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Selecting the Best Hub Fastener for a Power Transmission Application

SDP/SI
STOCK DRIVE PRODUCTS/STERLING INSTRUMENT

Power transmission components including gears, pulleys, couplings, shafts, and shaft accessories are used in various types of applications. These markets include aerospace and satellites, industrial manufacturing, medical technology, military and defense, and robotics.

How components are secured to a rotating shaft in order to maintain alignment and position accuracy is an important feature to the design and operation of the assemblies they are a part of. To optimize manufacturing and operating functionality, many criteria should be considered during the design phase, including some that are frequently overlooked.

Holding Force: To guarantee the component does not slip or move during operation, engineers should establish the operating torque and the necessary holding force.

Alignment & Phase Adjustment: The type of hub fastener may be predetermined by the assembly, especially if more control and accuracy in axial positioning and angular alignment (phase adjustment) is a requirement. If phase adjustment is needed, mechanisms that fix the orientation of the component on the shaft, such as machine keys, should be avoided.

Costs: The issue of cost is a constant concern. When choosing the optimal hub fastener for an assembly, design engineers should consider production, purchasing, assembly, and maintenance expenses. While the initial cost may appear to be insignificant, it may pile up during the product's lifetime especially in high-volume production.

Shaft tolerances, keyways, drilled or tapped holes, flats, and shoulders on shafts, are machining factors that lead to higher costs. Additional purchased parts, such as clamps, keys, and pins, also contribute to the design's overall cost.

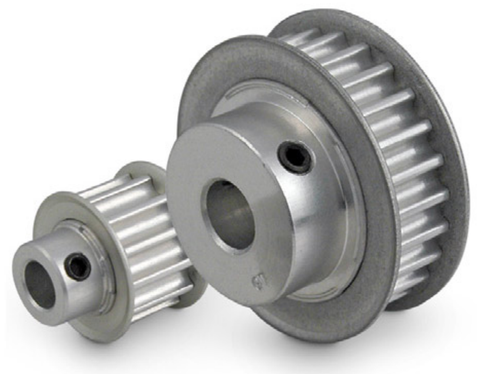
Fairloc® is completely self-contained and the unique design allows the hub to fully and accurately support the component on the shaft, reducing any motion and misalignment after clamping the hub.

The cost of assembly and maintenance should also be factored in. Serviceability is sometimes ignored, but can be important, particularly for assemblies that require periodic or frequent maintenance. Set screws, for example, might damage the shaft, necessitating repair when the component is frequently removed. When a part is pinned to a shaft, it may be necessary to replace multiple components.

Standard vs. Custom Components: Many designers believe that choosing a standard product over a custom design is always the best option. While this may be true for one-of-a-kind or low-volume designs, it is not always the case. When all of the design aspects are taken into account, a custom solution can be the best option.

Alternatives to Hub Fasteners

Engineers have a variety of fastening possibilities to choose from when determining the best configuration for their design. Set screws, keys, clamps, and pins are among the choices and each one has its own set of benefits and drawbacks.



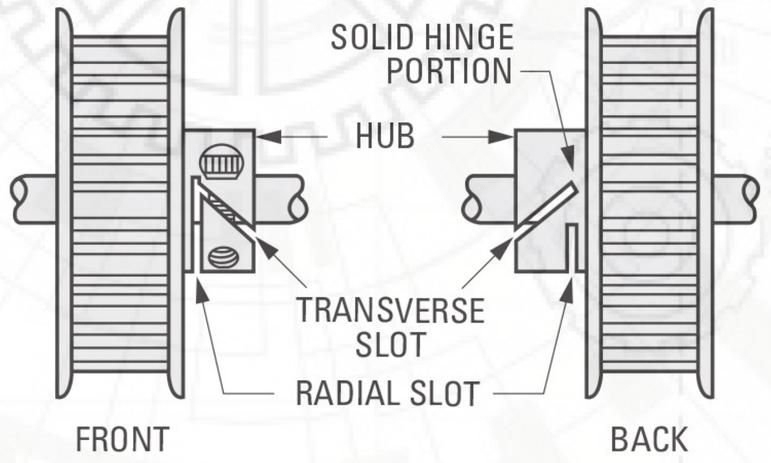
Set screws are one of the simplest and most popular ways to secure a component to a shaft, whether on the radius of the shaft or on a machined flat surface. The shaft may be marred if the set screw is sufficiently tightened enough to hold the component. Flats increase the component's production cost and prevent phase adjustments. Pins can be used to secure the component and prevent slippage.

