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Electromagnetic Bolt Inserter

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ABSTRACT

The Electromagnetic Bolt Inserter (EMB) is a new tool that combines functions that on previous machines were performed by two tools, a bolt inserter followed by an EMR. By combining the operations of two tools in one the processing time for the wing spar is reduced. The tool incorporates quality checks for bolt length, stake height and bolt insert height.

INTRODUCTION

The paper discusses the Electromagnetic Bolt Inserter (EMB) as applied to wing spar manufacture. The tool inserts lockbolts for fastening the chord, rib posts and stiffeners to the web. Currently four of these tools are in production, two on 777 and two on 737. Contracts are in place for eight EMB tools and it is likely this will expand to sixteen installations, so it is an important process. These tools have been effective at reducing the processing time for the spar assembly.

EXISTING VERSUS NEW PROCESS

In spar manufacture on 737 and 777 the chords are attached to the web with protruding head lockbolts and slug rivets. The previous lockbolt process incorporates the following steps:

1. Clampup on the spar assembly with a clamp table on the wet side and an opposing clamp table on the dry side.
2. Drill from the dry side.
3. Transfer the dry side tool shuttle to the bolt inserter position.
4. Drive in a protruding head lockbolt.
5. Transfer the dry side tool shuttle to the EMR position.
6. Bring the dry side EMR forward so the driver bears on the head of the bolt.
7. Bring the wet side EMR forward with the collar and place the collar on the bolt.
8. Pulse the EMRs to swage the collar.
9. Unclamp.

With the EMB the lockbolt installation process is revised as follows:

1. Clampup on the spar assembly with a clamp table on the wet side and an opposing clamp table on the dry side.
2. Drill from the dry side.
3. Transfer the dry side tool shuttle to the EMB position.
4. Drive in a protruding head lockbolt.
5. Bring the wet side EMR forward with the collar and place the collar on the bolt
6. Pulse the EMRs to swage the collar
7. Unclamp

The EMB process eliminates two steps and saves several seconds per lockbolt.

EMB Tool Design

The EMB is a tool for installing interference fit bolts and providing backup force for swaging collars. An EMB can be broken down into six sub-assemblies: the recoil assembly, gun assembly, feednose, injector, baseplate assembly, and pneumatic/electrical system. The recoil assembly, gun assembly, feednose, and injector compose the functional parts of the EMB. The baseplate assembly, pneumatic and electrical systems are adapted to handle whatever form the other assemblies take and will not be discussed in detail.

The baseplate assembly has linear rails and a ballscrew to guide and position the tool. The ballscrew nut is connected to the gun assembly. The recoil assembly and moving portion of the gun assembly are actuated from servo position by air cylinders to perform stake and swage operations. The baseplate assembly also holds the laser or thru-beam sensor for checking bolt length.

