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A Study of Ring Gear Runout Checking Fixture

Poonam D.Chavan[1], Komal M.Barge[2]
[1,2]*Department of production Engineering*
K.B.P.college of Engineering, Satara 415001, India

Abstract— Fixtures are widely used in industries due to their quality of increasing the accuracy and minimizing the operational time. Inspection in manufacturing includes measuring, examining, testing, or gauging one or more characteristics of a product or process and comparing the results with specified requirements to determine whether is the requirements are met for each characteristic. Inspection fixtures are used to check the quality of the workpieces, parts and components of machines. This paper presents the solution in the form of a special purpose 'Runout Checking Fixture', which can be useful for checking the runout of a component up to the desired tolerance with increased precision. The component is starter ring gear which is fitted on the periphery of flywheel of internal combustion engine.
Keywords— Inspection, fixture, runout, roundness, ring gear

I. INTRODUCTION

Fixture is a special purpose tool which is used to facilitate production (machining, assembling and inspection operations) when workpieces are to be produced on a mass scale. The use of fixture eliminates frequent checking, individual marking, positioning and non-uniform quality in the manufacturing process. This increase productivity and reduce operating time.An inspection (qualifying, gauging) operation is any examination of a workpiece that determines whether or not it meets the standards of quality. Dimension inspection or gauging fixtures raise the efficiency of the work of human inspectors; improve their working conditions, quality of workpieces, parts and components of machines. An inspection, fixture is used for verification of a product's geometric feature, dimensions and tolerance specification with respect to the product design specification. Fixtures for checking parts are usually employed at intermediate stages of machining (step-by-step inspection) and at the final stage of machining (acceptance inspection) to verify the accuracy of dimensions, relative position of surfaces and adequacy of surface geometry. Dimension inspection fixtures are designed to secure the pre-set accuracy and efficiency of the quality control operations and must be convenient in use, simple in construction, cheap and reliable in service. These fixtures need not be designed to withstand forces such as shock and vibrations, associated with machining or with some other fabricating and assembly processes. They are not associated with machining or with some other fabricating and assembly processes. They are not required to resist temperatures present in welding, brazing etc.Clamping forces in an inspection fixture are generally too small to affect its design, but they should not distort the workpiece.

II. PROBLEM STATEMENT

We know that the flywheel is used for creating momentum in an I.C. engine and ring gear is a circular ring having teeth on its periphery, which is mounted (press fitted) on the flywheel. Gears are mainly used for transmission of power and motion. In order to that the rotary motion of the driven shaft be perfectly uniform relative to the driving shaft, it is essential that both gears be of perfect geometrical form and be perfectly mounted on shaft. Thus in any vehicle for giving starting motion to the vehicle a smaller gear is provided. This smaller gear meshes with ring gear and the ring gear starts rotating. After giving the motion to the ring gear, smaller gear comes to its original position. As ring gear is fitted on the flywheel, the flywheel also starts rotating. Thus starting torque is given to an engine through flywheel.
Thus for accurate transmission of motion from ring gear to flywheel, the roundness of ring gear should be perfect so that there will be smooth transmission of power from ring gear to flywheel. So checking run out of ring gear is inevitable. For this reason run out checking fixture is made.

III.COMPONENT DETAILS

The component is starting ring gear sometimes called a starter ring or ring gear, is a medium carbon steel ring with teeth that is fitted on the periphery of a flywheel of an internal combustion engine, mostly for automotive or aircraft applications .In ring gear carbon content varies from 0.25 to 0.60%.It posses higher strength and hardness but low ductility than low carbon steel. The teeth of the starter ring are driven by the smaller gear (the pinion) of the starter motor. The primary function of the starter ring is to transfer torque from the starter motor pinion to the flywheel to rotate the engine to begin the cycle. The teeth of the starter ring need to be hardened in order to increase their strength and resist wear. The normal hardness at pitch circle diameter is 45-55 HRC.

Fig.1 Starting ring gear.

IV. RUNOUT

A. Out of roundness

Run-out is an inaccuracy of rotating mechanical systems, specifically that the tool or shaft does not rotate exactly in line with the main axis. In GD&T, runout tolerance is used to control the location of a circular part feature relative to its axis. This is different than circularity, which controls overall roundness. Runout is usually applied to parts with circular cross sections that must be assembled like drill bits, segmented shafts, or machine tool components. Runout helps to limit the axis offset of two parts to ensure they can spin and wear evenly. With the imposition of finer tolerances, development of improved measurement method, it is become apparent that no hole, spheres or cylinders can be produced with a perfectly symmetrical round shape. There is always any distortion in it. Even if the distortion is short, it may cause hum, vibration, heat built up and wear possibility leading to eventual failure of the components or assembly.

