

Micro Alignment Telescope

Electro optical metrology in the aircraft industry

“The Micro Alignment Telescope allows engineers to check the change in the attitude of very small holes relative to the component datum.”

Optical alignment of aircraft jigs

The problem: The production of jigs and fixtures for a new aircraft is always a major undertaking which increases proportionally with the size of the plane. Jig members must be set parallel and in line to each other.

The solution: the Micro Alignment Telescope and accessories are used as follows to align the jig members. The jig members are set parallel to each other by being set perpendicular to a common line of sight which is established between a telescope and targets positioned at the jig stations.

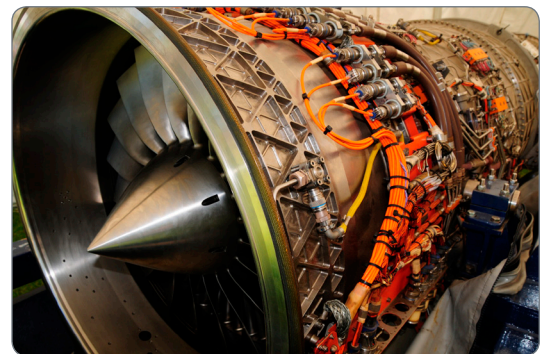
The Telescope can be used with optical squares to give a right angle line of sight onto a target if necessary and in some cases to sweep out a plane at right angles to the reference line.

It should be noted that the reference line of sight need not be related to any part of the jig structure; for convenience it can be made parallel to the edge of the base, or set horizontal using a Talyvel electronic level or stride level mounted to the Telescope tube.

CCTV and CCD cameras can be used to help automate and generally make the process more efficient. In some cases laser alignment systems can also be employed.

Aero engine applications

Aero engines are supplied to aircraft manufacturers and end users as modular units which can be quickly fitted or changed in service with complete interchangeability. During final inspection of the engine, it is necessary to check the profile of the engine cowlings relative to the datum mounting points. Positive errors in this area could cause interference between the engine cowling and lower wing surfaces. Difficulty in access to this surface was overcome by using the Micro Alignment Telescope with fixtures and optical scales.



The Micro Alignment Telescope can also be used for maintenance of these engines – after a prescribed number of flying hours, overhaul procedures must be carried out. Distortion which has taken place must be checked and, when feasible, repaired by removal of parts of the fabrication and re-welding new components in place. The Micro Alignment Telescope allows engineers to check the change in the attitude of very small holes relative to the component datum. The system can also use a precision clinometer as an aid to the measurement.

“With its unique features of focusing from zero to infinity and its autoreflection capability, the Micro Alignment Telescope can be used to align and set optical components and systems.”

Helicopters

Helicopters, although much smaller than aeroplanes, use similar technology in their design and construction. Jigs for assembly of the airframe structures are complex and require careful and accurate manufacture and calibration. A particular problem is to check the distance of a flange face to a plane in space defined by three bores spaced at approximately 2 metre centres. Conventional methods would have given rise to considerable handling problems and equipment requirements. A far simpler and adequately accurate solution was identified using the Micro Alignment Telescope and 4 inch offset optical square.



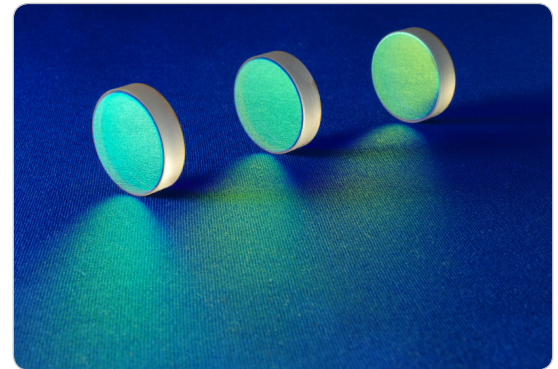
The angle of blades can be checked using a digital inclinometer like the one shown.

In some cases a target is placed on a part of the aircraft or assembly jig to monitor deflections over time. A simple target can be placed on the item to be monitored and a CCD camera mounted onto the alignment telescope with a time interval set when readings are automatically taken.



Satellites

The Micro Alignment Telescope has been used for various applications in the space industry from simple tasks such as setting things truly level with the aid of the Talyvel electronic level, to setting rails parallel and straight to setting platforms in line and square for assembly jigs used for satellite launch rockets.



Alignment of optical systems using telescopes

Various control systems such as those used on fighter aircraft utilise optical systems. The alignment of optical components in a system is complicated and time consuming. It is important to align the various components to the main optical path and in most cases also important to ensure these optical components are also square to the path.

With its unique features of focusing from zero to infinity and its autoreflection capability, the Micro Alignment Telescope can be used to align and set optical components and systems.

Advantages of Alignment Telescopes

- Optical to mechanical axes parallel to 3 seconds
- Focuses in a straight line from zero to infinity
- Unique auto-reflection capability allows setting of components square to the telescope line of sight as well as in line.

