

THE CANNONDALE FRAME

At Cannondale, we've looked at bicycling from the cyclist's point of view for years. Now we have built a revolutionary bicycle frame that is ideal for long distance touring, time trailing, and everything in between. Despite a long wheelbase that provides touring stability, the frame is extremely responsive to pedaling due to its remarkable stiffness. This rigidity is achieved through our use of large diameter aluminum alloy tubing, which gives our frame greater resistance to flexing than conventional steel frames. Whether pedaling up a steep hill with loaded panniers, or breaking into a sprint, you'll feel the difference a Cannondale frame makes.

Cannondale cycling performance is available two ways. You can choose our complete Sport/Touring bicycle, the ST-500, equipped with an intelligently selected group of components. Or you can build up your own cycling machine with a Cannondale frameset, the ST-300. For sport riding or long distance touring, any type of recreational road riding, you will find that a Cannondale Sport/Touring bicycle or frameset will add a dimension of excellence you never thought possible.

ABOUT ALUMINUM AND LARGE DIAMETER TUBING

We selected aluminum alloy for our frame only after careful study of the several materials available. Traditional steel tubing has served the cyclist well, but has always meant a compromise. To get the stable ride of a long wheelbase, cyclists have had to put up with a whippy (and often wimpy) frame. As a result, many cyclists are under the misconception that flexibility is desirable in a touring frame. The fact is, however, that the more flexible the frame, the less efficient is each pedal stroke. Energy that should be transmitted to the wheel is wasted flexing the frame, causing a sluggish, tiring ride.

We know that a tourist needs efficient pedaling as much as any other cyclist, so we decided to build a frame that combines touring performance with responsive stiffness. Our aluminum alloy frame has a better strength to weight ratio and is far more resistant to torsional and bending deflection than even the finest steel bicycles. How do we achieve this edge in strength and stiffness? We use large diameter tubing.



To demonstrate how the diameter affects strength and stiffness, let's compare Cannondale tubing to one of the best known, most highly regarded steel bicycle tubes, Reynolds 531.* For this comparison we will use the down tube because it is the keystone of the bicycle frame. The equations and figures we will need are in the following tables:

TABLE 1: Equations for relative strength and relative stiffness

$$\begin{aligned}\text{strength} &= (D^3 - d^3) \times S_y \\ \text{bending stiffness} &= (D^4 - d^4) \times E \\ \text{torsional stiffness} &= (D^4 - d^4) \times G \\ \text{where } D &= \text{outer diameter of the tube} \\ d &= \text{inner diameter of the tube} \\ S_y &= \text{typical yield strength} \\ E &= \text{modulus of elasticity} \\ G &= \text{modulus of rigidity}\end{aligned}$$

*We will use the figures for the butted section after brazing. The overall stiffness of a Reynolds tube will be less than the numbers we will derive because most of the tube has a smaller wall thickness than the butted section.

TABLE 2: Diameters, strength, and stiffness values of two bicycle down tubes.

	Cannondale 6061-T6 aluminum alloy	Reynolds 531 steel* (butted section after brazing)
D	1.5 inches	1.125 inches
d	1.368 inches	1.046 inches
S _y	40,000 psi	89,610 psi
E	10 x 10 ⁶ psi	30 x 10 ⁶ psi
G	4 x 10 ⁶ psi	12 x 10 ⁶ psi

*Based on manufacturer's literature.

Using the strength equation from Table 1 and plugging in the appropriate figures from Table 2, we find that the relative strength for the Cannondale down tube is 32,600, while for the Reynolds 531 down tube it is 25,091. Expressed in ratio form, this is

$\frac{32,600}{25,091}$, which becomes $\frac{1.30}{1}$, or 1.30 to 1.

This means that a Cannondale down tube is 30% stronger than a Reynolds 531 down tube.

