HUMMER 6.2 with. TURBO

Alumina. Deposition System.

OPERATIONS & SERVICE MANUAL

SN 1032001

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INTRODUCTION

The Hummer sputter coaters were introduced in 1971 as a more convenient and efficient method of coating samples for SEM.
Since this introduction many other designs have been brought to the market place. In this particular coating technique, samples of all types can be coated uniformly. The chamber is evacuated to approximately 1 x 10-5 Torr.

An inert gas (usually argon) is admitted to the chamber.
RF power running at 13.56mHz to the sputter gun. This RF power ionizes the gas and forms the plasma. The ions in this plasma are propelled toward the target where they remove material that is deposited on the specimen.

Use of the magnetron gun allows those samples to be coated without the damaging effects of electron bombardment typical of diode systems. The design of the magnetron system was developed to eliminate effects of high temperatures during plating operations. A high magnetic flux in the gun accelerates the electrons toward the side of the gun. The heat is mostly dissipated in the gun, which is why they need to be water-cooled.

NOTICE:
Please refer to the individual manuals for the Hummer 6.2 Turbo components for more detailed information about the:

Turbo-pump
RF Power Supply
RF Matching Network Rough-pump Sputter gun Pirani gauge
Water Flow Switch
Digital Thickness Monitor Water Chiller/Recirculator

Varian Turbo-V 70 with brick controller Advanced Energy RFX 600 II
Advanced Energy ATX Tuner
BOC Edwards E2M1.5
US Inc. MAK 2"
VRC Parani Vacuum Gauge &
Dual set point controller
Gems Sensors FS-4 Series
Maxtek, Inc. Model TM-100/200 Tek-Temp Model LK-10

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Paper Paper Paper
Paper
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SPECIFICATIONS
ELECTRICAL REQUIREMENTS
Voltage 120 VAC
Frequency 60 Hz
Phase Single
Current 15 Amperes

This system requires 3, 120 VAC standard wall power outlets. The first outlet is for the main system power; the second is used to power the systems water chiller with the final power requirement being used to power the Digital Thickness Monitor (DTM).

The system should be placed in a room with adequate ventilation and cooling. Ambient temperature should never exceed 75 °F.

GAS AND WATER REQUIREMENTS
Ionization Species/Working Gas 5 to 20 psi Argon, 1/4" TFE Tubing
Water .5 Gal/min. @ 20 deg. Celsius

DIMENSIONS
Main Console Size: H x W x D = *60"x 23"x 28" Weight: approx. 250 lbs.
Includes the chamber and the gun with water fittings.

Chiller
Size: H x W x D = 17"x 12.5"x 22" Weight: approx. 25 lbs.
DTM
Size:HxWxD= 3"x 6.5"x 8" Weight: approx. 1 lb.

Major components defined below have individual operation and maintenance manuals. Please refer to these manuals for more detailed descriptions on operation and maintenance.

VACUUM SYSTEM
Pumping System
Integral 70 1/s Varian turbo molecular pump, backed by 1.5 cfm Edwards rough pump (hydrocarbon prepped) with exhaust mist filter. The turbo should be turned on after the rough has been on for two minutes.

Vacuum Gauging
VRC Parani Gauge with dual set point controller monitoring from 100 mTorr down to 1 x 10-5 Torr. The gauge will light up once the AC power switch is turned to the on position.(The gauge will not start moving until system is below about .1 Ton)

Valves

The vent valve is a normally open valve. Once the rough pump switch is turned on the valve will close and allow the system to pump down. The vent valve is connected through a 10/32 port on the side of the Turbo. High precision needle valve for process pressure control, ON/OFF 110V AC process gas valve.

Chamber
Metal 12-inch diameter by 12-inch high, sealed with Viton 1 L-Gaskets for chamber ends. Chamber has additional Glass view port and NW-16 port for external monitoring. The chamber weight is approximately 40 pounds, exercise proper lifting techniques when removing the chamber from the base plate.

Top Plate
The top plate assembly is provided with a handle for ease of opening the top of the chamber. Simply lift the plate from the top of the chamber and toward the support post, the hinge on the edge of the plate is designed to help facilitate repositioning of the plate during the loading and unloading of the chamber.

Ensure that while moving the top plate to the stow position that you have centered up the shutter assembly below the gun. This keeps the shutter from catching on the edge of the chamber.
Quick Couple feed-through adapter for adjusting the MAK-2 gun height. Includes gas inlet port and shutter assembly.

MAK-2 gun
The MAK-2 gun can sputter either insulator of metals depending upon the power source. Refer to gun manual for technical specifications, water requirements, and target replacement instructions and gun maintenance. Ensure that when installing a target that the gun has adequate thermal compound applied to the face before operating the gun.
Base plate ISO 63 port for direct turbo mounting, 2-KF16 port for Vacuum gauge and DTM. Motor drive assembly is also mounted to the base plate for a direct drive of the stage. 1/8" NPT port that is available but not used in this application.

Stage
The stage is made of aluminum and is just over 8.0 in diameter. The motor has a direct connection to the bottom of the stage. A switch on the front of the system controls stage rotation.
Sputtering power delivery

RF Gun Power Supply
600 Watts Maximum (Limit to 400 watts), 120 Volts AC input, Advanced Energy Mfg. (NOTE: Certain Targets and Guns Have Lower Maximum Power Values Due To Lower Heat Capacity)
These values for gun sizes are a general guideline. Individual targets may vary greatly due to the materials properties. Water flow, temperature, and bonding style also will have an effect on the following values. A target manufacturer can help if there are any questions.

