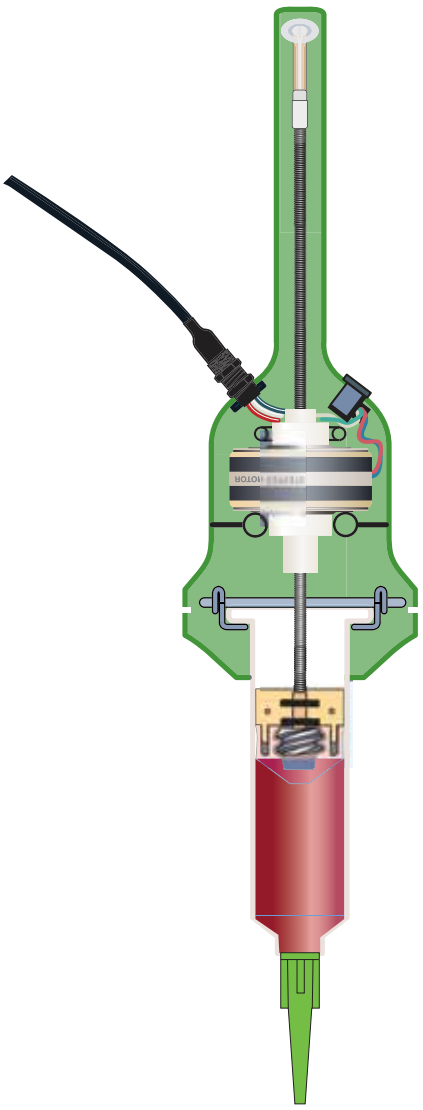
NOFLEX™ LINEAR DRIVE TECHNOLOGY

NoFlex™ Linear Drive Technology Ensures Accuracy in Dispensing of Adhesives and Solder Paste

By: Scott Beebe, President of Fishman Corporation

In dispensing adhesives and solder paste for medical device and electronics assembly, all types of dispensers have traditionally relied on pneumatics to "push" the material out of the barrel reservoir. Unfortunately, problems inherent with this type of dispensing, such as inconsistent dots due to variations in air pressure, changes in viscosity due to build-up, and, in the case of solder paste, separation of the paste and ux due to pneumatic exertions. As a result, technicians have been required to live with the uncertainties and shortcomings of pneumatics and essentially conform the process to the capabilities of the equipment. Production delays due to the need to calculate and recalculate settings, material waste, inconsistent performance, and rejected parts have become expected and inherent factors in the process.



Fishman Corporation has developed an air free dispensing system that eliminates the variations of air pressure dispensing. The system combines the precision of NoFlex™ linear drive technology, the intelligence of microprocessor control, and the cost-eectiveness and exibility of plastic barrel reservoirs. With this system, exact amounts of adhesive can be dispensed without variations in applied pressure, without problems with moisture and changing viscosity, and without degradation in repeatability as the amount of material is reduced within the syringe during dispensing.

The purpose of this paper is to describe the specic performance features and capabilities of AirFree™ dispensing. Before doing so, however, a point of reference and comparison will be established by reviewing: a) how conventional systems operate, and b) the limitations of pneumatics in dispensing adhesives and solder paste.

*Other dispensing technologies include: a) Archimedes valves, which incorporate an auger; and b) positive displacement piston pumps, plus variations. Such technologies are more costly, dicult to clean and may cause a negative reaction with certain uids. Also, in cleaning, MEK and acetone solutions are typically required, which can be harmful to employees in a hand-held environment.

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Pneumatic Dispensing

Commonly known in the industry as "time/pressure" dispensers, pneumatic dispensers are the dominant means employed by hand-held, bench-top and automated systems in delivering small quantities of adhesives and solder paste for electronics assembly.* Time/pressure dispensers are simple in design, in that they consist primarily of a plunger, or piston, and a syringe (Figure 1).

Pulsed air (AirPulse™) from a compressor is applied in such a way that it "slaps" the top of the plunger in a rhythmic pattern, moving the plunger forward in the syringe. As a consequence, the pulses of the air supply create a degree of turbulence in the uid as material is pushed out through the needle tip at the end of the syringe. The volume dispensed depends on the viscosity of the material, air pressure, and amount of time the pressure is applied.

