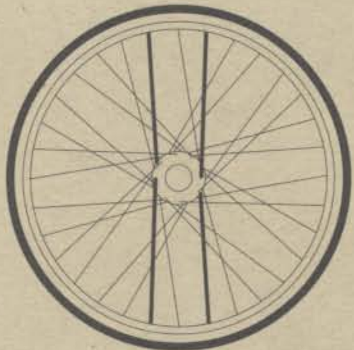
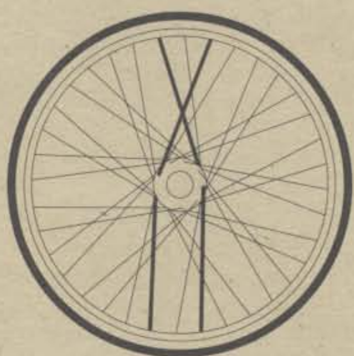
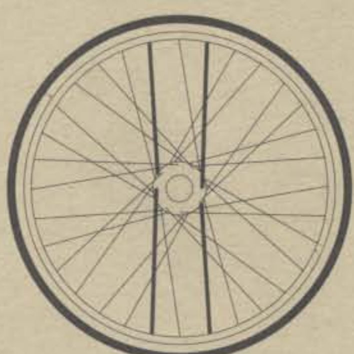
20th
ANNIVERSARY





SUTHERLAND'S

HANDBOOK FOR BICYCLE MECHANICS



Sixth Edition

SUTHERLAND PUBLICATIONS

SUTHERLAND'S
HANDBOOK FOR BICYCLE MECHANICS

Sixth Edition
SUTHERLAND PUBLICATIONS

Howard Sutherland, Leigh Moorhouse, Mark Huie, John S. Allen, Leonard Rubin, Don Milberger, Ed Colaianni, John Porter Hart

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INTRODUCTION

The sixth edition of Sutherland's Handbook for Bicycle Mechanics is a vital resource for people in the bicycle industry as well as for enthusiasts. Many sources, considerable traveling, measuring, and studying all contributed to gathering the details that make the information contained here so valuable. Bike'alog, the computer database of parts, was used at every stage of research. Most of the data in this handbook can not be found anywhere else.

Mountain bikes have, in the years since the last edition, become the major category of bicycles. Front suspension is covered here for the first time. And, throughout this edition, we added information to reflect the enormous number of new components available. The spoke lengths chapter has always been an important part of this handbook. Therefore, along with adding all the new rims and hubs we could get, we revised the layout to make it easier to find the right lengths.

As new rims and hubs are produced far more frequently than we can revise this book, we wanted a quicker way to supply new information to our customers. Through SpokeMaster, a computer program for calculating spoke lengths which is distributed with Bike'alog, we are now able to rapidly convey information. Every month that we have new rim and hub data, we supply the listings to Bike'alog who add them to SpokeMaster. We are exploring more ways to distribute the data in this book via computer.

Leigh Moorhouse has been the driving force behind this edition of the Handbook. The newly designed page layout with two colors are just some of the more visible contributions she has made. Incorporating insights gained from bike shop experience, printing and graphic production, she made sure that the information in the book is more accessible. This book wouldn't be here without her. Leigh also hired Mark Huie. Fresh from Avenue Cyclery in San Francisco and using his extensive hands-on knowledge of the industry as well as his conceptual grasp of bicycle parts, Mark wrote insightful and accurate descriptions of new bicycle parts and their repairs. And as if that weren't enough, Leigh and Mark willingly dove into piles of catalogs and reams of paper to extract the key bits of information that help mechanics get the job done.

John S. Allen has the remarkable ability to picture in his head how a very complex piece of equipment works and then write clearly about it. The 7-speed internal hub chapter illustrates this gift and we all appreciate his work.

Ron Sutfin of United Bicycle Institute has made his resources available whenever we needed them. He opened up the beautifully equipped shop at United Bicycle Institute to me, where I researched the previous edition. I am deeply grateful for his help and expertise.

John Barnett of Barnett's Bicycle Institute, once again, generously supplied detailed suggestions for improving the book. He knows, sometimes better than we do, what is needed. His book, Barnett's Manual - Analysis and Procedures for Bicycle Mechanics, is a valuable companion to this one.

Most importantly, I want to thank Nancy, my wife, for keeping the home fires burning while I was so engrossed in producing this edition of the Handbook.

In previous editions, prepaid reply cards were included to encourage readers' suggestions and comments. I incorporated as many of the past suggestions as I could, and certainly appreciate all the ideas I received. In this edition, I am again including prepaid reply cards and I look forward to hearing from anyone with suggestions for improving the Handbook. Questions and comments are always welcome.

I suggest you buy two copies of *Sutherland's Handbook*, one for the shop area and one for the order desk. You will probably be referring to them often. Many shops buy additional copies to resell to enthusiasts. Take some time to thumb through the book and become familiar with it. I know you will find it useful.

Howard Sutherland, April 1995

With thanks to the following people and organizations:

My father, William H. Sutherland, my mother, Betsy Sutherland and special thanks to my wife, Nancy Linn Sutherland, and children, Kory and Andrew Sutherland.

A Bicycle Odyssey, Sausalito
Albert Eisentraut
Alesa, Belgium
Alison Sosna
Amber Cycle Sports
Andy Nilon
Angle Lake Cyclery, Seattle
Araya, Japan
Ariel Trading Company
Ashby Avenue Bike Doctor, Berkeley
Ashland Cycle Sport
Ay Caramba Burritos
Berkeley Cycle
Bernie Smith
Bernie Wuthrich – Weinmann Sports, Inc.
Beverly Anderson
Bicycle Exchange, Cambridge
Bicycle Parts Pacific
Bicycle Repair Collective, Cambridge
Bicycle Technologies International
Bike'alog
Bill Horner
Bontrager Cycles
Branciforte Bicycles, Santa Cruz
Brian Grieger
Brian Williams
California Bike & Board, Danville
Campagnolo, Italy
Campagnolo, USA
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Chris Allen
Chris Lewis
Conrad Oho
Corso Distributing, Inc.
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Dan Cole
Dan Smith – Rock Shox
Dave Wilson, New Zealand
David Berstein & Jeff Sussman – Tioga
Don Milberger
Doug Hooten
Doug Milliken
Dr. Richard Allen - Chiropractor
El Cerrito Cyclery
Eli Silberberger – Shimano America
Euro Asia Imports
Faber's, San Jose
Fat Tire Trading Post, Fairfax
FIR, Italy
Frank Berto
Fred Willkie
Gary Fisher
Gita Sporting Goods, Ltd.
Glenn Reichwald – Campagnolo, USA
Grafton Performance
Greg Middleton
Guy-King Cycle Group
Hank and Frank's Bicycles, Oakland
Hi-E Engineering
Hillary Male
Howard Feldenkreis
Howie Cohen
International Bicycle Center,
J&B Importers West
Jack Kelly – Zeus
James Hargett
Jane Bernard
Jeff Gilmore
Jeff Tofler – Fisher Mountain Bikes
Jevelot
Jim Merz – Specialized Bicycle
Joe Breeze
John Porter
John Uthe
Josh Deetz
Karim Cycles, Berkeley
Karin Koller
Kathy Campbell
Kevin Moran
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Kip Byers
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Lee Chi
Lee Katz
Leigh Moorhouse
Linne Gravestock
Lois Rosner
Louise Lacy
Mark Huie
Marti Sacks – Sun Metal Products
Mavic, France
Mel Pinto Imports
Melanie M. Lewallen
Merry Sales
Michael Teller
Mike DaSilva
Missing Link Bicycle Shop, Berkeley
Naoto Kosugi – Dia-Compe, Inc.
Nationwide Cycleparts Supply Ltd.
Olivia Perish
Oschner
Pamela Maes
Performance Bike Shop, San Rafael
Pete Mason – Berkeley Cycle
Peter Ubelacker – Magura USA Corp.
Phil Wood & Co.
Pt. Reyes Bikes
Quality Bicycle Imports
Richard Goodwin, Mitch Clinton – Mavic
Richard McKown
Rick Caldwell
Rick Comar
Riggio Imports & Exports
Rigida, France
Ritchey, U.S.A.
Riteway Products
Ruby Wiles
Russ Okawa – Sachs Bicycle Components
Sachs-Huret, Inc.
Sal Corso – Stuyvesant Bicycle
Sam & Rick's, Oakland
Sam Patterson – SRAM Corp. (Grip Shift)
Seattle Bicycle Supply
Sharp Bicycles, Richmond
Shaw's Lightweight Bicycles, Santa Clara
Shimano, USA
Shook-Kingsberry Corp. (American Classic)
Silverio Perez
Siskiyou Cyclery
Skip Gathman
Solano Cyclery
Steve Brown
Susan McCallister
Ten Speed Drive Imports
The Components Company
The Square Wheel, Berkeley
Thorsten Schaette
Tim Snyder
Todson, Inc.
Tom Ruth
Tom Warner
Trek Bicycle Corp. (Matrix)
Troxel West
Tye Gribb – Klein Bicycle Corporation
United Bicycle Institute
Velo-Sport, Berkeley
Virginia Villani
Wayne Campbell
West, Duke Spinelli & Eric Chavez
Western States Imports
Wheelsmith Fabrications
Wilderness Trail Bikes
William Clauson – Bikelab (Hügi)
Winkel Wheel
Winning Wheels Bicycle Shop, Pacific Grove
Wolber, France
ZAR, International (FIR)

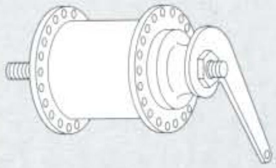
and Jerry Mathis – Collins-Phillips Tool Corporation, Escondido, CA (for producing a custom vernier perimeter tape that made possible much more accurate rim measurement)

and everyone who wrote to us with suggestions.

