to 1989	1 SET	65.00
5108-004	THERMOCOUPLE TUBE DV-23	VACUUM PIPING @ $58 from Lesker	2	116.00
A-0084-001-059	CARBON RODS 1½" LONG	CARBON ACCESSORY		151.00 PER 100
A-0084-039-036	LAVA BUSHING	CARBON ACCESSORY	2	12.61
5013-010	O-RING	¼" ROTARY MOTION SHAFT SEAL	2	.75

DENTON VACUUM INC.

SPARE PARTS LIST

DV-502A

JOB #

PART NO.	DESCRIPTION	LOCATION	QTY.	PRICE EA.
5013-210	O-RING	¼" ROTARY MOTION, ½" BLANK PLUG ⅜" L.V. AND H.V. FEEDTHROUGHS	1	.85
5013-258	O-RING	HIGH VACUUM VALVE POPPET PLATE	1	3.60
5013-240	O-RING	HIGH VACUUM VALVE POPPET MOUNTING FLANGE	1	1.25
5013-227	O-RING	HIGH VACUUM VALVE BELLOWS ASSEMBLY	1	1.00
5013-116	O-RING	HIGH VACUUM VALVE BELLOWS ASSEMBLY	1	.85
5013-212	O-RING	HIGH VACUUM VALVE COMPRESSION SEAL	1	.85
5013-218	O-RING	VACUUM PIPING ROUGHING LINE FLANGE	1	1.50
5013-238	O-RING	INLET, STANDARD 3¼" DIFF. PUMP	1	1.30
5013-258	O-RING	INLET, OPTIONAL 5¾" DIFF. PUMP	1	3.60
5013-224	O-RING	FORELINE, 3¼" OR 5¾" DIFF. PUMP	1	1.00
5015-111	O-RING	DRAIN AND FILL, OPTIONAL 5¾" DIFF. PUMP	2	1.50
5013-012	O-RING	ROUGHING AND BACKING VALVES, BELLOWS SEAL	1	.75
5013-215	O-RING	ROUGHING AND BACKING VALVES SEAT SEAL	1	.90
5013-226	O-RING	ROUGHING AND BACKING VALVES BONNET SEAL	1	1.00
0058-082-015-1	GASKET SET - BUNA N	STANDARD UNIT	1	45.00
0058-082-015-2	GASKET SET - BUNA N	UNIT WITH OPTIONAL 5¾" DIFF. PUMP	1	50.00
5042-031	CIRCUIT BREAKER 20 AMP (120V)	CONTROL PANEL	1	55.00

DENTON VACUUM INC.

SPARE PARTS LIST

DV-502A

JOB #

PART NO.	DESCRIPTION	LOCATION	QTY.	PRICE EA.
B-0001-007-033	BONNET	ROUGHING AND BACKING VALVES	2	$90.00
A-0084-001-077-1	ELECTRICAL LEAD (LONG)	CARBON FIXTURE	1	20.00
A-0084-039-038	ELECTRICAL LEAD (SHORT)	CARBON FIXTURE	1	18.00
0181-6429-06-015	THERMAL PROTECTION SWITCH	5¾" M4 PUMP	1	112.00
A-0084-039-033	STATIONARY CHUCK	CARBON FIXTURE	1	39.00
A-0084-039-034	MOVABLE CHUCK	CARBON FIXTURE	1	35.25
G-100D	ULVAC MECHANICAL PUMP			1,682.00
UM-2008A	ALCATEL MECHANICAL PUMP			2,670.00
0076-022-021	GLOW ROD ASSEMBLY	AC GLOW		22.00
A-0084-039-035	SPRING	CARBON FIXTURE	1	11.18

DENTON VACUUM INC.

SPARE PARTS LIST

TILTING OMNI ROTARY FIXTURE

JOB #

PART NO.	DESCRIPTION	LOCATION	QTY.	PRICE EA.
A-0084-029-010-1	CAM PIN		1	$10.66
5094-010	EXTENSION SPRING	MOUNTING BLOCK FOR SPECIMEN PLATE	2	3.69
5059-001	BALL BEARING	CAM SPROCKET & BEARING HOUSING	3	14.71
5013-210	O-RING	ROTARY MOTION FLANGE SEAL	1	.85
5013-010	O-RING	ROTARY MOTION SHAFT SEAL	2	.75
5013-236	O-RING	DRIVE BELT ON DV-502A BELOW FIXTURE MOUNTING PLATE	1	1.30
5013-227	O-RING	DRIVE BELT ON DV-515 BELOW FIXTURE MOUNTING PLATE	1	1.00
5116-006	GROOVED PULLEY	OMNI & ROTARY MOTION SHAFT	2	16.40
5116-003	SPROCKET	DRIVE FOR CAM SPROCKET	1	15.60
6C88-19 (0084-029-001-8)	LADDER CHAIN		15"	4.00/FT.
5052-001* CYQC43200-31-5	GEAR MOTOR	ROTARY MOTION *DV-502 needs shaft coupling and bracket	1	121.00
AP-1530-44	SHAFT COUPLING	GEAR MOTOR ON DV-502	1	26.00
B-0131-010-121	BRACKET	GEAR MOTOR ON DV-502	1	50.70
A-0084-029-013	SPECIMEN HOLDER	MOUNTING PLATE FOR JEOL ⅜" STUBS 391 MM DIA.		95.00

8033-017

DENTON VACUUM INC.

SPARE PARTS LIST

OMNI ROTARY FIXTURE

JOB #

PART NO.	DESCRIPTION	LOCATION	QTY.	PRICE EA.
A-0084-019-006	SPRING	SLIDE HOLDER	1	$2.75
5059-001	BALL BEARING	BEARING HOUSING	2	14.71
5116-006	GROOVED PULLEY	OMNI & ROTARY MOTION SHAFT	2	16.40
5013-236	O-RING	DRIVE BELT ON DV-502A	1	1.30
5013-227	O-RING	DRIVE BELT ON DV-515	1	1.00
5013-210	O-RING	ROTARY MOTION FLANGE SEAL	1	.85
5013-010	O-RING	ROTARY MOTION SHAFT SEAL	2	.75
5052-001* CYQC43200-31-5	GEAR MOTOR	ROTARY MOTION *DV-502 needs shaft coupling and bracket	1	121.00
AP-1530-44	SHAFT COUPLING	GEAR MOTOR ON DV-502	1	26.00
B-0131-010-121	BRACKET	GEAR MOTOR ON DV-502	1	50.70
5113-001	RHEOSTAT	OMNI POWER SUPPLY	1	31.20
A-0084-029-068	1⅛" FILTER HOLDER	WITH FILTER CASSETTES		

8033-097

DENTON VACUUM INC.

SPARE PARTS LIST

DSM-1 & DSM-5A SPUTTERING MODULES

JOB #

PART NO.	DESCRIPTION	LOCATION	QTY.	PRICE EA.
0089-001-031	BELLOWS SAFETY SWITCH	BASEPLATE	1	$232.00
5082-005	SILICON RECTIFIER	CONTROL CABINET	4	5.50
5093-008	RESISTOR 470 OHMS 1W 10%	CONTROL CABINET	1	.90
5013-210	O-RING	HIGH VOLTAGE FEEDTHROUGH	1	.85
5013-112	O-RING	GAS INLET AND BELLOWS SAFETY SWITCH	2	.80
A-0108-009-066-1	GOLD CATHODE	SPUTTERING CATHODE	1	199.00
A-0108-009-066-2	GOLD-PALLADIUM CATHODE (60/40)	SPUTTERING CATHODE	1	199.00
A-0108-009-070	HIGH VOLTAGE LEAD	SPUTTERING CATHODE (DSM-1)	1	7.00
A-0108-014-004-1	HIGH VOLTAGE LEAD	SPUTTERING ANODE (DSM-5)	1	7.00
A-0108-014-004-2	HIGH VOLTAGE LEAD	SPUTTERING CATHODE (DSM-5)	1	7.00
5107-001	INSULATOR	TOP OF DSM-5 CATHODE	2	1.98

