

Flexible All Electric Riveter

Peter B. Zieve
Electroimpact Inc.

Abstract

A new style of all electric riveting machine has been developed with saddle hoppers that does not require a track between the hoppers and the fingers. This enables feeding square rivets without difficulty. The upper ram has a bent knee which allows the rivet fingers to be brought up to the hopper and rotated 30 degrees rather than the rivet sliding down a track, which minimizes jamming that occurs with some fasteners in the track, and increases reliability. A mixture of fasteners can be loaded side by side in the hoppers, increasing flexibility. The rivet feeding is accomplished by bringing the rivet fingers to the hopper. The machine uses a power drawbar to change out different rivet fingers. A small industrial robot is incorporated into the machine to complete different sized coupons and also complete small assemblies. In larger machines larger robots or CNC positioners can be used to scale up the use of the machine.

Introduction

The electric riveting machine incorporates a new method of feeding rivets that significantly increases the number and type of fasteners that can be fed by one machine. A persistent problem with previous feeding systems was the difficulty of feeding square rivets in a track without jamming. This riveter uses a bent knee upper ram that brings the rivet fingers to the hopper and eliminates the need for both a track and for blowing the rivets.

Track fed compared to blow feeding

A riveting machine which feeds the rivets down a track is preferred. A machine of this type can reliably install a square rivet, which is a rivet where the head diameter is nearly equal to the rivet length. See the most popular square rivets, MS20470AD5-5 and MS20470AD6-6, in Figure 1.

Note the head diameter is wider than the length of the rivet shank. A blow machine is not an option for this rivet. It is very difficult to blow this rivet down a tube.

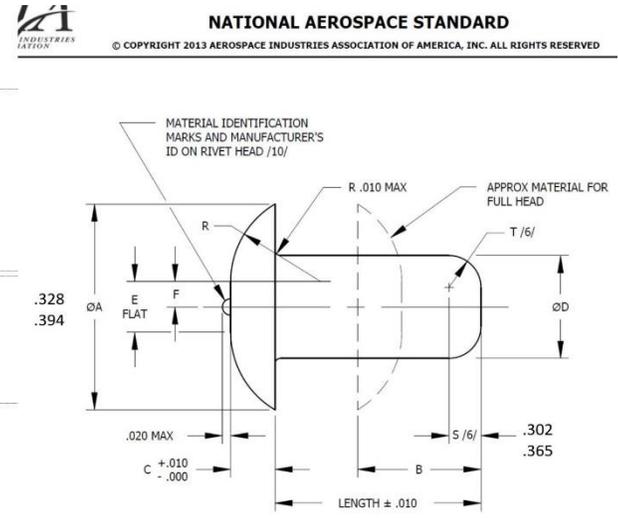


Figure 1: Example of square rivets

Flexible riveting system

Electroimpact has developed a new style of riveting machine which does not blow the rivet down a tube (Figures 2 and 3). The side mounted robot (lower left corner in Figure 2) is used for running a rivet coupon. It can be repurposed for other uses as well.