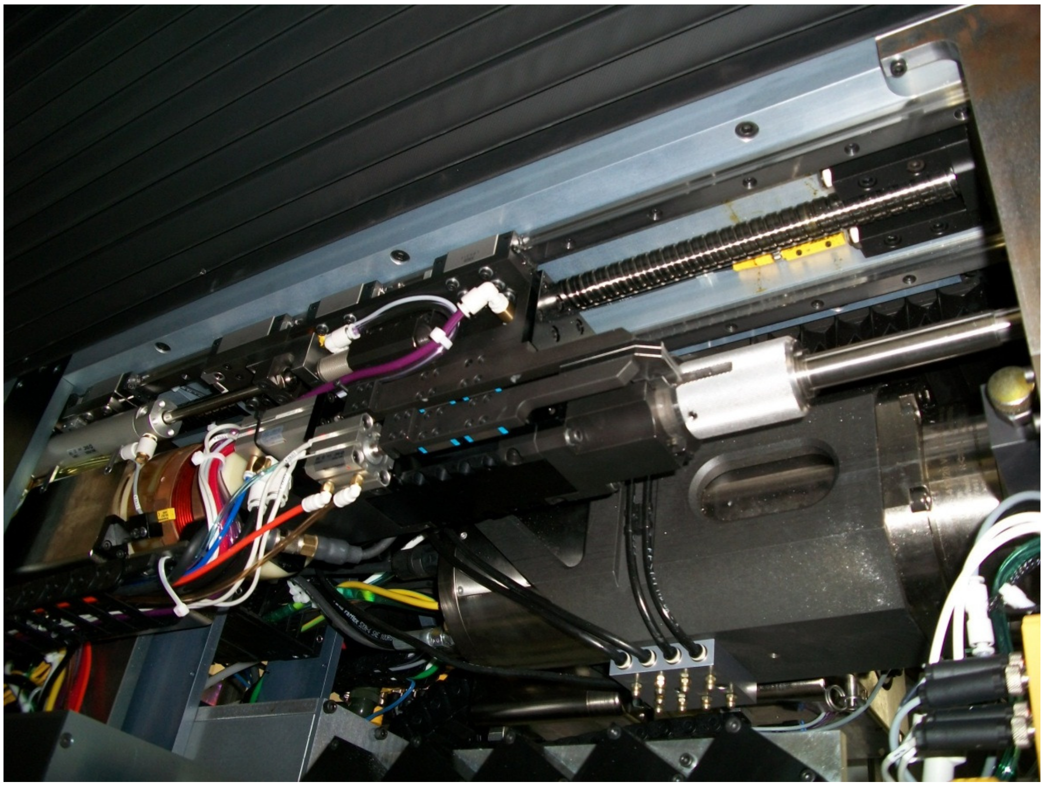


Figure 1 The EMB mounted on the riveting machine

Recoil Assembly

The recoil assembly contains the EMR mechanism. The EMR consists of the electromagnetic coil, pulse cable clamp, and air cylinder(s) mounted to the recoil mass. Once the bolt is driven down, the EMR is actuated to backup the head of the bolt while the collar is swaged by the EMR on the wet side.

Gun Assembly

The gun assembly contains the ballnut interface, stroke reading cylinder, chipping hammer, copper plate, and feednose interface. This is the main body of the tool. The gun assembly base is connected to the ballnut which servos the tool between stations including home, bolt inject, bolt length measurement, and stake positions. The rest of the assembly is actuated relative to the base by a stroke reading cylinder, usually referred to as the mag cylinder. The mag cylinder accurately reads position, even during operation of the chipping hammer, allowing the CNC to confirm that the bolt is staked correctly; it then hammers the bolt into the panel until the appropriate head height is reached indicating that the bolt is seated correctly. Our EMBs use a single chipping hammer to accommodate a wide range of fastener diameters by using a proportional flow valve to power the hammer and by varying the feednose geometry. The copper plate is the counterpart to the coil and drives away from the coil when the EMR is pulsed.

Feednose

For the spar assembly there are a variety of lengths of protruding head lockbolts. The shortest lengths (-5) provide a challenge to conventional clamshell rivet fingers. For this reason Electroimpact developed actuated split collet fingers. The head of the bolt to be inserted is presented to the collet fingers by the injector. As a second step the collet fingers are closed down to capture the underside of the bolt head. As a third step the collet fingers are pulled back to bring the head of the bolt in contact with the driver pin. The three steps are illustrated in Figure 2.

