

A Review Paper on Design, Analysis and Manufacturing of Fixtures for Aerospace Component

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Abstract— Performing operations on surface of the cylindrical components is always been a challenging job. Jigs and Fixtures are the devices used to hold and support the workpiece, ensuring that all parts produced using the fixture will maintain conformity and interchangeability. It also reduces the complexity of a process. This project is performed as per the requirement of TAL Manufacturing Solutions Limited, MIHAN, and Nagpur. The work is performed in the company to give innovative solution for drilling operation to make 90 degree angular offset holes on the surface of hollow cylindrical components. Also the components vary in cross sectional and various dimensions also. An attempt is made to design the fixtures for components named swaged tube and uniform tube.

Key words: Jigs and Fixtures, Drilling Fixture, Cylindrical Component

indexing shaft, drill bush, ball bearing, allen bolts and C-washer to achieve the indexing of shaft. [1]



Fig. 1: Proposed Model of Fixture

I. INTRODUCTION

Manufacturing has emerged as one of the highest growth sectors in India and worldwide. With fast development of aerospace sector, respective manufacturing industries are developing day by day with motto of accepting and proving manufacturing solutions to different components. Some of them are challenging with respect to manufacturing point of view. Also, time, accuracy, interchangeability, repeatability and quality requirements of customers are to be meet with immense responsibility. Fixtures are one of the most important manufacturing aids without which, manufacturing of the new product cannot be started. Therefore it is of top priority to develop suitable fixtures.

Making operations on surface of cylindrical workpiece is been always a challenging task. Again, the challenge becomes more critical if the operation is to be done with angular shift on curved surface of workspace. The concerned work is about an innovative approach to design the fixtures for making holes with 90 degree angular shift on the surface of cylindrical components.

II. LITERATURE REVIEW

A. Design and Fabrication of Jig and Fixture for Hollow Cylindrical Component in Drilling Machine

Nagarajan N, I Anbarasan, P Aravind and A Madesh in this paper give the detail discussion about importance of jigs and fixtures for holding hollow circular component. It also explains how difficult is the indexing and positioning of hollow circular component by index plate with crank and sector mechanism. In this paper an attempt is made for designing and fabrication of jig and fixture for indexing and positioning of hollow cylindrical component in drilling machine at lesser cost. They have used casing, base plate,

B. Design and Development of a Fixture for VMC Operation: A Case Study

In this paper, S. B. Malani, Dr. A. U. Awate, A. V. Deole have presented the need, application, and location system with help of a case study. They have also discussed theoretical and design considerations of jigs and fixtures for the part under study. To practically study and apply jigs and fixtures technique, they visited an industry. After discussion with authorities, they came to know about requirement of design of fixture for a part named "POWER HARROW GEAR BOX". For the purpose of designing a fixture, they studied about the part under requirement. Also, they gathered data about various operations to be performed in the part and its function in practical product. With the help of process planning study, they determined proper operation sequence. Operation sequence was decided by dividing them into various categories like basic operations, principal operations, major operations, etc. They have decided to manufacture the component on VMC machine named ERTICAL ACHIIGCETER model B -45 TC24, 4th axis rotary production system. Also detail parameters of machine required for manufacturing of component is also presented. After process planning and machine selection and study, they have elaborated locating, supporting and clamping surfaces. They have used the ball-spring concept for indexing. The CAD model of the fixture concept is described with components. [2]

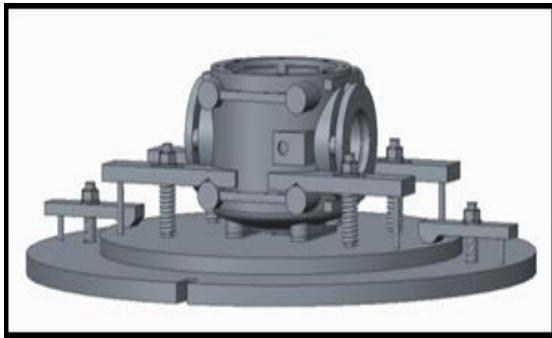


Fig. 2: Model of Fixture

C. Design and Analysis of Indexing Type of Drill Jig

NBV Lakshmi Kumari, G. Prsasna Kumar in this paper has presented an attempt to design and analysis of indexing type of drill jig. They have explained about importance and type of jigs for various operations. Then they have taken into account design considerations such as tooling cost, tooling details and tooling operation. They have detailed necessary features of jigs and fixtures such as reduction of idle time, provision for coolant, harness of surfaces, safety consideration, and mistake proofing etc.

