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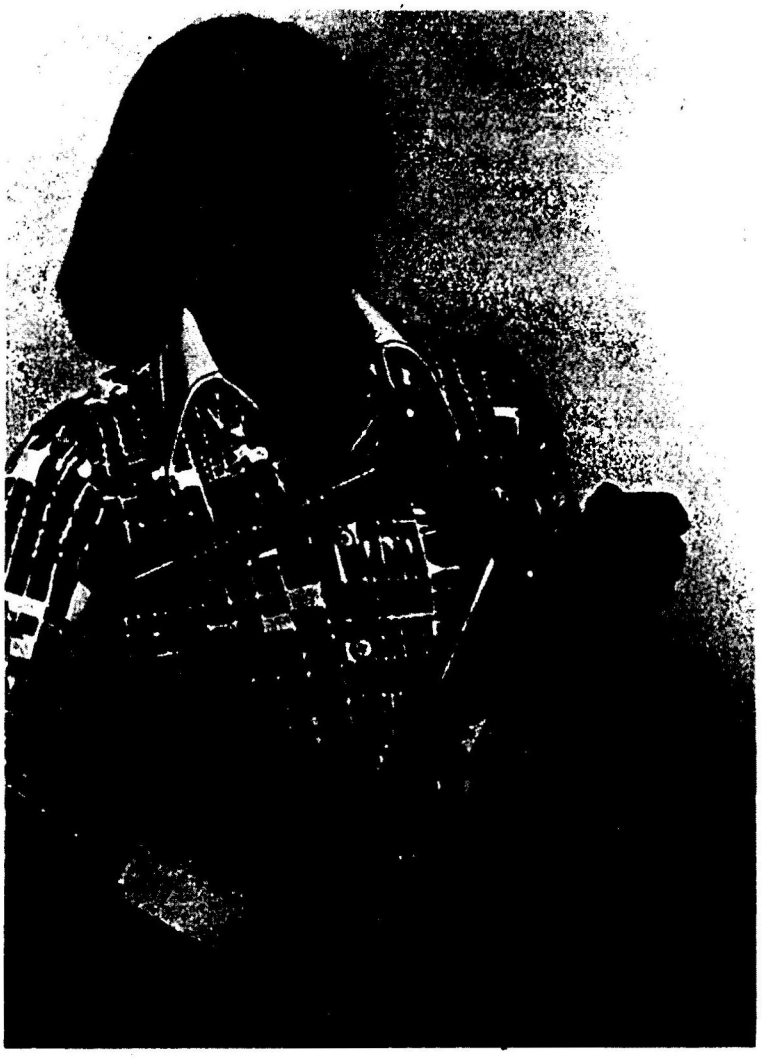


Titanium bike originator, Barry Harvey, shows tough titanium investment casting that attaches the titanium front wheel fork to the titanium frame.

First titanium bicycle combines extrusions, investment castings

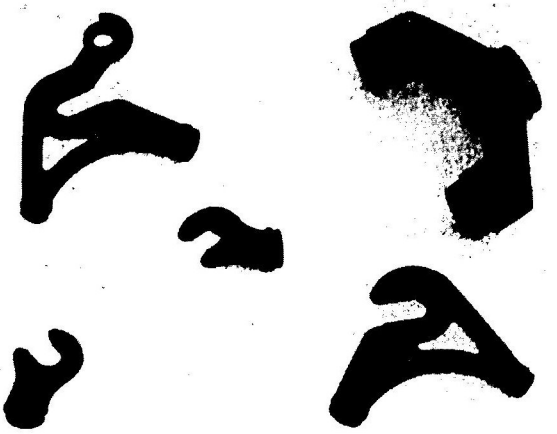
Inertia is one of a bicycle-rider's biggest enemies. An ultra-light weight bike frame made of titanium is taking much of the inertia-overcoming effort out of bicycling. By **SCHOLER BANGS**, *Western Editor*