CONTENTS

CONTENTS

CONTENTS



BICYCLE MANUFACTURERS — PARTIAL LIST

Manufacturer	Country
A.A. Vittorio	USA
A. Singer	France
A.D. Stump	USA
AMF	USA
AMP	USA
Aegis	USA
Action-tec	USA
Adams	Canada
Al Drysdale	USA
Alan Shorter	USA, Japan
Allegro	Switzerland
Alpinestars	Taiwan
American	USA
American Eagle	Japan
American Flyer	USA
Answer	USA
Argos	Great Britain
Armstrong	Great Britain
Arrow	USA
Astra	France
Atala	Italy
Atalaisienne	Italy
Atlantica	Italy
Austro-Daimler	Austria
Automoto	France
Azuki	Taiwan, Japan
Balance	Taiwan, USA
Barracuda	Taiwan, USA
Basso	Italy, USA
Batavus	Netherlands
Bates	Great Britain
Battle	USA
Beacon	France, USA, Japan
Benotto	Mexico, Italy, Panama
Bertin	France, Belgium
Bevilacqua	Italy
Bianchi	Italy, Japan, Taiwan
Bike Friday	USA
Bilenky	USA
Bob Jackson	Great Britain
Bontrager	USA
Bottecchia	Italy
Boulder	USA
Branca	Italy
Breeze	USA
Brew	USA
Bridgestone	Japan
Brodie	USA
Browning	Belgium
Bruce Gordon	USA
Bruni	USA
BSA	Great Britain
Burley	USA
Burtin	Switzerland
C. Hansen	USA
C. Itoh	Japan, Taiwan, Korea
CCM	Canada
CNC	France
CW	USA
Cal-Facet	USA
Caloi	Brazil
Camera	Italy
Campania	Japan
Cannondale	USA
Carbon Frames	USA
Carlton	Great Britain
Carnielli	Italy
Casati	Italy
Castellon	USA
Cavaliri-Milani	Italy
Cazenave	France
Celo Europa	Italy
Centurion	Japan, Taiwan
Cesare Rizzato	Italy
Chaplait	France
Chater Lea	Great Britain
Cherry	USA
Chiorda	Italy
Chris Chance	USA
Cignal	Taiwan
Cilo	Switzerland
Cinelli	Italy
Cinzia	Italy
Ciocc	Italy
City Road	Great Britain
Clark Kent	USA
Claude Butler	Great Britain
Cleveland Welding	USA
Colin Lang	Great Britain, USA
Colnago	Italy
Colner	Italy
Colson	USA
Columbia	USA
Columbine	USA
Co-motion	USA
Concord	Japan, Korea
Condor	Great Britain, Mexico
Conejo	USA
Coppi	Italy
Corex	Korea
Corso	Italy
Counterpoint	USA
Coventry Eagle	Great Britain
Crescent	Sweden, USA
Cross-Trak	USA
Curve	USA
Curtlo	USA
DBS	Norway
Dave Moulton	USA
Dahon	USA
Davidson	USA
Dawes	Great Britain
Dean	USA
de Gribaldy	France
DeKerf	Canada
Delacroix	France
De Rosa	Italy
Diamond Back	Taiwan, Japan
Drake	Great Britain, India
Ducheron	France
Dunelt	Great Britain
Durango	USA
Durkopp	Germany
Easy Racer	USA
Easy Rider	Taiwan
E Clipse	USA
Eddy Merckx	Italy, Belgium, Japan, Great Britain, France, Switzerland
Eisentraut	USA
Elgin	USA
Ellis Briggs	Great Britain
Ellison	USA
Emery Mfg. Co.	USA
Emperor	Japan
Erickson	USA
Eroba	Netherlands
Evans Products Co.	USA
Excelsior	USA
F.H. Grubb	Great Britain
F.W. Evans	Great Britain
FTW	USA
Falcon	Great Britain
Fat Chance	USA
Fat City	USA
Fattic	USA
Favorit	Czechoslovakia
Ferrare	Japan
Ficelle	Belgium
Fiorelli	Italy
Firestone	USA
Fisher	USA
Fish Lips	USA
Flandria	Belgium
Foes Fab	USA
Follis	France
Free Spirit (Sears)	USA, Taiwan
Freddie	
Frejus	Italy
Fuji	Japan, Taiwan
Funk	USA
G. Genet	France
Galmozzi	Italy
Garlatti	Italy
Geoffrey Butler	Great Britain
George Stratton	Great Britain
Giant	Taiwan
Gilliott	Great Britain
Giordana	Italy
Gios	Italy
Gitane	France
Gottfried	France
Graftek-Exxon	USA
Grandis	Italy
Green	USA
Grove Innovations	USA
GT	Taiwan, USA
Guerciotti	Italy
H. France	Argentina
Hannebrink	USA
Haro	Taiwan, USA
Harry Powers	USA
Harry Quinn	Great Britain
Hawthorne	Great Britain
Hedstrom	USA
Hercules	Great Britain
Hetchins	Great Britain
Hiawatha	USA
Holdsworth	Great Britain
Holland B.	USA
Holland J.	USA
Hooker	USA
Huffy (Huffman)	USA, Great Britain
Hugh Porter	Great Britain
Hujask	USA
Humber	Great Britain
Hurlow	Great Britain
Hutch	USA
Ibis	USA
Ideor	Italy
Indian	USA, Great Britain
Iron Horse	USA
Italvega	Italy
Itoh	Japan
Iver Johnson	USA
Iverson	USA
J.C. Penney	USA
J.C. Higgins (Sears)	USA, Austria
J.P. Weigle	
JRJ	Great Britain
Jack Taylor	Great Britain
Jaguar	Germany
James	Great Britain
Jamis	USA
Jet	Japan
Jeunet	France
Juvela	Switzerland
KHS	Japan, Taiwan
Kabuki	Japan
Kalkhoff	Germany
Kenstar	Taiwan
Kent	Taiwan
Kessels	Belgium
Kestral	Japan
King	Taiwan
Klein	USA
Kobe	Japan, Hong Kong
Kolo	USA
Kona	USA
Kuwahara	Japan
La Fleche	Canada
LaPierre	France
Lambert	Great Britain
La Moure	USA
Land Shark	USA
Legacy	
Legnano	Italy, Argentina
Lejeune	France
Lemond	Italy, USA
Liberia	France
Lighthouse	USA
Lightning	USA
Limited	USA
Linear	USA
Lippy	USA
Litespeed	USA
Liyang	Taiwan
Look	France
Lotus	Japan
Lucifer	Switzerland
Lupo	Italy
Lygie	Italy
MKM	Great Britain
MX Sport	Taiwan
Macalu	Taiwan, USA
Magneet	Netherlands
Main d'Or	Belgium
Maino	Italy
Mako	Japan
Mantis	USA
Maplewood	USA
Marin	USA
Marinoni	Canada
Maruishi	Japan
Maserati	Italy
Masi (Alberto)	Italy
Masi (Faliero)	USA
Matsuri	Japan
McMahon	USA
Medici	USA
Melton	USA
Meral	France
Mercian	Great Britain
Mercier	France
Merida	Taiwan
Merlin	Great Britain
Merz	USA
Miele	Canada
Mikkelson	USA
Miyata	Japan
Monarch	Sweden
Monark	Brazil
Mondia	Switzerland
Mondu	Germany
Mongoose	USA, Taiwan
Monolith	USA
Montague	Taiwan
Montgomery Ward	USA, Japan, Taiwan
Moots	USA
Morales	USA
Moser	Italy
Mossberg	USA
Motobecane	France, Taiwan
Moulton	Great Britain
Mountain Cycle	USA
Mountain Goat	USA
Mt. Shasta	USA
Mundo Cycle	Brazil
Murray	USA
Nashbar	USA
Nevil Cycles	USA
Nishiki	Japan
Nobilette	USA
Norco	Canada
Norman	Great Britain
Norman Fayh	Great Britain
Novara	Taiwan
Nuke Proof	USA
Ochsner	Switzerland
Ollis	France
Olmo	Italy
One-Off	USA
Orly	France
Otis Guy	USA
Paletti	Italy
Pan World	Belgium
Panasonic	Japan
Paragon	USA
Parkpre	Taiwan
Pashley	Great Britain
Passoni	Italy
Pennine Cycles	Great Britain
Performance	USA
Peter Mooney	USA
Peugeot	France
Phillips	Great Britain
Picchio	Italy
Pierce Arrow	USA
Pinarello	Italy
Pinto	France
Piscean	Taiwan
Plum	Belgium
Plume Vainqueur	Belgium
Pogliaghi	Italy
Powercurve	Taiwan
Presto	Netherlands
Proflex	Taiwan
Proteus	USA
Puch	Austria
Quantum	USA
Quattro Assi	Italy
Raleigh	Great Britain, Japan, Holland, USA, Taiwan
Ralph Ray	USA
Rambler	USA
Rampar	Taiwan
Ranger	USA, Great Britain
Rans	USA
Rapido	Czechoslovakia
Rauler	Italy
Rebike	USA
Redline	USA
Regina Sport	France
Rene Herse	France
Rensho/Cyclone	Japan
Research Dynamics	Taiwan
Retro-Tec	USA
REW Reynolds	Great Britain
Rhygin	USA
Rickert	Germany
Rigi	Italy
RIH	Netherlands
Ritchey	USA
Roadmaster	USA
Robert Meyers	USA
Roberts	Great Britain
Robin Hood	Great Britain
Rock Lobster	USA
Rocky Mountain	USA
Rodriguez	USA
Rollfast	USA
Romic	USA
Ron Cooper	Great Britain
Ron Kitching	Great Britain
Rosignolli	Italy
Ross	USA
Rossin	Italy
Royal Crown	Great Britain
Royal Enfield	Great Britain
Royce Union	Italy, Japan
Rudge	Great Britain
Ryan	USA
S.P. Systems	USA
SR	Japan
Saint Tropez	Taiwan
Salsa	USA
Samurai	Japan
Santa Cruz Mtn. Bikes	USA
Santana	USA
Schauff	Germany
Schroeder	Denmark
Schwartz	Switzerland
Schwinn	USA, Japan, Taiwan
Manufacturer	Country
Scott	USA
Sears	USA, Austria, China, France
Sekai	Japan, Taiwan
Senator	Japan
Sentinel	USA
Serotta	USA
Shelby Flyer	USA
Shimano (pre-1954)	Japan
Shogun	Japan
Simonchini	Italy
Singele	Italy
Skyway	USA
Slingshot	USA
Softride	USA
Solex	France
Soma	Japan
Southern Cross	Great Britain
Spectra	USA
Spectrum	USA
Speedwell	Great Britain
Starnord	France
Steelman	USA
Stelber Cycle Corp.	USA
Stella	France
Sterling	China
Stevenson	USA
Steyr	Austria
Stinsmen	USA
Stowe	USA
Strawberry	USA
Suburban Machinery	USA
Suchia	Japan
Superia	Belgium
Sutter	France
Swiss Army	Switzerland
Syncros	Canada
Sycip	USA
T.M. Cycles	
Takara	Japan
Tech	
Teledyne Titan	USA
Terrot	France
Terry	USA, Taiwan, Japan
Terry Grimes	USA
Thruster	Taiwan, China
Ti Cycles	USA
Ti-Cranium	USA
Tigra	Switzerland
Titan	USA
Titus	USA
Tommasini	Italy
Tommaso	Italy
Torelli	Italy
Torpado	Italy
Torque Titanium	USA
Trek	USA
Trimble	USA
Triumph	Great Britain
Turner Suspension	USA
Umberto Dei	Italy
Unic Sport	France, Belgium
Unikap	Netherlands
Univega	Japan, Taiwan, Italy
Urago	France
Vainqueur	Luxemburg
Ventana	USA
Ventura	Taiwan
Victor	USA
Viking	Great Britain
Viner	Italy
Viscount	Great Britain
Vista	USA
Vita Sprint	France
Volkscycle	Japan
Vulcan	Great Britain
Waterford	USA
Western Auto	USA
Wheeler	Taiwan
Wilderness Trail Bikes	USA
Windsor	Great Britain
Windsor	Mexico
Witcomb	Great Britain
Wojcik	USA
Woodrup	Great Britain
Worksman	USA
Wynn	USA
Yale	USA
Yamaguchi	USA
Yeti	USA
Yokota	Japan
Zebrakenko	Japan
Zephyr	
Zeus	Spain
Zinn	USA
Zipp	USA

