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DESIGN OF TURNING TABLE FOR AUTOMATED PROCESSING SPM AND ANALYSIS ON VERTICAL SHAFT ASSEMBLY BENDING BEHAVIOR.

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Short Profile

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ABSTRACT:
Product customization work is includes here with specific solution to make feasible turning of heavy cylinder block in 90 degree to pass on dedicated track. Track is made for Passing component precisely into machine fixture. Overall customized mechanism explained here with its mechanical components with full proof validation to know the working reliability in actual working. Work including design and development in 3D cad also FEA results in ANSYS workbench gives description of product structural behavior.
Work gives feasible way to turning object with precise in cycle time as well as with its strength.

KEYWORDS
Cylinder Block, Locating Pad, Roller Wheel, Conveyor, Trolley, Pneumatic Cylinder, Turning Table, Shaft, Gear.

INTRODUCTION

Turning table is considered as a connecting part of the machine here which is very much needed to make transport of component from conveyor to machine model. Straight self powered conveyor is feeding components in assembly line but before assembly station need to be drill and tapped the holes for this process a common station SPM is designed for which component rotation and turning 90 degree needed to avoid manual track diverting process, While turning some locking and unlocking dogs to be fixed so that lifting and fitting can be modified with pneumatic cylinder. As the below construction layout shows specified working of the whole system. Housing will be needed to make stability of the vertical shaft shown in sketch. Working structure is decided from the indexing machines to rotate the machining table have used in references.

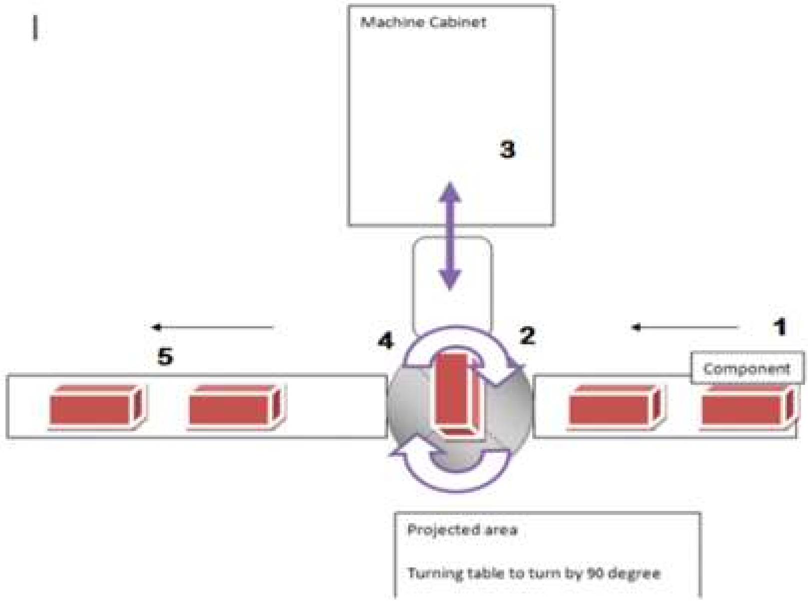


Fig: Working Layout

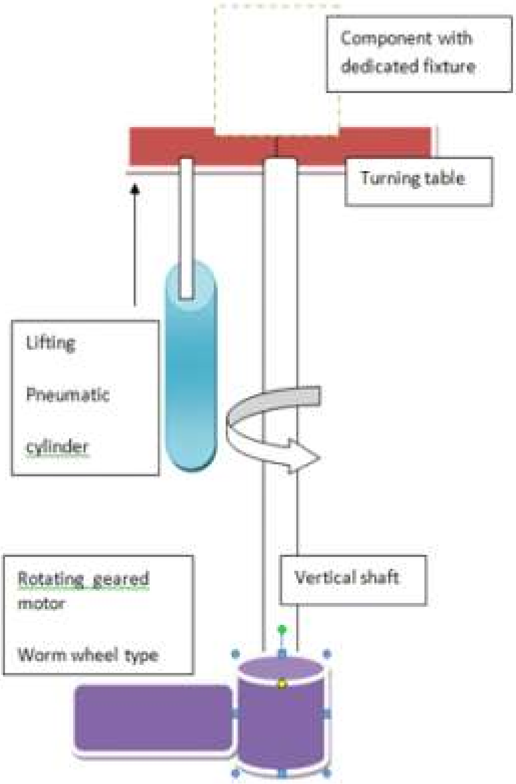
Need of turning table in the process:

1. Component comes from production site after verifying and quality checking.
2. Conveyor pushing the component on turning table dedicated fixture will fix the component.
3. Turning table activated get lifted by pneumatic cylinder and start rotation 90 degree to change the component facing position.
(Lifting is needed to make coaxial/concentric the circular track provided with fixture and machine track which is already fixed)
4. Dedicated fixture along with component gets pull inside the machine by pneumatic actuator.
5. Machine starts working on the component (spot facing and drilling, tapping).
6. Again component gets pushed on turning table.
7. Again turning table activated and turn 90 degree to pass outgoing conveyor.

