20th

ANNIVERSARY

SUTHERLAND'S

HANDBOOK FOR BICYCLE MECHANICS

Sixth Edition

SUTHERLAND PUBLICATIONS

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INTRODUCTION

T*he 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 he 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 huh 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 hike 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 I 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 hook. 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 he referring to them often. Many shops buy additional copies to resell to enthusiasts. Take some time to thumb through the hook 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.

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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 -
VVeinmann Sports, Inc.
Beverly Anderson
Bicycle Exchange, Cambridge
Bicycle Parts Pacific
Bicycle Repair Collective, Cambridge
Bicycle Technologies International
Bike'alog
Bill Homer
Bontrager Cycles
Branciforte Bicycles, Santa Cruz
Brian Grieger
Brian Williams
California Bike & Board, Danville
Campagnolo, Italy
Campagnolo, USA
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Dan Cole
Dan Smith - Rock Shox
Dave Wilson, New Zealand
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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
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Karim Cycles, Berkeley
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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.
Toni Ruth
Toni 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 (Hugi)
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.

SUTHERLAND'S

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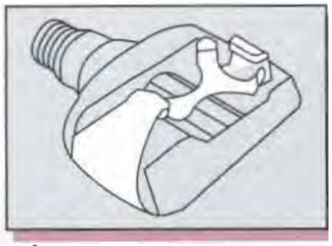

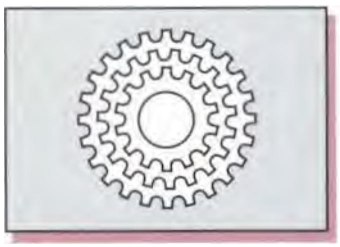

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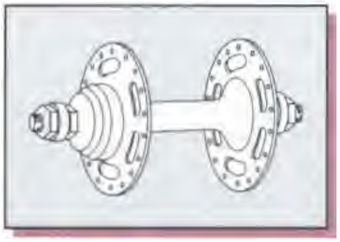

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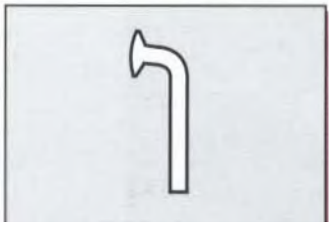

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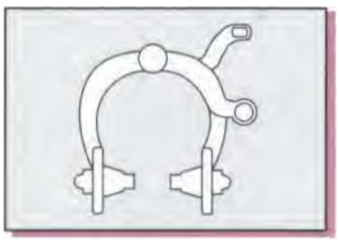

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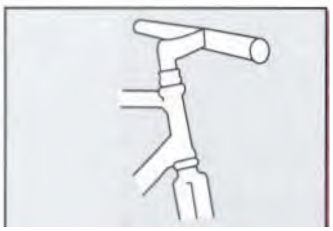

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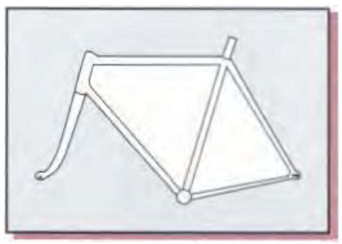

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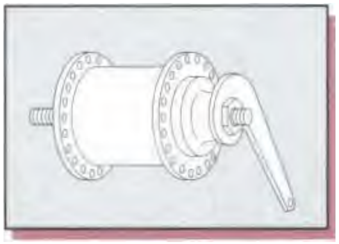


BICYCLE MANUFACTURERS — PARTIAL LIST

Manufacturer	Country
A. Vittoria	USA
A. Singer	France
A.D. Storer,	USA
AMF	USA
AMP	USA
Aegis	USA
Action-1n	USA
Adams	Canada
Al Drysdale	USA
Alan Shorter	USA, japan
Allegro	Switzartand
Alpinestan	Taiwan
American	USA
American Eagle	Japan
Arneriran Flyer	USA
Answer	USA
Argos	Great Britain
Armstrong	Crest Britain
Arrow,	USA
Mira	France
Maid	Italy
Atatannenne.	itety
At lantica	Italy
Asistro-Daimler	Austria
Autonwato	France
Azuki	Taiwan, japan
Balance	Taiwan USA
Barracuda	Taiwan, USA
Basso	Italy, USA
BiTIOVUS	Netherlands
Bates	Great Britain
Battle	USA
Beacon	France, USA, Japan
Benotto.	Mexico, Italy, Panama
Benin	France, Belgium
Bevrlacqua	Italy
Bra,	Italy, japan, Taiwan
Bil-	
Bit.	
Boa	Great Britain
Bin Ira ger	
Buttecchia	Italy
Boulder	
Branca	Italy
'Breeze	USA
Brew	USA
Bridgestone	Japan
Brodie.	USA
Browning	Belgium
Bruce Gordon	USA
Bruns	USA
BSA	Great Britain
Burley	
Benin	Switzerland
C Hansen	USA
C Itoh	lapan, Taiwan, Korea
CCM	Canada
	France
CW	USA
Cal-Facet	USA
Calol	Brazil
Camera	Italy
Campania.	Japan
Cannandale	USA
Carbon Frames	USA
Carlton	Great Britain
Carnielli	Italy
C asat	Italy
Castellon	USA
Cavaliri-Milani	L - Italy
Latenave	France
Cato Europa	Italy
Centurion,	japan, Taiwan
Cesare Renato	Katy
Chaplair	France
Chater Lea	Great Britain
Cherry	USA
Chlorda	Litaly
Chris Chance	USA
Cignal	Taiwan
Cao	Switzerland
Cinelll	Italy

Manufacturer	Country
Anna	Italy
Ciocc	Italy
City Road	Great Britain
Clark Kent	USA
Claude Butler	Great Britain
Cleveland Welding	
Colin Lang	Great Britain USA
Coinage	Italy
Cotner	Katy
Colson	115A
Calurnbia	USA
Columbine	
Co-motion	USA
Concord	japan, Korea
Condor	Great Britain, Mexico
C.onejo	USA
Copp.	Italy
Cores	Korea
Corso	Italy
Counterpoint	USA
Coventry Eagle	Great Britain
Crescent	Sweden, USA
Cross-Trak	USA
Curve	USA
Curtin	
DB5	Norway
Dave Moulton	USA
Dalton	USA
Davidson	USA
Dawes	Great Britain
Dean	USA
de Gribaldy	France
OeKert	Canada
Delacroix	France
De Rosa	Italy
Diamond Back	Taiwan, Japan
Drake	Great Britain, India
Ducheron	France
Dunelt	Great Britain
Durango	USA
Durlsopp	Germany
Easy Racer	USA
Easy Rider	Taiwan
Eddy Mercka	Italy. Belgium, japan, Great BritainFrance, Switzerland
Eisentraul	05A
Ellis Briggs	Great Britain
Ellison	USA
Emery Mfg, Co,	USA
Emperor	Japan
Erickson	USA
Ernha	Netherlands
Evans Products Co.	USA
Excelsior	USA
F.11 Grubb	Great Britain
F.W. Evans	Great Britain
	USA
Falcon	Great Britain
Fat Chance	USA
Fat City	USA
ionic	
Favorit	Czechoslovakia
Ferrare	Japan
Peelle	Belgium
Tomah	Italy
Firestone	USA
Fisher	USA
Fish tan	
Flandr 0	L. Belgium
Frier I.'	
Feta',	France
Free '.. as)	L. USA, Taiwan
Freddie	
Frejus	Italy
Fuji	Japan. Taiwan
Funk	USA
G. Genet	France
Galmozzi	L. Italy
Garlatti	Italy
Geohrey Butler	Great Britain

Manufacturer	Country
George Stratton	Great Britain
Giant	Taiwan
Giliott	Great Briton
Glorda na	Italy
Gios	Italy
Gitane	France
Gottlrred	France
Graftek-Exxon	USA
Grandis	Italy
Green	USA
Grove In novaten	USA
CT	Iaiwan, USA
Guert rot ti	Italy
H. France	Argentina
Harumbrink	USA
Ham	Iowan, USA
Harry Powers	USA
Harry Quinn	(real Britain
Hawthorne	Great Britain
Hedstrom	USA
Hercules	Great Britain
Hatch ins	Great Britain
Hiawatha	
Holchworth	Great Britain
Holland 8	USA
Holland .1.	USA
Hooker	USA
Holly (Huffman)	A Great Britain
Hugh Porter	Great Britain
alujasS	USA
Humber	Great Britain
Hurloni	Great Britain
Hutch	USA
his	USA
deer	Italy
ndian	I 'LA Great Britain
ron Horse	USA
taleega	Italy
ton	lapan
vet Joh nson	USA
versos	USA
C. Pennev	USA
C. Higgins (Sears.	USA, Austria
.P. Weinle	
Rj	Great Britain
ark Taylor	Great Britain
aquar	Germany
amen	i ,reat Bntain
am is	LISA
et	japan
eurint	France
Uvela	Svvilierland
KHS	la pan, Taiwan
Kabuki	japan
Kalkhon	Germany
Kenstat	Taiwan
Kent	Taiwan
kessels	Belgium
Kestral	Japan
King	Tarwari
Klein	USA
Kobe	japan, eking Kong
Kolo	
Krim	USA
Kuwahara	lapan
La Herne	Canada
LaPierre	France
Lambert	Great Britain
La Moore	USA
Land Shark	USA
Legacy	USA
Legn arm	Italy, Argentina
Lejeune	France
Lemond	Italy, USA
Liberia	France
Lighthouse	USA
Lightning	USA
Limited	1.1SA.
Linear	USA
Dopy	USA
trtespeed	USA
Lryang	Taiwan

Manufacturer	Country
Look.	France
Lotus	Japan
Lucifer	Switzerland
Lupo	Italy
Lygie	Italy
MKM	Great Britain
fnl: Sport	Taiwan
calu	Taiwan, USA
Magne	Netherlands
plain d'Or	Belgium
Maims	Italy
Mako	japan
Mantis	USA
Maplewood	USA
Mann	USA
Marinonl	Canada
Marurshi	Japan
Maserall	Italy
Mari (Alberto)	Italy
Masi (Cativo)	USA
Matturi	japan
McMahon	USA
Medici	USA
Melton	USA
Metal	France
Merman	neat Britain
Mercier	Franc a
Merida	Taiwan
Merlin	ieal Britain
Mere	DV,
Miele	Canada
Mrkkelson	USA
Miyata	Japan
Monarch	Sweden
Monark	Brat it
Mondla	Switzerland
Monde	Germany
Mongoose	USA, Taiwan
Monolith	USA
Montague	Taiwan
Montgomery Warn	i'i.a.. Japan, Taiwan
Moots	
Morales	USA
Moser.	Maly
Mossberg	USA
Motobecane	France, Taiwan
Moulton -	Great Britain
Mountain Cycle	USA
Mountain Gnat	USA
MI Shasta	USA
Mundo Cycle	Brazil
Murray	USA
Nashbar	USA
Neva Cycles	USA
Nishiki	japan
Nobilette	USA
Norco	Canada
Norman,	Ghat Britain
Norman Faytt	Great Britam
Novara	Taiwan
Nuke Proof	
Ochsner	Switzerland
011is	France
0 lmo	Italy
One-Off	USA
Orly	France
Otis Guy	USA
Paletti	Racy
Pan World	Belgium
Panasonic	japan
Paragon	USA
Parkpre	Taiwan
Pashley	ran Britain
Paasoni	Italy
Pennine Cycles	rant Britain
FertOrManCe	USA
Peter Mooney	USA
Peugeot	France
Phillips	rear Britain
Picchio	Italy
Pierce Arrow	USA
Pinarelto	Italy

Manufacturer	Country
Pinto	France
Piscean	anNa
Pluto	Belgium
Plume Vainguei	Belgium
Pogliegth	Italy
Powercurve	Taiwan
Presto	Netherlands
Prollex	Taiwan
Protein	LISA
Puch	Austria
Quantum	LISA
Quattro Assi	Italy
Raleigh	Great Bmainaispan Holland, USA.Tawan
Ralph Ray	USA
Rambler	USA
Rampar	Taiwan
Ranger	USA. Great Britain
Rans	USA
Rapido	Czechoslovakia
Railer	Italy
Rebike	USA
Redline	USA
Regina Sport	France
Rene Heise	trance
RenshoiCyclonP	Japan
Research Dynamics	1awan
RetroTec	
REW Reynolds	Great Britain
Rhygin	
Rickert	Germany
Rigi	Italy
RIH	Netherlands
Ritchey	USA
Roadmaster	USA
Robert Meyers	USA
Roberts	Great Britain
Robin Hood	Great lintain
Rock Lobster	
Rocky Mountain	USA
Rodriguez	
Rollfast	USA
Ramie	USA
Ron Cooper	Great Britain
Ron Kl tchi mg	Great Britain
Rosignolll	Italy
Ross	USA
Rosen	Italy
Royal Crown	Great Braalis
Royal Enfield	Great Britain
Royce Union	Italy, Japan
Budge	Great Britain
Ryan	USA
5.1., Systems	
SR	japan
Saint Tropez	Taiwan
Salsa	USA
Samurai	japan
Santa Cruz Mtn Bikes	USA
Santana	
Schauff	Germany
Schroeder L.	Denmark
Schwartz	Switzerland
St hwinn	USA. lapan, Taiwan
Manutacturer	Oountry
Scull..	USA
Sears	USA, Aintria,Chinaf ranee
Sek	japan, Taiwan
Senator	"apart
Sentinel	USA
Saran a	USA
Shelby Flyer	USA
Shimano (pre-1954i	japan
Shogun	japan
Si month in	Italy
Singele	Italy
Skyway	USA
Slingshot	USA
Softride	LISA
Soles	France
Soma	Japan
Soutlsem Gems	Great Britain

Manufacturer	Country
Spectra	USA
spectrum	USA
	mat Britain
Starno rd	France
Steelman	USA
Stelber Cycle Gnu	LISA
Stella	France
Sterling	China
Stevenson	USA
Steyr	Austna
St insmen	USA
Stowe	USA
Strawberry	USA
Suburban Machin,	USA
Such ia	japan
Supeha	Belgium
Sutter	France
Swiss Army	vitzerland
Sync ros.	Canada
Sycip	USA
T. M. Cycles	
Takara	japan
Tech	
Teledyne Titan	USA
Terrot	France
Terry	tISA, Taiwan, japan
Terry Grimes	
Thruster	Taiwan, China
TI Cycles	USA
Ti-Cranium	USA
Tigra	Switzerland
Titan	ISA
Titus	USA
Tommasinl	taly
TOMM.3,0	taly
Torelli	taly
Torpedo	taly
Torque Titanium	ISA
Trek	ISA
Trimble	ISA
Triumph	di 1 Retain
Turner Suspension	USA
Umberto Del	Italy
Unit'. Sport	France, Belgium
Unikap	Netherlands
Univega	japan, Taiwan, Italy
Urago	France
Vainguesir	Inaernburg
Ventana	LISA
Ventura	Taiwan
Victor	USA
Viking	G real Britain
Vizier	Italy
Viscount	Great Britain
Vista	USA
Vita Sprint	France
Voliscycle	japan
Vulcan	Great Britain
Waterford	USA
Western Auto	USA
Wheeler	Taiwan
Wilderness Trail Bikes	USA
Windsor	Great Britain
Windsor	Meeico
Witcomb	Great Britain
Wojcik	USA
Woodrup	Great Britain
Worksman	USA
Wynn	USA
Yale	USA
Yamaguchi	LISA
Yeti	USA
Yokota	japan
Zebrakenko	Japan
Zephyr	
Zeus	Spain
Zinn	USA
Zipp	USA

CONTENTS

HOW TO USE THIS BOOK

0

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. 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 he 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.

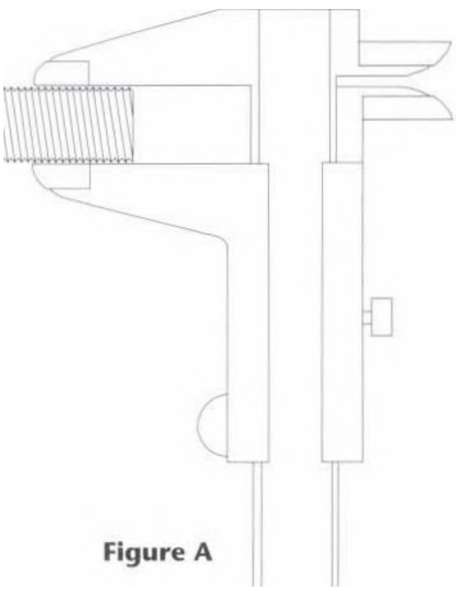


Figure A

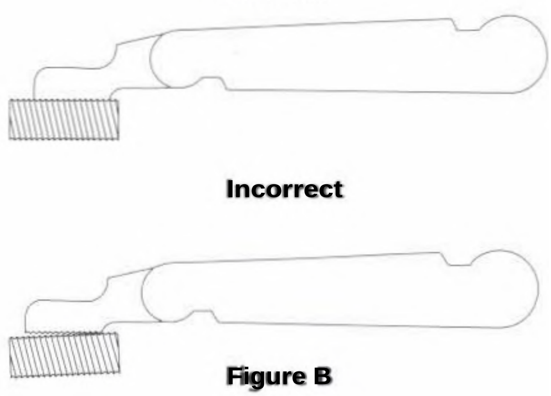


Figure B

NATIONALITY OF PARTS

Parts will he listed as English, French, Italian, Swiss, U.S., or Austrian to show the standard used in cutting the thread or the size of the parl. 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 hikes, it is important to know a little of the history of standards so problems can be avoided.

STANDARDS (CONT'D)

National Standards

In tact, 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 conic 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 hook, 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 hike 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. [he 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 t he 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 stun 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 he 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, Aerrnet 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, milk, 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 wit h 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 (CONTD)

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 triction 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. (ln 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.

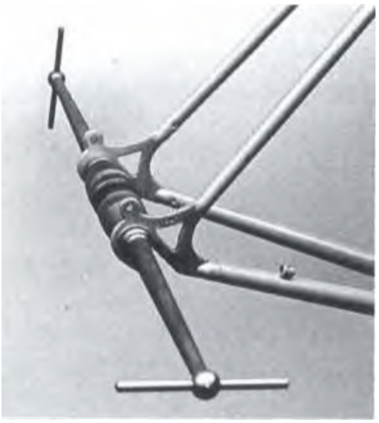


Figure 1

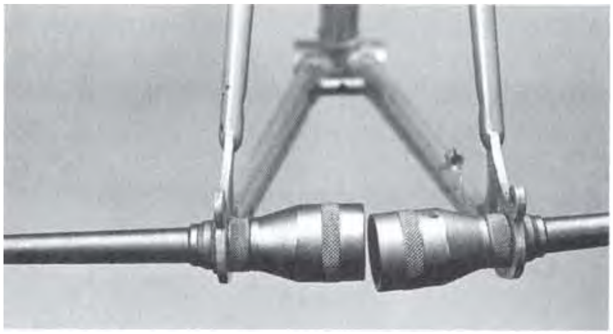


Figure 2

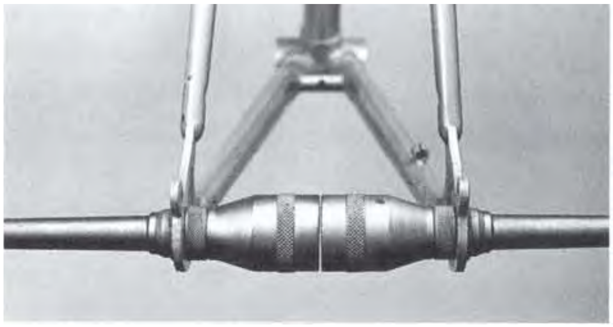


Figure 3

**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 arc 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 poinL 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 (CONTD)

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 he 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 tor 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)

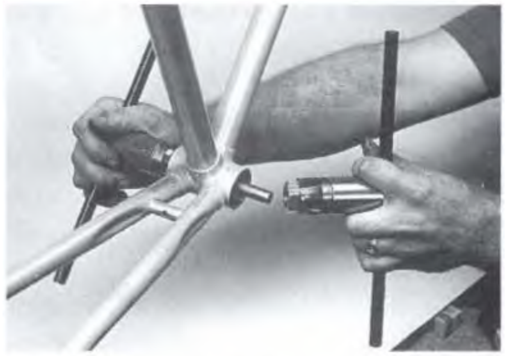


Figure 10.
Installing double-sided tap with aligning shaft

Figure 11.
Starting taps

aluminum pilot
facing mill

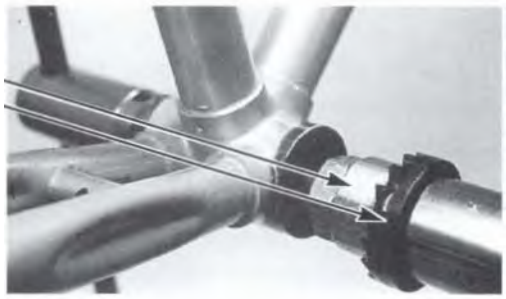


Figure 12.
Milling assembly

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
Chain ring 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.

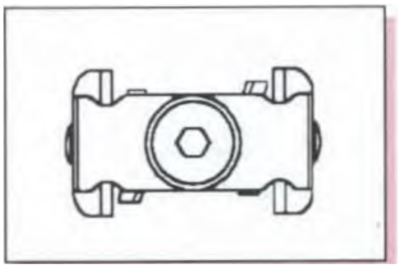
- 1" stanchion vise blocks
- Seal separator (puller)
- Snap ring pliers
- Long 4mm alien
- Long 5mm al len
- Long 6mm alien
- Long 8mm alien
- Phillips screwdriver
- Fork air pump w/needle
- 19mm socket
- 22mm socket
- Metric ruler
- Rebuild kits
- Teflon-based grease
- Blue Loctite
- Flat blade screwdriver

ONE LAST WORD ABOUT TOOLS:

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

CONTENTS

1



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	6500	10mm	19mm
SunTour outer pedal	698	5mm	20111m
Onza '94	686	6mm	**12mm**
Time	6901	12mm	24mm

Thread Sizes

150* 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 hack 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

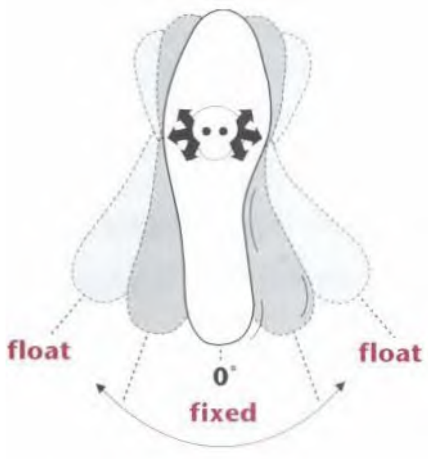
	Right	Left
English	R	L
French	I7	CT
Italian		
Spanish		

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. It 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.

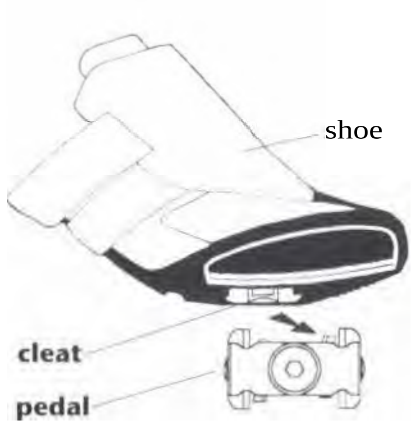
Floating Cleat

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	
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.

PEDALS, CLEATS, SHOES

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	all1	Grafton	3 Bolt/Look		10°	allen
LOOK	S2R and 525 MP-90[8]	MicroLook Black, Red	2 Bolt/SPD Custom		6° fixed,6°	 flathead
MKS		MKS	2 Bolt/SPD		fixed	alien
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 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° 2502	none none
TIME	**MTB**	**TMT**	Custom[4]	**2 Hole/SPD**	**10°[3]**	**none**
TIOGA	**Clipman**	Clipman	2 Bolt/SPD		3°	alien
VICTOR	**VP-101**	VP	2 Bolt/SPD			alien

[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.

PEDALS, CLEATS, SHOES

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 alien flathead or alien
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°	alien screw
SAMPSON	Stratics 902 (earlier model)	Stratics 902	3 Hole/Look 3 Hole/Look	— —	fixed 0-15°[4] 4°	spring replace alien
SHIMANO[1]	Ultegra 6402 Dura Ace or Ultegra SPD A525(see *MTB pedal M525)*	SM-SH24 SM-SH70 SM-SH71 SM-SH50 SM-SH51 SM - SH55	3 Hole/Look 2 Hole/SPD 2 Hole/SPD 2 Hole/SPD 2 Hole/SPD 2 Hole/SPD	— 3 Hole/Look 3 Hole/Look — — —	fixed, 9° fixed 12° 3° 3° 3°	 alien alien alien alien allen

PEDALS, CLEATS, SHOES

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°	alien
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	415
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

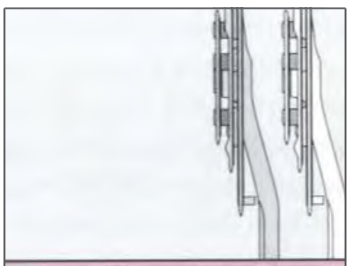
Make	Shoe drilling	Cleat style
Syntace	3 Hole/Look (Look) to	2 Hole/SPD
Thompson	none - chip**	3 Hole/Look (with Look cleat)
Winwood	none - clip**	2 Hole/SPD (with SPD cleat) 3 Hole/Look (with Look cleat) 4 Hole/Time (with Time cleat)

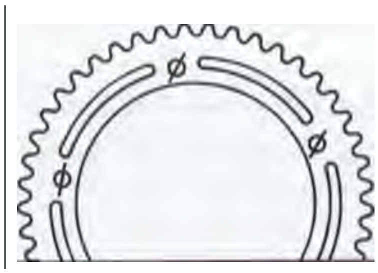
** Allows clipless pedals to be used like standard toe clips with street shoes.

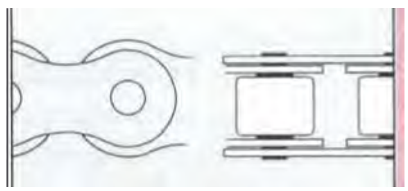
PEDALS, CLEATS, SHOES

CONTENTS

2





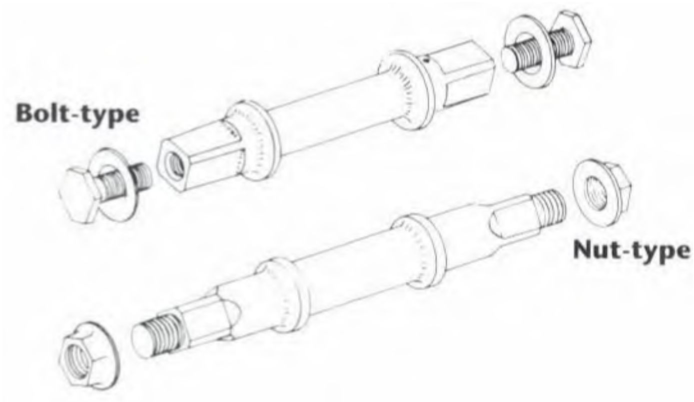


Cranks

Chainrings

Chain

COTTERLESS CRANK SPINDLE BOLTS AND NUTS



Thread Sizes

	Most Including 150	Exceptions
Bolt-type	8mm x 1.0mm	Viscount may be **5/16" x 26** TPI or **22** TPI
Nut-type	10mm x 1.25mm	Campagnolo Super Record is 10mm x 1mm

COTTERLESS CRANK EXTRACTORS

Most extractors have the same external threads (22mm x 1mm). The exceptions are on the next page in bold in the size column. Even with extractors that have the same nominal thread size, manufacturing variations in the extractor and/or the crank do occur. Keep several tools around; if one tool goes on too tightly or too loosely, try another that matches the threads more closely.

Nut-type crank extractors must be used on nut-type spindles. The center bolt on bolt-type extractors cannot be pulled back enough to engage the threads in a crank mounted Oil a nut-type bottom bracket spindle.

Campagnolo 1990-Record, (C-)Record, Croce d'Aune and Victory crank arms have **left-handed** extractor threads. Use only the built-in extractor *(see drawing below)* or Campagnolo's special left-threaded extractor.

Do not use the Park crank extractor on pre-1952 Stronglight cranks: the threads may strip. The Park tool will work where a bolt-type, nut-type, or TA extractor is used.

A Bicycle Research Products crank arm thread-chaser (TC-8) will restore cross-threaded or slightly damaged crank threads. It will not work on completely stripped threads. If the threads are completely stripped, use a gear-puller to pull the crank.

To remove frozen crank dust caps, drill two small holes in them and use a pin tool. Grease the threads before installing dust caps.

with built-in *left-threaded* **extractor.**

COTTERLESS CRANK EXTRACTORS (CONT'D)

Bold numbers indicate exceptions to common 22mm x 1mm

Make/Standard	Type Spindle[1]	Crank Bolt or Nut size	Extractor	Thread Size
150[2]	bolt-type nut-type	14mm 14mm	bolt-type nut-type	22mm x 1 mm 22mm x 1mm
Campagnolo 1990 Record, Croce d'Aune, (C-) Record, Victory	bolt-type	6mm allen	built into dust cap or use Campagnolo's special left-threaded extractor	**22mm x 1mm left-threaded**
Super Record all others	nut-type bolt-type	14mm 15mm	nut-type bolt-type	22mm x 1mm 22mm x 1 mm
	bolt-type nut-type	14mm 14mm	bolt-type nut-type	22mm x 1mm 22mm x 1mm
Lambert (early)	bolt-type			**7/8" x 24 TPI**
SR (Sakae Ringyo)	bolt-type nut-type	14mm **14mm**	bolt-type nut-type	22mm x 1 mm 22mm x 1mm
Shimano[5]	bolt-type	14mm	bolt-type/8mm allen	22mm x 1 mm
Specialized	bolt-type	15mm	bolt-type	22mm x 1mm
Stronglight3 pre-1982	bolt-type	16mm	Stronglight—pre-1982, Var 22	**23.35mm x 1mm**
1982-current	bolt-type	14mm	bolt-type	22mm x 1 mm
Sugino	nut-type bolt-type	14mm 15mm	nut-type bolt-type	22mm x 1mm 22mm x 1 mm
TA	bolt-type	15mm	TA, Var 392, Var 393, Var 408	**23mm x 1mm**
Takagi	nut-type	14mm	nut-type	22mm x 1mm
Viscount	bolt-type	15mm	bolt-type	22mm x 1 mm
Zeus	bolt-type	16mm4	bolt-type	22mm x 1 mm

1 *(See page 2-2)* for drawings of spindle types.

2 See Appendix for more details on ISO spindle standards.

3 **Extractors:** Pre-1982 Stronglight extractors have a shoulder at the end of the threads. **Do not use a TA tool (or the TA threads of a Park tool).** These tools will screw into an older model Stronglight crank but will probably strip the crank threads when you attempt to pull it. **Bolts:** For 16mm bolts, use a thin-walled socket with an outside diameter no larger than 22mm. Do not use the older 16mm bolts with newer cranks that have 22mm extractor holes. Only a very thin-walled socket or Zeus extractor will remove them.

4 Use a Zeus tool or a very thin-walled socket with an outside diameter no larger than 20.8mm. If you ever get the bolt out, use a 15mm bolt instead.

5 Shimano Dura-Ace AX, Dura-Ace EX, 600 AX, 600 EX, and Deore used a built-in extractor that didn't work very well. It is probably best to replace them with a conventional dust cap and crank arm bolt.

CRANKS, CHAINRINGS, CHAIN

INSTALLING COTTERLESS CRANKS

Adjust the chainline by selecting the appropriate parts-usually the correct length spindle. ***(See Buttons Bracket Spindles,** page **3-8.)*** The cranks mount in one position. Do not overtighten or leave loose to adjust the position.

Adjust the bottom bracket bearings with the cranks off. Install the right crank. Check bearing adjustment by putting side force on the end of the crank. Readjust until no play is felt. Install left arm.

The spindle end and the hole in the crank must be clean and dry. Do not use oil, grease, or an anti-seize compound. The tapered square system depends on the crank coming up firmly on the spindle. **Any lubrication will cause the arm to go on too far in tightening or to float on the spindle.** Either way, the arm will be mined. Grease or anti-seize compound may be used on the threads of the crank bolt.

Tighten the crank bolt firmly: 18-20 foot pounds (215-240 inch pounds). Re-torque the bolt after 100 miles of riding. This ensures that the crank seats properly on the spindle.

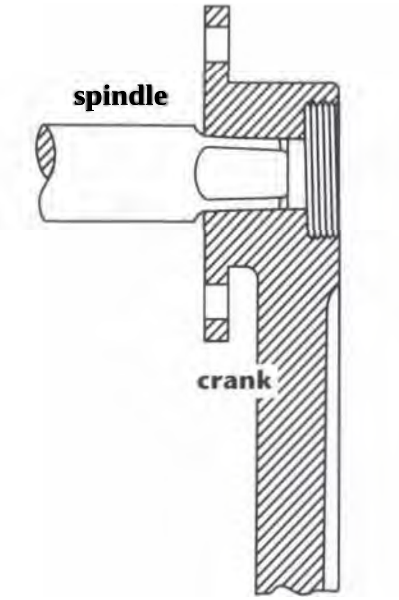


Figure A: Incorrect fit
Crank close to "bottoming" on end of taper flats.

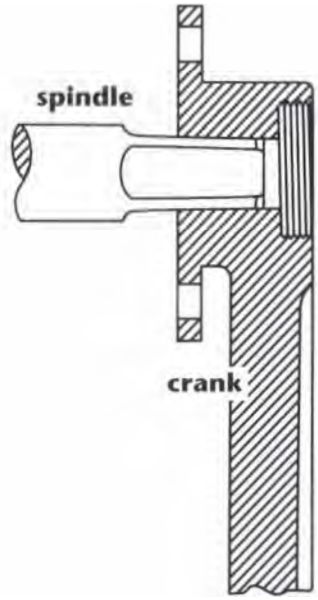


Figure B: Correct fit
Spindle end is not flush with bottom of crank extractor hole and crank arm does not "bottom" on end of taper flats.

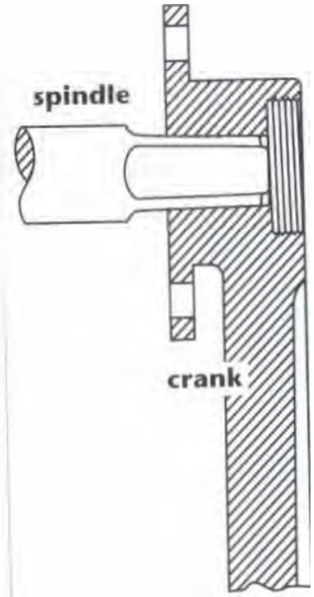


Figure C: Incorrect fit
Spindle end flush, or close to flush, with bottom of extractor hole.

FIT BETWEEN COTTERLESS CRANKS & SPINDLES

Spindle end and crank hole dimensions vary considerably due to manufacturing tolerances.

Taper Angles

JIS spindles are 2°. A very rare, out of production SR Silver crankset used a 3" taper. 3' taper ends are too wide to fit in a crank made for 2° spindles.

When crank and spindle taper angles differ, the spindle will wobble when loosely inserted into the crank as a test. Except when angle errors are extreme, the crank will seat itself during initial use, requiring only a few re-tightenings of the crank bolt.

FIT BETWEEN COTTERLESS CRANKS fit SPINDLES (CONT'D)

Taper Angles (CONT'D)

Failure to re-tighten the crank bolt will eventually destroy the crank.

Most of the difficult crank-fit problems are due to taper length differences, not angle differences.

When using the interchangeability charts, tighten the crank on the spindle to check the fit before installing it on the bike.

Be sure the crank does not come up against the end of the taper. This happens first near corners of holes. if the crank bottoms out, the square holes do not grip well, and will come loose or possibly crack. ***(See figure A on page 2-4.)***

After tightening, remove bolt to check that the end of the spindle is not coming through. If the spindle end is flush or near flush with the face of the crank bolt washer it sits against, ***(see figure C on page 24),*** the crank itself may not be tight enough or will loosen when ridden. Attempting to tighten the crank bolt further with this condition present will shear off the bolt, since it would be tightening against the spindle end itself.

Sometimes you can use a washer between arm and normal washer. File a hole in an unhardened washer so the spindle end corners can pass through it.

Taper End Sizes

While the angle of the taper end is nearly always close to 2', the size of the end does vary. Older Ofmega and Zeus spindles had the smallest taper end. This meant that these spindles would go in other brand cranks so far that the end of the spindle would be flush with the bottom of the crank hole. This would prevent the crank bolt from tightening enough to hold the crank firmly in place.

This is a list of spindle end size **tendencies** from smallest to largest. Individual spindles may he smaller or larger depending on the batch they were made in.

Ofmega
Zeus
ISO
Campy

We would like to be able to provide exact numbers for the spindle ends but the ISO is the only one that has published dimensions and tolerances ***(see Appendix).*** The JIS standard for spindle ends is 12.65mm but no manufacturing tolerances are given. Measuring actual spindles only confuses things since they vary so much.

Except for Ofmega and Zeus spindle ends are very close in size and can be interchanged if care is taken. Be sure when interchanging that the taper length is not going to cause a problem.

FIT BETWEEN COTTERLESS CRANKS Sr SPINDLES (CONT'D)

Taper Length Notes

XTR cranks have deep holes that prevent mounting a spindle that has shorter taper flats. You must use a spindle designed for XTR cranks.

Old combinations that don't work

- **TA cranks:** crank bolt face comes close to flush with the ends of many spindles.
- **Stronglight, JIS (Japan Industry Standards), and Sugino AT cranks:** bottom on the ends of the flat on most spindles except Stronglight, I A, JIS and Phil Wood.
- **JIS nut-type spindles:** stud does not protrude far enough through extractor hole of many cranks to engage nut.
- **Ofmega and older (indented markings) Avocet spindles and cranks:** spindle end and crank hole are narrower than others; **do not interchange.** Zeus also is narrower, though less so; take care that the spindle does not come flush with extractor hole when installing another brand of crank on a Zeus spindle.

Old useful combinations that do work

- JIS spindles can be used to place chainline farther from the frame with Stronglight or TA cranks.

You may also grind the end of a bolt-end spindle. Bevel the edges so it doesn't dig into the crank when tightened. Try the bolt before assembly. You may have to shorten it slightly.

Miscellaneous Items

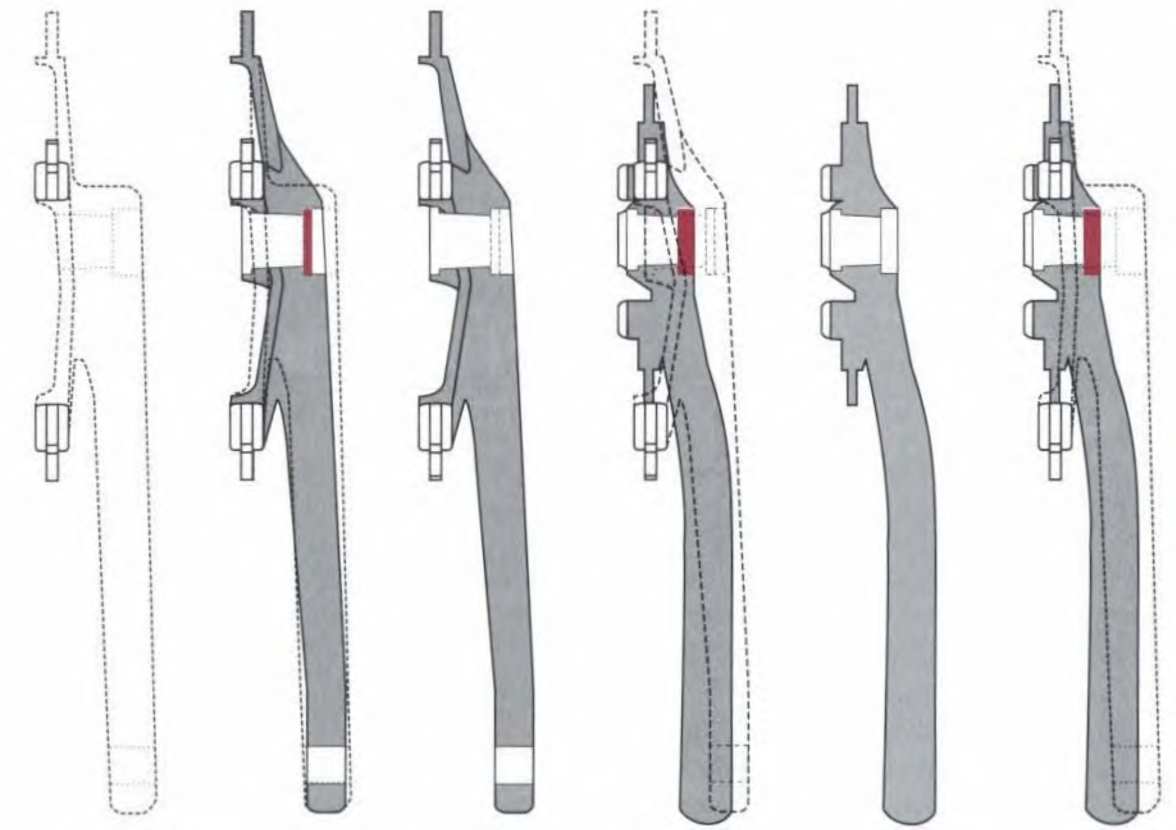
If you are using light alloy crank bolts, do not use them to install the cranks. Use normal steel bolts to tighten and retighten the arms. Then remove the steel bolts and install the alloy bolts. Tighten them finger-tight, then just enough more to tension them.

Always replace the dustcaps. They prevent damage to the threads. Damaged threads may make it difficult or impossible to install an extractor. A small amount of grease on dust cap threads will prevent corrosion.

CRANKS, CHAINRINGS, CHAIN

CRANK ARM PROFILES

Comparison of High Profile, Low Profile, and Super Low Profile Crank Arms



A B C D E F

High profile **Low profile** **Super Low profile**

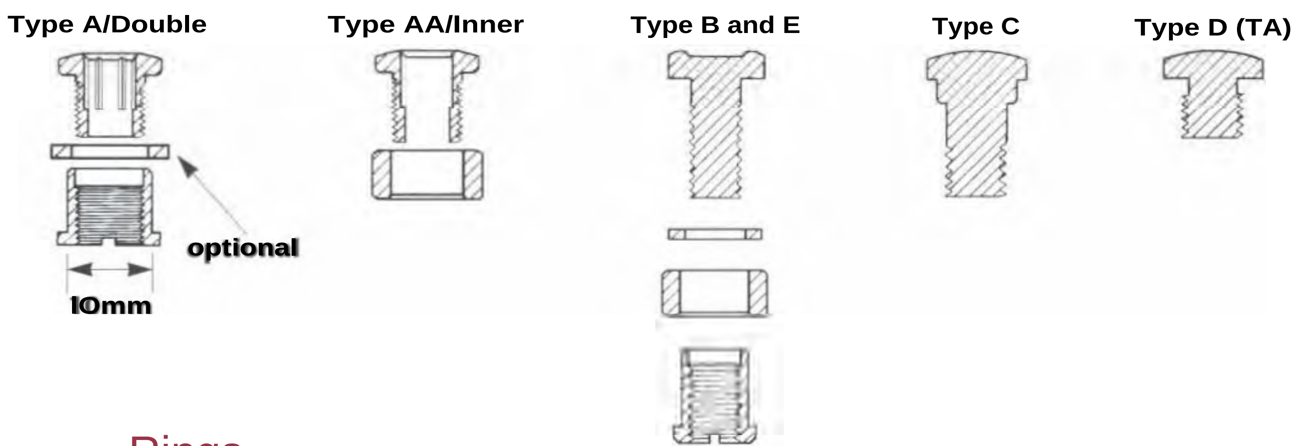
The crank arm in **figure A** is an old style crank arm. The arm in **figure C** is a low profile arm (pre '94) and the arm in **figure E** is the newer super low profile arm. Looking quickly at these arms, it would seem that if you wanted to keep the chainline in the same position and replace the high profile arm with either the low profile or super low profile arm, a much shorter bottom bracket spindle would be needed. **Figure B and D** show the two arms superimposed with chainring position showing as the same for both. The difference, in **figure B,** turns out to be only 3mm (see the red area where the crank bolt washer would be). In **figure D** the difference is 8mm and in **figure F** is 11mm. This difference varies, of course, with various models. The point is that the bottom bracket spindle length can vary greatly and careful measuring of chai n I ine is imperative.

Crank Arm lengths
165mm
167.5
170
172.5
175
177
177.5
180
181
185
195

CHAINRING BOLTS/SPACERS

Hex-headed bolts should be tightened and loosened with a socket or box-end wrench that has a face that has been ground flat.

Chainring Bolt and Nuts	Thread	Bolt Length (approx.))	Nut Length (approx.))	Hole in Arm, Chainring or Spacer ID	Notes
Type A					
Double	8mm x .75mm	8 - 9mm	7mm	10mm	Use 5mm alien key, slotted nuL Hold nut with special tool.
Single	8mm x .75mm	7mm	3.5 - 4mm	10mm	
Triple (see Type AA)					
Type AA (inner)					
Triple inner	8mm x .75mm	8 - 12mm		8mm	Use 5mm alien key
Special inner triple	6mm x 1mm 6mm x .75mm	16mm		6mm	
Type B	6mm x 1mm			8mm	Use slotted nut
Type C	7mm x 1 mm			threaded 7mm x 1mm or unthreaded 7mm	Collar diameter 8.9mm
Type D (TA)	7mmx l mm			7mmx l mm threaded	
Type E	5mm x .80mm			7mm or 8mm or 5mm x .75mm	Use slotted nut or 4mm alien key



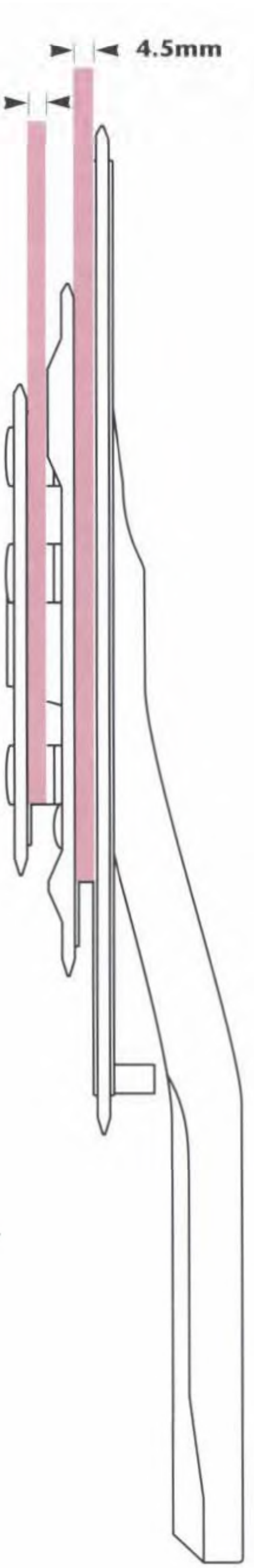
Rings

Middle and outer chainrings on triples have 10mm holes with 12mm recess .5 - 1 mm deep. Inner triple chain rings have 8mm bolts. Generally, steel and titanium inner chainrings have no recess (this also sometimes allows the user to simply flip the chainring over for increased chainring life, depending on the bevel of the teeth).

CHAINRING BOLTS/SPACERS (CONT'D)

Spacing

4.5mm is a good working space between the closest chainring surfaces for use with narrow chain. Chainring spacing must be narrow enough that the chain does not fall between the chainrings. Spacing must also be wide enough that the chain does not rub the next larger chainwheel in any useful chainring - freewheel sprocket combinations. Chainrings vary in thickness as does the depth of the recess in the hole. When replacing chainrings, these variations need to be accommodated with spacers of different thicknesses. Replacing aluminum chainrings with steel or titanium chainrings often requires adding very thin spacers.

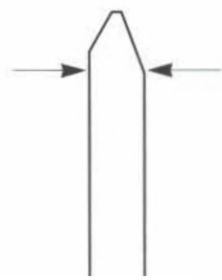


Chainring Spacers	Thickness	Outside Diameter	Inside Diameter	Notes
Type A Double Triple (See Type AA)	**.6 - 2mm**	14mm	10mm	Not used on some cranksets.
Type A Mavic Double	4mm	14mm	10mm	Flattened on one side for chain clearance when using 38T chainring.
Type AA Triple Inner	2 - 7mm	12mm	8mm	Not used on some cranksets.
Type AA Cook* Triple Inner	.15mm	12mm	8mm	Crank arm for SG chainrings.
Type AA Topline Triple Inner	HD-C 9mm	12.5mm	7.9mm	To adapt crank arm for SG chainrings.

* Cook has been sold to Delta (Germany).

Chainring Thickness

Standard	Tooth Thickness	Tolerance	Chain Inner Plate Width
J15 Standard Track	2.1mm 3.0mm	-0.3, +0 -0.4, +0	2.4mm
Shimano IG Hyperdrive -C	2.35mm	N/A	2.38mm



Chainring Thickness

CRANKS, CHAINRINGS, CHAIN

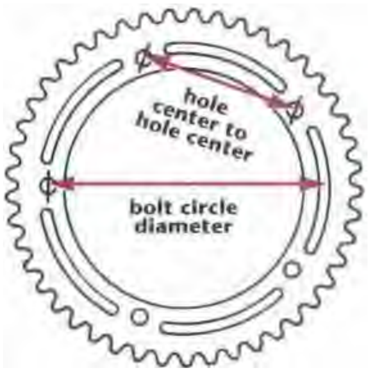
CHAINRING INTERCHANGEABILITY

Chainrings listed together in the same box are interchangeable. Model name does not necessarily determine the bolt circle. The same name is sometimes used on cranks with different bolt circles.

Common chainwheel sizes are:
74 mountain inner
110 mountain middle and outer
130 road double

Micro Drive (MD) chainwheel sizes:
56 inner
94 outer

Compact Drive (CD):
58 inner
94/95 outer



5-Arm Chainrings and Crank Arms

Bolt Circle Diameter	Hole Center to Hole Center	Make	Model	Bolt Type	Hole Size	Min. Teeth
56-MD	32.9	Action Tec	ELS, ATB-inner triple	AA	8	20
		Adventure Components	Race, Race Team Issue MD, HD/C-ARMS ONLY	8-16mm length		
		Avid	MD			20
		Boone	ATB-inner triple			20
		CODA	900 M-compact			*22*
		Cook Bros.	RSR-inner triple ARMS ONLY			
		Kooka	inner-ARMS ONLY			
		Paragon	inner triple titanium			20
		Profile	Billet MTB-inner			20
		SR/SunTour	MD 23-inner			20
		SRP	MD-inner			20
		TA	Zephyr-inner			20
		TNT	Billet-triple ARMS ONLY			
58-CD	**34.1**	Boone	ATB-inner triple	**AA**	8	20
		Grafton	Hyper-C ARMS ONLY			
		Kooka	inner-ARMS ONLY			
		Profile	Billet MTB-inner			20
		Ritchey	Compact-inner			22
		Sugino	Impel 700,500,400,300,			22
		Shimano	400CX, 700CX-inner, Deore XT, Deore LX, Alivio[1], STX[1] -inner and middle	AA	8	20
		SRP	CD-inner			22
		Syncros	Revolution ATB-ARMS ONLY			
		TNT	Billet-inner triple ARMS ONLY			

1 Inner chainring is not interchangeable w/1994 Deore XT, LX, 400CX, or 700CX. Has step on inner chainring. Middle ring has 95mm BCD for mounting outer ring, as well as 58mm for mounting crank arms.

CHAINRING INTERCHANGEABILITY (CONT'D)

5-Arm Chainrings and Crank Arms (cont'd)

Bolt Circle Diameter	Hole Center to Hole Center	Make	Model	Bolt Type	Hole Size	Min. Teeth
67			Alivio-triple inner, riveted middle and outer	M	8	
74	43.5	Action Tec	ELS, ATB-inner triple	8-16mm length	10	24
		Adventure Components	Race, Race Team Issue MD, HD/C-ARMS ONLY	AA		
		American Classic	inner-ARMS ONLY			
		Avenir	inner steel			24
		Avocet	Touring-inner triple	Long A		24
		Bicicleta	ATB-inner triple	bolt or A		24
		Boone	ATB-inner triple			24
		Campagnolo	Euclid, Centaur, Icarus Olympus (26)-inner triple	bolt or A	8 x .75 or 10	24
		CODA	900 ATB inner, road inner triple			24
		Cook Bros.	RSR,CBR-inner triple ARMS ONLY			
		CQP	F, M,MR,TI-2000 ARMS ONLY			
		Grafton	Joy Stix ATB-inner ARMS ONLY			
		Grove	Hotrods-inner ARMS ONLY			
		Hershey	Billet-inner ARMS ONLY			
		Kooka	inner-ARMS ONLY			
		Mavic	631 adapter, 637 inner triplet			
		Ofmega	2000-inner triple			
		Paragon	inner triple titanium			24
		Profile	Billet MTB-inner mtn triple			24
		Race Face	ATB Turbine-ARMS ONLY			
		Ritchey	inner triple			
		Sampson	ATB-inner ARMS ONLY			24
		SR/SunTour	300 series-inner triple, Ninja, Platinum, Rountech, Oval-Tech2			
		Shimano	All inner triple except older Deore (see 85mm), Deore [2]			24, 282
		Shimano SG-X	XTR,XT,LX			26
		Specialized	ATB-inner triple			28
		Specialized	Touring-inner triple			24
		SRP	inner triple			24
		Stronglight	1000, 300			26
		Sugino	inner triple			24
		Syncros	Revolution ATB ARMS ONLY			
		T.A.	Alize, Zephyr-triple, double			24
		Takagi	XT-inner triple			

2 Biopace rings

(contlnued)

CHAINRING INTERCHANGEABILITY (CONT'D)

5-Arm Chainrings and Crank Arms (cont'd)

Bolt Circle Diameter	Hole Center to Hole Center	Make	Model	Bolt Type	Hole Size	Min. Teeth
74 (cont'd)	43.5	T-Gear	ATB-ARMS ONLY			
		TNT	ATB triple-ARMS ONLY			
		Topline	TLX 500-ARMS ONLY			
85	50.0	Shimano	Older Deore	Special	10	26
			FC-DE30-inner triple			
		Takagi	TO AD-TP,TO ST-inner triple			
86	50.5	Sakae (SR)	TG series (old 400 series)-inner triple	A	10	28
		Solida	1531-inner triple			
		Stronglight	99, 49, 107-inner triple 100 all rings			
90	52.9	Edco	inner triple	Special	10	32
		Mavic				
94 - MD	55.3	Adventure Components	Race, Race Team Issue-MD, HD-C-ARMS ONLY	A	10	
		Action Tec	middle and outer			32/34
		Boone	ATB-middle			29
		CODA	900 M-middle and outer[3]			32
		Cook Bros.	RSR-middle and outer ARMS ONLY			
		Grafton	Hyper-C-middle and outer			
		Kooka	outer triple-ARMS ONLY			
		Paragon	aluminum			46
		Profile	Billet MTB-middle and outer			30/42
		Ritchey	Compact-middle and outer			32/42
		Selkirk	middle and outer			42
		Shimano	'95 STX, Deore, Deore XT, LX-middle and outer Hyper Drive-C			34
		SR/SunTour	MD-middle and outer			32/42
		Sugino	Impel-middle and outer			
		Syncros	Revolution ATB-ARMS ONLY			
95	55.8	Shimano	Pre-'95 STX[4], Alivio-outer	A	**10**	
		Takagi (3Arrows)	Tourney touring	A	10	30
		Takagi (3Arrows)	Tourney standard touring	B	8	30
100	58.8	Campagnolo	Triple	Special	10	36
		Merz	Adapter	A	10	31
102	**60**	Avocet	Touring	Special	**10**	32
		Ofmega	2000			
110	**64.7**	Adventure Components	**Race, Race Team Issue-** MD, HD-C-ARMS ONLY	**A**	**10**	
		Action Tec	**ELS, ATB-middle and outer**			**34/36**

3 Splined arms

4 Middle chainring is bolted into 58mm ring.

CHAINRING INTERCHANGEABILITY (CONT'D)

5-Arm Chainrings and Crank Arms (cont'd)

Bolt Circle Diameter	Hole Center to Hole Center	Make	Model	Bolt Type	r Hole Size	Min. Teeth
110	64.7	American Classic	middle and outer-ARMS ONLY			
(cont'd)		Bicicleta	ATB-middle, outer			36/46
		Boone	ATB-middle, outer			33/44
		Campagnolo	Euclid, Centaur,	A	10	34/46
			Olympus, tandem			
		Campagnolo	Gransport, Icarus-outer			42
		Campagnolo	Record O.R. (inner, middle) [5]			(20/30)
			outer			42,44
		CODA	Magic 900-inner and middle [3]			34
		Cook Bros.	RSR-outer ARMS ONLY			
		CQP	F, M,MR,TI-2000-ARMS ONLY			
		Flite Control	Cucamonga-ARMS ONLY			
		Grafton	Joy Stix ATB-ARMS ONLY			
		Grove	Hot Rods-outer ARMS ONLY			
		Kooka	ARMS ONLY			
		Mavic	637-middle and outer			34/46
		Onza	Buzz Saw			
		Paragon	triple titanium	A	10	34
		Profile	Billet BMX			34
			Billet MTB-middle and outer			34/44
		Race Face	ATB Turbine-ARMS ONLY			
		Ritchey	middle and outer			34/46
		Sachs	triple-middle and outer			
		Sampson	MTB-middle and outer			36/46
		Selkirk	triple titanium			42
		SR/SunTour	300 series-middle and outer,			34/46
			Platinum, Roundtech, Oval-Tech [2]			
		Shimano	triple cranks-middle and outer, 400CX,			32, 362
			700CX, BP II/HP* Deore XT, RSX			
		Specialized	triple-middle and outer			34/46
		Stronglight	Biostrong [2]			382
		Sugino	110, Maxy, BMX, others			
		Sugino	steel chainrings	E	7	34
		T.A.	ZephER - middle and outer			34/43
			tandem			34/38
		Takagi	XT outer			
		T-Gear	ATB-ARMS ONLY			

(continued)

2 Biopace rings
3 Splined arms
5 Splined cassette

CHAINRING INTERCHANGEABILITY (CONT'D))

5-Arm Chainrings and Crank Arms (cont'd)

Bolt Circle Diameter	Hole Center to Hole Center	Make	Model	Bolt Type	Hole Size	Min. Teeth
110 (cont'd)		TNT	ATB triple-ARMS ONLY			
		Topline	TLX 400-ARMS ONLY			
		Universal				39
112	65.8	Takagi (3 Arrows)	For 1-piece cranks	D	6	**34**
114	67.0	Schwinn Approved	For 1-piece cranks	D	6	39
		Takagi (3 Arrows)				
116	68.2	Campagnolo	Victory, Triomphe	A	10	36/50
		Ofmega		A	8 x .75 threaded	
118	69.4	Sakae (SR)	RG series (old 200 series)	A	10	36
		Sakae (SR)	old 600 series	B	8	36
120	70.5	Takagi (3 Arrows)	For BMX 1/8" chain	B	8	36
		Zeus		A	10	36
122	71.7	Edco	Touring-outer	A	10	38
		Nervar	Some models			
		Solida	5171, 5271			
		Stronglight	93	A	10	38
		Stronglight	200-1 49-inner only			48
		Stronglight	105, 104, 103, 101, 200			
128	75.2	Nervar	Sport	A	10	38
		Nervar	Star			
130	**76.4**	American Classic	double-ARMS ONLY			
		Boone	road-double	A	10	38/48
		CODA	900 R-tandem, touring			
		Cook Bros	PCH-double ARMS ONLY			
		CQP	ATB, ROAD-ARMS ONLY			
		Grafton	Speed Stix			
		Kooka	Road-ARMS ONLY			
		Mavic	631			39
		Paragon	double titanium			39
		Sachs	double cranks			
		SR/SunTour	current 200 series, Platinum, Roundtech, Oval-Tech 6			426
		Schwinn Approved	Le Tour Deluxe			
		Sampson	Road-double			39
		Shimano	105SC, double cranks, CR-8P20[6], Dura-Ace			426

6 Elliptical rings

CHAINRING INTERCHANGEABILITY (CON-T'D)

5-Arm Chainrings and Crank Arms (cont'd)

Bolt Circle Diameter	Hole Center to Hole Center	Make	Model	Bolt Type	Hole Size	Min. Teeth
130 (cont'd)	76.4	Shimano	Dura Ace Track (old style)			
		Specialized	double			38/50
		Specialized	ATB, outer-road			54
		Sugino	1 30			39
		Stronglight	300-1			48
		Stronglight	300-2			38
		SunTour	double cranks '87 - current			39
		Syncros	Revolution ATB-ARMS ONLY			
		TA	inner and outer			38/47
		Takagi (3Arrows)	Tourney Racing SP			39
		Thun	Coronado	A	1 0	39
		TNT	Billet-road double-ARMS ONLY			
		Topline	TLX 500 double-ARMS ONLY			
		Universal				39
130	76.4	Schwinn Approved	Le Tour	B	8	39
		Takagi (3Arrows)	Tourney **Racing** standard			
135	79.4	Boone	Road-double			39/52
		Campagnolo	Record (1985-current)	A	10	39
			Croce D'Aune, Chorus			
			Athena, Xenon			
		T.A.	Campy Chorus-inner and outer			39/51
		Topline	ARMS ONLY			
144	**84.6**	Avocet		**A**	**10**	**41**
		Campagnolo	Road 1967-1984			
		Campagnolo	Track 1972-current			
		Campagnolo	BMX			
		Edco				
		Gipiemme				
		Mavic	630			
		Merl	Adapter			
		Miche				
		Mikkelson	Adapter			
		Nervar	2000			
		Ofmega				
		Omas				
		Sakae (SR)	5LA series (old 100 series), Roundtech			
		Shimano	Track 1985 - current			
		Specialized	Racing			

(continued)

CHAINRING INTERCHANGEABILITY (CONT'D)

5-Arm Chainrings and Crank Arms (cont'd)

Bolt Circle Diameter	Hole Center to Hole Center	Make	Model	Bolt Type	Hole Size	Min. Teeth
144 (cont'd)	84.6	Stronglight	106, 107	A	10	41
		Sugino	Mighty, others			
		SunTour	Superbe, Cyclone pre-1987			
		T.A.	inner and outer			41/45
		Tevano				
		Topline	Track-ARMS ONLY			
151	88.8	Campagnolo	Track pre-1972	A	**10**	44
		Campagnolo	Road pre-1967			
		Merz				
		Shimano	Dura Ace Track (until 1985)			
		Sugino	Mighty Track (old style)			
		Williams				
		Zeus	Competition inner			

Chainring Adapters: Factors To Consider

- **Front or rear derailleur capacity:** Will the derailleur handle the wider range of gears? This is similar to the problems encountered when replacing a double with a triple,, though finding even larger capacity derailleurs may be harder to find.
- **Front derailleur throw (range of motion in and out):** Adding an extra (Maiming may reach the limits of how far the front derailleur can move inboard or outboard (even after completely loosening the derailleur adjustment screws).
- **Chain length:** The chain may need to be shortened so that the chain will not slap the chainstays when the bike is on the smallest chainring.
- **Gear range and availability:** Not all gear combination will be useable. Though you may shorten the chain, it still may slap the chainstay when on the smaller cogs. You must balance the available gears when on the smallest chainring and the available gears when on the largest chainring with the chain length. Shorten the chain as much as possible while still allowing a full range of motion across all the rear cogs when in the largest chainring. This would prevent the rider from easily damaging the bicycle while shifting.
- **Spacing/proper spacers:** Make sure that the chain cannot fall between the chainrings and that it does not scrape the adjacent chainring. Make sure the chain will not shift past the chain ring either.
- **Chainline/bottom bracket spindle length:** See previous discussion on chainline.
- **Bottom bracket shell clearance:** Most bottom bracket shells are under 41mm in diameter, while lockrings for bottom bracket cups are 45mm. Some adapters have a smaller inside diameter.

CHAINRING INTERCHANGEABILITY (CONT'D)

Chainring Adapters

Model	Part#	Replace or Add	Adapt From (Bolt Circle Diameter)	Adapt To	MInimum Inside Diameter
Avid					
Microadaptor		replace	74	56mm bolt circle	
Microadaptor2		replace	74	58mm bolt circle	45
Mavic					
631 triple adapter [4]	MV-631-008	add	110	74mm bolt circle	47
Mountain Tamer [3]					
Plus		replace & add	74	SunTour A freewheel cogs[1]	46
Quad Chainring		add	74	Maillard MR700 or GY cog [2]	42.5
Triple		replace	74	1 SunTour A freewheel cog [1]	46
TA [5]	CP-4551304	replace	130	74mm bolt circle	60
	CP-4551354		135	74mm bolt circle	60
White Industries					
Limbo Spider		replace	74	SunTour A freewheel cog[1]	45.8

1 SunTour A cogs available from 17 to 34 teeth.

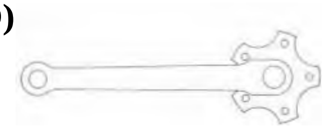
2 Maillard or Sachs cogs available from 16 to 21 teeth. Follow adapter manufacturer's instructions for removal of cog.

3 Detailed installation instructions including optimal spacing directions available from manufacturer.

4 Adapter for Mavic 631 crankset; has 9.9mm diameter, 1.53mm high shoulder on adapter.

5 This replacement chainring, 130mm BCD is available in 38-42 teeth, 135mm BCD is available in 39-42 teeth.

CHAINRING INTERCHANGEABILITY (CONT'D)



5-Pin Chainrings

Chainrings listed together are interchangeable.

Bolt Circle Diameter	Hole Center to Hole Center	Make	Model	Bolt Type	Hole Size	Min. Teeth
50.4*	29.6	Many including:				
		Cinelli				
		Duprat				
		Durax				
		Gnutti				
		Huret				
		Nervar	1004, 1006			
		Shimano	older Deore			
		Simplex				
		Solida				
		Stronglight	49			
		Sugino	Pro Dynamic, PX, Super Maxy			
		TA	Criterium, Cyclotouriste			
		Williams				
		Zeus				
50.8 (2")	29.9	Bullseye				

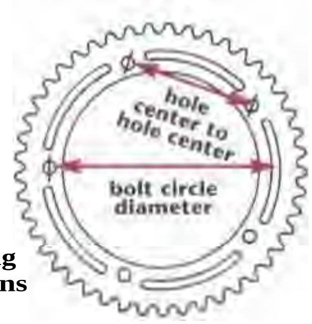
6-Bolt Chainrings

Bolt Circle Diameter	Hole Center to Hole Center	Make	Model	Bolt Type	Hole Size	Min. Teeth
80	40.0	TA	Cyclotouriste	E	7.2	26
		Lambert	middle bolt			
116	58.0	TA	Randonneur	E	7.2	36
143	71.5	Lambert	outer bolt circle	E	7.2**	
152	76.0	TA	Criterium	E	7.2	43
157	78.5	Nervar				
		Haubtmann				
		RFG				
		Solida				
		Simplex				
		Zeus & others				

* This is a common bolt circle used with a 40mm hole in the chainring. Bolt sizes are frequently 5 x .75 or 5 x .80. Hole sizes in aluminum chainrings are frequently 7 or 8mm or are threaded for 5mm bolt in steel chainrings.

** Hole threaded on inner ring.

CHAINRING INTERCHANGEABILITY (CONT'D)



Chainring Dimensions

3-Arm Chainrings

Chainrings listed together are interchangeable.

Bolt Circle Diameter	Hole Center to Hole Center	Make	Model	Bolt Type	Hole Size	Min. Teeth
85	**73.5**	Sakae (SR)	Custom 3	A	10	28
88.9 (3 1/2")	77	Nicklin Cross Williams	N34 N34 C34			
95	82.3	Shinano	600, **310**	**A**	10	30
106	92	Dague Mundo Sakae (SR) Sugino Takagi (3 arrows)	Caloi Apex w/8mm holes Maxy, others Tourney, American Flyer, others	B	8	32*
106	**92**	Sakae (SR)	Apex w/10mm holes	A	**10**	34
112	97	Takagi (3 arrows)	1 piece crank	**D**	**8**	
116	**101**	Campagnolo Cinelli, Duprat Durax, Gnutti Haubtmann Magistroni Nervar, Simplex Solida Stronglight TA TA Adapter Ring Zeus and others	Sport, Grand Sport Professional	**C** or D	9	36**
140	121.2	Campagnolo	Grand Sport. inner	B	8	40

Chainrings come in steel and aluminum; there are different spacers for each. Generally, 5mm spacers are used for steel and 3.5mm are used for aluminum.

Often attaches to spigots (raised bumps) on crank arms. This bolt circle is often used with a larger (157mm) bolt circle. Sometimes a piece of metal that looks like this joins the two circles. Nervar, Haubtmann, Solida, Zeus, and most others arc 78.5mm between hole centers. Some Italian chainrings with this large bolt circle use unevenly spaced holes. Pairs of holes were spaced 63.4mm apart on ones we measured.

CHAIN CHARACTERISTICS

Chain Sizes

Chain	Nominal Size in Inches A	X	B	Nominal Size in Millimeters A	X	B
Internally Geared Hubs and Coaster Brakes	1/2" 1/2"	X X	1/8" 3/16"	*12.7* 12.7 12.7	X X X	3.17 3.30 4.76
Road/MTB	1/2" 1/2" 1/2"	X X X	5/64" 3/32" 1/8"	12.7 12.7 12.7 X 3.17or	X X	1.98 2.38 12.7 X 3.3
ATB/MTB	1/2"	X	3/32"	12.7 12.7	X X	3.17 3.30
Block Chain (now obsolete)	1	X	3/16"	25.4	X	4.76
Track	1/2"	X	1/8"	12.7 X 3.17or		12.7 X 3.3

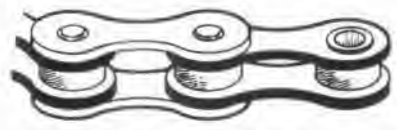
* Used for 2, 3 and sometimes 4 and 5 speed freewheels.

Number of Links

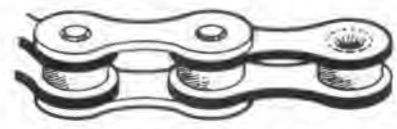
Youth — **56**
BMX — **96 - 105**
Internal Geared — **105-112**
ATB, Road — **114 - 118**
Tandem — **131 - 280**

Bushings

Bushingless chain has the ability to twist more than chain with bushings. Some systems work best with a chain that will twist and some with a chain that resists twist. Be sure to follow the recommendations in each manufacturer's section ***(see Indexing Chapters 5-9).***



Chain with Bushing

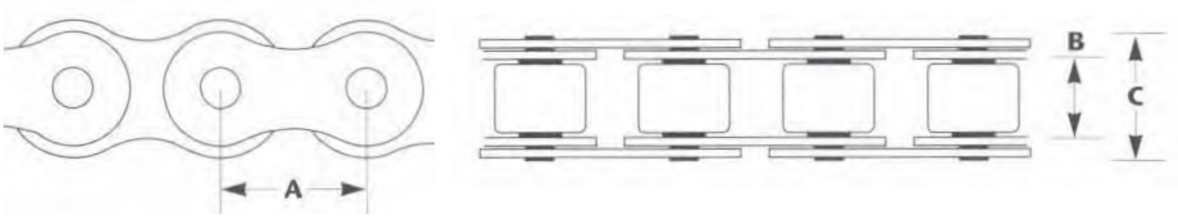


Chain without Bushing

CHAIN CHARACTERISTICS (CONT'D)

Chain Dimensions

The first number refers to the pitch or the distance between the center of one roller and the center of the next roller bearing the same load **(Dimension A).** The second number refers to the distance between the inside plates or the smallest space for the tooth of the sprocket **(Dimension B).** Nominal and actual sizes are not exactly the same.



A narrow chain has the same inside **(Dimension B)** as a regular 1/2" x 3/32" chain. The outside **(Dimension C)** is smaller. **A regular width chain is approximately 8.0mm wide while a narrow chain is 7.2 to 7.4mm wide.** This difference allows a 7 or 8 speed freewheel to be used in the space of a regular 6 speed freewheel. There are a few super narrow chains for use on 8 speeds only, they are approximately 6.8 - 7.2mm wide. The super narrow chains work better with cogs designed for narrow chains such as Shimano Hyperglide. Regular width chains cannot be used on narrow 6, 7, and 8 speed freewheels.

Generally a bevelled chain is used with indexing systems. See chain recommendations in the beginning of each manufacturer's indexing section. Some models can be identified by the markings on the pin heads.

Chain Width/Pin Length (In Millimeters)

Chain	Size in mm
Campagnolo	
Contax	6.85
Daido (DID)	
Super L	7.20
KMC	
UG50	7.30
HP70	7.30
alpha 50	7.30
HP20	7.80
410	9.40
Regina	
53 Turismo	9.30
51 Sport	9.10
50 Corsa	8.10
50 Racing	7.20
50 SL	7.20
50 Anniversario	7.20

Chain	Size in mm
Rohloff	
SLT 99 Road	6.85
SLT 99 MTB	6.95
Sachs	
SC-30, 40	7.05
SC-M 50, 55	7.05
SC-R80	7.05
SC-M90	7.05
CH-TM10	9.20
CH-TM20	8.10
SR/SunTour	
AP	7.30
XC Expert	7.27
XC-Pro	7.37

Chain	Size in mm
Shimano	
Dura-Ace HG	7.4
Dura-Ace UG	7.4
HG-7401	7.4
UG-30	7.4
Deore XT II	7.4
CN-IG30	7.2
CN-IG50	7.2
Taya	
Extreme	6.85
Relief	6.85
Turbo 900	7.30
Bridge	7.30
Union	
800	7.40
810	7.40
900	7.25

CHAIN CUTTING NOTES

Sedisport Chain

Sedisport M90, M55, M50, Pro, and ATB chain have mushroomed over pins to help it withstand side thrust. Special care must be used when removing the chain. These chains have a special dimpled connecting pin that is located by a single black side plate. Push the pin on the dimpled end when removal is needed. Push the mushroomed non-dimpled end when installing.

Shimano IG, Hyperglide (HG), and Uniglide (UG) Chain

IG, Hyperglide (HG), and Uniglide (UG) chains have widened outer plates that require chain tools that are designed for them.

IG and Hyperglide chains have mushroomed over pins that help them withstand side thrust. When breaking a chain, push a single pin all the way out. When rejoining the chain, use the special HG pin to replace the pin you removed. After the new pin is inserted, break off the remaining end with pliers.

The IG chain gauge Shimano tool #130 0600 is used to insure there is enough space between the inner plates after joining a chain. The space required for the teeth of IG sprockets and chainwheels is 2.38mm. The connecting pins must protrude an equal amount on either side of the chain.

IG and Hyperglide chains are best cut with a straight stroke style chain tool rather than a pliers type.

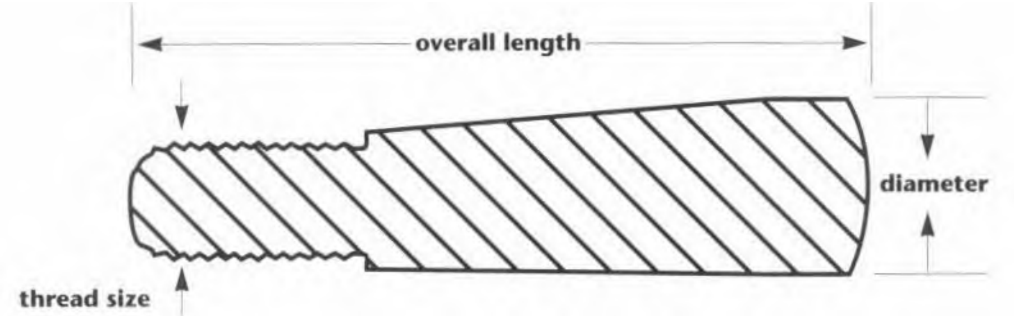
Taya

Use a Sigma Connector to attach the chain. Do not use a chain tool. This chain is 1/2" x 5/64".

It will fit most sprockets and chainrings less than or equal to 2.0mm thick but should only be used on narrow spaced freewheels.

CRANKS, CHAINRINGS, CHAIN

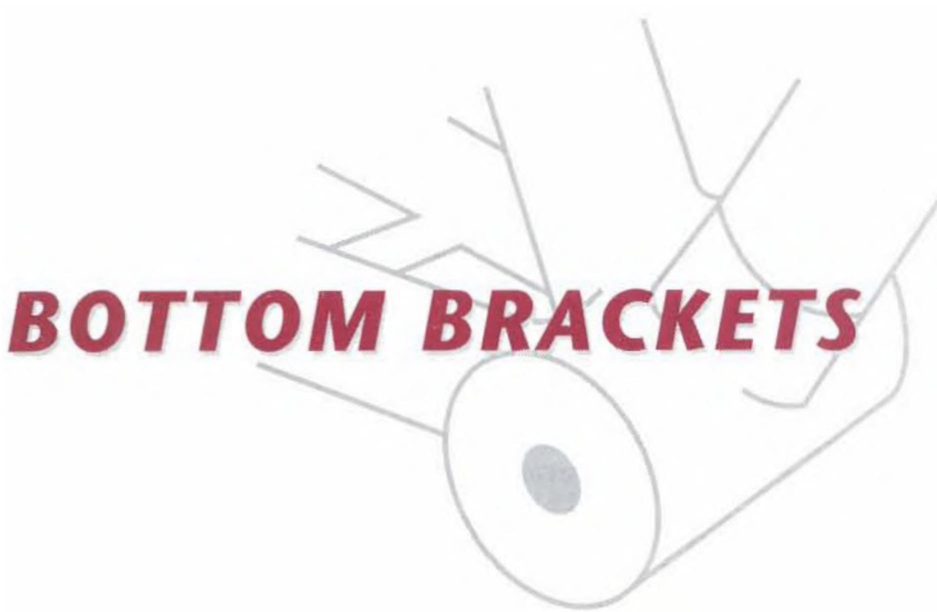
CRANK COTTERS



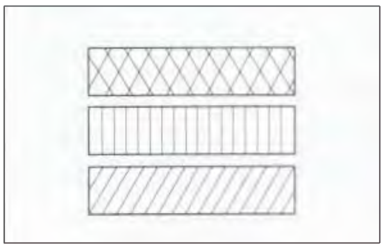
National Tendencies and Others	Diameter	Overall Length Without Nut	Thread Size	Flat
ISO	9.5 (3/8")	43	7mm x 1 mm	see Appendix
English	9.5 (3/8")	43	6.7mm x 26 TPI	moderate
French	9.0	40, 43	7mm x 1 mm	moderate
German	9.5, common 9.0	43 43	7mm x 1 mm 1/4" x 26 TPI	moderate
Italian	9.0, common 8.5	43 41.5	7mm x 26 TPI 7mm x 26 TPI	short steep cut
Japanese	9.5	41.3*	6mm x 1mm Japan Standard 1/4" x 26 TPI also common	
Peugeot old style	9.0	37.5	6mm x 1 mm	entire length of body cut
new style	9.0	42	7mm x 1mm	moderate
Steyr	9.5	45	1/4" x 26 TPI	entire length of body cut
Thompson (adult) (child)	9.5 8.0	42.5 43	1/4" x 26 TPI 1/4" x 26 TPI	moderate cut moderate cut
Windsor	8.5	41.5	1 /4" x 26 TPI	short steep cut

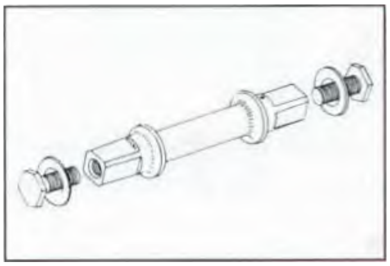
* S.R. alloy cottered cranks: use extra long cotters.

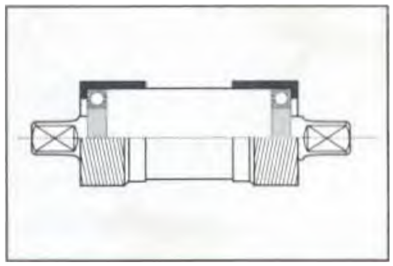
8.5mm and 9.0mm holes in cranks may be drilled out to accept 9.5mm cotters. Use a 3/8" drill.



BOTTOM BRACKETS







BOTTOM BRACKETS

BOTTOM BRACKET CUPS-BOTTOM BRACKET SHELL

Ball Sizes

11 - 1/4" balls per side.

Exceptions: Campagnolo used 3/16" balls for one year in the mid-1960's.

Campagnolo Super Record and (C-)Record used ball cages with 14 - 3/16" balls.

1990 Record uses ball cages with 14 - 7/32" balk.

Shimano Selecta uses 15 - 3/16" balls on the left side only.

Thread Sizes:

		Adjustable Cup (Left Side)	Fixed Cup (Right Side)	Approx. Shell I.D.	Approx. Cup O.D.
1S0'	1.375" x 24 TPI	right-hand thread	left-hand thread	33.8mm	34.8mm
English - B.S.C.	1.370" x 24 TPI1	right-hand thread	left-hand thread	33.8mm	34.8mm
French2	35mm x 1mm	right-hand thread	right-hand thread	33.8mm	34.8mm
Italian	36mm x 24 TPI	right-hand thread	right-hand thread	34.8mm	35.8mm
Raleigh3	1-3/8" x 26 TPI	right-hand thread	left-hand thread	33.8mm	34.8mm
Swiss	35mm x lmm	right-hand thread	left-hand thread[4]	33.8mm	34.8mm
Chater LeaS	1.450" x 26 TPI	right-hand thread	left-hand thread		

ISO size is compatible with English.

1 Raleigh describes Phillips bottom bracket cups as 1-3/8" x 24 TPI Whitworth. This is different from the British Standard Cycle. ***(See Thread Measuring, page 0-3, for a description of thread differences.)***

2 Motobecane uses left threaded (Swiss style) fixed cups on most hikes. For cottered cranks, it is left threaded if the fixed cup has 8 flats; it is right threaded if it has 2 flats. ***(See page 3-3 for markings on Swiss left-threaded cups for cotterless cranks.)***

3 Raleigh U.S.A. uses 1.370 x 24 TPI. With English made bikes such as Raleigh, Rudge, Humber, and brands made by Raleigh after 1963, use 1-3/8" x 26 TPI except for bikes made by Carlton. They use 1.370 x 24 TPI. A Raleigh with 71 or 76mm bottom bracket shell generally uses 26 TPI. 67 or 68mm shells use 24 TP1.

4 Some Swiss bikes have French right threaded fixed cups. ***(See page 3-3 for markings on Swiss left-threaded bottom bracket cups.)***

5 This is an obsolete British size which is sometimes found on tandems and other bikes.

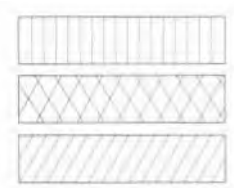
Phil Wood & Co. makes mounting rings for their sealed crank bearing that fit all the bottom bracket threads listed above, including Chater Lea.

mill **All stripped bottom bracket threads except the Italian ones can be reamed out and re-threaded to Italian. Use a size K expansion reamer or a Bicycle Research bottom bracket reamer.**

Viscount bottom brackets can be reamed and tapped to Italian. Be sure to replace the aluminum forks; they break without warning.

BOTTOM BRACKETS 

BOTTOM BRACKET CUP MARKINGS

	FIXED CUP	ADJUSTABLE CUP	MARKINGS ON LOCKRING EDGES
CAMPAGNOLO			
English (BSC)	1.370" x 24 TPI	1.370" x 24 TPI	
French	35 x 1	35 x 1	
Italian	36 x 24F	36 x 24F;	
Swiss (left-thread)	35 x lG		
JAPANESE & TAIWANESE			
English (BSC)	1.370" x 24TPI	1.370" x 24TPI	
French	35 x P1	35 x PI	
Italian	36 x 24T	36 x 241	
Swiss (left-thread)	35 x Pl S1		
NERVAR			
English (BSC)	1 ring 2 flats	1 ring 6 sides	
French	no ring	no ring 6 sides	
Italian	2 rings 2 flats	2 rings 6 sides	
RFG			
English (BSC)		4CR	
French	C	C	
German	GL	DR	
Italian	2 flats	4 pin hole	
Raleigh	no flange		
STRONGLIGHT*			
English (BSC)	2 rings 8 sides	6 sides no rings	4 or 8 notch**
French	1 ring 8 sides	6 sides no rings	6 notch
Italian	1 ring 8 sides or 1 ring 2 flats	4 pin tool holes no rings	4 or 8 notch**
Swiss (left-thread)	no rings 8 sides		
TA			
English (BSC)	2 rings	2 rings	
French	1 rIng	1 ring	
Italian	no rings	no rings	

* Stronglight Competition for all sizes have 2 flats, no rings.

** Italian lockrings slip over English bottom bracket cups and English lockrings do not fit over Italian bottom bracket cups.

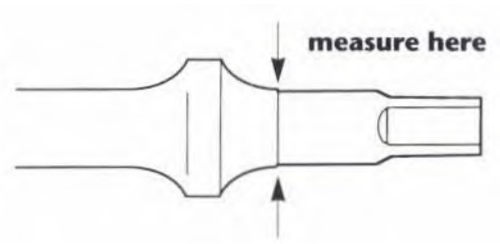
SUTHERLAND'S

BOTTOM BRACKETS

BOTTOM BRACKET CUP-SPINDLE COMPATIBILITY

Since bearing race diameters vary, not all conventional bottom brackets using 1/4" balls are compatible.

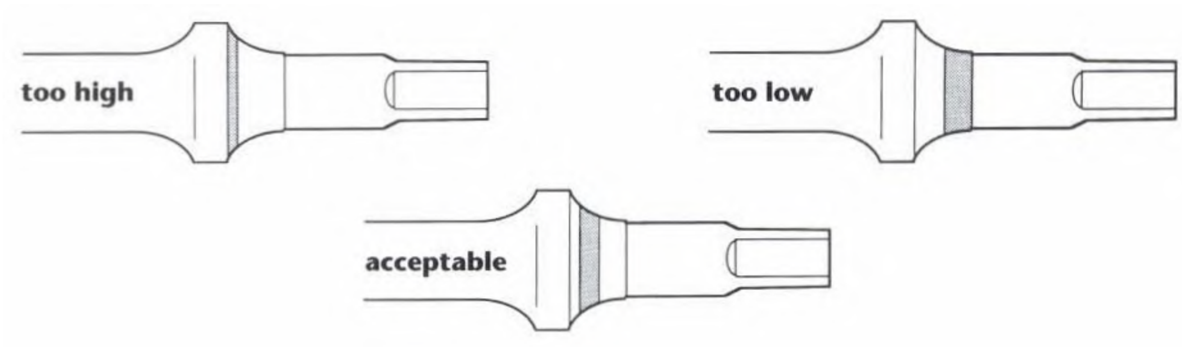
Spindle diameter at base of bearing race



Peugeot cottered	15.90mm	.626 inch
Raleigh cottered	16.40mm	.646 inch
Japanese cottered	16.50mm	.650 inch
Japanese (JIS)	16.50mm	.650 inch
Sugino Mighty	16.50mm	.650 inch
Phillips, other British cottered	16.55mm	.652 inch
Stronglight, TA	16.75mm	.659 inch
Campagnolo, SR Royal, Shimano Dura-Ace, SunTour Superbe, Zeus	16.90mm	.665 inch

When possible, use cups and spindles of the same make and model. When mixing brands and models, test the bearing fit before installing cups in the bicycle. Smear inside of cup lightly with grease and install bearing balls (balls in retainers are more convenient for this purpose). Insert spindle and rotate. Remove and note position of ball track on spindle.

Bearing Track



If the bearing track is too high or too low, it will accelerate wear. Especially avoid leaving one track high and the other low, as this would produce a strong "wedging" force on the races. if one cup is worn out, find a matching replacement or replace both cups with a matched pair.

Cup race diameters tend to follow spindle race diameters. Individual manufacturing variations may affect fit. Typically, cups as much as 0.25mm (.010") oversize and 0.12mm (.005") undersize are acceptable. Due to a more gradual slope of the bearing race surface, Stronglight and Sugino cups accept a wider range of spindle diameters than others. Sugino Mighty spindles will accept a wide range of cups, even those made for 16.90mm spindles.

BOTTOM BRACKET CUP-SPINDLE COMPATIBILITY (CONT'D)

Old Combinations That Don't Work

- Peugeot cottered spindles and cups will not interchange; its bearing race diameter is much smaller than the others.
- Old-type Shimano Dura-Ace spindles (BF3-7200, BB-7300, and BB-7500) will not fit through **the** holes in other brands of cups. The entire bottom bracket set is interchangeable.
- Cups for British cottered spindles will not work with many cotterless spindles.

Old Useful Combinations That Do Work

- 26 TPI Raleigh cups will work with Maxy-type cotterless spindles.
- Sugino Mighty triple axle will fit in Campagnolo Nuovo Record cups.
- Maxy-type spindles can be used to place chainline farther from the frame with Stronglight or TA cranks.

BOTTOM BRACKET CUP FACTORS

When exchanging bottom bracket cups, depending on the thickness of the cup, the relative position of the spindle may be moved left or right.

To find **the** amount the bottom bracket spindle has moved, compare the fixed cup factors in the following table. If the new cup has a greater factor, the spindle will be moved to the left (a smaller factor will move it right). Take care to assure that there will still be enough threads to properly adjust the lockring when choosing cups with a smaller factor than the old cups.

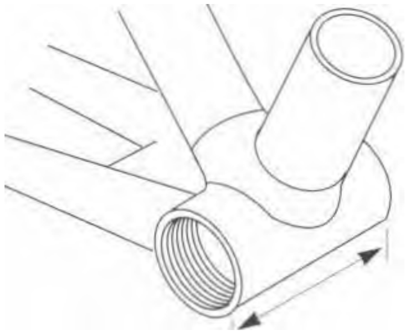
		Fixed Cup Factors			
Make	**Comments**	**English**	**French**	**Italian**	**Lockring Thickness**
Campagnolo	thin	2.0	2.5	2.5	3.0
Campagnolo	thick	4.0	4.5	4.0	3.0
Nervar		2.5	2.5		3.0
Ofmega	cadmium-plated	—		3.0	2.5-4.0
Ofmega	chrome-plated		—	3.0	4.0
Ritchey	bulged out	0.0		—	3.5
Shimano	Dura-Ace* pre '85	1.5	1.5	1.5	3.5
Shimano	Dura-Ace after '85	4.0	4.0	4.0	3.0
Stronglight		2.0	1.5	2.0	4.0
SR		3.5	3.5		3.5
Sugino	Maxy	4.5	4.0	4.5	3.5
Sugino	Mighty	4.0	4.0	4.0	3.5
SunTour		4.0	4.0	4.0	3.0
Specialized		4.0			3.5
TA		2.5	2.0	3.0	5.0
TDC		3.0	—		3.5
Zeus			—	2.0	--

* Old Dura-Ace cups had larger holes to accommodate a larger diameter axle. Not interchangeable **with others.**

BOTTOM BRACKETS

BOTTOM BRACKET SHELL WIDTHS

This chart lists only tendencies. As there are exceptions, measure to he sure. Bottom bracket spindles are made to be used with a specific cup thickness. Different cup thicknesses may cause problems.



Bottom bracket shell width

Bottom Bracket Shell Widths

Standard	Shell Width	Cottered Spindle Centers	Uses
English	66-67mm often listed as **68mm** (2-19/32" – 2-5/8")	52.5mm (2-1/16")	Road and track
French	**68mm**	54.5-56.5mm	Road and track
Italian	**70mm**	56.5-58mm	Road
	65, 68, 70mm	varies	Track
Japanese	68, 71 mm	52-53, 55mm	Varies
	73mm	57	Mountain bike

Exceptions

Brand	Shell Width	i Cottered Spindle Centers	Uses
Cinelli (model SC for several years in the 1960's)	74mm		
Raleigh	71 mm (2-13/16")	55.0mm (2-5/32")	Most Raleighs, except bikes with 24TPI threads
	76mm (3")	62.0mm (2-7/16")	Tourist, Chopper, Twenty, others
Thompson (Thun)	65mm, 70mm	*(See page 3-58.)*	3-piece style cranks with press-in cups and threaded spindles

BOTTOM BRACKETS

BOTTOM BRACKET INTERCHANGEABILITY

The charts on the following pages are for replacing worn spindles, cups, or complete bottom bracket sets. By comparing the numbers listed, you can determine the differences that affect the fit of the parts.

Consider this an experimental system which will work when used with care. Please write and tell us if you have any problems. We are not and cannot be responsible for any difficulties arising from the use of these charts. Occasionally manufacturers change specifications without changing the model names and numbers and measurements also vary from batch to batch because of manufacturing tolerances. The parts we measured may not be representative, but we feel the numbers here are close enough to be useful.

Center-width and spindle-end factors are numbers that are useful only when comparing one spindle to another.

Bolt-type spindle

How To Use The Bottom Bracket Charts

1. Completely read these steps before starting to disassemble the bottom bracket and cranks.
2. Examine the bicycle. Determine how much the position of the chainrings can be changed. Will the chainrings rub against the chainstays if they are moved in? Will the derailleur work if the chainrings are farther out or in? Estimate in millimeters how much the chainrings can go in or out. Write down your estimate. **If** you are installing a new crank and bottom bracket, place the new crank on the old bottom bracket on the bicycle and make your estimates from that position.
3. Note the position of the lockring on the adjustable cup. How many threads are showing? Write down the number. Estimate how many more or less threads will work. Write that down.
4. Measure the distance from the right-hand edge of the bottom bracket shell to spindle end (do not count threaded section if it is a nut-type spindle). **This is the Shell to End, Right Measurement (SER).** Write the measurement down.
5. Remove the crank.
6. Disassemble the bottom bracket set.
7. Measure bottom bracket shell width and spindle length.
8. Determine which parts need replacing. Then, go to the correct chart:

   A. **Replacing Spindles Only** ***(see also Bottom Bracket Cup-Spindle Compatibility, page 3-4).*** JIS* spindle replacing JIS spindle, ***(see page 3-8).*** Non-JIS spindles with balls in retainers, ***(see page 3-14).***

   B. **Replacing Complete Set Only,** ***(see page 3-15).*** JIS bottom bracket sets, ***(see page 3-8).*** Non JIS bottom bracket sets with ball retainers, ***(see page 3-15).***

   C. **Replacing Cups Only.** Bottom Bracket Cup Factors, ***(see page 3-5).***

Once you understand how to use the charts, it is possible to use them for other combinations or replacements. This will, however, increase the possibility that the combinations won't work.

NOTE: For all charts, all dimensions are in millimeters unless otherwise specified.

* JIS spindles are the ones most commonly found in imported bikes.

Nut-type spindle

BOTTOM BRACKETS

Bolt - type spindle

OS AND CLONE SPINDLES

Stamped numbers and letters are consistent enough among makers that dimensions can be listed. Left sides may vary among makers.

Interchangeability

(See page 3-7), for further notes on interchangeability, spindle end factors, and SER.

Taper Angle on Spindle Ends

(See Taper Angles on page 2-4.)

Crank and Spindle Compatibility

The square taper of JIS spindles is similar (though longer) to that of older Stronglight and TA spindles. The square taper of many spindles, including top-of-the-line Japanese, is too narrow and/or too short to be compatible with cranksets designed for JIS spindles.

Bottom Bracket Cup Compatibility

Bearing race diameter is smaller for JIS spindles than for most other spindles except English cottered. Do not interchange cups without testing the position of the bearing track ***(see page 3-4).***

Bottom Bracket Shell Width

The single-digit number stamped on the spindle indicates which shell width to use. 3 is for 68mm bottom bracket shells with 52mm spindle centers. 5 is for 71 mm shells with 55mm spindle centers. 7 is for 73mm shells with 57mm spindle centers. 2 indicates a 65mm shell and 50.5mm center.

Cup thickness varies, so it may be possible to use a spindle with a 55mm center with extra-thin cups in a 68mm bottom bracket, or a spindle with 52mm center with extra-thick cups in a **71mm** bracket.

Nut-type spindle

JIS and Clone Spindle Markings

Note: there are exceptions and additional letters in the complete spindle chart.

IN THIS POSITION:
D indicates bolt-type*
No mark indicates nut-type
F indicates SR polished race bolt-type
- **B** after marking also indicates bolt-type;
  example: D-3NL = 3NL-B -

IN THIS POSITION:
- **2** indicates 65mm bottom bracket width (50.5mm spindle center)
- **3** indicates 68mm bottom bracket, width (52.5mm spindle center)
- **5** indicates 70mm bottom bracket width (55mm spindle center — Shimano bolt-type is listed as 54mm)
- **7** indicates 73mm bottom bracket width (57mm spindle center)

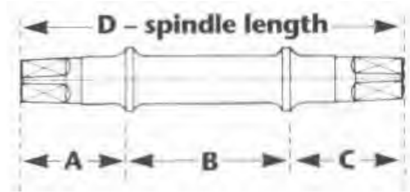
This position indicates the approximate right side (chainring) spindle length:
H is 30.5mm
A, L, J are 32mm
P N are 35mm
S is 37.5mm

D - 3 N L

This position indicates the approximate left side spindle length.
S means shorter than original
L means longer than original
Original in this example would be a D-3N spindle

)IS AND CLONE SPINDLES

SER denotes shell to end, right measurement.
(See page 3-15 for further explanation.)

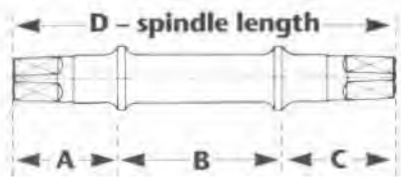


65mm Shell Width

Crankset Used with	Nut-type marking	Bolt-type marking	Shimano Cartridge marking	Sugino Bolt-type marking	Old marking	Old Shimano marking	A	B	C	D - Spindle Length	Spindle End Factor	SER
	685						32	50.5	32.5	115	9.0	25.25
	68K						32	50.5	36	118.5	12.5	28.75
	2S						32	50.5	37.5	120	14.0	30.25
	2R						32	50.5	42	124.5	18.5	34.75

68mm Shell Width

Crankset Used with	Nut-type marking	Bolt-type marking	Shimano Cartridge marking	Sugino Bolt-type marking	Old marking	Old Shimano marking	A	B	C	D - Spindle Length	Spindle End Factor	SER
SLP Double			SS103							103	2.5	18
			MM107							107	3.5	19
	3K	D-3K					28	52	28	108	4.5	20
			MM 110							110.5	5.5	21
SLP CD												
Triple				31-B			30	52	29	111	5.5	21
					68-S		31	52	30	114	6.5	22
		D-3H	LL113	3H-B			30.5	52	30.5	113	7.0	22.5
			D-H							115	8	23.5
LP Triple	3L,3J	D-3L		3j-B		68 W 116	32	52	32	116	8.5	24
			XL118							118	9	25
LP Double	3A	D-3A					32	52	33.5	117.5	10.0	25.5
	3P	D-3P				68 W 119	32	52	35	119	11.5	27
Triple	3N	D-3N		3N-B	68-W		32	52	36	120	12.5	28
		D-3NL	D-NL				34.5	52	36	**122.5**	12.5	28
	3N N			3NN-B			36	52	36	124	12.5	28



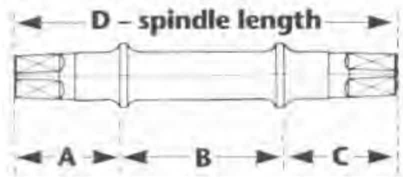
)IS AND CLONE SPINDLES (CONT'D))

68mm Shell Width (contd)

Crankset Used with	Nut-type marking	Bolt-type marking	Shimano Cartridge marking	Sugino Bolt-type marking	Old marking	Old Shimano marking	A	B	C	D - Spindle Length	Spindle End Factor	SER
Triple	3SS	D-3SS		3S-8		68 T 121.5	32	52	37.5	121.5	14.0	29.5
	35,(35),3S2						35	52	37.5	124.5	14.0	29.5
	3Y		D-EL				37.5	52	37.5	127	14.0	29.5
	3T	D-3T		3T-B			35	52	39	126	15.5	31
			3TM-B				37.5	52	39	128.5	15.5	31
		D-3TS, D-3TSP					37.5	52	39	128.5	15.5	31
Triple	R3T						39	52	39	130	15.5	31
				3TR-B			42	52	39	133	15.5	31
	3U	D-3U*		3U-B	68-T		32*	52	40.5	124.5*	17.0	32.5
	3UM						37.5	52	40.5	130	17.0	32.5
	3X						40.5	52	40.5	133	17.0	32.5
				3R-B			32	52	42	126	18.5	34
	3R						35	52	42	129	18.5	34
	3RM						37.5	52	42	131.5	18.5	34
				3TR-8			39	52	42	133	18.5	34
	3RMC						40.5	52	42	134.5	18.5	34
				3RR-B			42	52	42	136	18.5	34
	3M						35	52	43.5	130.5	20.0	35.5
	3IC						35	52	45	132	21.5	37

* Conflicting manufacturer's specifications, use either 32 or 35mm left end width.

SER denotes shell to end, right measurement.
(See page 3-1S for further explanation.)



CIS AND CLONE SPINDLES (CONT'D)

70mm Shell Width

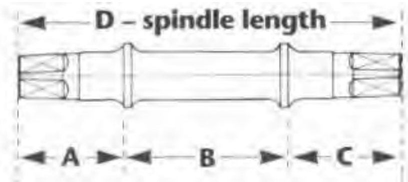
Crankset Used with	Nut-type marking	Bolt-type marking	Shimano Cartridge marking	Sugino Bolt-type marking	Old marking	Old Shimano marking	A	B	C	D - Spindle Length	Spindle End Factor	SER
SLP Double			SS103							103	.5	16.5
SLP Dbl/Trp			MM107							107	3.0	18.5
		D-5K					27	54	27	108	3.5	19
SLP Triple			MM110							110.5	4.5	20.5
			LL113							113	6.0	21.5
			D-H							115	7.0	22.5
	5H	D-5H					30.5	55	30.5	116	7.0	22.5
			XL118							118	8.0	24
	5L			5IB			30.5	55	32	117.5	8.5	24.5
	5LL	D-5L*,D-5LL				70 W 119	32*	55	32	119	8.5	24.5
	5A	D-5A					31	54	32.5	117.5	9.0	24.5
	5P	D-5P					30.5	55	33.5	119	10.0	26
					70-W		32	55	34	121	10.5	26.5
Single	5N			5N-B		70 W 122	32	55	35	122	11.5	27.5
		D-5NL	D-NL				33.5	54	35	122.5	11.5	***27***
Double	5SB						32	55	36	123	12.5	28.5
			D-EL							127.5	13.5	29.5
	5SP	D-5SP**					30.5**	55	37.5	123**	14.0	**30**
	5SS	D-5S		5S-B		70 T 124.5	32	55	37.5	124.5	14.0	**30**
	5S, (55)						35	55	37.5	127.5	14.0	**30**
					70-T'		32	55	38.5	125.5	15.0	31
Double	5T	D-5T		5T-B			35	55	39	129	15.5	31.5
		D-5U*		5U-B			32	55	40.5	127.5	17.0	**33**
Triple	5U						35	55	40.5	130.5	17.0	**33**
	SR						35	55	42	132	18.5	34.5

* Conflicting manufacturer's specifications, use either 32 or 35mm left end width.

** Conflicting manufacturer's specifications, either 30.5 or 35mm left end width.

SER denotes shell to end, right measurement.

(See page 3-15 for further explanation.)



OS AND CLONE SPINDLES (CONT'D)

73mm Shell Width

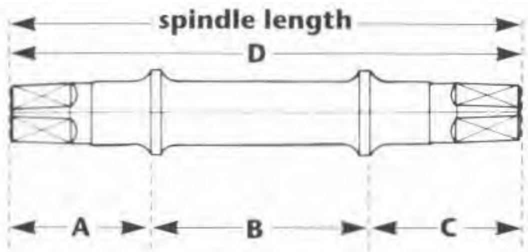
Crankset Used with	Nut-type marking	Bolt-type marking	Shimano Cartridge marking	Sugino Bolt-type marking	Old marking	Old Shimano marking	A	B	C	D - Spindle Length	Spindle End Factor	SER
			MM107							107	1.5	1 7
			MM110							110.5	3.0	19
			LL113							113	4.5	20
			D-H							115	5.5	20
		D-7H	XL118				30.5	57	30.5	118	7.0	22.5
Triple	7NL	D-7NL	D-NL				32	57	33.5	122.5	10.0	25.5
			D-EL							127.5	12.5	28
	7EL	D-7EL					35	57	36	128	13.0	28
		D-7TL					35	57	39	131	15.5	31

SER denotes shell to end, right measurement.
(See page 3-15 for further explanation.)

BOTTOM BRACKETS

BOTTOM BRACKETS

INSTRUCTIONS FOR REPLACING SPINDLE ONLY



The most effective way to replace just a spindle in a loose bottom brackets is to match the A, B, and C dimensions in the chart. The bearings must contact the proper area on the races, *(see page* **3-4).** Match the number and size of the balls for the old and new spindles. **For example: A spindle designed for 1/4" ball bearings probably will work with a spindle designed for 7/32" balls.**

A spindle with different A, B, or C dimensions will give the following variations. An increase in C will move the chainrings out if they are too close to the chainstays. An increase in A will bring the left crankarm out. An increase in B will move the left crankarm and the adjustable cup out. A smaller B is possible only if there are sufficient threads showing on the adjustable cup. On rare occasions, the chainrings can be moved out by inserting a freewheel spacer between the fixed cup and the frame, and using larger B dimension.

To get the best results, try to match the taper you already have. A good match will help prevent any spindle-to-crankarm incompatibilities like bottoming the fixing bolt against the spindle or the crankarm bottoming against the spindle shoulder. ***(See page 3-5 for combinations that don't work.)*** It will also keep your chainline calculations relatively consistent. Mixing tapers may introduce errors of up to 5mm in the chainline calculations. **For instance: if you were to replace a French taper (it is important not to get taper and threading mixed up) with a Japanese spindle with the same dimensions, the crankarms would be between 3mm -**

i

The spindle end and center width factors, which are included from previous editions of this book, may be useful when mixing tapers on older spindles. The factors have the same effect as B and C and can be used instead of B and C as long as you use them exclusively. Match the center width factor and spindle end factor for both of your old and replacement bottom brackets.

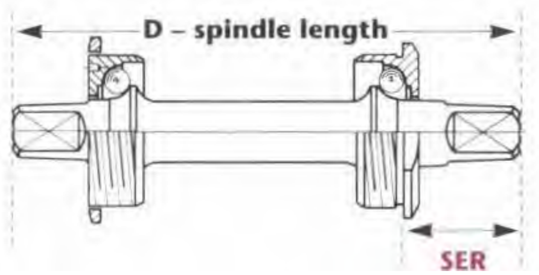
Non-JIS Bottom Bracket Spindle Interchangeability

Model Used with	**Model Number**	**Spindle Marking**	**Shell Width**	**A**	**B**	**C**	**0 - Spindle Length**	**Closest Taper End Size**
Avocet								
Double (USA)	114.0	20	68	30.0	54.0	30.0	114.0	Campy
Triple (USA)	119.5	30	68	30.5	55.0	34.0	119.0	Campy
Double	120.0	2	68	31.5	57.0	31.5	120.0	Ofmega*
Triple	125.5	3	68	32.5	57.0	36.0	126.0	Ofmega*

* Otmega taper ends are smaller than others and are not interchangeable.

INSTRUCTIONS FOR REPLACING COMPLETE SET

Preserving a chainline is important when replacing a bottom bracket set. **To preserve the chainline, the distance between the bottom bracket shell and the end of the spindle needs to be the same for the original bottom bracket set and the replacement set. This distance is called the SER, Shell to End Right measurement.**



SER denotes shell to end, right measurement.

It is also important to match the shell width the bottom bracket sets are designed for and check the position of the left crank arm.

The above rough method for choosing the proper bottom bracket will work with most modem spindles. Errors of 1.5mm are within manufacturers' tolerances. Expect up to 2mm variance due to differences in torque, grease on the bolt, grease on the spindle taper (not recommended), grease on washers, or serrations on the nut or bolt. if you avoid mixing Italian or French bottom bracket sets with JIS sets, then your errors should be less than 3mm.

When mixing older bottom bracket sets, for example, a French bottom bracket set with newer Japanese standard bottom bracket sets, the taper end size differences may add up to errors of 5mm or more. ***(See page 3-5 for older combinations that don't work.)*** In previous editions, we attempted to minimize these errors by using our spindle end and center width factor. By comparing these factors, you could estimate the changes in chainlines and the number of threads available for a lockring. We have included these charts in this edition also. SFR is easier to use than the spindle end and center width factors because it is a more direct measurement and can be determined for any bottom bracket using inexpensive calipers (or even a decent rule and a good eye).

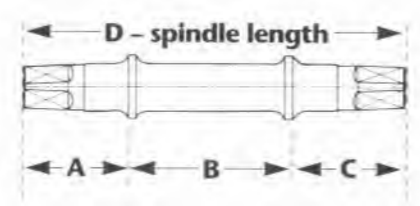
Non-JIS Complete Bottom Bracket Set Interchangeability

		SPINDLE ONLY		COMPLETE BOTTOM BRACKET SET ONLY					
				ENGLISH		**FRENCH**		**ITALIAN**	
SER (right overhang)	**L/R Taper Length**	**center width factor**	**spindle end factor**	**center width factor**	**spindle end factor**	**center width factor**	**splndle end factor**	**center width factor**	**spindle end factor**
Avocet									
23	15/15.5	74.5	6.0	67.5	6.0	68.0	5.5	68.0	5.5
27.5	15/15.5	75.5	10.0	68.0	10.0	69.0	9.5	68.5	9.5
26	15/15	77.5	7.5	68.0	6.5	68.0	6.5	70.0	5.5
30.5	15/15	77.5	12.0	68.0	11.0	68.0	11.0	70.0	10.0

BOTTOM BRACKETS

Non-)I5 Bottom Bracket Spindle Interchangeability

Numbers in ***bold italics*** were deduced rather than measured



Model	Ball Size	Cup Thickness	Shell Width	A	B	C	D - Spindle Length	Closest Taper End Size
Campagnolo'								
Super Record, (C)	3/16"	Thick	**68**	28.0	52.0	28.0	109.0	Campy
Record 3/16" balls	3/16"	Thick	**68**	29.0	52.0	29.0	111.0	Campy
(Spindles are not	3/16"	Thick	**68**	**29.0**	52.0	32.0	112.0	Campy
interchangeable with	3/16"	Thick	68	30.0	52.0	33.0	114.5	Campy
other spindles made	3/16"	Thick	70	27.0	54.0	27.0	109.0	Campy
for different ball sizes.	3/16"	Thick	70	28.0	54.0	28.0	111.0	Campy
Complete BB sets	3/16"	Thick	70	30.0	54.0	32.0	115.5	Campy
may interchange.)								
1990 Record	7/32"	Thick	68	29.0	52.0	29.0	111.0	Campy
7/32" Balk	7/32"	Thick	70	28.0	54.0	28.0	111.0	Campy
(Spindles are not interchangeable with other spindles made for different ball sizes. Complete BB sets may interchange.)								
1/4" Balls	1/4"	Thick	68	31.0	49.5	31.0	111.0	Campy
(Spindles are not	1/4"	Thick	68	30.0	49.5	32.5	112.0	Campy
interchangeable with	1/4"	Thick	68	33.0	49.5	33.0	117.5	Campy
other spindles made	1/4"	Thick	68	31.0	49.5	34.0	114.5	Campy
for different ball sizes.	1/4"	Thick	68	35.0	49.5	35.0	124.0	Campy
Complete BB sets	1/4"	Thick	68	39.0	49.5	39.0	132.0	Campy
may interchange.)	1/4"	Thick	68	41.0	49.5	41.0	132.0	Campy
	1/4"	Thick	68	***41***	49.5	41.0	***131.5***	Campy
	1/4"	Thick	68	41.0	49.5	45.0	136.0	Campy
	1/4"	Thick	68	45.0	49.5	45.0	140.0	Campy
	1/4"	Thick	68	***45***	49.5	45.0	***139.5***	Campy
	1/4"	Thin	68	25.0	54.5	26.0	105.0	Campy
	1/4"	Thin	68	27.0	54.5	27.0	109.0	Campy
	1/4"	Thin	68	28.0	54.5	28.0	111.0	Campy

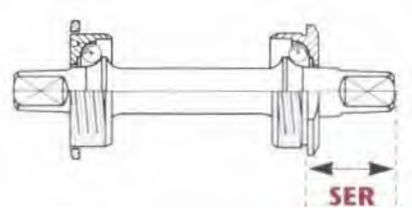
* Rifled cups and cups with seals are thick.

** To match model to spindle measurement, ***(see "Campagnolo Spindle Information"* on *page 3-28 through 3-33).***

BOTTOM BRACKETS

Non-JIS Complete Bottom Bracket Set Interchangeability

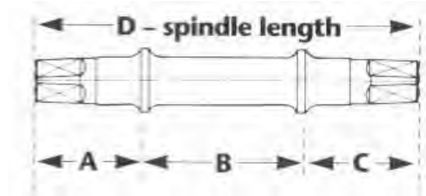
SER denotes shell to end, right measurement. See page 3-15 for further explanation.



		SPINDLE ONLY		COMPLETE BOTTOM BRACKET SET ONLY: ENGLISH		FRENCH		ITALIAN	
SER (right overhang)	L/R Taper Length	center width factor	spindle end factor	center width factor	spindle end factor	center width factor	spindle end factor	center width factor	spindle end factor
Campagnolo									
20	15/15	70.0	5.5	67.0	3.5	68.0	3.0	68.5	3.5
21	15/15	70.0	6.5	67.0	4.5	68.0	4.0	68.5	4.5
24	15/15	70.0	9.5	67.0	7.5	68.0	7.0	68.5	7.5
25	15/15	70.0	10.5	67.0	8.5	68.0	8.0	68.5	8.5
19	15/15	72.0	7.0	69.0	5.0	70.0	4.5	69.5	4.5
20	15/15	72.0	8.0	69.0	6.0	70.0	5.5	69.5	5.5
24	15/15	72.0	12.0	69.0	10.0	70.0	9.5	69.5	9.5
21	15/15			67.0	4.5	68.0	4.0	68.5	4.5
20	15/15			69.0	6.0	70.0	5.5	69.5	5.5
22	15/15	70.0	6.5	67.0	4.5	68.0	4.0	68.5	4.5
23.5	15/15	70.0	8.5	67.0	6.5	68.0	6.0	68.5	6.5
24	15/15	70.0	8.5	67.0	6.5	68.0	6.0	68.5	6.5
25	15/15	70.0	9.0	67.0	8.0	68.0	7.5	68.5	8.0
26	15/15	70.0	10.0	67.0	9.0	68.0	8.5	68.5	9.0
30	15/15	70.0	14.0	67.0	13.0	68.0	12.5	68.5	13.0
32	15/15	70.0	16.0	67.0	15.0	68.0	14.5	68.5	15.0
32	15/15	70.0	16.0	67.0	15.0	68.0	14.5	68.5	15.0
36	15/15	70.0	20.0	67.0	19.0	68.0	18.5	68.5	19.0
36	15/15	70.0	20.0	67.0	19.0	68.0	18.5	68.5	19.0
36	15/15	70.0	20.0	67.0	19.0	68.0	18.5	68.5	19.0
19.5	15/15	75.0	1.5	68.0	1.5	69.0	1.0	68.5	1.0
20.5	15/15	75.0	3.0	68.0	3.0	69.0	2.5	68.5	2.5
21.5	15/15	75.0	4.0	68.0	4.0	69.0	3.5	68.5	3.5

BOTTOM BRACKETS

Non-JIS Bottom Bracket Spindle Interchangeability



Numbers in ***bold italics*** were deduced rather than measured.

