A Paper on Study & Design of Multipurpose Riveting Machine

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Abstract – *The successful implementation of any manufacturing sector is largely depend upon the quality & its productivity. In traditional machining process for performing the different operation a separate machine required which becomes a time consuming also the inaccuracy in productivity due to involvement of human error which affects to productivity cannot be get improved at faster rate .the main purpose of this paper to develop special purpose machine for drilling and riveting machine which leads to improve the quality and productivity by minimizing the time period. in this process two or more operation can be performed simultaneously due to this cost of a material reduces.*

Key Words: Riveting, Productivity, Automation, OHNS, Drilling.

1. INTRODUCTION

The conventional machining process consists of pull riveting and push riveting .basically these are,

1. Push riveting - In this process usually a pneumatic hammer is used where the riveting head or punch is mounted on the machine which is moved to and fro by pneumatic power, the rivet is solid in this case. The rivet is positioned in the hole between the mating parts and then the rivet portion projecting out of the joint is formed by the impact of the rivet head. This process requires considerable force and only fixed joints can be formed. There is a chance of the work-piece to be damaged due to impact. This process is used for joining solid steel elements and finds less application for hollow components.

2. Pull riveting – In this process a scissor riveting machine operated either manually or by power (electric / pneumatic) is used. In this process is hollow and the pull force is applied on the nail projecting out of the rivet. The nail is gripped in the gripper head of the machine and is pulled to form the rivet head. This process is relatively fast. This process is used in production of sheet metal bodies, cabins etc.

Thus the above mentioned process required considerable force and only fixed joint can be formed also there is a chances of failure of work piece due to impact. therefore developing world performing drilling and riveting operation simultaneously on individual machine which becomes complicated for workshop and various batch and mass production. In this advertence attempt had been made to develop a machine which can perform drilling and riveting operation instantaneously on the same machine. the entire machine concept feed most concise economical and portable design which was very easy to handle and simple in operation by manually.

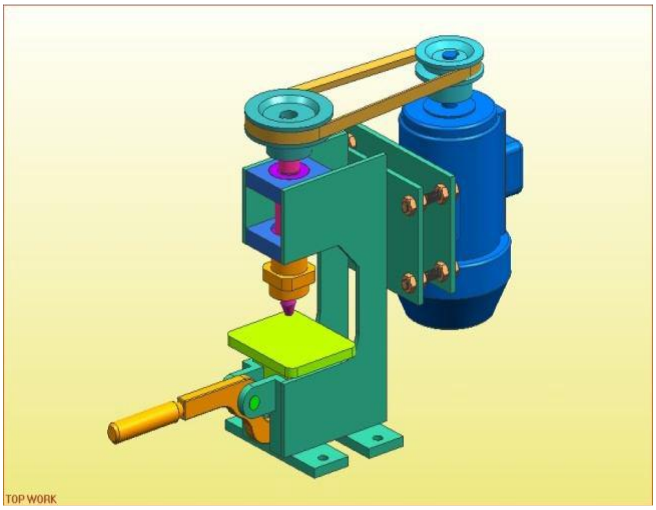

Fig -1. Orbital riveting machine [6]

Basically, orbital riveting machine consist of Three phase induction motor transmit power to drive mechanism through belt and pulley arrangement. In this mechanism we used two spindles on machine to reduce the time period for greater accuracy and productivity with 3-6 degree offset spindle used. The material of the rivet can be spread over the work piece in desire shape is mostly depends upon the design of tool.

2. COMPONENT OF ORBITAL RIVETING MACHINE

The system should be compact enough so that it can be accommodated at a corner of a room. All the moving parts should be well closed & compact. A compact system design gives a high weighted structure which is desired.