If that fabulous Texas department store should advertise His and Her titanium bicycles at $1250 a copy, it will come as no surprise to—

- Lovely Sherrie Lane on the cover of this issue about to take off on a prototype bike;
- Barry Harvey, eight times Canadian bike racing champion, who conceived it;
- Teledyne Linair, a prestigious Gardena, California aerospace division of Teledyne, Inc., convinced that a well-heeled bicycle market is ready for this titanium framed Rolls-Royce of recreational cycling, which they have engineered and have in production; or
- TiTech International, Inc. of Pomona, California, first to investment-cast titanium bicycle parts for stress points of a steel-strong frame that can be finger-lifted with ease.

Harvey, sales manager for Teledyne Linair's surprise venture into

This dropout is one of two load-carrying titanium investment castings that mount the rear wheel and drive assembly to the frame.



Three titanium investment castings are the first to be designed for a bicycle. The largest casting carries the front wheel fork; large slotted castings attach rear frame tubing to rear wheel drive assembly; smaller slotted castings carry the front wheel and fit in bike's tubular front fork.

bicycle manufacturing, is quick to point out that while a Rolls-Royce-ish price tag is in sight with all sorts of costly accessories attached to the frame, it needn't be frightening to thousands who are expected to become buyers for sheer riding excitement (as well as the status symbol) of the first titanium production bike.

"Buyers who choose to go Bently-class, rather than Rolls, should be able to acquire a Titan bike, trade-named by dropping the 'ium' from 'titanium', for $1250", he said. All components, as well as the basic frame, will be titanium.

"Actually, for the budget-minded, the price may rock-bottom at around $750, although for a model retailing at $1250 we are certain of having orders for all we can build."

Harvey isn't playing price tag games. The basic frame will retail for around $400.

"What some 200 dealers add to the bare-bones frame is what will determine the final pricing," he said. "But, just as the lower-priced Bentley automobile still is a Rolls-Royce except for the grille, every Titan will still have the feather-weight titanium frame."

Small, oddly shaped investment castings of titanium seen in TiTech International's plant were the tip-off to bikes made of the queen metal of the aerospace industry.

"They're dropouts; wheel-holding castings that attach to an all-titanium bicycle frame," said E. A. Williams, TiTech's president. "And this slightly larger one is a fork crown, mating front wheel forks to the main frame. They are the first titanium castings ever made for the bicycle manufacturing industry."

Williams foresees a growing demand for TiTech's bicycle castings, as well as for other precision parts made from other manufacturers for add-ons to the distinctive titanium frame. Forgings for high-strength pedal cranks, lightweight die cast gearshift fingertip levers, die cast or forged brake arms, forged or cast chain drive sprocket wheels, and wheel rims fashioned from precision-extruded aluminum.

TiTech's president had done some market investigations of his own before committing his investment casting section to the bicycle project.

He told us:

"The recreational market for quality bicycles is terrific! Bicycling is the sudden 'in thing' for the wealthy as well as those who think twice before filling the tanks of their cars with gasoline at today's prices."

Harvey says of his own marketing survey:

"We are seeing, easily, an annual market for 25,000 bikes priced at $700 or more, and it will be ready-made for invasion by the titanium bicycle."

How much of such a market will go titanium remains to be seen.

Harvey said Teledyne Linair is tooled to turn out 2500 Titans in what's left of this year; up to 4000 in '75.

"Naturally it is going to take a bit of doing to persuade even knowledgeable cycling enthusiasts that this is the one they've been waiting for," he said.

"A bicycle that you can lift with one finger suggests a fine, delicate, hand-crafted racer for a smooth board oval and skilled rider.

"It may be hard to imagine, at first, that a comparably lightweight titanium bike, with a casual owner on its pedals, can be ridden all out over rough country roads that would ruin its racing counterpart.

"Bike owners are educated to steel and its historic strength in what they've been buying up to now.

