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SMD Operations Procedures Manual

8.1.1.36 3M Direct Wiring Machine

Text Pages 1 through 16
Attachment(s) 1, 2, 3, 4, 5

Hand Processed Changes

<u>HPC No.</u>	<u>Date</u>	<u>Page Nos.</u>	<u>Initials</u>
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8.1.1.36 3M Direct Wiring Machine

1.0 Purpose and Scope

- 1.1 This procedure provides instruction in the operation of the 3M Direct Magnet Wiring Machine, located in Building 902.
- 1.2 This procedure establishes the minimum qualification for any person who will operate the Wiring Machine.

2.0 Responsibilities

- 2.1 Cognizant Technical Supervisor is in Building 902.
- 2.2 The operator shall complete the following documentation:
 - 2.2.1 Log Book. Entries shall include notes of any irregularities regarding operation of the Machine.
 - 2.2.2 Interlock Test Form. The form shall be completed when the safety interlocks are tested. A copy of the form shall be posted near the Wiring Machine.
 - 2.2.3 Wiring run sheet. Documents repairs from factory and repairs made by wiring tech.

3.0 Prerequisites

- 3.1 Training
 - 3.1.1 Operator shall be hands-on instructed by the cognizant Technical Supervisor before operating the Wiring Machine.
 - 3.1.2 Operator shall be trained as an “affected employee” as defined by SBMS Subject Area: Lockout/Tagout (LOTO)
- 3.2 Physical Requirements
 - 3.2.1 Machine area should be roped off and appropriate signs posted while the winding machine is in operation.

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- 3.2.2 Eye protection must be worn while winding machine is in operation.
- 3.2.3 Track areas must be marked (stripped yellow caution tape, etc.)
- 3.2.4 All protective guards around belt drives must be on and secured.
- 3.2.5 The area around the winding machine must be clean of any debris before put into operation.

3.3 Initial State of Wiring Machine

- 3.3.1 Operator controls shall be set to their “initial” settings (see paragraph 5.3) before activating power to the Wiring Machine.

4.0 Precautions

This procedure involves working near moving machinery.

- 4.1 Do not wear loose clothing or hanging jewelry. Keep long hair tied up.
- 4.2 All guards and covers should be in place.
- 4.3 Keep hands away from all pinch points when the machine is in motion. A sudden movement might hit your hand or catch your clothing, causing injury.
- 4.4 A test of the interlocks shall have been performed within the last six months. A dated Interlock Test Form shall be posted near the Wiring Machine.
- 4.5 Verify machine is clear of any foreign objects which could damage equipment or be thrown from machine.

5.0 Procedure

5.1 Overview

The 3M Direct Wiring Machine provides a means of feeding wire in a tightly controlled pattern into a layer of epoxy pre-impregnated fiberglass cloth.

The machine consists of a rotary head for turning the magnet tube, with a movable gantry to position the wiring head along the axis of the tube. On the gantry are

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two additional linear axis, one to raise and lower the wiring head, and the second to horizontally position the wiring stylus within the slot on the tube. Three rotary axis are on the head, theta is for rotating the head the full 360°, while two axis are used for positioning the wire feed mechanism and one axis is used for paying out the wire.

The machine is computer controlled, with a keyboard for operator input and a monitor for display of menu driven operating instructions and Machine status.

5.2 Operator Controls

5.2.1 System Controls (Attachment 1)

- A. Item 1 B 120 volt input disconnect switch. Disconnects all power to the machine.
- B. Item 2 B CRASH red mushroom-head push buttons (qty 5) and a **RED CRASH** cord. Deactivates power to the servos; causes all machine motion to stop; requires that the machine be reset before power can be re-activated.
- C. Item 3 B ON green push button. Activates power to the servos after the RESET button is depressed.
- D. Item 4 B OFF black push button. De-activates power to the servos; the machine does not have to be reset before re-activating power to the servos.
- E. Item 5 B CONTROL POWER ON red indicator light. Illuminates when power to the servos is activated.
- F. Item 6 – AC on orange lamp. Illuminates when AC connected.
- G. Item 7 B Joystick control.