Assemblies that use machine keys can sustain relatively high torques without slipping and are simple to make and assemble, but they do not allow for phase adjustment, incur additional manufacturing expenses, and may introduce backlash.

Clamping devices are a commonly used external hub fastening device. Clamps protect the shaft from marring while allowing for axial and radial movement. They do not, however, completely support the component and cannot be pinned.

Fairloc® — A Better Way to Fasten Rotating Components

Engineers have relied on Fairloc® from Stock Drive Products/Sterling Instrument (SDP/SI) for over 50 years. It's a component fastening design that's built into the hub of the part and may be applied to gears, pulleys, couplings, shaft adapters, and other miniature-to-medium-sized (up to 2 in. bore diameter) components.



Fairloc uses two slots machined into the hub; one oriented radially and the other angularly. Unlike some similar designs, the hub remains in one piece. The slots create a transverse wedge that remains attached to the solid portion of the hub on one side. The resultant cantilevered clamping section has a tapped hole to accept a cap screw which passes through a clearance hole in the solid portion of the hub, and into a threaded hole in the transverse wedge section. Turning the cap screw clamps the cantilevered wedge section securely against the shaft. The screw can be tightened and released repeatedly without marring the shaft or affecting its torque transmitting abilities.

Fairloc eliminates many of the issues associated with other fastening methods. Fairloc is completely self-contained and the unique design allows the hub to fully and accurately support the component on the shaft, reducing any motion and misalignment after clamping the hub. Fairloc keeps the shaft centered and mounted components perfectly aligned.

Holding Force

Lab tests have proven Fairloc to be superior in high-torque applications, as high as 400 lbf/in. for a hub with a 5/8 in. bore. The following charts show the slip torque values for stainless steel gears mounted on stainless steel shafts. All

gears and shafts were made of 303 stainless steel. Gear bores were within +/-0.0003 in. of nominal values. Shafts had a maximum surface finish of 16 µin. and were within -0.0002 in. of the nominal diameters.

