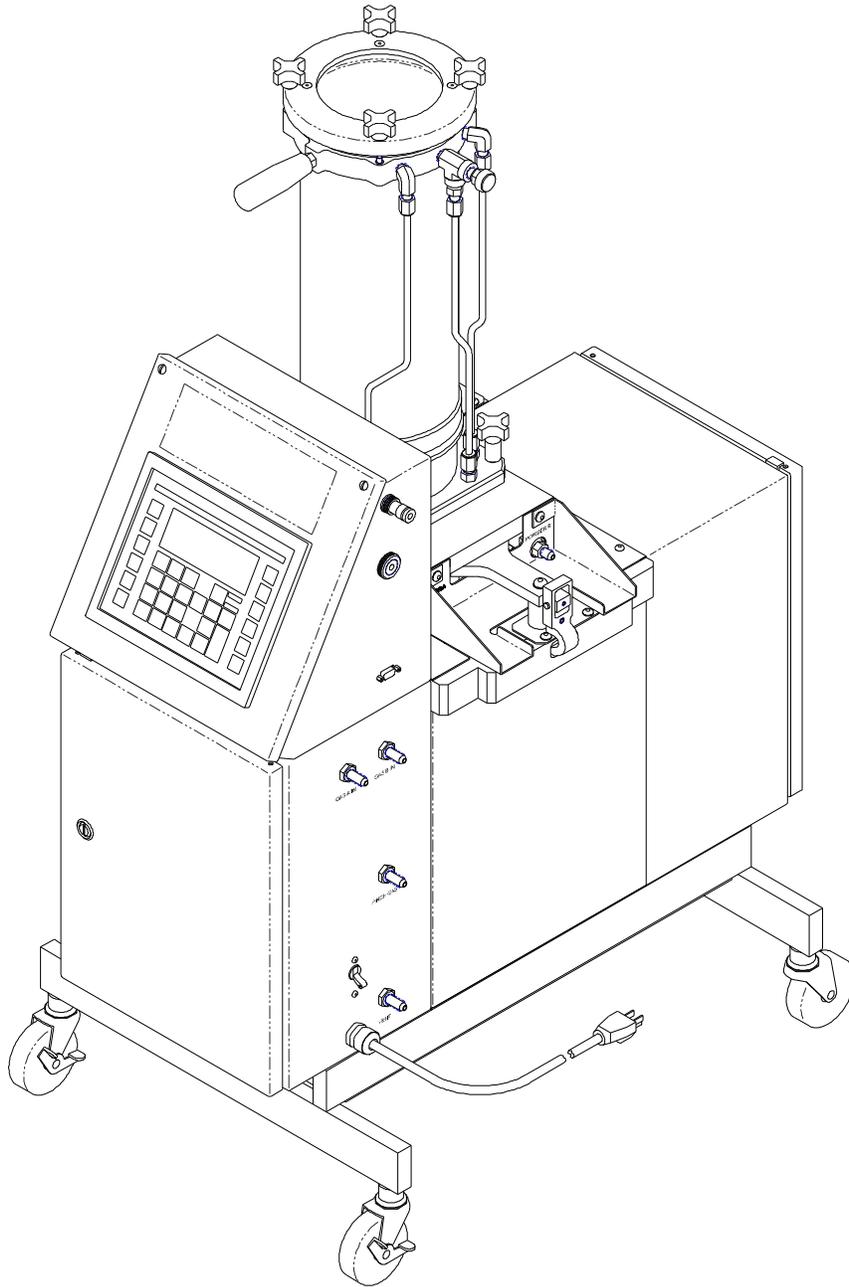




23190 DEL LAGO
LAGUNA HILLS CA, 92653
TEL (949)770-1160
FAX (949)770-6717

MODEL 171D POWDER FEEDER

OPERATORS MANUAL



MAXIMUM RATINGS	
Input Volts	120vac rms @ 60hz
Input Current	5 amps
Input Pinch Valve Pressure	80-160 psi
Feed Wheel Speed	20.0 rpm
Canister Pressure	40 psi
Weight	150 lbs
Canister Volume	6.5 Liters
Max Flow (standard feed wheel)	133 mL / min
Dimensions	22" x 31" x 46"

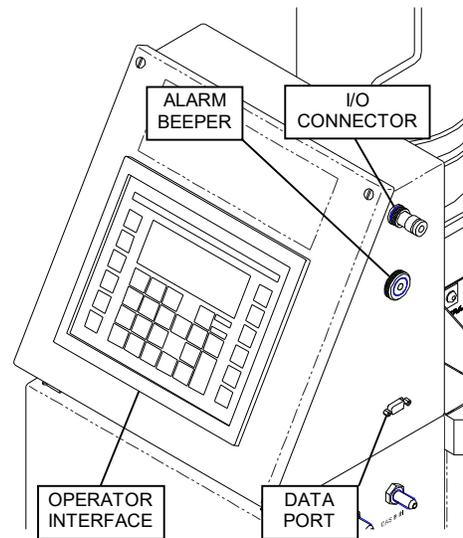
OVERVIEW

The 171D Powder Feeder is a dual output volumetric powder feeder designed for accurate and consistent delivery of gas suspended powder in production applications.

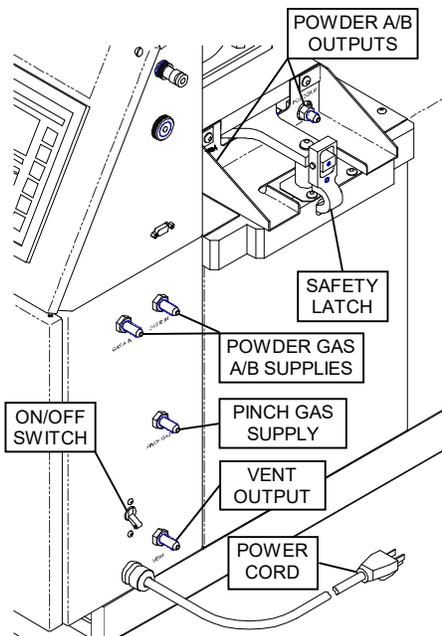
The feeder uses a dual chamber feed mechanism to eliminate variations due to changes in the amount of powder in the canister. A precision-pocketed feed wheel volumetrically feeds powder at high and low delivery rates accurately and with high linearity. Pressure at the feed line is equalized with the rest of the canister to eliminate powder backflow. The canister is protected by a 40-psi pressure safety valve. The entire feed mechanism rests on three electronic load cells that measure and control the amount of powder in the canister.

This feeder also operates with a gas bypass system that uses long lasting pneumatic pinch valves to switch gas and powder flows. The bypass system allows the powder canister to isolate the stabilized feed pressure while the feeder is not in use. This system allows instant startup times without having to wait for pressure stabilization between runs. The gas bypass also keeps the powder line free of clogs and prevents back flow from the plasma gun by maintaining a continuous flow of gas through the line. The isolation of the canister also allows the feeder to be filled while the plasma gun is operating in atmosphere or vacuum. The system also includes a venting pinch valve to purge air in the chamber.

The 171D uses a combined programmable logic controller and operator interface terminal to control all functions of the powder feeder. The control module allows for many convenient features which includes full external control, crystal oscillator controlled feed rpm and timing, feed motor vibration, calibration of all analog inputs, feed adjusting based on weight measurements from the load cells, auto-charging of the canister, weight over-limit and powder low alarms, run timeout, cycle counting, and serial output of feeder statistics for data logging.



Control Panel Interface (fig. 1)



Input Output View (fig. 2)

CONTROL ELEMENTS

- ◆ The **Operator Interface** located in the center of the control panel (fig. 1) is used to edit and save parameters, display relevant information, and control the operations of the feeder. See the Operator Interface section for more information.
- ◆ The **Alarm Beeper** located on the right side of the control panel enclosure (fig. 1) will alert the user with a 100-decibel beep for use in noisy environments. The alarm will beep at 1Hz when powder level transitions from high to low, 10Hz to indicate a weight over-limit condition and 1.25Hz to indicate the pressure has exceeded the maximum limit. The alarm can be silenced by pressing the Alarm Reset key or disabled permanently through the settings.
- ◆ The **Data Port** located on the right side of the control panel enclosure (fig. 1) is used for programming the PLC and outputting feeder status information periodically when the AUTO PRINT parameter is on or whenever the Print key is pressed.
- ◆ The **ON/OFF Switch** located on the right side of the control cabinet near the bottom (fig. 2) is used to toggle power to the powder feeder. The switch also functions as a 20-amp circuit breaker to protect the electronics.