B. Run-out has two main forms

1) *Radial run-out:* It is caused by the tool or component being rotated off centre, i.e. the tool or component axis does not correspond with the main axis. Radial run-out will measure the same all along the main axis.
2) *Axial run-out:* It is caused by the tool or component being at an angle to the axis. Axial run-out causes the tip of the tool (or shaft) to rotate off centre relative to the base. Axial run-out will vary according to how far from the base it is measured.

In addition, irregular run-out is the result of worn or rough bearings which can manifest itself as either axial or radial run-out. Runout will be present in any rotating system and, depending on the system; the different forms may either combine increasing total runout, or cancel reducing total runout. At any point along a tool or shaft it is not possible to determine whether runout is axial or radial; only by measuring along the axis can they be differentiated [3].

C. Runout Measurement

Typically run-out is measured using a dial indicator pressed against the rotating component while it is turned. Total indicated run-out (TIR) is a technician's term for the measured run-out of any rotating system, including all forms of run-out, at the measured point. A part must be rotated to inspect runout. A calibrated instrument is placed against the surface of the rotating part to detect the highest and lowest points.

D. Runout tolerances

Runout tolerances can be state by two tolerance zone. These are circular or total runout

1) *Circular Runout:* It is limited in the measuring plane perpendicular to the axis by two concentric circles, the common centre of which lies on the datum axis. Also it is can be defined as two-dimensional geometric tolerance that controls the form, orientation, and location of multiple cross sections of a cylindrical part as it rotates.
2) *Total runout*: It involves tolerance control along the entire length of, and between, two imaginary cylinders, not just at cross sections. Total run out controls the entire surface simultaneously hence it controls cumulative variations in circularity, coaxiality, straightness, taper, angularity, and profile of a surface.

V. INSPECTION FIXTURE

1) It used to ensure that the workpiece meets a standard for size and shape
2) The main requirement of an inspection fixture is accuracy
3) Each inspection fixture should contain only those elements needed to check the specified sizes
4) Two general types are:

A. Gauging fixture: It is used to check a part against a preset standard size

This setup is used to check the inside and outside diameters of a ring. If both are within the prescribed tolerance, the ring will drop into the fixture. However, if the outside diameter is too large or the inside too small, the ring will not fit. An

alternative for this would be to use separate gauges to check each diameter

B. Measuring fixtures: It indicates where and by how much a part is out of tolerance. The part is located by its centre hole and rotated past a dial indicator to check the runout of the diameter. In the inspection of the part the first requirement would be to ensure the proper relationship of the referenced datum to the measuring fixture and the dial indicator used to inspect the part. The inspection and gauging fixture consists of locating, clamping and auxiliary elements mounted in the body of fixture. The locating elements are used to locate the part or workpiece from its reference for gauging. The clamping devices prevent displacement of part (assembly) set in it for checking relative to the gauging device and assure positive contact between the part's locations and fixture's supports. Clamping devices are not needed if the part is quite stable in the fixture's supports and the gauging forces do not disturb its stability in the fixture. [4]

VI. FIXTURE ELEMENTS

A. *Plate:* It is made by mild steel. Structure of plate is rectangular type having size 510 X 250 X 20mm.It is rigid and can resist wear. This base plate is machined on knee type milling machine. It has one milling slot of rectangular size with round ends of 190 X 20mm through for fixing dial gauge. Also it has eleven holes of M8 through in which top four holes for fixing plate to the legs, middle three holes for fixing upper spacer to the plate and bottom four holes for fixing lower spacer to the plate. There are two holes of dia.15mm for fixing two ball bearings to the plate with upper spacer. Front face of plate will accommodate upper spacer, lower spacer and dial gauge. The back face rest on the legs.

B. *Upper spacer*: It is a rectangular plate made from carbon steel of size 250 X 100 X 25mm.It is hardened and ground. It is fixed to the plate by using three standard Allen screws. Two ball bearings are fixed to the upper spacer with the plate. While checking the runout, ring gear is placed on bearings in such a way that on the other side its inner surface touches to the plunger of dial gauge.