INCH BORE TORQUE DATA

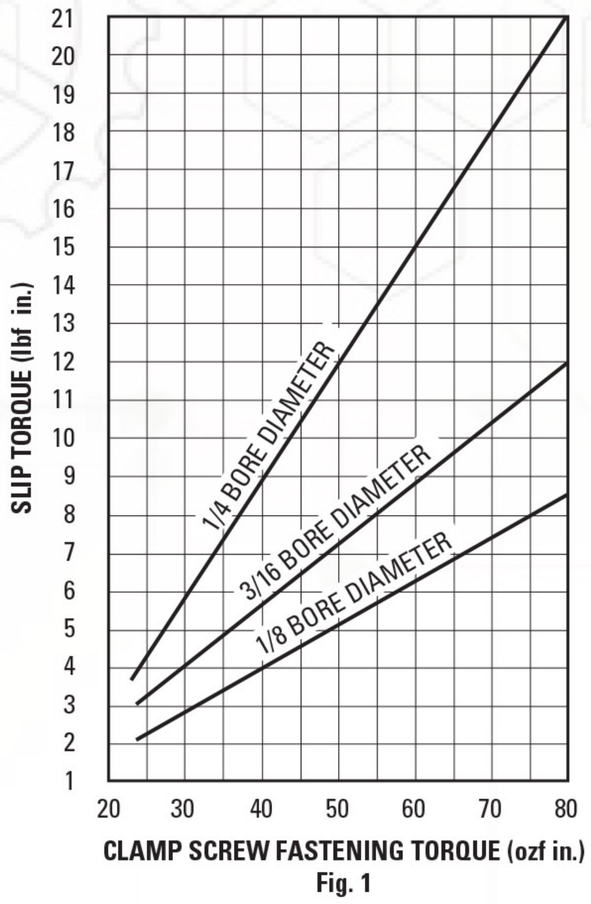


Fig. 1

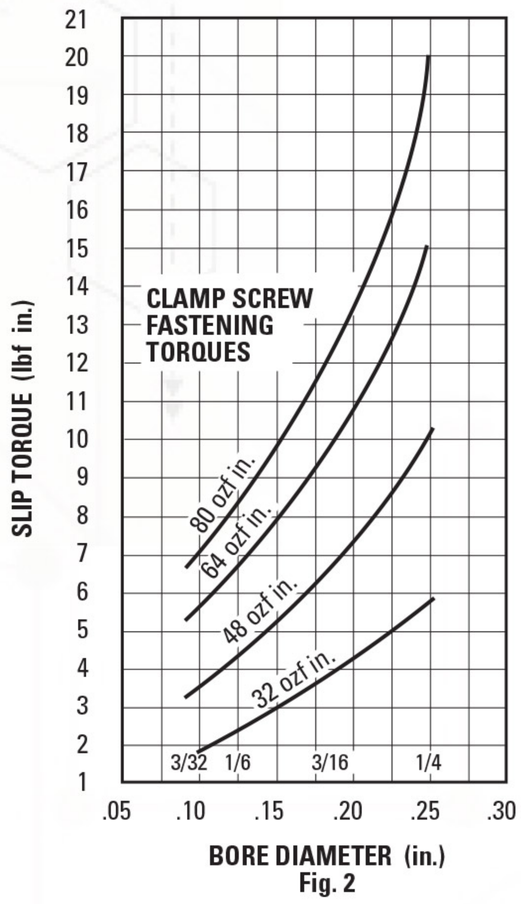


Fig. 2

Figure 1 shows the torque at which the component starts to slip for various bore sizes and clamp screw fastening torques.

Figure 2 compares the slip torque for different values of the clamping screw fastening torque.

METRIC BORE TORQUE DATA

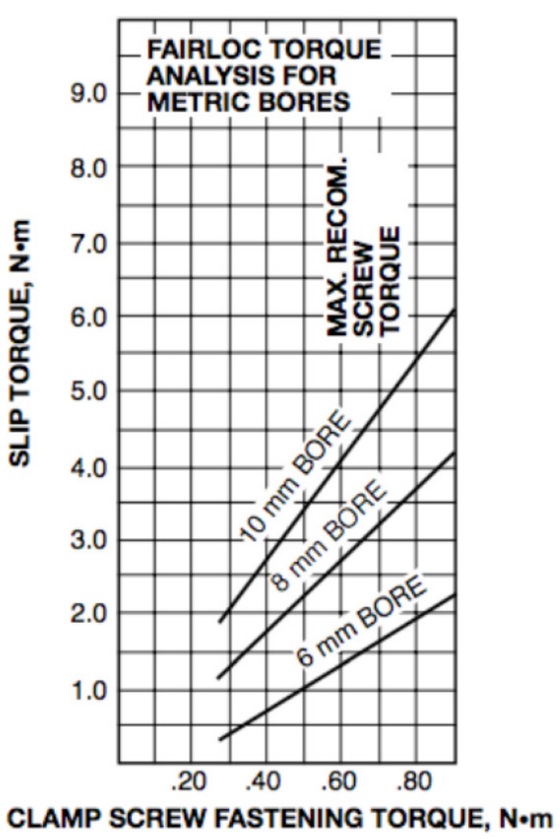


Figure 3

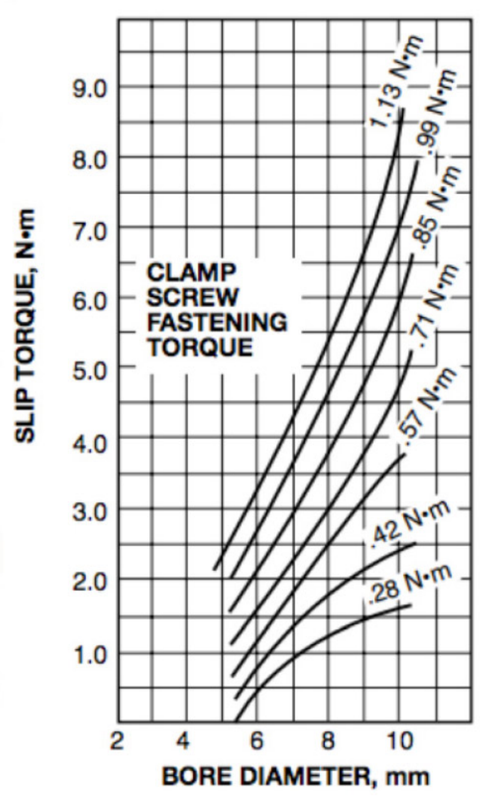


Figure 4

Figure 3 shows the torque at which the component starts to slip for various bore sizes and clamp screw fastening torques.

Figure 4 compares the slip torque for different values of the clamping screw fastening torque.

Alignment and Phase Adjustment:

Fairloc does not require any modification to the shaft and allows for infinite and easy phase adjustment as well as axial adjustments. The component maintains perfect alignment with the shaft. The Fairloc design also facilitates pinning the hub, if desired.