Cycle repeat for all components with uniform cycle time

Working construction

Proposed Mechanism:



REVIEW OF LITERATURE

1.Available indexing tools heavy machines
2.Drilling by linear indexing only drilling can be possible. Component moves linearly not tool post.
3.Circular indexing and turning.
4.Components are moving around on disc tools are fixed at their places. And activated by the sensors when components are present.

SCOPE OF WORK

Concept study:

1.Design the concept and mechanical parameters ,
2.3D modeling and assembly,
3.Applying 3-2-1 principle to make component fixing.
4.Design calculations
5.Selection of material and required components ,
6.Boundry conditions and outcomes,
7.Analysis on the mechanism for holing and lifting structure.
8.Analysis on vertical setup holding assembly.
9.Comparison on validate results.

METHODOLOGY

1)Structural design

1.Concept design ,
2.3d modelling, layout considerations .
3.Design calculations,
4.Selection of standard components and actuators.

2)FEM approach

1.Structural bending behaviour analysis.
2.Stress analysis.
3.Optimized design solution.

SIGNIFICANCE

Typical fixtures are welding fixtures, Assembly fixtures, using 3-2-1 principle these can be designed,

3-2-1 Principle of Location:

A work piece can be positively located by means of 6 pins so positioned that collectively they restrict the work piece in nine of its degree of freedom.

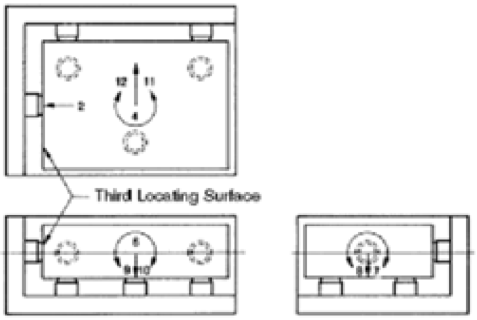


Figure: The 3-2-1 principle of location

This is known as six point location method. Three of these pins are in first plane and two in the second plane perpendicular to the first and one in the third plane perpendicular and adjacent to the both first and second planes.

When heavy components are to be operated fixture elements selection is very important term ,To overcome the difficulties in fixturing as well as operation methodology rotary type can be innovated A new approach to automated modular fixture planning is presented. The approach identifies all the location plan candidates of a workpiece using linkage mechanism theory and excludes the infeasible location plan candidates by evaluating their accessibility and fixturability. The algorithms for analyzing accessibility and fixturability and generating feasible clamp positions of a fixture plan are developed based on several new concepts including IRC triangle, locator visible cone, rotary mechanism etc. The approach is capable of handling the workpiece whose side clamping faces consist of planar faces or cylindrical faces.

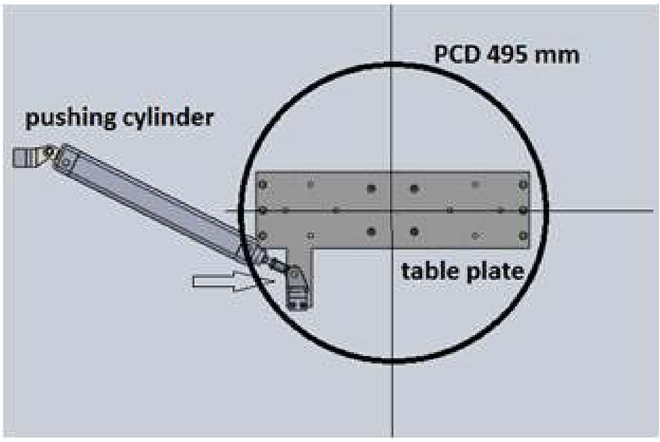
The focuses of the contribution are principles of modeling engineering objects. Theoretical inputs have their basis in the design system of the general model of the fixture and its interpreting. Their parts are the functional model of the fixture and the force model of the fixture. The questions of selection and positioning of a model's elements from the fixture kit are solved according to workpiece characteristics in the functional model. In the force model influencess of cutting and clamping forces to the set of workpiece-fixture are evaluated. The final phase of the design process is interpreting of the fixture model. The models of elements are replaced and the actual fixture kit's elements are inserted to the fixture model in this step of the design procedure. Drawings are made by 3-D modeling.