In some special applications we have used CCTV or CCD to view or help automate systems. There has also been a need in some cases to change the coatings of the visual alignment telescope to allow detection in the infra-red region.

“Telescopes and collimators (to provide a line of sight) are mounted in a sighting frame and alignment checking jig.”

Fighter aircraft weapons alignment – harmonization

The problem: The effectiveness of the navigational/attack system of fighter aircraft depends on the accurate alignment of all systems to the aircraft's longitudinal fuselage datums (LFD). This is termed harmonization and is normally maintained using the Taylor Hobson Micro Alignment Telescope.

Checks need to be made after a front windscreen change or removal of the nose cone, or following any disturbance to the pilots display unit, platform navigational system or radar mainframe.

The solution: To allow ground crew to check the harmonization, telescopes and collimators (to provide a line of sight) are mounted in a sighting frame and alignment checking jig.

This job is made much easier with the use of CCTV or CCD systems to replace the 'human eye' or provide digital output.

During aircraft construction, the gun pod mounting points are accurately aligned to the longitudinal fuselage datum (LFD) and this then provides the datum.

An alignment jig incorporating a Telescope is bolted to the gun pods and an aircraft sighting board incorporating collimators is attached to the front of the aircraft. The inclination of the checking jig and aircraft roll is checked using a clinometer.

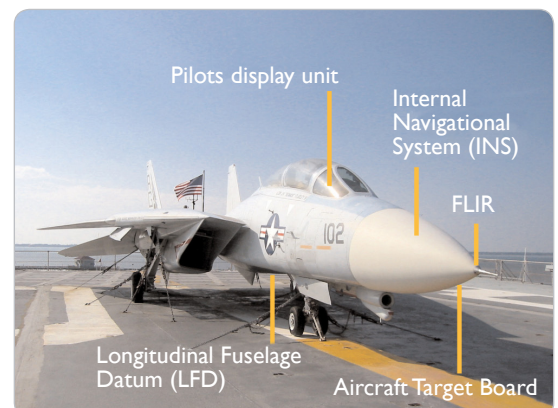
The first stage of the harmonization sequence is to align the Longitudinal Fuselage Datum jig (LFD) with the Aircraft Target Board (ATB), to provide an accurate datum. Once this is achieved, the target board is then used to align the Internal Navigational Unit (INU) and Pilots Display Unit (PDU).

Aligning Aircraft Target Board (ATB)

A Micro Alignment Telescope (focused to infinity) is mounted in the Longitudinal Fuselage Datum sighting frame and sighted onto a collimator mounted in the corresponding bracket of the Aircraft Target Board. The frame assembly is then adjusted in elevation and azimuth until the telescope crosslines are centred to the collimator graticules. Any movement that occurs after this setting, is monitored and error corrected.

Checking alignment of Internal Navigational Unit (INU):

A telescope is located in the INU sighting jig and aligned to the corresponding collimator on the ATB. Any necessary realignment as required is corrected by re-shimming. Similar procedures are adopted to align the PDU and FLIR.



Our electro-optical metrology product range comprises:

Micro-Alignment Telescope



Used for checking and setting for example:

- Alignment: (series of bores or bearings)
- Squareness: (column to a base)
- Parallelism: (series of rollers)
- Level/flatness: (machine bed foundation)
- Straightness: (rails or guideways)

...with its optical and mechanical axes aligned to within 3 seconds, a typical accuracy of 50–70 um at 30 m is achievable.

Autocollimators

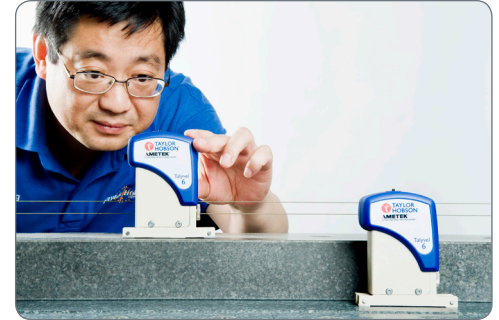


Used for measuring for example:

- Angle: (indexing head accuracy)
- Straightness: (machine tool slides in two axes)
- Squareness: (spindles to slideways)
- Parallelism: (slideways)

...from inexpensive visual to dual axis digital systems capable of measuring 0.01 second, equivalent to 50 nm per m.

Electronic Levels and Clinometers



Used for angle and level measurements:

- Level/flatness: (granite tables)
- Straightness & twist: (machine slides)
- Squareness: (of machine columns)
- Angle: (remote monitoring of movement of structures)

...from full 360 degree measurement to level measurements to 0.1 second.

Windows® based software programs are available for computer processing and graphic output of flatness, straightness, squareness, twist and polygons up to 72 faces.

Calibration of all instruments is traceable to international standards.

This application note demonstrates just one of the applications for the Taylor Hobson electro-optical metrology range.

Contact Spectrum Metrology to discuss your own measurement requirements.



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