Gun Diameter	Recommended Wattage Maximum
1.3"	200
2"	400 MAK-2 gun
3,,	750
4"	1200

The power supply is interlocked through a series of switch type contacts. If any are broken, the power supply will shut off and stay off until reset by the user. High Voltage output is enabled only when the pressure is below 20 millitorr (SET POINT LOW) and above 2 millitorr (Set Point High), water flow is adequate, the timer is running, and the thickness monitor is started and has not reached set point (option).

RF Automatic Tuner
Advanced Energy ATX Tuner tunes the output of the RF power supply into the varying load impedance seen at the MAK 2 gun. This match was set up to minimize the reflected power seen by the RF Supply. Call Anatech Ltd. prior to making any adjustments to the front panel controls of the controller.

General Electronics description
F r power distribution and control please refer to system electrical schematic in the b ck of this book. DWG # 1007106-6W, 1 sheet
main console power comes in from a standard wall outlet. The power goes through an on/off, 15 Amp circuit breaker located on the back panel. The power then s [its at the terminal block located on the inside back cover of the cabinet. The RF Power Supply, AZX Matching Network and Turbo controller will power up the main breaker is made. None of these devices will do anything other than turn to the standby mode until other steps are taken. The AC on/off switch located on the front panel controls the power to the rest of the cabinet.

Switches: Up is on, down is off.
S-1 AC on/off, turns on the AC power to K-1, K-2 & K-3
S-2 Rough Pump on/off, turns on the AC power to the rough pump and closes V-1 the normally open vent valve.
S-3 Turbo Pump on/off, turns on the Varian V-70 turbo pump, this switch should be turned on after the rough pump has been on for approximately 1 to 2 minutes.
S-4 Stage rotation on/off, turns on and off the AC power to the motor that drives the stage.
S-5 Gas on/off, turns on and off the AC control to the gas on valve.
S-6 RF on/off, "on" starts the timer for the RF "off' stops and resets the timer. S-7 Water Flow switch, the switch needs to have water flowing through this switch in order to enable "RF ON".
S-8 High-pressure set point is normally open; this switch is part of the Vacuum meter circuit once the system has reached 20 mTorr the switch closes.
S-9 Low-pressure set point is normally closed; this switch is part of the Vacuum meter circuit once the system has reached 2 mTorr the switch opens.

FUSES:
F-1, 3 Amp (Hot side of the 120 VAC to the Rough Pump)

F-2, 1.5 Amp (Hot side of the 120 VAC to the stage motor)
F-3, 3 Amp (Hot side of the 120 VAC to the Cabinet Fans)

Relays:
K-1
Contacts pin 7 – 4 Rough pump fuse and switch
Contacts pin 8 – 5 Timer relay K-3 AC power on
Contacts pin 9 – 6 Vacuum meter AC power on

K-2
Contacts pin 7 – 4 Vent valve switch power
Contacts pin 8 – 5 Fan power via F-3
Contacts pin 9 – 6 Gas On Switch power

INTERLOCKS:
All of the interlocks below need to be satisfied in order to turn on the RF Power:
Water Flow Switch
High pressure set point < 20 mTorr
Low pressure set point > 2 mTorr
Digital Thickness Monitor start

Note: If the operator is using the DIM to control the RF "on time" then the RE timer needs to be set to a number greater than the amount of time that it will take to achieve the desired thickness. If the operator is using the RF "on time" to control the process then the DIM needs to be set to a number greater than the thickness it will see during the process. Understanding this operational requirement will become apparent once the operator has had some time to develop the process.

UNPACKING
After removal of the system from the shipping crate, make a visual inspection of the equipment for obvious shipping damage.
Retain all cartons, crates, and packing material until the unit is operated and found to be in good working order.
The system has been packed in three major compartments, the main system in the large wooden box, and the chamber, top plate, and accessories in the two smaller boxes. Check the accessory boxes to see that everything is included.

If after inspection any shipping damage is found, please contact the Transportation Company and Anatech Ltd.'s service department for assistance. 1-800-390-4449

You can also call the same number to schedule the installation and operator training. Please have the tool and all of the accessories moved to the general area where the tool will be operated. If you feel confident proceed to the setup section otherwise wait for the Anatech Ltd. service personnel to do the setup.

SET UP (Refer to figures 1, 2 & 3)

Note: If you have opted to have the tool installed please contact Anatech to schedule the installation. The next steps are meant as a guideline for setting up the tool. The instructions assume the person doing the work has some basic experience in vacuum equipment. Most of the parts are bagged and labeled. Lay all of the parts out on a flat surface as this will aid in the setup. Avoid letting anything come in contact with the turbo port as this could damage the turbo.

The chamber has been shipped without the gaskets installed. Unpack them, wipe them off and place on top and bottom of the chamber.
Attach the stage to the shaft protruding from the base plate.
Next install the support arm for the crystal thickness detector, it should come from the base plate to up and over the stage. The arm should be at about 3 o'clock looking straight down on the base plate. Connect the Microdot connection to the port on the base plate and then install the holder for the crystal in the holder and connect to the other end of the Microdot cable.

