iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** IV **Month of publication:** April 2018

DOI: http://doi.org/10.22214/ijraset.2018.4124

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com

Study of Fixture and its Modifications

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Abstract: ***Now day's fixtures are widely used in many manufacturing industries. Fixtures are an essential element of the machining system, being part of the precision path and force flux between process and machine tool. In the manufacturing industry, fixtures have a direct impact on product manufacturing quality, productivity and cost. Therefore, we are presenting a paper on the importance of fixtures and this paper gives detailed information about modifications done in the fixtures up to now.***
Keywords: Fixtures, Clamping.

I. INTRODUCTION

During manufacturing of Mechanical components, different types of holding and guiding tools are used. These holding and guiding devices are called as 'Jig and Fixture'. A fixture is a device used for holding a component firmly in a machine to constrain its degree of motion. A jig is a device that performs both functions i) holding the component ii) guiding the tool. Earlier, simple mechanical fixtures were used to clamp a component by means of kinematic linkages. The forces developed due to linkages were unevenly distributed over the component so that there was a chance to disturbing the component profile. These problems were arisen many times and as the component shape changes fixture design also changes. To overcome these problems various types of fixtures are introduced for specific operations (like for welding & drilling, for inspection, for assembly, for milling etc.) and in this way modification in the fixture is done.

II. DEFINITION OF FIXTURE

A fixture is a work holding or support device used in manufacturing industry. Fixture is used to securely locate (position in a specific location or orientation) and support the work, ensuring that all parts produced using the fixture will maintain conformity and Interchange ability.[1]

III. ESSENTIAL FEATURES OF FIXTURE

A. It should increase the productivity.
B. To reduces the production cost.
C. To assure the high accuracy of the part.
D. The locating and supporting surfaces as far as possible should be replaceable, should be standardized so that their interchangeable manufacture is possible.
E. The design should assure the perfect safety of the operator.[4]
F. To enable heavy and complex shaped parts to be by holding rigidly to a machine.
G. To reduce the production cycle time.[2]

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
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IV. METHODOLOGY

The methodology we used to design the fixture is as follows:

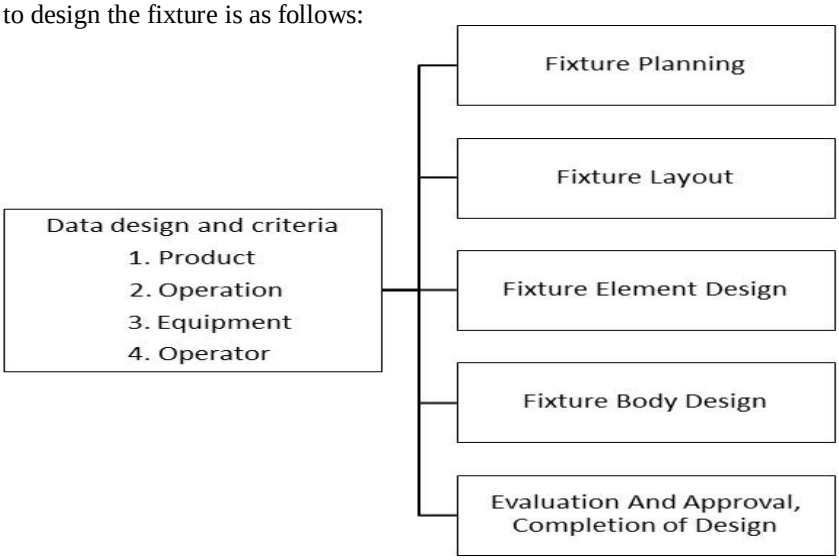

FIG 1: Classification of Residual stresses measuring techniques[5]

V. MODIFICATIONS IN THE FIXTURES

Earlier, simple manually operated mechanical fixtures were used in industry for clamping the workpiece firmly with the help of different linkages. Some parts may require only hand loading to clear the clamping units and sit properly in the work nest. However, many Hydraulic Fixtures hold a number of parts and they are all clamped simultaneously.[8] These manual linkages are easy to install and takes less time for changing the shape of component changes. Following are the advantages of manually operated fixtures:

Hold dynamic part in a secure position for machining.

Change part quickly with operator friendly clamping and unclamping.