Therefore, while time/pressure dispensers are relatively inexpensive, this one advantage is overshadowed by a number of distinct disadvantages, including:

- With single component materials, the pulsed air supplied to the syringe stresses the material, and the turbulence created by the blasts of air heats the adhesive in the syringe, causing the viscosity to decrease.
- With pre-mixed and frozen syringes, on the other hand, the thawing process actually begins to cure the adhesive, increasing the viscosity and ultimately making dispensing difficult, even with the air pressure "cranked up." (Both scenarios affect the amount of material being dispensed, and precise control is impossible to achieve.)
- Technicians often use the smallest needle size as a flow control to minimize fluctuations in the amount dispensed. This adds to the problem with pneumatics by stressing the material, creating more viscosity problems. At no time is the material in a "released" state, which is best for dispensing.
- Pulsed air exacerbates the control problem by changing the homogeneity of certain materials. Adhesives with fillers, for instance, begin to separate out, and suspended particles can actually become compressed along the inner walls of the syringe. As a result, variations in viscosity occur within the mix, affecting flow behavior and bonding properties. Thicker viscosities tend to dispense down the middle of the syringe, leaving large amounts of materials waste behind. Thixotropic materials can be an especially difficult problem, in that the viscosity of the material can change significantly due to the pulsing air and then change again while the fluid is at rest.

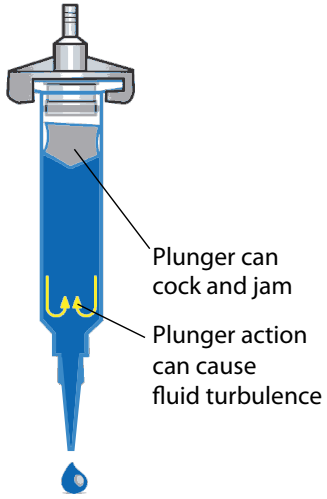

Figure 1.
Pneumatic (AirPulse™) dispensers consist of a plunger which slides within the syringe under pulsating air pressure. "Cocking" and possible jamming of the plunger, as well as turbulence in the material, are but two of a number of problems that can occur with this type of design.

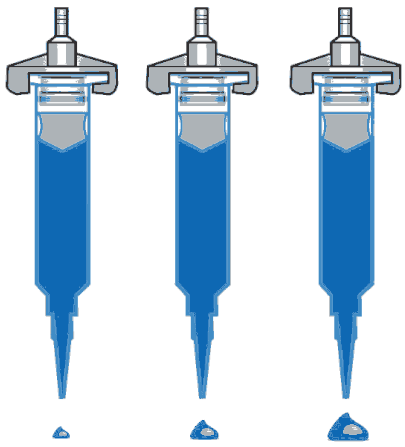

Figure 2.
Pneumatic (AirPulse™) dispensers can cause either "over" or "under" dispensing of material, due tothe inability to precisely control pressure inside the syringe. Inconsistency in deposits are the typical result.

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- Because of problems with control, technicians tend to "over" or "under" dispense adhesives. Over dispensing (Figure 2) wastes material, and often makes stenciling of encapsulated components impossible. It can even cause PCBs to be rejected during inspection. Under dispensing (Figure 2) is an opposite problem, but one every bit as serious: too little adhesive can lead to components falling off or shifting position before or during reflow. Either over or under dispensing can occur as the fluid becomes lower in the syringe. Pressure against the plunger is also less at this time, and the danger is that the dispensed dot or encapsulant may be undersized. In such a circumstance, the operator may then attempt to over-compensate for the lower pressure by increasing the pressure and the amount dispensed.
- While more time/pressure dispensers incorporate a vacuum to "draw back" the material and prevent dripping from the tip after dispensing, with pneumatic systems, the amount of vacuum—and hence, the draw back—cannot be
pre-set or adjusted.
- Pneumatic supply lines within a facility typically experience pressure drops along the line, which adds to the control problem. The air also contains moisture, and when the pulsed air is blasted against the plunger in the syringe, both the air and moisture can be forced around the sides of the plunger and into the material.

AirFree™ Dispensing

AirFree™ Design. The Fishman AirFree™ dispenser differs dramatically from time/pressure dispensers because it operates without air supply. Figure 3 is a cross-section illustration of the AirFree™ dispenser, which is called the LDS9000*. Small dot volume (SDAV), medium dot volume (MDAV) and large dot volume (LDAV) models are available. The LDAV provides dot volumes as small as 0.001cc at 3 Sigma for a 3cc syringe, the MDAV provides dot volume as small as .0005cc at 3 Sigma, and the SDAV achieves dot volumes as small as 0.00025cc, also at 3 Sigma for a 3cc syringe.

The dispenser employs a NoFlex™ linear actuator and a mechanical lead screw which lowers a piston on command from a microprocessor control unit to push the material through the syringe and out the tip. An interference fit between the plunger and syringe ensures against leakage of material and loss of pressure.