Figure 2: Flexible all electric riveter

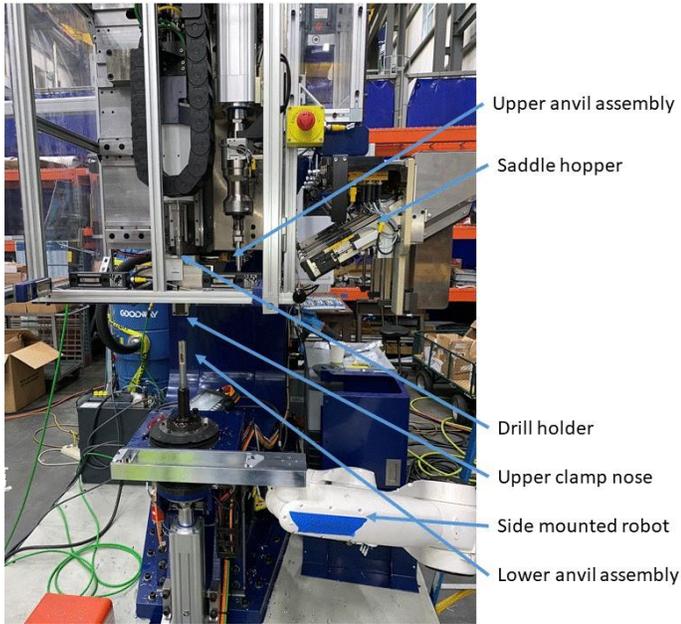


Figure 3: Overview of riveter components

Rotating fingers

This new style of all electric riveting machine with saddle hoppers has been developed and no track is required between the hopper and the fingers. Instead, the rivet fingers are brought to the hopper and rotated 30 degrees for reliable feeding. The upper ram has a bent knee which allows the fingers to be brought up to the hopper rather than the rivet sliding down a track.

Figure 4 shows the air cylinder mechanism that rotates the end of the anvil and brings the fingers in contact with the hopper. Note now there is no track required between hopper and the fingers. They come in direct contact. The design of the rotating joint is such that the force is 80% transmitted between mating flat surfaces. The interface has an x10 safety factor at infinite life.



Figure 4: Air cylinder mechanism in contact with the hopper

Other features in the rotating assembly

The rotating assembly at the end of the rivet ram contains an automatic drawbar. A zero clamp is mounted on the end of the ram. The pull stud for the zero clamp is incorporated into the back of the upper ram assembly (Figures 5, 6 and 7). The hoppers are on a slide which can be equipped with a servoed ballscrew.

