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Research Paper

CAD MODELLING & CONCEPT DESIGN OF JIG FIXTURE FOR CONCENTRIC DRILLING

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Due to today's heavy, growing competition environment, manufacturing companies have to develop technologies to produce no scrap. Owing to the trend towards reducing lead time and human effort, fixture design is one of the options. This paper discuss about Jig and fixture design to drill five equidistant concentric holes on coupling hub.

Keywords: Jig and fixture design, Drilling concentric equidistant holes

INTRODUCTION

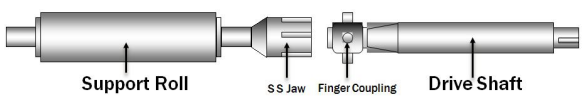
Anybody who has ever drilled on circular periphery knows that it is extremely difficult to prevent the drill from slipping and going off to the side, leaving misshaped holes. This is of course not something that is accepted in the industry. The tolerances are very high and mistakes are not allowed. For a single hole to be drilled there is no problem, but for five holes and that to concentric & equidistant on circular periphery of a coupling hub is a big problem. The process of drilling with the help of vertical drilling machine is all done manually. So there is a scope to be mistaken from starting (i.e. from marking & punching centers for holes) to the end drilling. So the project, to eliminate the rejection of finger coupling hubs was done to solve the problem by designing the Jig & fixture for the same.

PROBLEM DEFINITION

The support roll & drive shaft assembly is used in the zinc pot of a galvanizing line. The jaw coupling is fixed with the support roll while the finger coupling is fitted with the drive shaft. The figure will let us understand the position of the jaw & finger coupling on the support roll & drive shaft respectively.

The jaw is an imported component from other industry while the finger coupling is fabricated

Figure 1: Support Roll with Jaw Coupling & Drive Shaft with Finger Coupling



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in the workshop of the galvanizing industry. "The unavailability of finger coupling was occurring due to its improper fabrication. This resulted in non engagement with the jaw." This was the main problem which was to be rectified.

Figure 2: Actual Photo of Jaw & Finger Coupling Assembly

Non engagement

Proper engagement

PROCEDURE OF MAKING FINGER COUPLING

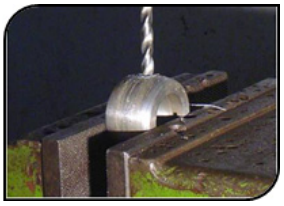
Firstly the fingers are made from EN08 (mild steel) round bar of Ø30mm. The Ø30mm round bar is turned into size of Ø25mm on lathe machine. Then external threading of M24x24mm is done one the lathe machine. Then the bar is cut into length of 50mm & the finger is ready. Then coupling hub is made from Ø100mm EN08 material round bar. The Ø100mm bar is machined on lathe to give a spherical shape of Ø85mm upto width of Ø50mm. Then a bore of Ø50mm is done. At the center of the bore a step of Ø60mm x 30mm & the hub is ready. Marking & punching of holes on the circular periphery. It is the most important & time consuming process. It requires highly skilled person to get the correct marking & punching. Then the hub is taken to the vertical radial drilling machine & fixed in the vise. This also requires high skill so as to place the marked hole position exact vertical to get the concentric drilling. After it is properly fitted in the vice, drilling is done at the marked position with a twist drill of 21mm size. In this too the procedure is critical & requires skilled person since the surface is spherical. Then the drilled Ø21mm sized holes are tapped manually with the help of M24 size tap set. After making the fingers & the hub, the fingers are fastened into the hub & the finger coupling is ready to use for fitting it into the drive shaft. The complete finger coupling fabrication procedure can be seen through the following photo.

Figure 3: Finger Coupling Fabrication Sequence

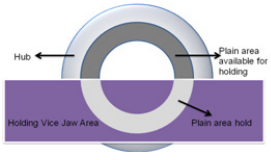
GEOMETRICAL CONCEPT GENERATION

First aim is to restrict all degrees of freedom of the object. This will be done with the help of the fixture. But for this let us see first, the current arrangement for holding the coupling hub.

Figure 4: Finger Coupling Clamping in Drilling Vice



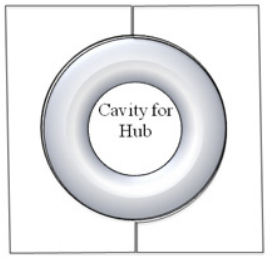
Actual Job Holding



Area for Clamping

For arresting its all degrees of freedom & for better clamping we will be using block type of fixture. The fixture can be of Split type so as to fix the hub inside as shown in figure.

Figure 5: Split Type Fixture Block



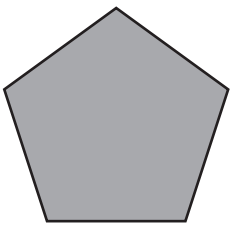
This type of fixture will arrest some of the degrees of freedom of hub. But we will have to arrest all the DOF. We will be evaluating it after the complete fixture concept. Now go for its indexing.