DENTON VACUUM, INC.
2 PIN OAK AVENUE, CHERRY HILL, NJ 08003

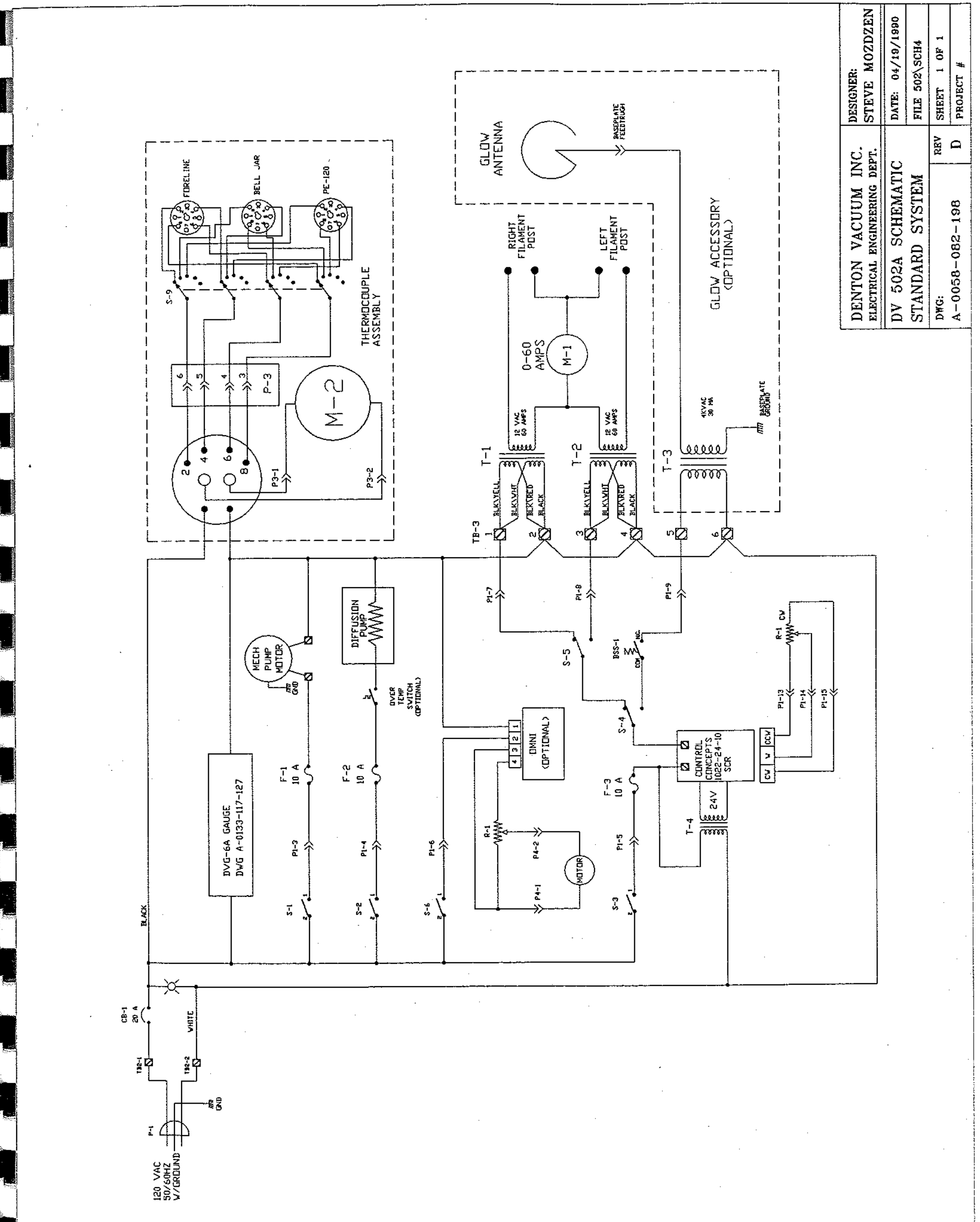
TELEPHONE: (609) 424-1012
FAX: (609) 424-0395