Place the chamber on top of the base plate, the view window should face the front of the tool with the extra KF-16 port on the right side. If the port is on the left you have the chamber upside down.
a Next take the support tube and install it on the right hand side of the chamber. Ensure that you connect the four of the screws provided. One of the screws should be used to connect the green wire on the front of the chamber to the support post. This wire should be in place whenever the chamber is being used.

Next you can assemble the top plate, the plate has 3 exposed holes and 1 plugged hole. First feed the gun support tube through the 1" gun port and tighten the support collar in place so that the gun is about half way through the top plate. Do not over tighten the fitting on the gun port. The collar holds the gun from sliding down in the port and will be adjusted later to improve process. Next attach the shutter plate to the 'A in rod and feed the rod through the IA" shutter port. The remaining port is for the gas line and will be connected later. Finally attach the hinge assembly to the top plate with the hardware provided. Place the top plate on the chamber by sliding the shaft into the support post. Adjust the gun height so the gun is about 4" above the stage and tighten the support collar. The shutter should be adjusted to a position 1" below the gun face and above the DTM Crystal holder. You can use a flashlight to look through the view port and make the adjustment. This height is only meant as a starting point for the gun and can be adjusted accordingly to improve process results.

Connect the gas line from the cabinet top to the top plate fitting.
Next you can connect the water lines to the guns. The tubing connections are delicate so the hookup should provide essential strain relief. The fittings are quick push in style for 1/4" 0. D. tubing. Connector J4 (2 pin Mate-n-Lock) has been provided to you for connection to a water flow switch. This switch should be put in line on the outlet of the gun and provide a closed contact when water flow is above 1/2 gallons per minute and outlet temperature is below 20 °C. Refer to the Tek Temp manual for setting up the chiller. The flow switch should be placed on the left side of the cabinet with the hardware provided. The intent of the hardware is

to hang the switch as well as the on/off valve from the rear side of the cabinet. However we have built in flexibility to allow the operator put the connection in almost any convenient location.

Finally you can install the RF cable from the matching network output on the top of the cabinet to the top of the gun.
Anatech Ltd. makes no effort to rewrite individual component service manuals. This manual only addresses the vacuum, safety interlocks, and system integration. Anatech Ltd. recommends you operate the system only after reading all the material provided.

At this point Anatech Ltd. recommends you read individual manufacturers component manuals for proper operation of this system if not done so already. The MAK-2 manual will show you how to install the new targets into the gun. Your target has not likely been installed already.
Please contact Anatech LTD's service department for assistance. Leave a message if necessary, an engineer will return your call. USA 1-800-PLASMA-9

OPERATION
The Anatech 6.2 Turbo uses a Varian 70 1/s turbopump and controller backed by Edwards E2M1.5 roughing pump. A high vacuum reading is displayed by a pirani Gauge, which has a range from 100 millitorr to 0.01 millitorr. Set points "Low" "HIGH" are used as RF Power interlocks. The magnetron sputter gun needs water cooling and this must be connected first with the water flow switch installed. The 2-pin connector (P4) is for the water flow switch. This should have already been INSTALLED.

Make sure all hoses and cables are connected properly. Install correct target that you wish to plate with. Place your samples onto stage for coating.

Adjust the gun height and shutter height on top plate assembly. Carefully place the top plate on top of the chamber. Connect the argon lines if you have disconnected them. Set pressure to 10 psi. Turn main power breaker on the back of the cabinet on, the RF Supply and Matching Network should now have power indicated by various light being lit on the corresponding panels. Ensure that the DTM is plugged in and on.

OPERATIONAL SEQUENCE:
The main power will supply power to the fan, rough pump switch, vent valve, and Pirani gauge. Turn this switch on first. Next turn on the "rough pump" switch the vent valve closes and the rough pump should start roughing the chamber. After 1 to 2 minutes turn on the "turbo pump". When the system has been shut down for a long period of time it may take several hours to pump into the .01 scale or 1 x 10-5 After reaching below .01 10 millitorr, turn the "GAS" switch on to allow gas in. Adjust gas valve until vacuum gauge reads 5 - 10 mTorr. On the front of the AE power supply ensure the control is set to remote and the set point is in local control. Adjust the power level to the desired value if this is the first time you have run the tool start at 200 watts. Set output set point to desired level with control knob. Position the shutter in front of the gun for around a minute especially if you have not sputtered this target recently.

Turn on the chiller and press start on the front of the DTM, the IL should light in the upper right corner of the display this indicates that the interlocks have all been satisfied.

Next look at the timer relay ensure you have programmed the timer to the desired sputtering time and that the timer is set to "C" in the first position of the thumb wheel. Next flip the switch located below the timer to the up position, this action should strike a plasma and start the timer counting down.

Gun should light within a few seconds, run for a minute or so before moving the shutter out of the way. This will etch away any contamination that has formed on the surface, providing better adhesion to your substrate.

The sputter rate should rise and level off within 10-15 seconds. Gun power is shown in watts. When timer finishes, gun will shut off. (Keep water running for a few minutes after to cool gun)
If a thickness monitor is installed as well, the relay will be connected in series with the water flow switch. Then the gun will shut off when thickness set point is reached. Note that depending on the control mechanism either time or thickness the one not being used to end the process needs to be set at a greater value. If it takes 10 minutes to sputter to a thickness of 1000 Angstroms and you want to end the process with the thickness monitor, then you should set the timer for greater than 10 minutes.

