

January 2012

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Recommended Citation

DAKHOLE, ASHISH Y. and TUFAIL, M.S. (2012) "DESIGN OF AUTOMATED CONVEYORISED FIXTURE ARRANGEMENT FOR BANJO BEAM IN SPECIAL PURPOSE MACHINE," *International Journal of Instrumentation Control and Automation*: Vol. 1 : Iss. 4 , Article 6.

Available at: <https://www.interscience.in/ijica/vol1/iss4/6>

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DESIGN OF AUTOMATED CONVEYORISED FIXTURE ARRANGEMENT FOR BANJO BEAM IN SPECIAL PURPOSE MACHINE

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Abstract - Automated moving Fixture for Banjo Beam or Case Axle cleaning machine is taken from the special purpose machine in which Different 17 types of components are to be cleaned, dry, and proceed for painting in continuous production line of Automotive Industry that is Manufacturer of Case axle Since the machine is to be made for the 17 different type of components and each component is of different shape and sizes. Components are taken by considering similar standard automotive components which are universally used.

The system is made for multistage processing with well defined process and operation for the decided cycle time. This system is the conveyorised Fixture for Banjo Beam along with component will be get stoppage at every station by provided sensors, Operation cycle is run through PLC Programme

Keywords - Banjo Beam; Material Handling; Machine tool; Poka-yoke; Automation.

I. INTRODUCTION

For an Automobile Industries it's a very difficult job to clean the typical components, engine components in assembly line before assembly of engine to obtain the required Millipore value. Hence in automotive, aviation, Auto ancillaries and other industries Automated Washing machines are highly demanded these can be called as Special Purpose Machines. Special Purpose Machines are use to save the time, man power and improve washing and drying quality Made from SS, MS quality raw materials.

The Conventionally using conveyor in production line is worldwide known .but in special purpose machines conveyor also needed with special Design and parameters for its operational feasibility. As the material handling equipment is needed for transferring components from one place to another place in case of special purpose cleaning machine material handling needed with special dedicated Fixture ,Poka-yoke, instrumented system, component transferring system.

In this automated Moving Fixture arrangement fixturing parameters like v pads, vertical rods, mounting pads, etc. along with chain Sprocket arrangement to reach at multiple station with stop and go operation with the given speed by gear box. Speed can be control by VFD (Variable Frequency Drive)

Gear Box used in system selected by considering required speed as per the production rate and number of components to be operated in machine per shift.

A. Process:

- Study and classification of different 17 components to finalize the mounting of component.
- Design of V-Pads, fixture trolley, spring loaded plates for arresting the movement.

- Design and selection of Roller Wheels, Bushes, Cir clips, and Bearings roller track etc.
- Poka-Yoke for full proofing and error free component mounting on fixture
- Selection and Design of Conveyor, chain drive, shaft.
- Selection of sensors, and use of sensor dog for Auto stopping at different stations.
- Design Calculations.
- Use of variable frequency drive with inbuilt braking arrangement (soft start and soft stop) for trolley drive.
- Logic development for overall Process for cycle counters through PLC.

B. Inputs for Design:

- 17 Different Case Axle to be used
- Maximum Weight Of component: 170 Kg
- Maximum Available Area: 10 Meter x 3 Meter.
- Loading Height: 1100 mm from ground
- Around 5.5 to 6.5 minutes /component /cycle

II. BANJO BEAM

A banjo beam is a rear case axle cover. Rear axle is the differential mechanism used in vehicles like trucks, buses and other commercial vehicles. Banjo beams are in different sizes as here data is collected from running banjo beams in world's Automobile Sector.

