

Design and Fabrication of Fixture for Angle and Radius Measurement in Hollow Workpiece

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ABSTRACT: The main aim of this fixture is facilitate angle and radius measurement in hollow workpiece by using a measuring probe which is fixed at the centre of the chuck bed. This fixture can be utilized for maneuvering even for extremely large workpieces (upto 800 cm diameter), where high product output is required. The fixture consists of a variable position chuck and a measuring probe with an attachment for manipulating a wide range of job sizes. The primary advantage of this method is it measures the angle and radius simultaneously with less time consumption which increases productivity. Though the diameter of the hollow workpiece can be measured manually by scale normally, this new method has an advantage over it. It can be also used to measure radius in concentric hollow pipes and large hollow jobs more quickly and accurately than manual method.

KEYWORDS: Fixture, Hollow workpiece Chuck, Servo Motor, Angle Measuring Probe

I. INTRODUCTION

Inorder to acquire high production rate in industries, developments are being made to ease the manufacturing process and to reduce the effort of the labour .The present technique used for measuring angles for hollow work pieces requires manufacturing of a template with almost similar size to that of the work piece and the inscribing the angles in the template for measurement. Such process requires more time and requires new template for every new job. Moving a template along a circular workpiece is more complicated and it requires skillful labour. To reduce the constrains, a multipurpose fixture along with a servo motor can be used for measuring a wide range of dimensions and also can be rotated for easy accessibility and future automation. The need of a special device which can rotate the job at a fixed rate is to assist other manufacturing process for circular components and to ensure good profile and homogeneous machining. The fixture can axially clamp the job to prevent lateral movement and utilized to hold the job rigidly to prevent vibrations and shattering while machining. This project will ultimately reduce the cycle time which inturn will increase the productivity to greater extents.

II. TRADITIONAL METHOD

Templates are being used traditionally for a very long time for measuring the angle in ultra large workpiece. But designing of a template requires more time and workforce. Moreover, this method requires machining of new templates, incase if the size of the workpiece is altered. So, use of templates is the prime cause of all the losses and so a new concept is proposed with Fixture, which not only measures the angle but also measures the inner and outer radius of hollow workpiece simultaneously.

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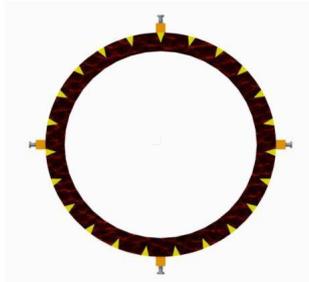


Fig.1

III. LITERATURE REVIEW

Kang and Peng [1] reported designing and fabricating fixtures can take up to 10-20% of the total cost of a manufacturing system and reviewed various approaches used in Computer-Aided Fixture Planning (CAFP).

Wang et al [2] presented a literature survey of computer aided fixture design and automation, including their approaches, requirements and working principles.

Related to computer aided fixture design approaches, an interactive Computer Aided Fixture Design (CAFD) system using the Gauss Elimination Method for the design of a fixture to hold prismatic components during machining on a CNC machining centre is described by Krishnamachary and Reddy [3].

Cecil, Pehlivan and Nee et al [4] have reported the other feature-based methodologies in CAFD. Boyle et al (2011) reviewed over seventy-five CAFD tools and approaches in terms of the fixture design phases and technology and reported two research issues that require further effort. The first is that current CAFD research is segmented in nature and there remains a need to provide more cohesive fixture design support. Secondly, a greater focus is required on supporting the detailed design of a fixture's physical structure.

The automation of fixture design and integration of setup and fixture planning is discussed by Stampfer [5]

Boonsuk and Frank [6] presented a methodology for the automated design of a fixturing system for a rapid machining process.

An adaptive fixture design system with an evolutionary search algorithm has been developed by Fathianathan et al [7] to deal with the automatic design changes to meet the requirements of different domains.

IV. COMPONENTS

FIXTURE

A fixture is a work-holding or support device used in the manufacturing industries. Fixtures are used to securely locate the position or orientation and to support the work, ensuring that all parts produced using the fixture will maintain conformity and inter-change ability. Using a fixture improves the economy of production by allowing smooth operation and quick transition from part to part, reducing the requirement for skilled labour by simplifying how work pieces are mounted, and increasing conformity across a production run.

CHUCK

A chuck is a specialized type of clamp used to hold an object, usually radial symmetry, especially a cylinder. It is most commonly used to hold a rotating tool (such as the drill bit) or a rotating workpiece (such as the bar or blank in the head-stock spindle of a lathe). Some chucks can also hold irregularly shaped objects (ones that lack radial symmetry). Many chucks have **jaws**, (sometimes called dogs) that are arranged in a radially symmetrical pattern (like the points of a star) to hold the tool or workpiece. The chuck keys help to loosen or tighten the jaws of the chuck which holds the workpiece.