Accommodate challenging workpiece large or small with a tailor-made the fixture.[7]

As the manually operated fixture are simpler, cheaper, and more cost-effective for most low volume part and requires very little maintenance but due to different mechanical linkages used there may be a deformation of the component takes place which is not feasible in the manufacturing industry. Some disadvantages of manually clamping fixtures are

Manual fixtures are operated intensively. They

have limited capacity to do work.[8]

FIG 2: Manual clamp fixtures

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com


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FIG 3: Pneumatic Press Fixture

Fixtures are also made for inspection and assembly works. Moreover, fixtures are used for castings and forgings which are rough and irregular in shape. With the use of locators and proper clamps, handling of those jobs will be made easy in fixtures than any other standard work holding devices. Later on, to eliminate those problem different types of the fixture are introduced in the manufacturing process which is given below:

A. Adjustable fixture:

An adjustable fixture is one which is used in a lathe where different cutting tools could be accommodated in one set up, to turn workpieces of different shape and length. The position of the cutting tool is adjusted by different gages. (FIG 4)

B. Grinding fixtures

When extreme accuracy is required for grinding parts like connecting rods, valve faces or bevel gears, grinding fixtures are used and they hold parts without any distortion. The positioning of the parts in the fixture is very important and the clamping should be designed to cover the parts for which machining is not required. (FIG 5)

C. Welding Fixture

Welding fixtures are used to hold the parts in the required shape and is used from smaller parts to larger parts of a plane.
Before welding, the parts are placed and positioned for the required shape. After clamping the parts welding work will be carried out.

D. Assembly Fixture

Large components in airplanes are usually assembled with assembly fixtures. Pipelines and other frames which are so lengthy will be placed in the fixture and assembled. As the use of fixture will be more with lengthy or large components the fixture material has to be stiffer to avoid deflection. Some parts are required to have simple operations like drilling or welding, after aligning with the adjacent parts. An assembly fixture should have to be constructed to accommodate such situations. (FIG 6).

E. Inspection Fixtures

The parts after getting finished with the manufacturing operation have to be checked for its accuracy in shape or in dimension. That will be performed with inspection fixtures and they are extensively used in automotive industries. The fixture will be the master in shape and every part will be compared to its shape conformity. For checking the dimension, the fixture is prepared in such a way that it could accommodate the correct dimensioned parts only. (FIG 7)

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F. Milling Fixtures

The use of fixture is oriented mostly with milling operation and there are different types of fixtures available for milling operation.[9]

The diagrams of respective fixtures are given below :

FIG 4: Adjustable fixture

FIG 5: Grinding Fixture

FIG 6: Assembly Fixture

FIG 7: Inspection Fixture

VI. CLAMPING

In every machining operation, clamping of the workpiece is an essential requirement. A clamp can be defined as a device for providing a location with respect to an external loading system. In other words, the process of clamping induces locking effect which through frictional or some other forms of mechanism provides stability of location which cannot be changed until and unless external loading is able to overcome locking effect. A clamp is a fastening device used to hold or secure objects tightly together to prevent movement or separation through the application of inward pressure. There are many types of clamps available for many different purposes. Some are temporary, as used to position components while fixing them together, others are intended to be permanent. [10]

It is also essential that the idle time involving loading, locking, unlocking and unloading of the workpiece should be minimized as much as possible to reduce the overall setup and nonmachining time. Certain additional requirements are therefore to be fulfilled with respect to the clamping device.

1) The clamping device must be easy to manipulate manually or otherwise.
2) This device must be quick acting so as to reduce the time for setting the clamping and simultaneous locating.
3) They must be low cost so that their application in small lot size is economical.

The clamping devices can be divided into two groups:

I. the clamping force changes with the deformation of the workpiece or the clamping device (screws, cams, wedges, springs) II. the clamping force is constant (hydraulic, pneumatic, magnetic, etc.) [11]

A. Types Of Clamp

Clamping elements may be either manually operated or actuated by pneumatic, hydraulic or a combination of other power facilities. They are also classified according to the mechanism by which a mechanical advantage is attained. The two basic classes include:

1) According to application inclined plane theory:

a) Wedge clamp
b) Screw Clamp
c) Lathe clamp IV. Pivoted clamp
d) Hinged Clamp

2) Application of liver principle

a) Heel clamp

Bridge clamp III. Toggle Clamp

Following are the other type of clamps which are explained in detailed.