5.2.2 Air Flow and Pressure Controls (Attachment 1)

- A. Item 8 B Main air feed shutoff valve. This valve is mounted on the behind the machine.
- B. Item 11 B Air regulator and gauge. Regulates cooling air onto the stylus mounted on the back right table pedestal.

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5.2.3 Ultrasonic Controls

Ultrasonic Generator (Attachment 2)

- A. Item 1 B ON/OFF toggle switch. Activates power to the U/S generator.
- B. Item 2 B NULL/NORM toggle switch. Calibration use; set to the NORM position during operation.
- C. Item 3 B Three position selector switch (labeled “1”, “2”, “3”). Calibration use; set to the “2 or 3” position during operation.
- D. Item 4 B DC mA meter. Indicates the power output of the Generator. Used for power output verification.
- E. Items 5 through 10 B Tuning adjustments. Calibration use; not for use during operation.

Ultrasonic Generator Power Supply (Attachment 2)

- A. Item 11 B Test jacks. Allow the output of the power supply to be monitored by connecting a voltmeter to the test jacks. The voltage across the jacks is 4.7 volts per 1 amp output.
- B. Item 12 B CURRENT ADJUST Potentiometer. Adjusts current output of the supply; calibration use; not used during operation.

Wattmeter (BNL) (Attachment 3)

- A. Item 1 B ON/OFF toggle switch. Activates power to the Wattmeter.
- B. Item 2 B Indicator lights (3). Illuminate when power is activated.
- C. Item 3 B Potentiometer with readout. Not functional when MAN/SWEEP/NULL selector switch (item 4) is set to null (as it is during operation).
- D. Item 4 B MAN/SWEEP/NULL three position selector switch. Calibration use; set to NULL during operation.

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- E. Item 5 B SINE WAVE/SQUARE WAVE toggle switch. Selects the control output waveform sent to the U/S generator. Calibration use; set to SINE WAVE during operation.
- F. Item 6 B Potentiometer. Adjusts the output amplitude; calibration use; set to the OFF position during operation.
- G. Item 7 B IDLE/RUN/NULL three position toggle switch. Calibration use; set to the RUN position during operation.
- H. Item 8 B WATT/AMP/VOLT selector switch. In the WATT position, the digital display (Item 9) indicates the power (in watts) delivered to the ultrasonic stylus; In the AMP position, indicates the DC biasing current delivered to the drive coil; in the volts position, shows the peak to peak voltage delivered to the drive coil.
- I. Item 9 B Digital display. Displays the parameter selected by the WATT/AMP/VOLT selector switch (Item 8).
- J. Item 10 B Toggle Constant Voltage/Constant Power (CV/CP).
- K. TEST POINTS. Calibration use.

5.3 Initial Control Settings (Assumes norm operation stylus in calibration)

Place the 120 volts disconnect switch, located on the rack cabinet, in the OFF position.

- 5.3.1 U/S Gen. ON/OFF toggle switch (Item 1, Attachment 2) set to off.
- 5.3.2 U/S Gen. Selector switch (Item 3, Attachment 2) set to position 2.
- 5.3.3 Wattmeter MAN/SWEEP/NULL three position selector switch (Item 4, Attachment 3) set to RUN.
- 5.3.4 Wattmeter SINE WAVE/SQUARE WAVE toggle switch (Item 5, Attachment 3) set to SINE WAVE.
- 5.3.5 Wattmeter Potentiometer (Item 6, Attachment 3) set to OFF.
- 5.3.6 Wattmeter IDLE/RUN/NULL three position switch (Item 7, Attachment 3) set to RUN.

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5.3.7 Wattmeter WATT/AMP/VOLT selector switch (Item 8, Attachment 3) set to WATT.

