A

Seminar report

On

Autocollimator

Submitted in partial fulfillment of the requirement for the award of degree
Of Mechanical

SUBMITTED TO:
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Preface

I have made this report file on the topic **Autocollimator**; I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to ……..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

Acknowledgement

I would like to thank respected Mr…….. and Mr. ……..for giving me such a wonderful opportunity to expand my knowledge for my own branch and giving me guidelines to present a seminar report. It helped me a lot to realize of what we study for.

Secondly, I would like to thank my parents who patiently helped me as i went through my work and helped to modify and eliminate some of the irrelevant or un-necessary stuffs.

Thirdly, I would like to thank my friends who helped me to make my work more organized and well-stacked till the end.

Next, I would thank Microsoft for developing such a wonderful tool like MS Word. It helped my work a lot to remain error-free.

Last but clearly not the least, I would thank The Almighty for giving me strength to complete my report on time.

Content

Introduction

Autocollimators are used to detect small misalignments. If a parallel beam of light is projected from the collimating lens and if a plane reflector R is set up normal to the direction of the beam, light will be reflected back along the same path and light will be brought back to focus exactly at the position of the light source.

If the reflector is tilted through a small angle (Theta) the parallel beam will be reflected through twice the angle (2?) and would be brought to focus in the same plane as the light source but to one side of it. The image will not coincide but there will be a distance equal to focal length times the angle of reflection (2f??) where f is the focal length of the collimating lens.

The distance between the reflector and the lens has no effect on the separation between the source and the image. For high sensitivity, a long focal length is required. Although the distance of the reflector does not effect the reading, if it is moved too far back, reflected rays will miss the lens completely and no image will be formed.

Element by Element Inspection of Gear: Laborious, useful in error analysis, can't be used by the gear manufacturers.

- Tooth thickness measurement
- Base pitch measurement

Composite Error Checking: Used in Gear Inspection by conducting only one test

- Parkinson Gear Tester

Thread Inspection - Terminology

- Pitch - It is the distance measured parallel to the axis between the corresponding points on adjacent surfaces in the same axial plane.
- Lead - It is the axial distance advanced by the thread in one revolution. Lead is equal to the same multiples of pitches as the number of starts.
- Included angle - It is the angle between the flanks of the thread measured in an axial plane.
- Pitch diameter - It is the diameter of tee imaginary coaxial cylinder which intersects the surface of the thread in such a manner that the intercept on the generator of the cylinder is equal to half the pitch.
- Major Diameter - It is the diameter of imaginary coaxial cylinder that just touches the crests
- Minor Diameter - It is the diameter of imaginary coaxial cylinder that just touches the
- Roots

Measurement of Major Diameter

Bench micrometer is normally used for this measurement. It has measuring anvils so that the thread can be held between them. It has fiducial indicator so that the required pressure can be applied for all the measurements.

Measurement of Minor Diameter

Bench micrometer can not be used for Minor Diameter. So, another one, Floating Carriage micrometer is normally used for this measurement. In this instrument, the thread is held between the centres so that the influence of helix angle can be nullified in this arrangement.

Measurement of Pitch (effective) Diameter

Again Floating Carriage micrometer is normally used for this measurement. Here, the prisms used in the measurement of minor diameter are replaced by the steel wires whose size is chosen such that they pitch at the effective diameter.

Two wire Method

The two wires used should be identical in diameter and should pitch properly between the flanks. Reading of the floating carriage micrometer is taken over these two wires so that the effective diameter can be calculated using the formula developed.

Diameter of the best wires

If the wires used make contact exactly at the pitch diameter, then such wire is called the best wire. The diameter of such wire can be estimated from the formula. Compression & Rake correction.

Measurement of flank angle

Flank angle may be measured using Tool Maker's Microscope with a goniometric head. This consists of glass screen with datum lines which can be rotated through 3600. The thread is mounted on centers and illuminated from below. The microscope is mounted above the thread in such a way it can be swiveled to be in line with the thread helix and avoid interference of the image.

The datum lines in the microscope head are set to zero and the table is rotated until the crests of the thread coincide with the horizontal datum and the angle is measured.

