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Gantry Horizontal Slug Riveting System

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Abstract

Previously given Paper 09ATC-0232 delivered at the SAE Aerotech conference in Seattle in 2009 reports on the E6000 machine installing slug rivets with the EMR. Paper 2015-01-2491given at the SAE conference in Seattle in 2015 reports on index head rivets being installed with screw driven squeeze process. This paper reports on the screw driven squeeze process installing unheaded slug rivet which is a more complex process. We also report on improvements to the fixture automation.

Introduction

Electroimpact has developed a gantry riveting system with new features. Two wings, a port and a starboard, are held vertically. The riveting process is a horizontal squeeze process. The rivets are slug rivets so the protrusion must be precisely set by the machine. Furthermore, the wing is held in a rigid fixture. The riveting method is to snug the rivet in contact with the headstone and then back up the skin side clamp to prevent the clamp from absorbing upset pressure. This motion is referred to as the dance move. Then the rams are moved toward each other to provide zero wink. Perfect rivets were reliably produced. There is also a bolting process. Stump lockbolts are pressed in. Collars are slid over the protruding bolt tail and swaged. The fixture is the most advanced that Electroimpact has built. In position the posts have clamps that locate all the stringers and the skin. The posts are controlled by the CNC. Posts move automatically from in position to out of position under control of the CNC. Post motion in process allows 100% of the panel to be accessed by the machine. Posts are automatically moved to the side to install rivets behind and then returned to position to securely hold the panel. The posts feature multiple stringer clamps that acquire the stringers, release the stringers when commanded to do so and reacquire the stringers when commanded to do so. This is the first time this has been done. The entire riveting process is nearly autonomous with the operator sitting in a safe zone watching and controlling the process via cameras. The work share was shared approximately equally by the Electroimpact USA company and the Electroimpact UK company.

Squeezing Unheaded Slug Rivets

The gantry horizontal riveter allows a complete panel build without a buildup or tack fixture. The panel varies in rigidity and the slug rivets must be precisely positioned along the central axis in the drilled hole. Snug on the headstone was found to be the most effective and gave consistent results. Fig 1 shows the machine that this article is referring to.

FIGURE 1 Gantry horizontal riveting machine E6000

This next Fig 2 shows the BUCA headstone. The function of this was reported on in an oral only paper given at SAE Aerotech 2023 in Fort Worth, TX.

The BUCA cylinder is pushed in and fully seated when the machine is clamped up on the wing panel. We strove to find the best way to snug the rivet and to be sure that the snug occurs at the desired protrusion value. After some experimentation we arrived at this process. Figure 3 shows the process head before clampup. In Figure 4 you can see that the skin side process is precisely landed in contact with the skin side surface. In Figure 5 the V side process presses up against the rigid U side process and the clampup is complete.

The machine then drills and countersinks with the drill spindle. During the drilling the V side ram is back to prevent the drill bit from contacting the die. Then the skin side process transfers to the rivet driver position. The V ram is advance to the theoretical protrusion position. Then the rivet is inserted and pushed up against the V side die as shown in Figure 6.

In the next step Figure 7 the rivet is snugged by advancing both heads slightly. This is the snug. The wing panel is pressed up against the headstone so we can precisely set the rivet protrusion.

Before the final rivet squeeze we make space to the headstone via the “dance move” which is illustrated in Figure 8

Then the final upset occurs with a gap behind the nosepiece as shown in Figure 9 therefore the headstone is decoupled from the rivet upset motion.

FIGURE 2 Skin side riveting process with BUCA headstone

FIGURE 3 Heads before clampup.