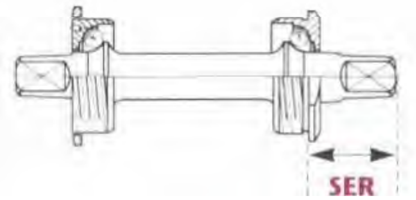
Model	Ball Size	Cup Thickness*	Shell Width	A	B	C	D - Spindle Length	Closest Taper End Size
Campagnolo**								
1/4" Balls (cont'd)	1/4"	Thin	68	27.0	54.5	30.0	112.0	Campy
(Spindles are not	1/4"	Thin	68	30.0	54.5	30.0	114.0	Campy
interchangeable with	1/4"	Thin	68	31.0	54.5	31.0	116.0	Campy
other spindles made	1/4"	Thin	68	28.0	54.5	32.0	114.5	Campy
for different ball sizes.	1/4"	Thin	68	27.0	54.5	35.0	117.0	Campy
Complete BB sets	1/4"	Thin	68	28.0	54.5	35.0	117.5	Campy
may interchange.)	1/4"	Thin	68	30.0	54.5	38.0	123.0	Campy
	1/4"	Thick	70	30.0	51.5	30.0	111.0	Campy
	1/4"	Thick	70	30.0	51.5	31.0	113.0	Campy
	1/4"	Thick	70	32.0	51.5	32.0	117.5	Campy
	1/4"	Thick	70	31.0	51.5	33.0	115.5	Campy
	1/4"	Thick	70	34.0	51.5	34.0	124.0	Campy
	1/4"	Thick	70	38.0	51.5	38.0	132.0	Campy
	1/4"	Thick	70	40.0	51.5	40.0	132.0	Campy
	1/4"	Thick	70	40.0	51.5	44.0	136.0	Campy
	1/4"	Thick	70	44.0	51.5	44.0	140.0	Campy
	1/4"	Thin	70	26.0	56.5	26.0	109.0	Campy
	1/4"	Thin	70	***27***	56.5	27.0	***110.5***	Campy
	1/4"	Thin	70	27.0	56.5	29.0	113.0	Campy
	1/4"	Thin	70	29.0	56.5	29.0	114.0	Campy
	1/4"	Thin	70	30.0	56.5	30.0	116.0	Campy
	1/4"	Thin	70	28.0	56.5	31.0	115.5	Campy
	1/4"	Thin	70	***34***	56.5	34.0	***124.5***	Campy
	1/4'	Thin	70	27.0	56.5	35.0	118.0	Campy
	1/4"	Thin	70	29.0	56.5	37.0	122.0	Campy
	1/4"	Thin	70	30.0	56.5	38.0	124.0	Campy
	1/4"	Thin	70	***40***	56.5	40.0	***136.5***	Campy
	1/4"	Thin	70	***44***	56.5	44.0	***144.5***	Campy
	1/4"	Thin	74	27.0	60.5	30.0	117.0	Campy

Rifled cups and cups wit h seals are thick.

" To match model to spindle measurement, ***(see "Campagnolo Spindle Information" on page 3-28 through 3-33).***

Non-JIS Complete Bottom Bracket Set Interchangeability

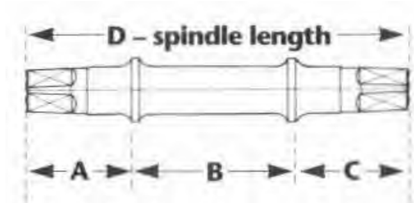
SER denotes shell to end, right measurement. See page 3-15 for further explanation.



				COMPLETE BOTTOM BRACKET SET ONLY					
		SPINDLE ONLY		ENGLISH		FRENCH		ITALIAN	
SER (right overhang)	L/R Taper Length	center width factor	spindle end factor	center width factor	spindle end factor	center width factor	spindle end factor	center width factor	spindle end factor
Campagnolo									
23.5	15/15	75.0	6.0	68.0	6.0	69.0	5.5	68.5	5.5
23.5	15/15	75.0	6.0	68.0	6.0	69.0	5.5	68.5	5.5
24.5	15/15	75.0	6.5	68.0	6.5	69.0	6.0	68.5	6.0
25.5	15/15	75.0	7.5	68.0	7.5	69.0	7.0	68.5	7.0
28.5	15/15	75.0	10.0	68.0	10.0	69.0	9.5	68.5	9.5
28.5	15/15	75.0	10.0	68.0	10.0	69.0	9.5	68.5	9.5
31.5	15/15	75.0	13.5	68.0	13.5	69.0	13.0	68.5	13.0
21	15/15	72.0	7.0	69.0	5.0	70.0	4.5	69.5	4.5
22	15/15	72.0	8.0	69.0	6.0	70.0	5.5	69.5	5.5
23	15/15	72.0	9.0	69.0	7.0	70.0	6.5	69.5	6.5
24	15/15	72.0	9.5	69.0	7.5	70.0	7.0	69.5	7.0
25	15/15	72.0	10.0	69.0	8.0	70.0	7.5	69.5	7.5
29	15/15	72.0	14.0	69.0	12.0	70.0	11.5	69.5	11.5
31	15/15	72.0	16.0	69.0	14.0	70.0	13.5	69.5	13.5
35	15/15	72.0	20.0	69.0	18.0	70.0	17.5	69.5	17.5
35	15/15	72.0	20.0	69.0	18.0	70.0	17.5	69.5	17.5
19.5	15/15	77.0	2.0	70.0	2.0	70.5	1.5	70.5	1.5
20.5	15/15	77.0	3.0	70.0	3.0	70.5	2.5	70.5	2.5
22.5	15/15	77.0	5.0	70.0	5.0	70.5	4.5	70.5	4.5
22.5	15/15	77.0	5.0	70.0	5.0	70.5	4.5	70.5	4.5
23.5	15/15	77.0	6.0	70.0	6.0	70.5	5.5	70.5	5.5
24.5	15/15	77.0	6.5	70.0	6.5	70.5	6.0	70.5	6.0
27.5	15/15	77.0	10.0	70.0	10.0	70.5	9.5	70.5	9.5
28.5	15/15	77.0	11.0	70.0	11.0	70.5	13.5	70.5	13.5
30.5	15/15	77.0	13.0	70.0	12.0	70.5	12.5	70.5	12.5
31.5	15/15	77.0	14.0	70.0	14.0	70.5	13.5	70.5	13.5
33.5	15/15	77.0	16.0	70.0	16.5	70.5	15.5	70.5	15.5
37.5	15/15	77.0	20.0	70.0	20.5	70.5	19.5	70.5	19.5
23.5	15/15	**81.0**	**3.0**	**74.0**	**3.0**	**74.5**	**3.0**	**74.0**	**3.0**

BOTTOM BRACKETS

Non-JIS Bottom Bracket Spindle Interchangeability



Model Used With	Model Number	Spindle Marking	Shell Width	A	B	C	D - Spindle Length	Closest Taper End Size
Galli								
Double		2	68	33.0	54.0	33.0	120.0	JIS
Triple		3	68	33.0	54.0	39.0	126.0	JIS
Nervar								
Single		115	68	27.0	57.0	31.0	115.0	Campy
Double (5 pin)		117	68	28.5	56.5	32.0	117.0	Campy
Double (3,5 arm)		121	68	28.5	57.0	35.5	121.0	Campy
Triple		126	68	29.0	57.0	40.0	126.0	Campy
Ofmega								
Children's		60 C	60	30.0	47.5	32.0	109.5	Ofmega*
Track		68 P	68	30.0	55.5	29.5	115.0	Ofmega
Double		68 C	68	30.0	55.5	33.0	118.5	Ofmega*
Triple		68 Ca	68	30.0	55.5	36.5	122.0	Ofmega*
Track		70 P	70	30.0	57.5	28.5	116.0	Ofmega*
Double		70 C	70	30.0	.57.5	32.0	119.5	Ofmega*
Triple		70 Ca	70	30.0	57.5	35.5	123.0	Ofmega*
Ritchey								
Logic Comp		LOGIC COMP	68	29.0	62.0	29.0	120.0	Campy/JIS
Logic Pro 120		LOGIC PRO =120=	68	30.0	60.0	30.0	120.0	Campy/JIS
Logic Pro 123		LOGIC PRO =123=	68	31.0	60.0	32.0	123.0	Campy/JIS
Logic Pro 124.5		LOGIC PRO =124.5=	68	31.5	60.0	33.0	124.5	Campy/JIS
Shimano Dura-Ace"								
Single (Track)-(old)***		68 W 107	68	26.0	.50.0	31.0	107.0	JIS
		70 W 109	70	26.0	52.0	31.0	109.0	JIS
Double- (old)	BB-7200***	68 W 112	68	27.0	50.0	35.0	112.0	JIS
Double- (old)	BB-7200***	70 W 113	70	26.0	52.0	35.0	113.0	JIS

* Ofmega taper ends are smaller than others and not interchangeable.

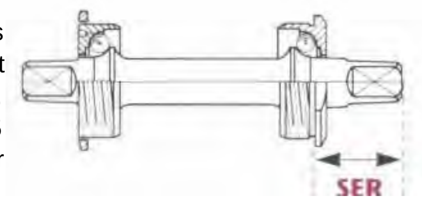
***** (Also see RS/Shimano chart for other Shimano spindles and cartridges, pages 3-9 to 3-12.)***

*** Not interchangeable with others. Spindle is larger in diameter and doesn't fit hole in newer Dura-Ace cups.

BOTTOM BRACKETS

Non-JIS Complete Bottom Bracket Set Interchangeability

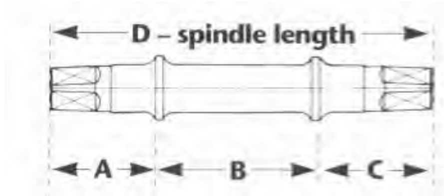
SER denotes shell to end, right measurement. See page 3-15 for further explanation.



				COMPLETE BOTTOM BRACKET SET ONLY					
		SPINDLE ONLY		ENGLISH		FRENCH		ITALIAN	
SER (right overhang)	**L/R** Taper Length	**center** width factor	**spindle** end factor	**center** width factor	**spindle** end factor	**center** width factor	**spindle** end factor	**center** width factor	**spindle** end factor
Galli									
26	15/15	74.0	11.0	68.0	9.5	68.0	9.5	70.0	9.5
32	15/15	74.0	17.0	68.0	15.5	68.0	15.5	70.0	15.5
Nervar									
25.5	16/16	76.0	7.5	69.5	7.5	69.5	7.0		
26.5	16/16	75.5	8.5	69.0	8.0	69.0	8.0		
30	16/16	76.0	12.0	69.0	12.0	69.0	12.0		
34.5	16/16	76.0	16.5	69.0	16.5	69.0	16.5		
Ofmega									
26	15/15.5	67.5	7.5	60.0	6.5	60.0	5.5	60.0	4.5
23.5	15/15.5	78.5	5.0	68.0	4.0	68.0	4.0	68.0	3.0
27	15/15.5	75.5	8.5	68.0	7.5	68.0	6.5	68.0	5.5
30.5	15/15.5	75.5	13.0	68.0	12.0	68.0	11.0	68.0	10.0
22.5	15/15.5	77.5	4.0	70.0	3.0	70.0	3.0	70.0	2.0
26	15/15.5	77.5	7.5	70.0	6.5	70.0	5.5	70.0	4.5
29.5	15/15.5	77.5	12.0	70.0	11.0	70.0	10.0	70.0	9.0
Ritchey									
26	15.5/15	81.0	5.5	68.0	9.5				
26	15.5/15	79.0	6.5	68.0	9.5				
28	15.5/15	79.0	8.5	68.0	11.5				
29	15.5/15	79.0	9.5	68.0	12.5				
Shimano Dura-Ace									
21.5	15/15	68.0	2.0	68.0	2.0	68.5	2.0	68.5	1.5
21	15/15	70.0	1.5	70.0	1.5	70.5	1.5	70.0	1.0
26	15/15	68.0	6.5	68.0	6.5	68.5	6.5	68.5	6.0
25.5	15/15	70.0	6.0	70.0	6.0	70.5	6.0	70.0	5.5

BOTTOM BRACKETS

Non-PS Bottom Bracket Spindle Interchangeability



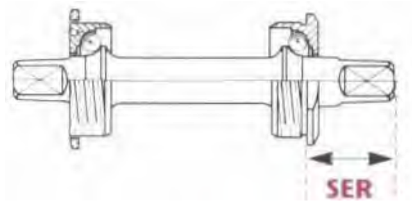
Model Used With	Model Number	Spindle Marking	Shell Width	A	B	C	D - Spindle Length	Closest Taper End Size
Shimano Dura-Ace (cont'd)**								
Double- (old)	BB-7300 (7500 AX)"*	68 S 107	68	26.0	50.0	31.0	107.0	JIS
Double- (old)	BB-7300 (7500 AX)***	70 S 109	70	26.0	52.0	31.0	109.0	JIS
Single (Track)	BB-7600	68 S	68	27.0	50.0	32.0	109.0	Campy
Single (Track)	BB-7600	70-S	70	25_5	52.0	31.5	109.0	Campy
Double	BB-7400	68 W 112	68	27.0	50.0	35.0	112.0	Campy
Double	BB-7400	70 W 113	70	26.5	52.0	34.5	113.0	Campy
Double	BB-7400	68-W	68	27.0	50.0	35.0	112.0	Campy
Double	BB-7400	70-W	70	26.5	52.0	34.5	113.0	Campy
Salida								
Single (Track)		118.5	68	29.0	58.0	31.5	118.5	
Double		122	**68**	**28.5**	58.0	35.5	122.0	
Triple		125	68	28.0	58.0	39.0	125.0	
Mountain, BMX		129	68	34.0	58.0	37.0	129.0	
Specialized								
Double		107-68	68	28.5	50.0	28.5	107.0	Campy
Double		109-70	70	28.5	52.0	28.5	109.0	Campy
Campagnolo Double (pre '85)		112-68	**68**	29.5	50.0	32.5	112.0	Campy
Campagnolo Double (pre '85)		113-70	70	29.5	52.0	31.5	113.0	Campy
Triple		114.5-68	68	30.5	50.0	34.0	114.5	Campy
Triple		115.5-70	70	30.5	52.0	33.0	115.5	Campy
Campagnolo, TA triple (pre '85)		119.5-68	68	30.5	50M	39.0	119.5	Campy
Specialized Mtn.triple		120-68	68	35.0	50.0	35.0	120.0	Campy
Campagnolo, TA triple (pre '85)		120.5-70	70	30.5	52.0	38.0	120.5	Campy

*** (Also see JIS/Shimano chart for other Shimano spindles and cartridges, pages 3-9 to 3-12.)*

*** Not interchangeable with others. Spindle is larger in diameter and doesn't fit hole in newer Dura-Ace cups.

Non-JIS Complete Bottom Bracket Set Interchangeability

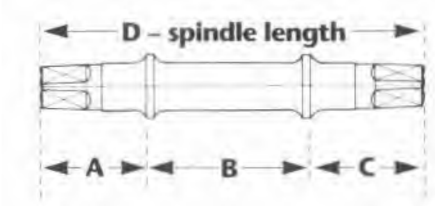
SER denotes shell to end, right measurement. See page 3-15 for further explanation.



		SPINDLE ONLY		COMPLETE BOTTOM BRACKET SET ONLY					
				ENGLISH		FRENCH		ITALIAN	
SER (right overhang)	L/R Taper Length	center width factor	spindle end factor	center width factor	spindle end factor	center width factor	spindle end factor	center width factor	spindle end factor
Shimano Dura-Ace (cont'd)									
21.5	15/15	68.0	2.0	68.0	2.0	68.5	2.0	68.5	1.5
21	15/15	70.0	1.5	70.0	1.5	70.5	1.5	70.0	1.0
23	15/15	69.0	8.5	68.0	3.5	68.5	3.5	68.5	3.0
22.5	15/15	71.0	8.0	70.0	3.0	70.5	3.0	70.0	3.5
26	15/15	69.0	11.5	68.0	6.5	68.5	6.5	68.5	6.0
25.5	15/15	71.0	11.0	70.0	6.0	70.5	6.0	70.0	5.5
26	15/15	69.0	11.5	68.0	6.5	68.5	6.5	68.5	6.0
25.5	15/15	71.0	11.0	70.0	6.0	70.5	6.0	70.0	5.5
Solida									
26.5		77.0	8.0	68.5	8.0	68.5	8.5	70.0	8.0
30.5		77.0	12.0	68.5	12.5	68.5	12.5	70.0	12.0
34		77.0	15.5	68.5	15.5	68.5	16.0	70.0	15.5
32		77.0	13.5	68.5	13.5	68.5	14.0	70.0	13.5
Specialized									
19.5	14.5/14.5	70.5	4.0	67.5	2.0	67.5	2.0	67.5	2.0
19.5	14.5/14.5	72.5	4.0	69.5	2.0	69.5	2.0	69.5	2.0
23.5	14.5/14.5	70.5	8.0	67.5	6.0	67.5	6.0	67.5	6.0
22.5	14.5/14.5	72.5	7.0	69.5	5.0	69.5	5.0	69.5	5.0
25	14.5/14.5	70.5	9.5	67.5	7.5	67.5	7.5	67.5	7.5
24	14.5/14.5	72.5	8.5	69.5	6.5	69.5	6.5	69.5	6.5
30	14.5/14.5	70.5	14.5	67.5	12.5	67.5	12.5	67.5	12.5
26	14.5/14.5	70.5	10.5	67.5	8.5	67.5	8.5	67.5	8.5
29	14.5/14.5	72.5	13.5	69.5	11.5	69.5	11.5	69.5	11.5

BOTTOM BRACKETS

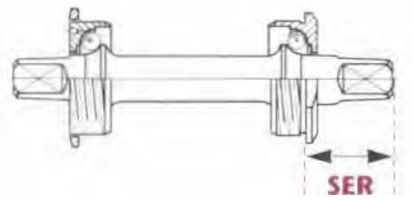
Non-JIS Bottom Bracket Spindle Interchangeability



Model Used With	Model Number	Spindle Marking	Shell Width	A	B	C	D - Spindle Length	Closest Taper End Size
Specialized (cont'd)								
Specialized Mtn.triple		125-68	68	37.5	50.0	37.5	125.0	Campy
Specialized Mtn.triple		127-68	68	38.5	50.0	38.5	127.0	Campy
Sugino Mtn. triple		130-68	68	10.5	50.0	40.5	130.0	Camp
SR Royal								
Single		T-68-S	68	27.5	51.0	27.5	106.0	JIS
Double		R-68	68	29.0	51.0	32.0	112.0	JIS
Double		R-70	70	31.0	53.0	31.0	115.0	JIS
Triple		R-68-T	68	32.0	51.0	35.5	118.5	JIS
Stronglight								
Single (Track)		113	68	28.5	56.0	28.5	113.0	JIS
Double (w/5 pin cranks)		118	68	30.5	56.0	32.0	118.5	JIS
Double (w/5 arm cranks)		120	68	30.5	56.0	33.5	120.0	JIS
Double (w/5 arm cranks) (Peugeot)		121	68	30.5	56.0	35.0	121.5	JIS
Double (w/5 arm cranks)		123	68	30.5	56.0	37.0	123.5	JIS
Triple		125	68	30.5	56.0	38.5	125.0	JIS
Triple (Peugeot)		126	68	30.5	56.0	39.5	126.0	JIS
Tandems		130	68	30.5	56.0	43.5	130.0	JIS
Tandem Triple		133	68	30.5	56.0	46.5	133.0	JIS
Mountain Bike		134.5	68	39.0	56.0	39.5	134.5	JIS
Sugino 75, Mighty								
Single (Track)		MS-68 or MW-68LP	68	29.0	51.5	29.0	109.0	Campy
Double (Road)		MW-68 or MT-68LP	68	29.0	51.5	35.0	114.0	Campy
Double (Road)		MW-70	70	29.0	53.5	32.5	115.0	Campy
Triple		MT-68	68	29.5	51.5	38.0	120.0	Campy
Triple		MT-70	70	29.5	53.5	37.0	120.0	Campy

Non-JIS Complete Bottom Bracket Set Interchangeability

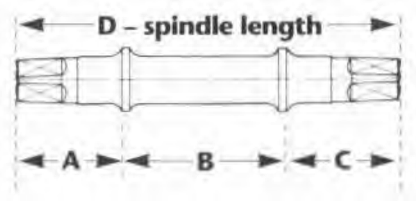
SER denotes shell to end, right measurement. See page 3-15 for further explanation.



				COMPLETE BOTTOM BRACKET SET ONLY					
		SPINDLE ONLY		ENGLISH		FRENCH		ITALIAN	
SER (right overhang)	L/R Taper Length	center width factor	spindle end factor	center width factor	spindle end factor	center width factor	spindle end factor	center width factor	spindle end factor
Specialized									
28.5	14.5/14.5	70.5	13.0	67.5	11.0	67.5	11.0	67.5	11.0
29.5	14.5/14.5	70.5	14.0	67.5	12.0	67.5	12.0	67.5	12.0
31.5	14.5/14.5	70.5	16.0	67.5	14.0	67.5	14.0	67.5	14.0
SR Royal									
19	16/16	71.0	5.0	66.5	2.5	66.5	3.5		
23.5	16/16	71.0	9.5	66.5	7.5	66.5	8.0		
22.5	16/16	73.0	7.5	68.5	5.5	68.6	6.0	69.5	5.5
27	16/16	71.0	16.0	66.5	14.0	66.5	14.5		
Stronglight									
22.5	14/16	77.0	5.0	70.0	5.0	69.5	5.0	71.0	5.0
26	14/16	77.0	8.0	69.0	8.0	68.5	8.5	70.0	8.0
27.5	14/16	77.0	10.0	68.0	10.0	67.5	10.5	69.0	10.0
29	14/16	77.0	11.0	68.5	11.0	68.5	11.5	70.0	11.0
31	14/16	77.0	13.0	68.5	13.5	68.5	13.5	70.0	13.0
32.5	14/16	77.0	15.5	68.5	15.5	68.5	16.0	70.0	15.5
33.5	14/16	77.0	16.5	68.5	16.5	68.5	17.0	70.0	16.5
37.5	14/16	77.0	20.0	68.5	20.0	68.5	20.5	70.0	20.0
40.5	14/16	77.0	23.0	68.5	23.0	68.5	23.5	70.0	23.0
33.5	14/16	77.0	15.5	68.5	15.5	68.5	16.0	70.5	15.5
Sugino 75, Mighty									
21		71.0	4.0	67.5	1.5	68.0	2.0	67.5	1.5
27		71.0	9.5	67.5	7.0	68.0	7.5	67.5	7.0
24.5		73.0	7.5	69.5	5.5	70.0	5.5	69.5	5.5
30		71.0	13.5	67.5	11.0	68.0	11.5	69.5	11.0
29		71.0	11.5	69.5	9.5	70.0	9.5	69.5	9.5

BOTTOM BRACKETS

Non-JIS Bottom Bracket Spindle Interchangeability

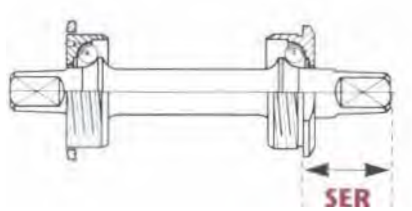


Model Used Wlth	Model Number	Spindle Marking	Shell Width	A	B	C	D - Spindle Length	Closest Taper End Size
SunTour								
Superbe, Sprint	BB-SB10, BB-5000	68-S	**68**	29.5	50.0	29.5	109.0	Campy
Superbe, Sprint	BB-S810, BB-5000	70-5	70	28.5	52.0	28.5	109.0	Campy
Cyclone-(Vx)-Taper	BB-400	68-W	68	31.5	50.0	31.5	113.0	JIS
Cyclone-(Vx)-Taper	BB-400	70-W	70	31.5	52.0	31.5	115.0	JIS
XC-Pro	BB-XP00	68-35	68	36	52	37.5	125.5	JIS
TA, Trevano								
Single (Track)		314	68	28.0	55.5	28.0	111.5	JIS
Double		344	68	30.0	55.5	31.0	116.5	JIS
Double		373	68	30.0	55.5	34.5	120.0	JIS
Triple		374	68	30.0	55.5	38.0	123.5	JIS
Zeus								
Single (Track)		109 x 55P	68	27.0	55.0	27.0	109.0	ISO
Chronos, New Racer		109 x 57P	70	26.0	57.0	26.0	109.0	ISO
Double (Road)		114 x 55C	68	29.5	55.0	29.5	114.0	ISO
Double (Road)		114 x 57C	70	28.5	57.0	28.5	114.0	**ISO**
Double (Road)		118 x 55C	68	29.5	55.0	33.5	118.0	**ISO**
Double (Road)		118 x 57C	70	28.5	57.0	32.5	118.0	**ISO**
Triple		123 x 55T	68	29.5	55.0	38.5	123.0	**ISO**
Triple		123 x 57T	70	28.5	57.0	37.5	123.0	**ISO**

BOTTOM BRACKETS

Non-JIS Complete Bottom Bracket Set Interchangeability

SER denotes shell to end, right measurement. See page 3-15 for further explanation.



SER (right overhang)	L/R Taper Length	SPINDLE ONLY center width factor	SPINDLE ONLY spindle end factor	COMPLETE BOTTOM BRACKET SET ONLY ENGLISH center width factor	ENGLISH spindle end factor	FRENCH center width factor	FRENCH spindle end factor	ITALIAN center width factor	ITALIAN spindle end factor
SunTour									
20.5	14.5/14.5	70.0	5.5	67.0	3.5	68.0	3.0	68.5	6.5
19.5	14.5/14.5	72.0	4.5	69.0	2.5	70.0	2.0	69.5	3.5
22.5	16/16	70.0	8.0	67.0	6.0	68.0	5.5	68.5	8.0
22.5	16/16	72.0	9.5	69.0	7.5	70.0	7.0	69.5	7.0
29	17/17								
TA, Trevano									
22	16.5/16.5	76.0	6.5	69.5	6.0	69.0	6.5	71.0	5.0
25	16.5/16.5	76.0	9.5	69.0	9.0	68.5	9.5	70.5	8.0
28.5	16.5/16.5	75.0	14.0	68.5	13.0	68.0	13.5	70.0	12.5
32	16.5/16.5	75.5	16.0	69.0	15.0	68.5	15.5	70.5	14.5
Zeus									
20.5	14.5/15	75.0	0.5	68.0	0.5	68.5	0.0	68.0	0.5
19.5	14.5/15	77.0	-0.5	70.0	-0.5	70.5	-1.0	70.0	-0.5
23	14.5/15	75.0	5.0	68.0	5.0	68.5	4.5	68.0	5.0
22	14.5/15	77.0	4.0	70.0	4.0	70.5	3.5	70.0	4.0
27	14.5/15	75.0	9.0	68.0	9.0	68.5	8.5	68.0	9.0
26	14.5/15	77.0	8.0	70.0	8.0	70.5	7.5	70.0	8.0
32	14.5/15	75.0	14.0	68.0	14.0	68.5	13.5	68.0	14.0
31	14.5/15	77.0	**13.0**	70.0	13.0	70.5	12.5	70.0	13.0

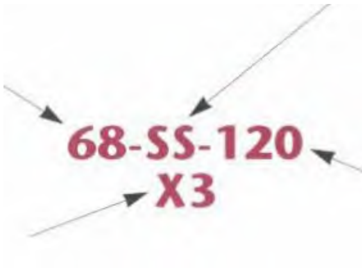
BOTTOM BRACKETS

CAMPAGNOLO BOTTOM BRACKET IDENTIFICATION

MARKINGS

Number in this position indicates bottom bracket shell width in mm.

X3 indicates that the spindle was intended for triple chainwheels.



Letters in this position indicate intended use:
SS - road
P - track
SP - road or track

Road spindles (marked SS) with a 3-digit number here are pre-1978. The 3-digit number was used to indicate ideal rear hub width, 120 in this example. This number lasted longer for track spindles.

When identifying Campagnolo bottom brackets, it is best to use all the available evidence. Start with the marking on the spindle; there are many different spindles with the same marking. Next, identify the ball sizes it is used with. Most spindles use 1/4" balls. Spindles with a 1mm step between the bearing surface and the main shaft use 3/16" or 7/32" balls. Measure the spindle center to determine if it normally is used with thick cups or thinner cups *(see **columm B in charts on** pages **29-31).*** Then, if needed, measure the right side, the left side, and the overall length to confirm you have an exact match. In the following tables under cups, rifled refers to the spiral grooves in the hole.

INTERCHANGING CAMPAGNOLO BOTTOM BRACKET PARTS

Ball sizes cannot be interchanged. Each spindle is designed for a specific ball size and cup size and cannot be mixed.

Interchanging Complete Bottom Bracket Sets

Generally, complete bottom bracket sets with the same overall length of spindle and marked with the same shell width can be interchanged without moving the chainline.

Examples: The following complete bottom bracket sets are interchangeable as a unit:

68-SS	Chorus	length 111mm
68-SS	Croce d'Aune	length 111mm
68-SS	(**C-)** Record	length 111 mm

Interchanging Bottom Bracket Spindles Only

Generally bottom bracket spindles that use the same ball size, have the same length and the center size can be interchanged without moving the chain line.

Example: The following bottom bracket spindles are interchangeable:

68-P-120	(old) Record Track	length 109mm
68-SS	Victory	length 109mm

Moving the Chainline

Substituting a 68-SS Chorus spindle at 111 mm for a 68-SS Victory spindle at 109mm will move the chainline out 1mm. Study the charts carefully and note that the similarities of the dimensions will show many substitutions when moving the chainline is possible or needed.

Interchanging Cups

Super Record cups interchange with (C.- Record (pre-1990 with 3/16" bearings) cups. Croce d'Aune cups interchange with Nuovo Record Cups. Chorus cups interchange with Athena, Triomphe Record, and Gran Sport cups. Thick, sealed cups for mountain bikes are the same thickness for spacing purposes as thick, rifled-hole cups.

CAMPAGNOLO BOTTOM BRACKET SPINDLE INTERCHANGEABILITY

Pre-1978 Bottom Brackets: 11 the marking +1.0 — +1.5 appears in addition to the other markings, ***(see 1978 Spindles om page 3-30).***

Campagnolo Super Record Spindles with 3/16" Balls

No.-size Balls/cage	Marking on spindle	A	B	C	D	Cups	Chain-rings	Models
14-3/16"	65-P-110	25	54.0	25	104	thin*	Track	Super Record
14-3/16"	68-P-110	24	57.0	25	105	thin*	Track	Super Record
14-3/16"	68-P-120	26	57.0	26	109	thin*	Track	Super Record
14-3/16"	68-55-120	29	52.0	32	112	thick, rifled*	Double	Super Record
14-3/16"	70-P-120	25	59.0	25	109	thin*	Track	Super Record
14-3/16"	70-SS-120	29	54.0	30	113	thick, rifled*	Double	Super Record

* Aluminum with steel insert

Campagnolo Spindles with 1/4" Balls

No.-size Balls/cage	Marking on spindle	A	B	C	D	Cups	Chain-rings	Models
11-1/4"	65-P-110	26	51.5	26	104	thin	Track	(old) Record
11-1/4"	68-P-110	25	54.5	26	105	thin	Track	(old) Record
11-1/4"	68-P-120	27	54.5	27	109	thin	Track	(old) Record
11-1/4"	68-SS-120	29	49.5	33	112	thick, rifled*	Double	Nuovo Record
11-1/4"	68-SS-120	27	54.5	30	112	thin	Double	(old) Record, Gran Sport
11-1/4"	68-SS-120 X3	27	54.5	35	117	thin	Triple	(old) Record, Gran Sport

Aluminum with steel insert

Campagnolo Spindles with 1/4" Balls (contd)

No.-size Balls/cage	Marking on spindle	A	B	C	D	Cups	Chain-rings	Models
11-1/4"	70-P-120	26	56.5	26	109	thin	Track	(old) Record
11-1/4"	70-SS-120	30	51.5	31	113	thick, rifled*	Double	Nuovo Record
11-1/4"	70-SS-120	27	56.5	29	113	thin	Double	(old) Record, Gran Sport
11-1/4"	70-SS-120 X3	27	56.5	35	118	thin	Triple	(old) Record, Gran Sport
11-1/4"	74-SS-120	27	60.5	30	117	thin	Double	(old) Record, Gran Sport

* Aluminum with steel insert

1978 SPINDLES

In 1978, Campagnolo modified their double and triple crank arms and spindles. Track cranks and spindles did not change. The double and triple spindles were lengthened 1.0mm on the left and 1.5mm on the right. The spindle markings in 1978 were the pre-1978 markings with +1.0-+1.5 added. What is now marked 68-SS was marked 68-SS-120+1.0-+1.5. These long, confusing markings were used for a year and replaced by the markings 68-SS, 70-SS, 68-SS X3, and 70-SS X3 for the corresponding spindles. The letter Z, found on many pre-1978 spindles, was dropped in 1978. To identify the crank arms, look at the collar around the spindle hole on the hack of the arm. The pre-1978 style has a raised collar 5-6mm wide and 2mm high. The 1978 and later crank arms collars were 10mm wide and 3mm high.

1979 THRU CURRENT BOTTOM BRACKETS

Changes: In 1979 road spindles for double chainrings became 1.0mm longer on the left side and 1.5mm longer on the right than the corresponding pre-1978 spindles. The rear hub width marking on the spindle was dropped for road hubs.

In 1985, the 109mm spindles were lengthened to 111 by adding 1mm to each side.

Campagnolo Super Record, (C-)Record and (1990-current) Record

These spindles have a 1mm step between the bearing surface and the main shaft.

No.-size Balls/cage	Marking on spindle	A	B	C	D	Cups	Chain-rings	Models
14-3/16"	65-SP	30	49.5	30	109	thick, rifled*	1 or 2	(C-) Record
14-3/16"	68-SP	28	52.0	28	109	thick, rifled*	1 or 2	(C-) Record (same as 109mm 68-SS)
14-3/16"	68-SP	29	52.0	29	111	thick, rifled*	1 or 2	(C-) Record

1979 THRU CURRENT BOTTOM BRACKETS (CONT'D)

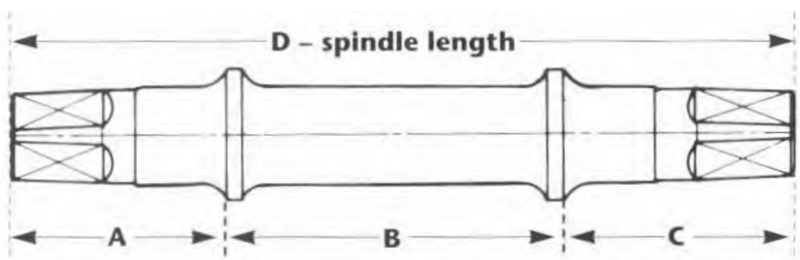
Campagnolo Super Record, (C-)Record and (1990-current) Record (cont'd)

These spindles have a 1mm step between the bearing surface and the main spindle shaft.

No.-size Balls/cage	Marking on spindle	A	B	C	D	Cups	Chain-rings	Models
14-3/16"	68-SS	28	**52.0**	28	109	thick, rifled*	1 or 2	(C-) Record (same as 109mm 68-SP)
14-3/16"	68-SS	30	**52.0**	33	114.5	thick, rifled*	Double	Super Record Road
14-3/16"	70-SP	*27*	**54.0**	*27*	109	thick, rifled*	1 or 2	(C-) Record (same as 109mm 70-SS)
14-3/16"	70-SP	28	**54.0**	28	**111**	thick, rifled*	1 or 2	(C-) Record
14-3/16"	70-SS	*27*	**54.0**	27	109	thick, rifled*	1 or *2*	*(C-)* Record (same as 109mm 70-SP)
14-3/16"	70-SS	30	**54.0**	32	115.5	thick, rifled*	Double	Super Record Road

14-7/32"	68-SP C	29	**52.0**	29	111	thick, rifled*	1 or 2	(1990-current) Record
14-7/32"	70-SP C	28	**54.0**	28	**111**	thick rifled	1 or *2*	(1990-current) Record

* Aluminum with steel insert



1979 THRU CURRENT BOTTOM BRACKETS (CONT'D)

Campagnolo Spindles with 1/4" Balls

Parenthesis around the marking sometimes indicates using the spindle with thick cups such as the Croce d' Aune. These spindles have narrower centers than those used with thin cups.

No.-size Balls/cage	Marking on spindle	A	B	C	D	Cups	Chain-wheels	Models
11-1/4"	68-SS	27	54.5	27	109	thin	Double	Victory
11-1/4"	68-SS	27	54.5	30	112	thin	2 or 3	Triomphe double, Victory triple
11-1/4"	68-SS or 68-SS A	31	49.5	31	111	thick, rifled**	Double	Croce d'Aune
11-1/4"	68-SPc	30.5	50.0	30.5	111	thick, rifled**	Double	Record/Record OR
11-1/4"	68-SS or 68-SS B	28	54.5	28	111	thin	Double	Chorus
11-1/4"	68-SS or 68-SS G*	30	54.5	30	114	thin	Double	Athena - black
11-1/4"	68-SS G*	31	54.5	31	116	thin	Double	Athena - black (current)
11-1/4"	68-SS F	31	54.5	31	116	thin	Double	Xenon - black
11-1/4"	68-SS Fl	33	49.5	33	117.5	thick**	Double	Xenon - black
11-1/4"	68-SS	31	49.5	34	114.5	thick, rifled**	Double	Nuovo Record
11-1/4"	68-SS	28	54.5	32	114.5	thin	Double	(old) Record, Gran Sport
11-1/4"	68-SS X3	28	54.5	35	117.5	thin	Triple	(old) Record-grey
11-1/4"	68-SS X3	30	54.5	38	123	thin	Triple	Gran Sport-black
11-1/4"	68-S5 X3-M	41	49.5	41	132	with seal**	Triple	Euclid 132 (w/center bulge)
11-1/4"	68-SS X3-M	41	49.5	45	136	with seal**	Triple	Euclid 136 (w/center bulge)
11-1/4"	68-SS X3-M SPE	45	49.5	45	140	with seal**	Triple	Euclid 140 (w/center bulge)
11-1/4"	68-SS X3-S	35	49.5	35	124	with seal**	Triple	Centaur 124 - black
11-1/4"	68-SS X3-S SPE	39	49.5	39	132	with seal**	Triple	Centaur 132 - black
11-1/4"	68-SS X3§	35	49.5	35	124	with seal**	Triple	Olympus 124 - black
11-1/4"	68-SS X3§ SPE	39	49.5	39	132	with seal**	Triple	Olympus 132 - black
11-1/4"	70-SS	26	56.5	26	109	thin	Double	Victory
11-1/4"	70-SS	27	56.5	29	113	thin	2 or 3	Triomphe double, Victory triple
11-1/4"	70-SS or 70-SS A	30	51.5	30	111	thick, rifled**	Double	Croce d'Aune
11-1/4"	70-SPc	29.5	52.0	29.5	111	thick, rifled**	Double	Record/Record OR
11-1/4"	70-SS or 70-SS B	27	56.5	27	111	thin	Double	Chorus

* 68-SS G was first produced as 114mm, then as 116mm.

** For spacing purposes, thick, rifled-hole cups, cups with a seal, and thick Xenon cups are the same thickness.

BOTTOM BRACKETS

1979 THRU CURRENT BOTTOM BRACKETS (CONT'D)

Campagnolo Spindles with 1/4" Balls (cont'd)

Parenthesis around the marking sometimes indicates using the spindle with thick cups such as the Croce d' Aune. These spindles have narrower centers than those used with thin cups.

No.-size Balls/cage	Marking on spindle	A	B	C	D	Cups	Chain-wheels	Models
11-1/4"	70-SS or 70-SS G	29	**56.5**	**29**	**114**	thin	Double	Athena - black
11-1/4"	70-SS F	30	**56.5**	30	116	thin	Double	Xenon - black
11-1/4"	70-SS FI	32	**51.5**	32	117.5	thick**	Double	Xenon - black
11-1/4"	70-SS	31	**51.5**	33	115.5	thick, rifled**	Double	Nuovo Record
11-1/4"	70-SS	28	**56.5**	**31**	**115.5**	thin	Double	(old) Record, Gran Sport
11-1/4"	70-SS X3	29	**56.5**	37	122	thin	Triple	(old) Record-grey
11-1/4"	70-SS X3	30	**56.5**	38	124	thin	Triple	Gran Sport-black
11-1/4"	70-SS X3-M	40	**51.5**	40	132	with seal**	Triple	Euclid 132 (w/center bulge)
11-1/4"	70-55 X3-M	40	51.5	44	136	with seal**	Triple	Euclid 136 (w/center bulge)
11-1/4"	70-SS X3-M SPE	44	51.5	44	140	with seal**	Triple	Euclid 140 (w/center bulge)
11-1/4"	70-SS X3-S	34	51.5	34	124	with seal**	Triple	Centaur 124 - black
11-1/4"	70-SS X3-S SPE	38	***51.5***	38	132	with seal**	Triple	Centaur 132 - black
11-1/4"	70-SS X3§	34	**51.5**	34	124	with seal**	Triple	Olympus 124 - black
11-1/4"	70-SS X3§ SPE	38	**51.5**	38	132	with seal**	Triple	Olympus 132 - black

** For spacing purposes, thick, rifled-hole cups, cups with a seal and thick Xenon cups are the same thickness.

BOTTOM BRACKETS

CARTRIDGE BEARING BOTTOM BRACKETS

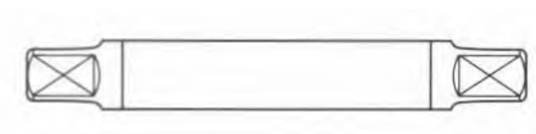
There are three main types of cartridge bearing bottom brackets: straight spindles; fixed, shouldered spindles; and cartridge units.

Preserving the chainline is important when replacing a bottom bracket set. **To preserve the chainline, the distance between the bottom bracket shell and the end of the spindle needs to be the same for the original bottom bracket set and the replacement set. This distance is called the SER, Shell to End Right measurement.**

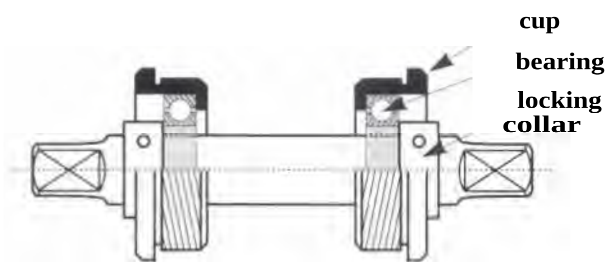
Straight Spindle

The spindle of a straight spindle bottom bracket has no shoulder, lip, or flange. Locking collars that slide along the spindle until tightened determine the position of the spindle end. This makes for an easily adjustable chainline. Straight spindles can be installed in various widths of bottom bracket shells.

Replacing just the cartridge bearings is possible. Straight spindles that press fit into the bearings may require special tools or may he installed much like a shouldered spindle.



Straight Spindle Only



Complete Straight Spindle Bottom Bracket Set

Installing Straight Spindles

Choosing a spindle is relatively easy since a straight spindle allows for almost infinite adjustment. Fit the crank arm to the spindle properly. The spindle must be long enough so neither crank arm hits the frame under load: start by matching the new spindle length to the old.

Install a straight spindle bottom bracket by threading the cups into the bottom bracket shell; tighten them in place. Then, insert the spindle, adjust the position of the spindle, slip the locking collars over the spindle, butt them against the bearings, and tighten the locking collars in place. The new SER should match the old SER plus or minus any desired adjustments to the chainline.

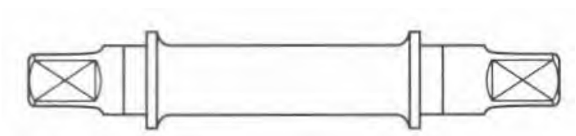
Super Low Profile cranks: locking collars may be too thick for a proper chainline using super low profile cranks. One option is to use the locking collars inboard of the bearings, although this may be time consuming to set up properly and may expose the bearing seals to the elements.

CARTRIDGE BEARING BOTTOM BRACKETS (CONT'D)

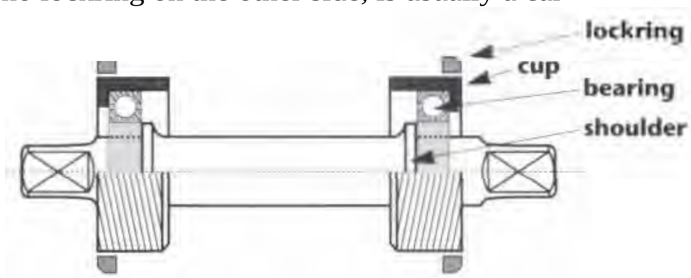
Fixed or Shouldered Spindles

With a fixed spindle bottom bracket, the spindle has shoulders that butt up against the hearings. The cartridge bearings may be either pressed onto the spindle or into the cups. Replacing just the cartridge bearings is possible.

Do not confuse the dust sleeve of a fixed shouldered bottom bracket with the shell of a cartridge unit bottom bracket. The two types of spindles are adjusted differently. A bottom bracket with no lockrings or flanges, or with one flange and no lockring on the other side, is usually a cartridge unit.



Shouldered Spindle Only



Complete Shouldered Bottom Bracket Set

Installing Shouldered Spindles (with one or two adjustable cups)

Choose replacements carefully as the SER is slightly adjustable only if both cups are adjustable. The new SER should match the old SER plus or minus ally desired adjustments to the chain line.

Installing shouldered spindles with one or two adjustable cups is similar to a regular loose bearing bottom bracket. Install the right side cup, and insert the spindle (and hearings, if they are separate). Then install the other cup and adjust it until there is no side-to-side play in the bearings. If there are two adjustable cups, the chainline line may be adjusted slightly if there are enough threads for the lockrings. The final adjustment must not have any side load on the bearings. Side load pushes the balls in the cartridge to the side of the bearing surface instead of the middle where the load belongs. Check for drag by turning the spindle.

Installing Shouldered Spindles (with two fixed cups)

Choose replacements carefully as the new SIR must match the old SLR plus or minus any desired adjustments to the chainline.

Installing shouldered spindles with two fixed cups may require spacers for either the spindle, or the cups, or both. install the first cup and the spindle. While tightening the second cup, check the side-to-side play of the spindle. If there is no play and the fixed cup is still not fully tightened, remove a spacer from the spindle or add a freewheel spacer to either fixed cup. Then attempt to tighten it down again. Add shims (supplied by the manufacturer) to the spindle between the spindle and bearings or between the the bearings and the cups until there is little side play in the spindle when both cups are tightened. The amount of play should be about the same as or less than the smallest shim thickness. If there is no side play, there might be too much side load on the bearings. Check for drag by turning the spindle.

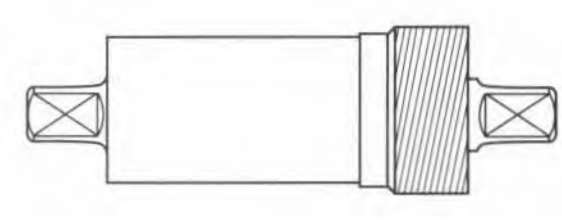
CARTRIDGE BEARING BOTTOM BRACKETS (CONT'D)

Cartridge Unit (sealed cartridge bottom bracket)

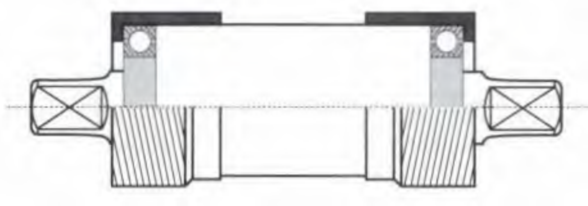
A cartridge unit has the hearings and spindle sealed in a contained unit. The bearings are kept a fixed distance apart by the shell of the cartridge unit. The term "cartridge bearing" refers to just the bearing while the term "cartridge unit" refers to the spindle, bearings, and shell as a single unit.

Do not confuse the dust sleeve of a fixed shoulder bottom bracket with the shell of a cartridge unit bottom bracket. The two types of spindles are adjusted differently. A bottom bracket with no lock-rings or flanges, or with one flange and no lockring on the other side, is usually a cartridge unit.

The bearings in a cartridge unit are generally not replaceable. Replace the entire unit when worn.



Cartridge Spindle Only



Complete Cartridge Unit

Installing Cartridge Units

Choose a replacement cartridge unit with the same SER plus or minus any desired changes in the chainline. If the right cup is not flanged, it is usually possible to decrease the SER. if the right cup is flanged, it is possible to increase the SER slightly with freewheel spacers. Often, splined tools are needed for installing and adjusting these cartridges.

Install cartridge units by first installing one cup (if there is a fixed cup, install that first and tighten it down), and insert the bearing unit if it is not already attached to one of the cups. Then, tighten the other cup, adjust chainline if necessary and possible. There is no need to worry about sideloads because the outer bearings are held apart by the cartridge shell which resists compression by the cups.

CARTRIDGE BEARING BOTTOM BRACKETS (CONT'D)

Pressed In Bearings or Unthreaded Bottom Bracket Shells

Bikes such as the Klein, early Merlin, or certain Fishers have unthreaded bottom bracket shells and require the spindle and bearings to be pressed into the shell instead of using threaded cups. Usually they use a straight spindle and are held into place by an interference fit and Loctite (sleeve retainer, not thread locker). Manufacturers, like Fisher, also offer a combination of shouldered spindles, a press fit, and retaining clips to keep everything in place.

Eor the straight spindle, special tools are needed to press the bearings onto the spindle and into the bottom bracket shell. Install the bearings and spindle carefully, and in the proper order so as not to ruin the bearings. Do not place too great of an unsupported side load on them.

Various manufacturers make press fit straight spindles to fit the bearings used in these hikes. Slip fit spindles can be used in place of press fit spindles if there is enough room to fit the locking collars for the spindles. Even proper shouldered spindles may be used in their place, if installed with an unusual amount of care.

The positioning of shouldered spindles is preset, but avoid sideloads on the bearings. This is tnie especially if there is an interference fit between the spindle and bearing and between the bearing and shelL

Instructions are provided with the tools for installation and removal of the bearings and spindle.

Because cartridge bearings are narrower than standard cups, they can place a more concentrated load on the bottom bracket shell. Press fit bearings are usually at the edge of the bottom bracket shell and have no other support; if the shell is not thick enough, the bearings may deform the shell. When the shell is deformed, the crank can develop up and down play that might be mistaken for a worn bearing. If the whole bearing and spindle moves up and down together, the shell is deformed and a bearing cannot be press fit in. In this case, it would be best to contact the frame manufacturer for warranty.

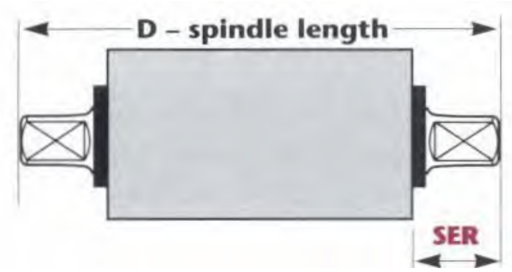
Depending on the size of the bottom bracket shell, it may also be possible to use one of the cartridge units mentioned on the previous page. The important thing is to get the cartridge unit to rest on the bottom of the shell and to distribute any downward force all across the shell instead of at the edges of the shell. Check for further damage to the bottom bracket shell before installing the bottom bracket.

Other Bottom Brackets

Some manufacturers make cartridge unit bottom brackets that do not need a threaded shell or a press fit. Most common is the Mavic bottom bracket (others include the Edco, FAG, and the YST). These bottom brackets are held in by holding both sides of the shell in opposition, much li ke a C clamp. They keep their concentric alignment by having close tolerances or having a conical/wedge shape that fits them in and centers them. The Mavic uses a conical shape to wedge itself in and a bottom bracket shell chamfered to the same conical shape for better contact.

DESIGN ELEMENTS

Action Tec



SER denotes shell to end, right measurement.
See page 3-15 for further explanation.

The Attack Bracket System has shouldered spindles made for 68mm bottom bracket shells and has no chainline adjustability (both cups are like fixed cups). Adjust the bearings by using shims that fit between the spindle and bearings until there is less than 1.5mm of play.

For 73mm bottom bracket shells, two 2.5mm spacers slip on the spindle to effectively move the shoulders out. This decreases the SER and the Spindle End Factor by 2.5. Then the shims are used again to reduce play.

The Attack Bracket Spindle uses the same cups but has slip fit straight spindles and locking collars (6.6mm thick).

Slight recesses in cups may accommodate some super low profile cranks, but do not provide much clearance. 1.4mm protrudes from the bottom bracket shell edge, which sticks out 5.2mm with the locking collars. The 6903 (or 61903) bearings are pressed into cups from inside. Although this is counter intuitive for external collars, they are pretty securely pressed in.

Attack Bracket System spindles are available in: 107, 112, 118, F20, 122.5, 124, 128, 133 & 135mm lengths.

Straight Attack Bracket Spindles (smooth slip fit) are available in: 109, 112, 120, 122.5, 124, 128, 130, 132 & 135mm lengths. A press fit spindle is available in 124mm.

All the Action Tec spindles are titanium.

Model	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
Attack Bracket System	68	107	19.5	15	JIS	4
	68	112	22	15	11S	6.5
	68	118	25	15	JIS	9.5
	68	120	26	15	JIS	10.5
	68	122.5	27.5	15	JIS	11.5
	68	124	28	15	JIS	12.5
	68	128	30	15	JI5	14.5
	68	133	32.5	15	JI5	17
	68	135	33.5	15	JIS	18
Attack Bracket Spindle		see above	adjustable	15	JIS/ISO	adjustable

DESIGN ELEMENTS (CONT'D))

American Classic

Bottom bracket has lockrings on both cups (available in either English or Italian, both have the same specifications) with enough room for some chainline adjustment. The 6903 bearings are pressed into the cups from the inside. The spindles are shouldered.

Titanium or steel spindles are available.

Model	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
American Classic	68	113	*22-22.5*	14	JIS	6.5-7
	68	117	24-25	14	JIS	9-10
	73	121.5	23-24.5	15/14	JIS	7.5-9
	73	125	25-26.5	14	JIS	10-11.5

Bullseye

Spindles come in 1/4" increments from 4-1/2" to 5-1/2" for English or Italian threading.

Model	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
Rollerbracket	68, 70, or 73	108 114.5 120.5 127 133.5 139.5	user adjustable	n/a	US	user adjustable

Campagnolo

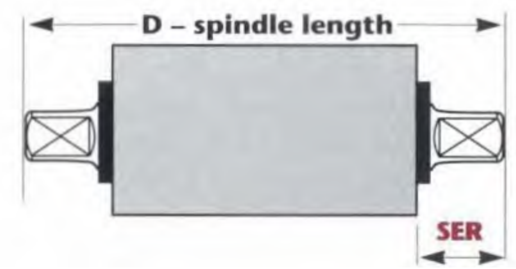
TBS bottom brackets have a single 61903 bearing on the non-drive side and two smaller bearings on the drive side. The aluminum dust cover doubles as a separator, making it a cartridge unit bottom bracket. Available in 68mm English or 70mm Italian.

The installation tool is the same as the lockring tool for the cassette: Campagnolo tool #7130036.

Model	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
Campagnolo - Record TBS	68	111	*21.5*	15.5	ISO	3.5
	70	111	**20.5**	**15.5**	ISO	**2.5**

DESIGN ELEMENTS (CONT'D)

Cook Bros. Racing



SER denotes shell to end, right measurement.
See page 3-15 for further explanation.

CBR bottom bracket sets have straight spindles with locking collars (7.1mm wide each) or external spacers. For super low profile cranks, you can use a mix of spacers on the drive side and a collar on the non-drive side

Spindles, spacers, and locking collars are available separately for bikes with pressed in bearings, 14mm inside diameter, English threading, pressed in BMX, and others.

6002 bearings come pressed into cups (from the outside). Spindles are available in titanium or cro-moly steel, and in 110, 115, 120, 124, F27, 130, 133, 145mm lengths.

Model	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
Cook Brothers Racing - EBR		see above	adjustable	15/16	ISO	adjustable

Edco

Available in English, Italian, or French threading or as a friction clamp for stripped shells.

Model	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
Edco						
- Double	68	116	26	15	ISO	9.0
- Triple	68	120	30	15	ISO	13.0

DESIGN ELEMENTS (CONT'D)

Erickson

Ultimate bottom brackets have an oversize diameter, shouldered titanium spindle. Newer models have splined cups (using the Shimano type splining). Older models use a standard pin tool. Both older and newer models have lockrings on both cups. The chainline has about 1mm of adjustment.

The bearings are pressed into the cups. Cups are available in English threading or Italian (except for 103 and 107mm lengths).

Spindle Length Suggested Use:

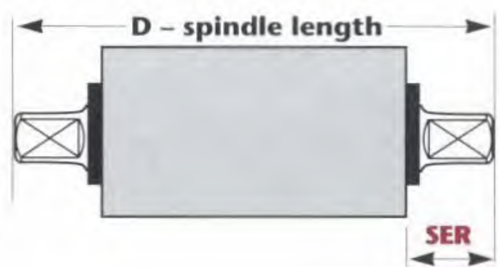
103 Dura Ace SLP
107 XTR, XT, and LX SLP
110 C-Record or some older Dura Ace
113 Mavic, Dura Ace EC-7402, SLP cranks on wide chainstay bikes
116 Older Ultegra, 105 C Record, XC Comp, and XC Pro
122 XT, DX, and many specialty cranks
127 Triple on a tandem or wide chainstays

Custom lengths and offsets (SER) are also available.

Model	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
Erickson - Ultimate	68	103	17.5	17	JIS/ISO	1.5
	68	107	19.5	17	JIS/ISO	3.5
	73	107	17	17	JIS/ISO	1
	68	110	21	17	ISO	3.5
	70	110	20	17	ISO	2.5
	68	113	22.5	17	JIS/ISO	6.5
	70	113	21.5	17	JIS/ISO	5.5
	73	113	20	17	JIS/ISO	4
	68	116	24	17	JIS/ISO	8
	68	122	28	17	JIS/ISO	12
	73	122	25.5	17	JIS/ISO	9.5
	68	127	30.5	17	JIS/ISO	14.5
	73	127	28	17	JIS/ISO	12

BOTTOM BRACKETS

DESIGN ELEMENTS (CONT'D)



SER denotes shell to end, right measurement.
See page 3-15 for further explanation.

Fag

Model numbers are preceded with L66BSA for English. L66FRA for French, and L66ITA for Italian threading. This is a cartridge unit style bottom bracket. An SKF style tool is used to thread in the cartridge and cup. There is no chainline adjustment.

Model	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
Fag -						
V119/23	68 or 70	119	27	n/a	JIS	11.5
EV119/23	68 or 70	**120**	27	n/a	ISO	10.5
V127/25	68 or 70	127	29	n/a	JIS	14
EV127/25	68 or 70	127	29	n/a	ISO	13

GT

GT bottom brackets have 61903 bearings pressed onto the spindle with a spacer between them, making it a cartridge unit. Bearing adjustments are not necessary. It has shoulderless cups with splines (Shimano type) and is recessed for super low profile cranks. It can be used on either 68 or 73mm bottom bracket shells.

The SER can be much less, especially on 73mm bottom bracket shells – chainline adjustability is possible depending on how deeply the shell is threaded.

The bottom bracket comes as a titanium spindle with titanium 8mm alien fixing bolts.

Model	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
GT	68 or 73	107	17	15.5/16	Univ.	2
	68 or 73	113	20	15.5/16	Univ	5
	68 or 73	122.5	25	15.5/16	Univ.	10

DESIGN ELEMENTS (CONT'D)

King Cycle Group (or Chris King)

The King bottom bracket is a cartridge unit type with a smooth spindle and roller bearings. The spindle is held in by an interference fit. Adjust the spindle position by loosening the alien bolt down the center of the spindle accessed by one of the bolt holes. By loosening the bolt, there is less of an interference fit and the spindle can be slid. Adjust for proper chainline and tighten the alien bolt.

Model	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
King Cycle Group	68	104	adjustable	16	Univ.	adjustable
	68	109	adjustable	16	Univ.	adjustable
	73	109	adjustable	16	Univ.	adjustable
	68	113	adjustable	16	Univ.	adjustable
	73	113	adjustable	16	Univ.	adjustable
	68	118	adjustable	16	Univ.	adjustable
	73	118	adjustable	16	Univ.	adjustable
	73	123	adjustable	16	Univ.	adjustable
	73	127	adjustable	16	Univ.	adjustable

McMahon

The BB Gun uses a relatively smooth slip fit titanium spindle with a snap ring in the middle and has internal spacers allowing adjustment of 1.7mm either way. Unshouldered cups butt against each other so no bearing tension adjustment is necessary (though using shims for fine tuning of play might be a good idea). Because there are no shoulders on the cups, it is possible to fine tune chainline.

Though it comes with two cartridge bearings, you can increase the number to three or four by exchanging either one or both of the two 7mm spacers with 6903 or 61903 bearings.

Sizes available: 105, 109, 113, 119, 125, and 131mm.

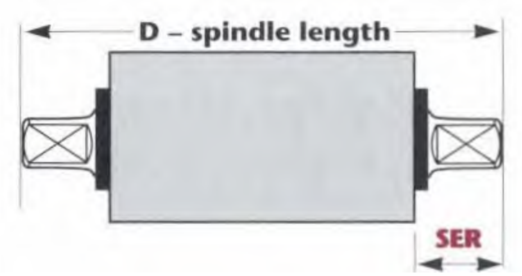
This manufacturer recommends using anti-seize compound on the spindle flats (and especially on the threads, if you are using titanium bolts).

Model	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
McMahon - BB Gun	68	105	18.5	14	ISO	2
	68	109	20,5	14	ISO	4
	68	113	22.5	14	ISO	6
	68	119	25.5	14	ISO	9
	68	125	28.5	14	ISO	12
	68	131	31.5	14		15

DESIGN ELEMENTS (CONT'D)

Mavic

Identification: Old-style 600 series had flat conventional lockrings. 610, 611, 612, and 613 series have lockrings that mate to a beveled bottom bracket shell; the bottom bracket shell must be beveled with special Mavic cutting tool 652/653. There should be a conical plastic washer on each lockring.



SER denotes shell to end, right measurement.
See page 3-15 for further explanation.

The 616 bottom brackets stick out from the bottom bracket shell for better spindle support.

Regulate bearing sideload/play by adjusting bearing cover on non-drive side of bottom bracket (labeled "MOBILE").

Model	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
Mavic						
610 URD 110 - Track	68	110	21	13.5	ISO	3.5
611 RD - Track	68	112	22	13.5	ISO	4.5
610 URD 114 - Double*	68	114	23	13.5	ISO	5.5
610 URD 116 - Double long	68	116	25	13.5	ISO	7.5
612 RD	68	116	25	13.5	ISO	7.5
610 URD 119 - Triple	68	119	28	13.5	ISO	10.5
613 RD	68	121	30	13.5	ISO	12.5
610 URD 123 - Triple long	68	123	32	13.5	ISO	14.5
Mountain Bike Symmetric						
616 RD 124	68	124	28	n/a	JIS	10.5
616 RD 134	68	134	33	n/a	JIS	15.5

* Replacement titanium spindles are available from SRP.

Nadax

Installation: Use standard bottom bracket tools. No chainline adjustments are possible.

Model	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
#2	70	113	22	n/a	JIS	8.5
#3	70	119	25.5	n/a	JIS	12

DESIGN ELEMENTS (CONT'D.)

Sachs

Most models are available in BSC/ISO and Italian threading. They have an integrated cartridge unit on the spindle like Shimano, but the locking cup has a flange like a fixed cup. The fixed cup is just pressed in and is removable (with a rubber mallet and vice).

Most spindles are a JIS taper (JIS is indicated by two notches at the end of the spindle). Some models are also available in ISO taper and in steel spindles.

For the cups labeled "SKF", use Park BBT-4, a SKF tool, or Thun #'s 1718710 and 1718703 for removal and installation.

Model	Spindle Length	Taper
BB R 80	114.5	JIS or ISO
BB R 50	114.5	JIS
BB M 80	110	JIS
BB M 50	110	JIS
BB M 20	114.5	JIS

Model	Part Number	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
Sachs							
(JIS Taper)		68	110	**21**	16/17	JIS	5.5
(ISO Taper)	1300190 LW NS	68	114_5	23.5	16.5	ISO	6.5

Sampson

The Stratics has a fluted large diameter titanium spindle, whereas the Colorado has a conventional spindle. Both models have cups with lockrings on both sides. There is some chainline adjustability, it depends on the spindle — the minimum SER (right overhang) and spindle end factors are listed.

Model	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
Colorado or Stratics	68	103	18.5	16.5	JIS	3
	70	103	17.5	16.5	JIS	2
	68	108	21	16.5	JIS	**6**
	73	108	18.5	16.5	JIS	3.5
	68	112	21	16.5	JIS	6
	70	112	20	16.5	JIS	**5**
	68	116	23	16.5	JIS	8
	68	122.5	26.5	16.5	JIS	11.5
	73	122.5	24	16.5	JIS	9
	68	126	28.5	16.5	JIS	13.5

BOTTOM BRACKETS

DESIGN ELEMENTS (CONT'D.

Shimano

The cartridge spindle unit press fits into a shouldered cup. There are different cups for different shell widths, threadings, and different models.

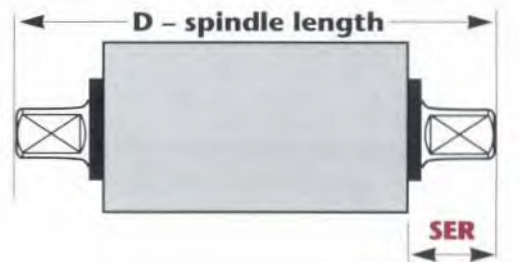
Model numbers vary according to quality. Cartridges are usually ordered by model shell width and spindle length. The dimensions arc the same for the same spindle length and shell width.

The cartridge spindle unit does not allow chainline adjustment, although the unit can be moved different directions by using a different rated shell size unit or adding freewheel spacers to the shouldered cup.

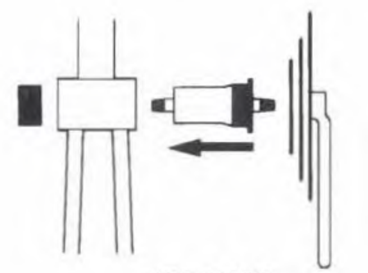
The splined and recessed cups allow the use of super low profile cranks. Shimano tools #TL-UN72, TL-UN73, or Park tool #BBT-2 apply, although the newer cups are incompatible with some older tools.

UN and 7410 series bottom brackets are installed from the right-hand side of the hike; LP, CP, and CT series bottom brackets are installed from the left, ***(see figure to the right).***

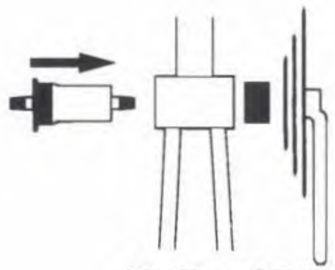
CT series bottom brackets and the LP-25 are "Easy-Set" bottom brackets. This means they have a collar around the spindle which establishes the correct chainline when used with an Easy-Set crank arm.



SER denotes shell to end, right measurement. See page 3-15 for further explanation.



UN, 7410



LP, CS and CT

Identical model numbers are repeated often in the first column. To identify a spindle, use model number, shell width, and spindle length.

(See page 3-54 for Phil mounting ring adapters for Shimano.)

Model (see note above)	Number Stamped on Spindle End	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
Shimano 7410, UN91	SS103	68	103	17.5	15	JIS/ISO	1.5
UN91, UN90, UN71, UN51	MM107	68	107	19.5	15.5-17.5	JIS	4
UN51, LP30, LP25, LP20	**MM110**	**68**	**110.5**	20.0	15.5-17.5	JIS	4.5
UN91, UN90, UN71, UN51, **LP30, LP20**	**LL113**	**68**	**113**	22.5	15.5-17.5	JIS	7

BOTTOM BRACKETS

DESIGN ELEMENTS (CONT'D) .

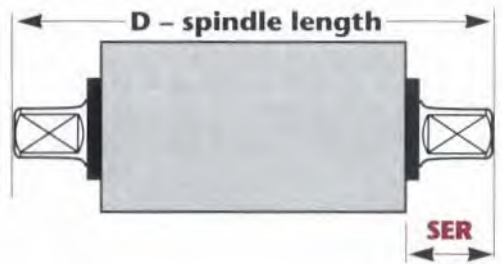
Shimano (cont'd.

Model (see note above)	Number Stamped on Spindle End	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
Shimano (cont'd) UN91, UN71, UN70, UN51, UN50, CS21, CS20, CS11, C510	D-H	68	115	23.5	15.5-17.5	JIS	8
CT90*	YL116	68	116	24	15.5-17.5	}IS	
UN51, LP30, LP20	XL-118	68	118	25	15.5-17.5	JIS	9.5
UN71, UN70, UN51, UN50, CS21, CS20, CS11, CS10	D-NL	68	122.5	28	15.5-17.5	JIS	12.5
UN71, UN70, UN51, UN50, CS21, CS20, CS11, CS10	D-EL	68	127.5	30.5	15.5-17.5	JIS	15
7410, UN91	SS103	70	103	16.5	15-15	JIS/ISO	0.5
UN91, UN90, UN71, UN51	MM107	70	107	18.5	15.5-17.5	JIS	3
UN51, LP30	MM110	70	110.5	19.0	15.5-17.5	JIS	3.5
UN91, UN71, UN51, LP30	LL113	70	113	21.5	15.5-17.5	JIS	6
UN91, UN71, UN70, UN51, UN50, CS21	D-H	70	115	22.5	15.5-17.5	JIS	7
CT90*	YL116	70	116	23	15.5-17.5	JIS	
CT90*	ZL121	70	121	25.5	15.5-17.5	**JIS**	
UN71, UN70, UN51, CS21	D-NL	70	122.5	27	15.5-17.5	JIS	11.5
UN71, UN51, CS21	D-EL	70	127.5	29.5	15.5-17.5	JIS	14
UN91, **UN71, UN51**	MM107	73	107	1 7	15.5-17.5	JIS	1.5
UN51, LP30	MM110	73	110.5	17.5	15.5-17.5	JIS	2.0
UN91, UN90, UN71, UN51, LP30, LP20	LL113	73	113	20	15.5-17.5	JIS	4.5
UN51, LP30, LP20	XL-118	73	118	*22.5*	15.5-17.5	JIS	7
CT90*	ZL121	73	121	24	15.5-17.5	JIS	
UN71, UN70, UN51, UN50, C521, CS11	D-NL	73	122.5	25.5	15.5-17.5	JIS	10
UN71, UN70, UN51, UN50, CS21, CS11	D-EL	73	127.5	28	15.5-17.5	JIS	12.5

* CT series bottom brackets are made to be used with the Easy-Set front derailleur with support plate.

DESIGN ELEMENTS (CONT'D.

Stronglight



SER denotes shell to end, right measurement.
See page 3-15 for further explanation.

The bearings are pressed onto the spindle. 113, 118, 124, 133mm length spindles are available.

The dimensions of all Stronglight models are similar. The model designations are as follows:

600: All steel unit
650: Titanium spindle, aluminum cups. Chainline not adjustable.
651: Same as 650 except with steel spindle.
700: Aluminum cartridge threaded at both ends for lockrings.
701: Same as 700 but full-length threads. Recommended for aluminum frames.

Currently only models 650 and 651 are being imported into the US.

Adjustable cups on both sides allow for minor chainline adjustments.

Model	**Shell Width**	**D - Spindle Length**	**SER**	**L/R Taper Length**	**Closest Taper End Size**	**Spindle End Factor**
Stronglight 37/24 650	68	114	23	15/15.5	ISO	4.5
37/24 650	**68**	**123.5**	**31.5**	15/16.5	**ISO**	14

DESIGN ELEMENTS (CONT'D.

Sugino

The Maestro bottom bracket has adjustable cups on both sides with the 6903 bearings pressed onto the titanium spindle. Both cups have 2.5mm recesses (but the recesses are only 23mm in diameter, which is smaller than for Shimano super low profile cranksets).

The Guines bottom bracket is a cartridge unit. The retaining cups are installed with standard bottom bracket tools. Though the left cup is adjustable, there is no need to adjust it for no load on the bearings - just tighten it down so the cartridge is not loose.

The other Sugino bottom brackets have spindles with a shoulder, on only one side and the other side is threaded. They also have two different cups: one with the bearing flush with the face of the cup, the other with a recessed bearing. Other pieces required are two Belleville springs, a notched washer, a slotted nut and a spanner style nut. **Installation:** Thread both cups into the frame. The cup with the flush-mounted bearing should be installed on the right side of the bike. Use Sugino tool #214 to tighten both cups. Insert the spindle through the bearings from the right side of the bike. Place the springs face to face so the outsides are touching and put them over the end of the spindle on the left side of the bike. Loosely thread the slotted nut onto the spindle behind the springs. The slotted nut should not be so tight as to completely compress the wave spring, but tight enough so there is almost no side-to-side play in the spindle. Slide the notched washer onto the spindle followed by the spanner style nut. Tighten the nut using the Sugino tool - you may need to place a crankarm onto the spindle in order to be able to tighten the nut enough. Check for play or drag in the spindle and tighten or loosen the slotted nut appropriately.

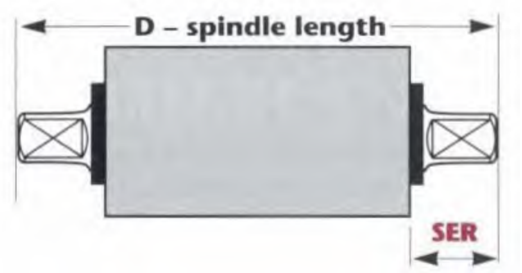
There is no chainl ine adjustability for either style bottom bracket.

Model	Part Number	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
Sugino Maestro	BB-TiMA	69.5	111	21.5-23	15/15.5	JIS/ISO	5.5-5.7
MS		68 or 70	114.5	22	n/a	ISO	3.5
MW, Guines		68 or 70	118.5	25.5	n/a	ISO	7.5
SB		68 or 70	124.5	30	n/a	JIS	14
RB		68 or 70	129	34.5	n/a	JIS	17.5
RRB		68 or 70	136	36	n/a	JIS	19

DESIGN ELEMENTS (CONT'D.

SunTour

The Superbe BB-SB20 and XC-Pro BB-SL10 are much like normal loose ball bearing bottom brackets except that the cartridge bearing inner races are pressed onto the spindle and the outer races, with the bearings and cages in them, are pressed into the cups. The cartridge bearings are angular contact bearings, so it is possible to have the inner race separate from the rest of the bearing.



SER denotes shell to end, right measurement. See page 3-15 for further explanation.

Adjustment of these bottom brackets is much the same as the adjustment of normal loose ball bearing bottom brackets. When installing the bottom bracket, make sure the rubber seals are seated in the cups for proper Grease Guard operation. Also make sure to use the supplied bolts with the holes in them in order to be able to inject grease into the bearings.

The BB-CBOO is a cartridge unit bottom bracket. It uses a splined Shimano style cartridge bottom bracket installation tool. A lockring is provided to fit on the left-hand cup, but it is not necessary.

The SS and SA series bottom brackets are cartridge style bottom brackets with mounting cups. The mounting cups are available in English, Italian, or French threading and fit 68 or 70mm bottom bracket shells. Chainline is adjustable. Use SunTour tool #TA-230 or Shimano cartridge compatible tools.

The DS series bottom brackets are also cartridge units, but they are mounted with adjustable cups with lockrings using standard bottom bracket tools. The cups are available only in English threading.

DESIGN ELEMENTS (CONT'D.

SunTour (cont'd).

Model	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
SunTour MicroDrive Sport (BB-CB00)	68	115	22	1 7.5	JIS/ISO	6
Superbe (BB-SB20)	70 68	112 112	21 22	1 5.5/16 15	ISO ISO	2.5 4
XC-Pro (BB-SL10-73)	73	119	23.5	17.5	jIS	8
SL/XC-Pro (BB-SL10)	68	115	24	1 7/16.5	JIS	8.5
SA-100, SS100	68 or 70	108	20	n/a	ISO	3
SA-110, 55110	68 or 70	117	24.5	n/a	ISO	7.5
SA-120, SS-120	68 or 70	120	29.5	n/a	ISO	13
SA-130, SS-130	68 or 70	126	27	n/a	ISO	10.5
SA-190, SS-190	68 or 70	117	28.5	n/a	JIS	13
SA-160, SS-160 SA-140, SS-140	68 or 70 68 or 70	126 126	32 31	n/a n/a	PS JIS	1 6.5 15.5
55-150	68 or 70	131	32	n/a	JIS	16.5
DS-200, DS-210	**68**	**126**	31	n/a	JIS	15.5
DS-220, DS-230	68	131	31.5	n/a	JIS	1 6.5

BOTTOM BRACKETS

DESIGN ELEMENTS (CONT'D.

Syncros

Pro Series bottom brackets use 7mm-wide 61903 bearings pressed onto the spindle, and Hardcore uses double row 10mm-wide INA bearings. The cups are interchangeable, but the spindles are different for these two because of the bearing-width difference.

Dual adjustable cups can be used on different-width bottom bracket shells and provide some chainline adjustment (depending on the bottom bracket shell width).

Three kinds of cups are available: recessed cups with Italian threading, recessed cups with English threading, and flat cups. Use either recessed cups with shorter spindles (113mm or less) or super low profile cranksets. Use the flat cups, which are available in English threading only and provide better bearing support, with longer spindles.

If your bottom bracket shell is narrower than the shell width listed, you will have more adjustability in the chainline, SER, and spindle end factor by the amount that it is narrower.

SUGGESTED SPINDLES FOR GIVEN CRANKARMS:

103 With recessed cups. For Dura-Ace SLP.
107 With recessed cups. For Deore XT & LX Compact.
108 With recessed cups. For XTR, Raceface Turbine LP and Cooks Bros. E.
111 With recessed cups. All Campagnolo Road & Mountain 1990.
113 With recessed cups. For '93 Deore LX, pre '93 Dura-Ace, Sugino Fuze, Topline Road, and SunTour Microdrive (68mm).
117 For most Syncros Mtn Triple, Ritchey, XT pre '94, SunTour Microdrive (73mm), Grafton Mtn, and some Kooka.
122.5 For most XT pre '94, most Kooka, some Syncros Mtn, Cook Bros. RSR and most CBR, most Topline Mtn, Cooks, and Raceface Turbine.
127.5 For XT pre '94, Cook Bros. RSR, and CBR, Topline Mtn, and most Cooks.
131 For odd size cranks or cranks on wide clearance stays/swingarms.

Model	Shell Width	D - Spindle ' Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
Syncros						
Pro Series	70	103	17	15.5	ISO	0.5
Pro Series/Hardcore	68.5	107	18	17	Univ.	4
	73	108	17	16	Univ.	-0.5
Pro Series	70.5	111	20.5	15.5	ISO	2
Pro Series/Hardcore	73	113	20.5	15.5	ISO	4
	74	117	22	15.5	ISO	5.5
	74	122.5	25	15.5	ISO	8.5
	74	127.5	27.5	15.5	ISO	11
	74	131	29.5	15.5	ISO	13

DESIGN ELEMENTS (CONTD.

TNT Performance Products

The titanium spindles have bearings pressed onto them. Double adjustable cups allow slight chainline adjustment.

The XT bottom bracket has recessed cup(s).

Model	Part Number	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
TNT	BB/68/103	68	103	17.50	17.5	jIS	2.5
	BB/68/103/I	68	103	17.50	17.5	JIS	2.5
	BB/681107	68	107	19.50	17.5	JIS	4.5
	BB/68/107/94XT	68	107	19.50	17.5	JIS	4.5
	BB/73/107	73	107	17.00	17.5	JIS	2
	BB/73/107/94XT	73	107	17.00	17.5		2
	BB/68/112.5	68	112.5	22.50	17.5	JIS	7
	BB/68/112.5/1	68	112.5	22.50	17.5	JIS	7
	BB/68/112.5194XT	68	112.5	22.50	17.5	JIS	7
	BB/73/112.5	73	112.5	20.00	17.5	JIS	4.5
	BB/73/112.5/94XT	73	112.5	20.00	17.5	JIS	4.5
	BB/68/117	68	117	24.50	17.5	JI5	9.5
	BB/73/117	73	117	22.00	17.5	JIS	7
	BB/68/122.5	68	122.5	27.50	17.5	JIS	12
	BB/73/122.5	73	122.5	25.00	17.5	JIS	9.5
	BB/68/125	68	125	28.50	17.5	JIS	13.5
	BB173/125	73	125	26.00	17.5	JIS	11
	BB/68/127.5	68	127.5	30.00	17.5	JIS	14.5
	BB/73/127.5	73	127.5	27.50	17.5	JIS	12
	BB/68/130	68	130	31.00	17.5	JIS	16
	BB/73/130	73	130	28.50	17.5	JIS	13.5

Phil Wood & Co.

Phil Wood bottom brackets are a type of cartridge unit. Both cups (referred to as mounting rings by the manufacturer) are splined and are available in English, Italian, French, Swiss, Raleigh Super Course, and Chater Lea threading. The splined installation tool for the mounting rings is also available from the manufacturer.

Spindles lengths available are: 90, 95, 100, 103, 105, 108, 111, 113, 116, 119, 123, 125, 127.5, 130, 135, 140, 145, 150, 155, 160, 165, 170, 175, 180, 185, 190, 195 , 200, 205, 210, 215, and 327mm.

Bottom brackets can be ordered to fit shell widths of 64-67, 68-72, 73-78, 86-90, or 104mm.

The stock bottom brackets available are listed next. Other spindle lengths, shell widths and SER's can be custom ordered.

DESIGN ELEMENTS (CONT'D.

Phil Wood & Co.

Available in stainless steel or titanium. The chainline can be adjusted 2. 5mm in either direction.

Phil mounting rings can be used to mount Shimano Cartridge Brackets . This makes it possible to mount Shimano Cartridge units in unusually threaded bottom bracket shells and also makes the chainline more adjustable. Remove the Shimano cups using a vise and a rubber mallet.

Model	Shell Width	D - Spindle Length	SER	L/R Taper Length	Closest Taper End Size	Spindle End Factor
Phil Wood	68	103	17.5	18.5	JIS/IS0	1.5
	68	105	18.5	18.5	JIS/IS0	2.5
	68	108	20	18.5		4
	68	108	20	23	JIS/IS0	4
	68	111	21.5	23	**JIS/IS0**	5.5
	68	113	25	23	JIS/IS0	9
	68	116	26.5	23	JIS/ISO	10.5
	68	119	27.5	23		11.5
	68	1 23	30	23	JIS/ISO	14
	68	1 25	31	23		15
	68	127.5	32.25	23		16
	68	130	31	23		15
	73	103	15	18.5	J1S/IS0	-1
	73	105	16	18.5	JIS/IS0	0
	73	108	1 7.5	18.5	JI5/ISO	1.5
	73	113	20	23	JIS/IS0	4
	73	116	21.5	23		5.5
	73	119	25.5	23		9.5
	73	123	27.5	23		11.5
	73	125	28.5	23		12.5
	73	127.5	29.75	23	JI5/IS0	13.5
	73	130	28.5	23	JI5/IS0	12.5
	73	135	33.5	23	JIS/IS0	17.5
	73	140	36	23	JIS/IS0	20

ENGLISH COTTERED SPINDLE INTERCHANGEABILITY

Shading indicates most commonly used spindles.

The following chart was compiled from five different sources. Numbers are rounded to the nearest 1/16" or .5mm. There may be minor discrepancies but none that should affect the interchangeability. Please write if you have any problems with the chart.

Spindles on the same line are interchangeable but may not have precisely the same dimensions. Spindles within each center size category are arranged in order of increasing right side. In cases where the right side is the same, they are listed in order of increasing left side.

Many of the spindles listed are no longer being made and are listed only so that replacements can easily be made. Hercules, Brampton, Bayliss Wiley, and Phillips that have only the old stamping number are no longer manufactured.

Centers	Left	Center	Right	Total	Raleigh sales no.	Raleigh American Ref. no.	Raleigh no. on spindle	Phillips sales no.	Phillips no. on spindle-current	Phillips no. on old spindle	TDC sales no.	TDC no. on spindle	RFG no. on spindle	Bayliss Wiley no. on spindle	Hercules no. on spindle	Brampton no. on spindle	Japanese JBG no.	Notes
1-11/16 (43.0mm)	1-5116 (34.0)	1-11/16 (43.0)	1.5;8 (41.5)	4-5/8 (117.5)				PBA 601		F103	C16/6	6		20				Miniature cycles
1-15/16' (49.0mm)	1.7/16 (36.5)	1-15/16 (49.0)	1-11/16 (43.0)	5-1/16 (129.0)							0 6/7	7		1				
2-1/16" (52.5mm)	1-5/16 (33.5)	2-1/16 (52.5)	1-5/16 (33.5)	4-11/16 (119.0)				PBA604		1102				15				single chainrings
	1-5/16 (33.5)	2-1/16 (52.5)	1-3/8 (35.0)	4-3/4 (121.0)							06/2 519/2	2						
	1-5/16 (33.5)	2-1/16 (525)	1-7/16 (36.5)	4-13/16 (122.0)				PBA 510		I	C16/9 519/9	9		23R				5-speeds
	1-5/16 (33.5)	'1!16 .!.5)	7-5/8 (41.5)	5 (122.0)				PBA512	3900431	I 01				14	MC34	88A280	3758	
	1-5/8 (41.5)	2-1/16 (52.5)	1-5/8 (41.5)	5-1/4 (133.5)				F'BA506		1139				8				
	1-5/16 (33.5)	2-1/16 (52.5)	1-11/16 (43.0)	5-1/16 (129.0)				PBA504		F113	0 6/4 519/4	4	4					1 0-speeds
	1-3/8 (35.0)	2-1/16 (52.5)	1-3/4 (44.5)	5-1/4 (133.5)				PBA513	3900437	F109	C16/5 519/5	5		2C	MC3GC	BBA261	3759	
2-3/16" (55.0mm)	S/16 3 5)	2-3/16 (55.0)	1-7/16 (36.0)	4.15/16 (126.0)	RBA104	A16	16				C16/10	10						
	5/16 S3.5)	2-3/16 (55.0)	1-9/16 (393)	5 (127.0)	RBA103	A23	23											
	1-11/32 (34.0)	2-3/16 (55.0)	1-13/16 (46.0)	5-11/32 (135.0)	RBA105	Al 6GC	16GC				C16/11	11					3760	Raleigh 1,3,5 most 10-speeds
	1-5/8 (39.0)	2-3/16 (55.0)	1-7/8 (47.5)	5-11/16 (144)	RBA102	22	22											Raleigh Tandem
2·7/16"	, 7/32 {32.0)	2-7/16 (62.0)	1-3/4 (44.5)	5-7/16 (137.0)	RBA108	A8	08GC				R16/8	8	AEG R				3757	R51.N 16, Tourist
	1-7/16 (36.0)	2-2/16 (62.0)	1.3/4 (44.5)	5-5/8 (148.0)	RBA101	A21	21GC	PBA508	3900709	F104				12				Chopper, Twenty
	1-11/16 (410)	2-7/16 (62.0)	1-11/16 (43.0)	5·1/2 (142.5)							R16/14	14		3				Delivery (Carrier)

BOTTOM BRACKETS

COTTERED BOTTOM BRACKET SPINDLES

Spindle End Diameter

	Nominal	Actual
ISO*	16mm	15.9mm
English	5/8" (15.88mm)	15.75-15.8mm
French	16mm	15.9mm
Italian	16mm	15.9mm

(See Appendix for more detail om ISO standards.)

FRENCH COTTERED SPINDLES

French bottom bracket spindles are catalogued by overall length.

Overall Length	Left	Center	Right	Markings on Spindles	Notes
Gitane—all black					
130	33	56	41	none	
134	35	56	43	none	
138	35	56	47	none	
Motobecane—all black					
134	36	55	43	none	Original equipment on Motobecane until '74, used with Solida cranks.
136	35	56	45	none	Original equipment on Motobecane from '74, used with Solida and Nervar cranks.
138	35	56	47	none	For Nervar cranks on Gitane **and** other French bikes.
Peugeot*—black ends, unpolished middle, polished left and right sides					
140	42	55	43	none	
142	42	55	45	none	Original equipment to fit folding bike.
145	43	55	47	none	OrigInal equipment to fit U08, A08, A018, U018C.
RFG—marked RFG					
135	37	54	44	13554C	
137	37	54	46	13754C	
140	40	54	46	140 54C	
135	(see note)			68 135	Original equipment on Sutter and other French bikes. Balls run in grooves on spindle, cups are extra thick and not interchangeable with others

* Peugeot spindles and cups are not interchangeable with others.

ASSORTED OTHER COTTERED SPINDLES

	Overall Length	Left	Center	Right	Markings on Spindles
GERMAN — (not interchangeable with others)					
RFG	135	36	56	43	170
Steyr	142*	40	56	46	none
(Puch)	135**	38	56	41	none
ITALIAN					
Magistroni	127	33	56	38	Magistroni 5R
Ofmega	137	44	58	35	Made in Italy
RFG	136	36	57	43	136
JAPANESE					
	145	41	51	43	No. 1
	139	40	53	46	S
	146	42	53	51	S3
	143	41	53	49	U3
	143	41	54	47	ST
	139	35	55	49	LB
	13.5	35	55	45	ITAZAM
	138	35	57	46	57
	140	33	62	43	A-8***

For Clubman and 10-speeds.

** For 1- and 3-speeds.

***Similar to Raleigh A-8.

BOTTOM BRACKETS

THOMPSON (THUN) BOTTOM BRACKET SETS

For Bottom Bracket Shells (inside diameter by width)

	40 x 65, 40 x 70	45 x 65, 45 x 70	30 x 65, 30 x 70
Axle Diameter	5/8" (15.8mm)	5/8" (15.8mm)	13mm (.511")
[1] Length	5-1/2" (140mm)	5-1/2" (140mm)	137mm (5-1/4")
Ball Size	**1/4"**	5/16"	3/16"
Cotter Size	3/8" (9.5mm)	3/8" (9.5mm)	8mm
Locknut Size	26mm (1.02")	26mm (1.02")	—

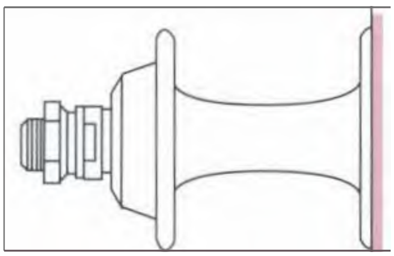
Adjustable left side is left-threaded. Be sure that the indentations in the left dust cover line up with the slot in the cone. Tighten locknut by holding crank arm on other side. Leave the cone on the right side in place.

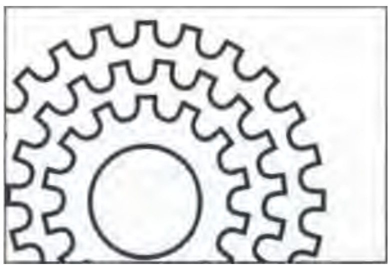
ONE PIECE (ASHTABULA) CRANKS

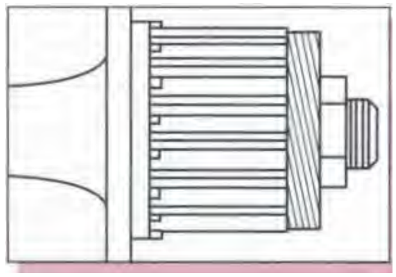
Thread Sizes and Ball Retainers

	Right-threaded Right Side (Stationary Cone)	Left-threaded Left SIde (Adjustable Cone)	Retainer	Ball Number and Size
USA	15/16" x 24 TPI	7/8" x 24 TPI	66	10 - 5/16"
Schwinn	15/16" x 28 TPI	7/8" x 28 TPI	64	9 - 5/16"


FREEWHEELS
FREEHUBS
FIXED GEARS







FREEWHEEL, FREEHUB, FIXED GEARS

MULTI-SPEED FREEWHEEL—HUB SHELL

Ball Sizes 1/8"

Counting freewheel halls is a waste of time. It is better to use one or two too few balls than too many.

Thread Sizes

ISO*	1.375" x 24 **TPI (34.92mm x 1.058mm)**
English	1.370" x 24 TPI (34.80mm x 1.058mm)
French	34.7mm x 1mm (1.366" x 25.4 TPI)
Italian	35mm x 24 TPI (1.378" x 1.058mm)

Country of manufacturer does not indicate thread dimensions.

During the 70's and 80's most freewheels imported into this country had English threads. English, Japanese and USA bicycles generally came with English threaded freewheels. French bicycles generally come with French threaded freewheels; however, later Peugeots and some others use English threaded freewheels. Italian bicycles generally used Italian threaded free-wheels. Recent Italian bicycles use ISO or English threaded freewheels.

Stop and measure before forcing a freewheel.

A check with a **thread pitch gauge** will separate French from Italian and English threads. English and Italian huh threads cart be distinguished by measuring with a vernier caliper. A two-inch micrometer, however, **is** the preferred tool. This method may not work on some hubs.

FREEWHEEL INTERCHANGEABILITY

	ISO Hub	**English Hub**	**French Hub**	**Italian Hub**
ISO Freewheel	**A**	**A**	**C****	A
English Freewheel	A	A	C**	
French Freewheel	C**	**C****	**A**	**C****
Italian Freewheel	**A**	**B*****	**C****	**A**

Class of Fit

A Made to fit.
B Will fit and be serviceable but will damage threads slightly.
C Looks like it might work but won't.

* See Appendix for more details on ISO standards.
** Difference in thread pitch makes this combination unacceptable.
*** This combination works, but avoid changing back and forth between Italian and English freewheels. Not for strong or heavy riders.

FREEWHEEL, FREEHUB, FIXED GEARS

ID MARKINGS ON FREEWHEEL BODIES

Markings on freewheel bodies are only found on some models.

Atom

English	rectangular punch mark on back of body
French	no mark

Maeda

English	no mark
French	M stamped in inner ring of body on outside

Normandy —see Atom

Regina

Old Marking

English	F.I. stamped in back
French	F.F. stamped in back
Italian	nothing stamped in back

Current Marking

ISO	3 grooves in back
English	1 groove in back
French	2 grooves in back
Italian	no grooves in back

Zeus

English	B stamped in back
French	M stamped in back

ID MARKINGS ON HUBS

Campagnolo

Old Marking—between spoke hole flange and freewheel threading

English	1 groove
French	no groove
Italian	no groove

Current Marking—marked with thread size

Ofmega—marking between spoke hole flange and freewheel threading

English	1 groove
French	2 grooves
Italian	no grooves

Zeus

English	B.S.C. stamped on center shaft of the hub
French	nothing stamped on center shaft on the hub

FREEWHEEL, FREEHUB, FIXED GEARS

FREEWHEEL SPACERS

(Between hub and threaded or freewheels)

Bicycle Research	1, 1.5, 2mm
Campagnolo	1, 1.5, 2mm
Sturmey Archer HMWI27	1/16" (1.6mm)
Raleigh	1/32" (.8mm), 1/8" (3.2mm)
Cyclo (French)	1.2, 1.7mm
Wheels Manufacturing	1, 1.5, 2mm

MOUNTING FREEWHEELS

Factors to Consider

1. Hole in freewheel has to be large enough to lit over locknuts of hub.
2. Before you put it on, make sure you can remove it. ***(See "Problems to Avoid" below.)***
3. Match the threads with the hub.
4. Be aware of any chainline changes. Note the offset differences on the freewheel back. ***(See hub section on page 10-5.)***
5. Check outside clearance, especially clusters with outside chainguards. Will they clear seat stay, chain stay and derailleur mounting bolt?
6. Be sure faces of freewheel and hub that butt together are compatible, i.e. Regina Scalare (close ratio) has a recessed face that may not butt properly on some hubs.
7. Is a new chain necessary?

Problems to Avoid

Don't use an old style Shimano splined freewheel on Campagnolo, Shimano Dura Ace or similar hub. It comes off only after removing axle from other side.

Mount splined Atom, Zeus, or Regina to a Campagnolo or similar hub only if you have a thin wall Atom tool like the Phil Tool.

Before installing a freewheel on a sealed bearing hub, be sure you can get it off. Atom-type splined freewheels can only be removed with a thin wall tool or by disassembly.

Old style Shimano splined freewheels must he disassembled to he removed from Phil, Hi-E, Weyless, and other sealed hearing hubs.

Always remove the freewheel before cutting the spokes out of a wheel.

12mm tandem axles are too big for the holes in many freewheel pullers. Current Bicycle Research tools have clearance for 12mm axles.

REMOVING FREEWHEELS

Factors to Consider

Fit for notch tools:

1. Tools must be in good shape
2. Dogs must closely fit notches
3. Tool must butt against body, not bottom of notch
4. Tool must he properly located against body or axle or both, to ensure the dogs stay properly engaged when force is applied
5. Tool **must** be secured with quick release or axle nut to break freewheels loose
6. With remover clamped **in** a vise, press down at rim while turning to remove

Dogs that are too long prevent the rim from seating on the body. This allows the remover to rock and the dogs to climb up and strip the body.

If stripped, chisel off the chewed-up part on a Regina notched-type freewheel. Often it will chip off square. Then start again.

Freewheel Removing Tools

Combinations of freewheels and pullers are listed as "A", "B", or "B-". An "A" fit is probably the most successful combination and, if properly secured and located, won't result in any damage to the freewheel or tool. With a "B" fit there is some chance of damage to the freewheel and tool. A "B-" fit is more likely to damage both tool and freewheel; but if you have to remove freewheel to throw it out, it might be worth it.

Not all combinations that work are listed. If you try others, be sure to follow recommendations listed under "Factors to Consider."

If all else fails, you can remove a freewheel by dismantling it. Exceptions to this are the old style Winner.

FREEWHEEL, FREEHUB, FIXED GEARS

REMOVING FREEHUBS - CASSETTE COGS

Factors to Consider

1. Most current cassettes have all cogs splined and are held on with a lockring threaded into the freehub body.
2. Older cassettes have the smaller one or two cogs threaded onto the freehub body. These are removed much like sprockets are removed from freewheels: with two chain whips. Check the sprocket interchangeability charts to see which cogs are splined and which are threaded.
3. Tool can be held in place with quick release or axle nut to break cassette loose if necessary.
4. Some freewheel tools may be used to remove cassette lockrings. Be careful when using them. Because they are designed for freewheels, they are longer than they need to be for cassettes and may press the inside seals against the freehub bearings.

MOUNTING FREEHUBS - CASSETTE COGS

Factors to Consider

1. Because lockrings are not tightened by pedaling forces, be sure to torque the lockrings when installing them, but do not overtighten them either.
2. See also individual sections on cassette cog interchangeability.
3. Grease the threads on the lockring or any threaded cogs and make sure enough threads engage the cassette body.
4. Be sure the sprockets are aligned on the cassette body (if necessary).
5. Check the sprockets for play that would indicate that the top sprocket is not seated properly.
6. Make sure the largest cog is spaced far enough away from the hub flange that the rear derailleur does not hit the spokes when shifting into the largest cog.
7. If there are any rivets or bolts holding the sprockets together, make sure they are not contacting the freehub body, especially if the freehub body is aluminum.

FREEWHEEL, FREEHUB, FIXED GEARS

TOOLS FOR REMOVING FREEWHEELS AND FREEHUBS

Make	Class of Fit—Tool	Notes
ATOM - splined	**A** Atom (splined) Bicycle Research CT-1 Atom Park FR-4 Phil Tool Var 407, 401 Zeus (splined) Regina 805032	With Phil or Park Tool, removing axle spacers is not necessary. Be sure tool is well seated. Keep a sawed-off one for hubs that don't allow tool to seat fully. Atom-style splined removers are not all the same size due to tolerances. Keep several around to match different freewheels. Too loose a fit or one that doesn't go in all the way can cause trouble.
- notched	B Var 186 Var 01 **B-** Bicycle Research CT-1 Regina	
CAIMI **EVEREST** **SIMPLEX**	B Bicycle Research CT-1 Regina Campagnolo 704 Kingsbridge 101 Shimano Dura-Ace (new style) **B-** Cyclo (English) Kingsbridge 100 Shimano Dura-Ace (old style) Var 186 Var 188 Var 01	
CAMPAGNOLO - FREEWHEEL	**A** Campagnolo 0520/40 Kingsbridge 115 Var 404 Bicycle Research CT-9	
CAMPAGNOLO - FREEHUB		
- Sprocket lockring	**A** Campagnolo 71 30036 Var 414B, Park BBT-5 B Shimano tools or Pamir Hypercracker	Tool also fits Campy bottom bracket cassette.
- Freehub		Loosen set screw in axle nut. Loosen axle nut. If pawls and springs pop out use Campy tool that comes with hub to reinstall the cassette body.
CYCLO (English)	**A** Cyclo (English) Kingsbridge 100	French and English Cyclos are completely different.
CYCLO (French)	**A** Cyclo (French) DR.64 B Kingsbridge 100 Var 188	French Cyclo tools will fit over the large locknuts found on New Star hubs. English and French Cyclos are completely different.

TOOLS FOR REMOVING FREEWHEELS AND FREEHUBS (CONT'D)

Make	Class of Fit—Tool	Notes
CYCLO-PANS (French)	A Use tool that comes with the freewheel DR.68, DR.P	Modify SunTour tool to work by filing the outside of the dogs.
FALCON	A Lifu 09B.1	**Note:** the regular 22.4mm O.D. splined tool will not work. Original Falcon had a hole so small Shimano 22.4mm O.D. splined tool had to bepounded in, which ruins the tool. Current Falcon freewheels have an oversized 23,6mm O.D. hole that will damage a regular Shimano tool.
MAEDA	*(See SunTour)*	
MAILLARD, SACHS-HURET		
– notched Aris, 700	A Maillard 409, 410 & 411 Kingsbridge 110 Var 413	411 has a special skewer.
	B- Shimano Dura-Ace (old style) Var 186	
- splined (old)	*(See Atom splined)*	
- large-diameter hole with 6 slots	A Var 412 large diameter remover with 6 bumps	
- Helicomatic	A Maillard 415 wrench Var 524 wrench	Remove ring with special wrench, then pull freewheel off.
MERVEILLE	A Eldi BGM Var 187 B B Regina single-speed remover Var 01 A Two 5mm alien wrenches	Threads that mate with the hub go straight through. You will have to remove the two smallest sprockets before using the Eldi tool. Var 01 may have to be filed slightly to match.
MAVIC - FREEHUB		
- Cassettes		
- Sprocket lockring	*(See Shimano Hyperglide lockring)*	Remove axle cap with alien wrenches.
MILREMO		
- splined	*(See Atom splined)*	
- Pans	*(See Cyclo Pans)*	
- 2 notch	*(See Atom notched)*	
NORMANDY	A Bicycle Research CT-3 Normandy Maillard 408 Var 405	

TOOLS FOR REMOVING FREEWHEELS AND FREEHUBS (CONT'D)

Make	Class of Fit—Tool	Notes
REGINA		
– splined	A Regina 805032 Park FR-4 Phil Atom Tool Var 401 *(See also Atom splined)*	
- notched	A Bicycle Research CT-1 Regina Kingsbridge 101 Shimano Dura-Ace (new style) B Kingsbridge 100 B- Cyclo (English) (some) Var 01 Var 186 Var 188	Campagnolo adapter (704/1) for 13-tooth cogs and 6-speeds lacks the ring that prevents sideways slippage. The Campagnolo #1 remover can be modified to fit a freewheel with 13 teeth by grinding off the outside dogs. This modification means you can't turn the remover block over when it becomes worn or use it for single speed sprockets. Bicycle research fits 12-tooth Regina.
SACHS-HURET	*(See Maillard)*	
SACHS		
- Aris splined freewheel - Sachs cassette body	A Any Shimano-style Post-'85 splined tool. A Sachs Cassette Body Tool (U500400) and 32mm wrench	Narrow side of double threaded piece is for 7-speed. Wider threaded side is for 8-speed. Use mallet with tool threaded in cassette to reinstall.
SCHWINN Approved	*(See Atom splined or Shimano Pre-'85 splined for small-diameter internal splined cogs.)* *(See Normandy for large-diameter internal-splined cogs.)* *(See Sun Tour or Atom for notched cogs.)*	
SHIMANO *Freehub*		
- Freehub for pressed on freewheel body	A Shimano Freehub removal tool (TL-FH 30)	Tool works like a gear puller. For pressed-on freehub-type body found on 600AX, AX, 600 EX 7-speed. (Pre '85).
- Freehub Dura-Ace, Dura-Ace EX	A Shimano Freehub tool (TL-FW10)	Bolt-like tool
- Freehub freewheel body held on with hollow bolt	A 10mm alien wrench	Remove axle.
- Freehub on steel hub shell	Not removable	
- Hyperglide sprocket locknut	A Shimano TL-HG15 Bicycle Research Park FR-5 Pamir Engineering B CT-6 Shimano	

TOOLS FOR REMOVING FREEWHEELS AND FREEHUBS (CONTD)

Make	Class of Fit—Tool	Notes
SHIMANO *Splined* Freewheels		
Pre-1985 - old style splined A Type	A Bicycle Research CT-4 Shimano Shimano TL-FW20 (A type) Var 411	Tool outside diameter 20.0mm. Shimano old style splined freewheel will not fit on a Shimano Dura-Ace hub. A 17mm hex locknut will just fit through the splines in an old-style splined freewheel.
After 1985 - new style splined B Type	A Bicycle Research CT-6 Shimano CT-6MB Shimano TL-FW30 (B type-UC)	Tool outside diameter 22.4mm. Removing axle spacers is not necessary. Bicycle Research CT-6MB is a heavy duty version for mountain bike and tandem use. Nuts and spacers must be removed to use it.
Uniglide MF-1500 MF-1600 600 EX MF-6208 Sante MF-5000 Dura-Ace MF-7400 (no name) MF-Z012	Park FR-1 Var 414	
SHIMANO *Notched* Freewheels		
- Dura-Ace very old style	B Shimano Dura-Ace (very old style) B- Var 186	Very old style has flush surface (threaded flange doesn't protrude above the freewheel's adjusting cone).
- Dura-Ace old style, 600 *(See also 600 EX)* MF-7160 MF-6160 MF-6150	A Bicycle Research CT-1 Regina Kingsbridge 101 Shimano TL-FW10 B Cyclo (English) Kingsbridge 100 Var 188	On old-style freewheels the threaded flange protrudes above adjusting cone face. Shimano Dura-Ace very old and old-style freewheel tools are not interchangeable; be sure to use the correct one. Tighten the tool down extra snug. Old style has ring to locate tool on body. Very old style tool has two dogs.
- 600 EX(with black ring inside smallest sprocket) MF-6207	*(See above* tools *for Dura-Ace old style, 600)*	Remove black ring with a pin tool, then use tools listed for Dura-Ace old style, 600. To avoid removing ring use Bicycle Research CT-600 carefully.
SHIMANO *Other*		
- Automatic	A Shimano Automatic	Freewheel must be partly dismantled before removal. Reassembly is **easy.**
- FF System Friction Freewheel	A Shimano A type	Remove outer locknut and spacers to gain access to splines.
SIMPLEX	*(See Caimi-Everest-Simplex)*	

TOOLS FOR REMOVING FREEWHEELS AND FREEHUBS (CONT'D)

Make	Class of Fit—Tool	Notes
SUNTOUR Notched		
(Maeda) Winner, Winner-Pro, and *a* - 4 notch	A Bicycle Research CT-10 Park FR-3 SunTour TA-320	Bicycle Research has reinforced dogs.
MicroLite - 6 notch	A SunTour MicroLite (6 dog)	
Perfect Pro Compe, 8.8.8. and New Winner - 2 notch	A Bicycle Research CT-7 SunTour Kingsbridge 111 SunTour (2 dog) Var 706 Park FR-2 B Cyclo (English) - some	Bicycle Research or Kingsbridge tool can be used without removing locknuts and without quick release to hold it in place. Use vice and press down at rim while turning. SunTour tool will not fit on 6- or 7-speed freewheels. (2 notch)
- 4 notch(old)	A SunTour (4 dog) (old) B- Maillard 700 Var 413	
SUNTOUR *Freehub*		
- Pre-1991, not removeable		
- 1991 - current	10mm allen wrench	Remove axle; insert hex wrench through hub from left side.
TDC - 3 or 4 notch	A Bicycle Research CT-5 TDC TDC Var 402	
- 4 notch	A Bicycle Research CT-5 TDC TDC Var 402 B Var 01 Var 186	
ZEUS 2000	A Bicycle Research CT-2 Atom Park FR-4 Phil Tool Var 401 Var 407 Zeus (splined)	

Cassette Sprocket Removal

All SunTour cassettes and Shimano pre-Hyperglide cassettes have threaded outer cogs. The last cog is threaded onto the cassette body except for the SunTour Microdrive cassettes where the outer cog is threaded onto the next cog in and that cog is threaded onto the cassette body. These cogs are removed the same as with a freewheel on the wheel: with two chain whips. One to loosen the outer cog and one to hold the cassette body position.

Most other cassettes have all splined cogs and are held on by an externally threaded lockring that threads into the cassette body. The lockring is removed with the appropriate removal tool and with a chain whip holding the cassette in place.

Cassette Body Removal

There are many ways manufacturers attach cassette bodies to hubs. Some cassette bodies are pressed on, some are bolted on, some are not removable. If the cassette body is removable usually the wheel axle needs to be removed from the hub in order to remove the cassette body.

(See Tools For Removing Freewheels and Freehubs, on page 4-7 to 4-11, for special tools needed to unbolt the cassette bodies.)

Many smaller manufacturers make hubs that use a Shimano-style cassette body. Sometimes the cassette bodies are made by Shimano so they are removed the same. Other times the cassette bodies are made by other manufacturers and removal varies.

Sprocket Replacement

When installing a new chain, you should also replace any worn sprockets because the new chain may not run or shift smoothly on sprockets that have worn with the old, stretched chain. Depending on how much the old chain stretched, either only the high wear cogs (usually the smaller cogs) or all the cogs may need to he replaced.

Freewheel Sprocket Removal

Modern freewheels have splined inner sprockets held in place by threaded outer cogs. This allows easy removal of all sprockets, even with the freewheel in place on the rear wheel. Removing the sprockets from an older, all threaded freewheel body is different. One or two of the larger sprockets are left threaded and remove from the inside, the rest are right threaded and removed from the outside. Do not attempt to hold the bare freewheel body when removing the last threaded sprocket. Instead, thread two sprockets and lock them against each other (like a cone and locknut), not against the freewheel body shoulder. Use this pair of sprockets to hold the freewheel while loosening the last sprocket.

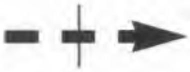
FREEWHEEL, FREEHUB, FIXED GEARS

HOW TO USE THE INTERCHANGEABILITY CHARTS

Horizontal rows represent freewheel models and vertical columns represent sprocket positions (1 inside to 7 outside).

Sprockets inside each outlined box are interchangeable with one another. One-way interchangeability is indicated by an arrow crossing a heavy line. Restricted interchangeability is indicated by a dotted arrow (if one-way) or by a dotted line (if two-way) and is explained in a lettered footnote.

 **One-way Interchangeability**

 **Restricted Interchangeability (One-way)**

 Restricted Interchangeability (Two-way)

For each sprocket listed, the manner in which it attaches to the cluster is indicated. Also indicated is any provision a sprocket may have to hold the next smaller sprocket. The following symbols are used:

Symbol	**To attach to cluster, sprocket has:**	**To accept next smaller sprocket, sprocket has:**
	Splines	
	Inside threads (left-handed)	
	Inside threads (right-handed)	
	Outside threads (right-handed)	
	Inside threads (right-handed)	Inside threads, same diameter
	Inside threads (right-handed)	Inside threads, lesser diameter
	Outside threads (right-handed)	Inside threads
	Inside threads (right-handed)	Outside threads

Arrow indicates the direction of sprocket removal. Note that splined and right-threaded sprockets always come off to the right (outside) of the cluster, left-threaded sprockets come off to the left (inside).

CAMPAGNOLO CASSETTES

Campagnolo Pre '94 Cassettes:

Pre '94 cassettes come in three levels of quality: Aluminum, Steel Record, and Steel Athena.

The cogs come in three series: A for the outer cog (with built in spacer), B cogs for the middle (the aluminum is only available in the B series), and C cogs for the inner position(s). C cogs are designed not to shift to a smaller cog while hack pedaling especially given the chainline in those positions.

The A cog is only for the outer position. The B cog is for anything but the outer position. The C cogs should only be used on the inner positions, there should also be no B cog larger than the smallest C.

The 1993 and earlier series of cogs were a symmetric 8 notch cog and cassette body. The B and C series cogs had the letters A through H successively labeled clockwise on their cogs. Special alignment of these cogs is important for best shifting performance due to the different tooth profiles on the cogs.

Look to the chart to see the alignment of the cogs.

Reading the Cog Alignment Chart:

For any two cogs next to each other, look up the larger one on the bottom line, look up the smaller on the right side of the chart, find the intersection of the two cogs. That letter should be the letter on the smaller cog directly above the A' stamped on the larger cog. (The letters on the cogs should face out.)

The orientation of the smallest cog (the A series cog) does riot matter. If the smallest cog is an 11-tooth cog, use the special lockring (part #7203085) to hold the cassette on, otherwise use the normal lockring (part #7203084).