◆ The **Power Cord** located on the right side of the control cabinet near the bottom (fig.2) powers the system through a standard 110v wall socket.

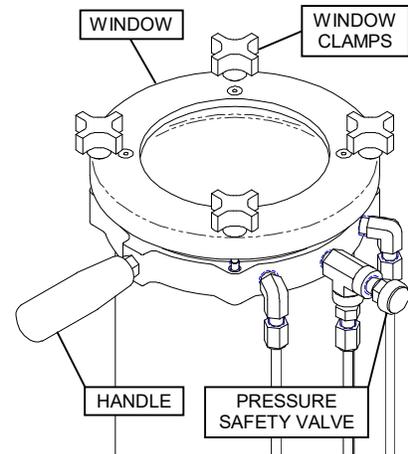
◆ The **Safety Latch** located next to the load cell contact furthest from the feed mechanism pivot point (fig.2) prevents the feed mechanism from accidentally falling down on the load cells (fig.5) and damaging them. After pivoting the feed mechanism backwards it can be placed back on the load cells by carefully supporting its weight while flipping the latch away from the frame and then carefully lowering the feed mechanism all the way down.

◆ The **Powder Gas A and B Supply** input connectors on the right side of the control cabinet near the top (fig.2) supplies carrier gas to both of the powder outputs. This input should be supplied with a mass flow controlled gas supply.

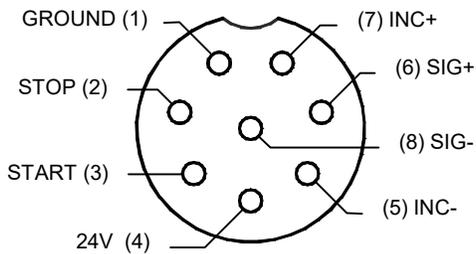
◆ The **Pinch Gas Supply** input connector located in the middle of the control cabinet (fig.2) supplies the pinch valve pressure. This input must be supplied with 80 – 160 psi.

◆ The **Vent Output** connector located at the bottom of the control cabinet (fig.2) is the location where pressure is vented from the canister for filling, cleaning, or purging.

◆ The **Powder A and B Output** connectors located on the powder feeder mechanism (fig.2) are the locations where powder/gas or bypassed gases flow out to the plasma gun.



Canister (fig.3)



Electrical I/O Connector (fig.4)

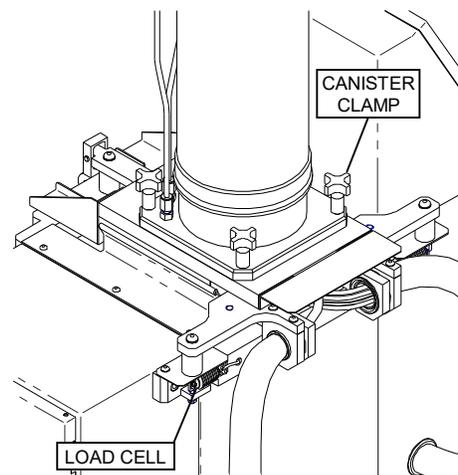
◆ The **I/O Connector** located on the right side of the control panel cabinet (fig.1) is an 8-pin connector that uses digital and analog signals to allow for auxiliary control of the powder feeder. The Ground pin (1) connects to the system ground. The Stop pin (2) will stop the feed cycle when high in 2 Wire control mode. The Start pin (3) will start the feed cycle when high in 1 Wire control mode or maintain the feed cycle when high in 2 Wire control mode. The 24v pin (4) provides power to the Stop, Start, Inc- and Inc+ input pins or power for auxiliary control devices. (Current should not exceed 200mA) The Inc- pin (5) decrements the feed speed or gpm rate by the *RPM INC* and *GPM INC* values respectively when the pin transitions from low to high. The Inc+ pin (7) increments the feed speed

or gpm rate by the *RPM INC* and *GPM INC* values respectively when the pin transitions from low to high. The Sig- and Sig+ pins (8,6) are a floating 0-10V input that is used to specify the feed speed or gpm rate of the powder feeder.

◆ The **Pressure Safety Valve** located at the top of the canister (fig.3) will release pressure if the canister is charged above 40 psi in order to prevent damage to the window and clamps.

◆ The **Window and Window Clamps** located at the top of the canister (fig.3) are designed to be quickly removed for powder filling while in operation. When resealing the window turn opposing Window Clamps at the same time to clamp the window evenly. Only tighten the window clamps until the window o-ring is fully compressed.

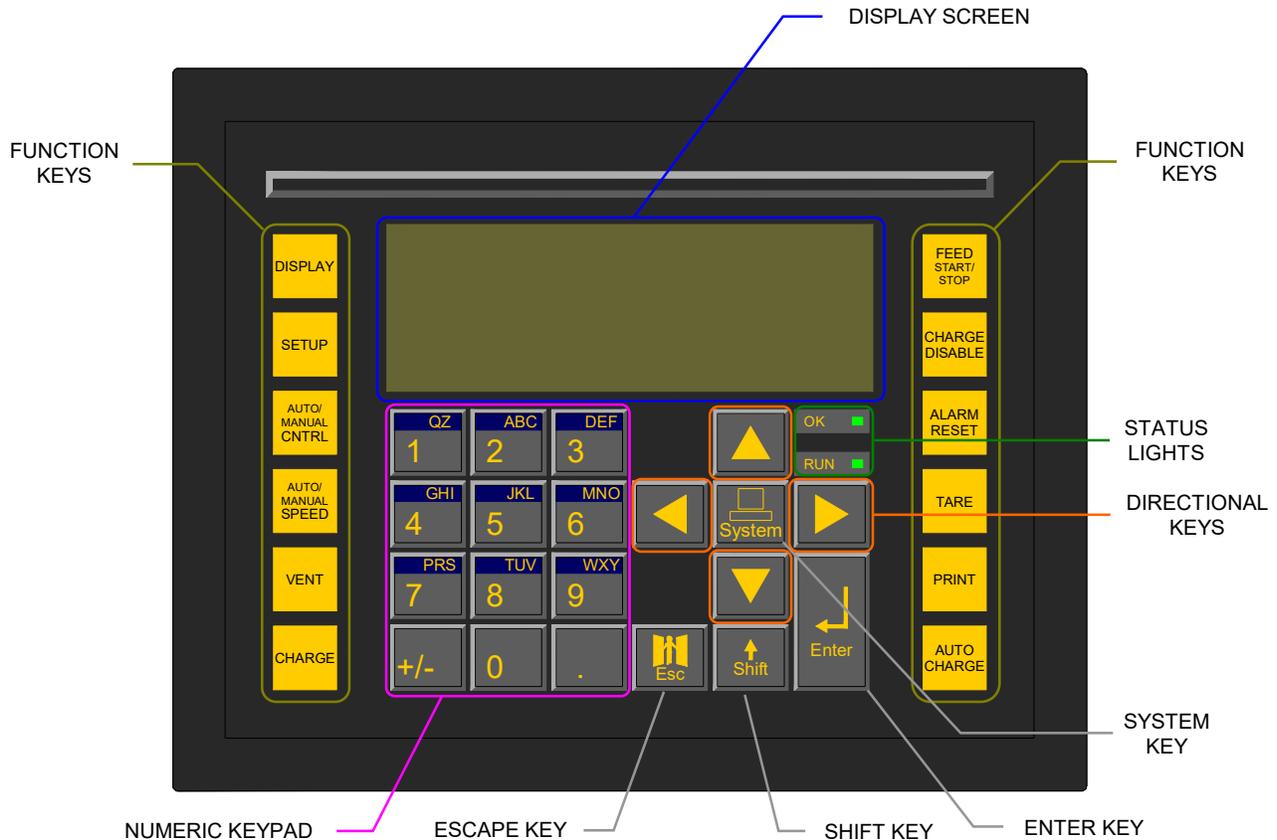
◆ The **Canister Clamp** located at the bottom of the canister (fig.5) are designed to quickly disassemble the canister and feed mechanism for cleaning. When reassembling the canister turn opposing Canister Clamps at the same time to clamp the canister evenly. Only tighten the Canister Clamps until the canister o-ring is fully compressed.