5.3.8 Wattmeter ON/OFF toggle switch (Item 1, Attachment 3) set to ON.

5.3.9 Wattmeter CV/CP toggle switch (Item 10, Attachment 3) set to CP.

5.4 Starting the Machine

5.4.1 Refer to the applicable Magnet Assembly Procedure for instructions on setting up the substrate on the magnet tube.

5.4.2 Verify that the controls are set to their initial settings (5.3).

5.4.3 Turn on the air supply by turning the valve on the air line next to the machine. Verify that the regulator settings are as per the log book for the machine.

5.4.4 Mount the wire spool and thread the wire through the wiring head.

5.4.5 Place the 120 VOLTS disconnect switch, located on the rack cabinet, in the ON position. The AC **ON** amber lamp illuminates on the Control Box.

5.4.6 Turn on the computer by operating the rocker switch on the front panel of the computer case. When the login prompt appears, log into the system.

5.4.7 Once logged in, a window will appear. Start the MEI software. Select the 8-axis board, reset it. Repeat for the 3-axis board. Close the MEI software.

5.4.8 Push the on pushbutton located on the control panel in the center of the machine.

5.4.9 Start the winding software. The Visual Basic software will load. Click on the run button in the center top tool bar. Once the program has started, the main winding screen will appear.

5.4.10 Activate power to the Ultrasonic Wattmeter by placing/verifying the ON/OFF toggle switch in the ON position.

5.4.11 Choose an action from the menu of action choices on the computer monitor (Refer to the next section for a description of the operator choices available from the software menu).

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5.5 Compute Software Operations

The correct version of computer software must be loaded per the magnet traveler.

5.5.1 Active choices are: Files, Joystick, “Parameter field”, Exit. Files are used for selection or retrieving a wiring file from the network.

5.5.1.1 Once a file has been selected, the program will retrieve it. Each file has four associated files:

- 5.5.1.1.1 “filename”.hom provides the home position information.
- 5.5.1.1.2 “filename”.pin provides the pin location on the tube relative to zero.
- 5.5.1.1.3 “filename”.ini provides the wiring parameters.
- 5.5.1.1.4 “filename”.xxx provides the tube position correction information.
- 5.5.1.1.5 “filename”.xxx provides the information for correction harmonics.

5.5.1.2 The program will notify the operator should the associated files do not exist, as for example, when a wiring file is run for the first time. The system will prompt the operator for a file that will be copied under the new filename for use by the current filename.

- 5.5.1.2.1 .hom, .pin All the files for a specific layer must be the same, and should be the same for all layers of a specific tube.
- 5.5.1.2.2 .ini All the files for a layer should be the same.
- 5.5.1.2.3 .cor, .add All the files for a layer must be the same.

Once the five files are set, the program will load the wiring file, and indicate when it is finished successfully.

5.5.1.3 Once a wiring file is loaded, the program will enable the home selection. Click to begin the home process.

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5.5.1.4 Once the homing is complete, select pin check to verify the correct location of the pin, This verifies the placement of the tube, as well as the accuracy of homing procedure. The machine will go to a point over the pin, and at a Z height of 5 inches. Use the joystick to bring the stylus down to the pin. If all is correct, the stylus should drop into the slot of the pin. If not, use the joystick to move the offending axis to the correct location. (Note: use caution when the stylus is in the vicinity of the pin, as the wrong move can break the stylus.) Use the microscope for checking the pin into the slot travel, as sub one mil accuracy is required.

5.5.1.5 When the location of the pin and stylus is correct, exit out of the pin check procedure by closing the joystick window. Once done, the operator will be prompted to either save the information or ignore it. If a new stylus home position was determined, select yes. The program will than ask for the Z height. Read the height from the program screen Z position readout. (Note: It is not possible to zero the z axis as Z zero is the center of the magnet tube.

NOTE: In the event of incorrect machine travel, use the crash buttons or wire to halt machine travel.