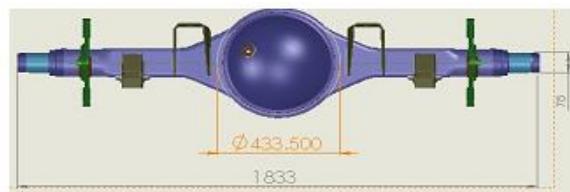


Figure 1. Component having Minimum length

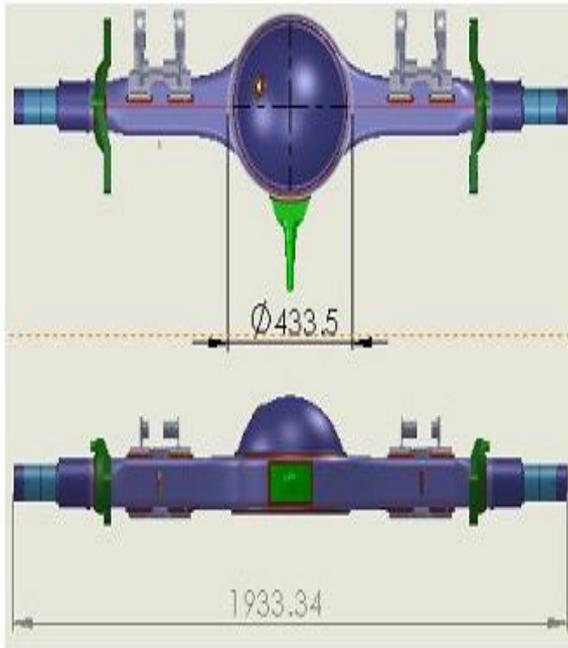


Fig. 2 : Component having Maximum length

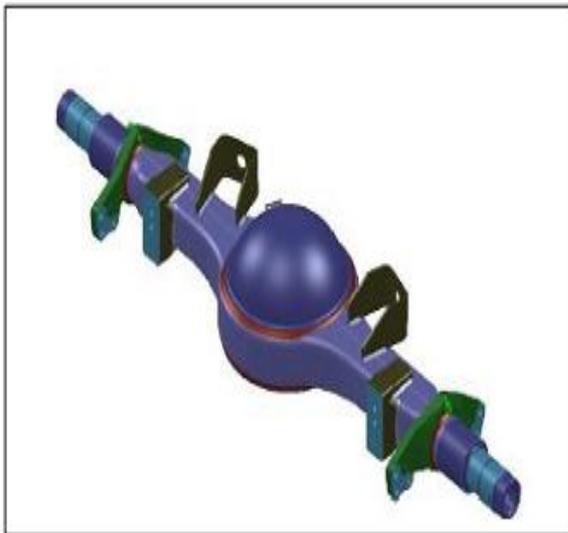


Fig. 3 : Isometric View of one of Banjo Beam from 17 different which are to be considered for fixturing

III. FIXTURE DESIGN FOR THE SYSTEM

A. Theory

A fixture is a device for locating, holding and supporting a work piece during a manufacturing operation. Fixtures are essential elements of production processes as they are required in most of the automated manufacturing, inspection, and assembly operations. Fixtures must correctly locate a work piece in a given orientation with respect to a cutting tool or measuring device, or with respect to another component, as for instance in assembly or welding. Such location must be invariant in the sense that the devices must clamp and secure the work piece in that location for the particular processing

operation. There are many standard works holding devices such as jaw chucks, machine vices, drill chucks, collets, etc. which are widely used in workshops and are usually kept in stock for general applications.

Generally, all fixtures consist of the following elements:

- Locators

A locator is usually a fixed component of a fixture. It is used to establish and maintain the position of a part in the fixture by constraining the movement of the part. For work pieces of greater variability in shapes and surface conditions, a locator can also be adjustable.

- Clamps

A clamp is a force-actuating mechanism of a fixture. The forces exerted by the clamps hold a part securely in the fixture against all other external forces.

- Supports

A support is a fixed or adjustable element of a fixture. When severe part displacement/deflection is expected under the action of imposed clamping and Processing forces, supports are added and placed below the work piece so as to prevent or constrain deformation. Supports in excess of what is required for the determination of the location of the part should be compatible with the locators and Clamps.

- Fixture Body

Fixture body, or tool body, is the major structural element of a fixture. It maintains the spatial relationship between the fixturing elements mentioned above, viz., locators, clamps, supports, and the machine tool on which the part is to be processed.

B. General Requirements of a Fixture

In order to maintain the work piece stability during a machining process, an operational fixture has to satisfy several requirements to fully perform its functions as a work holding device. The following constraints must be observed while designing a viable fixture:

- Deterministic Location

A work piece is said to be kinematically restrained when it cannot move without losing contact with at least one locator. The work piece is constrained by a set of appropriately placed locators so that it is presentable for the machining operation. Locating errors due to locators and locating surfaces of the work piece should be minimised so as to accurately and uniquely position the work piece within the machine coordinate frame.