Measurement of Major Diameter

The major diameter of internal thread is normally measured using horizontal comparator fitted with ball end styli of radius less than the root radius of the thread to be measured. When the thread is mounted on a comparator, it aligns itself with the axis of the machine and measurement would be done along the helix of the thread as indicated above.

Measurement of Internal Threads

- Measurement of Effective Diameter: The effective diameter of internal thread is measured using the horizontal comparator using ball ended styli of the best size wire.
- Measurement of Flank angle: The semi cast of the thread form may be made using dental plaster and measurement is obtained as done for external thread.

Thread inspection can also be carried out using gauges designed according to the Taylors Principles

Limit gauges for Internal threads

- Full form Go Gauge
- Truncated Effective Diameter NOGO gauge
- Minor Diameter NOGO gauge

Limit gauges for External threads

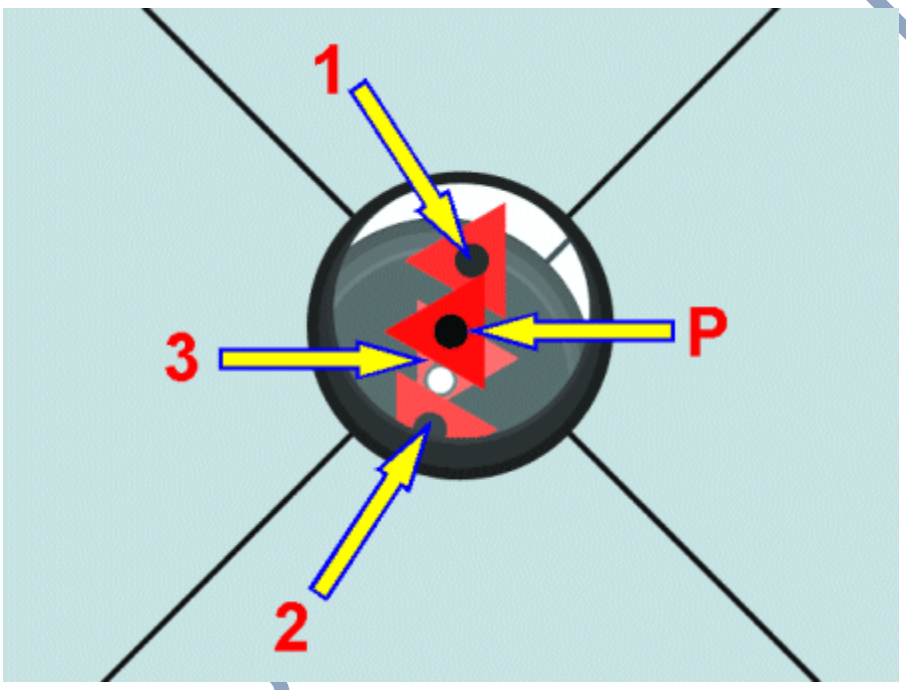
- This is usually carried out using caliper type gauges
- Full form Go Gauge
- Truncated Effective Diameter NOGO gauge
- Major Diameter NOGO gauge

