EVERGREEN SOLAR, INC.

Solder Dispenser Connects the Dots

By: Scott Beebe, President of Fishman Corporation

Evergreen Solar (Marlboro, MA) manufactures photovoltaic modules for residential and commercial use. Two series of modules are offered. One has 72 cells, and the other has 36 cells. Applications for the modules can range from a 50-watt system installed on the roof of a dwelling in the Dominican Republic to an 85-kilowatt solar pyramid on top of the World Trade Center in Tokyo. Undoubtedly, the most notable customer is the White House, where solar panels are used as a source of energy.

Production of solar cells is based on a process for growing crystalline silicon strips 250 to 300 microns in thickness, a technology known as "string ribbon." "The strips are continuously grown 3 inches wide," explains Randy Rotermund, director of supply chain management for Evergreen. "We rough cut them into 6-foot lengths with a scribing pen and then laser cut them into 6-inch-long, P-type wafers."

The wafers are subjected to a number of processes to convert them into photovoltaic cells, including diffusing phosphorus into the top surface of each wafer to create the junction, etching the phosphorous glass film that forms on the wafers during diffusion and applying a silicon nitride antireflective coating to the front of the wafer by chemical vapor deposition. "These are processes that we understand very well," says Rotermund. "Our overriding concern, each step of the way, is to ensure precision and quality during manufacture, and ultimately, consistent electrical performance from cell to cell within a panel. To do this, we have custom-designed and built most of the automated equipment stations on our production line."

In initially setting up the line, there was one particular challenge. After the chemical vapor deposition coating is applied, a silver pattern is fused on the top side of the wafer and an aluminum-silver pattern on the bottom side. The bottom-side pattern masks the surface of the wafer, except for six square contact points. After testing the wafers to measure output efficiency, solder-coated wire strips are installed across the circuitry on the top side. The solder is reflowed with a heat gun. The strips extend beyond the wafers to provide a means of linking cells together.

Figure 1.
Evergreen selected four AirFree™ LDS9000 dispensing guns from Fishman Corporation. They are mounted side by side in a housing to optimize assembly line throughput.

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Each wire strip requires an exact amount of solder paste to be deposited in three locations. The dots line up with the exposed square contact points on the bottom side of the next wafer in the assembly line. In this way, either nine or 18 cells are linked together, depending on the size of the module. The amount of solder paste deposited for each dot must be 50 mils, and this must be consistent from dot to dot.

Unfortunately, pneumatic dispensing systems were unsuitable. After investigating various possibilities, Evergreen selected four AirFree LDS9000 dispensing pumps from Fishman Corporation. (Hopkinton, MA). They are mounted side by side in a housing to optimize assembly line throughput.

The LDS9000 differs from a pneumatic pump. The AirFree dispenser uses a linear actuator and a mechanical leadscrew which lowers or retracts a piston at the end of the screw. The linear actuator rotates a nut between electrically charged poles. While the nut turns, its axial position does not change. The leadscrew, threaded through the nut and secured from turning itself, moves up and down on command from a microprocessor unit.

As a result of the precisely controlled rotation of the leadscrew, the piston pushes exact and repeatable amounts of solder paste through the syringe and dispensing tip. Once the system is calibrated, the control unit automatically calculates the distance the piston must travel for the volume of solder paste required. The dispensing operation is the same each time, regardless of the viscosity. After a dot of solder paste is dispensed, a programmable pullback of the piston prevents fluid ooze.

"In our opinion, the Fishman dispenser overcomes the drawbacks of a pneumatic system. We have also minimized our material and operating costs. Because of the design of the LDS9000, the syringes we get are three-quarters filled with solder paste. . . That's part of the story. Including less waste, almost no rejects and less downtime in switching out syringes, we figure our costs are 70 percent less than what we would be paying with pneumatic dispensers," says Rotermund.

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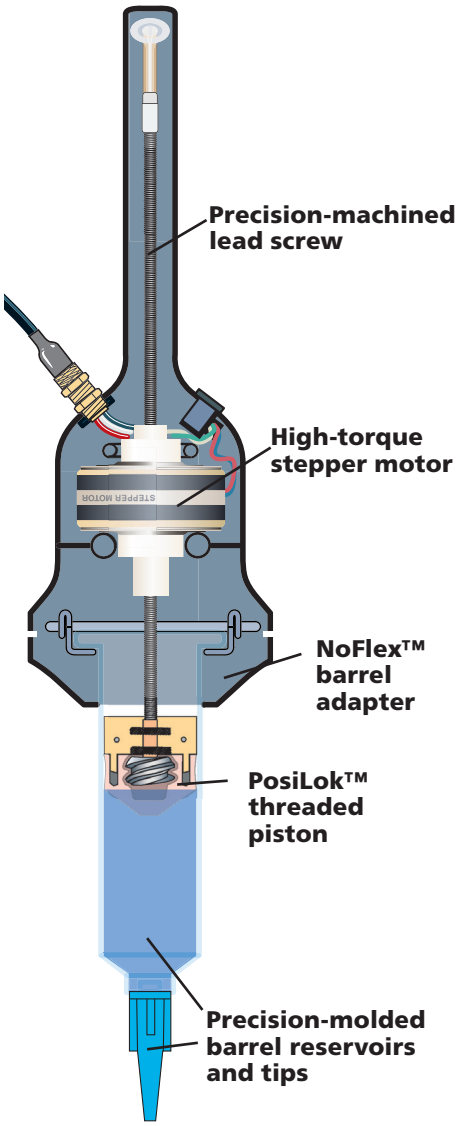

Figure 2.
Cutaway View of Fishman LDS9000*

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