JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue

JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Design, Modelling and Manufacturing of 8 and 16 Cylinder Hydraulic Fixture with Automated Clamping System

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Abstract : The function of a fixturing system is to hold a workpiece firmly in position during a manufacturing process. The work presented in this paper adds the practical value to research by applying theoretical principles of fixture for real industrial component. The component is rear flange of gear case, widely used in automobile industry. The major operations to be performed are drilling and milling. Machine tools, material handling devices, transport and other mobile equipment, aviation systems, etc. do use hydraulic systems, but application of hydraulic principles in fixture is of uncovered area till now. This paper includes designing and manufacturing of 8- and 16-cylinders hydraulic fixture with automated clamping system, which provides location and clamping arrangement for machining 4 components in one cycle on VMC 640 of pallet size 800 mm x 500 mm. Fixture is not only designed but manufactured also, it sets the classical example of design for manufacturing**.**

IndexTerms **- Hydraulic Fixture, Hydraulic, Automated Clamping System, Rear Flange, VMC, Design for manufacturing.**

I. INTRODUCTION

Fluid power technology is passing through a revolutionary change due to the integration of electronics as a control medium for hydraulic components and systems. Wide application of hydraulics in recent trends of industires. A few decades earlier in the western world, the use of oil hydraulic system as a means of power transmission in modern machines evolved. There is a great deal of urgency and importance to master the art of its application and maintenance in Indian industries.

This research paper includes Designing, Modeling and manufacturing 8 and 16-cylinder hydraulic fixture with automated clamping system for machining rear flange on VMC.

Selection and Positioning of locating points method of fixture design is proposed by Menassa, R., and Devrise, W. Different types of application of fixture considered are for prismatic workpieces that use the 3-2-1 locating principle as the general structure of the fixture [1].

Accuracy of the work piece is decided by the positioning and orientation error. Elastic deformation of loaded fixture–work piece due to the displacements of the rigid body work piece contacts strongly influence the ability to accurately locate a work piece in a machining fixture [2].

The present volume of this research work introduces a novel concept of hydraulic fixture and automated clamping system to achieve desired objective of significant improvement in the production rate and reduction in non-productive time. The input is the CAD model of the work piece and the output is the CAD models of the needed fixtures[3].

Hydraulic clamping system of a special CNC machine tool to design Hydraulic cylinder to ensure the safety and reliability of workpiece was introduced by Ke Yanga, Shangjun Guan, Cunlong Wang. Clamping automation of the workpiece was guaranteed by means of effective design of oil cylinder and theoretical calculation of feasible[4].

Hydraulic clamping system with Sensor integration was invented by Berend ,Dahlmann and Kiesner with an aim to hydraulic clamping system sensory integrate capabilities in a used in Continues production[5-6].

The machining process of a complex part is to be designed by using hydraulic clamping system. A case study of setup time decreases and steps of machining process ensuring the level of quality initially desired is very well described by Claudio costa and R.P.Martinho[7].

The following section presents the real-time research work of designing and developing 8 and 16-cylinder hydraulic fixture for machining rear flange on VMC 640 of pallet size 800 mm x 500 mm. The important details of the part and fixture are included in each section along with component drawing & fixture drawing, 3Dimension view of finished component & 3Dimension assembled view of fixture using Creo 2.

II. Design, Analytical Analysis and Manufacturing of Hydraulic Fixture

2.1 Statement of Problem

Design, modelling and manufacturing of hydraulic fixture with automated clamping system for machining rear flange on VMC 640 of pallet size 800 mm x 500 mm. Drilling and milling are the major operations to be performed.

2.2 Component Details

The component is rear flange of gear case, weighing 5 kg, made up of cast iron, widely used in automobile industry and in raw material form is forged. Machining operations are to be performed on six faces – 4 sides, top and bottom face.
The list of operations to be performed are as under:
1. Profile milling (17 mm x 3 mm)
2. Drilling (3 holes, ϕ 9 mm)
3. Pocket milling (17 mm)
4. Spot facing (19.8 mm x 0.3 mm deep)
5. chamfering of holes (top and bottom profile).