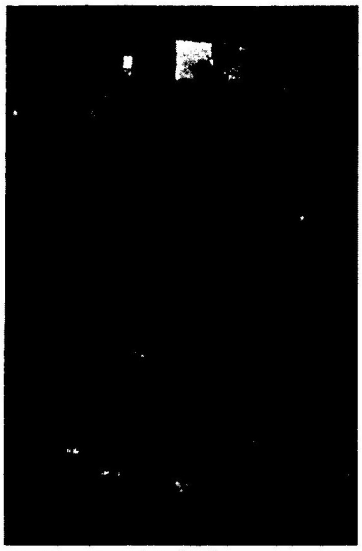
"Now they will be told that a cycle of little more than half the weight of a conventional, and made of an aerospace metal that has only half the density of steel, will be every bit as rugged, if not more so, and a dream to ride.

"But, we don't expect to have to do much persuading after just one trial ride!"

I took mine on the Titan "proving ground", the asphalt-paved parking lot strip in front of Teledyne Linair's plant and on the prototype Sherrie Lane had just ridden

Titanium investment castings start out here, in the mold room of TiTech International. Wax patterns for parts are removed from steel injection dies such as these to be assembled in trees.

Titanium looks like this before it is finally cast into parts for the bicycle. This pure titanium sponge, imported from U.S.S.R., is melted in a complex electric vacuum furnace, designed by TiTech.



Mold material is broken away from cooled casting trees. Parts will be cut from risers for finish machining and tumble polishing. Scrap will be remelted.

for her photo.

I had to wait until another Titan had been put through a series of sprints and "panic" stops, straight ahead and in wrenching left and right turns.

"Our design engineer," Harvey said. "He's testing front fork rigidity for a racing model we're about to ship to Japan's racing champion, Shimpei Okajima, at Osaka. We're sending another to Belgium for evaluation by the world's professional cyclo-cross champion."

My foot was secure in its right pedal stirrup and in a momentary pause I recalled the strenuous pump-to-get-going of the lumbering bike of my youth and newspaper route.

The next thing I knew, the end of the test strip was racing toward me!

"Where's the damned brake!"

I found a lever someplace and squeezed. Everything came to a sudden stop! Gently, ever so, I wheeled about and back to the spot where my education in titanium and low inertia to overcome had begun.

It produced new appreciation of what had happened when an aerospace fitting and tubing assembly manufacturer, searching for something different and consumer marketable to produce, decided upon a titanium bicycle.

British born and now 34, Harvey had won eight gold and three silver medals for Canadian cycling championships by the time he was 32.

At 15, he was an apprentice toolmaker in Leicester, England, at 21 a turbine rotor blades planning engineer with Rolls-Royce, at 26 assistant to the program manager of Canadair Limited in Canada, and on his way to cycling distinction as Canada's team captain for the 1969 world championships in Czechoslovakia.

A year later he jumped the border, left Canadair for a job in Torrance, California with Martin Marietta Titanium Division.

All that lovely, super-exotic, light as a Spring fancy, titanium tubing! What it could do for a bicycle!

So, he designed, built and raced the world's first bicycle with an all-titanium frame, enthusiastically formed a limited partnership with a titanium-minded friend, built nine more prototypes, and wound up with capital gone and the partnership liquidated.

Titanium's elastic modulus, half that of steel, had been a nemesis through all his designs. Wheel forks and frame would bend and weave when the going got rough.

And then came Teledyne, itching to turn aerospace skills into consumer product knowhow.

If Harvey would toss in his considerable experience with not quite successful titanium bike designing, its Linair Engineering Division would turn technical handsprings to lick modulus and other problems, to come up with a bicycle that should sell like crazy.

It was enough to lure Harvey away from Martin Marietta and into Teledyne Linair as director of sales and marketing for a brand new titanium bicycle that hadn't yet wheeled its way off the drawing boards.

Teledyne tackled redesign of Harvey's titanium bike as if it were a new jet fighter or missile.

Titanium tubing for the frame was plastered with strain gauges for stress and deflection testing.