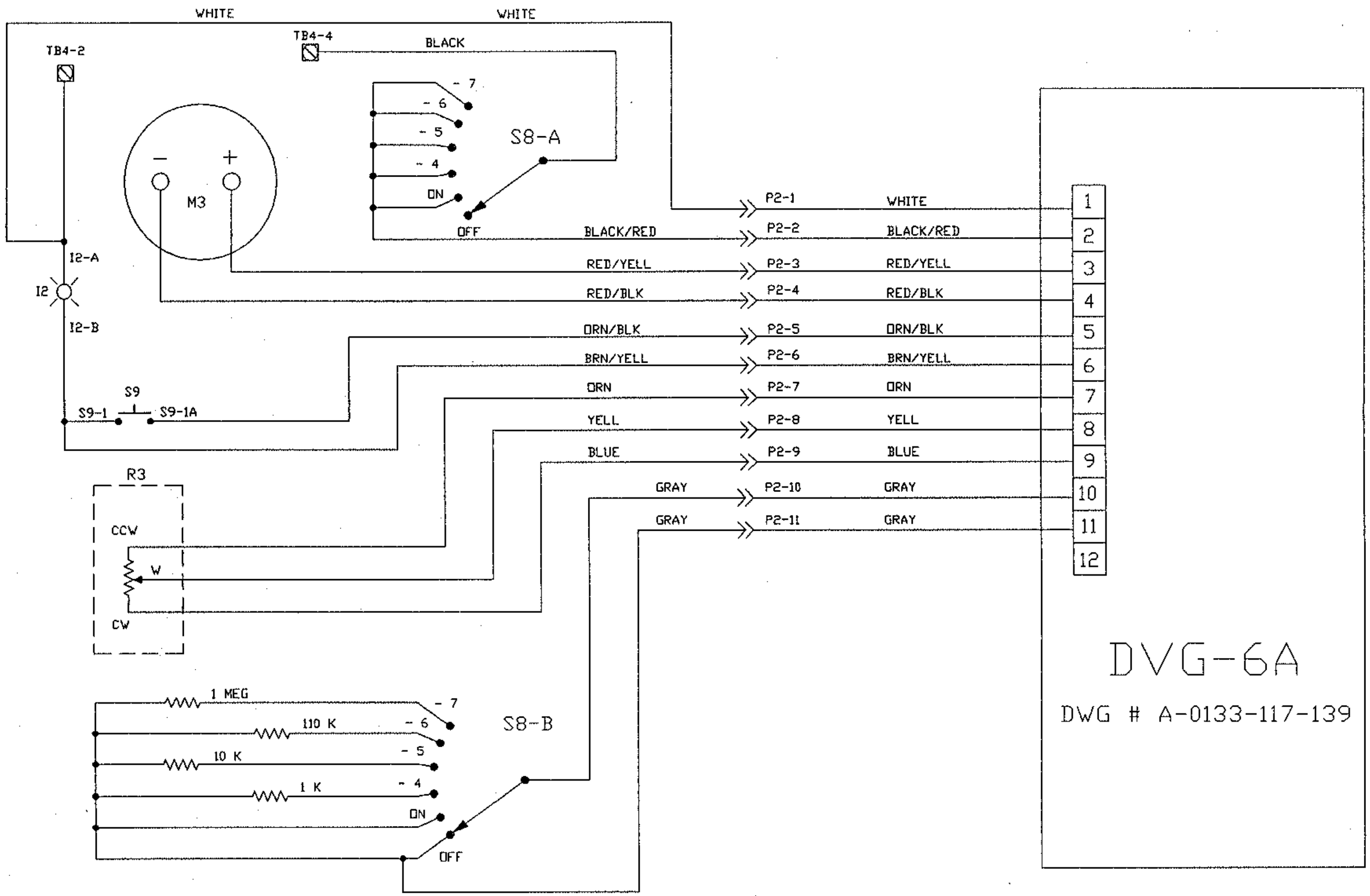
DV-502A

SUGGESTED SPARES

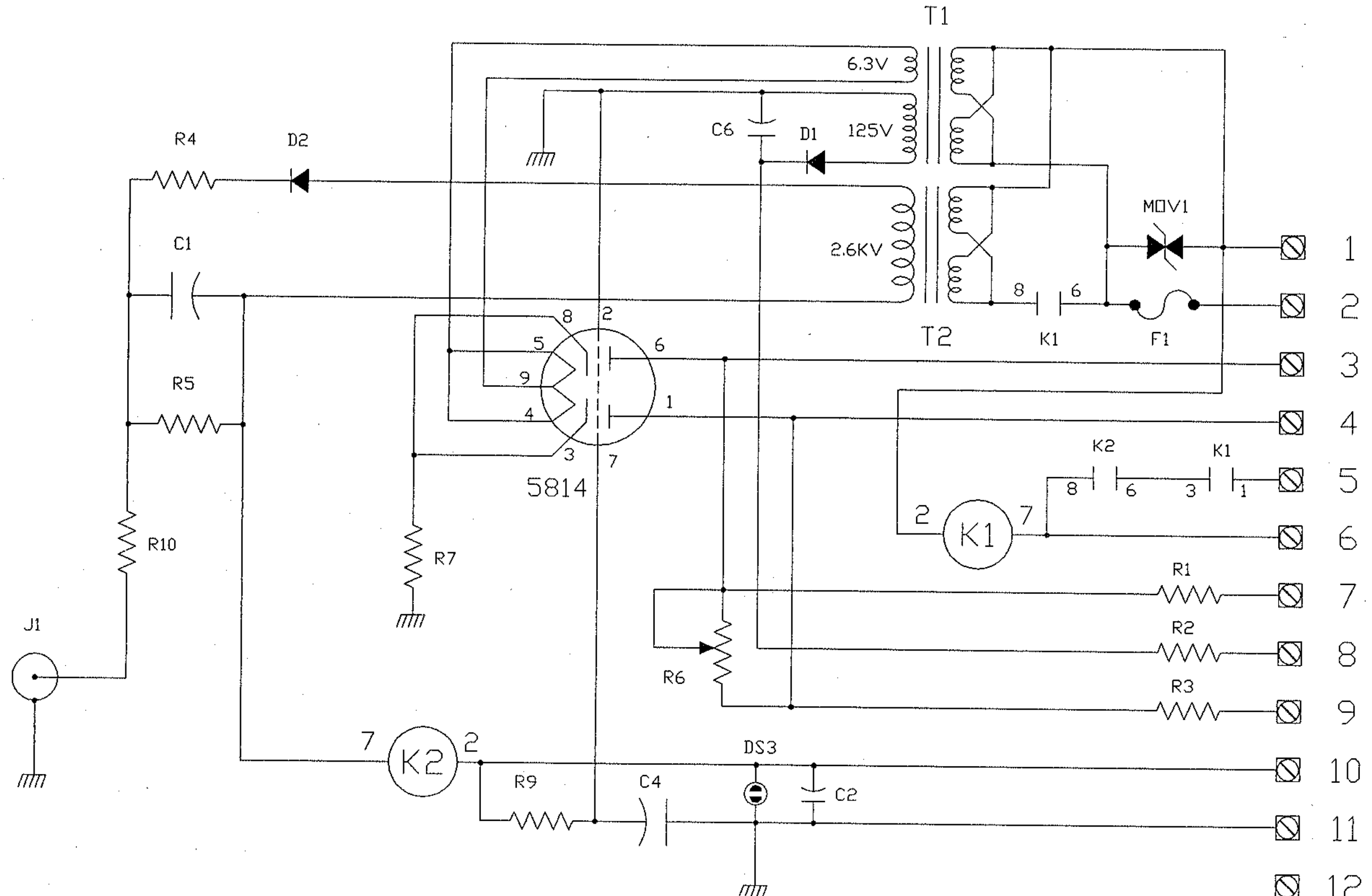
PART NO.	DESCRIPTION	PRICE
0058-082-015-1	Gasket Set, Buna N - Standard Unit	$ 45.00
0058-082-015-2	Gasket Set, Buna N - Unit with 5¾" D.P.	50.00
0058-082-015-3	Gasket Set, Viton - Standard Unit	165.00
0058-082-015-4	Gasket Set, Viton - Unit with 5¾" D.P.	170.00
5104-010	Mechanical Pump Oil	5.45/qt. 14.60/gal.
5104-002	Diffusion Pump Oil - 3¾" D.P. - 5¾" D.P.	35.00/100cc 87.00/250cc
A-0084-001-059	Reduced Section Carbon Rods (per 100)	151.00
5104-014	Vacuum Grease for O-Rings, Rotary Motion	3.75/vial
5108-004	Thermocouple Tube DV-23	116.00
B-0052-002-003	Cold Cathode Tube	135.00

MINIMUM ORDER $25





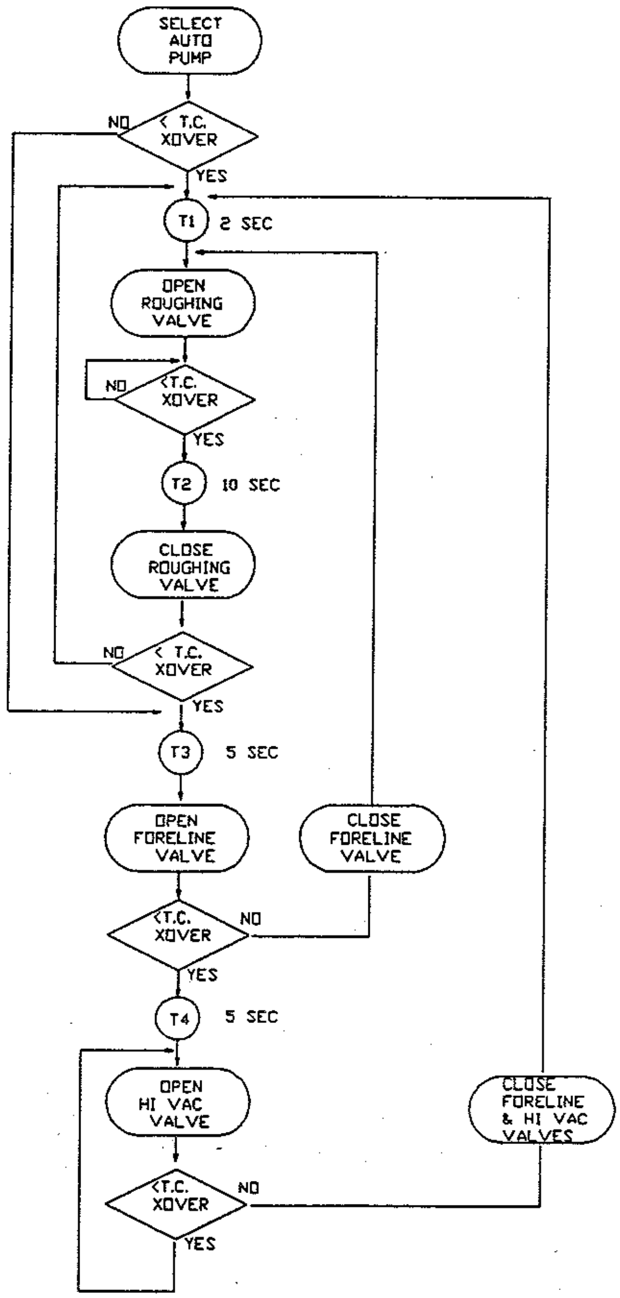
DENTON VACUUM INC.	ELECTRICAL ENGINEERING DEPT.	
	DESIGNER: STEVE E. MOZDZEN	
ELECTRICAL SCHEMATIC DVG-6A CHASSIS 110V		DATE: 05/09/1991
		FILE: 502\DVG6A110
DWG: A-0133-117-127	REV -	SHEET 1 OF 1
		PROJECT -

