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.

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.
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.

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.
**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).

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**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 actuators.
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.
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.

![Image 14: Hanger feeder for extremely long fasteners](image1)

**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](image2)

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](image3)

**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.
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.

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References