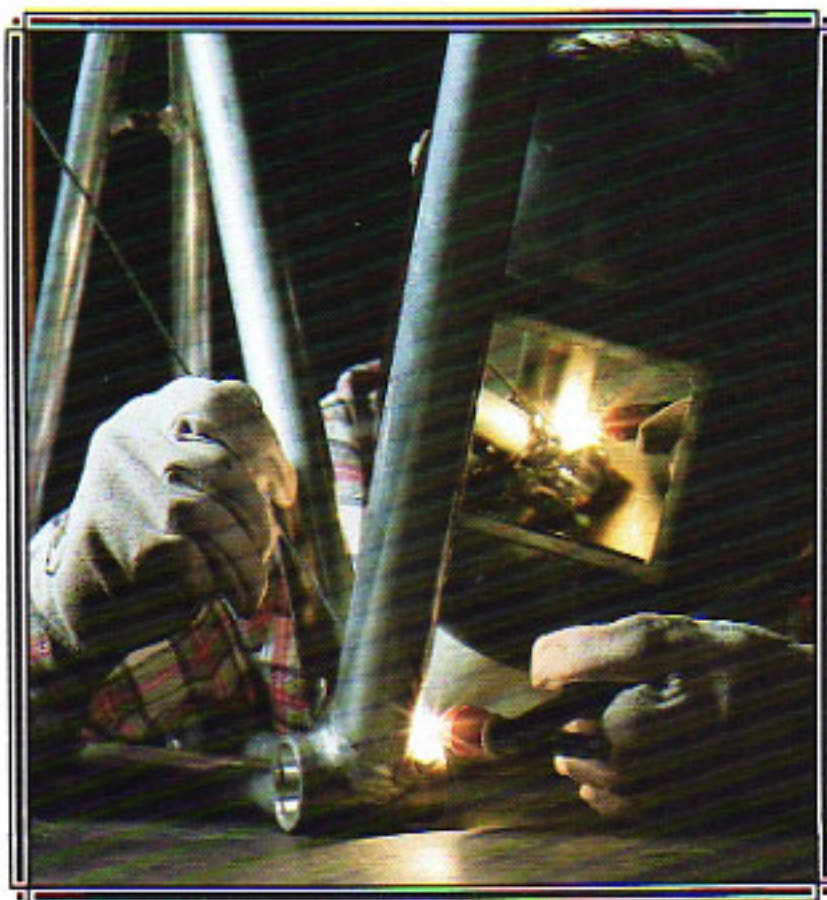
There are two types of stiffness that affect the responsiveness of a bicycle frame: bending deflection and torsional wind-up (twisting). The stiffer the tubing, the more efficient is each pedal stroke because less energy is wasted flexing the frame. Plugging the appropriate figures into the two stiffness equations shows that the relative bending stiffness for the Cannondale down tube is 15.60×10^6 , and that for Reynolds 531 is 12.15×10^6 , while the relative torsional stiffnesses are 6.24×10^6 and 4.86×10^6 . In ratio form for both instances, the Cannondale down tube has a 1.28 to 1 advantage over Reynolds 531; that is, 28% greater stiffness.**

The three equations in Table 1 show that tube diameter has a great effect on strength and stiffness. You can increase the stiffness of a steel frame by making the diameters larger, but then your frame would be far too heavy for practical use. Aluminum provides the optimum balance of strength and stiffness with weight. Our frame weighs in at less than 3.6 pounds, about half a pound lighter than many of the best steel frames.

**In reality the Cannondale tube will be 45% stiffer in torsion than the Reynolds tube due to the thinning of the Reynolds wall in the unbutted section.

FRAME CONSTRUCTION

From the drafting table to your local bike shop, the Cannondale Sport/Touring bicycle is the product of intelligent design and careful craftsmanship. Every step in our production process has been developed to assure that a Cannondale frame represents fine American quality. Construction is performed entirely at our factory in Pennsylvania by trained, highly skilled personnel. They take pride in the quality of their work, so we can be certain each frame meets our strict standards.



Our tubing is precisely mitered to within strict tolerances, then it is securely and accurately fixtured for TIG welding by our trained welders. TIG (Tungsten Inert Gas) welding is the strongest way to join aluminum. It is a sophisticated process using an electrical arc shielded by inert gas that makes clean, strong aluminum welds. The welds on a Cannondale frame are the work of skilled professional craftsmen.



FRAME GEOMETRY

The Cannondale Sport/Touring bicycle frame has been designed to give a versatile combination of touring performance and efficient response to pedaling. We have combined carefully selected geometry with the strength and stiffness properties of large diameter tubing to create a bicycle frame that offers a stable, responsive ride, making it ideal for many types of cycling.

Important Cannondale frame geometry:

Long wheelbase: For a stable ride with or without touring loads.

Long chainstays: Provides ample pannier to heel clearance for loaded touring, dampens road shock, helps to position the rider's weight more evenly over the bicycle.

Low bottom bracket: Keeps the center of gravity closer to the road for a more stable ride.

Oval seatstays: Horizontal major axis increases resistance to side to side deflection. This makes the drive train more efficient and reduces frame sway caused by loaded panniers. While the vertical minor axis allows the rear triangle to flex up and down to dampen road shock. Another Cannondale innovation; patent pending.

TABLE 3: Cannondale ST-300 frame geometry.

