

LTD Bolt Injection System

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ABSTRACT

Growing use of composite materials in aircraft wing construction requires a new generation of drilling machines. Electroimpact's new LTD drilling machine features a Bolt Injector with improvements for more streamlined operation and less operator intervention. The Bolt Injector "injects" or stages Single Sided Temporary Fasteners (SSTF). It features hands-free automated tool change between three different feed paths for a total of eight different fastener diameters being fed through one set of Bolt Injector hardware. This is accomplished with an indexing system for three feed tubes fed to the machine head, with each feed tube serving more than one diameter. Furthermore the LTD Bolt Injector checks fastener diameter at the machine head and also length in conjunction with Bolt Inserter servo axis. The bolt diameter is checked with an analog sensor attached to a gripping mechanism. The length check is accomplished with a "touch off" pad and the Inserter's servo motor encoder. The LTD Injector is the latest in SSTF bolt feed systems and offers increased functionality and reduced operator involvement contributing to more efficient utilization of the LTD drilling machine.

INTRODUCTION

The origin of the bolt feed system discussed in this paper was developed to address the LTD machine's bolt feed requirements where multiple diameters of bolts were required to be fed automatically. The Bolt Injector is an evolved design stemming from the Confined Spaces Bolt Injector discussed in SAE paper 2010-01-1879 [1] and works with the Bolt Inserter discussed in SAE paper 2010-01-1842 [2]. Bolts required were of diameter ranging from 3/16" to 5/8", constituting a total of eight different diameters with considerable length variation. These were all to be fed fully

automatically. The bolts, SSTF or Single Sided Temporary Fasteners [3], are increasingly replacing more cumbersome manual tools for temporary doweling and clamping of aerospace components during assembly.

This paper will focus on the Bolt Injector, a process tool which take the bolts from feed tube and delivers them to the Bolt Inserter. The LTD Bolt Injector features more streamlined functionality reducing machine operator interaction. The Bolt Injector provides length and diameter checking abilities and the ability to feed 8 diameters of bolts without a tool change operation.

SYSTEM OVERVIEW

An Electroimpact bolt feed system is tasked with delivering fasteners to the machine's head from a loading station some distance away from the end effector. The loading station allows access for resupplying fasteners and typically consists of hopper or Stick-style [4] Fastener Feed system. The fasteners are sent from the Fastener Feed system to the machine's head through plastic feed tube. On the machine's end effector are a Bolt Injector and a Bolt Inserter. These process tools take the bolt from the feed tube and install it in the drilled hole.

Electroimpact's new Lean Technology Drilling Machine (LTD) is pictured in Figure 1. The LTD machine is a highly capable and cost efficient solution for composite wing box drilling. Pictured, the machine's head is at the lower extent of its Y travel where the clamp table extends carrying the different process tools, including the Bolt Injector and Inserter.



Figure 1. Lean Technology Drilling Machine

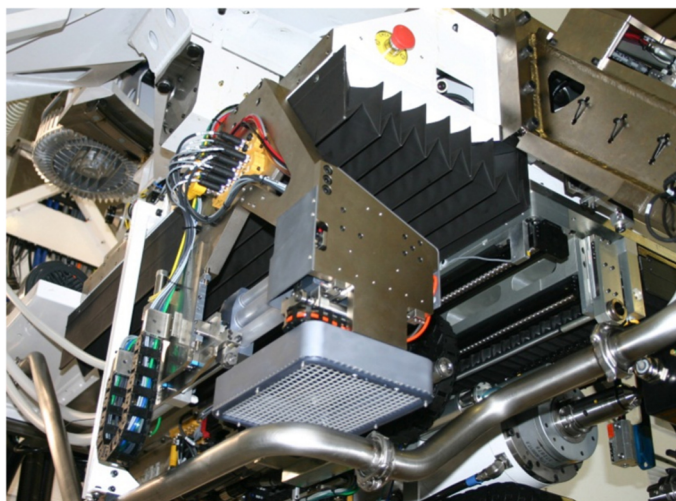


Figure 2. LTD Bolt Injector

The Bolt Injector is a pneumatically actuated tool whose task is to catch the incoming fastener traveling through the feed tube and present it to the Bolt Inserter. The Bolt Inserter is a process tool which resides on the machine's shuttle table and is tasked with picking up a fastener from the Bolt Injector and installing it in the drilled hole. The Bolt Injector resides on the end effector's clamp table (Figure 2), which is the machine's primary approach axis to the wing panel of the fuselage, typically moving in the Z direction. The Bolt Injector is mounted onto the side of the clamp table and it is

aligned with the Bolt Inserter, a tool on the shuttle table, when the machine is drilling a hole. With this setup, the bolt is feeding while the machine is drilling, one of many features that maximize machine utilization.

SINGLE SIDED TEMPORARY FASTENERS

Single Sided Slave/Temporary Fasteners are designed to clamp and dowel components for drilling in aerospace applications. They are replacing separate tools used for each of the clamping and the doweling processes. Furthermore, these bolts have been designed with a low profile head such that, after installation, they sit considerably closer to flush to the workpiece than their counterparts. This allows an automated machine to "fly over" them. The bolts can be used in countersunk and non-countersunk holes. The SSTF bolts' relatively small head also allows them to be fed through plastic feed tube. Its "blind" or one-sided capability makes them a fit to be installed by automated machines. With these features, the fasteners reduce the amount of tooling required for assembly and allow them to be installed by machine. Figure 3 [3] shows some of the key features of the SSTF bolts.

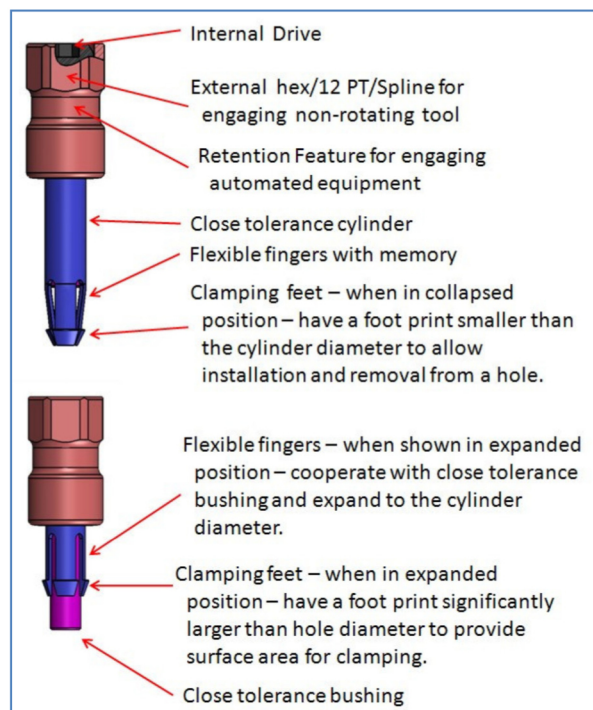


Figure 3. SSTF Bolt Features. Adapted from [3]

FEED TUBE INDEXING SYSTEM

The LTD Bolt Injector uses a feed tube indexing system to toggle between 3 different feed tubes of different size. The smallest feed tube is used with 3/16" and 1/4" diameter bolts.