2.3 Design of 8- Cylinder and 16-Cylinder Hydraulic Fixture

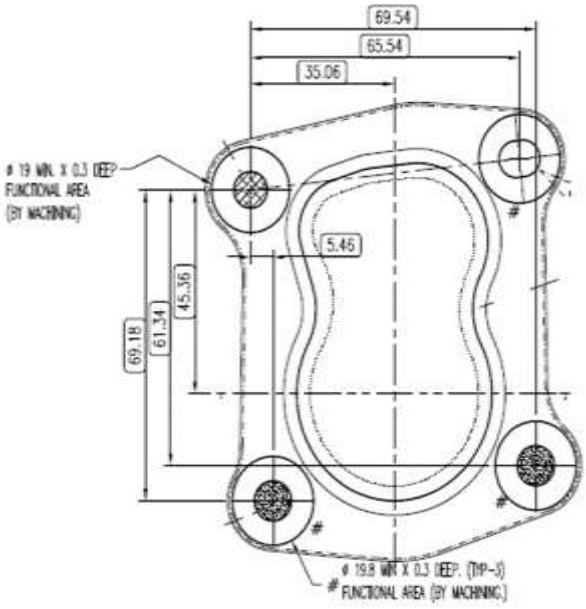

Fig. 1. 2D drawing of component.

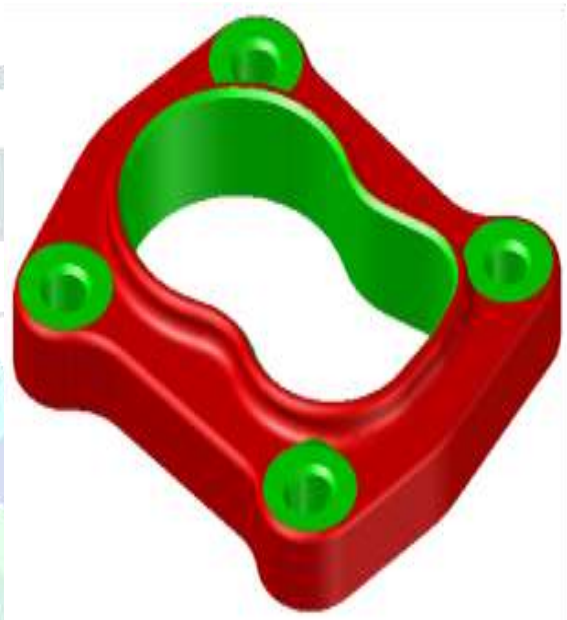

Fig. 2. 3D view of component.

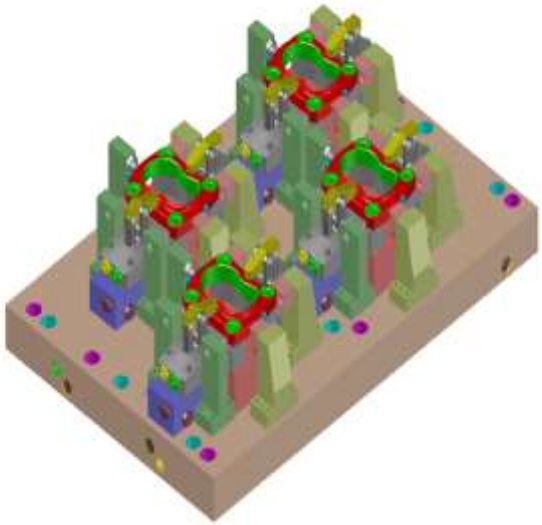

Fig. 3. 3D view of 8-cylinder hydraulic fixture.

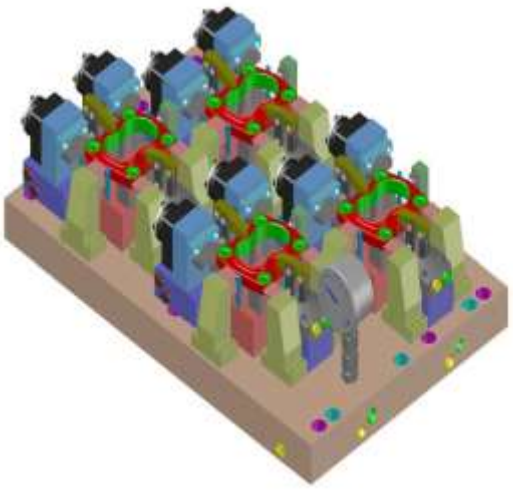

Fig. 4. 3D view of 16-cylinder hydraulic fixture.