1. 3-Phase Induction motor: The motor used in the machine is 3-phase induction motor, Power-0.5 Hp, Speed-1440 rpm, Foot mounted.
2. Motor pulley: it is used for transmit the power from motor to the main spindle Motor pulley (2.5" diameter), is a cast iron pulley single groove 'A-Section', keyed to the motor shaft.
3. Spindle Pulley: Spindle pulley (4" diameter), is a cast iron pulley single groove 'A-Section', keyed to the main spindle. Thus the transmission ratio1:1.6, i.e. the spindle rotates at 900 rpm.
4. Belt: Belt is an 'A-Section' belt with included angle 40^0 length 29 inches, hence the designate 'A-29'.
5. Top Spindle housing: It is rectangular element made from structural steel.EN9, bolted to the C-frame. It carries the single row deep groove ball bearing 6005zz.
6. Bottom spindle housing: it is a rectangular element made from structural steel EN9, bolted to the C-frame. It carries the single row deep groove ball bearing 6005zz.
7. Ball Bearings: The spindle locate at the top and bottom ends in single row deep groove ball bearing 6005zz. Internal & external diameter of bearing is 25 mm & 47 mm. the width of bearing is 12mm.
8. Spindle: The spindle is a high grade steel member (EN24), The spindle carries the spindle pulley at the top end where as the tool holder at the bottom end. The spindle runs at high speed 900 rpm.
9. Tool Holder: The tool holder is high grade steel member (EN24), held to the spindle at the lower end. The tool holder holds the rivet set (tool) at an angle 5^0, to the spindle axis.
10. Rivet set (Tool): The rivet set or tool is a hardened steel component OHNS (Oil Hardened Non

Shrinkage Steel).The rivet set is provided with cavity at its lower end according to shape of the rivet head to be formed. It is placed at an angle 5^0, to the spindle axis and is held in the tool holder. It is basically a fixture to the hold the job while carrying out the riveting operation. The work holder is held on the work table.

11. Work table: Work table is made from structural steel (EN9), it is basically a table to the hold the work holder while carrying out the riveting operation. The work table is held on the Table slide.
12. Table guide: Table guide is made from structural steel (EN9), it is basically a guide to the hold the Table slide while it moves up or down while carrying out the riveting operation. The Table guide is bolted to the C-frame.
13. Rollers: Rollers are basically two ball bearings namely 6002 and 6201 held on the end of the Feed handle on the handle roller pin, it moves the table slide up or down when the feed handle is operated. Pin is made from hardened steel (En24).
14. Feed handle: Feed handle is mounted in the handle hinge; it carries the roller at one end and the know about other end. It moves the table slide up or down when operated.
15. Handle Hinge: Handle hinge is fabricated from MS, it is welded to the C-Frame, it carries the hinge pin on which the feed handle is mounted.
16. C-Frame: The C-Frame is the basic structure of the machine on to which entire assembly of machine is made. It is made of Mild steel.
17. Belt Tension adjuster: Belt tension adjuster is arrangement to adjust the tension in the open belt drive. It comprises of basically four M10 bolts and motor plate. The position of the lock nuts is adjusted to adjust the belt tension

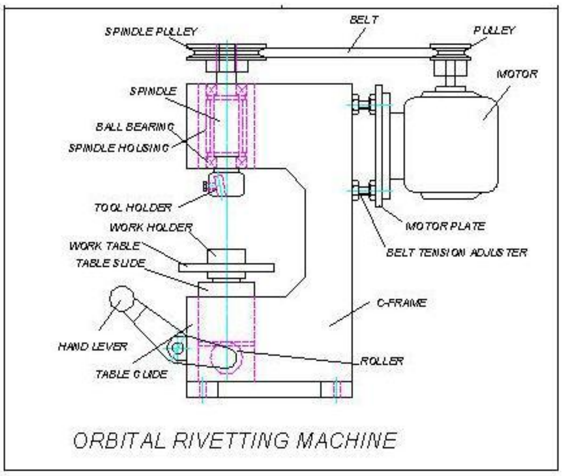

Fig 2. Orbital Riveting Machine [06]

