Design and Analysis of Drill-Bit Fixture

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Abstract— The Basic Operation of the fixture is to Hold, Support and easy to locate the component which is going to be machined. The Fixture mostly are installed manually and have their operation in manual form only. They have a high rate of application in industries. Usually the whole process takes a lot of time for uploading and unloading of the component on various machines and hence the manual fixture is optimized according to the operator for effective and fast operation. These fixtures are mainly used by workers having less skills and required to do same operation for number of times so, a design of optimized fixture is necessary. The propose design is in regard of obtaining a step angle on the drill bit using this fixture as a holding and locating device. This work aims at designing a fixture used for performing machining operations on particularly a Drill-bit.

Key words: Drill-bit, Fixtures, Step angle

I. INTRODUCTION

The machine tool industry has undergone sufficient changes as the requirement of user engineering systems changed; first it started with the manufacture of basic general purpose machine tools. These machines though offered higher flexibility were not suitable for mass production owing to longer set up times and the tedious adjustments of machine and tools besides requiring highly skilled operators. With growing need of fast production to meet the requirements of industry, mass production machines are conceived. The fixture designing and manufacturing is considered as complex process that demands the knowledge of different areas, such as geometry, tolerances, dimensions, procedures and manufacturing processes. While designing this review work, a good number of literature and titles written on the subject by renowned authors are referred. All findings and conclusions obtained from the literature review and the interaction with fixture designers are used as guide to develop the present research work.

The basic requirement of a fixture is to locate and secure the work piece in the correct orientation and relationship so the manufacturing process can be carried out according to design specifications. A typical fixture for prismatic parts consists of three components: locators, clamps, and supporters. Locators are used to position the work piece in static equilibrium thus removing all degrees of freedom.

Clamps are for holding the work piece firmly against the locators during machining for rigidity. The external cutting forces and tool direction are the major considerations. Additional support is added to reinforce the stability of the work piece. Since the work piece is subjected to the external cutting forces of machining, the three above fixture elements must make sure that the work piece is positively located, is rigid, and assures repeatability. Repeatability refers to the work piece and subsequent work pieces can be located by the fixture in precisely the same place. This activity is considered a 'set-up' in manufacturing. Drilling fixtures are basically the fixtures used to hold drill-bits which undergo high stresses while in operation. The use of this fixture is to hold the drill-bit according to the requirement of the operation to perform required operation on the drill-bit. As the current observation in the Conventional CNC machine states that there is a noteworthy wastage of time in injection and removal of the drill-bit in the CNC fixtures. Hence, the use of fixture mounted on the manual tool and cutter machine as an alternative for faster uploading of the drill-bit and increase in the production rate. The current scenario in the company is that there is a demand in the increasing the production rate of providing Step angle on the drill-bit. Study indicates that there are two major types of fixtures available to hold the drill-bit which are Dedicated and Flexible Fixture, as per the requirement of the company; Selection of the Dedicated Fixture was incorporated in the project.

II. A TOOL AND CUTTER GRINDER MACHINE

Before is used to sharpen milling cutters and tool bits along with a host of other cutting tools. It is an extremely versatile machine used to perform a variety of grinding operations: surface, cylindrical, or complex shapes. The image shows a manually operated setup, however highly automated Computer Numerical Control (CNC) machines are becoming increasingly common due to the complexities involved in the process. The operation of this machine (in particular, the manually operated variety) requires a high level of skill. The two main skills needed understand of the relationship between the grinding wheel and the metal being cut and knowledge of tool geometry. The illustrated set-up is only one of many combinations available. The huge variety in shapes and types of machining cutters requires flexibility in usage. A variety of dedicated fixtures are included that allow cylindrical grinding operations or complex angles to be ground. The vise shown can swivel in three planes.

Fig .1: Grinder Wheel on Tool & Cutter Machine

The table moves longitudinally and laterally, the head can swivel as well as being adjustable in the horizontal plane, as visible in the first image. This flexibility in the head allows the critical clearance angles required by the various cutters to be achieved.

Fig. 2: Bed on Tool & Cutter Machine

III. COLLET SELECTION

The Following figure shows a line diagram of collet used in the Fixture for holding the drill-bit with a certain required force.

