Panel Fastener / Expansion Nut Automation

Panel fasteners and expansion nuts come in a variety of shapes and sizes. Each type can have a several different names, depending upon what company manufactured the fastener or which company is using them in production. Common names are box-nut, push-nut, and mid-panel-nut. Here are several images for reference.




In production environments, these nuts are often installed by hand or by a robot. Fixed tooling is rare since most panels or structures will require a dozen or more nuts and they are often installed on various angles.

Manual Installation

Manual installation using a hand tool requires a smaller investment and can be implemented quickly, but doing so has several significant drawbacks. The ergonomic impact of installing a push-nut by hand is not good. Operators quickly become fatigued or injured. Recruiting and retaining employees for this task can be difficult. Quality is difficult to control when installing by hand as certain hole locations are difficult to see and can be all-together missed. Speed is another factor to consider. Installing by hand leads to highly variable throughput, and even the best operators fade over the course of a shift. Overtime, the cost of manual installation of push-nuts is far greater than most people realize.

When To Use: Short-term or low-volume programs. Low quantity of nuts per product.

Pros: Quick to deploy, low initial cost.

Cons: Long-term health and safety issues, employee recruitment and retention, inconsistent throughput. Requires poka-yoke sensors in fixture to ensure quality.

Semi-Automated Solutions

One semi-automated solution is to use Flexible Automation's Clip Setter HLP or HHP. This is a hand-held "gun" that is similar in concept to a staple-gun. The tool has a magazine that carries around twenty-five nuts. The operator aligns the barrel of the tool with the product's hole and pulls the trigger. A pneumatic cylinder drives the nut down into the hole. The Clip Setter family of tools uses a vibratory feeder and "Speed-Dock" to reload the tool in under three seconds. This family of tools reduces much of the ergonomic issues associated with installing nuts and clips. However, the panel / product should have easy install angles and a tool balancer may be desirable. Here are a few images for reference.

When To Use: Short-term or low-volume programs. Low quantity of nuts per product.

Pros: Improved ergonomics and employee retention. Typically, better through-put than manual hand-tool approach.

Cons: Moderate investment and time to deploy. Requires poka-yoke sensors in fixture to ensure quality.

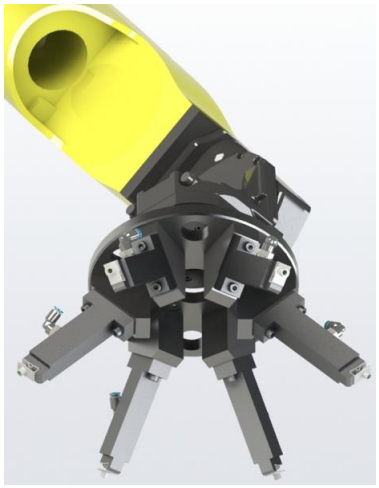
Fully Automated Solutions

Fully automated installation of expansion nuts requires a larger upfront investment, but the savings are quickly recouped. Ergonomic concerns are eliminated when using automation, so recruiting and retaining operators to only load a panel or structure is much easier. The quality of the product is improved since the supplier can assure their customer that all nuts were installed. The consistent throughput of automation simply cannot be matched by manual installation. Finally, an investment in automated equipment allows suppliers to win future programs at lower cost and with greater margins.

There are three primary methods for installing expansion nuts with robots; spoke tools, blow-feed systems, and guns equipped with a magazine.

Spoke Tools

Spoke tools are the simplest and least expensive way to install expansion nuts onto panels or structures. Spoke tools consist of a hub mounted on the robot's tooling flange. The hub supports two to ten spokes. Each spoke has a retaining feature on the end to secure the nut. Retaining options include magnets, vacuum, or spring-detents. The following image is an example of a robotic spoke tool.



While spoke tools are inexpensive, they have a few constraints that may make a different tool preferrable. The spoke tool must acquire one nut at a time when reloading at a part-feeder. Given the number of spokes on a tool, this reloading procedure may impact cycle time. Further, given that the number of spokes on a tool is limited, the robot may need to reload the tool multiple times for a given product. Finally, the shape and angles of a spoke tool may prevent it from being used on certain products that have install points adjacent to sidewalls, or that are tucked-in behind the product's overall profile.

When To Use: Long term or high-volume programs. Low quantity of nuts per product.

Pros: No ergonomic concerns, improved employee recruitment and retention, and higher throughput.

Cons: Larger investment and time to deploy. (However, the robot cells are reusable capital equipment.) Access / maneuverability may be limited. Requires poka-yoke sensors in fixture to ensure quality.

