FEATHER KEYS

The forgotten and ignored drive component

A simple mechanical part can reduce manufacturing costs and machine downtime.

Feather keys are relatively unknown in the U.S., but they're easy to assemble, cannot fall out, and permit lateral adjustment of mounted components.

With all of the new components and materials bombarding engineers these days, some simple but effective ways of the past have been pushed aside.

Take, for instance, shaft keys — sometimes called sunk keys — that transmit torque between shafts and shaft-mounted components such as gears or pulleys. Shaft keys come in a wide range of types and styles, including parallel, Woodruff, taper, Gib-head, and perpendicular versions. But some, such as the feather key, are all but forgotten. Here's why engineers striving for durable and cost-effective designs should consider them again.

Authored by:
Dennis G. Berg
CEO & Chief Engineer
Rino Mechanical Components Inc.
Freeport, N.Y.

Edited by **Kenneth J. Korane**
ken.korane@penton.com

Key points:

- Engineers can choose from a wide range of shaft keys to transmit torque in power-transmission systems.
- Feather keys are relatively unknown but offer durable, cost-effective designs.

Resources:

Rino Mechanical Components Inc., *www.rinomechanical.com*

Parallel keys

Parallel keys are sometimes called straight keys and include square and rectangular styles. They are the most common keys used today. The shaft usually has a slot running its full length to accommodate the key, or a slot longer than the key starting at the shaft end. Installation involves lining up keyslots in the shaft and component and then pressing in the parallel key.

Square keys, as the name suggests, have square cross sections. They are normally specified for shafts with 0.25 to1.0-in. diameters but larger square keys are available for shafts up to 6.5-in. diameter. Designers use them when they want greater key depth than is possible with rectangular keys.

Rectangular keys, sometimes called flat keys, are general-purpose components for shafts between 1.0 and 20-in. diameter. Their width exceeds the height, letting them transmit more torque without adding slot depth to the shaft or keyway depth to the component. Shafts over 11-in. diameter that use rectangular keys are often milled flat along their length, instead of machining a keyslot. The mounted component uses a standard broached keyway.

Parallel keys are inexpensive, readily available, and easy to install. The keyslot in the shaft can be cut

with an end mill or circular saw. Once installed, a setscrew or other retainer must hold the parallel key in the mounted component. Drives that vibrate or reverse directions often loosen the screw. When that happens, the parallel key may walk itself out of the assembly.

It is a frequent frustration to have a drive component suddenly spin free while the key is lost in the bowels of a machine, sometimes falling into critical mechanisms and causing catastrophic damage. Thus, parallel keys are recommended for transmitting unidirectional torques in transmissions not subject to heavy starting loads, and in applications that require periodic withdrawal or sliding of the hub.

In many instances, particularly with couplings, designs cannot accommodate a Gib-head key (see below) as there is insufficient room to remove the key from behind. In these cases, it is necessary to withdraw the component over the key, making a parallel key essential. Parallel square and rectangular keys are normally side fitting with top clearance, and are usually retained more securely in the shaft than in the hub. They come in a variety of widths and lengths or can be cut to length from key stock.

Woodruff keys

Semicircular Woodruff keys insert into a curved slot in the shaft. The advantage: Properly installed, it is captive and cannot walk out of the shaft. However, they are difficult to install. The key is first pressed into a curved slot milled in the shaft and then aligned so that its flat top is parallel with the shaft. But as the shaft and Woodruff key are pressed into the component, the key tends to slip out of position. Keys not installed parallel will cause problems in use.

Woodruff keys are also relatively short and cannot carry the same load as longer keys. They are used for light-duty applications and mounting taper-bored components onto tapered shaft ends. They're inappropriate for transmitting heavy torque, such as with wide-faced gears or multigroove V-belt pulleys. Mounting two or more Woodruff keys in line to carry higher loads is expensive and makes installation all the more problematic.

Woodruff keys are used on shafts from 0.25 to 2.5-in. diameter. They come in a range of sizes but require special key-cutting tools.

Taper and Gib-head keys

These keys transmit heavy, unidirectional, reversing, and vibrating torques and are suited for applications that require periodic key removal. Taper keys come in plain, saddle, and Gib-head styles and they all function much the same.

The shaft requires a long keyslot. Assembly calls for aligning the component keyway and shaft keyslot. The taper key is then inserted and pressed or hammered tightly into place.