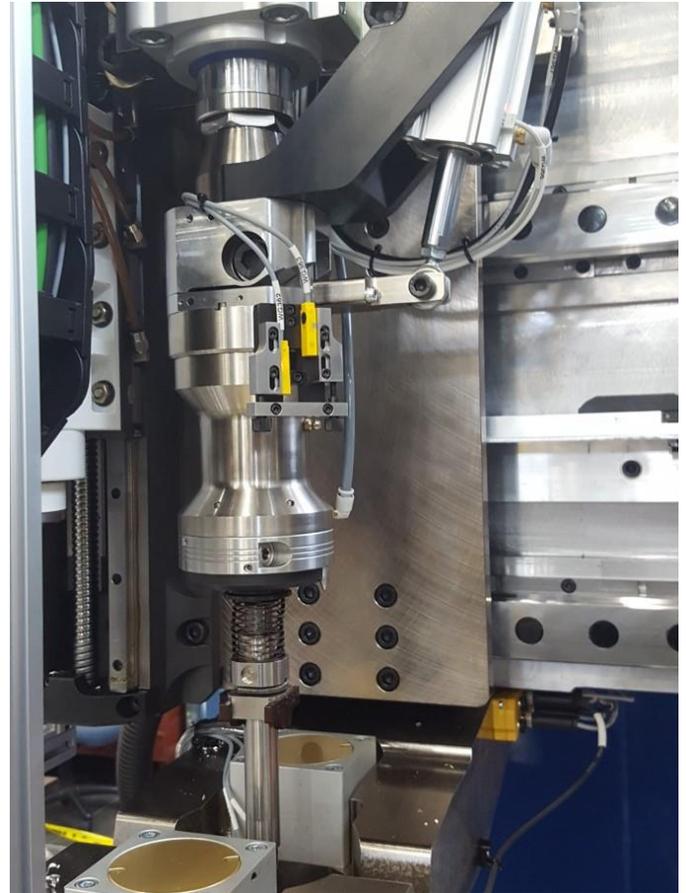


Figure 5: Rivet ram, automatic drawbar and zero clamp

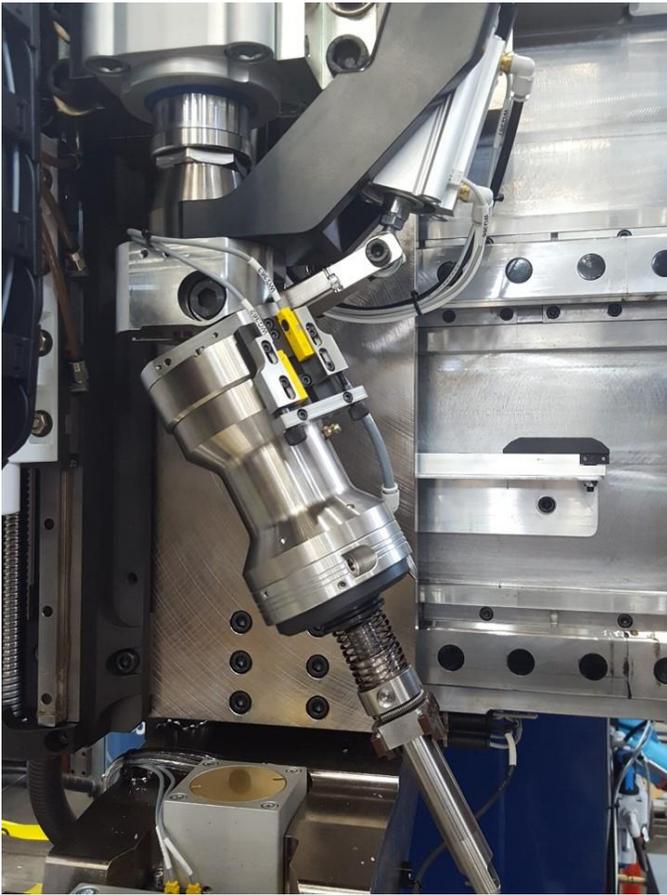


Figure 6: Rivet ram and automatic drawbar



Figure 7: Interior detail of rivet ram showing finger mechanism

Air gap sensor

Above the zero clamp is the air gap sensor. The air gap sensor prevents damage to the workpiece if the rivet does not properly seat at the base of the hole. This can occur if the hole is undersized or there is a chip in the hole. It can also occur if the rivet is not straight in the fingers. This technique has recently been granted US Patent 10065235 (Figure 8).

(12) United States Patent		(10) Patent No.: US 10,065,235 B2
Zieve et al.		(45) Date of Patent: Sep. 4, 2018
<hr/>		
(54) SYSTEM USING AN AIR GAP FOR WORKPIECE PROTECTION IN A FASTENER MACHINE	USPC	227/2-3, 112, 119, 121 See application file for complete search history.
(71) Applicant: Electroimpact, Inc., Mukilteo, WA (US)	(56) References Cited	U.S. PATENT DOCUMENTS
(72) Inventors: Peter B. Zieve, Seattle, WA (US); Reese R. Allen, Seattle, WA (US); Cosmos G. Krejci, Ames, IA (US)	5,661,887 A *	9/1997 Byrne B21J 15/105 227/2
(73) Assignee: Electroimpact, Inc., Mukilteo, WA (US)	5,666,710 A *	9/1997 Weber B21J 15/105 227/2
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 925 days.	2002/0029450 A1 *	3/2002 Kondo B21J 15/025 29/407.01
(21) Appl. No.: 14/491,068	FOREIGN PATENT DOCUMENTS	
(22) Filed: Sep. 19, 2014	EP	0468717 B1 * 3/1995 B21J 15/105 * cited by examiner
(65) Prior Publication Data	Primary Examiner — Michelle Lopez	
US 2016/0082501 A1 Mar. 24, 2016	(74) Attorney, Agent, or Firm — Jensen & Puntigam, P.S.	
(51) Int. Cl.	(57) ABSTRACT	
<i>B21J 15/28</i> (2006.01)	The system includes a ram assembly with fingers for grasping a fastener. An actuator moves the ram assembly toward the workpiece, under machine control. A housing member which is movable by the actuator includes a holding member for an anvil portion of the ram assembly, the holding member being movable within the housing member. The holding member and the housing member are arranged so there is a selected air gap between the movable member and the top of the housing at the start of the fastener cycle. An insertion sensor assembly changes signal state when the air gap begins to close. When the air gap begins to close either too early or too late relative to a properly positioned fastener, the actuator is stopped by the cycle motion controller.	
<i>B21J 15/02</i> (2006.01)		
<i>B21J 15/26</i> (2006.01)		
<i>B21J 15/32</i> (2006.01)		
<i>B21J 15/14</i> (2006.01)		
(52) U.S. Cl.		
CPC	<i>B21J 15/28</i> (2013.01); <i>B21J 15/02</i> (2013.01); <i>B21J 15/142</i> (2013.01); <i>B21J 15/26</i> (2013.01); <i>B21J 15/285</i> (2013.01); <i>B21J 15/32</i> (2013.01)	
(58) Field of Classification Search		
CPC .	<i>B21J 15/28</i> ; <i>B21J 15/02</i> ; <i>B21J 15/142</i> ; <i>B21J 15/26</i> ; <i>B21J 15/285</i> ; <i>B21J 15/32</i>	
11 Claims, 14 Drawing Sheets		