Canister Base (fig.5)

OPERATOR INTERFACE

PANEL DIAGRAM (fig.6)



USING THE OPERATOR INTERFACE

The operator interface keypad contains a 4 x 20 character backlight display, 12 function keys, a numeric keypad, directional keypad, escape, shift, enter, and system keys, and two status indicator lights. This interface is used to display feeder status and to edit set points and calibration values that are used by the PLC to control the operations of the feeder.

Editing Values

In the various menus and display screens whenever the last digit of a value is underscored with a bar (_), this value can be edited with the numeric keypad. The Left and Right directional keys can be used to select multiple values that are on the same screen. Once the desired value is selected press the Enter key to begin editing. Successful entry to edit mode will be signaled by a flashing block (■) or flashing bar (_) on the last digit of the value. Use the numeric keypad to enter the desired value. If the value being edited is a fixed decimal, integer or text value, then the Up and Down keys can be used to increment or decrement the value. After the new value is entered press the Enter key to update the new value or if the change needs to be canceled first press the Escape key to reset the parameter to the value stored before editing and then press the Enter key to exit editing. At this point the flashing bar or block will cease and the selected value will be updated and saved. If incorrect or out of range values are entered after pressing the Enter key the parameter will not be updated.

Switching Menus

There are two main screens that are used to navigate, control, and edit the various values and functions of the powder feeder, they are the Display screen and the Settings Screen. At any time the user can press the Display key or Settings key located on the upper left of the operator interface to return to the corresponding screen. While in the Settings screen sub menus can be selected with the Up and Down arrow keys. After selecting the desired sub menu press the Enter key to display that sub menu. To return to the previous screen press the Escape key. To enter the system menu press the System key. When in the system menu all other screens will be disabled. To exit the system menu press the Escape key.

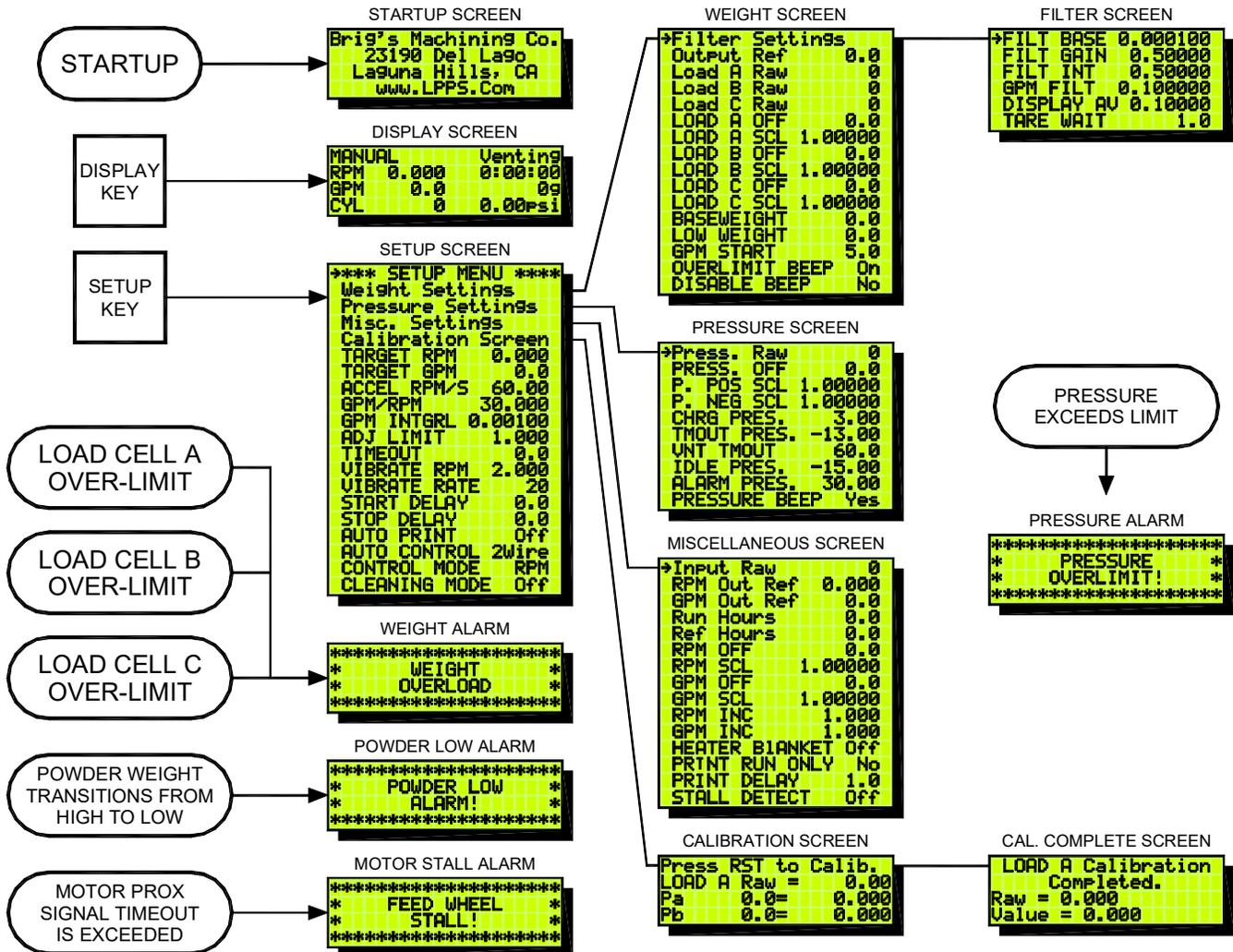
Status Lights

There are two status indicator LEDs located near the middle right of the operator interface marked "OK" and "RUN". When there are no errors present in the controller and the self-tests have "passed," the "OK" LED illuminates. When the program is running and there are no application errors, the "RUN" LED illuminates. During normal operation both indicator lights should be illuminated. If the "RUN" light is not on, the PLC can be manually started by going to the System Menu and selecting the "View OCS Status" sub menu. In that sub menu change the "OSC Mode:" parameter to "Run".

