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DESIGN AND FABRICATION OF CNC FIXTURE FOR A SPRING SHEET COMPONENT

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Abstract: **In machining fixtures, minimizing work piece deformation due to clamping and cutting forces is essential to maintain the machining accuracy. Fixture is required in various industries according to their application. This can be achieved by selecting the optimal location of fixturing elements such as locators and clamps. The fixture set up for component is done manually. For that more cycle time required for loading and unloading the material. So, there is need to develop system which can help in improving productivity and time. Fixtures reduce operation time and increases productivity and high quality of operation is possible. The fixture designing and manufacturing is a complex process that demands the knowledge of different areas, such as geometry, tolerances, dimensions, procedures and manufacturing processes. The basic requirement of a fixture is to locate and secure the work piece in the correct orientation and relationship so the manufacturing process can be carried out according to design specifications. Fixture being an essential part of any of the machining process, acts as a supporting system..**

Index terms- **Fixture design, Fabrication, Fixture and Spring sheet,**

I. INTRODUCTION

The successful running of any mass production depends upon the interchangeability to facilitate easy assembly and reduction of unit cost. Mass production methods demand a fast and easy method of positioning work for accurate operations on it. Jigs and fixtures are production tools used to accurately manufacture duplicate and interchangeable parts. Jigs and fixtures are specially designed so that large numbers of components can be machined or assembled identically, and to ensure interchangeability of components. [1] N.P.Maniar and D.P.Vakhariya have introduced the proposes direction for future research of fixture. In his paper basic requirements of fixture, phases of fixture design, flexible mechanical fixtures, locating and clamping consideration, fixture design process and computer aided fixture design have explained very well for the Design and Development of Fixture. [2] Makwana and Gosavmi have found that there are different steps and approaches are available for designing the fixture. Among those geometry method (3-2-1 principle) and it is very useful for the complex fixture design though it is the basic principle of the fixture design.

A. Jigs:

It is a work holding device that holds, supports and locates the work piece and guides the cutting tool for a specific operation. A jig is a type of tool used to control the location and/or motion of another tool. A jig's primary purpose is to provide repeatability, accuracy, and interchange ability in the manufacturing of products. A device that does both functions (holding the work and guiding a tool) is called a Jig. An example of a jig is when a key is duplicated; the original is used as a jig so the new key can have the same path as the old one.

B. Fixture*:*

It is a work holding device that holds supports and locates the work piece for a specific operation but does not guide the cutting tool. It provides only a reference surface or a device. Fixtures provide a means to reference and align the cutting tool to the work piece but they do not guide. Each fixture is unique as it is built to fit a particular part or shape. The main purpose of a fixture is to locate and in some cases hold a work piece during either a machining operation or some other industrial process. Fixtures that have the added function of guiding the tool during manufacturing are called jigs. Example: chucks.

C. Spring sheet:

Spring sheet is a component made up of mild steel alloyed with Carbon, Silicon, Manganese, Potassium, Copper, Sulphur and Aluminum of different proportions based on the requirement. Spring sheet is used in medium and heavy duty vehicle axles. Spring Sheets are used by companies like Automotive axle Limited, Wipro industries, KTMS, etc.

Fig.1.3 Spring sheet component

Spring sheets are forged to required dimension which has taper section at one half. Then the component undergoes specific machining operation. The spring sheet must be clamped on a fixture having an angled plate or block to account the taper of the component.

II. TYPE OF MACHINING OPERATIONS CARRIED OUT ON THE SPRING SHEET IN THE GRS ENGINEERING PRIVATED LIMITED

- Top surface facing operation
- Drilling operation
- Finishing operation

A. Top surface facing operation:

Fig.2.1.Top surface facing operation

In this operation first spring sheet has to be held in U shape block fixture which has angle plate to compensate the taper of the component. Spring sheet is seated on a center block and then it is tightened with bolts and keys. Once spring sheet is clamped on a fixture, top facing operation is to be carried out. After achieving of the required dimension, spring sheet undergoes next operation.

B. Drilling operation:

Fig.2.2 Drilled components

Drilling operation is 2nd operation, carried in the same machine

set up with tool change to drill bit in the pallet of the CNC. A

17.5mm hole will be drilled with the help of drill bit. After drilling, reaming operation is carried to size the drilled hole. Fig.2.2. shows the drilled components and unmachined components. Drilling carried on at top face of spring sheet which already machined in first operation. After completion of drilling operation, next operation is finishing operation that is final operation with help of burr removal tools.