A computer and aircraft landing gear stress engineer were put to

work to analyze design criteria and propose a front wheel fork that would keep its rigidity and alignment through all the wrenching and twisting "test pilots" could give it.

ASTM Type 338 titanium finally was selected for the frame. Unalloyed, it would keep a tensile strength of approximately 70,000 psi even after welding.

For years bicycle manufacturers had held to diameter standards for their steel frame tubing, and accessory makers had standardized, similarly, in making fittings that would match frame tubing dimensions.

Teledyne scrapped the standards and designed with bigger tube diameters. Where a 1.125 inch diameter steel tube had been conventional a 1.1250 inch titanium tube diameter was used; a 1.125 inch titanium diameter where steel tubing would have been 1 inch.

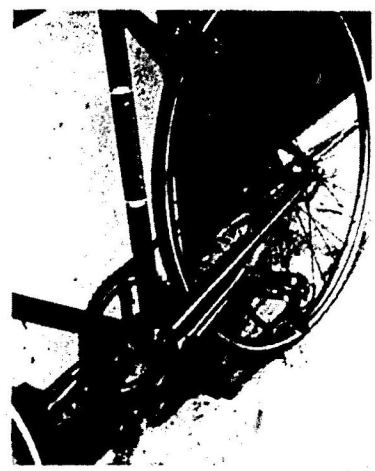
At points where standard accessories would have to be clamped to frame members Teledyne swadged over-size tubing and then regained tubular strength by inserting tubing. At high flexure points additional stiffness was achieved by inserting liners.

Teledyne took a new design approach with the titanium wheel mount "dropout" castings produced by TiTech. They are inserted in the circular ends of fork tubes and weld-secured. They uniformly distribute wheel impact loads as well as twisting and bending stresses to the fork tubing.

In addition to locations where large-diameter frame tubes were reduced to receive clamped-on accessories, for added strength an external sleeve was added to the frame's seat tube.

Frame design gives the Titan an unusually short wheelbase and exceptional maneuverability without loss of hands-off ride stability.

Harvey told us, "As finally engineered, the Titan frame gives a high modulus of resilience combined with low modulus of elasticity. It overcomes earlier springing and bending problems and simulates desirable steel frame characteristics without the harshness of the steel frame ride. Despite its shorter wheelbase, the Titan's light weight and frame resilience give ride comfort probably unequaled for a touring bicycle, however rough the road surface or steep the hills."



With few exceptions, components added to the frame of the Titan are Dura-Ace *line of aluminum cold forgings produced by the forging division of Shimano Group, Osaka, Japan. Dominant forgings seen in these two photos are handlebar brake levers, front and rear wheel caliper brake assemblies, wheel hubs, handlebar stem, seat post, foot pedal crank arms, chain sprockets, derailleur gearshift assembly, and gearshift finger lever.*

Quick-release levers on wheel hubs, designed for easy wheel changes, are steel forgings, also produced by Shimano. Titan's handlebar is made from extruded aluminum tubing made by a Shimano affiliate.

Titan's titanium frame, complete with forks, bottom bracket and head-set weighs only 3.6 lbs., 40 percent less than a conventional steel bicycle frame-set.

Completely assembled, the Titan still is a lightweight, tipping the scales at 17.5 lbs. compared to 21 lbs. for a high quality steel 'cycle. A racing model Titan weighs, assembled, 11.5 lbs. compared to 16 lbs. for a steel frame racer.

Future Titans probably will be even lighter as Teledyne pursues aerospace-type weight saving for components beyond the bare frame.

Already 38.4 percent weight reduction has been gained by replacing a hardened steel bottom bracket spindle, weighing .308 lbs., with a titanium alloy spindle weighing only 0.190 lbs.

Even though such weight reductions are relatively small, they become attractive with the possibility that titanium invesment castings, successfully demonstrated by Ti-Tech's wheel mounts for the Titan, might replace machined steel bicycle components. PM

For more information about investment casting capabilities, write in no. 444 on Data Retrieval Card.