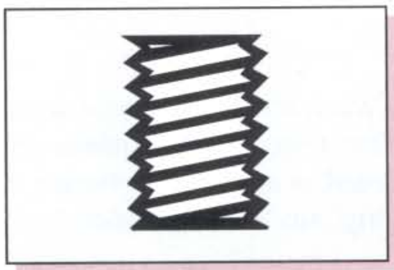
HOW TO USE THIS BOOK

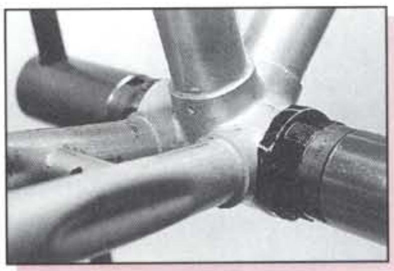
How the Handbook is organized.

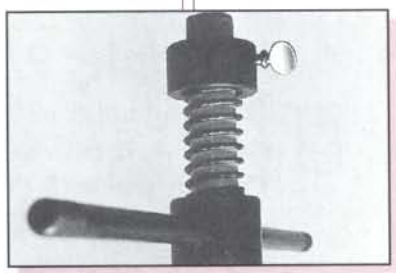
The chapters in this handbook are organized beginning at the pedals where the force is applied by the rider and continuing chapter by chapter to follow the force as it moves through the bicycle. This means that parts that work together are close to each other in the book. The pedals are attached to the crank, the crank is attached to the bottom bracket, and so on. Understanding that this is the order the chapters are in will also help you find your way around the book.

A contents page is at the beginning of each chapter. This contents page gives an overview of what is in the chapter as well as directions to find related items that may be found in other chapters.

The Appendix contains ISO standards, torque settings, conversion charts, as well as formulas, an index, and gearing charts.







HOW TO USE THIS BOOK

SYMBOLS

These symbols will be used to help you find the information you are looking for.

Ball Sizes

Thread Sizes

➔ Things to watch for; helpful information

ID The easiest way to identify a part

THREAD MEASURING

Example: 9/16" x 20 TPI

The first number refers to the nominal diameter of the male part. When actually measured, as in **Figure A**, it is frequently slightly undersize. The second number refers to the **Number of Threads per Inch (TPI)** or the **number of millimeters per thread** as measured in **Figure B** with a thread pitch gauge. Threads must be clean when measuring. Any rocking motion back and forth indicates an incorrect match.

In the past, the angle that threads were cut led to confusion. ***(See Thread Standards in the Appendix.)*** In modern bicycles this is not a problem.

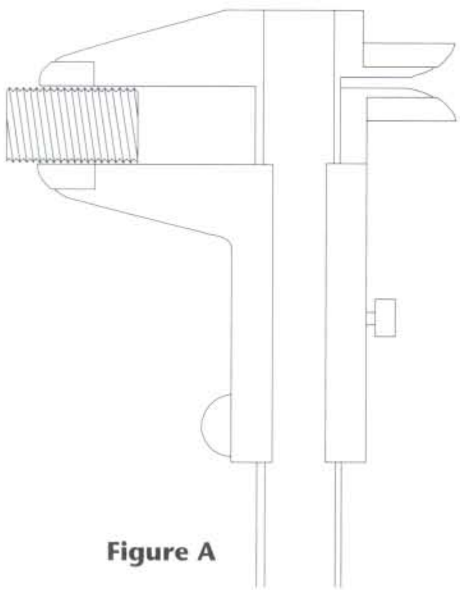


Figure A

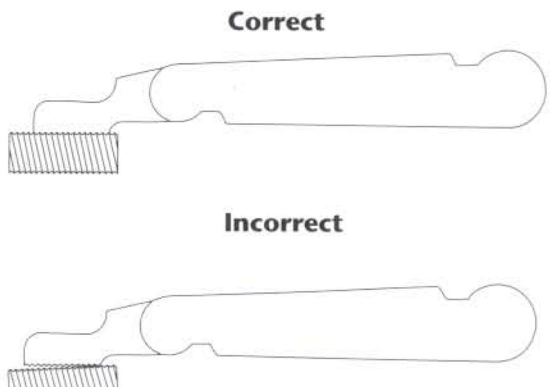


Figure B

NATIONALITY OF PARTS

Parts will be listed as English, French, Italian, Swiss, U.S., or Austrian to show the standard used in cutting the thread or the size of the part. Manufacturers, however, do not always use their national standard and different sizes are used instead. For this reason, Raleigh and Schwinn will be given their own categories in the chart below.

→ Country of origin does not necessarily indicate the national standard for a part. For instance, French bicycles that were exported to the U.S. on a large scale used English freewheel threads (BSC).

COUNTRY	STANDARD USED	COUNTRY	STANDARD USED
Australia	English	Japan	English, JIS, U.S.[3]
Austria	English, Austrian	Mexico	Italian
Belgium	English, some French	Netherlands	English
Canada	English	Norway	English
Denmark	English	Raleigh	English unless listed separately
Great Britain	English[1]	Schwinn	English unless listed separately
Finland	English	Sweden	English
France [2]	French (old) – English or ISO is current	Switzerland	French unless listed separately
Germany	English	Taiwan	English
India	English	United States	U.S., English
Italy	Italian		

1 Please note exceptions under Bottom Brackets and Headsets Chapters.

2 Used Swiss standard in bottom bracket briefly in late 1970's through early 1980's.

3 The Japan Industrial Standard(JIS) is based on the English standard(BSC). Where JIS is different or no English standard exists we will point out the JIS standard. Japanese bikes imported to the United States are either U.S. standard or English standard. Generally, if it has an Ashtabula (one-piece) crank, it is U.S. standard; if it has a three-piece crank, it is English standard.

STANDARDS

Confusion over thread sizes and interchangeability of parts used to be far worse than it is today. For example, matching bottom bracket threads on modern bicycles is not the problem it once was. However, when working on older bikes, it is important to know a little of the history of standards so problems can be avoided.

STANDARDS (CONT'D)

National Standards

In fact, there are standards. But there are so many of them. Back when American bicycles were sold in the U.S., French bicycles in France, Italian bicycles in Italy, and English bicycles most everywhere else . . . national standards worked most of the time. In the early 1970's, the demand for high-quality lightweight bicycles brought bicycles from all over the world to the U.S., and this is when the confusion began.

