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Semi-Automatic Riveter G39 Replacement

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Abstract

This paper reports on a new design of semi-automatic riveting machine designed to be affordable. This work started in 2024. There are no customers yet. The machine is all electric. The machine installs interference bolts as well as squeeze rivets. Cost is a key criterion. The machine must feed a wide variety of fasteners. This machine is called Flexriveter.

Introduction

A semi-automatic riveter is a machine where the part is presented manually, and the machine installs a rivet or bolt along the drill axis. The functionality of the semi-automatic riveter is to clamp the part, drill a hole with countersink, insert and set the fastener. Optional operations include lubricant spray for drilling, sealant application and location acquisition by various means. If the part location is acquired automatically the machine becomes an automatic riveter. This paper is about a new design for a semi-automatic riveting machine that takes advantage of modern components. The resulting machine remains flexible and can be adapted to a broad range of applications.

Historical Semi-Automatic Riveting Machines

Up until now semi-automatic machines have all been hydraulic machines. Either with a hydraulic pump or air over oil. The supply of semi-automatic riveters was dominated by Gemcor with the iconic G39 machine. G39 is a hydraulic machine with saddle hoppers. They were manufactured until 1966. Another supplier was ITC which produced an air over oil machine. ITC stopped making riveting machines in 1999. The air over oil design was passed along to Townend aerospace. The inspiration of their design was Herb Cupp. Herb moved from ITC to Townend and then joined forces with Electroimpact in 2016. On that date Townend Aerospace stopped supplying riveting machines. Electroimpact (EI) supplied one EI-12-84-C machine of Herb's air over oil design to Textron in 2019. Hydraulic and air over oil machines are not desirable when all electric technology is available as an option. The oil eventually leaks out, makes a mess and creates a fire hazard. An all-electric machine is desirable.

Squeeze Components

Electroimpact now introduces the first all-electric semi-automatic riveting machines. For the upset force ball screw jacks look attractive. These are made by a variety of manufacturers including Nook, Duff-Norton and Power Jacks. They combine a worm gear reducer, a rotating ball screw nut and a thrust plate. They are commonly used for jacking up construction items. But in this case, they are used for squeezing rivets. Power Jacks were chosen because they present with a metric drive shaft. The Power Jacks had adequate load capability for squeezing ¼ rivets. These are way over specified for the 3/16 or smaller rivets that this machine will upset.

The same Powerpacks were ordered for the upper and lower ram. For both jacks the ball screw has a 20mm pitch and the input shaft is geared down at 8:1. Therefore for each rotation of the motor shaft the ball screw moves up or down 2.5mm.

Power Jacks were the most economical solution. The reasonable price of the Power Jacks is one of the factors that allow us to sell this all-electric machine for the same price in 2025 that was charged for an air over oil machine in 2019.

In this design both the upper and lower ram are guided by a linear bearing to bolster the accuracy and stiffness. The upper jack is designed to operate with the load below the mounting flange and the opposite for the lower jack.

FIGURE 1 Semi-automatic riveter

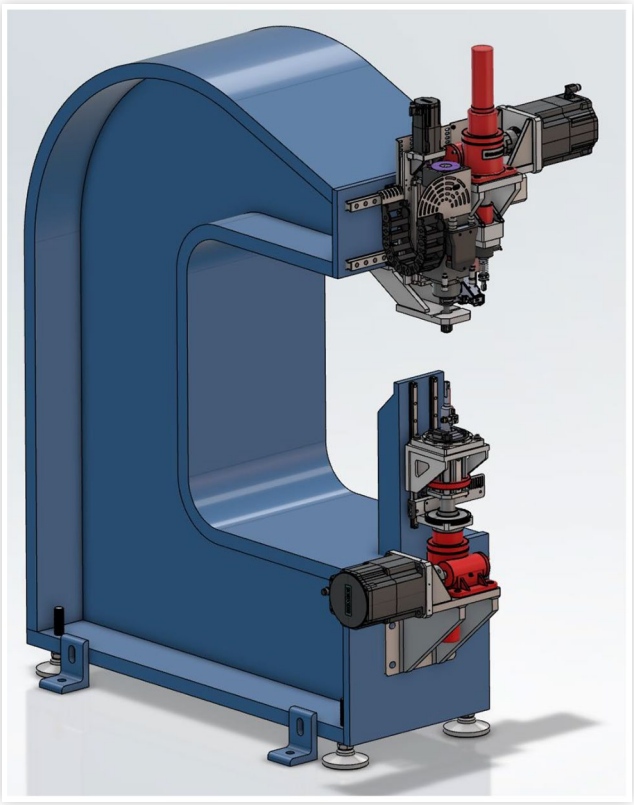


FIGURE 2 Hiteco spindle

Spindle and Tooling

The spindle utilized is Hiteco model QF-1D. This is a low-cost spindle with good performance up to 24,000 RPM. The power rating is 4.5 kW. The drill tool holder is ISO 30. There is a drawbar release switch on the side of the spindle. See the spindle in Figure 2. A standard drill extension allows the use of short drill bits which are less expensive. There is a small collet in the distal end that grips the drill bit. See the ISO 30 drill tool holder in Figure 4.