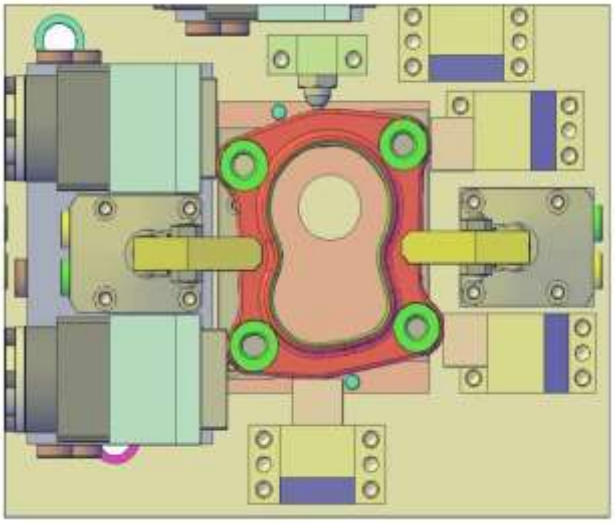

Fig. 5. 3D view of 16-cylinder fixture assembly for one component

Fig. 6. Photograph of manufactured fixture

All these state of the art guidelines are used to design the present research work. According to very basic principle of location suggesting that machined surface should be used for location, bottom face of the component is used for machining as it is received finished in the raw material form. The complete location is achieved using base plate, two rest pads, two orientation cylinders, one orientation pad and one spring plunger. Base plate provides the plane to rest the component and it has same profile as that of the component to accurately locate the component. Using principle of mutually perpendicular planes, two rest pads and two orientation cylinders are used in a plane perpendicular to base plate to locate the component. Orientation pad pushes the component against the spring plunger in a plane perpendicular to both the planes of base plate and rest pads. Two hydraulic clamps are used to clamp the component. Fixture assembly locates and holds four components in one cycle increasing productivity. So total 8 cylinders are required to operate 8 hydraulic clamps – two for each component.

Due to vibration and noise crated in 8 cylinder used so modification of design to eliminate vibration 16 cylinder is used for hydraulic fixture. Following the very basic principle of location by machined surface, bottom face of the component is used for machining as it is received finished in the raw material form. Base plate, two rest pads operated by hydraulic cylinder, two orientation cylinders, one orientation pad and one spring plunger are used to achieve complete location. Base plate is used to provide the plane to rest the component and it has same profile as that of the component to accurately locate the component. Two hydraulically operated rest pads and two orientation cylinders are used in a plane perpendicular to base plate to locate the component according to principle of mutually perpendicular planes. Orientation pad pushes the component with the help of hydraulic cylinder against rest pads. Two hydraulic clamps are used to clamp the component.. So total 16 cylinders are required to operate 8 hydraulic clamps and 8 rest pads for all four components. Figure 1 & 2 show 2D drawing and 3D view of component. Figure 3 & 4 show assembly of 8 cylinder and 16 cylinder hydraulic fixture respectively. Figure 5 shows the fixture assembly for one component with locating and clamping devices. Figure 6 shows photograph of manufactured fixture.

III. CONCLUSIONS

The Unique approach of hydraulic fixture is used in the present research work, which results into increase in productivity by saving time. 15 to 20 seconds per clamp are required for manual clamping and de-clamping. Increase in non-productive time presents a serious problem in case of a fixture with multiple clamping points as more than one minute will be required for clamping and this time will still be more for uniform clamping. Automatic clamping using hydraulic cylinder will reduce non-productive time significantly.

Another worth-noting advantage of hydraulic fixture is reduction in fatigue of operator. The efficiency of operator decreases due to fatigue in manual clamping, which may result in reduction in safety and less clamping torque at the end of the shift, specifically for the elderly operators. By introducing automatic clamping system, such problem can be overcome.

8 cylinder to modification of 16 cylinder Hydraulic fixture and automated clamping improves quality of clamping as an operator can operate all clamps at the same time with control over clamping force for dimensional accuracy to have a consistent clamping force without vibration during operation.

IV. ACKNOWLEDGMENT

The support of Mr. Pradeep Thanki and Mr. Sudhir Thaker, Supra Technology, Rajkot, Gujarat, India is acknowledge for the present research work.

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