Micro Alignment Telescope

Electro optical metrology in the defence industry

"A CCD camera, with software attached to a laptop, greatly speeds up and simplifies the measurement."

Torpedo tube alignment

The problem: To provide an easy-to-operate method of checking the straightness and diameter of torpedo tubes to within an accuracy of 0.05 mm (0.002 in). This method also eliminates the use of long, cumbersome plug gauges and the need to dry dock the vessel whilst the checks are carried out.

The solution: The measuring system uses a trolly with central glass target, which is towed along the entire length of the tube. The target is viewed through the micro alignment telescope, with vertical and horizontal displacements at preselected points being measured and recorded. Simultaneously the tube diameter is measured by means of displacement transducers incorporated in the arms of the measuring head.

Recorded data is used to prepare a graph of the tube's interior profile for comparison with a template which specifies the profile necessary for a torpedo to pass cleanly through the tube.

Gun barrel alignment

The problem: There are a number of methods used to check the straightness of small and large gun barrels. An optical system designed and manufactured by Taylor Hobson provides a simple but accurate solution to the difficulties associated with checking the straightness of tank and gun barrels.

Due to gravitational forces, gun barrels have a natural tendency to droop; in addition a certain amount of 'bend' is present, caused during the machining and manufacturing processes. To ensure a true trajectory of the shell when the gun is fired, manufacturers must measure and record the 'droop' and 'bend' for which compensation can be made.

The solution: This system comprises a telescope with CCD. Either a collimator or target is mounted in a sledge arrangement and moved up or down the barrel. The target arrangement must be able to cope with the spiral rifling which is present in all gun barrels.

Micro Alignment Telescope improves fighting vehicle performance

The problem: Modern light armoured tracked vehicles can travel at comparatively high speed and because of this it is essential that the track drive shaft bearings are in good alignment and the track suspension rollers are parallel to each other and aligned square to the drive axis. Failure to ensure this causes excessive wear and vibration, leading in some cases to breakage of the track and subsequent damage to the vehicle. Normally any errors are discovered only on the test ground, when considerable dismantling must be carried out before the error can be corrected.

The solution: Micro Alignment Telescope equipment can be used for checking the alignment at an early stage of manufacture – as soon as the locating bores have been machined in the hull. A diagrammatic view of the hull illustrating the method of checking the alignment is shown in figure 1. The drive, located between bores B and C, is taken to the two tracks independently via drive shafts passing through bores A, B, C and D. Conventional alignment techniques are used to check the alignment of these bores, with the telescope positioned centrally in bore A.

An optical square on the end of the telescope establishes a right angle line of sight down the side of the hull. The faces of the track suspension bores are checked for distance from this line by sighting on a scale. The height of the bores with respect to the main track drive shafts is then checked. The two sides of the hull are machined by independent machines, so it is very important to relate the measurements made on one side with those made on the other. In particular the two lines of sight must be co-planar if skew of the hull is to be detected. This is ensured by the use of a Taylor Hobson Talyvel level mounted on the optical square.

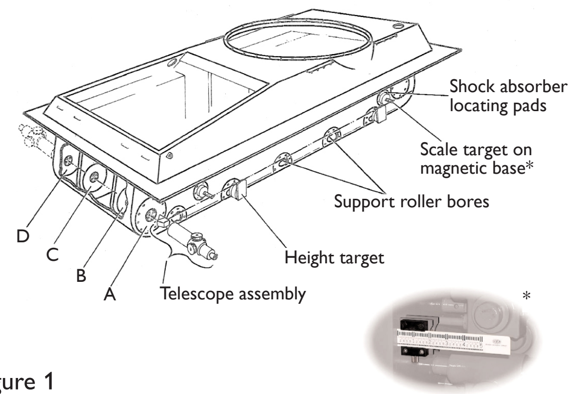


Figure 1

Periscope alignment

The problem: Periscopes are the eyes of a submarine. A periscope which is operating in misaligned bearings needs more power in the motors to overcome this resistance. The resultant power surge results in a higher noise level being generated which can be easily detected by enemy search craft.

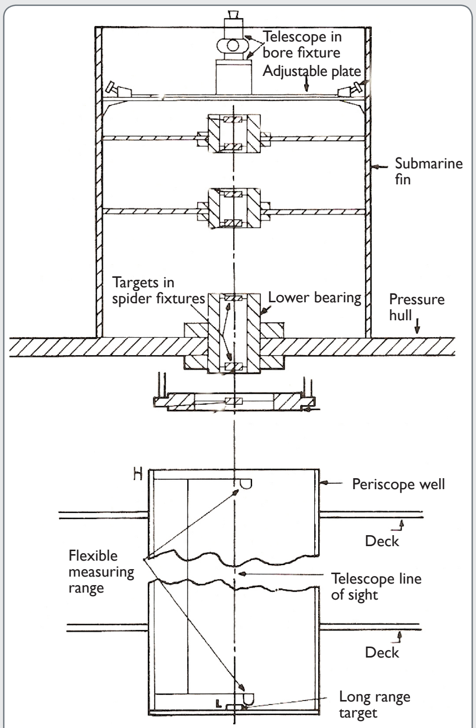
The periscope is approximately 10 metres in length, approximately 25 centimetres in diameter and is raised, lowered and rotated by hydraulic motors.