Currently, there is the Japan Industrial Standard or JIS. Since many of today's Asian components come from Japan or did until recently, they are made to JIS standard. Many of the JIS standards are based on the English standard so when there is no JIS standard listed in this book, refer to the English standard.

De Facto Standards

In addition to national and international standards, there are **de facto** standards. Sizes for many BMX bikes, for example, are based on the Schwinn sizes because when BMX first began, Schwinn components were the most durable. The marketplace determined the standard. A similar situation used to exist for the high-quality road bike market. Because Campagnolo has been used by elite riders for years, a company making parts for this market has needed to make them interchangeable with "Campy." This led to a Campagnolo standard.

A third de facto standard now exists in drive train components: the Shimano standard.

International Standards

Manufacturers, distributors, and cyclists from various countries met in Geneva over a period of years and came up with standards for the **International Standards Organization (ISO).**

The **ISO** is an international agency, a meeting ground for representatives of national standards organizations such as the U.S. American National Standards Institute. The **ISO** attempts to standardize dimensions, markings, and safety requirements to increase compatibility, help international trade, and reduce product hazards. Standards are introduced slowly to avoid disruptions in trade.

The **ISO** tries to make new, standardized equipment work as often as possible with existing equipment. For this reason, despite the trend elsewhere towards metric standards, many of the **ISO** bicycle standards are based on English measurements. **ISO** thread form is slightly different from English, but parts are still compatible. Axle threads, wrench flats, and the like, which require the use of standard tools in manufacturing or servicing, are metric in the new **ISO** standards.

Throughout this edition, we have included the **ISO** standards along with the various national standards. In addition, more detailed specifications are included in the Appendix.

To sum up, standards exist; although they are never as comprehensive as we would like them to be, having different sets of standards is better than not having any standards at all.

MATERIALS

Working on bicycles requires some basic knowledge of metals and their characteristics. Contrary to the current use of the word in the bicycle trade, alloy does not mean aluminum, but rather indicates a mixture of metals. An alloy is generally a base metal such as steel or aluminum with relatively small percentages of alloying metals that impart desired characteristics to the base metal; these include strength, hardness, wear resistance, machinability, and corrosion resistance. The characteristics of a metal can be changed further by heat treating and/or work hardening.

Aluminum: Pure aluminum is a soft, weak metal with very good corrosion resistance. To be used for bicycle parts, it is alloyed with other metals to increase its strength and make it heat treatable. As this alloying degrades the corrosion resistance, most aluminum parts are anodized to protect against corrosion. Generally this coating is clear, although black and other colors are used.

Steel: The most common steel used on bicycles is carbon steel, which ranges in carbon content from a few tenths of a percent in some frame tubes to about one percent in springs. Generally, the higher the carbon content, the stronger the steel. By adding small amounts of other metals such as chromium, molybdenum, or manganese, much stronger steel can be produced. These alloys are generally found in higher quality frame tubes.

Exotic Materials

Most of the exotic materials bicycle frames are made with require very skilled labor, often in special environments. These frames need only minimal preparation at the shop.

Titanium: Pure titanium is a light, flexible metal. For bicycle use, it is alloyed with other metals, usually aluminum and vanadium, to increase its strength and durability. This alloying also increases the hardness of the metal, making it more difficult to work with. When working with titanium, you will need to have your tools sharpened often.

Carbon Fiber: Carbon fiber is made from strands of monocrystalline carbon atoms. It is strongest in tension; carbon fiber strands can be strengthened in other directions depending on how the fibers are oriented. Carbon fibers need to be held together in a 'matrix', which is usually made from resin. Carbon fiber can be weakened by small cuts or holes, the same way a piece of tough plastic can be torn once a small notch has been cut into it. Leave cutting and drilling to the manufacturers.

Aermet 100: Though Aermet 100 is a type of steel, it is an especially hard metal. **Do not attempt any cutting operations on it.** However, Aermet 100 is mostly used for frame tubing only and not for drop-outs, lugs, or the bottom bracket shell, so conventional cutting methods and tools can be used except on the tubing itself.

Metal matrix composites are a class of materials and cannot easily be lumped together. Be careful though, most metal matrix composites have very hard materials added to them that can dull cutting tools quickly.

→ ***Beryllium*** dust is extremely toxic. Therefore, beryllium should not be cut, milled, or tapped except in special environments not generally available to bicycle shops.

MATERIALS (CONT'D)

Heat Treating

Most steel can be hardened by a variation of two general techniques: **tempering** and **case hardening**.

Tempering: **High carbon steel, and many steel and aluminum alloys may be tempered**. In this process, the material is heated to a specific temperature and then quenched to harden it. The parts are held at another lower temperature for an appropriate length of time to lower the internal stresses and draw back the hardness to the desired point. This leaves the part uniformly hard throughout.

Case Hardening: **Case hardening can be used on low carbon steel**, which generally cannot be tempered by the process of heat treating. Case hardening loads the surface of the part with a material, usually carbon, that will allow the surface to become quite hard while leaving the core unhardened. This is desirable to give a hard-wearing surface and a nonbrittle body. Case hardening also involves heating and quenching.

Work Hardening

Another method of hardening, sometimes unintentional, is by work hardening. Bending, pounding, or manipulating the metal causes it to harden and become more brittle. This can be demonstrated by putting a sharp bend in a piece of wire and then attempting to straighten it. The bent part obviously has hardened and will not straighten to its original form. This characteristic makes it difficult to properly straighten a bent fork blade, because the bent section is now harder than the unbent section.

Annealing

Annealing is the process of softening metal by heating it close to its melting point and slowly cooling. This also helps relieve internal stresses in the metal and allow alloying elements (or impurities) to redistribute over a slighter larger volume.

CUTTING OPERATIONS

The tool used to work a material should be significantly harder than the material itself or the tool will wear quickly and not last very long. Because most tools found in bicycle shops were designed for use with steel frames, they may be inadequate for use with harder materials. ***(Please see Exotic Materials on page 0-5 for notes on titanium, carbon fiber, Aermet 100, metal matrix composites and beryllium.)***

Tool Steel

Cutting tools that are intended to cut steel are made of a special class of steel called tool steel. Tool steels may be either **high carbon** or **alloy steel**. Alloy steels are generally called **high-speed steel**, as they retain their edges at the temperature generated by high-speed cutting. Carbon steel tools are less expensive than high-speed steel and are generally quite adequate for thread cutting, reaming, and milling when the job is done by hand. The greater cost of high-speed steel is justified by increased durability when driven by a power tool. Drill bits for cutting steel should always

CUTTING OPERATIONS (CONT'D)

be high-speed, as they will surely be used with a power drill. Regardless of the material used, all metal cutting tools have delicate, brittle cutting edges that are easily damaged by misuse. Many more cutting tools are broken than worn out. Do not throw them together in a box or a drawer.

→ Lubrication and Cooling

When using cutting tools, both the tool and the piece to be cut must be properly lubricated and cooled with cutting oil. Most metal-cutting done on bicycles is in steel or aluminum. For best results in steel, use a high-sulfur base cutting oil available from hardware stores. It is also adequate for aluminum. Motor oil, bicycle oil, WD 40, or yesterday's coffee will not do in a pinch! You will dull your tools and do an inferior job unless you use the right cutting oil in the right quantity. Dabbing a little oil somewhere on the tool or work before cutting is a waste of time. The heat and friction are at the cutting edges. **Keep them flooded with cutting oil throughout the operation.**

→ Sharpening

Even under the best conditions, cutting tools get dull. Mechanics throw razor blades away after a few shaves, but expect a tap to cut steel forever. It will, of course, but only if you get it resharpened before it gets so dull that it breaks off in a hole. Quality drills, taps, dies, mills, reamers, and the like can all be resharpened at a fraction of their replacement cost! When the tools don't seem to cut as cleanly and effortlessly as they did when new, look in the Yellow Pages under "Grinding—Precision and Production." Most large cities will have at least one shop that can do this type of work.

Drilling

Probably the most common metal-cutting operation is drilling. Like other power-cutting operations, it requires eye protection and lubrication. The two lips on the end of the drill do all the cutting and should be kept flooded with cutting oil. The point between these lips is a small chisel that does not have a sharp edge and must be forced into the work. When drilling larger-diameter holes, you will find it much faster and easier to drill a pilot hole equal in size to the chisel edge on the larger drill. All drills, even when properly sharpened, make a hole larger than the drill bit by a small percentage. When improperly sharpened, this error may become quite large and the hole may not be round. Drilling with a dull bit causes overheating of the work, the bit, the motor, and the operator. The undue friction can cause the walls of the hole to become work hardened, which may lead to tap breakage if you attempt to thread the hole.

Thread Cutting

1. It is important that the hole or shaft size be appropriate for the tap or die being used. ***(For tap drill sizes for common fasteners, see Appendix, page 17-6.)***
2. If the tool is required to remove too much material, it will bind and possibly break. If too little material is removed, the thread will not be strong enough. In reality, the thread profile is never as sharp as the drawing on page 17-12. The strength of a thread is not improved significantly by exceeding 60% of the theoretical thread height pictured in the drawing.

CUTTING OPERATIONS (CONT'D)

3. Since all the cutting is done by the first few threads of the tap or die, **these edges must be flooded with cutting oil during the threading operation**. Failure to adequately lubricate these edges will result in rapid dulling of the tool, and torn and ragged threads in the work.