Cog Alignment Chart

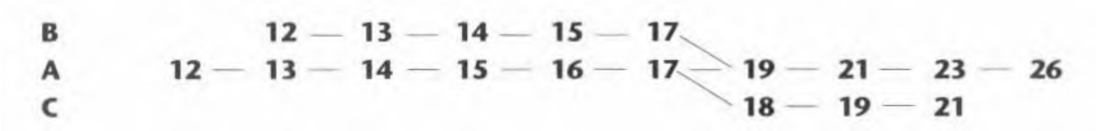
smaller cog \ larger cog	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	28	30	32
32																		
30																		H
28																	E	F
26																G	A	C
25																D	C	
24															A	H		
23														F	G			
22													C	G	H			
21											G	G	E	E				
20										G	A	E	C					
19									A	A	B							
18								B	H	G								
17							G	B	C									
16						A	A											
15					B	D												
14				B	F													
13			A	D														
12																		

Campagnolo Exa-Drive Cassettes and Bodies:

1994 Campy cassettes use sprockets with eight dogs. One of the dogs is narrower than the others. The cassette body has eight grooves with one narrower than the other. That means that the 1994 cassette sprockets will work on any of the cassette bodies, but 1994 cassette bodies can only use 1994 cogs (earlier cogs will not fit). 1994 cogs should not be mixed with earlier cogs.

Currently there are three sequences of cogs: the A, B, and C sequence of cogs. (Not related to Pre-'94 A, B, and C series sprockets.)

Choose any eight cogs, from the chart below, that form a continuous path from the left to the right. Sprockets can only he used in order. B and C sequence cogs should never be mixed.



Exa-Drive A, B, and C series cogs have no correspondence to non Exa-Drive A, B, or C series cogs.

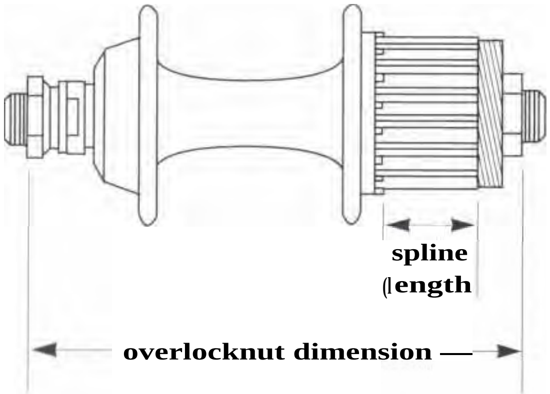
Example: B12, B13, B14, B15, B16, B17, B19, B21, B23 will work but B12, B13, B14, B15, A17, B19, B21, B23 will not work.

These cogs are marked with either a triangle or diamond at the narrower dog, so when installing on a pre-'94 cassette body, he sure to have these aligned. The circles on the face of the cogs should form a smooth spiral.

Campagnolo tool #7130036, Var 414B or Park BBT-5 should be used to tighten the lockring to 50 Nm or 37ft. lbs. for all the cassettes.

FREEWHEEL, FREEHUB, FIXED GEARS

FREEHUB (CASSETTE) BODIES — LENGTHS



Speeds	Freehub Body Spline Lengths*	Overlocknut Dimensions
CAMPAGNOLO		
7-speed	30.5	126
8-speed	34.6	130

* There is no external threaded section on Campagnolo freehubs.

CAMPAGNOLO SPROCKET INTERCHANGEABILITY

Freewheel	(inside) 1	2	Sprocket Positions 3	4	5	6	(outside) 7
Campagnolo 6-speed	17-28T A	16-27T B	14-23T DE		13-18T F	12-16T G	
Campagnolo 7-speed			16-23T	15-22T	14-21T		

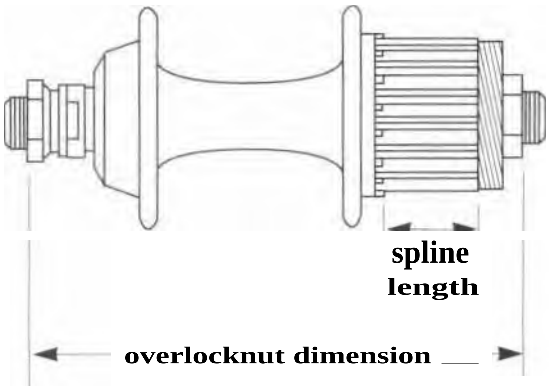
Notes:

Spacer © is used between sprockets (B) and (DE). For the 7-speed an additional spacer is needed between sprockets 3 and 4. Early models combined sprockets (A) and (B) into sprocket (AB). If a 16-tooth sprocket was used in the second position, this required spacer (C2) to be used between

MAVIC CASSETTES

There are two Mavic cassette bodies. One for Mavic cogs and one for Shimano Hyperglide cogs. The Mavic cassette body has grooves to fit the rounded dogs on the Mavic cogs. Use only a Mavic lockring on a Mavic cassette, although the Shimano lockring tool works to remove the lockring. The Shimano cassette body has squared off grooves for the squared off dogs and uses a Shimano lockring.

FREEHUB (CASSETTE) BODIES — LENGTHS



Speeds	Freehub body Spline Lengths	Overlocknut Dimensions
MAVIC		
8-speed	36.4	130
8-speed hyperglide compatible	34.8	130

MAVIC SPROCKET INTERCHANGEABILITY

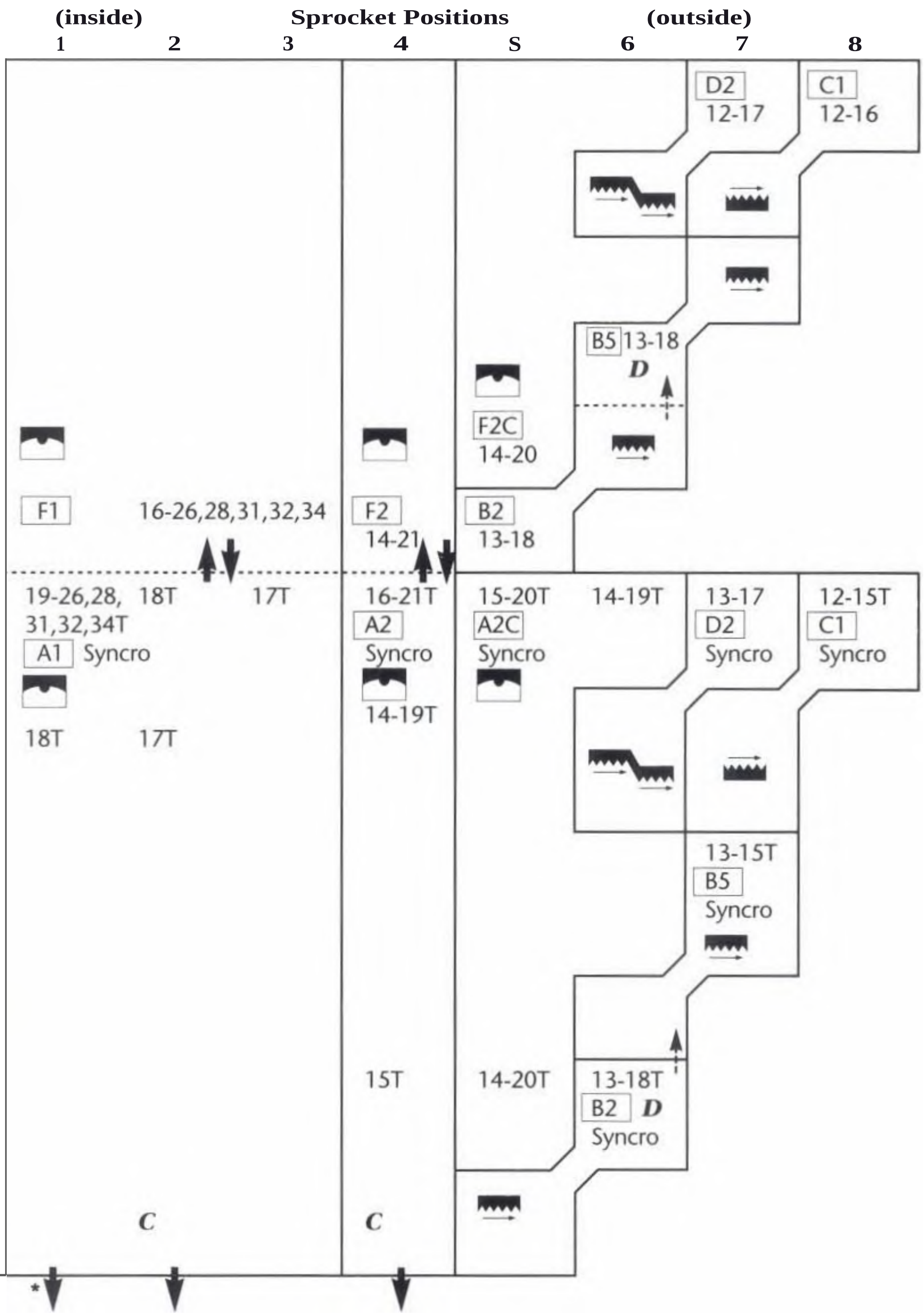
Cassette	1	(inside) 2	3	Sprocket Positions 4	5	6	7	(outside) 8	
Mavic	13-26,28T							 12-14T	 lockring*

* Models 571 & 577 use a threaded top cog. Models 571/2 & 577/2 use a splined top cog and lockring.

MAVIC SPACERS

Cassette	1	(inside) 2	3	Sprocket Positions 4	5	6	7	(outside) 8
Mavic	I 3.2mm							

REGINA SPROCKET INTERCHANGEABILITY *(See Regina page 4-20.)*



Freewheel

Syncro '92-S
8-speed

Syncro/America '92-5
7-speed, Body #3

Syncro/America '92-S
Ultra 7, Body #4

Syncro/America '92-5
Ultra 6, Body #3

Syncro/America '92
6-speed, Body *#2*

Syncro/America '92
5-speed, Body #1

Syncro 90-S
8-speed narrow
longer Syncro body

Syncro 90-S
7-speed narrow
smallest cog [
smaller 7-spd Sync. body

Syncro 90-S
7-speed narrow
smallest cog **B5**
longer 7-spd Sync. body

Syncro 90-S
6-speed narrow

Syncro 90
6-speed regular

Syncro 90
5-speed regular

Notes:

* Arrows refer to interchangeability. *(See page 4-20.)*

C. Syncro sprockets will work in corresponding non-syncro positions. Non-syncro sprockets should not be used for index systems.

Notes: (cont'd)

- Parts can he interchanged but with change in spacing.

For the Regina XLR8 cassette adapter, only aluminum cogs should be run on it, except for the special top cogs:
B7 for Dura-Ace threaded (non-Hyperglide) cassette bodies.
B8 for other Shimano threaded (non-Hyperglide) cassette bodies.
B9 for Hyperglide bodies (use with lockring).

REGINA SPROCKET SPACERS

Freewheel	1 (inside)	2	3	4 Sprocket Positions	S	6	7 (outside)	8
Syncro '92-5 8-speed						none	none	
Syncro/America '92-5 7-speed, Body #3					none	none		
Syncro/America '92-5 Ultra 7, Body #4						none		
Syncro/America '92-5 Ultra 6, Body #6	T21			T3	none			
Syncro/America '92-S 6-speed, Body #2			T6	T8	none			
Syncro/America '92-S 5-speed, Body #1					none			
Syncro 90-5 8-speed narrow longer Syncro Body	K2	K2	K7	K3	K3	none	none	
Syncro 90-S 7-speed narrow shorter 7-spd Sync. body	K2	K2	K7	K3	none	none		
Syncro 90-5 7-speed narrow longer 7-spd Sync. body	K2		K7	K3	K3	none		
Syncro 90-5 6-speed narrow		K2	K7	K3	none			
Syncro 90-5 6-speed regular	K11	K1	K6	K8	none			
Syncro 90 5-speed regular	K1	K1		none				

REGINA SPROCKET INTERCHANGEABILITY *(See Regina page 4-18.)*

Notes:

* Arrows refer to interchangeability. ***(See page 4-18.)***

A. America Superleggera 7-speed—Use a [B3] sprocket in place of the [B6] and S4 spacer.

B. America Superleggera 6-speed—Use a ___ sprocket and [S4] spacer in place of the sprocket and [S5] spacer.

FREEWHEEL, FREEHUB, FIXED GEARS

REGINA SPROCKET SPACERS

Freewheel	(inside) 1	2	3	Sprocket Positions 4	5	6	(outside) 7
CX-S 6-speed narrow	K2	K41	none	K3	none		
CX-S, America A 7-speed narrow	K2 S2	K4]A S4	none	K3 1 S3 1	none	none	
CX, America B [6-speed regular	I K1 I S1	K5 *B* 55	none	none	none		
BX 6-speed regular	K1	[K1]	K6]none	none	none		
BX 5-speed regular	K1	K1	K6]	none			
CX 5-speed regular	K1	K5	none	none			

REGINA SPACER DIMENSIONS

Usually the thickness is 4.95mm for the cog and spacer on the inside (the cog tooth to tooth distance can he approximated by adding the thickness of a cog and the spacer adjacent to it on the inside).

4.95mm for 8-speed, 7-speed, 6-speed freewheel spacing. Approximately 5.45mm for 6-speed standard spacing.

Spacer	Thickness	ID	OD	Color
K1, S1	3.45	49	52	Natural steel
K2, 52	2.95	49	52	Black Delrin
K3, S3	2.95	41	45.5	Silver Steel
K4, 54	0.8	46.5	51.5	
K5, S5	1.5 beveled	46.5	51.5	
K6	3.80 beveled	41	52	Natural Steel
K7	3.10 beveled	41	52	Brown Steel
K8	3.45	41	45	Natural Steel
T1	3.65	49	52	Blue Delrin
T2	3.15	49	52	Grey Delrin
T3	3.15	41	45.5	Grey Delrin
T6	4.00 beveled	41	52	Brass Plated
T7	3.00 beveled	41	52	Zinc Coated Steel
T8	3.65	41	45	Blue Delrin

Note: Colors may be different for older spacers.

SUTHERLAND'S

FREEWHEEL, FREEHUB, FIXED GEARS

T.D. CROSS, REGINA THREADED AND ATOM THREADED FREEWHEEL SPROCKET INTERCHANGEABILITY

Freewheel Body	(inside) 1	2	Sprocket Positions 3	4	5	(outside) 6	notes
T.D. Cross	20,22-24 28T A	18-22,24T		14-171			
Regina—threaded 3-speed **B**	17-31T (3)	16-24T C2)	14-18T (1)				
Regina—threaded Scalare *E* **M**			15-161 (*CM	0 C			Regina Sprockets 4-Speed 14-18T top
Regina—threaded Extra (normal body)				14-171	13T *D* 9	12T 1-1) YIIY	Regina Sprockets 6-Speed 12T top
Atom—threaded							
Schwinn Approved Model F—threaded					13-15T	12,131 *N*	Atom Sprockets 6-Speed 12,13T top
					13-17T 7		Regina Sprockets 5-Speed 13-17T top
				14-16T !MIMI	13T NIP		Atom Sprockets 5-Speed 13T top
				(4) 15-22T	14-20T 8		Regina Sprockets 6-Speed 13-17T top
					14-18T 5		Regina Sprockets 5-Speed 14-18T top
				15-18T D	14-16T *K*		Atom Sprockets 5-Speed 14-16T top

Any outer sprocket combhuItion in the shaded area can be mounted on any of the above four freewheel bodies.

Manufacturer's series desigi tations are circled.

Identifying Re Gina Freewheels

Regina Extra and Scalare have all positions threaded; inner sprockets unscrew clockwise to the inside. Extra body has flush hub mounting; Scalare has back of body slightly recessed around hole for huh.

Regina CX (regular), BX (regular) and CX-S (narrow-spaced) freewheels are labeled on *the* lockrings.

Regina Futura Cassette Freewheels have sprockets that arc not individually replaceable.

Notes:

A. T.D. Cross #1 sprocket is dished and is not interchangeable with the others, although the spline configuration is the same.

B. Regina 3-speed uses the same sprockets as other Regina freewheels.

C. a n ci 16) have the same threads but -)is 4.5mm thick with beveled flange while 10 is 3.5mm thick with squared flange.

T.D. CROSS, REGINA THREADED AND ATOM THREADED FREEWHEEL SPROCKET INTERCHANGEABILITY (CONT'D)

Notes: (cont'd)

D. New-style ® (threaded 1161*- as shown) is clearly not interchangeable with old-style ® threaded ! -
Old-style ® is no longer available (see note M for its use on Scalare body).

E. Note that Regina Scalare is the only all-position threaded body that will accept a 15T sprocket in the 3rd position.

K. Regina ® and Atom ©sprockets here are interchangeable with Schwinn F2 and F3, and with Normandy outer sprockets. ***(See page 4-34.)***

M. Old-style Scalare freewheels do not use the Regina and Atom outer combinations shown, but have (1) in place of (10) and old-style ® in place of ® making a 00 old(9)(7) five-speed instead of the current (3)(2)(10)(6)

N. Atom 12, 13T with 34.8mm O.D. thread also fits Regina CX-S and ;Millard Helicomatic 7-speed.

SACHS, MAILLARD: ARIS FREEWHEEL SPROCKET INTERCHANGEABILITY (SEE MAILLARD PAGE 4-26)

Freewheel

ARIS

7-speed narrow
CC body ***H***
87-89 3 notch

6-speed regular 3 notch
CS body H
87-92

7-speed '90
3 notch ***H***

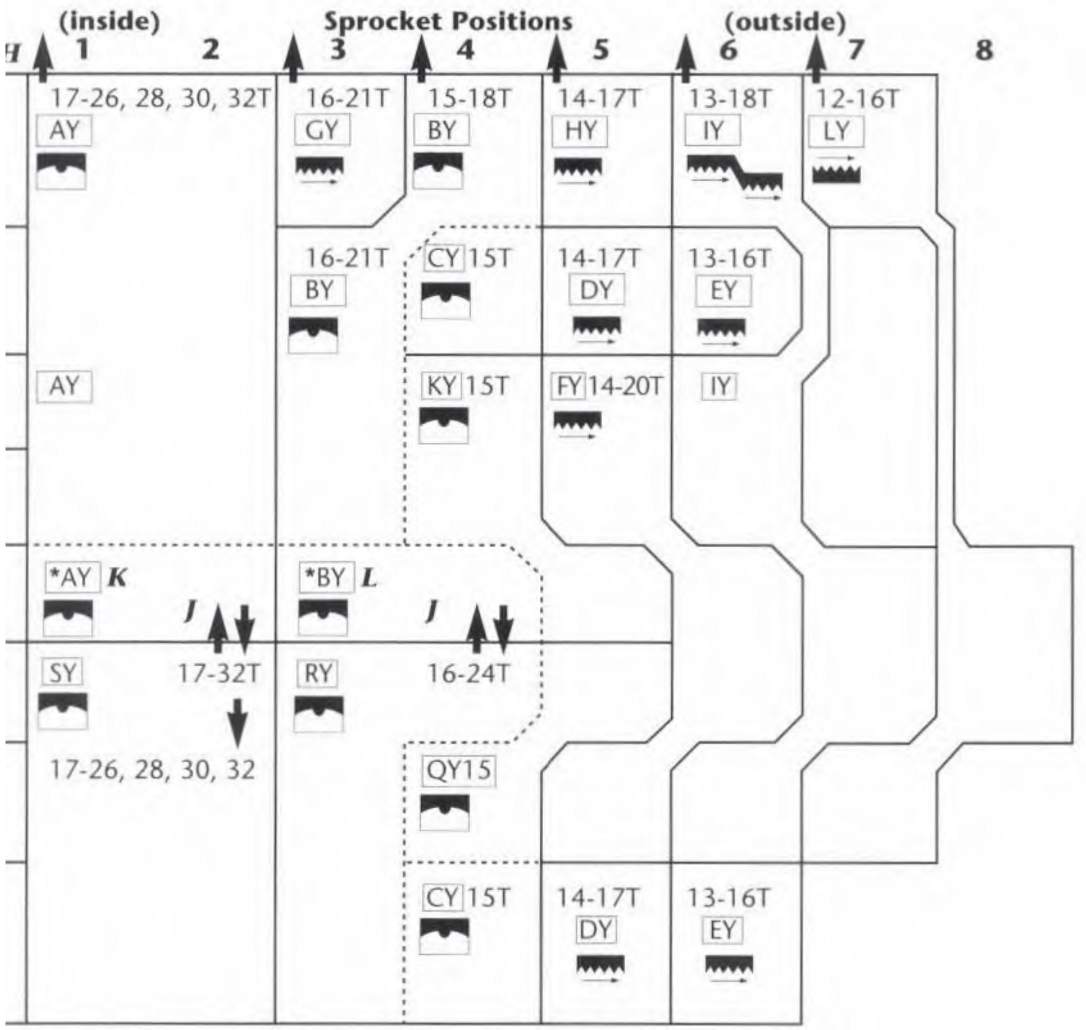
7-speed '91, '92
4 notch ***H, I***

8-speed Pre '92
4 notch

8-speed '92
4 notch

7-speed '92
4 notch

6-speed '92
4 notch



Notes:

H. ARIS sprockets can be used in place of the corresponding Maillard 700 sprockets. Maillard 700 sprockets cannot be used on ARIS freewheels if indexing is to be used.

I. Aris freewheel body with 4 notches but comes stock with 3 tab cogs. 4 tab cogs will work also.

1. 4 tab cogs will only work on 4 notch bodies

K[*AY] cogs are the same as, (4 tabs, 1.8mm thick unlike [AY] which is 3 tab and 2.0mm thick)

L[*BY] cogs are the same as, (4 tabs, 1.8mm thick unlike [BY], which is 3 tab and 2.0mm thick)

[AY], SY and *AY can be mixed on 4 tab bodies and will still index properly if the proper spacers are used (match cog to corresponding spacer on inner side).

BY RY, and [*BY] can be mixed the same as [AY], [SY] and ____

Sprockets should be placed so that the open end of the "Y" tooth profile points in the direction of travel, clockwise.

ARIS SPROCKET SPACERS

Freewheel — (inside) **Sprocket Positions** (outside)
2 3 4 5 6 7 8

ARIS
7-speed narrow
CC body
87-89 3 notch

6-speed regular
CS body
87-92

7-speed '90

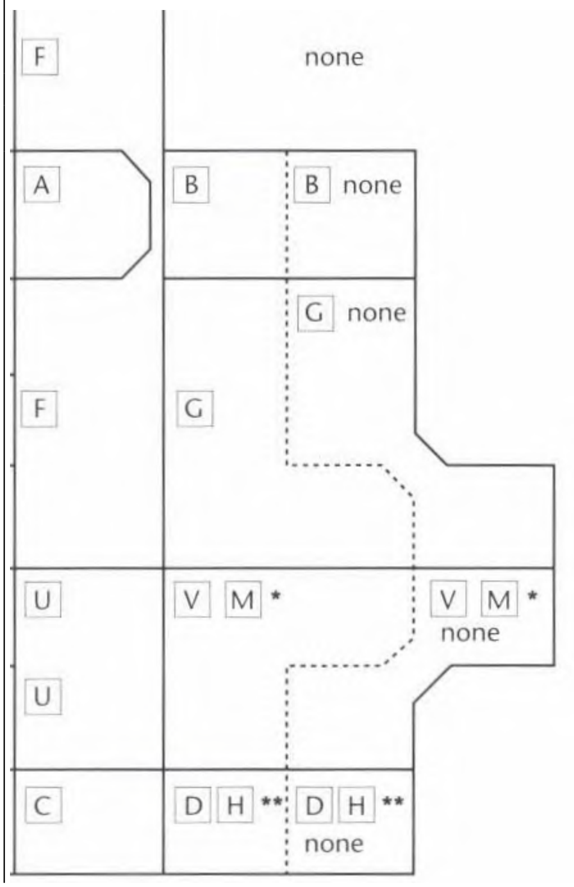
7-speed '91, '92

8-speed Pre '92

8-speed '92

7-speed '92

6-speed '92

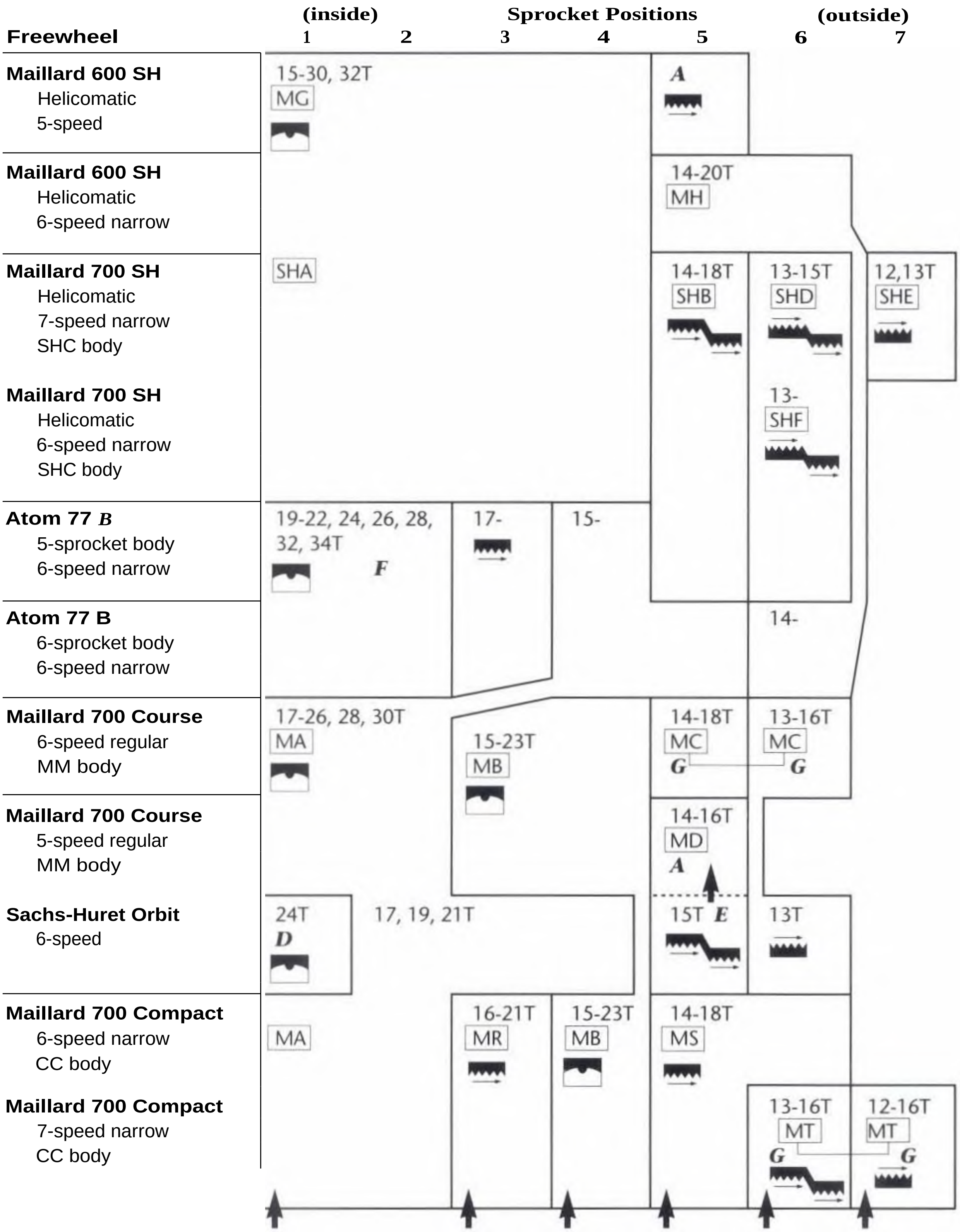


* If the larger sprocket is larger than 18 teeth, use the [M] spacer.
** f the larger sprocket is larger than 18 teeth, use the [H] spacer.

Freewheel Model	Body	Speeds & Spacing	Spacer	I.D.	O.D.	Thickness
ARIS	CS	6-speed regular pre'92	3564 white (A)	50	56.5	3.45
			3583 white (B)	44	53	3.45
	—	6-speed regular after '92	grey (C)	50	56.5	3.65
			grey (D)	44	53	3.65
			grey (H)	44	56.5 beveled	3.65
	CC	7-speed pre '89	3568 black (F)	50	56.5	2.95
	—	7-speed '9Q'91,'92	3569 black (F)	50	56.5	2.95
		8-speed pre '92	black (G)	44	53	3.0
		7-, 8-speed after '92	brown (U)	50	56.5	3.2
			brown (V)	44	53	3.2
			black (M)	**44**	56.5 **beveled**	**3.2**

FREEWHEEL, FREEHUB, FIXED GEARS

MAILLARD, ATOM 77, SACHS-HURET FREEWHEEL SPROCKET INTERCHANGEABILITY



SUTHERLAND'S

MAILLARD,ATOM 77, SACHS-HURET FREEWHEEL SPROCKET INTERCHANGEABILITY (CONT'D)

Notes:

A. Maillard 700 5th-position sprocket has a wide inner flange and may be used on a 600 SH 5-speed directly; it is too wide for use on a SH 6-speed. 600 SH 6-speed outer sprockets Ref.

i

a body S sprockets wide, with an outer sprocket pair and a 13T minimum. Others have a body 6 sprockets wide, with all sprockets threaded on and a 14T minimum.

B. The Atom 77 freewheels listed here are narrow 6-speeds. All sprockets of 6-sprocket body Atom 77 attach directly onto body. The 6th-position sprocket of 5-sprocket body Atom 77 attaches to 5th-position sprocket. The 5-sprocket body Atom 77 can be built up as a 7-speed using Maillard SHIT, SHE) and SHE sprockets in 5th, 6th and 7th position.

D. Sachs Orbit inner sprocket is dished and so not interchangeable with others.

E. 14, 15T Maillard 700 sprocket's inner flange is not high enough to secure neighboring lugged sprocket on Orbit.

F. Also interchanges with 3-lug sprockets on Normandy; Schwinn Approved Models F2, F3 and J; Shimano MF 1501, A-type and B-type. ***(See page 4-34.)***

G. Sprockets are sold as a pair but can he separated.

H. ARIS sprockets can be used in place of the corresponding Maillard 700 sprockets. Maillard 700 sprockets cannot be used on ARIS freewheels if indexing is to be used. ***(See page 4-24.)***

MAILLARD SPROCKET SPACERS

Freewheel Model	Body	Speeds Ea Spacing	Spacer	I. D.	O.D.	Thickness
Helicomatic	SHC	6-, 7-speed narrow	2263 silver steel or black plastic	45.5mm 45.5mm	50mm 50mm	3.0mm 3.0mm
700 Course	MM	5-, 6-speed regular	2160 red 2163 red	50mm 44mm	56.5mm 54mm	3.6mm 3.65mm
700 Compact	CC	6-, 7-speed narrow	2141 green	50mm	56.5mm	3.0mm

SHIMANO HYPERGLIDE CASSETTE SPROCKET INTERCHANGEABILITY

	11	12	13	14	15	16	17	18	19	20	21	23	24	25	26	28	29	30	32	34
8-Speed XT and XTR																				
P		12		14		**16**		**18**			**21**		**24**			**28**			32	
Q		12	13	14		161		18			21		24			28				
R	**11**	12		14		16		**18**			**21**		**24**			**28**				
8-Speed: CS-7401 (Dura Ace), CS-HG90-8, CS-HG70-8		[12]																		
S			13	14	**15**		**17**				21									
T			**13**	14	**15**	16	**17**		19		21	23								
U		**12**	**13**	**14**	**15**		**17**		19		21	23								
V			113	**14**	**15**		17		19		21	23			26					
W		12		J	15		17		19		21	23		25						
8-Speed Compact																				
ah '95	111	12		14		16		18			21		24			28				
ae	11	12	13	14	115		171		19		21,									
7-Speed Compact																				
ab	[11]	12	13	14	15		17		19											
ac	**11**		13		15			18			21		24			28				
ai '95	11	**12**		**14**		**16**		18			21]		24							
7-Speed Standard																				
B'89		12		14		16		18			21					28				
E		12		14		116		18]			21		24			28				
F				14		116					21					28			**32.**	
D '89				14		16		18			21		24			28			**32**	
C '89			13		15		17			20		23			26			30		
G			13		115					20		23			26			30		
K			13		15		17			,20			24				29			34
M			13		**15**		**17**		**19**		**21**		24			28				
H			**13**		**15**		**17**				**21**	**23**			26					
L		12	**13**	14	15		**17**		**19**		**21**									
I			13	14	**15**		**17**		**19**		**21**	**23**								
			13	14	**15**	16	**17**		**19**		**21**									
6-Speed																				
ad		12		14]		**16**		**18**			21		24							
of '95	11		13		15			18			21		24							
7-Speed IG																				
ag '95	11		13		15			18			21		24			28				

Sprocket Combinations:

Sprockets listed together in black vertical boxes are interchangeable.

Groups of sprockets listed together in red horizontal boxes are only interchangeable as a group with the adjoining group.

Gray shading indicates sprockets are bolted to a spider.

Red shading indicates sprockets are riveted together.

SHIMANO HYPERGLIDE SPACERS AND LOCKRINGS

	(inside)			Sprocket Positions				(outside)
Cassette	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Hyperglide **8-speed XTR** Group mark P	none *AA*					none		Hyperglide lockring ***BB*** 5mm
8-speed Group **mark R**								
8-speed XTR Group mark Q								
8-speed Group 5, T, U, V, W	Aluminum Silver mark 85							
Hyperglide-C **8-speed** Group mark ah	spacer B 3.0mm							Hyperglide-C lockring ***BB*** 5mm
8-speed Group mark ae								
7-speed Group mark ab	Resin- dark grey mark 7S			spacer 8mm			Hyperglide lockring ***BB*** 5mm	
7-speed Group mark ai	spacer B or D 3.15mm							
7-speed Group mark ac					spacer 11E0300 1 mm			
Hyperglide **7-speed** Group mark L							Hyperglide-C lockring ***BB*** 5mm	
7-speed Group mark F, G, H, I, J, K,					spacer AV **IT** 3.3mm			
7-speed Group mark E						none		
7-speed Group mark B, C, D (1989)					spacer A or C *Z* 3.3mm		Hyperglide lockring **X** 7mm	
6-speed Group mark ad					spacer 11E0300 1m m	Hyperglide Lockring B***B*** 5mm		
Hyperglide-C **6-speed** Group mark at	Riveted unit					Hyperglide-C lockring ***BB*** 5mm		
Interactive Glide **7-speed** Group mark ag	Riveted unit						Hyperglide-C Lockring **X** 5mm	

(See page 4-30 for footnotes.)

SHIMANO HYPERGLIDE SPACERS AND LOCKNUTS (CONT'D)

Notes:

1989 Group mark vs. 1990 and later: 1989 group mark cassettes use 23mm through bolts that screw into the 5th sprocket from the inside. This requires a 3.3mm spacer (A) that has indents or holes to clear the ends of the bolts. The lockring is 7mm thick and requires a lockring spacer.

1990 and later 7-speed cassettes use 28.5mm through bolts that screw into the 6th sprocket from the inside. This requires a 3.3mm spacer (Hyperglide A) that has holes for the bolts. The lockring is 5mm thick and requires no spacer.

Hyperglide 8-speed cassettes use 26.5mm alien head through bolts that that screw into the 6th sprocket from the inside. This requires a sprocket with notches to clear the ends of the bolts.

X. 7mm thick lockring must be used with lockring spacer or lockring will hind on freehub.

Y. Hyperglide A spacer has holes for through bolts. If no through bolts are used, non-hyperglide 3.3mm spacer may be used.

Z. Spacer C used on B, C, and L) groups has indentation for ends of through bolts.

AA. Spider provides spacing: XTR (groups P and Q) sprockets are bolted to spider. XT (group R) sprockets are riveted on.

BB. Hyperglide-C lockrings should be used on only 11-tooth cassettes; standard Hyperglide lockrings should only he used on cassettes with outer cogs greater than 11 teeth. The Hyperglide-C lockrings are 35.3mm in diameter. Standard Hyperglide lockrings are 37.9mm in diameter. Hyperglide-C lockrings will not adequately grip standard Hyperglide cassettes, and standard Hyperglide lockrings will interfere with the chain on 11-tooth cogs.

SPROCKET THRU BOLTS

Model	Number of Sprockets Joined	Length
Dura-Ace	not used	not used
7-speed Non-Hyperglide	5	21.5
6-speed Non-Hyperglide	5	23.0
6-speed Hyperglide	5	riveted
7-speed Hyperglide Group B, C, D	5	23.0
7-speed Hyperglide Group E, F, G, H, I, J, K, M	6	28.5
7-speed Hyperglide Group L	5	21.5
8-speed Hyperglide Group 5, T, U, V, ***W***	6	25.7
7-speed Hyperglide-C Group ab	4	16.85
7-speed Hyperglide-C Group ac, ai	5	21.5
8-speed Hyperglide-C Group ae	5	***21***
8-speed Hyperglide-C Group ah		25.7

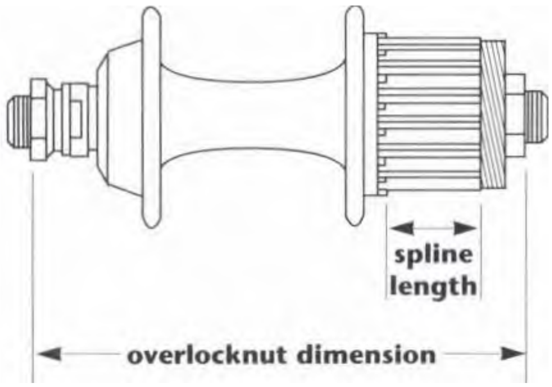
FREEWHEEL, FREEHUB, FIXED GEARS

SHIMANO FREEHUB (CASSETTE) SPACER DIMENSIONS

Speeds	Spacer	Thickness	Color	I.D.	O.D.
8-speed	spacer B	3.0mm	Silver	34.5mm	42mm
7-speed	spacer B spacer A	3.1 mm* 3.3mm	Grey Black	34.5mm 34.5mm	38.5mm 38.5mm
6-speed	spacer B spacer A	3.65mm 1.0mm		34.5mm 34.5mm	42mm 42mm
8-, 7-, or 6-speed	washer washer	1.0mm 0.8mm	Black Bronze	34.5mm 34.5mm	38.5mm 38.5mm

- Resin Spacers are listed as 3.15mm, steel as 3.1 mm.

SHIMANO FREEHUB (CASSETTE) BODIES — LENGTHS



Speeds	Freehub Body Spline Lengths	Overlockout Dimensions
SHIMANO		
5-speed	23	120, 126
6-speed Hyperglide or non-Hyperglide	28.4	126, 130
7-speed Hyperglide or non-Hyperglide	30.4	126, 130, 135
8-speed Hyperglide or non-Hyperglide	34.8	130, 135
6-speed Hyperglide-C	25.6	130
7-speed Hyperglide-C	28.4	126, 130, 135
8-speed Hyperglide-C	32.9	130, 135

Hyperglide and non-Hyperglide splines run to the end of the cassette body.

Non-Hyperglide splines overlap the threaded section.

Hyperglide-C splines run to within 3mm from the end of the cassette body (2.5mm for 6-speed and 1.7mm for 7- or 8-speed).

A spacer can he added to an 8-speed body to convert it to a 7-speed cassette.

SHIMANO NON-HYPERGLIDE CASSETTE SPROCKET INTERCHANGEABILITY

	(inside)			Sprocket Positions			(outside)	
Cassette	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Dura-Ace A **CS-7400-8** 8-speed	14-26,28T						Marked: INDEX 7S or 7-8S	Marked: INDEX 7S or 7-8S 12-14T
Dura-Ace **CS-7400-7** 7-speed						13-15T w/ built- in spacer	C	
Sante CS-5000 **600 Ultegra** **CS-6400-7** 7-speed	14-26,28,30,32,34T				E	D	Marked: 6S 7S or 7-85 12-16T	
Dura-Ace A **CS-7400-6** 6-speed, 5-speed ***B***					1 3T Marked: 13 INDEX 6S	Marked: 65 or no mark 12-18T		
600 EX **CS-6400-6** **CS-6208-6** **Standard CS-1000** 6-speed					***D,*** *E* w/ built- in spacer	No mark 13-16T		

Notes:

A. Includes AX, EX and "New" Dura-Ace.

B. Dura-Ace AX and EX 5-speed has same outer 2 sprockets as 6-speed with one less inner sprocket.

C. Dura-Ace threaded-on cogs (champagne colored) are not interchangeable with others.

D. Cog without built-in spacer can be used here when combined with proper spacer.

E. To mount as a cassette, sprockets used in sprocket position 5 on a 6-speed or 7-speed must have threaded sprocket through-bolt holes.

F. Standard spline sprockets are interchangeable with Dura-Ace and others, but do not have the high-performance tooth profile.

SHIMANO NON-HYPERGLIDE CASSETTE SPROCKET SPACERS

Cassette	(inside) 1	2	3	Sprocket Positions 4	5	6	7	(outside) 8
Dura-Ace A **CS-7400-8** 8-speed	Aluminum Silver Spacer B 3.0mm					none	none	
Dura-Ace **CS-7400-7** 7-speed	Steel- Silver Spacer B 3.1 mm *J*				none	none		
Sante C5-5000 **600 Ultegra** **CS-6400-7** 7-speed	Resin- Dark Grey mark: 75 Spacer B 3.1 5mm				Resin- Dark Grey mark: 75 2nd position Spacer A 3.3mm *H*	none		
Dura-Ace A **CS-7400-6** 6-speed, 5-speed	Steel-Grey Spacer **B** 3.65mm **K**			none	none			
600 EX **CS-6400-6** **CS-6208-6** **Standard CS-1000** 6-speed	Resin-Light Grey Spacer B 3.7mm			Resin- Light Grey Spacer B 3.7mm *H*	Steel with spline cuts *H*			

Notes:

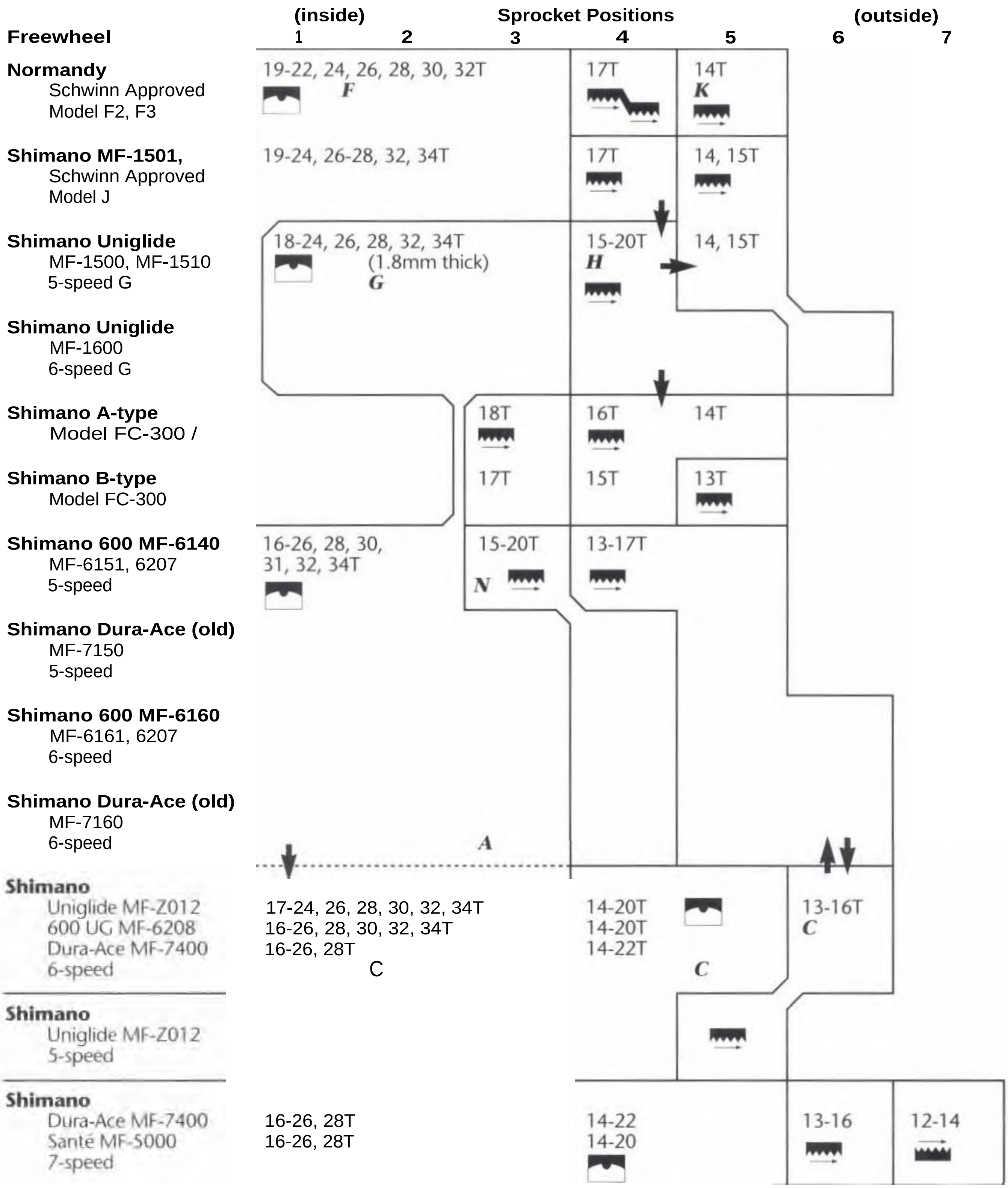
A. includes AX, EX and "New" Dura-Ace.

H. None if sprocket has built-in washer.

I. Steel-Silver 75 Spacer B may be used in place of Resin-Dark Grey 75 Spacer B if sprocket through-bolts are not used.

K. Steel-Grey 65 Spacer B may be used in place of Resin-Light Grey Spacer B if sprocket through-bolts are not used.

SHIMANO, NORMANDY AND SCHWINN APPROVED (MODELS F2, F3 AND J) FREEWHEEL SPROCKET INTERCHANGEABILITY



Notes:

A. Sprockets above the dotted line are 3-dog type; sprockets below the dotted line are sawtooth-splined type except 30, 32 and 34T. 3-dog sprockets will fit on sawtooth splines of cassette bodies in positions 1, 2,and 3, but sawtooth-splined sprockets will not fit 3-dog bodies.

C. Sprockets with built-in spacers are marked 6S for 6-speed and 7S for 7-speed.

F. Also interchanges with Atom 77. *(See page 4-26.)*

G. Shimano Uniglide freewheel body lockring is level with outer rim. Splined sprockets are thinner and will not lock in place if used on other similar Shimano freewheels.

H. Shimano Uniglide outer sprockets may be used on other similar Shimano freewheels if a spacer like the one behind the 4th sprocket is used to the inside of each sprocket. The 16T sprocket requires a special beveled spacer (a bevel may be ground on the standard spacer) to prevent chain interference.

I. Note that Shimano A-type FC-300 has two threaded diameters and one splined diameter.

I. Note that Shimano B-type has outer sprocket threaded into face of body.

K. Schwinn Approved models F2 and F3 outer sprocket has special threads to accept high gear chain guard; it is otherwise interchangeable with the Regina • and the Atom ®.

SHIMANO FREEWHEEL SPROCKET SPACERS

		(inside)		Sprocket Positions			(outside)
Freewheel	1	2	3	4	5	6	7
Shimano Uniglide MF-Z012 600UG MF-6208 Dura-Ace MF-7400 6-speed			A	B	C	none	
Shimano Uniglide MF-Z012 5-speed			A X	B X	none		
Shimano Dura-Ace MF-7400 Sante MF-5000 7-speed			7A X	7B X	7C X	none	none

X. Use this spacer it not built in to next smaller cog.

SPACER DIMENSIONS

Spacer	**jD**	**OD**	**Thickness**
A	49.5mm	53mm	3.65mm
B	42.5mm	53mm	3.65mm beveled
C	42.5mm	47.48mm	3.65mm
7A	49.5mm	53.5mm	3.1mm
7B	43mm	53.5mm	3.1mm
7C	43mm	47-48mm	3.1mm

SUNTOUR CASSETTE SPROCKETS

Cassette	1 (inside)	2	3	4 (Sprocket Positions)	5	6	7 (outside)	8

Superbe Pro
8-speed

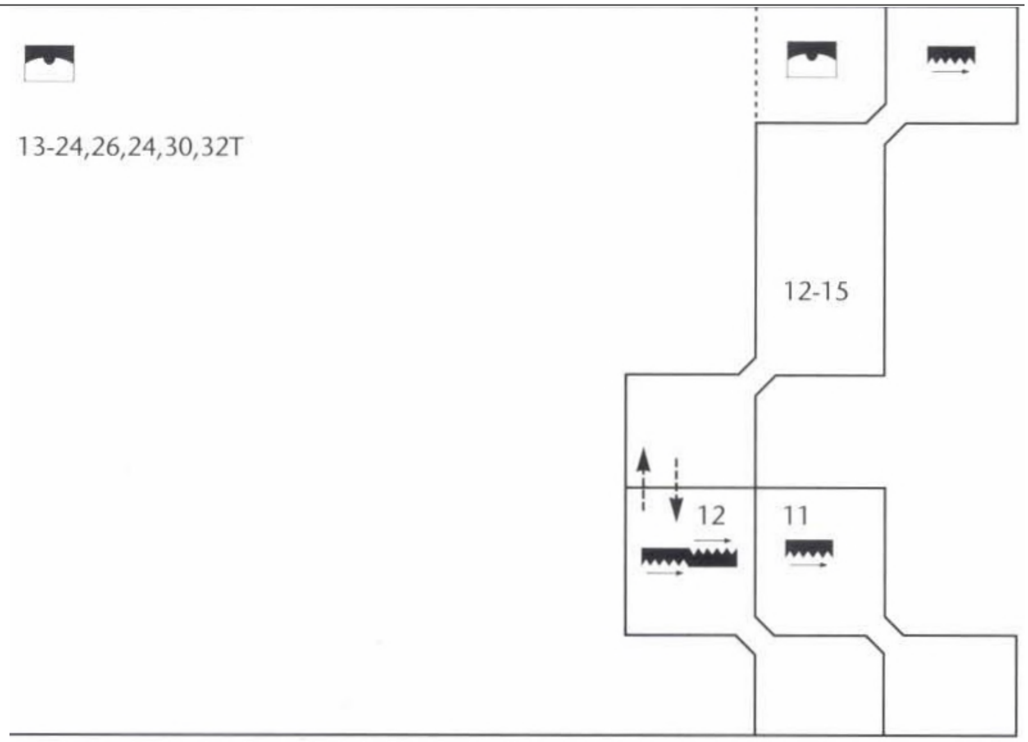
Microllte/SL
7-speed

XC Pro, XC Comp, XC LTD, XCSport, XC Expert, XCD
7-speed

XCD 6000
6-speed

XC Comp Pro Microdrive
7-speed

XC Pro Microdrive
8-speed



Notes:

Accushilt Plus and Accushift Plus II (also known as PowerFlo, though most commonly labeled APID cogs can be used interchangeably, but shifting may vary when mixing the two due to differences in cog spline orientation.

The thru holt should be removed for the SL hub.

SUNTOUR POWERFLO REAR FREEWHEEL SPROCKET INTERCHANGEABILITY

Freewheel	1 (inside)	2	3 (Sprocket Positions)	4	5	6 (outside)	7

PowerFlo Rear PFR*
FW-PF1 2
7-speed

PowerFlo Rear PFR*
FW-PF1 2
6-speed

lockring

* Also referred to as Accushift Plus III or PowerFlo 3.0. Do not confuse with "normal" PowerFlo. PowerFlo is spaced for Suntour derailleurs. PowerFlo rear is spaced for Shimano derailleurs.
(See page 8-3 for markings on PowerFlo cassettes and freewheels.)

FREEWHEEL, FREEHUB, FIXED GEARS

SUNTOUR CASSETTE SPACERS

Cassette	1	2 (inside)	3	4 Sprocket Positions	5	6	7	8 (outside)
XC Comp, Pro Microdrive 7-speed	2.8mm			3.0mm	none	none		
XC Pro Microdrive 8-speed					3.0mm	none	none	
8-speed Standard						none	none	
7-speed Standard				3.0mm	t = 3.3mm	none		
6-speed	Grey 3.55mm			*	none			

Notes:

* Some claim this works.

Arrows on spacer point to the hole the pin goes through. Arrows on cogs point in the direction of rotation (clockwise).

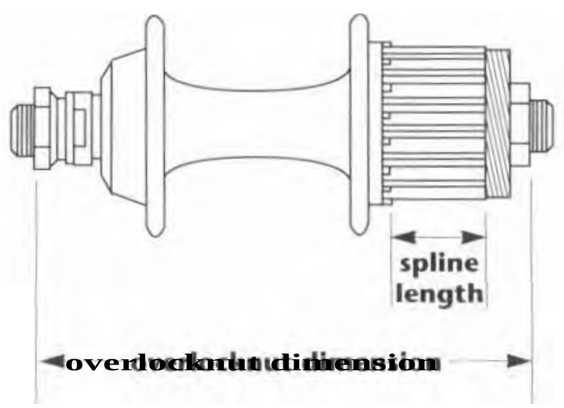
SUNTOUR POWERFLO REAR FREEWHEEL SPACERS

Freewheel	1	2 (inside)	3	4 Sprocket Positions	5	6	7 (outside)
PowerFlo Rear PFR* FW-PF12 7-speed	3.15 52mm Blue		3.15 44mm Blue			3.00mm 44mm Black	none

* Also referred to as Accushifi Plus III or PowerFlo 3.0. 1)o not confuse with "normal" PowerFlo.
PowerFlo is spaced for Suntour derailleurs. PowerFlo rear is spaced for Shimano derailleurs.

SUNTOUR FREEHUB (CASSETTE) BODIES — LENGTHS

Speeds	Freehub Body Spline Lengths	Overlocknut Dimensions
SUNTOUR 6-speed	23.7	126, 130
7-speed	**26.1**	**126, 130, 135**
8-speed	**30.8**	**130, 135**
7-speed microdrive	20.7	130, 135
8-speed microdrive	25.4	**135**



SUTHERLAND'S

SUNTOUR ACCUSHIFT FREEWHEEL SPROCKET INTERCHANGEABILITY

Winner and WinnerPro 7-, 6-, and 5-speed freewheels are built on the same body.

a 7-, 6-, and 5-speed bodies are all different. 7-speed bodies have the threaded portion protrude 4.2mm from freewheel face. 6-speed bodies have the threaded portion protrude 2mm. 5-speed bodies have a flush face.

Sprockets are stamped with the sprocket letter and number of teeth. The stamped side should be facing the next largest sprocket.

Note: In SunTour literature, sprocket positions are numbered from 1 on the outside.

Freewheel		(inside) 1	2	Sprocket Positions 3	4	5	(outside) 6	7
Winner **Winner** **WinnerPro** 7-speed Ultra (narrow)	FW-WT10-57U WT-7000 WP-7000	18-26, 28, 30, 32, 34T [A]	17T	16-23T	15-22T	[C] 15-171 F 114T	13-16T [L]	12-14T [U]
Winner **Winner** **WinnerPro** 6-speed Ultra (narrow)	FW-WT10-S6U WT-6500 WP-6500			[B]	15-22T	A	13-15T LS]	
Winner **Winner** **WinnerPro** 6-speed regular	FVV-VVT10-S6R WT-6000 WP-6000				15-22T	14-16T [X]	13-15T E	
Winner **Winner** **WinnerPro** 5-speed regular	FW-VVT10-S5R WT-5000 WP-5000		i v 16T with built-in spacer	15-23T [B]15-22T	[C] 15-17T 10114T B	13-15T		
a a 7-speed Ultra (narrow)	FW-ALOO-S7U FW-ALOO-K7U	19-26, 28, 30, 32, 34T		17-24T	16-24T	15-24T	[C] 15-17T [‡] 14T	13T
a 6-speed regular	FVV-ALOO-SR6	18-26, 28, 30, 32, 34T		15-23T		[C] 15-17T 14T ,	13-16T	
a. 5-speed regular	FW-ALOO-SR5	18-26, 28, 30, 32, 34T		15-23T	[C] 15-17T [Pi 14T	13-16T		
PowerFlo 6-speed Ultra FW-PF00 (5mm spacing)								
PowerFlo 7-speed Ultra FW-PF00	FW-P102							

SUNTOUR ACCUSHIFT FREEWHEEL SPROCKET INTERCHANGEABILITY (CONT'D)

Notes:

A. If next smaller sprocket has more than 13T, then [B] sprockets can be used in this position.

B. If next smaller sprocket is ___ 13T, use C or [D] sprocket in this position.
If next smaller sprocket is [E] 14T or [E] 15T, use [B] sprocket in this position.

SUNTOUR ACCUSHIFT FREEWHEEL SPACERS

Freewheel	1	2 (inside)	3	4 Sprocket Positions	5	6	7 (outside)
Winner FW-VVT10-S7U **Winner** **W1-7000** **WinnerPro** WP-7000 7-speed Ultra (narrow)		[UBD]	**UCB]**	**UCF]**	**[U[C]F M**	none	none
Winner FW-VV1-10-56U **Winner** WT-6500 **WinnerPro** WP-6500 6-speed Ultra (narrow)		**UBD**	**[UCB]**	[UCF]	**U[C]F M**	none	
Winner FW-VVT10-56R **Winner** WT-6000 **WinnerPro** WP-60'0 6-speed regular		BD	[CB]	[CB]	[SB]	none	
Winner FW-WT10-S5R **Winner** WT-5000 **WinnerPro** WP-5000 5-speed regular		**O**	**CB**	**[C]BI *R***	**SB *P*** **RB**		
a FW-ALOO-S7U a FW-ALOO-K7U 7-speed Ultra (narrow)		**UBD**	54mm OD **44mm** ID 2.8mm thick	**UCF]**	**[U[C]F**	**[UCF] *N***	none
a FW-AL00-SR6 6-speed regular		BD] 44mm 1D 3.6mm thick	54mm OD 44mm ID 3.6mm thick ***S***	54mm OD 44mm ID 3.6mm thick ***R***	48mm OD 44mm ID 3.6mm thick ***R***	none	
cx FW-AL00-5R5 5-speed regular		**[BD] *0*** 44mm ID 3.6mm thick	54mm OD 44mm ID 3.6mm thick ***R***	48mm **OD** 44mm ID 3.6mm thick ***R***	none		
PowerFlo FW-PF00 6-speed							
PowerFlo FW-PF00 7-speed		**UBD]**	**[UCB]**	54mm OD 44mm ID **3.1mm**	**U[C]F**	3.1 mm	none
PowerFlo FVV-PF02 7-speed		52 ID 3.0mm	3.0mm like UCB	54mm OD 44mm ID	3.0mm		none

SUNTOUR ACCUSHIFT FREEWHEEL SPACERS (CONT'D)

Notes: M. (cont'd)

No spacer needed if [F] 14T is next smaller sprocket.

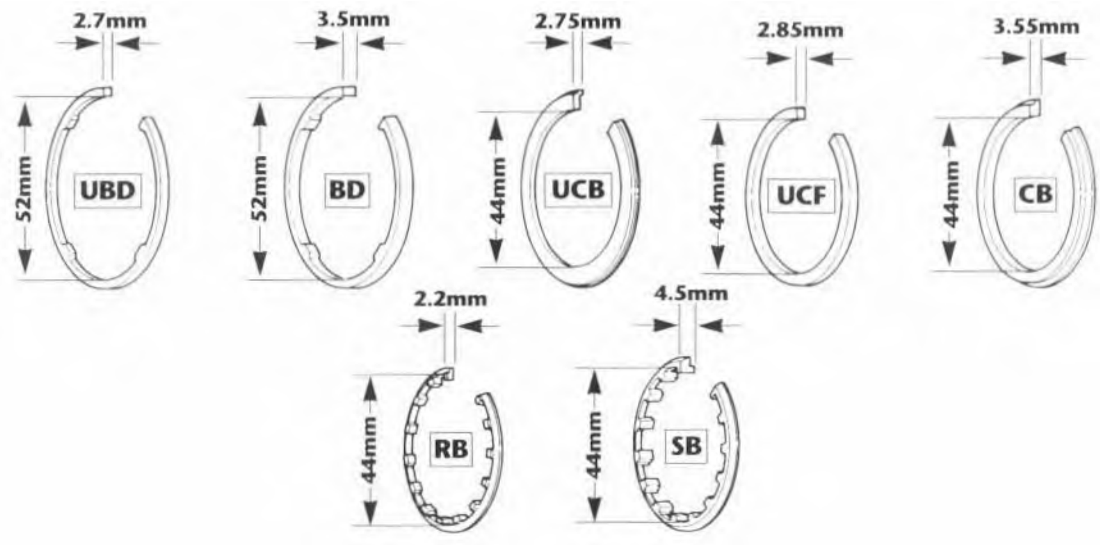
N. No spacer needed if [H] 14T is next smaller sprocket.

O. No spacer needed if V 16T is next smaller sprocket.

P. Spacer [SB] is used if next larger sprocket is a Hi sprocket. Spacer RBI is used if the next larger sprocket is a [C] or D sprocket.

R. No spacer needed if 14T is next smaller sprocket.

S. Use [CBI if next smaller sprocket is 15T.



FREEWHEEL, FREEHUB, FIXED GEARS

SUNTOUR SPROCKET INTERCHANGEABILITY

Freewheel — **(inside)** **Sprocket Positions** **(outside)**: **1 2 3 4 5 6 7**

SD, Perfect - 1/8" chain
3-speed

SD, Perfect - 1/8" chain
4-speed

Pro-Compe PC-5000, Perfect PT-5000, AG
5-speed

Perfect PN-6000 ***B***
6-speed regular
(for use on Fujis and others)

Pro-Compe PC-6000
6-speed regular

Perfect PS-6000, PS65
6-speed regular

Perfect PS-6500
6-speed Ultra (narrow)

New Winner NW-7000, Microlite LF-7000 **X**
7-speed Ultra (narrow)

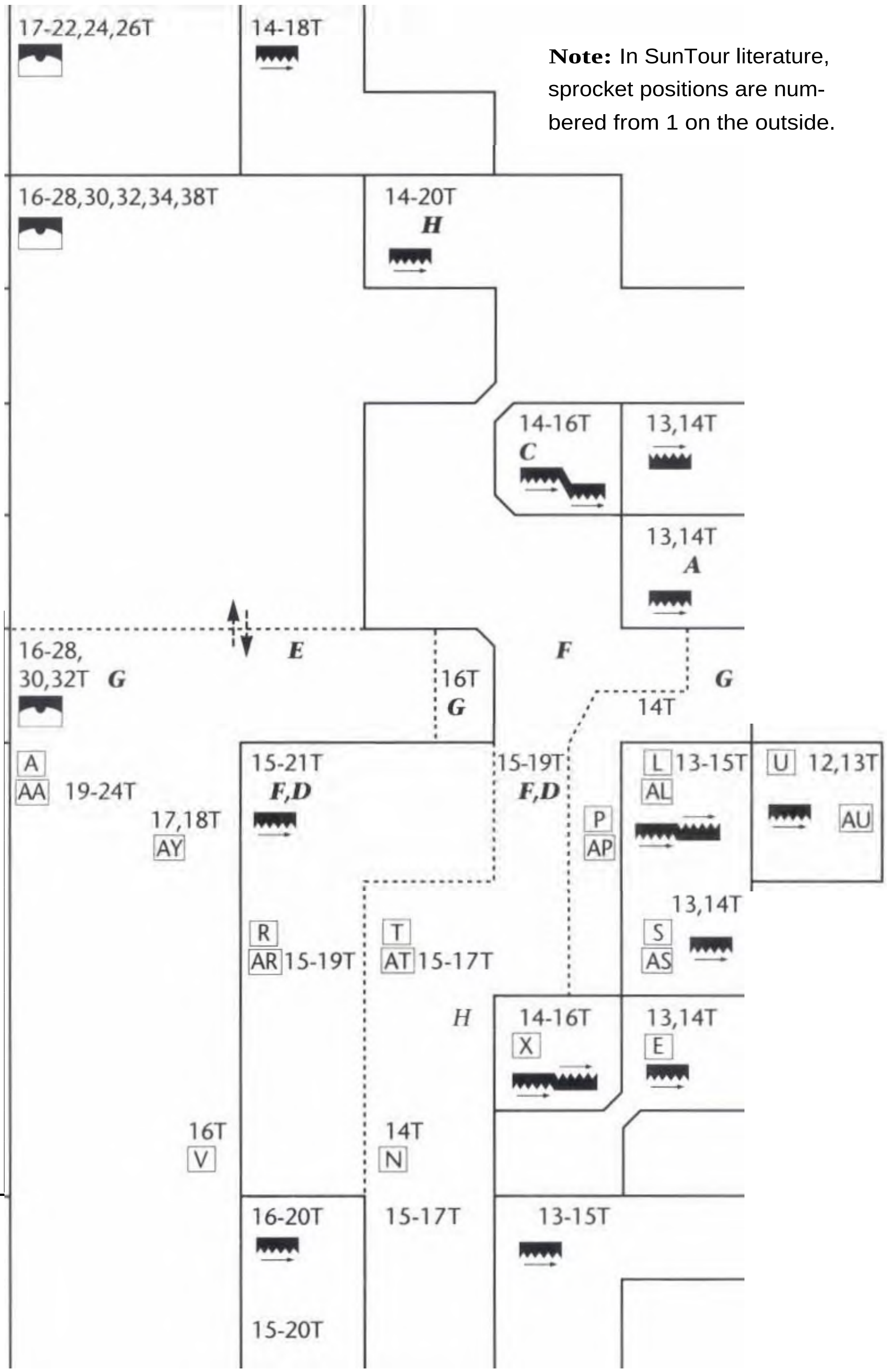
New Winner NW-6500, Microlite LF-6000 **X**
6-speed Ultra (narrow)

New Winner NW-6000
6-speed regular

New Winner NW-5000
5-speed regular

Winner-S
6-speed regular

Winner-S
5-speed



Note: In SunTour literature, sprocket positions are numbered from 1 on the outside.

SUNTOUR SPROCKET INTERCHANGEABILITY (COrm))

Notes:

A. Interchangeable with Shimano Dura-Ace and 600 outer sprockets.

B. For use on Fuji and other bicycles with 124mm overlocknut hubs. Since this freewheel is slightly narrower, it may not work with some brands of standard chain.

C. Mounting 5-speed sprocket here leaves outer ball race exposed.

D. When moving a sprocket to the right across the dashed line, a bevel must be ground on the right side of the teeth. Sprockets moved to the left will fit regular width Winner, but must have a high flange at the inside to secure Ultra Winner's splined sprockets.

E. Some sprockets have haf-circle shaped dogs and must he filed to fit freewheels below the dashed line.

F. 1ST steel sprocket requires beveled spacer #15004514.

G. Ultra 16T and 14T sprockets have a narrow built-in spacer and fit only Ultra, New Winner and Microlite bodies.

X. Letters in boxes are SunTour's series designations. Boxes where the first of at least two letters is an A designate a Microlite sprocket or a spacer. Microlite aluminum sprockets are interchangeable with the New Winner steel sprockets, except splined AA sprockets that have eight dogs and do not fit onto the steel body for sprockets with four dogs.

SUNTOUR SPACERS

(inside) Sprocket Positions (outside)

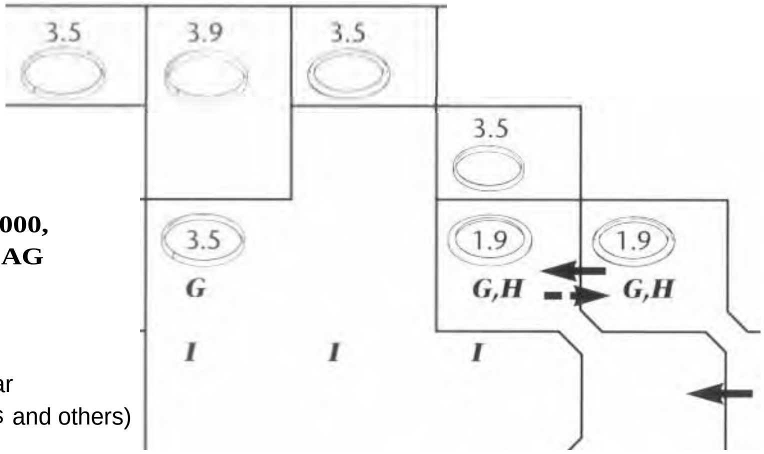
Freewheel 1 2 3 4 5 6 7

SD, Perfect
3-speed

SD, Perfect
4-speed

Pro-Compe PC-5000,
Perfect PT-5000, AG
5-speed

Perfect PN-6000
6-speed regular
(for use on Fujis and others)



Spacer thickness given in millimeters with symbol.

SUNTOUR SPACERS (CONT'D)

Notes:

F. 15T steel sprocket requires beveled spacer #15004514.

G. Ultra 16T and 14T sprockets have a narrow built-in spacer and fit only Ultra, New Winner and Microlite bodies.

H. 15T sprocket requires beveled spacer #15004511 or #15004515.

I. Where thin shims are used in addition to standard spacers, they must be replaced exactly as they were.

Y. [AUTF] spacer is for use only with Microlite sprockets.

SUNTOUR NON-ACCUSHIFT FREEWHEEL SPROCKET INTERCHANGEABILITY

New Winner and Winner/ WinnerPro Interchangeability		Innermost Splined Sprockets	Middle Sprockets	Outermost Threaded Sprockets
7-speed Ultra (narrow)	Winner/ WinnerPro	A	**C**	LU]
	New Winner			
6-speed Ultra (narrow)	Winner/ WinnerPro	]]A]	**C**	
	New Winner			
6-speed Regular	Winner/ WinnerPro	[A	**C**	] [_E]
	New Winner			
5-speed Regular	Winner/ WinnerPro		**C**	
	New Winner			

Notes:

C. Middle sprocket positions on early (and only early) Winner/ WinnerPro bodies were threaded and grooved for threaded or splined freewheel cogs. Current bodies are not threaded and will only accept splined Winner/ WinnerPro cogs. Threaded New Winner cogs can be used in the middle positions of the early Winner/ WinnerPro bodies only if New Winner spacers are used. The resulting freewheels are not Accushift compatible.

FREEWHEEL, FREEHUB, FIXED GEARS

CYCLO FREEWHEEL SPROCKET INTERCHANGEABILITY

Freewheel	1 (inside)	2	3	4	5	6 (outside)	7
Cyclo 3-speed 1/8" chain	15-28, 30T		14T A not removable				
Cyclo 4-speed				14T A not removable			
Cycle 64, 72 Competition 5-speed					14T A not removable		
Cyclo 64, 72 Competition 13T top 5-speed				14T A not removable	13T		
Cyclo 64 Competition 6-speed					14T A not removable		
Cyclo Pans 5-speed	15-28, 30T			13-18T P68			
Cyclo Pans 6-speed					14-16T M68		
Cyclo Pans 6-speed narrow						B	
Cyclo Pans 7-speed narrow						14-16T	
Cyclo, Type B (made in England) C			16-20T		14-16T		

Notes:

A. This sprocket is part of the freewheel body and is not removable. Inner sprockets are left-threaded and unscrew towards the inside.

B. For correct spacing on 6-speed, turn outside sprocket over.

C. Type B Cyclo is made in England and is unrelated to the French Cyclo models listed above it. All sprockets unscrew to the outside. To remove #5, loosen the others, lock #2 and #3 together (like cone and locknut) and loosen #5.

G.CAIMI, EVEREST AND SIMPLEX FREEWHEEL SPROCKET INTERCHANGEABILITY

Freewheel	1 (inside)	2	3	4	5	6 (outside)
5-speed G. Caimi Everest Simplex	17-26,28,30T		15-21T	14-18T		
6-speed G. Caimi Everest Simplex					14-16T	13,14T

"Sprocket Positions" is printed as a heading above columns 1–6.

FREEWHEEL, FREEHUB, FIXED GEARS

SINGLE-SPEED FREEWHEEL THREADS

Most single-speed freewheels use the same threads as multi-speed freewheels, *(see page 4-2)*. Exceptions are as follows.

French Juvenile 32mm x 1.0mm
SunTour mini size 30mm x 1.0mm

Tools For Removing Single-speed Freewheels

Make of Freewheel	Class of Fit — Tool	
Atom-Maillard	A	Var 412 Var 413 for French Juvenile
Cyclo (French) **103 fit 303**	A	DR.SD
Everest	A	Campagnolo #1
Merveille	A B	Var 187 Linden Eldi Regina
Regina	A B	Regina Campagnolo #1 (may need a bit of grinding) Eldi
Shimano - standard **DX - 4-notch**	A A	Shimano Single and Freehub A removal tool Kingsbridge 120 SunTour EZ OFF 4 dog tool
SunTour (standard)	**A**	SunTour Single freewheel removal tool Kingsbridge 120
EZ OFF - 4-notch	**A**	SunTour EZ **OFF 4 dog** tool
TDC		Eldi Regina

FIXED GEAR—HUB SHELL

Fixed gear hubs have a left-threaded lockring to secure sprocket. Thread sizes of fixed gear sprockets are the same as those used for freewheels.

Thread sizes of lockrings may vary from maker to maker. A maker will usually use one lockring size for all hubs, even though the sprocket thread is different. This is true of Campagnolo and Zeus.

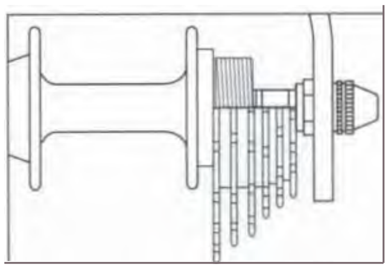
Sprocket Lockring Threads

Campagnolo	1.32"	x	24 TPI left-threaded
English	1.29"	x	24 TPI left-threaded
French	33mm	x	1.0mm left-threaded

CONTENTS

S

INDEXING DERAILLEURS



Shifting

SUTHERLAND'S

INDEXING DERAILLEURS

INDEXING CHECKLIST

Items to check first: New bike*	Tune-up	Repair		Item	Page numbers to find more information: Campagnolo	Sachs	Shimano	SunTour
				COMPONENT COMPATIBILITY				
		✔	❑	Levers compatible with derailleurs.	6-4	6-9	7-3	8-3
		✔	❑	Levers compatible with freewheel spacing	6-4	6-9	7-3	8-3
		✔	❑	Derailleur compatible with freewheel minimum and maximum teeth with given rear drop-out.	6-5	6-9	7-6	8-6
		✔	❑	Chain compatible with derailleur and freewheel.	6-2	6-8	7-2	8-2
		✔	❑	Correct space for freewheel plus drop-out thickness.	5-8	5-8	5-8	5-8
		✔	❑	Brazed-on lever bosses must be correct dimensions.	5-5	5-5	5-5	5-5
		✔	❑	For large diameter down tubes (larger than 28.6mm) use flat lever stop instead of radiused one.				
				CABLE AND CASING				
		✔	❑	Cable is correct diameter and smooth to touch.	5-6	5-6	5-6 I	5-6
✔	✔	✔	❑	Cable casing seated, "stretched/' and lubricated.				
		✔	❑	Casing is compatible.	5-6	5-6	5-6	5-6
		✔	❑	Casing ends cleanly cut, capped using correct caps.	5-7	5-7	5-7	5-7
		✔	❑	Cable routing is smooth with no kinks or sharp bends. Route is not inside frame.				
		✔	❑	Cable casing is correct length to eliminate binding at cable stops and derailleur.				
	✔	✔	❑	Cable stops are tight on frame.				
✔		✔	❑	Cable is on correct side of derailleur anchor bolt.				
✔	✔	✔	❑	Cable anchor bolt is tight.				
				LEVERS				
✔	✔	✔	❑	Lever clamp is tight.				
✔	✔	✔	❑	Selection ring set for desired function.	6-3			L8-3
✔	✔	✔	❑	Lever not too tight or too loose.				
	✔	✔	❑	Check lever for wear causing too much free play.				
	✔	✔	❑	Campagnolo lever insert correct.	6-4			
				DERAILLEUR				
✔	✔	✔	❑	Derailleur is mounted securely to drop-out.				
	✔	✔	❑	Check derailleur and guide pulley for wear.				
		✔	❑	Guide and tension pulleys not reversed.			5-14	5-141
				CHAIN				
	✔	✔	❑	Check chain for wear.				
		✔	❑	SunTour Pro, Regina CS-X or Regina 50 Anniversario chain right side up.	5-14			5-14
				FREEWHEEL				
	✔	✔	❑	Check cogs for wear.				
	✔	✔	❑	Check bearings for wear and looseness.				
	✔	✔	❑	Freewheel cogs installed correctly front to back on body and correct spacers used in assembly.	4-15	4-24	4-20 4-22	4-26
				FRAME				
	✔	✔	❑	Drop-out parallel.	0-10	0-10	0-10	0-10
	✔	✔	❑	Gear hanger adjusted.	5-3	5-3	5-3	5-3

Correctly Spec'd

INDEXING ADJUSTMENT

(See page 6-3 for additional Campagnolo setup tips.)

Frame Adjustments

1. **Align the drop-outs with a fork end gauge set.**

2. **Align the gear hanger with gear hanger adjustment tool.**

Derailleur Adjustments

3. **Attach derailleur to hanger.**

4. **Set shift lever to friction mode, if possible.**

5. **Adjust high gear and low gear adjusting screws.** Adjust the guide pulley so it is centered under the smallest cog with the high gear adjusting screw. Then adjust the guide pulley so it is centered under the largest cog with the low gear adjusting screw.

6. **Check chain length.** Put chain on largest chainring and smallest freewheel cog. Guide pulley and tension pulley centerline should be close to right angles to the ground. Check the large chainring and large freewheel combination to be sure there is enough chain. Check the small chainring and small cog combination to be sure the derailleur can handle the chain length.

7. **Stress the cable.** Be sure the casing ends are seated and the cable end is seated in the lever.

8. **Check cable smoothness.** A slight movement of the lever should move the derailleur a slight amount. ***(See Cable and Cable Casing, page 5-6.)***

9. **Adjust derailleur angle for guide pulley clearance.** Some derailleurs don't have this adjustment screw. Some SunTour derailleurs rely on the D/T attachment. ***(See SunTour Derailleur Capacity Chart, Chapter 8.)*** Unscrew the angle adjusting screw until it doesn't affect the angle of the derailleur. While on the smallest chainring, shift to the largest cog and then shift down one cog. If it hesitates in down-shfting, turn the angle adjusting screw in until the chain shifts off the largest cog. The guide pulley should he as close as possible to the sprocket without making excess noise when back pedaling.

10. **Set shift lever to indexing mode, if this is not already done.**

11. **Adjust cable tension.** Shift to the second smallest cog. Tighten the cable with the adjusting barrel until it is slightly too tight. Then turn the crank and loosen the cable until the symptoms are eliminated. Continue through all (he cogs making adjustments as needed.

12. **Shift through all the gears.** Run through all the gear combinations with the smallest and largest chainrings and readjust as needed. ***(See Indexing Checklist* on *page 5-2 and Indexing Troubleshooting Chart on pages 5-9 through 5-14 as needed.)***

INDEXING DERAILLEURS

ABOUT INDEX SHIFTING

Index shifting requires more attention to details when adjusting and repairing than non-index shifting. A chattering rear derailleur in a non-indexing system is taken care of by moving the lever slightly. In an indexing system that same symptom may need to be fixed using a repair stand.

There are about ten different components that determine how well an indexing system works. In each one of these components there is a little play, a little room for wear, and an allowance for slight misadjustment. This play, wear, and misadjustment allowance can add up and keep the system from working. Hopefully, the system is designed so that a little play here is canceled out by a little wear there, and the system works well for a lot of miles.

Indexing systems are designed as a whole, with levers, cable, cable casing, cable casing end caps, derailleurs, drop-outs, derailleur hangers, hubs, freewheels, and chain all matched carefully to produce a complete system. **Interchangeability is not practical between systems.** Our measurements of various systems indicate you cannot mix manufacturers' components. Within SunTour there is a lot of interchangeability and within Shimano there is a lot (see tables for exceptions), but between the two there isn't any consistent interchangeability.

In an ideal index system, the derailleur guide pulley is close to centered under each freewheel cog when each shift is completed. Up-shifting arid checking each cog, then down-shifting and checking each cog is 12, 14, 18 or more checks. Some less than ideal combinations of components will shift in the repair stand and maybe work for a couple of weeks of riding, but then be nothing but trouble after wearing in a little. Thoroughly checking systems, although time consuming, is the only way to spot potential problems.

The information in this section is derived largely from manufacturers' information and our experience. There are a lot of factors that are common to all systems and some that are unique to each brand. This section is divided up to reflect that.

Problems

Assuming the components are compatible, cable and cable casing are the components to check first. ***(See the checklist on page 5-2 for a detailed list of cable and cable casing-related items to check.)***

Next, check the chain for wear and compatibility. Many times, a change of chain can remedy the problem. ***(See chain page and each manufacturer's page for chain recommendations.)***

Systematically going through the checklist on the previous page should nail down any problems. (If it ***doesn't, go to the troubleshooting section which begins on page 5-9.)***

INDEXING DERAILLEURS

BRAZED-ON SHIFT LEVER BOSSES

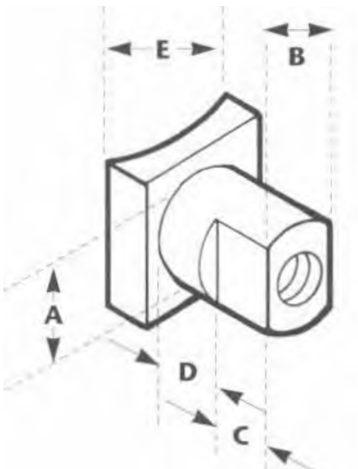
Thread Sizes

Campagnolo 5mm
Sachs-Huret 5mm x 0.8mm*
SunTour 5mm x 0.8mm*
Shimano 4.5mm x 0.75mm

* 5mm x 32 TPI and 5mm x 0.8mm are so close, they are interchangeable.

Markings

Shimano lever fixing bolts with 5mm x 0.8mm threads are marked M5. Shimano lever fixing bolts with 4.5mm x 0.75 threads are unmarked.



A: 9mm

B: 5.85mm

C: 4.5mm

D: 5mm

E: 12mm

Campagnolo Type Boss (sometimes referred to as Italian)

Shimano A Type Boss

Shimano levers designed for Cam pagnolo type bosses can be mounted to Shimano A Type bosses using Shimano Conversion Kit (680 9858) for M4.5 lever boss.

O

Shimano B Type Boss

SUTHERLAND'S

INDEXING DERAILLEURS

CABLE, CABLE CASING, AND CASING CAPS

Cable, cable casing, and casing caps are a critical part of successful index systems. Keep in mind the following:

Cable

- Use a high quality **1.2mm** cable that is smooth to the touch. The exceptions are Shimano Dura-Ace systems, which use **1.5mm** braided cables. SIS '95 XTR, Xi **1.1mm** contoured outer strand cables can be used in place of I.2mm cables. It is best to measure cables since the finish can make the cable appear fatter or thinner.
- SunTour recommends using **1.2mm** cable for all its indexing systems.
- Using larger or smaller diameter cable changes the amount of derailleur movement and is not recommended. (Thick Campagnolo derailleur cables change the amount of derailleur movement and should be avoided.)
- Using a **1.1mm** cable on twist-shift style levers is common.

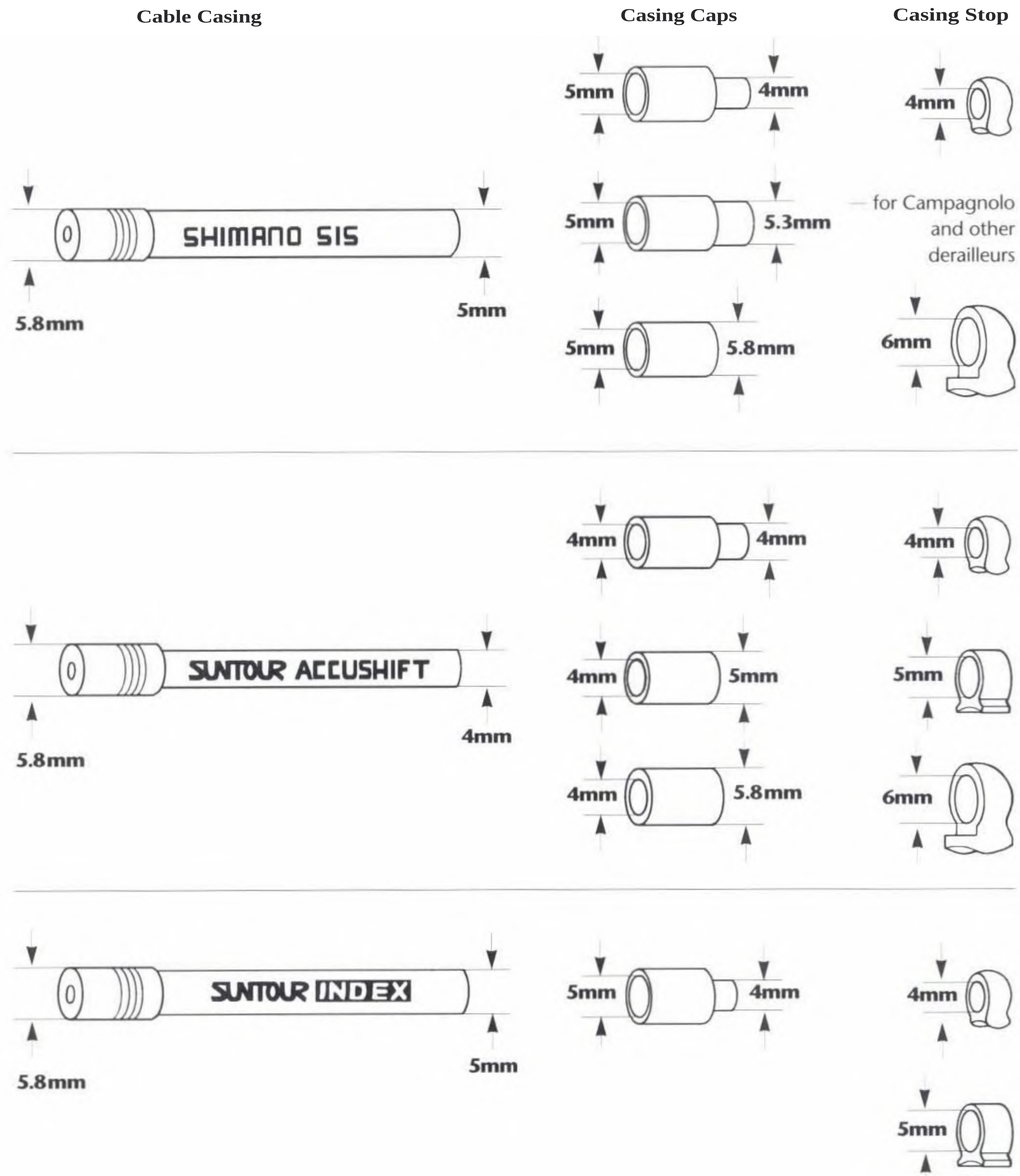
Cable Casing

- Use Shimano SIS or SunTour Accushift casing. (Accushift casing is better than casing marked SunTour Index.)
- Do not use ordinary wound or lined cable casing.
- Casing ends must be cleanly cut and/or ground smooth with a grinder or file. **Shimano cable cutter TL-CT1O is recommended.**
- Cable casing must be correct length to eliminate binding at stops and derailleur. Casing should curve without abrupt or compound bends.
- Internal routing of cables is not recommended; it causes too many tight bends. Some bikes benefit from switching routing to upper cable stops, and then crossing cables under down tube, making sure they don't rub frame.

Casing Caps

- Use casing caps on casing ends. Be sure casing caps closely fit the casing, the derailleur, and the cable casing stops on the frame. Shimano and SunTour make several different casing caps. *(See next page.)*

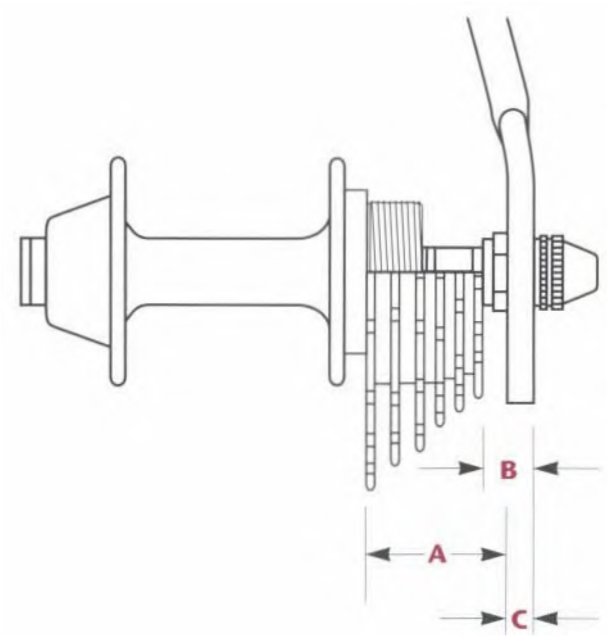
CABLE CASING CAPS



INDEXING DERAILLEURS

CASSETTE/FREEWHEEL DROP-OUT SPACING

This chart is based on a normal drop-out thickness **Dimension C** of 6.5mm. **Dimension B** is the handiest since it can he measured with the wheel and the cassette or freewheel mounted in the bicycle.



Shimano recommends that the drop-out he 7,5mm plus or minus 0.5mm thick. Drop-outs are often closer to 6.5 mm.

For wheels with freewheels, when **Dimension B** is too great, add a spacer between the freewheel and the hub. Be sure to check the clearance between the frame and the chain when **the** chain is on the smallest cog.

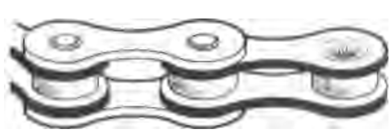
Extra thick drop-outs on aluminum frames may cause **Dimension B** to go over the recommended amount. This can cause difficulty shifting the largest cogs as the derailleur swings to its inside limits.

	Freewheel	**A**	**B**
Campagnolo	7-speed narrow spaced	36.0	9.5 - 11.5
	6-speed regular spaced	36.0	9.5 - 11.5
Shimano	8-speed spaced	40.5	10.0 - 11.5
	7-speed narrow spaced	36.0 - 38.0	10.5 - 11.5
	6-speed regular spaced	34.5 - 37.0	11.5 - 15.0
SunTour	7-speed narrow spaced	36.5	11.5 - 13.5
	6-speed regular spaced	36.5	11.5 - 13.5
	5-speed regular spaced	36.5	12.5 - 15.5

CHAIN RECOMMENDATIONS

Bushingless chain has the ability to twist more than chain with bushings. Some systems work best with a chain that will twist and some with a chain that resists twist. Be sure to follow the recommendations in each manufacturer's section.

Chain with Bushing



Chain without Bushing

TROUBLESHOOTING CHART

Shift Lever: Brazed-on Bosses

Trouble	**Cause**	Remedy
Lever doesn't fit or is too loose.	Brazed-on boss dimensions incorrect.	Carefully remove paint and chrome. Check dimensions of boss. Oversize dimensions can be carefully filed down. Undersize boss may be unusable.
Lever movement is too tight or selector is difficult to turn.	Lever friction adjusting screw is too tight.	Loosen lever friction adjusting screw slightly.
	Lever boss is too large for lever.	Check lever boss flat dimensions, ***(see page 5-5, measurement E).***
	Boss hole not centered.	Replace boss.
Lever friction adjusting screw won't tighten enough.	Lever boss threading is not deep enough.	Grind a small amount off the end of the friction screw. Note: Grind as little as possible.
	Braze or glue in lever boss threading.	Clean threads using correct tap. ***(See lever boss dimensions, page 5-5.)***
	Spacer or washer missing.	Check assembly against exploded drawing in catalog.
	Boss is too long.	Carefully grind a little off the end of the boss.
	Flats are not deep enough.	Carefully file the flats deeper.
Index selector doesn't work.	Lever boss flats perpendicular to down tube.	Replace boss. **SunTour:** If flats are installed exactly 90' to down tube, the lever will shift ultra freewheels when indicating "RE," and will shift regular spaced free-wheels when on "UL." Some SunTour clamp mount lever flats are 90" to the down tube. The levers attached to these clamps can be used when the lever bosses are perpendicular to the down tube. GPX levers don't engage the flats and can be used.
	SunTour: Using clamp mount levers on brazed-on bosses.	See above note.
Lever stop does not fit down tube.	Down tube diameter is greater than 28.6mm.	Replace radiused lever stop with flat lever stop.

TROUBLESHOOTING CHART (CONTD)

Shifter: All Mountings

Trouble	Cause	Remedy
Index selector doesn't work.	Mode selector is set between functions.	Check that the mode selector is lined up correctly with desired function.
Shifter movement is too tight or selector is difficult to turn.	Shifter friction adjusting screw is too tight.	Loosen lever friction adjusting screw slightly.
Shifter doesn't index with 8-speed freewheel.	Shifter not designed for 8-speed freewheel.	Check shifter compatibility chart for correct shifter
Shifter doesn't index with 7-speed freewheel.	Shifter not designed for 7-speed freewheels.	Check shifter compatibility chart for correct shifter.
	Campagnolo: incorrect insert.	Check Campagnolo shifter chart for correct insert.
	SunTour: IPC or IFC lever selector ring set to "RE."	Set selector ring to "UL." Also see SunTour note on previous page under "Index selector doesn't work."
Shifter doesn't index with 5- or 6-speed freewheel.	Shifter not designed for regular spaced freewheels.	Check shifter compatibility chart for correct lever.
	Campagnolo: Incorrect insert.	Check Campagnolo lever chart for correct insert.
	SunTour: Selector ring set to "UL," "power" or friction.	Set selector ring to "RE" or index.
SunTour: c(-3000 lever or ct-3000 derailleur doesn't index.	cx-3000 lever must be used with u-3000 derailleur.	Match components.

TROUBLESHOOTING CHART (CONT'D)

Derailleur

Trouble	Cause	Remedy
Rear derailleur doesn't move far enough to shift onto large cogs. **OR** chain skips cogs when shifting to larger cogs. **OR** slight clatter after shifting to larger cog.	Cable not tight enough.	Tighten cable with derailleur adjusting barrel.
Shift to largest cog hesitant.	Low limit adjustment screw needs loosening.	Loosen low limit adjusting screw.
Shifts from large to small cogs hesitant. **OR** chain skips cogs when shifting from large to smaller cogs. **OR** grinding noise after shifting to smaller cog.	Cable too tight.	Loosen cable with derailleur cable adjusting barrel or cable anchor bolt.
Shifts to smallest cog hesitant.	High limit adjusting screw too tight.	Loosen high limit adjusting screw.
Chain will not shift off or is hesitant to shift off the largest cog (chain is noisy when the crank is turned backwards).	Rear derailleur guide pulley too close to largest freewheel cog. Either the angle adjustment screw is incorrectly adjusted or the largest cog exceeds the derailleur capacity.	Check the derailleur capacity. If it should be able to handle the largest cog, turn the angle adjusting screw in to rotate the guide pulley away from the freewheel. **SunTour:** For derailleurs without adjusting screw, check ❑/T block for correct installation. *(See Derailleur Capacity Chart in* **Chapter** *8.)*
Random mis-shifts. Hard to turn the rear derailleur adjusting barrel.	The casing end is not capped at the derailleur.	Cap the casing end with the correct cap. SunTour has 5 different ones to match different combinations of cables and stops. Shimano has 3.

INDEXING DERAILLEURS

TROUBLESHOOTING CHART (CONT'D)

Other Symptoms

Trouble	Cause	Remedy
Indexing gradually deteriorates.	Cable was not stretched and/or casing not seated before adjustment.	Stretch cable, check sealing, and readjust.
	Cable anchor bolt loose.	Tighten cable anchor bolt.
	Freewheel not fully tightened on hub, or freewheel sprockets not fully tightened on freewheel body.	Tighten freewheel and sprockets.
	Derailleur mounting bolt loose.	Tighten mounting bolt.
	Worn out freewheel or chain.	Replace.
Consistent mis-shifts *—misses only certain cogs (other than the smallest and largest).*	Cable casing ends not cut flat adding spring to system or cable binds.	Grind or cut cable ends flat, eliminate cable binding.
	Shift lever selector ring set incorrectly.	Set selector ring for freewheel being used.
	Incompatible freewheel.	Replace with compatible freewheel.
	Derailleur high gear limit screw out of adjustment.	Set lever to "friction" or "power setting." Re-adjust high gear limit screw so guide pulley is directly under smallest sprocket. Screw adjsuting barrel in all the way and re-tension the cable.
	Drop-out misaligned.	Straighten drop-out, readjust derailleur and re-tension cable.
	Freewheel sprockets face the wrong way, or are single bevel instead of double, or spacers are incorrect.	Check cable and casing routing for binding before blaming freewheel spacing. If needed, install correct sprockets and spacers in *correct* positions.
continued next page	Hub/freewheel/drop-out spacing incorrect.	See component chapter for correct spacing.

TROUBLESHOOTING CHART (CONT'D)

Other Symptoms (contd)

Trouble	Cause	Remedy
Consistent mis-shifts-*misses only certain cogs (other than the smallest and largest) (contd).*	Cable too stiff or too large in diameter.	Use correct cable.
	Cable not stiff enough or too small in diameter.	Use correct cable.
	Campagnolo	***(See notes on Campagnolo in Chapter 6.)***
Works on one chainring but not another	Bad chainline.	Adjust chainline.
	Dirty derailleur.	Clean derailleur.
	Incorrect **chain length.**	Adjust chain length. ***(See page 5-3, #6.)***
Random mis-shifts	Cable not sliding freely.	Points to check: 1. Quality 1.2mm cable, correct cable casing, and correct cable ends. 2. Cable casing ends cut flat. 3. Cable stops and levers are secured tightly to frame. 4. Cable and casing free from dirt and properly lubricated. Lining is no substitute for lubrication. 5. Casing may be too long or short causing binding. 6. Bottom bracket cable guide causes binding. If lubrication improves performance, it will probably be temporary. Replace guide with clamp-on type. 7. Cable is attached on correct side of anchor bolt. 8. Internal cable housing can cause binding. Check by moving the shift lever slightly. The derailleur must move a corresponding amount, otherwise re-route the cable.

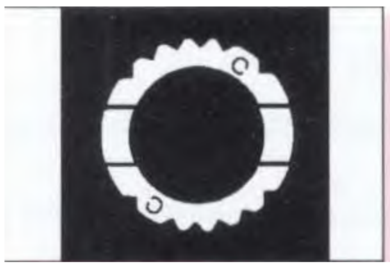
continued next page

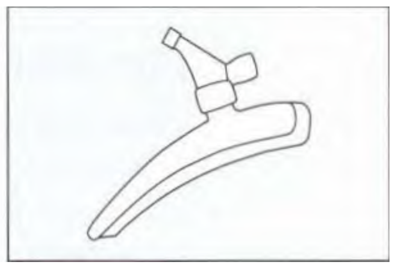
TROUBLESHOOTING CHART (CONT'D)

Other Symptoms (cont'd)

Trouble	Cause	Remedy
Random mis-shifts (cont'd.)	Chain and/or freewheel dirty, rusty, or worn.	Clean and lubricate or replace with new compatible chain. If trouble persists, replace freewheel with new compatible freewheel.
	Chain is not compatible.	Check chart and install correct chain.
	Chain is incorrect length.	Add or subtract chain. **SunTour:** Shift into high gear. Add or subtract links until dot on pulley cage lines up with mark on derailleur body.
	SunTour Pro, DID Supershift, Regina CX-S, or Regina 50 Anniversario chain installed upside down or inside out.	Turn right side up. **Regina CX-S** must also have silver-colored plate facing out. **Regina 50 Anniversario** must have black plate facing in.
	Derailleur dirty or worn.	Clean or replace. Check guide pulley.
	Derailleur guide and tension pulleys are reversed.	**Shimano:** Guide pulley (marked Centeron or Ceramic Bushing) can move side-to-side. Tension has no side-to-side play. **SunTour:** Guide pulley (marked "G") has square tooth profile. Tension pulley (marked "T") has a pointed tooth profile.
Random mis-shifts *—unusually noisy drive train*	Rear drop-out misaligned.	Straighten rear drop-outs.

INDEXING DERAILLEURS Campagnolo & Sachs





Campagnolo

Sachs

INDEXING DERAILLEURS

CAMPAGNOLO SYNCRO 8-SPEED

Design Elements

- Shifters only available in 8-speed.
- Must use 8-speed rear derailleurs with the shfters.
- Cog-center-to-cog-center spacing is 5.0mm.

Syncro 8-speed is a different design from Syncro and Syncro II. It will no longer work with a variety of different freewheels and derailleurs Instead it will only work with freewheels and cassettes with a 5.0mm cog-center-to-cog-center spacing (as is provided on their 8-speed cassette hubs) and using Syncro 8-speed rear derailleurs (most Campagnolo rear derailleurs made after 1993).

Chain Recommendations

Overshifting is no longer required. The indexing system does not need a chain with bushings and is provided with a bushingless, Sachs SC-R80 chain. *(See page 2-21 for chain specifications.)*

CAMPAGNOLO (PRE-8-SPEED) SYNCRO AND SYNCRO II

Design Elements

- Several different lever inserts are available, to allow for different derailleur and freewheel spacing.
- Works best with Campagnolo Approved Regina 90 S Freewheel and Regina 50 Anniversario chain.
- Levers require the rider to overshift slightly when shifting onto larger sprockets.

Campagnolo's shift lever inserts allow the same levers to he used for different freewheel spacings and a variety of different derailleurs with very different geometries.

Overshift is required to complete a shift onto a larger cog. Overshift pushes the chain past the cog centerline to shift. The lever is then released, which allows the guide pulley to return to a position where it is centered under the cog.

Chain Recommendations

A high quality chain with bushings is recommended. Regina SO Anniversario chain works best.

CAMPAGNOLO SYNCRO II LEVERS

Syncro 11 levers use different inserts to vary the amount of cable pulled between detents. The inserts are the same for Syncro and Syncro

Campagnolo literature has shown many more combinations than are listed here. The ones listed here represent the best combinations. Please he sure to follow the Syncro II Setup Tips listed below.

To change to friction mode, note lever position (gear), then pull knurled washer (#I0) away from frame, and turn the washer clockwise 90°. To go from friction mode to Syncro mode, position the lever in the same gear as it was when the lever was changed from Syncro to friction. Then turn the washer 90° counterclockwise.

Syncro II Setup Tips

In addition to all the indexing adjustment instructions, *(see page 5-3)*, try the following:

1. Use what seems like too much grease when assembling each part of the lever.
2. Check that the release bush (part 5) matches perfectly with the flats on the boss. File the flats slightly to improve the match, if it can be done without making the clearance excessive.
3. The friction D-ring (part 6) should feel loose. Tighten the D-ring as you would on a friction lever, then back it off I/2 to I full turn. You may want to put a drop of Loctite on the threads.
4. Pre-bend the cable. Insert the cable into the lever with the head fully seated. Wrap the cable around the lever 90° to the way it normally goes and pull tight. This will put a bend in the cable that will help it settle quickly.

ABOUT THE DERAILLEUR CAPACITY CHARTS

The numbers listed in the derailleur capacity charts have been compiled from Campagnolo's literature. We have found some of these to be optimistic. Drop-out geometry, chainring sizes, huh position, chainstay geometry, and other factors may increase or decrease a given derailleur's capacity. Manufacturers tend to spec bikes with lower conservative numbers.

Max. Chainring Difference = Largest chainring minus the smallest teeth.

Total Capacity = Largest freewheel sprocket minus smallest, plus the Max. Chainring Difference.

Max. Freewheel Teeth = Largest freewheel sprocket

Blank spaces indicate no listing in the manufacturer's literature.

INDEXING DERAILLEURS

Campagnolo Syncro Lever Inserts

Model Categories	Shift Lever Inserts	Derailleur	Cassette/Freewheel
8-speed	• Grey Metallic - no mark	Campagnolo 8-speeds	Campagnolo 8-speeds
7-speed	• Blue - no mark	Athena Xenon	Campagnolo approved Regina 90-S 7-speed**
	• Green - stamped A7	Chorus - "A" mode	Shimano SIS 7-speed
	• Black - stamped B7	Chorus - "B" mode Euclid Centaur	
	• Grey - no mark	Croce D'Aune	
6-speed	• Yellow - stamped "C"	Athena Xenon	Regina regular spaced 6-speed
	• Red - stamped A6	Chorus - "A" mode	Shimano SIS 6-speed
	• White - stamped B6	Chorus - "B" mode Euclid Centaur	

* A yellow insert without a "C" stamped on it was also produced. The notches in it, however, are spaced differently.

** Marked with the C in a diamond trademark inside the threaded portion that mates with the hub.

The insert silhouettes are the size of the actual inserts. By placing the insert on the silhouettes, you can identify which one it is even if the paint has been dissolved.

Blue

Green

Black

Grey

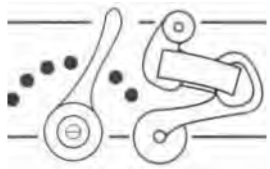
Yellow

Red

White

Grey Metallic

INDEXING REAR DERAILLEURS



CAMPAGNOLO REAR DERAILLEUR CAPACITY

(Please see notes "About the Derailleur Capacity Charts" on page 6-3.)

Note: When using Shimano SIS cable casing, Campagnolo derailleurs require an end cap that steps down to 5.3mm. When using Accushift cable casing, use the 5mm end cap.

Campagnolo Indexing Rear Derailleurs

Model	Model No.	Total Capacity	Maximum Freewheel Teeth Drop-out L = 24mm
• Record 1995 model	RD-31 RE**	26T	26T
1994 model	RD-21 RE**	26T	26T
1993 model	RD-11RE**	26T	26T
1992 model	RD-10RE**	26T	26T
• Record 1990 model ("C-Record")	N/A	27T	28T
• Racing T	RD-01 RA3**	37T	28T
• Croce D'Aune (original)			
Short Cage	B010-SM	30T	28T
Long Cage	B010-LG	33T	30T
1990 model	N/A	27T	28T
• Chorus 1995 model	RD-31 CH**	26T	26T
1993 model	RD-11 CH**	26T	26T
1992 model	RD-01 CH**	26T	26T
Short Cage	C010-SM		
"A" setting		25T	27T*
"B" setting		33T	32T
Long Cage	C010-LG		
"A" setting		35T	30T*
"B" setting		37T	32T
• Athena 1995 model	RD-31 AT**	26T	26T
1994 model	RD-21AT**	26T	28T
1993 model	RD-11AT**	26T	28T
1992 model	RD-01 AT**	26T	26T
	D010	30T	30T
• Veloce 1995 models	RD-31VL**	26T	28T
Long Cage	RD-31VL3**	37T	28T
1994 model	RD-11VL**	26T	28T
1993 model	RD-01VL**	26T	28T
• Stratos 1994 model	RD-01 ST**	26T	28T
• Mirage 1995 models	RD-31 MI**	26T	28T
Long Cage	RD-31MI3**	37T	28T
• Avanti 1995 model	RD-31 AV**	26T	28T
• Xenon	F010	30T	30T

* We recommend a maximum freewheel of 19T in the "A" setting.

** 8-speed com patible derailleurs.

REAR DERAILLEURS

Campagnolo Indexing Rear Derailleurs (cont'd)

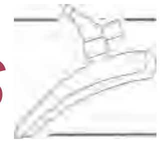
Model		Model No.	Total Capacity	Maximum Freewheel Teeth Drop-out L = 24mm
• Record OR 1994 model	Short Cage	RD-21 OR**	30T	30T
	Medium Cage	RD-220R**	36T	32T
	1993 model Short Cage	RD-11 OR**	30T	30T
	Medium Cage	RD-120R**	36T	32T
	Long Cage	RD-130R**	42T	32T
	1 992 model Short Cage	RD-01 OR**	32T	30T
	Medium Cage	RD-020R**	38T	32T
	Long Cage	RD-030R**	44T	32T
• Euclid	Short Cage	M010-SM	32T	30T
	Medium Cage	M010-MD	38T	32T
	Long Cage	M010-LG	44T	32T
• Icarus	Short Cage	RD-011C**	32T	30T
	Medium Cage	RD-021C**	38T	32T
	Long Cage	RD-031C**	44T	32T
• Centaur	1992 model Medium Cage	RD-02CE**	38T	32T
	Long Cage	RD-03CE**	44T	32T
	Short Cage	Q010-SM	32T	30T
	Medium Cage	Q010-MD	381	32T
	Long Cage	Q010-LG	44T	32T
• Olympus	Medium Cage	Z010-MD	38T	32T
	Long Cage	Z010-LG	44T	327

** 8-speed compatible derailleurs.

Campagnolo Non-Indexing Rear Derailleurs

Model	Model No.	Maximum Freewheel Teeth Drop-out L = 24mm
• Gran Turismo	2270	36T
• Gran Sport (short cage)	3500	26T
• Gran Sport GT (long cage)	3550	32T
• Nuovo Record	1020/A	26T
• Rally	3450	36T
• Record ("C-Record") (original)		28T
• Super Record	4001	28T
• Triomphe Corsa (short cage)	0010-SM	28T
• Triomphe Leisure (long cage)	0010-LG	32T
• Valentino Extra	21 70	26T
• Velox	2250	26T
• Victory Corsa (short cage)	G010-SM	28T
• Victory Leisure (long cage)	G010-LG	32T
• 980	0102068	26T

FRONT DERAILLEURS



Campagnolo Front Derailleurs

Model	Model No.	Half-Step/ Alpine**	Maximum Chainring Difference	Clamp Diameter or Braze-On (B/0)
• Record, Chorus &	FD-21 SRE, FD-21 FRE,	half-step	15T	B/0, 28.6
Athena ('95)	FD-02FRE, FD-03FRE	half-step	15T	32, 35
• Record ('93 - '94)	FD-1 1 SRE, FD-1 1 F RE	half-step	1 4T	B/0, 28.6
('92)	FD-01SRE, F D-01FRE	half-step	16T	B/0, 28.6
• Record ("C-Record")	A021, A022	half-step	18T	B/0, 28.6, 29.5*
• Super Record	1023/00, 1022/00	half-step	11T	B/0, 28.6
• Nuovo Record	1050	half-step	11T	28.6
	1 021/00, 1052/NT	half-step	18T	B/0, 28.6
• Racing T ('95)	FD-01 SRA3, FD-01 FRA3,	alpine	22T	B/0, 28.6
	FD-02FRA3, FD-03FRA3	alpine	22T	32, 35
• Chorus ('92 - '94) &	FD-11 SCH, FD-01 FCH,	half-step	14T	BYO, 28.6
Athena ('94)	FD-02FCH	half-step	14T	29-33 (adjustable)
• Chorus ('92)	FD-01SCH	half-step	14T	B/0
• Athena, Chorus,	CO21, CO22,	half-step	18T	B/0, 28.6
Croce D'Aune	CO23	half-step	18T	28-33 (adjustable)
• Athena ('92 - '93)	FD-01 SAT, FD-01 FAT	half-step	1 4T	B/0, 28.6
• Veloce ('95)	FD-21 SVL, FD-21 FVL,	half-step	15T	B/0, 28.6
	FD-02FVL, FD-03FVL	half-step	15T	32, 35
• Veloce ('94)	FD-1 1 SVL, F D-11 FVL	half-step	14T	B/0, 28.6
	FD-02FVL, FD-03FVL	half-step	14T	29-33, 35-36
• Veloce ('93)	FD-01 SVL, FD-01 FVL	half-step	14T	B/0, 28.6
• Veloce T ('95)	FD-01 SVL3, FD-01 FVL3	half-step	22T	B/0, 28.6
	FD-02FVL3, FD-03FVL3	half-step	22T	32, 35
• Stratos ('94)	FD-01 SST, FD-01 FST,	half-step	14T	B/0, 28.6
	FD-02FST	half-step	14T	29-33 (adjustable)
• Mirage ('95)	FD-01 SMI, FD-01 FM1,	half-step	1ST	B/0, 28.6
	FD-02FMR, FD-031MI	half-step	151	32, 35
• Mirage T ('95)	FD-01 SM13, FD-01FMI3,	half-step	22T	B/0, 28.6
	FD-02FMI3, FD-03FMI3	half-step	22T	32, 35
• Avanti ('95)	FDO1 SAV, FD-01 FAV	half-step	15T	B/0, 28.6
• Xenon	F021, F022	half-step	I 81	B/0, 28.6
• Victory or Triomphe Corsa	0021, 0022	half-step	11T	B/0, 28.6
Victory or Triomphe Leisure	0021-LX, **0022-LX**	alpine	23T	B/0, 28.6
• Gran Sport	3600	half-step	11T	28.6
• Nuovo Valentino	0104008	half-step	11T	28.6
• Valentino	2050	half-step		28.6
• 980	0104012	half-step	11T	28.6
• Record OR ('92 - '94)	FD-01 FOR, FD-01TPOR	half-step	22T	28.6
	FD-02FOR, FD-02TPOR	half-step	22T	28.6 - 33
	FD-03FOR, FD-O3TPOR	half-step	22T	35 - 36
• Centaur, Euclid	MO22, MO24	alpine	26T	28.6, 35 - 36
	MO23	alpine	26T	28 - 33 (adjustable)
• Olympus	2021, 2022	alpine	26T	B/0, 28.6
• 990	0104013	alpine	23T	28.6

* Limited production run for carbon fiber seat tubes.

***** (See page 7-10 for half-step/alpine definition.)***

INDEXING DERAILLEURS

SACHS-HURET ARIS

Design Elements

- Overshift built into lever. Overshift is about 2mm of cable travel.
- Floating guide pulley.
- Grooved and pinched freewheel teeth.
- Systems are supplied with Sedisport bushingless chains, although we recommend a chain with bushings.

Sachs-Huret uses overshift built into the lever, like SunTour, only more so (overshift of 2mm of cable travel for Sachs-Huret vs. 1mm for SunTour). This pushes the chain centerline past the cog centerline to complete the shift. The guide pulley then settles into a position where it is centered under the cog.

Like the Shimano system, Sachs-Huret also has a floating guide pulley. This allows the guide pulley to center itsef under the sprocket when it is not perfectly aligned.

The grooved and pinched freewheel teeth are not as "active" as the Shimano twist teeth but work well when combined with overshift of the shift levers.

Chain Recommendations

Bushingless chain is usually supplied with these systems. However, we have found that a chain with bushings, that has less side flex and twist, works better.

Sedisport Pro and ATB Chain

Because the Sedisport Pro,, ATB, MC-90, MC-50 and MC-55 chains have mushroomed-over pins to help them withstand side thrust, Sachs recommends special care when removing the chain. These two chains have a special dimpled connecting pin that is located by a single black chain side plate. Push the pin on the dimpled end when removal is needed. Push on the mushroomed non-dimpled end when installing.

About the Derailleur Capacity Charts

The numbers listed in the derailleur capacity charts have been compiled from Sachs-Huret's literature. The capacities listed are for "normal conditions." Drop-out geometry, chainring sizes, hub position, chainstay geometry, and other factors may increase or decrease a given derailleur's capacity.

Max. Chainring Difference = Largest chainring minus the smallest teeth.

Total Capacity = Largest freewheel sprocket minus smallest, plus the Maximum Chainring Difference.

Max. Freewheel Teeth = Largest freewheel sprocket

Blank spaces indicate no listing in the manufacturer's literature.