Function Keys

- ◆ The **Display Key** will switch the operator interface to the Display screen at any time this key is pressed, except when the System menu is being displayed.
- ◆ The **Setup Key** will switch the operator interface to the root Setting screen at any time this key is pressed, except when the System menu is being displayed.
- ◆ The **Auto/Manual Cntrl Key** will toggle the feed run control state between "auto" which uses the I/O pins 2 and 3 to control the run and between "manual" which only uses the keypad to control the run. When either mode is selected the other input source is disabled. The current run control state is displayed in a combined message on the upper left of the display screen.
- ◆ The **Auto/Manual Speed Key** will toggle the speed control state between "auto" which uses the analog I/O pins 6 and 8 to control the feed rpm or gpm and between "manual" which only uses the keypad to enter rpm or gpm values. When either mode is selected the other input source is disabled. The current speed control state is displayed in a combined message on the upper left of the display screen.
- ◆ The **Vent Key** will toggle the vent valve open or closed. This key is disabled while the feeder is running and will flash a warning in the upper right corner of the display screen when pressed. Pressing this key also cancels an auto charge cycle. When venting is on "Venting" will be displayed in the upper right corner of the display screen.
- ◆ The **Charge Key** will momentarily divert the bypassed gas flow into the canister while the output line is isolated in order to charge the canister to operating pressure. This key is disabled while the feeder is running and will flash a warning in the upper right corner of the display screen when pressed. Pressing this key also cancels an auto charge cycle and also closes the vent valve. When charging is on "Charging" will be displayed in the upper right corner of the display screen.
- ◆ The **Feed Start/Stop Key** will toggle the feed run state while in manual run control mode. This key is disabled while the vent valve is open and will flash a warning in the upper right corner of the display screen when pressed. Pressing this key also cancels an auto charge cycle. When the feeder is running "Running" will be displayed in the upper right corner of the display screen.
- ◆ The **Charge Disable Key** will temporarily disable the idle pressure maintenance function so the canister can be opened to atmosphere. The maintenance function will resume when the Charge or Feed Start/Stop keys are pressed. The pressure maintenance function can be permanently disabled through the IDLE PRES. parameter.
- ◆ The **Alarm Reset Key** will reset the powder low alarm beeper and flashing screen when pressed. This key is also used to complete calibration in the calibration screen.
- ◆ The **Tare Key** is used to zero out the weight display on the display screen. If the TARE WAIT value is greater than zero then the feeder will wait for the value stored so that the weight measurement has time to settle. During this timeout period the weight display will be filled with e's. Hold this key down for 3 seconds to zero out the weight at the low powder weight level specified by the BASEWEIGHT and LOW WEIGHT parameters.
- ◆ The **Print Key** manually outputs feeder status data through the data port whenever pressed.
- ◆ The **Auto Charge Key** initiates an auto charge cycle. The cycle starts by opening the vent valve and waiting for canister pressure to fall below the value stored in the TMOUT PRES parameter. The cycle will continue to vent for the period specified by the VNT TMOUT parameter and the timer display will count down the timeout. During the vent cycle "Auto Vent" will be displayed in the upper right corner of the display screen. Afterwards the vent will close and the canister will be charged until it reaches the pressure value stored in the CHRГ PRES parameter. While charging "Auto Chrg" will be displayed in the upper right corner of the display screen. The venting portion of the cycle can be skipped if the TMOUT PRES value is set to 50 and the VNT TMOUT value is 0. This key is disabled while the feeder is running and will flash a warning in the upper right corner of the display screen when pressed. When pressed during an auto charge cycle this key will cancel the auto charge cycle.

MENU DIAGRAM (Fig.7)



Display Screen

The display screen (fig.8) is used to display all relevant information for the monitoring and control of the powder feeder. The *Control* display combines the run control and speed control states to show what mode the feeder is in. When both run and speed controls are in manual mode, the *control* display reads “MANUAL”. When run and speed control are both automatic the *control* display reads, “AUTO FULL”. When only run control is automatic the *control* display reads “AUTO CNTRL”, and when only speed control is automatic it reads “AUTO SPEED”. The *status* display shows the current action of the powder feeder. The *status* display



Display Screen (fig.8)

reads “Running” when running, “Venting” when the vent is on, “Charging” while the canister is charging, “Auto Vent” when venting during an auto charge cycle, and “Auto Chrg” when charging during an auto charge cycle. The *speed* display shows the current RPM in 0.001 increments while running and the target RPM when not running. This value is also editable to allow the user to change the feed rpm value without going to the settings menu. The *timer* display shows the current runtime in hours, minutes and seconds during a run, and also counts backwards during the auto charge vent timeout cycle. The *gpm* display shows the current calculated grams per minute. This value is updated only while running for more time than the value stored in the GPM START parameter. Editing this value will update the manual GPM TARGET parameter. The *weight* display shows the current zeroed weight value in grams. When waiting for the TARE WAIT parameter, or while any load cells are over-limited, the *weight* display is filled with “e” characters. The *counter* display shows the current run count. This count is incremented every time a run cycle stops. This value is also editable to allow the user to zero out the cycle counter. The *pressure* display shows the canister pressure in 0.01 psi units. To select the *speed*, *gpm* or *counter* displays use the left and right arrow keys. While in this screen the up and down arrow keys will increment and decrement then RPM TARGET of GPM TARGET parameters by the values stored in RPM INC or GPM INC depending on the CONTROL MODE parameter.

Setup Screen

- ◆ **Weight Settings** – Pressing the enter key on this item will display the weight screen.
- ◆ **Pressure Settings** – Pressing the enter key on this item will display the pressure screen.
- ◆ **Misc. Settings** – Pressing the enter key on this item will display the miscellaneous screen.
- ◆ **Calibration Screen** – Pressing the enter key on this item will display the calibration screen.
- ◆ **TARGET RPM** – This parameter stores the manual speed target in rpm. The range is 0–20 rpm.
- ◆ **TARGET GPM** – This parameter stores the manual gpm target in grams per minute.
- ◆ **ACCEL RPM/S** – This parameter defines the accel/deceleration rate of the feed wheel in rpm / sec.
- ◆ **GPM/RPM** – This parameter is used in gpm control mode to define the rough grams per minute that are outputted for every rpm of the feed wheel. This value allows instantaneous adjusting when new gpm targets are inputted. This value will vary according to different powder densities, particle sizes and gas flow rates.
- ◆ **GPM INTGRL** – This parameter defines the amount of acceleration in rpm of the feed wheel speed for the difference in calculated gpm to the target gpm for every second. In gpm control mode this value is used as an integral adjustment of the rpm to match the output gpm to the target gpm.
- ◆ **ADJ LIMIT** – This parameter defines the maximum rpm adjusting limit when using gpm control. The output rpm will not vary more than this value from the base rpm calculated by dividing TARGET GPM by the GPM/RPM.
- ◆ **TIMEOUT** – This parameter defines the amount of time in seconds that a feed run in manual mode or auto run mode with 2wire control will last. The run timeout is disabled when the value is set to 0.0.
- ◆ **VIBRATE RPM** – This parameter defines the motor vibration amount in rpm. When this parameter is set to 0.0 vibration is disabled. The vibration will raise and lower the target rpm by the amount specified on a %50 duty cycle while still maintaining average target rpm.
- ◆ **VIBRATE RATE** – This parameter defines the vibrate-period in milliseconds. The range is 2-100 ms.
- ◆ **START DELAY** – This parameter defines the amount of time in seconds that the feed wheel will wait before rotating after a start signal is received. This feature allows extra time for carrier gas to clear the line before feeding powder.
- ◆ **STOP DELAY** – This parameter defines the amount of time in seconds that the carrier gas will continue to flow after a stop signal is received. This feature allows extra time for carrier gas to clear the line of powder after a run has completed.

- ◆ **AUTO PRINT** – This parameter is used to toggle the auto print feature on and off. When this parameter is set on the feeder will output statistics serially according to the PRINT RUN ONLY and PRINT DELAY parameters located in the Miscellaneous Screen Menu.
- ◆ **AUTO CONTROL** – This parameter is used to select the external run control mode. When this value is “1wire” automatic runs are controlled through a single I/O pin (3). In this mode the feeder will run when pin 3 is high and stop when pin 3 is low. When the value is “2wire” automatic runs are controlled through I/O pins 2 and 3. In this mode the feeder will start when pin 3 transitions from low to high, and stop when pin 2 transitions from low to high.
- ◆ **CONTROL MODE** – This parameter is used to select the method of control for the feed wheel speed. When “RPM” is selected the feed wheel speed will be directly controlled by the TARGET RPM value in manual speed mode, and the external analog input in automatic speed mode. When “GPM” is selected the output rpm is constantly adjusted to match the calculated gpm to the TARGET GPM in manual speed mode, and to the external analog input in automatic speed mode.
- ◆ **CLEANING MODE** – This parameter is used to toggle the cleaning mode feature on and off. When this parameter is turned on carrier gas is disabled during run cycles. This allows the canister to be opened to atmosphere while running the feed wheel in order to recover powder from the mechanism while still attached to a system under vacuum. **WARNING!** Only run in cleaning mode while the canister is upside down, otherwise powder clogging may occur.