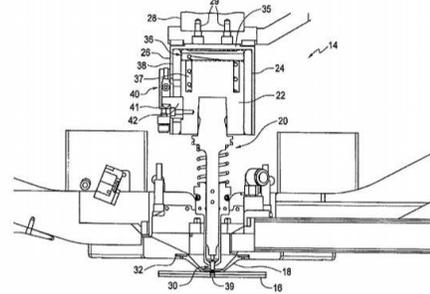


Figure 8: Patent on air gap for workpiece protection

Hopper design for flexible riveter

A hopper design has been made specifically for this riveter (Figure 9). Inside the hopper the design is conventional, rotated to 30 degrees. The fingers are rotated up to 30 degrees so the separator and injector are all in-line with gravity assisting. In Figures 10 and 11 you can see the air cylinder which both separates a rivet and injects it. This is a simplification over previous track fed riveting machines in which the separator and the injector are two different actuations.



Figure 9: Flexible riveter hopper



Figure 11: Air cylinder injecting rivet

Figure 12 shows the jam which occurs in conventional mini-hoppers. If the rivets reverse shingle, which occasionally will happen, the shank of the rivet jams the separator. This is particularly a problem for longer rivets. Note in Figure 13 that even in the case of reverse shingling the separator will not jam for this riveter, because the separator and the injector are rotated 30 degrees to be in line with the rivet path. This is facilitated by the fingers rotating 30 degrees from vertical to meet up with the injector.