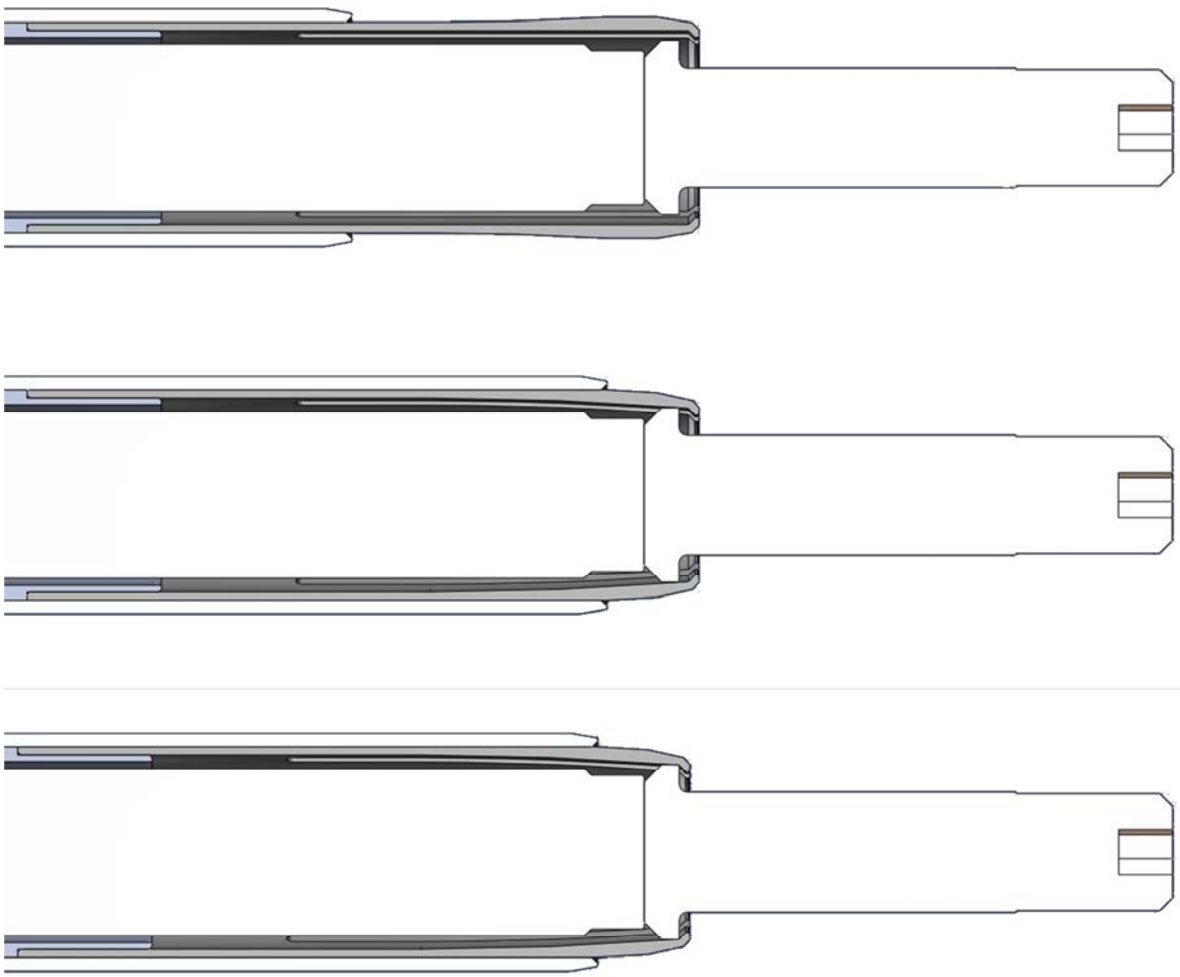
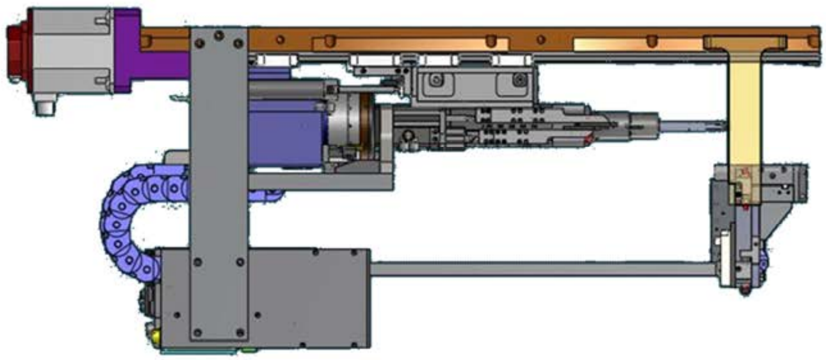


Figure 2: The three steps of loading the bolt into the collet fingers. In the third step the bolt head is pulled in registration with the pin

We also have an EMB in operation for another customer with conventional clamshell fingers. See SAE paper **09ATC-0182.**

Injector

The injector stops the bolt without damage while still allowing for very high speed bolt transfer. The injector delivers the bolt into the fingers. Figure 3 below illustrates the operation of the injector.



