The Original
Moyer
Mean Machine

Computerized Free Length Control System

Built by:

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I Description and Specifications

A. DESCRIPTION OF FEATURES

The Mean Machine spring gage is a microprocessor based controller and probe which measures the free length deviation from a target mean free length while coiling. When used in conjunction with a pitch controller and sorting chute, the Mean Machine adjusts the coiler to correct for free length error based upon statistical data, then sorts the springs according to selected free length tolerances into three or five categories.

Some of the unique features of the Mean Machine spring gage include the patented feedback control system, an improved temperature stabilized probe, a five way sorting capability, and statistical printouts which analyze the data and enable the operator to make scrap reduction simple. Other features include push button auto zero, set-up, and programming. The Mean Machine is also capable of producing machine and process capability studies.

The Mean Machine Feedback Control system is unique to what the industry has been used to. Each spring is first measured 32 times prior to cut-off. Then these measurements are sorted from the longest to the shortest and the average of the most center measurements provides the length reading for that spring. This patented measuring method increases the accuracy of spring length measurements and greatly reduces the effects of electrical noise and mechanical vibration. The two patented pitch control methods which are selectable by the operator are "Optimize" and "BA+" (Improved Barrier Avoidance).

Optimize Mode : The gage makes a proportional adjustment based upon the variation from the target mean free length. The adjust knob is set for an initial setting by the operator. A good place to start is with the dot set at the 12:00 o'clock position or midway of its travel. All the way counter clockwise provides minimum adjustment and all the way clockwise provides maximum adjustment. The following will list the position of the knob in regard to the approximate amount of proportional control.

Adjust knob setting	Proportional Control
full counter clockwise - 7:00	minimum adjustment
1/4 - 9:00	1/8 of variation
1/2 - 12:00	1/4 of variation
3/4 - 3:00	3/8 of variation
full clockwise - 5:00	2/3 of variation

Example: If the knob is set at 12:00 and the spring is 0.010" longer than the mean target length, the gage will make an adjustment so that the next spring should fall between 0.0075" and target mean. If the next spring is shorter than target mean, the amount of pitch adjustment is decreased. If the next spring is longer than 0.0075", the amount of pitch adjustment is increased. In addition, the gage is monitoring the three sigma of the last thirty springs coiled and never makes a the pitch adjustment on the portion of a springs length which may exceed +/- three sigma of the last 30 springs. This is called flyer rejection and improves centering on poor wire.

Note: The adjust knob setting is a target setting. The internal fine pitch adjustment is automatically optimized as mentioned in the example above to obtain the target results desired. Normally the process stabilizes to provide the maximum amount of good spring yield in 100 to 200 coiled springs (max). After this, it continues to optimize to follow process changes.

BA+ (Improved Barrier Avoidance): The gage may make an adjustment as often as one out of two springs or as seldom as one out of twenty springs. The amount of the adjustment and the frequency of adjustment is based upon the statistical data and the setting of the adjust knob. When the adjust knob is turned all the way counter clockwise the gage will make a large adjustment less often. When the knob is turned all the way clockwise, the gage will make small adjustments more often. Each time a pitch adjustment is made the gage checks the next spring to see if it is close to the target mean free length based upon the statistical data. If the spring is not within a acceptable range as established by the gage, the pitch adjustment is automatically adjusted (optimized) to improve good spring yield.

Generally, BA+ will only be better than optimize mode when running less consistent wire or loose mechanical coilers. You should try using OPTO mode first. This adjustment is a trial and error method. You should change the adjust knob setting until the coiler provides the highest spring yield.

B. DESCRIPTION OF ACCESSORIES

Mean Machine (Gage)

The main control unit into which all accessory equipment such as sorting chutes, pitch controllers, etc. are connected. It contains all operational controls such as on/off, configure, and set-up.

Temperature Stabilized Probe (Probe)

The Mean Machine uses non-contact capacitive measuring techniques. The device used to implement this technique is the Temperature Stabilized Probe. This measuring device has a micrometer at one end and a threaded barrel at the other end. The probe tip threads onto the threaded barrel. A cable having a six pin connector extends from the probe for connection to the Mean Machine's "PROBE" input connector.

Probe Tip

This threads onto the end of the probe. The O.D. of the probe tip is chosen to be slightly larger than the O.D. of the spring. Refer to chart in set-up portion of the manual for recommended tip sizes and distances from probe tip to spring.

Probe Holder

The bracket that holds the temperature stabilized probe. It is mounted on the coiler in a location so that the probe tip is centered in front of the coiled springs.

Pitch Controller Assembly

This assembly includes a pitch drive motor, flexible shaft, gear box, and pitch rod adapter nut. The pitch drive motor is housed in an enclosure such that the drive shaft protrudes from the housing. One end of the flexible shaft is connected to the motor drive shaft while the other end connects to the input shaft of the gear box. The pitch rod nut threads onto the coilers pitch control shaft. The hollow bore of the gear box fits over the O.D. of the pitch rod adaptor nut and is tightened by two set screws. The height of the pitch drive motor is adjustable vertically using the two adjustable end brackets on the pitch drive motor housing. A two position switch is located on the underside or front of the pitch drive motor housing which changes the direction of the motor.

There are two sizes of pitch controllers available. The standard system is designed for #00 thru #2 coilers or for a pitch control shaft measuring up to ½" For coilers larger than a #2 or for coilers having a pitch control shaft larger than ½" , a heavy duty pitch controller is required, all components of a heavy duty pitch controller are the same except for a size increase. A cable having a three pin connector connects the pitch drive motor to the 'ADJUST' output connector on the Mean Machine.

Read Switch Assembly

The assembly is comprised of a pick up mounted on an aluminum block, wire ties, prox switch with cable having a three pin connector for connecting to the Mean Machine's 'READ' receptacle and hardware for mounting. The read switch pick up is mounted on a shaft that makes one revolution per spring while the prox switch is positioned to detect the pick up so that a read signal is sent to the Mean Machine after the spring is coiled, but prior to cut off.