5.5.1.6 Select Run to begin the wiring. The machine will move the head to the start location, at a Z of 5 inches, then ask “is the stylus in the correct location?” A “no” exits the run. A “yes” causes the machine to lower the Z axis until the stylus is at the surface of the tube. The computer then asks “ok to run?.” A “no” will exit the run, a “yes” will start the run. Note: In the center of the screen is a text box with the heading “next position.” By entering a number in this box prior to starting the run, it is possible to begin at a point other than the first point of the file. This makes it practical to restart a file in the middle of the pattern.

NOTE: A pause will halt all controlled motion, but does NOT de-energize the motor circuits. If access within the motion envelope is required, disable the machine using the crash string.

5.5.1.7 Once the run is started, it is possible to pause the operation of the machine at any time by depressing any key on the keyboard or clicking the pause menu selection at the top left menu bar. To continue, click the continue menu selection.

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5.5.2 Joystick

5.5.2.1 Once selected, a screen comes up allowing the selection of the axis to be moved using the joystick. The top bar allows the operator to select the speed for use in moving the axis.

5.5.2.2 When finished, select finished, and exit. The joystick box will disappear, returning to the main program.

5.5.3 Parameter Field

5.5.3.1 By clicking on any parameter in the setup field, the parameter can be changed. When clicked, a screen pops up allowing the parameter to be changed. This can be done during the running of the wiring file, after a pause has been enabled.

5.5.3.2 In joystick mode, move the z axis down to engage the zero hole in the magnet tube. Select appropriate axis' to verify the accuracy of the zero location. When the zero location is confirmed as accurate, select "done", and then "no" at the "save zero" screen". If zero has changed, choose "yes", and enter the new z height in the zero height screen. Typically, after zero has been re-located, move the z axis up to 5 inches, and then save the z height as 5 inches. This also serves to raise the tip of the stylus out of harms way.

5.5.4 Exit

5.5.4.1 Select this to exit the program.

5.5.5 End

5.5.5.1 This choice is for ending the program.

5.6 Shutting Down the Machine

5.6.1 Return the wiring head to the load position.

5.6.2 Wait for the green lights on the side of the power amplifiers to turn off before shutting the computer off.

5.6.3 Exit from the control software.

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5.6.4 Turn off the computer.

5.6.5 Place the 120 volts disconnect switch in the OFF position.

5.6.6 Turn off the air.

5.7 Testing the Safety Interlocks

5.7.1 Set all the controls to their initial settings.

5.7.2 Place the 120 volts disconnect switch, located on the rack, in the ON position.

5.7.3 Turn on the computer. Enter the MEI software program.

5.7.4 Depress the ON green push button on the control box. Verify that the CONTROL POWER ON red indicator light illuminates.

5.7.5 Depress a CRASH mushroom push button. The CONTROL POWER ON red indicator light and the RESET green lighted push button should extinguish.

5.7.6 Check the appropriate box on the Interlock Test Form (Attachment 5).

5.7.7 Test all seven CRASH push buttons and both crash cords. To re-energize the Machine after each crash, depress the ON green push button.

5.7.8 After the last CRASH push button has been tested, re-start the Machine

5.7.9 Using the MEI software, move the head gantry (X axis) towards the positive limit of travel.

5.7.10 Before the end of the track is reached, the positive optical limit switch should trip. Motion should stop. The servos remain on.

5.7.11 Within the MEI software, disable the positive limit switch for the X axis.

5.7.12 Continue moving the gantry in the positive direction.

5.7.13 Before the end of the track is reached, a mechanical limit switch should trip. Motion should stop and the servos should shut off.

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5.7.14 To re-start the machine, it will be necessary to hand move the gantry back off the mechanical crash switch. This is done by rotating the lead screw. Note: the power to the servo's cannot be activated as long as the crash switch is depressed. Once the gantry has been moved off the switch, the operator will be able to re-energize the servo power with the on button.