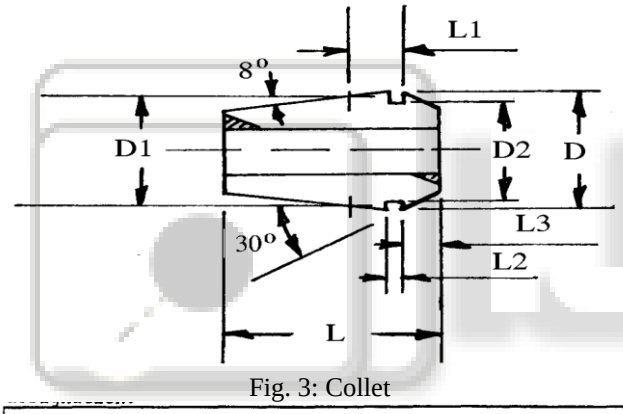

Fig. 3: Collet

Table 1. Collet Geometry Standards from DIN 6499 (8-degree Cone).

Collet Design	$d_2=2R_{c1}$, mm	$d_5=2R_{top}$, mm	$d_{11}=2R_a$, mm	$l_1=L_{bar}$, mm	l_3, mm	l_4, mm	$l_{11}=R_c$, mm
ER11	11.0	9.5	7.5	18.0	2.0	2.5	5.0
ER25	25.0	22.0	18.0	34.0	2.5	5.0	11.5
ER32	32.0	29.2	23.5	40.0	2.7	5.5	14.9
ER40	40.0	36.2	30.5	46.0	3.5	7.0	18.5

Fig. 4: The Table represents the range of the collet size that can be used for selection of the collet

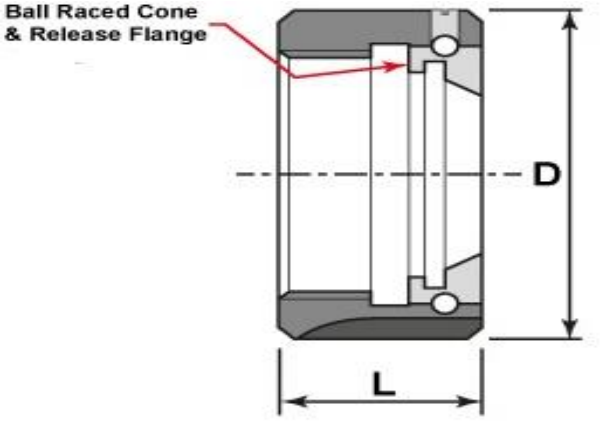

Fig. 5: Collet Nut

IV. DESIGN AND CALCUATION

As per the requirement for the fixture to work without breaking during the operations the input values and the output values were determined so that the operation will be carried out without damaging the fixture of the Drill bit.

A. Input Data

Ideal metal removal rate;
MRR= 0.02 cm^2/Sec; A30TBF
$\Rightarrow$ Q = 1.2 cm^3/min
Feed Rate = 0.05mm/rev
Average unit power requirement for grinding.
$\Rightarrow$ INPUT POWER = 1.5 HP
Considering motor to be of following specifications
Power = 1.5 Hp =1.2 KW
Speed 2880 rpm
Thus Torque = Torque at spindle is given by
Ts = 975 N / n
The Radial cutting force acting on the fixture is given by
F = 156 N

Here it has been observed the assembled view of the Fixture which has been designed using the values determined during the process. This model was developed using the Creo software.

It contains of Handle, Cam, Follower, Locking pin mechanism. This is all supported on the Base.

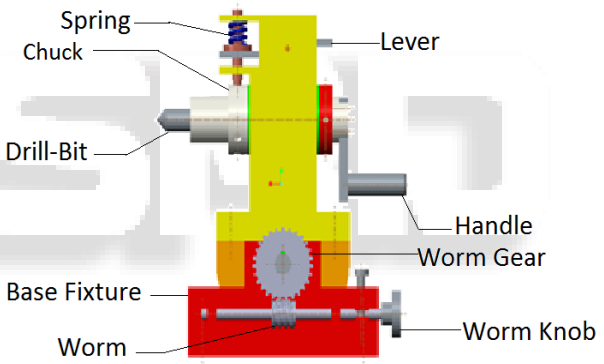

Fig. 6: Design of Fixture

Following are the steps of the operation conducted using the above designed fixture.