C. *Lower spacer*: It is made from carbon steel which is also hardened and ground like upper spacer. Both the upper and lower spacer is attached to plate by using Allen screws.

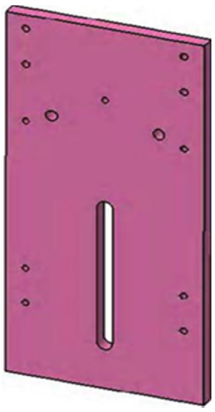

Fig.2 Plate

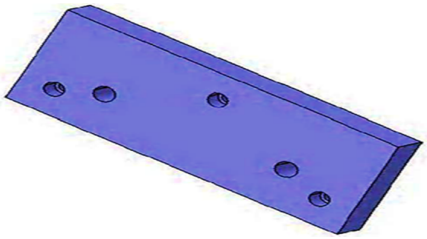

Fig.3 Upper Spacer.

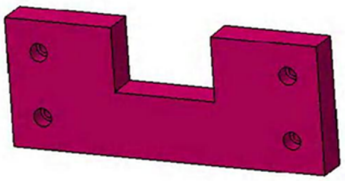

Fig.4 Lower Spacer

D. *Side spacers*: Front side spacer and back side spacer are used for dial fitment. Material used for these spacers is mild steel. A slot is provided at downside of the plate and lower spacer is also provided. The front side spacer fits in the slot on which the dial gauge is fixed. It is made in such a way that plunger of dial gauge comes on lower spacer.

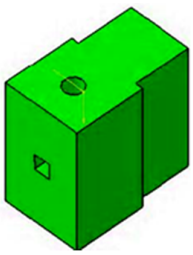

Fig.5 Front side spacer for dial fitment

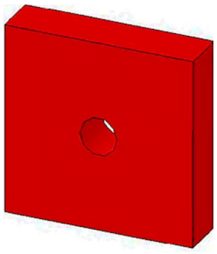

Fig. 6 Back side spacer for dial

fitment

E. *Ball bearing:* The ball bearing consists of an inner race which mounted on the pin. In between the inner race and outer race there are balls. The bearing used here is 6202-zz .It has bore 15mm, outer diameter 35mm and width 11mm.Features of this bearing are deep, honed raceways resulting in perfectly balanced raceways. These bearings are located on upper spacer by using Allen screws. On these bearings ring gear is mounted while checking.

F. *Dial indicator*: Dial indicator is used to accurately measure a small distance. Probe type dial indicator is used in this fixture. It consists of a graduated dial and needle to record minor increments with a smaller embedded clock face and needle to record number of needle rotations on main dial. The plunger moves perpendicular to the object being tested either by retracting or extending from the indicator body. Dial gauge is fixed on the front side spacer in such a way that plunger of dial gauge touches the inners surface of the ring gear

Fig. 7 Ball Bearing

Fig.8 Dial Indicator

VII. RUNOUT CHECKING FIXTURE

A. Design process for fixture

The part which is supposed to be inspected should first be analyzed which means its shape, size and its intricate design should be studied to determine the type of fixture which will do justice to its shape. After the part is studied the basic design of the fixture is to be made which will help hold the component easily. If the design conforms then carry on with the analysis or else repeat the first two steps. Design the fixture in 2-dimensional and 3-dimensional software and carry out virtual analysis and if it fails, repeat the process else carry on with the manufacturing. The manufacturing includes machining of each and every component and heat treatment, including through hardening or case hardening making sure it extends the life of the fixture. Finally the quality check is done and the repeatability of the component is also calculated so as to further install the fixture respectively [1].

B. Woking principle of runout checking fixture:

There are two bearings provided on the fixed tapered plate made up of casting. A slot is provided on the downward side of the plate in which spacer is fitted and the plunger dial gauge is fixed in this spacer. While checking the runout, ring gear is placed on bearings in such a way that on the other side its inner surface touches to the plunger of dial gauge. Then the ring gear is rotated manually. If there is any error in runout of ring gear the pointer of dial gauge gets deflect. In this way run out of ring gear is checked by using this fixture.