5.7.15 Depress **ON** green push button.

5.7.16 Repeat the test in the negative X axis direction.

5.7.17 Check the appropriate boxes on the Interlock Test Form.

5.7.18 Repeat Steps 5.7.9 through 5.7.10 for the Y and Z axis.

5.7.19 Initial and date the Form and post it near the Wiring Machine.

5.7.20 If an interlock fails, stop work, write "fail" on the form, and immediately notify the Cognizant Engineer and the ES & H Coordinator.

5.8 Aligning the Stylus

5.8.1 Verify that the controls are set to their "initial" settings (5.3).

5.8.2 Mount the wire spool (do not thread the wire through the wiring guide yet).

5.8.3 Place the 120 volts disconnect switch, located on the rack, in the ON position.

5.8.4 Turn on the computer by operating the rocker switch on the computer front panel. Wait until the Main Menu of the control software is displayed on the monitor.

5.8.5 Depress the ON green pushbutton on the Control Box. Verify that the CONTROL POWER ON red indicator light illuminates.

5.8.6 Home the wiring machine.

5.8.7 Run Zero check.

5.8.8 Insert a 200 mil shim under the stylus voice coil.

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5.8.9 Using the joystick on Z axis, lower the stylus to a point 50 mils above the home hole adapter in the tube.

5.8.10 Verify the stylus drops into the adapter hole.

5.8.10.1 If the stylus does not drop into the hole, loosen the bottom assembly screws, and re-position the stylus holding mechanism to allow a clean drop into the hole.

5.8.11 Re-shim the stylus above the hole. With the joystick set to theta, rotate the stylus and head 180°.

5.8.12 Verify the stylus drops into the hole.

5.8.12.1 If the stylus is now misaligned, use the joystick with both x and y axis to move the stylus halfway to the hole. Use wrenches to move the stylus the other half of the error.

5.8.13 Re-verify the stylus position with theta=0 and 180. Repeat step 5.8.12.1 until zero is correct.

5.8.14 Exit zero check, and enter the present z height.

5.9 Setting up and Calibrating the Ultrasonic Unit

5.9.1 Equipment Needed to Tune the U/S unit

- A. U/S Wattmeter Tuning Module
- B. Oscilloscope with differential input (Minimum bandwidth 100 Khz) with 10x probe.

5.9.2 Initial Settings

5.9.2.1 Set the AC power switch on the Wattmeter to “ON”.

5.9.2.2 Connect oscilloscope probe to test point H and test point K (ground) on U/S Wattmeter. (This is to test output of U/S Wattmeter.

5.9.2.3 Set oscilloscope vertical gain to 20mV/div (AC) and sweep rate to 10uS/div.

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- 5.9.2.4 Place U/S Wattmeter switch marked with a sine wave figure and a square wave figure (Attachment 3, Item 5) towards the sine wave figure.
- 5.9.2.5 Place U/S Wattmeter switch parked IDLE-RUN-NULL (Attachment 3, Item 7) on position NULL.
- 5.9.2.6 Place U/S Wattmeter switch marked MAN-SWEEP-NULL (Attachment 3, Item 4) on position NULL.
- 5.9.2.7 Turn amplitude control on U/S Wattmeter (Attachment 3, Item 6) until a signal of 25 Khz and about 100mV p-p is observed on the oscilloscope screen. (Period of about 40 microseconds)
- 5.9.2.8 On U/S Generator, place “NULL/NORM” switch on “NULL” position (Attachment 2, Item 2).
- 5.9.2.9 Turn U/S Generator rotary switch to position 2 (Attachment 2, Item 3).

5.9.3 To Adjust Stylus DC Bias Current

- 5.9.3.1 Set the AC power switch to “ON” on the U/S Generator (Attachment 2, Item 1).
- 5.9.3.2 Place switch marked WATT-AMP-VOLT on U/S Wattmeter (Attachment 3, Item 8) on AMP position.
- 5.9.3.3 With a small screwdriver, adjust the potentiometer on the Power Supply labeled CURRENT ADJUST (Attachment 2, Item 15) until the current is 1.1 A +/- .1 A. (This value is read on the digital display on the U/S Wattmeter).