Stainless Steel Chute-Three Way Sorting

This chute sorts springs into three different categories, short, long, and good (within the tolerances set). The chute comes complete with a cable and three pin plug and is connected to the SORT output.

Stainless Steel Chute-Five Way Sorting

This chute sorts springs into five different categories. The total good spring length tolerance is divided into three good groups.

Example: If the total good spring tolerance is +/- 0.012", the 0.024" total tolerance is divided into three inner groups of 0.008" each as in the case of 3-way sorting and two outer groups long and short that may have very long and very short springs. The outer groups are sometimes thrown away or manually 100% inspected.

The chute comes complete with the two cables, one with a three pin plug and the other with a two pin plug. These cables connect to the Mean Machines' "SORT" and "AUX OUT" output.

Coiler Kill Kit

The coiler kill kit includes two three pin sockets and relay mounted on a pc board and a three pin cable. It turns off the coiler in the event that a predetermined number of sequential bad springs, as set by the operator, have been coiled or broken tooling has been detected. The cable connects to the AUX-OUT of the gage.

When using a five way chute, connect the two pin plug from the chute to one of the sockets on the coiler kill board, and connect the three pin cable from the coiler kill cable to the AUX-OUT socket.

Good Spring Counter

The good spring counter counts the number of good and bad springs. On the front of the good spring counter is a button that has "PR" on it. Pressing this button will enable the operator to preset the number of good springs allowed to be coiled before the coiler is shut down. The counter has a fifteen pin connector on both ends. Connect either end to the srping counter and the other end to the gage marked "COUNTER". The good spring counter will now shut the coiler off after it reaches the preset number of good springs.

C. PACKAGE #1 through #4

Package #1

This version of the gage provides the user with a basic control and sort system. It includes a temperature stabilized probe with one probe tip of your choice and a read switch with the complete mounting assembly.

Accessories that can be used with package #1 are: air sorting valve or three way sorting chute, and pitch controller

Package #2

This version has all the features of package #1 and includes automatic shut (coiler kill) and five way sorting capability.

Additional accessories that can be used with a package #2 are: package #1 accessories, five way sorting chute, and coiler kill kit.

Package #3

Package #3 includes all of the features of the #1 and #2 packages and include a serial data interface.

All accessories listed above in packages #1 and #2 can be used in addition to computers and other data collectors.

Package #4

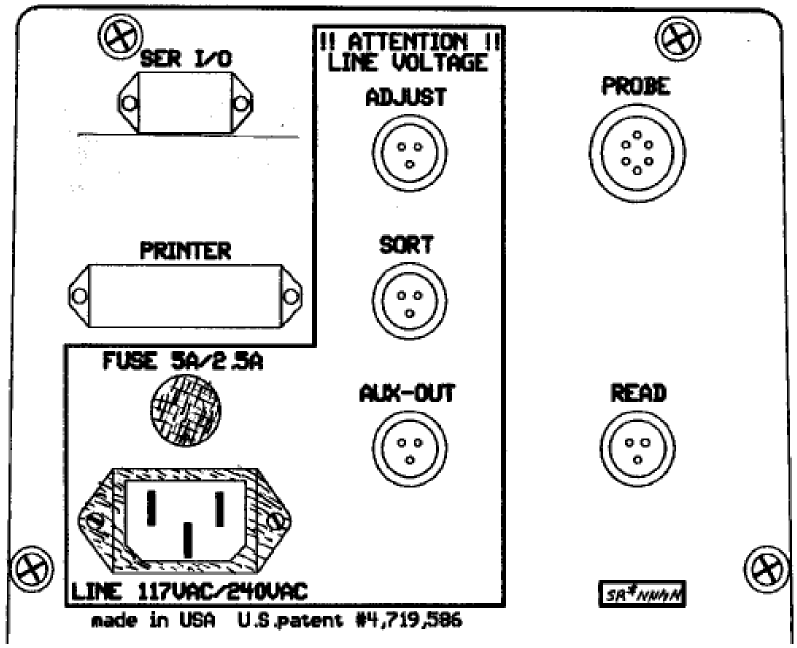
This version includes all of the features of the above packages and has the optional printer capabilities that provide SPC charting, good and bad spring counts and set up data.

All accessories listed above in packages #1, #2 and #3 can be used in addition to various types of printers which are Epson and C-ITOH compatible.

The Mean Machine was designed to give springmakers a wide variety of options so they can custom fit the gaging system to their own environment.

D. CONNECTORS & SWITCHES, FUNCTIONS AND PLACEMENT

Back panel



PRINTER: When using package #4, plug the 25 pin printer cable into this receptacle.

SER I/O: When using package #3 or #4 with a data collection device, plug the nine pin connector into this receptacle.

FUSE: Use either a 5 amp 250vac fast blow or 3 amp 250vac slow blow.

LINE 117/240VAC: The main power connector which requires the supplied grounded plug. In plants with extreme power line noise, extra grounding maybe required.

ADJUST: The three pin plug from the pitch drive motor is plugged into this socket.

