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## TERMINOLOGY

### Fatigue Strength or Fatigue Life

In materials science, fatigue is the weakening of a material caused by repeatedly applied loads. Fatigue strength, or fatigue life, describes the range of cyclic stress that can be applied to a material without causing failure due to fatigue. Related is fatigue limit, a value beneath which a material can endure an infinite number of stresses without failure. Steel does have a fatigue limit whereas aluminum does not. Counterintuitively, this means that an aluminum tube will eventually fail no matter how low the cyclic stress remains. To mitigate this, aluminum tubes usually have thicker walls. Thankfully, the stresses involved in cycling are so low compared to industrial scales of stress that a well-designed aluminum frame can last many decades. Titanium, on the other hand, has a fatigue strength and fatigue limit similar to steel alloys.

### Double Butted

Butted tubes have varying wall thicknesses with more material at the ends so that joints remain strong. Meanwhile, the thinner sections in the middle save weight. A double-butted tube has two thicknesses, a triple-butted tube has three, and so on.

### Heat Treating

Heat treating — the controlled application of heat or cold — is used to harden or soften a material. In the case of steel, the application of heat within a specific range hardens the material, making it more durable. But too much heat can produce a brittle material, and too little heat will result in soft steel. Steel tubes are heat treated during the manufacturing process to increase strength. Unlike aluminum alloy frames, steel frames are not heat treated after they are welded or brazed.

### Air Hardening

Some modern steel tubesets are air hardened, meaning that the heat from brazing or welding actually increases the strength of the material at the heat-affected area of the joint after cooling. Reynolds 853 is one example. This allows for thinner tube walls, saving weight and resulting in more damage-resistant steel.

### Stiffness

The scientific measurement of stiffness is called modulus of elasticity. This refers to the degree to which a material can undergo a stress, deform, and return to its original shape after the stress subsides. The larger the number, the stiffer the material. A steel bicycle tube is typically stiffer than a titanium or aluminum tube of the same dimensions. This is why aluminum and titanium tubes are often larger in diameter than their steel counterparts.

### Lugging

Lugged frames are brazed together with either silver or brass filler to fix the tubes inside the lugs.

## VARIANTS

### 4130

As mentioned, 4130 is widely used in bicycle frames. It is a generic term, not a brand name like others we'll discuss. Many bicycle manufacturers have it custom drawn, sometimes internally and/or externally butted, to suit their design needs. It may take many forms and be given many names, such as the "Cobra Kai" tubeset Salsa designed for its Marrakesh, or the "Utilitour" tubeset Marin uses on its Four Corners, but 4130 is the steel most likely to be seen on touring bikes from larger manufacturers.

### Brazing

Brazing uses a filler material with a lower melting temperature than that of the material being joined. Fillet-brazed frames forgo lugs and instead employ sections of filler to create fillets that join the tubes.

### Reynolds

Legendary British brand Reynolds has a long history of producing tubing for bicycles. In 1897, the company was granted a patent for producing butted tubes. In 1934, they debuted the iconic 531 double-butted tubeset. More recently, Reynolds 853 was among the first air-hardening alloys, offering stronger joints and increasing dent and impact resistance. Reynolds is widely used by touring bike manufacturers.

### Tange

When Japanese bicycles like Miyata, Fuji, and Nishiki made a splash in the 1980s, Tange entered the cycling vernacular. But the Japanese tubing maker had been in the cycling business for over 60 years by then and has been producing butted tubing since the 1950s. Their expertise was such that Tom Ritchey sought them out to produce his Logic tubing. To this day, Tange is used by brands like Soma Fabrications.