The riveter is designed around the G100 tooling family. This is a tooling style that was originally designed by Gemcor but is now available from a variety of sources such as Electroimpact and Pacific Tool. See Figure 3. Going from left to right is the upper inserter for universal head rivets, then for flush head rivets, and then lower ram and last is upper clamp nosepiece, all for 3/16 inch rivets.

FIGURE 3 G100 tooling used on Flexriveter

Fastener Feed

The Flexriveter was equipped with a single mini hopper. The mini hopper must be swapped when changing from one rivet style to another. This mini hopper is an older design. It is the same style of mini hopper which EI supplied to all of the Townend Aerospace customers. An advantage of a mini hopper is that it can feed square rivets. A design is being progressed in where the Flexriveter can hold six mini-hoppers simultaneously and feed from whichever one is desired.

Controls

The riveter is controlled by a Siemens S7-1515F PLC with integrated I/O. The Siemens PLC is an excellent motion control platform, and the 1500 series PLC provides

FIGURE 4 Drill chuck used on Flexriveter

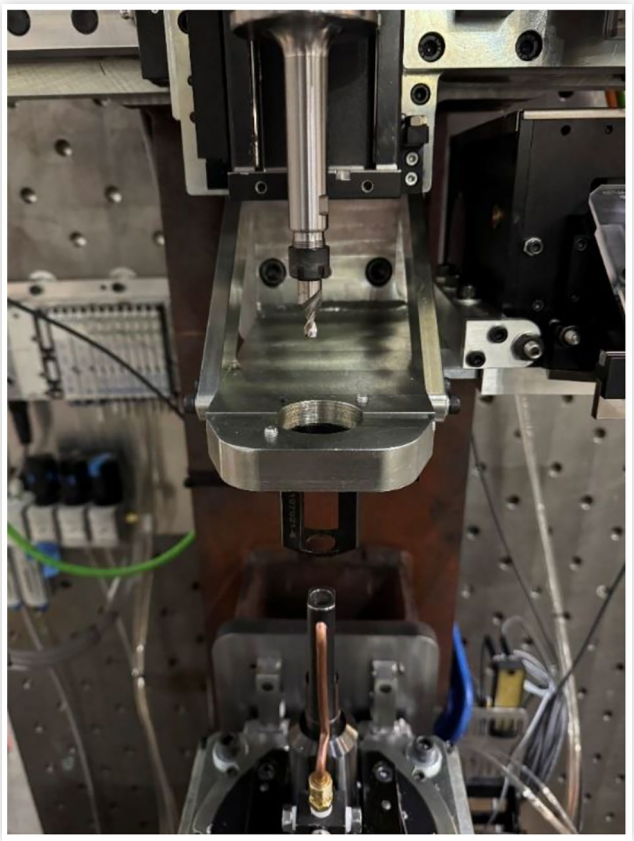


FIGURE 5 Flexriveter is equipped with a single Mini hopper.