1) Switch ON the power supply and activate the machine
2) Allow the Grinding wheel to rotate for a few seconds
3) Insert the Drill-bit inside the fixture.
4) Adjust the fixture longitudinally so that the drill-bit touches the Grinding wheel
5) After incorporation of the step angle on the drill-bit, retract the Fixture.
6) Rotate the handle and press down the lever simultaneously such that the locking pin will disengage and the drill bit will rotate at a required angle.
7) Again move the fixture near the grinder wheel for incorporation of the step angle.
8) Retract the fixture
9) Allow the drill-bit to cool off for a few seconds.
10) Remove the drill-bit.

V. ANALYSIS

The Main component on which the application of stress was determined is the Chuck which rotates along the handle.Two main Stress analysis were performend i.e Equivalent (Von-mises) Stress and Total Defoemation.

It was observed that under both the testing the chuck retains to be intact with minimal stress application on majority portion of the cross-sectional area.

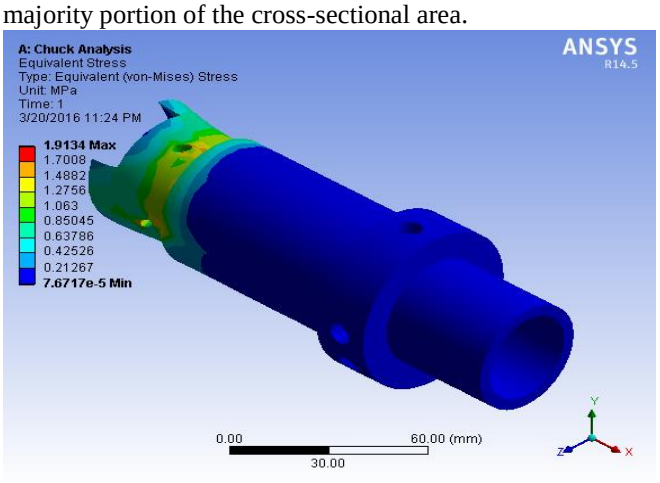

Fig. 7: Equivalent Stress

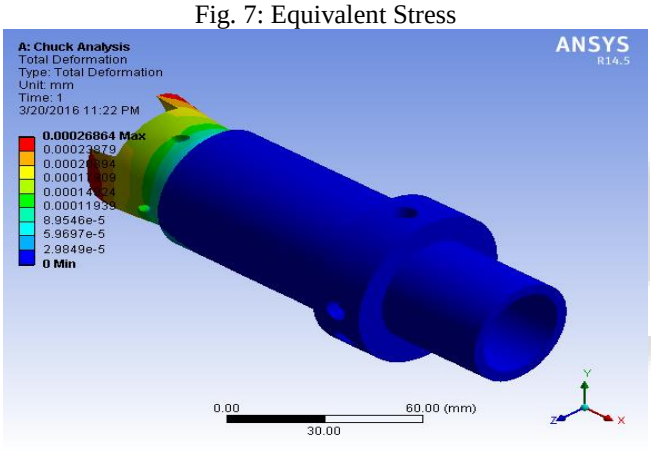

Fig. 8: Total Deformation Stress

VI. ADVANTAGES AND LIMITATIONS

A. *Advantages*

1) Elimination of individual marking, positioning and frequent checking of the part during manufacturing.
2) Reduction in operation time 6 minute.
3) Simplified locating and clamping of the drill-bit.
4) Easy assembly and savings in labor costs result in substantial reduction in the cost by 20% (approx.) of product produced.
5) Easy to insert and remove capability.
6) Continuous working of the fixture making it wear and tear resistant.
7) Step angle from (0°-360°) can be obtained with ease.

B. *Limitations*

1) Finishing compared to CNC machine is not obtained.
2) Requires human involvement frequent than CNC machine.

VII. CONCLUSION

There are not many fixtures available for Drill-Bit at an affordable price in today's scenario. As application for fixture design differs from industry to industry because dimensions required by industries differ from each other.
This simple design of drill bit fixture assembly enables to perform such operation with accuracy and repeatability which will eliminate the use of highly overprice Fixture and thus benefiting the company.

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