Costs:

Purchasing costs for components with Fairloc hubs are comparable to competitive products, however, the assembly and maintenance costs can be considerably lower. There are no keyways or flats to mill, no holes to drill or tap and no extra parts to buy. Phase adjustments are easy — loosen the cap screw, adjust and tighten. The Fairloc design also ensures that the shaft will not be marred, eliminating shaft repair costs.

There are other self-locking hubs with integral fasteners, but none of them offer all of the benefits of the Fairloc design. Fairloc solves the problems associated with alternative designs and checks all of the design criteria boxes.

Fastening Method	Shaft Remains Smooth	Self-Contained	Component is Fully Supported	Easy Adjustment	Can be Pinned if Desired
Clamps	YES	NO	NO	YES	NO
Fairloc®	**YES**	**YES**	**YES**	**YES**	**YES**
Keys	NO	NO	NO	NO	NO
Pins	NO	NO	NO	NO	YES
Set Screws	NO	NO	NO	NO	YES

Standard vs. Custom Product:

SDP/SI manufactures a broad line of standard inch and metric-series components with a variety of hub fastening methods in addition to Fairloc. Plastic products with steel Fairloc hubs can also be purchased off the-shelf. Standard components with Fairloc hubs include:

Gears
- Stainless steel gears: 48, 32, 24DP (module 0.5, 0.8, 1)
- Plastic gears: 72, 64, 48, 32, 24DP (module 0.5, 0.8, 1)
- Mini-lash gears
- Miter and bevel gears
- Anti-backlash gears

Couplings
- Miniature bellows couplings
- Bellows couplings
- Neo-Flex® couplings
- Rigid couplings

Timing pulley
- Aluminum pulleys: MXL, HTD, GT®2/GT®3
- Plastic pulleys with aluminum inserts: XL, HTD

Shaft reducers and extenders
Shaft collars
Precision gear and dial hubs

Produced By:

IEEE

For those occasions when a standard product isn't available, SDP/SI offers value-added application, design and manufacturing services. Application engineers are available to help find the best solution for all simple to complex design problems and can furnish cost-effective custom products that meet the customer's requirements. Do not compromise the integrity of a design by designing around standard products. If off-the-shelf products are not suitable, SDP/SI is here to help.

For example, a common custom need is for a non-standard bore size. Modification of the bore by the end-user is not recommended for Fairloc hubs, as it could compromise the hub locking characteristics. SDP/SI can custom engineer a solution and furnish the exact bore size required. Due to the many benefits of the Fairloc design, a custom solution is frequently more cost-effective than adapting the design for a catalog product.

In addition to components with an integral hub, SDP/SI also manufactures a line of Fairloc hubs and sleeves that can be adapted to an existing product, furnishing a specialty or proprietary product with all of the advantages that Fairloc has to offer.

Custom Case Studies

Medical Pumps and Drives

Miniaturization is a driving factor for change in medical devices. In response to customer requirements, SDP/SI has successfully developed a more compact Fariloc pulley. The efficiency and integrity of a belt drive is closely attributed to the quality of the pulleys involved. The miniature Fairloc pulley and belt drive system will provide years of uninterrupted service.

Aerospace

When designing an actuation/positioning system for a satellite, our customer was concerned about the need for accuracy during deployment. The resulting gear assembly was built using Fairloc hub gears, ensuring precise alignment and positioning. The project proved to be highly successful and has resulted in years of repeat and new business, always specifying the Fairloc design.

Applications

Fairloc couplings are appropriate for virtually any industry. Typical applications include military and aerospace gear trains, aircraft instrumentation and controls, machine tools, medical equipment, business machines, military fire control systems, optical equipment and power transmission drives.

Fairloc hubs are also used in two of the fastest rising markets today: 3D printers and robotics. Robots and printing equipment each rely on many gears, pulleys and couplings to provide accurate and repeatable motion control. These applications are ideally suited for components with Fairloc hubs.

Conclusion

When specifying a power transmission component, design engineers should look beyond the operating specifications. Factors such as holding force, positioning accuracy after clamping, alignment and phase adjustment and purchasing, machining and maintenance costs should also be considered. Selecting the best hub fastening method is a critical aspect that affects all of these criteria. The Fairloc hub fastener, by SDP/SI, addresses these items and is a better choice than pins, keys and other methods.

If a standard catalog product is not available, do not compromise the design. The application engineers from SDP/SI are available to help develop a custom solution at a competitive cost to solve your unique design challenges.

Visit the Fairloc product page on the SDP/SI website for additional information:
http://www.sdp-si.com/products/Fairloc/index.php

SDP/SI design, engineering or manufacturing services:
http://www.sdp-si.com/resources/sdpsi-capabilities.php