The periscope is mounted in a series of bearings located in the submarine fin and pressure hull structure. Alignment of these bearings is critical and any misalignment can result in distortion of the periscope and possible damage to the bearings themselves. Premature hydraulic motor failure can also occur, due to the extra power demands.

The solution: All alignment checks are made with reference to a line central to the bore of the lower bearing, which is located in the submarine's pressure hull.

A Micro Alignment Telescope is mounted in an adjustable support plate situated at the top of the submarine fin. A target mounted in a spider fixture (adjustable target holder) is fitted into the lower bearing bore. A second target is mounted in a second target fixture.

The Micro Alignment Telescope is then focused onto both targets. The other targets are then adjusted to be on this reference line.



Submarine periscope bearing alignment

> *"The effectiveness of the navigational/attack system of fighter aircraft relies on the accurate alignment of all systems to the aircraft's longitudinal fuselage datum (LFD)."*

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 datum (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 pilot's 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.

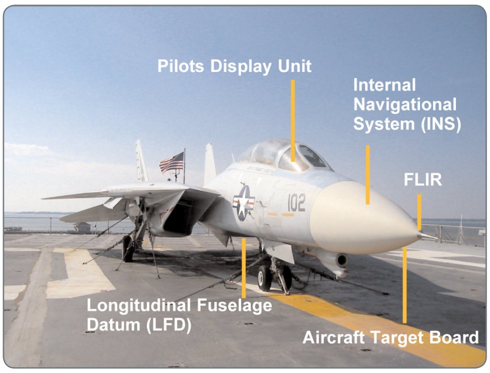
An alignment jig incorporating a Telescope is bolted to the gun pods and an aircraft sighting board incorporating collimators is attached to the front of the aircraft. The inclination of the checking jig and aircraft roll is checked using a clinometer.

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): Micro Alignment Telescopes (focused to infinity) are 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 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 re-alignment as required is corrected by re-shimming.

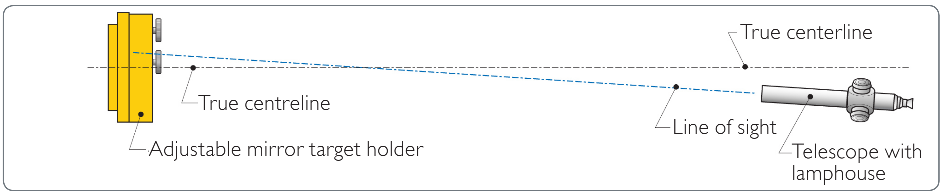
Similar procedures are adopted to align the PDU and FLIR. Harmonization of smaller systems such as handheld anti-tank weapons have a similar problem of parallelism setting. Here the sighting aid telescope, tracer rifle and missile itself must all be parallel to each other and can be set using autocollimation.



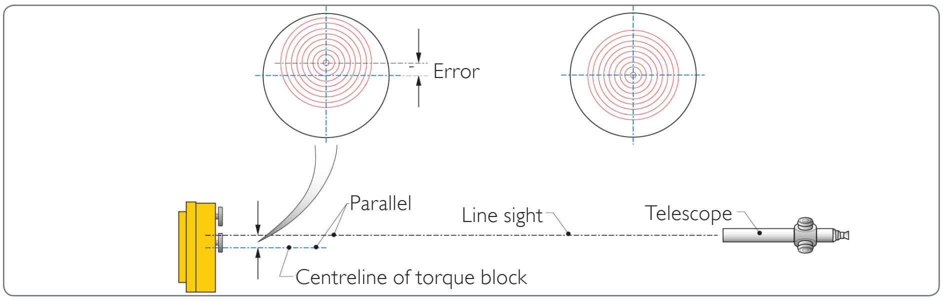
Alignment of helicopter drive shafts

A helicopter gearbox and drive shaft can be aligned correctly using the Taylor Hobson Micro Alignment Telescope and mirror. The Taylor Hobson Micro Alignment Telescope is unique in that it can focus from zero to infinity in a straight line and can also then be used to put components square to that straight line.

First put the telescope square to the mirror target:



... then in line with the centre of the mirror target:



Missile platform levelling

The problem: Some missile systems require a precision datum for the ground equipment before launching the missile.

The solution: The Talyvel electronic level provides a reference to gravity in two directions to be used in any location prior to launch.

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 problems

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