Shut the turbo off first then the rough pump, the system will start venting as soon as the roughing switch is shut off.

CARE & CLEANING OF YOUR HUMMER

Vacuum Chamber
The chamber should be cleaned after every 10 coatings maximum to prevent water vapor or other contaminants build up by adsorbing to coatings in the system, which will result in a longer pumping time (some biological and geological specimen will out gas for a considerable amount of time).

Sputter Gun
The gun should never be handled without gloves, since oil and moisture from your hands will crystallize on the surface. Results are that the specimen turns blue, or you can see the plasma form but obtain no coating. To clean the gun, remove the water lines, RF cable, and gas line. With a hex wrench, take the cover and target hold down plate off of the sputtering head. Clean the aluminum parts with Scotch Barite and alcohol. Rinse completely and blow dry. See manual for more details.

DTM Crystal
The digital thickness monitor crystal holder, mounted on the tilt/rotate bracket, should be cleaned rarely, only about every 40 runs. The crystal should not get cleaned, just turned over or replaced occasionally. Once the crystal becomes too heavily plated, it stops oscillating or

oscillates randomly, which will cause an oscillator failure. If turning the crystal over can not clear this then the crystal needs replacement. See the DTM manual for more details.

Rough Vacuum Pump
The oil in the vacuum pump should be changed at regular intervals. Please check the pump manual for frequency of oil changes and recommended oil types. The filter should be replaced about every 6 months.

Pirani Gauge Tube
A contaminated gauge tube can be cleaned by removing it from the base plate and filling it with acetone or Freon 23. Rock the tube (do not shake) to loosen contamination. Rinse the tube in alcohol and bake at 150 degrees F for about 1 hour to de-gas.

Recirculator/Chiller
The water in the chiller should be distilled to reduce the amount of corrosion in the cooling coils and pump. The water should be changed at least every 3 months, and the water
lines should be replaced when noticeably dirty.

Turbopump
The turbopump requires no special maintenance, however with certain care its lifetime can be extended. Please see the manual for details.

Technical CONSIDERATIONS OF SPUTTER COATING

INTRODUCTION
In electron microscopy an image is produced by electrons, which flood over the s[specimen. Typically the materials examined in this manner are poor conductors of electricity and as such will accumulate a negative charge from the electron flooding. Such a charge causes undesirable image distortion. In order to minimize distortion and produce clear clean images, the surface conductivity of specimens should be increased. Specimens which are somewhat conductive will yield a better image by enhancing their conductivity. Specimen conductivity can be increased by coating with metal, usually a precious metal such as gold or palladium. If applied correctly the coating will not impair resolution or surface detail. Several acceptable techniques have been developed and employed routinely for electron microscopy. Two such methods are evaporative coating and sputter coating.

EVAPORATIVE COATING
Evaporative coating relies on sublimation of a metal at high temperature and vacuum. The metal vapor "sprays" the target material, adhering to any exposed surfaces to the "spray". Coating in this manner is directional and an irregularly shaped specimen may require tilting and rotation to achieve total coverage. Additionally, the metal released is hot, and can damage some specimens. Finally, since metal particle size and coating thickness are difficult to control, satisfactory results are dependent upon operator skill, technique and care.

SPUTTER COATING

Sputter coating is a cold process whereby metal atoms are liberated from a target by ion impacts, The atoms disperse throughout the process chamber in a manner which provides adequate coating of irregularly shaped specimens, without tilting and rotating

The atoms are cool; consequently no thermally induced damage results. Sputtering s a microscopic process involving clouds of metal atoms, as opposed to the "spray" of relatively large macroscopic clumps of evaporated metal used in evaporative coating. As a result the uniformity and thickness of the coatings are easily controlled. In general, the quality and repeatability obtained by sputter coating are superior to that obtainable through evaporative means.

ADDITIONAL BENEFITS OF SPUTTER COATING

Several additional benefits are derived from the sputter process. Sputtering is done in a soft vacuum of 5 to 70 millitorr pressures obtainable by small,IDES reliable and inexpensive mechanical pumps. This eliminate the costly and elaborate high vacuum pump system required in evaporative coating. Sputter coating is specific with regard to the amount of coating material needed to achieve a desired coating thickness. Evaporative coating is much more wasteful of material; consequently the annual cost of the precious metal used is significantly reduced.

PLASMA PRODUCTION AND USE

Technically accurate descriptions of gas plasmas can be obtained in numerous references. Rather than burden the reader with undue scientific definitions, a lay description is provided to enhance understanding and provide ample basis for working with the plasma. Gas plasma may form whenever gas is exposed to an electric field.

If the field is sufficiently strong, a high percentage of gas atoms will surrender an electron or two and become ionized. The resultant ionized gas and liberated energetic electrons comprise the gas plasma, or plasma. Typically a noble gas is used, and is ionized in an electric field produced by hazardously high voltage.

The ionized gas atoms are heavy but have relatively little kinetic energy unless accelerated through the electric field. When this is done, they will smash into a negatively charged surface, or target, and some of the ions will dislodge a metal atom. Once dislodged, the atom can float around and will eventually adhere to a specimen.