Autocollimator Reflections

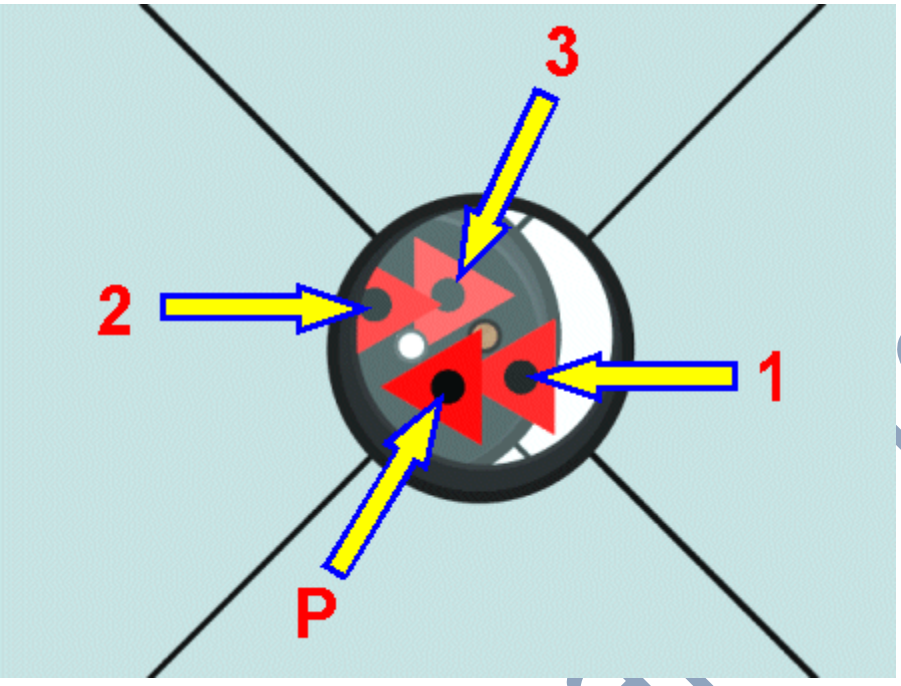
When "perfect" collimation is "close at hand", 4 center-spot reflections can be seen in the INFINITY™ autocollimator and are the result of multiple reflective interactions between the 3 mirror components of Primary, Secondary and Autocollimator.

In these simulations below, both Primary and Focuser optical axes alignment errors are present resulting in the reflections being spread apart from their "perfect collimation" stacked position.

You might see something like this....



Or perhaps this ...



- Reflection "P" is the "Primary" or "first" reflection and is the direct reflected image of the spot itself via the Diagonal mirror after 1 FL pass. Reflection "P" is what is visible "without" the autocollimator whereas images (#1, #2, & #3) are reflections of "P".
- Reflection "1" is generated from reflection "P" after an additional reflection back from the A/C mirror, via the diagonal to be reflected off the Primary and back via the diagonal to the eye for a total of 3 FL passes from the original spot. It's sensitivity to Primary axis error is 4X and to Focuser axis error is 2X.
- Reflection "2" (inverted) is generated from the "real" image response from the (parabolic) Primary mirror at its Center of Curvature (COC at 2 FL's away) from the spot reflection it sees in the Autocollimator mirror (which is 1 FL away). The trick here is that the autocollimator reflects (or "folds") the real image back onto the Primary surface where it is then seen via diagonal reflection by the eye (just like reflection "P") - it is a total of 5 FL passes from the origin.

  The reflection "2" sensitivity to both Primary and Focuser axes errors is 4X each. Total distance between reflections "1" and "2" is the vector sum of the primary mirror and focuser axial errors. When the other axial error has been removed, this distance is either 8X the primary mirror axial error or 6X the focuser axial error.

- Reflection "3" (inverted) is a reflection of reflection "#2" following a path like that of reflection "#1" (generated from reflection P) for a total of 7 FL passes to the eye from the original spot. When the faintest reflection (#3) is in view, the distance from "P" to "3" represents a sensitivity to focuser axis error of 2X regardless of the Primary axis error.

  It is this unilateral sensitivity to the focuser axial error that allows us to use this reflection to "zero" the focuser axis with Vic Menard's "Carefully Decollimated Primary Mirror"

protocol, leaving the primary mirror axial error, magnified 8X, visualized as the distance between reflections 1 and 2.

The distance and direction between reflections "#2" and "#3" is always equal to that seen between "P" and "1" and between the two A/C pupil reflections; thus, these two spot reflection "pairs" will always be arranged with their centers forming 2 separate parallel lines that are also parallel to the A/C pupil reflections.

PRODUCT RANGE AND SPECIFICATION

The Autocollimator is a single instrument combining the functions of a collimator and a telescope. It detects small angular displacements of a mirror by means of its own collimated light.The two reticles are positioned in the focal plane of the corrected objective lens, so that the emerging beam is parallel. This usual configuration is known as infinity setting, i.e the autocollimators are focused at infinity.When moving the reticles out of the focal plane of the objective lens, the autocollimator can be focused at finite distances, and the beam becomes divergent (producing a virtual image) or convergent (real image). This results in a focusing autocollimator. The shape of the beam -convergent or divergent-depend on the direction in which the reticles are moved.

