DESIGN AND MANUFACTURING OF FIXTURE FOR COUPLING 4-RUBBER COMPONENT FOR DRILLING AND TAPPING OPERATIONS ON SPM

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ABSTRACT - *The main objective of this paper is to design and manufacture fixture used for multi-spindle drilling and tapping SPM (special purpose machine) for drilling and tapping operation on COUPLING 4-RUBBER BRAKE DRUM component. . At first the component features are studied, suitable, conceptual & detailed layout is drawn in Solidworks. Limits, Fits & Tolerances given for the fixture component is in between mating component. Manufacturers are compelled to be more responsive to the customer's demands regarding to quality.*

***Key Words*: SPM, Fixture, Coupling 4-Rubber Brake**
Drum Component, Solidworks

1. INTRODUCTION

The fixture is a device which is used to locate, hold & clamp the given component in a respective position also it is used to guide the tool with the help of jig plate & bushes. The value of the fixture design & manufacturing is nearly 10-20% of the manufacturing process. There are various types of fixtures according to their applications like machining fixture, Assembly fixture, Inspection fixture etc. The machining fixture is classified mainly two types dedicated fixture & modular fixture. If mass production is there the dedicated fixture is used. & its setup cannot change. When the production is of batch type the modular fixture used. Because it can accommodate the similar product in the batch as it is reconfigurable fixture. The use automation of fixture design is called as computer aided fixture design that results in the lower time required for the fixture design because the traditional method of fixture design of trial & error method is completely avoided. Much software is used for the fixture design. The ultimate aim of any fixture design is to manufacture the given component with the accuracy such that the loading & unloading time of the component would be lower as possible as possible so that the operator fatigue is reduces that surely helps to increases the productivity of given component. To achieve the interchangeability of components fixture has significant role & directly affect the accuracy of component. The fixture design may be multi modal solutions by considering the fixture generic requirements the fixture layout which fulfills all the aspects that fixture layout is selected as best fixture layout for any given component. Modular fixture contains set up of standard elements which can assemble to form the fixture for various sizes of suitable range component.

1.1 FIXTURE DESIGN

The fixture consists of many elements like locating system, clamping system & supporting system. Each of them having different types of elements according to its suitability to the component they are selected. The most significant part in the fixture is the locators. The locator should be place such that it is easy to every time mount the given component & clamping system should be such that it exerts the force against the locator. Types of locators are Round & diamond pin, Floating locating pins, Bullet nose dowels, Bullet nose pins, Cone locator pins etc. & diamond pin locator is used two compensate the gap between two locating surface. Type of clamping are strap clamp, hinged clamp, quick action clamps, power operated clamps etc. The clamping characteristic should be such that position of clamping force on the supported part of work piece. The strength of clamping force should be enough to fix the work piece. If more number of clamps is needed for respective fixture then power operated clamping is suitable to prevent the more time for loading & unloading of component & operator fatigue.

Mainly there are four steps for the fixture design setup planning, Fixture planning, Unit design, Verification. Before the actual fixture design process is started the input for all the step is component cad model & machining operation information. Setup planning shows that the component is oriented in a respective direction by taken into consideration of machining features on the component & when other group of machining feature is to be carry out then the position & orientation of the component is changed.

In Fixture planning desirable requirement & characteristic of respective fixture & fixture layout are find out. In unit design the various types of element is required for the fixture designing & has to be assemble the locating system, clamping system & supporting system. The conceptual unit design & detail unit design needs to be carry out. Last stage is the fixture design verification against the desirable outputs of fixture i.e. checks the desirable requirement of the fixture is fully satisfied or not.

1.2 METHODOLOGY

a. Study of Coupling 4 - Rubber component.
b. Study of location system.
c. Study of clamping system.
d. Conceptual Idea generation of different possible fixture layout.
e. Selection of best fixture layout considering its fixture requirements.
f. Modeling in Solidworks software.

h. Limits, Fits & Tolerances used wherever necessary between the mating components.
i. Assembly of fixture elements.
j. Manufacturing of fixture.
g. Design of individual fixture elements.

2. STUDY OF COMPONENT

Fig.1: Top view and side view of coupling 4-rubber component

Component details:
a. Material- Aluminum alloy (Aluminum Silicon)
b. Weight of component- 545 grams.
c. Operations to be performed- Drilling of ø9.38 mm for 4 no.s of holes & tapping M10×1.5P 4 no.s of tapping. d. Hardness: 150 BHN.

3. REQUIRED DATA FOR FIXTURE

Sr.No.	Required Data	Outcome
1.	Component Details: 2D-drawing, pre-machined operations and machined operations to be performed, orientation of component, material, co-efficient of material, hardness, strength,	Locating Position, Clamping position and supporting positions.
2.	Machining operation and Mechanical properties : Spindle speed Feed Depth of cut Width of cut	Calculating cutting forces and Torque required.
3.	Machine details: Maximum movement of spindle, Machining bed details, ATC, etc.	Check work piece fixture and tool interface.
4.	Cost investment	To decide type of clamping : Manual clamping or Hydraulic clamping

Table No.1: Required data and outcomes for fixture design.

3.1. CONCEPTUAL IDEA GENERATION OF FIXTURE LAYOUT:

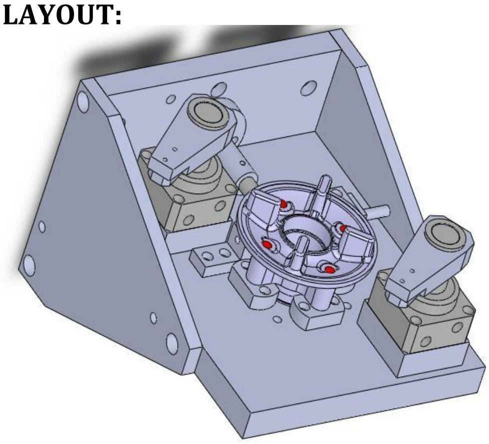

Fig.2 : 1st Assembly layout of fixture and coupling

4-rubber component.