INDEXING REAR DERAILLEURS

Sachs-Huret Indexed Right Shift Levers

Derailleurs on same or next line correspond cosmetically. Shift levers in the same box work with any of the derailleurs in the adjacent box.

Model Categories	Models	Shift Lever	Derailleur	Freewheel
7- Er 6-speed	• New Success • New Success Touring • Rival Sport • Rival Touring	MA 85.5* MA 82.4*, MA 82.7 P	**AR** 47.2 D AR 47.2 T AR 41.3 D AR 41.3 T	Sachs-Maillard, ARIS 7-speed narrow or 6-speed regular
6-speed	• Rival ATB	MA 82.8* G	**AR 41.4** T	Sachs-Maillard RGS 5- or 6-speed regular w/spoke guard
6- Er 5-speed	• Rider IS • Elysee (w/"Positron-type" cable) • Explorer	MA 88.30, MA 88.33 MA 93.1* G MA 90	AR 46.2 AR 49.1 D AR 48	 Sachs-Maillard,ARIS Sachs-Maillard Explorer

E following these numbers stands for frame mount. G stands for handlebar mount.

Sachs Rear Derailleur Twist-Shift Lever Compatibility

Model	Component Group	3-speed	5-speed	6-speed	7-speed	8-speed
Power Grip Pro Shifter	7000 New Success 3000, 5000				SL-PGPO SL-PGP1	SL-PGPO SL-PGP1
Power Push	3x7 New Success 3000, 7000, 5000				SL-PPOO SL-PPOO	
Kid Grip	1000, 2000, 3000	SL-KGOO	SL-KGOO	SL-K000	SL-KG00	

Sachs Twist-Shift Lever Model Information

Model	Fits Handlebar Diameter	Direction of Rotation for Cable-Pull* Front	Rear
Power Grip Pro 7-speed 8-speed	22.0-22.4mm	Counter clockwise 1 00' - rotation	Clockwise 1 00 - rotation 118' - rotation
Kid Grip	22.0-22.4mm	Counter clockwise	Clockwise
Power Push	**22.2-22.5mm**	**Counter clockwise**	**Clockwise**

* As viewed from end of handlebar.

INDEXING REAR DERAILLEURS

Sachs Front Derailleur Twist-Shift Lever Compatibility

Model	Double/Triple Chainrings	Component Group
Power Grip	D, T	7000
	0, T	5000
	D, T	3000
	D, T	New Success
SL-PPOO	I Internal 3	**3** X 7, Pentasport, Super 7
Power Push	T, Internal 3	7000
	T, Internal 3	5000
	T, Internal 3	3000
	T	New Success
	T, Internal 3	2000
	T	**1000**

Sachs-Huret Indexing Rear Derailleurs

(Please see notes, "About the Derailleur Capacity Charts," on page 6-8.)

Model Categories	Models	Model No.	Maximum Chainring Difference	Total Capacity	Maximum Freewheel Teeth Drop-out L = 24	1 = 28
8-speed Road	• New Success	RD RN500		28T		
	• 7000	RD R7000		28T		
	• 5000	RD R5000		28T		
7-speed Road	• 3000	RD R3000		28T		
	• 2000	RD R2000		28T		
	• ECO	RD RECOO		28T		
8-speed MTB	• New Success	RD MN300		40T		
	• 7000	RD M7000		40T		
	• 5000	RD M5000		40T		
7-speed MTB	• 3000	RD M3000		40T		
	• 2000	RD M2000		40T		
	• 1 000	RD M1000		40T		
	• ECO	RD MECOO		40T		
7- & 6-speed	• New Success	AR 47.2 D	**16T**	28T	26T	28T
	• New Success Touring	AR 47.2 T	26T	40T	30T	32T
	• Rival Sport	AR 41.3 D	16T	28T	26T	28T
	• Rival Touring	AR 41.3 T	26T	40T	30T	32T
6-speed	• Rival ATB	AR 41.4 T	26T	**40T**		**34T**
6- & 5-speed	• Rider	AR 46.2		**43T**		**34T**
	• Elysee (w/"Positron-type" cable)	AR 49.1 D	1 6T	28T	30T	32T
	• Explorer	AR 48		28T		28T

NON-INDEXING REAR DERAILLEURS

Sachs-Huret Non-Indexing Rear Derailleurs

Model	Model No.	Total Capacity	Maximum Freewheel 1 Teeth Drop-out 1 , 24mm	1 = 28mm
• Jubilee	AR 44/2	31T	28T	
■ Jubilee—long cage	2253	40T	28T	
■ Success	2470	31T	28T	
• New Success	47/2	301	30T	
• New Success—long cage	AR 47/3	42T	36T	
■ Duopar	**40/3**	34T		**36T**
	2648 H	36T		36T
	2648 GC	36T		38T
• Duopar Eco	2690 H	36T		36T
	2690 GC	36T		38T
• Pilot	2900-00 H	30T	28T	
	AR 45/2	30T	30T	
• Rival	**41/2**		**28T**	**36T**
• Rival—long cage	AR 41/3		42T	36T
	2850-00	30T	28T	
■ Rider	AR 46/2	28T		32T
• Rider—long cage	AR 46/3	43T		36T
• Eco	AR 30/2	31T	28T	
• Eco—long cage	AR 30/3	38T	28T	
• Eco-5	AR 31/2	31T	28T	

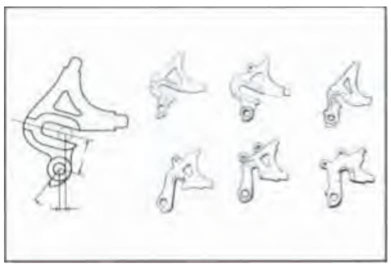
FRONT DERAILLEURS

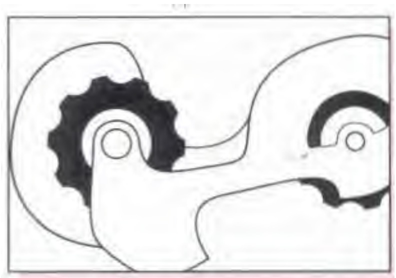
Sachs-Huret Front Derailleurs

Model	Model No.	Half-Step/ Alpine***	Maximum Chainring Difference*	Clamp diameter or Braze-On (B/0)
• Jubilee	AV 66/2	half-step	16T	28-28.6
• Success	AV 975	half-step	16T	28-28.6
• New Success	AV 67/3	alpine	26T	28-28.6, 29, 30
	FD NS00	alpine	26T	28.6, 31.8, 34.8 B/0 C.D./Standard
• New Success, Pilot	AV 67/2	half-step	**16T**	28-28.6, 29, 30
• New Success Sport	**FD** RNS00	half-step	16T	28.6, 34.8 B/0
• New Success ARIS	AV 66.5 D	half-step	16T	28-29
	AV 66.6 D	half-step	16T	B/0
	AV 66.5 T	alpine	26T	28-29
	AV 66.6 T	alpine	26T	8/0
• 7000	FD R7000	half-step	16T	28.6, 31.8 B/0
• 6000	FD M6000	alpine	26T	28.6, 31.8, 34.8-C.D.
• Hi Stepper (Duopar)	AV 67/3s	half-step	16T	28-28.6, 29, 30
• 5000	FD R5000	half-step	16T	28.6, 31.8, 34.8B/0
• MTB 5000	FD M5001	alpine	26T	28.6, 31.8, 34.8 C.D./Standard
• Rival	AV 62/2	half-step	16T	28-29, 30
	AV 62/2	alpine	26T	28-29, 30
	AV 62/3	half-step	16T	B/0
• Rival Sport ARIS	AV 62.2 D	half-step	16T	28-29, 30
	AV 62.2 T	alpine	26T	28-29, 30
	AV 62.3 D	half-step	16T	B/0
• Rival ATB ARIS	AV 41.4 T	alpine	26T	28-29, 30
• 3000	**FD** R3000		16T	28.6, 31.8
• MTB 3000	FD M3001	alpine	28T	28.6, 31.8, 34.8
• 2000	**FD** R2000		16T	28.6, 31.8
■ Eco S	AV 60/2	half-step	16T	28-29, 30
	FD RECOO			28.6
• Rider, Eco, Commander	AV 69/2	half-step	16T	28-29, 30
• Rider, Eco	AV 69/3	alpine	26T	28-29, 30
• Rider Sport ARIS	AV 62.4 D	half-step	16T	28-29
• Club	**	half-step	**16T**	28-28.6, 25.4
• Club AS	**	half-step	16T	28-28.6, 25.4

* Subtract 4 teeth when using oval chainrings
** Model number not available
****** (See page 7-10 for half-step/alpine definition.)***

INDEXING DERAILLEURS Shimano





Shimano

INDEXING DERAILLEURS

SHIMANO SIS

Design Elements

- **Centeron:** Floating guide pulley to allow slight misadjustment of indexing.
- **Uniglide:** Twisted tooth rear sprockets for improved chain engagement when shifting.
- **HyperGlide:** Rear sprockets with contoured faces for improved downshifting under load (when used with the proper chain).
- **5G-X:** Guide ramps on chainrings (integrated with chain width) for improved shifting.
- **Interactive Glide:** Refinement of contoured sprockets and chainrings (integrated with chain and floating guide pulley) for improved upshifting and downshifting under load.

Chain Recommendations:

Freewheel or Cassette	Chain
HyperGlide narrow 8-speed	CN-7401 CN-HG91, 90, 70, 50 Sedis SC-M50, SC-M55, SC-R80, SC-M90*
HyperGlide narrow 7-speed	CN-7401 CN-HG91, 90, 70, 50 CN-M732, CH-MT62 Sedis ATB, PRO, SC-M50, SC-M55, 5C-R80, SC-M90*
Non-HyperGlide 7- or 8-speed	Shimano narrow Most third-party newer (post '92) narrow chains
6-speed regular spaced	Shimano UG regular chain Shimano narrow Most third-party chains

* ***(See Chain Recommendations page 6-8.)***

Many third part manufacturers make chains with shorter pin lengths that will work with HyperGlide sprockets.

HyperGlide freewheels require the use of a special HyperGl ide chain with mushroomed-over pins that can help the chain withstand side thrust. The Hyperglide chain must then be cut with a straight stroke chain tool that accommodates widened outer plates. Use a Uniglide chain tool or the Park Super Chain tool. When breaking the chain, push a single pin all the way out. When rejoining the chain, use the special FIG pin to replace. After the pin is inserted, break off the remaining end with pliers.

When cutting Uniglide chains with plier-type cutters, Shimano recommends installing their Var adapter for Var pliers or their Hozan adapter for I lozan pliers.

INDEXING DERAILLEURS

ABOUT THE DERAILLEUR CAPACITY CHARTS

The numbers listed in the derailleur capacity charts have been compiled from SunTour's literature. The capacities listed are for "normal conditions." Drop-out geometry, chain ring sizes, hub position, chainstay geometry, and other factors may increase or decrease a given derailleur's capacity.

Max. Chainring Difference = Largest chainring minus the smallest.

Total Capacity = largest freewheel sprocket minus smallest, plus the Max. Chainring Difference.

Max. Freewheel Teeth = Largest freewheel sprocket.

Blank Spaces indicate no listing in the manufacturer's literature.

SHIMANO SIS LEVERS

Dura-Ace levers and derailleurs must he used together. Dura-Ace levers will not work with standard 515 derailleurs and standard 515 levers will not work with Dura-Ace derailleurs.

Standard SIS levers can be used with any 515 rear derailleur except for Dura-Ace. Uniglide freewheels and cassettes can be used with any chain. HyperGlide cassettes need compatible chains, *(see page 7-2).* Interactive Glide cassettes should be used wit h Interactive Glide (or compatible) chains, Interactive Glide rear derailleurs and Interactive Glide chainrings. Any rear derailleur can be used with HyperGlide or Uniglide freewheels and cassettes, though the shifting may need to be adjusted more often when using an Interactive Glide rear derailleur.

Different speed levers and freewheels or cassettes cannot be interchanged. 6-, 7- and 8-speed freewheels, cassettes and levers are designed for different cog-center-to-cog-center spacing.

6-speed rear freewheels and cassettes are spaced approximately 5.55mm from cog-center-to-cog-center (except between the 4th and 5th cogs, counting from the inside), 7-speed is approximately 5.0mm (except between the 5th and 6th cogs, counting from the inside), and 8-speed is approximately 4.95mm average from cog-center-to-cog-center.

Shimano Index System Levers

Model Categories	515 Type	Lever Models	Freewheel/ Cassette	Rear Derailleur
Dora-Ace 8-speed ,	Dura-Ace	Dura-Ace 8-speed, Integrated-8 SL-7402, 5LBS50-8, 5T-7400	515 8-speed	, Dura-Ace RD-7402
Dura-Ace 7-speed	Dura-Ace	Dora-Ace 7-speed SL-740l	SIS 7-speed	Dora-Ace RD-7402 or RD-7401
Dura-Ace 6-speed	Dura-Ace	Dora-Ace 6-speed SL-7400	S15 6-speed	Dura-Ace RD-7402, RD-7401, or RD-7400

(continued)

INDEXING DERAILLEURS

SHIMANO SIS LEVERS (CONT'D)

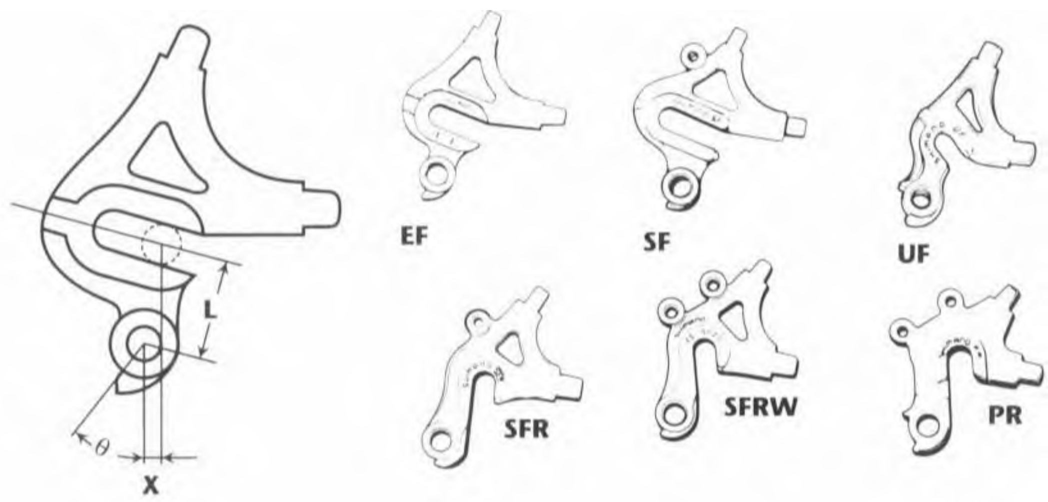
Shimano Index System Levers (cont'd)

Model Categories	515 Type	Lever Models	Freewheel/ Cassette	Rear Derailleur
Standard' 8-speed	Standard"	Any non-Dura-Ace 8-speed lever	515 8-speed	Any 8-speed rear derailleur except Dura-Ace
Standard[1] 7-speed	Standard"	Any non-Dura-Ace 7-speed lever[2]	515 7-speed3	Any 7- or 8-speed rear derailleur except Dura-Ace
Standard" 6-speed (or less)	Standard"	Any non-Dura-Ace 6-speed (or less) lever[2]	SIS 6-speed (or less)	Any 6-, 7-, or 8-speed rear derailleur except Dora-Ace

1 Do not confuse standard SIS with standard, or regular (vs. narrow), freewheel spacing. Standard 515 is non-Dura-Ace SIS.

2 600 Ultegra 51.-6400 and SL-BS-50 levers can be modified for 6- or 7-speed use. For 6-speed, hook the adapter shim into the cable groove, reinove the adapter for 7-speed use.

3 When using an Interactive Glide cassette, also use an Interactive Glide chain, rear derailleur and chainwheels. An interactive Glide rear derailleur will work with a normal HyperGlide or Uniglide rear cluster, but may need to be adjusted more often.



SHIMANO SIS DROP-OUT DIMENSIONS

The following are the recommended dimensions for optimum shifting performance and the Shimano drop-outs that meet these dimensions.

L	0	X	Drop-out Model	
24mm	30-35'	4-12mm	Shimano-EF	FE-EF20
26mm	30-35°	6-12mm	Shimano-SF	FE-SF20
28mm	25-30"	6-12mm		
29mm	25-30°	6-12mm	Shimano-SFR Shimano-SFRW	FE-5121 FE-S122
30mm	25-30'	7.5-12mm		

INDEXING REAR DERAILLEURS

SHIMANO SIS REAR DERAILLEUR CAPACITIES

(Please see notes, "About the Derailleur Capacity Charts," on page 7-3.)

Derailleurs listed here are SIS compatible. Some derailleurs with identical names are not SIS compatible. Carefully check model numbers stamped into the frame, on the back of the body.

Dura-Ace levers will not work with standard derailleurs and standard levers will not work with Dura-Ace derailleurs.

Shimano SIS Rear Derailleurs

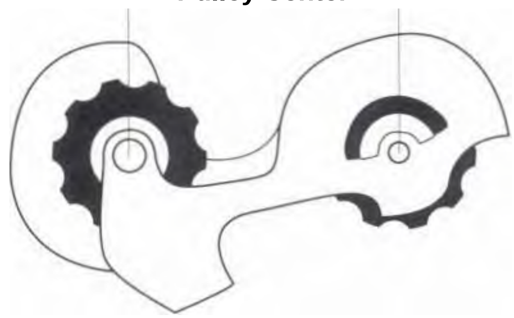
Model Categories	Model No. Stamped in Back of Body	SIS Type	Maximum Chain ring Difference	Total Capacity	Max. Freewheel Teeth Dropout EF L=24	Max. Freewheel Teeth Dropout SF L=26
Dura-Ace 8-, 7-, & 6-speed	RD-7402	Dura-Ace	14T	26T	26T	
(See page 7-9 for older non-indexing model numbers.)	RD-7401 RD-7400	Dura-Ace	13T 13T	26T 26T	26T 26T	
Standard 6-, 7-, & 8-speed						
• 600 Ultegra	RD-6401	Standard	13T	28T	28T	
• 600 Ultegra	RD-6400		14T	26T	28T	
• 600 EX*	RD-6208		13T	28T	28T	
• Sante	RD-5000		**13T**	24T	24T	
	RD-5001		13T	24T	24T	
• Sante–Medium Cage **(LS)**	**RD-5001**		13T	28T	23T	**281**

* ***(See page 7-9 for older models.)***

Pulley Pins

Model	Length	Width	Notes
Road 8-speed	12.8	5mm	3mm allen
Road 7-speed	14.0	5mm	3 mm alien
MTB 7-speed			
'94 XTR	12.8	5mm	3mm alien
'94 Deore XT, LX	14.0	5mm	3mm allen
MTB 7-speed			
'95 STX/RC, LX, DX, XT	16.1	5mm	3mm allen
'94 Alivio, Acera, Altus	15.8	5mm	8mm hex
ATB 6-speed			
'95 MJ, MJ II	15.8	5mm	8mm hex

Rear derailleur cage viewed from the back.



SHIMANO SIS REAR DERAILLEUR CAPACITIES (CONT'D)

(Please see mites, "About the Derailleur Capacity Charts," on page 7-3.)

The capacity for the derailleurs listed on this page can be determined by the pulley center to pulley center length. *(See the table at the bottom of the page.)*

Model Categories	Model No. Stamped in Back of Body
8-speed (works with 7- and 6-speeds)	
• XTR	RD-M900, RD-M910
• Deore XT	RD-M737
• Deore LX	RDM565
• 105 SC	RD-1056
• RX100	RD-A551
Standard 6- fit 7-speed (may not work with 8-speeds)	
• Deore XT	RD-M735, RD-M732, RD-M730
• Deore DX	RD-M650
• Deore	RD-MT60, RD-MT62
• Deore LX	RD-M550, RD-M560, RD-M563
• (Exage) Mountain LX	RD-452
• STX-RC	RD-MC33
• STX	RD-MC32, RD-MC31, RD-MC30
• Alivio	RD-MC12, RD-MC11, RD-MC10
• Acera-X	RD-M290
• Exage ES	RD-M520
• Exage LT	RD-M320
• Exage 500LX, 500CX	RD-M500
• Exage 400LX	RD-M400
• Exage 300LX	RD-M300
(continued next column)	

Model Categories	Model No. Stamped in Back of Body
• Exage Mountain	RD-M450
• Exage Trail	RD-M350
• Exage Country	RD-M250
• 200GS, 200CX	RD-M200
• 100GS	RD-M100
• Altus A10	RD-AT10
• Altus A20	RD-AT20
• Altus C10	RD-CT10
• L (Light Action) **Note:** Models L532, L523, and L525 are SIS compatible only in the SS (short cage) model.	RD-L554, RD-L553, RD-L532, RD-L523, RD-L525
• 700 CX	RD-C700
• 400 CX	RD-C400
• 105SC	RD 1055
• 105	RD-1051, RD-A550
• RX100	RD-A553, RD-A550
• (Exage) Sport LX	RD-A452
• Exage Sport	RD-A450
• Exage Action	RD-A350
• Exage Motion	RD-A250
• RSX	RD-A410
• Exage 500EX	RD-A500
• Exage 400EX	RD-A400
• Exage 300EX	RD-A300
• (Marked SIS, as are other models.)	RD-L541

Case Length Designation Example: RD-452-SGS	Pulley Center to Pulley Center	515 Type	Chainring Difference	Total Capacity	Max. Freewheel Teeth: Drop-out EF L=24	Drop-out SF L=26	Drop-out SFR, SFRW L=29
55 or no designation	56mm	Standard	13T	28T	28T		
GS	75mm		20T	34T*		26T	30T
SGS	86.5mm		20T	38T		28T	32T

1990 Shimano Service Handbook lists GS Total Capacity as 36T.

INDEXING REAR DERAILLEURS

SHIMANO SIS REAR DERAILLEURS

(Please see notes, "About the Derailleur Capacity Charts," on page 7-3.)

Model Categories	Model No. Stamped in Back of Body	SIS Type	Maximum Chainring Difference	Total Capacity	Maximum Freewheel Teeth
Standard 6-speed that can fit PR20 drop-out • (marked SIS, as are other models)	RD-M531	Standard		36T	30T*
Standard 6-speed with gear hanger • (marked Shimano SIS, as are other models)	RD-R552-SS	Standard	13T	28T	28T
	RD-R552-GS		20T	36T	30T
	RD-CT90-GS**,SS				
	RD-1Y20-SS, RD-TY70-SS,		13T	28T	24-28T
	RD-M11 0-GS, RD-CT20-GS,		20T	34T	28T
	RD-TY70-GS, RD-TY15-GS				
	RD-TY20-GS		20T	34T	30T
	RD-MJ10-SS, RD-MJ05-SS		13T	28T	28T
	RD-MJ05-GS		20T	34T	24T
Standard 5-speed with gear hanger • (marked Shimano 515, as are other models)	RD-R552-SS	Standard		28T	28T
	RD-R552-SGS			36T	30T

* Use Shimano drop-out SF or PR20.
** Fits 7-speed.

SHIMANO OLDER NON-SIS INDEXING REAR DERAILLEURS

These derailleurs must be used with Shimano's corresponding levers for indexing to work. The Positron listed below must be used with the corresponding lever and push-pull cable.

Model Categories	Model No. Stamped in Back of Body	Maximum Chainring Difference	Total Capacity	Maximum Freewheel Teeth
Dura -Ace AX	RD-7300	**13T**	26T	24T
600 AX	RD-6300	13T	28T	28T
Adamas AX	RD-AD10	1 3T	28T	28T
Positron	DG-100	1 3T	34T	34T
Positron AX	RD-AX10	13T	28T	28T
Positron-FH*	RD-PF10*	13T	28T	28T*
Positron-FH (medium cage)*	RD-PF20*	1 3T	32T	32T*
Positron-FH 400*	RD-PF40*	1 3T	28T	28T*
Positron-FH EM*	RD-PF30*	1 3T	32T	321*
Positron-II*	RD-P210*	1 3T	28T	281*
Positron-111*	RD-P312*	1 3T	28T	28T*
Positron-400*	RD-P240*	13T	28T	28T*

* For use with Shimano Front Freewheeling setup only.

NON-INDEXING REAR DERAILLEURS

SHIMANO NON-INDEXING REAR DERAILLEURS

(Please see notes, "About the Derailleur Capacity Charts," **on** *page 7-3.)*

Derailleurs that have cage length designations as part of the model number measure as follows:

1 Cage Length Designation Example: RD-L513-SGS	Cage Size	Pulley Center to Pulley Center
SS	Short Cage	56mm
GS	Long Cage	75mm
SGS	Super Long Cage	86.5mm

For many of these derailleurs, no drop-out dimension (I.) was given in Shimano's literature. Generally, the short cage derailleurs use a 24mm drop-out, while the longer cage derailleurs need a 26mm or longer drop-out. We have noted where Shinano made a specific recommendation.

Shimano Non-Indexing Rear Derailleurs

Model	Model No. Stamped in Back of Body	Maximum Chainwheel Difference	Total Capacity	Maximum Freewheel Teeth
• Deore (medium cage)	RD-DE10	20T	301	301
(long cage)	RD-DE20	20T	34T	34T
• Deore XT (w/Superplate)	RD-M 700-SP		40T*	34T
■ Deore XT	RD-M700	22T	40T	34T
• 600	RD-6100	1 3T	1 3T	28T
■ 600 (long cage)	RD-6101	1 3T	13T	34T
• 600 AX	RD-6300	1 3T	28T	281
• 600 EX**	RD-6200	1 3T	28T	281
	RD-6207	1 3T	281	281
• 600 EX (long cage)	RD-6210	1 3T	34T	341
	RD-6207-GS	13T	34T	34T
■ 105	RD-A105	13T	28T	28T
	RD-A105-GS	13T	34T	34T
■ L (Light Action) The Light Action derailleurs Fisted in the next column have the capacities listed according to the cage lengths	RD-L512 RD-L513 RD-L514 RD-L522 RD-L523 RD-L525 RD-L532			
SS— Short Cage			28T	281
GS— Long Cage			34T	34T
SGS— Super Long Cage			40T	341

* This is 42T when equipped with drop-out that has a 29mm L dimension.

***** (See page 7-5 for newer models.)***

NON-INDEXING REAR DERAILLEURS

Shimano Non-Indexing Rear Derailleurs (cont'd)

Model	Model No. Stamped in Back of Body	Maximum Chainring Difference	Total Capacity	Maximum Freewheel Teeth
• Z The Z derailleurs listed in the next column have their capacities listed according to cage lengths	**RD-Z501** **RD-Z503** RD-Z505			
SS- Short cage			30T	28T
GS- Long cage			34T	**34T**
SGS- **Super Long Cage**			40T	**34T**

Older Models (alphabetically)

Model	Model No. Stamped in Back of Body	Maximum Chainring Difference	Total Capacity	Maximum Freewheel Teeth
• AL-11	RD-AL11	22T	40T	34T
• Altus-LT	RD-AT12	13T	28T*	28T*
• Altus-LT (long cage)	RD-AT22	13T	34T	34T
• Altus-ST	RD-AT11	13T	28T*	28T*
• Altus-ST (long cage)	RD-AT21	13T	34T	34T
• Crane	DB-100	13T	28T	28T
• Crane-GS	DB-110	13T	34T	341
• Dura-Ace**	RD-7100	13T	26T	26T
• Dura-Ace EX	RD-7200	13T	26T	26T
• Eagle-II	**RD-EG10**	13T	34T	34T
• Lark Ⅱ	RD-LK10	**13T**	34T	34T
• Lark-Mini	RD-LK20	13T	28T	28T
• RS	RD-R511	13T	**34T**	**34T**
	RD-RS12	13T	**34T**	**34T**
• **Sky Lark**	**RD-SL10**	**13T**	**34T**	**34T**
• Titlist	RD-TL10	13T	28T	28T
• Titlist-G5	RD-TL11	1 **3T**	34T	34T
• Tourney	RD-TN10	13T	28T	28T
• Tourney-GS (long cage)	RD-TN11	13T	34T	34T
• Tourney	RD-TY10-55	13T	30T	30T
• Tourney-GS (long cage)	RD-TY10-GS	13T	34T	34T
• 500	DC-100	13T	28T	28T
• 500-GS	DC-110	13T	34T	34T
• 400	DC-400	13T	28T	28T
• 400-GS	DC-410	13T	34T	34T
• 400 FF	**RD-401 F**	**13T**	**34T**	**34T**

* Add 2 teeth with a drop-out that has a 29mm **L dimension.**

***** (See page 7-5 for newer models.)***

FRONT DERAILLEURS

SHIMANO FRONT DERAILLEUR CAPACITIES

(Please see notes, "About the Derailleur Capacity Charts," on page 7-3.)

Half-Step

Refers to a gearing setup with chainrings that are close enough in tooth number to make a front shift that is roughly haf that of a rear shift (% increase or decrease in gear inches). In common setups, this is a chainring difference of 4 or 5 teeth. This setup requires a front derailleur whose inner arid outer cages are close in height (matching the closeness of the diameters of the chainrings).

Alpine (sometimes called "Crossover")

Refers to a gearing setup featuring chainrings that are typically 10-12 teeth apart. This makes for distinct ranges of gears (one for each chainring), as opposed to the evenly dispersed front and rear shifts found with a **"Half-Step"** setup. **"Alpine"** derailleurs have inside and outside plates that differ considerabl y in height, thus allowing the chain to be guided over the large shifts between chain rings.

Shimano Indexing Front Derailleurs

Indexing front derailleurs must use their corresponding shift levers.

Model	Model No.	Capacity Min.	Max.	Half-Step/ Alpine	Clamp Diameter or Braze-On (B/O)
• Exage Sport	FD-A450* FD-A451 FD-A350* FD-A351	3T	14T	half-step	28.0-28.6, 8/0
• Exage Mountain**	FD-M450* FD-M451		20T***	alpine	28.0-28.6, 31.8, 34.9, 8/0

Shimano Dual SIS-Indexing Front Derailleurs

Model	Model No.	Capacity Min.	Max.	Half-Step/ Alpine	Clamp diameter or Braze-On (B/O)
• XTR '94	FD-M900		26T	alpine	28.0-28.6, 31.8, 34.9
• Deore XT	FD-M737	10T1	22T[3]		28.0-28.6, 31.8, 34.9, 8/0
• Deore DX	FD-M650		26T		28.0-28.6, 31.8, 34.9
• Deore LX	FD-M560		26T		28.0-28.6, 31.8 - 34.9
• 700CX	FD-C700		22T3	alpine	28.0-28.6, 31.8, 34.9
• Deore LX-HDC	FD-M563	10T1	22T[3]	alpine	28.0-28.6, 31.8, 34.9
• STX-SE	FD-MC31	8T1	22T3	alpine	28.0-28.6, 31.8, 34.9
• STX	FD-MC32	10T	22/42[3]		28.0-28.6, 31.8, 34.9

FRONT DERAILLEURS

Shimano Dual SIS-Indexing Front Derailleur (cont'd)

Model	Model No.	Capacity Min.	Max.	Half-Step/ Alpine	Clamp Diameter or Braze-On (B/O)
• Alivio	FD-MC122	8T	18/423		28.0 - 28.6, 31.8, 34.9
	FD-MC11	8T	22T3	alpine	28.0 - 28.6, 31.8
	FD-MC10				28.0 - 28.6
• Acera-X[2]	FD-M290	8T	18/42T3	alpine	28.0 - 28.6, 31.8
• Altus-050	FD-CT50	10T	22T	alpine	28.0 - 28.6
Altus-CT90[2]	FD-CT90-E	8T	14/38T3	alpine	28.0 - 28.6, 31.8
• Tourney	FD-TY30-65	10T	22T	alpine	28.0 - 28.6
• MJ	FD-MJ10	8T	18T	alpine	28.0 - 28.6
	FD-MJ12	10T	14T	half-step	
• MJ 11[2]	FD-MJ05	6	14T3		28.0 - 28.6
• 400 CX '94	FD-C400		22T3	alpine	28.0 - 28.6, 31.8, 34.9
• Dura-Ace '93	FD-7410		15T	half-step	28.0 - 28.6

1 Top-middle capacity

2 "Easy Set" Systems use a bracket that sets position and attaches to special bottom bracket.

3 These derailleurs are made to work with smaller Compact Drive chainrings.

* Narrow chains cannot be used with these derailleurs. Shimano recommends the regular width UG chain only.

** Shimano recommends that this derailleur he used with under-the-bottom bracket cable routing only.

*** 241 when used in the friction mode.

Shimano Non-Indexing Front Derailleurs

Model	Model No.	Half-Step/ Alpine	Capacity Min.	Max.*	Clamp Diameter or Braze-On (B/O)
• Dura-Ace	FD-7403	half-step		15T	28.0-28.6, B/O
	FD-7410	half-step		15T	28.0-28.6, B/O
• Deore DX	FD-M650	alpine		26T	28.0-28.6
• Deore LX	FD-M550	alpine		26T	28.0-28.6, 31.8, 34.9
• Deore XT	FD-M700	alpine	81	*22T*	28.6
	FD-M730-HS	half-step	5T	26T	28.0, 28.6, 31.8
	FD-M730-AL	alpine	8T	26T	28.0, 28.6, 31.8
	FD-M735	alpine		26T	28.0-28.6, 31.8, 34.9
• Deere XT II	FD-M732-HS	half-step	5T	24T	28.0, 28.6, 31.8
	FD-M732-AL	alpine	8T	24T	28.0, 28.6, 31.8
• Sante	FD-5000	half-step		14T	28.6, B/0
• 600 Ultegra	FD-6400	half-step	3T	14T	28.0-28.6, B/0

* Shimano recommends subtracting 4 teeth from maximum capacity for Biopace. Subtract 2 teeth for Biopace HP.

FRONT DERAILLEURS

Shimano Non-Indexing Front Derailleurs (cont'd)

(See page 7-13 for older models.)

Model	Model No.	Half-Step/ Alpine	Capacity Min.	Max.*	Clamp Diameter or Braze-On (B/O)
• 600 EX	FD-6207	half-step	3T	18T	28.6, B/0
• 105	FD-1050	half-step	**3T**	14T	28.0-28.6, RIO
	FD-1055	half-step		14T	28.0-28.6, B/O
• 105SC	FD-1056	half-step		15T	28.0-28.6, 31.8, 34.9
• Z	FD-Z254	half-step		14T	28.0-28.6
	FD-Z255	alpine		22T	28.0-28.6
	FD-Z260	half-step		14T	28.0-28.6
	FD-Z261	alpine		22T	28.0-28.6
• XTR '93	FD-M900	alpine		26T	28.0-28.6
• Mountain LX	FD-M452-HS	half-step	ST	26T	28.0, 28.6
	FD-M452-AL	alpine	8T	26T	28.0, 28.6
• Sport LX	FD-A452	half-step		14T	28.0-28.6, B/0
• RX-100	FD-A550	half-step		14T	28.0-28.6, B/0
	FD-A551	half-step		15T	28.0-28.6
	FD-A553	alpine		26T	28.0-28.6
• Exage 300 EX	FD-A300	half-step		14T	28.0-28.6
• Exage 400 EX	FD-A400	half-step		14T	28.0-28.6, B/O
• Exage 500 EX	FD-A500	half-step		14T	28.0-28.6, 8/0
• Altus Al 0	FD-AT10	alpine		26T	28.0-28.6, 31.8
• Altus A20	FD-AT20	alpine		22T	28.0-28.6
• Altus C10	FD-CT10	alpine		*22T*	28.0-28.6
• Altus C20	FD-CT20	alpine		22T	28.0-28.6
• Exage 300 LX	FD-M300	half-step		14T	28.0-28.6
• Exage 400 LX	FD-M400	alpine		26T	28.0-28.6, 31.8, 34.9
• Exage 500 LX	FD-M500	alpine		26T	28.0-28.6, 31.8, 34.9
• Exage LT	FD-M320	alpine		26T	28.0-28.6, 31.8, 34.9
• Exage ES	FD-M520	alpine		26T	28.0-28.6, 31.8, 34.9
• Exage Country	FD-M250	alpine	8T	221	28.0-28.6

* Shimano recommends subtracting 4 teeth from maximum capacity for Biopace. Subtract 2 teeth for Biopace HP.

INDEXING DERAILLEUR

Shimano Non-Indexing Front Derailleurs (cont'd)

Model	Model No.	Half-Step/ Alpine	Capacity Min.	Max.*	Clamp Diameter or Braze-On (B/O)
• Exage Motion	FD-A250	half-step		17T	28.0-28.6
• Exage Trail	FD-M350	alpine		22T	28.0-28.6, 29.0, 31.8, 34.9
	FD-M351	alpine		22T	28.0-28.6, 29.0, 31.8, 34.9
• 400CX	FD-C400	alpine		22T	28.0-28.6, 31.8, 34.9
• 200CX	FD-M202-C			26T	28.0-28.6, 31.8, 34.9
• 200 GS	FD-M200	alpine		22T	28.0-28.6
• 100GS	FD-M100			22T	28.6, 31.8, 34.9
• 70GS	FD-TY70			22T	28.0-28.6
• (no name)	FD-AX50	half-step	3T	14T	28.0-28.6
• (no name)	FD-AX55	alpine	8T	22T	25.4, 28.6
• Youth	FD-TY20	half-step		14T	28.0-28.6
• Tourney	FD-TY25	alpine		22T	28.0-28.6
	FD-TY21	alpine		22T	28.0-28.6
	FD-TY15-SS	half-step		14T	28.0-28.6
	FD-TY15-GS	alpine		22T	28.0-28.6

Shimano Non-Indexing Front Derailleurs

— Older Models (pre-1985) alphabetically

Model	Model No.	Half-Step/ Alpine	Capacity Min.	Max.*	Clamp Diameter or Braze-On (B/O)
• Adamas AX	FD-AD10	half-step		141	28.6
• Altus	FD-AL11	alpine	8T	22T	28.6, 25.4
• Altus	FD-AT11	half-step		14T	28.6, 25.4
• Altus-LT	FD-AT12	half-step		14T	28.6, 25.4
• Altus-ST	FD-AT-11	half-step		14T	28.6, 25.4
• Deore	FD-DE10	alpine		20T	28.6
• Deore	FD-MT60-HS	half-step	51	26T	28.0, 28.6, 31.8
	FD-MT60-AL	alpine	8T	26T	28.0, 28.6, 31.8
• Deore II	FD-MT62-HS	half-step	ST	24T	28.0, 28.6, 31.8
	FD-MT62-AL	alpine	8T	24T	28.0, 28.6, 31.8

* Shimano recommends subtracting 4 teeth from maximum capacity for Biopace. Subtract 2 teeth for Biopace HP.

Shimano Non-Indexing Front Derailleurs (cont'd)

— Older Models (pre 1985) alphabetically (cont'd)

Model	Model No.	Half-Step/ Alpine	Capacity Min.	Max.*	Clamp Diameter or Braze-On (B/O)
• Dura-Ace	EA-100	half-step		16T	28.6
	FD-7100	half-step		16T	28.6
• Dura-Ace EX	FD-7200	half-step		14T	28.0-28.6, B/O
• Dura-Ace AX	FD-7300	half-step		14T	28.0-28.6, B/O
• New Dura-Ace	FD-7400	half-step		15T	28.0-28.6, B/O
• FE	FD-FE11	half-step	3T	14T	28.6, 25.4
	FD-FE12				
• Positron-III	FD-P311	half-step		14T	28.6
	FD-P312				
• Positron AX	FD-AX10	half-step		14T	28.6, 25.4
• Thunder Bird-II	ED-300	half-step		16T	28.6
• Titlist	EB-200	half-step		14T	28.6
• 400	EC-400	half-step		14T	25.4, 28.6
• 500	EC-500	half-step		14T	25.4, 28.6
• 600	FD-6100	half-step		14T	28.6
• 600 EX	FD-6200	half-step		14T	28.6
• 600 AX	FD-6300	half-step		14T	28.6
• Z	FD-Z202	half-step		14T	28.6
	FD-Z204-HS	half-step	3T	18T	28.6
	FD-Z204-AL	alpine	6T	27T	28.6
	FD-Z206-HS	half-step	3T	18T	28.6, 31.8
	FD-Z206-AL	alpine	6T	27F	28.6, 31.8

* Shimano recommends subtracting 4 teeth from maximum capacity for Biopace. Subtract 2 teeth for Biopace HP.

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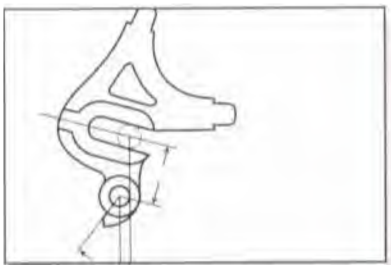
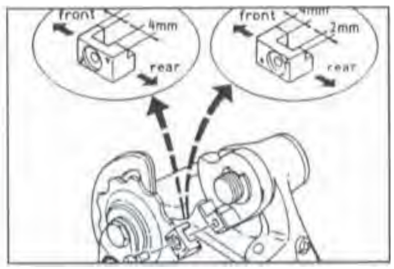
INDEXING DERAILLEURS SunTour





Sun Tour

SUTHERLAND'S

INDEXING DERAILLEURS

SUNTOUR ACCUSHIFT AND ACCUSHIFTPLUS

Design Elements

- Overshift built into shift levers.
- System has less built-in "play" than others.

■ S-I adjusting notes see page 8-4.

SunTour Accushift is very different from Shimano SIS.

Overshift is built into the levers (overshi ft of I mm of cable travel). This pushes the chain centerline past the cog centerline to complete the shift. The guide pulley then settles back into a position where it is centered under the cog.

The guide pulley lines up exactly under each freewheel cog without as much "play" as other systems.

Chain Recommendations

Freewheel	Chain
PowerFlo 8-, 7-speed narrow spaced	PowerFlo Sedis SC-M90*, Sedis MC-50, Sedis MC-55
AccushiftPlus 8-speed narrow spaced	PowerFlo Sedis SC-M90*
AccushiftPlus 7-speed narrow spaced	AccushiftPlus Sedis ATB*, Sedis MC-50*, Sedis MC-55*
AccushiftPlus 6-, 5-speed regular spaced	AccushiftPlus Sedis ATB*, Sedis MC-50*, Sedis MC-55*
Accushift 7-speed narrow spaced	AccushiftPlus Sedis ATB*, Sedis MC-50*, Sedis MC-55* SunTour Superbe Pro, Pro, Cyclone, GPX
Accushift 6-, 5-speed regular spaced	AccushiftPlus Sedis ATB* SunTour Superbe Pro, Pro, Cyclone, GPX HKK "7" DID Lanner

** (See Sedisport chain notes on page 6-8 in the Sachs-huret section when using Sedis chain.)*

SUNTOUR PLUG AND PLAY (SHIMANO COMPATIBLE)

Design Elements

- Shimano compatible SunTour derailleurs have parallelogram with the same geometry as Shimano Standard SIS derailleurs and a "floating" guide pulley.
- Shimano compatible SunTour shifters pull the same amount of cable as a Shimano SIS shifter.
- Shimano compatible SunTour freewheels are spaced like a Shimano SIS freewheel.

INDEXING DERAILLEURS

ABOUT THE DERAILLEUR CAPACITY CHARTS

The numbers listed in the derailleur capacity charts have been compiled from SunTour's literature. The capacities listed are for "normal conditions." Drop-out geometry, chainring sizes, hub position, chainstay geometry, and other factors may increase or decrease a given derailleur's capacity.

Max. Chainring Difference = Largest chainring minus the smallest.

Total Capacity = Largest freewheel sprocket minus smallest, plus the Max. Chainring Difference.

Max. Freewheel Teeth = Largest freewheel sprocket.

Blank Spaces indicate no listing in the manufacturer's literature.

SUNTOUR CASSETTES AND FREEWHEELS

Cassettes and freewheels in each group have the same spacing and are listed in order of decreasing performance.

Accushift (SunTour) Spacing	**Shimano Spacing**
7- AND 8-SPEED NARROW SPACED	
Cassettes - narrow spaced	**Cassettes - narrow spaced**
PowerFlo - 15 splines-sprockets marked **APII**	PowerFlo Rear (PFR) - 9 splines-sprockets marked **PF**
Accushift Plus II - 15 splines	(also called PowerFlo 3 and Plug and Play)
Accushift Plus - 15 splines	
Freewheels - narrow spaced	**Freewheels - narrow spaced**
PowerFlo - sprockets marked **APII**	PowerFlo Rear (PFR)-sprockets marked **PF**
Accushift Plus	(also called PowerFlo 3 and Plug and Play)
Accushift	
Winner Pro	
Winner	
Ultra 7	
6- AND 5-SPEED REGULAR SPACED	
Freewheels only - regular spaced	**Freewheels only - regular spaced**
PowerFlo-sprockets marked **APII**	PowerFlo Rear (PFR)-sprockets marked **PF**
Accushift Plus	
Accushift	
Winner Pro	
Winner	
(not Ultra 6)	

INDEXING DERAILLEURS

SUNTOUR SHIFTERS

Accushift down tube clamp-on index shifters have lever post flats that are often perpendicular to the down tube while the braze-cans have lever post flats that are normally parallel to the down tube. If you run across braze-ons that are mounted with the flats perpendicular you can use levers from a damp-on set. Another solution is to use GPX levers that are keyed to the large square portion of the braze-on rather than the post flat.

Lever, Express Twist or ErgoTec	Cassette/Freewheel	Derailleur
8-speed		
Accushift	8-speed MicroDrive	XC-Pro MD XC-Comp MD SUperbe Pro
7-speed		
Accushift	Any 7-speed Accushift narrow spaced freewheel	Any Accushift derailleur except a-3000
6-speed		
Accushift	Any 6-speed Accushift regular spaced freewheel (not Ultra 6)	Any Accushift derailleur except a-3000
6-speed		
a-3000	Any 6-speed Accushift regular spaced freewheel (not Ultra 6)	Use with cr.-3000 derailleur only
7-speed		
Plug and Play compatible ErgoTec ST-E520 Twist XR-50, XR-150	7-speed Shimano or SunTour PowerFlo Rear (PFR)	Any Shimano standard 515 or XR-50*, XR-150*
6-speed		
Plug and Play compatible Thumb XR-50	SunTour PowerFlo Rear (PFR)	Any Shimano standard 515 or X R-50*,XR-150*
7-speed		
S-1** 5X-100	Any 7-speed Accushift narrow spaced	5-1** SX-100
6 -speed		
SX-100	Any 6-speed Accushift regular spaced	SX-100
5-speed		
SX-100	FW-S100-K5	SX-100

* For capacity of XR-50 and XR-150, ***(see note at bottom*** **of page 8-6).**

** To adjust S-I derailleur adjust so parallelogram is parallel to chainstay. Next select 2nd gear, then using index adjust screw, center guide pulley under 2nd smallest sprocket.

INDEXING DERAILLEURS

SUNTOUR SHIFTER MARKINGS

Older SunTour Shift levers were marked as follows

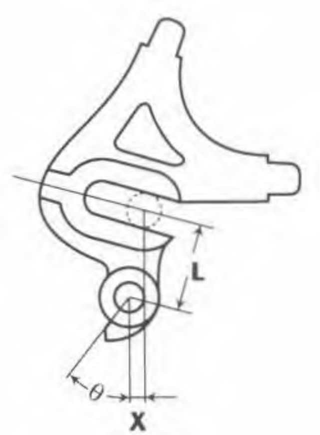
regular spacing for 6- and 5-speed freewheels.

UL – Ultra (narrow) spacing for 7-speed freewheels.

F - Friction mode—non-indexing.

P – Power—ratcheted non-indexing.

SUNTOUR DROP-OUT RECOMMENDATIONS



The chart below has the recommended dimensions for optimum shifting performance and some of the SunTour drop-outs that meet these dimensions.

S-I has shift hanger that is brazed onto the underside of the chainstay. Use SunTour S-1 Braze on Boss Alignment Jig #TA-S100.

L	¢	X	Drop-out Model	
24mm	30-35° ideal-35°	3-7mm	Superbe-Pro	EF-230
			SunTour-a	DO-ALA1
				DO-ALAO
				DO-ALB1
				DO-ALBO
26mm	30-35° ideal-35°	3-7mm	Superbe-Pro	EF-160
28mm	30-35° ideal-30°	3-7mm	SunTour-GS	EF-101
				EF-1 70
				EF-180
			SunTour-GT	EP-101
				EF-200
				EF-140
30mm	30-35° ideal-30°	3-7mm	SunTour-SD (vertical)	EF-121
				EF-210
				EF-220

INDEXING REAR DERAILLEURS

SUNTOUR ACCUSHIFT AND ACCUSHIFT PLUS REAR DERAILLEUR CAPACITY

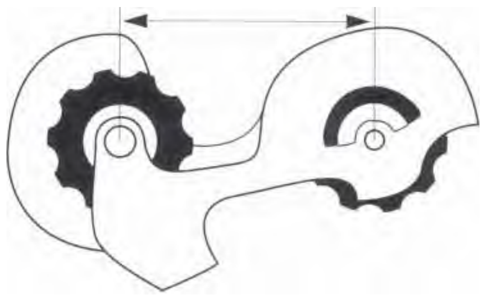
with Angle Adjusting Screw-on Derailleur

Lightweight Models	Model No.
• Superbe Pro	RD-SBOO
■ SL	RD-SLOO
• Sprint 9000	RD-SP10
• GPX	RD-GPOO
• Radius	RD-RA00
• Ole	RD-OLOO
• Cyclone 7000	RD-CL10
• Edge	RD-EDOO
■ Blaze	RD-BE00
• VX	RD-VXOO
• RT	RD-RTOO
■ FT01	RD-FT01
■ FTU	RD-FUOO
• a-5000	RD-5000
■ a-3000	RD-2000

ATB Models	Model No.
■ IC-Pro	RD-XPOO
• XC-9000	RD-XCOO
• XC-Comp	RD-XC20

ATB Models (cont'd)	Model No.
• XC Sport	RD-X501
• XC Sport 7000	RD-X500
• XC-LTD	RD-XLOO
• XC-Expert	RD-XXOO
■ XCD	RD-XD1O
• X-1 Chroma	RD-CROO
• X-1	RD-X100
• F5-E	RD-FE00
• ICE	RD-XE00
• XCM	RD-XM00
■ ICI	RD-XT00, XT01
■ XR100	RD-XR00
• XCU	RD-XU00
• AC-2000	RD-A200
• AC-1000	RD-A100
• a-1500	RD-1500
• Scrambler II	RD-5100
■ Scrambler	RD-SR21
• Honor	RD-HNOO
■ S-1	RD-5100

Rear derailleur cage viewed from the back
Measurement indicated is the **pulley center to pulley center.**



Cage Length Designation Example: RD-XMOO-GX	Pulley Center To Pulley Center	Maximum Chainring Difference	Total Capacity	Maximum Freewheel Teeth		
				Drop-out L.24	Drop-out 1=26	Drop-out 1=28
SS - for SL	—	121	24T	24T	241	26T
55 - Superbe Pro, Sprint, and GPX	47.5mm	1 2T	26T	26T	26T	28T
SS others	56.5mm	12T	28T	26T	28T	28T
GT	80mm	19T	34T	28T	30T	32T
GX*	85mm	21T	401	281	30T	32T

* Reduce total capacity and maximum freewheel teeth by 2T for Plug and Play Shimano compatible XR-50 and XR-150

SUNTOUR ACCUSHIFT REAR DERAILLEUR CAPACITIES

with D/T attachments (1988, 1989 models only)

The capacities for the derailleurs on this page can be determined by measuring the length between pulley centers. See the tables below.

Models	Model No.	Models	Model No.
• XC 9010	RD-XC10	• XCD 4050	RD-4050
• XCD 6000	RD-X DOO	• Blaze 3040	RD-BE45
• Edge 4050	RD-ED45	• u-3040	RD-3040
• o-4050	RD-4050	• XCM 3040	RD-XM34
• XCE 4050	RD-XE45	• a-3000	RD-3000

with SunTour, Campagnolo and Tange Drop-outs (NR stands for not recommended).

Cage Desig-nation	Pulley Center to Pulley Center	Max. Chain-ring Differ-ence	Total Capac-ity	6-speed Regular Spacing Maximum Freewheel Teeth			7-speed Narrow Spacing Maximum Freewheel Teeth	
				Drop-out L=24	Drop-out 1=26	Drop-out 1=28	Drop-out L=24	Drop-out L=30 or less
SS	56.5mm	1 21	28T	26TH	26T	28T	26TA,G	NR
GX	85mm	20T	40T	28Tc	28T	32TH	28TD	32TD,F,H

with Shimano Drop-outs (NR stands for not recommended).

Cage Desig-nation	Pulley Center to Pulley Center	Max. Chain-ring Differ-ence	Total Capac-ity	6-speed Regular Spacing Maximum Freewheel Teeth			7-speed Narrow Spacing Maximum Freewheel Teeth		
				Drop-out EF 1=24	Drop-out UF, SF 1=26	Drop-out SFR 1=28	Drop-out EF 1=24	Drop-out UF, SF L=26	Drop-out SFR L=28
SS	56mm	1 2T	28T	26T6	28T C	NR	26TB	28Tc	NR
GX	85mm	20T	40T	26T1	30T1	32TK	26TD	30TD, F	32T-D,F,K

A For 261 freewheels, add D/T attachment with 2mm nd facing forward.

B For 24T freewheels, add D/T attachment with 2mm end facing forward.
For 26T freewheels, add D/T attachment with 4mm end facing forward.

C For 26T freewheels, add Da attachment with 2mm end facing forward.
For 28T freewheels, add D/T attachment with 4mm end facing forward.

D Smallest three cogs must he 13, 15 and 17T.

E largest cog must be 28T.

F Largest cog must he 28, 30, or 321.

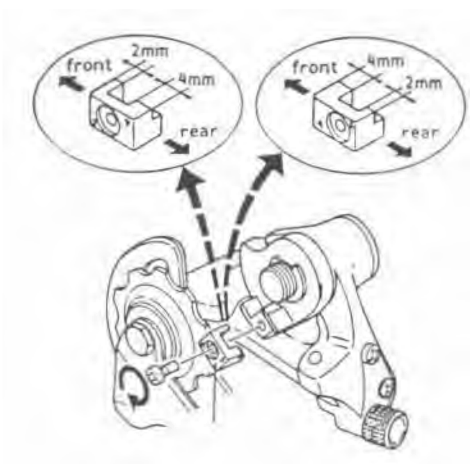
G Largest cog must he 24 or 26T.

H For 32T freewheels, add D/T attachment with 4mm end facing forward.

I For 26T freewheels, add D/T attachment with 4mm end facing forward.

J For 28T freewheels, add D/T attachment with 2mm end facing forward.
For 301 freewheels, add D/T attachment with 4mm end facing forward.

K For 301 freewheels, add D/T attachment with 2mm end facing forward.
For 321 freewheels, add D/T attachment with 4mm end facing forward.



D/T Attachment

SUNTOUR NON-ACCUSHIFT INDEXING REAR DERAILLEURS

Model	Model No.	Maximum Chainring Difference	Total Capacity	Maximum Freewheel Teeth L=26
• Mighty Click*	RD-2700	13T	22T	30T
• Mighty Click-GT*	RD-2800	13T	34T	34T

This model uses early indexing system; required Mighty Click levers.

NON-INDEXING
REAR DERAILLEURS

SunTour Non-Indexing Rear Derailleurs

Model	Model No.	Max. Chainring Diff./Total Capacity/Max. Freewheel			
		Drop-out L=24mm	Drop-out L=26mm	Drop-out L=28mm	Drop-out L=30mm
• Sprint	RD-7000				
• SVX-GT	RD-7400			14T/ 32T/ 32T	
• SVX-SS	RD-7300			12T/ 26T/ 28T	
• AT-1000	RD-AT10-GX			20T/ 40T/ 32T	
• RT-1 000	RD-RT1 0-SS			14T/ 28T/ 28T	
• Seven-GT	RD-SNOO-GT	*/34T/281		*1341/ 301	
• Seven-SS	RD-SNOO-SS			*/30T/ 28T	
• Honor-GT	RD-H000-GT		*/ 32T/ 34T		
• Honor-SS	RD-1100		11T/ 28T/ 30T		

SunTour Non-Indexing Rear Derailleurs

— Older Models (pre-1987) alphabetically

Model	Model No.	Max. Chainring Diff./Total Capacity/Max. Freewheel			
		Drop-out L=24mm	Drop-out L=26mm	Drop-out L=28mm	Drop-out L=30mm
• Allegro	RD-AE00	11T/ 28T/ 26T	1 1T/ 28T/ 281		
	R D-A E 00-G X	19T/ 39T/ 28T	19T/ 39T/ 30T	19T/ 39T/ 32T	
• AG Tech	RD-5000		10T/ 34T/ 37T		
• AG Tech-GTL (extra long cage)	RD-5600		19T/ 40T/ 37T		
• AR	RD-4200		15T/ 28T/ 26T		
• AR-GT (long cage)	RD-4400		13T/ 34T/ 34T		
• ARX	RD-4300		14T/ 28T/ 26T		
• ARX (long cage)	RD-4500		13T/ 32T/ 32T		
• BL (short cage)	RD-3200		1 3T/ 24T/ 24T		
• BL-S (medium cage!)	RD-3600		1 7T/ 30T/ 26T		
• BL-GT (long cage)	RD-3300		1 3T/ 34T/ 34T		

(continued)

* Maximum Chainring Difference is not listed in SunTour literature.

NON-INDEXING
REAR DERAILLEURS

SunTour Non-Indexing Rear Derailleurs (cont'd)

— Older Models (pre 1987) alphabetically (cont'd)

Model	Model No.	Max. Chainring Diff./Total Capacity/Max. Freewheel			
		Drop-out L = 24mm	**Drop-out L = 26mm**	**Drop-out L = 28mm**	**Drop-out L = 30mm**
• Cyclone	RD-6000		13T/ 24T/ 25T		14T/ 28T/ 26T
	RD-6200		13T/ 24T/ 25T		14T/ 30T/ 28T
	RD-6800		13T/ 24T/ 25T		17T/ 34T/ 30T
	RD-1 700		13T/ 24T/ 251		
• Cyclone GT	RD-1800		17T/ 32T/ 34T		
• Cyclone Mark II	RD-3500		14T/ 28T/ 26T		
• Cyclone Mark II-GT (long cage)	RD-3700		12T/ 34T/ 34T		
• GT	RD-1200		15T/ 36T/ 34T		
• LePree-S	RD-6100				14T/ 30T/ 28T
• LePree-GT	RD-6700				17T/ 34T/ 30T
• MounTech	RD-4900		13T/ 34T/ 34T		
• MounTech-GTL	RD-5500		19T/ 40T/ 34T		
• Seven	RD-1900		13T/ 26T/ 26T		
• Seven-GT	RD-2000		11T/ 32T/ 34T		
• Skitter*	RD-1000		12T/ 28T/ 301		
• Superbe Pro	RD-3100		10T/ 20T/ 23T		
	RD-5200		11T/ 251/ 261		
• Superbe	RD-2100		10T/ 20T/ 23T		
	RD-5300		1IT/ 22T/ 23T		
• Superbe Tech-S (short cage)	RD-4700		15T/ 28T/ 26T		
• Superbe Tech-L (long cage)	RD-4800		13T/ 34T/ 34T		
• Superbe Tech-GTL (extra long cage)	RD-5400		191/40T/ 34T		
• Trimec	RD-4600				1 3T/ 28T/ 28T
• Trimec	RD-6400				1 7T/ 30T/ 26T
• XC	RD-6300				17T/ 38T/ 34T
• VX	RD-2200		11T/ 24T/ 26T		
• VX-GT	RD-2400		13T7 34T/ 34T		
• VX-S	RD-2500		15T/ 28T/ 26T		
• VGT	RD-1500		18T/ 34T/ 30T		
• Volante (short cage)	RD-2600		10T/ 21T/ 24T		
• Volante-S (long cage!)	RD-4100		15T/ 30T/ 28T		

* Low normal derailleur—cable pull shifts to smaller freewheel cog.

FRONT DERAILLEURS

SUNTOUR INDEXING FRONT DERAILLEURS

(See notes, "About the Derailleur Capacity Charts," on page 8-3.)

Half-Step

Refers to a gearing setup with chainrings that are close enough in tooth number to make a front shift that is roughly half that of a rear shift (% increase or decrease in gear inches). In common setups, this is a chainring difference of 4 or 5 teeth. This setup requires a front derailleur whose inner and outer cages are close in height (matching the closeness of the diameters of the chainrings).

Alpine (sometimes called "Crossover")

Refers to a gearing setup featuring chainrings that are typically 10 to 12 teeth apart. This makes for distinct ranges of gears (one for each chainring), as opposed to the evenly dispersed front and rear shifts found with a **"Half-Step"** setup. **"Alpine"** derailleurs have inside and outside plates that differ considerably in height, thus allowing the chain to be guided over the large shifts between chainrings.

SunTour Accushift Indexing Front Derailleurs

Other models are also used with indexing shifters. XCE 4051 and Scrambler require matching model shifters.

Model	Model No.	Half-Step/ Alpine	Capacity min. 1	Max. 2	Clamp Diameter
• XCE 4051 *	FD-XE46-GX	alpine		24T	28.6
• Scrambler*	FD-4200	half-step		22T	28.6

SunTour Non-Accushift Indexing Front Derailleurst

Model	Model No.	Half-Step/ Alpine	Capacity Min. 1	Max.2	Clamp Diameter
• Mighty Click 10*	FD-1800	half-step		18T	28.6
• Trimec	FD-3600	alpine		24T	28.6

SunTour "Top-Pull" Front Derailleur"

Model	Model No.	Half-Step/ Alpine	Capacity Min.1	Max. 2	Clamp Diameter
• Top Pull	FD-TPOO-GX	alpine	6T	24T	28.6, 31.8

* Requires matching model indexing shift lever.

**** "Top normal"** derailleur (cable pull produces shift to smaller chainring).

Early indexing systems; required matching shift levers.

tt Cable is routed down to derailleur from above—requires appropriate braze-ons on frame.

1 When inner chainring is oval, add 21'; when outer chainring is oval, subtract 2T..

2 Subtract 4T when both chainrings are oval; subtract 2T when one chainring is oval.

FRONT DERAILLEURS

SunTour Front Derailleurs

— Lightweight Models

Model	Model No.	Half-Step/ Alpine	Chainring Difference Min.[1]	Max.[2]	Clamp Diameter or Braze-On (B/O)
• Superbe Pro	FD-SBOO-SS	half-step	2T	16T	28.6, 28.0, 31.8, B/O
• Sprint 9000	FD-3900-SS	half-step	2T	18T	28.6
• Sprint	FD-SPOO-SSB	half-step	2T	18T	28.6
• Cyclone 7000	FD-CL10-SS	half-step	2T	18T	28.6, B/O
• GPX	FD-GPOO-SS	half-step	2T	16T	28.6, B/O
• Ole	FD-OLOO-SS	half-step	2T	18T	28.6, B/O
• Radius	FD-RA00-SS	half-step	2T	16T	28.6, 31.8, B/0
• a-5000	FD-5000-SS	half-step	2T	18T	28.6, B/O
	FD-5000-GT	alpine	6T	22T	28.6
	FD-5000-GX	alpine	6T	24T	28.6
• Edge	FD-EDOO-SS	half-step	2T	18T	28.6, 31.8
• Edge 4050	FD-ED45-SS	half-step	2T	18T	28.6, B/O
• a-4050	FD-4050-SS	half-step	2T	18T	28.6, B/O
• Blaze	FD-BE00-SS	half-step	2T	18T	28.6, 31.8
• Blaze 3040	FD-BE34-SS	half-step	2T	18T	28.6
• a-3040	FD-3040-SS	alpine	6T	24T	28.6, B/O
• a-3000	FD-3000-SS	half-step	2T	18T	28.6
• SVX	FD-4300	half-step	2T	18T	28.6
• VX	FD-VX00-SS	half-step	2T	18T	28.6, 31.8
• AC-2000	FD-A200-SS	half-step	2T	18T	28.6
• a-2000	FD-2000-SS	half-step	2T	18T	28.6
• a-1500	FD-1500-55	half-step	2T	18T	28.6
• AC-1000	FD-RT10-SS	half-step	2T	18T	28.6, 31.8
	FD-AT10-GX	alpine	6T	24T	28.6
• RT-1000	FD-RT10-SS	half-step	2T	18T	28.6
• Allegro	FD-AE00	half-step	2T	16T	28.6
• Seven	FD-SNO0	half-step	2T	18T	28.6
• Spirt	FD-1000	half-step	2T	18T	28.6

1 When inner chainring is oval, add 2T; when outer chainring is oval, subtract 2T.

2 Subtract 4T when both chainrings are oval; subtract 21 when one chainring is oval.

SunTour Front Derailleurs (cont'd)

– All-Terrain Models

Model	Model No.	Half-Step/ Alpine	Chainring Difference Min.1	Max. 2	Clamp Diameter or Braze-On (B/O)
• XC Pro	FD-XPOO-GX	alpme	6T	24T	28.6, 31.8, 35.0
• XC Comp	FD-XC10-GX	alpine	6T	24T	28.6, 31.8, 35.0
• XC Sport	FD-XS01-GX	alpine	6T	241	28.6
• XC 9000	FD-XCOO-GX	alpine	6T	24T	28.6, 28.0
• XC Sport 7000	FD-XSOO-GT	alpine	6T	22T	28.6
	FD-XSOO-GX	alpine	6T	22T	28.6
• XCD	FD-XD1O-GX	alpine	6T	24T	28.6, 31.8, 35.0
• XCD 6000	FD-XDOO-GX	alpine	61	24T	28.6, 31.8, B/0
	FD-XSOO-GX	alpine	6T	24T	28.6, 31.8, 8/0
• XC 6000	FD-XSOO-GT	alpine	4T	22T	28.6, 31.8, 8/0
• a-5000	FD-5000-GT	alpine	41	22T	28.6
	FD-5000-GX	alpine	6T	24T	28.6
• XC-Expert	FD-XX00-GX	alpine	6T	24T	28.6, 31.8, 34.9
• XC-LTD	FD-XL00	alpine	6T	24T	28.6
• XCD 4050	FD-4050-GX	alpine	6T	24T	28.6, 31.8, B/0
• XCE 4050	FD-XE45-GX	alpine	6T	24T	28.6
• XCE 4051	FD-XE46-GX	alpine	6T	24T	28.6
• a-3040	FD-3040-GX	alpine	6T	24T	28.6
	FD-3000-GX	alpine	6T	24T	28.6
• XCM 3040	FD-XM34-GX	alpine	6T	24T	28.6
• X-1	FD-X100-GX	alpine	6T	24T	28.6, 31.8, 35.0
• X-1 Chroma	FD-CROO-GX	alpine	6T	24T	28.6, 31.8, 35.0
• FS-E	FD-FE00	alpine		24T	
• XCE	FD-XE00-GX	alpine	6T	24T	28.6, 31.8, 35.0
• a-3000	FD-3000-GT	alpine	6T	22T	28.6
• XCM	FD-XMOO-GX	alpine	6T	24T	28.6, 31.8
• XCT	FD-XTOO-GX	alpine	6T	24T	28.6, 31.8
• XR100	FD-XR00-GX	alpine	6T	24T	28.6
• XCU	FD-XTOO-GX	alpine	6T	24T	28.6
• a-2000	FD-2000-GX	alpine	6T	24T	28.6
• AC-2000	FD-A200-GX	alpine	6T	24T	28.6
• a-1500	FD-1500-GX	alpine	6T	24T	28.6
• AT 1000	FD-AT10-GX	alpine	6T	24T	28.6
• AC 1000	FD-AT00-GX	alpine	4T	22T	28.6
• Scrambler	FD-4200	half-step	2T	22T	28.6
• Honor	FD-HNO0	alpine	4T	24T	

1 When inner chainring is oval, add 2T; when outer chainring is oval, subtract 2T.

2 Subtract 41' when both chainrings are oval; subtract 2T when one chainring is oval.

FRONT DERAILLEURS

SunTour Front Derailleurs (contd)

— **Older Models (pre-1987)**

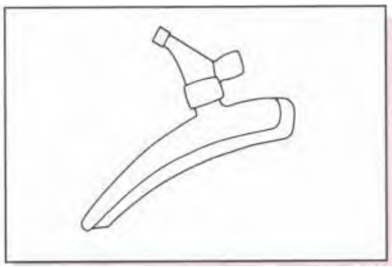
Model	Model No.	Half-Step/ Alpine	Chainring Capacity Min)	Max. [2]	Clamp Diameter
• Superbe Pro	FD-2000	half-step		14T	28.6
• Superbe	FD-3000	half-step	2T	1 **8T**	28.6
• Superbe	FD-1500	half-step	2T	1 **8T**	28.6
• AG Tech	FD-2800	alpine	6T	26T	28.6
• AR	FD-2500	half-step	2T	1 8T	28.6
• ARX	FD-2600	half-step	2T	1 8T	28.6
• **BL**	FD-1900	half-step	2T	18T	28.6
• Compe-V*	FD-1100	half-step	2T	18T	28.6
• Cyclone	FD-1300	half-step	2T	1 8T	28.6, 28.0
• Cyclone Mark-II	FD-2300	half-step	2T	1 8T	28.6
	FD-2400	half-step	2T	1 8T	28.6
• Le Pree	FD-3400	half-step	2T	1 8T	28.6
• MounTech	FD-2700	alpine	6T	26T	28.6
• NSL*	FD-1 700	half-step	2T	**16T**	28.6
• Seven	FD-1400	half-step	2T	18T	28.6
• Trimec	FD-2900	half-step	2T	18T	28.6
• VX	FD-1600	half-step	2T	18T	28.6
• XC	FD-3500	alpine	6T	22T	28.6

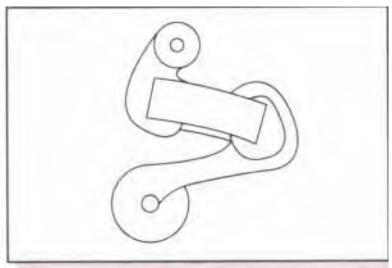
* Top normal derailleur-cable pull shifts to smaller chainring.

1 When inner chainring is oval, add 21; when outer chainring is oval, subtract 2T.

2 Subtract 4T when both chain rings are oval; subtract 2T when one chainring is oval.

DERAILLEURS/ SHIFTERS Grip Shift, Mavic, Simplex





INDEXING DERAILLEURS

Grip Shift Rear Derailleur Compatibility*

		Grip Shift Model No.		
Make	**Model**	**6-speed**	**7-speed**	**8-speed**
Campagnolo	Chorus "A"	R310		
Pre-'92	Athena	R330		
Sachs-Huret	New Success	R510	R515	
Pre-'92	Rival	R520	R525	
Shimano	**Dura-Ace**	R110	R115	R118
Pre-'92	Other SIS Models	R120	R125	
SunTour Pre-'92	Superbe Pro Sprint 9000, Edge 4050, '90 Edge, Blaze, X-1, Chroma, XC 9010, XC 9000, XCD 6000, XCE, XCM, GPX, SL, Radius, '91 Edge, Cyclone 7000 (6-spd. only), XC Pro, XC Comp, XCD	R210 R210	R215, CX-DT 215 R215 R225 R225 R225, SRT 300	
Shimano	**5-, 6-speed**	SRT 200i Quickshift		
	8-speed XTR, Deore XT, Deore LX		SRT 300 Pre-'93	SRT 800, SRT 600, SRT 500R
	Mountain LX, Exage		SRT 300 Pre-'93	
	100/200 GS/CX		SRT 300 Pre-'93	
	DEORE XT, Deore LX		SRT 600	
	7-speed STX, Alivio, Acera-X, Altus		SRT 500R SRT 400 SRT 300i MRX 100	
	STX, Alivio, Acera-X, Altus		SRT 200i Quickshift	
	Ultegra			CX-DT 128
	105, RX-100		CX-DT 125	CX-DT 128

* All specifications presume freewheels or cranksets specified by derailleur manufacturer for each model.

INDEXING DERAILLEURS

Grip Shift Front Derailleur Compatibility*

Make	Model	Double/Triple i Chainrings	Grip Shift Model No.
Campagnolo Pre-'92	Chorus, Athena, Croce D'Aune	Double	F310, F330
Sachs-Huret Pre-'92	New Success Rival	Double Double	F510, F515 F520, F525
Shimano Pre-'92	Pre '93 Dura-Ace Pre '93 Other Models	Double Double	F110, F115, F118 F120, F125
		Triple	Fl 201, Fl 25T
	XTR	Triple	SRT 500, 600, 800
	8-speed Deore XT, Deore LX	Triple Triple	SRT 3001, 400, 500, 600, 800
	STX, Alivio, Acera-X, Altus	Triple Triple	SRT 300i, 400, 600, MRX **100**
	5-, 6-speed	Triple	SRT 200i, Quickshift
	7-, 8-speed, Ultegra, 105, RX-100	Double	CX-DT 118
	RX-100, RSX	Double	CX-DT 118
SunTour Pre-'92	Superbe Pro Sprint 9000 GPX Cyclone 7000 XC Pro XC Comp XCD	Double	F210, F215, CX-DT 215
		Triple	F210T, F215T

.* All specifications presume freewheels or cranksets specified by derailleur manufacturer for each model.

INDEXING DERAILLEURS

Grip Shift Model Identification

Model Name	Fits Handlebar Diameter	Direction of Rotation for Cable-pull* Front	Rear	Distinguishing Features
Cat-1 [1]	23.9 - 24.4 mm	Counter-clockwise	Clockwise	Knurled plastic, dosed on one end
DB [2]	(Supplied)	Counter-clockwise	Clockwise	Knurled plastic, closed on one end
CX	22.2 - 22.6 mm	Clockwise	Counter-clockwise	Knurled plastic, open on both ends
Pro-Cat'	23.9 - 24.4 mm	Counter-clockwise	Clockwise	Foam grip, closed on one end
Pro-CX	.*22.2* - 22.6 mm [3] or 23.9 - 24.4 mm [3]	Counter-clockwise	Clockwise	Foam grip, open on both ends
Pro-CX	22.2 - 22.6 mm [4]	Counter-clockwise	Clockwise	Foam grip, open on both ends
CX -DT	22.2 - 22.6 mm [5]	Clockwise	Counter-clockwise	Krayton rubber grip, for road bars
SRT [6]	22.2 mm	Clockwise	Counter-clockwise	Krayton rubber grip, for ATB bars
800		72°		24 speeds
600		72'		24/21 speeds
400		72°		21 speeds
MRX/100		143°		21 speeds
Quickshift				18/15 speeds
300		143°		21 speeds
200				18/15 speeds

* As viewed from the end of the handlebar.
1 Requires drilling handlebars.
2 Same as Cat-1, except supplied with pre-drilled handlebar.
3 Intended for use with aero bars; comes with a removable shim to accommodate both sizes.
4 Intended for use with mountain bars; the damp is designed to provide extra clearance for brake lever clamps.
$ Comes with collars to fit larger size bars.
6 All are index or friction.

Model number location

Pro series
model number location

GRIP SHIFT PARTS COMPATIBILITY CHART

	100/150	200/300	200i/300i	400	500/500R	600	800
1. Springs				600-401	500-509	600-401	600-401
index rear	500-318	500-318	500-318		600-505		
index front	500-319	500-319			(metal upgrade		
friction front	500-255	500-255			spring)		
2. Retention/cable cover							
front			500-364		500-505	500-6Q7	500-607
rear			500-363		500-505	500-505	500-50
3. Set screw	600-304-1	600-304-1	600-304-1				YT
4. Clamp bolt				600-502	600-502	600-502	600-502
S. Clamping collar-front				600-601		600-601	600-601
6. Clamping collar-rear	600-210	600-210	600-211	600-501	600-501	600-501	600-501
7. Nylon washer	500-308	500-308				600-201	
8. Retention screw	600-302	600-302					
9. Retention & cable cover-front			500-364	500-407			
10. Retention & cable cover-rear			500-363	500-406			
11. Barrel adjuster	600-308	600-308	500-506	500-506	600-506	500-506	500-506
12. Cover screw					600-503	600-503	600-503
13. Rubber seal					500-508	500-508	500-508
14. Noodle-front						500-609	500-609
15. Noodle-rear					500-507	500-507	500-507
16. Fr. housing (no barrel adjust)	500-252	500-252					
17. R. housing (no barrel adjust)	500-251	500-251					
18. Front housing	500-2511	500-302	500-362	500-4021	500-502	500-602	500-802
19. Rear housing	500-301		500-361	500-401	500-5011	500-601	500-8011
20. Friction front grip	500-256	500-5266	500-3663	500-405	500-5122	500-605	500-805
21. Dual SIS front grip	500-323	500-323	500-3654	500-404	500-513	500-604-1	
22. Dual SIS front grip 8-spd					500-517	500-604	500-804-2
23. Shimano 5-spd front grip	500-303-8	500-303-8	500-303-8				
24. Shimano 6-spd rear grip	500-303-7	500-303-7	500-303-7				
25. Shimano 7-spd rear grip		500-303-1	500-303-115	**500-403**	**500-503-5-R**	**500-603-12**	
26. Shimano 8-spd rear grip					500-503-3-R	500-603	500-803-2
27. Monster Paw							500-810
28. Mini Paw							500-610
29. Mud Paw							500-521
30. Ribbed grip cover				500-410			

Replacement 1.1 cable for 800 SRT (standard was 1.2 cable), some teflon cables do work/Grip Shift is changing cable groove on grip.

GRIPSHIFT PARTS COMPATABILITY CHART (CONT'D)

CX-DT, PRO-CX, PRO-CAT

Slid Stud	**600-010**
Thrust Washer	**600-017**
Crash Shield	**500-231**
Cleat	**500-232**
Back Screw	**600-205**
.875 Clamping Collar	**600-201**
.940 Clamping Collar	**600-200**
Set Screw	
(9.4mm for .94 clamping collar)	**600-012-2**
(11mm for .875 clamping collar)	**600-012-3**
Down Tube Adjuster Bracket	**600-004**
Adjuster Barrel	**600-005**
Adjuster Barrel Spring	**600-006**
Button Head Screw	**600-003**
Mandrel	**500-202**
Dura Ace 7/8-spd Grip	**118RG07**
Ultegra/105 8-spd Rear Grip	**128RG0**
Shimano 7-spd Grip(not DA)	**125RG0**
Dura Ace Front Grip	**118FGO**
Ultegra/105 Front Grip	**128FG0**
Shimano Front Grip(not DA)	**125FG0**
Suntour 7-spd Rear Grip	**215RG0**
Suntour Front Grip(not DA)	**215FGO**

1 Housing assemblies include a clamping collar, clamping bolt and barrel adjuster.
2 Front and rear grips do not include grip covers.
3The 300i-11 front grip is interchangeable with 200i-1 1 front grip.
4The 300i-32 front grip is interchangeable with 2001-33 front grip.
5The SRT 300i-71 rear grip is interchangeable with a SRT 150-71 rear grip.
6 The SRT 150-11 front grip is interchangeable with SRT 100-11 front grip.
7CX-DT single shifter assemblies include a complete shifter with a cable and down tube barrel adjuster hardware.

INDEXING REAR DERAILLEURS

MAVIC INDEXING

Design Elements

- One set of levers (821) is used to index both 6- and 7-speeds. The cable routing through the derailleur is adjustable for narrow- or regular-spaced freewheels.
- The derailleur guide pulley is a non-floating design and overshift is built into the lever.

Chain Recommendations

Use Sedis ATB, MC-90, MC-55, or MC-50 chain or other high quality bush i ngless chain, *(see Sedis chain notes on page 6-8 in the Sachs-Huret section when using Sedis chains.)*

Freewheel Recommendations

Mavic found that Shimano or Aris freewheels work best. Do not use Sun 1 our CS-PF12 and CS-PF22.

MAVIC INDEXING LEVER (821 ROAD)

On the derailleur between the cable anchor bolt and the cable adjusting barrel is a small arm with a hole in it. Route the cable through the hole for regular-spaced freewheels. Route the cable behind the arm for narrow spacing.

Mavic Indexing Rear Derailleurs

Model	Total Capacity	Max. Freewheel Teeth
840 (short cage)	301	28T
841 (longcage)	32T	30T
845 (ATB)	**44T**	32T

MAVIC ZAP ELECTRONIC INDEXING DERAILLEUR

Installation

Fhe 5mm alien hole in the mounting bolt is in the opposite end of the bolt from the usual position. Remove the wheel and insert the alien key on the inboard side of the hanger. The indexing adjusting knob is where the mounting bolt head usually is. When installing or removing the derailleur, loosen the indexing adjusting knob a few turns until the pin that is visible through the mounting bolt allen hole is either flush with bottom of the hole (for installation) or deeper (for removal). This insures proper engagement of wrench and bolt so that neither gets stripped.

Adjusting for 7- and 8-speeds

To adjust the derailleur from a 7-speed to an 8-speed (or vice versa), take off the derailleur body cover by removing the two recessed screws facing outward from the bike (do not remove the two non-recessed screws facing downwards) and slide the gray body cover off. Rotate the upper pulley

MAVIC ZAP ELECTRONIC INDEXING DERAILLEUR (CONT'D)

Adjusting for 7- and 8-speeds (contd)

of the derailleur so the flathead screw on the arm is easily accessible. To adjust from 7 to 8 speeds, turn the flathead screw 1/8 turn clockwise. To adjust from 8 speeds to 7, turn the flathead screw 1/8 turn counter-clockwise. Replace the plastic gray cover and adjust the derailleur.

Adjusting the Indexing

Mount the wheel. Extend the derailleur completely by pulling on the jockey wheel. Use the indexing adjusting knob to align the jockey wheel beneath the largest cassette cog.

Shifting

The in and out position of the two Phillips head screws on the bottom of the derailleur body is critical. We don't recommend adjusting these screws. However, we learned the following by playing with them. If all the screws are tightened too far down, the sensory switch may indicate that the derailleur is between cogs and may shift multiple times. If the screws are marginally too tight, the derailleur may intermittently mis-shift, usually shifting two cogs at a time. If the screws are marginally too loose, the derailleur may keep shifting until it reaches the limits of its travel. if the screws are very loose or missing, the derailleur will not shift at all. Remember to reapply Locktite (blue 242) to the screws.

Other

The early version of the microprocessor unit was susceptible to moisture. With all versions of the ZAP system, try not to immerse the derailleur or microprocessor unit and make sure that the plug connection on the derailleur is attached firmly and is clean and dry.

Do not attempt to remove the round ("manhole") covers with the six holes in them. These house the solenoids and sensor switch and are not user serviceable. Removal of the covers or the upper pulley will void the manufacturer's warranty.

Mavic Non-Indexing Rear Derailleurs

Model	Total Capacity	Max. Freewheel Teeth
■ 801	36T	32T
■ 803	36T	32T
■ 851	361	321
• 853	36T	32T

NON-INDEXING DERAILLEURS

Mavic Front Derailleurs

Model	Half-Step/ Alpine*	Max. Chainwheel Difference	Clamp Diameter or Braze-On (B/O)
• 810	half-step	20T	28.0
• 811	half-step	20T	French Style B/0
• 812	half-step	20T	Italian Style B/0
• 813	alpine	26T	28.0
• 830	alpine	26T	28.0
• 831	alpine	26T	French Style B/0
• 832	alpine	26T	Italian Style B/0
• 860	half-step	20T	28.0
• 861	half-step	20T	French Style B/0
• 862	half-step	20T	Italian Style B/0
• 863	alpine	26T	28.0
• 870	alpine	26T	28.0
• 871	alpine	20T	French Style B/0
• 872	alpine	26T	Italian Style B/0
• 875	alpine	26T	28.0

(See page 7-10 for half-step/alpine definition.)

Simplex Front Derailleurs

Model	Model No.	Half-Step/ Alpine*	Capacity Min.	Max.	Clamp Diameter or Braze-On (B/0)
• SJA 103 MB		alpine		24T	28.0-28.6
• SJA 102		half-step		14T	28.0-28.6
• SJA 103		alpine		24T	28.0-28.6
• SJA *222*		half-step		14T	French-style 8/0
• SJA 223	10650	alpine		24T	French-style B/0
• SJA 302	10535	half-step		14T	28.0-28.6
• SJA 303	10594	alpine		24T	28.0-28.6
• SLJ A 422		half-step		14T	French-style B/0
• SLJ A 423	10710	alpine		24T	French-style B/0
• SLJ A 522	4983	half-step		14T	28.0-28.6
• SLJ A 523	4998	alpine		24T	28.0-28.6
• SLJ A 622	10785	half-step		14T	Italian-style B/0
• SX A 32	10500	half-step		14T	28.0-28.6, 25.4
• SX A 33	10510	alpine		24T	28.0-28.6, 25.4

* ***(See page 7-10 for half-step/alpine definition.)***

NON-INDEXING DERAILLEURS

Simplex Rear Derailleurs

Model	Model No.	Total Capacity	Max. Freewheel Teeth
• Alpha T/P	10074	30T	24T or 30T (adjusting screw)
• Criterium (with dimpled cage)		301	30T
• Criterium AR 637 NI		34T	34T
• 1000 T		30T	30T
• LJ 4000 CP/SP	5578	26T	26T
• Super 615		30T	30T
• Maxi (Prestige)		39T	36T
• Prestige 637 (see SX 100T)			
• Prestige AR 637 NI		34T	34T
• Prestige AR 637 P		34T	34T
• S 001 T/P	10039	30T	30T
• S 061 T/P		30T	30T
• SJ 810 GT/P		39T	36T
• SLJ 5500 CP/SP	5550	26T	26T
• SLJ 5500 GT/SP	5554	39T	36T
• SLJ 5500 T/SP	5551	30T	30T
• SLJ 6600 GT/SP	5552	39T	36T
• SLJ 6600 T/SP	5553	22T	24T
• SLJ A 5000 T		30T	30T
• SLJ A 5000GT		39T	36T
• SLJ AR 615 NI		36T	34T
• SO 1 T/P	10043	30T	30T
• SX 1 T/P		30T	24T or 30T (adjusting screw)
• SX 100 T 637-P		30T	30T
• SX 400 GT		40T	36T
• SX 410 GT/P		39T	36T
• SX 410 T/P		30T	30T
• SX 440 GT/SP	10165	40T	34T
• SX 440 T/SP	10125	30T	30T
• SX 610 GT/P		38T	36T
• SX 610 T/P		28T	28T
• SX 630 GT/SPMB		38T	34T
• SX 630 T/SP		28T	28T
• SX 640 GT/SP	10235	38T	32T
• SX 640 T/SP	10185	28T	28T
• SX 810 GT		39T	36T
• SX 810 T		30T	30T

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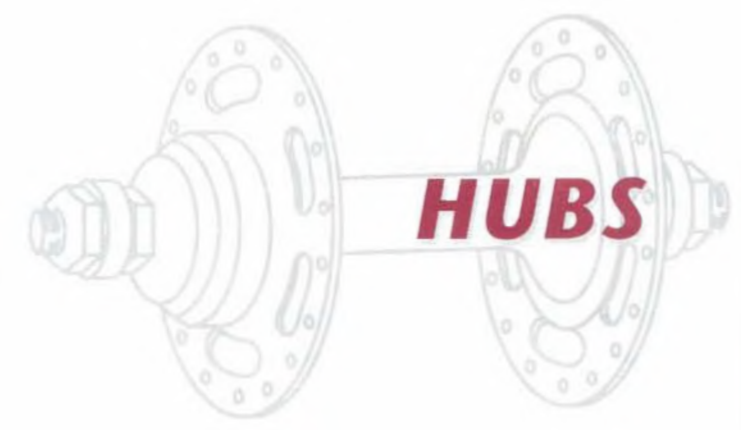
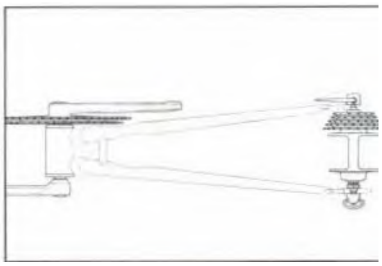
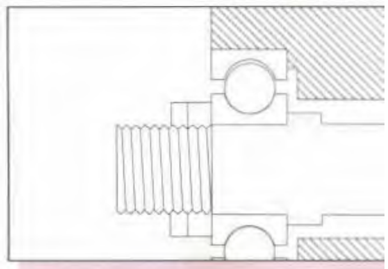






Hubs

SUTHERLAND'S

HUBS

FRONT HUBS

Ball Sizes

Most front hubs use 10 - 3/. " balls per side except the following:

ACS Pre-1983	9 - 5/64" balls per side
ACS 1983 - current	**9 -** 1/4" balls per side
Campagnolo	**9 -** 7/32" balls per side-Nuovo Record, Super Record, Record*
	10 - 3/16" balk per side-Grand Sport, Victory, Chorus, Croce D'Aune and others
Maillard Spidel	9 - 7/32" balls per side
Normandy Competition	(old style with shallow cut cone) 12 - 3/16" balls per side
Sunshine Pro-Am	11 - 3/16" balls per side
Superbe	11 - 3/16" balls per side
Zeus Gran Sport	**9 -** 7/32" balls per side

* Record marked S.U. on center of hub shell uses 9 - 7/32".
Record not marked S.U. on center of hub shell uses 10 - 3/16".

Right-hand hub cones tend to rotate and tighten toward the center, eventually cracking the hub shell. Tighten the right cone and locknut firmly against each other and make adjustments on the left side.

When installing Phillips or Raleigh hubs with fixed cones that fit against a shoulder on the axle, he sure that the fixed cone is on the right and the adjusting cone with flats is on the left.

On Schwinn front hubs without cone locknuts, be sure the cone lockwasher is on the **right** side.

USA Retainers

Retainer	No. of Balls Per Retainer	Diameter of Balls	Manufacturer
23	8	1/4"	Bendix Heavy Duty
42	10	1/4"	Bendix Trailer Hub
10	5	1/4"	Excel' Mark VII
5	7	3/16"	Excel Mark 60
10	5	1/4"	Monark Silver King
13	7	1/4"	Musselman
5	7	3/16"	New Departure
3201A	7		Schwinn
5 Skived	7	3/16"	Schwinn Union
5	7	3/16"	Schwinn Union
4962H	.		Union Heavy
[13	7	1/4"	Westfield

REAR HUBS – MULTI-SPEED FREEWHEEL

Ball Sizes

- 1/4" balk per side except the following:

ACS Pre-1983	9 - 15/64" balls per side
ACS 1983-current	9 - 1/4" balls per side
Maillard Helicomatic	13 - 5/32" balls per side
Schwinn Disc Brake	12 - 3/16" balls per side
Suntour Cassette Hubs	12 - 3/16" balls per side
Suntour XCD 1989	9 - 1/4" balls left side, 12 - 3/16" balk right side

HUBS

FRONT HUB AND AXLE DIMENSIONS

Note: 9.5mm is very close to 3/8". The same is true of 8mm and 5/16".

Front	Thread	Over Locknuts	Axle Length
ISO Solid	8mm x 1mm	100 ± 1 mm (primary) 91 ± 1mm (secondary)	
ISO Hollow (and BMX solid)	9mm x 1 mm	100 ± 1mm (primary) 91 ± 1 mm (secondary)	
English			
Solid	5/16" x 26 TPI	too many variations	
Dynohub	3/8" x 26 TPI*		
French Most common	5/16" x 26 TPI		
Solid - Rare	8mm x 1 mm (or 26 TPI)	96mm	132mm
Hollow	9mm x 1mm (or 26 TPI)	96mm	105mm
Italian			
Solid	8mm x 26 TPI	102mm	135mm
Hollow	9mm x 26 TPI	102mm	111mm
Japanese			
'82 SunTour MTB	10mm x 1mm	100mm	
Solid - Common road	5/16" x 26 TPI	89, 93mm	130mm
Common off-road	3/8" x 26 TPI*	96mm	133mm
Off-road SunTour/ Shanshin/Specialized	9mm x 1mm (JIS)	100mm	108mm
Hollow - Rare	9mm x 26 TPI	96mm	104mm
Common	9mm x 1mm (JIS)	100mm	108mm
Shimano, SunTour, Maillard**	9mm x 1mm	100mm	110mm
USA			
Solid - Economy types, Quality types	5/16" x 24TPI, 3/8" x 24TPI*	too many variations	
Campagnolo			
Solid - Nuovo Tipo	8mm x 26 TPI	100mm	132mm
Solid - Track	9mm x 26 TPI	100mm	139mm
Hollow	9mm x 26 TPI	100mm	108mm
**	9mm x 26 TPI	100mm	110mm
JOU YU (Joy Tech)			
Solid	8mm x 26 TPI	140mm	
Hollow	9mm x 26 TPI	110mm	
Ringle (unthreaded)	21.7mm axle		107.8mm
BMX–Solid		93, 96mm	
Mountain Bike		96, 100mm	

* flatted to 5/16"(8mm)

*** Wheels Manufacturing, Inc.*

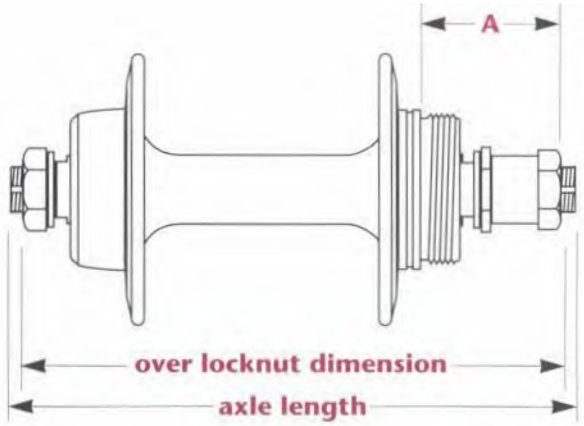
REAR HUB DIMENSIONS

National Tendencies

There are many exceptions, so measure if in doubt. Make up for differences by adding, removing, or relocating washers and spacers. if axle length won't allow the change, squeeze or spread the drop-outs. Align the drop-outs with the proper tool after altering the width. Never use the action of a quick release unit to squeeze the drop-outs together.

To Measure Dimension A

Hold a piece of square bar (a square-shank screwdriver for approximate measure) against the locknut and axle so that it's perpendicular to the axle, then measure the distance between the side the freewheel butts against and the bar.



Axle Spacers

Axle spacers arc available I rom a number of sources.

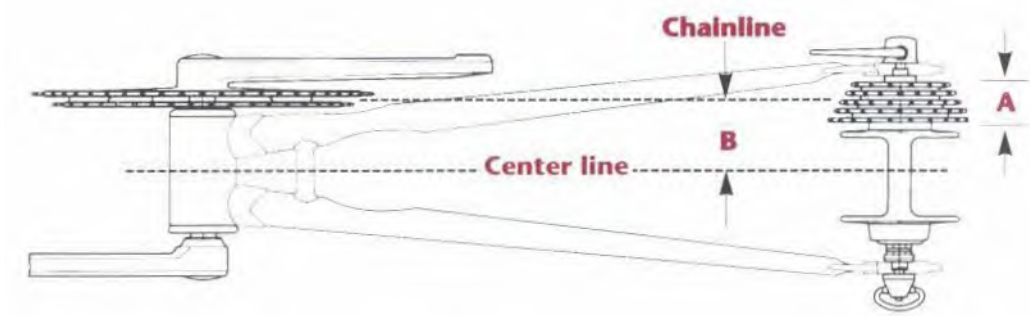
CHAINLINES

Front chainline refers to the distance from the bicycle centerline to chainring midpoint. Rear chainline is the bicycle centerline to sprocket midpoint. Front and rear chainlines rarely match in practice. Chainrings are frequently moved out to avoid having the chain rub on the outside chainring when the gears are in a small chainring and small sprocket combination. Also, sometimes the frame will he built with the right drop-out extending out further than the left.

To Measure Dimension B

Rear chainline is easily determined by measuring the distance from the drive side locknut to the sprocket midpoint and subtracting that dimension from haf the overlocknut dimension. This method will not work with offset rear triangles, but those are not common.

Front chainline is determined by measuring the distance from the seat tube to the chainring midpoint and adding the half the diameter of the seat tube. Generally, bikes with a single chainring have a 40 to 42.2mm front chainline. Bikes with double chain rings have a 43.5 to 45.5mm front chainline. Bikes with triple chain rings have 47 to 50mm front chainline.



HUBS

FREEWHEEL CLEARANCE

	Freewheel Width (Sprocket Face to Sprocket Face)	Minimum Dimension A
Regular Spacing		
5 speeds	25	29
6 speeds	31	35
Narrow Spacing		
6 speeds	*27*	31
7 speeds	32	36
8 speeds	36.5	40.5

Frames whose right stays have flattened ends must be used with Campagnolo and other similar hubs wit h a **minimum Dimension A.** This is so the chain clears easily and the wheel can be removed.

REAR HUB AND AXLE DIMENSIONS

Rear	Thread	Over Locknuts	Axle Length	Dimension A	Dimension B
ISO					
Solid	9mm x 1 mm				
Hollow	10mm x 1mm				
Single freewheel, Coaster brake		110mm		21mm	
3-, 4-speed freewheel, Hub gear		117mm		28mm	
4-, 5-speed freewheel		122mm		34mm	
5-, 7-speed freewheel		126mm		36mm	
ENGLISH—Solid	3/8" x 26 TPI	many variations			
FRENCH					
Solid - Rare	9.5mm x 1 mm	122mm	160mm	34mm	
Rare	(or 26 TPI)	124mm	162mm	36mm	
		126mm	165mm	36mm	
Common	3/8" x 26 TPI	**130mm**	168mm	36mm	
Hollow - Rare	9.5mm x 1mm	122mm	133mm	34mm	39.5mm
Rare	(or 26 TPI)	124mm	135mm	36mm	40mm
Common	10mm x 1mm	126mm	137mm	36mm	varies
Maillard 700	10mm x .75mm	130mm	140mm	36mm	varies
ITALIAN					
Solid	9.5mm x 26 TPI	122mm	155mm	34mm	
Hollow	9.5mm x 26 TPI	122mm	132mm	34mm	
		126mm*	136mm	36mm*	

* Before ISO standards were adopted, many were 125mm with 35mm freewheel space.

REAR HUB AND AXLE DIMENSIONS (CONT'D)

Rear	Thread	Over Locknuts	Axle Length	Dimension A	Dimension B
JAPANESE					
Coaster	3/8" x 26 TPI				
Solid - Common	3/8" x 26 TPI,	124mm*	169mm	36mm*	43.5mm
SunTour/Sanshin/	10rnmxlmm(JIS)	126mm	169mm	36mm	varies
Specialized		130mm	175mm	37mm	varies
Hollow - Rare	3/8" x 26 TPI,	120mm	128mm	31mm	42mm
Common	10mm x 1 mm (J15)	124mm	132mm	34mm	
		126mm*	136mm	36mm*t	43.5mm
		130mm	140mm	37mm	43.5-45mm
		135mm	145mm	varies	45-47.5mm
SA—Solid - Coaster/BMX	3/8" x 24TPI				
BMX		109mm		21mm	
		110mm			
MOUNTAIN BIKE		126mm		37mm	
		130mm		37mm	
		135mm		42mm	
CAMPAGNOLO					
Solid - Nuovo Tipo - Rare	9.5mm x 26 TPI	120mm	155mm	29mm	
Solid -Track	10mm x 26 TPI	110mm	149mm	21.5mm	40mm
		120mm	159mm	24mm	42.5mm
Hollow	10mm x 26 TPI	121 mm**	129,132mm	30mm"	43.5mm
		125mm	134mm	35mm	43.5mm
		126mm	136mm	36mm	43.5mm
		130mm	140mm	36,37mm	43.5-47.25mm
JOU YU (Joy Tech)					
Solid	9.5mm x 26 TPI				
Hollow	10mm x 26 TPI				
CRONOMETRO - cartridge axle	20.6mm x sealed				

* Before 150 standards were adopted, many were 125mm with 35mm freewheel space.

t These hubs may also come with a 31 or 33mm Dimension A to accommodate derailleurs (mostly higher priced) that will not sweep the 36mm.

" This hub is often listed as 120 over the locknuts with a 29mm Dimension A.

*** For use in EFC Manitou Fork only.

ABOUT CARTRIDGE BEARINGS

Cartridge bearings are used extensively in the bicycle industry and it would seem logical to just pop a standard bearing in a bicycle hub to get the advantage of its seal. Unfortunately, these bearings are designed to be mounted with more precision than can be achieved in a conventional huh. For long bearing Iife, the inner and outer bearing races must he aligned precisely and stay aligned. Flexing or bending under a load makes this impossible with the 8 to 10mm huh axles used on many standard hubs. Except in extremely muddy conditions, this misalignment results in bearing life even shorter than that of **unmaintained** cup and cone bearings.

Figure A shows a bearing mounted in a bicycle hub. Note that the load pushes down in the center of the raceways and there is a slight gap at the top, exaggerated for clarity in the drawing. [his gap is essential if the bearing is to function smoothly; it can be felt at the rim of a built-up wheel as a trace of side-play. Trying to eliminate this side-play by pushing one of the bearing raceways to the side will ruin the bearing quickly, ***(see figure B).*** Flexing and bending can be reduced by using a large diameter axle, ***(see Cartridge and Sealed bearings, on page 0-10).***

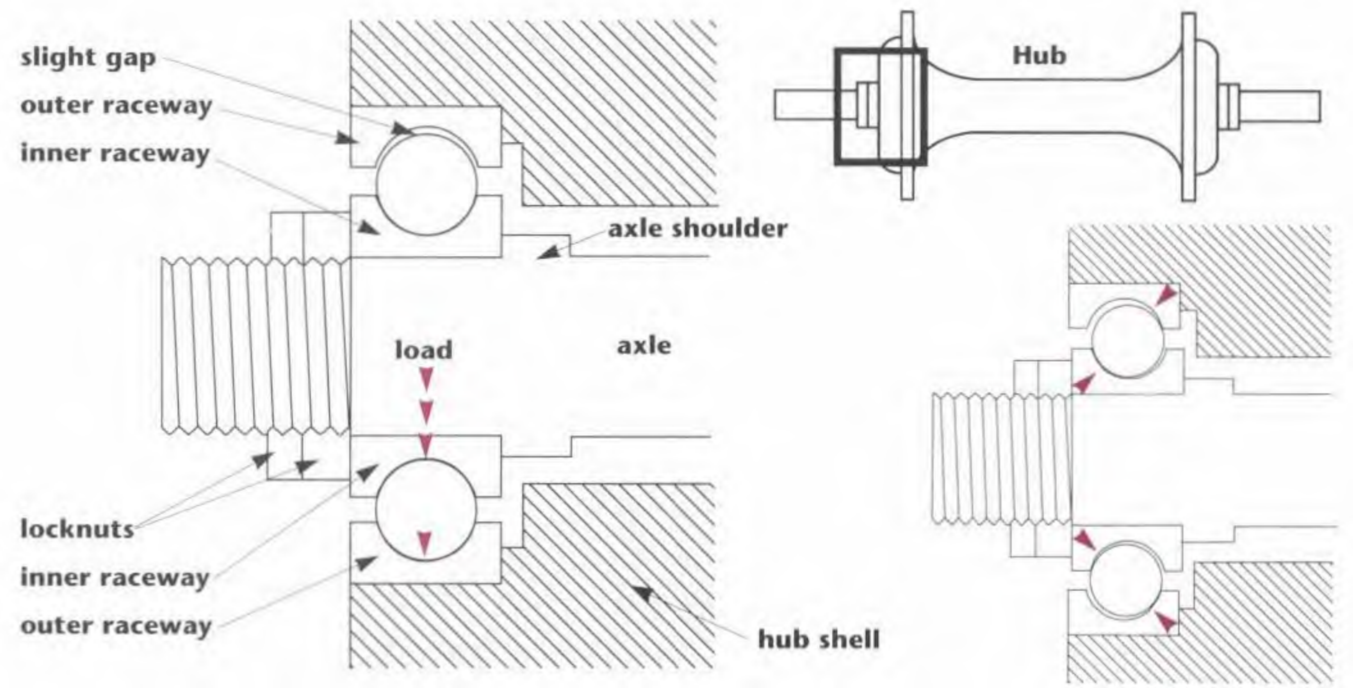


Figure A. **Properly Aligned Cartridge Bearing** Figure B. **Misaligned Cartridge Bearing**

To work effectively, the outer raceway must be pressed securely into the huh shell and the inner raceway must he held securely between shoulders on the axle and tightened locknuts. At the same time, the inner and outer raceways must be aligned so that the balls run in the center of the raceways. Always use an exact replacement axle since an axle with shoulders too far apart or too close together will accelerate hearing wear, ***(see figure B).*** All parts must be clean so that debris does not cause misalignment of the raceways.

ABOUT CARTRIDGE BEARINGS (CONTD)

Axles must be straight to keep the inner raceways properly aligned. A bent axle will cause rapid wear. Tightening a huh with a straight axle into fork ends that are not aligned, *(see page 0-10)*, will bend the axle enough to cause misalignment of the raceways.

Most cartridge hearings are marked with SKF numbers. All the bearings we measured were metric except Cook Bros., which were inch sizes and therefore not interchangeable with the others.

The markings usually consist of a brand name and a number followed by letters. Some common brand markings are NTN, WTW, NACHI, and KSK. The numbers indicate the standard size. The letters following the number indicate the type of seal used. Seals are not standard.

The following sizes are common:

Number	Inside Diameter	Outside Diameter	Number	Inside Diameter	Outside Diameter
6000	10mm	26mm	6200	10mm	30mm
6001	12mm	28mm	6201	12mm	32mm
6002	15mm	32mm	6202	15mm	35mm
6003	17mm	35mm	6203	17mm	40mm

SEALED CARTRIDGE BEARINGS COMPATIBILITY

Compiled by Wheels Manufacturing. Used with permission.

Bearing No.	Compatibility	ID	OD	Width
6901 2rs	White Industries rear cassette, front	12mm	24mm	6mm
6001 215	American Classic, Kingsbery, Avocet front, Bullseye, Machine Tech, Mavic, Phil Wood, most Ringle, Sansin, Specialized, SunTour, Vertical Dexcent, T-Gear, WTB	12mm	28mm	8mm
6000 2rs	Hugi, Pulstar rear, Ringle Freewheel (non-drive side), Sachs, Suzue front, GT front, Perrigrine front, Hope, Joy Tech front sealed, Performance, Sovos front sealed	10mm	26mm	8mm
6200 2rs	Suzue rear, Joy Tech rear sealed, Sunshine rear, GT rear, Minoura trainers, Perrigrine rear, Sovos rear sealed	10mm	30mm	9mm
99 2rs	Zipp, Hershey racing, Nuke Proof, SR sealed, Old GT, DK Products	9.5mm	22mm	7mm
6902 2rs	Dia Compe front, Sansin cassette rear, Sansin front, SunTour Microlite, Phil Wood rear and front suspension, White Industries freewheel	15mm	28mm	7mm
6903 2rs	TNT front suspension	17mm	30mm	7mm

CARTRIDGE-BEARING HUBS (EXCEPT PHIL*)- DISASSEMBLY AND ASSEMBLY

1 DISASSEMBLY

Be sure you want to replace the bearings, as removal will ruin good hearings. Note the arrangement of the locknuts and washers so they can be replaced in the same order. Note also whether the unthreaded portion of the axle extends past the cartridge. Remove the locknuts from both sides of the huh.

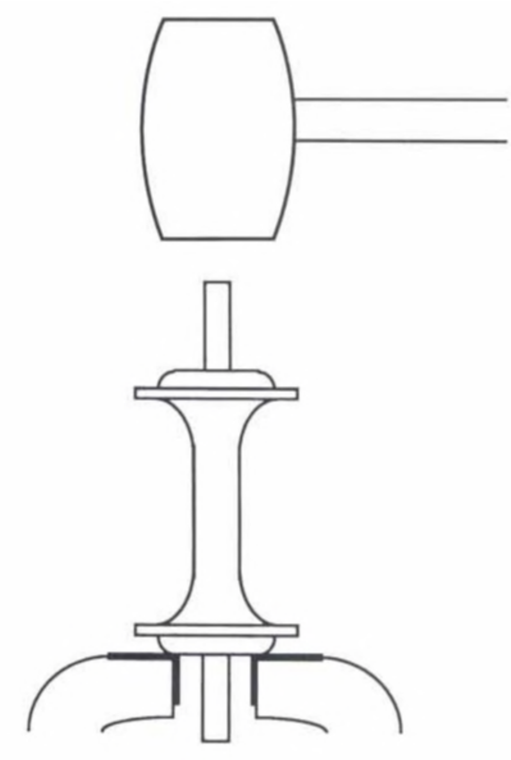


Figure C. Removing bearings from hubs with shoulders on the axle.

2 DISASSEMBLY

For hubs with shoulders on the axles
Using soft jaws, support the huh shell (hut not the hearing or axle) between the open jaws of a vice. ***(See figure*** C.) Thread an axle nut on the axle to protect the threads. Gently tap on the end of the axle with a rubber mallet until the cartridge on the opposite side comes loose, ***(as shown in figure C).***

For hubs without shoulders on the axles
Remove axle. Squeeze the ends of a SunTour hearing remover together and insert it through the hole in the inner raceway of the bearing. Insert an old axle in the other side of the hub. Gently tap on the end of the axle with a soft hammer until the cartridge on the opposite side comes loose.

3 DISASSEMBLY

Remove the loose cartridge bearing. Repeat to remove the remaining cartridge.

- For Phil hubs, replace the axle and hearings as a unit using the kit and instructions supplied by Phil Wood and Co.

CARTRIDGE-BEARING HUBS (EXCEPT PHIL*)-DISASSEMBLY AND ASSEMBLY (CONT'D)

1 ASSEMBLY

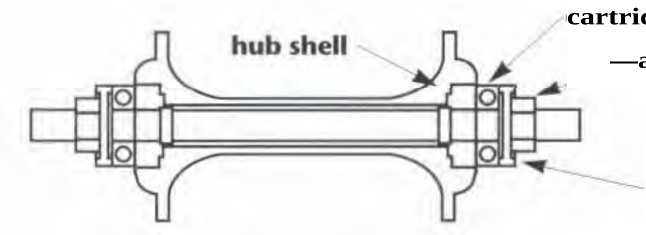


Figure D. Use of cartridge-bearing installation washers

Hammering on cartridge bearings will ruin them. Insert the axle in the hub. Place one cartridge on each side. Then place a dished cartridge-bearing installation washer on each end, ***(see figure D).*** Be sure to use a washer of proper size that contacts the outer race only. Applying force on the inner race will damage the bearing. If an unthreaded portion of the axle extends past the cartridge, additional washers or spacers may be necessary. If used, they should slip freely over the unthreaded portion of the axle. Hand-tighten axle nuts on each end of the axle and align the installation washers over the cartridges.

2 ASSEMBLY

Hold the assembly in a vise by one of the axle nuts. Tighten the other axle nut to squeeze the cartridges into place. Observe progress closely, making sure the cartridges go in straight.

3 ASSEMBLY

For hubs with shoulders on the axles
Loosen one axle nut and add an extra axle nut to it. Lock them together. Working against the two locked-together nuts, loosen the nut on the other end. Then unlock and remove the remaining two nuts. Remove the installation washers and replace the various locknuts and washers in their original order.

For hubs without shoulders on the axles
Loosen and remove the axle nuts. Remove the installation washers and replace the various locknuts and washers in their original order.

" For Phil hubs, replace the axle and bearings as a unit using the kit and instructions supplied by Phil Wood and Co.

HUBS

THREAD CHASER MARKINGS

Bicycle Research

Type	Size	Marking	Notes
TC-1	8mm x 26 TPI	small (1/2") hex, no groove	
TC-2	9.5mm x 26 TPI	large (9/16") hex, no groove	
TC-3	5/16" x 24 TPI	small (1/2") hex, 1 groove	Also fits X caliber skateboard trucks
TC-4	3/8" x 24 TPI	large (9/16") hex, 1 groove	
TC-5	5/16" x 26 TPI	small (1/2") hex, 2 grooves	
TC-6	7.5mm	small (1/2") hex, 3 grooves	Fits Chicago skateboard trucks
TC-7	3/8" x 26 TPI	large (9/16") hex, 2 grooves	Many BMX, some skates

Quick Release Skewers

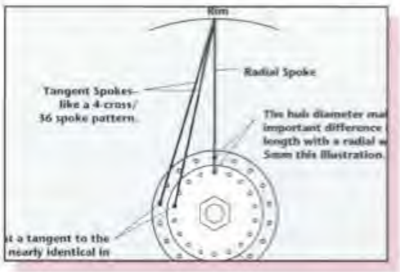
Model	OD		Pitch
Atom	5mm	x	0.90mm
Brev. **Stop**	5mm	x	0.80mm
Campagnolo	5mm	x	0.80mm
Gnutti	5mm	x	0.80mm
Milremo	5mm	x	0.90mm
Normandy	5mm	x	0.90mm
Pelissier	5mm	x	0.90mm
Schwinn Approved (made in France)	5mm	x	0.90mm
Shimano		x	0.80mm
Simplex Old Style*	5mm	x	0.75mm
Simplex New Style*	5mm	x	0.80mm
Suspension			
Front	9mm	x	25 TPI
Rear	10mm	x	25 TPI
Weyless	.25"	x	28 TPI
Zeus	5mm	x	0.80mm

* Simplex Old Style has plastic wing nut; Simplex New Style is all metal.

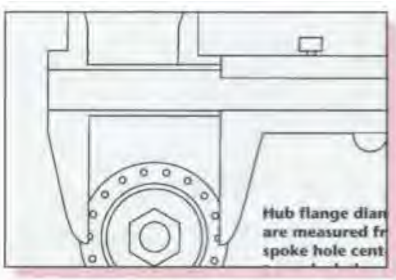
CONTENTS

11

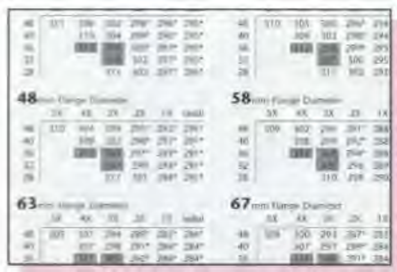
SPOKE LENGTHS



About Spoke Lengths



Calculating Spoke Length Step 1: Hub Flange



Calculating Spoke Length Step 2: Spoke Charts

Calculating Spoke Length Step 3: Rim Correction

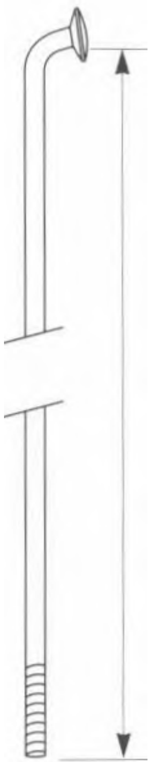
SPOKE LENGTHS

INDEX OF HUB MODELS

SPOKE LENGTHS

ABOUT THE SPOKE LENGTH CHARTS

Using the tables in this chapter will give you spoke lengths that are accurate to within + or - 1.5 mm. This is as accurate as is needed for most wheels. For wheels that are smaller than 20", many more factors come into play, and these tables will he less accurate and should only be considered as a starting point for sonic trial-and-error wheel building. When more accuracy is needed or when spoke lengths are needed that are not listed here, we recommend using the Spoke Master program that is part of Bike`alog or the Wheelsmith Spoke Calculator. We have listed rim and hub dimensions for the Wheelsmith and other computer programs in separate shaded columns. When using the Wheelsmith calculator or other programs, you will only need to use the tables in steps 1 and 3.