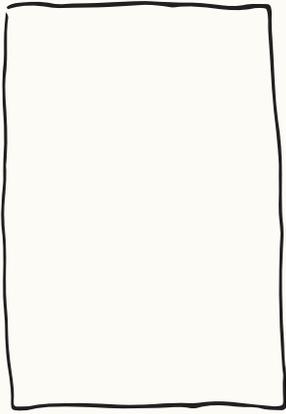
### Columbus

Stalwart Italian tube maker Columbus was founded in 1919 and is still going strong after building its reputation during the era when steel reigned supreme among professional racers. Italian brands like Bianchi, Pinarello, De Rosa, Ciocc, and Colnago have all used tubes from the firm. Columbus currently produces an expansive line of tubesets ranging from the affordable Cromor, through its Niobium line of Spirit, Life, and SL tubing, all the way to its gorgeous XCR stainless steel tubeset.

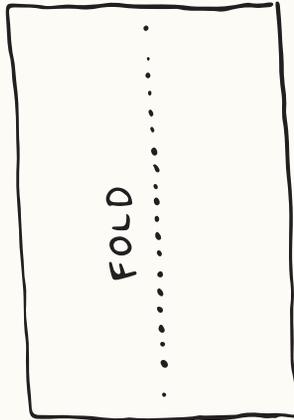
### True Temper

Unfortunately, after many years of making high-quality U.S.-produced steel tubing for bicycles, True Temper phased out its bicycle tubing options at the end of 2016. But because the firm's tubesets were so popular, you may still see them in use, especially if you're looking at the used bicycle market.

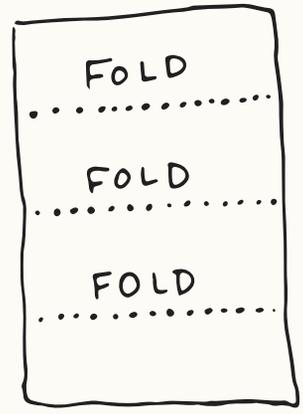
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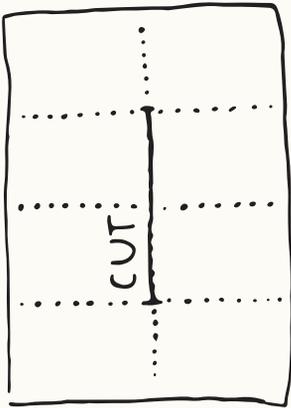
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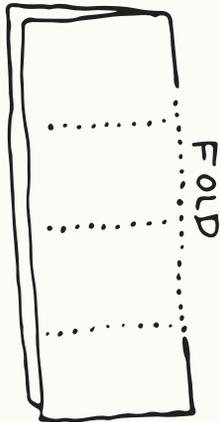
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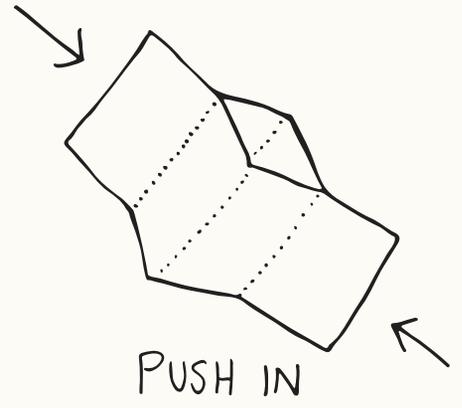
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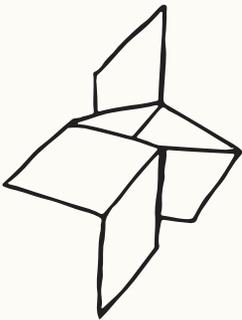
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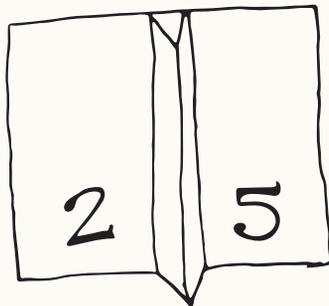


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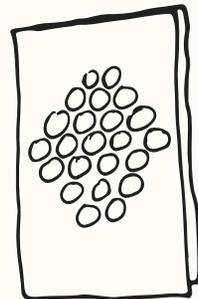
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