C. Finishing Operation:

Fig.2.3 Burr removal process and packed components

The machined component will have burrs and sharp edges which are necessary to remove else which may cause harm to workers while handling or may cause problem during assembly with other parts. To remove burrs and sharp edges manual deburring operation is done with the help of burr removal hand tool. Then the component is applied with the rust preventive oil. The component is sent to final inspection where component number is printed and dipped in rust preventing oil-axonal 33cd or Caster oil and hydraulic oil. Then the components are ensured for rusts, dents, cracks, burrs etc. and packed in a VCI covers. Packed components are shipped to the predetermined destinations.

III. PROBLEM DEFINITIONS

Fig.3 CNC fixture

As we know that current fixture shown in fig.3 is used to hold the spring sheet component during machining operation on a CNC. But it causes two problems if component is not properly clamped on the fixture i.e component taper gets reduced and position of the drilled hole gets shifted from the desired position. These problems lead to defective components.

A. Taper reduction:

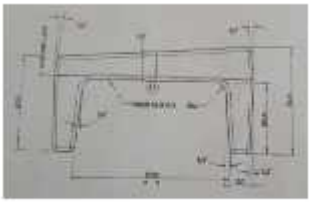


Fig.3.1 Spring sheet drawing

The Spring Sheet must be clamped properly on the Fixture. The fixture has angled plate which accounts the taper of the component. When the Spring Sheet is clamped on the fixture the top surface of the component will be parallel to the base plate of the fixture i.e. parallel to X-axis in spite of taper of the component. So butting should be made properly to get a straight surface else during top surface facing operation more amount of material will be removed and taper gets reduced which is undesirable.

3.2 Hole position shift:

Fig.3.2 Defective component

To keep the Spring Sheet firmly on the Fixture locating and locking pins are used. If the pins are insufficiently tightened the component vibrate during machining operation due to cutting forces acting on the component which causes undesired material removal. And if the pins are over tightened the component will move from the desired position during adjusting pins. So the drilled hole will be not at the required position. Sometimes the distance that the hole has shifted will be more than the specified tolerance. So all these process takes more time in loading and unloading of a component which increases lead time.

Fig.3.3 Ideal CNC 3 jaw chuck fixture

After studying the problems of old fixture, we feel that adjustment of locating and locking pins are the main drawback and it should be modified. With these problems loading unloading of component required was 2 min 34sec. So number components produced are 10-12components per hour. For workers also it was not ease of handling. So we took this challenge to design a new fixture in order to overcome all problem of old fixture. Fig.3.3shows the ideal modified CNC 3 jaw chuck fixture and the fixture has 3 jaws which holds the component simultaneously. So component will be positioned properly at the center which eliminates the hole position shift problem.

IV. DESIGN AND FABRICATION OF 3 JAW CHUCK FIXTURE

A. Design of 3 Jaw chuck base plate: Material: mild steel & Standard: ISO 9001

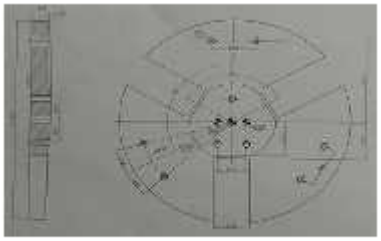


Fig.4.1 Base plate

Fig.4.1 shows the design detail of base plate having outer diameter of 315mm. It has 3 slots to fit the 3 jaws of the fixture. These 3 jaws hold the component firmly at the center. The base plate is fitted to CNC machine with the help of nut and bolts. It has center space provided for center block to support the spring sheet component. The inner surface of the component rests on the fixture.

B. Wear pad design:

Material for wear pad: Mild steel & Standard: ISO9001

The main advantage of wear pad is to avoid wear of the fixture. The wear occurs due to contact with the component which is under cutting forces. The surface of the component and fixture rubs against one another which lead to wear over the period of time. To avoid the wear, wear pad will be provided between fixture and the component. The wear pad is about 60mm broad and 32mm length. It has two holes of outer diameter 10mm and inner diameter of

6.5mm.

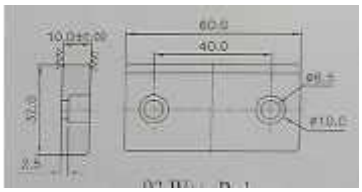


Fig.4.2 Wear pad design

C. Support blocks design:

Material for support block: Mild steel & Standard: ISO9001

The support block provides support to the component. The component has taper at one end. The inner surface of the component is placed on the center support block. The support block has taper at one end to compensate the taper of the spring sheet component. So when the component is placed on the center support block the surface of the component will be flat and parallel to horizontal axis. The support block has chamfer at the ends to provide grip to the component to sit firmly on the support block. A chamfer of 20mm distance and 45 degree is provided. The support block has taper of 4 degree. The support block is 111mm length and

62mm breadth. The support block is mounted on the base plate with the help of nut and bolts. It has 3 dowel pins of diameter

12mm to fit the block on the base plate of the fixture.

