# A SPECIAL TYPE OF MILLING FIXTURE FOR DISCONTINUOUS THREADS

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**Abstract** A discontinuous thread is one, which is normally made for lug finishes as seen in jam jar bottles and other food products, bottles that are usually filled under vacuum. The current practice of machining the threads in the die for lug finish is done manually. This increases the lead-time and the quality of lug finish is very poor. In order to reduce the lead time and to improve the quality of the lug finish in the components, a novel method using a special type of milling attachment along with an indexing mechanism has been developed to machine the discontinuous threads. This paper explains clearly the fabrication details and the working mechanism of a model of the special type of fixture used for milling discontinuous threads.

*Keywords: Discontinuous threads, milling attachment, lug finish and fixture*

## INTRODUCTION

Lug finishes are neck portion of the bottles as shown in "Fig.2". The lug finishes bear discontinuous threads on their outer surface. Lug finishes are generally found in the bottles used for packing solid and semisolid forms of foods in vacuum condition. This type of packaging helps to avoid the contamination of the food items thereby improving the shelf life. Standard size of Lug Caps are available for which the dimensions are maintained as per the L&T standards.

The discontinuous thread is broken at intervals as shown in "Fig.4". The helix angle of the thread is not the same throughout its profile; hence it poses a great difficulty in machining the thread. Conventional machining of the discontinuous threads, which is done manually, has the disadvantage of increased lead-time. Moreover the finish was not satisfactory. In order to obviate these disadvantages, a special fixture to guide the milling cutter along the correct helix angle to achieve the required profile of the thread was developed in the Department of Mechanical Engineering, Pondicherry Engineering College, Pondicherry, India in collaboration with Owens-Brockway Limited, Pondicherry, India (an US based glass bottles manufacturing factory).

## BOTTLE MANUFACTURING PROCESS

The bottle manufacturing has units as shown in "Fig.1". The raw materials used for molten glass are Silica sand, Limestone, Calcite and Felspar. They are thoroughly washed and cleaned in the Batch house. Then they are heated to a temperature of 1400°C in the furnace. The dies are already positioned in the inividual section of the bottle-manufacturing machine, and the bottles take the profile of the dies. The bottles are inspected and their quality is assured. Finally the bottles are packed and dispatched. Regarding the mould manufacturing unit, it starts with basic design criteria for which several drawings are drafted for various dies. The castings are done in the foundry and further machining of various dies is done in the CNC workshop.

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## DETAILS OF LUG FINISH

"Fig.2" shows the profile of the discontinuous thread. The study of the profile of 63 mm lug cap shows the following.

(i) There are four threads on the inner circumference of the neck ring.
(ii) The starting point of all the four threads are on the same circumferential line and the ending point of all the threads are also on the same circumferential line.
(iii) Each thread starts at phase shift of 90°.
(iv) "Fig.4" shows the profile of the thread, which has an angular length of 83,° is divided into three portions.
   (a) It is inclined at an angle 5.08° for an angular length of 46°.
   (b) It is straight for an angular length of 8°.
   (c) The thread is inclined at angle of 5.08° for the remaining length of 83°.
(v) The profile of the starting and ending corners of the thread are governed by cutter profile.

(vi) The depth of cut of the thread is 1.6 mm, and the width of the thread is 3.2 mm.

## CUTTER SELECTION

The different modes possible to generate the required profile are as follows

1. Tool vertical throughout the profile of the thread
2. Tool inclined at 5.08° throughout the profile of the thread.

The modes are drawn and verified by simulating the tool path in AutoCAD and it was found that the best mode for machining operation is "Tool inclined at 5.08° throughout the thread. The cutter used was Woodruff type.

On the upper part of the cutter a clearance of 32° is given while on the lower part has a clearance of 35°. Since the cutter is inclined at 5.08° and if the same clearance is provided on both sides, it results on the removal of more metal on the lower part of the thread. In order to avoid this difficulty a clearance of extra 3° is given on the lower part of the cutter.

The milling machine used was turret ram type, as the ram in this case is mounted on a swivel base on the top of the column. This feature facilitates the ram to be swiveled about a vertical axis. The vertical movement of the spindle obtained through a quill is power operated. This machine is especially suitable for tool room work. In this type the ram can be swilled to about 45° on both side of the vertical axis.