Weight Screen

- ◆ **Filter Settings** – Pressing the enter key on this item will display the filter screen.
- ◆ **Output Ref** – This item is not editable and is used to reference the calibrated weight value.
- ◆ **Load A Raw** – This item is not editable and is used to reference the raw input value for load cell A.
- ◆ **Load B Raw** – This item is not editable and is used to reference the raw input value for load cell B.
- ◆ **Load C Raw** – This item is not editable and is used to reference the raw input value for load cell C.
- ◆ **LOAD A OFF** – This parameter is used to define the raw value zero-point for load cell A.
- ◆ **LOAD A SCL** – This parameter defines the scale value to calibrate load cell A. The calibration formula for this load cell is $\text{Output Grams} = (\text{Load A Raw} - \text{LOAD A OFF}) \times \text{LOAD A SCL}$.
- ◆ **LOAD B OFF** – This parameter is used to define the raw value zero-point for load cell B.
- ◆ **LOAD B SCL** – This parameter defines the scale value to calibrate load cell B. The calibration formula for this load cell is $\text{Output Grams} = (\text{Load B Raw} - \text{LOAD B OFF}) \times \text{LOAD B SCL}$.
- ◆ **LOAD C OFF** – This parameter is used to define the raw value zero-point for load cell C.
- ◆ **LOAD C SCL** – This parameter defines the scale value to calibrate load cell C. The calibration formula for this load cell is $\text{Output Grams} = (\text{Load C Raw} - \text{LOAD C OFF}) \times \text{LOAD C SCL}$.
- ◆ **BASEWEIGHT** – This parameter defines the permanent zero point, in grams, for the total weight of the feeder mechanism without any powder weight added.
- ◆ **LOW WEIGHT** – This parameter defines the amount of weight above the BASEWEIGHT in grams that the user considers to be a low powder level. This value is used to trip the low powder alarm.
- ◆ **GPM START** – This parameter defines the amount of time in seconds after a feed run starts when gpm calculations and adjustments will begin while running in gpm mode. This value is used to ignore initial fluctuations in weight at the beginning of the feed run.
- ◆ **OVERLIMIT BEEP** – When this parameter is set to “On” the feeder will give an audible beep warning when any load cells are over-limited.
- ◆ **DISABLE BEEP** – This parameter is used to disable the audible beep alarm when the powder level transitions from high to low. When “yes” is selected the audible alarm is disabled for the powder alarm but not the flashing display alarm. Setting “no” will not disable the weight over-limit alarm, both display or sound.

Pressure Screen

- ◆ **Press. Raw** – This un-editable item is used to reference the raw input value for the transducer.
- ◆ **PRESS. OFF** – This parameter is used to define the raw value zero point of the pressure transducer.
- ◆ **P. POS SCL** – This parameter defines the scale value to calibrate the transducer when input values are above PRESS. OFF. The calibration formula for the transducer is $\text{Psi} = (\text{Press. Raw} - \text{PRESS. OFF}) \times \text{P. POS SCL}$.
- ◆ **P. NEG SCL** – This parameter defines the scale value to calibrate the transducer when input values are below PRESS. OFF. The calibration formula for the transducer is $\text{Psi} = (\text{Press. Raw} - \text{PRESS. OFF}) \times \text{P. NEG SCL}$.
- ◆ **CHRG PRES.** – This parameter defines the auto charge cycle target charge pressure in psi. After the auto charge venting cycle defined by TMOU PRES. and VNT TMOU the feeder will automatically charge the canister until the pressure exceeds CHRG PRES. at which point the auto charge cycle will end.
- ◆ **TMOU PRES.** – This parameter defines the lower pressure limit in psi where the venting timeout portion of the auto charge cycle will begin. To disable the waiting portion of the auto charge cycle set this parameter to 50.0.
- ◆ **VNT TMOU** – This parameter defines the venting timeout period in seconds that the auto charge cycle will wait while venting the canister before beginning the charge cycle. To disable the time out set this parameter to 0.0.
- ◆ **IDLE PRES.** – This parameter defines the pressure in psi that the feeder will actively maintain in the canister while not feeding. Enter the unattainable value of -15.0 psi to disable this feature.
- ◆ **ALARM PRES.** – This parameter defines the positive pressure limit that triggers a pressure alarm.
- ◆ **PRESSURE BEEP** – This parameter is used to disable the audible beep alarm when canister pressure is above the alarm pressure limit defined by ALARM PRES. When “yes” is selected the audible alarm is pressure alarm is enabled. Setting “no” will not disable the display alarm.

Miscellaneous Screen

- ◆ **Input Raw** – This item is not editable and is used to reference the raw value for the analog input.
- ◆ **RPM Out Ref** – This item is not editable and is used to reference the calibrated analog rpm value.
- ◆ **GPM Out Ref** – This item is not editable and is used to reference the calibrated analog gpm value.
- ◆ **Run Hours** – This un-editable item is used to reference the total runtime in hours for maintenance.
- ◆ **Ref Hours** – This item is used to reference and set the runtime in hours from the last reset.
- ◆ **RPM OFF** – This parameter defines the raw value zero point of the analog input for the automatic rpm value.
- ◆ **RPM SCL** – This Parameter defines the scale value to calibrate the analog input for rpm control. The calibration formula for the input is $\text{Output RPM} = (\text{Input Raw} - \text{RPM OFF}) \times \text{RPM SCL}$.
- ◆ **GPM OFF** – This parameter defines the raw value zero point of the analog input for the automatic gpm value.
- ◆ **GPM SCL** – This Parameter defines the scale value to calibrate the analog input for gpm control. The calibration formula for the input is $\text{Output GPM} = (\text{Input Raw} - \text{GPM OFF}) \times \text{GPM SCL}$.
- ◆ **RPM INC** – This parameter defines the incremental change, either positive or negative, of the rpm target when the I/O pins 5 and 7 go from low to high, or when the up and down keys are pressed in the display screen. This value only applies when the feeder is in rpm control mode.
- ◆ **GPM INC** – This parameter defines the incremental change, either positive or negative, of the gpm target when the I/O pins 5 and 7 go from low to high, or when the up and down keys are pressed in the display screen. This value only applies when the feeder is in gpm control mode.
- ◆ **HEATER BLANKET** – This parameter is used to toggle the heater blanket on and off.
- ◆ **PRINT RUN ONLY** – This parameter is used while in AUTO PRINT mode to output feeder statistics while the feeder is not running. “Yes” will output feeder statistics only while the feeder is running, and “No” will output feeder statistics all the time.
- ◆ **PRINT DELAY** – This parameter defines the AUTO PRINT period in seconds.
- ◆ **STALL DETECT** – When a motor proximity switch is installed on the feeder this parameter is used to enable the stall alarm when the motor spindle feedback indicates a motor stall.

Filter Screen

- ◆ **FILT BASE** – This parameter is used to control the base sensitivity to the load cell measurements. The range is from 0.00000 – 1.00000. To disable filtering set to 1. See the note below for details.
- ◆ **FILT GAIN** – This parameter controls the proportional gain in sensitivity to the load cells. The range is from 0.00000 – 99.00000. To disable filter gain set to 0. See the note below for details.
- ◆ **FILT INT** – This parameter is controls the integral gain in sensitivity to the load cells. The range is from 0.00000 – 99.00000. To disable filter integral gain set to 0. See the note below for details.
- ◆ **GPM FILT** – This parameter is used to control the sensitivity to changes in the calculated gpm to smooth out the rpm adjustment while running in gpm mode. The range is from 0.00000 – 1.00000.