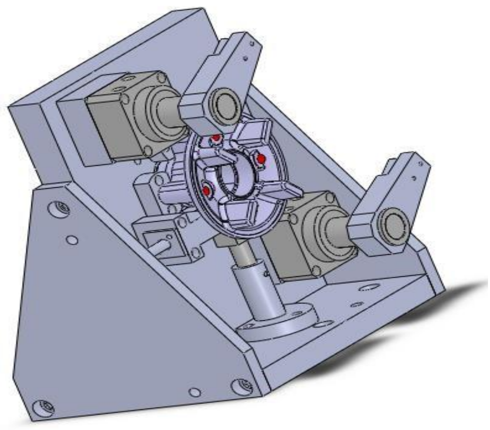

Fig.3: 2nd Assembly layout of fixture and coupling 4-rubber component

4. ASSEMBLY OF FIXTURE ON SPM

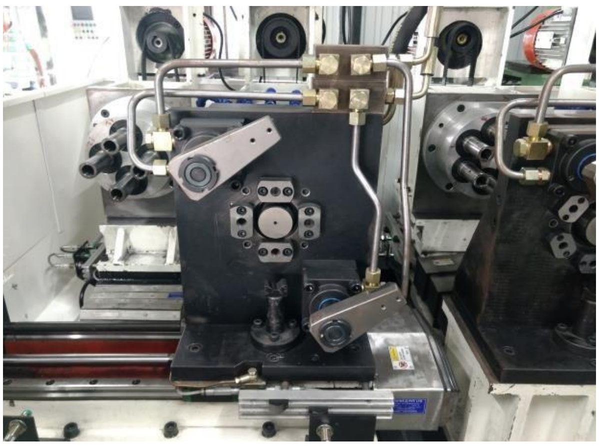

Fig.4: Actual manufactured fixture assembled on SPM.

5. ANALYTICAL FORCE AND POWER CALCULATION

SR.NO.	PARAMETERS	SYMBOL	VALUES
1.	Diameter of Drill	D	9.38mm
2.	Revolution per minute	n	
3.	Cutting Speed	v	35-55 m/min (As per the CMTI design data book, Tableno.277.)
4.	Feed per revolution	S	0.12-0.2 mm/rev. (As per the CMTI design data book, Table.no:278)
5.	Material factor	K	0.55 (As per the CMTI design data book, Table.no:272)
6.	Power at the spindle	N	$1.25 \times D^2 \times K \times n \times (0.056 + 1.5 \times s)/10^5$ (From CMTI book, Table.no:260)
7.	Power of the motor	N_{el}	$N_{el} = N/E$
8.	Torque	T_s	$T_s = 975 \times N/n$
9.	Thrust	T_h	$T_h = 1.16 \times K \times D \times (100 \times S)^{0.85}$

Table No.2: Parameters for Power and Force Requirements in machining.

Revolution/min (RPM):

$v = \pi \times D \times n/1000$

$n = 55 \times 1000/ \pi \times 9.38$

$n = 1866$ rpm

1. Power at the spindle (KW):

$N = 1.25 \times D^2 \times K \times n \times (0.056 + 1.5 \times s) / 10^5$

$N = 1.25 \times 9.38^2 \times 0.55 \times 1866 \times (0.056 + 1.5 \times 0.18) /10^5$

$N = 0.368$ KW = 368 watts

The value calculated above is power required by single Spindle , now the total power required for 4 spindle is

$= 4 \times 0.368$

$= 1.482$ KW

2. Power of the motor (KW):

$N_{el} = N/E$

$N_{el} = 1.482/0.8$

$N_{el} = 1.66$ KW

3. Torque at the spindle (N-m):

$T_s = 975 \times N \times 9.81/n$

$T_s = 975 \times 0.368 \times 9.81/1866$

$T_s = 1.89$ N-m

Thrust at the spindle (N):

$T_h = 1.16 \times K \times D \times (100 \times S)^{0.85}$
$T_h = 1.16 \times 0.55 \times 9.38 \times (100 \times 0.18)^{0.85}$
$T_h = 69.82$ N

5.1 FORCE AND POWER CALCULATION FOR TAPPING.

SR.NO	PARAMETERS	VALUES
1.	Tapping Diameter	10mm
2.	Cutting Speed	14–18m/min (From CMTI design data book, Table 277.)
3.	Pitch	1.5mm

1.Revolution/min (RPM): $v = \pi \times D \times n/1000$ $n = 16 \times 1000/\pi \times 10$
$= 509$ rpm

2. Power at the spindle (75% of thread engagement) :

$N = 0.326 \times D \times p \times n \times K/10^4$

$N = 0.326 \times 10 \times 1.5 \times 509 \times 0.55/10^4$

$N = 0.1369$ KW

3. Power of the motor (N_{el}):

$N_{el} = N/E$

$N_{el} = 0.1369/0.8$

$N_{el} = 0.17$ KW

4. Torque (N-mm) :

$T_s = 975 \times N \times 9.81 / n$

$= 975 \times 0.1369 \times 9.81 / 509$

$T_s = 2.56$ N-mm

CONCLUSION:

1. The change in orientation & position of component can completely avoided, Reduction in the orientation & position of the component reduces error in machining operations so it increases accuracy.

2. Fixture is successfully designed & manufactured for the COUPLING 4-RUBBER COMPONENT component within minimum setup on the SPM to increase the productivity & accuracy.

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