4. When threading, the tool should be reversed periodically to break the chip that is formed by the cutting edge. When threading a deep, small-diameter hole such as the rear axle adjuster in a drop-out, the tap should be backed out completely and chips removed from the tool to prevent binding and breaking. When cutting large-diameter fine-pitch threads such as bottom brackets and steerer tubes, the cutting tool must be accurately aligned with the work. **A die stock with an accurate guide must be used on steerer tubes and a piloted double tap set must be used on bottom brackets to assure proper alignment of the bearing races and minimize tool wear or breakage.** It is important to use the proper tap handle or die stock and rotate evenly with both hands to prevent side thrust, which may result in broken tools and ruined work.

Thread Chasing

Thread chasing is distinct from tapping in that it is not cutting threads, but is reforming damaged threads. Taps and dies designed for cutting threads may be used for this purpose as well as cheaper tools that are adequate only for chasing. While it may seem to be a much easier job, use care, and flood with cutting oil as in thread cutting. Most bottom bracket "thread chasers" have little or no pilot, making it difficult to align the tool with the hole. When chasing right-hand threaded bottom bracket threads with a pilotless tap, use a lockring threaded onto the tool to help judge straightness.

Milling (Facing) and Reaming

The ends of the head tube and bottom bracket must be cut accurately so that they are parallel. Facing assures alignment of the bearing races and freedom from binding. The head tube must also be reamed so that the pressed bearing races will fit into the head tube properly. Facing and reaming operations are done with special cutters made for the job. As with other cutting operations, the tools must be sharp and well flooded with the proper cutting oil. **Do not reverse the cutting direction when reaming or milling as this may cause the cutting edge to chip.** Generally, the face of the tube should be milled until the tool is cutting all the way around the hole.

Grinding

Grinding may be used on any steel. It may be used on hardened steel, as normal cutting tools will not work. Grinding is a hazardous operation, requiring guards, eye protection, and proper technique. Grinding wheels must be sharpened and formed with a "wheel dresser" to get good results. **Do not attempt to grind nonferrous metals such as aluminum or brass!** Use a file or power sander for these soft metals or they will clog the pores of the grinding wheel.

CUTTING OPERATIONS (CONT'D)

Filing and Sawing

These methods of metal cutting have a very important detail in common: they are generally done without lubrication. Always use top quality files and saw blades; their increased life makes them well worth the purchase price. Select the proper grade or teeth per inch for the material to be cut. Use fine teeth close together for steel or thin material, use larger teeth further apart for aluminum or thick material. At least two teeth should be in contact with the work at all times. Cut away from your body using a smooth slow stroke. **Release pressure on the back stroke to protect the edges of the teeth.** Files should be cleared of chips after a few strokes to prevent clogging, which affects speed of cutting and the quality of the job.

FITS AND TOLERANCES

Parts that are meant to be assembled together must be designed to fit each other. The desired degree of tightness of the fit and the size of the parts determine the **tolerance** or amount of variation permitted on dimensions or surfaces of the parts. On threaded parts, the pitch of the threads and the length of the engagement must also be considered.

Unfortunately, poor quality control in manufacturing can alter the results of even the best designs. Many of the "interchangeable" bicycle parts are so poorly made that to get a good fit, several "identical" parts must be tried. This shortcoming applies to some of the best known and most expensive components in the industry. Measuring a sample of bottom bracket components showed that several of the major Japanese manufacturers hold very good tolerances, but they are the exception. It is fortunate that bicycles are forgiving machines due to their simplicity, flexibility, and light loading. As bicycles become more important as vehicles for basic transportation or as manufacturers strive for better performance and less weight, let us hope quality control continues to improve.

BEARINGS

Bearing Design

Bearings are used to minimize friction and heating where various parts rub against each other. The type of bearing used almost exclusively in bicycles is the ball bearing; it is very efficient, easy to fit, and inexpensive. Ball bearings fall into three general classifications which dictate their design and application:

radial bearings which are designed to be loaded at right angles to the axis of the shaft,
thrust bearings which are designed to be loaded on the axis of the shaft, and a combined
radial/thrust bearing which will accept some loading on both axes.

The separate cup, cone, and ball arrangement used on most bicycles is of the radial/thrust type. The major load on bicycle bearings is radial, except for the high thrust load on the headset lower bearing.

Bicycle bearings are lightly loaded and rotate slowly. This allows the use of inexpensive, rather crude bearing surfaces. Except in very expensive components, these surfaces are stamped or machined rather than ground true to a fine finish. Grinding would add more to the cost than the minimal decrease in friction can justify.

BEARINGS (CONT'D)

Cartridge or sealed bearings are finding their way into quality bicycle components. These bearings, commonly used in industrial applications, have the balls captured between inner and outer races making up a one-piece unit. (In a normal bicycle bearing, the cups and cones are the races.) These cartridge bearings are very precisely made and may include felt or plastic seals to hold in grease and keep out dirt and water. While this type of bearing is vastly superior, it lacks one important virtue that the cup/cone type bearing does have: it will not tolerate nearly as much misalignment as the cup/cone bearing can (and must). The thin flexible axle and the narrow spool of a standard bicycle hub cannot hold cartridge bearings in alignment. A larger diameter spool is required to keep the **outer** races aligned as the rider imposes both radial and thrust loads on the hub flanges. Similarly, the axle inside the hub must be larger in diameter to keep the **inner** races precisely lined up. Good design can accomplish this without a weight penalty.

BEARING MOUNTINGS

Drop-outs

— A bearing is no better than its mounting.—

The smoothness, efficiency, and longevity of bicycle bearings can usually be improved by refining the mountings found on the average bicycle frame. For general instructions on reaming, tapping, and milling ***(see previous section on cutting operations)***. Procedures for specific bearings follow.

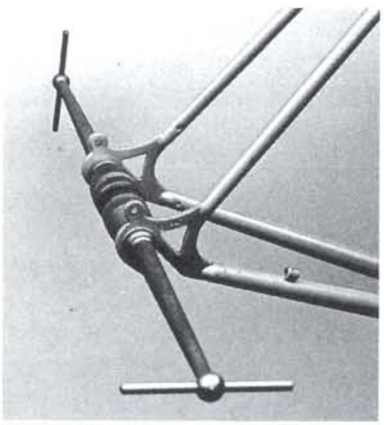


Figure 1

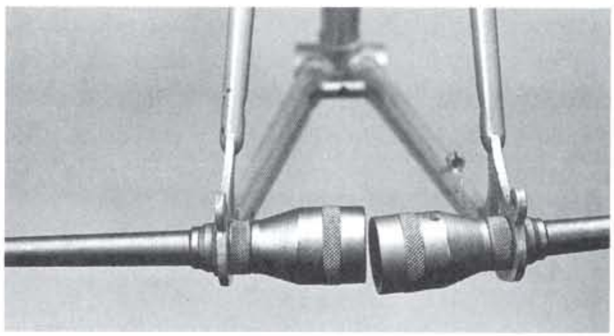


Figure 2

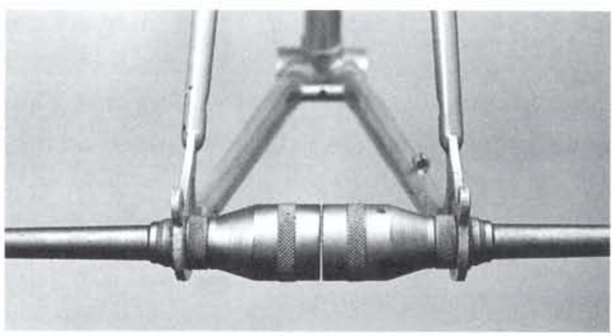


Figure 3

Figure 1. Drop-out alignment gauges installed
Figure 2. Drop-out out of alignment
Figure 3. Drop-out aligned

BEARING MOUNTINGS (CONT'D)

Hubs

The rear drop-outs and fork-ends are an important part of the wheel bearing mounting. If the hub is clamped between non-parallel surfaces, the thin axle will bend and misalign the cones. Drop-out alignment gauges are made by Campagnolo, Park, and VAR to check and correct the alignment and spacing of drop-outs. ***(See Figures 1, 2, and 3.)*** These tools are a combination gauge and lever for bending the drop-outs into alignment. Use these tools to align only steel frames not aluminum or carbon fiber. **(NOTE: Most mountain bike and road bike rear drop-outs must be properly spaced and re-aligned for new 8-speed wheels.)**

Head Tube

The headset bearing cups seat in the ends of the head tube. The inside of the tube must be accurately reamed for a press fit and the ends of the tube must be milled parallel to align the cups. Bicycle Research Products, Campagnolo, Park Tool, VAR, and Zeus make tools which will do both of these operations; some head tools also serve as a press to install the cups. As shown ***(see Figure 4)***, the head tool has a T-shaped handle, a flat milling cutter, and a reamer mounted on a threaded rod. The rod is inserted in the head tube, and a centering cone, a spring, and a star nut are installed at the other end of the tube. The nut should be tightened to compress the spring about halfway. Flood the work area with cutting oil and rotate the tool clockwise, looking down on the handle. **Do not reverse direction** as this may cause the tool steel cutting edges to chip. As the tool turns, the reamer will go into the tube until the milling cutter contacts the tube face, ***(see Figure 5)***. More spring tension may be needed at this point. Further rotation will cut the face of the tube at precisely 90° to its axis. Continue cutting until there is bright metal all the way around the tube. (It may be necessary to remove the tool to check this.) After one end of the tube is finished, repeat the procedure for the other end. After both ends are done, clean the metal chips and cutting oil from the tube. The tool may be used to press the cups into the head tube. A centering thrust washer is installed between the reamer and the bearing cup, as shown ***(see Figure 6)***. The centering cone and spring are not used in this operation. Make sure the cups start straight, then turn the handle until they are pressed tight against the tube ends, ***(see Figure 7)***.