Note: Every 10ms the WEIGHT Value is updated with the following equation:

$$\text{INTEGRAL} = \text{INTEGRAL} + (\text{FILT_INT} \cdot \text{WEIGHT_ERR} \cdot 0.01)$$

$$\text{FILTER} = \text{FILT_BASE} \cdot (1.0 + \text{FILT_GAIN} \cdot \text{WEIGHT_ERR} + \text{INTEGRAL})$$

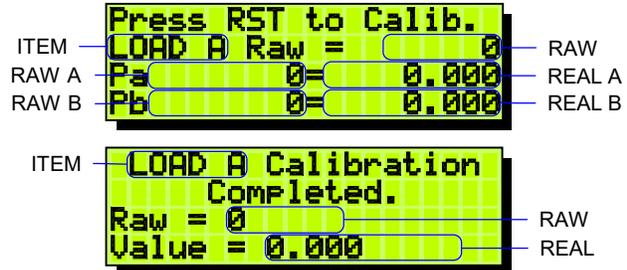
$$\text{WEIGHT} = \text{WEIGHT} \cdot (1.0 - \text{FILTER}) + \text{RAW_WEIGHT} \cdot \text{FILTER}$$
 Every 100ms the GPM Value is updated with the following equation:

$$\text{GPM} = \text{GPM} \cdot (1 - \text{GPM_FILT}) + \text{RAW_GPM} \cdot \text{GPM_FILT}$$

- ◆ **DISPLAY AV** – This parameter is used to smooth out the displayed weight on the display screen. The range is from 0.00000 – 1.00000. A higher value gives more sensitivity.
- ◆ **TARE WAIT** – This parameter defines the amount of time in seconds the feeder waits before zeroing the weight after pressing the tare key. To disable the wait set this value to 0.0.

Calibration Screen

The calibration screen (*fig.10*) is used to quickly calculate and save the offset and scale parameters for the various calibration settings of the powder feeder. The *Item* value is used to select the input source to be calibrated by pressing the enter key and using the up and down keys. “LOAD A” is the input source calibration for load cell A, the load cell nearest the control cabinet next to the pivot point. “LOAD B” is the input source calibration for load cell B, the load cell furthest from the control cabinet next to the pivot point. “LOAD C” is the input source calibration for load cell C, the load cell next to the safety latch (*fig.2*). “PSI UP” is the input source calibration for the pressure transducer when reading values above atmosphere. “PSI DN” is the input source calibration for the pressure transducer when reading values below atmosphere. “RPM IN” is the input source calibration for the 0-10v input when being used to externally control RPM. “GPM IN” is the input source calibration for the 0-10v input when being used to externally control GPM. “WEIGHT” is the combined input source of all three load cells used for a standard weight calibration (see *WEIGHT CALIBRATION instruction list*). The *Raw* value is not editable, and is used to display the current raw value of the selected input source.



Calibration Screen (*fig.9*)

The calibration screen needs two calibration points to calculate the offset and scale values for the selected input source. To do this enter the raw value and its corresponding real value for points A and B. Use the left and right arrow keys to select the *Raw A*, *Real A*, *Raw B* and *Real B* fields and enter the appropriate values. When all values are entered press the Alarm Reset key to calculate and save the calibration values. When the calibration calculation is complete the interface will switch to the completed screen. This screen will display the raw value and calibrated value to verify that calibration has been updated successfully. To return to the calibration screen for further calibration press the Escape key.

GENERAL OPERATION

FILLING THE CANISTER

1. The 171D powder feeder is capable of being filled while still connected to a plasma gun that is in operation. In order to refill the canister during operation first make sure the powder feeder is not running, charging or venting.
2. Check the pressure display to see if the canister pressure is at atmosphere. If the pressure is above atmosphere use the powder feeders vent function to lower the pressure. If the pressure is below atmosphere pull up on the pressure safety valve (*fig.3*) or preferably, manually charge the feeder to allow pressure into the canister (*Do not pull up on the pressure safety valve if the pressure inside the canister is greater than atmosphere, this may lead to powder degrading the seal causing an air leak*). Press the Charge Disable key if idle pressure maintenance is used.
3. After pressure is equalized and the canister is isolated, unscrew and remove the *Window Lid* (*fig.10*) (*Do not attempt to unscrew the window lid if pressure inside the canister is greater than atmosphere, as this may result in damage to the window clamps*).
4. Fill the canister with powder then replace and secure the *Window Lid* making sure the top lip of the canister and o-ring surfaces of the lid are clean. Be careful not to fill the canister above the level where the pressure safety valve and equalizing tube fittings (*fig.3*) enter the top of the canister. This may result in damage to the pressure safety valve or clogging of the equalizing line causing unstable powder flows.

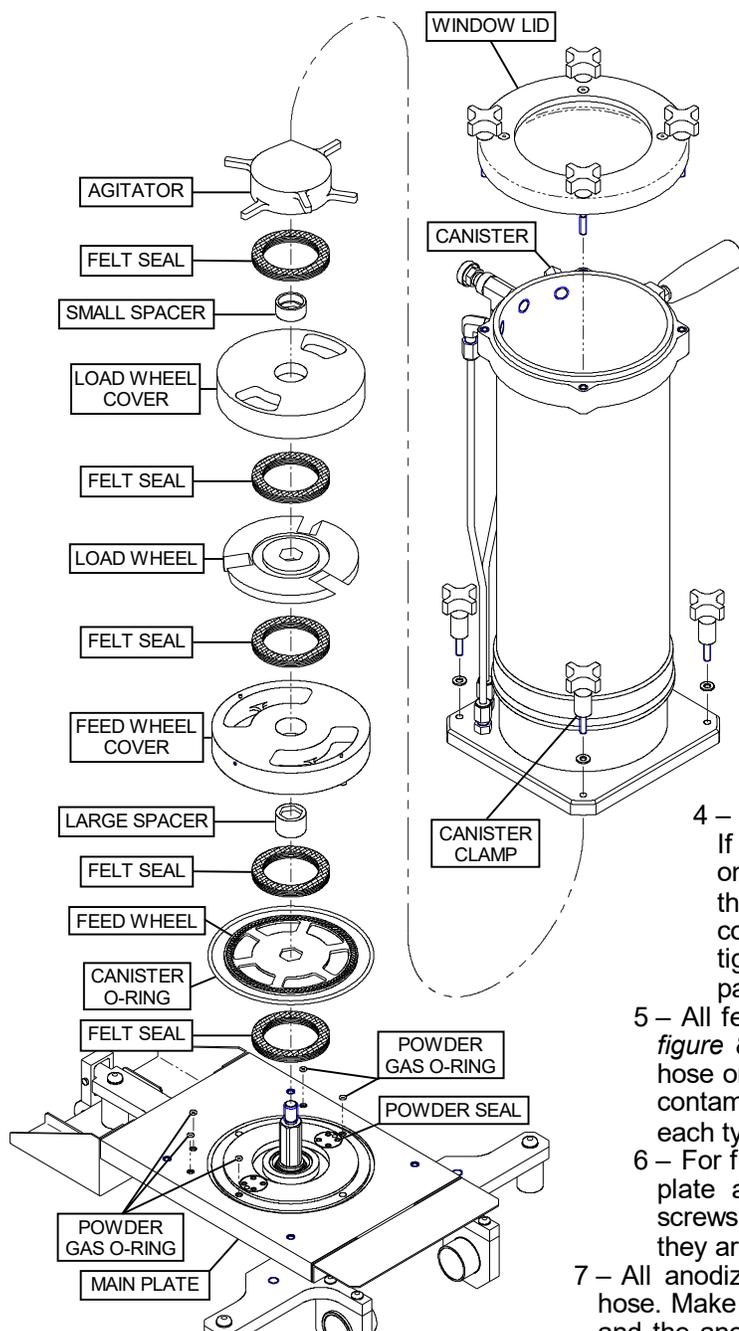
OPERATING THE POWDER FEEDER

1. If the powder gas must be purged before spraying, turn the vent on and use the pressure display to see when the canister has been pulled down to vacuum. Wait for the desired amount of time for the air in the canister to be purged by a sufficient amount for the spray process. Afterwards use the powder feeders charge function to backfill the canister to the “operating pressure”. The feeder’s auto charge function can be used to automatically complete this process. If purging is unnecessary skip the venting process.
2. The “operating pressure” is determined by the powder gas mass flow rate, type of powder, feed wheel speed, powder line length, and plasma gun backpressure. In order for the powder feeder to operate with instant-on times during the spray cycle the canister must remain at the stabilized “operating pressure”. To determine the “operating pressure” run the spray cycle with all desired settings at stable positions (*powder gas flow rate, feed wheel speed, plasma arc power, plasma arc gas flow rate and plasma chamber pressure*) and watch the pressure display as the canister pressure stabilizes.
3. Once the canister is charged to “operating pressure” the feeder can be turned off and on manually or automatically during the spray cycle of the plasma system.
4. If dry runs are required while operating in auto mode, the powder feeder can be disabled by toggling the control mode to manual by pressing the Auto/Manual Cntrl key.