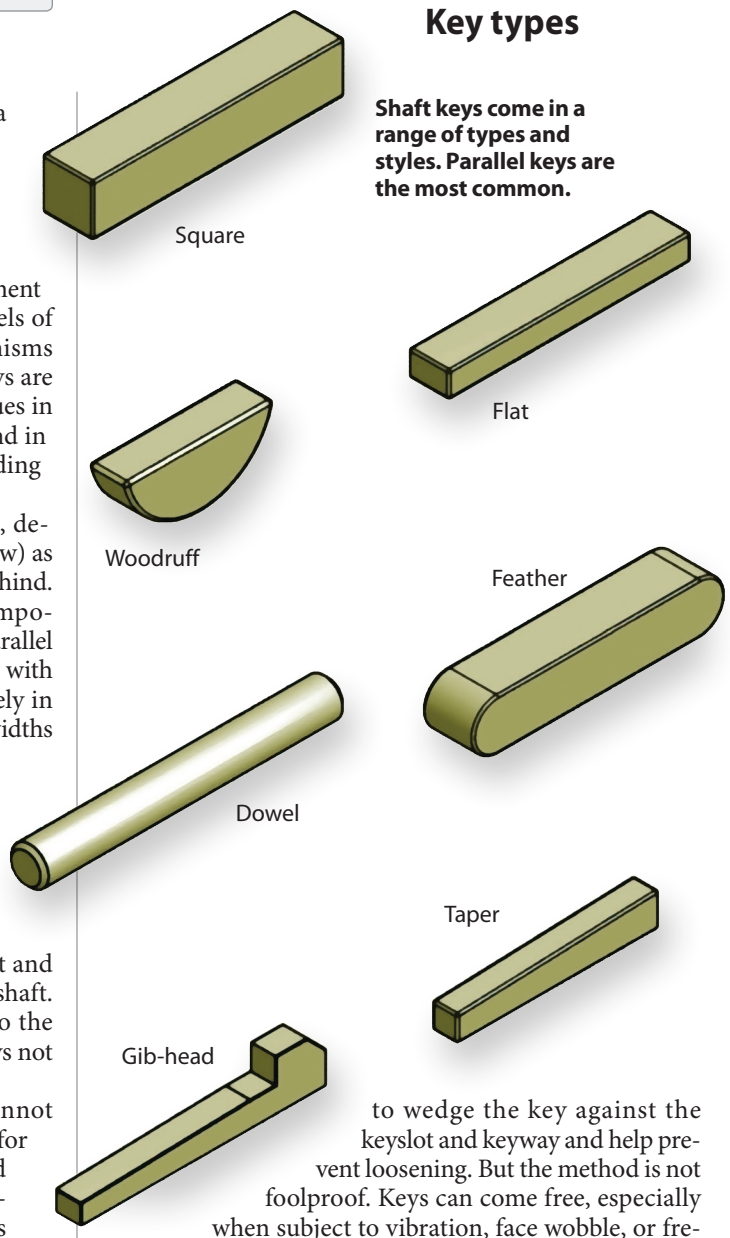
The taper on these keys is 0.125 in./ft, which is enough to wedge the key against the keyslot and keyway and help prevent loosening. But the method is not foolproof. Keys can come free, especially when subject to vibration, face wobble, or frequent stop and starts or reversals.

The key's taper is in the hub member. A well-fitted taper key has no clearance on the top, bottom, or sides; hence engineers may require closer tolerances on taper-keyway depths than on parallel-keyway depths. Tapered sunk keys not only act as drivers, but hold components against axial or endwise movement. Tapered keys should have load-bearing support on all sides.

Gib-head types have a raised head on the large end of the taper. This simplifies removal — just insert a prying tool between the Gib and face of the mounted component. Some plain-taper keys have a cross-drilled hole in the larger end to aid removal.

Slot depth in both the shaft and component controls axial position, but it cannot be predetermined. The deeper either slot, the further the key enters axially.

Excessive keyslot or keyway depth might let a Gib-head taper key slide so far into the slot that it contacts the face of the component. If this happens, users cannot trust the

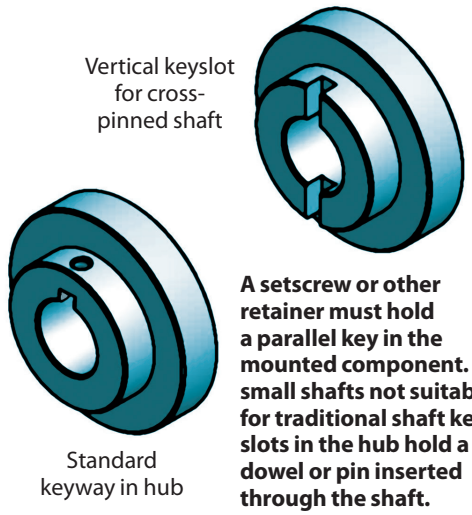


taper key to wedge strongly and should expect failures.