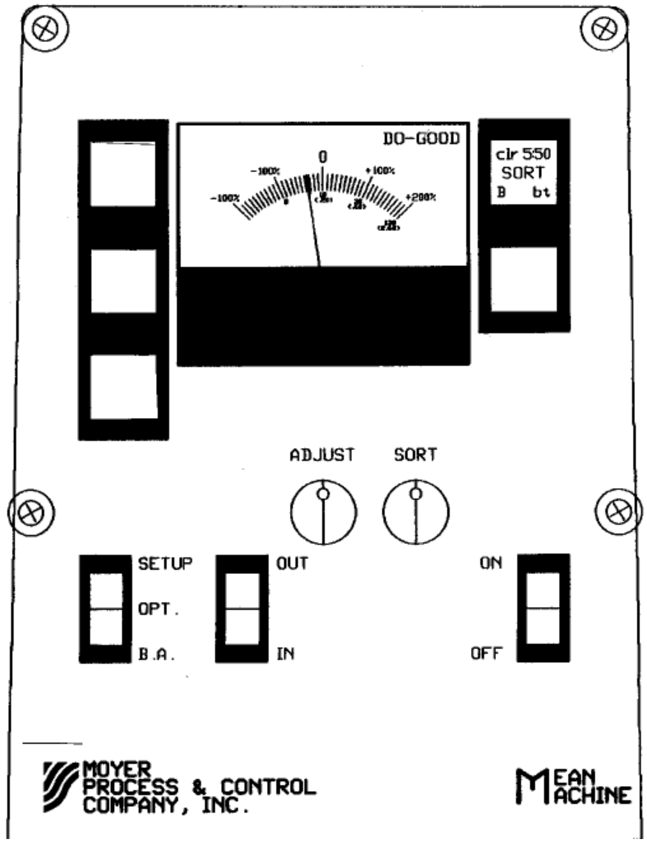
SORT: The three pin plug from the air valve, three way chute or the five way chute plugs into this socket.

AUX OUT: The two pin plug from the five way chute or the three pin plug from the coiler kill kit plugs into this connector.

PROBE: The six pin plug from probe cable plugs into this socket.

Read: The three pin plug from the read switch cable is plugged into this socket.

Front Panel Description



<u>("A") Left Hand Red Button:</u> Sets short limit, changes between 5 way and 3 way sort, metric to English, test the serial port ,and used with the "E" button (yellow) to set printer type,.

<u>("B") Right Hand Red Button:</u> Set long limit, turns data collector and broken tool detection on or off, abort studies, test the printer port, used with the "E" button (yellow) to change the baud rate,

<u>("C") Left Hand Green Button:</u> Shows that an adjustment is made to make the spring longer.

<u>("D") Right Hand Green Button:</u> Shows that an adjustment is made to make the spring shorter, starts both MCS and SPC studies, used with the sort knob to set tolerances for the statistical print out, and used with the "E" button to clear good spring counts and time on the print out.

<u>("E") Lower Left Hand Yellow Button:</u> Auto zero the gage, used with the "A" button (top left red) to change printer type, and with the "B" button (top right red) to change baud rate, used with the "D" button (right green) to clear good spring counts and time on the print out, used to test the meter for functional operation, to test auto zero for functional operation and to simulate a read.

<u>Adjust Knob:</u> Set pitch adjustment, used with the "E" button (yellow) to test meter and probe for functional operation.

<u>Sort Knob:</u> Used to set sort time, used with in/out switch to establish time between MCS and SPC samples, used to set the dimensional units for the statistical print out, and used to test all output for chutes, pitch control motor, etc for functional operation.

<u>In/Out Switch:</u> This switch will run the pitch tool in and out manually, starts and starts the data sent to the serial output, used with the sort knob to set time delay for MCS and in SPC samples.

<u>Mode Switch:</u> The Set-up mode is for initially setting the gage, clearing good spring counts, time between samples on print out, configuring the gage, and for hardware test. The OPT mode selects the run mode "Optimize". The BA+ mode selects the run mode "BA+" (Barrier Avoidance).

<u>Meter Display:</u> The meter is used to zero the gage, to set the sort points, display the length from the target free length of each spring. As the meter is divided into percentages and as the sort limits are always referenced to 100%, the operator can catch a spring and look at the meter to correlate the gage readings verus the manual reading. The lower numbers on the meter are for setting the time interval between samples for SPC data and for numerical value for SPC print out.

II RECEIVING AND INSTALLING THE MEAN MACHINE GAGE

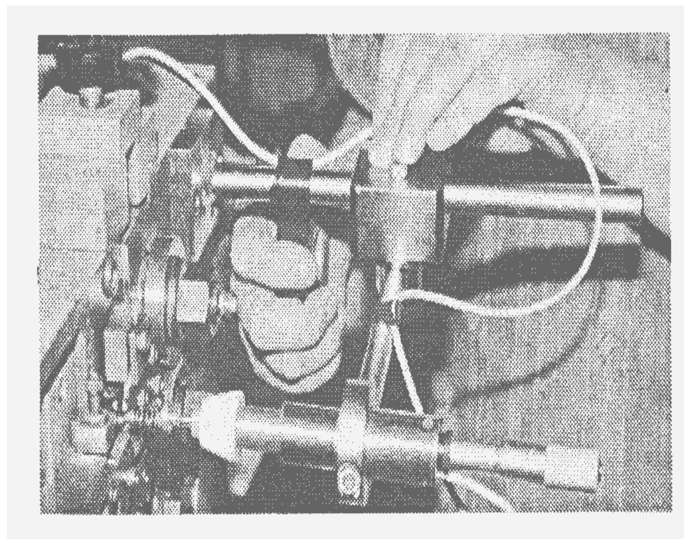
Unpacking

Prior to accepting shipment from carrier, inspect all cartons for damage. If a carton is damaged, open the carton in front of the carrier to check contents. Each part will be shipped with approved packing. Check carefully that no parts are lost in packing material. In all cases, report any missing parts or damage to the carrier and Moyer Process and Control, Co.,Inc immediately.

Installation

Do not connect power until instructed . Place the gage so the operator has good access to all controls on the front of the gage.

Probe and holder



Coil a spring by hand until wire feed quits. Put the probe thru the 1" hole in the holder. Slide the probe forward so that the collar is holding the back of the probe, close to the micrometer. Tighten the collar around the probe.