3) Mechanical Clamp: The bayonet system locks the mold onto the machine by just turning the handle manually and stays securely locked during operation. The mechanical clamping system can be installed on new and existing injection molding machines up to 200 T, using the existing mounting hole patterns. To reduce your production costs, QMC solutions can be applied in a series of cost-effective steps. Take a look at the other solutions EAS has to offer, helping you speed up your changeover time.[13]

4) Pneumatic clamp: The standard pneumatic clamps used for holding the components were selected from SMC catalog. These clamps yield high-speed operations with secure and finally control clamping pressure. Any number of these clamps can be operated instantly at the touch of a switch and where required they can be arranged to operate in any desired clamping sequence. A pneumatic system is a system that uses compressed air to transmit and control energy. Pneumatic systems are used in controlling train doors, automatic production lines, and mechanical clamps. (FIG 8)

Functions:

a) Very high clamping forces
b) Automated actuation of the clamping systems
c) Compact design.
d) Optimal machine spindle accessibility. [17]

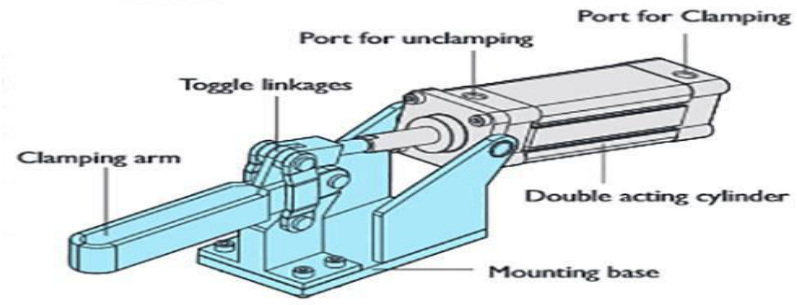

FIG 8: Pneumatic Clamp

5) Hydraulic Clamp: A hydraulic clamp is made by the clamp body, hydraulic cylinder, the movable jaw and the fixed jaw composed of an external hydraulic system provides the oil pressure for the hydraulic cylinder, the hydraulic clamp of the movable jaw and one of a fixed jaw, crushing objects to achieve results. The major benefit of hydraulic work holding is the enormous time saved in clamping and unclamping the components. When we compare the time required for hydraulic clamping with that required for manual clamping the gain is no less than 90 to 95%.[16]

Hydraulic Clamping Benefits

There are many benefits associated with hydraulic clamps, some of which include:

a) Reduced setup time
b) Clamping consistency
c) Improved part quality
d) Improved productivity.[15

6) *Magnetic Clamp:* Precision in turning, eroding, grinding and milling**.** The cutting performance of modern machine tools is enormous and is constantly evolving. Furthermore, it is necessary to achieve maximum utilization of equipment, among others, minimum set-up times. By choosing the right magnetic clamping system, preparations can be made, while work is still running on another workpiece.

Function:

a) uniform clamping force
b) no deformation during clamping of bearing rings
c) multi-sided machining in one clamping process
d) greater availability for multiple occupancies
e) achieving very high precision[14]

7) *Vacuum Clamp:* When a vacuum is created, a pressure differential is created between the vacuum clamping plate and the workpiece - the vacuum causes an 'under-pressure' beneath the workpiece which effectively presses the work piece against the clamping plate. Thus the work piece is not 'sucked' but rather 'pressed' against the vacuum table. The sliding force of the workpiece depends on its surface structure, the pressure differential generated by the vacuum and the workpiece area on which the vacuum acts. The larger the area, the better the holding force. All objects are subject to the atmospheric pressure of approx. 1 bar. When a vacuum is generated some of the air under a workpiece is removed, thus removing part of the pressure load on the workpiece surface.[12]

VII. ACKNOWLEDGMENT

Inspiration and guidance are invaluable in every aspects of life, especially in the fields of academics. The completion of this paper would not have been possible without the kind support and help of teachers.
I would like to extend our sincere thanks to Prof. U.C. Agashe for their guidance as well as for providing necessary information regarding paper. I would also like to thanks Mr. Devendra Haldavnekar and Mr. Amol Gawande and MARIGOLD DIES & TOOL Pvt. Ltd. for their help and advice and for acknowledging their faith in our abilities.
I would like to thank them all as they are responsible for the complete presentation of our paper.