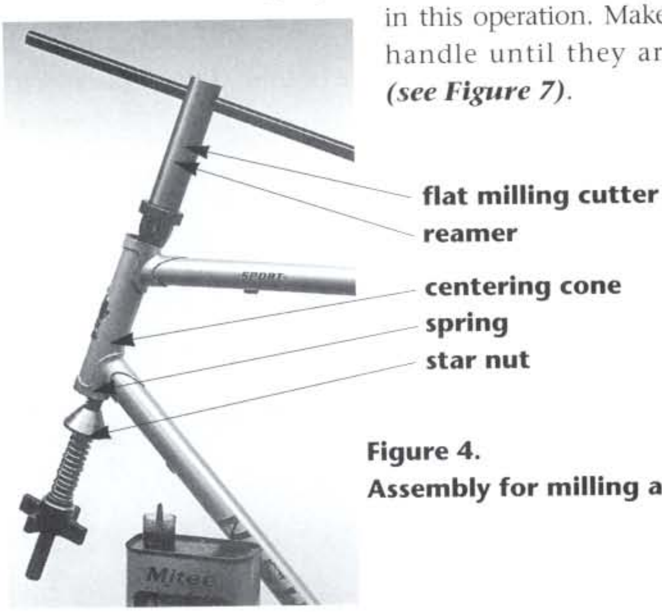


Figure 4.
Assembly for milling and reaming head tube

Figure 5.
Milling and reaming head tube

BEARING MOUNTINGS (CONT'D)

Figure 6. Head cup press assembly

Figure 7. Installing head cups with press

Steerer Tube

To assure that the threads on the top of the steerer tube are aligned with the tube axis, the die cutting them must be held in a die stock provided with a suitable guide, ***(see Figure 8)***. The top cone of the headset bearing depends on these threads for its alignment. Campagnolo, Hozan, VAR, and Zeus make the proper tools for this job.

Fork Crown

Where the steerer tube enters the fork crown, the diameter of the tube and the top of the crown must be machined to accept the headset bottom cone. This job is best done on a lathe, but an acceptable job may be done with a **crown race cutter** as made by Campagnolo, VAR, or Zeus, as shown ***(see Figure 9)***. The tool is slipped over the steerer tube and the spring compressed to apply downward pressure to the hollow cutter. Using a cutting oil, rotate cutter clockwise until it leaves a complete circle of bright metal on the fork crown. **Do not reverse direction as this may cause the cutting edges to chip.** Clean the fork and drive the bearing cone in place with a hollow slide hammer or a piece of water pipe.

Figure 8. Steerer tube thread cutting

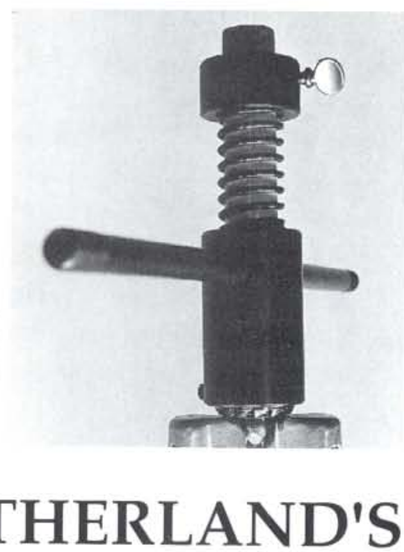


Figure 9. Fork crown race cutting

BEARING MOUNTINGS (CONT'D)

Bottom Bracket

The threads and the face of the bottom bracket shell are the mount for the crank bearing cups. Even if these are accurately machined, they will probably be distorted during the brazing of the frame. Bicycle Research Products, Campagnolo, Park, VAR, and Zeus all make a double tap with an aligning pilot shaft that may be used to correct or cut these threads. Select the proper taps for the bottom bracket to be cut. The adjustable cup is always right-handed threading and the fixed cup varies right- or left-handed threading. To be sure if the fixed cup is right- or left-handed threading, ***(see Bottom Bracket Chapter page 3-2, Thread Sizes)***.

Inspect the inside of the bottom bracket shell to make certain that none of the frame tubes extend into the path of the cutters. If they are in the way, they may damage the taps. Use a file for the slow and tedious job of removing the unwanted tube ends. Install the taps on the handles and insert the pilot shaft through the bottom bracket shell and into the hollow handle. ***(See Figure 10 on the following page.)*** Flood with cutting oil and start both taps into the shell at the same time, ***(see Figure 11)***. Run the taps in until there are enough complete threads to accept the bearing cups. Remove one tap and replace it with the flat facing mill and aluminum pilot, as shown ***(see Figure 12)***. Insert the handle onto the protruding pilot shaft until the cutter is against the shell. Using cutting oil, press in and turn clockwise (**do not reverse**) until the bright metal shows all the way around the end of the shell, ***(see Figure 13)***. Repeat on the other end of the shell, changing taps if required. Clean up chips and oil, including the chips hiding in the chain stays, and install the bottom bracket.

Since Italian threading is the largest diameter, a bottom bracket shell with stripped or badly damaged threads may be made as good as new by converting to Italian standard threading, unless it was already Italian thread. Remove the old threads using a Bicycle Research Product Bottom Bracket reamer on one side of the double tap handle, with a tap matching the threading in the shell threaded into the other side, as shown ***(see Figure 14)***. Using cutting oil, push the reamer into the shell while turning it clockwise until the old threads are removed. Continue turning **clockwise** while pulling the reamer out of the shell. Without removing the tap, replace the reamer with an Italian tap and cut new threads.

Leave the Italian tap in the shell and remove the other tap. Replace this tap with the reamer and repeat the reaming and threading operations. This fast, easy repair saves a ruined frame for the cost of the bearing cups and twenty minutes work. The old spindle may be used, if serviceable.

IN CONCLUSION

Always keep in mind that a bearing may only function if it is rigidly and accurately mounted. The more precise the bearing, the more vulnerable it is to misalignment.

BEARING MOUNTINGS
(CONT'D)

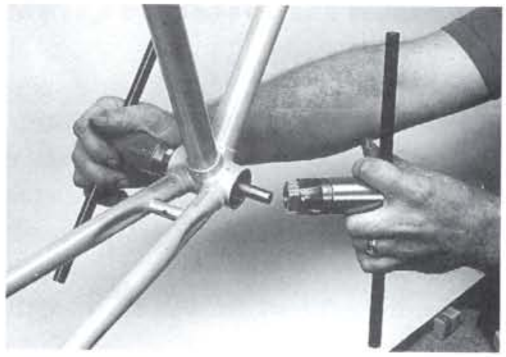


Figure 10.
Installing double-sided tap with aligning shaft

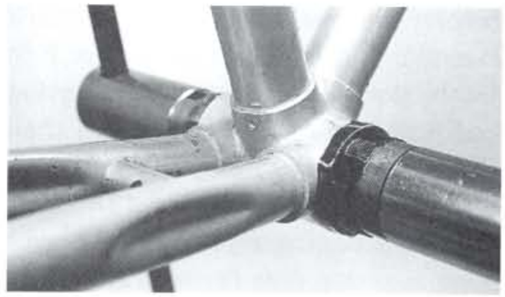


Figure 11.
Starting taps

aluminum pilot
facing mill

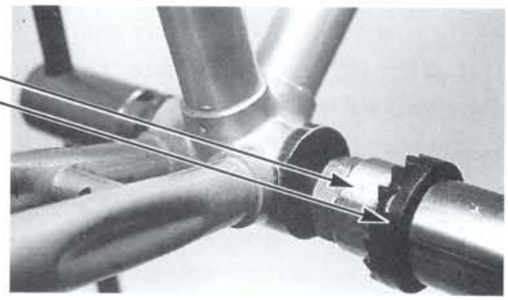


Figure 12.
Milling assembly

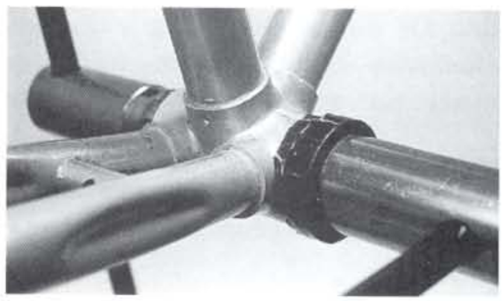


Figure 13.
Milling bottom bracket face

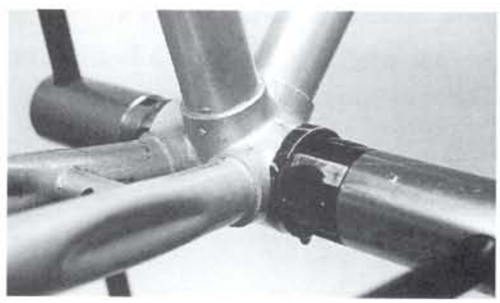


Figure 14.
Reaming bottom bracket shell to remove stripped threads

HAND TOOLS

Screwdrivers, pliers, wrenches, hammers, and various special tools are used in bicycle repair and assembly. The **quantity**, **quality**, and **profitability** of work done in a shop generally matches what is found on the work bench. A good tool is a long term investment, but a poor or missing tool continues to run up expensive labor costs. Screw heads marred by a dull screwdriver, or nuts rounded by an adjustable wrench tell a customer where not to take his or her bike next time.

For a shop doing repair work on all makes of bicycles, many tools are needed. Consider the tools in the following list as a basic minimum for a profitable shop.