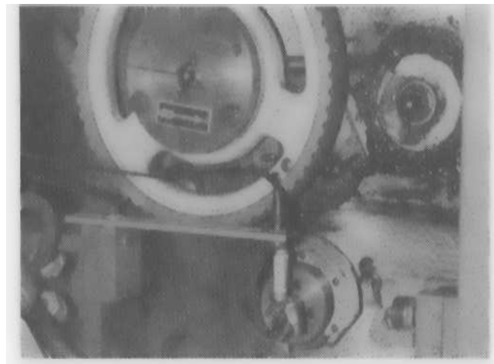
Place the base of the probe holder on the coiler so that won't interfere with the spring dropping down after cut off and that won't interfere with the operator during tooling changes. Make sure the probe measuring end is in front of the coiled spring. Mark the location of the holes in the probe holder base. Drill and tap holes on the front of the coiler as marked for 1/4-20 screws. After tapping, file the coiler face to remove any burrs, then mount the probe holder base to the coiler.

Select a probe tip that is slightly larger than the O.D. of the coiled spring. Make sure that the brass spring is in the probe tip prior to screwing it onto the probe. Screw the tip tightly onto the probe (finger tight is sufficient). Refer to "Setting up the Mean Machine" for tip size selection and distance between the end of the spring and the tip. Using the probe holder sliding block, position the probe tip in front of the coiled spring so that the tip is on the same axis of the spring and that the tip covers the O.D. of the spring. Tighten the two 1/4-20 cap screws on the probe holder sliding block. Route the probe cable so it is out of harms way. Connect the six pin plug to socket marked "PROBE".

NOTE: The probe must be held rigid as any movement will affect the free length reading.

Moyer temperature compensated probes are interchangeable with any Mean Machine, Eurogage, Merlin gage and PJM100.

Read Switch



The read switch assembly consists of a pick up mounted on a lock collar or block, a prox switch and cable with a three pin plug, mounted in a bracket. The pick up is mounted on a shaft that makes one revolution per spring.

Position the prox switch and pick up so that a read signal will be made after the wire quits feeding but prior to cut off. On a segment type coiler, the read signal should take place at the midpoint of the dwell time and on an escapement coiler or high speed coiling the read must take place as soon as the wire quits feeding as the gage takes multiple readings prior to cut off for improved accuracy.

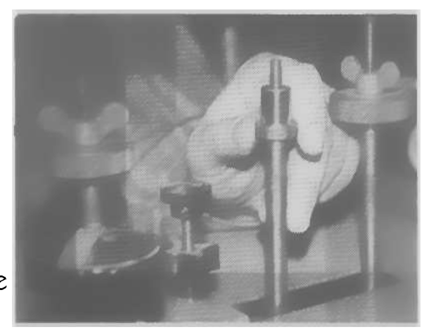
Coil a spring by hand slowly to ensure that the pick up does not hit anything. Make sure there is a .030" to .100" air gap between the pick up and prox switch. Plug the three pin plug into the socket on the back of the gage marked "READ".

With no other accessories plugged into the gage plug in the power cord and turn the gage on. Put the mode selector switch in "Opt" or "BA+" mode.

Coil a spring by hand and check the read signal. The "E" button (yellow) will light when a read signal is received by the gage.

Mounting the Pitch Drive Motor

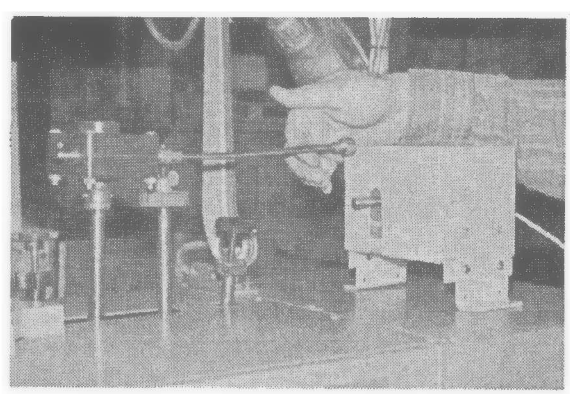
The pitch controller assembly consists of a pitch motor, flex shaft, adaptor nut and the reducing gearbox.



Remove the pitch rod locking nut. Check the threads for cleanliness and rough spots. If necessary, clean threads by using a die to ensure smooth operation of the adaptor nut on the pitch rod. Screw pitch rod adaptor nut onto pitch rod.

Install the flex shaft on the gear box's input shaft and set the gear box's hollow shaft over the nut on the pitch rod and position the flex shaft so that the end of the flex shaft which attached to the pitch drive motor will be in the proper position to attach it to the pitch drive motor. Tighten the two set screws in the gear box hollow shaft to the nut.

Adjust the height of the pitch drive motor using the two legs on the base of the pitch drive motor housing so that the flex shaft is parallel to the coiler. Fasten the flex shaft to the pitch drive motor.

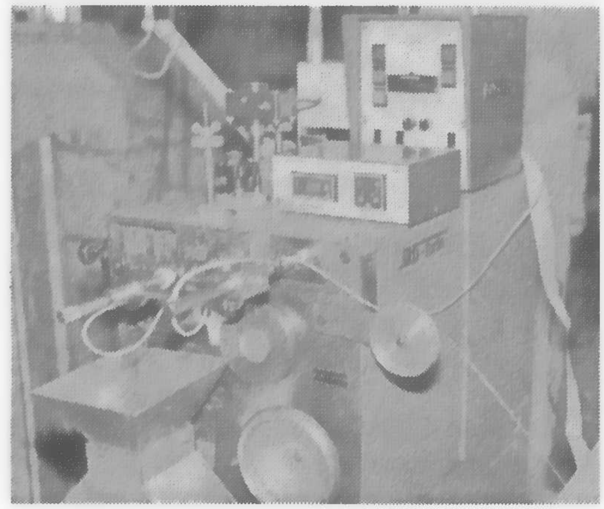


Position the pitch drive housing so that the flex shaft does not hit anything and is not on a bind. Mark the mounting holes in the two legs onto the coiler. Slide the pitch drive motor housing out of location and drill clearance mounting holes for 10/32 screws. When fastening the 10/32 screws thru the mounting plate on the coiler and on the housing legs use lock washers to prevent the locking nuts from coming loose and falling into the coiler mechanism.