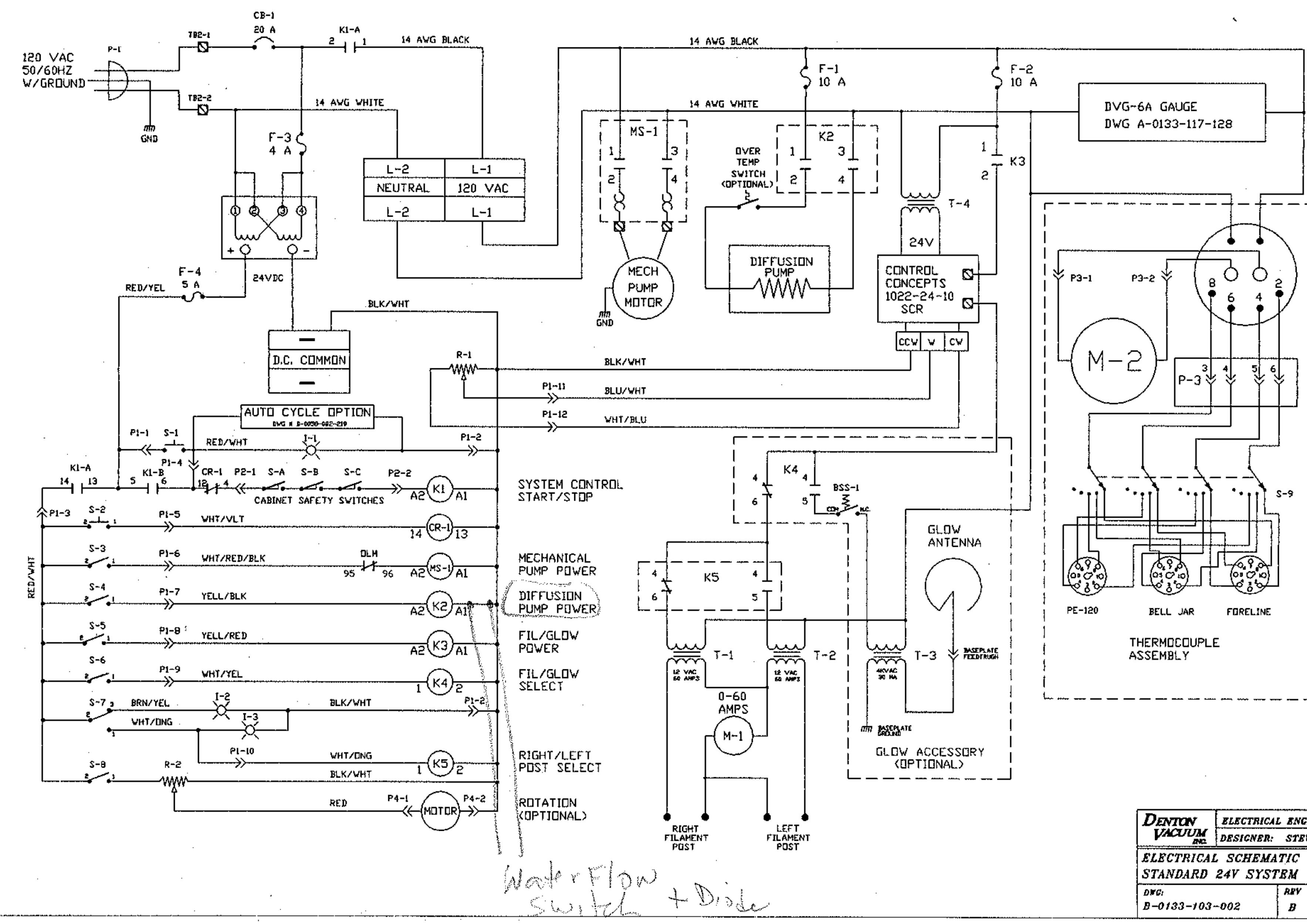


R1 2.2KΩ	C1 .0047uf
R2 10KΩ	C2 .05uf
R3 2.2KΩ	C3 .05uf
R4 50KΩ	C4 .05uf
R5 10MEGΩ	C5 16uf
R6 2KΩ	
R7 1.3KΩ	F1 1 AMP
R8 5.1KΩ	MOV1 SIOV-S07K250
R9 1MEGΩ	D1 1N3254
R10 250KΩ	D2 LHC5-10

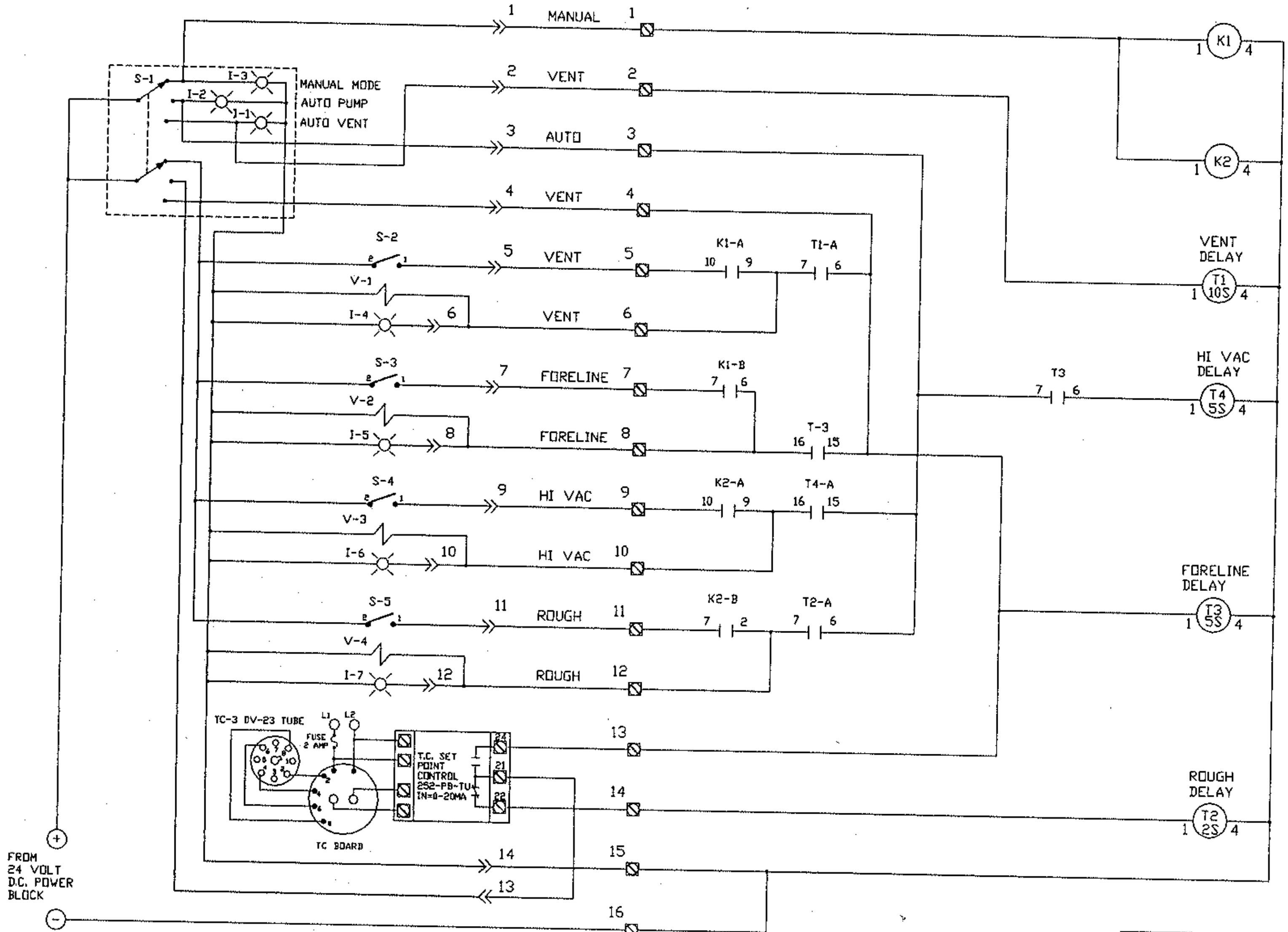
DENTON VACUUM INC.	ELECTRICAL ENGINEERING DEPT.	
	DESIGNER: STEVE E. MOZDZEN	
ELECTRICAL SCHEMATIC DVG6-A CHASSIS 110V		DATE: 03/14/1991
		FILE SCH\DVG110
DWG: A-0133-117-139	REV -	SHEET 1 OF 1
		PROJECT -