WRENCHES

6mm through 17mm Combination
6mm through 17mm Box End
1/4" through 5/8" Combination
13mm through 17mm Cone Wrenches
Pedal Wrench
6", 8", 12", and 16" Adjustable Wrenches
8mm through 15mm Socket Wrenches
Metric Allen Set (1.5mm – 10mm)
Inch-size Allen Set
Torque Wrench

SCREWDRIVERS

1/8" or 3/16" Wide Blade Type
1/4" or 5/16" Wide Blade Type
Various sizes Phillips-type

PLIERS

8" Slip Joint
7" Diagonal Cutter
6" Long Nose
12" Channel Lock
Cable Cutter
SIS Cable Casing Cutter

HAMMERS

1/2 lb. Ball-peen
1 lb. Rubber Mallet

MISCELLANEOUS

Center Punch
Set Pin Punches
5" Bench Vise, 50 lbs. or more in weight
6" (15cm) Calipers
6" (15cm) Machinist Scale
6' (2 Meter) Tape
2.5 Meter Flat Metric Tape

MISCELLANEOUS (CONT'D)

18" Straightedge
Hacksaw
Files
Thread-pitch Gauge, Metric and English
6" Bench Grinder
Grinding Wheel Dresser
Wire Wheel
3/8" Drill and Bits

SPECIAL BICYCLE TOOLS

Every type Freewheel and lockring Tool you can find
Every type Crank Extractor you can find
Shimano Ball Cup Tool
Spoke Wrenches
1/2" and 9/16" left and right Pedal Taps
5, 6, and 10mm Taps
Bottom Bracket Fixed Cup Remover
Bottom Bracket Lockring Tool
Bottom Bracket Peg Spanner
Cotter-pin Press
Cup Press
Third-hand Brake Tool
Fourth-hand Brake Tool
Chainring Tool
Axle Thread Chasers
Various Special Shimano Tools
Chain Rivet Extractor
Drop-out Alignment Tool
Shimano Derailleur Hanger Tool
Alignment Tool
Wheel Dishing Tool
Repair Stand
Truing Stand
Phil Spoke Cutter Threader

HAND TOOLS (CONT'D)

SPECIAL BICYCLE TOOLS–SUSPENSION FORKS

Specialty tools are supplied by the manufacturer in consumer tool kits and the tool designs change annually. Hopefully, the bicycle industry will not need many specialty tools for suspension forks in the future, as many manufacturers streamline repairs to use basic tools such as seal pullers, snap ring pliers, air pumps, and hands.

1" stanchion vise blocks
Seal separator (puller)
Snap ring pliers
Long 4mm allen
Long 5mm allen
Long 6mm allen
Long 8mm allen
Phillips screwdriver
Fork air pump w/needle
19mm socket
22mm socket
Metric ruler
Rebuild kits
Teflon-based grease
Blue Loctite
Flat blade screwdriver

ONE LAST WORD ABOUT TOOLS:

— Cheap tools are an extravagance no bicycle shop can afford.—

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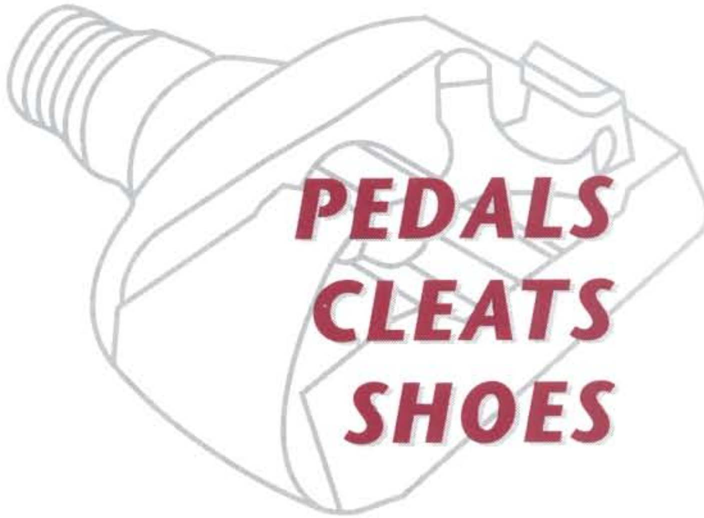
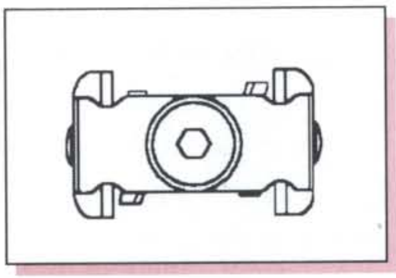
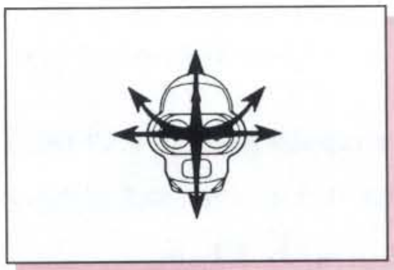
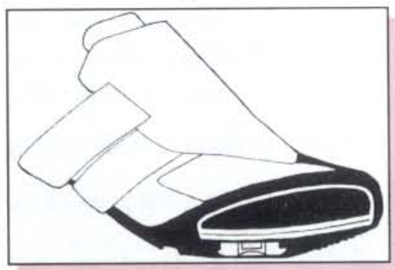


PEDALS CLEATS SHOES







Pedals

Cleats

Shoes

PEDALS, CLEATS, SHOES

PEDAL-CRANK

Ball and Retainer Sizes

Most pedals use 10 to 15 - 5/32" per side or 1/8" balls

Sealed cart. bearings	Bearing no.	ID	OD
SunTour inner pedal	6800	10mm	19mm
SunTour outer pedal	698	8mm	20mm
Onza '94	686	6mm	12mm
Time	6901	12mm	24mm

Thread Sizes

ISO* Primary	1/2" x 20 TPI	Right- and left-handed thread
Alternate	9/16" x 20 TPI	Right- and left-handed thread
English	9/16" x 20 TPI	Right- and left-handed thread
French**	14mm x 1.25mm	Right- and left-handed thread
Italian	9/16" x 20 TPI	Right- and left-handed thread
U.S.A.	1/2" x 20 TPI	Right- and left-handed thread

Italian threads are slightly different than English and are a tighter fit in English threaded cranks.

* ***See Appendix for more details on ISO standards.***

** Peugeots and some other French bicycles have used English 9/16" x 20 TPI for the U.S. market since the mid '70s.

→ **French cranks can easily be tapped to 9/16" x 20 TPI.**

When retapping pedal threads, start from the back of the crank arm.

ID Markings on Wrench Flats

	Campagnolo, others	Zeus
English, Italian	9/16" x 20	BSC
French	14 x 1.25	no mark

ID Markings on Crank Arms

	European	Japanese
English	9/16" x 20	no mark
French	14 x 1.25	M14
Italian	9/16" x 20	

ID Pedal Codes for Right- and Left-handed Threads

	Right	Left
English	R	L
French	D	G
Italian	D	S
Spanish	D	I

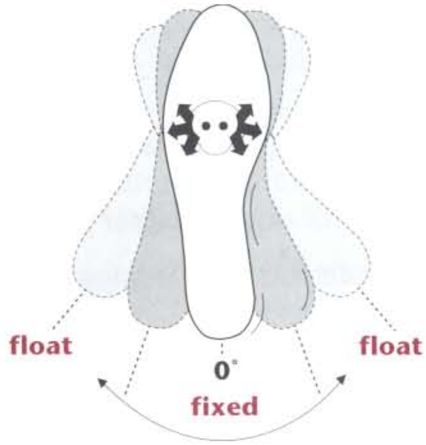
Toe Clip Bolt – Pedal

Use 5mm x 0.8mm threads.

CLIPLESS PEDALS, CLEATS, AND SHOES

Types of Clipless Systems

Fixed Cleat



The fixed cleat system keeps the shoe stationary in the pedal. The shoe may be able to twist or slide from side to side, but there will be a returning or centering force trying to return the shoe to its original position. If the shoe is moved against this centering force beyond a certain position, the cleat and pedal will disengage. Some older systems needed to be disengaged by hand.

Floating Cleat

The floating cleat system allows the shoe to float, or rotate from side to side, in the pedal. The shoe is able to twist or slide from side to side within a given range, with little or no return force. Outside this range either the pedal and cleat immediately disengage, or the return force progressively increases until the cleat disengages.

Parts of the Clipless System

Cleat - The piece on the shoe that attaches to the pedal; it allows the shoe to latch and unlatch from the pedal. **Cleat adjustment** describes adjusting the cleat to the rider's foot over the pedal. Clipless systems have fore and aft adjustment. In addition, most have side to side and rotational adjustments.

Pedals - Generally, the clipless systems come with 9/16" threaded axle spindles, two sided pedals with mounting brackets, or plates for mountain bikes, or single sided pedals for road. The pedal controls the tension capabilities.

Release Tension Spring - This spring, adjustable on most pedal systems, controls the tension which releases the cleat from the pedal. The rider must twist the shoe to one side which releases the shoe from the pedal.

Adapter plates - These plates allow adaptability from shoe to pedal. The three main types are: **shoe adapter plates** that are made to fit one specific manufacturer's shoes (usually within the recess in the shoe); **cleat adapters** that are made to adapt the drilling of one specific manufacturer's cleat to a different drilling on a shoe; and **universal adapter** are plates that adapt one style of drilling to a different bolt pattern.