Connect three pin plug from pitch drive motor to socket on the back of the gage marked "ADJUST".

Mounting Three way and Five way Sorting Chute

Position the chutes so that the front angle plate of the chute is as close to the face of the coiler as possible. This is usually directly beneath the cut off mechanism. Align the chute so that the springs after cut off fall into the throat potion of the chute with out bouncing out.



Fabricate an attachment plate which connects the chute to the coiler in the correct position. A good arrangement for the attachment plate consists of a block with a club shaft welded onto it, in the vertical plane, using standard pipe. Fit the pipe I.D. over the club shaft and weld a horizontal pipe off the pipe in the vertical plane. Using a larger pipe which will slide over the horizontal pipe to attach to the chute mounting bracket. Drill and tap the pipes which fit over the inner pipes so that the chute can be adjusted in both planes and locked in place during set-up. The operator can then loosen the set screw in the pipe over the stub shaft and swing the chute out of the way.

Connect the three pin connector on the three way chute into the socket on the back of the gage marked "sort".

When using a five way chute there are two cords to connect to the gage. Connect the three pin connector into the socket on the back of the gage marked "sort" and connect the two pin connector into the socket on the back of the gage marked "AUX OUT".

When using a five way chute with a coiler kill a Y adaptor is plugged into the "aux" socket and the two pin connector of the chute is plugged into one leg of the Y adaptor. While the three pin connector of the coiler kill is plugged into the other leg of the Y.

III Configure and Set-up of The Mean Machine Gage

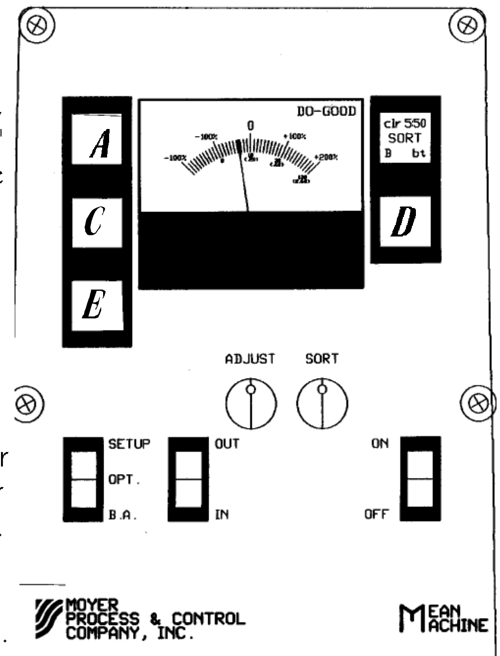
A. USING THE MEAN MACHINE

Versions 2 thru 4 must be taken through a series of steps before first use. The first step is the configure mode. Using this mode, you can change the gage options.

The second step is the set-up mode. This mode is used to set the sort limits of the particular spring to be coiled.

The last step is the run mode which is the mode used during production. As the gage will not lose it's memory if turned off, there is only one way to clear a set-up. The gage only erases a previous set-up when it is turned on while in set-up mode. Refer to section III, configuring your Mean Machine if required.

B. Configuring your Mean Machine Package #2, #3, and #4



1. Place the mode switch in setup mode.

2. While holding in the "E" (yellow) button, turn on the gage, then release the button. The gage is now in 'configuration #1' mode. This mode will allow for configuring the gage for the following options:

   -3 or 5 way sorting operation.
   -RS232 enable. (Pkg #3 and #4)
   -RS232 baud rate. (1200/9600 bps)(Pkg #3 and #4)
   -Printer type. (Epson/C-ITOH)(Pkg #4)
   -MCS time & SPC time (for stats)(Pkg #4)

3. The 'A' (left red) button is used to select and indicate the 3 or 5 way sorting option. By simply pressing the 'A' button, the 3 or 5 way option is toggled. If 'A' is lit, the gage is set for 5 way sort. If not lit, the gage is set up for 3 way sorting.

4. To enable the RS232 port, press the "B" (right red) button. When 'B' is lit, the RS232 port is enabled. If 'B' is not lit, the RS232 port is disabled. If the RS232 is enabled, the baud rate will have to be set to match the baud rate of the device that is connected to the serial port. (Refer to the device's user manual for correct setting.)

5. The baud rate is toggled between 1200 and 9600 baud by holding in the 'E' (yellow) button and pressing the 'B' (right red) button. The 'D' (right green) button is used to indicate the gages' baud rate. When the 'D' button is lit, the baud rate is 9600 bps. If the 'D' button is not lit, the baud rate is set at 1200 bps. If nothing is hooked up to the RS232 port, then the port should be disabled.

6. The gage is capable of sending Epson or C-ITOH printer codes to the parallel port. The printer type is toggled between Epson and C-ITOH by holding in the 'E' (yellow) button and pressing the 'A' (left red) button. The 'C' (left green) button is used to indicate the gages' printer type. When the 'C' button is lit, the printer type is Epson. If the 'C' button is not lit, the printer type is C-ITOH.

7. To change the time interval between samples while taking a Machine Capability Study (MCS), while holding in the 'IN' button, turn the sort knob until the desired number of seconds to wait is indicated on the lower scale of the meter.

EX: If it is desired that the coiler take MCS samples every 16 seconds, set the needle of the meter on '16' on the lower scale of the meter.

8. To change the time interval between samples while taking a Statistical Process Control Study (SPC), while holding in the 'OUT' button, turn the sort knob until the desired number of min. to wait is indicated on the lower scale of the meter.

EX: If it is desired that the coiler take SPC samples every 3 min., set the needle of the meter on '3' on the lower scale of the meter.

