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This machine was made to assemble plunger and barrels and test the interaction between two. The plunger and barrel components are the high pressure generating components within a pump or unit injector. There is a feature on the barrel and the plunger that when the two intersect, cause an injection event to occur. This dimension is very critical and must be tested prior to being assembled into an injector. The previous practice used to perform this measurement was air, however air did not correlate to the actual performance of the part, thus the need for a different way to perform the measurement (with fluid).



### Background

This machine accepts up to four trays of forty matched barrel and plunger parts that are queued up on a conveyor. A precision robot picks up the individual parts, assembles them and places the assembly into a test fixture. The pumping chamber of the assembly is purged of air by flooding it with calibration fluid. The pumping chamber is then isolated and an actuator depresses the plunger at a steady rate. A ½ micron resolution encoder on the actuator continuously monitors the actuator position as it travels through its stroke, building up pressure inside the pumping chamber. When the features in the plunger line up with the feature in the barrel, the pressure suddenly drops and the actuator position is quickly recorded. As the actuator continues through its stroke, the features pass by each other and pressure builds up in the chamber again. This actuator position is noted as well as the pressure increase. Using the collected information, the machine can quickly determine at what position the features intersect and for how long. Because calibration fluid is used, the measurement correlates directly with the performance that is observed in the injector. The fixture unclamps, the robot removes the part and loads the next part to yield a total cycle time of 11 seconds.

### Machine Features:

- Accommodates several styles of plunger and barrels. Usually takes about ten minutes for changeover.
- Conveyor accommodates approximately 30 minutes of product unattended.
- Failed parts get rejected to a separate reject tray.
- Robot end effector designed for quickly recoverable crashes.
- Complex signal analysis used to determine lead measurement and gap width.
- Machine is capable of automatically verifying calibration with a master on a programmable interval.
- Calibration deviation alarm will keep the machine from operating, should something have drifted.
- Consecutive reject alarm stops the process and warns the operator.
- Automatic plant fill circuit refills the Viscor tank from a plant feed, when the tank becomes low.
- Robot pauses immediately if any door is opened and resumes when the door is closed again.

### Success Story

When we were asked to quote this project, the process was currently performed with air, which did not directly correlate to the application. We conceived the first machine using calibration fluid and found it to correlate and repeat very well. The customer ran this machine round the clock seven days a week and subsequently ordered three more for the other product lines which run the same schedule.



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**Specifications**

<u>Controlled Feature</u>	<u>Control Type</u>	<u>Description</u>
Plunger stroke rate	Manually settable	As the plunger is stroked, the pressure in the barrel steadily increases making it more difficult to move. Our actuator must move at the same speed regardless of load to provide the most repeatable signature that will yield an accurate measurement.
Cavity Sealing	Fixture design	In the actual application, the components use a metal to metal seal. We must design our fixturing to be robust enough to handle the high cycles that will be put to it, while still sealing good.
Clamping Geometry	Fixture Design	Considering that we are measuring less than 1 micron of movement, it is important that our fixture be very stiff so that there is no deflection as the plunger and barrel assembly build up pressure. If the fixture deflects at all, it will show up in the measurements. It is also important that the fixture be perfectly square to the part.

**Measurements**

<u>Feature</u>	<u>Method</u>	<u>Min</u>	<u>Max</u>	<u>Resolution</u>
Plunger height	Linear 1/2 micron encoder	0 mm	20 mm	1/2 micron
Pressure	Pressure Transducer	0 PSI	1000 PSI	0.06 PSI
Lead and Gap width	Signature Analysis using a digital signal processor	0 mm	20 mm	1/2 micron

**Options**

Although we can make anything to suit your needs, the following have been variations of this machine.

- Single station, manual load
- Quick change adapter to accommodate virtually any plunger and barrel
- PC HMI rather than embedded for SPC and data collection