DV-502A AUTO PUMP FLOW CHART





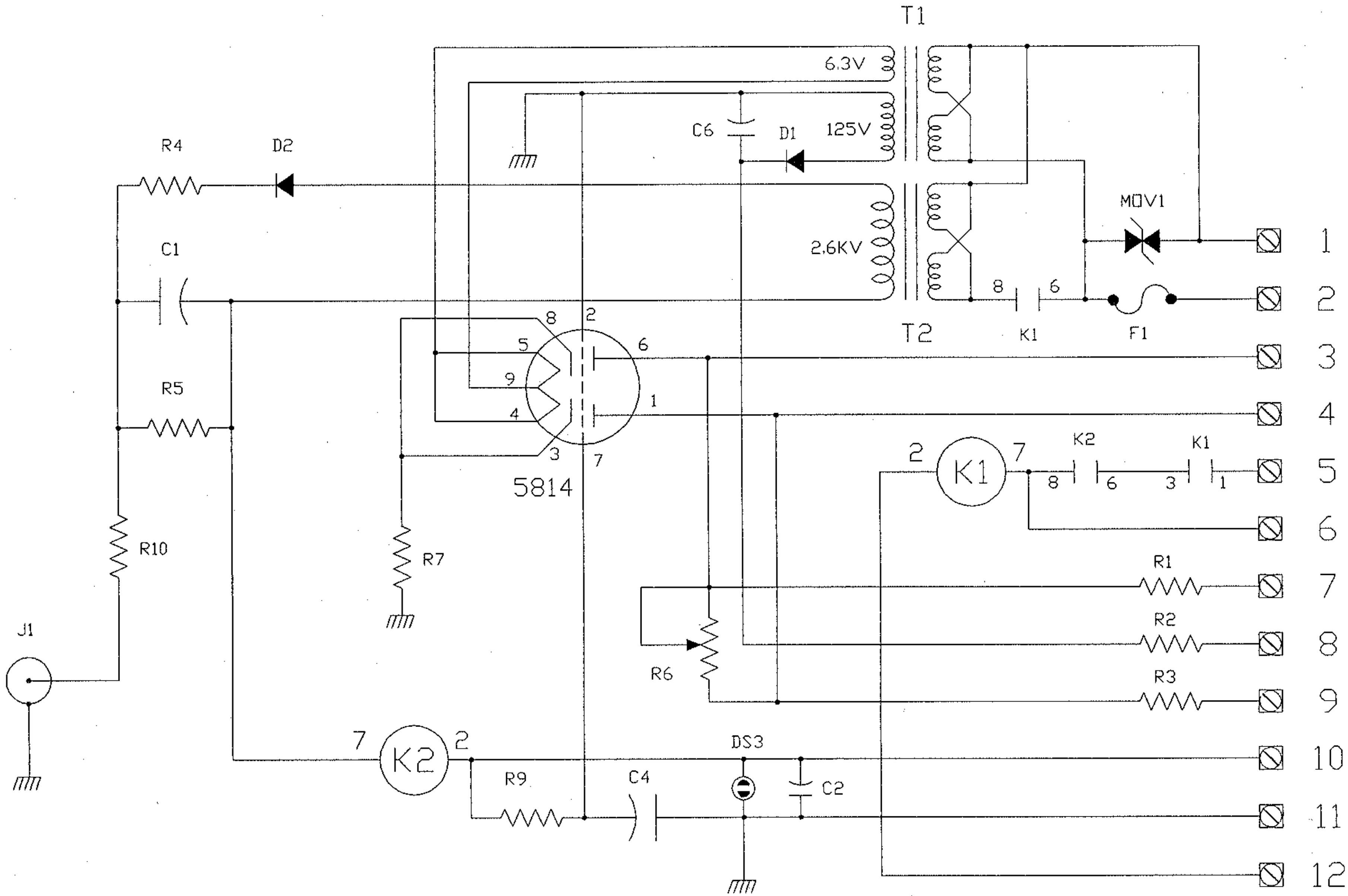
DENTON VACUUM INC.	ELECTRICAL ENGINEERING DEPT.	
	DESIGNER: STEVE E. MOZDZEN	
ELECTRICAL SCHEMATIC STANDARD 24V SYSTEM		DATE: 05/09/1991
		FILE: 502\SCH01
DWG: B-0133-103-002	REV B	SHEET 1 OF 1
		PROJECT -



15 PIN MOLEX PLUG

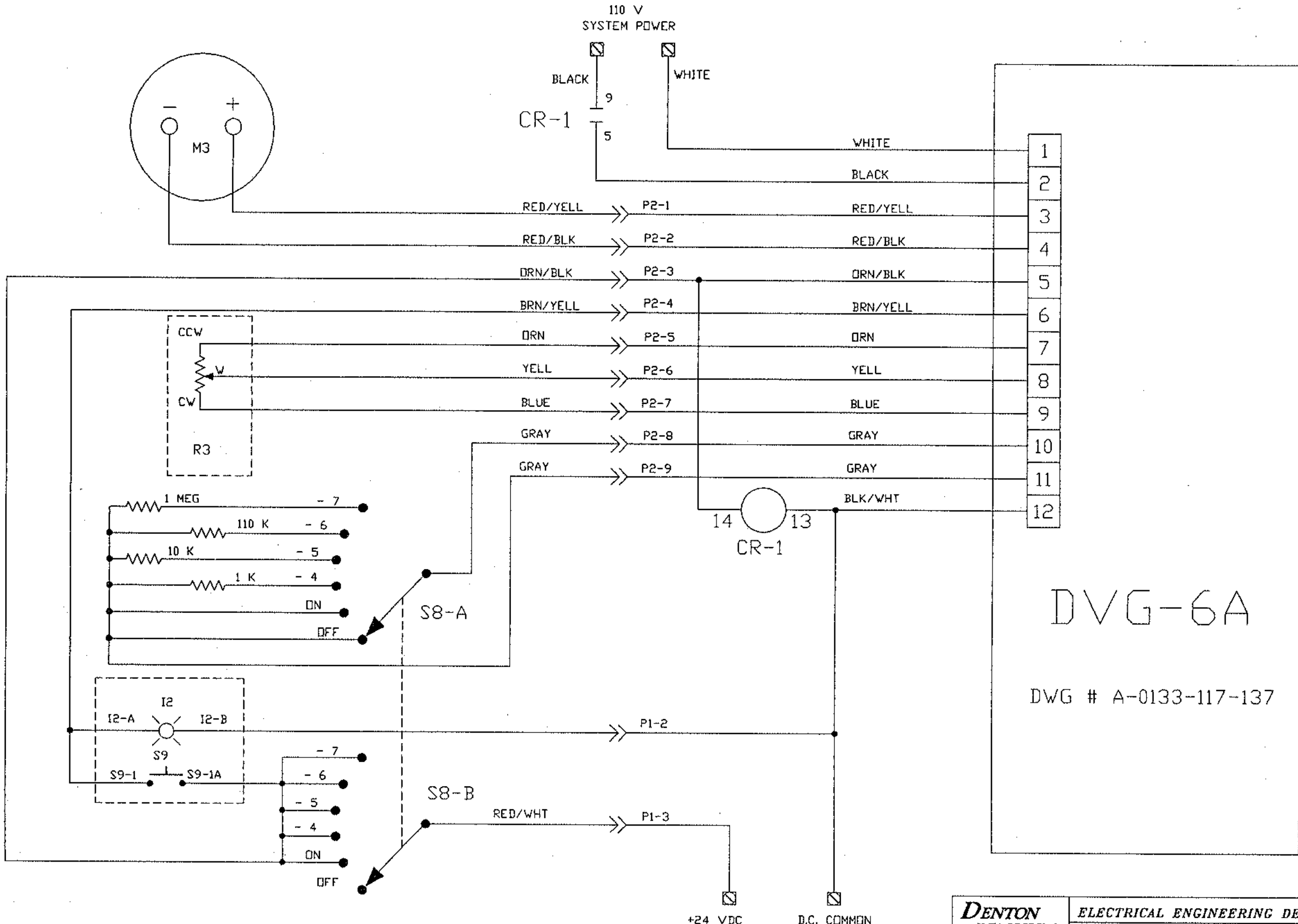
1 ORG
2 VLT
3 BLUE
4 WHT/BLUE
5 BLUE/YELL 20 AWG
6 BLUE/YELL 24 AWG
7 WHT/GRN 20 AWG
8 WHT/GRN 24 AWG
9 PINK 20 AWG
10 PINK 24 AWG
11 WHT/PINK 20 AWG
12 WHT/PINK 24 AWG
13 BLUE/WHT
14 BLACK/WHT
15 N.C.

