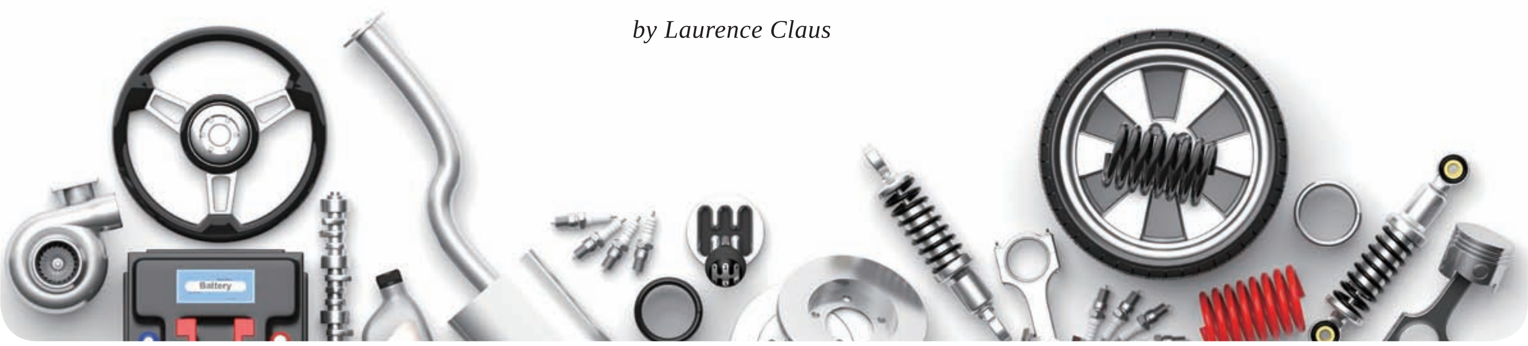
Automotive Cold Headed Brake Components

by Laurence Claus



The other day I received an email from an individual at one of the companies that I work with asking me if I was aware of any industry standards for wheel studs. I had to think about this for a bit and ultimately replied that I was unaware of any formal, industrywide document pertaining to this product. I went on to explain that in my experience, although many wheel stud designs were likely similar from one automotive OEM or supplier to another, that each OEM or supplier had their own special "spin" on part design and functionality. The result is a wide body of 'Tribal Knowledge" on such parts but a dearth of formal, industrywide standards or know-how.

This situation is essentially true across most, if not all, of a vehicle's component systems. In other words, design teams for different automotive systems have their own tribal knowledge related to components for those systems, but it is rarely, if ever, institutionalized across their company or the industry. So, for example, design teams on engines have a different perspective and understanding of fasteners than those assigned to suspensions.

One of the automotive systems that have a wide variety of specialized engineered fasteners and components is the braking system. This article will take a look at some of the specialized components that typically come from fastener manufacturers that perform functions beyond the standard bolt, screw, or nut.

To best understand some of these special components, one must first have a rudimentary understanding of automotive braking systems. In essence, the braking system is intended to slow down or halt the forward or reverse momentum of an automobile. This is usually accomplished with a system that, once activated, will convert the kinetic energy of the moving vehicle to heat. Most modern automobiles accomplish this by using what is referred to as a Foundation Braking System which is a hydraulic system that squeezes friction pads against discs or drums that rotate with the wheels. Since the discs (known as rotors) are integrated with the wheels, as they are slowed down, so is the vehicle. These hydraulic systems are a series of multiple components that work in unison to apply this stopping function.

The main components include the brake pedal, brake booster, master cylinder, rotor, caliper, and/or drum. In recent years, most automobiles no longer utilize drum brakes but rather the better performing four wheel disc brakes. In fact, on most cars today there are also Anti-Skid Braking Systems (ABS), traction control, and stability control systems that integrate sophisticated control with the traditional foundation brake system for better vehicle stopping and control performance.

Although there are fasteners and fastener-like components is all of components, this article will explore those found in the caliper, drum brake, booster, and ABS units. These are clearly the most interesting and the ones that often separate the standard fastener supplier from the specialty fastener and component supplier.

The Caliper:

The brake caliper is paired with the rotor and is the part of the system that actually generates the friction to stop or slow the vehicle down. The caliper is essentially a hydraulic clamp. When it is activated, one or more pistons function to push one brake pad against the rotor while pulling the other brake pad into the other side of the rotor. The effect is that of a clamp applying the brake pad's friction material against the front and back side of the rotating rotor. The result is the kinetic energy of the rotor is transformed into heat, which dissipates in the wheel well of the vehicle.