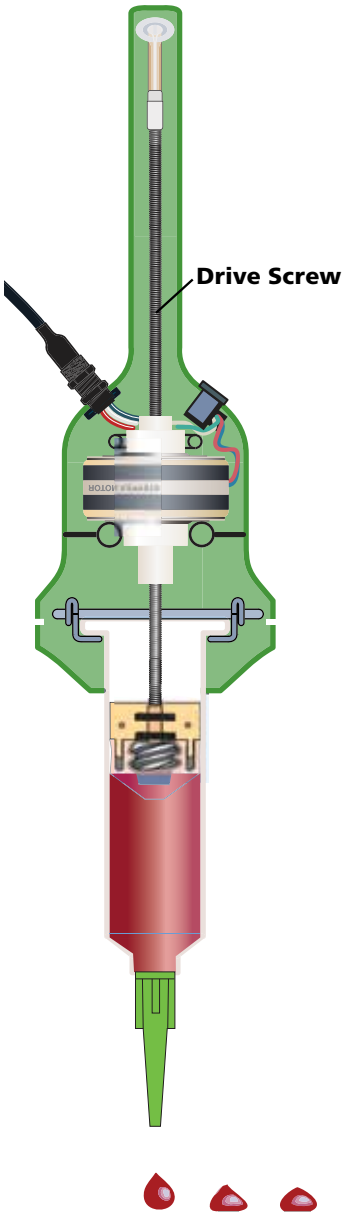

Figure 3.
In the Fishman LDS9000 dispenser, a NoFlex™ linear actuator-driven mechanical lead screw moves the piston out on command from a microprocessor control unit. The material is pushed through; the syringe and out the tip. A programmable drawback of the plunger prevents material drip.

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Key to the smooth operation and precision movment of the dispenser is how the screw travels along its axis, which is what makes LDS9000 different from all other dispensers on the market. (See Figure 4.) The NoFlex™ linear actuator moves the plunger in the syringe by rotating a nut between electrically-charged poles. The lead screw threads through the nut; the dispensing housing captures the top of the screw and prevents the screw from rotating. When actuated, the nut steps from one magnetic pole to the other, causing the screw and plunger to move outward.

With AirFree™ dispensing, control is achieved with the NoFlex™ linear drive system and not by the size of the needle. Since the proper needle size can now be used for the material and the application, the adhesive is in a relaxed state and dispenses smoothly. Materials with fillers remain homogenous. Tunneling does not occur, and without air, no infusion of moisture or other contaminants is possible. Also because of the mechanical action of the lead screw, precise dispensing is achieved, even with changing viscosity.

The lead screw and plunger represent an improvement over auger mechanisms as well as pneumatic systems. With metering valves, the adhesive is compressed between the auger thread and the housing as it moves through the pump (Figure 5). As a result, changes are possible in the properties of the material. On the other hand, because the mechanical screw in the LDS9000 attaches to the piston and never touches the material, dispensing occurs without crushing the adhesive.

Software. The NoFlex™ dispensing "gun" with the mechanical lead screw is one componentof the LDS9000 system. Companion to the dispenser is an intelligent microprocessor that provides precise control over volume output, based on the prescribed dispense rate and the known inside diameter of the syringe being used. The control unit automatically calculates the distance the plunger must travel forward and backward for the correct shot size. The operator only needs to calibrate the system at the beginning of the process. Once calibrated, the LDS9000 delivers the shot volumetrically, which means that even if the viscosity changes, the shot size is repeatable, dot after dot. The intelligent microprocessor will even track the amount of adhesive in the syringe, so that an incomplete shot at the end will not be fired.

To prevent dripping of material from the tip after a deposit, the LDS9000 is programmed to automatically draw the plunger back, causing the material to recede slightly within the tip. The microprocessor calculates the distance traveled forward and back so that on the next dispense cycle,the correct volume is dispensed. When potting or beading with a compressible fluid, a delay can be built in at the end of the forward motion of the plunger, before the drawback, to ensure complete dispensing.