DENTON VACUUM INC.	ELECTRICAL ENGINEERING DEPT.	
	DESIGNER: STEVE E. MOZDZEN	
ELECTRICAL SCHEMATIC 502A AUTO PUMP		DATE: 05\08\1991
		FILE SCH\APUMP
DWG: A-0058-082-219	REV E	SHEET 1 OF 1
		PROJECT -

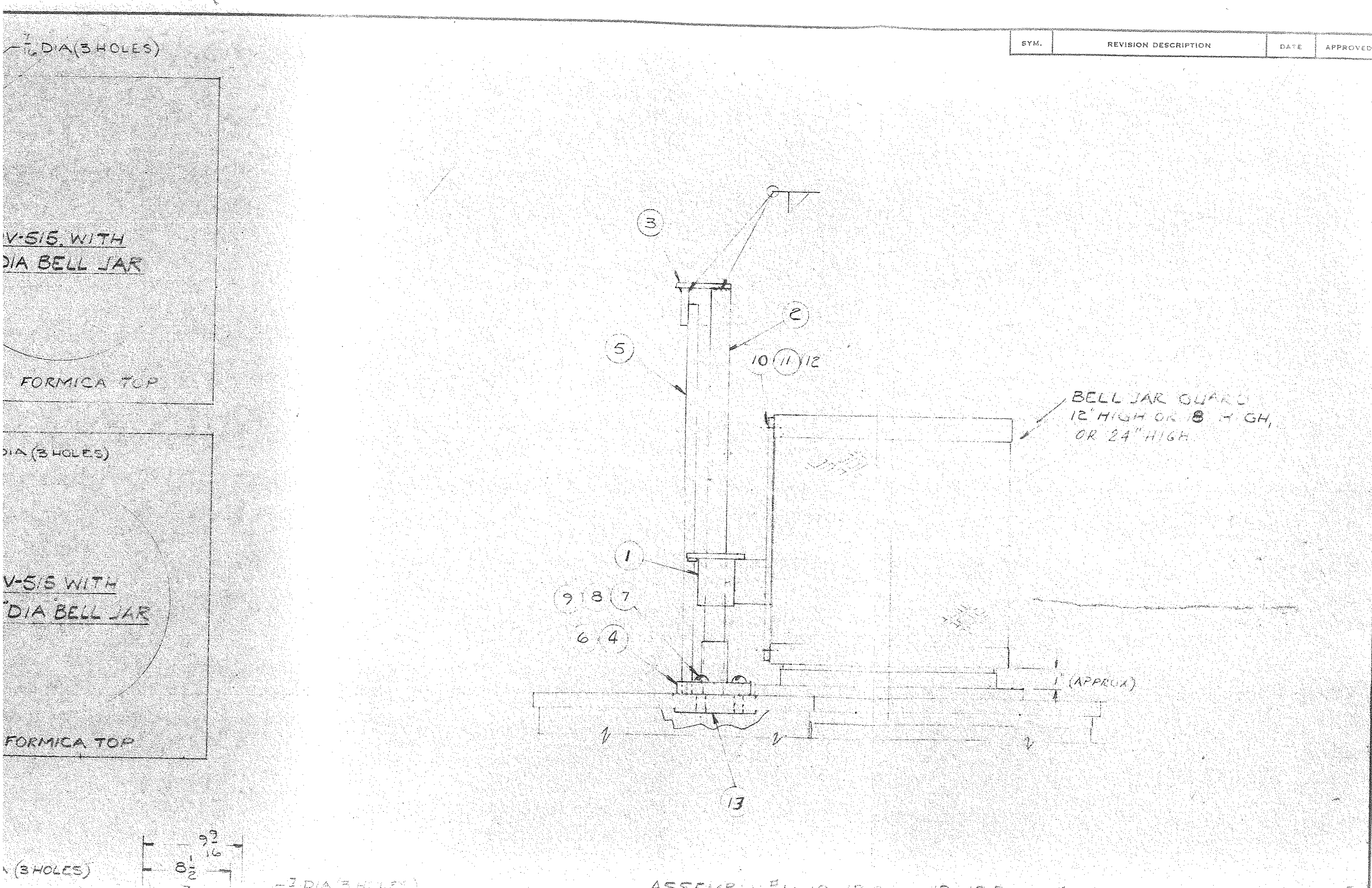


R1 2.2KΩ	C1 .0047uf
R2 10KΩ	C2 .05uf
R3 2.2KΩ	C3 .05uf
R4 50KΩ	C4 .05uf
R5 10MEGΩ	C5 16uf
R6 2KΩ	
R7 1.3KΩ	F1 1 AMP
R8 5.1KΩ	MOV1 SIOV-S07K250
R9 1MEGΩ	D1 1N3254
R10 250KΩ	D2 LHC5-10