- Total constraint

A work piece should be fully constrained at all times to prevent any movement.

Clamps should provide locking forces to hold the work piece in place -once it is located. A totally restrained part should be able to remain in static

equilibrium to withstand all possible processing forces or disturbance. A necessary and sufficient

Condition to warrant work piece stability is to satisfy the condition of force closure.

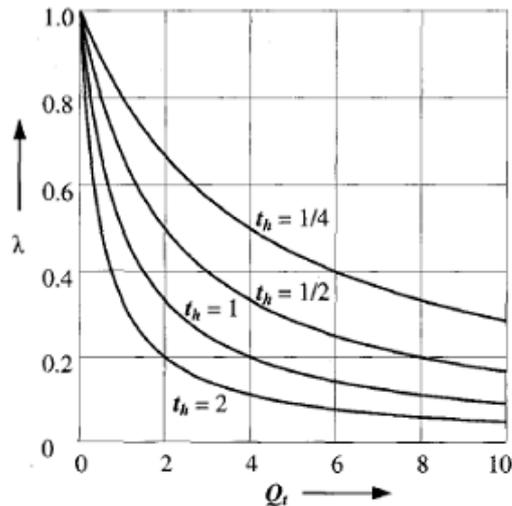


Fig. 4 : Effect of setting and handling time (th) on production efficiency.

- Contained deflection

Work piece deformation is unavoidable due to its elastic/plastic nature, and the external forces impacted by the clamping actuation and machining operations. Deformation has to be limited to an acceptable magnitude in order to achieve the tolerance specifications.

- Geometric constraint

Geometric constraint guarantees that all fixturing elements have an access to the datum surface. They also assure that the fixture components do not interfere with cutting tools during a machining operation. In addition to these requirements, a fixture design should have desirable characteristics such as quick loading and unloading, minimum number of Components, accessibility, design for multiple cutting operations, portability, and low Cost, etc.

Generation of fixture layout is to represent the fixture Concepts in a physical form. The following outputs are included in the fixture layout:

- Positions of locators
- Positions of clamps
- Positions of supports, if any
- Type of locators
- Type of clamps
- Type of supports
- Clamping forces and sequence

C. Locating Principles:

One of the principal purposes of a fixture is to locate the work piece surfaces for performing a different operation. This is usually done with respect to a number of factors to be considered such as the reference datum, supporting surfaces, features that are likely to obstruct the tool movement or access

direction, etc. In general, the following Surfaces should be distinguished:

- Active surfaces

These are surfaces to be machined, *i.e.* surfaces which are subjected to the action of cutting tools.

- Supporting and locating surfaces.

These are surfaces by means of which the work piece is to be located with respect to set-to-size cutting tools.

- Clamping surfaces.

Clamping surfaces are subjected to the clamping forces for obtaining invariant location. Clamping surfaces are usually not finish-machined surfaces as clamping marks could damage the finish.

- Datum surfaces

Datum surfaces are reference surfaces where the dimensions are to be maintained and measured.

- Free surfaces.

Free surfaces are surfaces not involved in the set-up for the particular operation.

One method of reducing manufacturing and processing cost per component is to reduce process cycle time. The process cycle time can be reduced by reducing nonproductive time like loading, unloading, and the placing of work piece onto the machine. Here jig and fixture design has important role to play.

In short, the fixture is a tool that ensures correct and quick clamping (or loading) of the work piece with respect to the machine tool.

For a fixture designer, the major portion of design time is spent deciding how to locate the work piece in the fixture.

Any free body has a total of twelve degrees of freedom as below:

6 translational degrees of freedom: +X, -X, +Y, -Y, +Z, -Z

And 6 rotational degrees of freedom:

- Clockwise around X axis (CROT-X)
- Anticlockwise around X axis (ACROT-X)
- Clockwise around Y axis (CROT-Y)
- Anticlockwise around Y axis (ACROT-Y)
- Clockwise around Z axis (CROT-Z)
- Anticlockwise around Z axis (ACROT-Z)

It's Important to fix all the 12 degrees of freedom except the three translational degrees of freedom (-X, -Y and -Z) in order to locate the work piece in the fixture. So, 9 degrees of freedom of the work piece need to be fixed.