SHUTTING DOWN THE POWDER FEEDER

1. When shutting down the powder feeder the default state of the pinch valves is venting open, output line isolated and the pinch gas is bypassed. As long as pinch gas pressure remains above 80 psi even when power is off the powder feeder will remain in this state. Otherwise to isolate the canister after the end of operations power and pinch gas pressure must be maintained. If pinch gas pressure is lost after shutdown both venting and powder output valves will open releasing any canister pressure into the plasma system. All settings in the interface module are saved when updated so they are not lost when power is removed.

CLEANING / MAINTENANCE



Feed Mechanism Assembly (fig.10)

The 171D Powder Feeder feed wheel assembly is designed for rapid disassembly and reassembly for cleaning and maintenance. Disassembly requires the removal of only four *Canister Clamps* and the removal of one part to disassemble the feed wheel mechanism. All feed mechanism parts are sandwiched between the *Main Plate* and the *Agitator*, which unscrews on a single thread. The steps to disassemble and clean the feed mechanism are as follows.

CLEANING INSTRUCTIONS

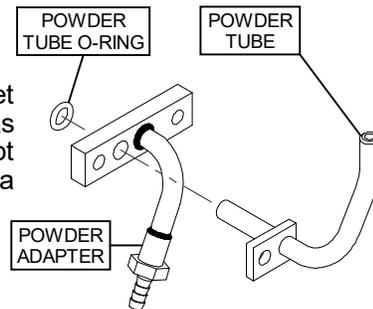
- 1 – Remove the *Window Lid* and pivot the feed mechanism backwards to recover the powder left in the *Canister*. Slap the side of the *Canister* to dislodge excess powder. If necessary, set the *CLEANING MODE* option “On” and then manually run the feed wheel while emptying.
- 2 – Remove the four *Canister Clamps* at the base of the *Canister*.
- 3 – Lift the *Canister* vertically being careful not to wedge or scratch the *Feed Wheel Covers* or *Agitator*. Clean the *Canister* with an air hose and remember to blow out the tubing lines connected to the *Canister*.
- 4 – By hand, unscrew the *Agitator* counter-clockwise. If the *Agitator* appears to be stuck do not use tools on the *Agitator* fingers as they are easily bent and the hard anodizing may be scratched leading to contamination. When reassembling only lightly hand tighten the *Agitator* clockwise until all feed wheel parts are sandwiched firmly.
- 5 – All feed wheel parts lift off freely in the order shown in figure 8. The five *Felt Seals* can be cleaned with an air hose or replaced. (Do not wash the felt seals) To prevent contamination a separate set of *Felt Seals* can be kept for each type of powder used.
- 6 – For full cleaning remove the *Powder Seals* on the main plate and *Feed Wheel Cover* by unscrewing the four screws each. Replace *Powder Seals* or their o-rings if they are overly worn.
- 7 – All anodized parts can be washed, or cleaned with an air hose. Make sure all parts are dry and free from oil and grease and the anodized coating is intact before reassembly. Do not wash the *Main Plate* and do not use any grease on the *Canister*, *Powder Seal* and *Powder Gas O-rings*. Make sure to blow out the tubing lines on the *Canister* and *Main Plate*. If able, remove gas lines connecting to the plasma system and then remove the pinch gas supply to blow out the powder line. Do not blow air backwards down the powder gas line as this may clog the solenoid.
- 8 – Reassemble all parts in the order shown by fig.8 making sure all five *Powder Gas O-rings* are in place on the *Main Plate*. Slip on the *Canister O-ring* after assembling the *Agitator*. Make sure all pins on the *Feed Wheel Cover* line up to their corresponding holes.

PINCH VALVE MAINTENANCE

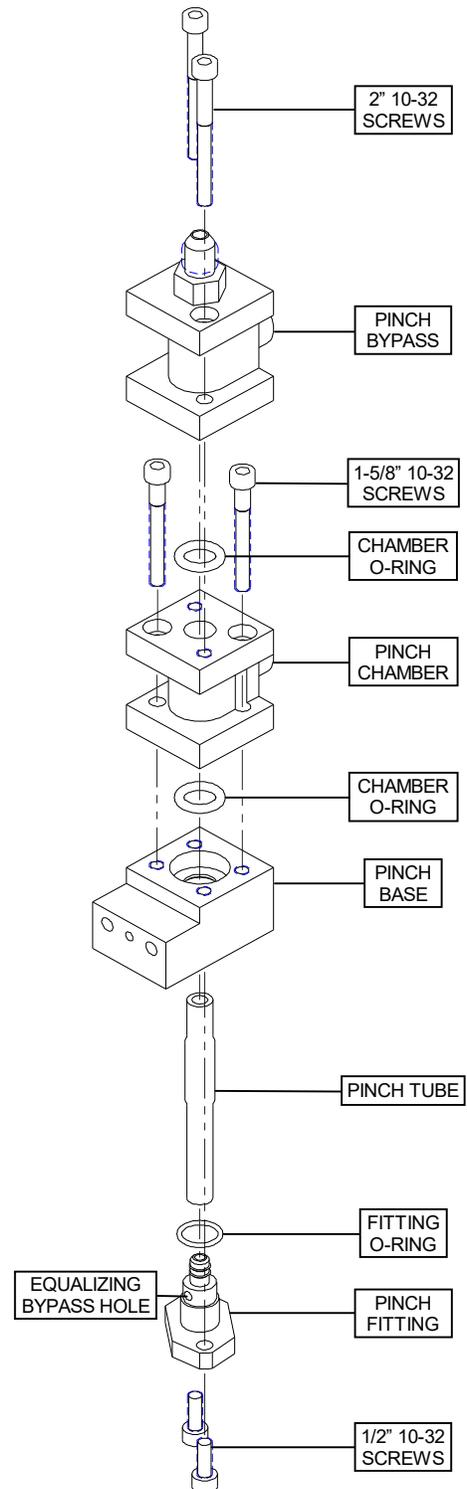
The three pinch valves on the 171D powder feeder periodically need to be maintained due to wear from abrasive powders and switching cycles. The stainless steel *Powder Tube* shown in *figure 8* also must be periodically replaced due to wear from abrasive powders. There are two powder tubes, a left and a right, for each of the dual powder outputs. In order to replace the output *Pinch Tubes* located underneath the *Main Plate* (fig.10) use the following steps.

- 1 – Remove the output powder lines and pivot the feed mechanism backwards.
- 2 – Unscrew the two 10-32 bolts holding down the *Pinch Base* (fig.12) to the *Main Plate*. Then remove the two 10-32 bolts holding down the powder tube assembly (fig.11). At that point the powder tube assembly and pinch valve assembly will lift together vertically out of the *Main Plate*. Do not detach any hose connections to the pinch valve or powder adapter. Once the powder tube assembly and pinch valve are free, carefully remove the *Powder Tube* from the pinch valve so as not to scratch the o-ring inside the *Pinch Fitting*. Slide the *Powder Tube O-ring* off of the *Powder Tube*.
- 3 – Remove the two 10-32 bolts holding down the *Pinch Bypass* block and slide the *Chamber O-ring* off of the *Pinch Tube*.
- 4 – Remove the two 10-32 bolts holding down the *Pinch Chamber* block and slide the *Chamber O-ring* off of the *Pinch Tube*.
- 5 – Unscrew the two 10-32 bolts holding down the *Pinch Fitting* to the *Pinch Base* block and slide the *Fitting O-ring* off of the *Pinch Fitting*. At this point inspect all o-rings and the *Pinch Tube* to determine if any need replacement.
- 6 – If the *Pinch Tube* needs to be replaced make sure the reinforced end of the *Pinch Tube* points away from the *Pinch Fitting*. Then reassemble the pinch valve in the same order and orientation as shown in *figure 7* making sure that the *Equalizing Bypass Hole* in the *Pinch Fitting* points towards the *Main Plate*. Before reassembly, make sure all surfaces are free from powder, grease and oil. Do not use grease on any of the o-rings or the *Pinch Tube*.
- 7 – after the pinch valve and powder tube assemblies have been reconstructed carefully insert the powder tube assembly into the *Pinch Fitting* before bolting any parts to the *Main Plate*. Make sure all o-rings are present in the *Main Plate* before bolting.

