Technical Disclosure[1]

1. Title

Torque Satellite

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4. Publication type

Technical Disclosure

5. Abstract

The present disclosure relates to a torque-assistance apparatus, referred to as a Torque Satellite, developed to address ergonomic and operational inefficiencies during wind machine head assembly, specifically during torquing of bolts that secure a yaw bearing to a bedplate. The apparatus replaces a conventional crane-suspended torquing arrangement with a self-supported, yaw-bearing-mounted frame that travels along the circular profile of the yaw bearing. The Torque Satellite is primarily constructed from aluminum beams, brackets, screws, and wheels, and supports a torque tool and controller in a manner that allows constrained, continuous movement around the workpiece. The system reduces unnecessary operator motion, improves tool alignment, decreases cycle time, and enables operation by fewer personnel with less specialized lifting training.

6. Technical field

The present disclosure generally relates to industrial assembly tooling and, more particularly, to apparatuses for supporting and guiding torque tools during assembly of wind turbine components. More specifically, the disclosure relates to a movable torque tool support system configured to travel along the profile of a yaw bearing during fastening operations in machine head assembly.

7. Background

In the assembly of wind machine heads, a yaw bearing is positioned onto bedplate studs and secured using multiple bolts that must be torqued in sequence. Conventional torquing methods have relied on a jib crane to suspend and position the torque tool. This approach introduces several drawbacks.

First, jib crane operation requires specialized operator training, thereby limiting the number of qualified personnel available to perform the task. Second, the crane-based arrangement is not well suited to the circular path required for yaw bearing bolt installation, since the crane typically performs discrete and less constrained movements rather than smooth profile-following travel. Third, operators must repeatedly reposition the suspended torque tool and often move across the inner diameter region of the yaw bearing, which disrupts alignment from one bolt position to the next. Finally, precise alignment of the hanging torque tool with each bolt head requires time and effort, contributing to long cycle times and operator burden.

Accordingly, a need exists for a torque tool support apparatus that reduces dependence on crane-supported positioning, improves movement along the circular work profile, preserves alignment efficiency, and reduces the labor and time required for torquing operations.

8. Summary of the disclosure

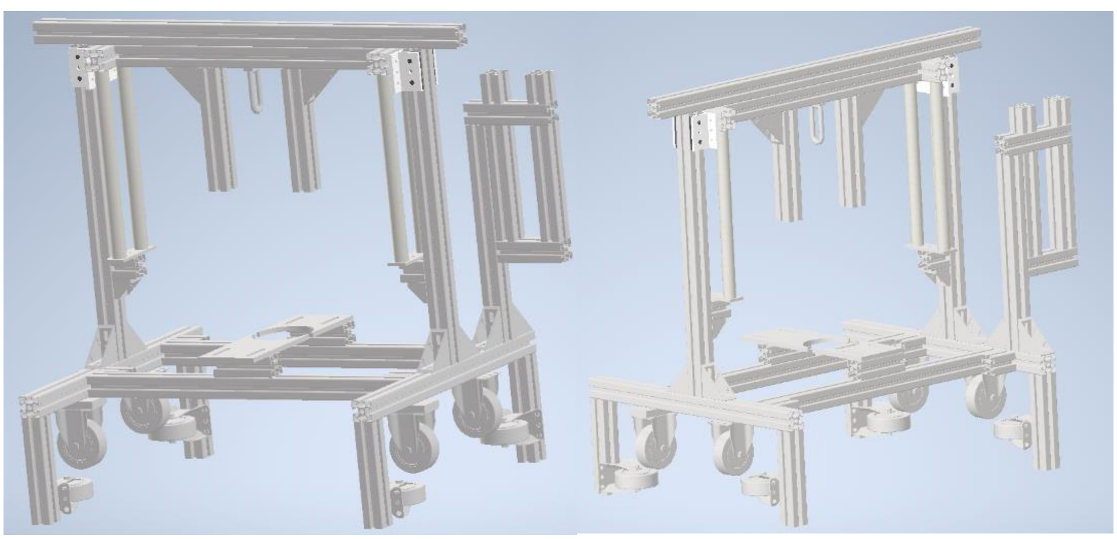
The present disclosure provides a Torque Satellite apparatus configured to support and guide a torque tool along the circular profile of a yaw bearing during assembly. After the yaw bearing is placed onto bedplate studs, the Torque Satellite is lifted onto the yaw bearing using a manually operated material lift. Once installed, the apparatus remains supported by and movable along the yaw bearing without need for an external lifting device during the fastening operation.