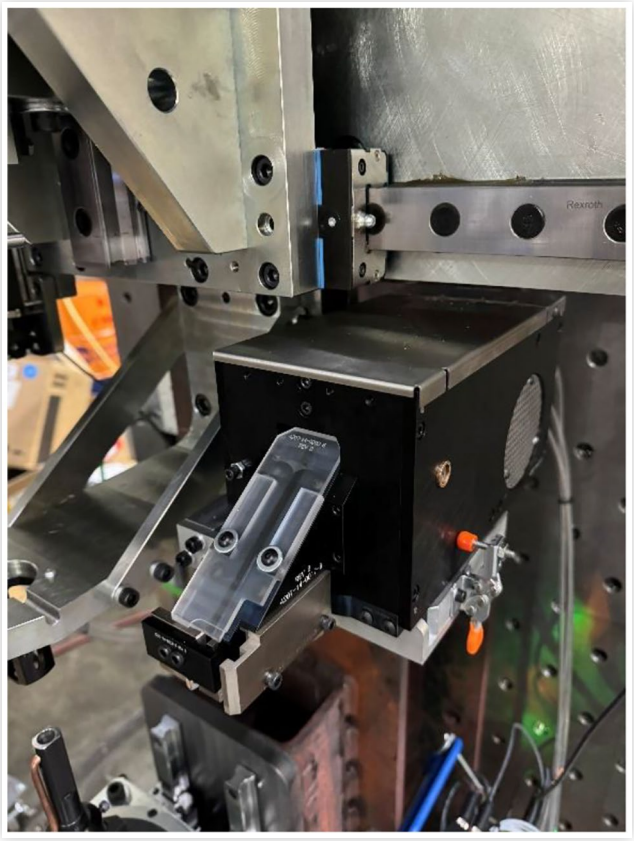
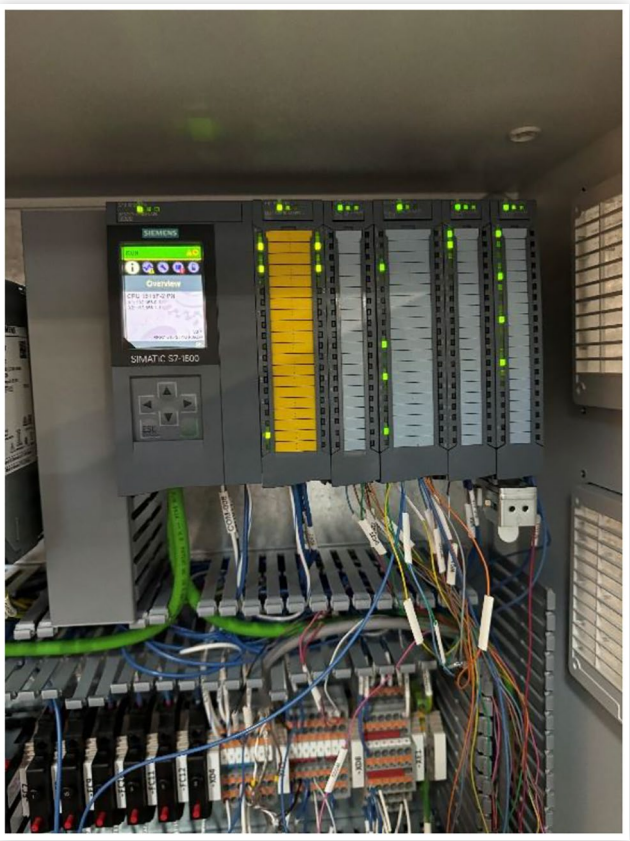


FIGURE 6 Siemens PLC controls the riveter



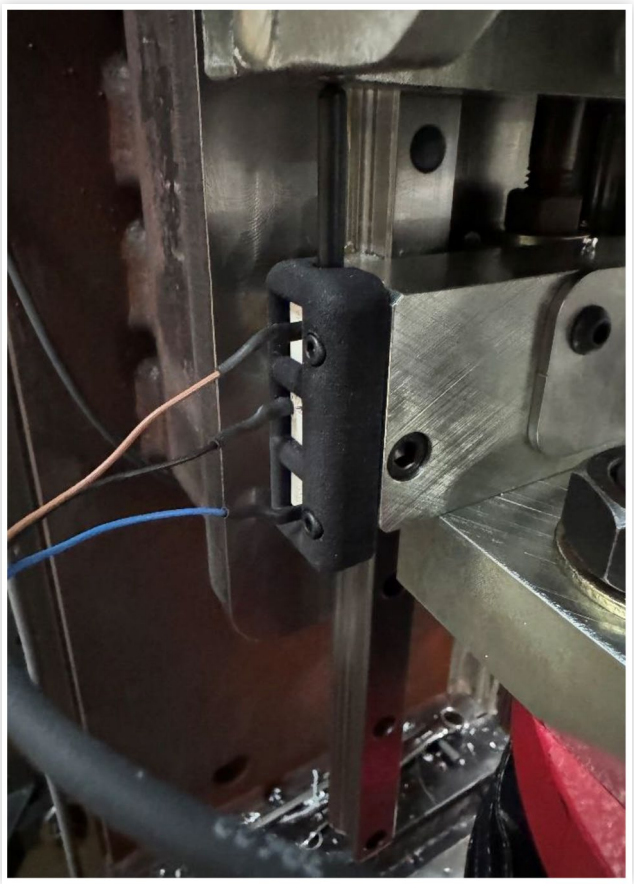
performance, industrial reliability, an integrated servo and I/O ecosystem that is easy to package and maintain. Programming of the PLC and Servo Configuration is all done in the TIA Portal V19 software package. Software provides excellent diagnostics information, and the option of factory connections for Industry 4.0 makes the 1500 series PLC an excellent choice for ensuring minimal downtime. The servo system is the Sinamics S210. system. See the Siemens PLC in Figure 6.