5.9.4 Bridge Calibration

- 5.9.4.1 Connect oscilloscope probe to test point “F” and test point “K” (ground) on the Wattmeter. Adjust coil “E” on the Generator (Attachment 2, Item 9) for minimum signal as displayed on oscilloscope. Always tune coil “E” through a minimum, until signal increases, then back off again to minimum. This is to ensure that a true minimum is found.

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- 5.9.4.2 Adjust pot. B (Attachment 2, Item 7) to a minimum signal as displayed on the screen.
- 5.9.4.3 Adjust pot. E again to verify that a minimum has been achieved.
- 5.9.4.4 Turn the amplitude control on the U/S Wattmeter (Attachment 3, Item 6) to the “OFF” position.

5.9.5 Initial Gain Loop Adjustment

- 5.9.5.1 Connect oscilloscope probe to test point “B” and the ground lead to test point “K” on the Wattmeter.
- 5.9.5.2 Set oscilloscope vertical gain to 10V/div. And sweep rate to 10uS/div. Set the input for AC only.
- 5.9.5.3 Set U/S Generator rotary switch to position 2 (Attachment 2, Item 3).
- 5.9.5.4 Place “NULL/NORM” switch on Generator on “NORM” (Attachment 2, Item 2). A sine wave (5 to 20 volt p-p) may occur, if no signal, adjust pot 6.
- 5.9.5.5 Place switch marked WATT-AMP-VOLT on U/S Wattmeter (Attachment 3, Item 8) on position WATT.
- 5.9.5.6 Adjust “run” amplitude to 45 V p-p or 25 watts (maximum allowed) by turning pot. **D CAW**.

5.9.6 Idle Voltage Adjustment

- 5.9.6.1 Set U/S Generator rotary switch (Attachment 2, Item 3) to position 2. Adjust U/S Generator pot. C until “idle voltage” is 8 to 12 v p-p.

5.9.7 Loop Tuning

- 5.9.7.1 Check that the signal (the “run voltage”) on the oscilloscope is from 40V p-p to 45V p-p. If the signal is too large, adjust pot. D.
- 5.9.7.2 Check that the signal has a frequency of 25Khz. Tune coil G (Attachment 2, Item 10) until this frequency is obtained.

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5.9.7.3 Adjust coil “G” to tune the signal. When the loop is correctly tuned, the waveform will “snap” to the proper frequency, and a “knee” will be apparent on the left side of the positive part of the waveform. (This snapping action is most apparent when tuning from a lower frequency to a higher.).

5.9.8 Final Tuning

5.9.8.1 Verify that the oscilloscope is connected to points K (ground) and B (signal).

5.9.8.2 Set the rotary switch on U/S generator to position 2.

5.9.8.3 Check that the switch marked WATT-AMP-VOLT (Attachment 3, Item 8) on U/S Wattmeter is in position WATT.

5.9.8.4 Carefully adjust coil G while observing the digital display on U/S wattmeter. Coil G should be adjusted through a maximum, or peak wattage, and then back to maximum. Coil G will now be correctly tuned for maximum efficiency. While tuning coil G, care must be taken not to exceed the maximum values of 25 watts or 45 volts p-p. (Best settings are: 40V p-p, 23 watts, 1.1 A).

5.9.8.5 If optimum readings cannot be obtained, repeat the tuning procedures beginning from step 5.9.4.

5.9.8.6 Make final adjustment of power output by adjusting pot for consistently good wire bonding while wiring. Do not exceed 45 Watts output.