By using the 3-2-1 method as shown below:

Rest the work piece on three non-collinear points of the bottom surface (XY), and you will be able to fix the +Z, CROT-X, ACROT-X, CROT-Y and ACROT-Y degrees of freedom.

Now, rest the work piece at two points of side surface (XZ), and you will be able to fix the +Y and ACROT-Z degrees of freedom.

Now, rest the work piece at one point of the adjacent surface (YZ), and you will be able to fix the +X and CROT-Z degrees of freedom.

So, we can successfully fixate 9 required degrees of freedom by using the 3-2-1 principle of fixture design.

The jig and fixture are tools used for holding the work piece in a correct location for mass production. Various types of fixtures (like Special purpose, drilling fixtures, milling fixtures, and welding fixtures) are used in industry. The 3-2-1 method is the fundamental principle for all types of fixture design.

III. DESIGN AND SELECTION PARAMETERS

A. Dedicated Fixture arrangement:

- In this Fixture It has two pairs of resting removable plates of different height which are vertically mounted, say pair of PLATE-1 & PLATE-2. As shown.

Plate's height is considered by the operation oriented inputs so that further processes should not affect by fixturing and locating the. Since uniformity is to be considered for all 17 components in process of the machine

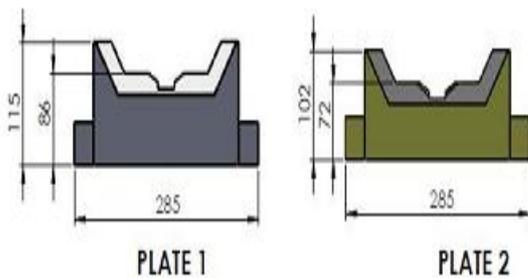


Figure 5. Plates

- Following are the locations of plates mounting; say A1, B1, C1 & C2, B2, and A2 as shown.

If plate no.1 is on left side then necessary that right side plate to be used plate no.1 for similar height.

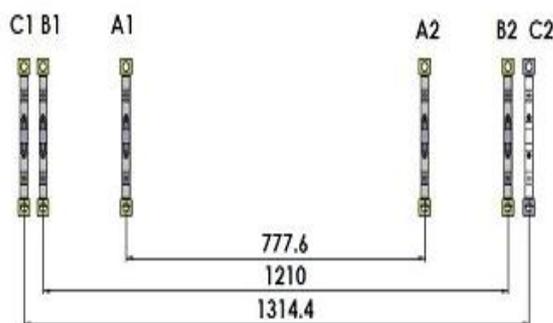


Fig. 6 : Plate position

- Trolley made for platform which hold together all the fixture elements along with component. Trolley made up of rectangular hollow section 80mm x 40mm x 3 mm.