9. Place the mode switch in 'OPT' mode. This setting places the gage in 'Configuration #2' mode. This mode will allow for configuring the gage for the following options:

-**Broken tool detection option**. (toggle on/off)
-**Coiler kill number option**.
-**Units of measurement**. (Metric/Imperial)(pkg #3 and #4)

10. In order to change the units of measurements of the data that is sent to the RS232 and parallel port, the 'A' (left red) button is used to select whether units are to be in metric or imperial. By simply pressing the 'A' button, the Metric/Imperial option is toggled. If 'A' is lit, the metric unit is selected. If 'A' is off, the imperial unit (inches) of measurement is chosen.

11. The 'B' (right red) button is used to select and indicate the broken tool detection option. By pressing the 'B' button, broken tool detection is toggled on and off. If 'B' is lit, this option is turned on. If 'B' is not lit, the option is off.

12. The combination of the 'IN' button and sort knob allows the coiler kill number to be changed. While holding in the 'IN' button, turn the sort knob until the desired coiler kill number is indicated on the lower scale of the meter.

EX: If it is desired that the coiler be shut down after coiling 10 springs in a row which fall outside the set sort limits, set the needle of the meter on '10' on the lower scale of the meter.

If the coiler kill number is set to '0', the option is disabled.

13. Turn the gage off to exit the configure mode. All of the above parameters are stored in the gage, and these settings are not cleared until the gage is turned on while in the setup mode.

Refer to set-up section.

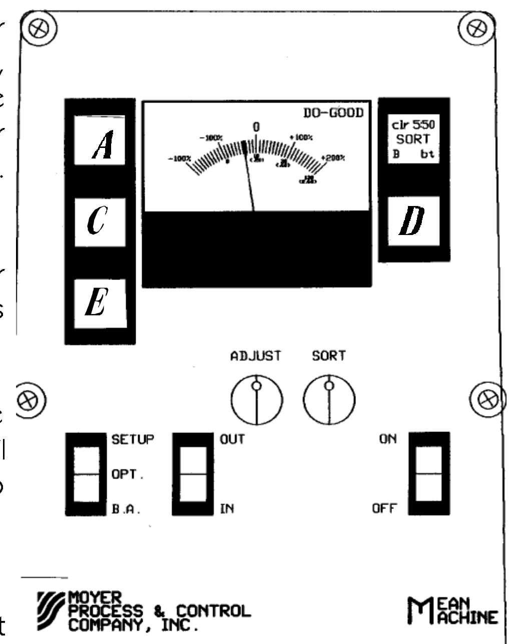
C. Setting Up The Mean Machine

1. For the first set up or setting up a new job, put the mode switch in the setup position. Turn on the power. Let the gage warm up for about three minutes.

2. Place the probe the recommended distance from the spring as shown below.

Spring O.D.	Recommended Tip size	Initial Standoff
0.062" to .125" [1.6mm to 3.2mm]	1/8" [3.17mm]	.065" [1.65mm]
0.125" to .250" [3.2mm to 6.4mm]	1/4" [6.35mm]	.125" [3.17mm]
0.250" to .375" [6.4mm to 9.5mm]	3/8" [9.52mm]	.200" [5.08mm]
0.375" to .500" [9.5mm to 12.7mm]	1/2" [12.7mm]	.275" [6.98mm]
0.500" to .625" [12.7mm to 15.9mm]	5/8" [15.9mm]	.350" [8.89mm]
0.625" to 1.00" [15.9mm to 24.4mm]	1" [25.4mm]	.650" [16.5mm]

3. Press the 'E' button on the gage. (Auto Zero). Turn the probe micrometer clockwise to the sort distance. The meter should read between 80% and 110%. If it reads below 80%, the probe is too far away. If it reads more than 110%, the probe is too close. If either case is true, move the micrometer zero point in if under 80%, out if over 110%, and start over. Otherwise proceed.



4. Press the 'B' (right red) button. The meter will move on or very close to 100%. This indicates that your sort distance is 100%.

5. Return the micrometer to zero and continue turning to the short sort distance. Push the 'A' (left red) button and wait until the meter stops moving. The meter should read very close to -100%. Your distance is now calibrated.

6. The sort knob sets the amount of time the air or flappers on a chute are activated. For example, if you are running at 3600 parts per hour, a correct setting would be at the 12:00 position as indicated by the sort knob.

7. The adjust knob sets the pitch adjustment time. Start with the dot on the knob at the 12:00 position.

8. (Package #3 and #4 only) While holding in the 'D' (right green) button, adjust the sort knob until the needle of the meter indicates your sort limits using the lower scale on the meter. EX: If you have set your sort limits at +\- .0010 inch, set the meter needle on '10', then release the 'D' button. This will provide proper scaling for the data output on the serial port & printer.

9. Place the mode switch in 'OPT' and begin coiling springs. Watch the pitch controller to make sure it is correcting in the right direction by watching the length of the springs.

10. Catch a spring that is close to zero on the meter, and compare this to the target length. Correct the length by moving the micrometer the amount that the spring differs. Repeat if necessary.

11. Most jobs will run very well with the adjust knob at this setting. Occasionally you may want to increase or decrease the amount of correction for further scrap reduction. The gage has built self improvement, so give it 50 to 100 springs before you change the adjust knob setting.

12. (Package #3 and #4 only) To toggle the serial port on and off (if enabled), the IN/OUT switches are used. Start sending data out thru the serial port by depressing the 'IN' switch. Stop the flow of data by depressing the 'OUT' switch.

13. (Package #4 only) To do a Machine Capability Study (MCS) depress and hold the 'D' (right green) button for just over 1 sec. (printer required) When the MCS is done the gage will automatically continue taking Statistical Process Control Study (SPC) samples. To abort the studies before done press and hold the 'B' (right red) button for just over 1 sec., action is indicated by the printer ejection the page it was printing on. To pause the SPC press ane release the 'B' button less than 1 sec., action is indicated by the printer moving the paper up 1 line. To continue a paused study press and release the 'D' button.

VI Statistical Process Control

A. Normal Distribution

A normal distribution is represented by a bell shaped curve which has few points (or measured spring lengths) at either end and the majority of the points (spring lengths) in the middle. If a line is drawn through the middle to the base line the two parts should be similar in shape and nearly equal in area in order to be called a normal distribution.