## DESCRIPTION OF MILLING FIXTURE

"Fig.6" shows the different parts of fixture, which are as follows.

1. Base
2. Lifter
3. Cam
4. Follower
5. Indexer
6. Hand wheel
7. Chuck

**Base**

Base is bolted by means of four 'T' slot bolts in the milling machine Table. The base has two steps. In the first step there are two holes 180° apart to push the follower shaft. The second steps serves as a mere shaft, where the lifter slides and rotates. There is a deep hole running through the center of base providing a way for chip disposal.

**Lifter**

The Lifter lifts and rotates the Chuck along with work piece during the machining operation. The lifting motion is actually got from the Cam, transmitting to the Chuck, which holds the job, through the lifter. The rotational motion is affected manually by rotating the handle in the Lifter. Lifter has two internally bored steps. The first step bored exactly fits into the projecting step of the Base. The step is done to spare a way for the disposal of chips. At the top outer surface of the Lifter, a hand wheel is provided which is bolted or welded to the surface for easy rotational operations. At the bottom outer surface it has four holes each at interval of 90° for the purpose of indexing. Just above the holes, there are graduations engraved for the proper indexing of thread. Three tapped holes drilled at top in order to fix the Chuck.

**Cam**

The Cam bears the profile of the thread starting from 0° to 83° on opposite faces, each having a distance of 180° apart. In addition to this, it has graduations engraved at the top. Just below the markings, two indexers are fixed 180° apart in such a way that the distance between the starting position and the indexer is 90°.

**Follower**

Bearings are used as Followers (SKF No 608). The bearings are fixed in position in two bearing shaft fixed to the base. To keep the bearing in position a circlip is provided on one side and the other side a washer is provided.

**Indexer**

The fixture bears two Indexers fixed to the Cam and they are 180° apart. The purpose of Indexer is to engage/disengage the Cam and the Lifter during the machining of threads.

**Hand wheel**

It facilitates easy manual rotation during the machining operations.

**Chuck**

The chuck used was three jaws self-centering scroll chuck. The Chuck is placed and bolted to the Lifter by three Allen screws.

## WORKING MECHANISM OF THE FIXTURE

To start machining, first the cutter is inclined at 5.08° i.e., the head is inclined to 5.08°.

**Case 1.** When the Follower is at initial stage.

The Neck ring is fixed in the Chuck and the correct point in which the thread starts in identified. The graduations are checked and the 0° of the Lifter and 0°of the Cam should coincide. Now the indexing pin is operated to extend and fit it exactly in holes provided in the lifter. As the handle is rotated in anticlockwise direction the Cam traces the path of the profile and there is a gradual lift in the Lifter, which is transmitted to the job fixed in the Chuck. At the same time the cutter is allowed to rotate at the desired speed to generate the profile through 46°.

**Case.2**. When the Follower is at the dwell region.

Up to 46° there is a gradual lift in the Lifter and the profile is generated. For the next 8° of angular length, dwell period, there is no inclination at the profile of the cam. There is no lift in the lifter and the path generated is a straight profile.

**Case.3**. When the Follower is at the completion of the thread.

At this stage the profile of the cam is again inclined at 5.08° to the remaining length of 29°. Hence once again there is a lift in the Lifter, transmitted by the Cam to the job and the remaining profile of the thread is generated. So the total length of the profile for 83° is generated. After finishing the first thread, we can proceed with the second, third and fourth threads using the indexing mechanism.

## INDEXING MECHANISM

Now the cutter is withdrawn from the inner circumference of the Neck ring. The handle is then rotated in the clockwise direction to reach the starting point. Now the index pin is operated to disengage the link between the Lifter and the Cam, which allows the Lifter to rotate freely. The Lifter is rotated through 90° to position the starting point of the second thread. After positioning the starting of the second thread, the Indexer is engaged in such a way that the 0° graduations of the Cam coincides with 90° marking of the Lifter. Now the machining operation is repeated after bringing the cutter in contact with the Neck ring. Similarly the third and fourth threads are machined. During the starting position of the third thread it should coincide with 180° of the lifter, for the fourth thread it is 270° of the lifter.

For all the thread the desired depth of cut is fed by moving the table in the desired direction. The width of the thread is maintained by the profile of cutter.