A bothersome byproduct of this ion movement into the target is a movement of energetic electrons in the opposite direction. These can impact the specimen and cause heating. Biological specimens, polymers, or any specimen, which is heat sensitive, may be affected and distorted by this heat, leading to artifacts when observed in the electron microscope. The Hummers alleviate electron-heating problems by employing a planar magnetron. A magnet is located within the cathode electrode configuration. Electrons moving away from the target toward the specimen will be diverted away from the specimen by the magnetic field provided by the magnet.

The term 'sputtering' specifically refers to this process of nicking loose material from the target. The tet in 'sputtering rate' refers to the amount of target material per unit time interval that is removed. Another useful term is 'sputter coating rate' which is the rate at which a specimen is covered by sputtered material, usually expressed as angstroms per minute. Naturally, the higher the sputter rate, the higher the sputter coating rate will be, since there will be more atoms of target material floating around.

Many different gases are useful for sputtering. Argon is most frequently used because it is reasonably priced. Nitrogen is sometimes used. However, it has a lower sputter rate, and hence the sputter coating rate is decreased. Nitrogen gas will result in reductions of sputter coating rate of about twice from that of argon.

Bibliography
A very short bibliography follows for those individuals wishing to learn more about the sputtering process.
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Figure 1

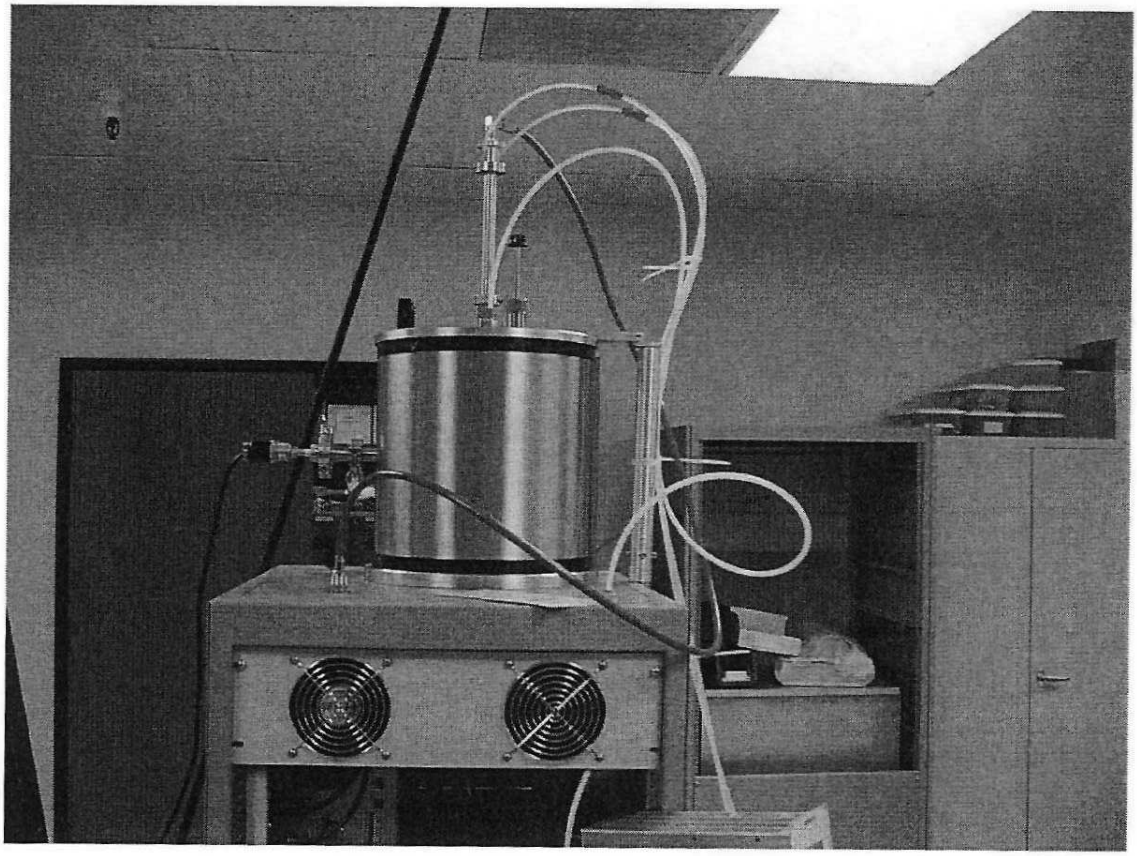


Figure 2

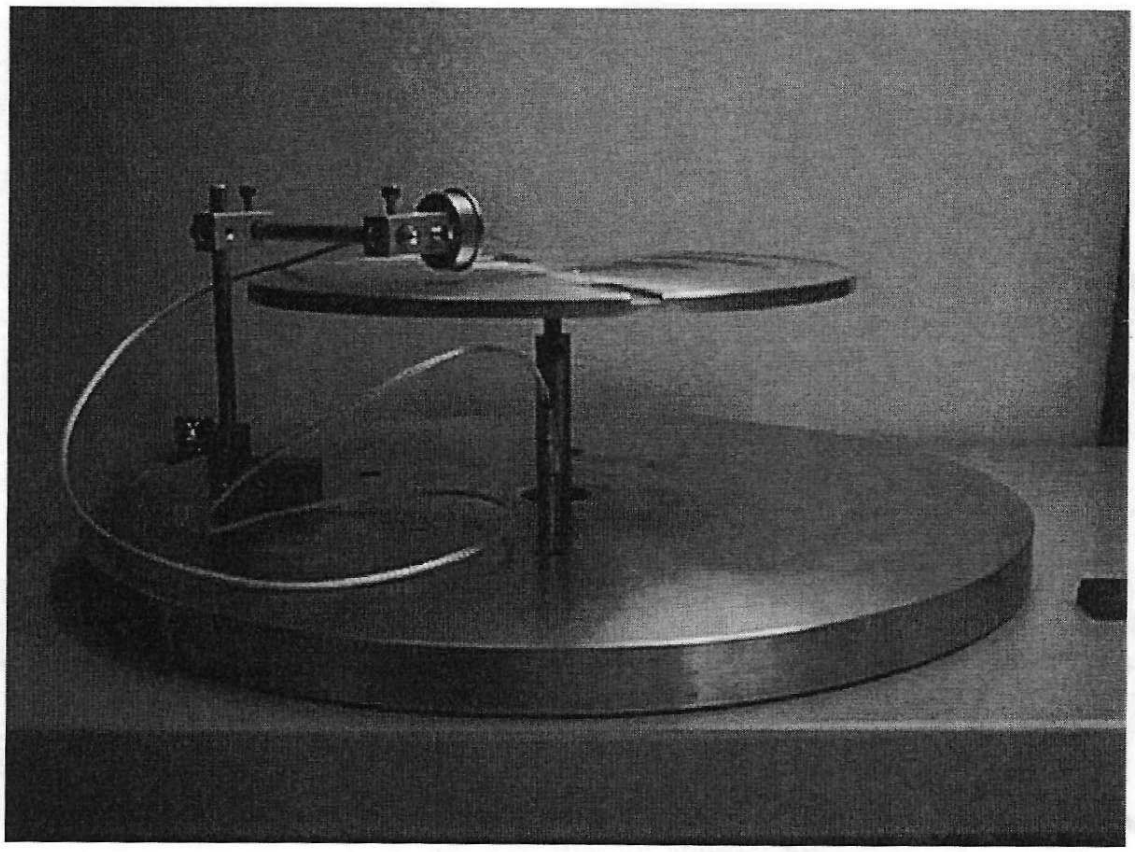
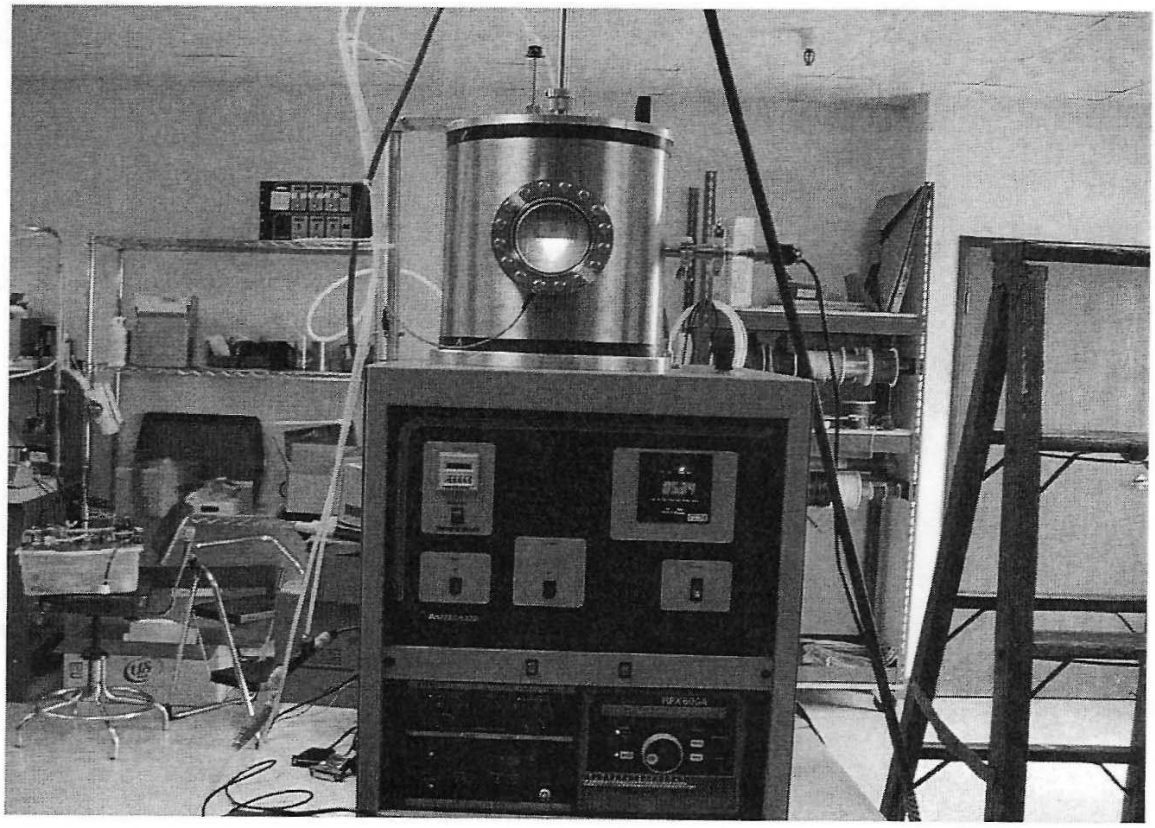
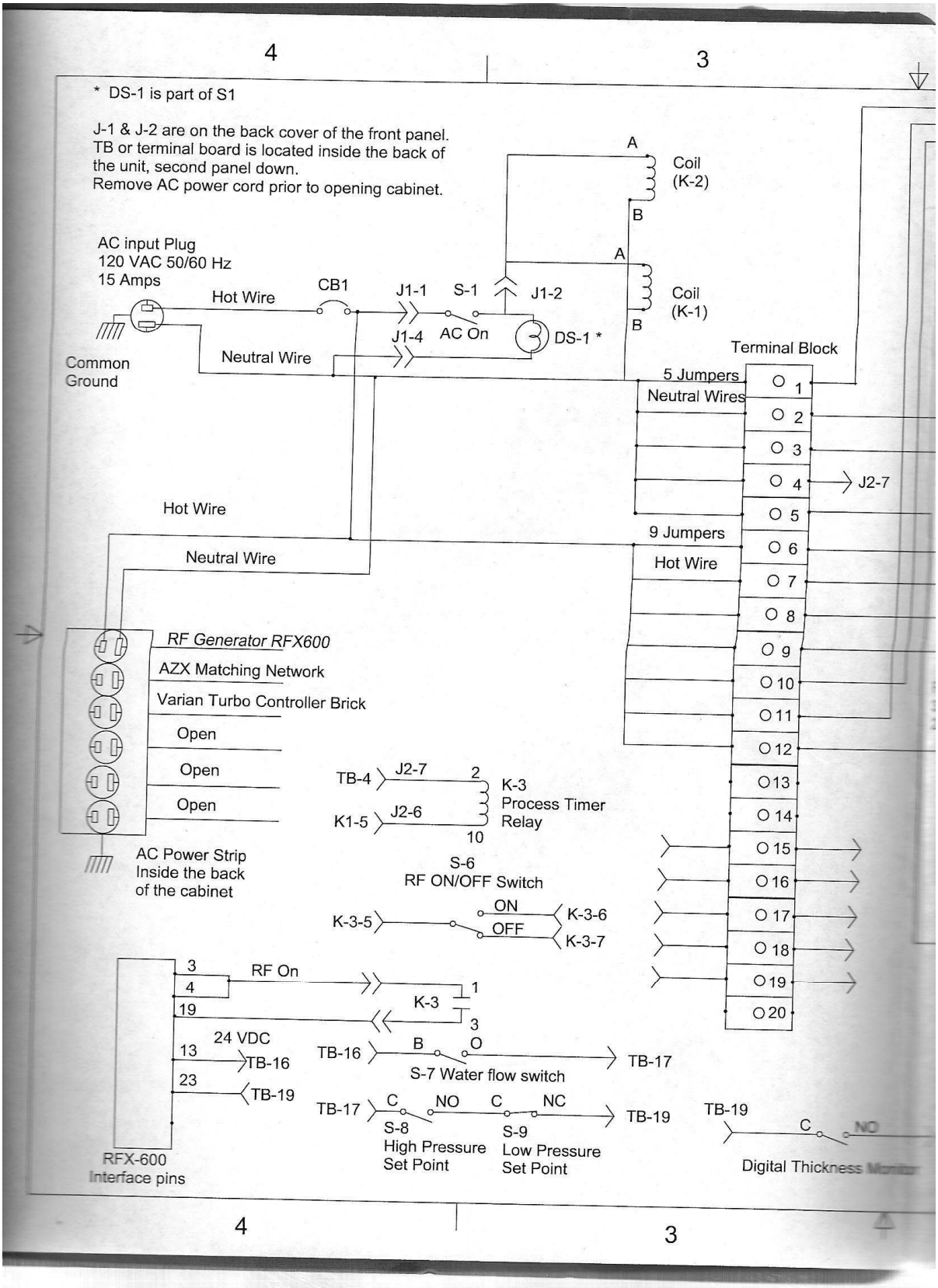