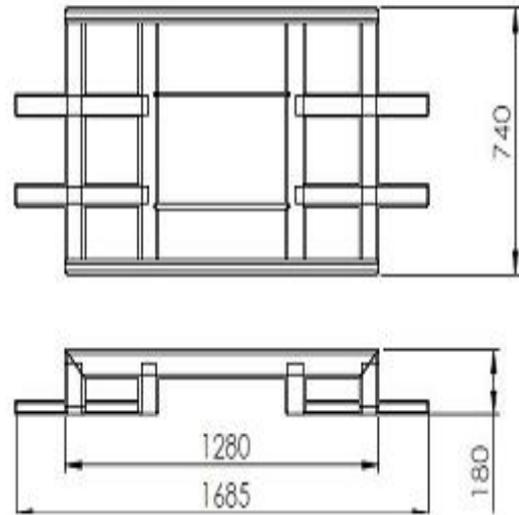


Fig. 7: Fixture trolley

B. Fixture setup

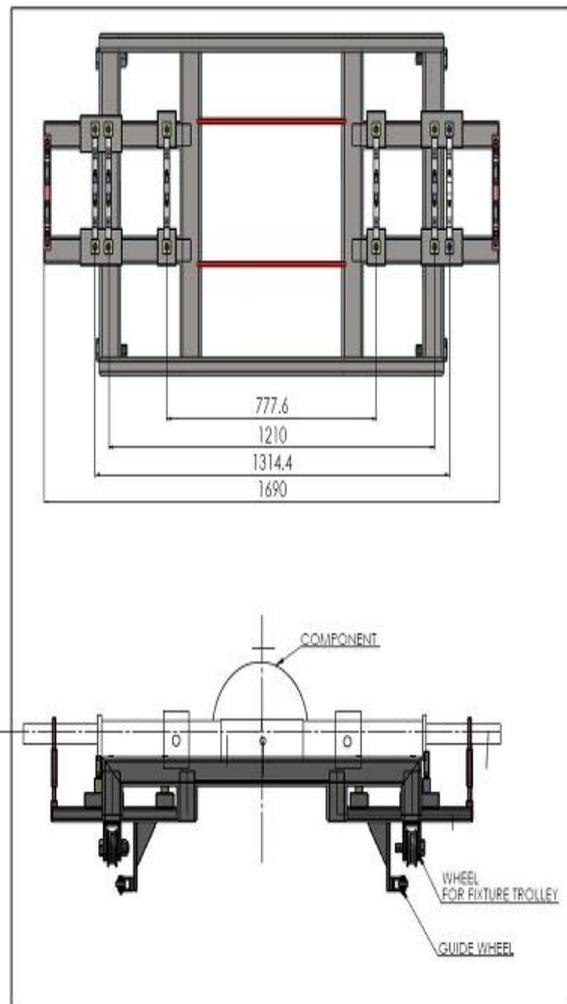


Fig. 8 : Fixture setup

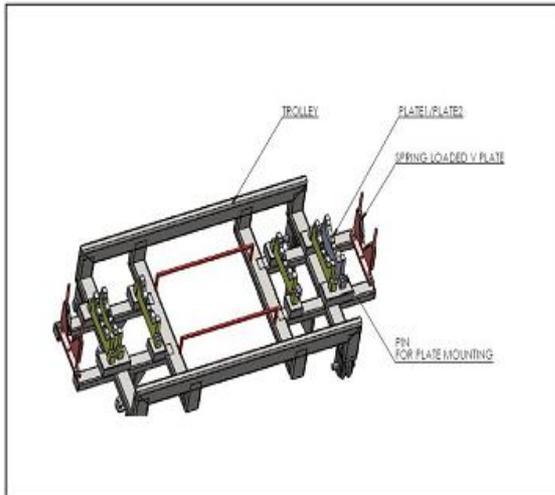


Fig. 9 : Fixture Setup

- Spring loaded v-plate.
Spring loaded v plate used here for restricts the component's forward backward motions and these plates are nothing but the poka-yoke for making components horizontally straight and concentric with both tubular ends

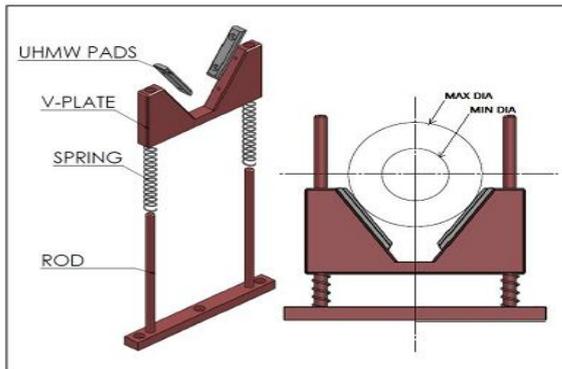


Fig. 10 : Spring loaded V-plates

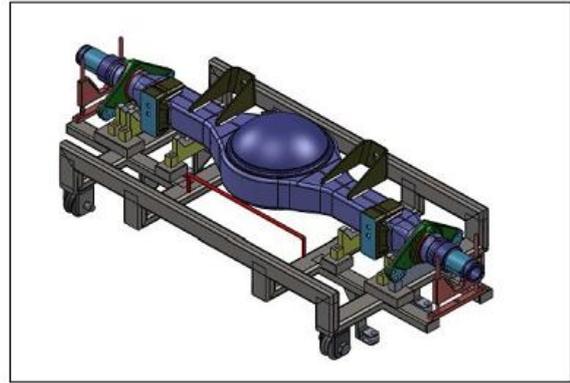


Fig. 11 : Complete assembly of dedicated fixture for Banjo Beam

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