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A self-centering chuck, also known as a scroll chuck uses dogs (usually called jaws), interconnected via a *scroll* gear (scroll plate), to hold onto a tool or workpiece. Because they most often have three jaws, the term three-jaw chuck without other qualification is understood by machinists to mean a self-centering three-jaw chuck. The term universal chuck also refers to this type. These chucks are best suited to grip circular or hexagonal cross-sections when very fast, reasonably accurate (± 0.005 inch [0.125 mm] centering is desired).

Sometimes this type of chuck has 4 or 6 jaws instead of 3. More jaws grip the workpiece more securely if it is truly cylindrical, and thin-walled work will deform less. Four jaws are also useful for square bar work. There are also independent-jaw (non-self-centering) chucks with three jaws. There are hybrid self-centering chucks that have adjustment screws that can be used to further improve the concentricity after the workpiece has been gripped by the scroll jaws. This feature is meant to combine the speed and ease of the scroll plate's self-centering with the run-out eliminating controllability of an independent-jaw chuck.



Fig.2

V. MEASURING PROBE

It consists of three main components

1. Telescopic cylinder
2. Angle inscribed circular plate
3. Freely moving metal scale attachment (to measure angle and radius)

The telescopic cylinder acts as the base component to which the angle inscribed plate is fixed at the top. It is used to extend the span of circular plate depending on the height of the work piece where measurement has to be done. The plate is embedded with various angle from 0-360 degrees. Over the circular plate, a metal scale attachment is fixed with a bearing such that it is free to rotate 360⁰ and to mark the measured angle for the impeller hub. The metal scale also measures the inner and outer radius of hollow workpiece while measuring the angle by visual observation of reading on the scale. Consequently diameter can be found. This entire set up acts as a measuring probe.



Fig.3

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SERVO MOTOR:

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system.

VI. CONSTRUCTION

The construction begins with manufacturing of movable jaws in the chuck, such that it is capable of holding wide range of objects firmly at the centre of the chuck. The servomotor is connected to the chuck. The servo motor is used to provide 180° rotation to the chuck, thereby improving manoeuvrability and reducing production time drastically. The chuck is provided with a hole at the centre to hold the telescopic cylinder. The whole diameter should be equal to the diameter of the bottom of telescopic cylinder. At the top of telescopic cylinder a circular, angle measuring plate is fixed where the angles ranging from 1° to 360° are embedded on the plate. A freely moving metal scale attachment is connected with bearing above the plate which positions the angle of the pipe in the circular plate. The metal scale also gives the inner and outer radius of the workpiece. This component acts as the metal probe. The attachment between the probe and the chuck is facilitated with the help of a magnet setup.

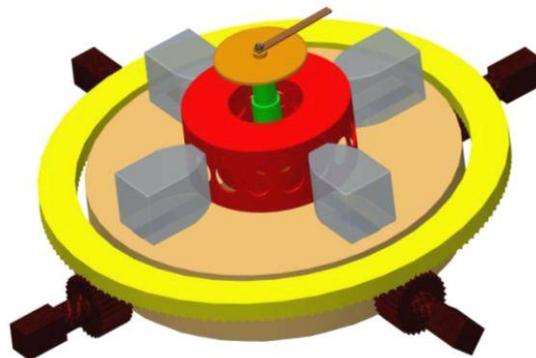


Fig.4

VII. WORKING

The hollow work piece whose angle is to be measure is placed on the chuck bed. The jaws are moved to lock the work piece at the centre by using the chuck key. The measuring probe is fixed at the centre of the chuck bed. The telescopic cylinder is moved to the length of the work piece until the metal attachment touches the outer diameter of the work piece. Angle measured from the metal plate is marked on the work piece by drawing straight lines from the centre which is facilitated by the metal scale attachment. Simultaneously the inner and outer radius of hollow workpiece is found. This saves time and reduces human error while measuring compared to ordinary method and thus increases productivity. Moreover in concentric hollow pipes of same length, radius can be measured precisely. Further markings are enabled using servo-motor by rotating the work piece to the necessary angle and marking again. This thereby sets the milestone for automation in angle measuring and machining processes in the future.

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VIII. RESULT

By implementing this fixture the production time is reduced, which consequently improves productivity as well as hassle free work experience for labourers handling such big jobs where manoeuvrability is extremely difficult. This fixture measures angle and radius accurately and is easy to handle. Thus, it ultimately improves manoeuvrability along with setting up a base for automation for machining in near future. Further instead of metal scale, measuring tape can be used which is more compact and detachable

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