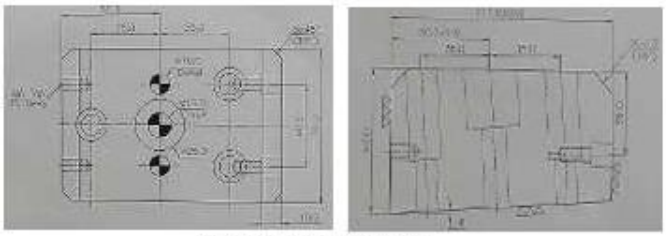


Fig.4.3 Support Block

D. Three jaw Chuck fixture and spring sheet component:
Material for 3 jaw chuck: Mild steel & Standard: ISO9001

The fixture has base plate, wear pad, center support block and three jaws. Base plate is mounted on the CNC plate with the help of nut and bolt. To the base plate three jaws and center support. Once it is placed the three jaws are moved with the help of a chuck key. The three jaws moves simultaneously and holds the component firmly in the center. To check the flatness of the component t square can be used. So this fixture eliminates the problem of taper reduction and hole position shift. And also facilitates ease of loading and unloading. So the production rate is increased to 16-20 components per hour. Time required to load and unload the component is approximately 1 min. Idle time and lead time are reduced. The profit in terms of man, material, money, machine increases.

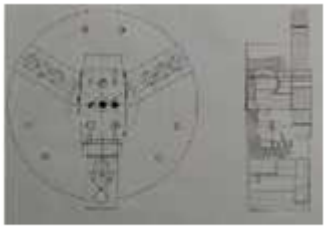


Fig.4.4 Three jaw chuck fixture

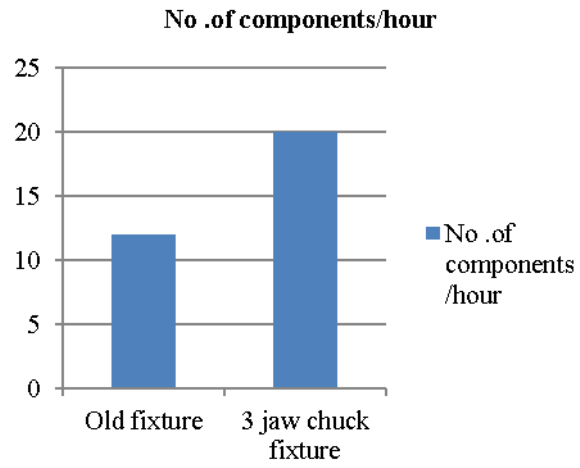
E. Advantages and demerits:

Advantages-

- Skilled worker is not required.
- Eliminates taper reduction and hole position shift problems.
- Easy to load and unload
- Time required to load and unload is reduced.
- Production rate is increased.

Demerits-

- Chuck key should be maintained properly.
- Wear pad is necessary to avoid wear of the component or fixture.



V. CONCLUSION

Fixtures have a direct impact upon product manufacturing quality, productivity and cost. Fixture design needs to be tested and evaluated in real manufacturing environments and integrated with other design activities, which often are related with production resources, equipment, cost and machining processes, etc. Fixtures are the essentials part of any manufacturing setup, the purpose of fixture is to hold the work piece in such way that these should facilitate machining. So these fixtures are used in final machining operation in order to achieve the concentricity. The fixture mainly consist buttons, locater, threaded holes and brake drum. The design of the fixture is simple, the loading and unloading of component is very easy. At a time all the operations such as milling, boring, drilling, tapping can be done in a single set up which in turn decreases the handling and machining time. This fixture is designed in such a way that any operations are supposed to be done at certain angle can be easily performed on this fixture as we can perform the machining action on both the sides. And the fixture has to be designed with minimum number of parts. Considering the static force over the component which is in contact with the fixture is analyzed, the total deformations and the stresses acting on the fixture during the machining process done on the fixture. Hence these results should indicate that the design is well within the safe limits of operation.

VI. FUTURE SCOPE

By the successful trail run, new CNC fixture is more comfortable than old fixture. So this fixture can be used in manufacturing companies because of its simple design and less cost. Block is attached with the help of locating dowel pins. Wear pad is provided between fixture and the component to avoid wear and tear of the fixture and to avoid any damage to the component. The component is placed on the center support block firmly.

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