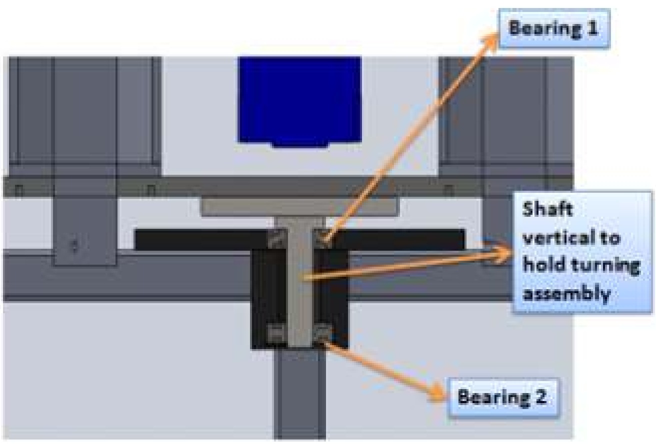
CALCULATIONS

Design of rotation parameters:

BEARING SELECTION

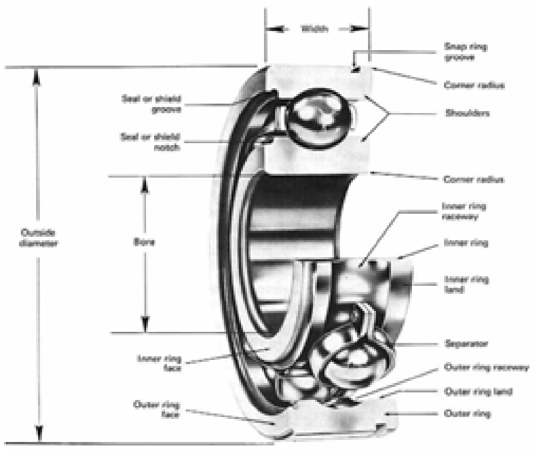
Angular contact ball bearings to be install for Axial and radial force As shaft diameter is 25 mm ,Force to carry 421 N, Normal force 421 N & Radial total 421N





Angular contact ball bearings:

Angular contact ball bearings, capable of carrying a combination of axial and radial loading. Note how one side of the groove in both the inner and outer races provides more contact with the balls than the other side. The bearing must therefore be mounted in the correct orientation to carry the axial load.



In ball bearings in general, the rolling elements are spheres of high quality, hardened and polished alloy steel, rolling in hardened alloy steel INNER and OUTER RINGS or RACES.

For radial load its good.

Torque and drive calculations required to drive the system:

Component weight : 92 kg,
Weight of other parts : 51 kg
Total weight: 143 kg

For rolling applications, generally preferred value the coefficient of friction is 0.2.

Maximum Pull = Total Pulling weight × Coefficient of Friction

= 143 × 0.3
= 42.9 kg

= 421 N ....,

Pitch Circle Diameter of platform (PCD) = 495 mm
Distance to travel for turning 90 degree area to be covered, hence 495/4 =124 mm
Required torque = Maximum pull × (PCD of table / 2)
= 421 × (0.495 / 2)
= 104.2 Nm

Design of shaft in vertical mount condition:

Shaft Design based on the strength

Axial stress:

$$\sigma_a = \frac{F}{A}$$

F = 1430N

A= $\frac{\pi}{4}D^2$.............. (D=25mm)

= 4417.86 mm^2

$$\sigma_x = \frac{1430}{490.87} = 2.91\ \text{N/mm}^2$$

Shear stress is given by

$$\tau_{xy} = \frac{T\,R}{J}$$

Where,
T = torque = 104200 Nmm
R = radius = 12.5 mm

J = Polar moment inertia = $\frac{\pi}{2}R^4$ = 38349.5 mm^4

Therefore,

$$\tau_{xy} = \frac{104200 \times 12.5}{38349.5} = 33.96\ \text{N/mm}^2$$

Maximum Allowable shear stress

$$\tau_{max} = \sqrt{(\frac{\sigma_x}{2})^2 + \tau_{xy}}$$

$$\tau_{max} = \sqrt{(\frac{2.91}{2})^2 + 33.96}$$

τ_{max} = 3.30 N/mm^2.............. (i)

$$\sigma_{max} = \sqrt{\sigma_x{}^2 + 3\tau_{xy}{}^2}$$

$$\sigma_{max} = 58.85 \text{ N/mm}^2 \text{............. (ii)}$$

As maximum stress developed due to axial load of 1430 N is less than yield strength of the material i.e. 205 MPa, Hence design of shaft is safe.

Maximum Deformation is

$$\delta L = \frac{P\,L}{A\,E}$$

Where,
P = Load = 1430N
L = Length = 100mm
A = Area = 4417.86 mm^2
E = Modulus of Elasticity = 200MPA
Therefore
δL = 0.16 mm

Results

Total force required to turn: 421 N
Torque required pushing and turning the table with component: 104.2 Nm.

CONCLUSION

Turning of heavy engine cylinder block is possible by the vertical turning table; validation seems perfect to execute the designed system in SPM wherever turning of heavy component is needed.

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