Injector delivers bolt to fingers

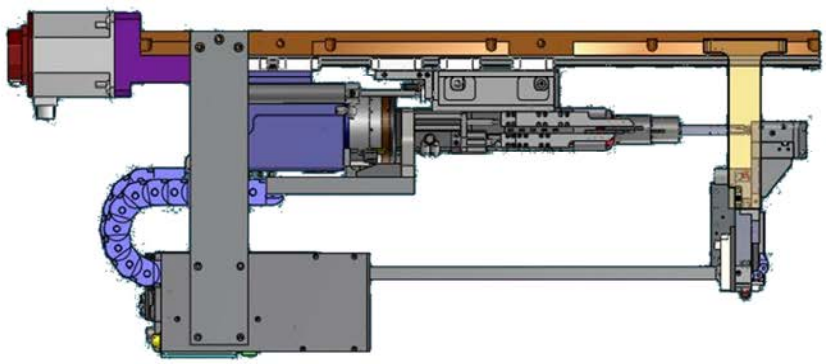


Figure 3: Injector receives the bolt and delivers the bolt to the collet fingers

In Figure 4 an intermediate step is illustrated in which the length of the bolt is measured while in the collet fingers.

Laser or thru-beam captures bolt length as the EMB servos forward.

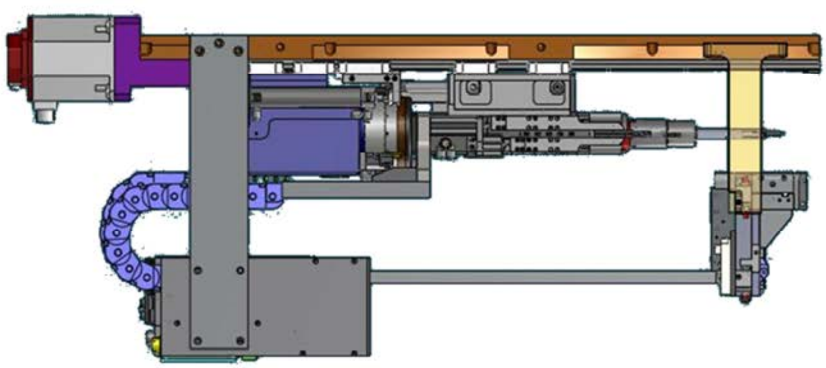


Figure 4: The end of the bolt is driven into a laser beam in order to accurately measure and confirm the bolt length before installation into the wing spar

After the bolt length check, the servo drives the bolt to the stake position. To confirm that there will be interference the bolt is required to stall before the shank enters the hole. This is confirmed by the position of the mag cylinder. After stake check the bolt is rattled down into the panel. The height of the head is confirmed with the mag cylinder.

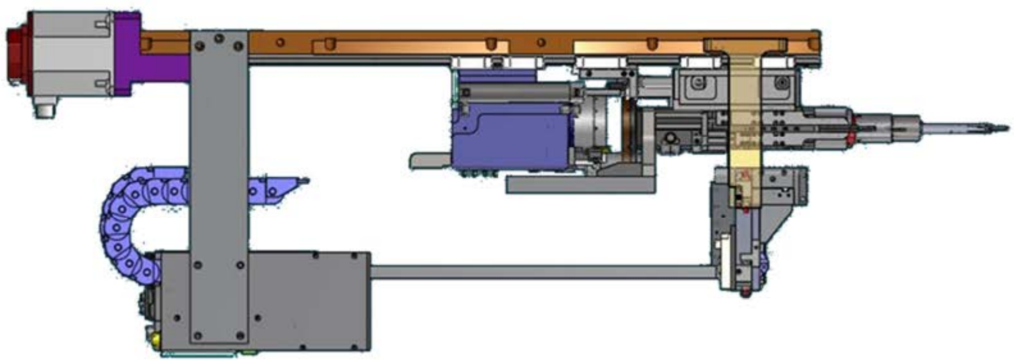


Figure 5: The bolt is advanced to the stake position

As a final step the collar is loaded from the wet side and the EMRs are pulsed to swage the collar.

SUMMARY/CONCLUSIONS

The EMB is reliable and has improved the efficacy of spar riveting machines.

REFERENCES

09ATC-0182 Pinch Bolt Injector
Jarrod Wallace Electroimpact and David Colebourn Airbus UK

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