The component study was done where it was found that it is a Casted Component which is having angular holes inclined at 25 deg equi-spaced. In the designing phase, initially the component was deigned, solid moldeled and edited to get the important details for design of the jig. Individual parts such as Base Plate, Locator, Clamping Devices, Bushes, Jig Plate are designed as per functional requirements. Modeling is done using SOLIDWORKS Software. Indexing is achieved by using spring and plunger arrangement. Calculations are done and compared with allowable limits. Analysis of stresses is performed using ANSYS and results are discussed. . [3]



Fig. 3: Isometric View of the model

D. Advanced Fixture for Angular Drilling on Cylindrical Objects

Nikhil. G. Lokhande and C. K. Tembhurkar in this paper explain about difficulties in drilling operation on cylindrical objects. According their survey, angular drilling is required in manufacturing of grenade fuse, manufacturing turbine blades with holes on surface for the aerospace industry, generating micro-holes in diesel fuel injection nozzles etc. They unfold a study which says trepanning, gun drilling are the operations available for drilling at specific angle, but for using them, drilling angle should be than 10 degree. They

interpret about computer aided fixture design and its uses. They have also studied existing literatures about drilling fixtures. After literature study, they detailed the challenges in making angular holes on cylindrical workpiece. Then they revealed that there are not plenty of fixtures available for drilling on cylindrical objects in today's situations. They took a workpiece for which it was desired to make 5mm hole at an angle 55 degree and 20mm long. They prepared plan for fixture design as well as the approach of fixture design was decided.

The square block and circular plate are the main parts of fixture. Square block is used to hold cylindrical objects and can rotate at particular angle with supporting plates it is serving as locator for workpiece. Left hand and right hand circular plate is used for dual purpose of locating and supporting a square block. The main purpose of providing these plates is to provide adjustment to square block at any angle, and drilling can be done accurately. As this is angular drilling, they have elaborated drilling forces in various axes in analytical calculations. Software analysis is done using Ansys workbench 12. Stress analysis of drill is performed using FEA and results are compared with analytical ones. [4]

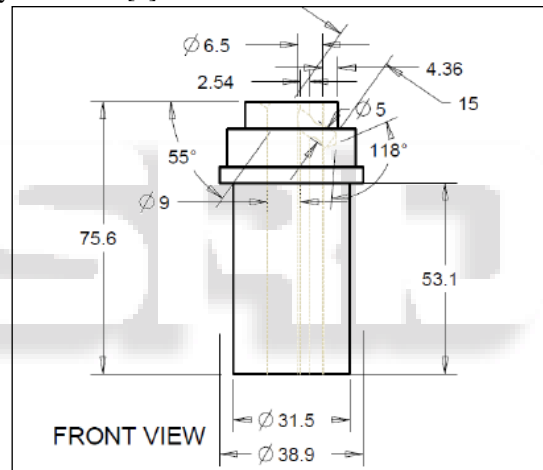


Fig. 4: Cylindrical Workpiece



Fig. 5: Suggested Drilling Fixture Assembly

E. Design and Development of Milling Fixture

In this paper, Mr. Kulkarni Kaustubh A. & Mr. Patel Akshay kumar K. unfolds the attempt made by them in Jadhao Industries to increase mass production of cylindrical objects by developing a fixture for simultaneous operation of multiple parts. It is required in various industries according to their application. Design of the existing fixture is a modified and new fixture is prepared to overcome drawbacks. Previously, the fixture setup for component was done manually resulting in excess cycle time consumed for

loading and unloading the material. So as per need of increasing production rate, the new fixture was designed. They did a literature survey on design of fixtures where they got information about various type of location methods, steps in fixture design and location principles etc.

The new fixture designed consists of plate surface, cylindrical pin, v-block surfaces and clamp. Also the restricted movements of work piece by respective elements are shown. Modified fixture reduces operation time and increase productivity and high quality of operation is possible. The company uses plate fixture having pins for adjustment or locate circular job. For new fixture, OHNS material was used replacing MS used in old fixture due to difference in resistance to wear ability. They have to use 16 different fixtures for 16 different types of shafts. They concluded that main objective of project about optimizing the fixture for shafts having various dimensions used in automobile gear box was achieved.[5]

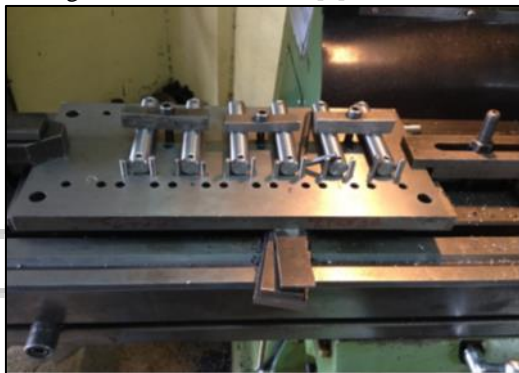


Fig. 6: Old Fixture



Fig. 7: New Fixture

F. Design and Analysis of Weight Lever Drilling Jig

Mohsin Ali, and Ganesh Mahalle here in this paper focused on the use of fixture for drilling operation for one of the part called auto feeder of cotton ginning machine. The considered work was performed in Amravari based Jadhao Gears Industry. It is a Manufacturer in Amravati region. This industry manufactures ginning machine which separates the seed from cotton. They found that due to curvy shape of the workpiece, holding of it is difficult. The design of fixture was executed in the steps-Observation of Manual Operations, Selection of components for which a better manufacturing solution can be developed, components study, prepare drilling jig, design calculations, validation of design calculations using Ansys-Workbench-13.0 etc. The drilling jig was designed consisting of elements body, locator, jig plate and clamp so that marking and punching operations are eliminated. Mandrel of Jig was designed so

that it gets held at center hole of work piece. In this way manual drilling method was replaced by drilling fixture and problem of industry regarding low production rate was solved. [6]