Spokes are measured from the inside of the bend to the end.

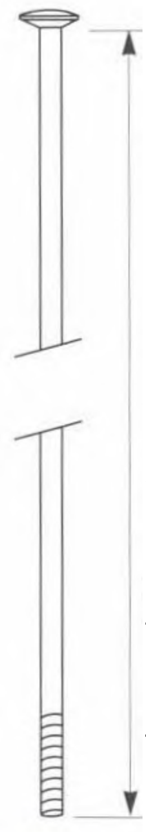
Spoke and Nipple Differences

Spoke lengths are calculated to come to the bottom of the slot of a Union, DT, or Wheelsmith spoke nipple. Measure the spokes you use; compare your measurement with the measurement printed on the box they came in. You may need to make your own adjustments to the final lengths to get more consistently accurate results.

Hub Spoke Holes and Spoke Diameter

Heavy gauge spokes combined with large hub spoke holes generally use the same lengths as normal size spokes. The effect of the larger hole is cancelled out by the larger nipple used. To use a regular gauge spoke in a larger hub hole will require a shorter spoke. The amount the spoke is shorter is usually small (less than 0.5mm) but can combine with other factors to result in a spoke that is too long.

Straight-pull spokes are used with hubs specifically designed for them. Instead of having spoke holes that are parallel to the axle like normal hubs, the spoke holes point towards the rim. The position of the spoke holes and the angle of the holes drilled into the hub to accommodate the spokes determines the lacing pattern for the wheel. Due to these factors, each straight-pull hub has only one lacing pattern that can be used.



Straight pull spokes are measured from the base of the head to the end.

LARGE FLANGE HUBS

When building wheels with large flange hubs, check the angle the nipple enters the rim. Breakage will occur if the spoke nipple is stressed at this point. Rims are sometimes dimpled to make up for this. Some nipples will work at a bigger angle from perpendicular than others. Try it in a spoke hole to see. Problems usually occur when using drum brakes or other extra large flange hubs and a 3- or 4-cross pattern. Other problems arise when combining a large flange hub with a 20- or 24-inch rim. The solution is to use a 2- or 1-cross pattern.

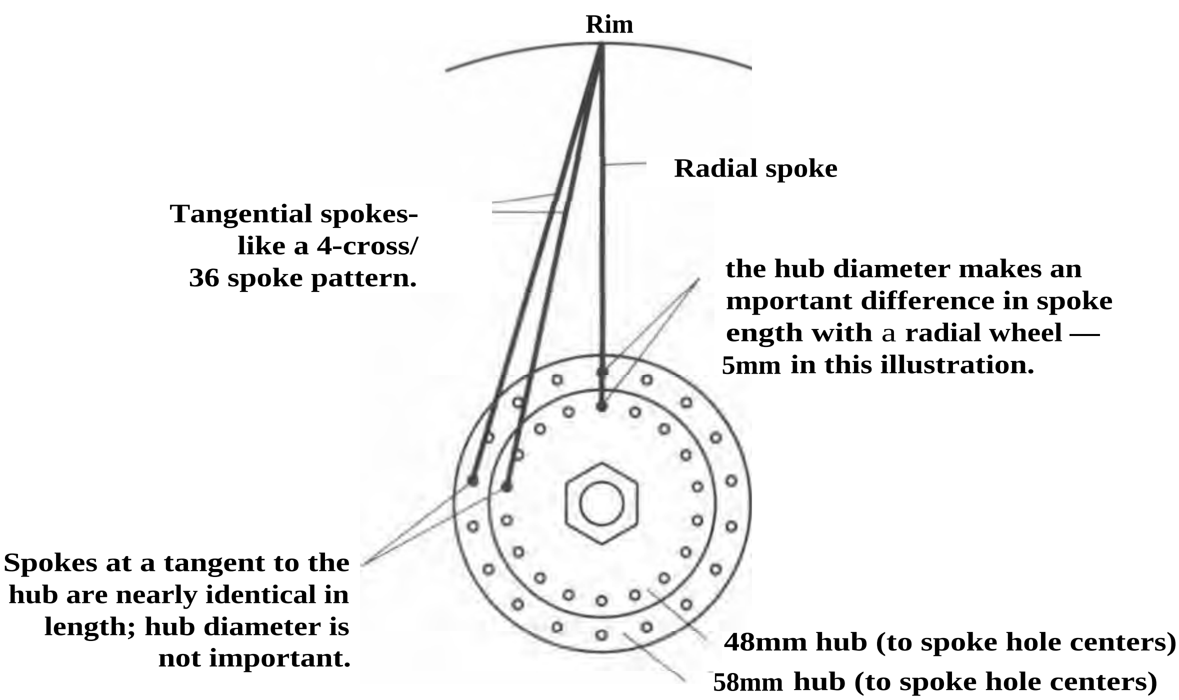
SPOKE LENGTHS

RADIAL PATTERNS

The spoke length tables work most easily with tangent or close-to-tangent spoke patterns like 4- or 3-cross. *(See drawings below.)* The fewer crosses the wheel is built with, the more exactly the hub diameter has to match the huh diameter categories in Step 1. Radially built wheels must match the diameter category exactly for accurate results. For radial wheels, note the difference between the hub diameter category listed and the actual huh diameter. Subtract or add 1 mm from the final spoke length for every 2mm difference.

Note: Many hubs are not sufficiently reinforced for radial spoking (not enough metal around flange).

EXAMPLE: Radial spoking pattem with Phil hubs. Phil all-alloy front hub has a 42mm flange diameter (spoke hole center to spoke hole center). This is 2.5mm smaller than the 44.5mm category. Since the hub is 2.5mm smaller, add 1.25mm to the final spoke length to get an accurate length for a radial wheel. In practice, adding 1 mm is accurate enough.



SPOKE AND NIPPLE DIMENSIONS

Wire diameter below refers to the diameter before the threads are rolled on. The major 0 diameter usually referred to, in thread sizes, will be larger than the wire diameter.

Sizes listed in the same column are roughly the same size.

ISO							
Wire Diameter (mm) x TPI	1.5*		1.8 x 56	2.0 x 56		2.3 x 56	2.6 x 56
Wire Diameter (inches) x TPI	.059*		.071 x 56	.079 x 56		.091 x 56	.102 x 56
Nipple Flats (mm)			3.3	3.3		3.8	4.5
Nipple Diameter (mm)			4.0	4.0		4.5	5.5
English							
Gauge (SWG)	17*	16*	15	14		13	12
Wire Diameter (inches) x TPI	.056*	.064*	.072 x 56	.080 x 56		.092 x 56	.104 x 56
French							
Gauge (JP)	10*	11*	12	13	14	15	16
Wire Diameter (mm) x mm per thread	1.5*	1.6*	1.8 x .4	2x.4	2.2x.45	2.4 x .45	2.7 x .55
Wire Diameter (inches) x TPI	.059*	.063*	.071 x 63.5	.079 x 63.5	.087 x 56.4	.094 x 56.4	.106 x 46.2
Nipple Flats (mm)			3.2	3.2	3.2	3.7	4.0
Nipple Diameter (mm)			4.0	4.0	4.0	4.5	5.0
(Japanese)							
Gauge (for reference only)			15	14		13	12
Wire Diameter (mm) x TPI			1.86 x 56	2.0 x 56		2.3 x 56**	2.6 x 56
Nipple Flats (mm)			3.4	3.4		3.6	3.9
Nipple Diameter (mm)			4.0	4.0		4.3	4.6
USA							
Gauge (US Steel Wire Gauge)			15	14	13	12	
Wire Diameter x TPI			.072*	.080 x 56		.092*	.106 x 56
Nipple Flats (mm)				3.3			3.9
Nipple Diameter (mm)				3.7			4.57

* These measurements are for the narrower butted portion of the spoke where there are no threads.

** Wire diameter may be 2.3mm. This can then be swaged down to 2.0mm x 56TPI at the threads with a corresponding shrink in nipple flats and diameter.

Notice that as the wire gets larger, French gauge numbers go up while English and USA gauge numbers go down. The gauge numbers cross right where cycle spokes are. This is one reason the ISO standards for spokes are being adopted all over the world.

To distinguish a spoke with a 56 TPI thread, a 28 TPI thread gauge may be used. It will fit nicely in every other thread.

SPOKE LENGTHS

CALCULATING SPOKE LENGTH

1st Step of 3 steps:

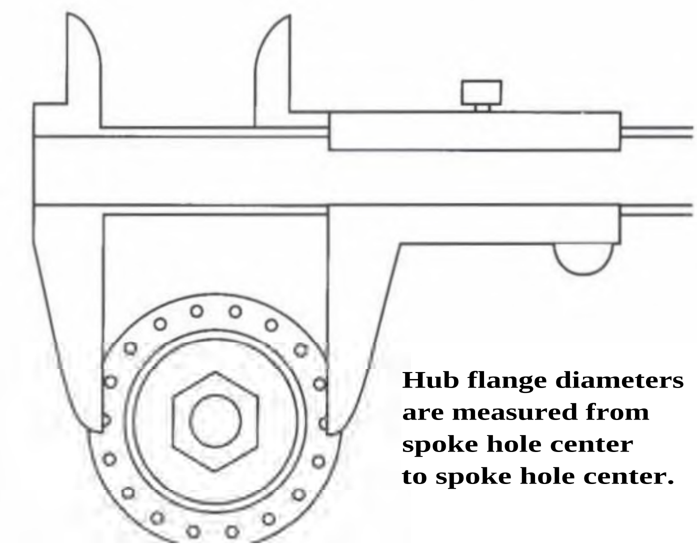
Determine which hub flange diameter category the hub fits into.

Sample hubs are listed for each category. Be sure to measure since there are many models than are listed here.

Example One: Shimano Dura-Ace small flange front measures **38mm.** It fits the **40mm** hub flange diameter category. Adjustments will be made in the next step, if necessary.

Example Two: Mavic 500 small flange rear is **44.8mm** so it fits in the **44.5mm** hub diameter category.

HUB FLANGE DIAMETER



Hub flange diameters are measured from spoke hole center to spoke hole center.

Flange Diameter Categories

31mm	from 30mm - 32mm
34mm	from 33mm - 36mm
40mm	from 37mm - 42mm
44.5mm	from 43mm -46mm
48mm	from 47mm - 52mm
58mm	from 53mm - 60mm
63mm	from 61mm - 64mm
67mm	from 65mm - 69mm
90mm	from 80mm - 90mm
102.5mm .	from 102.5mm - 112mm

ELECTRONIC CALCULATIONS

The information in the shaded area of the charts to the right of the flange diameter column is for use with electronic spoke calculators or computer programs. It is also useful for making adjustments to spoke lengths for unusual hubs.

When using an electronic spoke-length calculator such as Wheelsmith's or a computer program, you will need only the information in steps i and 3.

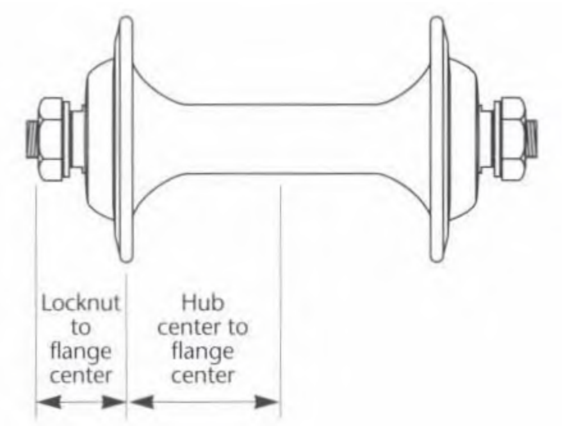
2nd Step

27" rims, go to page **11 · 38**
700C rims, go to page **11 ·46**
26", 700D and **650** rims, go to page **11 ·62**
24", 22", 600 and **550** rims, go to page **11 · 74**
20" rims, go to page **11 ·82**
16" rims, go to page **11 ·92**
400 rims, go to page **11 · 101**
14" rims, go to page **11 · 104**
12" rims, go to page **11 · 106**
10" rims, go to page **11 · 107**

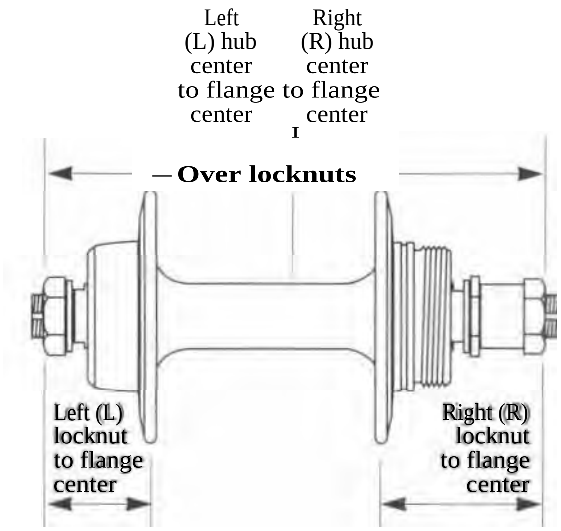
CALCULATING SPOKE LENGTH

1 st Step (contd)

FRONT HUB MEASUREMENT



REAR HUB
LEFT AND RIGHT MEASUREMENTS



31 mm FLANGE DIAMETER (30mm - 32mm)

Generally: small flange front hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
AMERICAN CLASSIC							
	Speedster	Time Trial	front	30	24	100	26
HERSHEY	Naked	Lexan	front	31.7	30	100	20
UNION/HOPE ADVANCED SYSTEM							
	Super Ultralight		front	25.5	35	100	15
NOSLER	TI-90		front	31.3	36	100	14
		Flip-Flop	rear	* L-31.3 R-43.7	L-47 R-18	130	L-18 R-47
	MTB	Flip-Flop	rear	* L-31.3 R-43.7	L-44 R-21	135	L-24 R-47
	Stiffy	suspension	front	31.3	36	100	14
	TI-90	(not Flip-Flop)	rear	* L-31.3 R-45.4	L-44 R-19	130	L-21 R-46
		(not Flip-Flop)	rear	* L-31.3 R-45.4	L-45 R-21	135	L-23 R-47
NUKE PROOF	XT-Pre '94	sealed	front	31.5	37	100	13
	XT-Pre '94	sealed	rear	* L-31 R-43	L-45 R-17	126	L-18 R-46
			rear	* L-31 R-43	L-43 R-19	130	L-22 R-46
			rear	* L-31 R-43	L-41 R-23	135	L-27 R-45
	MPS-1		front	32	37	100	13
	XT	cassette	rear	* L-32 R-47.3	L-40 R-25	135	L-28 R-43
	XTR	cassette	rear	* L-32 R-47.3	L-38 R-22	135	L-30 R-46
	XTR	cassette	rear	* L-32 R-47.3	L-38 R-20	130	L-27 R-45

SPOKE LENGTHS

31 mm FLANGE DIAMETER (30mm - 32mm)

Generally: small flange front hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center—Flange Center	Over Lock-nuts	Locknuts-Flange Center
TNT	Road		front	31.7	37	100	13
	Road		rear	* L-31.8R-45.3	L-35 R-19	130	L-30 R-46
	Mtn.		rear	* L-31.8R-45.3	L-33 R-22	136	L-35 R-46
	Suspension		front	41.7	39	100	11
		8spd	rear	* L-32 R-42	L-34 R-23	130	L-31 R-42
		8spd	rear	* L-32 R-42	L-35 R-22	135	L-33 R-46
	7-11 [1]	8spd	rear	* L-32 R-42	L-39 R-18	130	L-26 R-47
		8spd	rear	* L-32 R-42	L-39 R-18	135	L-29 R-50
		7spd	rear	* L-32 R-42	L-35 R-22	130	L-30 R-43
		7spd	rear	* L-32 R-42	L-35 R-22	135	L-33 R-46
ULTIMATE	standard		front	32	32	100	18
	cassette	7spd	rear	* L-31.7R-41.4	L-36 R-19	135	L-32 R-49
	cassette	8spd	rear	* L-31.7R-41.4	1-33 R-21	136	L-35 R-47

31mm footnotes

* See Spoke Length chart for 40mm, 44.5mm, 48mm Flange Diameter for large flange side of hub.

1 7-speed cassette with added 11-tooth cog.

34MM FLANGE DIAMETER (33mm - 36mm)

Generally: fair to good quality small flange front hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center—Flange Center	Over Lock-nuts	Locknuts-Flang Cent
CLARK KENT			**rear**	***L-36.3** R-47.6	L-34 R-23	135	L-34 R-45
EXCEL	XLB4290	steel	front	34	36	89	9
HERSHEY	Naked	Lexan	front	31.7	30	100	**20**
UNION/HOPE ADVANCED SYSTEM							
	Ultralight		front	34	34	100	16
KING KONG							
KK	H-480960	steel-5/16	front	34	34	100	16
	H-480961	steel-28H	front	34	35	100	15
MAILLARD	Sealed Mechanism		front	34	35	97	13

SPOKE LENGTHS

34mm FLANGE DIAMETER (33mm - 36mm)

Generally: fair to good quality small flange front hubs

Make	Model		Front/ Rear	Flange Diameter		Hub Center-Flange Center		Over Lock-nuts	Locknuts-Flange Center	
MAVIC			front	34		28		80	1 2	
	CX 580		front	34		28		81	12	
NORMANDY	Low Flange B.O. [3]		front	34		35		96	13	
PHIL	Wheelchair									
	Dinky		front	35		22				
	Straddle Mount Dinky		front	35		23		63	9	
SHIMANO	HB-SN11	**steel**	**front**	**35**		**32**		**93**	**15**	
STURMEY ARCHER			**front**	33				**88**	**11**	
SUNTOUR	XCD-6000		front	36		3		100	**17**	
TNT		8spd	rear	* L-32	R-42	L-34	R-23	130	L-31	R-42
		8spd	rear	* L-32	R-42	L-35	R-22	135	L-33	R-46
	7-11 [1]	8spd	rear	*L-32	R-42	L-39	R-18	130	L-26	R-47
		8spd	rear	*L-32	R-42	L-39	R-18	135	L-29	R-50
		7spd	rear	* L-32	R-42	L-35	R-22	130	L-30	R-43
		7spd	**rear**	*** L-32**	**R-42**	L-35	R-22	135	L-33	**R-46**
ULTERRAIN [2]	Road		front	35		35		1 00	15	
		7spd	rear	35		L-37	R-16	130	L-28	R-49
		8spd	rear	35		L-37	R-16	130	L-28	R-49
	Mtn.	suspension	front	35		35		100	15	
		7spd	rear	35		L-34	R-19	135	L-34	R-49
		8spd	rear	35		L-34	R-19	135	L-34	R-49
UNION		steel	front	34		36		100	14	
WALD	**Low** Flange B.O. [3]		front	333		37		102	14	
WHITE TI			**front**	**34**		**35**		100.	15	

34mm footnotes

* See Spoke Length chart for 40mm Flange Diameter for large flange side of hub.

1 7-speed cassette with added 11-tooth cog.

2 Use 2-cross for all.

3 Bolt-on.

SPOKE LENGTHS

40mm FLANGE DIAMETER (37mm - 42mm)

Generally: good to high quality small flange front hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
AMERICAN CLASSIC							
	Standard		front	42	35	102	**16**
ARAI	8000		front	40	32	82	9
ARIEL	ATB		front	40	38	100	12
BICI	MTB		front	40	36	**100**	1**4**
CAMPAGNOLO							
OLD	*Super* Record		front	38.5	34	**100**	16
	Nuovo Record		front	38.5	34	100	16
	Gran Sport		front	38.5	34	100	16
	Victory		front	38.5	34	100	16
	Triomphe		front	38.5	34	100	16
NEW	C-Record		front	38.5	34	100	16
	Chorus		front	38.5	34	100	16
	Athena		front	38.5	34	100	16
	Xenon		front	38.5	34	100	16
	Veloce		front	38.5	34	100	16
	Mirage		front	38.5	34	100	16
	Stratos		front	38.5	34	100	16
	Record O.R.		front	38.5	34	100	16
	Icarus		front	38.5	34	100	16
	Euclid		front	38.5	34	100	16
	Centaur		front	38.5	34	100	16
	Olympus		front	38.5	34	100	16
	Themis		front	38.5	34	100	16
	Record Track		front	38.5	34	100	16
CLARK KENT			front	**38**	33	100	17
	Ultralite		front	38	35	100	15
CODA			front	39	**38**	101	**13**
CUNNANE	Paioli-HPS	suspension	front	41.9	37	100	13
		8spd cassette	rear	**6** L-41.1 R-44	L-37 **R-19**	**130**	L-28 **R-46**
DIACOMPE	Tsali Comp		front	39	37	100	13
	Tsali Competition		front	39	41	**110**	14
	Tsali Standard		front	39	37	106	16
DK			front	38	32	96	16

SPOKE LENGTHS

40mm FLANGE DIAMETER (37mm - 42mm)

Generally: good to high quality small flange front hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
ELF	BMX	7075	front	41	34	95	14
GT	Low Flange	Flip-Flop	front	38	32	94	15
	BMX		front	40	35	94	12
HERSHEY	TI	cassette	rear	* L-37 R-49	L-36 R-19	130	L-29 R-46
	6/4 TI	cassette	rear	* L-37 R-49	L-33 R-21	136	L-35 R-47
	TI	cassette	rear	* L-37 R-49	L-34 R-20	135	L-32 R-48
HI-E			front	39	39	101	11
UNION/HUGI	HF-1		front	39	33	100	17
JOY TECH	833		front	38	35	99	15
JUSTIN	Prohubz3		front	42	36	100	14
	Pro-Eight [4]	suspension	rear	42	L-34 R-19	135	L-34 R-49
KT	H-480966	3/S B.O. [2]	front	40	35	100	15
	H-480967	5/16 B.O. [2]	front	40	35	100	15
	H-480970	Q.R. sealed	front	40	35	100	15
	H-480976	steel-3/8	front	42	31	100	19
	H-480980	steel-105	front	42	31	100	19
MAILLARD	Low Flange	Q.R. sealed	front	39	29	100	21
MAVIC	500,501,520,530, 531,550,571,577		front	40	28	100	22
	Sulky (500 R.D.)		front	40	41	120	19
MICHE	Competition		front	40	34	100	16
	Sealed		front	40	34	100	16
NUKE PROOF	Bomb Shell	carbon	front	42	33	100	17
ODESSEY			front	39	31	94	16
PHIL	all-alloy—BMX		front	42	35	90	10
	all-alloy--BMX		front	42	35	95	13
	all-alloy—road		front	42	35	100	15
	all-alloy—road		front	42	35	108	19
Wheelchair hub				42	35		
PROFILE	**BMX**		**front**	**38**	**33**	**96**	**15**
PULSTAR [5]	standard	28 holes	front	40.7	33	100	17

SPOKE LENGTHS

40mm FLANGE DIAMETER (37mm - 42mm)

Generally: good to high quality small flange front hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
REDLINE	Flight Group	**B.O.2**	front	38	32	96	16
REVCORE	BMX		front	41	29	109	26
RHINO			front	38	33	100	17
RINGLE	Superbubba		front	42	34	**100**	16
	Bubba		front	40	34	100	16
	Bubba Mtn.	6spd	rear	L-40 R-41	L-42 R-23	130	L-24 R-43
		7spd	rear	L-40 R-41	L-39 R-26	135	L-29 R-42
		8spd	rear	L-40 R-41	L-40 R-21	135	L-28 R-47
	Bubba Road	7spd	rear	L-40 R-41	L-43 R-21	126	L-20 R-42
		8spd	rear	L-40 R-41	L-42 R-18	130	L-23 R-47
SACHS							
Sport	New Success		front	38.5	29	100	21
	Rival 7000,6000		front	38.5	29	100	21
	Sachs 5000		front	38.5	29	100	*21*
	Classic 3500		front	38.5	29	100	21
ATB	Rival 7000		front	38.5	33	100	17
SAMPSON	Stratics	Road	front	38	33	100	17
			rear	** L-38 R-43	L-35 R-16	130	L-30 R-49
SANSIN	Gyromaster		front	39	35	100	15
SELKIRK	Titanium	1-piece	front	39	34	100	16
SHIMANO							
600 EX	HB-6207		front	38	35	100	15
105	H B-1050		front	38	35	100	15
Exoge Mtn.	HB-M450		front	38	35	96	13
	HB-M450	B.O.2	front	38	35	100	15
Alloy	HB-RA50		front	38	34	96	14
	HB-RA50	**B.0.2**	front	38	34	100	16
Alloy	HB-RM50		front	38	34	96	14
	HB-RM50	B.0.2	front	38	34	100	16
Alloy	HB-AQ11		front	38	35	96	13
Alloy	HB-AQ21		front	38	35	96	13
Alloy	HB-AN11		front	38	35	93	13
Alloy	HB-AN21		front	38	35	93	13
Deore	HB-MT60		front	38	34	100	16

SPOKE LENGTHS

40mm FLANGE DIAMETER (37mm - 42mm)

Generally: good to high quality small flange front hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
SHIMANO (cont'd)							
Deore (contd)	HB-MT60	B.0.2	front	38	34	100	16
STX - Special Edition			front	38	34	100	16
Duro-Ace	HB-7400		front	38	37	100	13
600 *Ultegra*	HB-6400		front	38	36	100	14
105 (SC)	HB-1055		front	38	36	100	14
RX 100	HB-A550		front	38	36	100	14
Exage	HB-RM50		front	38	36	100	14
XTR	HB-M900		front	38	37	100	13
Deore XT	HB-M 730		front	38	37	100	13
Deore XT-94	HB-M730		front	38	34	100	16
Deore DX	HB-M650		front	38	36	100	14
Deore LX	HB-M550		front	38	36	100	14
Deore LX-94	HB-M550		front	38	34	100	16
Deore	HB-MT60		front	38	37	100	13
700 CX	HB-C700		front	38	36	100	14
400 CX	HB-C400		front	38	36	100	14
Mj 11	HB-MJ05		front	38	34	100	16
SOVOS		B.0.2	front	38	34	100	16
SPECIALIZED	Sealed-Bearing		front	39	33	100	17
STRONGLIGHT		Standard	front	39	28	100	22
	Delta	Mtn.	front	39	28	100	*22*
SUNTOUR							
Superbe Pro	HB-SB00		front	39	33	100	17
SL	SLO1		front	39	33	100	17
Blaze	HB-RA01		front	39	33	100	17
XC Pro	HB-XPO1		front	39	33	100	17
XC Comp	HB-XCO2		front	39	33	100	17
XC-9000			front	38	33	100	17
XC Ltd.	HB-ATO1		front	38	33	100	17
X1	HB-ATO1		front	38	33	100	17
XC-Sport	HB-CE60		front	39	33	100	17
GPX			front	39	33	100	17
Sprint			front	39	33	100	17
Suspension	H B-SV00		front	39	33	100	17
XC Sport	HB-CE60		front	39	33	100	17
XR100	HB-CE60		front	39	33	100	17

SPOKE LENGTHS

40mm FLANGE DIAMETER (37mm - 42mm)
Generally: good to high quality small flange front hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
SUZUE							
BMX	SI-BMX		front	38	35	98	14
	CSH-SB-BMX		front	38	34.5	96	13.5
Mountain	SI-SS-MTB		front	38	34.5	101	16
	CSH-SB-SSMTB		front	38	34.5	100	15.5
Road	SI-SQ		front	38	34	100	16
	CSH-SQ		front	38	30.5	101	20
TNT	Suspension		front	41.7	39	100	11
		8spd	rear	** L-32 R-42	L-34 R-23	130	L-31 R-42
		8spd	rear	** L-32 R-42	L-35 R-22	135	L-33 R-46
	7-11 [1]	8spd	rear	** L-32 R-42	L-39 R-18	130	L-26 R-47
		8spd	rear	** *L-32* R-42	L-39 R-18	135	L-29 R-50
		7spd	rear	** L-32 R-42	L-35 R-22	130	L-30 R-43
		7spd	rear	** L-32 R-42	L-35 *R-22*	135	L-33 R-46
T-GEAR	Eclipse	8spd	rear	38	L-34 R-19	134	L-33 R-48
		suspension	front	42	35	100	15
		suspension	rear	42	L-35 R-22	135	L-33 R-46
ULTIMATE	Comp. Suspension		front	**41**	36	100	14
	cassette	7spd	rear	** L-31.7 R-41.4	L-36 R-19	135	L-32 R-47
	cassette	8spd	rear	** L-31.7 R-41.4	L-33 R-21	136	L-35 R-47
WCW	CR	suspension	front	38	37	100	13
	CR	C.D.	rear	L-38.6 R-46.2	L-39 R-21	135	L-29 R-47
		H.G.	rear	L-38.6 R-46.2	L-37 R-23	136	L-31 R-45
		M.D.	rear	L-38.6 R-46.2	L-37 R-22	134	L-30 R-45
		threaded	rear	L-38.6 R-46.2	L-37 R-21	135	L-31 R-47
WHEELSMITH [7]			front	39	39	100	11
WHITE	Tracker	suspension	front	40	35	100	15
WILDERNESS TRAILS	Momentum		front	40	34	100	16

40mm footnotes

* See Spoke Length chart for 40, 44.5, and 48mm Flange Diameter for large flange side of hub.

** See Spoke Length chart for 31mm Flange Diameter for small flange side of hub.

1 7-speed cassette with added 11-tooth cog.

2 Bolt-on,

40mm FLANGE DIAMETER (37mm - 42mm)

Generally: good to high quality small flange front hubs

40mm footnotes (cont'd)

3 19 and 25mm axle end caps available.

4 19 and 31.5mm axle end caps available.

5 All Pulstar hubs require straight-pull spokes. Add 5mm to all spoke lengths.
28-hole and 32-hole work only for 3-cross. 36-hole hubs work only for 4-cross.

6 Fits Shimano cassettes.

7 15mm axle end cap.

44.5mm FLANGE DIAMETER (43mm - 46mm)

Generally: small flange rear hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center—Flange Center	Over Lock-nuts	Locknuts-Flange Center
A/C	APX		front	**43**	37	100	13
	APX-8		rear	44	L-36 R-22	135	L-32 R-46
ACS	10861	**B.O.3**	front	44	**32**	**100**	**18**
	10863	B.O.3	rear	44	L-38 R-18	130	L-27 R-47
		Q.R.	front	43.5	36	108	18
		Q.R.	rear	43	L-37 R-19	129	L-28 R-46
	10875	**B.O.3**	front	44	33	100	17
	10876	B.O.3	rear	44	L-28 R-27	109	L-27 R-28
	BMX Z		front	44	33	92	**13**
AMERICAN CLASSIC							
	Standard		rear	43	L-39 R-19	126	L-24 R-44
	Mountain	1spd threaded	rear	43	L-37 R-21	121	L-24 R-40
		6,7spd	rear	43	L-39 R-19	126	L-24 R-44
		6,7spd	rear	43	L-41 R-21	130	L-24 R-44
		7,8spd	rear	43	L-41 R-16	130	L-24 R-49
		6,7spd	rear	43	L-35 R-24	135	L-33 R-44
		7,8spd	rear	43	L-40 R-19	135	L-28 R-49
		7,8spd	rear	43	L-37 R-21	**140**	**L-33 R-49**
ARIEL	**ATB**		rear	**45**	**L-35 R-23**	135	**L-33 R-45**
A.R.R.	Vicki G.		front	43.5	32	100	18
	Ultimate	Road	rear	44.7	L-34 R-16	127	L-28 R-48
ATOM		threaded	rear	45	**L-38 R-20**	**122**	**L-23 R-41**
BICI		Mtn.	rear	**45**	**L-31 R-16**	**126**	**L-32 R-47**

SPOKE LENGTHS

44.5mm FLANGE DIAMETER (43mm - 46mm)

Generally: small flange rear hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
BULLSEYE	BMX		front	42.5	37	93	10
	BMX		rear	42.5	L-34 R-27	111	L-22 R-28
			rear	43	L-41 R-21	130	L-24 R-44
			rear	43	L-39 R-22	135	L-29 R-46
CAMPAGNOLO							
NEW	Record	8spd cassette	rear	44	L-37 R-17	130	L-28 R-48
	Croce D'Aune	6,7spd[1]	rear	44	L-37 R-20	127	*L-27* R-43
		7spd	rear	44	L-37 R-20	130	L-28 R-45
		8spd cassette	rear	44	L-37 R-17	130	L-28 R-48
	Chorus	6,7spd'	rear	44	L-37 R-20	127	L-27 R-43
		7spd	rear	44	L-37 R-20	130	L-28 R-45
		8spd cassette	rear	44	L-37 R-17	130	L-28 R-48
	Athena	6,7spd1	rear	44	L-37 R-20	127	L-27 R-43
		7spd	rear	44	L-37 R-20	130	L-28 R-45
		8spd cassette	rear	44	L-37 R-17	130	L-28 R-48
	Xenon	6,7spd1	rear	44	L-37 R-20	127	L-27 R-43
	Veloce	8spd cassette	rear	44	L-37 R-17	130	L-28 R-48
	Mirage	8spd cassette	rear	44	L-37 R-17	130	L-28 R-48
	Startos	8spd cassette	rear	44	L-37 R-17	130	L-28 R-48
	Avanti	8spd cassette	rear	44	L-37 R-17	130	L-28 R-48
OLD	Record	6,7spd	rear	44	L-37 R-20	130	L-28 R-45
	Nuovo Record	5spd	rear	44	L-34 R-18	120	L-27 R-40
			rear	44	L-34 R-18	121.5	L-27 R-43
		6,7spd	rear	44	L-36 R-20	126.5	L-27 R-43
	C-Record	6,7spd1	rear	44	L-37 R-20	127	L-27 R-43
		7spd	rear	44	L-37 R-20	130	L-28 R-45
	Gran Sport	5spd	rear	44	L-34 R-18	120	L-27 R-40
		5spd[2]	rear	44	L-34 R-18	121.5	L-27 R-43
		6,7spd	rear	44	L-36 R-20	126.5	L-27 R-43
	Victory	6,7spd	rear	44	L-37 R-20	127	L-27 R-43
MTB	Record O.R.	8spd cassette	rear	44	L-35 R-18	136	L-33 R-50
	Icarus	8spd cassette	rear	44	L-35 R-18	136	L-33 R-50
	Centaur	8spd cassette	rear	44	L-35 R-18	136	L-33 R-50
	Euclid	8spd cassette	rear	44	L-35 R-18	136	L-33 R-50
	Euclid	7spd	rear	44	L-37 R-17	130	L-28 R-48
	Olympus	6,7spd	rear	44	L-35 R-18	136	L-33 R-50
	Themis	6,7spd	rear	44	L-37 R-20	127	L-27 R-43
Track	Record Pista		rear	44	**L-44** R-31	**120**	**L-16 R-29**

SPOKE LENGTHS

44.5MM FLANGE DIAMETER (43mm - 46mm)

Generally: small flange rear hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
DK	BMX	Flip-Flop	rear	43	L-28 R-28	114	L-29 R-29
DIACOMPE	Tsali Disk		front	* L-50.6 R-45.1	L-26 R-34	100	L-24 R-16
ELF	BMX	7075	front	41	34	95	14
		Flip-Flop	rear	43.5	L-28 R-28	113	L-29 R-29
GT	BMX		front	43	34	96	
		Flip-Flop	rear	43	L-31 R-31	112	L-25 R-25
	Low Flange	Flip-Flop	rear	43	L-28 R-28	112	L-28 R-28
HERSHEY[6]		suspension	front	45	37	100	13
	Ti-cassette[7]	suspension	rear	45	L-36 R-22	135	L-32 R-46
HOOKER	Elite		front4	45	**22**	**64**	10
UNION/HOPE ADVANCED SYSTEM							
	Suspension		front	43	32	100	18
	Susp. Disc.	splined	front	*43*	L-23 R-33	100	L-27 R-17
		threaded	front	43	L-23 R-33	100	L-27 R-17
		splined	rear	43	L-33 R-18	130	L-32 R-47
		threaded	rear	43	L-33 R-20	135	L-35 R-48
UNION/HUGI	HR-1/HRIA	aluminum/					
		standard	rear	45	L-38 R-19	126	L-25 R-44
		7spd	rear	45	L-36 R-21	130	L-29 R-44
		8spd	rear	45	L-38 R-19	130	L-27 R-46
		7spd	rear	45	L-35 R-22	135	L-33 R-45
		8spd	rear	45	L-37 R-20	135	L-30 R-47
		8spd	rear	45	L-33 R-24	**140**	L-37 R-46
JOY TECH	414	steel B.0.[3]	front	42	31	100	19
	211	steel B.0.[3]	rear	45	L-37 R-19	127	L-27 R-45
	834	alloy B.0.[3]	rear	43	L-32 R-23	135	L-36 R-45
KINGSBERY		7075	front	43	35	100	15
		Road	rear	43	L-46 R-15	126	L-17 R-48
		MTB/Road	rear	43	L-43 R-17	130	L-22 R-48
		MTB 8spd	rear	44	L-41 R-20	**135**	L-27 R-48
KING KONG							
KK	H-480984	**B.0.3** steel 3/8	rear	45.5	**L-26 R-27**	**114**	**L-31 R-30**

SPOKE LENGTHS

44.5mm FLANGE DIAMETER (43mm - 46mm)

Generally: small flange rear hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
KT	H-480969	3/8 threaded	rear	45	L-27 R-27	113	L-30 R-30
	H-480972	Q.R. sealed	rear	45	L-35 R-19	126	L-28 R-44
	H-480968	B.0.3 sealed	rear	45	L-35 R-19	126	L-28 R-44
MACHINE TECH		MTB	front	43	**34**	100	16
MAILLARD		Q.R. sealed	front	45.2	29	100	21
		Q.R. thread	rear	45	L-39 R-19	126	L-24 R-44
		Q.R sealed	rear	45	L-39 R-20	130	L-26 R-45
		B.0. 3 sealed	rear	45	L-39 R-19	126	L-24 R-44
			rear	44.5	L-27 R-21	135	L-41 R-47
MAVIC	500	Road	rear	45	L-37 R-19	126	L-26 R-44
	501	7spd	rear	44.9	L-29 R-18	127	L-34 R-45
		8spd	rear	44.9	L-31 R-17	130	L-34 R-48
	506	Road	rear	44.5	L-37 R-19	126	L-26 R-44
	520	Track	rear	44.5	L-43 R-31	120	L-17 R-29
	530	MTB	rear	44.5	L-36 R-21	130	L-29 R-44
ATB	531	MTB	rear	44.5	L-30 R-19	130	L-35 R-46
		8spd	rear	45	L-31 R-17	135	L-41 R-46
	550	Road	rear	45	L-37 R-19	126	L-26 R-44
Track	Pista	Track	rear	45	L-41 R-31	120	L-19 R-29
Track	570	Track	rear	45	L-36 R-26	120	L-24 R-34
M .R. C.	570	Z hub	rear	45	L-37 R-19	126	L-26 R-45
NOSLER		Flip-Flop	rear	** L-31.3 R-43.7	L-47 R-18	130	L-18 R-47
	MTB	Flip-Flop	rear	** L-31.3 R-43.7	L-44 R-21	135	L-24 R-47
	T1-90	(not Flip-Flop)	rear	** L-31.3 R-45.4	L-44 R-19	130	L-21 R-46
		(not Flip Flop)	rear	** L-31.3 R-45.4	L-45 R-21	135	L-23 R-47
NUKE PROOF	XT-Pre '94	sealed	rear	** L-31 R-43	L-45 R-17	126	L-18 R-46
			rear	** L-31 R-43	L-43 R-19	130	L-22 R-46
			rear	** L-31 R-43	L-41 R-23	135	L-27 R-45
	Bomb Shell	carbon	front	44.5	36	100	14
	Bomb Shell	titanium	front	44.5	36	100	14
PROFILE	BMX		rear	44.5	L-32 R-29	**110**	L-23 R-26
REDLINE	Flight Group						
		Flip-Flop	rear	44	L-28 R-29	**115**	L-30 R-29
RHINO			rear	44	L-34 R-22	133	L-33 R-44

SPOKE LENGTHS

44.5mm FLANGE DIAMETER (43mm - 46mm)

Generally: small flange rear hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Lock nuts-Flange Center
RINGLE	Supereight Mtn		rear	45	L-34 R-22	135	L-34 R-46
	Supereight Road		rear	45	L-37 R-20	130	L-28 R-45
SACHS							
Sport	New Success	8spd cassette	rear	45	L-35 R-17	130	L-30 R-48
	Rival 7000	8spd cassette	rear	45	L-34 R-17	130	L-31 R-48
	Classsic 3500, Rival 6000	7spd	rear	45	L-34 R-17	126	L-29 R-46
ATB	New Success		front	45	33	100	17
		7spd	rear	45	L-34 R-18	130	L-31 R-47
		7spd	rear	45	L-30 R-22	135	L-38 R-46
	Rival 7000	7spd	rear	45	L-38 R-20	130	L-27 R-45
	Classsic 3500	7spd	rear	45	L-38 R-20	130	L-27 R-45
SAMPSON	Stratics	8spd	rear	** L-38 R-43	L-35 R-16	130	L-30 R-49
SELKIRK	Titanium	cassette	rear	45	L-32 R-23	130	L-33 R-42
SHIMANO							
Mj11	FH-MJ05		rear	45.5	L-35 R-22	130	L-30 R-43
BMX Freehub — DX			rear	44.5	L-32 R-21	111	L-23 R-34
BMX Freehub			rear	45.5	L-32 R-22	110	L-23 R-33
600	FH-6207	6spd	rear	45	L-33 R-21	126	L-30 R-42
105	FH-1050	6spd	rear	45	L-33 R-21	126	L-30 R-42
	FH-1051	6spd	rear	45	L-33 R-21	126	L-30 R-42
	FH-1051	7spd	rear	45	L-35 R-19	126	L-28 R-44
Steel	FH-5A10	5spd	rear	45	L-30 R-25	124	L-32 R-37
	FH-6A10	6spd	rear	45	L-36 R-18	124	L-26 R-44
Mtn. LX	FH-M452-QR	7spd	rear	45	L-33 R-21	130	L-32 R-44
	FH-M452-NT		rear	45	L-31 R-23	135	L-37 R-45
Exage Mtn.	FH-M450-QR		rear	45	L-35 R-19	126	L-28 R-44
	FH-M450-NT		rear	45	L-33 R-21	130	L-32 R-44
700CX	FH-C070	7spd	rear	45	L-34 R-21	130	L-31 R-44
	FH-C070		rear	45	L-31 R-24	135	L-37 R-44
400CX	FH-0070	7spd	rear	45	L-35 R-21	130	L-30 R-44
	FH-C070		rear	45	L-32 R-23	135	L-36 R-45
Exage Sport	FH-A450		rear	45	L-33 R-21	126	L-30 R-42
Alloy	FH-RA50		rear	45	L-35 R-19	126	L-28 R-44
Alloy	FH-RM50	6spd	rear	45	L-33 R-21	126	L-30 R-42
	FH-RM50	6spd	rear	45	L-31 R-23	130	L-34 R-42
Alloy Q.R.	FH-AQ11		rear	45	L-34 R-24	124	L-28 R-38

SPOKE LENGTHS

44.5mm FLANGE DIAMETER (43mm - 46mm)

Generally: small flange rear hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center–Flange Center	Over Lock-nuts	Locknuts-Flange Center	
SHIMANO (cont'd)								
Alloy	FH-AN21		rear	45	L-34 R-21	124	L-28	R-41
Steel	FH-SN11		rear	45	L-36 R-18	124	L-26	R-44
Deore II	FH-MT62	7spd	rear	45	L-34 R-21	130	L-31	R-44
	FH-MT62	7spd	rear	45	L-31 R-24	135	L-37	R-44
Deore	FH-MT60		rear	45	L-35 R-19	126	L-28	R-44
Deore	FH-MT60		rear	45	L-33 R-21	130	L-32	R-44
Deore	FH-MT60	B.O.3	rear	45	L-35 R-19	126	L-28	R-44
Deore	FH-MT60	B.O.3	rear	45	L-33 R-21	130	L-32	R-44
Dura-Ace	8515	integrated	rear	44	L-35 R-19	130	L-30	R-46
	FH-7400	6spd	rear	44	L-37 R-23	126	L-26	R-40
	FH-7400	7spd	rear	44	L-38 R-22	126	L-25	R-41
	FH-7402	8spd	rear	44	L-37 R-21	130	L-28	R-44
	FH-7403	8spd	rear	44	L-37 R-21	130	L-28	R-44
	FH-7463	8spd	rear	44	L-37 R-21	130	L-28	R-44
600 *Ultegra*	FH-6400	6,7spd	rear	45	L-36 R-22	126	L-27	R-41
600	FH-6401	7spd	rear	45	L-37 R-21	126	L-26	R-42
	FH-6402	8spd	rear	45	L-37 R-21	130	L-28	R-44
Sante	HB-5000		front	44	39	100	11	
	FH-5000	7spd	rear	45	L-36 R-22	126	L-27	R-41
	FH-5001	7spd	rear	45	L-37 R-21	126	L-26	R-42
105, 1055C	FH-1055	7spd	rear	45	L-37 R-21	126	L-26	R-42
	FH-1056	8spd	rear	45	L-37 R-21	130	L-28	R-44
RX 700	FH-A550	7spd	rear	45	L-37 R-21	126	L-26	R-42
XTR	FH-M900	8spd	rear	45	L-37 R-23	135	L-31	R-45
Deore XT	FH-M732	7spd	rear	45	L-37 R-24	130	L-28	R-41
Deore XT-92	FH-M732	7spd	rear	45	L-39 R-26	135	L-29	R-41
Deore XT-94	FH-M732	7,8spd	rear	45	L-35 R-22	135	L-33	R-46
STX - Special Edition		7spd	rear	45	L-35 R-22	135	L-33	R-46
Deore DX	FH-M650	7spd	rear	45	L-36 R-24	130	L-29	R-41
	FH-M650	7spd	rear	45	L-36 R-29	135	L-32	R-39
Deore LX	FH-M550	7spd	rear	45	L-36 R-24	130	L-29	R-41
	FH-M550	7spd	rear	45	L-36 R-29	135	L-32	R-39
Deore LX	FH-M560	7 spd	rear	45	L-33 R-25	135	L-35	R-43
Deore LX-94		7,8spd	rear	45	L-35 R-23	135	L-33	R-45
Deore	FH-MT62	7spd	rear	45	L-36 R-24	130	L-29	R-41
	FH-MT62	7spd	rear	45	L-36 R-29	135	L-32	R-39
Exage	FH-HG50	7spd	rear	45	L-38 R-20	126	L-25	R-43

44.5mm FLANGE DIAMETER (43mm - 46mm)

Generally: small flange rear hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
SHIMANO (cont'd)							
Exage (cont'd)	FH-HG50	7spd	rear	45	L-36 R-23	130	L-29 R-43
	FH-HG50	7spd	rear	45	L-33 R-25	135	L-34 R-43
200G5	FH-HG20	7spd	rear	45	L-38 R-21	126	L-25 R-42
	FH-HG20	7spd	rear	45	L-36 R-23	130	L-29 R-42
700 CX	FH-C070	7spd	rear	45	L-35 R-23	130	L-30 R-42
400 CX	FH-C040	7spd	rear	45	L-36 R-22	130	L-29 R-43
		8spd	rear	44	L-36 R-20	130	L-29 R-45
			rear	44	L-34 R-20	135	L-34 R-48
SOVOS		cassette	rear	45	L-30 R-24	136	L-38 R-44
		B.O. [3] thread	rear	45	L-35 R-19	126	L-28 R-44
		B.O. [3]	front	38	34	100	16
	K.J.	B.O.3 steel	front	45	**35**	94	**15**
SPECIALIZED	BMX		front	43	33	100	**17**
	Sealed Bearing		rear	44.5	1-34 R-21	130	L-31 R-44
STRONGLIGHT	Delta	Road	rear	44	L-37 R-20	126	L-26 R-43
	Delta VTT	Mtn.	rear	44	L-37 R-20	126	L-26 R-43
SUNTOUR							
SL-Microlite	FH-SL10	7spd	rear	45	L-35 R-19	125	L-28 R-44
Superbe Pro	HB-SBOO	7spd	rear	44	L-36 R-19	126	L-27 R-44
Superbe Pro	FH-SBOO	8spd	rear	45	L-36 R-18	130	L-29 R-47
XC 9000			rear	45	L-34 R-21	130	L-31 R-43
XCD 6000			rear	45	L-34 R-20	130	L-31 R-45
XCD 9000			rear	45	L-33 R-20	130	L-32 R-45
XC Pro	FH-XPO2	7spd	rear	45	L-33 R-23	135	L-35 R-45
XC Pro-MD [5]	FH-XP20	7spd	rear	45	L-32 R-23	135	L-36 R-45
XC Pro-MD [5]	FH-XP20	8spd	rear	45	L-34 R-21	135	L-34 R-47
XC Comp	FH-XCO2	7spd	rear	45	L-31 R-23	135	L-37 R-45
XC Comp-MD [5]	FH-XCl 1	7spd	rear	45	L-32 R-23	135	L-36 R-45
XC Comp-MD [5]	FH-XCl 1	8spd	rear	45	L-34 R-21	135	L-34 R-47
XC Ltd	FH-XL01	7spd	rear	45	L-31 R-23	135	L-37 R-45
XC Ltd	FH-AT01	7spd	rear	45	L-33 R-23	135	L-35 R-45
XC Expert-MD [5]	FH-XX00	8spd	rear	45	L-34 R-21	135	L-34 R-47
X1	HB-ATO1	7spd	rear	45	L-31 R-23	135	L-37 R-45
X1-MD [5]	FH-ATO1	7spd	rear	45	L-33 R-23	135	L-35 R-45
XC Sport	HB-CE60	7spd	rear	45	L-31 R-23	135	L-37 R-45
XR100	HB-CE6O	7spd	rear	45	L-31 R-23	135	L-37 R-45

SPOKE LENGTHS

44.5mm **FLANGE DIAMETER (43mm - 46mm)**

Generally: small flange rear hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center—Flange Center	Over Lock-nuts	Locknuts-Flange Center
SUZUE							
Wheelchair	CH-2		front	46	25	71	11
BMX	SI-BMX		rear	44	L-29 R-28	110	L-28 R-28
	CSH-SB-BMX		rear	44	L-28 R-27	110	L-27 R-28
Mountain	SI-SS-MTB		rear	44	L-34 R-21	130	L-31 R-44
Road	SI-SQ		rear	44	L-36 R-18	126	L-27 R-45
	CSH-SQ		rear	44	L-36 R-18	126	L-27 R-45
	CSH-SB-SQ		rear	44	L-34 R-21	130	L-31 R-44
T-GEAR	Eclipse		front	43	35	100	15
TNT	Road		rear	** L-32 R-45	L-35 R-19	130	L-30 R-46
	Mtn.		rear	** L-32 R-45	L-33 R-22	136	L-35 R-46
WHEELSMITH			rear	43.6	L-35 R-18	130	L-30 R-47
WHITE	TI	6spd	rear	44	L-30 R-25	126	L-34 R-38
			rear	44	L-27 R-27	130	L-38 R-38
		7spd	rear	44	L-33 R-22	126	L-30 R-41
			rear	44	L-32 R-22	130	L-33 R-43
			rear	44	L-29 R-25	135	L-38 R-43
ZIPP	Ballistic 97		front	43	36	100	14
	Road	7spd	rear	43	L-39 R-18	126	L-24 R-45
		8spd	rear	43	L-41 R-16	130	L-24 R-49
		7,8spd cassette	rear	43	L-36 R-20	130	L-29 R-45
	Mtn	7,8spd cassette	rear	43	L-36 R-21	135	L-32 R-47

44.5mm footnotes

* See Spoke Length charts for 48mm Flange Diameter for large flange side of hub.

** See Spoke Length charts for 31, 34, and 40mm Flange Diameter for small flange side of hub.

1 The 127mm hub (6-speed) is referred to as a 7-speed since a spacer will allow the use of a narrow freewheel.

2 The 5-speed hub is generally considered a 120mm hub.
However, Campagnolo made locknut lengths to order and we found a few 121.5mm hubs out there.

3 Bolt-on.

4 Spoke hole ellipse difference of -1 mm.

5 Microdrive.

6 22mm axle end cap.

7 26mm axle end cap.

SPOKE LENGTHS

48mm FLANGE DIAMETER (47mm - 52mm)

Generally: medium flange and coaster brakes

Make	Model		Front/ Rear	Flange Diameter	Hub Center— Flange Center	Over Lock-nuts	Locknuts- Flange Center
BENDIX	Coaster-70		rear	51	L-28 R-27	107	L-26 R-27
CLARK KENT			rear	* L-36.3 R-47.6	L-34 R-23	135	L-34 R-45
		suspension	front	48	**36**	**100**	**14**
COOK BROS.			front	52	39	99.5	L-11 R-11
DIACOMPE		Disc.	front	50.2	L-17 R-35	100	L-33 R-15
			rear	49.6	L-30 R-27	127	L-34 R-37
			rear	49.6	L-34 R-23	135	L-34 R-45
	Tsali Comp.	cassette	rear	49.6	L-34 R-21	134	L-33 R-46
	Tsali Disk		front	* L-50.6 R-45.1	L-26 R-34	100	L-24 R-16
GT	**BMX**		rear	46	L-29 R-29	112	L-28 R-27
HERSHEY	**TI**	cassette	rear	* L-37 R-48.7	L-36 R-19	130	L-29 R-46
	6/4 TI	cassette	rear	* L-37 R-48.7	L-33 R-21	136	L-35 R-47
	TI	cassette	rear	* L-37 R-48.7	L-35 R-20	135	L-32 R-48
KK	H-480981	B.0.3 steel	rear	46	L-27 R-27	114	L-30 R-30
	H-480982	steel-105	rear	46	L-36 R-19	126	L-27 R-44
	H-480983	steel-102	rear	46	L-27 R-27	114	L-30 R-30
MAVIC	571	Road	rear	53	L-32 R-17	130	L-33 R-48
	577	MTB	rear	53	L-32 R-17	135	L-36 R-51
	571	8spd cassette	rear	53	L-27 R-22	130	L-34 R-48
	571/2 [1]	8spd cassette	rear	53	L-35 R-18	130	L-30 R-47
ATB	577	8spd cassette	rear	53.5	L-31 R-17	135	L-37 R-51
MICHE		5spd thread	rear	46	L-40 R-19	126	L-23 R-44
		6spd thread	rear	46	L-40 R-19	126	L-23 R-44
NUKE PROOF	XTR-13 Pre '94	sealed	rear	* L-31 R-47	L-39 R-19	130	L-26 R-46
	Pre '94	sealed	rear	* L-31 R-47	L-39 R-21	135	L-29 R-47
	XT	cassette	rear	* L-32 R-47	L-40 R-25	135	L-28 R-43
	XTR	cassette	rear	* L-32 R-47	L-38 R-22	135	L-30 R-46
	XTR	cassette	rear	* L-32 R-47.3	L-38 R-20	130	L-27 R-45
PHIL WOOD							
Time Trial			front	48.2	L-28	100	L-22
		7spd	rear	48.2	L-35 R-19	126.5	L-28 R-44
		7spd	rear	48.2	L-32 R-21	130	L-33 R-44
		8spd	rear	48.2	L-36 R-18	130	L-29 R-47
		7spd	rear	48.2	L-31 R-24	135	L-37 R-44
		8spd	rear	48.2	L-36 R-19	135	L-32 R-49

SPOKE LENGTHS

48mm FLANGE DIAMETER (47mm - 52mm)

Generally: medium flange and coaster brakes

Make	Model	Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
PHIL WOOD (cont'd)						
Road		front	48.2	35	100	15
	7spd	rear	48.2	L-39 R-20	126.5	L-25 R-43
	7spd	rear	48.2	L-37 R-21	130	L-28 R-44
	8spd	rear	48.2	L-37 R-18	130	L-28 R-47
	7spd	rear	48.2	L-35 R-24	135	L-33 R-44
	8spd	rear	48.2	L-36 R-19	135	L-32 R-49
MTB		front	48.2	35	100	15
	7spd	rear	** L-48.2R-57.5	L-38 R-20	126.5	L-25 R-44
	7spd	rear	** L-48.2R-57.5	L-37 R-21	130	L-29 R-44
	8spd	rear	** L-48.2R-57.5	L-40 R-18	130	L-25 R-47
	7spd	rear	** L-48.2R-57.5	L-34 R-24	135	L-33 R-44
	8spd	rear	** L-48.2R-57.5	L-39 R-19	135	L-28 R-49
	7spd	rear	** L-48,2R-57.5	L-32 R-26	140	L-38 R-44
	8spd	rear	** L-48.2R-57.5	L-37 R-21	140	L-34 R-49
Tandem		front	48.2	35	100	15
		front	48.2	35	110	20
	7spd	rear	48.2	L-33 R-20	126.5	L-30 R-44
	7spd	rear	48.2	L-31 R-21	130	L-34 R-44
	7spd[2]	rear	48.2	L-24 R-24	135	L-44 R-44
	8spd	rear	48,2	L-34 R-19	135	L-34 R-49
	7spd[2]	rear	48,2	L-26 R-26	140	L-44 R-44
	8spd	rear	48.2	L-31 R-21	140	L-39 R-49
	7spd[2]	rear	48.2	L-29 R-29	145	L-44 R-44
	8spd[2]	rear	48.2	L-24 R-24	145	L-49 R-49
	7spd[2]	rear	48.2	L-31 R-31	150	L-44 R-44
	8spd[2]	rear	48.2	L-26 R-26	150	L-49 R-49
	8spd[2]	rear	48.2	L-29 R-29	155	L-49 R-49
	8spd[2]	rear	48.2	L-31 R-31	160	L-49 R-49
Tandem Brake Hubs						
Arai Brake	7spd2	rear	48.2	L-24 R-24	135	L-44 R-44
	7spd[2]	rear	48.2	L-26 R-26	140	L-44 R-44
	8spd	rear	48.2	L-26 R-21	140	L-44 R-49
	7spd[2]	rear	48.2	L-29 R-29	145	L-44 R-44
	8spd[2]	rear	48.2	L-24 R-24	145	L-49 R-49
	7spd[2]	rear	48.2	L-31 R-31	150	L-44 R-44
	8spd[2]	rear	48.2	L-26 R-26	150	L-49 R-49
	8spd[2]	rear	48.2	L-29 R-29	155	L-49 R-49
	8spd[2]	rear	48.2	L-31 R-31	160	L-49 R-49

48mm FLANGE DIAMETER (47mm - 52mm)

Generally: medium flange and coaster brakes

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
PHIL WOOD (cont'd)							
	Phil Brake						
		7spd	rear	48,2	L-29 R-19	125	L-34 R-44
		7spd	rear	48,2	L-31 R-21	130	L-34 R-44
		7spd 2	rear	48.2	L-24 R-24	135	L-44 R-44
		8spd	rear	48.2	L-34 R-19	135	L-34 R-49
		7spd 2	rear	48.2	L-26 R-26	140	L-44 R-44
		8spd	rear	48.2	L-31 R-21	140	L-39 R-49
		7spd 2	rear	48.2	L-29 R-29	145	L-44 R-44
		8spd 2	rear	48.2	L-24 R-24	145	L-49 R-49
		7spd 2	rear	48.2	L-31 R-31	150	L-44 R-44
		8spd 2	rear	48.2	L-26 R-26	150	L-49 R-49
		8spd 2	rear	48.2	L-29 R-29	155	L-49 R-49
		8spd 2	rear	48.2	L-31 R-31	160	L-49 R-49
	Standard Brake						
		7spd	rear	48.2	L-33 R-20	126.5	L-30 R-43
		7spd	rear	48.2	L-31 R-21	130	L-34 R-44
		7spd 2	rear	48.2	L-24 R-24	135	L-44 R-44
		8spd	rear	48.2	L-34 R-19	135	L-34 R-49
		7spd 2	rear	48.2	L-26 R-26	140	L-44 R-44
		8spd	rear	48.2	L-31 R-21	140	L-39 R-49
		7spd 2	rear	48.2	L-29 R-29	145	L-44 R-44
		8spd	rear	48.2	L-24 R-24	145	L-49 R-49
		7spd 2	rear	48.2	L-31 R-31	150	L-44 R-44
		8spd	rear	48.2	L-26 R-26	150	L-49 R-49
		8spd	rear	48.2	L-29 R-29	155	L-49 R-49
Front Brake Hubs and Front Suspension Brake Hubs							
	Standard Broke	8spd2	rear	48.2	L-31 R-31	160	L-49 R-49
			front	** L-57.5R-48.2	L-23 R-30	100	L-28 R-20
			front	** L-57.5R-48.2	L-28 R-30	110	L-28 R-25
			front	48.2	L-29 R-29	115	L-29 R-29
	Phil Brake		front	** L-67.5R-48.2	L-21 R-32	100	L-27 R-19
			front	** L-57.5R-48.2	L-26 R-32	110	L-28 R-23
			front	48.2	L-29 R-29	115	L-29 R-29
Specialty							
	Front Pursuit		front	48.2	19	80	21
	Symmetric-Time Trial	7spd	rear	48.2	L-20 R-20	126.5	L-43 R-43
		7spd	rear	48.2	L-22 R-22	130	L-43 R-43

SPOKE LENGTHS

48mm FLANGE DIAMETER (47mm - 52mm)

Generally: medium flange and coaster brakes

Make	Model		Front/ Rear	Flange Diameter	Hub Center– Flange Center	Over Lock-nuts	Locknuts- Flange Center
PHIL WOOD (cont'd)							
Specialty							
	Asymmetric-Specialty	7spd	rear	** L-48.2 R-67.5	L-35 R-18	120	L-25 R-42
		8spd	rear	** L-48.2R-67.5	L-35 R-18	130	L-30 R-47
FSA BMX							
	Standard		front	48.2	35	100	15
	Symmetric	Flip-Flop	rear	48.2	L-28 R-28	110	L-27 R-27
		1spd	rear	48.2	L-28 R-28	110	L-27 R-27
		1 spd	rear	48.2	L-28 R-28	117	L-31 R-31
		1spd	rear	48.2	L-28 R-28	120	L-33 R-33
	Annihilator		front	48.2	33	95	15
			front	48.2	33	100	18
		1spd	rear	48.2	L-27 R-27	110	L-28 R-28
PULSTAR[4]	8spd cassette	32 holes	rear	47.2	L-33 R-21	135	L-35 R-47
	threaded	36 holes	rear	50.7	L-32 R-24	136	L-36 R-44
	suspension	32 holes	front	47.6	33	100	17
		36 holes	front	50.8	33	100	17
	8spd cassette	32 holes	rear	47.1	L-29 R-21	135	L-39 R-47
	8spd cassette	36 holes	rear	49.6	L-29 R-20	135	L-39 R-48
	threaded	32 holes	rear	47.6	L-35 R-24	135	L-33 R-44
REVCORE		**BMX**	**rear**	**46.5**	L-29 R-28	109	L-26 R-26
SACHS							
Jet	T1110	coaster	rear	50	L-25 R-26	105	L-28 R-27
	T1110		rear	50	L-24 R-26	100	L-26 R-24
	T1110		rear	50	L-26 R-26	111	L-30 R-30
Komet	T1112	coaster	rear	50	L-25 R-26	109	L-30 R-29
Torpedo		coaster	rear	52.6	L-27 R-26	117	L-32 R-32
SANSIN	Gyromaster		rear	46	L-33 R-19	126	L-30 R-44
			rear	46	L-30 R-24	135	L-38 R-44
SHIMANO	D-Type Coaster		rear	51	L-29 R-27	109	L-25 R-27
SPECIALIZED	**BMX**		rear	46	*L-27* **R-24**	**110**	L-27 R-31
STURMEY ARCHER							
	BF/C drum brake 90mm		front	*** L-1023 R-48	L-25 R-29	100	L-25 R-21
SUNSHINE	BMX Sealed Bearing		front	52	*23*	100	27

SPOKE LENGTHS

48mm FLANGE DIAMETER (47mm - 52mm)

Generally: medium flange and coaster brakes

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
SUNTOUR	BMX Coaster		rear	51.5	L-28 R-27	110	L-27 R-28
WCW	CR	C.D.	rear	* L-38.6 R-46.2	L-39 R-21	135	L-29 R-47
		H.G.	rear	* L-38.6 R-46.2	L-37 R-23	136	L-31 R-45
		M.D.	rear	* L-38.6 R-46.2	L-37 R-22	134	L-30 R-45
		threaded	rear	* L-38.6 R-46.2	L-37 R-21	135	L-31 R-47

48mm footnotes

* See Spoke Length chart for 31, 34, 40, and 45mm Flange Diameter for small flange side of hub.

** See Spoke Length chart for 58, 67mm Flange Diameter for large flange side of hub.

*** See Spoke Length chart for 102.5mm Flange Diameter for large flange side of hub.

1 Spoke heads are alternately recessed (chamfered) on the flange.

2 Symmetric (non-dished) rear wheel configuration.

3 Bolt-on.

4 Add 5mm to all spoke lengths. 28-hole and 32-hole work only for 3-cross.
36-hole hubs work only for 4-cross. Ignore the fact that the spoke heads cross at the flange.

58mm FLANGE DIAMETER (53mm - 60mm)

Generally: ATB rear, large flange front and internally geared 3 speeds

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
BULLSEYE	BMX-large flange		front	53.5	36	93	11
	BMX-large flange		rear	54	L-33 R-27	111	L-22 R-28
UNION/HUGI	disc/splined	7spd	rear	56	L-35 R-22	135	L-33 R-46
	or threaded	8spd	rear	56	L-37 R-20	135	L-31 R-48
		8spd	rear	56	L-33 R-24	140	L-37 R-46
PHIL WOOD							
Front Suspension			front	57.5	36	100	14
			front	57.5	36	110	19
			front	57.5	36	115	21
Front Suspension Brake Hubs							
Standard Brake			front	* L-57.5 R-48.2	L-23 R-30	100	L-27 R-20
			front	* L-57.5 R-48.2	L-28 R-30	110	L-28 R-25
Phil Brake			front	* L-57.5 R-48.2	L-26 R-32	110	L-28 R-23

SPOKE LENGTHS

58mm FLANGE DIAMETER (53mm - 60mm)

Generally: ATB rear, large flange front and internally geared 3 speeds

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
PHIL WOOD/Front Suspension Brake Hubs (coned)							
Disc Brake Front Hubs			front	57.5	L-22 R-35	100	L-28 R-15
			front	57.5	L-27 R-30	110	L-28 R-25
			front	57.5	L-28 R-29	115	L-30 R-28
MTB		7spd	rear	* L-48.2 R-57.5	L-38 R-20	126.5	L-25 R-43
		7spd	rear	* L-48.2 R-57.5	L-37 R-21	130	L-28 R-44
		8spd	rear	* L-48.2 R-57.5	L-40 R-18	130	L-25 R-47
		7spd	rear	* L-48.2 R-57.5	L-34 R-24	135	L-34 R-44
		8spd	rear	* L-48.2 R-57.5	L-39 R-19	135	L-29 R-49
		7spd	rear	* L-48.2 R-57.5	L-32 R-26	140	L-38 R-44
		8spd	rear	* L-48.2 R-57.5	L-37 R-21	140	L-33 R-49
SACHS							
Komet	Super ❏		rear	55	L-28 R-27	112	L-28 R-29
Torpedo	Duomatic		rear	58	L-24 R-27	112	L-32 R-29
Torpedo	3-Speed S	coaster brake	rear	58	L-26 R-25	117	1-33 R-34
Torpedo	3-Speed		rear	58	L-26 R-25	117	L-33 R-34
SHIMANO							
Coaster Brake	Type A		rear	56	L-28 R-29	110	L-27 R-26
	Type B		rear	56	L-27 R-28	105	L-26 R-24
3-Speed	Cartridge		rear	59	L-29 R-30	110	L-26 R-25
	F		rear	59	L-25 R-26	110	L-30 R-29
3-Speed Coaster Brake							
	35C		rear	59	L-26 R-26	114	L-31 R-31
	3CC		rear	59.5	L-21 R-30	122	L-40 R-31
STURMEY	Coaster Brake SC.1		rear	53	L-25 R-24	107	L-29 R-29
WHITE TI	Cassette	7spd	rear	55	L-36 R-23	130	L-30 R-43
			rear	55	L-36 R-23	135	L-32 R-45
		8spd	rear	55	L-38 R-20	130	L-27 R-45
			rear	55	L-38 R-20	135	L-30 R-48
WILDERNESS TRAILS							
	126		rear	59	L-27 R-27	126	L-35 R-35
	131		rear	59	L-30 R-25	131	L-35 R-41
	136		rear	59	L-27 R-27	136	L-41 R-41
	141		rear	59	L-27 R-27	141	L-43 R-44

58mm footnotes

* See Spoke Length charts for 48mm Flange Diameter for small flange side of hub.

63mm FLANGE DIAMETER (60mm - 64mm)

Generally: fair to good quality large flange front and rear hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center- Flange Center	Over Lock- nuts	Locknuts- Flange Center
ACS	10827	B.O.3 alloy	front	63	32	100	18
	10828	B.O.3 alloy	rear	63	L-27 R-27	110	L-28 R-28
	R.L. Hub –Free Coaster		rear	62.5	L-30 R-26	112	L-24 R-28
GT	Superlace		front	61.4	35	95	13
		Flip-Flop	rear	61.4	L-28 R-27	112	L-28 R-29
JOY TECH	BMX		front	62	34	93	12
	BMX		rear	62	L-27 R-27	112	L-29 R-29
KING KONG KT	H-480988	sealed	front	63	31	100	19
	H-480986	B.O.3 alloy	rear	63	L-27 R-27	115	L-31 R-31
MAILLARD		B.O.3-sealed	rear	62	L-38 R-20	126	L-25 R-43
NORMANDY		Q.R. sealed	front	62	36	97	13
		B.O.3-sealed	front	62	36	95	12
PEREGRINE		B.O.3 steel	front	62.5	34	100	16
		sealed	rear	62.5	L-27 R-26	110	L-28 R-29
PMC	BMX	6061	front	63.6	34	100	16
		Flip-Flop	rear	65	L-31 R-31	115	L-27 *R-27*
SANSIN	AE-15A		front	62.5	31	95	17
	Tandem		front	62.6	33	100	17
			rear	62.6	L-30 R-23	136	L-38 R-45
	Tandem Drum		rear	62.3	L-33 R-24	140	L-37 R-46
SHIMANO *Deore XT*	HB-MN72-QR		front	62.5	35	100	15
	FH-MN72-QR		rear	62.5	L-30 R-24	126	L-33 R-39
	FH-MN72-QR		rear	62.5	L-36 R-19	130	L-29 R-46
	FH-MN72-NT		front	62.5	35	100	15
	FH-MN72-NT	5spd	rear	62.5	L-30 R-24	126	L-33 R-39
		6spd	rear	62.5	L-34 R-21	130	L-31 R-44
SUNSHINE	BMX		front	61.5	35	93	12
SUNTOUR	BMX		front	63	34	96	13
	Dual Freehub		rear	62	L-27 R-27	111	L-29 R-29

SPOKE LENGTHS

63mm FLANGE DIAMETER (60mm - 64mm)

Generally: fair to good quality large flange front and rear hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
SUZUE							
Wheelchair	WH-3B	B.0.3	rear	62	49	71	
	WH-3C	Q.R.	rear	62.5	49	69	
	CH-1	28H	front	62	25	71	11
BMX	SIL-BMX		front	62.5	32	97	17
			rear	62.5	L-27 R-27	109	L-28 R-28
	SIL-SB-BMX		front	63	**31**	96	17
			rear	62.5	L-26 R-26	110	L-29 R-29
Tandem			front	63	35	100	15
			rear	63	L-27 R-27	140	L-43 R-43

63mm footnotes

3 Bolt-on.

SPOKE LENGTHS

67mm FLANGE DIAMETER (65mm - 69mm)

Generally: quality large flange front and rear hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
CAMPAGNOLO							
NEW	Centaur	6,7spd	rear	67.5	L-36 R-21	126.5	L-27 R-43
		6,7spd	rear	67.5	L-37 R-17	130	L-28 R-48
	Euclid	6,7spd	rear	67.5	L-37 R-17	130	L-28 R-48
OLD	Record		front	67,5	34	100	16
		5spd	rear	67.5	L-34 R-22	120	L-26 R-38
		6,7spd	rear	67.5	L-36 R-21	126.5	L-27 R-43
	Nuovo Record	5spd	rear	67.5	L-34 R-22	120	L-26 R-38
	Gran Sport	5spd	rear	67.5	L-34 R-18	120	L-27 R-40
	Gran Sport	5spd	rear	67.5	L-34 R-18	121.5	L-27 R-43
	Super Record Track		rear	67.5	L-44 R-31	120	L-16 R-29
	Record Track		rear	67.5	L-44 R-31	120	L-16 R-29
	Nuovo Record Track		rear	67.5	L-44 R-31	120	L-16 R-29
	C-Record Track		rear	67.5	L-44 R-31	120	L-16 R-29
	Tandem		front	65	32	100	18
	Tandem	8spd	rear	65	L-36 R-20	140	L-34 R-50
	Mtn. Tandem	7spd	rear	65	L-36 R-20	140	L-34 R-50
HI-E	121		rear	67	L-35 R-24	121	L-26 R-37
	127		rear	67	L-38 R-21	127	L-25 R-43
	130		rear	67	L-36 R-23	130	L-29 R-43
	131		rear	67	L-40 R-18	131	L-25 R-47
PHIL WOOD							
Track			front.	67.5	34	100	16
			rear	67.5	L-44 R-29	120	L-16 R-31
		2spd [2]	rear	67.5	L-29 R-29	120	L-31 R-31
		1spd	rear	67.5	L-44 R-29	126.5	L-20 R-34
		1 spd	rear	67.5	L-29 R-29	130	L-36 R-36
Tandem			front	67.5	34	100	16
			front	67.5	34	110	21
		7spd	rear	67.5	L-33 R-19	126.5	L-31 R-44
		7spd	rear	67.5	L-31 R-21	130	L-34 R-44
		7spd [2]	rear	67.5	L-23 R-23	135	L-44 R-44
		8spd	rear	67.5	L-33 R-18	135	L-34 R-49
		7spd [2]	rear	67.5	L-26 R-26	140	L-44 R-44
		8spd [2]	rear	67.5	L-31 R-21	140	L-39 R-49
		7spd [2]	rear	67.5	L-28 R-28	145	L-44 R-44
		8spd [2]	rear	67.5	L-23 R-23	145	L-49 R-49

SPOKE LENGTHS

67MM FLANGE DIAMETER (65mm - 69mm)

Generally: quality large flange front and rear hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
PHIL WOOD (cont'd)							
Tandem?		7spd [2]	rear	67.5	L-31 R-31	150	L-44 R-44
		8spd [2]	rear	67.5	L-26 R-26	150	L-49 R-49
		8spd [2]	rear	67.5	L-28 R-28	155	L-49 R-49
		8spd [2]	rear	67,5	L-31 R-31	160	L-49 R-49
Tandem Brake Hubs							
	Arai Brake	7spd [2]	rear	67.5	L-23 R-23	135	L-44 R-44
		7spd [2]	rear	67.5	L-26 R-26	140	L-44 R-44
		8spd	rear	67.5	L-26 R-21	140	L-44 R-49
		7spd [2]	rear	67.5	L-28 R-28	145	L-44 R-44
		8spd [2]	rear	67.5	L-23 R-23	145	L-50 R-50
		7spd [2]	rear	67.5	L-31 R-31	150	L-44 R-44
		8spd [2]	rear	67.5	L-26 R-26	150	L-49 R-49
		8spd [2]	rear	67.5	L-28 R-28	155	L-49 R-49
		8spd [2]	rear	67.5	L-31 R-31	160	L-49 R-49
	Phil Brake	7spd	rear	67.5	L-28 R-18	125	L-34 R-44
		7spd	rear	67.5	L-31 R-21	130	L-34 R-44
		7spd [2]	rear	67.5	L-23 R-23	135	L-44 R-44
		8spd	rear	67.5	L-33 R-18	135	L-34 R-49
		7spd [2]	rear	67.5	L-26 R-26	140	L-44 R-44
		8spd	rear	67.5	L-31 R-21	140	L-39 R-49
		7spd [2]	rear	67.5	L-28 R-28	145	L-45 R-44
		8spd [2]	rear	67.5	L-23 R-23	145	L-49 R-49
		7spd [2]	rear	67.5	L-31 R-31	150	L-44 R-44
		8spd [2]	rear	67.5	L-26 R-26	150	L-49 R-49
		8spd [2]	rear	67.5	L-28 R-28	155	L-49 R-49
		8spd [2]	rear	67.5	L-31 R-31	160	L-49 R-49
	Standard Brake	7spd	rear	67.5	L-33 R-19	126.5	L-31 R-44
		7spd	rear	67.5	L-31 R-21	130	L-34 R-44
		7spd [2]	rear	67.5	L-23 R-23	135	L-45 R-45
		8spd	rear	67.5	L-33 R-18	135	L-34 R-49
		7spd [2]	rear	67.5	L-26 R-26	140	L-44 R-44
		8spd	rear	67.5	L-31 R-21	140	L-39 R-49
		7spd [2]	rear	67.5	L-28 R-28	145	L-44 R-44
		8spd	rear	67.5	L-23 R-23	145	L-49 R-49
		7spd [2]	rear	67.5	L-31 R-31	150	L-44 R-44
		8spd	rear	67.5	L-26 R-26	150	L-49 R-49
		8spd	rear	67.5	L-28 R-28	155	L-49 R-49
		8spd	rear	67.5	L-31 R-31	160	L-49 R-49

67MM FLANGE DIAMETER (65mm - 69mm)

Generally: quality large flange front and rear hubs

Make	Model		Front/ Rear	Flange Diameter		Center— Flange Center		Over Lock- nuts	Locknuts- Flange Center	
PHIL WOOD (cont'd)										
Front Brake Hubs and Front Suspension										
Standard Brake			front	67.5		27		110	28	
			front	67.5		28		115	29	
Phil Brake			front	67.5		25		110	29	
			front	67.5		28		115	29	
BMX										
F SA			front	67.5				100	16	
			front	67.5				110	21	
		Flip-Flop	rear	67.5		*27*	R-27	110	L-28	R-28
			rear	67.5		27	R-27	110	L-28	R-28
		1spd	rear	67.5		'27	R-27	117	L-31	R-31
		1spd	rear	67.5		27	R-27	120	L-33	R-33
SACHS										
Orbit	Standard	5spd	rear	67		35	R-22	122	L-26	R-39
		6spd	rear	* L-67	R-54	-36	R-19	126	L-27	R-44
		7spd	rear	* L-67	R-54	L-39	R-18	130	L-26	R-47
	ATB	6spd	rear	* L-67	R-54	L-38	R-19	126	L-25	R-44
		7spd	rear	* L-67	R-54	L-39	R-18	130	L-26	R-47
3x7	H21101		rear	* 67		L-37	R-18	130	L-28	R-47
Pentasport	HS103	standard	rear	175		L-30	R-29	122	L-31	R-32
	H5113	coaster	rear	175		L-30	R-29	122	L-31	R-32
	H5213 5 spd	push-pull	rear	175		L-30	R-29	122	L-31	R-32
Super 7	H7201		rear	175		L-36	R-33	130	L-29	R-32
	H7213	coaster	rear	175		L-36	R-33	130	L-29	R-32
SANSIN	Track		front	67		34		100	16	
			rear	67		L-39	R-39	136	L-29	R-29
SHIMANO										
Dura-Ace	HB-7600	track	front	67		35		100	15	
Duro-Ace	HB-7600	track	rear	67		L-41	R-31	120	L-19	R-29
STURMEY ARCHER										
AW, 55			rear	65		L-29	R-27	110	L-26	R-28
S3C			rear	65		L-30	R-25	115	L-28	R-33
ABC	Drum brake	3spd	rear	** L-102.5	R-66	L-40	R-26	117	L-19	R-33
SABC	Steellite drum brake 3spd		rear	L-84	R-65	L-35	R-26	118	L-24	R-33

SPOKE LENGTHS

67mm FLANGE DIAMETER (65mm - 69mm)

Generally: quality large flange front and rear hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
SUNTOUR		3spd	rear	65	1-28 R-26	111	L-27 R-29
		track	front	67.5	31	100	19
			rear	67.5	L-36 R-31	119	L-24 *R-28*

67mm footnotes

* See Spoke Length charts for 58mm Flange Diameter for small Flange side of hub.

** See Spoke Length charts for 102.5mm Flange Diameter for large flange side of hub.

1 Use 67mm charts. Add 1.6mm to spoke length on 36-hole.

2 Symmetric.

90mm FLANGE DIAMETER (80mm - 90mm)

Generally: aluminum shell and drum brakes

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
BENDIX	2-speed		rear	80	L-29 R-30	117	30
SACHS							
Orbit	Drum Brake	6spd	rear	90	L-36 R-19	126	L-27 R-44
		7spd	rear	90	L-37 R-18	130	L-28 R-47
	ATB Drum	6spd	rear	90	L-36 R-19	126	L-27 R-44
		7spd	rear	90	L-37 R-18	130	L-28 R-47
Drum Brakes	VT3000		front	87	26	100	24
	HT3020	5spd	rear	87	L-33 R-19	122	L-28 R-42
		6spd	rear	87	L-36 R-16	124	L-26 R-46
		6spd	rear	87	L-35 R-17	126	L-28 R-46
	VT5000		front	90	L-30 R-26	100	L-20 R-24
	HT5020	5spd	rear	90	L-36 R-21	122	L-25 R-40
		6spd	rear	90	L-37 R-19	126	L-26 R-44
		7spd	rear	90	L-37 R-19	130	L-28 R-46
	VT7000		front	90	L-30 R-26	100	L-20 R-24
	HT7020	6spd	rear	90	L-37 R-19	126	L-26 R-44
		7spd	rear	90	L-37 R-19	130	L-28 R-46
Galaxie	HT5320		rear	87	L-34 R-21	*122*	L-27 R-40
Galaxie	HT6320		rear	87	L-36 R-19	126	L-27 R-44

SPOKE LENGTHS

90mm FLANGE DIAMETER (80mm - 90mm)

Generally: aluminum shell and drum brakes

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
SACHS (contd)							
Super 7	H7220	drum	rear	90	L-36 R-35	135	L-32 R-33
Pentasport	H5120	drum	rear	90	L-30 R-31	126	L-33 R-32
STURMEY ARCHER							
SABC	Steellite drum brake 3spd		rear	* L-84 R-65	L-35 R-26	118	L-24 R-33
SBFC	Steellite drum brake		front	83	L-22 R-29	100	L-28 R-21
SBRC	Freewheel/drum brake		rear	83	L-37 R-20	126	L-26 R-43
Elite ST	Freewheel/drum brake		rear	90	L-43 R-18	127	L-21 R-46
Elite VT	Drum brake		front	90	27	100	23
AT3	Hub brake	3spd	rear	90	L-36 R-25	118	L-23 R-34
AT5	Hub brake	5spd	rear	90	L-38 R-25	117	L-21 R-34

90mm footnotes

* See Spoke Length charts for 67mm Flange Diameter for small flange side of hub.

102.5mm FLANGE DIAMETER (102.5mm - 112mm)

Generally: brake hubs and dyno hubs

Make	Model	Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
STURMEY ARCHER						
AW Dyno Hub		rear	112	L-40 R-32	111	L-16 R-24
BFC	drum brake 90mm	front	* L-102.6 R-48	L-25 R-29	100	L-25 R-21
ABC	drum brake 90mm	rear	* L-102.5 R-66	L-40 R-26	117	L-19 R-33

102mm footnotes

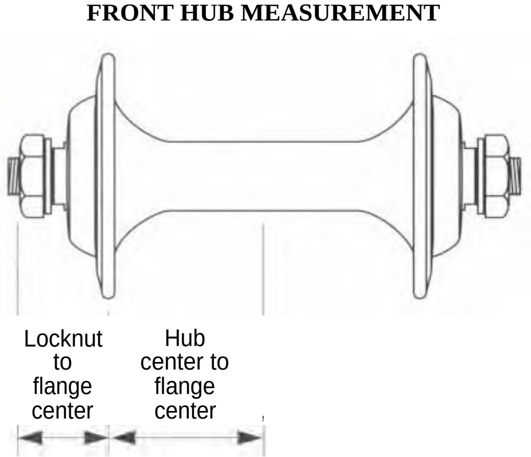
* See Spoke Length charts for 48 and 67mm Flange Diameter for small flange side of hub.

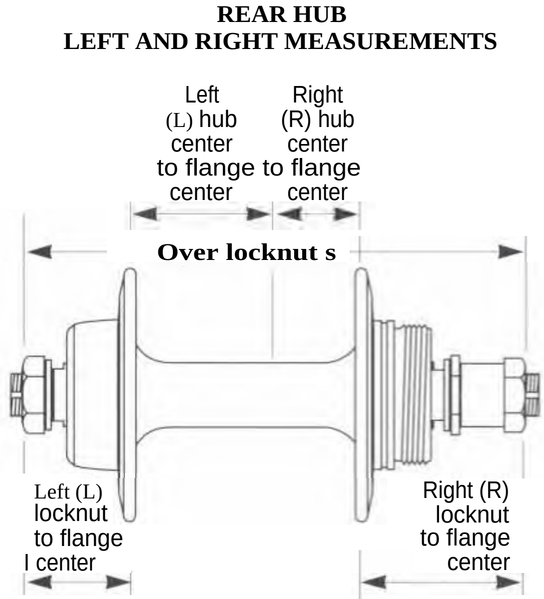
SPOKE LENGTHS

SUTHERLAND'S

CALCULATING SPOKE LENGTH

1st Step (cont'd)





34mm FLANGE DIAMETER (33mm - 36mm)

Generally: fair to good quality small flange front hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center—Flange Center	Over Lock-nuts	Locknuts-Flange Center
NUKE PROOF	OEM	aluminum	front	35.5	38	1 00	1 2

40mm FLANGE DIAMETER (37mm - 42mm)

Generally: good to high quality small flange front hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center—Flange Center	Over Lock-nuts	Locknuts-Flange Center
ANSWER	Manitou-EFC	suspension	front	38	40	1 00	N/A
FALCON	Dynahub	MTB Q.R.	front	38	35	100	15
		Road Q.R.	front	40	32	1 00	1 8
KING	suspension		front	40	37	100	1 3
NUKE PROOF	Bomb Shell	carbon	front	42	33	100	1 7
PRIMO	Standard	BMX9	front	38.1	32	96	1 6
	Pro-Comp	BMX9	front	38.4	32	96	1 6

SPOKE LENGTHS

40mm FLANGE DIAMETER (37mm - 42mm)

Generally: good to high quality small flange front hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center– Flange ter	Over	knuts- ge er
SHIMANO							
Deore (Japan)	HB-MT60		front	38			
Deore (Japan)	HB-MT60	B.0.2	front	38			
105 (SC)	HB-1055		front	38			
RSX *(SH)*	HB-A410		front	38.2			
XTR	HB-M900		front	38			
Deore XT (SA)	HB-M738	parallax	front	38.1			
STX-RC (51)	HB-MC33	parallax	front	38.2			
Acera X(S1)	HB-M290	parallax	front	38.2			
TREK	System 2[8]		front	40	36	100	1 4
	System 3[8]		front	40			
UNION/HOPE	Fatso	suspension	front	40.9			
		suspension	front	41			
	Be Fast	road/MTB	front	41			
	TI-glide	7,8spd cassette	rear	40.9			
	TI-glide	7,8spd cassette	rear	41			
WILDERNESS TRAILS	Momentum		front	40			
DPP	MTB		front	42.2			
	Road	7,8spd cassette	rear	42.3			
	Road	8spd threaded	rear	41.5			

40mm footnotes

See Spoke Length chart for 40, 44.5, and 48mm Flange Diameter for large flange side of huh.

** See Spoke Length chart for 31mm Flange Diameter for small flange side of hub.

1 7-speed cassette with added 11-tooth cog.

2 Bolt-on.

3 19 and 25mm axle end caps available.

4 1 9 and 31.5mm axle end caps available.

5 All Pulstar hubs require straight-pull spokes. Add 5mm to ail spoke lengths.
28-hole and 32-hole work only for 3-cross. 36-hole hubs work only for 4-cross.

6 Fits Shimano cassettes.

7 15mm axle end cap.

8 System 2 - cup and cone bearing, System 3 - cartridge bearing.

9 Allen locking cone.

SPOKE LENGTHS

44.5mm FLANGE DIAMETER (43mm - 46mm)

Generally: small flange rear hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center—Flange Center	Over Lock-nuts	Locknuts-Flange Center
AMERICAN CLASSIC							
	Speed		front	43	34	100	16
	Speed	threaded	rear	43	L-41 R-17	130	L-24 R-48
		7,8spd cassette	rear	43	L-28 R-19	130	L-37 R-46
	Track		rear	44	L-35 R-23	126	L-28 R-40
CODA	900R	cassette	rear	43.4	L-38 R-21	135	L-30 R-47
FALCON		Road Q.R.	rear	45.7	L-34 R-19	130	L-31 R-46
	Dynahub	MTB	rear	45.2	L-33 R-23	135	L-35 R-45
GILA	suspension6		front	42.7	38	100	12
MACHINE TECH							
	Hollow Core	7,8spd[8]	rear	42.7	L-35 R-21	135	L-33 R-46
MOUNTAIN CYCLE							
	Disc-splined[8,9]		front	44.9	L-21 R-32	100	L-29 R-18
	Disc-threaded	7,8spd[8,9]	rear	44.9	L-34 R-21	135	L-34 R-47
PRIMO	Standard10	BMX Flip Flop	rear	43.6	L-28 R-28	114	L-29 R-29
	Pro-Comp[10]	BMX Flip Flop	rear	41.7	L-28 R-28	114	L-29 R-29
SHIMANO							
XTR (RIG)	FH-M900		rear	45	L-35 R-22	135	L-33 R-46
XT (SK)	FH-M737	8spd para	rear	45	L-35 R-21	135	L-33 R-47
STX-RC *(IS)*	FH-MC33	7spd	rear	45	L-34 R-23	135	L-34 R-45
Acera-X (SC)	FH-M290	7spd para	rear	45	L-34 R-22	135	L-34 R-46
RSX (SE)	F H-A410	7spd	rear	45	L-35 R-19	130	L-30 R-46
Alivio (TA)	FH-MC12	7spd	rear	45	L-34 R-24	135	L-34 R-44
TNT	Hard Drive		front	44.8	38	100	12
	Hard Drive		rear	44.9	L-34 R-21	135	L-34 R-47
UNION	Be Fast"	7spd road	rear	L-44 R-48	L-36 R-20	130	L-29 R-45
	Be Fast"	7,8spd MTB	rear	L-44 R-48	L-35 R-21	135	L-33 R-47
ZIPP	Road		front	43	37	100	13

44.5mm footnotes

6 22mm axle end cap.

8 20mm axle end cap.

9 Splined to fit Pro-Stop disc brakes.

10 Allen locking cone.

11 L-19mm and R-22mm axle end cap.

SPOKE LENGTHS

48mm FLANGE DIAMETER (47mm - 52mm)

Generally: medium flange and coaster brakes

Make	Model		Front/ Rear	Flange Diameter		Hub Center—Flange Center	Over Lock-nuts	Locknuts-Flange Center	
FALCON	Type D	coaster	rear	51		L-28 R-28	109	L-27	R-27
	Type E	coaster	rear	49		L-27 R-23	112	L-29	R-33
			rear	46		L-30 R-24	135	L-38	R-44
UNION	Be Fast	7spd road	rear	L-44	R-48	.-36 R-20	130	L-29	R-45
	Be Fast	7,8s pd MTB	rear	L-44	R-48	.5 R-21	135	L-33	R-47

48mm footnotes

* See Spoke Length chart for 31, 34, 40, and 45mm Flange Diameter for small flange side of hub.

** See Spoke Length chart for 58, 67mm Flange Diameter for large flange side of hub.

*** See Spoke Length chart for 102.5mm Flange Diameter for large flange side of hub.

1 Spoke heads are alternately recessed (chamfered) on the flange.

2 Symmetric (non-dished) rear wheel configuration.

3 Bolt-on.

4 Add 5mm to all spoke lengths. 28-hole and 32-hole work only for 3-cross.
36-hole *hubs* work only for 4-cross. Ignore the fact that the spoke heads cross at the flange.

5 L-19mm and R-22mm axle end cap.

58.m FLANGE DIAMETER (53mm - 60mm)

Generally: ATB rear, large flange front and internally geared 3 speeds

Make	Model		Front/ Rear	Flange Diameter	Hub Center—Flange Center	Over Lock-nuts	Locknuts Flange Center
PERFORMANCE							
	ISOLATOR	suspension	front	53	29	100	21

63MM FLANGE DIAMETER (60mm - 64mm)

Generally: fair to good quality large flange front and rear hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center Flange Center	Over Lock-nuts	Locknuts—' Flange Center
HYPER	BMX	B.0.3	front	61	32	94	15
	BMX	B.0.3	rear	61	L-28 R-29	108	L-26 R-25
STURMEY	Sprinter	5spd w/o brake	rear	65.2	L-35 R-21		L-28 R-42

SPOKE LENGTHS

90mm FLANGE DIAMETER (80mm - 90mm)

Generally: aluminum shell and drum brakes

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
SHIMANO							
	INTER 7	internal 7spd	rear	87	L-29 R-22	130	L-36 R-43
WESTPINE							
	Neutron-HC	suspension	front	91	**34**	100	1 6

1 02.5mm FLANGE DIAMETER (80mm - 90mm)

Generally: brake hubs, dyno hubs and suspension hubs

Make	Model		Front/ Rear	Flange Diameter	Hub Center-Flange Center	Over Lock-nuts	Locknuts-Flange Center
WESTPINE							
	Neutron-DH	suspension	front	112.5	**34**	100	1 6

SPOKE LENGTHS

SUTHERLAND'S

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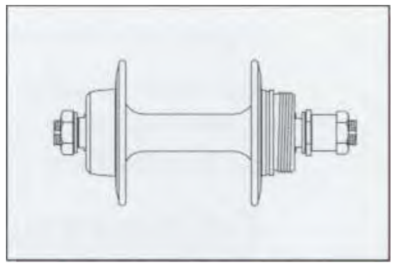


SUTHERLAND'S

27" ROAD SPOKE LENGTHS

2nd Step of 3 steps:

27"and 28" Rims

Count the number of holes in the hub and decide on a spiking pattern, i.e. 4-cross, 3-cross, (4X, 3X) etc. Find the length listed for that combination in the hub flange diameter category selected in step 1. Write down the length. For the right rear of multi-speed freewheel hubs subtract 2mm. *(See below Tor details.)* Adjustments will also be needed for hubs that are different from the specifications below.

27" **Example One:** Shimano Dura-Ace front hub with **32 holes.** Look at the **40mm** hub flange diameter table. For **3X** wheel write down the length **308mm,**

27" **Example Two:** Mavic 500 rear hub with **36 holes.** On the **44.5mm** table a **3X** wheel indicates a length of **305mm** for the *left* side. For the right side use **303 mm.**

The tables on the facing page will give you a length for the theoretical rim diameter of a 630mm rim. Step 3 (rim correction factor) will adjust these lengths for the exact rim you have.

Approximate Dimensions

The following hub dimensions were used for the tables on the opposite page. They are the approximate dimensions for road hike front hubs and the left rear of a road bike rear hub.

Huh center to flange center - **35mm**
Spoke hole diameter - **2.6mm**
Spoke seating and stretch - **0.4mm**

Differences in Hubs

Many hubs differ from the hub dimensions listed above so adjustments may need to he made as follows:

Huh center to flange center - **a 1mm difference will make a 0.1mm difference in final spoke length.**

27" **Example Three:** A front track hub with a **45mm** hub center to flange center is **10mm** wider than the dimensions these tables are based on. Multiplying **10mm** by **0.1mm** you get 1**mm.** Add **1mm to** the final spoke length.

Spoke hole size - a 0.2mm difference in will make a 0.1mm difference in the final spoke length. In practice this is usually not enough difference to matter.

Right Rear Hub Spoke Length

Most right rear road hubs require a shorter spoke. How much shorter varies. Many hubs have a hub center to flange center on the right rear of 20mm. This is a 15mm difference from the tables. Using the guidelines for differences in hub center to flange dimensions, **subtract 1.5mm for the right rear spokes.** This is usually rounded up to 2mm.

These combinations have the same spoke length:

16 hole 1X = 32 hole 2X
20 hole 2X = 40 hole 4X
24 hole 2X = 48 hole 4X

3rd Step - go to page 11-40

27" ROAD SPOKE LENGTHS

31 mm Flange Diameter

	5X	4X	3X	2X	1 X	radial
48						
40						
36		313	308	304*	301*	300*
32			310	305	301*	300*
28			312	306	301*	300*
24				308	302*	300*

34mm Flange Diameter

	5X	4X	3X	2X	1 X	radial
48						
40		310	306	302*	299*	298*
36		,313	307	302*	299*	298*
32			309	304	300*	298*
28			312	305	300*	298*
24				307	301*	298*

40 mm Flange Diameter

	5X	4X	3X	2X	1 X	radial
48	311	306	302	298*	296*	295*
40		310	304	299*	296*	295*
36		312	306	300*	297*	295*
32			308A	302	297*	295*
28			311	303	297*	295*

44.5mm Flange Diameter

	5X	4X	3X	2X	1 X	radial
48	310	305	300	296*	294*	293*
40		309	303	298*	294*	293*
36		ill2	305	299*	295*	293*
32			301	300	295*	293*
28			311	302	295*	293*

48mm Flange Diameter

	5X	4X	3X	2X	1 X	radial
48	310	304	299	295*	292*	291*
40		309	302	296*	293*	291*
36		312	304	297*	293*	291*
32			307	299	293*	291*
28			311	301	294*	291*

58mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	309	302	296	291*	288*	286*
40		308	299	292*	288*	286*
36			302	294*	288*	286*
32			305	296	289*	286*
28			310	298	290*	286*

63mm Flange Diameter

	5X	4X	3X	2X	1 X	radial
48	309	301	294	289*	285*	284*
40		307	298	291*	286*	284*
36		311	301	292*	286*	284*
32				294	287*	284*
28			310	297	287*	284*

67mm Flange Diameter

	5X	4X	3X	2X	1 X	radial
48	308	300	293	287*	283*	*282**
40		307	297	289*	284*	282*
36		311	300	291*	284*	282*
32			304	293	285*	282*
28			310	296	286*	282*

90mm Flange Diameter

	5X	4X	3X	2X	1 X	radial
48	307	295	285	277*	272*	271*
40		304	291	280*	273*	271*
36			9	282 k	274*	271*
32			01	285*	274*	271*
28			308	290*	276*	271*

102.5mm Flange Diameter

	5X	4X	3X	2X	1 X	radial
48		293	282	272*	266*	264*
40			288	276*	267*	264*
36			293	278*	268*	264*
32			299	282	269*	264*

* Hubs using these combinations must match the diameter category exactly for accurate results. *(See drawings and text page* **on** *11-4.)*

27" ROAD SPOKE LENGTHS

3rd Step of 3 steps:

27" and 28" Rims

Find the rim in the tables below. Subtract the rim correction factor from the number you came up with in step 2. The answer is the final length of the spoke you need.

Identifying Rims

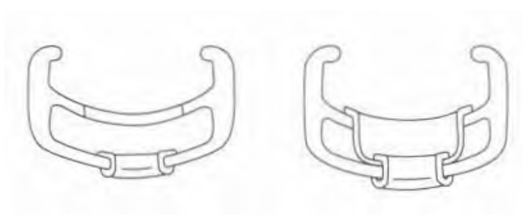
Rims arc grouped in descending order by bead seat diameters. ISO rim markings are used in these tables to help distinguish the various models of rims. For an explanation of these markings, *(see page 12-3.)*

The rim cross section drawings are not exact representations of each rim.

Unless noted otherwise, rims listed do not have eyelets or dimples.

27" Example One: Dura-Ace front hub with an Araya **SS-40 27 x 1 1/8** rim. Rim correction factor for this rim is **-6.** The length from step 2 is **308. 308** minus **6** is **302. 302** is the final length.

27" Example Two: Mavic rear hub with a Mavic **700C Open 4** rim. The rim correction factor for this rim is **-12.** The lengths from step 2 are **305** minus **12** is **293** and **303** minus **12** is **291. 293** and **291 are** the final lengths.



28 x11/2"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	steel		24-635	Model 1	2	627
Sturmey-Archer	steel		24-635	EA 4	3	624
			25-635	F	2	625

27 x 1 1/4", 27 x 1 1/8" 27 x 1"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Spoke End Dia.
Akront	alloy		13-630	50	5	621
Ambrosio	alloy		14-630 with single eyelets	Elite	-5	6201
			14-630 with rim washers	Aero Elite	9	611

Alesa—see Weinmann (use old reference numbers)

27" ROAD SPOKE LENGTHS

27 x 1 1/4", 27 x 11/2", 27 x 1 " (contd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	alloy		14-630	S5-45	-5	621
			16-630	16A(5)	-4	622
			17-630	18	-3	624
			17-630	5P-30	-4	622
			19-630	16A(3)	-3	623
			13-630 with double eyelets	20A	-6	618
			14-630 with double eyelets	5S-40	-6	618
			14-630 with rim washers	Aero 1W (ADX-1W)	-8	615
			16-630	Aero 2W (ADX-2W)	-10	610
			**20-630**	15	-4	623
	steel		16-630	Aero 4W (ADX-4W)	-6	618
			16.5-630	5H	-3	624
			20-630	5	-3	624
CMC	steel		18-630		-4	622
Femco	steel		18-630	**5**	-3	623
Fiamme	alloy		14-630 with single eyelets	80-Elan	-5	**603**
			18-630	71-Sport	-2	609
M.O. Mfg.	steel		20-630		-3	614
Marzorati MP	**alloy**		18-630		-3	
Matrix	alloy		17-630 with single eyelets	Titan T	-4	622
			13-630 with single eyelets	Titan	-6	618
			13-630 with single eyelets	Titan Tour	-8	613
			12-630	ISO C	-12	605
			13-630	ISO C II	-10	609
Magic	alloy		13-630 with double eyelets	G40	-6	619
			13-630 with double eyelets	MA 2	-6	618
			13-630 with double eyelets	MA 40	-6	618

27" ROAD SPOKE LENGTHS

27x 1 1/4", 27 x 1 1/8", 27 x 1" (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Magic (coned)	alloy		13-630 with single eyelets	Moldule E	-5	620
			13-630 with double eyelets	Module E2	-4	621
			13-630 with single eyelets	MA	-6	618
			15-630 with double eyelets	Module 3D Argent	-6	619
			15-630 with single eyelets	Module 3	-6	618
			19-630 with double eyelets	Module 4	-6	618
Milremo—see Wolber						
Mistral—see Sun Metal						
M.O. Mfg.	steel		20-630		-3	614
Nisi	alloy		20-630	Sport-Toro-Strettisimo	-5	620
Rigida	alloy		13-630 with single eyelets	AL 13/20	-6	618
			13-630 with single eyelets	Rush	-6	618
			16-630 with single eyelets	AL 16/22	-4	622
	steel		17-630	Deco 30	-4	622
			21-630	Deco 35	-4	623
Salurae	alloy		16-630 with single eyelets	C22	-4	622
(Specialized)			14-630 with double eyelets	HC19	-4	622
			15-630 with double eyelets	C20	-4	622
Schwinn	steel		20-630	S-6	-5	620
Sturmey-Archer	steel		20-630	EA25.0	-4	
			20-630	K25.0	-2	626
Sun Metal	alloy		17-630	L17	-5	620
			18-630 with single eyelets	M17	-5	620
			20-630	L20	-7	616
			20-630 with single eyelets	M20	-5	620
			25-630 with single eyelets	M25	-5	619
			13-630	L13	-6	618
			13-630 with single eyelets	M13	-6	618

27" ROAD SPOKE LENGTHS

27 x 1 1/4", 27 x Ws", 27 x 1" (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Sun Metal (cont'd)			13-630 with single eyelets	M1311	-6	618
			13-630 with single eyelets	M1 31_	-6	618
			16-630	C16	-6	619
			16-630	CR16	-8	615
			14-630	M14A pre '91	-8	614
			14-630	M14A '91 & after	-10	611
	steel		18-630	Style L	-3	624
Torelli	alloy		13-630 with single eyelets	Expert 27"	-6	617
Ukai—see similar Araya model:						
Velocity	alloy		16-630	Twin Hollow	-5	619
Weinmann (old reference numbers in parentheses)						
	alloy		15-630	2115	-4	622
			16-630	2115 (716, 416, 116)	-4	622
			16-630 with dimples	2115 (716, 416, 116)	-5	620
			16-630 with single eyelets	2115 (716, 416, 116)	-3	624
			17-630	(256)	-2	626
			13-630 with double eyelets	231 3 (913 SQR)	-7	615
			13-630 with single eyelets	(613)	-7	615
			14-630 with single eyelets	(513 5)	-5	619
			17-630 with double eyelets	2317 (917 SQR)	-7	615
			14-630	(514/AI24)	-2	625
			16-630	(516/AI29)	-3	624
			16-630 with single eyelets	(516/AI29)	-2	625
	alloy		15-630	2215 (415X)	-2	625
Wolber	alloy		14-630 with double eyelets	Gentleman GTA2	-4	622
			14-630 with double eyelets	Gentleman GTX	-4	622

27" ROAD SPOKE LENGTHS

27x 1 1/4" 27 x 1 1/8", 27 x 1 " (contd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Wolber/Super Champion						
	alloy		17-630 with single eyelets	**Modele 58**	-4	622
			17-630 with single eyelets	**Modele 59**	-4	622
			14-630 with double eyelets	**T430 Alpine**	-4	622,
			14-630 with single eyelets	**Gentleman 81**	-5	620

27" ROAD SPOKE LENGTHS

3rd Step of 3 steps:

27" and 28" Rims

Find the rim in the tables below. Subtract the rim correction factor from the number you came up with in step 2. The answer is the final length of the spoke you need.

Identifying Rims

Rims are grouped in descending order by bead seat diameters. ISO rim markings are used in these tables to help distinguish the various models of rims. For an explanation of these markings, ***(see page 12-3.)***

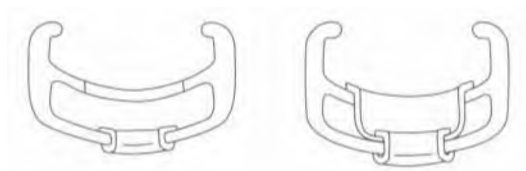
The rim cross section drawings are not exact representations of each rim.

Unless noted otherwise, rims listed do riot have eyelets or dimples.

Example One: Dura-Ace front hub with an Araya **55-40 27 x** rim. Rim correction factor for this rim is **-6.** The length from step 2 is **308. 308** minus **6** is **302** **302** is the final length.

27" Example Two: Mavic rear hub with a Mavic **700C Open 4** rim. The rim correction factor for this rim is **-12.** The lengths from step 2 are **305** minus **12 is 293** and **303** minus **12 is 291. 293** and **291** are the final lengths.

Rim with single eyelet | **Rim with double eyelet**



27 x 11/4" 27 x W8" 27 x 1"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
van Schothorst	steel		18-630	U 24	-4	621
	alloy		17-630	AS 23X	-5	619

27" ROAD SPOKE LENGTHS

700C Rims SPOKE LENGTH

SUTHERLAND'S

7000 ROAD SPOKE LENGTHS

2nd Step of 3 steps

700C Rims

Count the number of holes in the huh and decide on a spoking pattern, i.e. 4-cross, 3-cross, (4X, 3X) etc. Find the length listed for that combination in the huh flange diameter category selected in step 1. Write down the length. For the right rear of multi-speed freewheel hubs subtract 2mm. ***(See below for details.)*** Adjustments will also be needed for hubs that are different fro m the specifications below.

700C Example One: Shimano Dura-Ace front hub with **32 holes.** Look at the **40mm** hub flange diameter table. For **3X** wheel write down the length **308mm.**

700C Example Two: Mavic 500 rear hub with **36 holes.** On the **44.5mm** table a **3X** wheel indicates a length of **305mm** for the left side. For the right side use **303 mm.**

The tables on the facing page will give you a length for the theoretical rim diameter of a 630mm ri m. Step 3 trim correction factor) will adjust these lengths for the exact rim you have.

Approximate Dimensions

The following hub dimensions were used for the tables on the opposite page. They are the approximate dimensions for road bike front hubs and the left rear of a road bike rear hub.

Hub center to flange center - **35mm**
Spoke hole diameter - **2.6mm**
Spoke seating and stretch - **0.4mm**

Differences in Hubs

Many hubs differ from the hub dimensions listed above so adjustments may need to be made as follows:

Huh center to flange center - **a 1mm difference will make a 0.1mm difference in final spoke length.**

700C Example Three: A front track hub with **a 45mm** hub center to flange center , is **10mm** wider than the dimensions these tables are based on. Multiplying **10mm** by **0.1mm** you get **1mm.** Add **1 mm** to the final spoke length.

Spoke hole size - a 0.2mm difference in will make a 0.1 mm difference in the final spoke length. In practice this is usually not enough difference to matter.

Right Rear Hub Spoke Length

Most right rear road hubs require a shorter spoke. How much shorter varies. Many hubs have a hub center to flange center on the right rear of 20mm. This a 15mm difference from the tables. Using the guidelines for differences in huh center to flange dimensions, **subtract 1.5mm for the right rear spokes.** This is usually rounded up to 2mm.

These combinations have the same spoke length:

16 hole 1X = 32 hole 2X
20 hole 2X = 40 hole 4X
24 hole 2X = 48 hole 4X

3rd Step - go to page 11-48

700C ROAD SPOKE LENGTHS

31 mm Flange Diameter

	5X	4X	3X	2X	X	radial
48	—	—	—	—	—	——
40	—					
36		313	308	304*	301*	300*
32			310	305	301*	300*
28			312	306	301*	300*
24				308	302*	300*

34mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48						
40		310	306	302*	299*	298*
36		313	307	302*	299*	298*
32			309	304	300*	298*
28			312	305	300*	298*
24				307	301*	298*

40mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	311	306	302	298*	296*	295*
40		310	304	299*	296*	295*
36		312	306	300*	297*	295*
32				302	297*	295*
28			311	303	297*	295*

44.5mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	310	305	300	296*	294*	293*
40		309	303	298*	294*	293*
36				299*	295*	293*
32				300	295*	293*
28			311	302	295*	293*

48mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	310	304	299	295*	292*	291*
40		309	302	296*	293*	291*
36			304	297*	293*	291*
32			307	299	293*	291 *
28			311	301	294*	291*

58mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	309	302	296	291*	288*	286*
40		308	299	292*	288*	286*
36				294*	288*	286*
32				296	289*	286*
28			310	298	290*	286*

63mm Flange Diameter

	5X	4X	3X	2X		radial
48	309	301	294	289*	285*	284*
40		307	298	291*	286*	284*
36			301	292*	286*	284*
32			305	294	287*	284*
28			310	297	287*	284*

67mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	308	300	293	287*	283*	282*
40		307	297	289*	284*	282*
36		311	00	291*	284*	282*
32			04	293	285*	282*
28			310	296	286*	282*

90mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	307	295	285	277*	272*	271*
40		304	291	280*	273*	271*
36		311	295	282*	274*	271*
32			301	285*	274*	271*
28			308	290*	276*	271*

1 02.5mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48		293	282	272*	266*	264*
40			288	276*	267*	264*
36				278*	268*	264*
32			299	282	269*	264*

* Hubs using these combinations must match the diameter category exactly for accurate results. ***(See drawings and text page on 11-4.)***

700C ROAD SPOKE LENGTHS

3rd Step of 3 steps

700C Rims

Find the rim in the tables below. Subtract the rim correction factor from the number you came up with in step 2. The answer is the final length of the spoke you need.

Identifying Rims

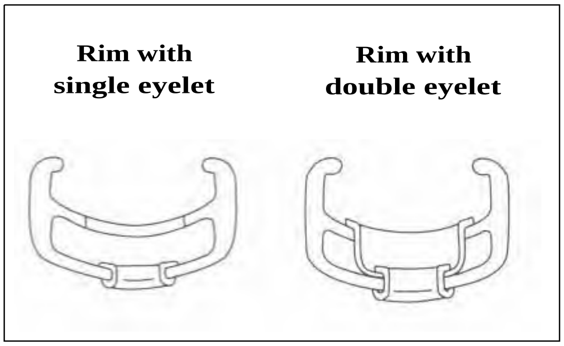
Rims are grouped in descending order by bead seat diameters. ISO rim markings are used in these tables to help distinguish the various models of rims. For an explanation of these markings, *(see page 12-3.)*

The rim cross section drawings are not exact representations of each rim.

Unless noted otherwise, rims listed do not have eyelets or dimples.

27" Example One: Dura-Ace front hub with an Araya 55-40 27 **x 1 1/8** rim. Rim correction factor for this rim is **-6. The** length from step 2 is **308. 308** minus **6** is **302. 302** is the final length.

27" Example Two: Mavic rear hub with a Mavic **700C Open 4** rim. The rim correction factor for this rim is **-12.** The lengths from step 2 are **305** minus **12** is **293** and **303** minus **12 is 291. 293** and **291** are the final lengths.