3. WORKING OF ACTUAL MACHINE

Motor is started which rotates the main spindle at high speed. The tool or rivet set mounted in the tool holder rotates at high speed. The job to be riveted along with the rivet is placed in the work holder .The feed handle is pressed in the downward direction to lift the table slide and table in the table guide by means of roller arrangement. The tool spins about the rivet projecting out of the joint thereby cold forming the head on the rivet side. The amount of pressure applied depends upon the type of joint i.e., fixed or hinged to be done. After riveting is done, the feed handle is released which brings the table slide down by self-weight. Job is replaced in holder to form the next riveting joint.

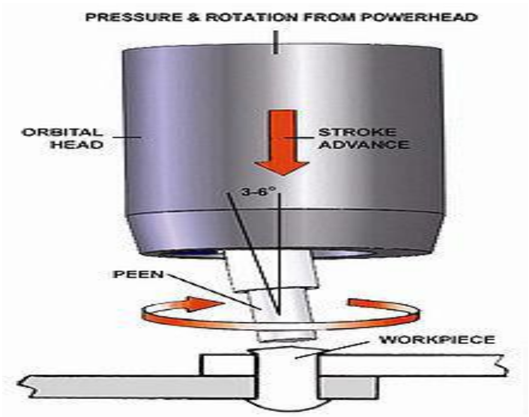

Fig 3. Principle of Operation [1]

4. DESIGN PROCEDURE

Design consists of application of scientific principles, technical information and imagination for development of new or improvised machine or mechanism to perform a specific function with maximum economy & efficiency .Hence a carefully design approach has to be adopted.

- System design.

In system design we mainly concentrated on the following parameters: -

1. System Selection Based on Physical Constraints - While selecting any machine it must be checked whether it is going to be used in a large-scale industry or a small-scale industry. In our case it is to be used by a small-scale industry. So space is a major constrain. The system is to be very compact so that it can be adjusted to corner of a room.

2. The mechanical design has direct norms with the system design. Hence the for most job is to control the physical parameters, so that the distinctions obtained after mechanical design can be well fitted into that.

3. Arrangement of Various Components- Keeping into view the space restrictions the components should be laid such that their easy removal or servicing is possible. More over every component should be easily seen none should be hidden. Every possible space is utilized in component arrangements.

4. Components of System -As already stated the system should be compact enough so that it can be accommodated at a corner of a room. All the moving parts should be well closed & compact. A compact system design gives a high weighted structure which is desired.

5. Man Machine Interaction- The friendliness of a machine with the operator that is operating is an important criterion of design. It is the application of anatomical & psychological principles to solve problems arising from Man – Machine relationship. Following are some of the topics included in this section.

   - Design of hand lever
   - Energy expenditure in foot & hand operation
   - Lighting condition of machine.

6. Chances of Failure**-** The loss incurred by owner in case of any failure is an important criterion of design. Factor safety while doing mechanical design is kept high so that there are less chances of failure. More over periodic maintenance is required to keep unit healthy.

7. Servicing Facility- The layout of components should be such that easy servicing is possible.

Especially those components which require frequents servicing can be easily disassembled.

8. Scope of Future Improvement- Arrangement should be provided to expand the scope of work in future. Such as to convert the machine motor operated; the system can be easily configured to required one. The die & punch can be changed if required for other shapes of notches etc.

9. Height of Machine from Ground-For ease and comfort of operator the height of machine should be properly decided so that he may not get tired during operation. The machine should be slightly higher than the waist level, also enough clearance should be provided from the ground for cleaning purpose.

5. MANUAL CALCULATIONS

As per the requirement of the use machine has been designed.