The apparatus includes a lower frame having multiple wheels arranged to contact the top surface, inner diameter, and outer diameter of the yaw bearing, thereby constraining movement of the apparatus to the circular path of the bearing while allowing access around the full circumference. An upper frame supports a torque tool and associated controller. The upper frame includes an outer fixed frame and an inner vertically translatable frame coupled by a rail system. Spring-rod assemblies help control the vertical translation rate and steady-state position of the inner frame. A hook and custom mounting structure secure the torque tool while limiting undesired lateral movement.

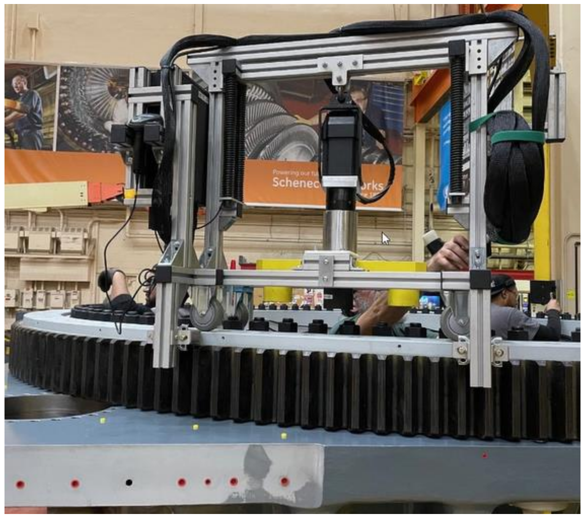
By constraining apparatus movement substantially to the work profile, the Torque Satellite reduces unnecessary operator repositioning and improves alignment efficiency from one bolt to the next. The system also eliminates continued reliance on a jib crane during the torquing process, reduces required operator count, and supports modularity for maintenance, alternate torque tools, and adaptation to other workpiece profiles.

9. Brief description of drawings

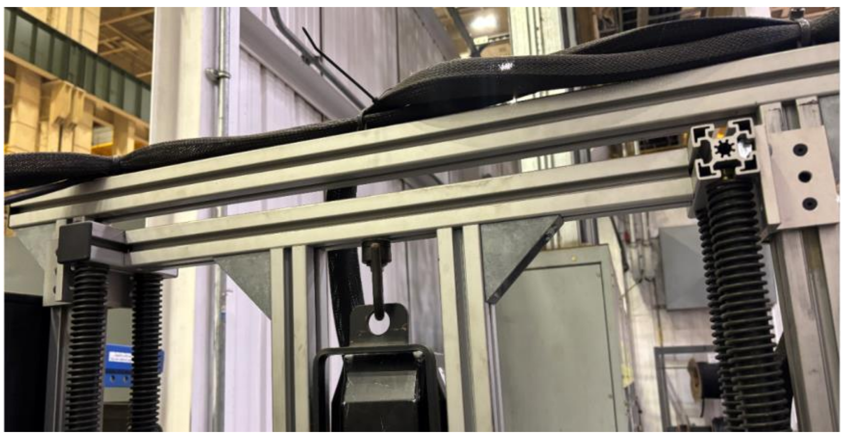
- A perspective view of 3D models of the tool



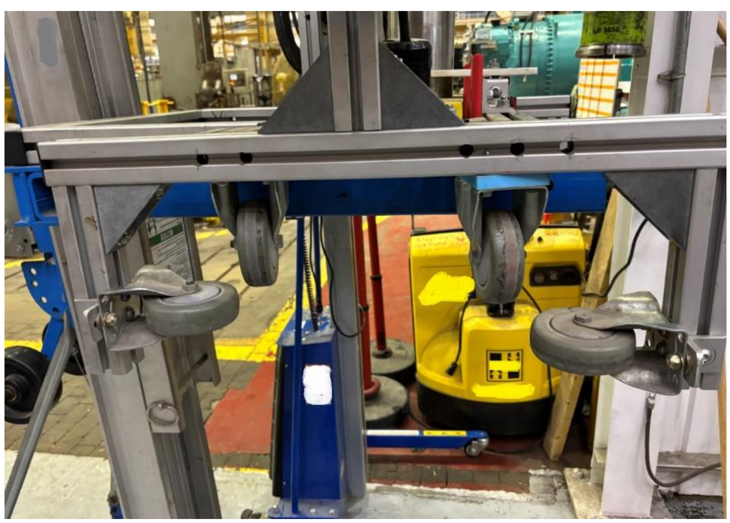
- A perspective view of the Torque Satellite mounted on a yaw bearing.