## CONCLUSION

A working model of the special type of milling fixture has been successfully developed and the machining of the required profile of the thread has been achieved. This type of milling fixture can be used for machining discontinuous threads with better surface finish and accuracy. Moreover, the lead-time can be very much reduced as the operation principle is very simple and the time consumed for machining is very less. Moreover these milling fixtures could be manufactured to cover a wider range, thus creating new standards of economy in discontinuous thread machining.

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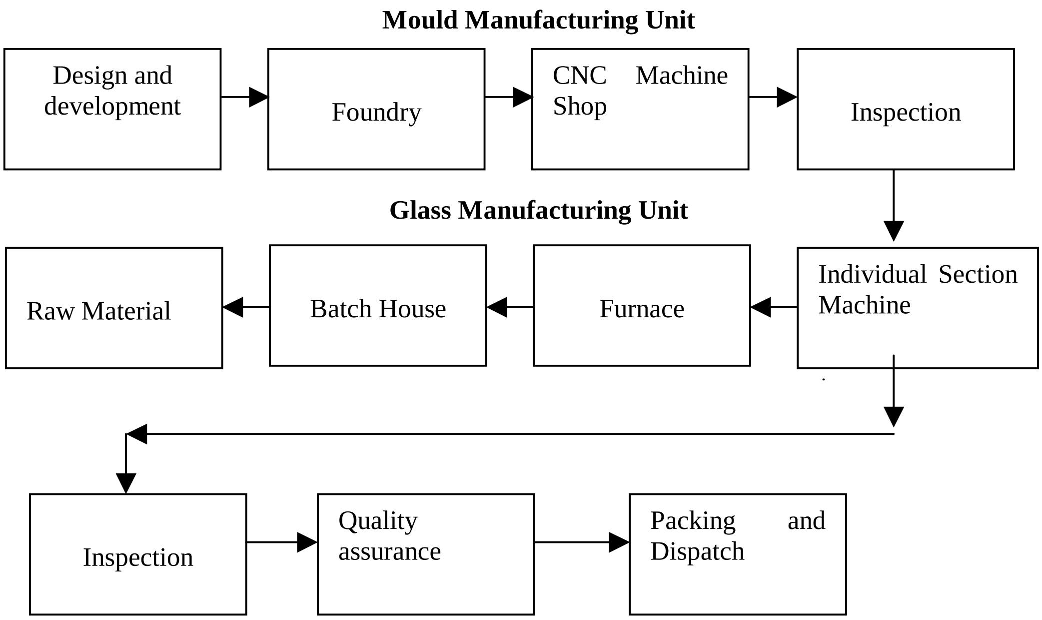