These calipers are, therefore, comprised of two halves. One half, the piston body, houses one or more pistons, which when flooded with brake fluid move forward to push the brake pad into the other side of the rotor. The other half, the bracket, provides a means to hold and move the opposite brake pad into the rotor. These two components are connected to one another by several (usually two) pins, known as the Caliper Pins or Caliper Bolts. There are several different designs utilized by brake manufacturers, but irrespective of the name they are called, they are almost all made by fastener manufacturers in a cold heading process.

Today two primary styles of caliper pin exist, the Collette style and the bolt style. **Figure 1** shows an early Collette style part. It is characterized by the unique application of a flat front bearing surface with an internally threaded cavity. The other end of the part is a round shafted pin. There are also a series of other part features such as upper and lower grooves, flats, and vent channels. **Figure 2** illustrates how the Collette Style Caliper Pin accepts a bolt in the head. It clamps the face of the head against the Caliper Piston Body.

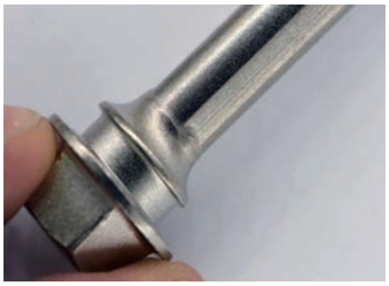


Figure 1: **Example of Colette Style Caliper Pin**

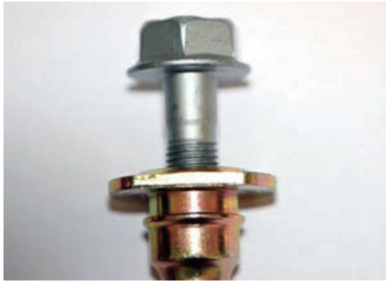


Figure 2: **Bolt and Collette Style Caliper Pin**

These Collette Style pins are complicated and not a good fit for a fastener manufacturer without expertise in multiple blow parts forming, working with close tolerance dimensions and secondary machining. When assembled into the application, the part must rest squarely on the mating contact surface of the Caliper Body. That means that both the Caliper Body and the Caliper Pin possess contact surfaces that are square and flat. On the pin this usually means a secondary machining operation to assure that the top of the head is perfectly flat and perpendicular to the shank. If the brake manufacturer fails to achieve perpendicularity the result will be that the shank centerline is oriented up or down and risks interference with the bore as the caliper slides back and forth. Any interference will result in premature wear of the caliper bore or a condition known as "juttering" where the pin and bore stick together so that the caliper does not freely release when pressure on the brake pedal is lifted.

Most of these parts will possess a groove underneath the head. This groove is to accept the upper rim of a rubber boot. This rubber boot plays a critical role as it prevents moisture and debris from entering the bore which the Caliper Pin slides in. A dimensionally incorrect or groove with sharp edges can result in failure of this protective boot and ultimate failure of the caliper.

The Caliper Pin shank is tight tolerance. As the shank functions as a shaft to guide the sliding action of the caliper, it is intuitive that they must be relatively precise. In many cases the tolerance is just at the edge or tighter than what is practical from the cold heading process. Occasionally, designers require even tighter tolerances and these shanks receive secondary grinding. However, even if the dimensional tolerance is capable right off the header, these shanks often carry challenging straightness and surface finish requirements.

Figure 1 shows a Collette Style Pin with three equally spaced flats on the shank. These flats provide two purposes. First they provide room for grease storage around the assembled Caliper Pin. The grease helps maintain lubrication over the life of the caliper. The other function they provide is a little more difficult to explain. As the pin is assembled into the bore it displaces the air that was previously in this space. Ideally this air would just rush out into the surrounding environment. However, if the assembly takes place too quickly the rubber boot can seal before all of the air is evacuated, either making it difficult to seal the boot or expanding the boot like a balloon. These flats help assist in this evacuation of air.

The second style of headed component is a Caliper Bolt, or design with a drivable head and external threads. The shaft of the part functions in the same fashion as the Collette Style Pin, but the attachment is in a threaded hole on the piston housing side of the caliper rather than to its face. **Figure 3** shows a typical part of this design. All the same features, grooves, flats, tight tolerances, etc. exist on these as well. Again the only real difference is the way in which they are assembled into the caliper.

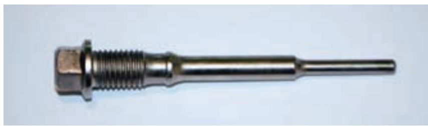


Figure 3: **Example of Caliper Bolt**

Drum Brakes:

Prior to disc brake systems becoming popular, automobiles were equipped with Drum Brakes. In fact, as automotive technology has evolved, automobiles went from four wheel drum brakes to rear wheel drum brakes, to today's more common four wheel disc brakes. Drum Brakes derive their name from the design. Unlike disc brakes which squeeze a rotating disc, Drum Brakes push brake "shoes" against a rotating cast iron drum. Like the disc brake system, these brake shoes are made of friction material which slows down or retards the motion of the drum, thus stopping or slowing the vehicle.