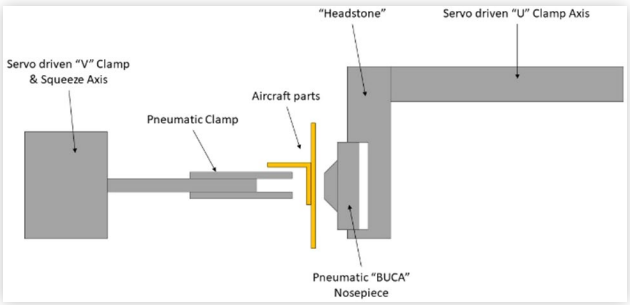


FIGURE 4 U side is landed and BUCA is pushed into contact

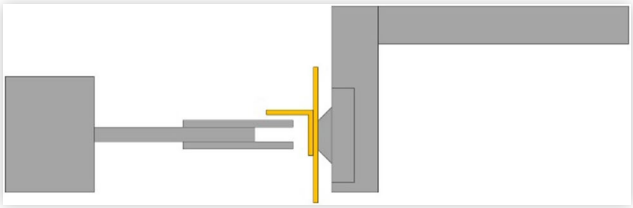


FIGURE 5 Fully clamped up

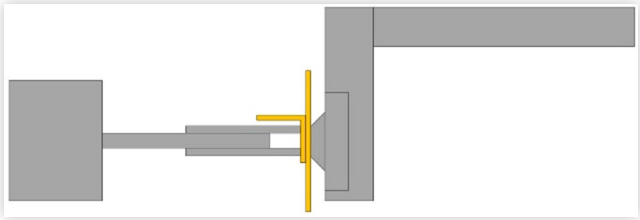


FIGURE 6 Driver positions the slug rivet up against the V side die

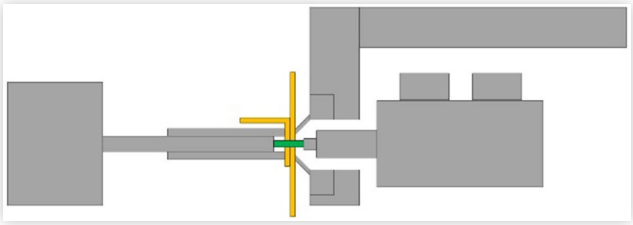


FIGURE 7 Rivet is snugged up against the headstone

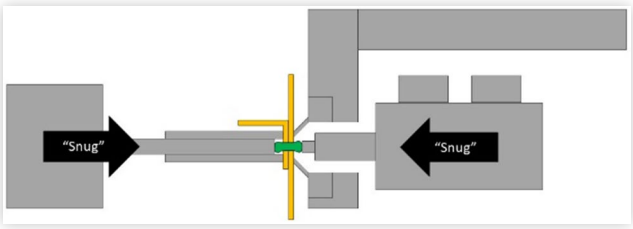


FIGURE 8 The dance move prior to the final rivet squeeze

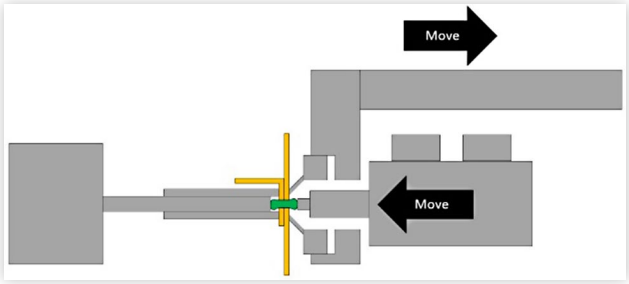
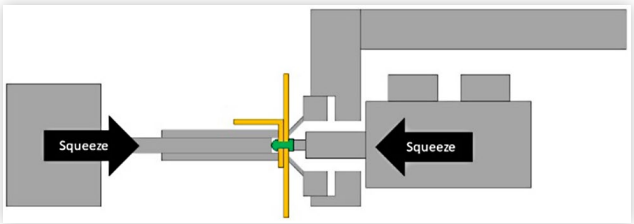


FIGURE 9 The main rivet upset is perfomred with a gap behind the nosepiece which decouples the headstone.



Fixture Posts Move Automatically

In prevous versions of the E6000 machine the fixture posts were draped manually by the operator. In this updated version the posts are moved automatically. The mechanism at the base of the posts is shown in Figure 10.

FIGURE 10 View of fixture post base for automatic operation

Note from the above figure that after unclamping the post backs up by climbing a seven degree incline. The benefits of that motion are that the stringer indexes do not scrape along the painted surface.

In Figure 11 it is illustrated that the seven degree incline is chosen to be more angle than the most rotated stringer reference, which in this case is the lowest stringer on the wing panel. The result of this is no damage to the

FIGURE 11 The seven degree escape path is adequate to pull clear of every stringer index surface.