Standard deviation is a term used in statistics to describe the "spread" of this data from the middle of a normal curve. As manufacturers we want this spread to be very close together around the middle of the bell curve.

B. Control

To determine if a process is under control, terms such as mean, X-bar ,and range will be used. When a process is in control it is generally understood to be producing springs whose measurements form a normal distribution in the bell shaped curve with a consistent mean (the center of the bell). This is monitored by the Mean Machine and is given via the printer.

C. Capability

1. Machine Capability Study

A machine capability study is a short term study using statistics to determine if a machine is running parts which have normal distribution,are in control and are capable of meeting the print requirements. When a machine capability study is done the data is collected into subgroups. The data is then analyzed using X-bar and R charts.

2. Process Capability Study

A process capability study is the long term study of the sample data taken by the Mean Machine and plotted against the machine capability studies data to see if the process is remaining in control and is the analyzed using X-bar and R charts.

D. Interpretation Of Statistical Printouts

The Mean Machine package 4 is programed to provide some very useful information via the printer. This section attempts to explain standard SPC data as well as our own additions. It is broken down into three sections: 'Is The Machine Running Properly?', 'Is The Process In Control ?', and 'Is The Process Capable ?' with examples.

Is The Machine Running Properly?

Compare the 3 sigma (v) value and the 3 sigma (r) values. The ratio r/v (sigma(r)/3sigma(v)) should be greater than 0.80 but less than 1.00 . If this ratio is greater than 1.00 then the gage is over probably over controlling. If this ratio is less than 0.80 then the gage is probably under controlling. These values represent short term (3sigma(r)) and long term variation (3sigma(v)) within the production.

Count the number of "X"'s between the two broken lines on the Xbar chart. This count is printed at the right end of the second broken line. This count should be 9, 10, or 11. If the count is 12 or greater then the gage is probably over controlling. If the count is 8 or less then the gage is probably under controlling.

Now, examine the last two digits of the mode column. Check if this value is getting larger, getting smaller, or staying the same. This value represents the gage's internal correction value. If the gage thinks it is over controlling this value will get smaller. If the gage thinks it is under controlling this value will get larger.

If the r/v ratio and the number of X's between the 50% confidence lines on the Xbar chart indicate the gage is over controlling and the last two digits of the mode column is staying the same or getting bigger then turn the "Adjust" knob counter clockwise to reduce the control level. Wait fifty or more springs and run another Machine Capability Study to see the results.

If the r/v ratio and the number of X's between the 50% confidence lines on the Xbar chart indicate the gage is under controlling and the last two digits of the mode column is staying the same or getting smaller then turn the "Adjust" knob clockwise to increase the control level. Wait fifty or more springs and run another Machine Capability Study to see the results.

The exact amount to increase or decrease the "Pitch" knob setting is a combination of experience and trial and error. Also not that too little control can sometimes result in Xbar values above the UCLx line or below the LCLx line on the Xbar chart. Too much control can sometimes result in R values which are above the UCLr line on the Range chart.

Once that you've generated a Machine Capability Study which shows a proper level of control it is then time to examine a few other items on the study.

Is The Process In Control ?

When we talk about a process being in or out of control we are speaking of its' predictability, not how much or how little the gage must adjust the coiler. In fact it is sometimes good to think of the gage and coiler as one machine and an adjustment as something an operator does to the probe or coiling point, not something that the gage does to the pitch mechanism. Again the point to be made here is gages don't actually adjust (the gages maintains), operators adjust, and control means predictable.

One of the most important aspects of Xbar and R charting techniques is that they offer a way to determine if a process is predictable and consistent. The premise is that doing continuous statistics on all parts is too much trouble so it is better to analyze samples taken from time to time from the parts to see if anything has changed or if the parts are still the same. The concepts of Xbar & R charting ar as follows :

(1) Samples (Xbar's and R's) taken from a random distribution of parts have a relationship to the statistics of the distribution from which they were taken. Or said another way, the overall quality of a distribution of parts from which samples are taken can be determined by sample statistics.

(2) After enough samples have been taken from a distribution of parts, limits (UCLx, LCLx, & UCLr) can be

calculated such that none of the sample statistics (Xbar's and R's) should exceed these limit. Also the statistics (mean and standard deviation) of the distribution of parts can be inferred.

(3) So long as additional samples are taken from the distribution their statistics should never exceed the limits calculated.

Here is where control comes in. If all the Xbar and R values calculated from samples from the production distribution fall within the calculated control limits UCLx, LCLx, & UCLr then we say the process is "IN CONTROL". It is in fact predictable and it will probably continue to run the same with all Xbar and R values within the control limits so long as nothing changes. Conversely something has probably changed if an Xbar or R value has exceeded a control limit. Out of control conditions usually require some corrective action.

When a process is out of control it is safe to say there is a cause for it. If that cause is corrected or eliminated the process will run with an improved quality. Therefore Xbar & R charting is a powerful tool for process improvement.

<u>Is The Process Capable ?</u>

If the statistics indicate that the parts are all within the quality requirements the process is considered "Capable" of producing good parts. Please note, a process may be "Capable" but not in "Control" or in "Control" but not "Capable". This is easy to realize if the you consider a coiler making very nice predictable springs with a maximum length variation of +/-0.002 inch but sadly the print requires +/-0.001 inch.

It is often a requirement of Xbar and R charting to determine if a process is "Capable". There are a number if indexes (CP, CPK, etc.) that are used to quantify (put in number form) the chance that a part being made will be (when finished) outside the allowable print tolerance. In most cases because coiling is one intermediate step in a total process, it is up to the springmaker to establish what "Process Tolerance" needed at the coiler to ensure final quality.

Here is where a problem may arise. What if the process is not capable?