700C, 28 x 1 5/8"x 13/8"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Akront	alloy		13-622	50	-9	613
Alesa	alloy		17-622 with double eyelets	9017	-11	609
			17-622 with single eyelets	6017	-11	608
	stainless		22-622 with dimples	822	-9	612
	steel		17-622 with dimples	817	-7	617
			20-622 with dimples	820	-8	614
Ambrosio—also see Weinmann for rims not listed here (use old reference numbers)						
	alloy		13-622 with double eyelets	Elite Prisma	-12	606
			13-622 with double eyelets	Super Elite	-10	610
			14-622 with single eyelets	Super Elite	-7	615
			14-622 with double eyelets	Elite City 22	-8	613
			14-622 with single eyelets	Elite	-8	614
			15-622 with single eyelets	Central Park	-11	608

700C ROAD SPOKE LENGTHS

700C, 28 x 1 5/8"x 1 3/8" (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Ambrosio (cont'd)			14-622 with rim washers	Aero Elite	-12	605
Araya	alloy		14-622	SS-45	-8	613
			16-622	16A(5)	-8	615
			16-622	SP-20	-8	615
			17-622	18	-7	616
			17-622	SP-30	-8	616
			17-622	PX-35	-8	614
			17-622	VX-300	-9	611
			18-622	PX-45	-8	614
			19-622	16A(3)	-7	616
			13-622 with double eyelets	CTL-385	-10	610
			14-622	CTL-370	-10	611
			14-622	20A	-10	611
			14-622 with double eyelets	20A	-9	611
			14-622 with double eyelets	S5-40	-9	611
			14-622 with double eyelets	VX-400	-8	614
			13-622	Super Aero SA-530	-25	581
			14-622	CT-19	-9	612
			14-622 with rim washers	Aero 1W (ADX-1 W)	-12	607
			16-622	Aero 2W (ADX-2W)	-14	602
			20-622	15	-8	615
	steel		16-622	Aero 4W (ADX-4W)	-10	610
			17-622	5H	-7	616
Campagnolo	alloy		13-622 with double eyelets	Lambda Strada	-8	614
			13-622 with double eyelets	Omega 19	-11	608
			13-622 with double eyelets	Omega Strada	-8	614
			13-622 with double eyelets	Omicron Strada	-8	614

700C ROAD SPOKE LENGTHS

700C, 28 x 1 5/8"X 1 3/8" (conttd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Campagnolo (cont'd)	alloy		13-622 with double eyelets	Ypsilon Strada	-8	614
			13-622 with single eyelets	Gamma Strada	-9	612
			14-622 with double eyelets	Delta XL Strada	-8	614
			14-622 with double eyelets	Omega XL Strada	-8	614
	alloy		13-622	Lambda Strada V	-15	600
			13-622	Omega Strada V	-16	599
			13-622	Ypsilon Strada V	-16	599
	alloy		13-622 with rim washers, and special nipples	Shama!	-22	586
Euro-Asia	alloy		13-622	Arrow	-24	582
Fiamme	alloy		14-622 with single eyelets	80 - Elan	-9	611
			18-622	71 - Sport	-6	617
Fir	alloy		13-622 with double eyelets	EL 20	-8	615
			13-622 with double eyelets	EL 45	-7	614
			13-622 with double eyelets	ES 35	-8	614
			13-622 with double eyelets	EU 90	-8	614
			14-622 with double eyelets	EA 50	-10	610
			14-622 with double eyelets	EA 60	-10	610
Galli	alloy		13-622 with rim washers	Aero Pro	-9	613
Matrix	alloy		17-622 with single eyelets	Titan T	-8	614
			12-622 with single eyelets	Aurora	-10	610
			13-622 with double eyelets	Journey	-10	611
			13-622 with double eyelets	Sonic	-13	604
			13-622 with double eyelets	Titan Tech	-10	610
			13-622 with single eyelets	Titan	-9	611
			13-622 with single eyelets	Titan S	-9	611

700C ROAD SPOKE LENGTHS

700C, 28 X 1 5/8" X 1 3/8" (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Matrix (cont'd)	alloy		13-622 with single eyelets	Titan-II	-10	611
			16-622 with single eyelets	Titan Tour	-12	605
			**18-622**	Fast Track	-13	**604**
			12-622	ISO C	-16	597
			13-622	ISO C-II	-14	601
Mavic	alloy		13-622 with single eyelets	G 40	-8	614
			13-622 with double eyelets	MA	-9	612
			13-622 with double eyelets	MA *2*	-9	612
			13-622 with double eyelets	MA 40	-9	612
			13-622 with single eyelets	Module E	-8	613
			13-622 with double eyelets	Module E2	-8	615
			13-622 with double eyelets	Open S.U.P.	-14	602
			13-622 with double eyelets	Reflex	-13	604
			14-622 with single eyelets	204S	-12	607
			14-622 with single eyelets	205	-12	607
			15-622 with double eyelets	Module 3D	-9	612
			15-622 with single eyelets	Module 3	-10	609
			19-622 with double eyelets	Module 4	-9	611
			17-622 with double eyelets	T217	-14	602
			13-622	195	-12	606
			13-622	196	-12	606
			13-622 with double eyelets	Open 4	-12	605
			13-622 with single eyelets	190 FB (Velo Tech)	-9	611
	carbon		13-622 with rim washers and	Cosmic Carbon	-14	602
	alloy		13-622 with rim washers and	Cosmic Al	-20	591

Milremo—see Wolber

Mistral—see Sun Metal

700C ROAD SPOKE LENGTHS

700C, 28 x 1 5/8" x 1 3/8" (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
			12-622 with double eyelets	HRB-22	-8	614
			11-622 with single eyelets	Mixer	-9	611
			12-622 with single eyelets	Mixer	-9	612
			12-622 with double eyelets	Contender	-9	612
Rigida	alloy		13-622 with double eyelets	Score	-9	-611
			13-622 with double eyelets	SX 100	-10	611
			13-622 with single **eyelets**	**AL** 13/20	-10	610
			13-622 with double eyelets	HLC 2000	-12	606
			13-622 with single eyelets	Aero	-13	604
			13-622 with single eyelets	Rush	-10	610
			16-622 with single eyelets	AL **16/22**	-8	616
	steel		17-622	Deco 30	-8	615
			21-622	Deco 35	-8	615
Ritchey	alloy		17-622	Vantage Comp	-10	611
			14-622	Vantage Comp Road	-10	611
			16-622	Vantage Cross-Sport	-9	613
			16-622 with single eyelets	Rock 450CE	-10	611
			17-622	Rock 490C	-10	611
			13-622	Vantage Pro Aero	**-14**	**603**
Saavedra	alloy		13-622 with rim washers	Featherweight	-9	612
Saturae	alloy		16-622 with single eyelets	C22		614
(Specialized)			14-622 with double eyelets	HC19	-8	614
			15-622 with double eyelets	C20	-8	614
Sideral	alloy		12-622 with single eyelets	2001 Prof. Profile SM	-13	604
			12-622 with single eyelets	2001 Prof. Profile SM	-13	604
Sun Metal	alloy		17-622	L17	-8	613
			17-622 with single eyelets	M17	-9	612
			18-622	L18	-10	

SUTHERLAND'S

700C ROAD SPOKE LENGTHS

700C, 28 x 1 5/8"x 1 3/8" (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Sun Metal	alloy		20-622	L20	-10	609
(cont'd)			20-622 with single eyelets	M20	-9	611
			25-622 with single eyelets	M25	-10	609
			13-622 with single eyelets	M13	-10	610
			13-622 with single eyelets	M1311	-10	610
			13-622 with single eyelets	M1 3L	-9	612
			15-622	CR16	-11	608
			15-622	CR1611	-9	611
			15-623	CRE16/CRT1611	-10	609
			17-622 with single eyelets	CR18	-9	612
			20-622	CR20	-11	608
			20-622	Rhyno/SST20	**-13**	604
			14-622	Mistral M14A		
				`91 and later	-14	603
			14-622	Mistral M14A pre '91	-12	606
			14-622 with single eyelets	ME14A	-14	601
			14-622	Venus	-19	592
			17-622 with single eyelets	CR17A	-12	605
	steel		18-622	Style L	-3	624
Torelli	alloy		13-622 with double eyelets	Expert	-10	**610**
			12-622 with double eyelets	Master	-12	606
Ukai—see similar Araya models						
Velocity	alloy		16-622	Twin Hollow	**-10**	**611**
			13-622	Aero	-17	596
			14-622	Arrowhead	-16	598
Weinmann—(old reference numbers in parentheses)						
	alloy		145-622 with single eyelets	414	-7	61
			15-622	215	-7	
			15-622	2115	-7	615

700C ROAD SPOKE LENGTHS

700C, 28 x 1 5/8"x 1 3/8" (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Weinmann—(old reference numbers in parentheses)						
	alloy		16-622	2115 (716, 416, 116)	-8	614
			16-622 with dimples	2115 (716, 416, 116)	-9	612
			16-622 with single eyelets	2115 (716, 416, 116)	-7	616
			20-622 drilled for .120/12g spokes	(720)	-8	614
			22-622	(722, 122)	-9	612
			13-622 with double eyelets	2313	-10	610
			13-622 with double eyelets	2313 (913 SQR)	-11	608
			13-622 with single eyelets	(613)	-11	608
			14-622 with single eyelets	(513S)	-9	612
			14-622 with single eyelets	571 S	-9	612
			17-622 with double eyelets	(917 SQR)	-11	608
			17-622 with single eyelets	2317 (617 SQR)	-11	607
			13-622	9013	-11	615
			14-622	(514/Al24)	-7	617
			14-622 with single eyelets	(514/Al24)	-6	618
			15-622 with single eyelets	(515X)	-5	619
			16-622	(516/A 129)	-7	616
			16-622 with single eyelets	(516/A 129)	-6	617
			19-622	(419X)	-7	617
			18-622	217	-8	614
			19-622	4019	-9	613
			15-622 with single eyelets	2215 (415X)	-6	619
			15-622	2215	-7	614
	stainless steel		22-622 with dimples	(811)	-9	612
			22-622 with dimples	(811 R)	-8	613
			20-622 with dimples	(801)	-8	614
Wolber	alloy		14-622 with double eyelets	Gentleman GTA2	-8	614
			14-622 with double eyelets	Gentleman GTX	-8	614

700C ROAD SPOKE LENGTHS

700C, 28 x 1 5/8" x 1 3/8" (contd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Wolber/Super Champion						
	alloy		17-622 with single eyelets	Modele 58	-8	615
			17-622 with single eyelets	Modele 59	-8	615
			14-622 with double eyelets	T430 Alpine	-8	614
			14-622 with single eyelets	Gentleman 81	-9	612
			14-622	TX Profil	-14	602
			10-622	Mixte*	-8	617

* Can be used with sew-ups too.

700C ROAD SPOKE LENGTHS

700C Sew-up

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Akront	alloy		20		-5	620
Alesa	alloy		22.5	920 Eterno	-6	617
			22.5	920 Professional	-7	617
			22.5	920 Race	-7	617
Ambrosio	alloy		20 with double eyelets	Crono	-7	615
			20 with double eyelets	Formula 20 Crono	-6	617
			20 with double eyelets	Montreal	-6	617
			20 with double eyelets	Formula 20 Crono	-6	617
			21 with double eyelets	Nemesis	-7	616
			22 with double eyelets	Metamorphosis	-6	618
			22 with double eyelets	Synthesis	-6	618
			19 with rim washer	Aerodynamic	-13	604
Araya	alloy		21 with double eyelets	16B Gold	-6	618
			21 with double eyelets	16B Red	-6	618
			21 with double eyelets	Pro Staff 340	-5	619
			21 with double eyelets	Pro Staff 400	-5	619
			21 with double eyelets	R-50	-6	618
			21 with double eyelets	Tita-Ace	-6	618
			17.5 with single eyelets	Aero 5 (ADX-S)	-9	611
			19	Aero 4 (ADX-4)	-10	611
			19 Super Aero	230	-23	584
			19 with rim washer	Aero 1 (ADX-1)	-11	609
			21 with rim washer	Aero 2 (ADX-2)	-12	607
Assos	alloy		18 with special nipples and washers†	Unspecified Model	-2	627

† Rim requires special nipples and washers. Due to extra length of nipples, spokes could be up to 4mm shorter than listed here. Rims are drilled for specific lacings. Small holes are drilled in the tire bed near the valve hole to indicate lacing pattern. Two holes indicates radial both sides. One hole indicates radial one side and crossed the other side. No hole indicates crossed pattern on both sides.

700C ROAD SPOKE LENGTHS

700C Sew-up (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Campagnolo	alloy		20 with double eyelets	Delta XL Strada	-7	617
			20 with double eyelets	Lambda Strada	-7	617
			20 with double eyelets	Omega Strada	-7	617
			20 with double eyelets	Omega XL Strada	-7	617
			20 with double eyelets	Record Crono	-7	617
			20 with double eyelets	Record Pave	-7	617
			20 with double eyelets	Record Strada	-7	617
			20 with double eyelets	Sigma 20 Strada	-7	617
			20 with double eyelets	Sigma Crono	-7	617
			20 with double eyelets	Sigma Keirin	-7	617
			20 with double eyelets	Sigma XL Keirin	-7	617
			20 with double eyelets	Victory Crono	-7	617
			20 with double eyelets	Victory Strada	-7	617
			22 with double eyelets	Sigma Pave	-7	617
			22 with double eyelets	Sigma Strada	-7	617
			19 with rim washers	Shamal	-22	586
Fiamme	alloy		18.5 with double eyelets	Speedy (Track)	-6	617
			20 with double eyelets	Ergal (Yellow Lbl)	-6	61 7
			21 with double eyelets	Ergal-Iride	-6	617
			21 with double eyelets	Hard Silver	-7	615
			21 with double eyelets	Master	-6	617
			21 with double eyelets	RCX	-7	616
			21 with double eyelets	Red Label	-6	617
			21 with double eyelets	Super Corsa	-7	615
Fir	alloy		18 with double eyelets	Alkor	-7	617
			20 with double eyelets	Isidis	-6	617
			20 with double eyelets	Pulsar	-6	618
			20 with double eyelets	Quasar	-6	618
			20 with double eyelets	Sirus	-6	618
Galli	alloy		20 with single eyelets	Criterium	-6	618
			20 with single eyelets	Paris-Roubaix	-7	61 7

700C ROAD SPOKE LENGTHS

700C Sew-up (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Galli (cont'd)	alloy		20 with single eyelets	Servizio Corse	-6	618
			20 with single eyelets	Top Pro	-6	618
Gimondi	alloy		21.5 with double eyelets	Bravo 45D	-6	619
Hi-E	alloy		21 with special nipples		**-11**	612
Matrix	alloy		21 with double eyelets	Photon	-8	615
			21 with double eyelets	Photon	-8	615
			18.5 with square washers	Iso	-8	614
			18.5 without washers	Iso	-9	612
Mavic	alloy		18 with double eyelets	CX-18	-7	616
			20 with double eyelets	Argent 8	-7	615
			20 with double eyelets	Argent 10	-7	615
			20 with double eyelets	Argent 12 SSC	-7	616
			20 with double eyelets	Bleu SSC	-7	616
			20 with double eyelets	G.E.L. 280	-7	615
			20 with double eyelets	G.L. 330	-7	615
			20 with double eyelets	GP4 (Pre-'94)	-7	615
			20 with double eyelets	GP-4 '94 (and later?)	-10	611
			20 with double eyelets	OR10	-7	615
			20 with single eyelets	Piste (Track)	-6	617
			20.5 with double eyelets	Montlhéry Legere	-7	615
			20.5 with double eyelets	MontIlhery Pro	-7	616
			21.5 with double eyelets	Montlhéry Route	-8	614
			21.5 with double eyelets	Paris Roubaix SSC	-7	616
			22 with double eyelets	Argent 7	-7	615
			22 with double eyelets	OR 7	-7	615
			22 with single eyelets	Speciale Sport	-8	614
			18.5 with double eyelets	CXP 25**	-6	618
			19 with double eyelets	Mach *2* **CD** *2*	-13	605
			19 with single eyelets	Mach 2 CD	-14	603

** Requires nipple with hex heads. Spoke length can be up to 3mm shorter than listed.

700C ROAD SPOKE LENGTHS

700C Sew-up (contd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Mistral—see Sun Metal						
Nisi	alloy		19	Pista Speciale (Track)	-5	620
			19 with double eyelets	Sludi Mod 290	-6	618
			19 with double eyelets	Sludi Mod 320	-6	618
			20 with double eyelets	AN-85	-6	617
			20 with double eyelets	Countach	-7	617
			20 with double eyelets	Solidal	-6	617
			21 with double eyelets	G-27	-6	618
			19 with single eyelets	Laser	-10	610
Rigida	alloy		21.5 with double eyelets	Club	-8	614,
			21.5 with double eyelets	Pro	-8	613
			21.5 with double eyelets	SC 200	-9	613
Saavedra	alloy		19 with rim washers	Turbo	-10	609
Saturae	alloy			all HT	-6	618
Sideral	alloy		19 with single eyelets	2001 Prof. Profile LM	-9	612
Sun Metal	alloy		21 with double eyelets	M20B	-8	613
			18.5	M19AII	-13	603
			17	M17A	-9	
			19	M19A	-13	604
Super Champion—see Wolber						
Ukai—see similar Araya						
Weinmann	alloy		22.5	904 Professional	-7	617
			22.5	906 Race	-7	617
			22.5	Carrera "AS"	-6	617
Wolber/Super Champion	alloy		20 with double eyelets	Arc-en-del	-7	616
			20 with double eyelets	Aspin/Aspen	-7	616
			20 with double eyelets	Aubisque	-7	616

700C ROAD SPOKE LENGTHS

700C Sew-up (cont'd)

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rime Spoke End Dia.
Wolber/Super Champion (cont'd)						
	alloy		20 with double eyelets	Com petition	-7	616
			20 with double eyelets	Medaille d'Or	-7	616
			17.5	Profil 18	-10	610
			1 9	Profil 20	-14	601
Zipp	carbon fiber		20	440	-51	528

700C ROAD SPOKE LENGTHS

700C, 28 x 1 5/8" x 1 3/8"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Alesa	alloy		17-622	317, 717	-8	615
			19-622	419X	-7	1-616
Araya	alloy		17-622	VX-300	-8	614
			13-622	CT-19N	-10	610
			13-622	SA-530C Super Aero	-25	2
Campagnolo	alloy		13-622 with double eyelets	Omega 20	-8	
			17-622 with single eyelets	Dedra	-10	609
			14-622 needs hex head nipples and wrench to true	Jet	-14	603
Matrix	alloy		16-622 with single eyelets	Titan Tour	-12	607.
Magic	alloy		13-622 with single eyelets	192	-10	609
Rigida	alloy		17-622	AS25	-8	614
			20-622	AS26F	-9	612
			13-622	SHP 6	-13	603
			14-622 with single eyelets	Excel 7	-12	607
			*18-622* with single eyelets	Laser 40	-13	604
			13-622	DP 18	-24	581
Sun Metal	alloy		15-622 with single eyelets	CR1611	-9	611
			16-622	CRT16	-9	611
Torelli	alloy		**13-622** with rim washers	Wide Guy	-21	587

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700C ROAD SPOKE LENGTHS

700C, 28 x 1 5/8"x 13/8"

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
van Schothorst	steel		22-622	WS 33	-9	612
Weinmann	alloy		19-622	2719	-10	609
Wolber	alloy		14-622 with double eyelets	GTX2	-8	614
			14-622	GR	-9	611

700C Sew-up

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Campagnolo	alloy		20 with double eyelets	Lambda	-7	617
			20 with double eyelets	Omega	-7	616
			20 with double eyelets	Omega 20 T	-7	616
			20 with double eyelets	Sigma 20	-7	617
			22 with double eyelets	Sigma	-7	617
			22 with double eyelets	Sigma T	-7	617
			19	Omega Strada V	-15	600
			20	Omega	-15	600
			20	Omega V	-15	600
			20	Omega V T	-15	600
	carbon fiber		20 with inverted spokes	Bora	-24	582
Euro Asia	alloy		19	Arrow	-23	584
HEM	carbon fiber/ alloy		19 needs hex head nipples and wrench to true	Jet	-14	602
Matrix	alloy		18	ISO 11	-11	608
Rigida	alloy		18	SHC 5	-14	602
Zipp	carbon fiber		19	340	-31*	568

* for more consistent results use 26" tables ***page 11-73***) with -16 rim correction factor.

CONTENTS

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26" MTB Rims SPOKE LENGTH

SUTHERLAND'S

26" MTB SPOKE LENGTHS

2nd Step of 3 steps

26", 700D and 650 Rims

Count the number of holes in the hub and decide on a spoking pattern, i.e., 4-cross, 3-cross (4X, 3X) etc. Find the length listed for that combination in the hub flange diameter category selected in step I. Write down the length. For the right rear of multi-speed freewheel hubs subtract 2mm. ***(See below for details.)*** Adjustments will also be needed for hubs that are different from the specifications below.

26" Example One: Shimano aura-Ace front hub with **32 holes.** Look at the **40mm** hub flange diameter table. For **3X** wheel write down the length **293mm.**

26" Example Two: Mavic 500 rear hub with **36 holes.** On the **44.5mm** table a **3X** wheel indicates a length of **290mm** for the left side. For the right side use **288 mm.**

The tables on the facing page will give you a length for the theoretical rim diameter of a 600mm rim. Step 3 (rim correction factor) will adjust these lengths for the exact rim you have.

Approximate Dimensions

The following hub dimensions were used for the tables on the opposite page. They are the approximate dimensions for road bike front hubs and the left rear of a road hike rear hub.

Huh center to flange center - **35mm**
Spoke hole diameter - **2.6mm**
Spoke seating and stretch - **0.4mm**

Differences in Hubs

Many hubs differ from the huh dimensions listed above so adjustments may need to he made as follows:

Flub center to flange center - a **1mm difference will make a OA mm difference in final spoke length.**

26" Example Three: A Sachs Jet coaster brake with a **25mm** hub center to flange center is **10mm** narrower than the dimensions these tables are based on. Multiplying **10mm** by **0.1mm** you get **1mm.** Subtract 1 **mm** to the final spoke length.

Spoke hole size — a 0.2mm difference will make a 0.1mm difference in the final spoke length. In practice this is usually not enough difference to matter.

Right Rear Hub Spoke Length

Most right rear road hubs require a shorter spoke. How much shorter varies. Many hubs have a hub center to flange center on the right rear of 20mm. This is a 15mm difference from t he tables. Using the guidelines for differences in hub center to flange dimensions, subtract 1 .5mm for the right rear spokes. This is usually rounded up to 2m m.

These combinations have the same spoke length:

16 hole 1X = 32 hole 2X
20 hole 2X = 40 hole 4X
24 hole 2X = 48 hole 4X

3rd Step go to page 11-64

26" MTB SPOKE LENGTHS

31 mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48						
40				—	—	—
36		298	293	289*	286*	285*
32		301	295	290	286*	285*
28			297	291	287*	285*
24				293	287*	285*

34mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48						
40		296	291	287*	284*	283*
36		298	292	288*	285*	283*
32		300	294	289	285*	283*
28			297	290	285*	283*
24				292	286*	283*

40mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	296	291	287	283*	281*	280*
40		295	289	285*	282*	280*
36		298	291	285*	282*	280*
32		301	293	287	282*	280*
28			297	288	283*	280*

44.5 mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	295	290	285	281*	279*	278*
40		294	288	283*	279*	278*
36				284*	280*	278*
32		301	293	285	280*	278*
28			296	287	281*	278*

48mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	295	289	284	280*	277*	277*
40		294	287	281*	278*	277*
36		297	289	283*	278*	277*
32			292	284	278*	277*
28			296	286	279*	277*

58mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	294	287	281	276*	273*	272*
40		293	284	278*	273*	272*
36			287	279*	273*	272*
32			291	281	274*	272*
28			295	283	275*	272*

63mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	294	286	279	274*	270*	269*
40		292	283	276*	271*	269*
36		297	286	277*	271*	269*
32			290	279	272*	269*
28			295	282	273*	269*

67mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	294	285	278	272*	268*	267*
40		292	282	274*	269*	267*
36		296	285	276	269*	267*
32				278	270*	267*
28			295	281	271*	267*

90mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	292	281	271	263*	257*	256*
40		290	276	266*	258*	256*
36		**296**	281	268*	259*	256*
32			286	271	260*	256*
28			294	275	261*	256*

102.5mm Flange Diameter

	5X	4X	3X	2X	1x	radial
48		278	267	258*	252*	250*
40			274	261*	252*	250*
36			278	263*	253*	250*
32			285	267	254*	250*

* Hubs using these combinations must match the diameter category exactly for accurate results. ***(See drawings and text on page 11-4.)***

26" MTB SPOKE LENGTHS

3rd Step of 3 steps

26", 700D and 650 Rims

Find the rim in the tables below. Subtract the rim correction factor from the number you came up with in step 2. The answer is the final length of the spoke you need.

Identifying Rims

Rims are grouped in descending order by head seat diameters. ISO rim markings are used in these tables to help distinguish the various models of rims. *(See page 12-3 for an explanation of these markings.)*

The rim cross section drawings are not exact representations of each rim.

Unless noted otherwise, rims listed do not have eyelets or dimples.

26" Example One: Dura-Ace front huh with an Araya **26 x 1.50 CV-7** rim. Rim correction factor for this rim is **-27.** The length from step *2* is **293. 293** minus **27** is **266. 266** is the final length.

26" Example Two: Mavic rear hub with a Mavic **26 x 1.50 Rando M4** rim. The rim correction factor for this rim is **-25.** The lengths from step 2 are **290** for the left side and **288** for the right. **290** minus **25** is **265** and **288** minus **25** is **263. 265** and **263** are the final lengths.

Rim with single eyelet | **Rim with double eyelet**

26 x 1.50" 26 x 1.75" 26 x 2.125"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
A.C.S.	plastic		23-559	Z-Rim	-26	548
Alesa—also see alloy Weinmann for rims not listed here (use old reference numbers)						
	alloy		17-559	417	-25	550
			21-559	421	-25	551
			21-559 with double eyelets	9021	-26	548
			21-559 with single eyelets	6021	-27	547
			21-559 with single eyelets	621	-26	547
All Weather Sports						
	alloy		41-559	Snow Cat EB-3	-23	554
Ambrosio	alloy		17-559	Fanatic	-27	546
			26-559	Benelux 32	-24	53
			20-559	Ontario	-27	546
			20-559 with single eyelets	Montana	-27	547

26" MTB SPOKE LENGTHS

26 x 1.50", 26 x 1.75", 26 x 2.125" (cont'd)

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Ambrosio	alloy		25-559	Endrick	-25	550
(cont'd)			30-559	California	-27	547
			14-559 with single eyelets	CC22	-26	548
			16-448 with double eyelets	CC24	-27	545
			19-559 with double eyelets	Compact	-27	546
			21-559	Ontario deLuxe	-28	545
			24-559 with double eyelets	Performance	-26	547
Araya	alloy		15-559 with double eyelets	RM-395 Team	-26	548
			16-559	RM-400 Pro	-26	**547**
			18-559	CV-7	-27	546
			19-559	RX-7	-27	546
			19-559	7S	-26	547
			20-559 with dimples	7X (N)	-26	548
			20-559 with dimples	RX-7	-26	548
			22-559	AP-21	-26	549
			22-559	MP-22	-26	547
			25-559 with dimples	7X, 7C	-27	**546**
			17-559	RM-17	-26	**547**
			17-559	TM-810	-27	**547**
			18-559	TM-18	-26	547
			19-559 w/ridges on the edge	RM-20	-26	**549**
			20-559	VP-20	-26	**547**
			25-559 w/ridges on the edge	RM-25	-27	546
			20-559	XA-1	-29	543
	steel		25-559	7A	-26	**549**
Bontrager	alloy		18-559	BCX-1	-23	554
			18-559	BCX-2	-23	**554**
			13-559 with double eyelets	MA 40	-25	550
			13-559 with double eyelets	Module 3 CD	-25	549
			18-559	BCX Red Label	-27	546
			18-559	BCX Blue Label	-27	546

26" MTB SPOKE LENGTHS

26 x 1.50", 26 x 1.75", 26 x 2.125" (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Bontrager (cont'd)	alloy		17-559	BCX-3	-24	553
			17-559 with single eyelets	Model 58	-24	553
Campagnolo	alloy		**13-559** with double eyelets	Beta	-25	551
			14-559	Atex	-30	541
			14-559 with double eyelets	Alpha XL	-24	553
			16-559 with double eyelets	Mirox	-28	543
			16-559 with double eyelets	Stheno	-30	540
			16-559 with double eyelets	Zark	-29	543
			14-559	Contax	-31	539
			17-559	Thorr	-30	540
			19-559 with double eyelets	Kappa	-26	548
			23-559 with double eyelets	Zeta	27	546
CMC	steel		24-559		27	547
			25-559		26	548
Deetz	alloy		**13-559** with double eyelets	D19	-26	548
			13-559 with single eyelets	HD19	-26	548
Femco	alloy		25-559 with dimples	A7	-27	547
	steel		30-559	OB	-26	548
Fir	alloy		13-559 with double eyelets	ES 35	-25	550
			19-559	MS 24	-27	546
			19-559	MS 26	-26	548
			22-559 with double eyelets	MS 29	-27	547
Kin-Lin	alloy		**26-559**	**21 AL**	-27	**546**
M.O. Mfg.	steel		25-559		26	549
Matrix	alloy		13-559 with single eyelets	Mt. Titan	-26	548
			13-559 with single eyelets	Single Track Pro	-26	548
			16-559 with single eyelets	Single Track Comp	-26	547
			15-559	Voo Doo	-27	546

26" MTB SPOKE LENGTHS

26 x 1.50", 26 x 1.75", 26 x 2.125" (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Matrix	alloy		12-559	'Iso C	-33	535
(cont'd)			13-559	Mt. Aero	-31	538
			18-559	Single Track	-29	541
Mavic	alloy		13-559 with double eyelets	MA 2	-25	550
			13-559 with double eyelets	MA 40	-25	550
			17-559	M234	-25	549
			21-559	121	-28	543
			16-559	237	-27	546
			16-559 with single eyelets	237S	-27	547
			16-559	M400	-27	547
			17-559	M230	-27	547
			17-559 with single eyelets	117 S.U.P.	-30	540
			17-559 with single eyelets	217	-31	538
			17-559 with single eyelets	M117	-30	540
			17-559 with single eyelets	M231	-26	548
			17-559	236	-27	547
			19-559 with double eyelets	Rando M4	-25	551
			20-559 with double eyelets	M261	-27	547
			25-559 with double eyelets	Rando M5	-26	549
			18-559 with double eyelets	Energy M7	-32	535
			22.5-559 with double eyelets	Oxygen M6	-29	542
			22.5-559 with double eyelets	Paris Dakar	-29	542
Nisi	alloy		26-559 with double eyelets	Zigguart	-29	542
			20-559 with single eyelets	Dart	-28	545
Rigida	alloy		25-559 with dimples	AL 25/32	-26	548
			25-559 with single eyelets	AL 25/32	-26	549
			18-559 with double eyelets	Laser 400	-27	545
			18-559 with single eyelets	Laser 40	-28	545
			20-559 with double eyelets	CTX 500	-30	540
			20-559 with double eyelets	Rally 300	-27	545
			20-559 with single eyelets	CTX 50	-31	539

26" MTB SPOKE LENGTHS

26 x 1.50", 26 x 1.75", 26 x 2.125" (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Rigida (cont'd)	alloy		20-559 with single eyelets	Rally 30	-28	544
	steel		25-559	U 25/34	-25	549
			25-559 with dimples	U 28137	-26	548
Ritchey	alloy		16-559	Vantage Cross-Sport	-25	550
			16-559 with single eyelets	Rock 395E	-27	546
			16-559 with single eyelets	Rock 41 5E	-26	547
			16-559 with single eyelets	Rock SC	-26	547
			17-559	Rock 440	-27	546
			17-559	Vantage Comp	-26	548
			17-559	Vantage Pro	-27	547
			19-559	Vantage Expert	-28	544
			20-559	Vantage Sport	-26	**548**
Saavedra	alloy		20-559	All Terrain Aerodynamic	-34	533
Saturae (Specialized)						
	alloy		17-559 with single eyelets	X22, HX22	-23	555
			20-559 with single eyelets	X28, HX28	-28	544
			25-559 with single eyelets	X32, HX32	-26	548
Schwinn	steel		25-559	S-2	-26	548
Specialized	alloy		15-559	GXL21, XL21	-26	549
			15-559	Z-21 Pro, Z-21	-27	546
			17-559	Z-23	-27	546
			19-559	BX25, X25	-26	548
			17-559	GX23, BX23, X23	-27	547
			19-559	GX26, BX26, X26	-26	547
Sun Metal	alloy		25-559	Style J	-24	551
			18-559	AT18	-27	547
			18-559	L18	-27	545
			20-559	L20	-26	548
			22-559	L22	-26	548

26" MTB SPOKE LENGTHS

26 x 1.50", 26 x 1.75", 26 x 2.125" (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Sun Metal	alloy		25-559	L25	-25	550
(cont'd)			25-559	Style I	-25	549
			25-559 with single eyelets	M25	-25	550
			13-559 with single eyelets	M13L	-26	549
			15-559	CR161I	-26	549
			15-559 with single eyelets	CRE16/CRT1611	-26	548
			16-559	C16	-26	548
			16-559	CR16	-26	547
			16-559	CRT16	-26	549
			17-559 with single eyelets	CR18	-26	548
			19-559	CR20	-28	545
			20-559	Chinook C20	-27	546
			20-559	Rhyno SST	-29	541
			14-559	M14A '91 & later	-30	539
			14-559	M14A pre '91	-28	543
			14-559 with single eyelets	ME14A	-33	534
			17-559 with single eyelets	CR17A	-28	545
	steel		25-559	Style M	-26	548
			27-559	Style N	-25	550
Torelli	alloy		16-559 with double eyelets	Blaster	-27	545
			15-559 with single eyelets	Rocket	-26	547
Ukai—see similar Araya model						
Velocity	alloy		16-559	Twin Hollow	-26	549
			13-559	Aero	-33	534
			14-559	Arrowhead	-33	534
			15-559	K-525	-31	539
			19-559	Aero Heat AT	-32	536
			19-559	Triple V	-26	547

26" MTB SPOKE LENGTHS

26 x 1.50", 26 x 1.75", 26 x 2.125" (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia
Weinmann—(old reference numbers in parentheses)						
	alloy		22-559 with single eyelets	(522 X)	-24	553
			25-559 with single eyelets	2225 (425X)	-24	552
			25-559 with single eyelets	2225-1 (525X)	-23	553
			**17-559**	217	-25	550
			17-559	BCX-3	-24	553
			18-559	BCX-1	-23	554
			18-559	BCX-2	-23	554
			20-559	(420)	-25	549
			20-559	4019	-26	547
			20-559	2219 (120)	-25	549
			21-559	2121	-25	551
			22-559	(122B)	-26	549
			25-559	2125	-25	551
			25-559 with dimples	525/431	-26	547
			25-559 with eyelets	525/431	-26	548
			18-559	BCX Red Label	-27	546
			18-559	BCX Blue Label	-27	546
			19-559	ZAC 19	-28	545
			19-559	2419	-17	546
			20-559 with double eyelets	2421 (921)	-26	548
Wilderness Trail Bikes						
	alloy		17-559 with reinforcement	Power Beam	-28	545
			17-559 with single eyelets	Speedmaster 2	-27	547
			17-559 with single eyelets	Speedmaster - 23mm	-25	549
			19-559 with single eyelets	Speedmaster - 25mm	-25	550
Wolber/Super Champion						
	alloy		14-559	AT 15	-25	551
			16-559	AT 18	-25	550
			27-559	Canyon	-26	548
			19-559	AT 20	-27	546

26" MTB SPOKE LENGTHS

26x 1.50", 26 x 1.75", 26 x 2.125"

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Alesa	alloy		**17-559** with double eyelets	9017	26	548
			21-559 with double eyelets	6017	-26	
All Weather Sports	alloy		41-559	44-Magnum	23	5 4
Araya	alloy		13-559	RM-14	-26	548
			20-559	VP-20	-26	547
			17-559 with double eyelets	TM-810F	26	548
			18-559 with double eyelets	RM-910DH	-26	548
Breezer/Ukai	alloy		16-559 with inner web holes	Backdraft	-26	547
Campagnolo	alloy		14-559	Atek	-29	539
			16-559	Stheno	-30	539
			16-559 **with single eyelets**	Arkos	-27	**547**
HED	carbon fiber/ alloy		17-559*	X-Country	-28	**545**
			20-559*	Downhill	-29	**541**
Matrix	alloy		13-559 **with double** eyelets	Single Track Pro	-26	**48**
Mavic	alloy		22-559 with double eyelets	281	-28	**545**
Rigida	alloy		20-559	AS26F	-26	
			**18-559**	**Laser**	**-28**	**544**
			16-559	Turbo 900	-30	541
			17-559	Turbo 9	-28	545
van Schothorst	alloy		**21-559**	**AS 28**	**-27**	**546**
	steel		25-559	US 34	-28	**543**
Weinmann	**alloy**		19-559	**2719**	**-28**	
Wilderness Trail Bikes	alloy		**17-559**	**Power Beam****	—27	**545**
			17-559	Power Beam***	-26	**548**

*needs hex head nipples and wrench to true. **'94-'95 (OD=571.5mm) "* 36 hole after 5/95 (OD=574.5mm)

SUTHERLAND'S

26" MTB SPOKE LENGTHS

26" Other Rims SPOKE LENGTH

26" OTHER SPOKE LENGTHS

2nd Step of 3 steps

26", 700D and 650 Rims

Count the number of holes in the hub and decide on a spoking pattern, i.e., 4-cross, 3-cross (4X, 3X) etc. Find the length listed for that combination in the huh flange diameter category selected in step 1. Write down the length. For the right rear of multi-speed freewheel hubs subtract 2mm. ***(See below for details.)*** Adjustments will also be needed for hubs that are different from the specifications below.

26" Example One: Shimano Dura-Ace front hub with **32 holes.** Look at the **40mm** hub flange diameter table. For **3X** wheel write down the length **293mm.**

26" Example Two: Mavic 500 rear hub with **36 holes.** On the **44.5mm** table a **3X** wheel indicates a length of **290mm** for the left side. For the right side use **288 mm.**

The tables on the facing page will give you a length for the theoretical rim diameter of a 600mm rim. Step 3 (rim correction factor) will adjust these lengths for the exact rim you have.

Approximate Dimensions

The following hub dimensions were used for the tables on the opposite page. They are the approximate dimensions for road hike front hubs and the left rear of a road bike rear hub.

Hub center to flange center - **35mm**
Spoke hole diameter - **2.6mm**
Spoke seating and stretch - **0.4mm**

Differences in Hubs

Many hubs differ from the hub dimensions listed above so adjustments may need to be made as follows:

I !Lib center to flange center - ***a* 1mm difference will make a 0.1mm difference in final spoke length.**

26" Example Three: A Sachs ***jet*** coaster brake with a **25mm** hub center to flange center is **10mm** narrower than the dimensions these tables are based on. Multiplying **10mm** by 0.1mm you get **l mm.** Subtract **1mm** to the final spoke length.

Spoke hole size – a 0.2111111 difference will make a 0.1 mm difference in the final spoke length. En practice this is usually not enough difference to matter.

Right Rear Hub Spoke Length

Most right rear road hubs require a shorter spoke. How much shorter varies. Many hubs have a huh center to flange center on the right rear of 20mm. This is a 1Sm m difference from the tables. Using the guidelines for differences in hub center to Flange dimensions, subtract 1.5mm for the right rear spokes. This is usually rounded up to 2mm.

These combinations have the same spoke length:

16 hole 1X	=	32 hole 2X
20 hole 2X	=	40 hole 4X
24 hole 2X	=	48 hole 4X

3rd Step go to page 11-74

26" SPOKE LENGTHS

31 mm Flange Diameter

	5X	4X	3X	2X	1x	radial
48						
40						
36		298	293	289*	286*	285*
32		301	295	290	286*	285*
28			297	291	287*	285*
24				293	287*	285*

34mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48						
40		296	291	287*	284*	283*
36		298	292	288*	285*	283*
32		300	294	289	285*	283*
28			297	290	285*	283*
24				292	286*	283*

40mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	296	291	287	283*	281*	280*
40		295	289	285*	282*	280*
36		298	291	285*	282*	280*
32		301	293	287	282*	280*
28			297	288	283*	280*

44.5 mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	295	290	285	281*	279*	278*
40		294	288	283*	279*	278*
36		297	290	284*	280*	278*
32		301	293	285	280*	278*
28			296	287	281*	278*

48mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	295	289	284	280*	277*	277*
40		294	287	281*	278*	277*
36		297	289	283*	278*	277*
32			292	284	278*	277*
28			296	286	279*	277*

58mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	294	287	281	276*	273*	272*
40		293	284	278*	273*	272*
36		297	287	279*	273*	272*
32			291	281	274*	272*
28			295	283	275*	272*

63mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	294	286	279	274*	270*	269*
40		292	283	276*	271*	269*
36		297	286	277*	271*	269*
32			290	279	272*	269*
28			295	282	273*	269*

67mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	294	285	278	272*	268*	267*
40		*292*	*282*	274*	269*	267*
36		296	285	276	269*	267*
32			289	278	270*	267*
28			295	281	271*	267*

90mm Flange Diameter

	5X	4X	3X	2X	1X	radial
48	292	281	271	263*	257*	256*
40		290	276	266*	258*	256*
36		296	281	268*	259*	256*
32			286	271	260*	256*
28			294	275	261*	256*

102.5mm Flange Diameter

	5X	4X	3X	2X	1x	radial
48		278	267	258*	252*	250*
40			274	261*	252*	250*
36			278	263*	253*	250*
32			285	267	254*	250*

* Hubs using these combinations must match the diameter category exactly for accurate results. *(See drawings and text* on *page 11-4.)*

26" OTHER SPOKE LENGTHS

3rd Step of 3 steps

26", 700D and 650 Rims

Find the rim in the tables below. Subtract the rim correction factor from the number you came up with in step 2. The answer is the final length of the spoke you need.

Identifying Rims

Rims are grouped in descending order by bead seat diameters. ISO rim markings are used in these tables to help distinguish the various models of rims. For an explanation of these markings, *(see page 12-3.)*

The rim cross section drawings are not exact representations of each rim.

Unless noted otherwise, rims listed do not have eyelets or dimples.

26" Example One: Dura-Ace front hub with a Sun Metal **26 x 13/4 ME14A** rim. Rim correction factor for this rim is **-27.** The length from step 2 is **293. 293** minus **27** is **266. 266** is the final length.

26" Example Two: Mavic rear hub with a Mavic **650C Open 4** rim. The rim correction factor for this rim is **-23.** The lengths from step 2 are **290** for the left side and **288** for the right. **290** minus **23** is **267** and **288** minus **23** is **265. 267** and **265** are the final lengths.

Rim with single eyelet — **Rim with double eyelet**

26" x 1 1/4", 26" x 1 3/8", EA1, 5-5, 5-6

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spok End Dia.
Alesa—see Weinmann (use old reference numbers)						
Araya	alloy		19-597	16A(3)	-5	591
	steel	L..,916-597		5H	-5	591
Rigida	steel	L2	1 7-597	Deco 30	-6	589
			20-597	Deco 35	-5	590
Schwinn	steel		22-597	5-5 (26x1-3/8)	-8	684
			20-597	S-6 (26x1-1/4)	-5	590
Sturmey-Archer	steel		20-597	EA 23.5	-5	590
Sun Metal	alloy		1 3-597 with single eyelets	Mistral M1311	-7	586
Weinmann—(old reference numbers in parentheses)						
	alloy	1.21	16-597	2115 (716, 416, 116)	-5	590

26" OTHER SPOKE LENGTHS

26" x 1 $^{3}/8$", EA3, 650A

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Alesa—see Weinmann (use old reference numbers)						
Ambrosio	alloy	rL	20-590		**-8**	**584**
Araya	alloy	L=r5	16-590	16A(5)	-9	583
			17-590	18	-8	584
			20-590	15	-9	583
	steel	(11_2	20-590	**5**	-9	**583**
CMC	steel	L.2)	18-590		-9	**581**
Femco	steel	(11.2	18-590	5	-6	**588**
M.O. Mfg.	steel	L2)	20-590		-8	**584**
Mavic	alloy		13-590 with double eyelets	Module E2	-9	582
			15-590 with single eyelets	Module 3	-11	578
			19-590 with double eyelets	Module 4	-11	578
Raleigh	steel	0=1/411	22-590	R 23.0	-11	**578**
Rigida	steel		17-590	Deco 30	-8	583
			21-590	Deco 35	-8	583
Schwinn—see 597mm Bead Seat						
Sturmey-Archer	steel	11...1)	24-590	R 23.0	-10	**579**
		...45	20-590	EA 210	-9	582
Sun Metal	alloy		20-590	L20	**-11**	578
			20-590 with single eyelets	M20	-10	579
			14-590	M14A	-15	**570**
			19-590	CR20	-12	576
			19-590	CR20	-11	578
	steel	L2	21-590	Style K	-10	581

26" OTHER SPOKE LENGTHS

26" x 1 3/8", EA3, 650A (contd)

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Weinmann—(old reference numbers in parentheses)						
	alloy	J	16-590	2115 (716, 416, 116)	-9	582
			16-590 with single eyelets	(Al25)	-8	585
			20-590	2119, (120)	-9	583
			20-590	(420, 420R)	-10	580
		R	20-590	2120	-10	580
						581

700D

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	alloy		19-587	RM 20	-13	**574**
Sun Metal	alloy	61	15-587	CR16	-15	570

26 x 1 1/2", 650B

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Alesa—see Weinmann (use old reference numbers)						
Araya	alloy		20-584	15	-12	576
			20-584	ADX-8W	-14	573411
Mavic	allay		15-584 with double eyelets	Module 3D	-14	**573**
			15-584 with single eyelets	Module 3	-14	**572**
			9-584 with double eyelets	Module 4	-14	*572*
Rigida	alloy		1 5-584 with single eyelets	AL 15/21	-14	572
		fl	16-584 with single eyelets	AL 16/22	-12	576
		L2	21-584	Deco 35	-12	577
Wolber/Super Champion						
	alloy	L.1	17-584 with single eyelets	Model 58	-12	576

26" OTHER SPOKE LENGTHS

26 x 1 ³/4", 650C

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	alloy		13-571 Super Aero	530	-36	52
Campagnolo	alloy		1 3-571 with double eyelets	Omega 19	-22	555
			13-571 with rim washers	Shamal	-33	533
Euro-Asia	alloy		1 3-5 71	Arrow	-34	**531**
Mavic	alloy		13-571 with double eyelets	MA 40	-20	**561**
		k_ 5	13-571 with single eyelets	Open 4	-23	554
Schwinn	steel	L2	25-571	5-7	-19	562
Sun Metal	alloy		13-571 with double eyelets	MI 3L	-20	**561**
			12-571	fv114A	-24	1 552
			13-571 with single eyelets	ME14A	-27	P 546
			14-571	Venus	-30	540
Velocity	alloy	V#	14-571	Arrowhead	-27	6 545

26" OTHER SPOKE LENGTHS

26" Sew-ups (650) - 597mm outside diameter

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Nisi	alloy		19 with rim washer	Unspecified	-9	582
Weinmann	alloy		26	950 Cycloball	-14	572

26" Sew-ups (650) - 594mm outside diameter

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Campagnolo	alloy		19 with rim washers, deep aero	Shamal	-33	533
Mavic	alloy		18.5 with double eyelets	CX-18	-11	577
			19 with double eyelets	Mach *2*	-21	587.
			19 with single eyelets	Mach 2 CD	-18	563
			20 with double eyelets	G.L. 330	-12	576

26" Sew-ups - 587mm outside diameter

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Mavic	alloy		19 with double eyelets	Mach 2 CD *2*	-21	5581

26" Sew-ups - 584mm outside diameter

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim. Spoke End Dia.
Araya	alloy	O	19	ADX-4 (Aero 4)	-21	559
Nisi	alloy	U	19 with single eyelets	Laser	-20	561
Sideral	alloy	U	**19** with eyelets	2001 Prof. Profile LM	-17	566
Zipp	carbon fiber		20 deep aero section	400	-59	481

26" OTHER SPOKE LENGTHS

26" Sew-ups - 582mm outside diameter

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Fiamme	alloy		18.5	Speedy	16	568
Saavedra	alloy		19 with rim washer	Turbo	-21	558
Sun Metal	alloy	U	17	M17A	-20	560
			19	M19All	-24	552
			17	Mistral M17A	-20	560
			19	Mistral M19A	-24	552
			21 with double eyelets	Mistral M20B	-19	562
Wolber/Super Champion						
	alloy		17.5	Profil 18	-21	559
			19	Profit 20	-25	551

26" Sew-ups - 579mm outside diameter

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Assos	alloy		16 with special nipples and washer	Unspecified Model	-15	569

26" Sew-ups - 572mm outside diameter

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Mavic	alloy		28 with double eyelets	TT B1 CD	-26	548

SPOKE LENGTHS

26" OTHER SPOKE LENGTHS

26 x 13/4", 650A, EA3

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rijn Spok End Di
van Schothorst	alloy		18-590	AS 25	-10	580

MIME

700D

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	alloy		16-583	RM 17	-13	573
			19-583	RM-20	-13	574
Sun Metal	alloy		15-583	CR16	-15	570

26" x 1 3/4", 650C

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spok End D
HED	carbon fiber/ alloy		13-571*	Jet	-24	552
Sideral	alloy		12-571 with single eyelets	2001 Professional Argentina	-23	

*needs hex head nipples and wrench to true.

26" MTB SPOKE LENGTHS

26" Sew-ups - 586mm outside diameter

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spokeal End Di
Campagnolo	alloy		20	Sigma	-15	569
			20 with double eyelets	Sigma Crono	-15	[illegible]

26" Sew-ups - 585mm outside diameter

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Zipp	carbon fiber		19	310	-41 *	519
			20	400	-59**	481

26" Sew-ups - 583mm outside diameter

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	alloy		19	SA-230S Super Aero	-34	532

26" Sew-ups - 582mm outside diameter

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
HED	carbon fiber alloy		19***	Jet	-24	552
Sun Metal	alloy	L.	21 with double eyelets	M2013	-21	558
Wolber	alloy	C /	25	TR1	-24	552

26" Sew-ups - 572mm outside diameter

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Wolber	alloy		*25*	TR1	-24	552

* for more consistant results use 24" tables (page 11-83) with -11 rim correction factor.

** for more consistant results use 24" tables (page 11-83) with -30 rim correction factor.

*" use hex head nipples and wrench to true.

CONTENTS

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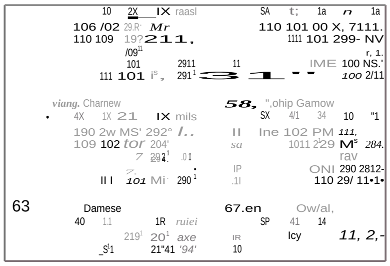
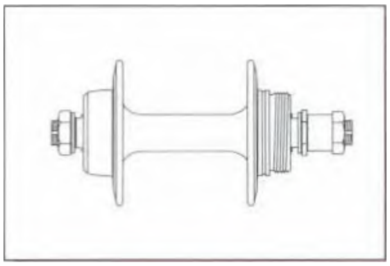
24" and Below Rims SPOKE LENGTH





SUTHERLAND'S

24" & 22"SPOKE *LENGTHS*

2nd Step of 3 steps

24", 600 and 550 Rims

Count the number of holes in the hub and decide on a spoking pattern, Le., 4-cross, 3-cross 14X, 3X) etc. Find the length listed for that combination in the hub flange diameter category selected in step Write down the length. For the right rear of multi-speed freewheel hubs subtract 2mm, ***(See below for details.)***

Adjustments will also be needed for hubs that are different from the specifications below.

24" Example One: Shimano aura-Ace front hub with **32 holes.** Look at the **40mm** hub flange diameter table. For a **3X** wheel write down the length **264mm.**

24" Example Two: Mavic 500 rear hub with **36 holes.** On the **44.5mm** table a **3X** wheel indicates a length of **260rnm** for the left side. For the right side use **258mm.**

The tables on the facing page will give you a length for the theoretical rim diameter of a 540mm ri m. Step 3 (rim correction factor) will adjust these lengths for the exact rim you have.

Approximate Dimensions

The following hub dimensions were used for the tables on the opposite page. They are the approximate dimensions for road bike front hubs and the left rear of a road bike rear hub.

Huh center to flange center - **35mm**
Spoke hole diameter - **2.6mm**
Spoke seating and stretch - **0.4mm**

Differences in Hubs

Many hubs differ from the hub dimensions listed above so adjustments may need to be made as follows:

Hub center to flange center —**a 1mm difference will make a 0.1mm difference in final spoke length.**

24" Example Three: A Sachs Jet coaster brake with a **25mm** hub center to flange center is **10mm** narrower than the dimensions these tables are based on. Multiplying **10mm** by **0.1mm** you get 1 **mm.** Subtract 1 **mm** to the final spoke length.

Spoke hole size — a 0.2mm difference will make a 0.1mm difference in t he final spoke length. in practice this is usually not enough difference to matter.

Right Rear Hub Spoke Length

Must right rear road hubs require a shorter spoke. How much shorter varies. Many hubs have a hub center to flange center on the right rear of 20mm. This is a 15mm difference from the tables. Using the guidelines for differences in hub center to flange dimensions, subtract 1.5mm for the right rear spokes. This is usually rounded up to 2mm.

These combinations have the same spoke length:

1 6 hole 1X = 32 hole 2X
20 hole 1X = 40 hole 2X
20 hole 2X = 40 hole 4X
24 hole 1X = 48 hole 2X
24 hole 2X = 48 hole 4X

3rd Step go to page 11-84

24" & 22" SPOKE LENGTHS

31 mm Flange Diameter

	4X	3X	2X	1X	radial
48					
40					
36	268	263	259*	256*	255*
32	271	265	260	256*	255*
28		268	261	257*	255*
24		271	263	257*	255*

34mm Flange Diameter

	4X	3X	2X	1X	radial
48					
40	266	261	257*	255*	254*
36	268	263	258*	255*	254*
32		265	259	255*	254*
28		267	260	255*	254*
24			263	256*	254*

40mm Flange Diameter

	4X	3X	2X	1X	radial
48	261	257	254*	251*	251*
40	265	259	255*	252*	251*
36	268	MI	256*	252*	251*
32		26411B7		252*	251*
28		267	259	253*	251*
24			261	254*	251*

44.5 mm Flange Diameter

	4X	3X	2X	1X	radial
48	260	255	252*	249*	249*
40	265	258	253*	250*	249*
36	268	260	254*	250*	249*
32		263	255	250*	249*
28		267	257	251*	249*
24			260	252*	249*

48mm Flange Diameter

	4X	3X	2X	1X	radial
48	259	254	250*	248*	247*
40	264	257	252*	248*	247*
36	267	259	253*	248*	247*
32		262	254	249*	247*
28		266	256	249*	247*
24			259	250*	247*

58mm Flange Diameter

	4X	3X	2X	1X	radial
48	257	251	246*	243*	242*
40	263	255	248*	243*	242*
36	267	257	249*	244*	242*
32		261	251	244*	242*
28		266	254	245*	242*
24			257	246*	242*

63 r l m Flange Diameter

	4X	3X	2X	1X	radial
48	256	249	244*	241*	239*
40	263	253	246*	241*	239*
36	267	256	247*	241*	239*
32		260	249	242*	239*
28		265	252	243*	239*
24			256	244*	239*

67i i m Flange Diameter

	4X	3X	2X	1X	radial
48	256	248	242*	239*	237*
40	262	252	244*	239*	237*
36	267	256	246*	240*	237*
32		260	248	240*	237*
28		265	251	241*	237*
24			256	242*	237*

90mm Flange Diameter

	4X	3X	2X	1x	radial
48	251	241	233*	228*	226*
40	260	247	236*	229*	226*
36	266	251	238*	229*	226*
32		257	241	230*	226*
28		264	245	231*	226*
24			251	233*	226*

102.5mrn Flange Diameter

	4X	3X	2X	1X	radial
48	249	237	228*	222*	220*
40		244	231*	223*	220*
36		249	234*	224*	220*
32		256	237	225*	220*
28		264	242	226*	220*
24			249	228*	220*

* Hubs using these combinations must match the diameter category exactly for accurate results. ***(See drawings and text on page 11-4.)***

24" ST 22" SPOKE LENGTHS

3rd Step of 3 steps

24", 22", 600 and 550 Rims

Find the rim in the tables below. Subtract the ri m correction factor from the number you came up with in step 2. The answer is the final length of the spoke you need.

24" Example One: Dura-Ace front hub with an Araya **24 x** 1 **1/4 20A** ri m. The rim correction factor for this rim is **-3.** The length from step 2 is **264. 264** minus **3** is **261. 261** is the final length.

24" Example Two: Mavic rear hub with a Sun Metal **24 x** **M17.** The rim correction factor for this rim is **-5.** The lengths from step 2 are **260** for the left side and **258** for the right. **260** minus **5** is **255** and **258** minus **5** is **253. 255** and **253** are the final lengths.

Identifying Rims

Rims are grouped in descending order by bead seat diameters. ISO rim markings are used in these tables to help distinguish the various models of rims. ***(See page 12-3 for an explanation of these markings.)***

The run cross section drawings are not exact representations of each rim.

Unless noted otherwise, rims listed do not have eyelets or dimples.

Be **sure to measure the outside diameter before building a wheel to confirm that you have the correct category of rim. Unlike 27 x** 1 **1/4 and 27 x 1'/8 rims which have the same bead seat diameter, 24 x 11/4 and 24 x 11/4 do not have the same bead seat diameter.**

24 x 1.25", 24 x1.375"

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Sun Metal	steel		HB 557 x 17	Style H	0	539

44

24 x Phi", Schwinn 5-5, S-6 (outside rim diameter approx. 559mm)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	alloy		1 3-546 with double eyelets	20A	-3	534
			16-546	1 6(5)	-1	538'
Femco	steel	f9	18-547	5	0	539
Schwinn	steel	a,1/4...p0	22-546	S-5 (24 x 1-3/8)	-4	532
		iL.2)	20-546	5-6 (24 x 1-1/4)		538

24" & 22" SPOKE LENGTHS

24 x 1'/4", Schwinn S-5, S-6

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Sun Metal	alloy	-	20-547	Levanter L20	-1	537
	steel		14-547	No. 912323	0	540
Ukai—see similar Araya model						
Weinmann	alloy		21-546	801	0	541
		L_A	20-546	2119 (120K)	***-2***	536

24 x 1 3/8" X 1 1/4", 600A **(outside rim diameter approx. 559mm)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Fiamme	alloy		17-541	71 - Sport (Yellow Label)	-1	537
Nisi	alloy		21-541	Sport-Toro-Stretto	-2	535
Rigida	steel	L1)	17-541	Deco 30	-4	533
Sun Metal	alloy	U	* 18-541	L17	-6	528
			* 18-541 with single eyelets	M1 7	-5	531
			* 20-541	L20	-5	530
			* 20-541 with single eyelets	M20	-5	529
		Z.-5	* 13-541 with single eyelets	M13	-5	530
			* 13-541 with single eyelets	M1311	-5	530
			* 13-541 with single eyelets	Ml 3L	-6	528
			* 20-541	CR20	-6	529
			* 14-541	M14A '91 & later	-9	522
			* 14-541	M14A pre '91	-8	525
Wolber/Super Champion	alloy	)	15-541 with single eyelets	Gentleman	-4	531

* Usable as a 540mm rim.

***** (See also 24*** x 13/4")

SUTHERLAND'S

24" 67- 22" SPOKE LENGTHS

24 x 1 3/8", (see also 24 x 1 3/8" x 1 1/2")

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Ambrosio	alloy		14-540	Elite	-5	530
Araya	alloy		20-540	1 5	-4	532
	steel		20-540	5	-4	532
CMC	steel		18-540		-4	532
Mistral—see Sun Metal						
Raleigh	steel		22-540	R21.0	-7	526
Rigida	steel	L2	1 7-540	Deco 30	-4	531
			20-540	Deco 35	-4	532
Schwinn—see 546mm Bead Seat Diameter						
Sturmey-Archer	steel	...S	20-540	EA 21.0	-4	532
Sun Metal	alloy	u	1 7-540	L17	-6	527
			1 8-540 with single eyelets	Ml 7	-5	531
			20-540	L20	-6	529
			20-540 with single eyelets	M20	-5	530
			1 6-540	CR16	-6	527
			20-540	CR20	-6	528
	steel	Lag	20-540	Style K	-5	530
Ukai—see similar Araya model						
Weinmann—(old reference numbers in parentheses)						
	alloy		20-540	2120	-5	530
			20-540	2119 (120K, 720K)	-5	530

24 x 1 3/4", Schwinn S-7

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Schwinn	steel	L2)	25-521	S-7	-15	510

24" & 22" SPOKE LENGTHS

24 x 1h/8"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	alloy		14-520	20A	-15	509
		5)	14-520	SS-45	-14	512
Sideral	alloy		12-520 with single eyelets	2001 Prof. Argentina	-18	503
Sun Meta	alloy		25-520 with single eyelets	M25	-17	506
			13-520	M13	-16	510
			13-520 with single eyelets	M1311	-15	510
			13-520 with single eyelets	MI3L	-15	510
	alloy		14-520	M14A pre '91	-20	501
			14-520	M14A '91 and later	-19	502
			14-520 with single eyelets	ME14A	-22	496

24 x 1.50", 24 x 1.75", 24 x 2.125"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
A.C.S.	plastic		25-507	Z-Rim	-20	500
Ambrosio	alloy		26-507	Benelux 32	-20	500
Araya	alloy		20-507 with dimples	Aero 7W (ADX-7W)	-28	484
			20-507 with dimples	7X (N)	-23	495
			25-507 with dimples	7X	-22	496
			20-507 w/ridges on the edges	RM-20	-22	497
			25-507 w/ridges on the edges	RM-25	-22	496
	steel	C____7	25-507	7A	-21	495
Kin-Lin	alloy		24-507 with dimples	21 AL	-23	495
Rigida	alloy		25-507	AL 25/32	-22	496
	steel	9	25-507	U 25/34	-19	502
			28-507 with dimples	U 28/37	-19	501

24"6r 22" SPOKE LENGTHS

24 x 1.50", 24 x 1.75", 24 x 2.125" (cont'd)

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Saturae (Specialized)						
	alloy		20-507 with single eyelets	X28	-23	495
Schwinn	steel	L.21	25-507	S-2	-22	496
Sun Metal	alloy	7	**24-507**	Type J	-21	498
		v.,	19-507	L18	-22	495
			20-507	L20	-21	497
			22-507 with single eyelets	M22	-20	500
			25-507	L25	-21	499
			25-507 with single eyelets	M25	-22	497
			1 6-507	CR16	-23	494
			1 6-507	CRE16/CRT1 611	-24	493
			20-507	C20	-23	494
			20-507	CR20	-24	495
			14-507	M14A	-24	493
	steel		25-507	Type M	-21	498
			27-507	Type N	-21	498
Velocity	alloy		20-507	Triple V	-21	497
Ukai—see similar Araya model						
Weinmann—(old reference numbers in parentheses)						
	alloy		I735-507 with dimples	S35	-23	494
			25-507	525/431	-21	498
			25-507 with dimples	525/431	-24	492
			25-507	2225 (525X)	-21	498
			25-507 with single eyelets	2225 (525X)	-20	500

24" Er 22" SPOKE LENGTHS

25" Sew-ups - 554mm outside diameter

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Saavedra	alloy		19 with rim washers	Turbo	-5	531

24" Sew-ups - 534mm outside diameter

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	alloy		1 9	Aero 4 (ADX-4)	-16	509
Fiamme	alloy	t9	18.5 with double eyelets	Speedy	-11	519
Mavic	alloy	c--- l	1 8.5 with double eyelets	CX-18	-11	518
			22	Sport	-13	514
			22 with double eyelets	GL 330	-11	518
			22 with double eyelets	Sport 600	-12	516
			1 9 with double eyelets	Mach 2 CD 2	-17	505
			19 with double eyelets	Mach 2	-17	505
Wolber/Super Champion	alloy		17.5	Profile 18	-14	511

24" Sew-ups - 532mm outside diameter

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Fiamme	alloy		18.5 with double eyelets	Speedy	-12	515
			1 8.5 with double eyelets	Speedy	-11	519
			21 with single eyelets	Red Label	-12	515
Saavedra	alloy		19 with rim washer	Turbo	-16	507
Sideral	alloy		19 with eyelets	2001 Prof. Profile LM	-13	513

SUTHERLAND'S

24" ST 22" SPOKE LENGTHS

24" Sew-ups - 532mm outside diameter (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Sun Metal	alloy	C=1	17	M17A	-15	511
			19	M19AII	-19	501
			19	M19A	-19	501
			21 with double eyelets	M2OB	-14	512

24" Sew-ups - 527mm outside diameter

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Assos	alloy		16 with special nipples and washer	16mm x 24	-11	518

22 x 3/8"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	alloy		20-501	15	-23	494
	steel	L_27	20-501	5	-23	494
Sun Metal	alloy		18-501	L17	-24	493
			20-501	L20	-25	491
			14-501	M14A	-30	479
	steel		15-501	No. 912213	-24	493
Weinmann—(old reference numbers in parentheses)						
	alloy	L r.j	20-501	2120	-24	492
			20-501	2119 (120K)	-24	492

24" El 22" SPOKE LENGTHS

550A

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Gitane OEM	steel	iLag	20-490		-28	483
Rigida	steel	lL.c9	17-490	Deco 30	-28	483

22 x 1.50", 22 x 1.75",22 x 2.125"

Make	Rim Material	Cross Section	BD/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	steel	7	25-457	7A	-47	446
CMC	steel	C___Y	24-457		-46	448

22" Sew-ups

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Fiamme	alloy				-37	466

20" SPOKE LENGTHS

2nd Step of 3 steps

20" and 500 Rims

Count the number of holes in the hub and decide on a spoking pattern, i.e. 4-cross, 3-cross (4X, 3X) etc. Find the length listed for that combination in the hub diameter category selected in step 1. Write down the length. Front hub flanges are often farther apart and generally need a 1 mm longer spoke, ***(see below for details).*** Adjustments will also be needed for hubs that are different from the specifications below.

20" Example One: GT BMX front hub with **32 holes.** Look at the **40mm** hub flange diameter table. For a **3X** wheel **218mm** is the listed length. Add **1 mm** for the front hub. ***See differences in Hubs below.*** Write down **219mm.**

20" Example Two: CT BMX rear hub with **36 holes.** On the **44.5mm** table a **3X** wheel indicates a length of **215mm.**

The tables on the facing page will give you a length for the theoretical rim diameter of a 450mm rim. Step 3 (rim correction factor) will adjust these lengths for the exact rim you have.

Approximate Dimensions

The following huh dimensions were used for the tables on the opposite page. They are the approximate dimensions for a rear BMX hub or coaster brake.

Hub center to flange center - **28mm**
Spoke hole diameter - **2.6mm**
Spoke seating and stretch - **0.4mm**

Differences in Hubs

Many hubs differ from the huh dimensions listed above so adjustments may need to be made as follows:

Ilub center to flange center --- **a 1mm difference will make a 0.12mm difference in final spoke length.**

Spoke hole size — a 0.2mm difference will make a 0.1mm difference in the final spoke length. In practice this is usually not enough difference to matter.

20" Example One: GT BMX front **hub** with a **35mm** hub center to flange center is **7mm** wider than the dimensions these tables are based on. Multiplying 7mm by **0.12mm** you get **0.84mm.** Add **1 mm** to the spoke length.

These combinations have the same spoke length:

16 hole 1X	32 hole 2X
20 hole 1X	40 hole 2X
20 hole 2X	40 hole 4X
24 hole 1X	48 hole 2X
24 hole 2X	48 hole 4X

3rd Step go to page 11-94

20" SPOKE LENGTHS

31 mm Flange Diameter

	4X	3X	2X	1X	radial
48					
40					
36	224	219	215*	212*	211*
32	227	221	215*	212*	211*
28		223	217	212*	211*
24		227	219	213*	211*
20			222	214*	211*

34mm Flange Diameter

	4X	3X	2X	1x	radial
48					
40	220	216	212*	209*	208*
36	223	217	212*	209*	208*
32		219	213*	210*	208*
28		222	215	210*	208*
24			217	211*	208*
20			220	212*	208*

40mm Flange Diameter

	4X	3X	2X	1X	radial
48	216	211	208*	206*	205*
40	220	214	209*	206*	205*
36	222	216	210*	207*	205*
32		218	211*	207*	205*
28		221	213	207*	205*
24			216	208*	205*

44.5mm Flange Diameter

	4X	3X	2X	1X	radial
48	215	210	206*	204*	203*
40	219	213	208*	204*	203*
36	222	215	209*	204*	203*
32		218	210	205*	203*
28		221	212	205*	203*
24			215	206*	203*

48mm Flange Diameter

	4X	3X	2X	1x	radial
48	214	209	205*	202*	201*
40	219	212	206*	203*	201*
36	222	214	207*	203*	201*
32		217	209	203*	201*
28		221	211	204*	201*
24			214	205*	201*

58mm Flange Diameter

	4X	3X	2X	1X	radial
48	212	206	201*	197*	196*
40	218	209	202*	198*	196*
36	222	212	204*	198*	196*
32		216	206	199*	196*
28		220	208	200*	196*
24			212	201*	196*

63mm Flange Diameter

	4X	3X	2X	1x	radial
48	211	204	199*	195*	194*
40	217	208	201*	196*	194*
36	222	211	202*	196*	194*
32		215	204	197*	194*
28		220	207	197*	194*
24			211	199*	194*

67mm Flange Diameter

	4X	3X	2X	1X	radial
48	210	203	197*	193*	192*
40	217	207	199*	194*	192*
36	222	210	201*	194*	192*
32		215	203	195*	192*
28		220	206	196*	192*
24			210	197*	192*

90mm Flange Diameter

	3X	2X	1X	radial
48	196	188*	182*	180*
40	202	191*	183*	180*
36	206	193*	184*	180*
32	212	196	185*	180*
28		200	186*	180*
24		206	188*	180*

102.5mm Flange Diameter

	3X	2X	1X	radial
48	193	183*	177*	174*
40	199	186*	177*	174*
36	204	189*	178*	174*
32	211	193	179*	174*
28		197	181*	174*
24		204	183*	174*

* Hubs using these combinations must match the diameter category exactly for accurate results.

(See drawings and text on page 11-4.)

20" SPOKE LENGTHS

3rd Step of 3 steps

20" and 500 Rims

Find the rim in the tables below. Subtract the rim correction factor from the number you came up with in step 2. The answer is the final length of the spoke you need.

Identifying Rims

Rims are grouped in descending order by bead seat diameters. ISO rim markings are used in these tables to help distinguish the various models of rims. For an explanation of these markings, *(see page 12-3)*.

20" Example One: GT BMX front hub with an Araya **20 x 1.50" 7X(N)** rim. The rim correction factor for this rim is **-27.** The length from step 2 is **219. 219** minus **27** is **192. 192** is the final length.

20" Example Two: GT BMX rear hub with a Sun Metal **20 x 1.75 M17.** The rim correction factor for this rim is **-27.** The length from step 2 is **215. 215** minus **27** is **188.** **:188** is the final length.

The rim cross section drawings are not exact representations of each rim.

Unless noted otherwise, rims listed do riot have eyelets or dimples.

20 x 1 3/8", 20 x 1 1/4", Schwinn 5-5, 5-6

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	alloy		14-451 with double eyelets	20A	-5	439
			14-451 with rim washers	Aero 1W (ADX-1W)	-7	436
			20-451 with dimples	1 5	-5	441
	steel	LO	20-451	5	-3	444
Dunlop	steel	CL,	21-451	E.5.J.	-3	444
Mistral—see Sun Metal						
Raleigh	steel	tly..11	20-451	R 18.0	-6	438
Rigida	steel	L.2	20-451	Deco 35	-3	444
Schurmann	steel		20-451		-3	444
Schwinn	steel	CLA,...,4	22-451	S-5 (20x1-3/8)	-6	438
		'&_2	20-451	S-6 (20x1-1/4)	-3	444

20 x 1 3/8", 20 x 1'/4", Schwinn S-5, 5-6 (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Sturmey-Archer	steel		20-451	EB 18.0	-3	444
Sun Metal	alloy		13-451	M13	-5	440
			13-451 with single eyelets	M1311	-5	440
			13-451 with single eyelets	M1 3L	-4	441
			16-451	CR16	-5	439
			20-451	CR20	-8	434
			14-451	M14A	-9	432
			14-451 with single eyelets	ME14A	-12	426
		Et--)51	18-451	L17	-4	441
			20-451	L20	-4	441
			20-451 with single eyelets	M20	-5	441
	steel		14-451	No 911914	-4	**442**
Ukai—also see similar Araya models						
	alloy		14-451		-7	436
			21-451	16A-1	-4	443
			13-451	Racer *Z-2*	-6	437
Velocity	alloy		15-451	K-525	-10	429
Weinmann—(old reference numbers in parentheses)						
	alloy		21-451	(A101)	*-2*	**445**
			21-451	2119 (120K)	-4	442

500A

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Rigida	steel		17-440	Deco 30	-9	433

20" SPOKE LENGTHS

20 x 1 3/4", Schwinn 5-7

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	steel	Lz9	24-419		-21	408
Schwinn	steel	L2	24-419	S-7	-21	408

20 x 1.50", 20 x 1.75", 20 x 2.125"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
A.C.S.	alloy	L,--_,J	25-406	RL-Edge	-25	400
	plastic	C,	25-406	7-Rim	-27	396
Ambrosio	alloy		26-406	Benelux 32	-25	400
Araya	alloy	U	20-406 with dimples	Aero 7W (ADX-7W)	-33	384
		L_}	20-406 with dimples	7X (N)	-27	395
			25-406 with dimples	7C	-28	394
			25-406 with dimples	7X	-28	394
			25-406 w/dimples & ridges on edges of brake surface	7L	-27	394
			17-406	RB-17	-26	394
			20-406	XA-1	-30	390
	steel		25-406	7A	-27	396
			25-406 with dimples	1 7 (4)	-27	392
		|L-3	25-406	1 7 (1)	-27	396
			30-406	17 (2)	-27	396
			30-406	17 (3)	-29	392
Bontrager	alloy	p	18-406	BCX Blue Label	-28	394
CMC	steel	C 7	25-406		-26	397

20" SPOKE LENGTHS

20 x 1.50", 20 x 1.75", 20 x 2.125" (cont'd)

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Femco	alloy	(5)	25-406	A7	-26	397
	steel	7	25-406	7A	-27	397
			25-406	7NF	-27	397
			30-406 with dimples		-31	388
Kin Lin	steel	C 7	30-406 with dimples		-31	**388**
M.O. Mfg.	steel	7	25-406		-28	394
Mavic	alloy		19-406 with double eyelets	TTM4, TTM4CD	-28	395
Odyssey	alloy		20-406	T-1000	-35	379
Peregrine	alloy		24-406	HP 48	-29	393
Rigida	alloy		25-406 with dimples	AL 25/32	-29	**391**
Ritchey	alloy		17-406	Vantage Comp	-29	393
Saavedra	alloy	Y	20-406	BMX Aerodynamic	-35	379
Sun Metal	alloy	Ei--3	17-406	L17	-28	395
			18-406 with single eyelets	M1 7	-27	396
			20-406 with single eyelets	M20	-27	396
			18-406	L18	-30	390
			20-406	L20	-27	396
		j	25-406	Style I	-27	396
			25-406 with single eyelets	M25	-27	395
			16-406	CR16	-28	393
			16-406 with single eyelets	CRE16/CRT1611	-30	390
			20-406	C20	-29	392
			20-406	CR20	-29	392
			20-406	Rhyno/SST	-31	387
			20-406 with single eyelets	MI 3L	-27	395
	steel		25-406	Style M	-27	396
			27-406	Style N	-27	396

20" SPOKE LENGTHS

20 x 1.50", 20 x 1.75", 20 x 2.125" (contd)

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Super Champion—see Wolper						
Ukai—see similar Araya model						
Velocity	alloy		15-406	K-525	-32	387
			20-406	Triple V	-28	395
Weinmann—(old reference numbers in parentheses)						
	alloy	J	25-406	525/431	-27	396
			25-406 with dimples	525/431	-27	395
			25-406 with single eyelets	525/431	-26	398
			25-406	2225 (525X)	-26	398
			25-406 with single eyelets	*2225* (525X)	-25	400
			18-406	BCX Blue Label	-28	394
Wolber/Super Champion						
	alloy		24-406 with single eyelets	Canyon	-28	394

20" Sew-ups

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	alloy		21 with rim washer	Aero 2 (ADX-2)	-22	405
Nisi	alloy		with rim washer		-17	**415**
Saavedra	alloy		19 with rim washer	Turbo	-22	409
Sun Metal	alloy		19	M19AII	-24	402
			19	M19A	-24	402

18" Eir 17" SPOKE LENGTHS

2nd Step of 3 steps

18" and 17" Rims

Use the directions for 20" rims. These tables should be considered as a start for some trial-and-error wheel building. Smaller wheels have too many variables to be accounted for in tables like these. Interlacing spokes is not recommended for these size wheels.

3rd Step go to page 11-100

Approximate Dimensions

The following huh dimensions were used for the tables on this page.

Rim diameter - **400mm**
I lub center to flange center - **28mm**
Spoke hole diameter - **2.6mm**
Spoke seating and stretch - **0.4mm**

These combinations have the same spoke length:

16 hole 1X = 32 hole 2X
20 hole 1X = 40 hole 2X

Differences in Hubs

flub center to flange center **a 1mm difference will make a 0.15mm difference in spoke length.**

34mm Flange Diameter

	2X	lx	radial
28	190	185*	183*
24	192	186*	183*
20	196	187*	183*
16		189	183*
12		192	183*

40mm Flange Diameter

	2X	1X	radial
28	189	183*	180*
24	191	183*	180*
20	195	185*	180*
16		187	180*
12		191	180*

44.5mm Flange Diameter

	2X	1X	radial
28	187	181*	178*
24	190	182*	178*
20	195	183*	178*
16		185	178*
12		190	178*

48mm Flange Diameter

	2X	lx	radial
28	186	179*	177*
24	190	180*	177*
20	194	182*	177*
16		184	177*
12		190	177*

58mm Flange Diameter

	2X	1X	radial
28	184	175*	172*
24	188	176*	172*
20	193	178*	172*
16		181	172*
12		188	172*

63mm FlangeDiameter

	2X	1x	radial
28	182	173*	169*
24	187	174*	169*
20	193	176*	169*
16		180	169*
12		187	169*

67mm Flange Diameter

	2X	1X	radial
28	181	171*	167*
24	186	172*	167*
20	193	175*	167*
16		178	167*
12		186	167*

90mm Flange Diameter

	1X	radial
28	161*	156*
24	163*	156*
20	166	156*
16		156*
12		156*

* Hubs using these combinations must match the diameter category exactly for accurate results. ***(See drawings and text on page 11-4.)***

18" & 17" SPOKE LENGTHS

3rd Step of 3 steps

18 x 13/8"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	steel	k2)	20-400	5	-4	392
Sturmey-Archer	steel		20-400		-4	392
			29-400	FA 16.0	-1	398
Sun Metal	**alloy**		14-400	M14A	-35	380

17 x 1'/4"

Make	Rim Material	Cross Section	150/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Milremo	alloy		18-369	early Alex Moulton	-18	363
Mistral—(English, not Sun Metal)	alloy		18-369	Alex Moulton	-18	363
Sun Metal	alloy		1 7-369	Ll 7	-22	357
			with single eyelets	M13L	-21	358

18x 1.75"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	steel	C)	25-355	7A	-28	344
Ukai	steel	C)	25-355 with dimples	Steel	-30	341

18" Sew-ups

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Fiamme	alloy	l	21	Bambino	-17	367
Sun Metal	alloy		19	Mistral M19A	-25	351

16" SPOKE LENGTHS

2nd Step of 3 steps

16" and 400 Rims

Use the directions for 20" rims. These tables should be considered as a start for some trial-and-error wheel building. Smaller wheels have too many variables to be accounted for in tables like these. interlacing spokes is not recommended for these size wheels.

3rd Step go to page **11-102**

Approximate Dimensions

'Ihe following huh dimensions were used for the tables on this page.

Rim diameter - **35Omm**
Hub center to flange center - **28mm**
Spoke hole diameter - **2.6mm**
Spoke seating and stretch - **0.4mm**

These combinations have the same spoke length:

16 hole 1X	= 32 hole 2X
20 hole 1X	= 40 hole 2X

Differences in Hubs

Hub center to flange center - **a 1 mm difference will make a 0.18mm difference in spoke length.**

34mm Flange Diameter

	2X	1X	radial
28	166	161*	159*
24	168	161*	159*
20	171	162*	159*
16		164	159*
12		168	159*

40mm Flange Diameter

	2X	1X	radial
28	164	158*	156*
24	167	159*	156*
20	170	160*	156*
16		162	156*
12		167	156*

44.5mm Flange Diameter

	2X	1X	radial
28	163	156*	154*
24	166	157*	154*
20	170	158*	154*
16		161	154*
12		166	154*

48mm Flange Diameter

	2X	1x	radial
28	162	155*	152*
24	165	155*	152*
20	170	157*	152*
16		160	152*
12		165	152*

58mm Flange Diameter

	2X	1X	radial
28	159	150*	147*
24	163	151*	147*
20	169	153*	147*
16		157	147*
12		163	147*

63mm Flange Diameter

	2X	Ix	radial
28	158	148*	145*
24	162	149*	145*
20	169	152*	145*
16		155	145*
12		162	145*

67mm Flange Diameter

	2X	1X	radial
28	157	147*	143*
24	162	148*	143*
20	168	150*	143*
16		154	143*
12		162	143*

90mm Flange Diameter

	2X		
28	152	137*	131*
24	158	139*	131*
20	167	142*	131*
16		148	131*
12		158	131*

Hubs using these combinations must match the diameter category exactly for accurate results. ***(See drawings and text on page 114.)***

16" SPOKE LENGTHS

3rd Step of 3 steps

16 x 13/s"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	steel	li..40	20-349	5	-5	340
Sturmey-Archer	steel	L2	20-349		-5	340
Sun Metal	alloy	tj	20-349	L20	-7	336
	steek	7	20-349	No. 941613	-6	339
Weinmann—(old reference numbers in parentheses)						
	alloy		21-349	2119 (120K)	-5	**339**

400A

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Weinmann—(old reference numbers in parentheses)						
	alloy		21-340	(A101)	-8	334

16" SPOKE LENGTHS

16 x 13/4"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	alloy		25-305	7X	-29	*292*
	steel	C 2	25-305	Steel	-28	294
			25-305 with dimples	Steel	-29	292
CMC	steel		25-305	Steel	*-27*	295
Femco	steel	7	25-305	7A	-28	294
Schwinn	steel		25-305	Steel	**-28**	**294**
Sun Metal	steel		25-305	Style M	-28	294
			27-305	Style N	-28	294
Ukai	steel		25-305	Steel	-28	294

16" Sew-ups

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke nd Dia.
Sun Metal	alloy		19	Mistral M19AII	-23	303
			17	Mistral M17A	-20	311
			19	Mistral M19A	-23	303

14" SPOKE LENGTHS

2nd Step of 3 steps

14" Rims

Use the directions for 20" rims. These tables should be considered as a start for some trial-and-error wheel building. Smaller wheels have too many variables to he accounted for in tables like these. Interlacing spokes is not recommended for these size wheels.

3rd Step go to page 11-105

Approximate Dimensions

The following hub dimensions were used for the tables on this page.

Rim diameter - **300mm**
Hub center to flange center - **28mm**
Spoke hole diameter - **2.6mm**
Spoke seating and stretch - **0.4mm**

Differences in Hubs

Hub center to flange center - **a 1mm difference will make a 0.19mm difference in spoke length.**

34mm Flange Diameter

	2X	1X	radial
28	141	136*	134*
24	143	137*	134*
20	147	138*	134*
16		140	134*
12		143	134*

40111M FlangeDiameter

	2X	1x	radial
28	140	133*	131*
24	142	134*	131*
20	146	136*	131*
16		138	131*
12		142	131*

44.5mm Flange Diameter

	2X	1X	radial
28	138	132*	129*
24	141	132*	129*
20	146	134*	129*
16		136	129*
12		141	129*

48mm Flange Diameter

	2X	1X	radial
28	137	130*	127*
24	141	131*	127*
20	145	133*	127*
16		135	*127**
12		141	*127**

58mm Flange Diameter

	2X	1x	radial
28	135	126*	122*
24	139	127*	*122**
20	145	129*	122*
16		132	*122**
12		139	122*

63mm Flange Diameter

	2X	1X	radial
28	134	124*	120*
24	138	125*	120*
20	144	*127**	120*
16		131	120*
12		138	120*

67mm Flange Diameter

	2X	lx	radial
28	133	122*	118*
24	138	124*	118*
20	144	126*	118*
16		130	118*
12		138	118*

* Hubs using these combinations must match the diameter category exactly for accurate results. ***(See drawings and text on page 11-4.)***

14" SPOKE LENGTHS

3rd Step of 3 steps

14 x 13/8"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Sturmey-Archer	steel		20-298		-5	290
Sun Metal	alloy	$	1 8-298	Levanter L17	-6	288
Ukai	steel	p21	20-298		-5	290

14x 1.75"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	steel	)	20-253 with dimples	17 (5)	-29	242
			25-253	7A	-28	244
Ukai	steel	9	25-253 with dimples		-30	241

14x 1.75"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Sun Metal	alloy		19	Mistral M19All	-4	242
			19	Mistral M19A	-4	242

12" SPOKE LENGTHS

2nd Step of 3 steps

12" Rims

Use the directions for 20" rims. These tables should be considered as a start for some trial-and-error wheel building. Smaller wheels have too many variables to be accounted for in tables like these. Interlacing spokes is not recommended for these size wheels.

Approximate Dimensions

the tollowing hub dimensions were used for the tables on this page.

Rim diameter - **250mm**
Hub center to flange center - **28mm**
Spoke hole diameter - **6mm**
Spoke seating and stretch - **0.4mm**

Differences in Hubs

Hub center to flange center - **a 1mm difference will make a 0.22mm difference in spoke length.**

34mm Flange Diameter

	1x	radial
20	113*	110*
16	115*	110*
12	119	110*

40mm Flange Diameter

	1x	radial
20	111*	107*
16	114*	107*
12	118	107*

44.5 mm Flange Diameter

	1X	radial
20	110*	105*
16	112*	105*
12	117	105*

48mm Flange Diameter

	1X	radial
20	108*	103*
16	111*	103*
12	117*	103

58mm Flange Diameter

	1X	radial
20	105*	98*
16	108*	98*
12	115	98*

63 mm Flange Diameter

	1x	radial
20	103*	96*
16	107*	96*
12	114	96*

67mm Flange Diameter

	1X	radial
20	102*	94*
16	106*	94*
12	114	94*

* Hubs using these combinations must match the diameter category exactly for accurate results. *(See **drawings and text on page 11-4.**)*

3rd Step of 3 steps

12 1/2 x 21/4"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
					-28	193
Sun Metal	alloy		24-203	Style J	-25	199
	steel		24-203	Style M	-27	196

SUTHERLAND'S

10" SPOKE LENGTHS

2nd Step of 3 steps

10" Rims

Use the directions for 20" rims. These tables should be considered as a start for some trial-and-error wheel building. Smaller wheels have too many variables to he accounted for in tables like these. Interlacing spokes is not recommended for these size wheels.

Approximate Dimensions

The following hub dimensions were used for the tables on this page.

Rim diameter - **200mm**
Hub center to flange center - **28mm**
Spoke hole diameter - **2.6mm**
Spoke seating and stretch - **0.4mm**

Differences in Hubs

Huh center to flange center - **a 1mm difference will make a 0.22mm difference in spoke length.**

Radial Pattern

Hubs must match the hub diameter category exactly. ***(See drawings and text on page 11-4.)***

34mm Hub - 87*
40mm Hub - 84*
44.5mm Hub - 82*
48mm Hub - 80*
58mm Hub - 75*
63mm Hub - 73*
67mm Hub - 71 *

3rd Step of 3 steps

10x PA"

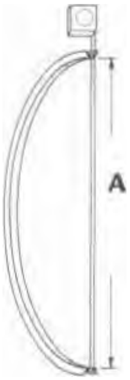
Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Marzorati	alloy	t	25-194	Mini Westwood	-9	182

10 x 1.5"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	steel	C____	HB 168 x 20 with dimples	17 (5)	-30	141

SPOKE LENGTHS

CALCULATING RIM CORRECTION FACTORS



To be sure rim is round, measure in several places.
This dimension will be called A.

1. Measure from next to one hole to next to the exact opposite hole.
2. Measure in units of millimeters, including tenths.
3. Avoid measuring within two holes of the rim seam.
4. Measure at four points equally spaced about the rim and get an average which should be rounded to the nearest 0.1 mm.

Measure the spoke nipple from the bottom of the slot to the end.
This dimension will be called B.

1. Measure in millimeters, including tenths.

C **Place a spoke nipple in the rim and measure that part that extends beyond the rim.**
This dimension will be called C.

1. Measure from the same points on the rim that "A" was measured from (i.e., if "A" was measured from beside a raised eyelet, "C" should be measured from beside a raised eyelet).

The **theoretical rim radius** the charts are based on will be called **D.**

D = 315 for 27" rims*	175 for 16" rims
300 for 26" rims	150 for **14"** rims
270 for 24" rims	125 for 12" rims
225 for 20" rims	100 for **10"** rims
200 for 18" rims	* also 700C, Sew-ups, and 28" rims.

The formula to find the correction factor from a rim not listed on the chart is:

$$\frac{A+2(B-C)}{2} - D = \text{Correction Factor} \quad \text{or} \quad (.5 \times A) + B - C - D = \text{Correction Factor.}$$

SUTHERLAND'S

NUMBER OF SPOKES

Figure A - 32 spokes

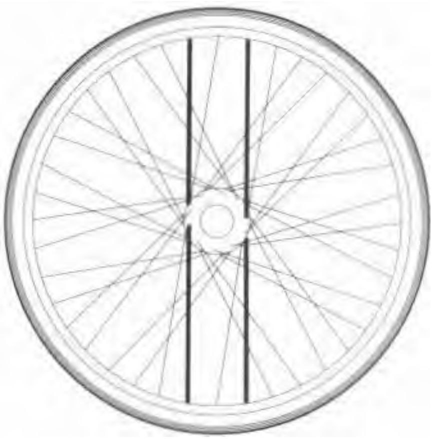


Figure B - 40 spokes

I D 32, 36 and 40 Spoke Wheels

32 and 40 spoke wheels have similar spoke patterns as illustrated in figures A and B. With practice they can be easily told apart by looking at the distance between spokes at the rim.

36 spoke wheels have pattern illustrated in figure C.

20, 24 and 28 Spoke Wheels

24 spoke wheels have a pattern similar to 32 and 40 spoke wheels.

20 and 28 spoke wheels have a pattern similar to 36 spoke wheels.

Figure C - 36 spokes

24" & BELOW SPOKE LENGTHS

24 x 1.50", 24 x 1.75", 24 x 2.125"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Rigida	alloy	ILL_A	20-507	A526F	-21	498

20 x 1.50", 20 x 1.75", 20 x 2.125"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Araya	steel	C___)	25-406 with dimples	17(4)	-29	392
Rigida	alloy		20-406	AS26F	-27	397
						391

18 x 13/8"

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Sun Metal	alloy		14-400	M14A	-10	380

20" Sew-ups

Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Saavedra	alloy		1 9 with rim washer	Turbo	-21	40911

16" Sew-ups

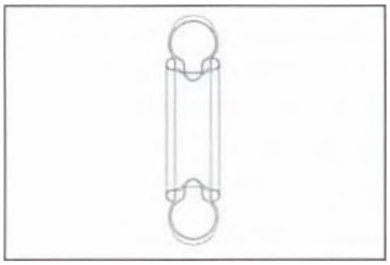
Make	Rim Material	Cross Section	ISO/ Distinguishing Features	Model	Rim Correction Factor	Rim Spoke End Dia.
Sun Metal	alloy	)19		M19A	-26	298

24" AND BELOW SPOKE LENGTHS

CONTENTS

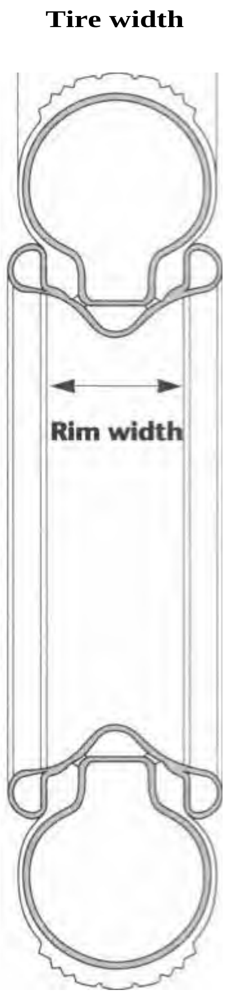
12

TIRES



HB 575 x 25

TIRES



TIRE AND RIM TYPES

The most common types of tires are **wired-on, hooked-bead[1],** and **sew-up.** Both wired-on and hooked-bead tires have a wire embedded in the rubber at the inside edge of the tire. Wired-on rims have straight sides. The bead seat of a wired-on tire is where the edge of the tire meets the rim. Air pressure in the tube keeps the bead of the tire pressed outward. Without air pressure, the bead can slip into the well in the center of the rim allowing it to come off over the edge on another part of the rim.

Hooked-bead tires have a protruding bead that fits around the hooked edge of the rim to hold the tire in place. ***(These rim cross sections are illustrated on page 12-7)***.

Sew-up tires, also known as tubulars or sprints, have the inner tube sewn in. Sew-up rims lack flanges; the tire is held to the dished face of the rim by air pressure and a special adhesive.

TIRE AND RIM FIT

Type: In the past, each rim type fit only the corresponding tire type. Now the distinctions are blurring. Many higher-pressure rims come with a ridge on the inside edge of the rim flange which is similar to though smaller than the hooked edge of a hooked-edge rim. Many folding tires must be mounted on rims with these bumps to prevent stretching of the flexible, plastic bead material.

Width: Tires with an f50[2] Section Width[3] of between 1.45 and 2.00 times the rim width (measured in millimeters between the inside of the flanges) should fit well. Hooked-edge rims hold tires with a section width of up to 2.25 times the rim width. Never use an inner tube that is too narrow for the tire in which it is installed: it may work at first but it will soon split at the seams.

Diameter: Bead and bead seat diameter are much more important dimensions than outside diameter because they determine tire/rim fit. (Unfortunately, most tires are still marked with the nominal outside diameter. Since tires with equal outside diameters may differ slightly in bead diameter, they may not fit the same rim.) To ensure proper fit, tire bead diameter must be very close to rim bead seat diameter—in general, within I mm. If the tire is too large, it will blow off the rim when inflated; if too small, the beads will pull down below the bead seat—if the tire can be mounted at all.

1 True clincher tires, tires held on by a pronounced bead and a lubber flap under the inner tube, are now obsolete in most parts of the world. Many people still use the term clincher to refer to the wired-on and hooked-bead tires that have replaced them.

2 The former European Tire and Rim Technical Organization (ETRTO) markings have been adopted by the ISO.

3 ISO Section Width is approximately equal to the distance between the beads, measured over the tread in millimeters, divided by 2.5. ***(See Measuring Tires and Rims, page 12-5.)***

TIRE AND RIM MARKINGS

ISO Tire Markings

The ISO tire size designations are the only accepted international standard. Many tires carry them in addition to the more familiar markings. For wired-on tires, the ISO tire markings consist of two numbers as follows:

ISO tire section width in mm --P. **37 - 622..** **bead diameter in mm**

ı looked-bead tires may or may not use the HB designation, ***(see ISO rim markings below).***

ISO Rim Markings

For wired-on rims, the ISO rim designations also consist of two numbers:

ISO rim width between flanges in mm **• 13 - 622•** **- bead seat diameter in mm**

For hooked-bead rims, the ISO has designated HB numbers, although the above markings for wired-on rims are also seen. HB numbers are as follows:

HB 575 x 25

HB* for Hooked-Bead **- inside width in mm**

outside diameter of rim in mm

** HB cumbers are only found on hooked-bead rims.*

British

Tires are marked in inches with two or three numbers as follows:

28 x x 1 3/8 **(ISO 37-622)**

Nominal outside diameter **standard width** --------------- **actual width**

Tires designed for standard rim sizes carry only two numbers:

,_28 x 13/4 **(I SO 44-571)**

Nominal outside diameter **actual width**

28 x 1.75, **(ISO 44-559)**

Nominal outside diameter **actual width**

SUTHERLAND'S

TIRE AND RIM MARKINGS (CONTD)

British (cont'd)

Common fraction in width designation indicates wired-on type, ***decimal*** fraction indicates hooked-bead type.

Note that 26 x PA and 26 x 1.75 are different type tires and are not interchangeable.

Schwinn

Schwinn tire markings are the same as the British markings described above with the following exceptions (also noted in the tire size chart):

Schwinn	**British**	**150**
26 x 1 1/2	26 x 1 1/4	32-597
24 x 11/2	24 x 11/4	32-546

These two Schwinn sizes are not interchangeable with the British sizes which have identical markings.

Vredestein-Paragon (Netherlands)

Markings are in inches, similar to those of the British system, except that when there arc **three** numbers, the last two are reversed compared to the British markings. British and Vredestein-Paragon tires in nominal sizes of 24" or less are not interchangeable.

28 x 1 3/8 x 1 5/8 (ISO 37-622)

Nominal outside - diameter | **actual width** | **– standard width**

French

Markings are in millimeters as follows:

07 0 x 35 C, (ISO 37-622)

Nominal outside diameter | **nominal width (sometimes omitted)** | **code**

In the French system, two tires have the same head seat diameter if the first numbers and the final letters match.

Italian, German, Swedish, and the like.

Many manufacturers mark their tires in inches although actual sizes are often different from true British sizes. Look for an ISO designation or measure the tire as described, *(see page **12-5**)*.

MEASURING TIRES AND RIMS

ISO measurements arc in millimeters. Measure tires and rims as described below.

Tires

ISO Section Width can be approximated as follows:

ISO Section Width	**Distance between beads measured over the tread in mm**	**2.5**

For proper tit, ISO lire Section Width should be between 1.4 and 2.0 times rim width (up to 2.25 ti mes for hooked-head tires and rims).

The most accurate way to determine the bead diameter is to measure a rim that the tire fits. Rim bead seat diameter is usually within 2mm of tire bead diameter. If no such rim is available, use the following technique to measure the bead circumference and calculate the bead diameter. Lay the tire on a flat surface and expand a 1/4" wide **flat** steel tape inside the head. If the tire will not lie flat against the tape, make up a long strip of thin cardboard, using 1" strips taped together, and measure **that.** Calculate the head diameter as follows:

bead diameter	**bead circumference**	**3.14**

The results will tend to be low, perhaps as much as anon due to the difficulty of holding the tape against the head.

Rims

Rim **width** is the distance between the inside of the flanges, which can be measured directly. To measure the **bead seat diameter,** first obtain the flange height and the outside flange diameter. The flange height is the distance from the head seat to the top of the flange. The outside diameter can he measured directly on a hare rim or with a dishing tool. Measure in several places and take an average.

Ii necessary, the outside flange diameter can be calculated from the rim circumference. Measure the circumference by marking a spot on the rim with a piece of tape and rolling the rim exactly one full turn along a flat surface. The distance of travel is the rim circumference. Calculate the bead seat circumference as follows:

ri m outside diameter	**ri m circumference**		**3.14**		
ri m bead seat diameter	**ri m outside diameter**	–	**2**	x	**flange height**

TIRES

TIRE AND RIM WIDTH

The following rim widths are recommended for use with the tire sections to the left. Rim width is measured between the flanges.

Rim Width (inside flanges)	Tire Section British	ISO	French
12 to 15mm	3/4	20	20
13 to 15mm	7/8	22	22
13 to 18mm	1	25	25
14 to 20mm	1 1/8	28	28
15 to 21mm	1 1/4	32	32
16 to 23mm	1 3/8	37	35
17 to 24mm	1 1/2	40	38
20 to 29mm	1 5/8	44	42
23 to 31mm	1 3/4	47	45
24 to 33mm	2	54	50
27 to 35.6mm	2 1/8	57	54
30.5 to 41 mm	2 1/4	62	57

CLASSIC RIM CROSS SECTIONS*

Hooked-bead or Hooked-edge Rims

30mmir.
41174
'19.8mm

33.5mm
24.6mm, 7

.111- 35.8mm
SS 2s.7.2m
C

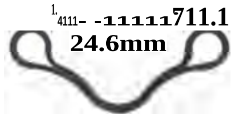
"Lightweight" 1.375 "Middleweight" 1.75 "Balloon" 2.125

Wired-on Rims

ha/ 33mm— If-
20.3mm

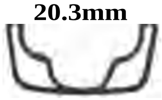
Narrow Westwood
E type

38.1mm
4111- -11111711.1
24.6mm



Westwood
F type

27.9mm
20.3mm



Endrick**
EA type

27.9mm
r%ll 3m:1

Westrick***
R type

E type Narrow Westwood
K type Special Light-weight
F type Standard Westwood
EB type Narrow junior Westwood
EA type Endrick Pattern
R type Westrick Raleigh Pattern

Schwinn Rims

35.4mm
1.4_1,..1
24.6mm

Schwinn 5-7
"Lightweight"

35.8mm
27.2mm

Schwinn S-2
"Middleweight"

* Modern rims vary so much they defy neat classification.

**** Schwinn S-6** is similar in shape to British Endrick.

*****Schwinn S-5** is similar in shape to British Westrick.

TIRE AND RIM CHARTS

Common Tire Markings (American, English, French, etc.): If width number is replaced by a dash a range of widths is available in the same bead seat size.

ISO Size Designation: Tire Section measurements are in mm, followed by bead seat diameter in trim. For FIB numbers, *(see page 1 2-3)*. When a range of widths is available, it is shown with the standard width in bold face: 32-340 to **37-340.**

Bead Seat Circumference: This is 3.14 times bead seat diameter.

Brake Radius: Subtract this value from the distance between brake bolt hole and axle center to obtain brake reach.

Rim Outside Diameter (assuming normal flange height): Actual value for a particular rim may be as much as 5mm less, especially with narrower rims.

Tire Outside Radius: Use this value to calculate tire to fork clearance. Radius of standard width tires is in boldface.

■ Indicates sizes that may not be interchangeable with other sizes with identical or similar markings. Use ISO markings to positively identify tire.
Bead seat circumference = n x bead seat diameter

Bead Seat Dia - meter	ISO Tire Marking (Width- Bead Seat Diameter)	North American Sizes	Schwinn Rim	British	British Rim	French	Italian	Vredestein*(V) Swedish (5) German (G) Standard Unidentified (5U)	Brake Radius	Approx.* Rim Outside Dia- meter	Approx. Tire Out- side Radius
647	**32-647**			**28x11/4**	EA2	**700**		**700x32 (V)**	323	659	358
642	**37-642** to 44-642			**28x** 1 %	FS EA4 E4	**700A** **28x1 ; x1'/8**	**28x1 3/g** **700x35A**	**28x13/8(V),** (S) **700x35A (V)** ^ **28x1** 1/2 (S) **28x11/2x1 3/8** (S)	321	654	361 - 368
635	**28-635** to **40-635** to 44-635	1⁰ **28x11/2**		^ **28x11/2**	F10 F25.0 FA25.0	**700B**	**700B** ■ **28x11/2**	**28x—xl** 1/2 **(V)** **700B (V)** ^ **28x1** 1/2 **(G)** ^ **28x1 5/8 (S)**	317	649	348-360
631	**32-631**							^ **27x11/4 (5)**	315	643	350
630	**20-630** to **30-630** to **37-630**	^ **27x13/4**		27x13/E ^ **27x11/4** **27x1V8** **27x1**	K2 K25.0 EA25.0	^ **27x11/4**	^ **27x11/4** **27x11/4**	^ **27x1** 1/4 **(G)**	315	642	338-348
623	**44623**							^ **28 x 1 5/8** (S)	312	636	359

622	18-622 to **47-622**	^ 700C 28x11/2 – (Canada)		**28x13/4** 28x11/4	F.13 E7 EA6	700C 28x 15/8x—	**7000** 28x1%	**28x—x1Y,** (V) ^ 28x—x1 5Ai (V) 28x1 1/4 (G) 28x13/4 (G) ^ 28x1 5/8 (G)	**311**	**634**	**334-361**
622	**44-622**						28x1.75	**28x1.75 (V), (G)**	**311**	**634**	**361**
[609	**40-609**							**27x Ph** 32x650	**304**	**622**	**347**
607	**44607**	**27x11/2**							**303**	**619**	346
599	32-599 to **37-599** HB 611x20	**26x1.375 26x1.25**							**300**	611	331-**334**
597	**32-597** to 37-597	^ 26x13/4- (Schwinn)	S-6 S-5	**26x1 ¼**	E.A.1 E.1 K.1 EA23.5	650 26x1 1/4		26x11/4 (V) 650)32 (V)	**298**	609	**333-**338
590	28-590 to **38-590** to 40-590	^ **26x13/8**		^ **26x-13/8**	E.A.3 E.3 F.4 EA23.0 R23.0 E23.0	650A 26x11/4 26x13/tix	26x1%	26x1 '/ (V) 26x11/2x11/4 (V) 26x1 3/8 A (G) 26x1'/2 (G) 650A (V)	295	602	**335-**338
587	**36-WS**	**700Dx1.4**							**201**	**lel**	**333**
585	**40-585 to 47-585**							^ **26x11/2 (S) 26x 13/4 Transit (5)**	292	600	**335-342**
584	32-584 to **40-584** to 50-584	^ 26x11/2 650B	S-4	**26x11/2** 26x1V8	**F9**	650B	^ 26x11/2 26x15/8	26x—x1 1/2 (V), (5) 6508 (V) 26x1 3/8 (G) 26x1 3/8x1 1/2 (G), (S) 26x1'/z x2 (SU)	292	599	327-**335-**342
571	20-571 40-571 to 44-571 to **47-571** to 54-571	**26x1** ^ 26x13/1 26x1 1/2 – (Canada)	S-7	^ **26x13/4** 26x2x1 3/4	12 F.22.5	650C	26x13/4 25x1 58 650x45C	**26x13/4** (V) 650x45C (V) 26x2 (G)	286	585	333-**336**
561	**62-561**	**25x11/8**						**26x2.25** (5)	281	576	346

BSR on a Vredestein tire stands for British Standard Rim.

TIRES

TIRE AND RIM CHARTS

Common Tire Markings (American, English, French, etc.): If width number is replaced by a dash (—), a range of widths is available in the same bead seat size.

ISO Size Designation: Tire Section measurements are in mm, followed by bead seat diameter in mm. For fiB numbers. *(see page 12-3).* When a range of widths is available, it is shown with the standard width in bold face: 32-340 to **37-340.**

Bead Seat Circumference: This is 3.14 times bead seat diameter.

Brake Radius: Subtract this value from the distance between brake bolt hole and axle center to obtain brake reach.

Rim Outside Diameter (assuming normal flange height): Actual value for a particular rim may be as much as Sinm less, especially with narrower rims.

Tire Outside Radius: Use this value to calculate tire to fork clearance. Radius of standard width tires is in boldface.

■ Indicates sizes that may not be interchangeable with other sizes with identical or similar markings. Use ISO markings to positively identity tire.
Bead seat circumference = t x bead seat diameter

Bead Seat Dia - meter	ISO Tire Marking (Width-Bead Seat Diameter)	North American Sizes	Schwinn Rim	British	British Rim	French	Italian	Vredestein*(V) Swedish (5) German (G) Standard Unidentified (SU)	Brake Radius	Approx. Rim Outside Dia-meter	Approx. Tire Out-side Radius
559	**40-559 to** **54-559 to** 57-559 HB 575x25	**26x1.4** **26x1.50** **26x1.6** **• 26x1.75** **26x1.9** **26x1.95** **26x2.0** **26x2.125**				26x1.75x2 26x2.125 650x50C	26x2	26x2.00 (V) 650x50 (V) 26x1.75 (G) 26x2.00 (G) 26x2x1% (G) 650x45 (G)	279	573	**321** - 330
	HB560x20	24x1.375 24x1.25								560	316- 313
547	**32-547** to 37-547	24x11/4 ■ 24x1 3/8 (Schwinn)	5-6 5-5	**24x11/4**				24x1 1/2 beaded (G)	273	559	**308-** 313
541	28-541 to **37-541**					**600A** ^ 24x1V8xl%		24x13/8 xl % (V)	271	554	305- **310**

SUTHERLAND'S

540	32-540 to **37-540**	^ 24x11/8 ^ 24x13/		^ **24x13/8**	E.5 F.3 EA21.0 F21.0 R21.0	600A	24x13/s 600x35A	24x1Ya xl 1/2 (V) 24x1 3/8 A (G) 600x35A (V) 24x1 1/2 xl 3/s (5) 24 xl 3/8 (5) 24x 38C (SU)	269	552	304- **309**
534	**40-534**			/\ **24x11/2**	F8	6008 24x1 1/2		24x1 1/2 (V) 600x38B (V)	26	548	310
531	**40-531**							^ **24x1 1/2** (S) 24x1Y8x1 1/2 (5)	265	545	308
521	**47-521**	^ 24x13/4	5-7	**24x13/4**					260	532	310
520	**25-520 to 47-520**	24x1 1.• 24x1 Vs ^ 24x13/4								520	286
508	**32-508**							22x 11/4 (V) 550x32 (V)	254	520	289
507	**40-507 to 57-507** HB 524x25	**24x1.5** ^ **24x1.75** **24x 1.9** **24x2.0** **24x2.125**	5-2			600x45 24x1.75	24x1.75x2	24x2x1 3/4 (V)	253	523	295- 304
503	**50** 503							24x2 **Transport** (5)	251	518	304
501	32-501 to **37-501** to 47-501			^ **22x1 3/a**	E.6 F.2 EA19.5		^ 22x11/4 550x32A		250	514	283- 290
498	32-498 to 37- **498**							^ **22x1 3/a** (G) 22x1 3/8x1 1/4 (5)	249	510	284- **289**
490	32-490 to 37- **490**					5S0A ^ 22 xl '/axl 1/4		**22x1 3/a A** (SU) ^ 22x1 1/4 (G)	245	502	280- **285**
489	32-489 to 37- **489**						22x11/2 550A	^ **22x1 3/a** (V) 550A (V)	244	501	279- **284**
484	**40- 484** to 44-484					**550B**		^ 22x1 1/2 (G) 22x1 5Axl 1/2 (S)	242	499	**285-** 289
482	**40- 482**							^ **22x11/2** (V) 5508 (V)	241	497	284

* BSR on a Vredestein tire stands for British Standard Rim.

TIRE AND RIM CHARTS

Common Tire Markings (American, English, French, etc.): It width number is replaced by a dash (—), a range of widths is available in the same bead seat size.

ISO Size Designation: lire Section measurements are in nun, followed by bead seat diameter in mm. For HB numbers, *(see page 12-3).* When a range of widths is available, it is shown with the standard width in bold face: 32-340 to **37-340.**

Bead Seat Circumference: This is 3.14 times bead seat diameter.

Brake Radius: Subtract this value from the distance between brake bolt hole and axle center to obtain brake reach.

Rim Outside Diameter (assuming normal flange height): Actual value for a particular rim may he as much as St11111 less, especially with narrower rims.

Tire Outside Radius: Use this value to calculate tire to fork clearance. Radius of standard width tires is in boldface.

1[10.] Indicates sizes that may not he interchangeable with other sizes with identical or similar markings. Use ISO markings to positively identify tire.
Bead seat circumference = it x bead seat diameter

Bead Seat Dia- meter	**ISO Tire Marking (Width- Bead Seat Diameter)**	**North American Sizes**	**Schwinn Rim**	**British**	**British Rim**	**French**	**Italian**	**Vredestein*(V) Swedish (5) German (G) Standard Unidentified (5U)**	**Brake Radius**	**Appro) Rim Outsid Dia- meter**	**.* Approx. Tire Out- side Radius**
470	**47-470**					**550C**	22x13/4		235	482	285
1457	**44-457 to 54-457** HB 473x7S	**22x1.75 22x2.125**							228	473	**270- 279**
451	28-451 to **37-451 to** 47-451 HB 459x25	20111/2 2011 1/4 • 200 Vs 20x1.375 20x1.25	5-5 5-6	■ **20x11/4**	E.51 EA18.0 818.0 EB18.0		20x1'/4 500x35A	20 x 1 1/2 B5R (V)	225	463 458	260- **265** 266- 1262
440	28-440 to **37-440** to 40-440					**500A** ■ 20x1 1/2 xl 1/4			220	452	251- **260-** 263
438	**37-438**						■ 20x11/4	■ **20x11/2** (V) 500x35A (V)	219	450	259

SUTHERLAND

432	**40-432**							**20x1'/2** (V) 500x38B (V)	216	446	259
428	**40-428 to** **54-428**					20x1s/axl 1/2		**20x2** (S)	214	442	257- **271**
419	**47-419**	^ 20x13/4	S-7	**20x 13/4**					209	431	259
406	**40-406 to** **54-406 to** 57-406 HB 422x25	^ **20x1.5** **20x1.75** **20 x1.9** **20x2.125**	S-2			20x1.75x2 500x50 500x45		20x2x13/4(V) 500x50 (V) 20x1.75x2 (5) 20x2.00 (G)	203	422	**244-** **253**
400	**37-400** to 54-400			^ **18x13/s** 18x1'/2 18x13/4 20x2	E.41 F.41 FA 1 6.0	450x28 450x37 450x55	18x13/4 450x32A	18x1'/2 BSR (V) 20x2x1 3/4 (S)	200	412	**240-** 257
390	**37-390** to 40-390					^ **450A** 18x1 3/gx1 1/4			195	403	**235 -** 238
387	**37-387**						^ 18x13/8	**18x1 3/8** (V) 450x38A (V)	193	400	233
381	**40-381**							**18x1 1/2** (V) 450x38B (V)	190	395	233
369	**32-369**			^ 17x1lAt				^ 1 6x11/2 (SU)	1 84	382	219
357	**32-357**							^ **17x11/4** (S)	179	371	214
355	**44-355 to** **57-355** HB 371x25	**18x1.75** **18x2.125**				450x45 1 8x1.75		18x2x13A(V) 1 8x1.75 (G) 18x2 (G)	177	371	219- 228
349	32-349 **to** **37-349**	^ **16 x1 Vs**		^ **16x13/8**	E. 3J **EA14.0** EB14.0		^ 16x1'/4 400x32A		174	362	209- 214
340	32-340 **to** **37-340** to 44-340					^ **400A** ^ 16x13/8x13/4			170	353	205- **210-** 217
339	**37-339**						^ 16x1Yii	^ **16x1 3/a** (V) 400x35A (V)	169	352	209
337	**37-337**							^ 16x1 3/8 A **(SU)**	168	350	208
335	**37-335**							^ 16x1 3/8 (Polish)	167	347	207

TIRE AND RIM CHARTS

Common Tire Markings (American, English, French, etc.): if width number is replaced by a dash (-1, a range of widths is available in the same bead seat size.

ISO Size Designation: Tire Section measurements are in mm, followed by bead seat diameter in mm. For HB numbers, *(see **page 12-3**).* When a range of widths is available, it is shown with the standard width in bold face: 32-340 to **37-340.**

Bead Seat Circumference: **This is** 3.14 times bead seat diameter.

Brake Radius: Subtract this value from the distance between brake bolt hole and axle center to obtain brake reach.

Rim Outside Diameter (assuming normal flange height): Actual value for a particular rim may be as much as Smm less, especially with narrower rims.