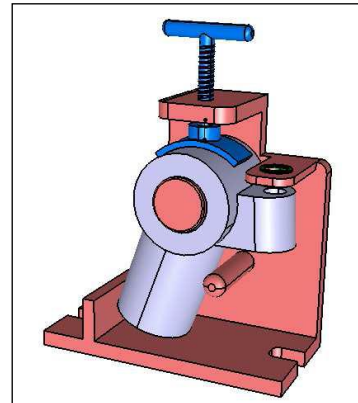


Fig. 8: Design of Weight Lever Jig

G. Design and Fabrication of Jigs and Fixtures for Drilling Operation

Midhun R. and Vignesh A. in this paper, focused on the drilling machine generally used in industrial fields. They have made an attempt to give solution for the accurate drilling on the rectangular object held by drilling machine. For solving this problem, they have tried designing a drilling fixture. They have also interpreted about essential factors to be considered in designing jigs and fixtures. They have designed the fixture elements such as jig plate, bushes, pillar, clamp, stud, and dowel pin. They conclude that, this design has made drilling on the particular workpiece easy and conformable to operate. [7]

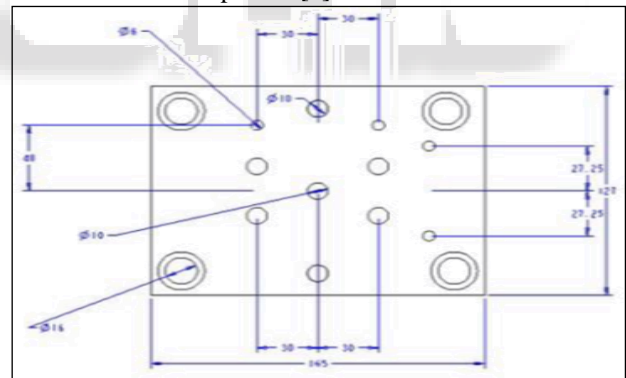


Fig. 9: Base Plate

H. Cad Modeling & Concept Design of Jig Fixture for Concentric Drilling

D. P. Kute, A. V. Gadge and A. P. Kedar in this paper, discuss about Jig and fixture design to drill five equidistant concentric holes on coupling hub. Authors also interpreted about difficulties in drilling operation on circular periphery objects. They also pointed out that inaccuracies due to drilling five concentric holes on such objects without any special arrangement will give unacceptable results. They have used vertical drilling machine for the concerned work. Improper manufacturing of finger coupling resulted in engagement with the jaw. Authors have also detailed the process of making finger coupling. Previous arrangement was clamping in vice and performing drilling operation was

producing very poor quality holes. To solve this problem, split type box fixture was designed with holes on every plane surface if pentagon. But it was fixing only some of degrees of freedom. To save unnecessary cost in automation, manual indexing was used and regular pentagonal structure block was used for indexing. Further, for complete restriction of DOF of hub base was developed with V-shape and legs. They have also elaborated about working of fixture in steps. In this way, a critical task of drilling five equiangular concentric holes on circular periphery is achieved by designing a simple manual indexing jig. [8]

III. NEED OF DESIGNING NEW FIXTURES

- 1) Order of new components was arrived in company TAL Manufacturing Solutions Limited.
- 2) The production of new components was to be started to meet customer requirement of quality and quantity time.
- 3) Drilling operation for making holes with 90 degree angular shift on surface of cylindrical components with varying dimensions was one of the challenging tasks.
- 4) To achieve the accuracy for all components in minimum number of fixtures and minimum number of set ups made the task more critical.
- 5) Hence the need of some innovative design of fixtures of angular indexing type concept was arised.

IV. RESEARCH METHODOLOGY

- Study of work piece
- Study of operations
- Deciding Material of Fixtures
- Selection of machine
- Machine Study
- CAD Modelling of Various Concepts
- Selection of Best Concept
- Analysis of Fixtures Model
- Changes in Design of Fixtures if Needed
- Manufacturing of Fixtures

V. CONCLUSION

It is clear that there are always difficulties faced wherever cylindrical component come across drilling. Also, to develop a simple, cost effective and functional design of fixture for such cylindrical parts drilling again becomes a point of research whenever such parts are arrived to produce in industry. Taking this objective, an attempt is made to design more effective and functional fixtures in the present work.

Through this project, the company Tal Manufacturing Solution Limited Nagpur, will be benefited with the design and manufacturing of fixtures for drilling operation of tubular component. Also the company shall be able to produce the tubular component with minimum manufacturing time and cost as well as meeting quality requirements. Also thought this work, new innovative concept for drilling operation for making holes with angular shift on surface of cylindrical component shall be developed.

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