*LDS denotes "Linear Dispensing System"

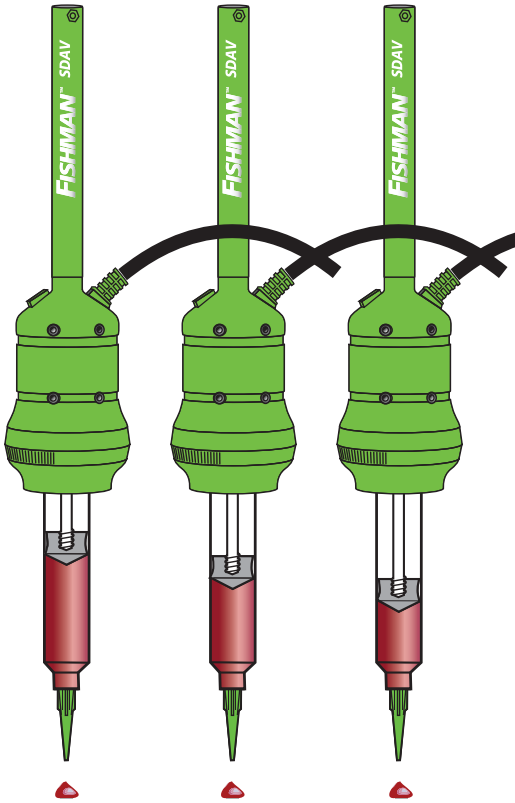

Figure 4.
Fishman LDS9000 deposits precise and repeatable amounts of material through an internal mechanical design.

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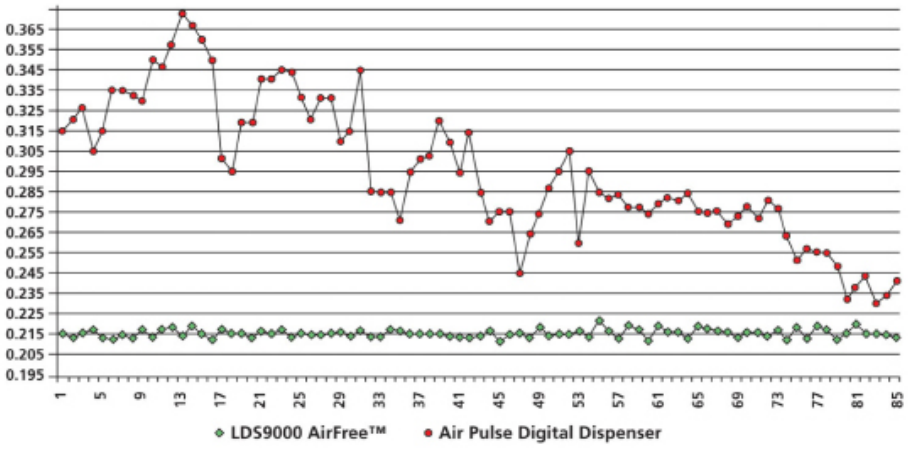
Performance Comparisons Between Pneumatic and LDS9000 Dispensers



Circalok 6755 is an olefin-based grease used in electronics manufacturing. The above chart demonstrates the superior process control of the LDS9000 over a digitally timed air pulse dispenser. The test sample is the second 85 dispenses or better known as the midsection of the barrel reservoir. Overall the LDS9000 maintained a repeatability standard deviation of .0057 versus a standard deviation of .0389 for the air pulse dispenser.

Conclusion

Pneumatic time/pressure dispensing has been around for a long time for hand-held, benchtop, and automated requirements; and users have been forced to live with system idiosyncrasies, waste, and lack of reliability. With the continuing trend toward smaller components and pitches, systems are fast becoming impractical because of their inability to deliver the required precision with consistency.

AirFree TM dispensing, a technology new to the market, overcomes the limitations of pneumatic dispensing systems to provide highly accurate and repeatable deposits without the material dripping at the end of the dispense cycle. The combination of the proprietary dispensing mechanism, microprocessor control unit, and inexpensive plastic syringes results in an economical system and — as supported with actual test data — a level of performance unobtainable with pneumatic-based dispensers.

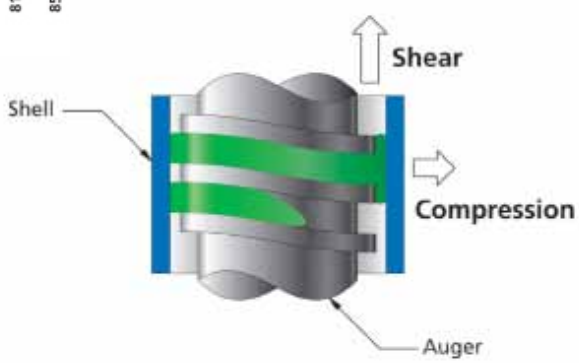


Figure 5.
In dispensing, auger mechanisms in rotary driven pumps tend to "crush" the material in the threads of the auger, possibly changing properties of the adhesive or solder paste. With the LDS9000, force is applied evenly to the material across the face of the plunger.