There are a variety of cold headed components that are unique to these assemblies, but perhaps the most interesting is a component that is used in the auto adjustment mechanism. Unlike disc brake pads that are essentially self-adjusting by design until they wear out, brake shoes must be "adjusted" to compensate for the continual loss of friction material from their face. This is accomplished by an auto adjustment mechanism which is normally comprised of a cold headed collar stud with a special toothed configuration in the collar. As the brake shoes wear this toothed collar is rotated (a tooth at a time) causing the ends of the stud to turn or push mating flanges outward that apply steady pressure on the brake shoes.

These adjuster assemblies are normally a combination of several components, but almost always have one or more pieces that are cold headed. **Figure 4** shows one of these Toothed Collar Studs.

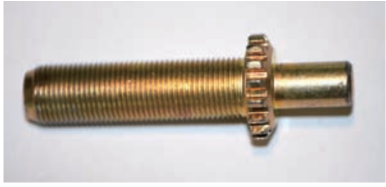


Figure 4: **Example of Drum Brake Adjuster Stud**

Brake Booster:

As vehicles have gotten larger and heavier over the years, it has become difficult to provide enough pressure to the hydraulic system to affect desired braking performance, especially in hard stopping situations. To assist in braking, therefore, many vehicles add a component that provides a power assist to the braking pressure applied when the operator steps on the brake pedal. This brake system component is known as the Brake Booster.

Although newer technology is replacing traditional technology with electronic booster systems, the old standby is a vacuum assisted booster. In these brake system components, a rubber bladder separates two sides of a disc shaped body. Using vacuum drawn from the engine, the pressure exerted by stepping on the brake pedal can be multiplied through a rod or series of rods and transferred into the pressure applied to the Master Cylinder pistons.

These Brake Boosters usually have two clam shell body halves that separate the two chambers formed by the interior diaphragm. These body halves are normally held together by several studs that pass through the body and serve three purposes; 1. To provide an attachment of the booster within the engine compartment of the vehicle (usually on the firewall), 2. To hold the two halves of the body together, and, 3. To provide a mounting point for the Master Cylinder. These double collared studs are sophisticated cold headed components which are often manufactured to very exacting dimensional and geometric tolerances. In fact, the geometric tolerances can be very challenging as perpendicularity, parallelism, and straightness can all be very critical to proper fit, form, and function.

Additionally the input and output rods to these booster systems are cold headed components. These are often long, complex designed parts. Both input and output rods usually require secondary machining for grooves and spherical tips. Input rods normally attach to the brake pedal so that there are additional steps required to develop a flattened configuration with a hole to accept a pin or other connection hardware.

ABS:

The final brake system components we will discuss in this article are Anti-Skid Braking Systems (ABS). Most often, the modulator unit, or part of the system which is able to independently pulse (apply and release) the brakes is also part of the Traction and Stability Control Systems as well. These units are comprised of a motor or motors and a series of solenoid valves that are able to very rapidly open or close based on signals from wheel sensors and a main control unit. This rapid open and closing provides for independent actuation of the brakes at each wheel (on vehicles so equipped). The sensors are able to determine when the wheel is about to imminently lock up allowing for quick brake release and reapplication. This prevents the wheels from locking and the vehicle from going into an uncontrolled skid.

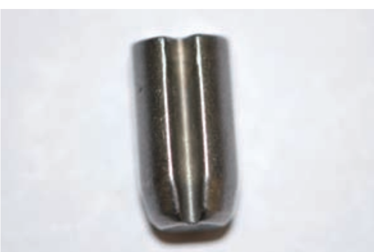


Figure 5: **Example Cold Headed ABS Solenoid**

Like the other components featured in this article, these components utilize a variety of cold headed parts. The ones that are most interesting, however, are the solenoid components. **Figure 5** illustrates what one of these solenoid components looks like. Do not be fooled, what appears to be a relatively simple looking part, is, in fact, an exceptionally difficult cold heading challenge. There are only a few cold heading companies worldwide that have mastered the skills necessary to make these parts.

In summary braking systems provide many unique and interesting challenges for cold heading companies that supply parts to these manufacturers. They normally require high levels of expertise in the cold heading and secondary operation arts. They also require a team that is committed to the highest levels of part engineering and quality. Although they are clearly not for every cold header, those that have mastered the necessary prerequisites and skills should be proud of their accomplishments. ■