Sequence of Operation

Flexriveter works in squeeze to position mode and not in squeeze to force mode. The Flexriveter can do either mode if equipped with a load cell. See the potentiometer in Figure 7. The coupon is held at the location where a rivet is desired. The following is the sequence of machine operation:

1. The lower ram rises until the lower clamp cylinder is slightly compressed and the coupon is clamped. The deflection of the clamp cylinder is measured by a potentiometer.
2. The spindle spins up and lowers until the hole is drilled or the countersink is made.
3. At the same time as the drill is stroking a rivet is injected into the rivet fingers.

FIGURE 7 Potentiomer is used to determine rivet upset



4. The shuttle table transfers to the rivet insert position
5. Upper ram lowers down and inserts the rivet
6. Lower ram rises to lower surface minus the desired rivet head height minus the potentiometer position.

Test Bench

A test bench was built to test out the new components. The goal of the test bench was to see all of the components working together and make final adjustments to the design. For example the G100 tooling would be tested on an all-electric machine and with the Power Jacks. You can see the test bench in Figure 8. Since the C-frame is not yet ready the components are bolted to a strong-back beam. All the selected components worked well but many improvements to the design were noted. The Power Jacks, the Siemens servos and the G100 tooling worked well together. The test bench installed good rivets, and the components did not fail.

The test bench was effective. Many good rivets were installed. See them in Figure 9. The rivets installed were MS20470AD6-5.

FIGURE 8 Riveter test bench

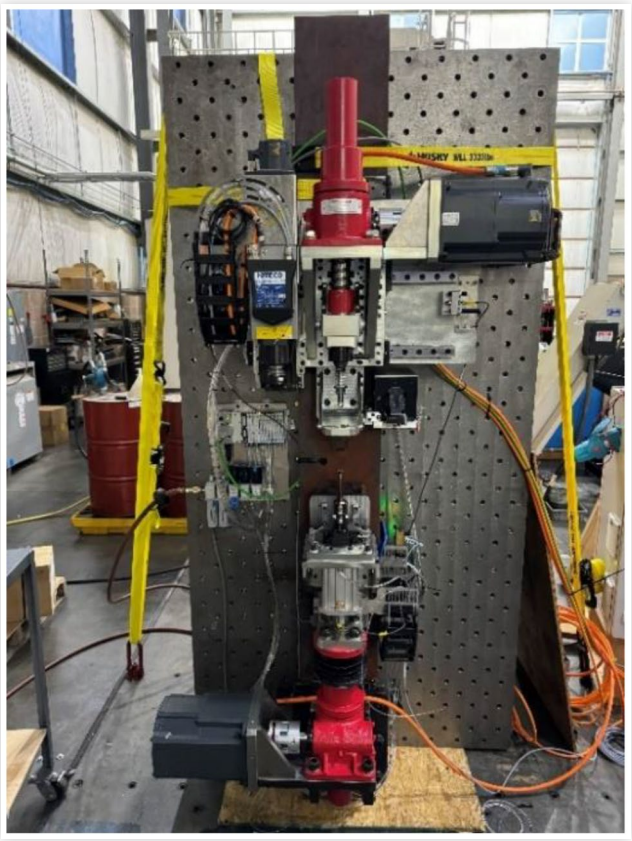


FIGURE 9 Rivets 3/16 installed by test bench

TABLE 1 Results from measuring ten rivets

number	Diameter in X	Diameter in Y	Tail height
1	.259	.250	.076
2	.260	.258	.076
3	.262	.262	.077
4	.257	.257	.076
5	.260	.258	.075
6	.258	.261	.075
7	.258	.258	.075
8	.257	.255	.076
9	.257	.257	.076
10	.256	.256	.077

The formed tail of ten rivets were measured. The results in inches are shown in Table 1.

Reviewing Table 1 the driven button diameter should equal or exceed 1.3 times the shank diameter. The tail height should equal or exceed 0.4 times the diameter. The results are all good.

Quality

A metric of the machine quality is the consistency of the diameter of the bucked rivet tails. See Table 1. The consistency is very good, a fraction of the tolerance.

Conclusion

The low-cost semi-automatic riveter development is successful and the Flexriveter machine is effective. The use of modern controls renders the “all electric” ideal to be readily attainable. A low cost Siemens PLC can now be used successfully and yields good rivet quality. There is no reason to go back to hydraulic or air over oil. An area of focus for future development is to find methods to mount multiple mini hoppers on the machine. The use of standard G100 tooling has been a success.

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