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DESIGN AND FABRICATION OF LATHE FIXTURE FOR BRAKE DRUM (cargo) MACHINING

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Abstract- Design of new fixture is a modified over the old fixture due to some drawback. The old fixture is not suitable for drum having slot on top face. This is because of the brake drum is seated on fixture ring instead of button so there is no gap maintained. Without sufficient gap it is difficult to machine the brake drum bore(pilot diameter), as well as brake drum surface in single set up to achieve the concentricity. Also current fixture is complicated in design and there is more work in fitting the button to fixture ring. So we designed new lathe fixture over the old fixture. In new modified lathe fixture, pads are provided instead of buttons and it could be suitable for brake drum having slot on the top face and other drum also. By trail run this lathe fixture is more comfortable than old fixture. So this fixture can be used in brake drum (cargo) manufacturing companies because of its simple design and less cost.

Index Terms- Fixture design, Fabrication, Fixture and Brake drum

I. INTRODUCTION

The successful running of any mass production depends upon the interchangeability to facilitate easy assembly and reduction of unit cost. Mass production methods demand a fast and easy method of positioning work for accurate operations on it. Jigs and fixtures are production tools used to accurately manufacture duplicate and interchangeable parts. Jigs and fixtures are specially designed so that large numbers of components can be machined or assembled identically, and to ensure interchangeability of components. [1]N.P.Maniar and D.P.Vakhariya have introduced the proposes direction for future research of fixture. In his paper basic requirements of fixture, phases of fixture design, flexible mechanical fixtures, locating and clamping consideration, fixture design process and computer aided fixture design have explained very well for the Design and Development of Fixture. [2]Makwana and Gosavmi have found that there are different steps and approaches are available for designing the fixture. Among those geometry method (3-2-1 principle) and it is very useful for the complex fixture design though it is the basic principle of the fixture design.

1.1 Jigs:

It is a work holding device that holds, supports and locates the work piece and guides the cutting tool for a specific operation. Jigs are usually fitted with hardened steel bushings for guiding or other cutting tools. A jig is a type of tool used to control the location and/or motion of another tool. A jig's primary purpose is to provide repeatability, accuracy, and interchangeability in the manufacturing of products. A device that does both functions (holding the work and guiding a tool) is called a jig. An example Of a jig is when a key is duplicated; the original is used as a jig so the new key can have the same path as the old one.

1.2 Fixture:

It is a work holding device that holds supports and locates the work piece for a specific operation but does not guide the cutting tool. It provides only a reference surface or a device. What makes a fixture unique is that each one is built to fit a particular part or shape. The main purpose of a fixture is to locate and in some cases hold a work piece during either a machining operation or some other industrial process. A jig differs from a fixture in that; it guides the tool to its correct position in addition to locating and supporting the work piece. Example: chucks.

1.3 Brake drum:

A broad, very short hollow cast-iron cylinder attached to the wheel against which the brake shoes press in a drum brake. The brake drum is generally made of a special type of cast iron that is heat-conductive and wear-resistant. It rotates with the wheel and axle. When a driver applies the brakes, the lining pushes radial against the inner surface of the drum, and the ensuing friction slows or stops rotation of the wheel and axle, and thus the vehicle. The drum provides a friction surface, usually iron, to which the brake shoes are applied. When the shoes and drum come together, they convert the kinetic energy of the moving vehicle into heat, which then dissipates. The brake drum rotates with the wheel. In some brake systems, the drum contains the wheel hub and the wheel bearings.

If the drum contains the hub, the drum provides the mounting hardware for the wheel and tire assembly. If the drum and hub are separate, the hub provides the mounting hardware for both the drum and the wheel/tire assembly. The brake drum must be perfectly round and concentric with the spindle or axle. Brake pedal pulsation occurs if the drum is out of round with the spindle or axle.

2. TYPE OF MACHINING OPERATION ON BRAKE DRUM CARRIED OUT IN THE LAMINA FOUNDRIES LIMITED

- Top diameter facing and inside flange roughing.
- Step turning and brake drum surface roughing.
- Inside step turning operation.
- Drilling operation.
- Finishing operation.

2.1 Top diameter facing and inside flange roughing:

Fig.2.1 Top diameter facing and inside flange roughing

In this operation first brake drum has to be held in four jaw chuck and then it is centered with the help of surface gauge. Once brake drum is centered, top facing operation is to be carried out. After top facing, next boring and inside flange roughing operations are to be carried out. After achieving of the required dimension, brake drum will be sent to next operation.