VIII. SUMMARY

The paper provides an overview of the different type of fixture used for clamping the component correctly. Also provided the comparison between manually operated fixture used in earlier and the modern fixture which reduces the production cycle time and increases the productivity. Also, this paper includes the various types of clamping devices and their functions.

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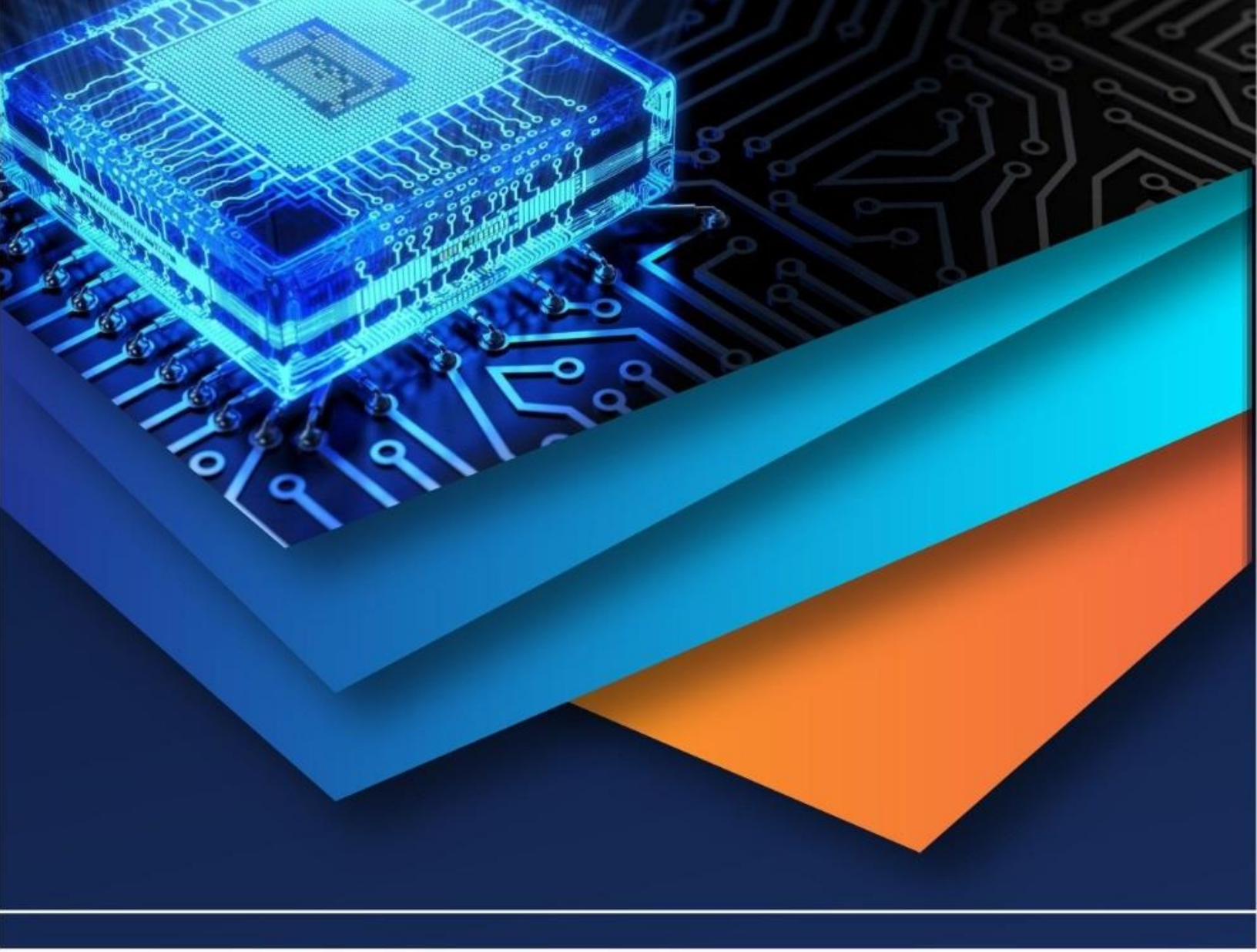

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