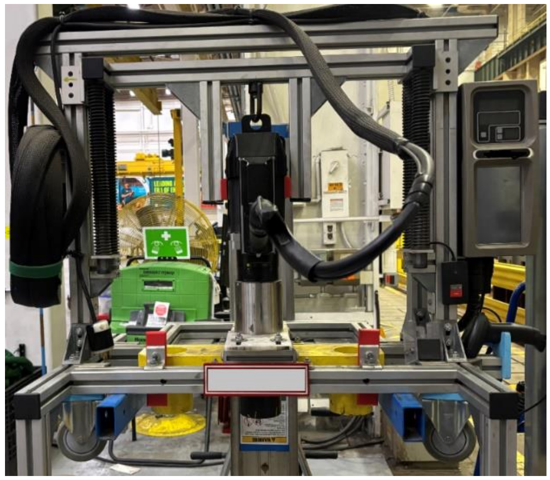
- A side view of the upper frame showing the fixed outer frame and vertically translatable inner frame.



- A view of the lower frame and wheel arrangement.



- A view of the torque tool mounting arrangement and controller placement.



10. Detail description

The Torque Satellite is an apparatus designed for use during torquing of bolts that hold a yaw bearing to a bedplate in wind machine head assembly. The apparatus is primarily constructed from aluminum beams, brackets, and screws, providing a structure that is sufficiently rigid while remaining suitable for handling and deployment in a manufacturing environment.

After the yaw bearing has been positioned on the bedplate studs, the Torque Satellite is lifted and placed onto the yaw bearing using a manually operated material lift. The apparatus is configured to run along the inner and outer non-toothed diameters of the yaw bearing as well as along the top surface of the yaw bearing. In one implementation, the apparatus is manufactured to fit standard yaw bearing dimensions, such that its contact points are fixed and non-adjustable for that standard geometry.

The apparatus includes an upper section and a lower section. The upper section is generally vertical and includes an outer fixed rectangular frame and an inner frame that is movable relative to the outer frame in the vertical direction. The inner frame is attached to the outer frame through a rail system, which permanently secures the inner frame while allowing guided vertical translation along a t-slot or similar structural feature of the outer frame.

To manage the motion of the inner frame, four spring-rod assemblies may be provided. These assemblies can be slotted through fixed brackets and arranged to control the rate of vertical translation as well as the steady-state position of the inner frame. This configuration can assist in controlled movement of the mounted torque tool relative to the bolt locations.

A torque tool is mounted to the upper section. In one embodiment, the frame is designed to fit a torque tool fitted with a custom mounting bracket. The torque tool may be attached to a hook mounted at the top of the inner frame. The tool also fits into a custom receiving part or fixture that restricts lateral translation of the torque tool while mounted, thereby helping maintain alignment during operation.

A controller may also be mounted on the apparatus. In one embodiment, a controller is affixed to the Torque Satellite to monitor and control the Torque tool. Power and data cables associated with the torque tool and controller are secured and routed along the frame away from moving parts to reduce interference and improve safety and reliability.

The upper section is affixed to the lower section using corner brackets or other structural connectors. The lower section includes a horizontal frame with eight fixed wheels mounted on short vertical extrusions. In one embodiment, four wheels contact the top surface of the yaw bearing, two wheels contact the inner diameter of the yaw bearing, and two wheels contact the outer diameter of the yaw bearing. This arrangement constrains the motion of the Torque Satellite to the circular profile of the yaw bearing while permitting travel around the full 360-degree circumference.

In operation, once the apparatus is installed on the yaw bearing, the operator can move the Torque Satellite freely along the work profile without the need for external support equipment. Compared with a suspended crane system, the apparatus reduces motion complexity by limiting repositioning substantially to one translational degree of freedom along the work profile and one rotational degree of freedom for aligning the torque tool head with the bolt head. This removes other unnecessary degrees of freedom present in crane-suspended arrangements and improves efficiency in sequential bolt torquing.

The modular construction of the Torque Satellite also permits replacement of damaged or obsolete components and may allow fitment of alternative torque tools. In some embodiments, the apparatus may be adapted for different diameters or shape profiles without requiring complete refabrication of the entire assembly.