Figure 3




4
3
* DS-1 is part of S1
J-1 & J-2 are on the back cover of the front panel.
TB or terminal board is located inside the back of the unit, second panel down.
Remove AC power cord prior to opening cabinet.
AC input Plug
120 VAC 50/60 Hz
15 Amps
Hot Wire
CB1
J1-1
S-1
J1-2
J1-4
AC On
DS-1 *
Neutral Wire
Common Ground
A
Coil (K-2)
B
A
Coil (K-1)
B
Terminal Block
5 Jumpers
Neutral Wires
1
2
3
4
J2-7
5
9 Jumpers
Hot Wire
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Hot Wire
Neutral Wire
RF Generator RFX600
AZX Matching Network
Varian Turbo Controller Brick
Open
Open
Open
AC Power Strip
Inside the back
of the cabinet
TB-4
J2-7
2
K-3
Process Timer
Relay
K1-5
J2-6
10
S-6
RF ON/OFF Switch
K-3-5
ON
OFF
K-3-6
K-3-7
3
4
19
RF On
K-3
1
3
24 VDC
13
TB-16
23
TB-19
TB-16
B
O
TB-17
S-7 Water flow switch
TB-17
C
NO
C
NC
TB-19
S-8
High Pressure
Set Point
S-9
Low Pressure
Set Point
TB-19
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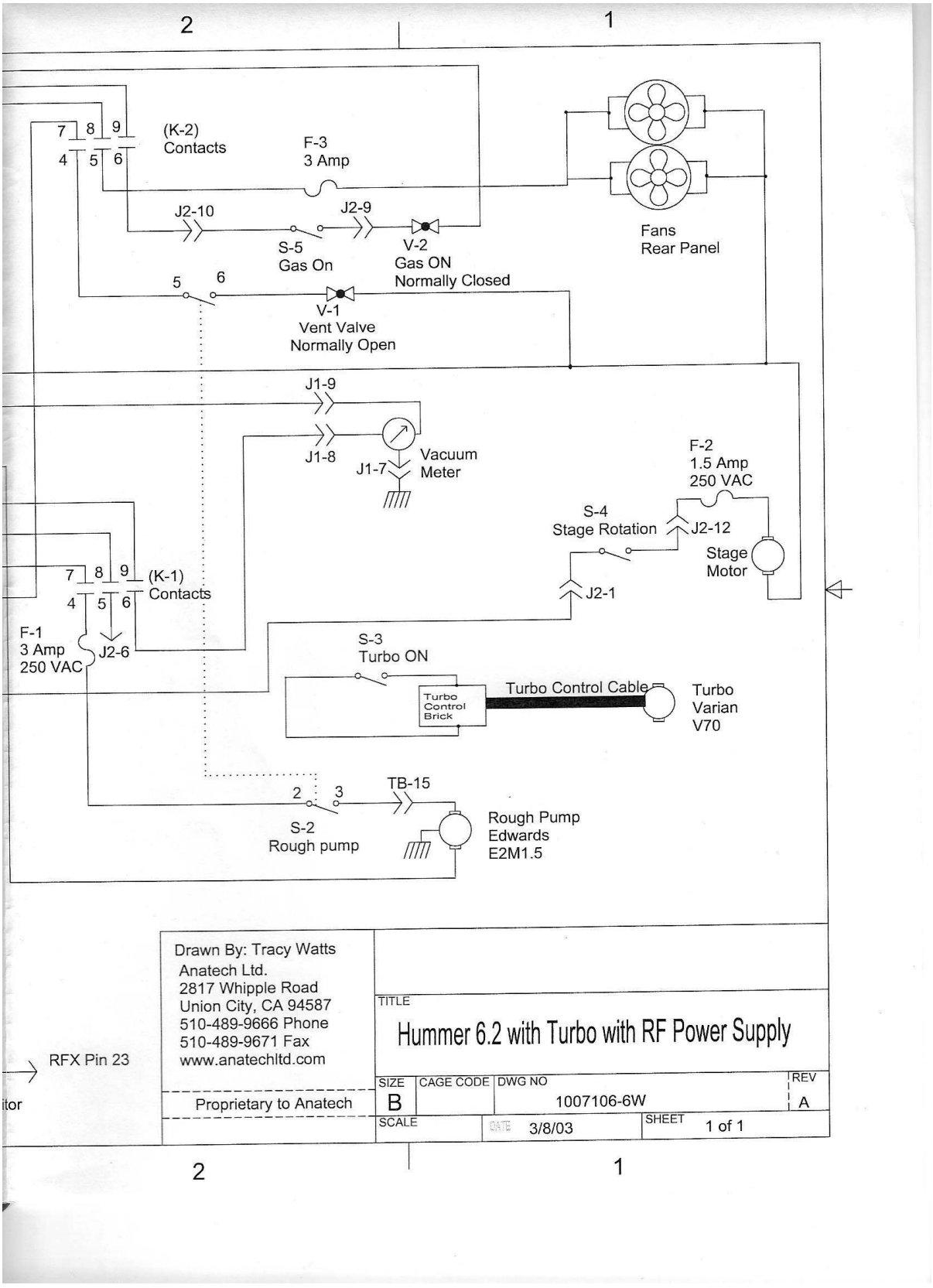
NO
Digital Thickness Monitor
RFX-600
Interface pins
4
3


2
1
7 8 9
4 5 6
(K-2)
Contacts
F-3
3 Amp
J2-10
J2-9
S-5
Gas On
V-2
Gas ON
Normally Closed
Fans
Rear Panel
5 6
V-1
Vent Valve
Normally Open
J1-9
J1-8
J1-7
Vacuum
Meter
F-2
1.5 Amp
250 VAC
S-4
Stage Rotation
J2-12
Stage
Motor
J2-1
7 8 9
4 5 6
(K-1)
Contacts
F-1
3 Amp
250 VAC
J2-6
S-3
Turbo ON
Turbo
Control
Brick
Turbo Control Cable
Turbo
Varian
V70
2 3
TB-15
S-2
Rough pump
Rough Pump
Edwards
E2M1.5
RFX Pin 23
itor
Drawn By: Tracy Watts
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Proprietary to Anatech
TITLE
Hummer 6.2 with Turbo with RF Power Supply
SIZE
B
CAGE CODE
DWG NO
1007106-6W
REV
A
SCALE
DATE
3/8/03
SHEET
1 of 1
2
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