Saddle keys are taper keys simply concaved on one side to fit the shaft and tapered on the top. They don't produce a positive drive, so only use them if there is little power to transmit.

Taper keys are usually top fitting, but may be top and side fitting. Rectangular-section taper keys are used for general purpose applications. Similar to parallel-rectangular keys, height is less than the width on taper keys and they are used for shafts 0.5 to 6 in. in diameter.

Typical keyways



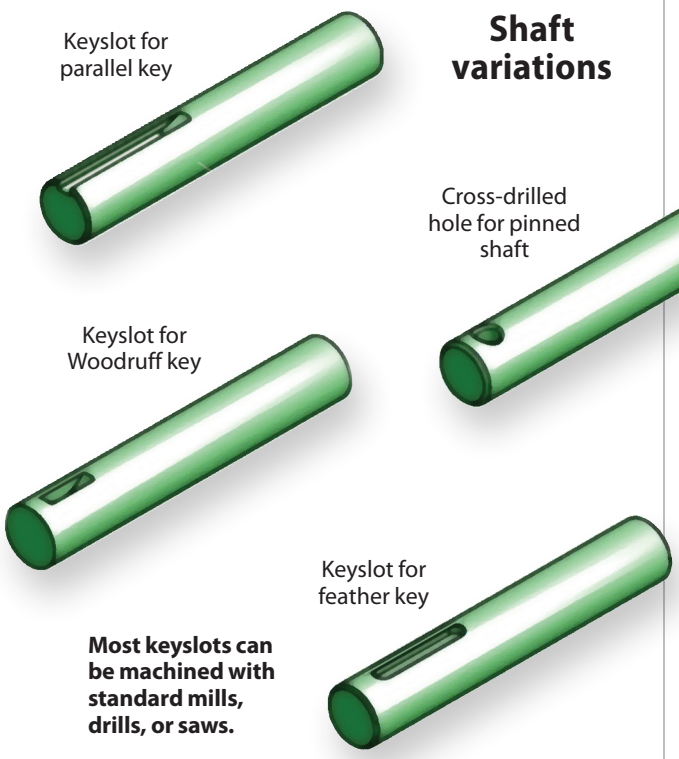
A setscrew or other retainer must hold a parallel key in the mounted component. For small shafts not suitable for traditional shaft keys, slots in the hub hold a dowel or pin inserted through the shaft.

Perpendicular pin

Shafts 0.25 in. in diameter or smaller may not be suitable for traditional shaft keys. But drilling a hole through the shaft and inserting a dowel or spring pin may solve the problem.

A vertical slot cut into the end of the component engages the two protruding ends of the pin and transmits torque. The vertical slot must be at least as deep as the pin diameter and can be deeper. Using a spring pin rather than dowel pin, along with a properly toleranced slot in the component, results in near-zero backlash between shaft and component.

Shaft variations



Most keyslots can be machined with standard mills, drills, or saws.

Feather keys

This brings us to the almost forgotten feather key. Feather keys are well known in Europe and elsewhere but not the U.S. They are used for shafts from 0.25 to 2.5 in. in diameter and have the same torque capacity as square and rectangular parallel keys.

The feather key is a parallel key, similar to square and rectangular keys except for a radius on both ends and tighter length tolerances. The mating shaft keyslot is machined with an end-mill cutting tool to the same length as the feather key. This oval shape precisely holds the key in the shaft and prevents axial movement. The broached keyway in the mounted component is identical to conventional keyways used for parallel keys, so no changes to the mounted components are necessary.

Feather keys have several advantages compared to traditional keys:

1. The radius end of the key funnels the key into the component keyway, simplifying assembly. And feather keys easily insert into shafts. The radius helps align the key in the shaft slot.
2. Feather keys are totally contained. It doesn't take a setscrew to hold the key in position and feather keys cannot walk out of an assembly.
3. An installed feather key cannot move axially. This lets workers laterally adjust the position of mounted components along the shaft.
4. Feather keys cannot fall out of the shaft and damage nearby machinery. (Loose keys in working machinery are a major cause of damage and injury.)
5. There is no possibility for a lost key and the related downtime.
6. Disassembly and reassembly with a feather key is hassle-free.
7. Feather keys are precut to exact lengths. There is no need for cutting, measuring, filing, or fitting.

The only down side is that feather keys are not readily available in the U.S.

The feather key, though a simple mechanical part, can lower the cost of manufacturing and assembly and possibly reduce warranty callbacks and customer downtime. For such a mundane low-cost part, it has world-class benefits. **MD**