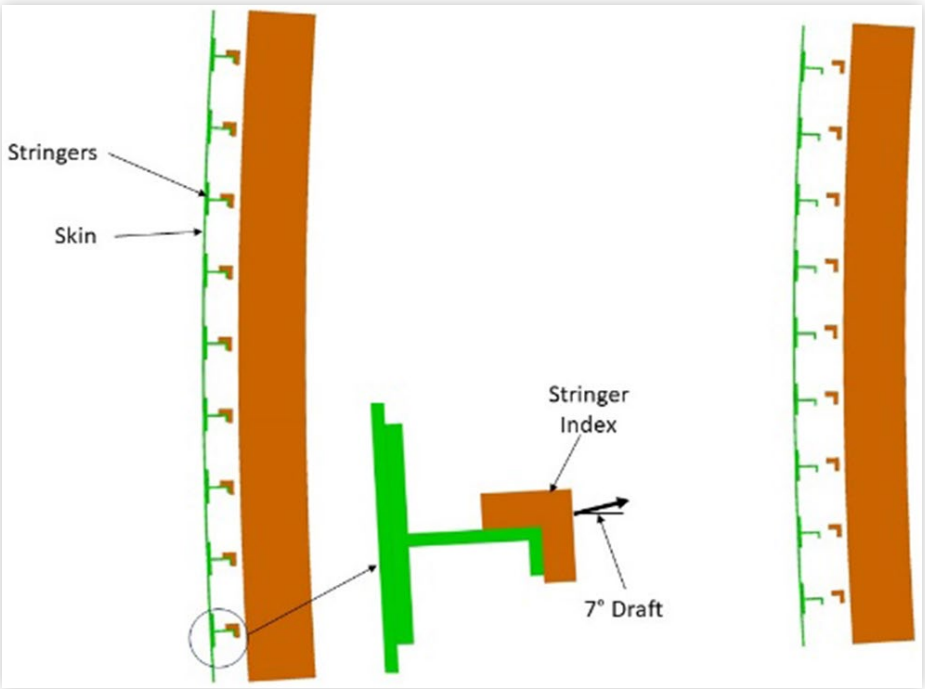
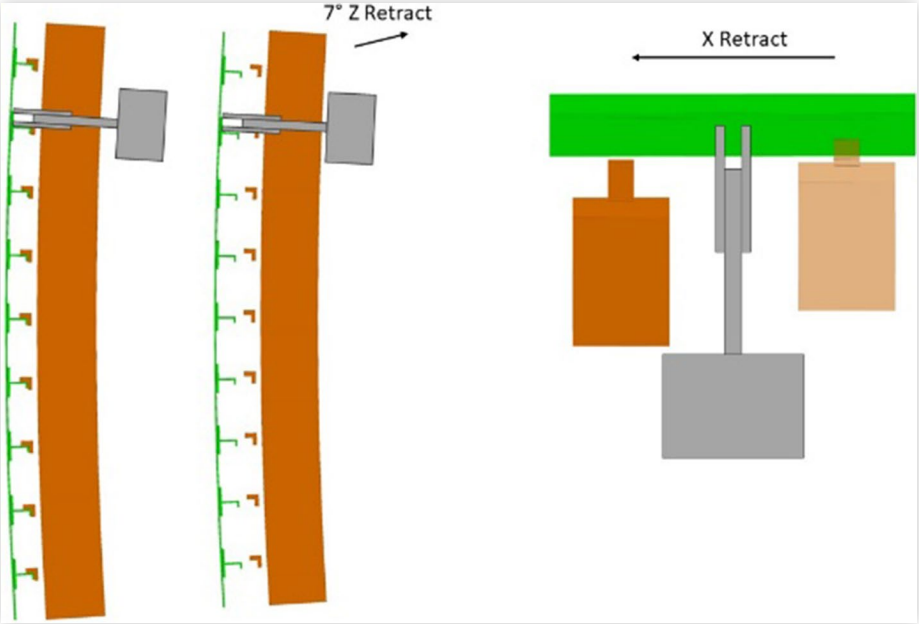


FIGURE 12 The V clamp table is always behind the header boards.



painted surface due to the automatic operation of the fixture.

In Figure 12 it can be seen that the posts are narrow so that the V side process tool can operate adjacent to the post. The V side clamp table is behind the header board making the machine faster.

Summary / Conclusions

- This version of the E6000 machine incorporates several improvements.
- The BUCA clampup method puts the panel in direct contact with the headstone regardless of the fixturing.
- Now that the panel position is known the rivet protrusion can be precisely set for the snug by positioning the V side die.
- The result is an extremely reliable and repeatable process for the installation of slug rivets.
- The automation of the fixture post move is another step towards full system automation.
- This eliminates manual functions. The E6000 is now capable of close to full lights out unattended automation for wing panel fastening.

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