CONSTRUCTION

The main components of a standard autocollimator i.e. focused at infinity are:

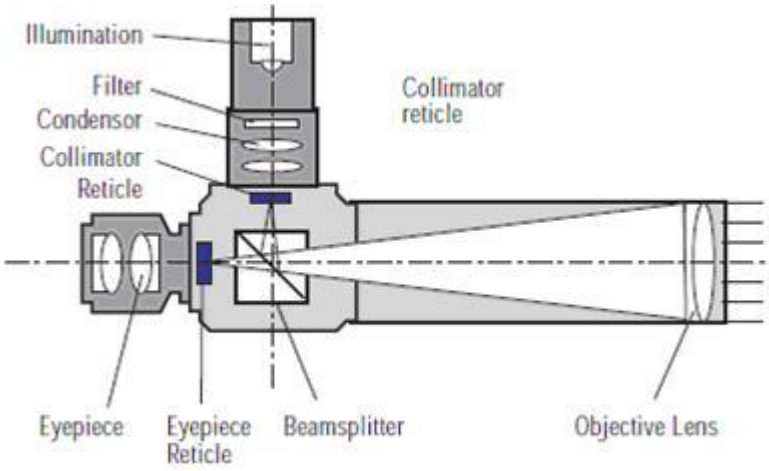
• Tube mounted objective lens

• Beam splitter mount which contains two reticles

• Eyepiece

• Illumination device

The illuminated reticle projected over the beamsplitter towards the lens is known as collimator reticle. The second reticle placed in the focus of the eyepiece is the eyepiece reticle.The beamsplitter mount together with the eyepiece and the illumination device form a main unit called: Autocollimator Head.A focusing autocollimator (finite disatnce setting) is similary built. The autocollimator head containing the two reticles is now mounted on a draw out tube for focusing adjustment.



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OPERATING PRINCIPLE

Autocollimation is an optical technique of projecting an illuminated reticle to infinity and receiving the reticle image after reflection on a flat mirror. The reflected image is brought to the focus of the objective lens in which the eyepiece reticle is located. Thus the reflected image of the collimator (illuminated) reticle and the eyepiece reticle can be simultaneously observed.

When the collimated beam falls on a mirror which is perpendicular to beam axis, the light is reflected along the same path. Between the reflected image and the eyepiece reticle which are seen superimposed, no displacement occurs.

If the reflector is tilted by an angle α the reflected beam is deflected by twice that angle i.e. 2α. The reflected image is now laterally displaced with respect to the eyepiece reticle.

The amount of this displacement „d“ is a function of the focal length of the autocollimator and the tilt angle of the reflector: d=2αf. (α in radians).

$$\alpha = \frac{d}{2f}$$

The tilt angle can be ascertained with the formula: where „f“ is the effective focal length EFL of the autocollimator. Since the „f“ is a constant of the autocollimator, the eyepiece reticle can be graduated in angle units and the tilt angle can be directly read off.

Types of Autocollimators

Visual Autocollimators

Taylor Hobson has a range of visual dual axis autocollimators which use a graticule in the eyepiece viewing system, with or without micrometers.

The TA60 Minidekkor uses a two axis graticule for general measuring duties in workshop and toolroom. The standard minidekkor is provided with a dark field graticule which allows clear images to be obtained from low reflectivity surfaces such as unsilverred glass and from surfaces as small as 3mm in diameter.

The VA900 Microptic Dual Axis Autocollimator allows measurement of the two axes using a combination of the instruments two axes graticule and single micrometer and is provided as standard with a dark field graticule.

The TA51 MIcroptic Dual Axis Autocollimator is supplied as standard with a light field graticule and has two micrometers, one in each axis of measurement. The micrometer is used to move the eyepiece graticule across the field of view until it coincides with the reflected target graticule image. The angular displacement of the reflector canthen be read directly from the micrometer scale.

Digital Autocollimators

Using the latest CCD technology the new Ultra Dual Axis Autocollimator offers high accuracy and stability over a range of applications. This wide range autocollimator comes with a laser sighting aid for simple setup and a tablet PC with integrated software for measurement, calculation and analysis of a range of features.

REFERENCES

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