6.0 Documentation

6.1 Log Book

6.2 Interlock Test Form

7.0 References

7.1 SBMS Subject Area: Lockout/Tagout (LOTO)

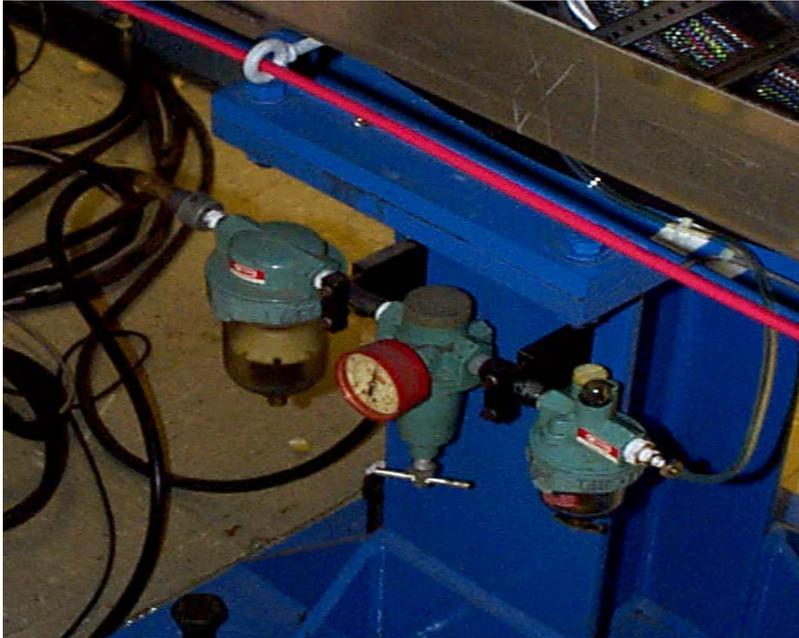
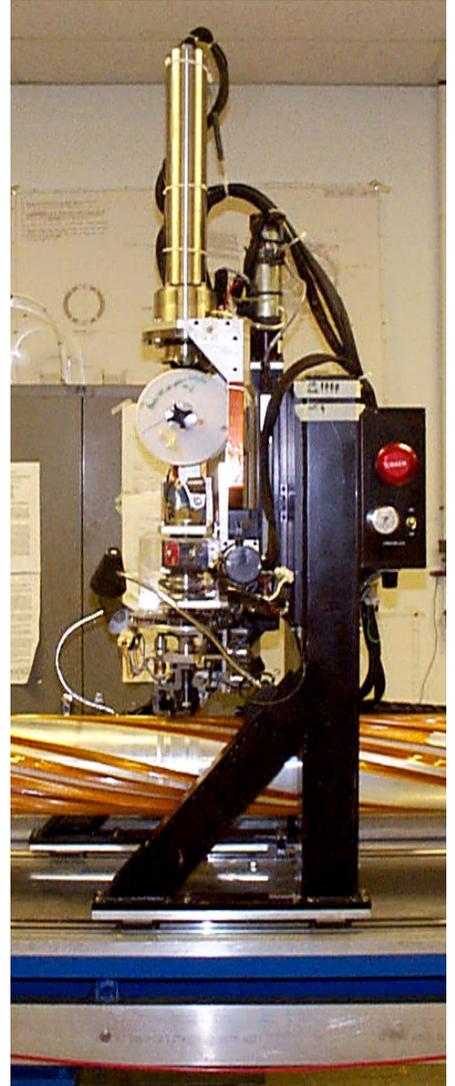
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8.0 Attachments

1. Wiring Machine Diagram
2. Ultrasonic Generator and Power Supply
3. Wattmeter
4. Interlock Test Form

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Attachment 1 - Wiring Machine Diagram



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Attachment 2

Ultrasonic Generator and Power Supply



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Attachment 3

Wattmeter



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Attachment 4

Interlock Test Form

Check if passed

Rack Crash Button	2 Table Crash Buttons	2 Head Crash Buttons	2 X Axis Range of Motion End Crash Switches	2 Y Axis Range of Motion Switches	Table Crash Cord	Operator	Date