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DESIGN DEVELOPMENT AND TESTING OF AUTO FEED DRILL MECHANISM WITH HYDRAULIC SELF CENTERING FIXTURE AND SENSOR BASED DEPTH CONTROL

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ABSTRACT

This paper deals with the elaborate Design Development and Testing of Auto Feed Drill Mechanism with Hydraulic Self Centering Fixture and Sensor based Depth Control. In existing design, the fixture set up is done manually which requires more cycle time for loading and unloading the material. Therefore, it is proposed to replace the existing fixture with hydraulic fixture and sensor based depth control in order to save time for loading and unloading of components. This hydraulic fixture will provide the manufacturer with flexibility in holding forces and to increase productivity and reduces operation time. In machining fixtures, minimizing work piece deformation due to clamping and cutting forces is essential to maintain the machining accuracy.

KEYWORDS: *Drill Mechanism, Fixture, Self Centering Fixture, Sensor*

I. INTRODUCTION

Fixture design plays an important role at the setup planning phase. Fixture is a special tool for holding a work piece in appropriate position during manufacturing operation. For supporting and clamping the work piece, this device is provided. To locate and immobilize work pieces for machining, inspection, assembly and other operations fixtures are used. A fixture consists of a set of locators and clamps. Locators are used to determine the position and orientation of a work piece, whereas clamps exert clamping forces so that the work piece is pressed firmly against locators. Clamping has to be appropriately planned at the stage of machining fixture design. Frequent checking, positioning, individual marking and non-uniform quality in manufacturing process are eliminated by the use of fixtures. In machining fixtures, minimizing work piece deformation due to clamping and cutting forces is essential to maintain the machining accuracy. The design of a fixture is a highly complex and intuitive process, which requires knowledge. Proper fixture design is crucial for developing product quality in terms of accuracy, surface finish and precision of the machined parts. In existing design, the fixture set up is done manually which requires more cycle time for loading and unloading the material. Therefore, it is proposed to replace the existing fixture by hydraulic self centered fixture in order to save time for loading and unloading of components & also by using self centering fixture mechanism we can apply proper clamping forces and avoids job rejection. By using auto feed drill mechanism with sensor based depth control we can achieve correct depths and Due to improvement of dimensional accuracy and proper clamping forces job rejection will be reduces and productivity will be increases.

This hydraulic fixture will provide the manufacturer the flexibility in holding forces and to increase productivity.

II. PROBLEM DEFINITION

Presently, the units are manufactured on a pillar type drilling machine using jig bushes that has following limitations:

- Inaccuracy due to improper location of work-piece under jig plate leading to job rejection.
- Very high cycle time for fixturing as location clamping and release are done manually.
- Drill feed is manual using stopper on the pillar machine that leads to wrong depths and job rejection.
- Very high cycle time for entire drilling process leading to 3 to 5 minutes per job.
  In the current study these limitations will be overcome by using Auto Feed Drill Mechanism with Hydraulic Self Centering Fixture and Sensor based Depth Control.

III. LITERATURE REVIEW

3.1 Shailesh, S.Pachbhai1and, Laukik, P.Raut [1] discussed that in machining fixtures, minimizing work piece deformation due to clamping and cutting forces is essential to maintain the machining accuracy. Loading and unloading of work piece in manual clamping is time consuming process, so reducing machining time, set up time etc is a main aim of process. The job having cylindrical shape, this is a challenging task for design engineer; hence hydraulic fixture design is incorporated in manufacturing industry.

3.2 Sawita D. Dongre, Prof. U. D. Gulhane and Harshal C. Kuttarmare [2] addressed the design and analysis of jigs and fixture used in the manufacturing of chassis bracket of Bajaj car RE60 (passenger car). The purpose of the jigs was to provide strength, holding, accuracy and interchangeability in the manufacturing of product. By performing analysis on jigs and fixtures stress acting on jigs, fixtures and bracket was found.

3.3 Arjun Shanmukam and Adarsh G Nair[3] attempted to design, modify and generate concepts to mount the sub-assemblies from the hydraulic excavator bucket component onto a fixture to perform welding on the sub-assemblies. Techniques suggested in this paperhelp in saving cycle time per job and also help in reducing the man hours, which might otherwise have been Spent on manual welding of all the sub-assemblies, by making the process automatic.

3.4 Necmettin Kaya [4] addressed the problem of deformation of the work piece that may cause dimensional problems in machining. Supports and locators are used in order to reduce the error caused by elastic deformation of the work piece.

3.5 K.R. Wardak, U. Tasch, and P.G. Charalambides[5] presented thedevelopment of scientifically based methodologies that usefinite element methods and optimization algorithms to designoptimal fixturing layouts for the drilling process.

3.6 Huseyin M. Ertunc, Kenneth A. Loparo , Hasan Ocak[6] presented that monitoring of tool wear condition for drilling is a very important economical consideration in automated manufacturing. Two techniques are proposed in this paper for the on-line identification of tool wear based on the measurement of cutting forces and power signals.

3.7 Gordana Ostojic, Prof. dr Stevan Stankovski, MSc Dorde Vukelic[7] defined the requirements for process automation handling fixtures and fixture elements within flexible technological structures. The second part includes analysis and systematization of handling processes for fixtures and fixture elements. Based on the previous analysis and systematization, the paper provides description of the solution that meets the requirements for flexible automation.