**Fig. 1Process Layout Of Bottle Manufacturing**

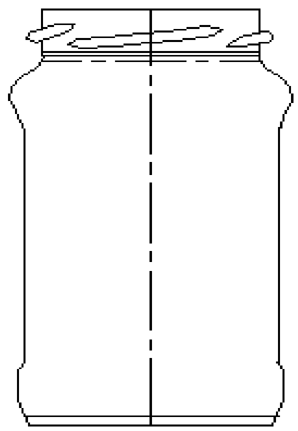


**Fig. 2 Front view of discontinous thread on a glass bottle**

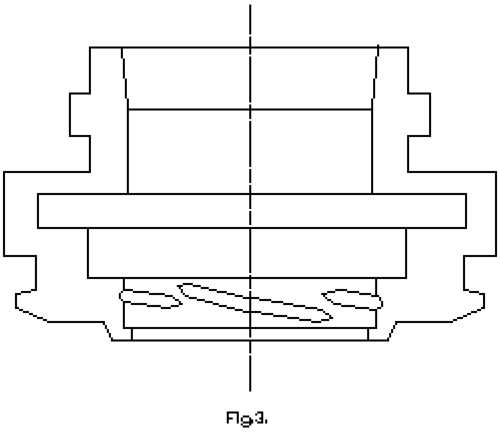



**Fig. 3 Front Sectional view of Neck ring die**

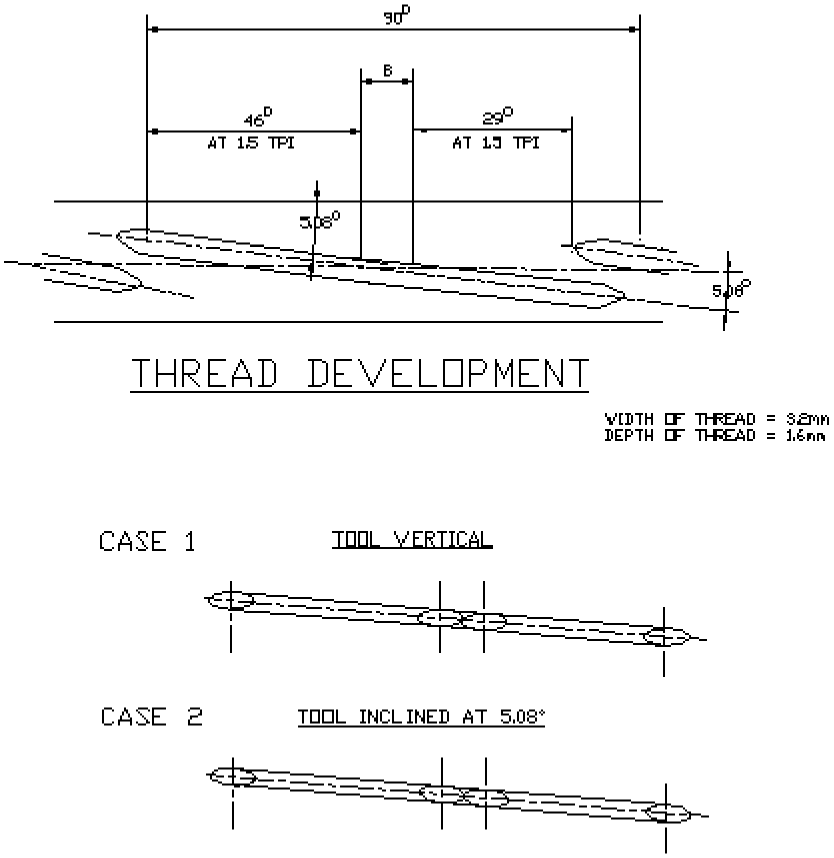



**Fig.4 Profile of discontinous thread**

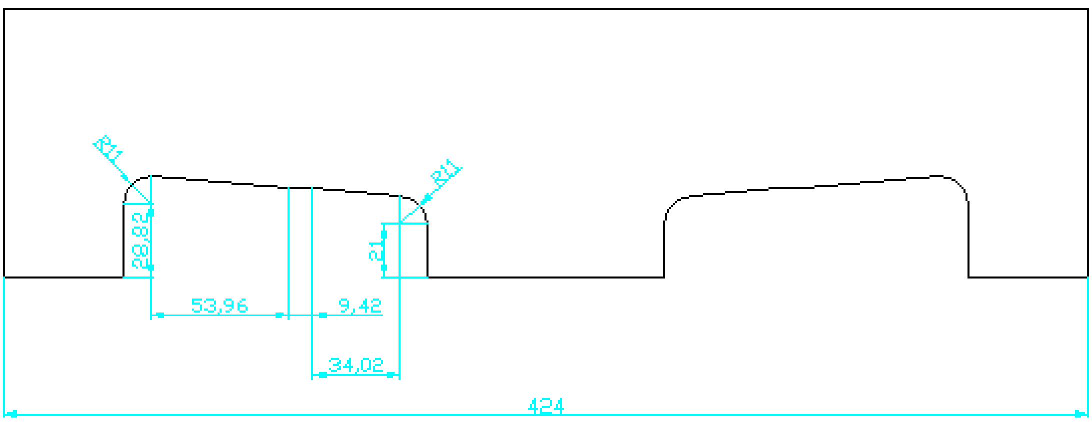
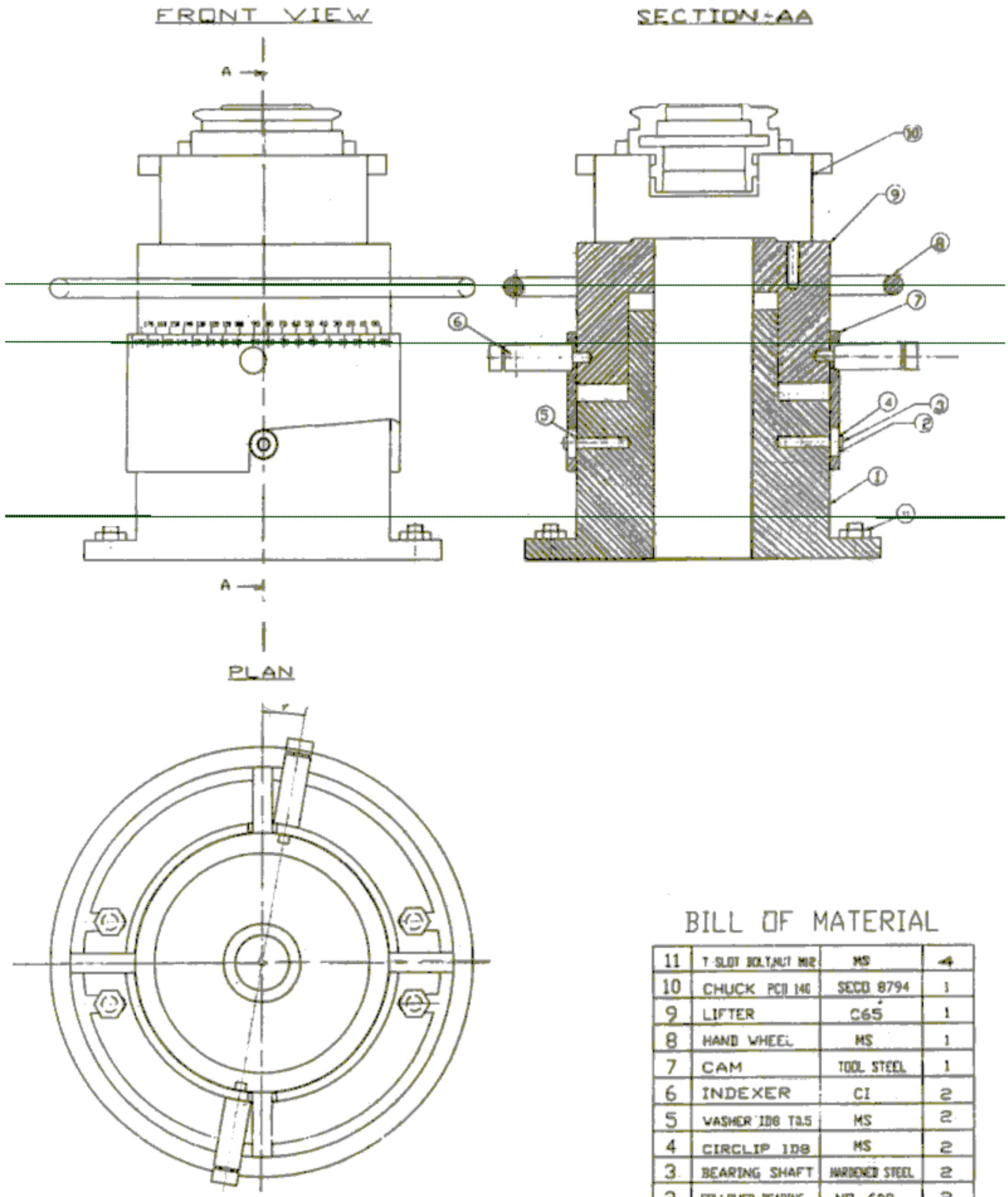



**Fig. 5 Development of Cam Profile**




BILL OF MATERIAL

| ITEM NO. | DESCRIPTION OF ITEM | MATERIAL | QTY. |
|---|---|---|---|
| 11 | T-SLOT BOLT,NUT M12 | MS | 4 |
| 10 | CHUCK PCD 140 | SECO 8794 | 1 |
| 9 | LIFTER | C65 | 1 |
| 8 | HAND WHEEL | MS | 1 |
| 7 | CAM | TOOL STEEL | 1 |
| 6 | INDEXER | CI | 2 |
| 5 | WASHER ID8 T3.5 | MS | 2 |
| 4 | CIRCLIP ID8 | MS | 2 |
| 3 | BEARING SHAFT | HARDENED STEEL | 2 |
| 2 | FOLLOWER BEARING | NO. 608 | 2 |
| 1 | BASE | CI | 1 |

**Fig. 6 Assembly Drawing of Milling Fixture for Discontinuous Threads**