2.1.1 Step turning and brake drum surface roughing:

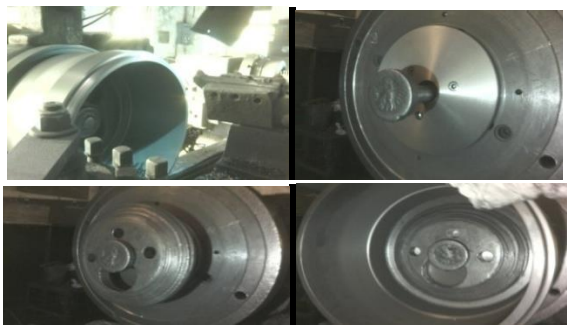

Fig.2.1.1 Step turning and brake drum roughing

In this operation, brake drum is to be held with help of spigot, screw rod and clamp as shown in fig.2.1.1 and brake drum base is seated in spigot which is bolted to face plate of the lathe. In this operation first inner diameter have to be machined and at the same time outside step turning operation also to be carried out. In step turning, step length, step height and depth are to be maintained. After achieving this dimension the brake will be moved to next operation.

2.1.2 Inside step turning operation:

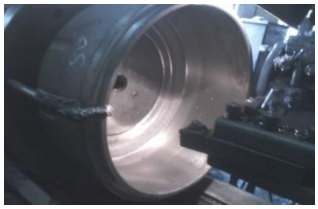

Fig.2.1.2 Inside step turning operation

In this operation brake drum is held with special types of c-clamp and brake drum is seated in the spigot but no clamp or screw rods are used. Fig.2.1.2 shows the arrangement of third operation with help c-clamp. After fixing of brake drum in c-clamp, inside step turning will be carried out. But this operation is not for all brake drum but only for mentioned one.

2.1.3 Drilling operation:

Fig.2.1.3 Drilling operation

Drilling operation is 4th operation, carried with help of radial drilling machine to drill ten hole of equal diameter. Drilling operation is carried with help of jig which guide the drill tool in order to drill ten holes. After drilling, reaming operation is carried to size the drilled hole. Fig.2.1.3 shows the drilling operation with help of jig. Drilling carried on at top face of drum which already machined in first operation. After completion of drilling operation, next operation is finishing operation that is final operation with help of lathe of fixture.

2.1.4 Finishing Operation:

Fig.2.1.4 Finishing operation setup and lathe fixture

When changing brakes from machine to machine, to carry out these four machining operations, there is chance of some error in the brake drum. Main problem is out of round or non-concentric. So in finishing operation some final touch has to be given in order to achieve fine finish as well as concentricity. Here concentricity means brake drum bore diameter that is‘d’ (pilot-

diameter) and brake surface diameter that is 'D' must be concentricity, means center axis of both diameter should lies in same line. So for that purpose, one type lathe fixture is used to achieve the concentricity between bore diameter (pilot diameter) and brake surface diameter. It mainly consists, buttons, locater and threaded holes as shown in fig.2.1.4. In this operation first lathe fixture is bolted to face plate of lathe firmly. After tightening of fixture, brake drum is placed in the locater and tighten with help of allen bolt and brake drum is seated on the buttons of lathe fixture so one thing we have to under stood that buttons plays major role in this fixture. Because they not only allow the brake drum to seat but also helps to machine the brake dram bore(pilot diameter) by providing some gap to move the lathe tool freely in order to machine. So it is easy to achieve concentricity in a simple way by machining the brake drum surface as well as brake drum bore (pilot diameter) in a single setup.

3. PROBLEM DEFINITIONS

Fig.3.1 Lathe fixture and brake drum

As we know that current shown in fig.3.1 which is used in final finishing operation is not suitable for the brake drum having slot on the top face. Because here brake drum is seated on fixture ring instead of button so there is no gap maintained and without sufficient gap, not easy to machine the brake drum bore. Also old fixture is complicate in design and there is more work in fitting the button to fixture ring. Buttons required equal in height and need hardening and totally more fabrication work. Other drawback is loosening of buttons sometimes while handling because buttons are screwed and heavy in weight.

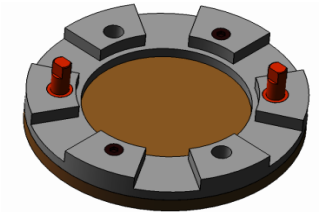

Fig.3.2 Ideal lathe fixture

After studying the problems of old lathe fixture, we feel that buttons are the main drawback and it should be modified. So we took this challenge to design a new fixture in order to overcome all problem of old fixture. Fig.3.2 shows the ideal modified lathe fixture and the fixture provided with pads instead of buttons and it can be suitable for brake drum(cargo) having slot on the top face and this fixture provides sufficient gap so that tool can be freely moved inside the brake drum bore and fixture is an in simple design.