Frame Size	19"	21"	23"	25"
Seat Tube Angle	75°	73.5°	73.5°	73.5°
Head Tube Angle	70°	72°	72°	72°
Top Tube Length*	20.5"	21.75"	22.25"	23.25"
Chainstay Length	18"	18"	18"	18"
Fork Rake	2 1/8"	2 1/8"	2 1/8"	2 1/8"
Bottom Bracket Height	10.14"	10.30"	10.44"	10.52"
Wheelbase	40.9"	41.0"	41.6"	42.7"

* center to center

Once all welding is complete, our frames are thoroughly heat treated. To be at its maximum strength, an aluminum alloy must have the proper distribution of the alloying elements. Welding disrupts this distribution by heating only one area of the material. We use a three step heat treating process to restore the proper alloy distribution and give the frame its greatest strength. First the frame must be solution heat treated, which means being placed in an oven and raised to a high temperature. This dissolves the alloying elements, forming a uniform supersaturated solid solution of the aluminum and its alloying elements. Next, the frame, in this supersaturated state, is rapidly cooled in a quench bath to "freeze" the solid solution. Finally, the frame is age hardened by being gently heated again. This allows a controlled, evenly dispersed precipitation of the alloying elements. The entire heat treating process creates a unified structure out of our aluminum alloy frame, and brings it up to its maximum strength.



After being fully assembled and heat treated, each frame is thoroughly cleaned and given an iron phosphate coating, which inhibits corrosion and provides excellent paint adhesion. We then electrostatically apply a thick coat of Dupont Imron polyurethane enamel — the finish used by most custom frame builders — and place each frame in an oven for forced drying. The end result is a beautiful, rich, long-lasting finish that we refuse to cover up with a lot of decorations and decals.

FRAME FITTINGS

The proper fittings substantially increase the function of a frame. The Cannondale ST-300 frame is loaded with the fittings a tourist needs. Shifter and bottle bosses, cable guides, a chain hanger, and rack mounts eliminate the need for clamps that can mar the bicycle's finish and add unnecessary weight. Especially useful to the tourist are two sets of down tube bottle bosses, one on top and one beneath, the preferred location for carrying a fuel bottle.

ST-300 frame fittings:

- Double eyelets on front and rear dropouts.
- Down tube shifter bosses.
- Down tube bottle bosses, over and under.
- Top tube cable guides.
- Self lubricating bottom bracket cable guide.
- Chainstay cable guide.
- Seatstay rack mounts for Cannondale rack.
- Seatstay chain hanger.

SPORT/TOURING COMPONENTS

Every Cannondale Sport/Touring bicycle features a well-matched component package to serve the cycle tourist and recreational rider. The cyclist, whether on a day's outing or a cross-country tour, needs special performance from his bicycle's components. This performance should translate into comfort for the rider, low maintenance, durability, and a wide range of touring gears. For this reason, we have selected our components carefully, making sealed bearings, 18 speeds, a leather touring saddle, Randonneur handlebars, responsive brakes, and well-built, sturdy wheels standard on every Cannondale Sport/Touring bicycle. This thoughtful selection is typical of the care we have exercised in building our bicycles. We know you expect nothing less from Cannondale.

SPECIFICATIONS

CANNONDALE SPORT/TOURING BICYCLE

ST-500

RIMS: Wolber/Super Champion Model 58, 27" X 1 1/8," satin anodized aluminum alloy

HUBS: Suntour sealed bearing, small flange, quick-release

SPOKES: 14 gauge, three-cross

TIRES: Specialized Touring, 27" X 1 1/8," presta valves

FRONT DERAILLEUR: Suntour Cyclone Mark II, special clamp

REAR DERAILLEUR: Suntour Superbe Tech-L, sealed mechanism

SHIFTERS: Suntour Superbe, down tube, "braze-on" type

CRANKSET: SR Super Apex triple, cold forged, 48/44/28

PEDALS: SR SP100BL, black cage, Christophe toe clips & straps

FREEWHEEL: Suntour New Winner, 13-15-18-21-25-30

CHAIN: Sedisport, narrow, silver

BRAKES: New Gran-Compe 500, sidepull, with NGC 200 levers

HANDLEBAR: Belleri, Randonneur, anodized, engraved

STEM: SR Apex, forged

HEADSET: Tange Levin Standard

SEATPOST: SR Laprade, one bolt micro-adjust

SEAT: Avocet Touring I, leather covered

FORK: Tange 124B, chrome moly, double eyelets, fully sloping crown.

FRAME: ST-300

COLORS: blue, charcoal, red

SIZES: 19", 21", 23", 25"

The Cannondale Sport/Touring bicycle is the first of a fine line of quality bicycles designed to offer the cyclist uncompromising performance. Watch for new Cannondale bicycle models in the future.

We've selected only the most dedicated, service oriented dealers to stock our bicycle. Take a closer look at the Cannondale Sport/Touring bicycle at your local authorized Cannondale dealer. We think you will be impressed.



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