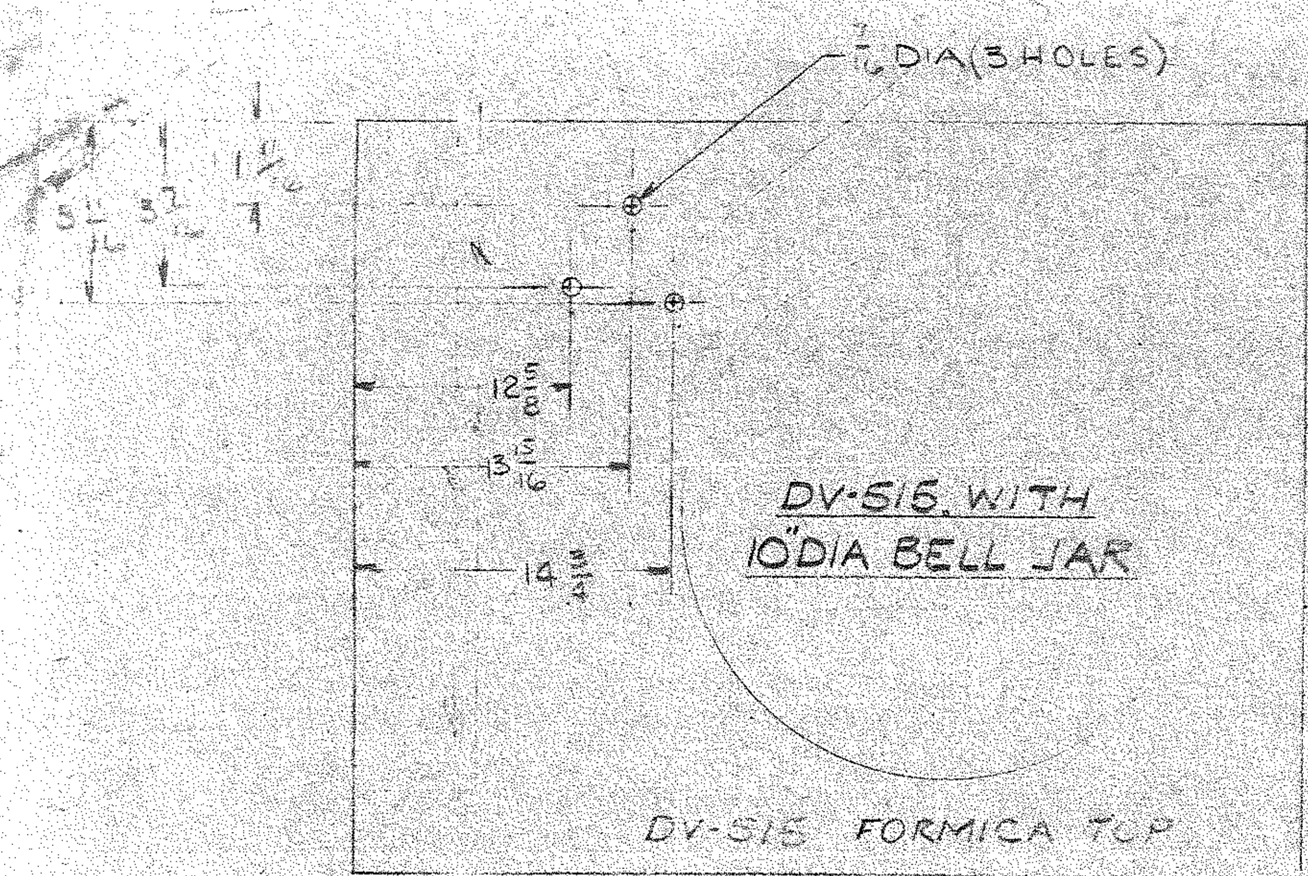
DENTON VACUUM INC.	ELECTRICAL ENGINEERING DEPT.	
	DESIGNER: STEVE E. MOZDZEN	
ELECTRICAL SCHEMATIC DVG-6A CHASSIS 110/24		DATE: 03/14/1991
		FILE SCH\110DVC
DWG: A-0133-117-137	REV -	SHEET 1 OF 1
		PROJECT -

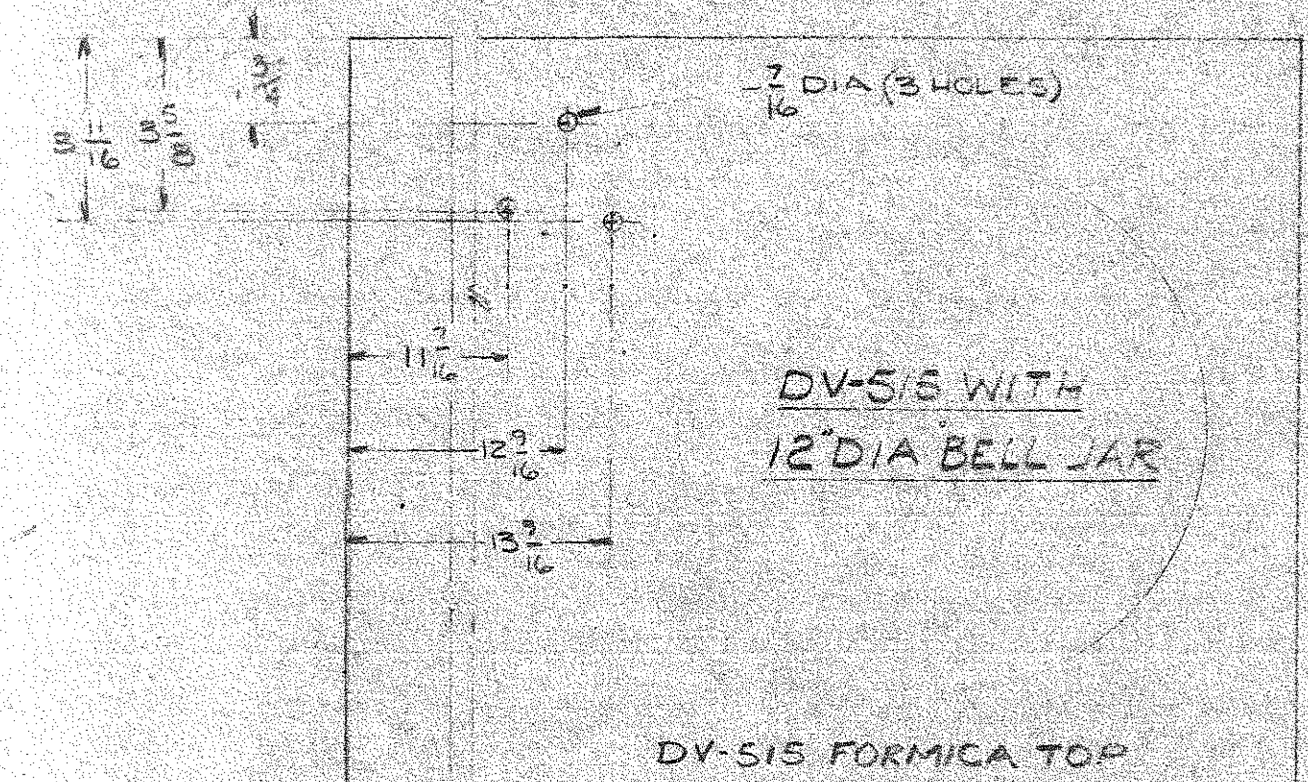


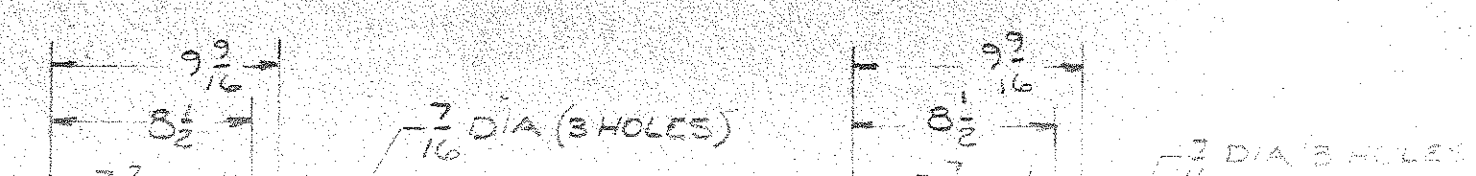
DENTON VACUUM INC.	ELECTRICAL ENGINEERING DEPT.	
	DESIGNER: STEVE E. MOZDZEN	
ELECTRICAL SCHEMATIC DVG-6A 24V SYSTEM		DATE: 03/15/1991
		FILE SCH\DVG6A24V
DWG: A-0133-117-128	REV A	SHEET 1 OF 1
		PROJECT -