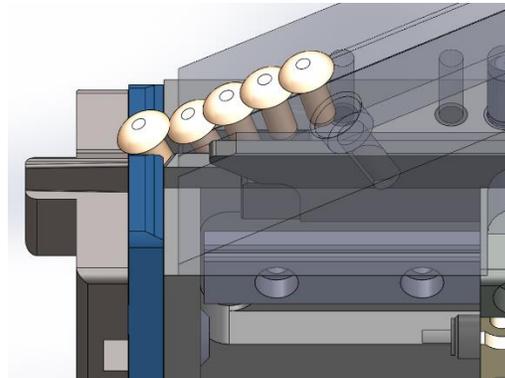


Figure 12: Example of rivets jamming in conventional mini-hoppers

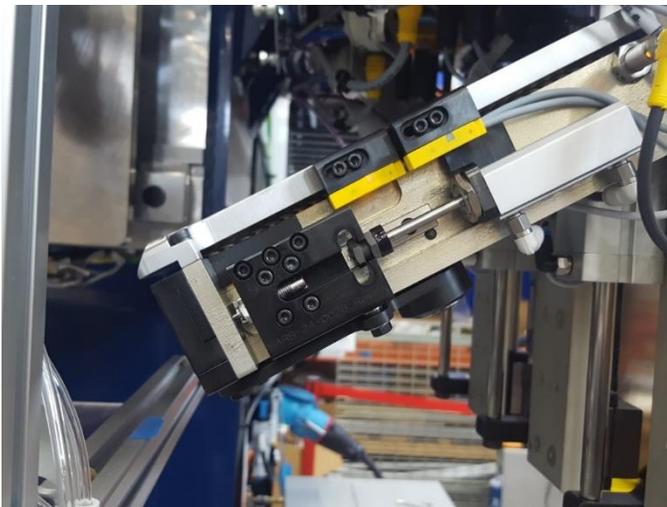


Figure 10: Air cylinder separating rivet

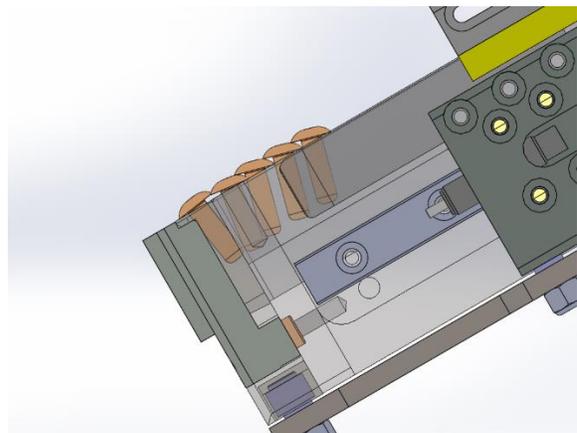


Figure 13: Flexible riveter feeding unjammed rivets

A different style of feeder called a hanger (Figure 13) is used for extremely long fasteners. The bottom is open so long fasteners, such as pintails, can be reliably fed.



Figure 14: Hanger feeder for extremely long fasteners

Bolt and rivet install

Figure 15 shows the variety of parts that can be reliably fed and installed with this riveter design.



Figure 15: Wide variety of parts flexible riveter can feed

This riveter uses roller screw actuators for both the upper ram and lower ram actuation. This allows the wide variety of parts, both bolts and rivets, to be installed. The design upset load is 20kip, but this can be adjusted upward and downward as desired.

Spindle with automatic power drawbar

Flexible riveting machines use the Precise SD60124 spindle with power drawbar. Figure 16 shows the drill holder which is an HSK 40.



Figure 16: HSK 40 drill holder

Fully automatic fastener diameter change

Figure 17 shows the saddle hoppers that are mounted on a slide track which can be moved with a servoed ball screw (not shown). Eight hoppers can be mounted; four could be 5/32" and four could be 3/16". If two rivet diameters are required, it is now feasible to change diameters by simply sliding the hoppers and changing the upper anvil and cutter. In previous technology of track fed riveting machines the rivet track had to be manually changed out. This design eliminates the separate rivet track.



Figure 17: Saddle hoppers

Side mounted robot

This riveter comes equipped with a side mounted Kuka KR10 programmable robot (Figures 2 and 3). The robot is mounted on the right side and the operator pendant is on the left side. This keeps the operator safe from the robot. The robot is linked to the riveter Siemens PLC control so it can complete coupons of various types. The side mounted robot can also allow the riveter to complete small assemblies. For larger assemblies you use a larger robot or a CNC positioner. This robot can be used to automatically change out the anvils and drill chuck.

Conclusion

This flexible electric riveter simplifies several different features of fastener installation and increases reliability and flexibility of the riveting process.

The jamming problems with feeding square rivets are eliminated by using a bent knee upper ram that brings the rivet fingers directly to the saddle hopper, eliminating the need for a track between the hoppers and the rivet fingers as used on earlier conventional riveters.

In addition, the side mounted robot increases the flexibility of the riveter by providing multiple options for manipulating anvils, drill chucks, test coupons and small assemblies.

This riveter has fully automatic fastener diameter change, provided by mounting the hoppers on a sliding track and using the side mounted robot to change the anvils and cutters. This eliminates a manual operation to switch fastener diameters.

Contact Information

Please contact Peter Zieve at 425-348-8090 or peterz@electroimpact.com with any questions.

References

US Patent #10,065,235 B2: "System using an airgap for workpiece protection in a fastening machine." Peter B. Zieve, Reese R. Allen and Cosmos G. Krejci, granted September 4, 2018.

Zero clamp Schunk Mini 90:
https://schunk.com/us_en/homepage/vero-s/

Problems with installing square rivets: Bigoney, B and Huddleston, N., "Automated Riveting of C-130J Aft Fuselage Panels," SAE Technical Paper 2017-01-2075, 2017, <https://doi.org/10.4271/2017-01-2075>.