4. DESIGN AND FABRICATION OF LATHE FIXTURE

4.1. Design of lathe fixture plate ring:

Material: mild steel & Standard: ISO 9001

Fig. 4.1 shows the design detail of fixture plate having outer diameter 269mm and inner diameter 163mm which matches to spigot of outer diameter 163mm And thickness 30 mm as per analysis. Pad having15 mm thinness which allows the drum to seat on it. Two number of M16 tap for allen bolt which helps to bolt the fixture to face plate and two number of M18 tap for bolting the locater and two number of drill hole of diameter 12.5 mm are give in which helps the fixture to bolt the face plate. Here brake drum top face is seated on the pad provided on ring. This ring eliminate the buttons and provide comfortable gap in order to machine the brake drum bore(pilot bore) which helps to maintains concentricity of brake drum bore diameter as well as brake drum surface diameter.

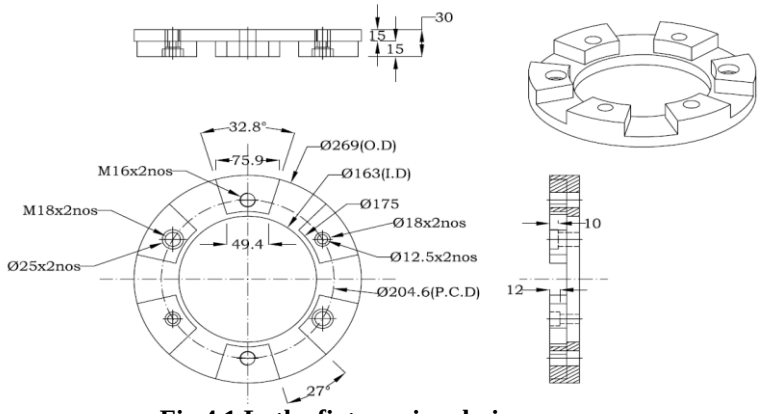

Fig.4.1 Lathe fixture ring design

4.2. Design of fixture locater:

Material for allen bolt: Mild steel (harden and tempered)
Standard: ISO 9001

The main purpose of the locater is to hold brake drum properly before bolting brake drum to lathe fixture. After proper placing in the locater, brake drum next is tighten with help of M16 allen bolt which is made up of mild steel. Detailed design as shown in the fig. 4.2

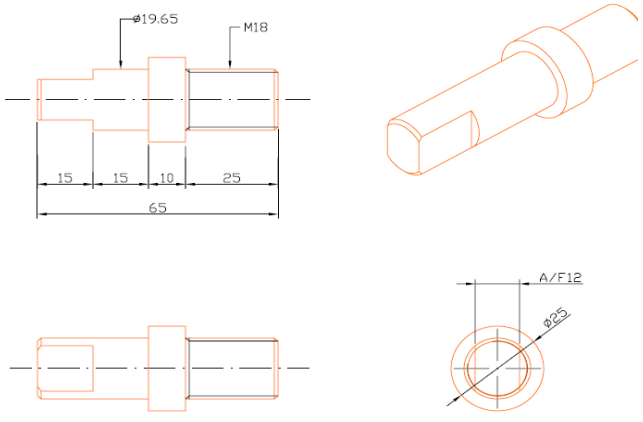

Fig.4.2 Locater pin design.

5. FABRICATION OF LATHE FIXTURE

5.1 Process planning of lathe fixture ring:

Fig.5.1 Lathe fixture plate ring

5.1.1. Cutting operation:

In cutting operation raw material is cut into required diameter and thickness. In this operation 32mm size mild steel plate is cut into outer diameter of 272mm and internal diameter cut into 158mm by using CNC cutting machining.

5.1.2. End milling operation:

An end mill is a type of milling cutter, a cutting tool used in industrial milling applications. It is distinguished from the drill bit in its application, geometry, and manufacture. While a drill bit can only cut in the axial direction, a milling bit can generally cut in all directions, though some cannot cut axially. End mills are used in milling applications such as profile milling, tracer milling, face milling, and plunging. In end milling operation, the plate machined to thinness 30mm, outer diameter 269mm and inner diameter 163mm as per the design. Slot is provided at equal place and depth of pad is 15mm.