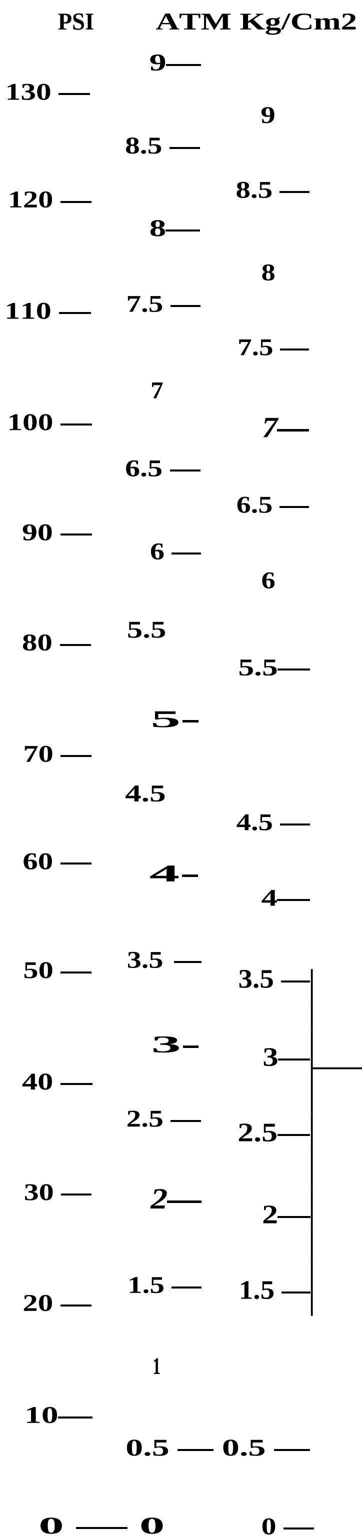
Tire Outside Radius: Use this value to calculate tire to fork clearance. Radius of standard width tires is in boldface.

‖0. Indicates sizes that may not be interchangeable with other sizes with identical or similar markings. Use ISO markings to positively identify tire.

Bead seat circumference = m x bead seat diameter

Bead Seat Dia-meter	ISO Tire Marking (Width-Bead Seat Diameter)	North American Sizes	Schwinn Rim	British	British Rim	French	Italian	Vredestein*(V) Swedish (S) German (G) Standard Unidentified (SU)	Brake Radius	Approx.* Rim Outside Dia-meter	Approx. Tire Out-side Radius
330	**40-330**							16x 1 Vz (V) 400x38B (V)	165	344	208
317	**44-317**	16x13/4	7	**L_16x13/4**					158	329	205
305	**44-305** to **57-305**	**16x1.75** **16x2.0** **16x1.9** **16x2.125**				16x1.75		16x2x1 3/1 (V) 16x2 (V) 16x1.75x2 (S)	152	321	**194-** **203**
298	32-298 to **37-298** to 47-298	Λ **14xPla** **(350A)**		Λ **14x1 3/8**	21 F.2J EAU .7		14x11/4 350x32A 14x15/8	14x1 1/2 BSR (V) l 4x13/8(S)	**149**	310	**184-** **189** 196
288	32-288 to **37-288** to 44-288 57-288	14x2.125 14x13/fix1YH				**350A** ^ 14x11/2x11/4			144	300	179- **184-** 191
286	**37-286**						Λ 14x13/8	**14x1 3/8** (V) 350x35A (V)	143	298	183

TIRE INFLATION
PSI: Pounds per square inch
ATM: Atmospheres (Bar, Atti)
Kg/Cm^2: Kilograms per square centimeter



TUBULARS SEW-UPS

Outside Diameters

(See Spoke Length charts for various models - Chapter 11.)

700C Sew-ups

700C sew-ups interchange with corresponding wired-on wheels without adjustments to the brake shoe position.

26" Sew-ups

Please note there is a wide and potentially dangerous variation in what is referred to as 26" sew-up rims. They vary between 579mm and 597mm in the outside diameter. To be sure that the rim and the tire are designed to fit together, measure the diameter cif the rim and confirm that the tire is designed for the rim's diameter. Note also, that 26" (650B) sew-up wheels with an outside diameter of 597mm interchange with wheels with wired-on 6508 rims. These interchange without having to adjust the brake shoe position.

24" thru 18" Sew-ups

There are also wide and potentially dangerous variations in the 24" and under category. Rims that have the same number vary in outside rim diameter. Always confirm that you are installing only the tire designed to fit the rim's outside diameter.

Sew-up wheels in nominal sizes of 24" and under have much smaller tire and rim diameters than wired-on wheels of the same inch sizes. Wired-on tires of the same inch size may not fit under the fork crown of a frame made for sew-ups; to avoid a low bottom bracket and long brake reach, it is often best to use the next larger sew-up size when substituting small sew-ups for wired-on tires.

TUBULAR TIRE SIZES

Tubular Size	Matching Wired-on ISO size	Rim Circum-ference	Brake Radius	Rim Outside Diameter	Tire Outside Radius
28 (700C)	622	1955	311	634	342
26 (650B)*	584	1835	292	596	323
24*	521	1635	261	533	292
22*	470	1475	235	482	266
20*	419	1314	210	431	241
18	369	1154	185	381	216

Moulton 17x1 ¼ has the same rim diameter as an 18" tubular tire rim.
* Sizes vary between brands, ***(see Spoke Length Charts, Chapter 11).***

VALVE HOLE SIZES

Presta 6.8mm **Dunlap** 8.3mm **Schrader** 9.0mm

CONTENTS

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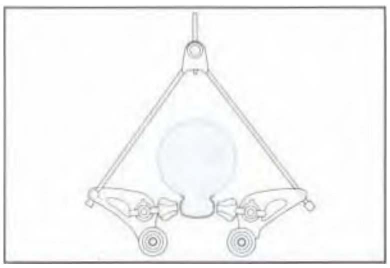
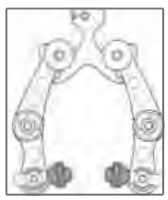
BRAKES





INNOVATIVE, MAGURA, SACHS *HYDRAULIC*

SUTHERLAND'S

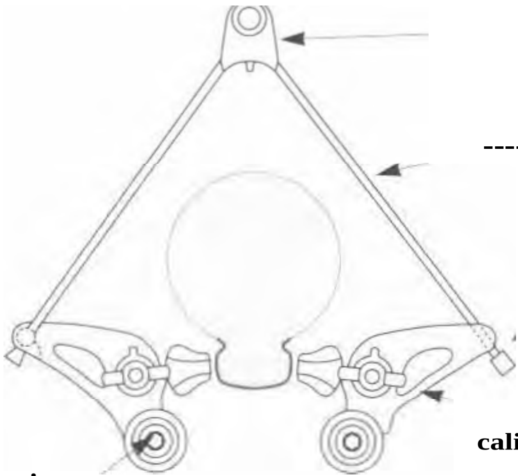
CANTILEVER BRAKES

brake cable

straddle
hanger

straddle
------ cable

cable
anchor



caliper arm

pivot

Note:

Careful mounting and servicing of cantilever brakes is essential to prevent the brake shoes from slipping past the rim and into the spokes.

Shoe Setup

Pad-Rim Position: *As* the pads of a cantilever brake wear, they will contact the rim closer and closer to the edge of the rim (away from lire). Adjust the pads close to the outside edge of the rim (close to tire). ***(See illustration below.)*** This is opposite to the way center-pull brakes wear.

Pad-Rim Clearance: Check for easy release of the straddle cable for quick wheel removal.

Brake Pads

rim

Side View

pad

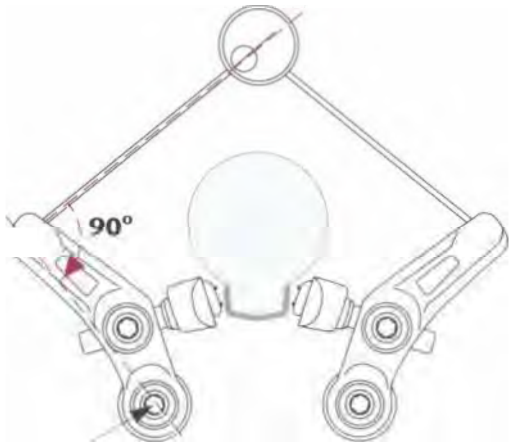
Straddle Hangers

Straddle Cable and Pad Setup: The length of the straddle cable, the height of the straddle hanger, and the brake pad-to-cantilever arm position all have an effect on braking power. Generally, the straddle cable bridge is set low and close to the tire for maximum braking force. The straddle cable should be high enough, however, to adequately clear the tire (and any debris that may stick to the tire) or to fit over the front reflector hanger. In the event of brake cable failure, the front reflector hanger would prevent the straddle cable from catching in the tire and locking up the front wheel.

Straddle Hangers (cont'd)

The straddle cable length (when adjustable) is set to transfer as much force to the brake pads as possible. For the most efficient transfer of force, the straddle cable and the line between the cantilever pivot and the cable anchor should form a right angle (90 degrees). ***(See illustration to the right.)*** If the force is not at a right angle, part of the force gets wasted in pulling on the brake post, which has no effect on braking.

Shoe-Caliper Arm Position



pivot

right angle alignment

Shimano Link Wires: For recent Shimano brakes, there are a variety of straddle cable setups available from Shimano.

The older Deore XT link wire has two tabs available to engage the brake (marked F and RI and was difficult to set up. When setting up a brake with this link wire, ignore the F and R markings.

Older Shimano low profile brakes had cantilever link wires similar to the older Deore XT link wire but with only one tab to hook onto the brake. These link wires use the Shimano Pro-Set gauge or Pro-Set jigs to properly set up the cable lengths, straddle angle, and the pad position. When using the Pro-Set jigs, first choose the proper length jig and hook the jig on both the brake cable and link wire. Pull the brake cable taut, and tighten the link carrier and brake anchor bolt. Set up the brake pads so that they are just touching the rims and are properly toed-in. When the jig is removed, the brake should be properly set up.

Newer brakes use the unit link wires that have a pre-set length of cable housing in addition to the normal link wire, ***(see figures below).*** With this setup of the straddle wire, there is no need to tighten the straddle cable bridge, and the straddle cable length is equal on both sides. By adjusting the length of the brake cable, the carrier unit height is set so the alignment mark lines up with the link wire. The pads arc then set up for proper clearance against the rim. Unit link wires come in two types: alignment and dynamic. The dynamic type allows the link wire to pivot in the link carrier; the alignment type is fixed.

Shimano Link Wires

Dynamic

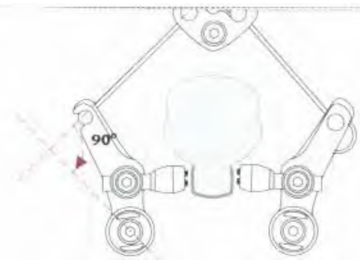
Alignment

Pro-Set

Straddle Hangers (cont'd)

Anchored Cable Hangers: For special cable hangers like the Cannondale Force 40+ and the SunTour Power Hanger (or Trek's version or Brodie's version), most of the above still applies: the cable hanger, anchor bolt, and pivot should be 90 degrees when the pads hit the rim though it is more important to have the cable exiting tangentially from either side of the cable hanger when the brake contacts the rim.

Cannondaie Force 40+



SunTour Power Hanger

Spring Setup

On models equipped with adjustable springs, adjust the spring tension so that both pads contact the rim at the same time. If this requires more than a little adjustment, check for other problems, (i.e. wheel not straight in drop-outs, incorrect dish, uneven pad wear, uneven pad installation, asymmetrical braze-on stud location, spring ends sitting in different holes on multiple-hole studs, etc.) Set spring tension as low as possible while also ensuring a good return. Some manufacturers recommend high spring tension on one side, especially for anchored cable hangers.

Factors that affect cantilever brake fit:

1. Distance between brake pivots. Standard width is approxi mately 80mm.
2. For parallel brake boss orientation, use a Vernier caliper to verify brake bosses are parallel.
3. Rim diameter and drop-out to brake boss distance: The difference should be about 20mm.
4. Rim width.
5. Drop-out axle slot position relative to brake pivot.
S. Width of tire relative to width of rim (i.e. narrow rims with tat tires require a different setup so brake pads do not contact the tire. Sometimes this necessitates a lower profile shoe, longer straddle cable length, etc.)
7. Position perpendicular to steering axis (straight forks may need to have canted pivot studs).
8. Spring-to-pivot stud compatibility (some brakes cannot achieve sufficient spring tension on older, single-hole studs).
9. Pivot stud length and diameter: some mounting studs may be too long and the spring tension becomes too loose. Fix by filing the stud down. If the stud is too short, the brake will bind.

Factors that affect cantilever brake fit: (contd)

Usually, the problem is that the washer on the mounting bolt has been deformed (usually from over tightening). Either replace the washer or flip it over. Over tightened bolts may deform the mounting stud, causing it to flare out and bind. Either shape it down and use a longer mounting bolt, or replace the brake with one which has a separate internal pivot sleeve.

Some bicycle manufacturers have run as much as .01" (.4mm) oversize on the outside diameter of the pivot stud. This may not pose a problem for inexpensive brake arms, as they typically have a loose fit anyway. High-quality arms are likely to bind or not even mount. Consequently, it is sometimes necessary to use a machinist's reamer to increase the inside diameter of the arm bushing or try a different brake arm.

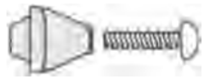
Note: On some pivot studs, the cylindrical part is only swaged in place. The studs are supplied to the manufacturer like this and need to be brazed-on to avoid possible subsequent failure (separation).

Check that the stud diameter isn't simply flared at the end due to over tightening of the mounting bolt before assuming that it is oversized. If the stud diameter is flared, lightly file the flared section down to the original outside diameter.

Straddle Cable End Types

Picture	End Type	Comments
	Standard single head	Sometimes can be used in place of Dia Compe E.Z.R.
	Dia Compe E.Z.R.	Will work instead of standard single head.
	New Shimano Dynamic link wire	***See page 13-3 for set up instructions.***
	Double head adapter	Provided with brake. Used with proper single head.
	Older Shimano Deore XT link wire	Can be replaced by single head straddle wire and hanger.
	Older Shimano low profile link wire	***See page 13-3 for set up instructions.***
	New Shimano alignment type unit link wire	***See page 13-3 for set up instructions.***

CANTILEVER BRAKE SPECIFICATIONS

Post type  **Nut type**  **Bolt type** 

Many nut-type and bolt-type brake pads use conical washers and mounting hardware to allow adjustment for toe-in or rim sidewall angle.

How to use the cantilever brake specifications chart:

Dimension A is the lowest position the brake pad can be bolted onto the cantilever arm. Note: often the pad can be rotated so that it can contact the rim even lower, but there may not be sufficient play to get the brake pad to hit the rim squarely.

Dimension B is the highest the brake can go on the cantilever. The note for Dimension A also applies here.

Center of Reach is the average of Dimensions A and B.

Shoe Type is usually either post-, bolt-, or nut-type. Post-type allows the pad to be mounted fart her inboard. The nut- and bolt-types might be able to be mounted farther inboard with washers depending on how many threads are available.

Adjustability indicates what can be adjusted on the brake shoe. **T.** Toe Adjustments - this is not necessarily the case for post-type shoes, but some bolt- or nut-type shoes have built-in toe adjustments. **FL,** Reach Adjustments; the pads can be mounted farther from the brake arm.

Spring Tension Adjustment indicates what type of screws, nuts, or bolts to adjust in order to regulate the spring tension on the brakes. Gross spring tension adjustments sometimes may be made by using different spring holes in either the cantilever body or the brake mounting boss if there are multiple holes. Usually, if both sides of the brake are adjustable, no spring hole is needed in the brake mounting boss.

Straddle Cable Ends indicates what style straddle cable is needed for the brake. In most cases, if a single-head straddle wire is indicated, use the Dia Compe E.Z.R. straddle cable in place of the standard single head straddle cable. Many brakes that need a double-headed straddle cable use a standard single- or round-head straddle cable and conic with a bolted-on adapter that fits on the other end of the cable.

Make Ea Model	Part Number	Center of Reach (in mm)	A		Shoe Type	Adjust-ability Toe-In (T) Reach (R)	Spring Tension Adjustment	Straddle Cable Ends
CAMPAGNOLO								
Compact (all models)		26	20	**32**	nut	T	2.5mm screws	single
Standard (all models)		**24**	*21*	**27**	post	T	**3mm** screws	single
CANNONDALE								
Coda	A350	25.5	**21.5**	**29.5**	post	T	**13mm** flats	single

CANTILEVER BRAKE SPECIFICATIONS (CONT'D)

Make & Model	Part Number	Center of Reach (in mm)	A		Shoe Type	Adjust-ability Toe-In (T) Reach (R)	Spring Tension Adjustment	Straddle Cable Ends
CHANG STAR								
(also marked Star and Pro Star)								
(plastic)		26	21	31	nut		none	single
	880A	24	21	27	post	T	none	double
	882A	27	26	28	post	T	none	single
	885AC	29	24	34	nut		none	single
CRYSTAL DESIGNS								
Power Brakes		21.5	13.5	29.5	post		13mm flats	single
CURVE CYCLING COMPONENTS		25	20	30	post		13mm flats	doublet
DEAN								
Rhino		25	20	30	post		13mm flats	doublet
D1A COMPE								
(also marked Gran-Compe)								
Colbar	984	25	20	30	nut	T	13 or 19mm flats	single
FS-E	CT-FE00	25	20.5	29.5	post	T,R		
New Gran-Compe	NGC982	24.5	23	26	post	T,R	none	single
X-1	CT-X100	25.5	21	30	nut	T	15mm flats	single
X-1	CT-X101	25	20.5	29.5	post	T, R	15mm flats	single
X-1 Chroma	CT-CROO	25.5	21	30	nut		15mm flats	single
X-1 Chroma	CT-CR01	25	20.5	29.5	post	T, R	15mm flats	single
XCE	CT-XE01	25	20.5	29.5	post	T, R	15mm flats	single
XCE (alloy)	CT-XE00	25.5	21	30	nut		15mm flats	single
XCE (plastic)		26.5	21	32	nut		none	single
XCM	CT-XM01	25	20.5	29.5	post	T, R		single
XCM (alloy)	CT-XMOO	25.5	21	30	nut	T	15mm flats	single
XCM (plastic)		26.5	21	32	nut	T	none	single
XCT	CT-XT00	25	20	30	nut	T		single
XCT	CT-XT01	25	20.5	29.5	post	T,R	none	single
XCT (plastic)	CT-XT100	25.5	21	30	nut		15mm flats	single
XCU	CT-XUOO	25	20.5	29.5	post	T,R	none	single
	960	23			post	T,R	none	double
	981	24.5	22	27	post	T,R	none	single
	983	24.5	23	26	post	T,R	none	single
	986	25.5	21	30	post	T, R	13mm flats	single
	973	24.5	21	28	post	T, R	13mm flats	single
	987	25.5	21	30	post	T, R	13mm flats	single

CANTILEVER BRAKE SPECIFICATIONS (CONT'D)

Make & Model	Part Number	Center of Reach (in mm)	A	B	Shoe Type	Adjustability Toe-In (T) Reach (R)	Spring Tension Adjustment	Straddle Cable Ends
GRAFTON								
Speed Controllers (earlier production)		23	20	26	post		.050" screws	doubler
Speed Controllers (later production)		25.5	22	29	nut		.050" screws	doubler
GRAVITY RESEARCH								
Rim Crushers		22	17	26.5	post	T, R	11/16" flats	doubler
Pipe Dreams		35	15	55	post	T, R	11/16" flats	doublet
INTERLOCK RACING DESIGNS								
Switchback	Type I	23	20	25	post	T, R	none	none **2**
Switchback	Type II	23	20	25	post	T, R	11/1C flats	none2
LEECH!								
	706A	26	21	31	bolt	T	none	single
	700A	25.5	23	28	post	T, R	none	double
(steel)	7065	25	20	30	nut		alien	single
MACHINE TECH								
Zero Flex		23	16.5	30	nut **7**		15mm flats	double'
MAFAC								
Criterium		25	25	25	post	R	none	single **3**
Tandem		25	25	25	post	R	none	single **3**
MARINOVATIVE								
Cheap Trick		34.5	25	44	nut9	T,R11	16mm flats	none12,13
Stoplite		25	20.5	30	bolt")	T,R[1] 1	16mm flats	nonel3
PAUL COMPONENT ENGINEERING								
Stoplights		23	20.5	25.5	post	T,R	16mm flats	doubler
Stoplights MC		23	20.5	25.5	post	T, R	16mm flats	double'
Crosstops		23	20	25.5	post	T,R	16mm flats	single 13,14
POLYGON								
— ("CANTISAFE")		27	24	30	post	T, R	2.5mm screw	single
— (steel)		25	20	30	nut	T	none	single
RITCHEY								
Logic, Logic W.C.S.		25	19.5	30.5	post	T,R	2mm screw	single

CANTILEVER BRAKE SPECIFICATIONS (CONT'D)

Make Ea Model	Part Number	Center of Reach (in mm)	A		Shoe Type	Adjust-ability Toe-In (T) Reach (R)	Spring Tension Adjustment	Straddle Cable Ends
SCOTT U.S.A.								
Pederson SE-'89								
(front) **4**		24.5	21	28	post	T,R	none **5**	single
(rear) **4**		24.5	21	28	post	T,R	none **5**	single
Pederson SE-'90								
(front) **4**		24.5	21	28	post	T,R	none **5**	single
(rear) **4**		24.5	21	28	post	T,R	⅝" flats **5**	single
Pederson SE-'91								
(front) **4**		24.5	21	28	post	T,R	⅝" flats (16mm)5	single
(rear) **4**		24.5	21	28	post	T,R	⅝" flats (16mm) flats 5	single
SHIMANO								
100GS	BR-M100	25.5	22	29	post	T,R	none	single
200G5	BR-M201	25.5	22	29	post	T,R	none	single
	BR-M200	25.5	22	29	post	T,R	none	single
400CX	BR-C400	26.5	22	31	post	T,R	phillips screw	double6
700CX	BR-C700	26.5	22	31	post	T,R	phillips screw	double6
Acera-X	BR-M290	26.5	22	31	post	T,R	phillips screw	double **6**
Alivio	BR-MC10	26.5	22	31	post	T,R	phillips screw	double **6**
	BR-MC11	26.5	22	31	post	T,R	phillips screw	double6
	BR-MC12	26.5	22	31	post	T,R	phillips screw	double6
	BR-MC15	26.5	22	31	post	T,R	phillips screw	double **6**
Altus	BR-AT10	26.5	22	31	post	T,R	phillips screw	double6
	BR-AT11	26.5	22	31	post	T,R	phillips screw	double6
	BR-AT20	26.5	22	31	post	T,R	phillips screw	double **6**
	BR-AT21	26.5	22	31	post	T,R	phillips screw	double **6**
	BR-CT10	26.5	22	31	post	T,R	phillips screw	double6
	BR-CT20	26.5	22	31	post	T,R	phillips screw	double6
	BR-CT50	26.5	22	31	post	T,R	phillips screw	double6
	BR-CT90	26.5	22	31	post	T,R	phillips screw	double6
Deore	BR-MT60	25.5	22	29	post	T,R	2mm screw	single
Deore DX	BR-MT62	25.5	22	29	post	T,R	2mm screw	single
Deore LX	BR-M550	24	19	29	bolt	T	2mm screw	single
	BR-M560	26.5	22	31	post	T,R	phillips screw	double6
	BR-M561	26.5	22	31	post	T,R	phillips screw	double6
Deore LX	BR-M565	26.5	22	31	post	T,R	phillips screw	double6
Deore XT	BR-M730	25.5	22	29	post	T,R	2mm screw	double **6**

CANTILEVER BRAKE SPECIFICATIONS (CONT'D)

Make Er Model	Part Number	Center of Reach (in mm)	A	B	Shoe Type	Adjust-ability Toe-In (T) Reach (R)	Spring Tension Adjustment	Straddle Cable Ends
SHIMANO - (cont'd)								
Deore XT (cont'd)	BR-M 737	26.5	22	31	post	T,R	phillips screw	double6
	BR-MC70	24.5	*22*	27	post	T,R	none	single
Deore XT II	BR-M732	25.5	22	29	post	T,R	2mm screw	double6
Exage ES	BR-M520	26.5	22	31	post	T,R	phillips screw	double6
	BR-M521	26.5	*22*	31	post	T,R	phillips screw	double6
Exage LT	BR-M320	26.5	22	31	post	T,R	phillips screw	double6
	BR-M321	26.5	*22*	31	post	T,R	phillips screw	double **6**
Exage 400 LX (plastic)	BR-M351	24	1 9	29	bolt	T	2mm screw	single
Exage Country (plastic)	BR-M250	24	1 9	*29*	bolt	T	none	single
Exage Mountain (alloy)	BR-M454	24	19	29	bolt	T	2mm screw	single
	BR-M450	24	19	29	bolt	T	2mm screw	single
Exage Trail (plastic)	BR-M350	24	19	29	bolt	T	2mm screw	single
	BR-AT50	24.5	22	27	post	T,R	2mm screw	single
STX	BR-MC30	26.5	*22*	31	post	T,R	phillips screw	double6
	BR-MC31	26.5	*22*	31	post	T,R	phillips screw	double6
	BR-MC32	26.5	*22*	31	post	T,R	phillips screw	double6
STX Special Edition	BR-MC30	26.5	22	31	post	T,R	phillips screw	double6
	BR-MC31	26.5	22	31	post	T,R	phillips screw	double6
STX-RC	BR-MC33	26.5	*22*	31	post	T,R	phillips screw	double6
Tourney	BR-TY20	26.5	22	31	post	T,R	phillips screw	double6
	BR-TY22	26.5	22	31	post	T,R	phillips screw	double6
XTR	BR-M900	26.5	22	31	post	T,R	phillips screw	
SUNTOUR								
(see also Dia-Compe)								
Honor	CT-HN00	25	22	28	post	T,R	no centering	single
X-1	CT-X100	25	20	30	nut	T,R	15mm flats	single
X-1 Chroma	CT-CR00	25	20	30	nut	T,R	1 5mm flats	single
XC 9000	CT-XC00	25	22	28	post	T,R	19mm flats	single
XC Comp	CT-XCO1	25	*22*	*28*	post	T,R	19mm flats	single
XC Expert (Microdrive)	CT-XX00	25	22	28	post	T,R		single
XC LTD	CT-XL00	25	*22*	*28*	post	T,R	19mm flats	single
XC Pro	CT-XPO0	25	22	28	post	T,R	19mm flats	single
XC Pro	CT-XPO1	25	22	28	post	T,R		single
XC Pro (Microdrive)		25	*22*	28	post	T,R	13815mm	single
XC Pro SE/XC90004	CT-XP10	25	22	28	post	T,R	1 6mm flats5	single
XC Pro/XC Comp	CT-XP20	25	22	28	post	T,R		single
XC Pro/XC Comp 5E4	CT-XP I 1	25	*22*	28	post	T,R	**5**	single

CANTILEVER BRAKE SPECIFICATIONS (coN-rD)

Make Ea Model	Part Number	Center of Reach (in mm)	A	B	Shoe Type	Adjust-ability Toe-In (1) Reach (R)	Spring Tension Adjustment	Straddle Cable Ends
SUNTOUR - (cont'd)								
XC-Comp	CT-XCO2	25	22	28	post	T,R		single
XC-Comp SE4	CT-XC11	25	22	28	post	T,R	5	single
XC-Sport/S-1/XR100	CT-XS0O	25	22	28	post	T,R		single
XCD	CT-XD00	25	22	28	post	T,R	19mm flats	single
XCD	CT-XD11	25	22	28	post	T,R		single
XCD 6000	CT-XD10	25	22	28	post	T,R	19mm flats	single
XCD SE4	CT-XD20	25	22	28	post	T,R	16mm flats 5	single
XCE	CT-XE00	25	20	30	nut	T		single
XCM	CT-XMO0	25	20	30	nut	T		single 8
WILDERNESS TRAIL								
Speedmaster								
Cantilever		27	20	34	post	T, R	16mm flats	single8

Notes:

1. A barrel fitting with a set screw is supplied so that a single cable can be used.

2. Notes on setup:

A. This design works best when the cable clamp (which is in the same position as the straddle bridge of conventional designs) is a minimum of 2½ - 3 inches above the tire (cable stop On frame needs this allowance).

B. Special design uses a straddle cable that is simply a loop; both ends attach to a cable anchor on the main cable.

C. Perfect setup is easiest with the in-depth instructions and illustrations available from I.R.D. Make sure there is sufficient clearance between the caliper arms and the tire when brake is fully applied. Check that both of the looped straddle cable's ends lay on top of the middle of the cable as they all pass under the anchor bolt. This requires a "twist".

3. Head of straddle cable is 3.8mm, similar to a derailleur cable, and sits in spool-shaped, 5.4mm ferrule.

4. Due to brake design, fronts and rears are different internally, and **MUST NOT BE INTERCHANGED.**

S. To ensure safe and proper performance use the following setup procedure. With the pivotbolt loose, rotate caliper until pad is against rim and adjust shoe so that it is at the same angle with the rim. Rotate caliper until shoe just clears tire (for easy wheel removal), and tighten pivot bolt.

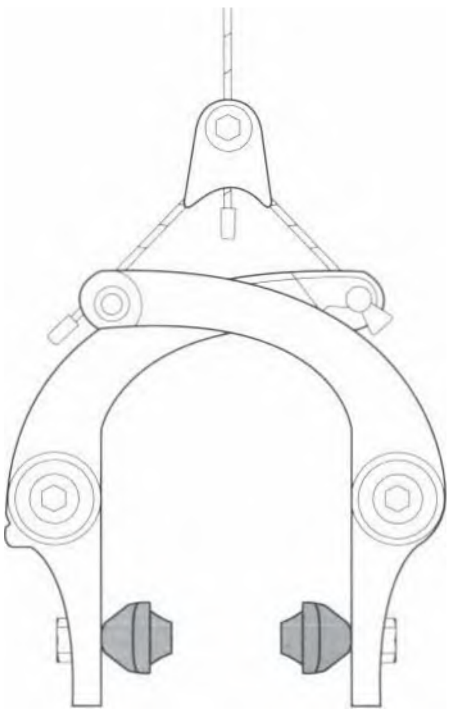
CANTILEVER BRAKE SPECIFICATIONS (CONT'D)

Notes: (cont'd)

6. Brake cable is connected directly to cable anchor on caliper. "Link cable" connects between other caliper and moveable carrier that rides on brake cable, and actually has three heads – the third serving as a finger grip to facilitate insertion and removal.
7. Comes with special alien head nut (works with standard nut-type pads).
8. l.ike a standard round brake cable head. Cables with thumb grip (either in line or on end) will not work.
9. Allen nut or bolt. Side of conical washer may need to be filed down to fit.
10. Bolt only (long bolt provided). Conical washers with brake pads may be removed.
11. Reach adjusted with provided spacers.
12. Special cable set piece provided. Fits cables 1.8mm and smaller.
13. Low profile cantilever designed for use without a cable hanger.
14. Round head only.

U-BRAKE SPECIFICATIONS

U-brakes follow many of the steps for pad and cable setup of cantilever brakes except that, for U-brakes, the pads should be adjusted low on the rims. As the brake pads wear, they creep up on the rims. These brake shoes will take longer to hit the tire sidewalk if adjusted farther down on the rim.



To get the best braking power from U-brakes, check the following three conditions. There should he at least 20mm between the straddle hanger and the cable housing stop. Usually, the straddle wire should be as short as possible. And, the straddle cable and the line between the brake boss and the cable mounting point should form a right angle.

Reach comments: If conical washers are used, measure the brakes with the conical washers squared. To have a wider range of adjustments, tilt the conical washer stack (sometimes at the sacrifice of the brakes hitting the rim evenly).

U-BRAKE SPECIFICATIONS (coNT'D)

Make Ea Model	Model Number	Center of Slot	A	B	Shoe* Type	Shoe Adjust	Spring Tension Adjustment	Straddle Cable Ends
CAMPAGNOLO								
All Models		39	33	45	nut	T1	3mm screws	single
DIA COMPE								
Advantage	AD-990	38.5	35	42	post	T	13&19mm flats [2]	single's
XCE	BA-XE00	40	33	47	nut	T1	13mm flats [2]	single
XCE-4050	BA-XE45	39.5	33	46	nut	T1		single
INTERLOC RACING DESIGNS								
Progressive		37.5	35	40	post	T,R	3/4" flats	double
Rotary		37.5	35	40	post	T,R [3]	3/4" flats	double
LEE CHI								
— (alloy)	737A	38.5	32	45	post		none	single
MCMAHON								
Powerlink		38	34.5	41.5	post	T,R	13mm flats	none
SCOTT U.S.A.								
Pedersen SE		40	34	46	post	T,R	none	single
SHIMANO								
Deore XT	BR-M731	42.5	37	48	nut	T1	2mm screws	single
Deore XT II	BR-M733	39	34	44	nut	T1	2mm screws	single
Exage Mountain (plastic)	BR-M451	41.5	35	48	nut	T1	2mm screws	single
SUNTOUR — *(see DIA-COMPE)*								

Notes:

* *(See page 13-6 for shoe type drawings.)*

1. Make adjustments with conical brake shoe washers. Use only shoes with conical washers.
2. Adjusting nuts are 19mm, and have an additional set of 13mm flats. Either wrench size can be used. Newer models may have just 13mm flats.
3. **Notes on setup:**
   A. The progressivity is affected by the total amount of pad extension. More extension decreases peak pad pressure, less extension increases peak pad pressure; too little pad extension will allow the rotor cam to lock up or pull through.
   B. limit the total cable travel so that no matter how hard the brake lever is squeezed, the rotor cam can't be pulled past the idler wheel.
4. Special round head with finger grip.

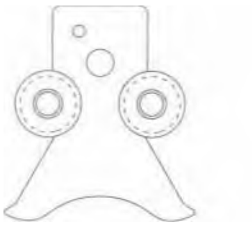
ROLLER-CAM BRAKE SPECIFICATIONS

The rollers in a roller-cam brake move along a series of ramps on the cam plate. The angle of the ramps determines the amount of movement and pressure at the brake pads. When viewed **turned on its side,** the cam has a steep ramp that guides the pads rapidly towards the rim. The next ramp is shallower, producing greater leverage while moving the pad a smaller amount.

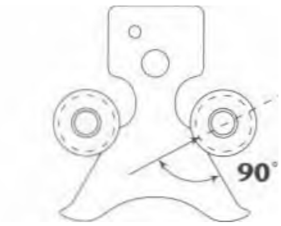
Adjust the brake so that when the pads contact the rim, the rollers are just past the crest of the steep ramp and are beginning to move along the shallow ramp.

Shallow ramp

Steep ramp



Roller position of brake when it is released.



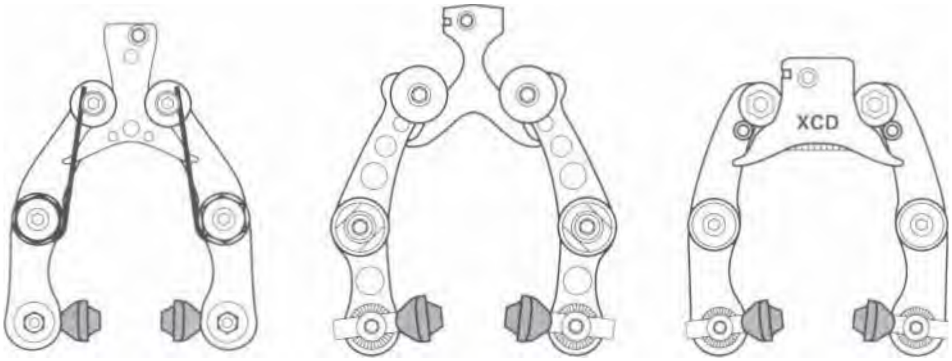
Roller position when pads contact the rim.

The roller hides the crest so it is difficult to see during setup. Mark the cam with a line perpendicular to the shallow ramp, starting just past the crest. The line should point to the center of the roller when the pads contact the rim. The rollers should not approach the reverse curve at the end of the cam plate.

Adjustments

For minor adjustments, adjust the cable and/or the distance between the shoe and the caliper arm. For larger adjustments, if the brake has two roller position holes, try the other position. If the rollers aren't even close to the right position, try a different ram plate. Wilderness Trail Bikes and SunTour offer narrow and wide cam plates.

ROLLER-CAM BRAKE SPECIFICATIONS (CONT'D)



Make & Model	Model Number	Center of Range	A	B	Adjustability Toe-In (T) Reach (R)	Spring Tension Wrench	Roller Positions	Mounting Stud Diameter
ODYSSEY								
Pitbull5		83	73	93	R			
SHIMANO								
Dura-Ace AX5	BR-7300 front	45	39	51	R			
	rear	48	42	54	R			
600 AX5	BR-6300 front	45.5	40	51	R			
	rear	47.5	42	53	R			
600 AX5	BR-6310 front St rear	45.5	40	51	R		1	
SUNTOUR								
XC Power	CB-6000	39			T	19mm2	1	8.9mm
XC Sport	CB-6600	39	35	43	T, R	1 7mm	2	8.9mm
XC 9000	BA-XC0O	39	35	43	T, R	1 3mm	2	8.9mm
XCD 6000	BA-XD00	39	35.5	42.5	T, R	none	2	8.9mm
XCD 4050	BA-4050	39	35.5	42.5	T, R	none	2	8.9mm
WILDERNESS TRAIL BIKES								
Speedmaster4 Compact		40	38	42	R	5/83,6	2	8.9mm
Speedmaster4		36	34	38	R	5/81,3,6	2	8.9mm
Mini-Can-11		40	26	36	T1, R	5/81"3	2	5/16" - 7.9mm
Potts/ Cunningham		40	38	42	R	※e 3	2	3/8" – 9.5mm
Toggle Cam4 Compact		40	38	42	R	5/81,3,6	2	
Toggle Cam4		40	38	42	R	5/8"3,6	2	

ROLLER-CAM BRAKE SPECIFICATIONS (CONTD)

Notes:

1. Make adjustments with conical brake shoe washers. Only use shoes with conical washers.
2. Use SunTour 16/19mm wrench TA-210. For earlier versions, use a 15mm wrench.
3. A 16mm wrench will work also.
   Spring Tension Adjustment:
   Screws 1 = Single alien screw in one caliper
   Screws 2 = Allen set screw in each caliper

   Flats 1 = Wrench-flats on one caliper
   Flats 2 = Wrench-flats on each caliper
4. **Note:** Different cam, linkages, rollers, and arms are available.

S. Mounts as standard side- or center-pull brake.

6. Toggle Cam and Speedmaster use the same arms (either compact or standard, depending on the width of the rims and how far apart the bosses are) and different cams and connecting hardware.
7. Older Potts/Cunningham brakes are built for bosses slightly larger in diameter.

SIDE-PULL BRAKE SPECIFICATIONS

When selecting a brake, choose one so that the brake shoes are close to the center of the range of motion t **o** and **B)** as shown in the illustration below. As the brakes wear or as the mounting adjusts, problems may arise if the brake is fitted at the highest or lowest limits.

The figures below are taken from manufacturers' catalogs.

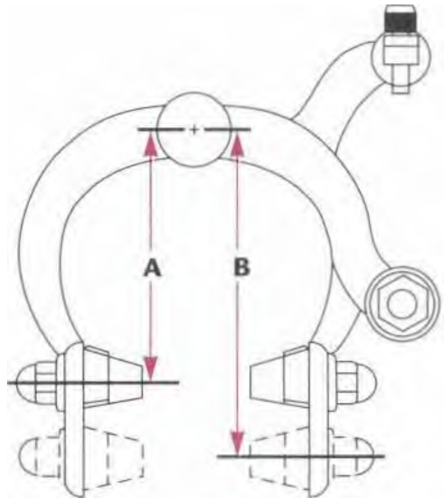
A rough rule of thumb for the placement of the bolt hole for a side-pull brake is that the distance from the bolt hole to the wheel's axle should be about half the bead seat diameter plus the center of slot measurement. To mount side-pull brakes, use a mounting bolt and recessed nuts with alien heads for short reach brakes. Use normal nuts to fix onto the mounting bolt for normal and long reach brakes.

Adjustments

Recessed nuts usually take a 5mm alien wrench and the fixing bolt is approximately 3cm for the front and 2cm for the rear.

Toe adjustments are usually part of the brake pad if that option is available, otherwise change the brake pad or carefully bend the brake arm.

Centering adjustments arc most easily done by pivoting the whole caliper around the mounting bolt, though sonic brakes come with centering adjustment screws.



Make *Ez* **Model**	**Model Number**	**Cable Side**	**Center of Slot**		B
ACS					
Boa		R	82.5	70	95
	860	R	77.5	70	**85**
CAMPAGNOLO					
New Short Reach					
Athena	D500	L	46	40	51.5
Athena '93	BR-02AT	L	46	41	52.5
Athena '94	BR-12AT	L	46	41	51
Chorus	C500	L	46	40	51.5
Chorus '92, '93	BR-02CH	L	46	41	51
Chorus '94	BR-02CH	L	44.5	39	50
Record '94	BR-04RE	L	44.5	39	50
Stratos	BR-02ST	L	45	39	51
Veloce '93 '94	BR-02VL	L	45	39	51
Xenon	F500	L	46	40	51.5

SIDE-PULL BRAKE SPECIFICATIONS (coNTD)

Make & Model	Model Number	Cable Side	Center of Slot		B
CAMPAGNOLO (cont'd)					
Old Short Reach					
Gran Sport	117		47	42	52
Record (pre-'85)	2040/1	L	47	42	52
Super Record	4061/1	L	47	42	52
Triomphe	915/102	L	47	42	52
Victory	415/001		47	42	52
Normal Reach					
Gran Sport	118		52	47	57
Record (pre-'85)	2040	L	52	47	57
Super Record	4061	L	52	47	57
Triomphe	915/101		52	47	57
CHANG STAR *(also marked Royal Star, C-Star, Star, or Cdr T)*					
Short Reach					
Pro-Star 400	P400		44	39	49
	N400		44	39	49
Normal Reach					
(marked CEIT)	CT500		50	43	57
Gran Star 500	GS 500-160	L	52	47	57
Pro-Star 500	P500		50	43	57
Long Reach					
(marked CST)	CT630		56.5	49	64
Pro-Star 500	P630AG	R	56.5	48	65
	N630	R	56.5	49	64
Pro-Star 400	N730A, N730S		62	53	71
BMX & Freestyle					
	1020A		82	73	91
	1080A	R	93	81	105
	810A, N810A, N810S, 890MX		69.5	61	78
	890A, N890A		77	68	86
	FS980, FS981	R	77	67	87
	MX1000A	R	82.5	73	92
	MX1010A	L	82.5	73	92
	MX900A	R	75	66	84
	MX910A	L	75	66	84
	P1020A		82	72	92

SIDE-PULL BRAKE SPECIFICATIONS (CONT'D)

Make El Model	Model Number	Cable Side	Center of Slot		
CLB					
Ultra Short Reach					
Compact, Promo, Space Line		L	42.5	38	47
Normal Reach					
Competition		L	51.5	46	57
GL 47.60		L	53.5	47	60
Professional	3842	L	52.5	48	57
Long Reach					
GL 48.65		L	56.5	48	65
GL 55.75		L	65	55	75
GL 63.85		L	74	63	85
DIA COMPS *(also marked Gran-Curve, Aero-Compe, Royal-Compe)*					
Ultra Short Reach					
Aero Gran-Compe	AGC300/BL	L	40	37	43
Aero-Compe	AC300G	L	40	37	43
BRS 500	8A50, BA50K	L	41	38	44
Short Reach					
a II	all-400	L	45	39	51
a-5000	a-5000 400	L	45	39	51
Blaze	BA-BE00-S	L	46	**40**	52
BRS 200	BA20	L	46	**40**	52
BRS 200	BRS 200	L	45	39	51
BRS 300	BA35	L	44	39	49
BRS 400	BA45	L	44	39	49
BRS 400	BRS 400	L	44	39	49
BRS 500	BA55, BA55K	L	45	42	48
BRS 500	BRS 500	L	45	42	48
BRS Blaze	BA08	L	46	**40**	52
BRS Edge	BA10	L	46	**40**	52
BRS Radius	BA25	L	46	**40**	52
Edge	BA-ED00-S	L	46	**40**	52
New Gran-Compe	NGC400	L	45	40	50
Ole 400	OLE400	L	45	39	51
Radius	BA-RA00-S	L	46	40	52
Radius	BA-RA01-S	L	45	39	51
Royal **Compe II**	R01400	L	44	39	49

SIDE-PULL BRAKE SPECIFICATIONS (CONITTD)

Make & Model	Model Number	Cable Side	Center of Slot		B
DIA COMPE (cont'd)					
Short Reach (cont'd)					
Royal Gran-Compe	RGC400	L	44	39	49
	400N, QS400N	L	43	38	48
Normal *Reach*					
500N	500N		50	43	57
Aero-Compe	AC500	L	53	48.5	57.5
ct II	cx11-500	L	51	45	57
rx-5000	rx.-5000 500	L	51	45	57
Blaze	BA-3E00-N	L	52	47	57
BRS 300	BA37	L	52	47	57
BRS 400	BM 7	L	52	47	57
BRS 70	BRS 70	L	51	45	57
BRS Blaze	BA09	L	53	47	59
DC Series	505, 506, 505Q 506Q	L	51	45	57
Gran-Compe (marked DC 500)	GC500	L	52	47	57
New Gran-Compe	NGC500	L	52	47	57
Ole 500	OLE500	L	51	45	57
Royal Compe II	RCII500	L	52	47	57
Royal Gran Compe	RGC500	L	52	47	57
RI	BA-RTO0-N		51	45	57
VX	BA-VX00-N		51	45	57
VX	BA07	L	51	45	57
	500, QS500N, 500N, CX500N	R	50	43	57
Long Reach					
730	730N	R	62	53	71
810	810N	R	70	61	79
Aero-Compe	AC800	L	67.5	63	72
Big Dog (dual pivot)	MX-999	L	69	58	80
Bulldog	MX-884	R	77	68	86
FS-E	BA-FE00	L	66	57	75
FS-E 887E	887E	L	66	57	75
XCM/XCT	BA-XMOO		70	60	80
	630	R	56.5	49	64
	730	R	62	53	71
	810	R	70	61	79
	890	R	78	68	88

SIDE-PULL BRAKE SPECIFICATIONS (CONT'D)

Make Ei Model	Model Number	Cable Side	Center of Slot		
DIA COMPE (cont'd)					
Long Reach (cont`d)	1 003		82.5	73	92
	1020		82	73	91
	1080		93	81	105
BMX & Freestyle					
Big Dog (Dual Pivot)	MXBIG	I L	78.5	67	90
Bulldog	FS884		77	68	86
FX	FS880		77	68	86
FX (marked MX)	FS880L		77	68	86
MX	MX1000		82.5	73	92
MX	MX883		77	68	86
MX	MX884		77	68	86
MX	MX900, MX903		75	66	84
MX	MX901		75	66	84
MX (marked Bulldog)	MX884Q		77	68	86
Nippon	FS883, FS883L		77	68	86
Trial (marked MX)	903		75	66	84
Trial (marked MX)	1003	R	82.5	73	92
LEE CHI	600AG		52	47	57
	896A		77	68	86
	LC400AG		48	43	53
MAFAC	LC-GL		52.5	45	60
	LS-2, LC-L		50	44	56
MAVIC					
Short Reach					
Pro	420	L	45	42	48
Route	410	L	45	42	48
Super Pro	430, 440	L	45	42	48
	451	L	45	42	48
Normal Reach					
Route	410	L	50	46	54
MODOLO					
Short Reach					
Equipe		L	46	40	52
Flash		L	46	40	52
Master Pro		L	46	40	52

SIDE-PULL BRAKE SPECIFICATIONS (CONT'D)

Make 6x Model	Model Number	Cable Side	Center of Slot	A	
MODOLO (cont'd)					
Short Reach (cont'd)					
Professional		L	46	40	52
Q-Even		L	45	40	50
Q-Exe		L	45	40	50
Speedy			46	40	52
X-Eras		L	45	40	50
X-Setra		L	45	40	50
X-Tenos		L	45	40	50
Normal Reach					
Corsa		L	50	43	57
Flash		L	52	46	58
Professional		L	52	46	58
Q-Exe		L	50	43	57
Speedy		L	50	43	57
Sporting		L	50	43	57
Long Reach					
Corsa		L	57	49	65
Sporting		L	56.5	49	64
T-EIT		L	**66**	57	75
PEREGRINE					
BMX	FSX-111		75.5	66	85
SACHS					
Short Reach					
New Success	BR-RNS00	L	45	40	50
7000	BR-R7000	L	45	40	50
5000	BR-R5000	L	45	40	50
Normal *Reach*					
5000	BR-R5000	L	50	43	57
3000	BR-R3000	L	50	43	57
2000	BR-R2000	L	50	43	57
Elysee	BR-RELY0	L	50	43	57
Long Reach					
3000	BR-R3000	L	62.5	53	72
2000	BR-R2000	L	62.5	53	72
Elysee	BR-RELYO		62.5	53	72

SIDE-PULL BRAKE SPECIFICATIONS (CONT'D)

Make St Model	Model Number	Cable Side	Center of Slot		
SHIMANO					
Short Reach					
105	BR-1050-49	L	44	39	49
105 (Super SLR)1	BR-1055	L	44	39	49
600	BR-6200-49	R	44	39	49
600 Ultegra	BR-6400-49	L	44	39	49
600 Ultegra (Super SLR)1	BR-6403-49	L	44	39	49
600EX	BR-6207-49	L	44	39	49
600EX	BR-6208-49	L	44	39	49
Dura-Ace	BR-7200	L	44	39	49
Dura-Ace	BR-7400	L	44	39	49
Dura-Ace	BR-7402	L	44	39	49
Dura-Ace (Super SLR)1	BR-7403-49	L	44	39	49
Exage (Super SLR)1	BR-A500	L	44	39	49
Exage Action	BR-A350-49	L	44	39	49
Exage Motion	BR-A250-49	L	44	39	49
Exage Sport	BR-A450-49	L	44	39	49
Light Action	BR-L490	L	44	39	49
RX100 (Super SLR)1	BR-A550	L	44	39	**49**
Sante	BR-5000	L	44	39	49
Normal Reach					
105	BR-1050-57	L	52	47	57
105	BR-Z105	L	52	47	57
600	BR-6200-57	R	52	47	57
600	BR-6210	L	52	47	57
105 (Super SLR)	BR-1055	L	52	47	57
600 EX	BR-6207-57	L	52	47	57
600 EX	BR-6208-57	L	52	47	57
600 Ultegra	BR-6400-57	L	52	47	57
Dura-Ace	BR-7210	L	52	47	57
Exage (Super SLR)	BR-A500	L	52	47	57
Exage Action	BR-A350-57	L	52	47	57
Exage Motion	BR-A250-57	L	52	47	57
Exage Sport	BR-A450-57	L	52	47	57
Light Action	BR-L570	L	52	47	57
RX100 (Super SLR)	BR-A550	L	52	47	57
	BR-Z570	L	50	43	57
Long Reach					
DX	BR-MX10	R	**79**	70	88
Tourney	BR-MX20	R	**79**	70	

SIDE-PULL BRAKE SPECIFICATIONS (CONT'D)

Make & Model	Model Number	Cable Side	Center of Slot		
SHIMANO (cont'd)					
Long Reach (cont'd)					
Tourney	BR-TS10		63	54	72
Tourney	BR-TS10	R	70	61	79
Tourney	BR-TS30	R	63	54	72
Tourney	BR-TS40	R	63	54	72
Tourney	BR-TS40	R	70	61	79
Tourney	BR-TS40	R	79	70	88
Tourney	BR-TS60	R	63	54	72
	BR-Z640	L	56.5	49	64
	BR-Z720	R	63	54	72
	BR-Z790		70	61	79
SUNTOUR					
(see also Dia Compe)					
Short Reach					
Cyclone 7000	CB-7100		44	39	49
GPX	BA-GPOO	L	44	39	49
SL	BA-SL00	L	45	39	51
Sprint	BA-SP00	L	44	39	49
Sprint 9000	BA-SP10	L	44	39	49
Superbe Pro	BA-S1300	L	44	39	49
Superbe Pro	BA-SB01		44	39	49
Normal Reach					
Cyclone 7000	CB-8100		52	47	57
Superbe Pro	BA-S1300-N		52	47	57
UNIVERSAL					
Ultra Short Reach					
Mod. CX	97		37	32	42
Short Reach					
Mod. 68	1 02		47.5	41	54
Mod. 77	99/B	L	45	40	50
Mod. 77 front	99/N		48	42	54
Normal Reach					
Mod. 125	125		51	46	56
Mod. 51 front	100	L	50.5	45	56
Mod. CX	98		52.5	46	59

SIDE-PULL BRAKE SPECIFICATIONS (CONT'D)

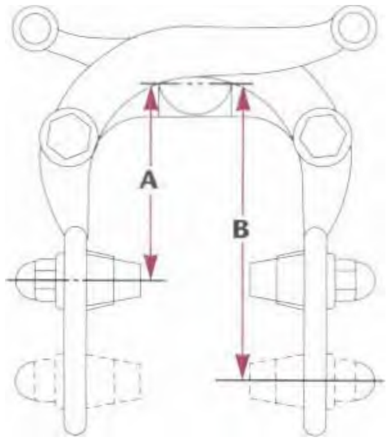
Make & Model	Model Number	Cable Side	Center of Slot		
WEINMANN					
Short Reach					
490 SQ	490		46.75	41	52.5
Carrera 400	400		46.75	41	52.5
Normal *Reach*					
605	605		53	46	60
590 SQ	590		52	47	57
Alpha LT 570	570		50	43	57
Carrera 600	600		53	46	60
NDC 577	577		50	43	57
Long Reach					
Alpha LT 720	720		62	53	71
Alpha TR 721	721		62	53	71
Alpha TR 801	801		70	61	79
Junior 1020	1020		83.5	74.5	92.5
Junior 730	730		62	53	71
Junior 810	810		70	61	79
Junior 890	890		78	69	87
NDC 727	727		62	53	71
NDC 728	728		62	53	71
NDC 808	808		70	61	79
PBS 300 714	714		66.5	62	71
PBS 300 804	804		75.5	71	80
SBS 200 7122	712		62	53	71
SBS 200 7922	792		70	61	79
Symetric 763	763		64	52	76
Symetric 923	923		83.5	75	92
Symetric 943	943		81	68	94

Notes:

1 Super SLR models must only he used with t he matching levers that have stiffer return springs.

2 Hybrid of side- and center-pull designs.

CENTER-PULL AND DELTA BRAKE SPECIFICATIONS



These brakes should be mounted and centered the same as side-pull brakes as shown in the illustration to the right. Fitting a brake shoe at the highest or lowest limits may cause problems as the pads wear or as the mounting bolt is adjusted.

Note: Some Delta brakes have an additional reach adjustment at the mounting bolt.

The figures below are taken from manufacturers' catalogs.

Make Ex Model	Model Number	Center of Reach		
CAMPAGNOLO				
Delta				
Croce D'Aune	B500	44	39	49
Record ('90)	A500D	47	38	56
CHANG STAR				
610A		56	49	63
750A		69	60	78
CLB				
Normal Reach				
CLB 2 Front		53.5	48.5	58.5
Racer Special		54	47	61
Long Reach				
CLB 1/55.77		66	55	77
CLB 1163.85		74	63	85
CLB 1/48.65		56.5	48	65
Half-Balloon Racer		81	71	91
Racer		62	55	69
Racer 73		60	51	69
DIA COMPE (Also *marked Gran-Compe, Royal-Compe)*				
-(current production)	610	54	47	61
-(earlier production)	610	56	49	63
Gran-Compe (marked "Gran-Compe DC 510")	GC510	50	43	57
Gran-Compe (marked "Gran-Compe DC 700")	GC700	61.5	52	71

CENTER-PULL AND DELTA BRAKE SPECIFICATIONS (CONT'D)

P

Make Ea Model	Model Number	Center of Reach		
DIA COMPE (cont'd)				
New Gran-Cornpe	NGC450	**48.5**	42	55
	750	69	60	**78**
MAFAC				
Short Reach				
Competition GL	CnOA	**44**	39	49
Competition GL	Cn1A	49	44	54
GT	GT0A	43	38	48
GT	GT1A	48	43	53
Normal Reach				
2000	M0A	50.5	43	58
2000	MIA	55.5	48	63
Competition GL	Cn2A	54	49	59
GT	GT2A	53	48	58
Racer	R0	50.5	43	58
Racer	R1	55.5	48	63
S	S0	51.5	44	59
Long Reach				
2000	M 2A	60.5	53	68
2000	M3A	65	55	75
Competition GL	Cn3A	58.5	51	66
Racer	R2	60.5	53	68
Racer	R3	65	55	75
Raid	Raid	72.5	65	80
S	S1	56.5	49	64
S	S2	61.5	54	69
S	**S3**	66	56	76
MODOLO				
Delta				
Kronos	**CP4**	**45**	**42**	**48**
SHIMANO				
Tourney	BR-TC10, 30	54.5	47	62
Tourney	BR-TO 0, **30**	**66**	**57**	75
UNIVERSAL				
Mod. 61 front	N.105	**54.5**	49	60
Mod. 61 rear	N.106	**64**	56	72
Sport front	N.108	**64**	56	72
Sport rear	N.109	·1	**56**	

CENTER-PULL AND DELTA BRAKES (CONT'D)

Make Ei Model	Model Number	Center of Reach		
WEINMANN				
Delta				
Delta II	576, 576-02, 576-06	49	**41**	57
Delta, Delta Pro		48	**41**	55
Center *Pull*				
Vainqueur 610		**55**	**49**	**61**
	CP 633	**55.5**	**48.5**	**63**
Vainqueur 750		**66**	**57**	**75**
	CP 753	**66**	**57**	**75**
Vainqueur 800	1232	**66**	**61**	**84**

BRAKE LEVERS

There are three main types of brake levers which are determined by where they clamp onto the frame: **Road levers, Mountain levers, and Tourist-style levers.**

Road levers are designed to be mounted on the bend of drop-style handlebars. If they were mounted on a straight section, the levers would be too close to the bar and have little travel. Road levers come in various styles such as standard routing, aero routing, and even reverse cable routing (for aero-handlebars).

Mountain, BMX, and Tourist levers are designed for straight bar sections. There is basically one style of routing cables to levers, although sonic levers are mounted on backwards.

Leverage Ratios:

Different types of brakes have different characteristics for cable travel to braking power. On road hikes with side-pull or Delta brakes, it is important to minimize caliper flex. A high leverage ratio (that is, lever travel to cable travel) for these brakes is needed due to the short caliper arms; the arm size requires more work from cable travel. With greater leverage conies the drawback of less pad-to-rim clearance. Since these brakes are used on road bikes that usually don't see as dramatic ri m damage as mountain hikes, this is acceptable.

The newer dual pivot style side-pull brakes have greater braking force due to the geometry of the caliper rather than by the force applied by the cable. These brakes use levers of medium leverage ratio.

Usually mountain bikes with cantilever, U-, or roller-cam brakes experience more rim damage than road hikes; thus, the brakes are usually designed for greater pad-to-rim clearance. Because these brakes operate over a greater distance, they need levers that will move the cables farther. This translates to a lever with a lower leverage ratio. The extra flex these calipers have is partially offset by the greater cable travel-to-lever movement ratio.

BRAKE LEVERS (coN-rD)

Brake Reach

Do not confuse short and normal reach brake levers with short, normal, and long reach brake calipers. Short, normal, and long reach calipers refer to the distance from the mounting bolt to the rim. Short and normal reach brake levers refer to the size hand the levers are designed for, or rather, the distance from the lever to the handlebar.

Some drop-bar-style brake levers are designed for smaller hands and thus have less travel. This is compensated for by reducing the leverage ratio so that the levers get the full amount of cable travel. These levers will not be as powerful as standard reach levers which are for side-pull brakes. This is partially offset since people with smaller hands weigh less and do not need as powerful brakes for comparable stopping distances. The leverage ratio of drop-bar-style brake levers for small hands is often close to the leverage ratio for dual pivot brakes.

There are various designs for both the brake lever and the brake caliper to get high initial travel and still have good power without bottoming the lever against the bar. These brake systems are designed for mountain bikes where greater pad-to-rim distance is desirable. There are also caliper designs where though the rear brake has less power, the action of either brake lever feels the same because the amount of total flex is the same for each side: for the rear, the flex is in the longer cable run; for the front, the flex is in the longer caliper arms. Other lever designs have reach adjustments for tuning the brakes' response to the rider.

These are generalizations that vary depending on the geometry of the individual caliper and the cable and straddle wire setup. The action of roller-cam brakes really depends on the cam itself, though low leverage and greater travel allow for greater play when adjusting the brake and cam.

Lever Selection

For the most efficient brakes, use levers designed for the particular calipers you are using. Levers designed for side-pull brakes do not offer enough travel for cantilevers and the pads do not ride far enough away from the rim to allow using the quick release on the caliper. It is possible to use levers designed for dual pivot brakes with cantilevers. There will be the same problems as above, but to a lesser degree (whether this is acceptable or not depends on the rider).

Remember to check for proper lever travel, pad-to-rim clearance, and braking power. Does the lever bottom-out against the handlebar? Does it feel like there is enough braking power? Too much? Are the levers easy enough to reach? Will your hands cramp when using the brakes for long periods of time?

Dual Cable Brake Levers

Some brake levers are designed for a special double cable or for two cables. These are used on tandems which have two caliper brakes and one huh brake. When using these levers, remember that different types of brakes have different characteristics and it is usually best to use similar brakes when they are attached to the same lever. Do not have a cantilever and hub brake connected to the same lever.

HYDRAULIC BRAKE SPECIFICATIONS

Specification table does not include disc brakes.

Make & Model	Model Number	Brake Mounting	Notes	Center of Slot		
INNOVATIVE BICYCLE CONCEPTS						
HydroCeps 940	940	cantilever	Mounts on cantilever bosses, brake pads mount directly on hydraulic pistons.[1]	26	18.5	33
MAG URA						
Hydro-Stop Mountain		cantilever		30	22.5	38
HS *221* HS 22 Raceline	HS *22*	cantilever	With Evolution adapter, ***(otherwise see Magura section page 13-32).*** Brake pads mount directly on hydraulic pistons.	*28*	22	33.5
HS 66	HS 66	center bolt	***(See "Center Bolt Installation" page 13-33.)*** Brake pads mount directly on hydraulic pistons.			
HS 77		center bolt		34	39	49
MATHAUSER						
Pro	483	center bolt	*front brake must be mounted*	52.0	39.0	65.0
Touring	481	center bolt	***BEHIND** the fork,* or ***DAMAGE***	52.0	39.0	65.0
BMX	484	center bolt	***TO THE BRAKE AND INJURY***	66.0	49.0	83.0
ATB	482	center bolt	***TO THE RIDER MAY RESULT!***	52.0	39.0	65.0
SACHS						
Hydro Pull		N/A	Lever and cable replacement used with current brakes.			
SCOTT/ MATHAUSER						
Superbrake		center bolt	scissors-like design.'	48.0	39.0	57.0
w/extender bushing		center bolt	scissors-like design[1]	54.0	45.0	63.0

1 System is factory sealed; no user-service is intended, other than shoe replacement.

HYDRAULIC BRAKE SPECIFICATIONS (CONTD)

Design Elements - Service Notes

Innovative Bicycle Concepts HydroCeps 940

Ifie IBC HydroCeps 940 is a hydraulic cantilever brakeset for straight handlebars. It comes with its own brake bridge, an essential part of the brake system. The brake bridge also acts as part of the quick release; it spreads the brake pads apart, making room for the wheel to be removed.

Horizontal Distance From Center of Post to Rim (in mm)	Center of Slot	A	B
19-39, 29-492	30	*22.5*	38

2 With adapters switched between left and right sides.

The hose fittings and brake pad screws are English threading. The hoses are a crimped, barbed fitting and do not rotate easily. The hose fittings and bleed screws are threaded differently, so be careful not to mix up the holes on the cylinders if replacing the hoses. Install the hoses as close to the frame as possible: looping them close ensures that they will not snag on objects.

There is an adapter to fit the Shimano Rapidfire and Rapidfire Plus shifter models without the optical gear display option. The adapter bolts onto the brake lever itself. The brake pads are bolted to plates on the slave cylinders. The brakes need little, if any, toe adjustment. If the brakes do squeal, you can toe the pads by placing something wedge-shaped (like a flathead screwdriver) under the leading edge of the brake pads and squeezing the lever to bend the brake pad and backing plate away from the rim.

Magura

The Magura hydraulic brakes are a modular system much like standard brakes are. The **master hydraulic cylinder (the** hydraulic cylinder that you push on) is incorporated into the brake lever. 1here are two kinds of brake levers; one for straight handlebars (such as mountain bikes) or ones for drop-style bars (like road bikes). There are two different kinds of **slave cylinders** (the cylinders that push the pads to the rim); a single slave cylinder that is mounted as part of a side-pull style brake and a dual slave cylinder arrangement where each cylinder is mounted on either side of the rim. There are adapters to fit the slave cylinders to both popular brake style mountings: cantilever bosses and side-pull centerholts. There are also special brackets that can be brazed onto the frame or fork.

Brake Model	Lever Style	Slave Cylinder Style	Normal Mounting
HS *22*	Mountain	Dual	Cantilever3
HS *22* Raceline	Mountain	Dual	Cantilever3
HS 66	Road	Dual	U-bracket3
HS 77	Road	Single	Side-pull only
HS 77 Raceline	Road	Single	Side-pull only

3 Use cantilever, U-bracket, or braze-on mounts. Make sure to use the right adapter or bracket.

HYDRAULIC BRAKE SPECIFICATIONS (coNrc)

Magura (cont'd)

HS 22 is a mountain-style brake lever with the dual slave cylinders and usually comes with the cantilever adapter. HS22 can be used with the 1J-bracket or braze-on brackets, also. Make sure you have the right adapter or bracket.

HS 22 Raceline is similar to the HS 22 though it is slightly lighter. It uses the same hardware as the I IS 22.

HS 66 is a road-style brake lever and has the same dual slave cylinders as the HS 22. Normally, [his lever is matched with a Ll-bracket centerbolt mounting, but this lever may also be used with a cantilever adapter for a tandem or touring bike.

HS 77 has the same master cylinder as the 115 66, but uses the single slave cylinder mounted to a more conventional looking side-pull style caliper.

Hydro-Stop brake is the predecessor to the IIS 22. The older cantilever adapter sets were designed for the Hydro-Stop.

Cantilever Adapter Installation (HS 22 or HS 66)

Older models had different adapters for different rim-to-brake post distances. The new Evolution adapter is a universal fit. Older adapter sets were used with the older Hydro-Stop brake.

Choose the appropriate adapter for standard cantilever mounts from the chart below.

Older Adapter Sets For Standard Cantilever Bosses

Horizontal distance[4] from center of post to rim (in mm)	Adapter Set Model Number	Adapter Set w/Quick-Release Model Number	A	
22.5-27.5	830201	830211	22.5	38
17.5-22.5	830202	830212	22.5	38
12.5-17.5	830203	830213	22.5	38

4 Includes 2mm distance on each side between rim and brake pads.

The flat-sided washer (labeled with the flat side up) should be placed on the brake post first. The quick release for the Evolution adapter is used in conjunction with the normal Evolution adapter.

Clamp the slave cylinders into the adapters so that the pads are about 2-3mm from the rim and the pads hit the rim flat (toe adjustment should not be necessary). The Evolution adapter has a slight ball joint for minor angle adjustments, but the larger angle adjustments should he done by rotating the offset upper brace legs on the adapters – a 13mm open end wrench may be needed for sufficient leverage. Likewise, adjust the distance from the pads to the rim as best as possible at the adapter, then fine tune by turning the reach screw on the master cylinder.

HYDRAULIC BRAKE SPECIFICATIONS (CONT'D)

Magura (cont'd)

Cantilever Adapter Installation (HS 22 or HS 66) (cont'd)

Evolution Adapter Set For Standard Cantilever Bosses

Horizontal distance[4] from center of post to rim (in mm	Adapter Set Model Number	Adapter Set w/Quick-Release Model Number	A	
[19-39	0322166	0322168	*22*	33.5

4 Includes 2mm distance on each side between rim and brake pads.

Center Bolt Adapter Installation (HS 22 or HS 66)

Magura recommends that Li-Brackets should be mounted behind the tront fork to simplify possible installation of light brackets or reflectors.

U-Brackets For Centerbolt Mountings

I – Bracket	Horizontal distance [4] from center of post to rim (in mm)	A	B	Bracket Part Number
A	19-27	59	66	0321368
B	19-27	62	69	0321373
C	19-27	65	73	0321354
D	19-27	71	80	0321381
E	28-36	83	92	0321386

4 Includes 2 mm distance on each side between rim and brake pads.

Bolts For Centerbolt Mountings (non-recessed nuts)

Bolt	Bolt Number
Front	0321353
Rear	0321352
Rear, "Pletscher" type plate	0321351

As with the cantilever adapters, the slave cylinders clamp into the Li-bracket but there is no adjustability for toe-in. First, adjust the pad-to-rim distance at the bracket; then, fine tune and adjust for pad wear at the master cylinder.

Center Bolt Adapter Installation (HS 77)

The HS 77 should come with the proper mounting kit: bolts for recessed nut mounting, part #0322018. Adjust the rim-to-pad distance by rotating knurled screw around the slave cylinder. Also, use the micro adjustment screw in brake lever.

HYDRAULIC BRAKE SPECIFICATIONS (CONT'D)

Magura (cont'd)

Braze-on Bracket Adapter Installation (HS 22 or **HS** 66)

Special lightweight, dedicated braze-ons and their adapters are available for the HS 22 or HS 66 slave cylinders, part #0321256. They adjust vertically 6111111 and pad-to-rim 9mm.

Braze-on Brackets

Horizontal bracket to rim distance difference in mm	B-A	Bracket Part Number
9	6	0321256

Brake Shoes

Due to system design, it is unnecessary and undesirable to toe-in the pads. **Pads should be parallel to the rim.** Magura has two pads, each with rubber compounds for different applications:

Shoe Color	Application	Part # for HS 22 or HS 66 (snap-on)	Part # for HS 77 (bolt-style pad)
Black	polished or anodized aluminum rims	0321406	0322035
Gray	hard-anodized, ceramic, or composite rims	0321407	0322036

If the brake line is to be routed through braze-ons, *(see instructions for shortening tubing on page 13-36)*.

Servicing

For major service of Magura brakes, have the following spare parts on hand:

Description	Part Number
Hydraulic line tubing	610150
Compression ferrule (have several of these on hand)	432264
Compression collar (threaded)	432268
Barbed fitting (threaded)*	432233
Syringe (for adding fluid) w/rubber gasket and fill and bleed hoses	321236
Spare rubber gasket (they have a limited life span)	431882
Special nylon blocks for holding tubing while inserting barbed fittings	431883

* Old-style, silver brakes used smaller diameter (5mm vs. 6mm) with threaded barbed fitting.

HYDRAULIC BRAKE SPECIFICATIONS (coNrcs)

Magura (contd)

The Barbed Fitting

Installing a new barbed fitting:

1. Cut the tubing cleanly and perfectly square with a razor knife.
2. Clamp the end of the tubing securely in a vise with special nylon clamp blocks; leave 15 mm (9116[1]) of tubing above the blocks.
3. With a plastic hammer, gently tap a barbed fitting down into the tubing completely. Make sure it remains straight and the line doesn't slip down further into the blocks.
4. the barbs on the barbed fitting will provide enough of a seal to allow the fitting to rotate without leaking.

The Compression Collar

Installing a new compression collar fitting:

1. Establish the correct tubing length. Be generous—it's easier to shorten than to lengthen! Carefully measure and mark where to make the cut.
2. Cut the tubing cleanly and perfectly square with a razor knife.
3. If there is a tubing protector, slide it up the brake line and out of the way.
4. Slide the compression collar up the line and out of the way. Position a new compression ferrule with the rounded end facing the end of the tubing. While maintaining light downward pressure on the line to ensure that a good scat results, slide the collar back down and screw in tightly. leave only 2-2.5mm of space between collar wrench-flats and slave cylinder body.

Shortening the hydraulic line tubing:

1. Completely unscrew the fitting on the hydraulic tubing where it connects to the slave cylinder (caliper), and carefully pull up the end of the tubing.
2. Establish the correct tubing length. Be generous—it's easier to shorten than to lengthen! Carefully measure and mark where to make the cut.
3. To install the new fitting, use a compression collar if it is connecting to the master cylinder or a barbed fitting if it is connecting the two slave cylinders.
4. If brake lever is not disturbed and movement of tubing is kept to a minimum during this procedure, no fluid should escape. Nevertheless, the line should be tested for oil leaks.

HYDRAULIC BRAKE SPECIFICATIONS (CONTD)

Magura (cont'd)

Testing The Hydraulic System

To check for loss of fluid or air in the line, squeeze the brake lever only 5 to 6mm (1/4"). Watch for a slight movement of the brake shoes. if there is no motion, add fluid and re-check. ***(See "Adding Fluid" page 13-37.)***

Leaks indicate that the compression fitting is not tight enough or is installed incorrectly, or there is severe damage to the line. To check for leaks, clean and dry all fittings, and squeeze lever very hard while inspecting for any wetness.

Lengthening the tubing:

1. Carefully measure and cut the new hydraulic tubing to length.
2. To connect the two slave cylinders together, install barbed fittings on both ends. To connect a slave cylinder to the master cylinder, install a barbed fitting on one end of the tuhing and a compression fitting to the other end. Match the fittings to the proper cylinders before installing them onto the tubing ends.

Maintenance

Adjusting for pad wear:

1. For minor adjustments:

   Turn the adjusting screw clockwise. It is located in the back side of each master cylinder on the brake lever unit, opposite from the side where the hydraulic tubing is connected. When installing new shoes, back the screw out (counterclockwise) to the starting position to begin adjustment.

2. For greater adjust ments:

   Loosen one or both of the screws that hold each slave cylinder in its mount and slide cylinder closer to rim. Re-tighten screws.

3. To change shoes:

   Replace shoes after 1/16" to 1/8" of wear or as soon as t he wear groove disappears. Pull or pop shoes out with a small flat screwdriver; new shoes snap into place. All new ones have arrows molded into the pad sides. Check that arrows point in the direction of tire rotation. After replacing the brake shoes, reset the fine adjustment screws. Test the brakes before riding.

HYDRAULIC BRAKE SPECIFICATIONS (coNtD)

Magura (cont'd)

Adding Fluid

There is very little need to change the brake fluid under normal conditions - the seals should he sufficient to prevent any contamination or oil loss. Change the oil onl y when changing or reconnecting the hoses.

Magma brakes use non-toxic, common mineral oil. **NEVER USE AUTOMOTIVE HYDRAULIC BRAKE FLUID!** You may substitute transmission fluid or shock oil for the mineral oil. Recommended weights are 5 or 10 weight or 2.5 weight for very cold weather use.

Do not attempt to bleed the brakes if the brake lever is disassembled (if the lever is not bolted to the lever assembly). The piston on the master cylinder is free floating and may pop out. Remove the lever from the housing only if the system is closed, unless you want to remove the piston too.

1. Rack out the fine-adjustment screw until the stop is reached. ***(See #1, under "Maintenance" on pg. 13-36.)***
2. Position the handlebars so that the **Master Cylinder** (in brake lever unit), for the brake you are working on, is oriented so that the hydraulic tubing is pointing upwards, and at the highest point in the system the brake lever will he facing downwards. One way to do this is by removing the stem and handlebars together; turn the bars on end during the procedure. The NS 22 does not need to be rotated; it has been designed so you can work on the bicycle in a normal orientation.
3. One of the **Slave Cylinders has a** hole closed off with a large-headed alien screw. This is the **Filler Hole** for the system. Remove the **Filler Hole Screw** and thread on the filler tube which is filled with mineral oil. The filler tube is attached to the **Syringe,** which is also filled with mineral oil.
4. Remove the **Vent Screw,** which is the large-headed allen screw next to the tubing connection on the **Master Cylinder.** Attach the other filler tube while keeping the opposite end in a container to catch the oil.
5. Force oil into the system with the syringe until it bleeds in a full stream from the **Master Cylinder Vent Hole** without any bubbles in the stream.
6. **Optional:** If you are adding oil to a cylinder that was completely drained, then, with **Syringe** still held in place and still approximately 1/3 full of oil, squeeze brake lever through its full travel, pushing any remaining air out of the **Master Cylinder.** Continue emptying oil from the **Syringe** into the system, and at the same time, slowly release the brake lever. This will cause the pressure to build in the **Master Cylinder.**
7. Remove the drain tube from the bleed hole and the **Vent Screw** with the **Syringe** still iii place.
8. Remove the **Syringe,** and re-tighten the **Filler Hole Screw.**
9. Wipe off all overflow. **Test the system as indicated in Testing The Hydraulic System,** ***(see page 13-36).***

HYDRAULIC BRAKE SPECIFICATIONS (CONT'D)

Magura (cont'd)

Adding Fluid (cont'd)

10. If you are adding a completely dry slave cylinder to the system, pump the brakes a few times and refill the fluid again.

11. if you have properly added fluid but it still seems as if there is not enough fluid (if the brake pads do not move in unison with the lever), you may need to tighten the micro adjustment screw on the master cylinder a few turns and refill with fluid.

Fine Adjustments

You can adjust the micro adjustment screw at the master cylinder to fine tune the brake pad position when pads start to wear. Locate the micro adjustment screw in line with the master cylinder on the lever handle itself. Adjusting for hand size can also be done at the lever. For straight bar levers, the adjuster is the set screw on the front of the lever.

Torque Specifications:

Bolt	Size	Torque (in. lbs.)
Brake lever mounting bracket screw		35
Adapter screws	M5, M6	35
Cantilever mounting screw	M5	53
STI adapter screw	M5	18
Braze-on mounting screws		35
U-bracket clip screws		35
Brake booster screws		35
Barbed fitting	M5 or M6	22
Compression nut	M8	40

Sachs Hydro Pull (or Hydraulic Power Cable)

All Sachs hydraulic systems (including the disc brake not mentioned here) use the same hoses and fittings as the Magura brake system, making the individual parts interchangeable. The directions for changing the tubing, fitting the swage and barbed fittings, and bleeding the system on the Magura apply to the Sachs.

From the Sachs 1994 Dealer Information Sheets:

The hydraulic cylinder mounts directly on the side-pull brake's caliper, replacing the 6 x .1mm threaded adjusting barrel. Cantilever applications require a cable hanger at the headset or the seatstays. The hydraulic cylinder can also attach to the adjusting barrel mount on the drum brake arm.

The cylinder needs 70 mm of clearance for installation. Replace the cable in the cylinder by removing the black top cap and pulling the cable out of the cylinder. Brake cables with smaller heads like those used for road levers work best. **Do not remove the circlip.** It holds the piston in place.

NON-STANDARD BRAKE SHOES AND PADS PARTIAL LIST

Many are not interchangeable although similar in appearance.

Make 81 Model	Brake Model No.	Notes	Shoe/Pad Part No.
DIA-COMPE (pre '94)			
BRS 500, Aero Compe	BA50, AC 300	"Aero" style, bolt-type shoe with eccentric.	AGC76
MODOLO			
Kronos		Caliper arm takes shoeless pad.	M0030
WEINMANN			
Delta II	576	This bolt type is "aero" style.	1772
SHIMANO			
Dura-Ace AX	BR-7300	Caliper arm takes shoeless pad.	3-815 9803
600 AX	BR-6300-6310	Caliper arm takes shoeless pad.	3-815 9803
Adamas AX	BR-AD20	Caliper arm takes shoeless pad.	3-867 9801
SUNTOUR			
XC Power	CB-6000	Used special threaded shoes; normal post type shoes don't look like they fit, but they do.	Original shoes are no longer available.
MAGURA	H S-22, HS-66	Snap on brake pad.	0231406 0231407

NON-STANDARD BRAKE STRADDLE CABLES PARTIAL LIST

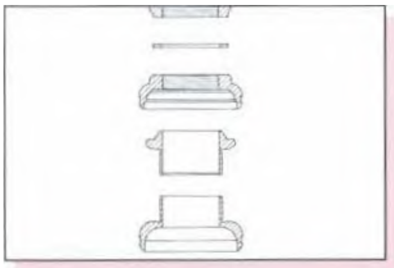
Many are not interchangeable although similar in appearance.

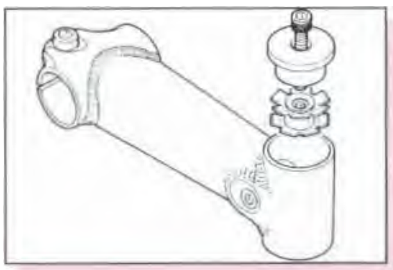
Make El Model	Brake Model No.	Notes	Straddle Cable Part No.
CHANG STAR	880A, 860A	double-headed straddle cables	***(See Diu-Compe 980 below.)***
CLB			
all cantilevers		double-headed straddle cables	18201, 18202, 18203,
CLB-1, -2, Racing		double-headed straddle cables	18204, 18205
DIA-COMPE			
New Gran-Compe	450	double-headed straddle cables	
		with tiny heads	1273.100
	610, 750	double-headed straddle cables	1270.100, -.100
	960, 980	double-headed straddle cables	1271.250, -.300
Advantage—U-brake	990	single-ended cable with barrel end and grip	1275.120
GRAFTON - all models		double-headed straddle cables	
IRD - all U-brakes		unique, double-headed straddle cables	
LEE CHI	700A	double-headed straddle cables	see Dia-Compe 980
MAFAC			
GT		unique, double-headed straddle cables	5469E
Competition, 2000,		double-headed straddle cables	4069
Cantilevers, Racer, Raid		straddle cable with a tiny head & spool	***(See Weil:moon CC-420 below.)***
MODOLO			
Cross		two identical, double-headed straddle cables per brake	M0376, M0377, M0413 (bridge)
Kronos		Kronos levers require special ferrule	M0156
WEINMANN			
Vainqueur	610, 750	double-headed straddle cables	1270.110, -.150
	NCL 620	integrated straddle bridge/cables	1242.120, -.140, -.170
	GRB 430	integrated straddle bridge/cables	1242.120, -.140, -.170
	CC-420	straddle cable with a tiny head & spool	1276.350 & 1277

CONTENTS

14

HEADSETS STEMS HANDLEBARS





SUTHERLAND'S

HEADSETS, STEMS, HANDLEBARS

HEADSET STANDARDS

Standard	Thread Standard Thread Sizes	Press Fit Dimension Pressed Head Tube Race Outside Diameter K*	Head Tube Reamer Size	Crown Race Inside Diameter L*	Crown Race Seat Cutter Diameter	Stem Outside Diameter	Common Use
Japanese (Jis)2	1" (25.4mm) x 24 TPI	30.0mm	29.8mm	27.0mm	27.1mm	22.2mm	
Professional/ Campagnolo	1" (25.4mm) x 24 TPI	30.2mm	30.0mm	26.4mm	26.5mm	22.2mm	High quality
1 1/8" OS (oversize)	11/8" (28.6mm) x 26 TPI	34.0mm	33.8mm	30.0mm (25.4mm)	30.1mm		Mountain, Tandem
1 1/4" OS	1 1/4" (31.8mm) x 26 TPI	37.0mm	**36.8mm**	33.0mm (28.6mm)	33.1mm	11/8 "	Mountain, Tandem
U.S.A. [2, 4]	1" (25.4mm) x 24 TPI	varies		varies		.833" (21.15mm)	Lower-priced
1501	1" (25.4mm) x 24 TPI	30.0mm	29.8mm			22.2mm	
English [2, 3]	1" (25.4mm) x 24 TPI	30.0mm	29.8mm	27.0mm 26.5mm	27.1mm 26.6mm	22.2mm	
Italian [2]	1" (25.4mm) x 24 TPI5	30.2mm	30.0mm	27.0mm [2] 26.5mm	27.1mm 26.6mm	22.2mm	
French	25mm x 1.0mm	30.2mm	30.0mm	27.0mm [2] 26.5mm	27.1mm 26.6mm	22.0mm	
Austrian [2, 6] (East German)	26mm x 1.0mm	30.8mm	30.6mm	26.7mm	26.8mm	22.0mm	Some Sears models6
BMX	1" (25.4mm) x 24 TPI	32.7mm	32.5mm	26.4mm	26.5mm	21.15mm	Most models
Raleigh [2, 7]	1" (25.4mm) x 26 TPI	30.2mm	30.0mm	27.0 [2, 7]	27.1mm		See **notes 2, 7**
Chater Lea	31/32" x 30 TPI						
Alex Moulton	1" (25.4mm) x 24 TPI	30.0mm [8] 36.4mm [8]	29.8mm 36.2mm	29.5mm	29.6mm	22.2mm	Moulton MK III & Earlier

HEADSET STANDARDS (CONT'D)

Notes:

* *(See "Headset chart Key," page 14-9.)* The numbers in these columns are nominal dimensions; the races' actual dimensions vary, depending on quality and manufacturing variations; *(see "Headset Press Fit Dimensions fi Tolerances," page 14-4.)*

1 See Appendix for more details on ISO Standards.

2 Professional models are often manufactured using Professional/Campagnolo standard.

3 Includes Dunelt and Phillips prior to 1963; after 1963, see Raleigh.

4 Higher-priced models are often manufactured using Japanese or Professional/Campagnolo standards.

5 Frequently marked 25.4 x 24F.

6 Found on Scars models made by Steyr of Austria.

7 Raleigh, Rudge, Humber and brands made by Raleigh in Nottingham after 1963. Brands made by Raleigh that had a 71 or 76mm bottom bracket shell generally used 26 TPI on the headset as well as the bottom bracket. Bikes with 67 or 68mm shells used 24 TPI in both the headset and bottom bracket.

8 Lipper and lower head tube races differ in size (head tube is tapered).

MARKINGS ON THREADED HEADSET PARTS

Campagnolo, Dura Ace, Tange, Levin and other marked headsets as follows:			Stronglight S5	Zeus
English	1" x 24 TPI	ENGLAND	English 25.4 x 1.058	English BSC
Italian	25.4 x 24 F	ITALY	French 25 x 1	French no mark
French	25 x 1.00	FRANCE		

ID ID and English/Japanese steering columns have the same diameter and number of threads per inch. The thread profile is, however, slightly different. *(See Appendix on measuring threads.)* In practice these sizes are interchangeable.

JUVENILE: Most juvenile bikes use standard headset threading. Some, however, use the following:

Lnglish	7/8" x 24 TPI
French	23mm x 1.0mm
Italian	22.2mm x 24TPI

TANDEMS: Tandems are currently using oversized headsets. In the past many tandems used standard headsets. Some, however, use 28mm x 1.0mm. Older English tandems used 1 1/8" x 26TPI which was also used on motorcycles.

OTHER: Some older English headsets (Chater Lea) were 31/32" x 30 TPI.

HEADSET PRESS FIT DIMENSIONS AND TOLERANCES

Inside Head Tube

Head tube reamers are sized 0.2mm (.008") smaller than the pressed race O.D. standards. ***(See chart on page 14-25.)***

Steel pressed races should be 0.15mm - 0.20mm (.006"

sizes up to 0.25mm (.010") larger than inside the head tube. Take care as an extra large pressed race may distort the head tube, making the next pressed race fit loosely.

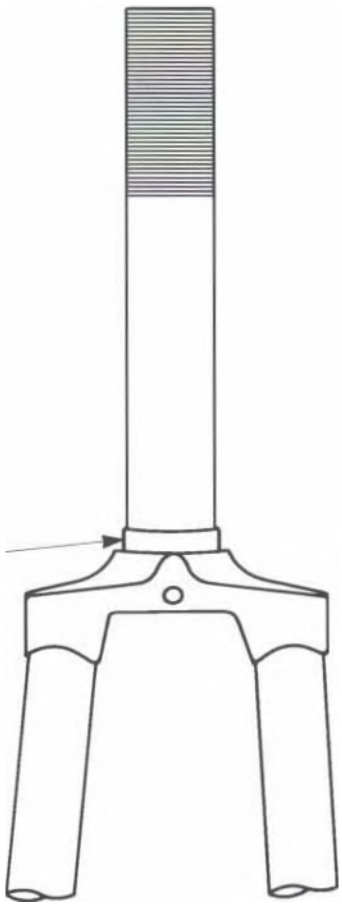
Aluminum pressed races need special care: de-burr inside the head tube edge and grease the parts. This will prevent raising a burr on the pressed race as it is inserted into the head tube. Aluminum pressed races should he 0.10mm – 0.15(.004" + .006") larger than the head tube.

Crown race seat cutters come in sizes 0.1mm (.004") larger than the crown race I.D. standards. ***(See page 14-2.)***

Medium to low quality steel crown races should be 0.05mm to 0.15mm (.002" to .006") smaller than the crown race seat.

High quality steel crown races should be less than 0.1 mm (.004") smaller.

Crown Race Seat - - -



HEADSET BINDING CAUSES

1. Bent fork, head tube or steering column.
2. Improperly milled head tube and/or crown race seat.
3. Poor fitting parts.
4. Worn or damaged parts.
5. Dirt, chips or other contamination.
6. Cross threaded, crooked, or wrong threads.
7. Poor adjustment.
8. Too many balls.
9. Wrong size balls.
10. No lubrication.
11. Poor quality headset—some aren't meant to work.

STACK HEIGHT

REPLACING STACKS

The "Fit" of a headset is so complicated that an exact replacement unit should be used unless there is a very good reason for using a different type. In most worn-out headsets, only the lower races are impaired. The chances of running into problems during replacement are minimized if only the "lower stack" is replaced. The top stack usually outlasts the lower stack by 2 to 1 (or more).

Replacing the lower stack—Points to check

1. Total height of the replacement stack.
2. Crown race 1.1). (inside diameter) and the crown race seat should be compatible sizes. *(See page 14-4.)* Be sure to note if crown race has a shoulder that will prevent it from seating properly.
3. Lower pressed race diameters should be .2mm larger than the inside head tube. The milled portion inside the head tube must be deep enough.

Replacing the top stack—Points to check

1. Threads of screwed race and locknut must match threads of steering column.
2. Total height of replacement stack. Don't forget brake hanger thickness.
3. Upper pressed head tube race diameter and head tube inside diameter should be compatible sizes. *(See page 144.)* The milled portion inside the head tube must be deep enough.
4. Lock washer or brake hanger diameter and locking device must be compatible with grooves or flats in steering column as well as with column diameter.
5. Stem must tit in hole in top locknut.

STACK HEIGHTS(CONT)

Replacing the top stack—Points to check (cont'd)

Campagnolo aluminum headset pressed head tube races have a radiused edge where it mates with the inside edge of the head tube. The Campagnolo head tube cutter cuts the head tube to match this radiused portion of the head tube race. When installing aluminum headsets be sure to bevel the inside edge of the head tube slightly with a hard deburring tool or file.

MIXING PARTS WITHIN STACKS

when possible. However, with care, mixing parts can work. Use the following factors to catch problems early in the job.

1. Are the parts of a similar design? For example, you can't replace a Peugeot screwed race with a Campagnolo screwed race.
2. Are mating parts designed to use the same size and number of halls?
3. Do the parts nest properly? Most headsets are designed so that the cups and cones overlap slighti to help keep dirt out.
4. Will the center pull brake hanger fit properly? Some will not seat properly without washers or different parts.

Try it. Before installing a mixed headset, try it out off the bike (or half off the bike if it's easier). First put the cup and cone pieces together without the balls to make sure that they nest. Then try the fit again with balls. Under pressure the parts should rotate smoothly on each other; and although they can rock slightly, they should not feel unstable. This also gives you a chance to check the stack heights.

If possible, avoid mixing a high and low quality race in one hearing since performance and reliability will be limited by the low quality part. Using one high quality stack (both races) in a low quality headset can give greatly improved performance, especially if the lower, more heavily loaded stack is the good one.

INCORRECT STEERER LENGTH

Steerer too short)Fop locknut must engage at least 3 full turns on good threads).

1. Remove any extra locknuts or spacers (be sure brake hanger still clears headset).
2. Find a headset with shorter stacks.
3. If the bicycle was assembled correctly in the first place and the fork isn't absolutely too short, enough metal can be milled from the top and bottom of the head tube to accommodate a thicker headset. Milling the frame is time consuming but preferable to stripping the end of the steerer.
4. Change to side-pull brakes that don't require brake cable hanger.

INCORRECT STEERER LENGTH (CONT'D)

Steerer too long.

1. Add extra lockwasher.
2. Cut or file shorter.
3. Use a taller locknut.

TIPS AND PROBLEMS TO AVIOD

When cutting a steerer tube, use a threaded fork miter block to insure the cut is square and the threads are clean. If you don't have a miter block, run a screwed race on below where you intend to cut. When you are finished you can unscrew the race to clean up the threads.

Whenever a headset is disassembled, it is good practice to replace all the balls. Headset balls carry the load and road shocks without rolling and are therefore likely to become deformed.

Putting a Campagnolo headset in a bike designed for another headset frequently results in a too-short steerer. One solution is to mount a Campagnolo track headset. Another is to mill the upper and lower ends of the head tube by a distance equal to the difference in thicknesses. Using either method, the frame will remain level and the steering geometry won't be changed.

Lockwashers should just fit over the steerer. If the hole is too large, the locking tang or flat will tend to rotate and damage the threads. Avoid the temptation to use an English or Italian lock-washer on a French bike. The flat can be filed to do the job of a tang. Don't file the lockwasher round. It must have a tang or flat, to do its job. You can simply use the old washer.

The cup and cone design of most headsets allows the bearing to function even with a slightly crooked steerer, steerer thread, or mis-milled frame or fork. Headsets with cones which are truly conical or which have u-shaped or v-shaped races require more critical alignment if the races are going to contact all the balls without having tight spots.

When mounting FT headsets or Stronglight V-4, or others of this type, it is important to mill the head tube and crown race seat to ensure the best performance from these designs.

If the frame is straight and the original headset binds, it is more likely due to imprecision in milling the frame than the original imprecision of the headset. Changing headsets without milling the head tubes and fork crown is not recommended.

On some frames, usually less expensive French and some Japanese, the ends of the head tube are milled slightly concave. This is to give better support to the pressed races of an inexpensive headset. If you plan to change to a more expensive headset, the head tube should be milled flat to match the new headset. Good headsets are usually thicker than cheap ones, so milling the head tube will also prevent the steering column from being too short. Do not mill the head tube too much, you may weaken it. Especially head tubes with lugs.

THREADLESS SYSTEMS

1. The frame and fork of the threadless system must he prepped before installation. lie head tube and fork crown race should be milled just as you would for a threaded headset.

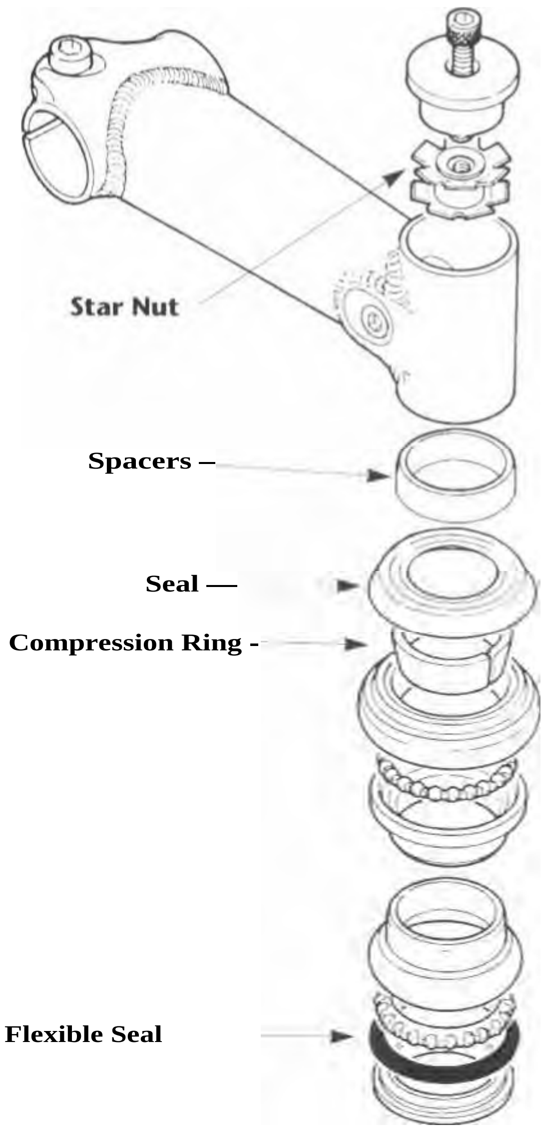
2. The old steerer tube is most likely too short for the system. Manufacturers supply a standard 12" tube especially for the front suspension threadless systems. These tubes are not threaded.

3. The length of the steerer tube protruding from t he the top of the head tube should be the stack height plus the stem height plus optional spacers minus 3mm. Also, cable hanger, retention washers, and spacer rings for stein height adjustment may be included.

4. Press the star nut inside the steerer tube 15mm below the top of the tube. This can be done using a Park threadless nut setter, or you can partially screw in the adjusting bolt and tap the top of the screw gently to place the star nut.

5. To set the proper preload of the bearing torque the top alien adjusting bolt to approximately 22 in. lbs. or tighten until all play is removed from the headset but it still rotates freely.

6. Tighten the stem pinch bolts approximately 130 in. lbs. It is very important that the stem is secure!



Steerer Tube Length Formula

Example:

Head tube length	+	**127mm**
Headset stack height	+	**28.2mm**
Stem height	+	**45mm**
Optional spacer height		**2mm**
Pre-load compression gap		(3.0)
Total steerer tube length		**199.2mm**

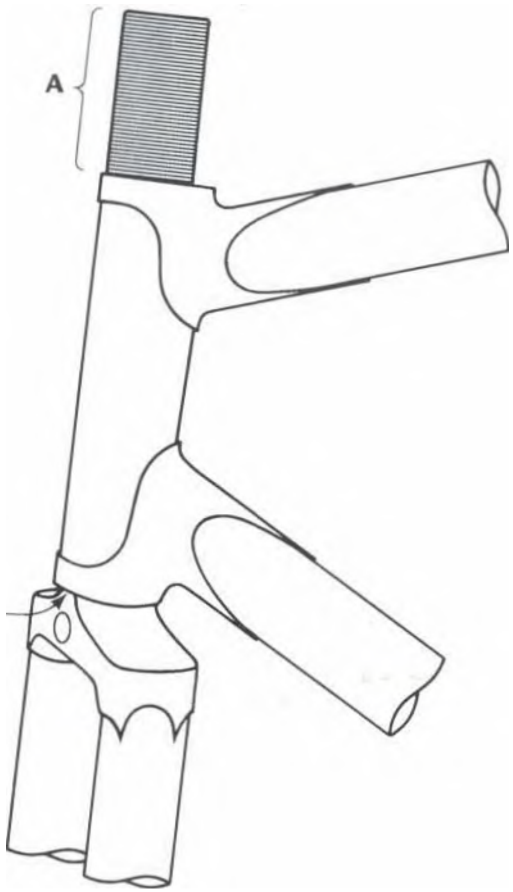


Figure 1:
With the fork crown race seat against the bottom of the head tube, the length of steerer tube protruding from the top should be about 2mm less than A.

Upper stack minus locknut lip thickness

HEADSET CHART KEY

A Upper and lower stack height minus locknut lip thickness

B Upper stack height minus locknut lip thickness

C Lower stack height

D Locknut height minus lip thickness

E Locknut stem hole — generally 0.2mm or more larger than the stem diameter. ***(See page 14-2 for stem diameters.)***

F Locknut flat dimension — F indicates wrench flats, Ø indicates diameter with pin-tool holes in edge

G Washer thickness (over teeth, if any)

H Washer locking method. French use flats. Others use tang.

Screwed race dimension — F indicates wrench flats, e indicates diameter with pin-tool holes or notches

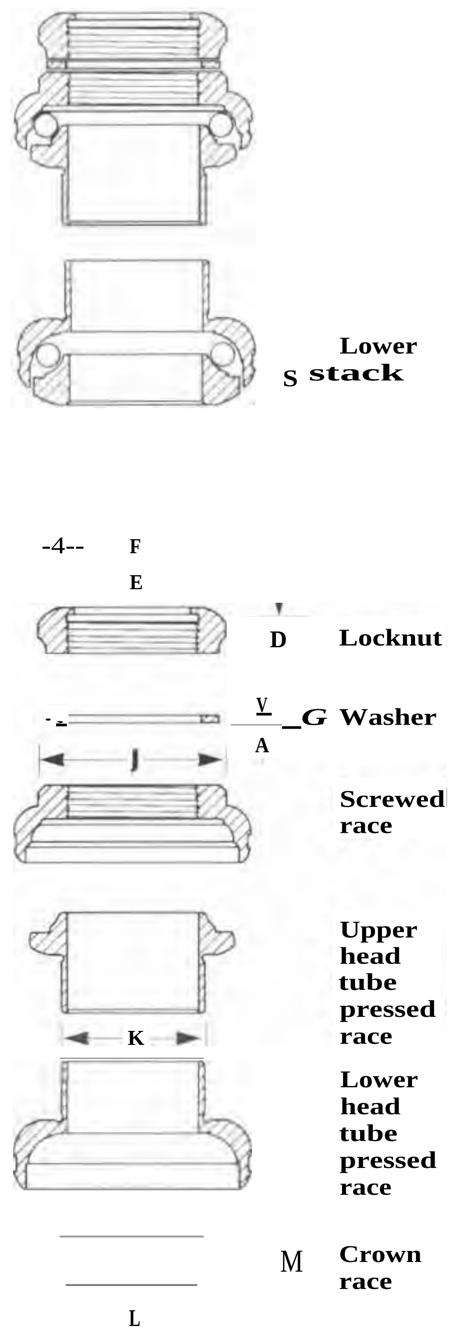
K Upper and lower head tube pressed race diameter

L Crown race seat diameter. ***(See page 14-2.)***

M Crown race seat depth

N Upper race — number and size of loose balls

O lower race - number and size of loose balls



Make & Model	Model No.	A	B	C	D			H*		M		0*
AMERICAN CLASSIC	1"	35.8	23.9	11.9	1 9.49			allen		5.1	cartridge	cartridge
	1 W	35.8	25.4	12.9	21.79			allen		5.1	cartridge	cartridge
AVOCET												
• Sealed		42.0	27.2	14.8	5.2	32 F	4.1'	2	32 F	11.9	sealed	sealed
BIANCHI (old)												
("U-race")		46.7	29.7	1 7	9	32ip	2.0	key	320	9.9	31 - 1 W	311A3"
CAMPAGNOLO												
• Record (1990) - w/seal		41.4	26.2	15.2	7.3	32 F	.44	key	32 F	7.5	22-3/16"	22-3/16"
• (C-)Record - 1982-89	Road	41.4	26.2	15.2	7.3	32 F	.44	key	32 F	7.5	25-Y321'	25-'/32"
• (C-)Record - 1982-89	Track	38.5	26.3	12.2	7.3	32 F	. 34	key	32 F	5.6	25-5/32"	25-5/32"
• Super Record-Road	4041	42.2	27.2	1 5.0	7.0	32 F	4.0	key	32 F	7.9	22-3/16"	22-3/16"
Super Record-Track	4141	33.7	22.3	11.4	7.0	32 F	2.1	key	32 F	6.0	25-5/32"	25-5/32"
• Nuovo Record (pre-'85) Victory, Triomphe - Road	1 039	39.1	24.6	1 4.5	5.7	32 F	2.1	key	32 F	9.9	22-3/161'	*22-3/46"*
• Nuovo Record Track (pre-1985),Gran Sport	1 040/A 1 040	33.7	22.3	11.4	5.7	32 F	2.1	key	32 F	7.0	25-5/32"	25-5/32"
• Chorus, Croce, D'Aune		41.2	25.6	15.6	7.1	32 F	.3⁴key		32 F	7.8	22-3/16"	22-1/16"
• Athena		41.0	25.8	1 5.2	7.2	32 F	.4⁴key		32 F	7.5	R19-3/16"	R19-3/16"
• Xenon		39.5	24.5	1 5.0		32 F		key	32 F		22-3/16"	22-3/16"
• Euclid, Centaur		40.6	25.6	15.0	7.2	32 F	*2.2*	key	32 F	10.0	*22-3/16"*	*22-3/16"*
• Centaur (steel)		40.7	26.0	14.7								
• Olympus (alloy)		40.5	25.5	15.0		32 F		key	32 F		22-3/46"	22-3/16"
• Olympus (steel)		39.0	24.3	1 4.7		32 F		key	32 F		22-3/46"	*22-3/16"*
OVERSIZED MODELS												
• Record OR 1 /18"	HS-010R	36.2	23.3	1 3.0	7.4	36 F	1.5	tang	36 F	6.5	R22-⁵⁄12"	R22-5/321'
• Euclid 1'/4"		36.	23.3	1 3.0	8.5	40 F	2.0	tang	40 F	6.5	R22-Y32"	R22-5/321'
CANNONDALE												
• Delta V		20.3	1 0.1	1 0.1							cart.B543	cart.B543
• Super V		20.3	1 0.1	1 0.1							cart.B543	cart.B543
CYCLE PRO												
• Deluxe Sealed	63-02-501	36.7	24.7	12.0	6.7	32 F	2.0	key	32 F	8.1	25-5/32"	25-5/32"
• MX alloy (Hatta)	63-02-230	41.3	28.3	13.0	9.1	30 F	2.6	key	30 F	5.9	22-³⁄16"	22-3/16"

(See page 14-19 for notes on this chart.)

Make Ea Model	Model No.	A	B	C	D	F	G	H*			N**	O**
DIACOMPE												
• AHead ' 516 1 "	HSO401	29.8	17.5	12.3	8.2			star		3.6	cartridge	cartridge
• AHead 1 V8"	HS0500	28.2	15.5	12.7	7.4			star		4.3	cartridge	cartridge
• AHead 11/4"	H S0600	29.9	17.5	12.4	8.4			star		3.4	cartridge	cartridge
• Konak 1"	HS0100	25.4	13.4	12.0	7.6			alien		5.8	R20-1/22"	R20-1/22"
• Threadhead 1"	HSO403	38.9	26.4	12.5	15.2	32.0		alien		3.3	cartridge	cartridge
• Threadhead 1'/8"	HS0502	38.7	26.3	12.4	17.4	36.0		alien		4.3	cartridge	cartridge
• Threadhead 11/4"	HS0603	38.4	26.1	12.3	17.3	36.0		alien		3.3	cartridge	cartridge
DIRT RESEARCH												
		36.2	24.5	11.7	8.4	31.8	1.4	key	31.7	5.5	R20-1/22"	R20-1/22"
	1 W	38.4	26.7	11 7	9.23	36.1	.75	key	35.8	5.4	R20-5132"	R20-1/22"
	1 1/4"	43.6	31.0	12.6	8.5	39.9	1.9	key	39.8	7.0	R20-1/22"	R20-1/22"
FISHER												
OVERSIZED MODELS												
• Evolution	11/4"	46.1	32.3	13.8	8.1	40 F	2.0	key	40 F	8.4	31-5/32"-	31-Y32"
w/o cable hanger		40.7	26.9									
FSA												
• Uniforce	1"	37.0	23.0	14.0				a lien	32 F	8.0	20-1/22"	20-roller
	1 W	37.0	23.0	14.0				alien	36 F	8.0	20-1/22"	20-roller
• Radii	1"	40.0	26.0	14.0	7.0	32 F	2.0	alien	32 F	8.0	20-roller	20-roller
	11/811	40.0	26.0	14.0	7.0	36 F	2.0	alien	36 F	8.0	20-roller	20-roller
• Duron	1"	37.0	23.0	14.0	7.0	32 F	2.0	allen	32 F	8.0	20-roller	20-roller
	1"	37.0	23.0	14.0	7.0	32 F	2.0	a lien	32 F	8.0	20-roller	20-roller
• Duralite	1"	38.5	27.0	11.5	9.0	32 F	2.0	alien	32 F	7.0	20-Y32"	20-1/22"
	11/8"	39.0	27.0	12.0	9.0	36 F	2.0	alien	36 F	6.5	20-1/22"	20-Y32"
	1 1/4"	39.0	27.0	12.0	9.0	40 F	2.0	alien	40.0	7.0	20-1/22"	20-5/32"
GALLI												
• Criterium		41.7	27.3	14.4	7.8	32 F	2.5	flat	32 F	6.2	rollers	rollers
• Conical		44.5	29.7	14.8	7.7	32 F	2.5	key	32 F	11.1	rollers	rollers
• Sport		42.2	27.7	14.5	7.7	32 F	2.5	flat	32 F	6.2	rollers	rollers
GIPIEMME												
• Cronosprint/E		41.1	26.6	14.5	6.9	32 F	2.0	key	32F	7.4	25-Y32"	25-5/32"

(See page 14-19 for notes on this chart.)

Make ix Model	Model No.	A	B	C				H*				
GT												
• Epoch BMX Super 6		43.0	31.6	11.4	10.6	30 F	1.7	key	6, 7	6.5	22-3A6"	22-3/k,"
HATTA												
• MX-II		39.9	29.0	1 0.9	1 0.0	30 F	2.6	key	30 F	6.0	22-3/46"	22-3/46"
KING'												
• Pre-93 Standard 1"		43.5	28.8	14.7	8.2	32 F			32 F	5.2	sealed	sealed
• Pre-93 Short Stack		35.9	23.9	12.0	8.0	32 F			32 F	3.8	sealed	sealed
• Standard 1"	80100	41	26.5	14.5	9.5	32F		grip	32F	5.1	cartridge	cartridge
• Short Stack 1"	82100	33	20.8	1 2.2	9.5	32F		grip	32F	3.8	cartridge	cartridge
• BMX	81100	39.1	25.6	1 3.5	9.5	32F		grip	32F	5.1	cartridge	cartridge
• OS 11/4"	84100	36	23.1	1 2.9	9.5	36F		grip	32F	4.6	cartridge	cartridge
• OS 1W'	85100	40	25.8	14.2	9.5	40F		grip	40F	4.6	cartridge	cartridge
KONA												
• Race Light Impact	11/s"	34.8	22.4	12.4	1 7.9			alien		6.0	22-V32"	15-'/4"
• Control Center	1 1/4"	34.3	22.0	12.3	1 9.5			alien		6.3	22-Y32"	15-1/4"
MAVIC												
• 305		40.4	26.9	13.5	9	32 F		alleri°	9	6.0	31-1/8"	31-W
• 315		45.3	31.3	13.5	9	32 F		10	9	6.0	31-Vs"	31 -Vs"
• 311		42.4	28.8	1 3.6	8.7	11	2.0	flat	11	6.3	31 -Vs"	31-Vs"
• 312		42.5	28.8	13.7	8.6	11	2.0	flat	11	6.3	31-Vs"	31-Vs"
• 315	1"	46.3	32.9	1 3.4	30.7	32 F				6.0	R22-1/4"	R22-W
• 316 VVT - ATB	1 1/4"	46.1	32.8	13.3	30.5	36 F		alien		6.0	R25-1/4"	R25-1/2"
• 317 VVT - ATB	1 1/4"	46.1	32.6	13.5	30.3	36 F		alien		6.0	R25-1/4"	R25-Vs"
(ALEX) MOULTON [12]	Pre-1980	37.2	26.4	1 0.8	9.8	31 F13	2.9			5.2	3 0 _ 1/21,14	37 ?/ II14
ODESSEY												
• Toro Pro	1"	35.4	22.0	13.4	5.5	32 F	4	key	32 F	8.3	20-roller	20-roller
	1 1/4"	34.1	21.1	13.0	5.5	36 F	4	key	36 F	8.2	22-roller	22-roller
OFMEGA												
• Ofmega		39.6	28.4	11.2	1 0.3	32 F	2.0	key	32 F	6.2	26-V32"	26-5/3Z
• Competizione		40.9	26.2	1 4.7	7.4	32 F	*2.2*	key	32 F	9.1	22-3/46"	223/4"
• Sport		38.8	27.0	11.8	8.9	32 F	1.3	key	32 F	6.6	26-s/v"	26-Y32"

(See page 14-19 for notes on this chart.)