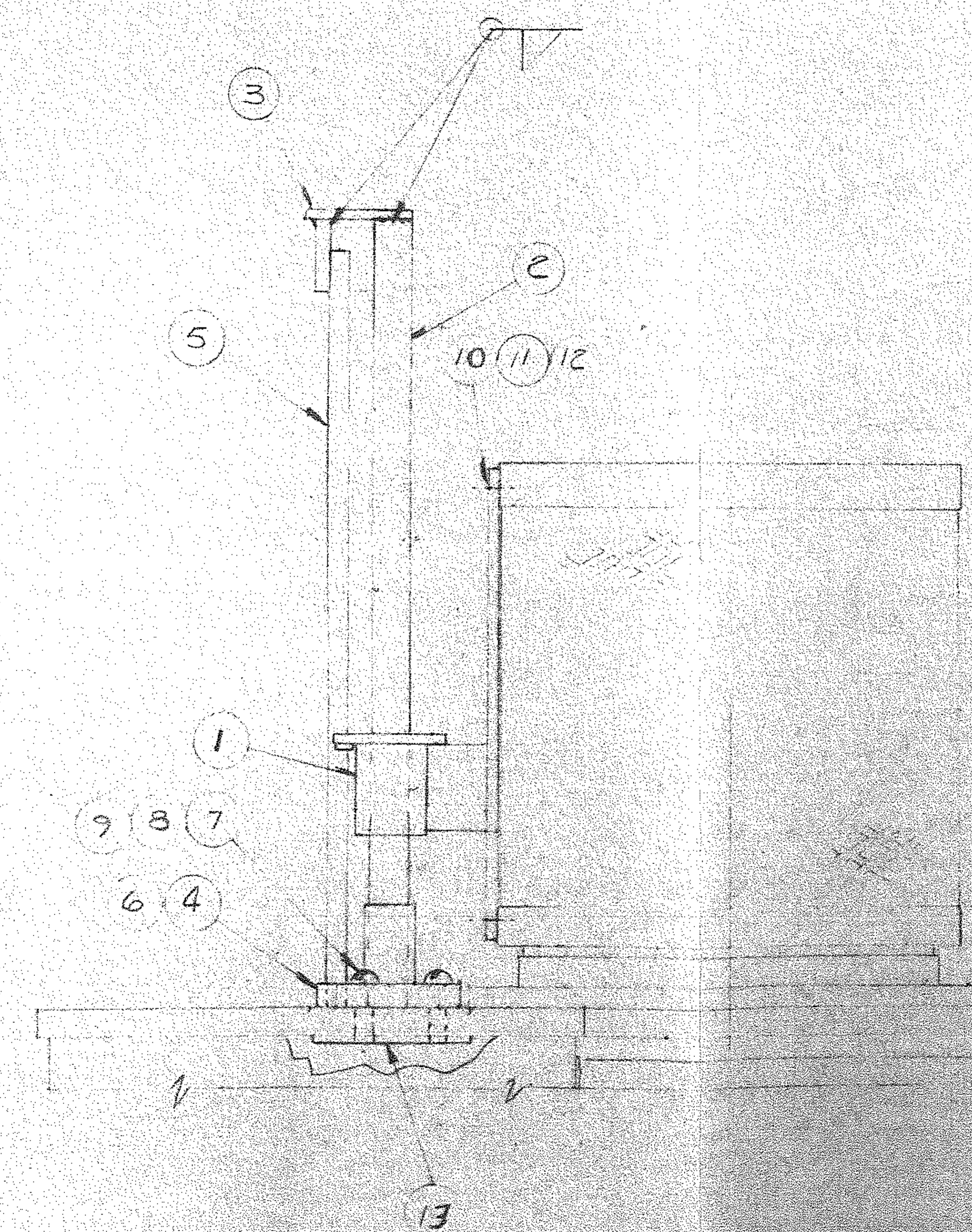


SYM.
REVISION DESCRIPTION
DATE
APPROVED
7/16 DIA (3 HOLES)
V-515 WITH
DIA BELL JAR
FORMICA TOP
DIA (3 HOLES)
V-515 WITH
DIA BELL JAR
FORMICA TOP
(3 HOLES)
9 9/16
8 1/2
3
2
5
10 11 12
1
9 8 7
6 4
13
BELL JAR GUARD
12" HIGH OR 18" HIGH,
OR 24" HIGH
1" (APPROX)

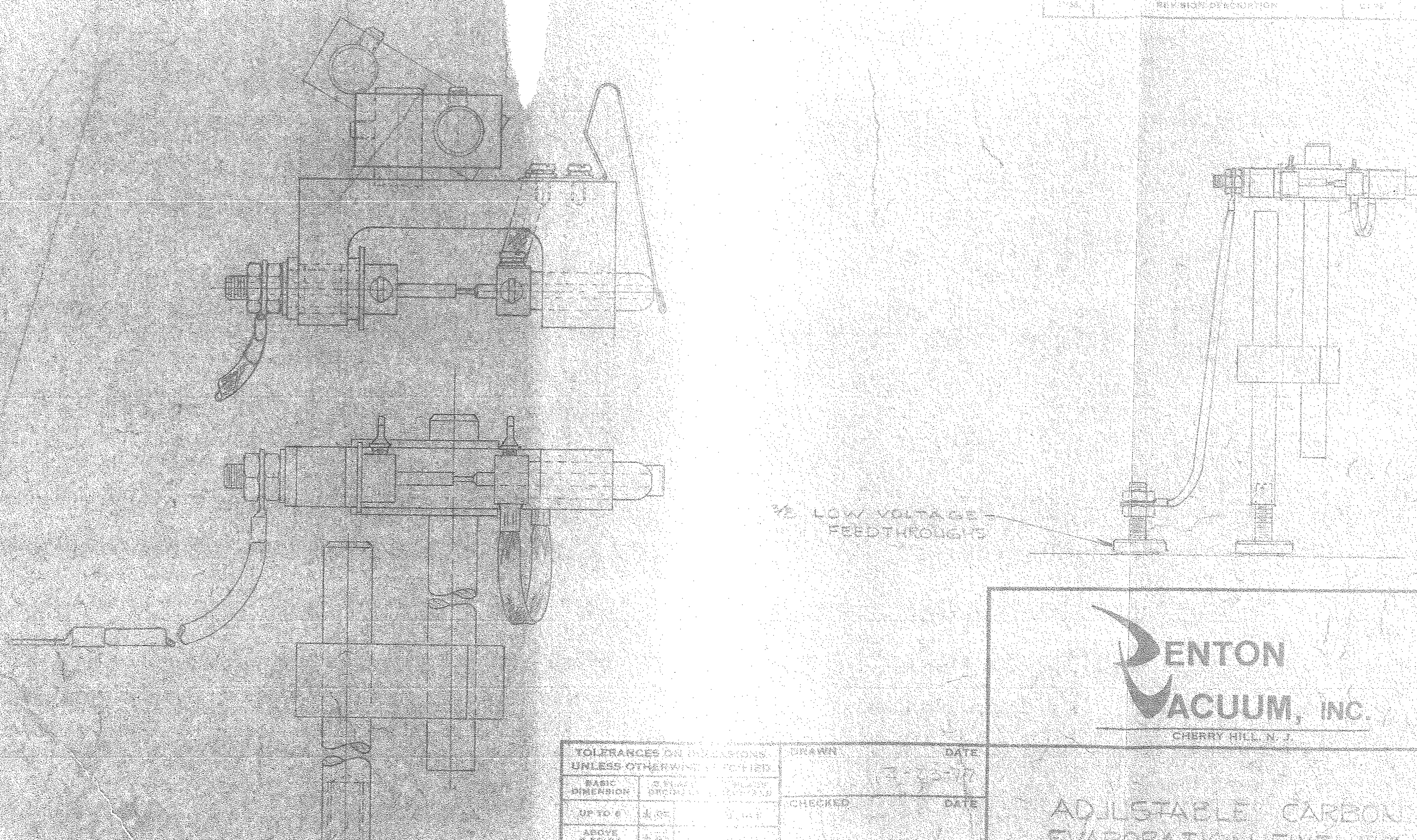








ASSEMBLY #1: 10x12 BJ, 12x12 BJ



REVISION DESCRIPTION

DENTON VACUUM, INC.
CHERRY HILL, N. J.

ADJUSTABLE CARBON EVAPORATION FIXTURE

TOLERANCES ON DIMENSIONS UNLESS OTHERWISE SPECIFIED		
BASIC DIMENSION	[illegible]	[illegible]
UP TO 6	[illegible]	[illegible]
ABOVE 6 TO 24	[illegible]	[illegible]
ABOVE 24	[illegible]	[illegible]
ANGULAR DIMENSIONS		

DRAWN DATE 3-25-77

CHECKED DATE

APPD DATE

NEXT ASS'Y

QTY / ASS'Y

ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND CLASS 3 AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B UNLESS OTHERWISE SPECIFIED.

THESE DRAWINGS ... ARE THE PROPERTY OF DENTON VACUUM ... REPRODUCED OR COPIED ... MANUFACTURE OR ...

PROJ. NO.

B 0051-025-003

REV

SCALE 1:1

SHEET