5.1.3. Drilling and reaming operation:

Drilling is a process of producing round holes in a solid material or enlarging existing holes with the use of multi tooth cutting tools called drills or drill bits. Various cutting tools are available for drilling, but the most common is the twist drill. Drilling operation is carried out at six places on the fixture ring pad. Here hole size of 15.5mm diameter is drill at two place on the pad for locater pins and hole size of 14mm diameter is drill at two place for allen bolt and hole size of 12.5 mm diameter is drilled at two place for allen bolt of 14M size.

5.1.4. Counter boring operation:

A counter bore is a cylindrical flat-bottomed hole that enlarges another coaxial hole, or the tool used to create that feature. A counter bore hole is typically used when a fastener, such as a socket head cap screw, allen bolt are required to sit with or below the level of a work piece's surface. Here counter boring is done to lathe fixture ring at four places on the pad. Two for allen bolt of M14 and other two locater step of size diameter 25mm and thickness 10mm.

5.1.5. Tapping operation:

Taps are cutting tools used to create screw threads, which is called threading. A tap is used to cut the female portion of the mating pair (e.g., a nut). A die is used to cut the male portion of the mating pair (e.g., a bolt). The process of cutting threads using a tap is called tapping. Here M18 tapping used for locater at two place on drilled pad of diameter 15.5mm and M16 tapping used to allen bolt at two place on the drilled pad of size 14mm diameter.

5.2 Process planning of lathe fixture locater:

Fig.5.2 Locater pin

5.2.1. Turning operation:

Turning is a machining process to produce parts round in shape by a single point tool on lathes. The tool is fed either linearly in the direction parallel or perpendicular to the axis of rotation of the work piece, or along a specified path to produce complex rotational shapes. The primary motion of cutting in turning is the rotation of the work piece, and the secondary motion of cutting is the feed motion. Here locater is turned to diameter of 19.65mm and step is turned 25mm.

5.2.2. Threading operation:

Different possibilities are available to produce a thread on a lathe. Threads are cut using lathes by advancing the cutting tool at a feed exactly equal to the thread pitch. The single-point cutting tool cuts in a helical band, which is actually a thread. Fig.5.2 shows the threading operation carried on locater of pitch 2.5mm (M18).

5.2.3. End milling operation:

In end milling operation, locator of head machined to get 12mm size as shown fig. 5.2.

5.2.4. Harding:

In hardening treatment, locater pin is heated to a temperature of 800 to850^{o}c and then oil quenched. Harding increases the hardness and strength of the locater, but makes it less ductile and more brittle. To remove some of the brittleness, it should be tempered after hardening.

5.2.5. Tempering:

In tempering locater pin is heated to a temperature of to 550^{o}c, holding it at that temperature for the required length of time and then cooling it, usually in still air.

5.2.6. Grinding operation:

Grinding is an abrasive machining process in which a rotating abrasive removes metal from the work piece. Grinding is a process for machining material which is too hard for other machining process. Material such as die steel and harder steel are generally machining by grinding. Here cylindrical grinding used for locater after hardening and tempering.

6. CONCLUSIONS

The purpose of both fixture is to hold the brake drum in such way that these should facilitate machining of brake drum bore as well as brake surface diameter in a single set up in lathe. So these fixtures are used in final machining operation in order to achieve the concentricity. The old fixture mainly consist buttons, locater and threaded holes and here brake drum is seated in the buttons. But current fixtures have some drawback and are not suitable for the brake drum having slot on the top face. Because here brake drum is seated on fixture ring instead of button and fixture is complicate in design and there is more work in fitting the button to fixture ring and complicate design. Other drawback is loosening of buttons sometimes while handling because buttons are screw to fixture ring and heavy in weight. In new modified lathe fixture, pads are provided instead of buttons and it could be suitable for brake drum having slot on the top face and other drum also. By trail run this lathe fixture is more comfortable than old fixture. So this fixture can be used in brake drum manufacturing companies because of its simple design and less cost.

7. FUTURE SCOPE

Fig.7.1 modified and old lathe fixture

By the successful trail run new lathe fixture is more comfortable than old fixture. So this fixture can be used in brake drum (cargo) manufacturing companies because of its simple design and less cost. The fixture can be improved further for better work and mainly that length of the locater pin and thickness of pads can be reduced for better design. In this design the length of the locater has extended 30mm from ring surface after tightening but thickness of the drum is (back plate thickness) 12mm. So extended locater length from fixture ring surface can be reduced to around 15mm for better design and also as the length increases it is difficult to match or fit the brake drum hole. So locater pin correctly fit to the hole of drum and there should not be any play. Also pad thickness can reduced further, for better balancing.

9. REFERENCES

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