(1) Use sorting to eliminate non conforming parts. The Mean Machine with chute or air sort is capable of sorting your springs into three or five groups according to length. Sorting to eliminate non conforming parts is common. If the load is a very important print requirement and length tolerances have been established which will ensure good loads, it may be adequate to just sort or reject springs outside of these tolerances. Some rejected springs may be fine, but the limits ensure all non-sorted springs are good.

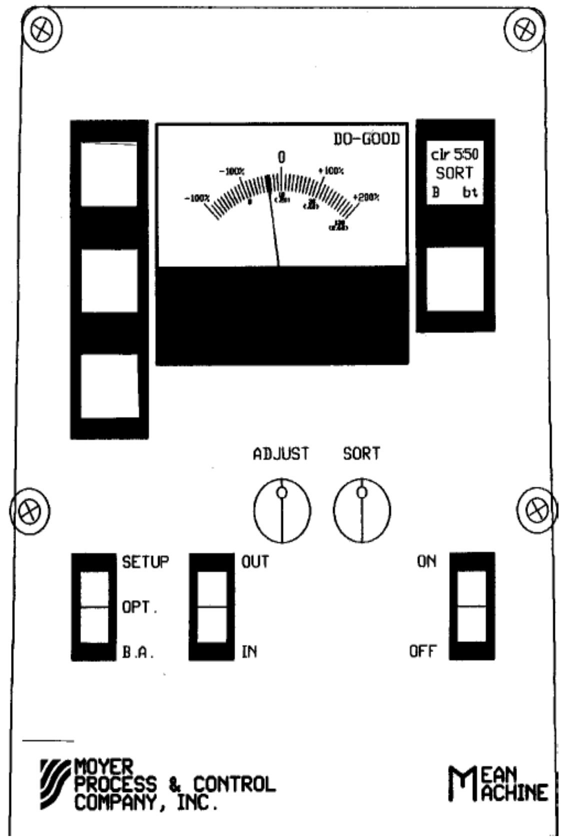
(2) Employ sorting to subdivide the process. The Mean Machine with chute or air sort may sort your springs into three or five groups. If grind is a very important print requirement, and relatively wide length tolerances have been established which will ensure good loads but would result in too much length variation for consistent grind, it may be adequate to sort the springs into five groups and grind each group separately. Here five way sorting has been employed to greatly reduce the variation in length of a sub process of unground springs to make it easier to control the quality of grind. In fact what we have done is split one big hard to manage process into several smaller easier to manage processes.

(3) Attempt to tighten or improve the process at another step to allow you to relax your process free length tolerance at the coiler. This may require using half tolerance wire, a powered de-reeler, in line heat treating, a set removal operation, heat setting, or a Moyer G2000 grinder length control. Usually manual or automatic 100% sorting should be considered a last resort and only rarely necessary.

NOTE: Problems can arise from sorting and are often due to the nature of truncated normal distributions. Sometimes problems are real, such as when stack up arises because too many parts are close to but not exceeding the print tolerance. Sometimes problems are imaginary, such as when final inspection calculates process limits and estimate that parts must be out of tollerance, yet extensive manual inspection finds that none are.

VII Troubleshooting

Hardware Test



If trouble should ever arise with the Mean Machine, there are several methods that one can use to locate and correct problems. The Hardware Test mode of the Mean Machine is one method for troubleshooting the gage. This mode will allow an operator to test the light, switches, AC outputs, printer and serial port, probe, and meter. To place the gage in hardware test mode, the following steps must be taken:

-Turn off the gage.
-Disconnect flex shaft from motor.
-Turn the sort knob full counter clockwise
-Place mode switch to 'Set-up'.
-Press and hold 'E' (yellow button) and turn on the gage.
-Release 'E', then place mode switch to 'BA+'.

1. The following procedure checks for functional operation of the lights, indicator light circuitry, AC outputs (chute, motor, etc) and sort knob.

All the lights should be off. Plug in the motor and chute. If a 5way chute is connected, the relay inside the front cover will activate. Slowly rotate the sort knob clockwise to light the "A" button. One flapper on the chute should activate. Continue rotating the sort knob until the "C" button lights. The flapper should release and the motor should start turning. Continur rotating the knob until the "E" button lights. The motor should stop and nothing but the light is on. The knob should be in the 12:00 position.

Rotate the sort knob again clockwise until the "D button lights. The motor should be turning but in the opposite direction. Continue rotating the knob until the "B" button lights. The motor should stop and the other flapper should activate. Rotate the sort knob clockwise until it stops. None of the light will be lite and flapper should release. If a coiler kill is connected, this will activate.

2. The following procedure checks for functional operation of the probe, meter and adjust knob.

Make sure the probe is attached and warmed up. Press and hold the "E" button. Slowly rotate the adjust knob from limit to limit. The meter should smoothly follow the knob position. Release the button. Rotate the adjust knob full counter clockwise. The meter should be between 0 and 200%.

Slowly turn the adjust knob clockwise while watching the meter. At some point, the meter will move to -200% and stay there as the adjust knob is rotated to the full clockwise position. Adjust the knob so the meter reads between -100% and +100%. Wave your finger close to the front of the probe. As you do, the meter should move to the + side.

3. The following procedure checks for functional operation of the printer and serial outputs.

A printer and the cable that came with the gage must be attached for this test. Press the "B" button for just over one second. This tests the printer output and cable by printing the following statement.
"Every Good Boy Does Fine. 0123456789"

A computer, serial printer, or other serial data collection device must be connected and properly configured for the following test. Press the "A" button for just over one second. This tests the serial output by printing the following statement.
"All Cars Eat Gas. 0123456789"

If there are problems coiling spring, but you have passed the tests so far, please go to the Configure Mode and check to see if the gage is properly set.

Hardware Test can help tell if the gage is functioning properly, and if not, where the problem may be. If you have passed the Hardware Test, chances are very good that your problem is mechanical, and not due to the gage. If you have not passed the tests or if you have questions or problems, please call us and we will be happy to help you.