Blow-Feed Solutions

An alternative tool is a blow-feed based system. These systems consist of a vibratory-bowl feeder to singulate and orientate the nut. The nut is then blown through a flexible hose to an installation tool on the end of the robot arm. These tools typically use a pneumatic actuator to drive the nut through a barrel and into the panel or structure. This technique yields high throughput, but the hoses must be custom made to fit the profile of the nut. The hose is a ware item that requires periodic replacement. Further, the hose can present accessibility challenges as the robot often needs to manipulate the install head using complex arm articulation angles. The following image is an example of a robotic blow-feed system.

When To Use:	Long term or high-volume programs. High quantity of nuts per product.
Pros:	No ergonomic concerns, improved employee recruitment and retention, and higher throughput.
Cons:	Larger investment and time to deploy. (However, the robot cells are reusable capital equipment.) Restricted maneuverability due to hose. Hose replacement and cost. Requires poka-yoke sensors in fixture to ensure quality.

Robot-Mounted Tool with Magazine

The third method for installing expansion nuts is to use a gun on the robot that includes a magazine full of nuts. An example of this type of tool is Flexible Automation's Clip Setter RHS, RHP, and RLP. This robot-mounted "gun" is similar in concept to a staple-gun. The tool has a magazine that carries around twenty-five nuts. The robot aligns the barrel of the tool with the product's hole and pulls the trigger. A servo actuator or pneumatic cylinder (depending upon model) drives the nut down into the hole. The Clip Setter family of tools uses a vibratory feeder and "Speed-Dock" to reload the tool in under three seconds. The servo-based model features upper and lower software limits for both position and force at both the initial contact with the substrate and at the final seated position. The software that controls the system has the capability to have a unique parameter set for each hole location. This feature acts as a poke-a-yoke and can eliminate the need for dozens of sensors in the product fixture. In summary, the magazine-based tool is superior to all other tool types because it has high carrying capacity, is quick to reload, has better accessibility, and is low maintenance. Here are a few images for reference.

When To Use: Long term or high-volume programs. High quantity of nuts per product.

Pros: No ergonomic concerns, improved employee recruitment and retention, and higher throughput. Better maneuverability and less-maintenance.

Tools with force and distance feedback eliminate the need for fixtures with part-present sensors.

Cons: Larger investment and time to deploy. (However, the robot cells are reusable capital equipment.)

Fixture Considerations

Fixture complexity and cost are correlated with the nut installation tool-type. Manual or semi-automated installation tools require a simple rough orientation fixture for the product. Robotic solutions require precise fixtures and / or the use of a vision system to guide the robot to the exact hole location. Part-present poke-a-yoke requirements will drive-up the cost of fixtures unless a manufacturer chooses to use the Clip Setter RHS which features integrated force and stroke monitoring.

Nut Considerations

Each nut type requires special consideration in the design of the install tool, feeding system, and / or fixture.

The box-style nuts tend to have products with tight hole dimensions, but often the product hole locations are poorly controlled. The lack of taper on the leading edge of the nut combined with the challenging hole features will often make it difficult to install the nut. The preferred solution in this case is to use a vision system to identify the hole location and then guide the robot. The box nuts also tend to have head "flanges" that vary dimensionally and are often out of spec. This variation can be the source of feeder and tool jams. The solution to this variation is to use the lower box dimensions to control the nut as it travels through the feed system and install tool.

The wedge-style nuts feature barbs on the lower portion of the nut body. These barbs are often out of specification and can have sharp edges and burs. These barbs can be the source of feeder and tool jams. The solution to this variation is to use the head "flange" to control the nut as it travels through the feed system and install tool. The head flange on the wedge style nuts are more dimensionally stable than on the box-style nuts. The wedge-style nuts require less precise product fixtures and product tolerances because the wedge profile acts as a lead-in as the nut is pushed into the hole. These simple fixtures cost less and are often easier to load and unload by the machine operator.

Which Tool, When?

You may be asking yourself, when should I use which tool? Manufactures can use manual install tools when the number of nuts per product is low and the overall volume of products is low. Semi-automated tools like the Clip Setter HHP are typically used when the number of nuts per product is high and the product has medium volume requirements or a below average program horizon. Robot solutions are the best choice when the product volumes are high. A spoke tool is a good solution if the number of nuts per product is relatively low (less than 10). The magazine-based robot tool is more reliable than the blow-fed solution and they have a great return on investment when the number of nuts per panel exceeds 10.

If you are considering automating the installation of your fasteners, you should carefully consider the nature of your product volumes, the quantity of nuts per product, the quality of your components, and the availability of reliable skilled labor. Selecting the right tool for the job can lead to more orders and less headaches. Choosing the wrong tool can be a waste of money and could result in a lost customer.

If you would like to learn more about expansion nut installation, please contact Flexible Automation, Inc. The company has been designing and implementing fastener installation tools for over twenty years. They also have experience automating the installation of many other types of fasteners including plastic pins, “Christmas trees”, U-style spring-nuts, and edge-clips.

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