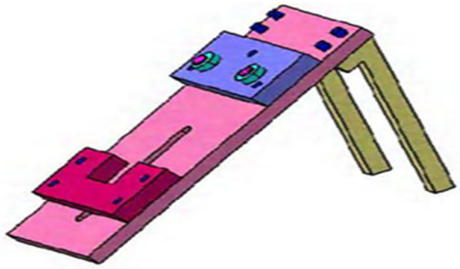

Fig.9 Assembly of fixture

Fig.10 Runout checking Fixture

VIII. CONCLUSIONS

This runout checking fixture enhances the efficiency and reliability of the system. It is easy to handle and reading can be taken in short duration. It can check the runout of ring gears having specific diameter but by some development run out of any ring gear can check. For this holes on the upper side of plate in an angle of 30^0 is provided and bearings are placed at any of the hole. Thus the runout of ring gear having any diameter can be checked.

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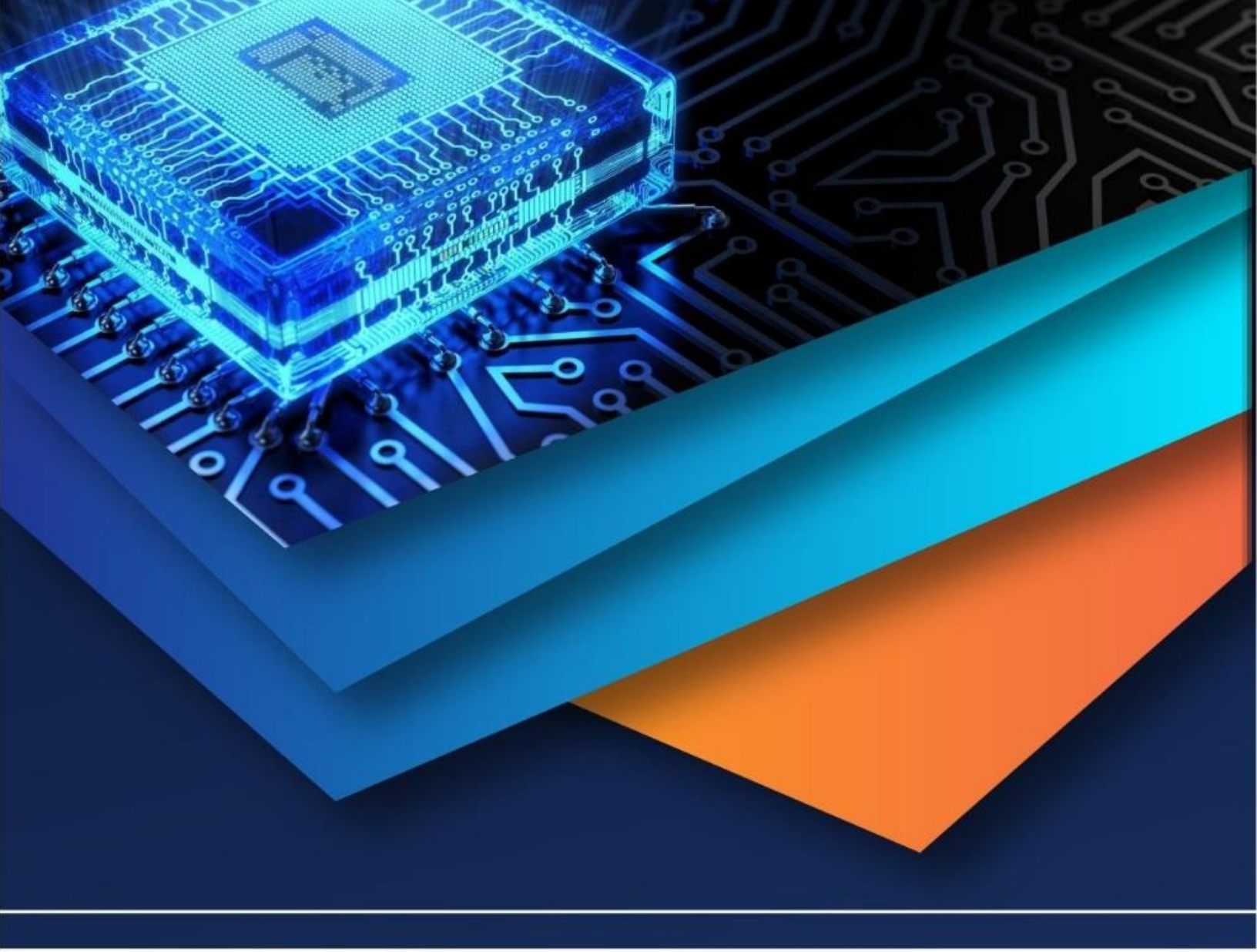

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