3.8 Branko Tadica, Djordje Vukelicb, Dragomir Miljanicc, Bojan Bogdanovica,Ivan Macuzica, Igor Budakb, Petar Todorovic[8] focused on the problem of compliance of interface between clamping/locating fixture elements and work piece, under dynamic loads during machining.

3.9 Diana M. Pelinescu, Michael Yu Wang[9] addressed a major issue in fixture layout design to determine and evaluate the acceptable fixture designs based on multiple quality criteria and to select an optimal fixture with appropriate trade-offs among multiple performance

requirements. The paper focuses on multi-criteria optimal design with a hierarchical approach.

3.10 Luis de Leonardoa, Dimiter Zlatanova, Matteo Zoppia, Rezia Molfinoa[10] described the base-bench subsystem which ensures rapid and precise locomotion, as well as secure docking, of the agent during the machining process.

3.11 Utpal Roy,Jianmin Liao[11]reported the development of a computational methodology for quantitatively analyzing the work piece's stability in the automated fixture design (AFD) environment. Automated fixture design (AFD) has become an attractive research area in which the complicated fixture design can be carried out by using analytical, artificial intelligence (AI) and computer-aided technologies to realize automation of the design processing.

The review of literature reveals that he existing methods have many drawbacks, which can be reduced by implementing hydraulic self centering fixture and sensor based depth control.

IV. SCOPE OF THE WORK

Presently, the units are manufactured on a pillar type drilling machine using jig bushes that has Inaccuracy due to improper location of work-piece under jig plate leading to job rejection. They require very high cycle time for fixturing as location clamping and release are done manually and Drill feed is manual using stopper on the pillar machine that leads to wrong depths and job rejection. By using auto feed drill mechanism with sensor based depth control we can achieve correct depths and by using self centering fixture mechanism we can apply proper clamping forces and avoids job rejection.

V. OBJECTIVES OF STUDY

The following are the objectives of the study

1. Design, development and analysis of auto feed drill head with sensor based depth control.
2. Design, development and analysis of hydraulically actuated self centering fixture.
3. Testing of drilling mechanism with self centering fixture in order to determine:
    - Reduction in cycle time of fixturing.
    - Improvement of dimensional accuracy due to implementation of fixture.
    - Productivity improvement owing to use of developed system.
    - Analysis of clamping force in self centering fixture at different hydraulic oil pressure.

VI. VALIDATION

Due to manual clamping we cannot apply exact clamping forces (analysis of clamping force in self centering fixture at different hydraulic oil pressure) & job Deflection occurs & job get rejected so by using self centering fixture this problem can be reduce. For achieving exact diameter of job (comparison of hole size and hole position) we can use auto feed drill head with sensor based depth control. Calculating increased Productivity & Reduced Time Factor due to this new mechanism.

VII. FUTURE WORK

1. Design, development and analysis of auto feed drill head with sensor based depth control.
2. Design, development and analysis of hydraulically actuated self centering fixture.
3. Testing of drilling mechanism with self centering fixture in order to determine:
    - Reduction in cycle time of fixturing.
    - Improvement of dimensional accuracy due to implementation of fixture.
    - Productivity improvement owing to use of developed system.
    - Analysis of clamping force in self centering fixture.

This work is planned to be completed in following phases

Phase 1- Literature review:

- Study of various configurations of Auto drill head, methods of self centering fixture etc will be studied using various Handbooks, United State Patent documents, Technical papers, etc.

Phase 2 - Design and Development:

- System design: theoretical derivation of motor power to develop enough cutting force to drill 12 mm hole in aluminium, Spindle and quill design for to and fro motion of spindle in the quill for drilling action, auto feed actuator rack and pinion orientation and mounting of the auto-feed actuator, location of automatic depth control sensor.
- System design and theoretical derivation of geometrical dimensions of the self-centering jaw clamp using kinematic linkage design
- Mechanical design of spindle, splines, spline hub, rack, pinion, quill, bearing selection etc, using theoretical formulae.
- Mechanical design of spur gear set, internal teeth and external teeth gear sectors, jaw arms, central hinge using theoretical formulae and validation for strength of internal & external gear sector, jaw arms and central hinge using ANSYS software.
- Selection of pump drive and actuator for hydraulic actuation of the self centering jaw head.

Phase 3 - Fabrication:

Suitable manufacturing methods will be employed to fabricate the components and then assemble the test set up.

Phase 4 - Validation of experimental results with theoretical results

A) Deflection of job due to clamping Forces
B) Diameter of job
C) Productivity & Time Factor

VIII. SOFTWARE TOOLS USED

ANSYS 14.5 for stress analysis & modeling (stress analysis of hydraulic cylinder & piston rod which is used in solenoid, bevel gear & spur gear).

IX. CONCLUSION

The main objective of this work is to save time for loading and unloading of components. Due to improvement of dimensional accuracy and proper clamping forces job rejection will be reduces and productivity will be increases. Hydraulic self centering fixture will lead to very low cycle time of fixturing (less than 20 seconds) thereby bringing down cycle time to 30 % and precision of location of job in fixture will lead to higher accuracy and fewer rejections. Auto feed drill head with sensor based depth control will lead to low cycle time of machining (less than 45 seconds) bringing down the machining cycle time to 25 % and precision of depth control will lead to nil rejections.

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