PEDALS, CLEATS, SHOES

COMPATIBILITY AND DRILLING

Shoes and clipless pedals are matched to each other by matching shoe drilling with cleat bolt patterns. Each cleat has one bolt pattern, but **cleat adapters** can be used to match the cleat to a different shoe drilling. Shoes can have multiple drilling to match different cleat bolt patterns. Some shoes have **shoe adapter plates** to match various cleat bolt patterns. Most cleats have one of the **three primary bolt patterns**: 2 hole/SPD, 3 hole/Look, or 4 hole/Time. Other cleats have a unique bolt pattern that matches a shoe made specifically for them. Often these cleats will come with a **cleat adapter plate** to match one of the primary shoe drilling.

Bolt patterns	Spacing
2 Hole/SPD	12mm apart
3 Hole/Look	31.5 x 31.5 x 33mm
4 Hole/Time	16.5mm wide x 54mm long

There are also shoes with custom drilling unique to the shoe design. These often have recesses for the shoe adapter plates and the shoe adapter plates may have any one of the three primary drilling in them.

Example for using the charts: Vittoria shoe to an Onza pedal, look under "Clipless Pedals and Cleats" on page 1-5, the Onza H.O. cleat has a 2 hole/SPD drilling. Then look below for the Shoes – MTB, find the Vittoria shoe; it has a 2 hole bolt pattern. The Vittoria shoes will work with the Onza pedals and cleats with no adapters needed.

Shoes — MTB

Make	Shoe Drilling	Shoe Adapter Plates for Bolt Patterns
ALPINESTARS	2 Hole/SPD 3 Hole/Look	
CARNAC	Custom	2 Bolt/SPD, Speedplay, Toe Clips
DIADORA	2 Hole/SPD, Custom	
DUEGI	2 HOLE/SPD	
GAERNE	2 Hole/SPD	3 Bolt/Look, Toe Clips
LAMSON	2 Hole/SPD	**1**
LAKE	2 Hole/SPD	
NIKE	2 Hole/SPD	
PERFORMANCE	2 Hole/SPD	
SCOTT	2 Hole/SPD	3 Bolt/Look
SHIMANO	2 Hole/SPD	recessed - none
SIDI	Custom	2 Bolt/SPD, 3 Bolt/Look, Toe Clips
SPECIALIZED	2 Hole/SPD	recessed - none
TIME	4 Hole/Time	2 Bolt/SPD, Speedplay
VITTORIA	2 Hole/SPD 3 Hole/Look	3 Bolt/Look 2 Bolt/SPD

Shoes — Road

Make	Shoe Drilling	Shoe Adapter Plates for Bolt Patterns
CARNAC	Custom	Ergo, Speedplay, 2 Bolt/SPD, 3 Bolt/Look, 4 Bolt/Time
DETTO PIETRO	3 Hole/Look	
DIADORA	3 Hole/Look Custom/Ergo	2 Bolt/Time, 4 Bolt/Time
EURO	3 Hole/Look	
LAKE	2 Hole/SPD, 3 Hole/Look	none
NIKE	2 Hole/SPD 3 Hole/Look and Custom	
SHIMANO	2 Hole/SPD, 3 Hole/Look	
SIDI	3 Hole/Look and Custom	2 Bolt/SPD, 4 Bolt/Time
SPECIALIZED	3 Hole/Look	
TIME	4 Hole/Time	3 Bolt/Look, Speedplay
VITTORIA	3 Hole/Look and Custom	Ergo, 2 Bolt/SPD, 4 Bolt/Time

1 Lamson makes soles to order for 3 Bolt/Look, Speedplay, and Diadora.

Clipless Pedals and Cleats — MTB

Make	Pedal Model	Cleat	Bolt Pattern	Cleat Adapters	Float	Release Tension
BEBOP	MTB	Bebop	2 Bolt/SPD		15°	none
GRAFTON	all[1]	Grafton	3 Bolt/Look		10°	allen
LOOK	S2R and S2S MP-90[8]	MicroLook Black, Red	2 Bolt/SPD Custom		6° fixed,6°	 flathead
MKS		MKS	2 Bolt/SPD		fixed	allen
ONZA	H.O.	Onza	2 Bolt/SPD		6°, 10°	replace elastomer
RITCHEY	Logic, Logic WCS	Logic	2 Bolt/SPD			allen
SHIMANO	M525 M737 M323[1,7] M535 M747	SM-SH50[6] SM-SH55 SM-SH51 SM-SH71 SM-SH50 SM-SH55 SM-SH51[6] SM-SH70 SM-SH71	2 Bolt/SPD 2 Bolt/SPD 2 Bolt/SPD 2 Bolt/SPD 2 Bolt/SPD 2 Bolt/SPD 2 Bolt/SPD 2 Bolt/SPD 2 Bolt/SPD		fixed fixed[5] 6° 6° 2° 2°[5] 12° fixed 12°	allen allen
SPEEDPLAY	Magnum Frog	SpeedPlay Frog	2 Bolt/SPD 2 Bolt/SPD		56° 25°[2]	none none
TIME	MTB	TMT	Custom[4]	2 Hole/SPD	10°[3]	none
TIOGA	Clipman	Clipman	2 Bolt/SPD		3°	allen
VICTOR	VP-101	VP	2 Bolt/SPD			allen

1 Standard toe clips can be used on some models.

2 25° of heel outward float, 0° inward, cleat can be rotated to adjust the inward and outward float.

3 Cleat also has 10mm of side to side play.

4 TMT uses standard 2 Hole/SPD drilling, but the cleat is thicker than standard 2 Hole/SPD cleats.

5 Shimano SM-SH55 allows easier release than SM-SH50.

6 This is the recommended cleat for this pedal.

7 Shimano tool TL-PD32 is needed to remove the plug on the pedal before a cleat can be used.

8 Look MTB is a custom 2 Bolt pattern.

Clipless Pedals and Cleats — Road

Make	Pedal Model	Cleat	Bolt Pattern	Cleat Adapters	Float	Release Tension
AEROLITE	Turcite	California Lite	custom	3 Hole/Look	none	none
CAMPAGNOLO[1]	SGR	SGR	3 Hole/Look	—	0 -10°	allen
CINELLI	Uniblock	Uniblock	custom	— —	fixed	manual release
DIADORA	Ergo	Static Dynamic	custom	3 Hole/Look 3 Hole/Look	fixed 8°[2]	allen none
KEYWIN			custom	3 Hole/Look	fixed	none
LOOK	PP286 or PP276	Black "FAC" Red "FREE ARC"	3 Hole/Look 3 Hole/Look	— —	fixed 0°, 3° 6°, 9°	flathead flathead
	PP96 1990	Red ARC '90, Grey 1990	3 Hole/Look 3 Hole/Look	— —	6° fixed	flathead flathead
	standard road[3] (and compatibles)	Red – "FREE ARC" or "ARC" '91 Black – "FAC" or "F"	3 Hole/Look 3 Hole/Look	— —	9° fixed	flathead or allen flathead or allen
MAVIC	645LMS	Black Look, "FAC" or "F"	3 Hole/Look	—	fixed 0-10°[4]	flathead
MKS	MXP-110 Mapstage	MXP-115	2 Hole/SPD 3 Hole/Look	— —	fixed 20°	allen screw
SAMPSON	Stratics 902 (earlier model)	Stratics 902	3 Hole/Look 3 Hole/Look	— —	fixed 0-15°[4] 4°	spring replace allen
SHIMANO[1]	Ultegra 6402	SM-SH24	3 Hole/Look	—	fixed, 9°	
	Dura Ace or Ultegra SPD	SM-SH70 SM-SH71 SM-SH50 SM-SH51 SM-SH55	2 Hole/SPD 2 Hole/SPD 2 Hole/SPD 2 Hole/SPD 2 Hole/SPD	3 Hole/Look 3 Hole/Look — — —	fixed 12° 3° 3° 3°	allen allen allen allen allen
	A525 *(see MTB pedal M525)*					

Clipless Pedals and Cleats — Road (cont'd)

Make	Pedal Model	Cleat	Bolt Pattern	Cleat Adapters	Float	Release Tension
SPEEDPLAY	X/1 or X/2	X-series	3 Hole/Look, 4 Hole/Time	Carnac, Nike, Sidi, and Time Shoes[6]	+29° -8°[5]	none
SR	FXP-100 (See Sampson 902)	FXP-100	3 Hole/Look	—	4°	allen
TIME	TBT TWT	TBT TWT	4 Hole/Time custom	3 Hole/Look	10°[7] 10°[7]	none none

1 Also makes Look compatible pedals. See Look standard road.

2 Allows 6mm of side to side play.

3 Low end models do not have release tension adjustment.

4 Play is independently adjustable inward and outward.

5 Has 29° of heel outward float and 8° of heel inward float (37° total).

6 Proper length screws are available for Carnac, Sidi, and Time shoes.

7 Depending on the pedal model, the cleat has 10 to 14mm of side to side play.

Shoe Size Conversion Chart

U.S.	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5
European	36.5	37	38	38.5	39.5	40	40.5	41	42	42.5
U.S.	**9**	**9.5**	**10**	**10.5**	**11**	**11.5**	**12**	**12.5**	**13**	
European	43	43.5	44 – 44.5	45	45.5	46	47	47.5	48	

CARNAC + ONE SIZE UP.

Universal Adapters

Make	Shoe drilling	Cleat style
Syntace	3 Hole/Look (Look) to	2 Hole/SPD
Thompson	none - clip**	3 Hole/Look (with Look cleat)
Winwood	none - clip**	2 Hole/SPD (with SPD cleat) 3 Hole/Look (with Look cleat) 4 Hole/Time (with Time cleat)

** Allows clipless pedals to be used like standard toe clips with street shoes.