The venting pinch valve located inside the control cabinet disassembles in the same way as the powder output valve except that there is no connection to a powder tube and no equalizing bypass hole in the pinch fitting.



Powder Tube Assembly (fig.11)



Pinch Valve Assembly (fig.12)

CALIBRATION

PRESSURE CALIBRATION (INSTRUCTION LIST)

Part I: Negative Calibration (Vacuum systems only)

- 1 – Attach calibration measurement equipment in line with the system vacuum supply at the *Vent Output* connector located at the bottom of the control cabinet (*fig.2*). If vacuum gauge pressure for the system is at a known value no calibration device is necessary.
- 2 – Go to the calibration screen (*fig.10*) and select *PSI DN* for the item field.
- 3 – Open the canister to atmosphere and record the raw value indicated by the calibration screen.
- 4 – Seal the canister and then vent gas until maximum vacuum pressure is reached. Then record the raw value indicated on the calibration screen along with the gauge pressure indicated by the calibration measurement.
- 5 – Enter the recorded raw value for atmosphere into the *Raw A* field, and the value 0.0 into the *Real A* field. Enter the recorded raw value for vacuum into the *Raw B* field, and the corresponding recorded gauge pressure into the *Real B* field. Then press the *Alarm Reset* key (*fig.6*) to calculate and save the new calibration. Alternatively the calibration values can be manually calculated and entered in the pressure settings screen with the *PRESS. OFF* and *P. NEG SCL* values.

$$PRESS. OFF = RawValue(Atmosphere)$$

$$P. NEG SCL = GaugePressure(vacuum) / (RawValue(vacuum) - RawValue(Atmosphere))$$

Part II: Positive Calibration

- 1 – Remove vacuum supply and attach calibration measurement equipment directly to the *Vent Output* connector located at the bottom of the control cabinet (*fig.2*).
- 2 – Go to the calibration screen (*fig.10*) and select *PSI UP* for the item field.
- 3 – Open the canister to atmosphere and record the raw value indicated on the calibration screen.
- 4 – Seal the canister and then charge the pressure using the *Charge* key (*fig.6*) until the raw value is roughly +20000. Press the *Vent* key (*fig.6*) to expose the canister pressure to the calibration equipment. Wait for pressure to stabilize. Then record the raw value indicated on the calibration screen along with the gauge pressure indicated by the calibration measurement.
- 5 – Enter the recorded raw value for atmosphere into the *Raw A* field, and the value 0.0 into the *Real A* field. Enter the recorded raw value for positive pressure into the *Raw B* field, and the corresponding recorded gauge pressure into the *Real B* field. Then press the *Alarm Reset* key (*fig.6*) to save the new calibration. Alternatively the calibration values can be manually calculated and entered in the pressure settings screen with the *PRESS. OFF* and *P. POS SCL* values.

$$PRESS. OFF = RawValue(Atmosphere)$$

$$P. POS SCL = GaugePressure(Positive) / (RawValue(Positive) - RawValue(Atmosphere))$$

- 6 – If vacuum calibration is not required go back to the calibration screen by pressing the *Escape* key and select *PSI DN* for the item field. Using the same parameters press the *Alarm Reset* key (*fig.6*) to set the negative scale calibration equal to the positive calibration. Alternatively the user can copy the value of *P. POS SCL* to *P. NEG SCL* under the pressure settings screen.

WEIGHT CALIBRATION (INSTRUCTION LIST)

Part I: Preliminary Calibration (Perform only when replacing load cells or for first time calibrations)

- 1 – Tilt the feed mechanism upside down and off of the Load Cell contact points (*fig.5*).
- 2 – Go to the calibration screen (*fig.10*) and select *LOAD A*, *LOAD B* or *LOAD C* for the item field.

- 3 – Record the raw value indicated on the calibration screen.
- 4 – Balance a calibrated weight on the currently selected Load Cell contact point; making sure the calibrated weight is not contacting any surface other than the Load Cell. Then record the raw value indicated on the calibration screen.
- 5 – Enter the recorded raw value for 0 grams into the *Raw A* field, and the value 0.0 into the *Real A* field. Enter the recorded raw value for the calibrated weight into the *Raw B* field, and the actual weight in grams into the *Real B* field. Then press the *Alarm Reset* key (fig.6) to save the new calibration. Alternatively the calibration values can be manually calculated and entered in the weight settings screen with the LOAD (ABC) OFF and LOAD (ABC) SCL values.

$$\text{LOAD (ABC) OFF} = \text{RawValue(Zero Weight)}$$

$$\text{LOAD (ABC) SCL} = \text{CalibrationWeight} / (\text{RawValue(At Calibration Weight)} - \text{RawValue(Zero Weight)})$$
- 6 – Repeat steps 2 to 5 until all Load Cells have been calibrated. The *Escape* key (fig.6) can be used to go immediately back to the calibration screen.

Part II: **Standard Calibration**

- 1 – Remove all weight from the feed mechanism, including powder in the canister, and make sure the *Window Lid* is attached. Then Tilt the feed mechanism upright and onto the Load Cells (fig.5).
- 2 – Go to the calibration screen (fig.10) and select *WEIGHT* for the item field.
- 3 – Tare the raw value by pressing the *Tare* key (fig.6) and verify that it reads zero before continuing.
- 4 – Place a calibrated weight in the center of the *Window Lid* (fig.3) of the powder canister. Then record the raw value indicated on the calibration screen.
- 5 – Enter the value 0.0 into the *Raw A* field, and the value 0.0 into the *Real A* field. Enter the recorded raw value for the calibrated weight into the *Raw B* field, and the actual weight in grams into the *Real B* field. Then press the *Alarm Reset* key (fig.6) to save the new calibration. Alternatively the calibration values can be manually calculated and entered in the weight settings screen with the LOAD (ABC) SCL values.

$$\text{LOAD A SCL} = \text{LOAD A SCL} \times \text{CalibrationWeight} / \text{RawValue(At Calibration Weight)}$$

$$\text{LOAD B SCL} = \text{LOAD B SCL} \times \text{CalibrationWeight} / \text{RawValue(At Calibration Weight)}$$

$$\text{LOAD C SCL} = \text{LOAD C SCL} \times \text{CalibrationWeight} / \text{RawValue(At Calibration Weight)}$$
- 6 – Go to the weight settings menu and copy the *Output Ref.* value to the *BASEWEIGHT* parameter.

SPEED/GPM INPUT CALIBRATION (INSTRUCTION LIST)

- 1 – Go to the calibration screen (fig.10) and, depending on the desired analog control mode, select *RPM IN* or *GPM IN* for the item field.
- 2 – Set the analog output connected to pins 6 and 8 of the I/O connector (fig.4) to its minimum point. Then record the raw value indicated on the calibration screen.
- 3 – Set the analog output to its maximum point and then record the raw value indicated on the calibration screen.
- 4 – Enter the recorded raw value for the minimum point into the *Raw A* field, and the actual minimum target value (RPM or GPM) into the *Real A* field. Enter the recorded raw value for the maximum point into the *Raw B* field, and the actual maximum target value (RPM or GPM) into the *Real B* field. Then press the *Alarm Reset* key (fig.6) to save the calibration. Alternatively the calibration values can be manually calculated and entered in the miscellaneous settings screen with the *RPM/GPM OFF* and *RPM/GPM SCL* values.

$$\text{RPM/GPM OFF} = \text{Raw(Min)} - (\text{Raw(Max)} - \text{Raw(Min)}) / (\text{Actual(Max)} - \text{Actual(Min)}) \times \text{Actual(Min)}$$

$$\text{RPM/GPM SCL} = (\text{Actual(Max)} - \text{Actual(Min)}) / (\text{Raw(Max)} - \text{Raw(Min)})$$