11. Advantages

The disclosed Torque Satellite provides several technical and commercial advantages.

Technical advantages include improved alignment of the torque tool relative to the bolt heads, which can reduce the possibility of damage to the yaw bearing and bolts caused by misalignment. The constrained-path movement also improves consistency in positioning and reduces unnecessary handling motions during operation.

Operational and commercial advantages include substantially reduced cycle time for torquing the yaw bearing to the bedplate. Sequential bolt torquing can be performed more quickly than with prior crane-based methods. The apparatus can be placed using a manually operated lift, which generally requires less specialized training than jib crane use, thereby increasing the pool of potential operators. In addition, the disclosed apparatus can enable the task to be performed by a single operator, whereas previous methods may require at least two operators.

Further advantages include portability within the shop floor, reduced dependence on external lifting equipment during the task, and modularity for maintenance, upgrades, and adaptation to alternative tools or geometries.

12. Example Embodiments

In an example embodiment, a Torque Satellite apparatus includes a lower frame configured to rest on and travel along a yaw bearing, and an upper frame configured to support a torque tool above the lower frame. The lower frame includes a plurality of wheels arranged to contact multiple surfaces of the yaw bearing, including the top surface, the inner diameter, and the outer diameter, such that the apparatus is constrained to follow the circular profile of the yaw bearing.

In another example embodiment, the upper frame includes a fixed outer frame and a vertically movable inner frame connected by a rail system. A torque tool is mounted to the inner frame, and one or more spring-rod assemblies are provided to control the vertical movement and resting position of the inner frame.

In a further example embodiment, the system further includes a custom mounting bracket and a custom fixture that restricts lateral movement of the tool. A controller may be mounted to the frame, with power and communication cables routed along the frame away from moving parts.

In another example embodiment, the apparatus is dimensioned for a standard yaw bearing geometry with fixed contact points. In alternative embodiments, one or more frame members, wheel positions, or mounting elements may be modified to accommodate different bearing diameters or other curved assembly profiles.

In yet another example embodiment, the apparatus is installed using a manually operated material lift at the start of the fastening process and removed using the same or similar lift after completion, with no external lifting device required during intermediate bolt-to-bolt repositioning.

13. Industrial Applicability

The disclosed apparatus is applicable to industrial assembly operations in which multiple fasteners are installed or torqued along a circular or curved work profile. The invention is particularly applicable to wind turbine machine head assembly, including fastening of yaw bearings to bedplates in wind manufacturing facilities.

More broadly, the system may be used in manufacturing, heavy equipment assembly, and other industrial environments where a torque tool must be repeatedly aligned with fasteners distributed around a circular component. The apparatus is especially useful where reduction in cycle time, ergonomic improvement, reduced lifting-equipment dependency, and repeatable guided movement is desirable.

14. Variations and Alternatives

Various modifications may be made without departing from the general principles of the disclosure.

For example, although one embodiment is configured for a standard yaw bearing dimension with fixed, non-adjustable contact points, other embodiments may include adjustable wheel positions, interchangeable support members, or reconfigurable frames to accommodate different diameters or shape profiles.

Although a torque tool and a controller are referenced, other torque tools, controllers, mounting brackets, and support fixtures may be used. The frame materials may also vary and can include metals, composites, or other structural materials suitable for the intended load and operating environment.

In some alternative implementations, the same general problem may be addressed by other systems, such as robotic arm-based systems that move a torque tool along a preset path, floor-supported devices that provide profile-following tool support without being mounted solely to the yaw bearing, or specialized crane systems configured to move only along the work profile. Nonetheless, the present disclosure is directed to a bearing-mounted, profile-constrained apparatus that remains freely movable throughout the task once installed.

Additional variations may include different numbers or arrangements of wheels, different translation control mechanisms in place of spring-rod assemblies, alternate rail or guide systems, different cable routing strategies, and alternate mounting or retention mechanisms for the torque tool.

15. Conclusion

The present disclosure provides a Torque Satellite apparatus for supporting and guiding a torque tool during fastening of a yaw bearing to a bedplate. By mounting directly to the yaw bearing and moving along its profile, the apparatus reduces reliance on crane-supported positioning, improves alignment efficiency, decreases cycle time, and can reduce operator requirements. The modular and adaptable structure further supports maintenance, alternate tooling, and use with different workpiece profiles. Accordingly, the disclosure presents a practical and effective solution for improving torquing operations in wind turbine assembly and related industrial applications.

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