INDEXING CONCEPT GENERATION

For indexing, there can be automated systems but this will increase the cost. And as per the consideration for achieving our aims stated earlier, we will go designing the concept for manual indexing.

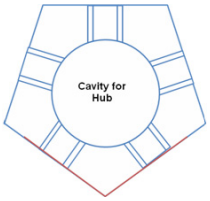
Now the process of is of drilling five equidistant holes, so square block of the fixture will not solve our problem. Also rather than providing another jig, which will increase number of parts, cost, time for fabrication etc, for correct drilling we will try for the jig to be made with the same fixture. It will provide the rigidity & ease of use by having fewer parts. For drilling five concentric & equidistant holes we can go for a regular pentagonal structure. (James Waltman, 2006; Lonny L Thompson *et al*., 1998). as shown in figure.

Figure 6: Pentagonal Fixture



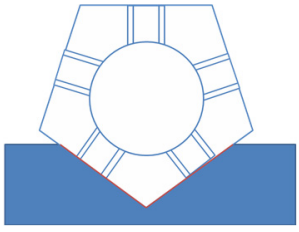
But with this position it is not possible to drill at the corners of the pentagon. So the correct position for drilling will be its inverted position as shown in figure below. Now at the plain surface we can provide jigs for drilling. We will provide five jig bushes, one on each side. This will solve our problem of drilling five holes

Figure 7: Correct Position for the Pentagonal Fixture



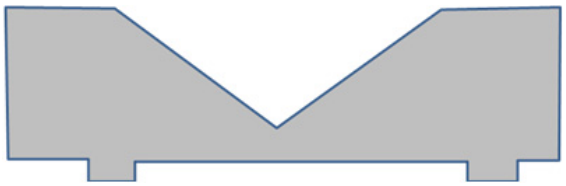
By rotating the fixture one by one such a way that the plain surface will be always perpendicular to the drill, or we can say the surface should be horizontal since we are using vertical drilling, can get the desired result. But still it can't be assured or it is difficult to keep the fixture always in the correct position. So as to have this we will be providing a base which will perform the task of correct indexing of the fixture. It is shown in the figure

Figure 8: Base for Fixture Indexing



Now our concept is almost completed but to have complete restriction of DOF of the hub we will have to do further development in the base. For this & correct positioning of the base itself, we will provide it legs which will fit in the gap of the vice bed. It is shown in figure below.

Figure 9: Fixture Indexing Base with Legs



WORKING WITH FIXTURE

Under this heading we will see, use of the fixture for proper drilling. A step by step procedure is given as below.

For first drilling

- Keep the pentagonal fixture in horizontal position.
- Place the hub inside the cavity of fixture.
- Clamp the hub inside the pentagonal fixture with the help of Clamp Plate & bolt by tightening it properly by the alen key.
- Take the fixture & keep it properly on the fixture base.
- Clamp the whole fixture by vice jaw.
- Now adjust the drill to the center of the jig bush & start drilling.

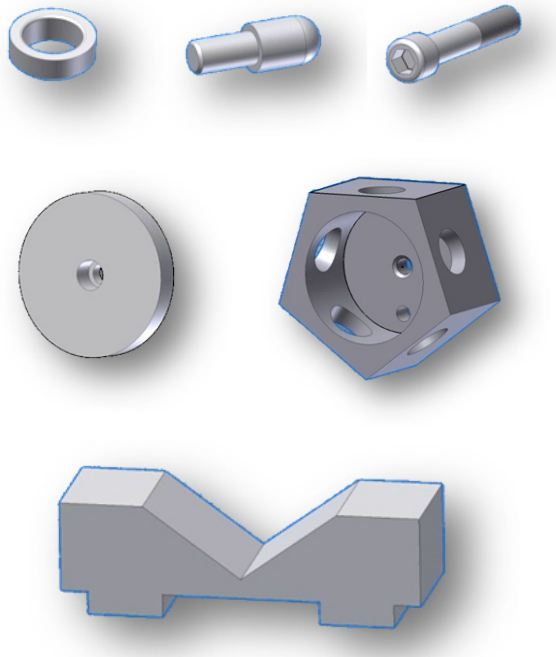
For second drilling

- After drilling first hole, release the jaw of vice & take out the pentagonal fixture.
- Then keep it back on the fixture base by keeping the next jig bush position on top & clamp the whole fixture by jaw of vice.
- Now from the second drill place the locating pin in previously drilled hole.
- Adjust again the drill (if necessary) to the jig bush center & star drilling.

For third, fourth & fifth drill Repeat the procedure as stated for the second drilling.

CAD MODELS

Figure 10: CAD Models of Drill Jig-Fixture Parts Using AUTODESK INVENTOR



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