Δ = mean thickness of deforming zone / length of deforming zone

$\Delta = h/2L$

$\Delta = 3/2(4) = 0.375$

$\Delta = 0.375$

$C = 0.8 + 0.2\,\Delta$

$= 0.8 + 0.2\,(0.375) = 0.875$

Where = Constant (Constraint factor) =0.875

σ = mean flow stress = 120 N/mm2

A = Forging projected area; mm2

$= \pi \times D2 /4$

$= \pi \times 32 /4 = 7.06$ mm2

$P = \sigma\, A\, C$

$= 120 \times 7.06 \times 0.875$

$= 741.03$N

Most of the work during orbital forming is focused at the tool's line of contact, not along the entire tool surface. This reduces axial loads by as much as 80%, which has several advantages.

Hence

Peff = 0.2 x 741.03 = 148.26N

Peff =149 N

This is the load that acts in the downward direction while forming the rivet, whereas the rivet head diameter is 6mm, hence the torque required at the spindle is given by:

T = Peff x r

= 149 x 3

= 447 N-mm

T = 0.447 N-m

Power required at spindle is given by,

$P = 2\,\pi\, N\, T /60$

$= 2\,\pi \times 900 \times 0.447 /60 = 42.12$ watt.

P= 42.12 watt.

VI. DESIGN OF MAIN SPINDLE.

Torque Analysis:-

Torque at spindle is given by;

$$Ts = \frac{975\,\Delta}{n}$$

$$\Rightarrow Ts = \frac{975 \times 0.375}{1440}$$

Ts = 0.253 kg .m

$\Rightarrow$ Ts = 2.53 Nm

Considering 25 % overload;

Design = 1.25 Ts

= 1.25 x 2.53

=3.10 Nm

$\Rightarrow$ Design = 1.5234 Nm

Planning an 1 stage transmission

Selection an open belt drives using V-belt;

1) Motor Pulley- (ϕ D1) = 2.5”

2) Spindle Pulley (ϕ D2) = 4”

Ratio = 1:1.6

Spindle transmission speed = 1440 rpm

Spindle Torque = Design x 1.6 = 4.973 N-m

D_{esign} = 4.973 Nm.

Ultimate Tensile Strength N/mm^2=720

Yield Strength N/mm^2=600

Using ASME code of design;

Allowable shear stress; fall is given stress;

Fa_{ll} = 0.30 sall= 0.30 x 60 =180 N/mm^2

Fa_{ll} = 0.18 x Sall= 0.18 x 720

= 130 N/mm^2

Considering minimum of the above values;

Fall = 130 N/mm^2

As we are providing key way on shaft;

Reducing above value by 25%.

⇒ Fall = 0.75 x 130 = 97.5 N/mm^2

a) Considering pure torsional load; Minimum section on the spindle as per system drawing is 20mm

$$D_{esign} = \frac{\Pi \; fa_{ct} \, d^3}{16}$$

$$\Rightarrow \quad Fact = \frac{16 \times T}{\Pi \times d^3}$$

$$Fact = \frac{16 \times 4973}{\Pi \times 20^3}$$

Fact = 3.1659 N/mm^2

As $fa_{ct} < fa_{ll}$

Spindle is safe under pure torsional load.

The materials commonly used for cold working orbital riveting rivet materials include:

1. Low and medium carbon steel. (C07 or C10)
2. Low alloy steels
3. Copper
4. Aluminum

6. APPLICATION

1. Leather work, tools, toys, kitchen utensils, general hardware.
2. Scissors, pliers, hinges, etc.
3. Parts subjected to thermal cycling. Eg. ,Boiler shells
4. Riveting machines are used in a wide range of applications including brake linings for commercial vehicles, aircraft, and locomotives, textile and leather goods, metal brackets, window and door furniture, latches and even mobile phones. Many materials can be riveted together using riveting machines including delicate and brittle materials, and sensitive electrical or electronic component.

7. CONCLUSION

The successful implementation and growth of any manufacturing industry deals with its market demand also the productivity. With the help of design machine we can do drilling and riveting operation on the same machine which leads to improve the productivity by minimizing the time factor.

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