Make SE Model	Model No.	A			D	F	G	11*	1			0**
OMAS												
• Art 120		40.1	26.6	13.5	7.0	32 F	1.6	key	32 F	8.1	31-'/s"	311/s"
ONZA												
• Mongo II		37.0	23.5	13.5	8.8	32 F	2.5	key		7.4	22-roller	22-roller
	1 W	38.7	22.5	16.2	13.5	38 F		ailed°		7.6	22-roller	22-roller
	11/4"	38.7	22.5	16.2	1 4.1	41 F		alien		7.6	22-roller	22-roller
PEUGEOT		38.5	26.5	1 2.0	1 0.8	32 F	2.5	key	45.79	7.0	26-5/3z"	26-5/32"
RACE FACE	11/s"	29.1	15.8	13.3	5.0			star		5.0	cart.6807	cart.6807
RALEIGH												
• Rat 101		37.0	23.7	13.3	8.2	30.2 F	2.7		41.3 F	6.1	25-5/12"	25-5/12"
• Pat 803		41.1	28.1	13.0	12.8	30.4 F	2.7		41.2 F	6.0	*25-Via"*	25-V12"
• Aletet		36.1	24.6	11.5	7.3	30.6 F	3.3		42.0 F	6.7	26-5/31	26-Y1,2"
RITCHEY												
• Logic		34.4	22.0	1 2.3	6.8	32 F	1.4"	key	32 F	6.8	31 -ys l, 26	22-3/16" 26
• Logic Comp		34.0	22.0	12.0	6.6	32 F	1.3"	key	32 F	6.8	31 -/ 26	*22-3A6"26*
• Logic Expert	1 1/4"	35.2	24.0	11.2	7.0	40 F	1.7	key	40 F	7.5	R28-1/8"	R22-1/16"
SCHWINN												
■ Deluxe'?		36.7	26.4	10.3	1 0.9	30 F	2.0	key	41.2(5	5.6	*25-5/31*	25-5/32"
• Standard's (Made in U.S.A.)		36.9	26.9	1 0.0	1 0.9	30 F	2.0	key	45.39	5.8	22-3/16"	22-3/16,"
• Standard (Made in Japan)	56-710	39.4	27.9	11.5	11.0	30 F	2.0	key	7	6.0	22-3/i6"	*22-Via"*
SHUMAN° 19												
• Dura-Ace	HP-7600	31.0	19.5	11.5		32 F		key	32 F		25-5/32"	25-5/32"
Dura-Ace	HP-7410	37.6	24.1"	13.5	5.1	32 F	1.1"	key	32 F	6.4	cart.9803	cart.9803
Dura-Ace	HP-7400	36.720	23.1"	1 3.4	5.1	32 F	1 . 1 15	key	32 F	6.4	22-3/16'	22-3/16"
Dura Ace EX"	HP-7200	37.9	23.1	14.8	4.5	21	2.0	key	21		22-3/16"	22-3/16"
Dura Ace	HP-71 00	39.7	24.7	15.0	5.4	32 F	2.1	key	32 F	9.6	22-34"	2 2 -Vib"
• 600 Ultegra	HP-6500	37.6	24.1	13.5		32 F		key	32 F		cart.9803	cart.9803
600 Ultegra	HP-6400	33.8	*22.2*	11.6	6.6	32 F	0.9"	key	32 F	6.0	25-5/32"	25-5/32"
600 EX	HP-6207	39.9	25.1	1 4.8		21		key	21		22-3/16"	22-Via"
600."	HP-6200	39.9	25.1	14.8		21			21		22-3/16"	22-3/16"
• Sante	HP-5000	33.4	23.3	1 0.1	8.5	30 F22	2 . 823	key	32 F	5.9	25-5/3i'	25-s/12"

Make Ez Model	Model No.	A	B	C	D	F	G	H*				
SHIMANO (contd)"												
105 SC	HP-1055	33.3	21.6	11.7	8.0	32 F	0.6 [15]	tang	32 F	6.7	25-5/32"	25-5/32"
105"	HP-1050	32.7	21.2	11.5		32 F		tang	32 F		25-5/32"	25-5/32"
XTR	HP-M900	34.3	22.8	11.5		32 F		tang	32 F		R20-3/16"	R20-3/16'
Deore XT	HP-M 740	37.6	24.1	13.5		32		tang	32 F		cart.9803	cart.9803
Deore XT	HP-M735	34.0	22.4	11.6	7.0	32 F	2.0	tang	32 F	5.4	17-1/4"	17-1/4"
Deore XT	HP-M730	32.1	20.6	11.5	6.5	32 F	0.1 [15]	tang	32 F	6.7	25-5/32"	25-5/32"
Deore DX	HP-M650	33.8	22.2	11.6	6.6	32 F	1.9	tang	32 F	5.4	17-1/4"	17-1/4"
Deore LX-HD-C	HP-M563	37.6	24.1	**13.5**		32 F		tang	32 F		cart.9803	cart.9803
Deore	HP-MT60	32.5	20.8	11.7	5.9	32 F	2.0	tang	32 F	6.7	25-5/32"	25-5/32"
STX-SE 1"	HP-MC30	37.6	24.1	13.5		32 F		tang	32 F		cart.9803	cart.9803
Alivio 1"		34.4	22.7	11.5	5.9	32F	1.9	tang	32F	6.7	R20-5/32"	R20-5/32"
Exage	HP-R500	32.7	22.0	11.5		32 F		tang	32 F		25-5/32"	25-5/32"
Exage	HP-A450	33.5	22.0	11.5		32 F		tang	32 F		25-5/32"	25-5/32"
Exage	HP-M450	33.5	22.0	11.5		32 F		tang	32 F		25-5/32"	25-5/32"
Exage	HP-M350	33.5	22.0	11.5		32 F		tang	32 F		25-5/32"	25-5/32"
Le Tour (OEM-Schwinn)		42.5	31.5	11.0	10.9	30 F	1.9	tang	45 0	6.7	25-5/32"	25-5/12"
OVERSIZED MODELS												
XTR 1 1/2"	HP-M901	343	22.8	11.5		36 F		tang	36 F		R22-3/16"	R22-3/16"
XTR 1 1/4"	HP-M902	40.3	27.3	13.0		40 F		tang	40 F		R24-3/16"	R24-3/16"
Deore XT 11/8"	HP-M741	37.6	24.1	13.5		36 F		tang	36 F		cart.9802	cart.9802
Deore XT 1 1/4"	HP-M 742	39.9	26.4	13.5		40 F		tang	40 F		cart.9802	cart.9802
Deore XT 11/4"	HP-M 737	40.3	27.3	13.0		40 F		tang	40 F		22-7/32"	22-7/32"
Deore XT 11/8"	HP-M736	33.5	22.0	11.5	6.7	36 F	2.0	tang	36 F	5.4	R18-1/4"	R18-1/4"
Deore DX 1 1/2"	HP-M651	33.5	22.0	11.5	7.2	36 F	2.0	tang	**36 F**	5.4	19-1/4"	19-1/4"
Deore LX-HD-C 1 1/2"	HP-M564	37.6	24.1	13.5		36 F		tang	**36 F**		cart.9803	cart.9803
STX-SE 1 1/4"	HP-MC31	37.6	24.1	13.5		36 F		tang	36 F		cart.9803	cart.9803
Alivio 11/2"		33.5	22.5	11.5	6.2	36F	1.9	tang	36F	6.7	R22-5/32'	R22-5/32'
SPECIALIZED												
Pro-Compact, alloy		35.3	23.4	11.9	6.0	32 F	1.1 [15]	tang	32 F	**6.4**	25-5/32"	25-5/32"

Make Ea Model	Model No.	A	B	C	D	F	G	H*	J	M	N**	O**
SPECIALIZED (cont'd)												
• Channel-Seal, alloy		45.1	29.6	15.5	7.2	32 F	2.0[4]	tang	32 F	10.2	25-Y32"	25-Y32"
• Pro Alloy	1 1/8"	35.9	24.5	11.4	7.6	36 F	0.7[4]	tang	36 F	5.4	R22-5/321'	R22-5/32"
• AV II	192-0410	36.9	24.4	12.5	6.0	32 F	.9	tang	32 F	6.2	R 2 0 -5/32"	R20-5/32"
• Channel-Seal, steel		35.0	23.3	11.7	6.3	32 F	1.0[15]	key	32 F	6.3	25-5/32"	25-5/32"
• Standard, steel		38.2	25.8	12.4	7.4	32 F	2.0	key	32 F	7.9	25-Y3.2"	25-Y32"
STEYR PUCH	81716	35.4	24.8	10.6	11.9	30 F	3.0	key	46.54)	6.7	25-Y32"	25-5/32"
STRONGLIGHT												
• Delta		40.7	25.7	15.0	7.5	32 F	0.64		32 F	7.6	tapered	tapered
• Mountain Delta		45.0	30.4	14.6	12.6	36 F			36 F	7.3	tapered	tapered
• A9		39.8	27.2	13.9	8.2	32 F	2.6	key	32 F	6.4	roller'	rollers
• V4		39.3	25.3	14	7.5	32 F	4.923	flat24	45d)	2max	25-Y32"	25-Y32"
• B10		39.5	25.6	13.9	7.5	31 F	5.3	flat	450	4.6max	25-Y32"	25-Y32"
• P3		34.0	22.9	11.1	6.4	28 F	4.523	flat24	450	5.2max	25-Y32"	25-Y32"
• 55		40.6	26.8	13.8	7.1	32 F	2.7		32 F	7.5	25-Y32"	25-Y32"
SUNTOUR												
• Superbe Pro	HS-SBOO	37 ('	23.5	13.5	6.8	F	2.1	key	32 F	7.8	25-5/32"	25-5/32"
TANGE-SEIKI												
• BMX		39.5	27.9	11.6	11.0	30 F	2.0	key	45 F	6.0	15-Yio"	15-1/46"
• G-Master	TR-2000	43.9	28.6	15.3	7.2	32 F	2.0	key	32 F	8.8	roller	roller
• Super Roller		34.3	21.1	13.2	6.5	32 F	0.74	tang	32 F	9.5	R20-5/32"	roller
• Levin CD		35.8	23.6	12.2	6.5	32 F	1.2"	key	32 F	6.9	25-5/32"	25-5/32"
• Levin		37.8	25.7	12.1	6.7	32 F	2.1	key	32 F	7.6	25-5/32"	25-5/3Z
• Levin	MTB-225	39.6	25.5	14.1	7.1	32 F	2.0	key	32 F	10.6	R20-5/32"	R20-5/32"
• Levin Dominas	OV286CA	38.3	24.2	14.1	7.4	36 F	1.1"	key	36 F	6.0	R22-5/32"	R22-5/32"
	AP-1 OS	34.4	23.6	10.8	7.1	36 F	2.0	key	36 F	6.0	R22-5/3.2"	R22-5/32"
	FOVST OS	45.7	34.7	11.0	8.0	40 F	1.115	key	40 F	8.0	R22-Y32"	R22-Y32"
• Falcon	FL-250S	40.1	25.9	14.2	7.3	32 F	2.0	key	32 F	10.1	25-5/32"	25-5/32"
• —	MA-60	36.0	25.0	11.0	9.5	32 F	4.0[23]	key[24]	7	7.1	25-Y32"	25-5/32"
• —	AW 27	38.9	27.7	11.2	11.1	30 F	2.0	key	30 F	6.0	22-5/32"	22 5/32'
	MX2	39.1	28.3	10.8	10.1	30 F	2.8	key	30 F	6.0	22-5/32"	22-5/32"

(See page 14-19 for notes on this chart.)

Make Ei Model	Model No.	A	B	C	D	F	G	H*	1	M	N**	0**
TIOGA												
• Road Expert		31,5	20.0	11.5							R20-5/32"	R20-5/32"
• Expert CR, Master DL		33.5	22.0	11.5							R22-5/32"	R22-5/32"
• MTB Expert, 1		37.1	25.3	11.8	7.2	32 F	2.1	key	32 F	8.0	R25-5/32"	R25-Y32"
•	MTB-KT-AL	40.8	26.4	14.4	7.3	32 F	2.1	key	32 F	8.2	R22-3/16'	R22-3/46"
• Beartrap 2		39.5	28.4	11.1	10.6	32 F	4.2"	key [24]	32 F	6.8	R22-3/16"	R22-3/16"
•	MX-2	39.3	28.1	11.2	10.2	30 F	2.6	key	30 F	6.3	R22-3/16"	R22-3/16"
•	MX101	43.1	31.9	11.2	13.3	32 F	2.0	key	32 F	6.0	R22-3/16"	R22-3/16"
•	MX-600	39.3	28.1	11.2	10.1	30 F	1.7	key	30 F	6.1	R22-3/46"	R22-3/16"
OVERSIZED MODELS												
• Avenger	OS-H1	35.1	24.2	10.9	6.9	36 F	1.2"	key	36 F	6.5	R29-Y32"	R29-5/32"
Avenger	05-H3	32.7	21.7	11.0	6.5	36 F	1.115	key	36 F	6.2	R29-5/32"	R29-5/32"
Avenger	05-H4	37.8	25.0	12.8	6.5	36 F	1.4'5	key	36 F	7.2	R29-5/32"	R29-5/3.2"
Avenger	05-H6	34.0	*22.2*	11.8	6.5	36 F	0.7"	key	36 F	5.8	R29-5/321'	R29-Y32"
• Alchemy	ALS	25	18.7	10.9				star		6.0	R22-5/Q"	R22-5/32"
Alchemy	AL2	25	15.6	11.9				star		7.0	R22-5/32"	R22-Y32"
Alchemy	ST2	2$	15.7	11.8				star		7.1	R22-5/32"	R22-5/32"
WHW		37.5	26	**11.5**	8.5	**31 F**	**4.123**	key [24]	7	5.0	26-3/16"	26-3/16"
WILDERNESS TRAIL BIKES												
• 1" Grease Guard [a]		42.8	28.0	14.8	8.0	32 F			**32 F**	5.5	cartridge	cartridge
YST												
	HP-831 1	35.8	23.8	12.0	7.0	32 F	1.0[4]	key	32 F	5.7	R20-5/32"	R20-5/32"
	HP-8002	36.9	27.0	9.9	8.6	32 F	2.0	key	32 F	6.0	R16-5/32"	R16-5/32"
• 11/4 OS	CS-707S	41.0	27.6	13.4	8.5	40 F	1.9	key	40 F	7.0	R22-Y32"	R22-5/32"
• 11/4 OS	Uitralight	35.0	23.3	11.7	6.6	40 F	.6"	key	40 F	5.7	R22-Y32"	R22-5/32'
• 11/4 OS	CS-707A	41.1	27.6	13.5	8.6	40 F	2.0	key	40 F	7.0	R22-Y32"	R22-5/32"
• 11/8 OS	CS-71 7	35.1	23.3	11.8	6.4	36 F	.8's	key	36 F	5.5	R22-5/32"	R22-5/32"
• MX Action		35.8	24.8	11.0	8.3	30 F	1.5[4]	key	46 F	7.0	15-5/32"	15-5/32"
■ Antech	8703	39.3	25.9	13.4	6.0	32 F	2.1	key	32 F	9.2	25-Y32"	25-5/32"
• BMX		39.8	28.6	11.2	8.6	30 F	2.1	key	7	6.0	22-3/ie	22-3/3f,"
ZEUS		40.7	25.8	**14.9**	6.4	32 F	**2.0**	**flat**	**32 F**	**9.1**	22-3/36"	22-3/16"

Threadless

Make & Model	Model No.	A	B	C	D	H	M	N**	O**
DIACOMPE									
• AHeaci' 5.16 1"	HSO401	29.8	17.5	12.3	8.2	star	3.6	cartridge	cartridge
• AHead P/8"	HS0500	28.2	15.5	12.7	7.4	star	4.3	cartridge	cartridge
• AHead 11/4"	HS0600	29.9	17.5	**12.4**	8.4	star	3.4	cartridge	cartridge
KING									
• 1 1/2"5			16.9	12.9	8.0	star	4.6	cartridge	cartridge
• NoThreadSet 1 "	80300	34	19.5	14.5		star	5.1	cartridge	cartridge
• NoThreadSet 11/8"15	84300	28	15.1	12.9		star	4.6	cartridge	cartridge
• NoThreadSet 1 1/4"	85300	31.1	16.9	14.2		star	4.6	cartridge	cartridge
RACE FACE	11/8"	29.1	15.8	13.3	5.0	star		cart. 6807	cart. 6807
TANG E-SEIKI									
• *228* - steel	1"	40.5	28.8	11.8		allen	7.3	R22-5/32"	roller pin
228 - alloy	1"	41.7	28.3	13.4		alien	8.3	R22-5/32"	roller pin
• 541 - steel	1 1/2"	42.8	29.9	13.8		alien	8.3	R28-1/2"	roller pin
541 - alloy	1 W	43.2	29.9	13.3		alien	7.7	R28-'/s"	roller pin
TIOGA									
• Alchemy	ALS	_25	18.7	10.9		star*	6.0	22-5/32"	22-5/32"
Alchemy	AL2	_ZS	15.6	11.9		star*	7.0	22-Y32"	22-5/32"
Alchemy	ST2	_25	15.7	11.8		star*	7.1	22-5/32"	22-5/32"

* Suggested torque stem cap alien 4 - 1()in. lbs., max 15in. lbs.

(See page 14-8 and 14-19 for more notes on this chart.)

"0" Rings

Brand	Headset Model No	Approx. I.D.	Approx.O.D	Approx. Cross-Section
MAVIC	312	21	26	2.5
TANGE	TR 2000	21	25	2
RITCHEY	Logic Comp	21	25	2
STRONGLIGHT	Delta (locknut)	22	25	1.5
SHIMANO	HP-7400	22	26	2
TIOGA	OS-H6	24	29	2
STRONGLIGHT	Mountain	35	39	1.5
	Delta (crown race)	35	39	1.5
CAMPAGNOLO	Euclid	38	41	2

Locknuts

Make Ei Model	Model No.		F	
DELTA				
■ HeadLock	1"	8.9	32 F	allen
• HeadLock	1 1/2"	8.9	36 F	alien
• HeadLock	1 1/4"	8.9	40 F	alien
GORILLA				
• Headlock	1"	8.0		allen
	1 -ye	8.0		allen
	1 N"	8.0		allen
SUGINO				
• High Column	1"	30.0		
	1 W	30.0		
TANGE				
• CDS Levin	1"	6.0		

Make Ex Model	Model No.	D	F	
WHEELS MFG.				
• Growler	1"	6.0		star
	1 1/8"	6.0		star
	1 1/4"	6.0		star
Y ST				
alloy	1"	8.0		
alloy	11/8"			
alloy	1 1/4"	12.0		
steel	r			
steel	11/8'	9.0		
steel	1 1/4"	12.0		

(See page 14-19 for notes on this chart.)

Notes:

There are more exceptions than rules here; French threaded headsets traditionally had washers that locked via flats, but even this varies.

** On some models it may be possible to add "one last ball," but it is usually better to resist the temptation; too many halls can damage the bearing.

1. "Middle nut" replaces washer.
2. Nesting conical tapers between bearing race and middle nut.
3. Internal wall continues up throughout bearing.
4. Washer fits almost flush in locknut.
5. Conical steel washers must be installed between hearings and races.
6. Has coil spring and ratchet anti-loosening mechanism.
7. Simply knurled.
8. **To avoid damage to the bearings** use the appropriate adapter hushing set for the following cup presses (each also includes bushing for crown race installation):

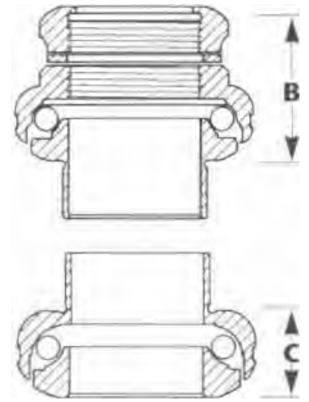
Campagnolo	**King 300/C**
Bicycle Research	**King 300/B**
Var	**King 300/VP**
Park	**None needed**

9. Screwed race, washer and locknut are replaced by one single unit.
10. Upper Unit ***(see footnote #11)*** has split collar w/2.Smm alien bolt.
11. Requires Mavic wrenches 671 and 672 (both are needed).
12. ***(See "Headset Standards," page 14-2.)***
13. Closer to 1-13/64", but the Park 31mm fits nicely.

MTB Headset Standards	**Stem O.D.**	**K - Head Tube Pressed Race O.D.**	**L - Crown Race I.D.**	**T.P.I.**
1" (25 4mm)	22.2mm	30.2 or 30.0mm	26.4 or 27.0mm	24
1 1/4" (28.6mm)	25.4mm	34.0mm	30.0mm	26
1 1/4 (31.8mm)	28.6mm	37.0mm	33.0mm	26

14. Note - upper and lower head tube races are different diameters (head tube is tapered).
15. Star nut presses into steerer tube 15mm below top of tube.
16. Stem height can only be adjusted with spacers.
17. Head tube pressed races **not** identical.
18. Head tube pressed races identical.
19. Some pre-1985 Shimano headsets have a 26.36 crown race - smaller than any other. To salvage a fork that these were fitted to, try using a Stein knurling tool to expand the crown race seat.
20. Supplied with extra washer (measured with only a single washer).
21. To avoid damage to aluminum surface, use two Shimano wrenches TL-HP10. (A 32mm wrench will work in a pinch.)
22. Remove plastic cap to expose the locknut's wrench-flats.
23. Serrated.
24. Washer locks to **both** fork **and** screwed race. When adjusting headset, washer must be lifted 3mm so as to disengage screwed race.
25. Stack height usually ranges between 33-44nim for star locking headsets.
26. Note difference in ball size between upper and lower races.

A = B C

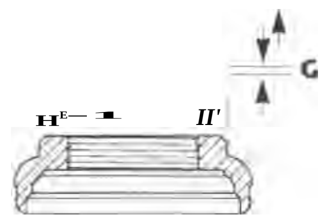


(See note on page 14-8 for E expld oration)

–F 1P-1

E

D



K

4- L

(See page 14-9 pr K and L explanation)

HEADSETS, STEMS, HANDLEBARS

HANDLEBARS—STEMS

Handlebar Diameters - Brake Clamp, Grip and Clip-on Diameters

22.0mm Italy, Germany, Switzerland, Northern Europe (also children's handlebars in France)
22.2mm England, U.S. steel, BMX
23.5mm France, Belgium, Spain, North Africa
23.8mm England, U.S. alloy
24.0mm Belleri, Mavic, Modolo, many Cinelli-style bars
24.2mm Cinelli

Road Bike Handlebar Center Diameters - Stem Clamp Hole Diameter

These figures can serve only as a rough guide. No hard and fast rules can be made.

Standard	Center Diameter	Notes
ISO	25.4mm (1")	
English	25.4mm, 23.8mm (1", 15/16")	Generally 23.8 is found on 3-speed and coaster brake bikes.
French	25.0mm, 23.5mm	Belleri - 26.0, Mavic - 26.0
Italian	25.0mm, 23.5mm	Exceptions: Cinelli - 26.4, TTT - 26.0, Modolo - 26.0, some Italmanubri - 25.6
Japanese	25.4mm	Exception: Dura-Ace stems - 26.0*, Cinelli Copies - 26.4, other quality bars - 26.0
U.S.	25.4min	Exception: Schwinn used 15/16" on Randonneur bars in 1971

* Dura-Ace stems can accept 25.4 bars by changing the internal push-plate. Likewise the 600 model stems can be changed to 26.0.

Other exceptions: Titan makes 27mm and 25in m centers. The 27mm center fits only Titan stems.

MOUNTAIN BIKE HANDLEBARS STEMS

Handlebars on mountain bikes are generally 22.2mm in diameter with a 25.4mm (1") center.

Stems come in three standard diameters (22.2mm), (25.4mm), (28.6mm). ***(See 14-2 for stem to steerer tube fit.)*** Tandem stoker stems generally have a 25.4mm center clamp and fit seat post sizes 26.8, 27.2, 28.6, 29.8mm.

Standard Mountain Bike Stem Diameters

Headset Size	Stem O.D.
	22.2mm (7/8")
	25.4mm (1")
1 3/4"	28.6mm (1'/8")

HEADSETS, STEMS, HANDLEBARS 7

Make & Model	Model No.	A	B	C	D	F	G	H	J	M	N 	O 

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CONTENTS

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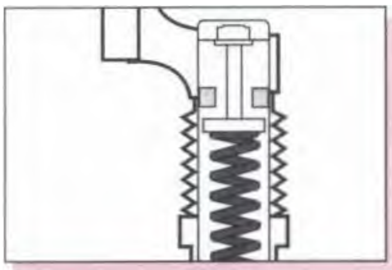
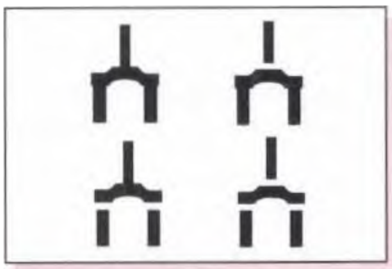
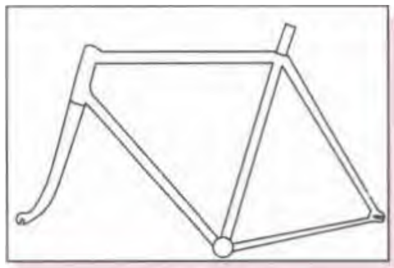
SUSPENSION FORKS and FRAMES







About Suspension Forks

Design Elements-Service Notes

Frames

SUTHERLAND'S

SUSPENSION FORKS

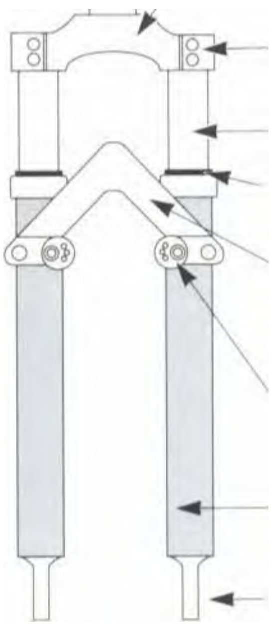
ABOUT SUSPENSION FORKS

Suspension forks need overhauling or maintenance specific to each manufacturer. Maintenance will he needed after heavy off-road use, damage from accidents, and after normal use for long periods. Most forks need to he taken off the bicycle for service. (Customizing the fork is not recommended; the warranty will he voided,) Typical service and repair would apply to these four main types of suspension: **1.** Coil Sprung, **2.** Elastomer, **3.** Air/Oil, and **4.** Linkage.

TYPES OF FRONT SUSPENSION FORKS

Slider-Telescoping Type Forks

(Includes Air/Oil, Elastomer, and Spring)

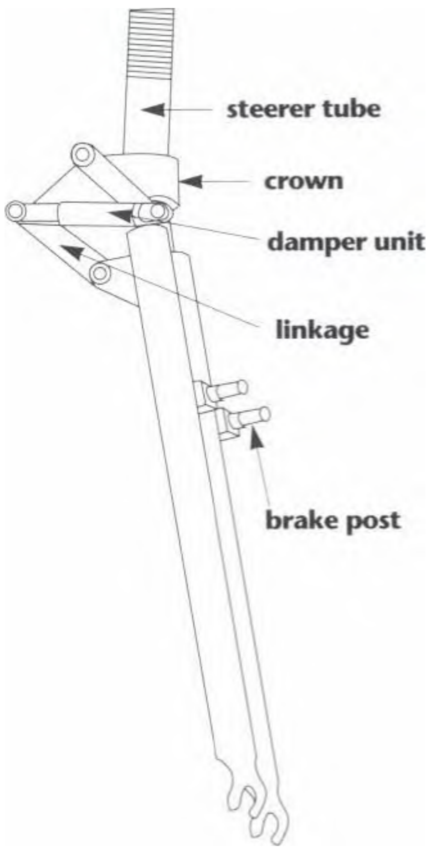


Common in motorcycle suspensions, the forks' sliders — the lower legs — are usually connected at the bottom to the front wheel axle, and at the top they slide over the stanchions of the upper legs. These in turn are connected to the fork crown and steerer.

This type of fork is best for situations where large travel of the suspension is needed; these will accommodate big humps. Slider forks provide straight-line motion, making the position of the wheel to the rest of the bicycle more predictable. Arid since the motion is strictly linear, the forks are more predictable across their full range of travel.

Linkage/Pivot Type Forks

Linkage forks have one or more pivots that the linkage rotates on. This kind of suspension is often seen on motor scooters. For long travel, the pivot points have to he far apart and strengthened for the increased leverage on the parts. This adds bulk and weight to the system. However, accurate application of leverage in the design can reduce the size of the suspension mechanism on a linkage fork. (**Note:** by comparison, telescoping forks cannot use leverage to reduce or increase the length of up-and-down motion.)



GLOSSARY

ANTI-POGO - a device to keep suspension from repeated bouncing.

BOTTOM-OUT - to compress the fork to the downward limit of motion.

BUMPER - a piece of elastomer or rubber used to prevent transmitting harsh forces.

BUSHING - a part that keeps the sliding parts precisely separated and facilitates the sliding motion.

COIL SPRING - usually a coiled piece of metal.

SPRING - "a mechanical element which exerts a force when deformed," (Shigly, *Mechanical high leering Design).*

COMPRESS - to make shorter by pressing together.

DAMPING - resistance to movement. (Damping does not exist when there is no motion.) ***(See page 15-S.)*** Technically, damping means a force resisting the **speed** of a movement. Spring means a Force that resists the **amount** of movement. Both are necessary for good suspension. Damping keeps the suspension from repeatedly bouncing (as a car will do when the shock absorber fails).

DUROMETER - an instrument for measuring hardness or a measure of hardness.

ELASTOMER - a piece of urethane, polyurethane, or similar material that changes shape to resist a mechanical force. It can act as both a spring and a damper at the same time.

ELASTOMER STACK - multiple elastomers stacked on top of each other. This allows for custom tuning of ilk springing and damping of the suspension.

FORK BRACE - sometimes referred to as a brake arch or brake bridge. The upper part that connects the two lower legs to keep them moving in unison.

LINKAGE - an assembly having a motion that links one or more pivots points on the fork.

LOWER LEG - the slider, the part of the leg (or fork blade) that is connected to the wheel and Moves with the wheel.

MICRO-CELLULAR URETHANE - a urethane foam with tiny closed air bubbles.

MONOSHOCK - single shock absorber central to fork.

MULTI-LINK SUSPENSION - a suspension fork with more than one pivot axis.

OFFSET - see rake.

OIL VISCOSITY - the ability of an oil to resist motion; higher viscosity oil resists motion more than low viscosity oil.

OIL WEIGHT - a measure of oil viscosity.

PRELOAD - initial force (or load) applied to a spring. Static initial load applied to a spring in its resting position.

RAKE - the measurement from the wheel axle to the (extended) steering axis.

REBOUND - the opposite of compression: extending or lengthening.

SUSPENSION FORKS

GLOSSARY (CONT'D)

SAG - the amount a suspension fork compresses at rest with a normal load.

SEALS - parts that keep contaminants out arid/or the working fluids in.

SLIDER (LOWER LEG) - the moving fork leg directly connected to the axle. This is specific to telescopic design.

SPRING CONSTANT - the number of pounds of force needed to compress or extend a spring one measured inch when the spring is not fully compressed or extended.

STANCHION - the stationary fork leg directly connected to the crown. This is specific to telescopic design.

STEERER TUBE - the primary part of a fork that joins the crown and stem. Usually, the headset is mounted to it.

STEERING AXIS - the line the fork rotates around.

STICTION - static friction. The friction force between two materials required to initiate sliding motion.

STRUTS - a combination of spring and damping units.

TENSION - a stretching force.

TOP-OUT - to extend to the upward limits of its motion. This is the same for bottom-out, except the extension is in the opposite direction.

TOP-OUT SPRING - a spring (usually a coil spring, but it can also be a bumper) to keep the fork from abruptly reaching its maximum extension.

TRAIL - the distance on the ground that the point directly underneath the wheel axle trails behind the point directly extending from the steering axis. This is different from rake in that it is measured along an angle.

TRAVEL - the length of the range of motion of the fork (the difference between its fully extended length and its fully compressed length),

UPPER LEG - This is the same as the stanchion,which is the part of the fork leg that is directly connected to the crown.

SUSPENSION FORKS

TYPES OF SUSPENSION

"A spring is a mechanical element which exerts a force when deformed."
(Shigly, Mechanical Engineering Design page 91.)

Every suspension fork has some sort of spring to allow the fork to compress and then return (rebound) to its original position. These materials absorb the road/off road shock in the system.

In addition, the fork often needs something to stop or slow it down near the limits of its travel. A spring (usually an elastomeil is used to prevent the fork from reaching its limits too suddenly; a bottom-out bumper or a top-out (rebound) spring is most commonly used.

Most forks also have some sort of damping to limit the speed at which the fork compresses or rebounds. Damping helps slow down the fork before it tops-out or bottoms-out. Damping also helps keep the fork from bouncing.

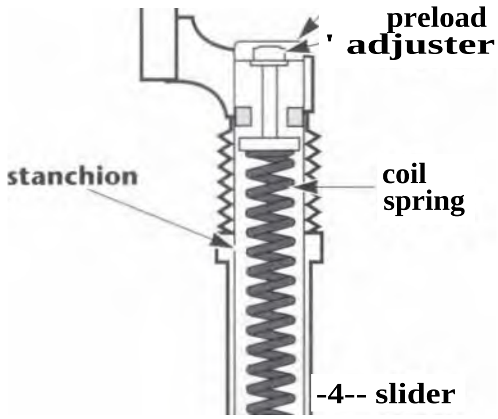
I. COIL SPRUNG SHOCK

Spring Action: Most often a coiled piece of metal, the spring acts as the rebound and compressing mechanism. The spring compresses or expands, providing increasing force the more it stretches or compresses from its resting position. The return force of a spring increases as the spring is compressed until the spring bottoms-out when the coils contact each other.

Damping: Damping is not effective in a coil sprung shock. It depends on the friction created, which is not reliable or controllable.

Typical Service to a coil sprung shock would be to replace the seals and spring. We've included descriptions of adjustments for each make in this chapter. Look for the specific fork under the appropriate manufacturer; adjustments are detailed in the design element section.

top cap



bottom-
out

top-out

SUSPENSION FORKS

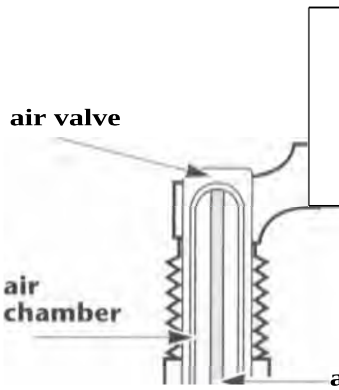
TYPES OF SUSPENSION (CONT'D)

II. AIR/OIL SPRUNG SHOCK

Spring Action: An air sprung fork works much like a balloon which bounces hack to its original position after it is compressed. The air is kept in a cylindrical chamber. The column of air compresses in proportion in the force applied.

The higher the air pressure, the stronger the return force. The force from increasing air pressure means it takes greater force to reach **lull** compression (bottom-out).

Damping: Generally on air/oil shocks the spring is air and the damping is oil. The oil is forced through a hole which has a valve that controls the amount of damping. The larger the hole, the less resistance there is to the motion. The damping force is proportional to the speed of the fluid and can change depending on the direction the fluid is moving. The two directions of damping are **compression** and **rebound.**



Compression damping is on the compression stroke (as the fork starts to hit a hump). Depending on the size of the bump and the speed of the hike, the effective size of the valve hole may vary. A harder hit should compress the fork faster.

Rebound damping is the damping when the fork tries to return to its original position. It is usually set at a rate so the return speed of the fork is constant and predictable.

Typical Service to an air/oil shock would include checking the seals, washers, air pressure, oil contamination, and oil levels. We've included descriptions of adjustments for each make in this chapter. Look for the specific fork under the appropriate manufacturer; adjustments are detailed in the design element section.

oil chamber

valve

_ippw

bottom out bumper

1

1 /

Oil Viscosity

To increase the rate of compression in an air/oil fork, use a lighter viscosity oil. For slowing the rate of compression, use a heavier viscosity oil.

LIGHT	**2.5 wt.]**
	3.0 *wt*
	5.0 wt.
	7.0 wt.
MEDIUM	**8.0 wt.**
	10.0 wt.
HEAVY	**Z0.0 wt.**

The amount of damping in an air/oil shock depends on the oil viscosity — how Fast it flows. Different oil viscosities in a particular suspension design can yield different damping results. ***(See Design Elements, page 15-11 Awn 15-51 for recommended oil** viscosities.)*

HIGHER PRE-LOAD on valve spring restricts oil flow.

LOWER PRE-LOAD on valve spring increases oil flow.

DISPOSE OF USED OIL PROPERLY!

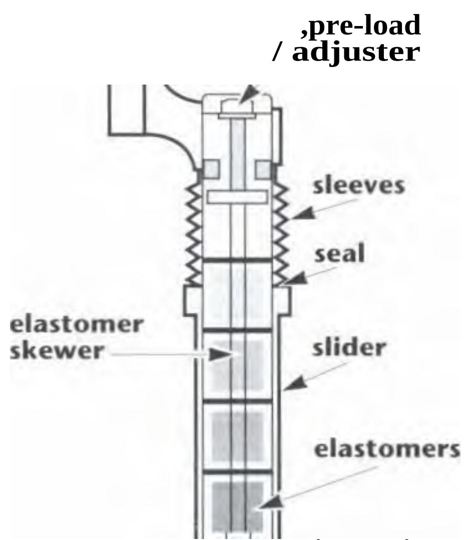
TYPES OF SUSPENSION (CONT'D)

III. ELASTOMER SPRUNG SHOCK

An elastomer spring is used in a similar way to the coil spring except that elastomers are somewhat temperature dependent. There are many types of elastomers; the most common are: polyurethane/elastopolymers and cellular urethane. These materials come in different durometer ratings and at present, manufacturers have different colors for varied ratings (generally referred to as hard, medium, and soft). Colder temperatures make elastomers stiffer, as if they were a higher durometer. Lower durometer readings work well in cold weather. Most manufacturers have charts for recommended elastomer durometer ranges. Because elastomers can be mixed, the compression characteristics can be customized to a certain degree.

Damping: Friction in the elastomer provides some resistance to the velocity of the fork. In addition, static friction, **stiction,** resists motion from a standstill and also causes wear. Heat generated from the internal friction can also cause the elastomer to expand. Elastomer damping is a less controllable type of damping than oil, but it is much more controllable than friction damping.

Typical Service to an elastomer shock would include checking the seals, washers, bushings, and replacement of elastomers. We've included descriptions of adjustments for each make in this chapter. Look for the specific fork under the appropriate manufacturer; adjustments are detailed in the design clement section.



top-out

bottom-
out

through-
shaft

-4-- drop-out

PARTS OF THE SUSPENSION FORK

Steerer Tube

Steerer tubes come in three diameters 1", 1W, and 11/4". Some suppliers label the forks by the inside diameter in millimeters while others label the forks by the outside diameter in inches. Sometimes it is difficult to determine whether the tube measurement is the inside or outside dimension. To he safe, use the outside diameter in inches.

Use threadless steerer tubes with threadless headset systems. These tubes come in a 10" to 12", or 260mm to 300mm lengths which can he cut to size using a steerer cutting guide. Threaded steerer tubes come in sizes determined by the manufacturer, ranging anywhere from 130mm - 260min.

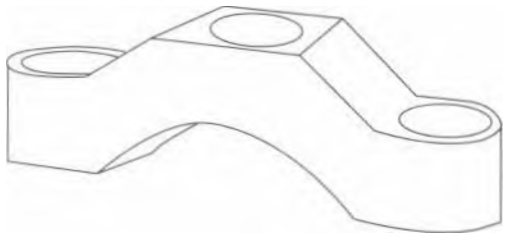
Generally, the steerer length equals head tube length plus stack height. ***(See Chapter 14 for stack height and fit.)***

The steerer tubes are clamped into the crown with pinch bolts, or are joined by either welding, a press fit, or bonding. Sometimes with clamping, the tubes may need spacers or shims to secure a tight fit, ***(See crowns on page 15-8).***

SUSPENSION FORKS

PARTS OF THE SUSPENSION FORK (CONT'D)

Crown



The crown is the piece that joins the steerer to the forks. It determines the rake or angle of the forks in relation to angle of the head tube. Most crowns are made for only one diameter of steerer tube, ie. I", We, or 11/4". There are exceptions where shims are used.

Currently there are four different types of crown/steerer assemblies:

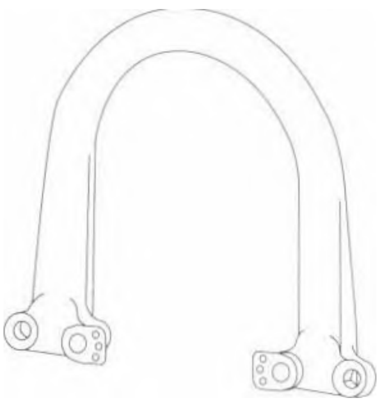
Complete 1-piece unit
t example: Rock Shox Quadra, Scott)

1-piece steerer and crown with separate legs
(example: Manitou 2 & 3, Rock Shox Mag 21)

Steerer separate; crown and legs integrated
(example: Antigravity Stage 3 & 4)

Steerer, crown, and stanchions separate
(example: RS1, Rock Shox RS-1)

Fork Brace (Brake Bridge)



Fork braces, or brake bridges, keep the Fork legs coupled so they slide and move in unison. If the lower legs of the fork were allowed to slide independently, then the wheel would have the tendency to cant from side to side causing the tire to hit the fork legs. This would drastically hinder handling and would be unsafe. Brake bridges also counteract the tremendous spreading force which is created when the brakes are applied. When installing a fork brace, always follow manufacturers recommended torque specs. Do not over torque, or cracking of aluminum/magnesium sliders (lower legs) is inevitable. The standard brake post stud measures 22mm x 26 TPI. #242 blue Locktite is recommended on all fork crown and fork brace bolts. Replace stripped mount ing hole threads with a helicoil kit.

TELESCOPING FORK PARTS

Stanchion (Upper Leg)

rile stanchions, the smooth inner part of the telescoping legs connected to the crown, may also be referred to as the upper legs. Often, the stanchions have most of the inner workings of the suspension within them, like the top-out bumpers, the elastomer stack, and air/oil or the coil spring. On some models of forks, these workings, especially the elastomers, are below the stanchion.

The stanchion needs to be kept clean so that there is a good seal between it and the rubber contact seal. Make sure there are no scratches or dents in the stanchion. Dents may interfere with the motion of the inner workings of the fork. In air/oil shocks, both scratches and dents allow the air pressure or oil to escape and destroy the seal.

PARTS OF THE SUSPENSION FORK (CONT'D)

TELESCOPING FORK PARTS (cont'd)

1)

Seals

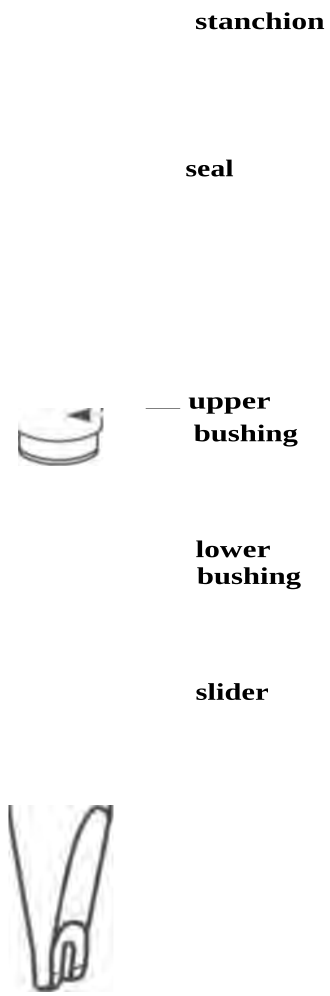
Seals keep contaminants out and keep the air or oil in. They also wipe the slider so vulnerable areas don't get dirty. It is important to keep contaminants Out of the fork so they do not wear at the bushings, stanchions, bearing surfaces, or seals.

Other parts that have functions similar to the seals:

BOOTS - these cover the exposed stanchion or upper leg and help keep dirt from contacting the stanchions.

WIPERS - located between the seal and the lower leg, they help keep the main seal and stanchion free of dirt, and well lubricated.

Make sure all these items are in good condition. Check for tears, wear, build-up, or grit. Foam wipers are easily removed and cleaned. Run your finger along the inside edge of the rubber wipers and seals. It they are gritty or have rough surfaces, clean or replace them.



Sliders (Lower Legs)

The sliders are usually the outer part of the legs. They are always directly connected to the wheel axle and are often called the lower legs. The slider dower leg) usually houses the bearings or bushings that the stanchion slides against.

Bushings

For almost any telescoping fork, some sort of bearing between the stanchion and the slider is needed. Most often this is a bushing (though the Cannondale uses roller bearings and Action Tech uses ball bearings). Obviously, the better the bearing fits, the less friction or play there will be.

Most often the bushing is pressed into the slider and moves against the stanchion. When the bearing is worn and gets thinner, there is play in the lower legs. When this happens, the wheels may cant, affecting the handling of the fork, and may actually cause the legs to stick.

If the bearing is oversized, there will be too much friction which may cause the bushing to scratch the stanchion. This would further increase friction and wear on both the stanchion and bushing.

SUSPENSION FORKS

DESIGN ELEMENTS – SERVICE NOTES

How to read the Design Elements charts:

Make *Ex* Model	Kind of Fork	Spring	Damping	I Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly

Make iT Model: manufacturer and model design.

Kind of Fork: slider-telescoping or linkage-pivot type.

Spring: either air, coil (usually steel), or elastomer. Elastomers may be made of urethane, micro-cellular urethane, or polyurethane.

Damping: either oil, friction, air, elastomer, or none. Friction is specified only if there is a specific frictional element incorporated into the design. Given an elastomer spring, there is an inherent amount of damping that can he engineered into the elastomer.

Length (axle to crown): this is the uncompressed length of the fork from the center of the axle to the crown race seat.

Rake: the distance from the axle to the steering axis of the uncompressed fork.

Travel: The difference between the uncompressed length of the fork and the compressed length of the fork.

Top-out/Bottom-out: This column lists the parts used for top-out and bottom-out protection. Depending on the type of fork, top-out or bottom-out protection may not be necessary. An elastomer fork may be engineered with a spring progressive enough to prevent the fork from reaching bottom-out. In this case, it is imperative to use elastomers engineered for that fork or the fork may compress too far and cause the tire to strike the crown. Oil damped forks may have sufficient rebound damping to prevent the fork from abruptly topping-out.

Crown Assembly:

Complete 1-piece unit — The steerer, crown, and stanchions are either press fit, bonded or welded together and are replaceable only as a complete unit. (example: Rock Shox Quadra, Scott)

II **1-piece steerer and crown with separate legs —** The steerer and crown are either press fit, bonded, or welded together so the crown and steerer tube combination has to he replaced as a unit. However, the legs should not need replacing. (example: Manitou 2 & 3, Rock Shox Mag 21)

ri **Steerer separate; crown and legs integrated —** Sometimes, only the steerer tube needs to be replaced for the fork to fit on another bike. Often a shim can be used to mate the steerer with the crown. At other times, the steerer is the wrong diameter and will not work with the original fork and the entire fork will need to be replaced. (example: Antigravity Stage 3 & 4)

ll **Steerer, crown, and stanchions separate —** Only the steerer tube may need to be replaced to fit another bike's fork, or the steerer tube with the appropriately sized crown may need replacing.(exampie: RS l', Rock Shox RS-11

DESIGN ELEMENTS - SERVICE NOTES (corirD)

ACTION TEC: Pro Shock Suspension System

The Pro Shock is a telescoping monoshock mounted in the steerer tube. It is available to fit only in 11/4" steerer tubes and for 106-107mm head tubes. Steerer tube length, for a threaded headset only, is effectively 145mm which includes 15mm of threads. Due to the configuration, a PA" threadless style stem and a 11/4" threaded headset must be used.

Eighty 1/8" ball hearings and special linear races provide motion for the fork. Only the boot protects the sliding surfaces, so make sure it is seated correctly and is undamaged. Otherwise, replace it immediately; this requires removing the fork from the bike.

Steerer/Crown Assemblies:

Steerer Tube Outside Diameter	Lengths	Steerer Tube Length
1 1/4"	106-107mm head tube	1145mm - headset stack height should be 57mm

Use only dual concentric coil springs. The outer spring may be changed. The inner spring may be filed down, but then it would need a spacer which is available only from the manufacturer. The oil damping is not easily adjustable and requires almost complete disassembly of the fork.

Coil Springs:

Stiffness	Color	Rider weight (lbs.)
soft	black	80-110
medium	natural	120-165
hard	red	166-210

Removing the top cap to replace the spring may be troublesome. The skewer that the top cap is attached to is not firmly attached to the fork blades or steerer tube, so the skewer may rotate. If you have this problem, make sure you have removed the set screw from the top cap. Then, carefully grasp the skewer with needle nose pliers as close to the top cap as possible and again loosen the top cap. Not much force will be needed to grasp the skewer but it is difficult to get between both springs. After removing the top cap, make sure there are no nicks on the skewer that may tear the elastomer around it.

When re-assembling the fork, make sure to tully extend the skewer. Then re-insert the springs and bumper and install the top cap. Extend the skewer by threading the top cap onto it; then pull the skewer completely out. **Make sure the set screw in the top cap is tight and flush with the top cap before riding.**

DESIGN ELEMENTS - SERVICE NOTES (CONT'D)

Tr

ACTION TEC: Pro Shock Suspension System (cont'd)

Torque Specifications:

Bolt	Torque (in. lbs.)
3/32" hex set screw at top of steerer	40
5mm hex bottom plug	70
knurled aluminum cap under boot	30
3/4" hex aluminum top cap	50
l" hex hydraulic cylinder	1 00

Make Ex Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
ACTION TEC Pro-Shock	Telescopic Monoshock	coil-spring	hydraulic	17570	1 5/8"	2W	0-ring/ elastomer	

ALUMAX: Sabre-202

The Sabre 202 is a telescoping leg fork with elastomer springs. The stanchions are clamped into the integrated crown-steerer tube. The dust caps on the top caps can he removed to expose the preload adjuster screws. The elastomer stacks are removed by unscrewing the top caps. Make sure the elastomer with the large hole in it is at the bottom of the stack to fit around the through-bolt at the bottom of the stanchion. The through-bolt al i he bottom of the stanchion is a 4mm alien bolt (unlike most other manufacturers who use a 5mm alien bolt).

Make sure that the black plastic retainer/seal at the top of the slider is seated properly; it is only the seal that holds the upper hushing in.

Steerer/Crown Assemblies:

Steerer Tube Outside Diameter	Lengths
1"	6.5, 7.5, 8.5"
1 W'	6.5, 7.5, 8.5"
114"	6.5, 7.5, 8.5"

DESIGN ELEMENTS - SERVICE NOTES (CONT'D)

ALUMAX: Sabre-202 (cont'd)

Elastomers:

Density	Elastomer Color
soft	black
medium	green
hard	red

Torque Specifications:

Bolt	Torque (in. lbs.)
brace bolts	60-80
brake studs	90-110
crown pinch bolts	90-110
thru bolts	60-80

Make 6r Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
ALUMAX Sabre 202	Telescopic	elastomer	elastomer	1 61/8"	1 1/2"	1 A"	bumper/ bumper	II

AMP RESEARCH: F-1 and Downhill

Both the standard and the downhill forks have linkage designs with the linkage at the crown.

The downhill fork is similar to the standard fork except it has dual through-shaft damping units with different valving instead of the standard's single damping unit. There is a retrofit kit available from the manufacturer to upgrade a standard fork to a downhill.

Spring preload is adjustable with a flathead screwdriver and 13mrn wrench. Spring preload should he set so that the damping unit is extended 5mm with the rider on the bike. 'fire clearance should be at least 1 lmm from the tire to the bottom of the fork crown.

Coil Springs:

Stiffness J	Rating (spring constant)
soft	900 lbs./in.
medium	1060 lbs./in. (standard)
hard	1150 lbs./in.

DESIGN ELEMENTS - SERVICE NOTES (CONT'D)

AMP RESEARCH: F-1 and Downhill (cont'd)

The damping units are serviceable. Use 7.5 wt. transmission fluid for oil. Take care when clamping the shock units; use AMP shock clamp tool #760. When overhauling the shock, make sure there is no air left in the system. If replacing the seals, soak them in oil before installing them. 1)o not use solvent to clean the shock and do not over-tighten the shock end cap (use light pressure - slightly more than finger tight).

Due to the design of the crown for the linkage, the crown may hit the down tube of certain bikes. if this happens, place spacers between the crown and the headset crown race to increase the crown-down tube clearance. AMP has both 1.5 and 3mm frame clearance spacers (any thicker and the headset crown race may not fit properly). This will also proportionally increase the axle- to-crown length – affecting the head tube angle slightly.

Replacement crown/steerer assemblies are available but require external snap ring pliers and AMP's pin press to change the legs.

Steerer/Crown Assemblies:

Steerer Tube Outside Diameter	Lengths (millimeters)
1"	130, 165, 200, 235, 260 unthreaded
1 W	130, 165, 200, 235, 260 unthreaded

Make 67 Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
AMP RESEARCH F-1	Linkage	coil-spring	hydraulic	16.75" no load/ 16.5" static load	1 1/2'	2"	none/ elastomer	steerer/ crown unit legs separate
Down Hill	Linkage	coil-spring	hydraulic	same as above	1 ½"	2"	none/ elastomer	same as above

ANSWER: Manitou 1, 2, 3, 4, Sport, Magnum, EFC

The Manitou 1, 2, 3 & 4. NI-Sport, Sport, Magnum, and FTC, are a telescoping leg, elastomer spring design. The stanchions on all Manitou forks (and Sport forks) arc the same diameter and can use the same crown. The brake arches of the Sport (`94), Manitou 2, and Manitou 3 are interchangeable; the brake arches of the original Man itou and the M-Sport are not interchangeable.

Manitou: The original Man itou is a telescoping leg fork with elastomer springs and top-out bumpers but no bottom-out bumpers. Its steerer tube, crown, and stanchions are completely separate, although these can he replaced with the newer one piece crown and steerer combinations.

DESIGN ELEMENTS - SERVICE NOTES (cowl))

ANSWER: Manitou (cont'd)

Some of the newer crowns are very lightweight and can be damaged it the stanchions spread them too much. **To prevent damage to the crown when installing the stanchions onto the crown, have the crown pinch bolts lightly threaded into the holes.** Minimum tire clearance is 1 3/4" (45mml. Level the top of the stanchions with the top 01 the crown – do not raise or lower the stanchions.

To reach the elastomers, remove the lower leg fixing bolts from the top of the stanchions and remove the sliders. Remove the dust seals and upper and lower bushings from the sliders. For reassembly, first load everything on the lower leg retaining bolts so you do not have to find the holes in the washers while they are in the slider. Insert the upper bushings and seals. The upper dust seal is very difficult to replace. The upper seals should he fully seated in their grooves before the stanchions are inserted. Run your finger around the seals to feel that they are properly seated. Then place the lower leg fixing bolts (with top-out bumpers) in the stanchions. **In the following order,** place on the fixing bolts: the lower bushing, the compression washer, the smaller elastomer, another compression washer, and the larger elastomer. To fit the lower hushing in the slider, squeeze it past the upper hushing. Did it pop hack into shape properly? Attach and torque the lower leg fixing bolts to specifications. Slowly thread the lower leg fixing bolts; it may take them a little while to fit into the threads at the bottom of the sliders properly. Do not fully tighten one leg and then insert the other bolt – get both holts started at the same time and then tighten them.

General Maintenance

Roth the upper dust seal bushings and the fork brace alien screws wear and will need to he replaced. Do not screw the compression stack bolt too tightly as the bolt may punch through the al urn i num drop-out assembly.

M-Sport ('93): The original Manitou elements apply here except the M-Sport has a one piece steerer tube/crown and it has 3 3/4" stack of three elastomers separated by compression washers. Minimum tire clearance is: 1 3/4" (45mm).

Manitou 2: Most original Manitou elements apply here, also. But like the elastomer stack on the M-Sport, the Manitou 2 stack is longer. Adjust the elastomer preload on the Manitou 2 by turning the plastic knobs at the bottom of the legs. When installing the sliders onto the crown, thread the crown pinch bolts lightly into the holes to prevent damage to the crown. Also, align the vent holes in the stanchions with the crown slots. Minimum tire clearance is : 1 3/4" (4Smm).

Sport (`94): This model has a one piece steerer tube and crown and a 3 3/4" stack of three elastomers which are separated by cup washers and accessed like the Manitou. The Sport is different as a retaining ring holds the upper hushing and dust seal in place. Pull up the dust seal cover to expose the retaining ring and use a screwdriver to pry the ring off so the sliders can be removed. Do not damage the upper seals or stanchions; you may need to use some force pulling the stanchions out of the sliders to remove the upper seals.

To re-assemble the fork, align the upper dust seal covers, the retaining rings, the upper dust seals, and the upper bushings over the stanchions. Insert the lower bushings on the stanchions, stack

DESIGN ELEMENTS - SERVICE NOTES (coNro)

ANSWER: Manitou (cont'd)

the elastomers on the lower leg fixing bolts, insert the bolts through the stanchions, and insert everything in the lower leg. Press the upper bushing and dust seal into place with a screwdriver or similar tool, and install the retaining ring, seating it correctly. Finally, thread and tighten the lower leg fixing bolts.

Minimum tire clearance is 2 1/8" (54mm).

Manitou 3: To adjust the elastomer preload, turn the black knobs on the top of the stanchions. To replace the elastomers, unscrew the blue knob at the top of the stanchion. This model has top-out and bottom-out bumpers. A retaining ring, similar to the one on the Sport ('94), holds the upper hushing and dust seal.

Disassembly of the fork is a four-step procedure: 1) unscrew the compression rod screws at the bottom of the sliders while compressing the fork to keep the compression rods from turning with the screws, 2) remove the upper seal retaining ring as with the Sport ('94), 3) remove the positive bottom clips and bottom-out elastomers from the compression rods, and 4) remove the compression rods.

To convert to a long travel setup, remove a 1/2" top-out elastomer from each compression rod. Each rod should now only have one 1/2" top-out elastomer. Finally, add a 1/2" elastomer to each stack.

Re-assembly is a five-step procedure: 11 place the compression stack with top-out bumpers hack in the stanchions, 2) install the bottom-out bumpers and positive bottom clips (in that order), 3) install the stanchions and bushings as with the Sport ('94), 4) install the elastomer stacks into the stanchions, and 5) install the compression rod screws on the bottom of the sliders. To keep the compression rods from turning with the screws, compress the suspension. Minimum tire clearance is 21/8" (54mm) in the standard configuration or *2W (67mm)* for the long travel setup.

Manitou 4 ('95): Manitou 4 is similar to Manitou 3 in that it has removable elastomer stacks that are unscrewed from the top of the stanchions. The preload can be adjusted by hand using the indexing knobs at the top of the stanchions. Each skewer has a stack of six 1" elastomers which are separated with plastic cup washers.

Disassemble and re-assemble the fork as you would the Manitou 3; note that Manitou 4 has only one top-out elastomer. When re-assembling, put the positive bottom clip on the correctly labeled slot in the compression rod. if you put the positive bottom clip in the ER: slot or do not install the clip, the fork may compress enough for the tire to strike the crown. The positive bottom clip in the Magnum slot (labeled "MAG") will reduce the forks travel.

The newer 1995 model forks, a crown/steerer tube combination with a split crown, have a single bolt pinch clamp for each stanchion. Insert the stanchions completely as these crown/steerer tube combinations have a inside lip. If there is no lip, level the top of the stanchion with the top of the hole in the crown.

Minimum tire clearance is 2 3/8" (60.3mm).

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

ANSWER: Manitou (cont'd)

Magnum ('95): The Magnum, Like the Manitou 3, has a top loading skewer with adjustable preload. Unlike the Manitou 3, the preload adjusts by removing the top cap and skewer, and clipping the E-clip into position on the skewer holder (higher up for more preload). Because the preload adjustment is done with the skewer out of the fork, you may need to press down on the top cap and skewer when screwing them into the fork. Be careful not to cross thread or strip out the top cap or stanchion.

Minimum tire clearance is 2 1/8" (54mm).

Manitou EFC and Manitou EFC/DH ('95): The EFC and EFC/DH are elastomer spring forks with oil damping. 'Elie EFC/DH has a special drop-out and uses its own hub and axle (included) for torsional strength, otherwise the forks are the same. The elastomers are accessed from the top of the stanchions. Preload is adjusted with the indexed knobs also at the top of the stanchions. Damping is also adjustable.

Both EFC models have top loading skewers with knob adjustable preload. The stack of seven 24mm elastomers are separated by plastic cup washers. The main compression elastomers used by the EFC forks are not the same as those used by the other Manitou forks - the EFC elastomers have oil damping, so they do not need elastomers with damping built into them.

The damping is integrated into the left stanchion. The knob at the bottom of the left slider adjusts the rebound damping.

Minimum tire clearance is 31/2" (79.4mm).

5teerer/Crown Assemblies:

5teerer Tube Outside Diameter	Lengths
1"	140(5.5"), 165(6.5"), 190(7.5"), *215mm(8.5")*, 305mm(12") unthreaded
1 W	140, 165, 190, 215mm, 12" unthreaded
1 1/4"	140, 165, 190, 215mm, 12" unthreaded

Elastomers:

Density	Elastomer Color
extra soft	black
soft	blue
medium	red
hard	ellow
extra hard	brown
medium (cold weather)	green

DESIGN ELEMENTS - SERVICE NOTES (CONT'D)

ANSWER: Manitou (cont'd)

Torque Specifications:

Model	Crown Bolts (inch/lbs.)	Brake Brace Bolts (inch/lbs.)	Cantilever Studs (inch/lbs.)	Lower Leg Fixing Bolts (inch/lbs.)
Manitou	**312**	**144**	**144**	30
M-Sport	90-110	90-110	90-110	30-40
Manitou 2	**90-110**	**60-80**	**90-110**	**30-40**
Manitou 3	**50-70**	**90-110**	**90-110**	10-30 for the compression stack screws
Sport ('94)	**50-70**	**90-110**	**90-110**	30-40
Manitou 4, EFC, EFC-DH	**(split crown) 110-130**	**90-110**	**90-110**	1 **0-30**

Make EL Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
ANSWER Sport '94	Telescopic	elastomer	elastomer	**16"**	1 1/2"	1 W	elastomer/ none	I I
M-Sport	Telescopic	elastomer	elastomer	**16"**	1 1/2"	1 1/4"	elastomer/ none	I I
Manitou	Telescopic	elastomer	elastomer	**16"**	1 1/2"	13/4"	elastomer/ none	
Manitou 2	Telescopic	elastomer	elastomer	1 **6"**	**1** 1/2"	1 3/4"	elastomer/ **none**	I I
Manitou 3	Telescopic	elastomer	elastomer	1 61/4"	1/2"		elastomer/ none	I I
Manitou 3 (long travel conversion)	**Telescopic**	**elastomer**	**elastomer**	**16W**	**Ph"**	21/2"	**elastomer/ elastomer**	II
Manitou **4**	**Telescopic**	**elastomer**	**elastomer**	**16W**	1 1/2"	2 A"	**elastomer/ elastomer**	I I
Magnum	**Telescopic**	**elastomer**	**elastomer**	161/4"	1 1/2"		**elastomer/ elastomer**	II
Manitou EFC	**Telescopic**	**elastomer**	**hydraulic cartridge**	**17"**	1 1/2"	"	**elastomer/ elastomer**	1

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

ANTI GRAVITY: Stage 1-4

The Anti Gravity Stage 1 – 3 arc telescoping leg forks with elastomer springs, top-out bumpers, no bottom-out, and no separate damping. As with most elastomer forks, remove both sliders at the same time and do not remove the fork brace unless necessary.

Be careful when exchanging elastomers: there are no bottom-out bumpers in these forks. The bottom-out is designed-in with the maximum compression of the elastomers. Use the same length (stack height) of elastomers and be certain to use either Anti Gravity or compatible elastomers. The fully compressed stack length of the elastomer stack should not be less than 2". Normal stack length (4") minus the travel (2") equals fully compressed stack length (2").

Stage 1 and Stage 2: Both forks, like the Tange Shockblade, have separate crown, steerer, and legs. Access the elastomers by removing the lower leg fixing bolts, removing the sliders, and removing the upper bushings from the slider. The Stage 1 upper bushing is held in by the upper seal, while the Stage 2 upper bushing is threaded in. The elastomers will just slide out of the sliders along with the lower bushing. When re-assembling, make sure the lower hushing goes on top of the elastomer stack with the open end up. Properly seating the seal on the Stage 1 is crucial ***(see Tange Struts, pages 15-48 thru 15-49).*** (he bushings on the Stage 2 are protected by the boots, so scat the boots and retaining 0-rings properly around the sliders before riding.

Stage 3 Pro: This fork has legs pressed into the crown. The steerer tube is clamped on and the 1", 1-1/8", or 1-1 W steerer tubes with the same crown can be adapted for smaller diameters. When using the special crown adapters, line up the split in the adapter with the split in the crown and properly engage the groove in the steerer tube with the lip on the adapter. The bushings on the Stage 3 are protected by the boots, so properly zip-tie the hoots to the sliders before riding.

Stage 4: The Stage 4 is available in 7 different models: Stage 4, 24" (for 24" wheels); Stage 4, 26"; Stage 4 Pro 26"; Stage 4 Pro Comp 26"; Stage 4 Carbon 26"; Stage 4 Pro Carbon 26"; and Stage 4 Pro Comp Carbon 26". The Carbon models have carbon fiber sliders instead of aluminum. Pro models have the 6 inch elastomer upper stack, whereas, Pro Comp models have the 6 inch upper elastomer stack with a preload adjuster. As with the Stage 3 Pro, the crown fits any size steerer tube with the use of shims. Crown race adapters are used to fit the headset crown race snugly onto the steerer tube.

The basic design is the same as the Stage 3 Pro: telescoping legs, elastomer sprung, no damping, and 2" of travel. Stage 4 models without the 6 inch elastomer upper stack can be converted to 2.5" of travel.

6 inch elastomer upgrade: This retrofits Stage 3 and 4 for an additional 6 inch elastomer stack that drops in at the top of the crown. The elastomer stack is an addition to the existing elastomers, not a replacement - **removing the lower elastomer stack may cause the tire to strike the crown.** Instead, the original elastomer stack should be replaced with softer elastomers. Adjust fork stiffness by replacing the upper (retrofit) elastomers. **Note:** the upper elastomers are different than the lower elastomers.

SUSPENSION FORKS

DESIGN ELEMENTS - SERVICE NOTES (CONT'D)

ANTI GRAVITY: Stage 1-4 (cont'd)

External index adjustment kit: This is used in conjunction with the 6 inch elastomer upper stack to provide preload on the upper elastomer stack. Adjust the preload with a 6mm alien wrench.

Steerer Assemblies:

Steerer Tube Outside Diameter	Lengths (millimeters)
1" with shim	130, 160, 190, 220, 250, 280, 250 unthreaded
1 1/a" with shim	130, 160, 190, 220, 250, 280, 250 unthreaded
1 1/4"	130, 160, 190, *220*, 250, 280, 250 unthreaded

Elastomers:

Density	Elastomer Color
soft	black
medium	orange
hard	purple or blue

Torque Specifications:

Model	Crown Bolts (inch/lbs.)	Lower Leg Fixing Bolts (inch/lbs.)
Stage 2	25-30	3
Stage 3	10-15	

Make Ea Model	Kind of Fork	Spring	Damping	(Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
ANTI GRAVITY Stage 3 Pro	Telescopic	microcellular elastomer urethane		16 1/2'	1 1/2"	2"	elastomer/ none	I ri
Stage 4	Telescopic	microcelluiar elastomer urethane		1 61/2"	11/2"	*2"*	elastomer/ none	I ri

AVITAR: *(See Shower)*

DESIGN ELEMENTS - SERVICE NOTES (CONT'D)

CANNONDALE: Delta V, Headshok DD, Headshok RDC, Headshok ELS

The Cannondale Headshok forks are monoshock telescoping forks with the slider and stanchion inside the head tube. The fork uses a non-standard size head tube, headset, and stem, so it is only available on the Cannondale Delta V and Super V series of bikes and framesets. As with the Action Tec fork, the boot at the crown of the fork is the only thing that protects the bearing surfaces from contamination. It uses adjustable needle bearings on the sliding surfaces for low friction.

The fork must be removed from the frame in order to grease the needle bearings or to adjust them or to change the shock cartridges. The needle bearings rarely need to be adjusted.

To remove the fork, take off the adjusting cap and stem. Loosen the lower bearing retaining screw. Using a section of pipe (such as a cut section of steerer tube) to protect the valve or adjuster, if there is one, support the frame and tap on the top of the fork until it comes out the bottom of the head tube. Be careful to hold onto the fork so it does not drop to the floor.

Delta V 1992 & 1993: This fork was not marketed as a Headshok fork; it was more commonly known as the Delta V fork. One version of the fork consisted of an air sprung, oil damped unit. It had a Schraeder valve at the top of the steerer tube for pressure adjustment, and a rubber knob that turned the Schraeder valve at the top of the steerer tube for damping adjustment. Air pressure should he set so that there is just a bit of sag with the rider on the bike; this would usually be between 80 and 120 psi.

To inflate the fork, sometimes it is necessary to remove the adjuster and damping dial to be able to thread on a Schraeder pump. The damping dial is a hexagonal piece of aluminum held onto the valve body with a set screw. When re-installing the damping dial, seat it in the same position on the valve body. If it is too low, the rider may not be able to adjust the fork for enough damping.

The fork can be retrofitted to a 1994 cartridge-style air/oil or elastomer unit with special tools. Instructions are provided with the retrofit cartridge unit. The elastomer retrofit cartridge is available with either a hard or soft elastomer.

Maintenance Recommended By Cannondale for Delta V:

Every three months: Grease the flats of the bearing surface. To do this, remove the upper zip-tie holding on the boot, and peel the boot down. This will allow you to grease the flats. Re-secure the boot in the groove properly; the groove will sit in the flange. Secure the boot with a zip-tie. Depressurize the fork, remove the Schraeder valve core with a core remover, and drip a few drops of light oil into the air chamber.

Once a year: Lubricate the needle bearings by removing the fork and using a grease gun to inject grease in the four grease ports in the center of the fork. Make sure you get grease in the grease ports and not in the needle bearing adjuster holes. Cannondale recommends about two squirts of synthetic grease per port.

1I1 DESIGN ELEMENTS – SERVICE NOTES (coNTD)

CANNONDALE: (coned)

Headshok OD, Headshok RDC, Headshok ELS 1994: There were both air sprung (Headshok DD and licadshok RDC) and elastomer sprung (I leadstiok HS) forks for 1994 model bicycles.

The inflation valve for the air sprung fork is now on the underside of the steerer tube. **The fork should always be ridden, stored, and transported (even on airplanes) with at least 75 psi. of pressure.** 1lie air pressure should generally be 3/4 the rider's weight, or more specifically, the air pressure should he set so that there is 1/16' sag with the rider on the bike.

The 1994 air sprung fork comes in two versions, one with an adjuster knob at the top of the steerer tube (called the Headshok DD) and another (called the Headshok RDC) with the adjuster coupled to a thumb shifter on the handlebar. The damping for both forks is the same, from full lockout to minimal damping. If you need to re-adjust the indexing on the damping, zero the damping in the full lockout position. Turn the adjuster knob completely clockwise, to the locked out position, or push the thumb lever all the way forward. Remove the adjuster cap or cap plate. Loosen the pinch bolt holding the split nut or collar to the center shaft. Use a screwdriver to turn the center adjuster until the fork just begins to lock out completely. Stand the bike on the ground and press down on the handlebars while slowly turning the adjuster shaft until the fork is firmest. Tighten the pinch bolt and test the lockout again. Re-install the top cap or plate.

Note: The 1994 Headshok RDC (with the Remote Damping Control lever mounted on the handlebar) was susceptible to failure of the remote damper. Replace the RDC lever with the DD knob.

The 1994 elastomer fork, I leadshok ELS, has elastomer preload adjusted by the alien set screw at the top of the steerer tube. To get to the adjuster, unscrew the black top cap.

Make El Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
CANNONDALE Delta V	Telescopic monoshock	air	oil	I 7 7/8"	1 3/4"	varies	bumper/ bumper	111 Custom
Headshok DO, Headshok RDC	Telescopic monoshock	air	oil	17 7/8"	1 3/4	varies	bumper/ bumper	Custom
Headshok ELS	Telescopic monoshock	elastomer	oil	1 7 7/6"	13/4"	varies	bumper/ bumper	Iii Custom

CONCEPT: *(See AMP)*

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

CONTROL TECH: Lawwill Leader

The Lawwill Leader has a parallelogram-style linkage design near the wheel axle and an air/oil monoshock bolted on in front of the head tube. The height of the legs on the crown is adjustable and this capability slightly' modifies the compression characteristics of the fork.

The monoshock is an air/oil design. Both the air and the oil pressure in the shock can be adjusted. Older models were air pressurized with a needle valve, whereas newer ones have a Schraeder attachment. The air pressure range should be between 55-95 psi. For the oil pressure, both the oil level and oil weight are adjustable. To change the oil in the newer models, first depressurize the shock. Be careful while doing so, because the oil may be emulsified and spray out. Then, remove the Schraeder valve core and pour the oil out. The fork is built with 551n1 of lOwt oil, so when replacing the oil, use more than 50m1 and less than 60m1.

The steerer tube is pressed into the crown, and the legs and shock unit are clamped onto the crown. Unlike most forks, the legs are clamped behind the steerer tube. This is the only' way to clamp on the legs and still be able to clamp on the monoshock unit. The suspension action/articulation can be controlled somewhat by where the crown clamps onto the legs.

The pivot points on both older and newer forks have eight grease ports that use a needle-style grease gun. The pivots should be greased sparingly, but often.

Steerer/Crown Assemblies:

Steerer Tube Outside Diameter	Lengths
1"	12" threadless
1 1/s"	2" threadless
1 1/4"	L12" threadless

Make & Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
CONTROL TECH Lawwill Leader	Linkage	air	hydraulic	17"	1 1/4"	2.5"	O-ring/O-ring	steered crown unit legs separate

DIRT RESEARCH: Al-Carbon Fiber, Aluminum, Ti-Carbon Fiber

The Dirt Research forks are all standard telescopic leg forks with elastomer springs. The stack of four 4cm-long elastoniers are loaded through the top of the legs and are held onto the skewer with 0-rings. The preload is adjustable using a 6mm alien wrench at the top of the legs.

SUTHERLAND'S

SUSPENSION FORKS

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

DIRT RESEARCH: (cont'd)

The crown, steerer, and legs are all separate, but the steerer has the crown race seat bonded onto it. So, in order to remove the steerer tube, remove the snap ring at the bottom of the crown.

The elastomers push against through-shafts that have 6mm alien heads in them and are held in place with a 5mm bolt at the base of the slider. Use a long 6mm alien wrench to hold the through-shafts in place and use a 5mm alien wrench (or a long 5min alien wrench for the aluminum model) to remove the bolt at the base of the slider. The white plastic upper bushing retainers are threaded into the slider. After those are removed, the sliders and stanchions can be separated.

Torque values, steerer tube sizes, and elastomers are unavailable.

Make flz Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
DIRT RESEARCH Aluminum	Telescopic	elastomer	elastomer	165/8"	1 1/2"	1 1/2"	elastomer/ elastomer	II
Aluminum/ Carbon Fiber	Telescopic	,Iastomer	elastomer	1 6-1/4"	1 1/2"	11/2"	elastomer/ elastomer	I

GIRVIN: Vector

The Vector is a monoshock linkage suspension fork with the linkage at the crown and stem. The spring is elastomer and damping is provided by a urethane-friction unit. When the fork gets over damped, the damping unit must he disassembled and lightly greased. Refer to service manual for greasing instructions.

The suspension fork is clamped to its own threadless stem (available in 120, 135, and 150mm lengths). Install a special headset sizing spacer onto the headset for 1 1/4" and 1 1/4" forks. The stem position is very important to the proper functioning of the fork, because the linkage is directly attached to the stem. The top of the stem should sit 1.5 - 3mm higher than the top of the (uncut) steerer tube and the stem is not adjustable.

To modify ride characteristics of the forks, rotate the lower front eccentric pivot. There is a hole in the middle of the eccentric pivot. When the chamfer in the hole is facing forward, the fork is in anti-pogo mode; when the chamfer is facing back, the fork is in the sensitive mode.

The elastomer preload is adjusted by tightening or loosening the blue I9mm nut (the preload adjuster) at the bottom of the shock absorber. Set the preload so that there is 3 - 8n n of sag in the sensitive mode or 0 - 3mm of sag in the anti-pogo mode.

To replace the elastomer, do not unscrew the bearing spring mount from the guide rod, or these pieces will have to be replaced.

DESIGN ELEMENTS - SERVICE NOTES (CONT'D)

GIRVIN: Vector (cont'd)

Check for wear or bending, especially at the guide rod, spring, or damper. Older models had aluminum upper pivot mounts that could bend under extreme use. Newer models have stronger steel pivot mounts.

The lower link should not hit the stop plate on the legs. If it does, check that the stem is at the proper height and that there are no loose parts. The shock absorber cannot have loose parts.

The steerer assemblies are replaceable, but this requires disassembly of the fork. Use the service manual as a guide.

Steerer Assemblies:

Steerer Tube Outside Diameter	Lengths
1"	1 33mm maximum head tube length
11/8"	127mm maximum head tube length
1/4"	127mm maximum head tube length

Elastomers: (the number is stamped on the end of the elastomers)

Density	Elastomer Number
extra soft	20
soft	30
medium	40
hard	50
extra hard	60

Torque Specifications:

Bolt	Torque (in. lbs.)
stern pinch bolts	100
upper and lower link pinch bolts (4 total)	1 00

Make is Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
GIRVIN Vector	Linkage	elastomer	friction	161/2"	1 W	2+"	urethane/ none	steerer/ crown unit legs separate

DESIGN ELEMENTS - SERVICE NOTES (CONT'D)

HALSON: Inversion

The Inversion fork is an inverted telescoping leg design with the stanchions on the bottom.

To remove the 7" skewered elastomer stacks, unscrew the knurled knob at the top of the legs. The upper elastomers are interchangeable and can he added to for preload. But the last two inches of the stack must be the narrow diameter, 2" long, red elastomers.

Set up the fork so that there is about 1/4" sag. Clearance between the tire and the bottom of the crown should be at least 3/16" when the fork is bottomed-out (i.e. without the elastomer stack in).

liaison recommends only Tri-Flo lubricant on the skewers and boots, and only Bel-Ray waterproof grease on the bushings. This is to protect the fork, for it has no seals and depends on the boots for contamination protection. Always check that the hoots are still soft and pliable, undamaged, and uncut, or replace them immediately.

The crown, upper legs and steerer are a single unit and cannot he individually replaced.

Steerer/Crown Assemblies:

Steerer Tube Outside Diameter	Lengths (millimeters)
	140, 170, 200, 230, 260 unthreaded
1 1/4"	140, 170, 200, 230, 260 unthreaded
1 1/4"	140, 170, 200, 230, 260 unthreaded

Elastomers:

Density	Elastomer Color
soft	white
medium	yellow
medium/hard	blue
hard	red

Torque Specifications:

Bolt	Torque (in. lbs.)
brake brace bolts	120

Make lx Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
HALSON Inversion	Telescopic	elastomer	elastomer	1 61/2"	1 1/2"	1 3/4"	bumper/ bumper	

SUSPENSION FORKS

DESIGN ELEMENTS - SERVICE NOTES (coNT'D)

LAWWILL LEADER: *(Sec Control Tech)*

MARZOCCHI: XC

All Marzocchi XC series forks are air sprung, oil damped forks.

1W and 11/4" crowns are available to fit XC50 through XC500 (older OEM bikes had 1" crowns). Crown reduction rings are available in PA" to 1", 1 1/4" to 1", and 11/4" to 11/2" to fit the steerer tubes to the crown.

1992 model forks: XC 100, XC 200, XC 300

The XC 100 contains stanchion ported valving, in contrast to the XC 200 and 300 which contain foot buffered valving in addition to the stanchion ported valving. All three forks are serviced with special tools. Only the XC 300 has a separate "bush unit" (also known as the pilot boss) that houses the upper hushing and seal assembly and needs to be removed with a pin spanner.

There are no rider-adjustable parameters besides air pressure. The forks come stocked with 7.5 wt oil, which can be changed for different ride characteristics.

When disassembling these forks, remove the compensating piston and the air cap assembly before pouring the oil out. Remove the air cap with snap ring pliers. Next, remove the compensating piston by first removing the Phillips head screw and 0-ring from the middle of the piston. Use a Marzocchi tool B (ref. 99) to keep the piston from rotating. Then, thread a 6mm threaded rod or a long 6mm screw into the screw hole and pull the compensator piston out. A three-piece basic tool kit is available for removing the air cap and compensating piston.

When re-installing the compensating piston, there should be no air trapped beneath it. Use Marzocchi tool B (ref. 99) to insert the piston to its proper height (the oil level minus 5mm). Another way to ensure there is no air beneath the piston is to put too much oil in, then press the piston to the proper level (the **intended** oil height minus the **thickness** of the piston) letting the excess oil escape through the hole in the piston. Then, put the Phillips head screw and 0-ring hack in the compensating piston, and pour out the rest of the excess oil.

The main seals on the XC 300 are both held in with a snap ring and are fixed in a bush unit threaded onto the top of the slider. This bush unit is unscrewed with a Marzocchi pin-style hook spanner tool (ref. 82). Remove the bush unit before servicing the upper bushings or seals. Removing the bush unit also allows you to remove the stanchions.

1993 model forks: XC 50, XC 150, XC 400, XC 50H

XC 50, XC 150: A press may be needed to create sufficient pressure to remove the seals. The most efficient way to create this press is by removing the seal-retaining ring, adding oil, capping the stanchion off again, and compressing it until the seal blows out. 1)o not damage the stanchion.

XC 400: There are no rider adjustable parameters on the XC 400, 150, and 50 besides air pressure. the fork comes stocked with 7.5wt oil, which can be changed for different ride characteristics. There is no static lockout on the XC 400, 150, or 50.

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

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MARZOCCHI (cont'd)

Note: These forks also have pistons that need to be removed before the oil can be poured out, ***(see comments about XC .1(X), 200, and 300 for removal and installation instructions).***

XC SOH: This fork model is a version of the XC SO made for hybrids.

1994 model forks: XC 500, XC 51

XC 500: These forks come with 20wt oil. Adjust the damping on the XC 500 by turning the knobs near the bottom of the legs: 1=minimum, 4=maximum damping.

Since these forks do not have compensating pistons, removing the stanchions and seals is pretty straightforward. If you cannot remove the stanchion from the slider, you may need to blow out the seal as with the XC 150. The valving on the XC 500 is held at the bottom of the slider with a set screw in the middle of the slider in the front. This may he behind the decal. Unscrew the set screw only a couple of turns; this should allow you to lever the valve unit out. Disassemble the valve unit only if necessary. When disassembling the valve, unit be careful because there is a spring loaded ball bearing in it. The 0-ring and conical seal on the valve unit need to be replaced after every overhaul. When re-installing the valve unit, align the "1" on the valve with the mark on the slider. Put Loctite on the set screw, tighten it lightly and hack it out 1/4 turn so the knob on the valve can be rotated.

XC 51: Like on the elastomer fork, the stanchion on the XC 51 is bolted in the slider at the bottom. Remove this bolt using a Marzocchi tool P ref. (5024) before removing the slider in order to access the seals.

1995 model forks: Zokes, Zokes LT, Zokes H, XC 600, XCR

Zokes, Zokes LT, Zokes H: These are telescoping leg, elastomer forks with adjustable preload at the top of the crown.

XC 600, XCR: XC 600 and XCR are telescoping leg, air/oil forks with rider adjustable valving. Both use 20wt oil. The design and disassembly of the XC 600 resembles that of the XC 500, although the valving is slightly different. The XCR resembles the XC 51 in that the stanchion is held in with a compression rod bolted to the bottom of the slider. The XCR also has a knob allowing the compression damping to be adjusted.

The stanchions of the XC 600 and XCR, however, measure 26mm which varies from the 24mm measurement of the previous XC forks. The old crowns do not fit these new models. The new crowns are a combination crown-steerer tube.

Steerer Assemblies (Note: XCR and XC 600 do not fit any other XC series forks):

Steerer Tube Outside Diameter	Lengths (millimeters)
1"	129, 154, 180, 210, 230, 180 unthreaded, 220 unthreaded
PA"	129, 154, 180, 210, 230, 180 unthreaded, 230 unthreaded
1 W	129, 154, 180, 210, 230, 180 unthreaded, 230 unthreaded

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

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MARZOCCHI (cont'd)

Elastomers:

Density	Elastomer Color
soft	yellow
medium	blue
hard	red

Recommended Oil/Air Heights (for various rider weights):

Model	Below 140 lbs.		140-180 lbs.		Above 180 lbs.	
	Oil	Air	Oil	Air	Oil	Air
MARZOCCHI						
XC 100+PH (7.5wt)*	55-60mm	40-80psi	**50-55mm**	**40-80psi**	45-50mm	40-80psi
XC 200 (7.5wt)*	55-60mm	40-80psi	**50-55mm**	**40-80psi**	45-50mm	40-80osi
XC 300 (7.5wt)*	55-60mm	40-80psi	**50-55mm**	**40-80psi**	45-50mm	40-80psi
XC 400 (7.5wt)*	45mm	40-80psi	**40mm**	**40-80psi**	35mm	40-80psi
XC 50 (7.5wt)	45mm	40-80psi	**40mm**	**40-80psi**	35mm	40-80psi
XC 150 (7.5wt)*	45mm	40-80psi	**40mm**	**40-80psi**	35mm	40-80psi
XC 500 (20wt)	50mm	40-80psi	**45mm**	**40-80psi**	40mm	40-80psi
XC 51 (20wt)	45mm	40-80psi	**40mm**	**40-80psi**	35mm	40-80psi

* Subtract 14mm when measuring to the top of co npensating piston.

1. * **Important Note:** Oil height is measured in millimeters from the top of the stanchion to the oil surface when **stanchion is fully compressed.** Stock oil viscosity is listed with each manufacturer/model. Information in this chart supplied by ***Bicycle Technology International (BTI).***

Torque Specifications:

Model	Steerer Pinch Bolts (ft. lbs.)	Brake Brace Bolts (in. lbs.)	Cantilever Studs (ft. lbs.)	Foot Valve (ft. lbs.)
EGS, XC 50, XC 50H, XC 51, XCR	**6**	3.8	5.8	5.8
PF-1, **XC** 100, XC **200,** XC **300, XC 400**	**6**	**3.8**	**5.8**	4.5
XC 500, XC 600	**6**	**3.8**	**5.8**	n/a
Zokes, Zokes LT, Zokes H	n/a	**n/a**	**5.8**	n/a

Torques (from BTI):

Bolt	Torque (in. lbs.)
M4	70
M5	**72**
M6	90

DESIGN ELEMENTS - SERVICE NOTES (CONT'D)

MARZOCCHI (cont'd)

Make Ea Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
Marzocchi EGS	Telescopic	air	hydraulic	16W	1 W		none/ none	I I
PF-1	Telescopic	air	hydraulic	1 6"	1 1/2"	1 W	none/ none	II
XC 100	Telescopic	air	hydraulic	161'	1 ½	1 1/4"	none/ none	I I I
XC 200	Telescopic	air	hydraulic	16"	1 /2"	1 1/4"	none/ none	II
XC 300	Telescopic	air	hydraulic	16"	1 1/2"	13/4"	none/ none	I I
XC 400	Telescopic	air	hydraulic	16"	1 1/2"	13/4"	none/ none	rti II
XC 50	Telescopic	air	hydraulic	16"	1 1/2"	1 W	none/ none	II
XC 500	Telescopic	air	hydraulic	16 3/s"	1 5/8"	1 1/4 "	none/ none	II
XC 50H	Telescopic	air	hydraulic	N/A	N/A	N/A	none/ none	I I
XC 51	Telescopic	air	hydraulic	1 6W	1 W	21'	none/ none	II
XC 600	Telescopic	air	hydraulic	16 W	1 W	"	none/ none	II
XCR	Telescopic	air	hydraulic	163/8"	1 W	"	none/ none	II
Zokes	Telescopic	elastomer	friction	16Y4"	1 W	"	spring/ none	
Zokes LT	Telescopic	elastomer	friction	N/A	N/A	2 1/2"	spring/ none	
Zokes H (hybrid L 700C wheel)	Telescopic	elastomer	friction	N/A	N/A	1 W	spring/ none	

DESIGN ELEMENTS - SERVICE NOTES (CONT'D)

McMAHON: Shaka

The Shaka is a telescoping leg, elastomer fork available with cantilever brake mounts or, by special order, with U-brake/roller-cam brake mounts.

The stanchions and carbon fiber reinforced titanium steerers are bonded into the crown.

Steerer/Crown Assemblies:

Steerer Tube Outside Diameter	Lengths (millimeters)
1"	160, 195mm, & unthreaded
1W	160, 195mm, & unthreaded

When re-assembling the fork, the spring assembly stacks from bottom to top in this order: black wear ring, aluminum washer, 21/4" elastomer, aluminum washer, and 21/4" elastomer. Do not seat the black wear ring onto the plug in the bottom of the stanchion, otherwise the wear ring cannot move past the upper wiper seal when it is seated on the plug; the ring must float freely just below the stanchion plug. These forks arc designed for W to 1/2" sag. Additional springs can be added for higher spring preload.

Elastomers:

Density	Elastomer Color
soft	yellow
medium	natural
hard	blue

Torque Specifications:

Bolt	Torque (in. lbs.)
fork crown bolts	130

Make & Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
McMAHON Shaka	Telescopic	elastomer	elastomer	16W	1 3/8"	2"	elastomer/ none	II

MONGOOSE: Amplifier *(See AMP Research)*

SUTHERLAND'S

DESIGN ELEMENTS – SERVICE NOTES (coN-rD)

MONOLITH: Rebound

Rebound: now made on a special order basis only. Rebound H: discontinued.

MOUNTAIN CYCLE: Suspenders

Suspenders, Suspenders II: both have been discontinued - we have no information on them.

PILOT: MK-2100S

The Pilot MK-2100S is a telescoping leg, elastomer fork with a top-out but no bottom-out bumper. It has a one-piece steerer-crown-stanchion combination. Remove both legs to change the elastomers. When removing the legs, as with other elastomer forks, it is not necessary to unbolt the fork brace. Loosen the lock bolt at the bottom of the sliders and unscrew the 5mm alien bolt within the stanchions like other elastomer forks. Wait until you have removed the stanchions, then remove the snap rings at the top of the sliders. These snap rings hold in the bushings and elastomers. Adjust elastomer preload by tightening the 5mm alien lower leg retaining bolt.

As with many elastomer forks without bottom-out bumpers, be very careful to replace the elastomers with the same kind or with ones provided by the manufacturer, in order to get the same or less travel out of the fork. You do not want to get too much travel out of the fork because the tire may hit the crown, which could cause an accident.

Steerer/Crown Assemblies:

Steerer Tube Outside Diameter	Lengths (millimeters)
1,	154, 180, and 255 unthreaded
1W	156, 175, and 255 unthreaded

Torque Specifications:

Bolt	Torque (in. lbs.)
Fork brace	92

Make 61 Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
PILOT MK-21005	Telescopic	elastomer	elastomer	16 3/4"	1 1/2"	1 1/2"	bumper/ none	

DESIGN ELEMENTS - SERVICE NOTES (coNT/D)

PROFORX: BMX, BMX Cruiser, Cross Country, Long Travel, ST (distributed under Girvin or Answer)

11w ProForx suspension forks are a combination coil spring/elastomer, telescoping leg fork with elastomer top-out bumpers. Two coil springs are available (hard or soft). The spring rates of the elastomers do not need to be changed. Spring preload can be adjusted with a 7/16" (or llmm) socket wrench and extension. Make sure the Nylock preload adjuster nut is properly engaged on the threads.

When disassembling the legs remove the fork brace. After you remove the fork brace, the spring preload nut, the upper dust seal cover, wiper, and seal retaining circlip, pound the slider off the stanchion, because the upper seal is pressed in very tightly. Do not damage the thin upper lip of the slider; use a wooden block placed against the brace mounting and pound on the wooden block while supporting the stanchion. Keep the stanchion clamped into the crown. A Rock Shox seal separator in conjunction with vise blocks will also work.

When re-assembling the fork, make sure the stepped spacer is engaged into the spring and the elastomers are in the proper order (first blue, then red). Without the brake brace on, tighten or loosen the 7/16 preload nut until there is barely any play. Doing this assures that each leg is in the same initial position. When adjusting the preload, make sure to turn the 7/16" nut the same amount in each leg .

Minimum tire-to-crown clearance is 2" for the standard forks or 3" for the long travel forks. The fork crown bolts for the crown with clamp-on legs and steerer tube should be tightened to 20 ft. lb. of torque.

The manufacturer suggests removing, cleaning, and re-oiling the foam wipers underneath the black nibber dust seals at the top of the sliders every eight hours of riding, or sooner for muddy or sandy conditions. A complete disassembly and inspection should be done after every 200 hours of riding.

Although older steerer tubes are not sold by the manufacturer anymore, they are available elsewhere. They are sold by themselves, but sometimes need separate crown race seats. Newer steerer tubes come with the crown.

Steerer Assemblies:

Steerer Tube Outside Diameter	Lengths
1"	135, 155, 175, 195, 215, 235mm, unthreaded (older- from Girvin) 5.5", 6.5", 7.5", 8.5", 12" threadless
1 W	140, 170, 200, 230mm, 260mm unthreaded (stock)
1 1/4"	140, 165, 190, 215mm, 12" threadless (newer with crown)

Torque Specifications:

Bolt	Torque in. lbs.)
crown bolts	20

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

PROFORX: (cont'd)

Make Ell Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
PROFORX BMX	Telescopic	elastomer! coil spring	friction	1 2 1/2"	11/2"	11/8"	bumper/ none	I II
BMX Cruiser	Telescopic	elastomer! coil spring	friction	1 41/2"	1'/2"	1 1/4"	bumper/ none	I I
Cross Country	Telescopic	elastomer/ coil spring	friction	1 6 ⅛"	1 1/2"		bumper/ none	II
Long Travel	Telescopic	elastomer/ coil spring	friction	17 ⅜"	1 1"	"	bumper/ none	II
ST	Telescopic	elastomer/ coil spring	friction	1 6 1/8"	1 ½"	2"	bumper/ none	I II

ROCK SHOX: Judy

The Judy fork comes in three versions: X(.7,, DI i, and SL. The stanchions, sliders, and elastomer stacks are the same on all three forks, but the crowns, brake braces, damping units and non-damping shaft assembly often differ.

All the forks have adjustable and replaceable elastomer springs. To remove the elastomer stack, the stanchion pinch bolts may need to be loosened. The elastomers can be changed or a solid spacer put in the place of one of the elastomers for a more progressive spring action. Adjust spring preload by using the knobs at the top of the stanchions.

Elastomers:

Density	Elastomer Color	Diameter
soft	red	18.5mm
firm	blue	20mm
solid	white	20mm

Adjust the damping on DH and SL by inserting a 2mm alien wrench through the hollow bolt at the bottom of the slider. There is only one damping unit, usually in the left leg. When re-assembling the fork, the hollow bolt must he attached to the damping unit and not the non-damped shaft assembly. The adjustable damping units have only two complete adjustment turns from a fully tightened (clockwise) position. Do not turn the adjusting bolt past two turns counter-clockwise from a fully tightened position. You will run the risk of having the damping unit leak.

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

ROCK SHOX: Judy (cont'd)

The damping units are cartridge units and arc easily interchangeable and (along with the non-damped shaft assemblies) are what affects the travel of the Forks. It is possible to change the travel of the Judy fork by replacing the damping unit and non-damping shaft assembly. The only tools needed are an alien wrench for the shaft bolts at the bottom of the sliders and internal ring pliers. Changing the damping units also changes the axle-to-crown distance. Though it is possible to dis-assemble the damping units, without the proper tools it is difficult to re-assemble them properly.

To re-assemble the fork, first place the upper shaft guide with 0-ring and shaft end plate on the unthreaded end of the non-damping through-shaft and, in this order, the top-out bumper and lower shaft guide on the unthreaded end. Insert the non-damping shaft assembly in the bottom of the stanchion, unthreaded end first, press the lower shaft guide into the stanchion, and install the snap ring into the groove in the stanchion. Set the upper shaft guide into the stanchion, and install the snap ring into the groove in the stanchion. Set the upper shaft guide properly by pushing the shall into the stanchion until the end of the shaft is flush with the end of the stan-chion. Next put the shaft end plate on the unthreaded end of the damping cartridge and install the unit in the bottom of the other stanchion, unthreaded end first; place the cartridge washer in the stanchion on the damping shaft and install the other snap ring. Thread the elastomer stacks into the stanchions, slide the stanchions into the sliders, and bolt the stanchions in at the bottoms of the sliders. Remember to use the hollow bolt on the damping unit side if necessary.

Regular maintenance includes lubing the stanchions, wipers, bushings, and elastomers with clean Tefloriⁿ" based grease. Do not use lithium based greases.

The adjuster knobs on the crown may ride too high, causing it to strike the down tube of the bike. The manufacturer recommends that you try adjusting the handlebar height so that the handlebar hits the top tube before the adjuster knob hits the down tuhe.

Make fi Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
ROCK SHOX Judy XC	Telescopic	elastomer	hydraulic cartridge	1 6 1/4"	1 W	2"	bumper/ bumper	II
Judy DH	Telescopic	elastomer cartridge	hydraulic	1 7 1/4"	15⁄x'	3"	bumper/ bumper	II
Judy SL	Telescopic	elastomer cartridge	hydraulic	161/4"	1 1/2"	2 1/f	bumper/ bumper	II

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

ROCK 51-10X: Mags Quadras

Mag 10 '93, Mag 10 '94, Mag 10 Long Travel '94, Mag 20 '92, Mag 21 '93, Mag 21 '94, Mag 21 51 (`93), Mag 21 51./Ti, Mag 21 Long Travel '93, Mag 21 Long Travel '94, May 21 7000, May 30 '92, Quadra '93, Quadra 10 '93, Quadra 21 '93, R5-1: The complete Mag series of Rock Shox forks and the Quadra 21 can use the same style crown and steerer combination, though they may differ in weight or rigidity. All the Mag and Quadra fork braces are also interchangeable.

Identification

The RS-L, the original Rock Shox, was usually black with a triple clamp crown: both legs and steerer clamped into the crown with bolts on the front face of crown. The RS-1 had some seal problems, but improved seals are available.

RS-1, Mag 30, and Mag 10 '93 are the non-adjustable Mag shocks. All that can be easily varied on these is the air pressure; of course, the oil can be changed with a little more effort. The Mag 30 is the older shock (circa 1991 or 1992); the Mag 10 was made after 1992. The Mag 30 can be identified by the lack of the negative spring that Rock Shox incorporated in its later products. To check for the negative spring, grasp the crown and brake brace in both hands and try to compress the fork with just your hands. If you are able to compress or extend the fork, it probably has the negative spring (or the air pressure is very low). It will probably be easier to extend the fork than compress it, because of the static lockout.

Similarly, the Mag 20 (circa 1991 or 1992) had no negative spring either, but it had adjuster knobs at the top of the stanchions for adjustable static lockout. The newer 1993 Mag 21 had the negative spring and plastic adjusting knobs. The 1994 model has the negative spring and aluminum adjuster knobs with sharp edges.

The 1994 Mag 10 had a negative spring like the 1993 Mag 10, but it also had an allen damping adjuster. All models since 1994 should have stickers on the legs indicating the model.

Other indications of the vintage of the forks are the crown and brake brace. The older forks had crowns with sharper edges, though since the crowns are interchangeable, an older fork may be equipped with the newer crowns with rounded edges. The brake brace on older forks had the brake cable stop arm welded on, whereas the newer ones look cast. Some original M-20 braces utilize countersunk mounting bolts. Rut all forks except RS-1 can use the new cast braces.

The 1993 Quadra has the grey legs, and alien caps at the tops of the stanchions for access to the elastomers. The alien bolts are inside the alien holes for preload adjustments to the elastomers. The 1993 Quadra's black crown has no bolts because both the legs and the steerer were pressed in.

The 1994 Quadra 10 is similar in appearance to the 1993 Quadra, but it has stickers on the legs and generally a silver crown indicating the model.

The 1994 Quadra 21 has a bolt-on leg crown design and adjuster knobs on the stanchions.

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

ROCK SHOX: Mags bt Quadras (cont'd) 7

General

Over torquing the fork brace bolts or the cantilever studs may strip the threads in the lower legs, requiring that they either be replaced or have helicoil inserts installed.

The whole Mag series of shocks and the Quadra 21 can use the same crown and steerer tube combinations, though the crown and steerer tube combinations may vary in weight and profile. Do not overtighten the leg pinch bolts, as that may force the stanchions into oval shapes. Check also for cracking on the crown.

Mag and Quadra 21 Steerer/Crown Assemblies':

Steerer Tube Outside Diameter	Lengths
1	1 40, 170, 200, 230, 260mm, 260mm unthreaded
1 1/2"	140, 170, 200, 230, 260mm, 260mm unthreaded
1 1/4"	140, 170 200 230, 260mm, 260mm unthreaded

Quadra 10 Steerer/Crown Assemblies':

Steerer Tube Outside Diameter	Lengths
	1 40, 170, 200, 230, 260mm, 260mm unthreaded
	140, 170, 200, 230, 260mm, 260mm unthreaded
1 1/4"	140, 170, 200, 230, 260mm, 260mm unthreaded

Quadra Steerer/Crown Assemblies":

Steerer Tube Outside Diameter	Lengths
1"	1 40, 170, 200, 230, 260mm, 260mm unthreaded
11/8"	140, 1 70, 200, 230, 260mm, 260mm unthreaded
1 1/4"	140, 170, 200, 230, 260mm, 260mm unthreaded

1 All three assemblies vary in design and are not interchangeable.

DESIGN ELEMENTS – SERVICE NOTES (coNro)

ROCK SHOX: Mags bz Quadras (cont'd)

R5-1 Steerer/Crown Assemblies:

Steerer Tube Outside Diameter	Lengths
1"	140, 170, 200, 230, 260mm (Pre-'94)
1 1/8"	140, 170, 200, 230, 260mm (Pre-'94)
1 1/4"	140, 170, 200, 230, 260mm (Pre-194)*

* Rock Shox no longer stocks these three-piece units. However, the most recent one-piece steerer and crown with separate legs is compatible.

Elastomers(Quadra):

Density	Elastomer Color
soft	red
standard	purple
hard	green
cold	ice blue

Recommended Oil/Air Heights (for various rider weights):

	Below 140 lbs		140-180 lbs		Above 180 lbs	
Model	**Oil**	**Air**	**Oil**	**Air**	**Oil**	**Air**
ROCK SHOX						
RS 1 (lOwt)	50-55mm	35-40psi	**45-50rnm**	**38-42psi**	40-45mm	42-48psi
92 Mag 20 (8wt)	35-40mm	35-40psi	**32-35mm**	**38-42psi**	*27-32mm*	42-48psi
92 Mag 30 (8wt)	50-55mm	35-40psi	**45-50mm**	**38-42psi**	40-45mm	42-48psi
93 Mag 21 (8wt)	40-45mm	35-40psi	**35-40mm**	**38-42psi**	30-35mm	42-48psi
93 Mag 10 (8wt)	50-55mm	35-40psi	**45-50mm**	**38-42psi**	40-45mm	42-48psi
94 Mag 21, SL, SL Ti (5w0	40-45mm	35-40psi	**35-40mm**	**38-42psi**	30-35mm	42-48psi
94 Mag 10 (5w1)	50-55mm	35-40psi	**45-SOmm**	**38-42psi**	40-45mm	42-48psi
93, 94 Mag 10 Long Travel (8wt)	45-50mm	38-42psi	**40-45mm**	**40-45psi**	35-40mm	42-psi
93, 94 Mag 21 Long Travel (8wt)	40-45mm	38-42psi	**35-40mm**	**40-45psi**	30-35mm	42-50psi

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important Note: Oil height is measured in millimeters from the top of the stanchion to the oil surface **when stanchion is fully compressed.** Stock oil viscosity is listed with each rnanufacturer/ model. Information in this chart supplied by ***Bicycle Technology International (B17).***

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

ROCK SHOX: Mags Quadras (cont'd)

Torque Specifications:

Model	Crown Bolts	Brake Brace Bolts	Cantilever Studs	Valve Assembly
RS-1	27 ft. lbs.	7 ft. lbs.	9 ft. lbs.	body: 35 ft. lbs. bolt: 5 ft. lbs.
Mag 10, 21	5 ft. lbs.	5 ft. lbs.	9 ft. lbs.	body: 35 ft. lbs.
Quadra 10	n/a	5 ft. lbs.	9 ft. lbs.	top cap: 5 ft. lbs

The Mag series of forks and the Quadra RS-1 are air sprung, oil damped telescoping leg forks. Older models come with 8wt oil ('94's use Swt oil). The Quadra series (except the RS-1) are elastomer sprung, friction damped telescoping leg forks.

Mag series: The Mag series of forks with the negative spring have coil spring top-out and elastonier bottom-out bumpers. The other forks have bumpers for both bottom-out and top-out.

To remove the top caps with adjuster knobs, hold the adjuster knob steady or the circlip at the bottom of the stanchion may unclip or bend, or the adjuster rod may bend. Do not force the adjuster knob to turn.

Disassembly of the forks is straightforward, but requires special tools. The eight steps to a smooth disassembly are as follows: 1) release the air pressure, 2) remove the leg, 3) remove the top cap, 4) pour out the oil, 5) remove the upper dust seal cover and snap ring, 6) screw the seal remover (part #70113) together and put it over the stanchion, 7) clamp the stanchion in a vise with the stanchion blocks (part #70101), and 8) separate the seal from the slider by unscrewing the seal remover. Unscrew the valve body with the valve body tool (part #70105) only when necessary.

When re-assembling an adjustable Mag fork, make sure you have the seals right side up. Replace the air cap, hand tighten it and turn the adjuster knob counterclockwise until it stops. The number 1 should line up with either the arrow or the slot in the crown. Look for the arrow on the top of the crown. if the number 1 does not align with either, rotate the stanchion until it does.

Mag 20: When adding oil, pump the stanchion slowly to keep from popping out the bottom plate. This will distribute the oil evenly and get rid of the air bubbles.

Mag 21: When removing the top cap with adjuster knob, hold the adjuster knob steady or the circlip at the bottom of the stanchion may unclip or bend, or the adjuster rod may bend. Do not force it to turn.

Quadra series: Ali the Quadras have a top-out coil spring and bottom-out bumper.

lubricate the elastomers well, especially at the ends so they do not twist when tightening the top cap or when preloading, or the elastomers may tear from the twisting. The boots are all that protect the Quadra bushings from contamination so make sure the boots are well seated.

SUSPENSION FORKS

DESIGN ELEMENTS – SERVICE NOTES (cowry)

ROCK SHOX: Mags bz Quadras (cont'd)

Disassembly is a three-step procedure: 1) sliding the boots up, 2) removing the snap rings, and 3) pulling sharply on the sliders. If the sliders do not pull free, spray some light lubricant into the sliders and heat with a hair dryer. Do **not ignite the** lubricant! Try again to separate the sliders from the stanchions.

Make Ea Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
ROCK SHOX Mag 10'93	Telescopic	air	hydraulic	16"	Std:11/2" Opt: 11/4"	13/4"	0-ring/ 0-ring	
Mag 10 '94	Telescopic	air	adjustable hydraulic	16"	Std:1 1/2" Opt: 11/4"	13/4"	coil spring/ 0-ring	
Mag 10 '94 Long Travel	Telescopic	air	adjustable hydraulic	16"	Std:11/2" Opt:11/4"	21/4"	coil spring/ 0-ring	
Mag 20 '91, 92	Telescopic	air	adjustable hydraulic	16"	Std: 1 1/2" Opt: 11/4"	1 3/4"	0-ring/ 0-ring	
Mag 21 '93	Telescopic	air	adjustable hydraulic	16"	Std: 1 1/2" Opt: 11/4"	**13/4"**	coil spring/ 0-ring	
Mag 21 '94	Telescopic	air	adjustable hydraulic	1 6"	Std: 11/2" Opt: 11/4"	1 3/4"	coil spring/ 0-ring	
Mag 21 SL '93	Telescopic	air	adjustable hydraulic	16"	Std: 1 ⁄2" Opt: 1 1/4"	13/4"	coil spring/ 0-ring	
Mag 21 SL/T1	Telescopic	air	adjustable hydraulic	16"	Std: 1 1/2" **Opt:** 1 1/4"	13/4"	coil spring/ 0-ring	
Mag 21 '93 Long Travel	Telescopic	air	adjustable hydraulic	161/2"	Std: 11/2" Opt: 11/4"	21/4"	coil spring/ 0-ring	
Mag 21 '94 Long Travel	Telescopic	air	adjustable hydraulic	161/2"	Std: 1 ⁄2" Opt: 11/4"	*21/4"*	coif spring/ 0-ring	
Mag 21 700C	Telescopic	air	adjustable hydraulic	15 5/x"	Std: 1 1/2" Opt: 11/4"		coil spring/ 0-ring	
Mag 30 (-'91)	Telescopic	air	hydraulic	16"	5t& 11/2" Opt: 11/4"	13/4"	0-ring/ 0-ring	
Quadra	Telescopic	polymer-spring	friction	**16"**	1 1/2"	**13/4"**	coil spring/ 0-ring	

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

ROCK SHOX: Mags iSt Quadras (cont'd)

Make Sr Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
ROCK SHOX (cont'd) Quadra 10	Telescopic	elastomer	friction	16"	1 1/2"	1 1/4"	coil spring/ 0-ring	
Quadra 21	Telescopic	elastomer	friction	16"	1 1/2"	1 3/4"	coil spring/ 0-ring	II
RS-1	Telescopic	air	hydraulic	16"			0-ring/ 0-ring	II

RST: 200, 300, 380, 400, 460, 500, 600

RST 380: The RST 380 is a telescoping leg fork with a combination of elastomers and coil springs. Preload is adjustable at the tops of the stanchions with a 6mm allen wrench. Remove the elastomer and coil spring stack by unscrewing the top cap by hand or with a 10mm alien wrench. Then remove the springs and elastomers from their skewers by holding the brass cap on the end of the skewer with pliers and unscrewing the preload adjuster with a 6mm allen wrench. Remove the sliders by unscrewing the shaft assemblies in the stanchions with a long 8mm alien wrench. Minimum clearance is 52mm from the tire to the crown.

Elastomers:

Stiffness	Elastomer Color
soft	yellow
firm	blue

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Torque Specifications:

Bolt	Torque (In lbs.)
crown bolts	100-120
brake arch bolts	100-120

Make Sr Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
RST 380	Telescopic	elastomer & coil spring	elastomer	161/4"	1 1/2"		bumper/ lone	I I

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

SCOTT USA: Unishock (Pre '93)

Unishock, Unishock LF, Unishock LFR, Unishock 5, Unishock TX, Unishock VR:

The Scott Unishocks are a unicrown style, telescoping leg design. The steerer, crown, and stanchions are one piece. They all share the same basic design, but differ in materials and the type of spring they use. All have spring preload, adjustable with a 4mm alien wrench through the hollow bolts at the bottom of the sliders. The preload screw can be tightened down 1cm, which is about 10 turns, from the fully loosened position. 'ate preload probably has a wider range, but tile manufacturer does not recommend it.

The coil spring forks, Unishock and Unishock 5, have 1/2" bottom-out and top-out bumpers. Elastomer spring forks have 1/4" bottom-out and 1/2" top-out bumpers.

The springs are accessed by removing the plunger bolts with Omm alien wrenches. This allows you to remove the sliders, remove the bottom-out bumper from the plunger, and then use a pin spanner or a special Scott pin tool to remove the ringnut. The springs will then slide out the stanchions.

The Unishocks TX, VR, LF, and LFR models may have either the VR elastomers (a stack of four 3cm-long elastomers with plastic separators between them on a skewer) or microcellular urethane (a single solid cylinder about 13cm long). Do not mix different VR elastomers.

Older models have a one-piece split bushing inside each slider. Newer models have two half-circle bushings that should be matched. You can remove and clean the bushings and re-install them.

When removing them, keep them in a matched set: do not mix the sleeves from one leg with the other. Do not clean the bushings with solvents. Install the sleeve bushings tapered end first.

All the coil spring forks are only friction damped. Therefore, the manufacturer warns not to grease the complete leg, just the sea] or boot area. The elastomers have some degree of damping incorporated into them, so you can grease the complete stanchion on the elastomer forks or just the seal or boot area for more friction damping. Also, grease the thread bolts on all the forks and the elastomers. Do not apply any torque to the thread bolts as preload adjustments are made. The seals or stanchions should be cleaned and greased frequently: every 25 hours of use or less.

Minimum clearance for all models except the TX is 1.9" from the top of the tire to the bottom of the crown.

VR Elastomers:

Density	Elastomer Color
soft	green
medium	black
firm	yellow

DESIGN ELEMENTS - SERVICE NOTES (CONT'D)

SCOTT USA: Unishock (Pre '93) (cont'd)

Torque Specifications:

Bolt	Torque (in. lbs.)
hollow ringnut	8-10
lunger bolts	10

Make ix Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
SCOTT Unishock (pre '93)	Telescopic	coil spring	none	161/4"	.1/2"	1 3/a"	bumper/ bumper	
Unishock LF	Telescopic	elastomer	elastomer	1 61/4"	1 1/2"	1 3/a"	bumper/ bumper	
Unishock LFR	Telescopic	elastomer	e astomer	1 6 1/4"	1'/2"	1 3/4"	bumper/ bumper	
Unishock S	Telescopic	coil spring	none	16'/4"	1 1/2"	1 3/4"	bumper/ bumper	
Unishock VR	Telescopic	elastomer	elastomer	16'/4"	1 1/2"	1 3/4"	bumper/ bumper	
Unishock TX	Telescopic	elastomer	,istomer	16 1/2'	1 1/2"	1"	bumper/ bumper	

SHOCK WORKS: Motivator, Liberator, Enforcer, Enforcer FactoryTune

file Enforcer and the Liberator are telescoping lug, air/oil forks. The Enforcer has damping knobs on top while the Liberator has preset damping. After removing the circlip under the upper seal, remove the lower seal much in the same way as the seals are removed from the Rock Shox RS-1 or the Marzocchi XC-150: add oil to the shock, cap it off, and compress the fork, making the oil pressure pop out the seal. Disassemble the rest of the stanchion much in the same way as the upper seals are removed from the Rock Shox Mag 20: use the seal puller and the stanchion clamps to extend the stanchion until the pressed-in upper hushing is removed. Remove the stop-per at the bottom of the leg by applying compressed air to the hole at the axle seat. Be careful, the stopper can go flying across the room. It can also he removed with a spoke, though that may scratch the inside of the leg or tear the 0-ring on the stopper.

Be careful with the adjuster rod on the Enforcer as it is made of aluminum and may easily crack or break. In addition, be especially careful when tightening the nut at the bottom of the adjuster. Align the valve and valve plate properly so their grooves are aligned with each other and the adjuster rod.

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

SHOCK WORKS: (cont'd)

Press the stanchion all the way down to force the stopper to the bottom of the leg when re-assembling the fork.

Torque Specifications not available.

Recommended Oil Volume:

Model	Recommended Oil Volume
Enforcer	80cc
Liberator	83cc
Motivator	95cc

Make El Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
SHOCKWORKS Enforcer	Telescopic	air	adjustable hydraulic	16 Ye	N/A	1 3/4"	bumper/ bumper	II
Liberator	Telescopic	**air**	adjustable hydraulic	16W	N/A	1 3/4"	bumper/ bumper	II
Motivator	Telescopic	air	adjustable hydraulic	1 6 3/8"	N/A	1 3/4"	bumper/ bumper	II

SHOWA: EX-7

The Showa EX-7 fork allows an adjustment range of 15mm air volume using the knob at the bottom of the legs. This means there is no need to take the fork apart to change the oil level. Adjust the air volume, and he sure to adjust the air pressure afterward. It is easier to make adjustments to the air volume if there is lower air pressure.

To change the oil, check that the adjusters at the bottom of the legs are in the same position. Preferably, the adjusters should be at the uppermost position, because the fork needs to be pressurized to allow for proper downward motion of the air piston.

The manufacturer claims that the seals and surface of the stanchions are maintenance-free.

The seals are pressed in very tightly. To remove them, fill the stanchion with oil and cap it off. Do not get any air bubbles in the oil. Use a lever (such as a 2 x 4) to press down on the stanchion and blow out the seal. Protect the stanchion and slider. An alternate way to remove the seals in three steps: 1) set the legs to the maximum **air** volume, with the stanchion capped and completely

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

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SHOWA: EX-7 (coned)

filled with oil and in the fully extended position; 2) tighten the knob on the bottom of the leg; and 3) decrease the "air" volume until the seal pops off. You may need a hook spanner to tighten the adjuster knob and you may have to fill the leg with oil more than once. **These repairs can create tremendous pressures, so make sure the end of the stanchion is not pointed at anyone and cover the seal area with a rag in case of oil spillage or spray.**

Recommended Oil/Air Heights (for various rider weights):

Model	Below 140 lbs		140-180 lbs		Above 180 lbs	
	Oil	Air	Oil	Air	Oil	Air
SHOWA EX-7	54mm	30-38psi	**49mm**	**35-42psi**	44mm	42-45psi

Important Note: Oil height is measured in millimeters from the top of the stanchion to the oil surface **when stanchion is fully compressed.** Stock oil viscosity is listed with each manufacturer/model. Information in this chart supplied by ***Bicycle Technology International (BM.***

Make Ea Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
SHOWA EX-7	Telescopic	air	hydraulic	16 1/8"	1 1/2"	13/4"	bumper/ bumper	.1. 1 I

SPECIALIZED: Future Shock

FSX '94, SE '93, SE '94, FSX '93, FS '93, FS '92, FS '94

Future Shock Sport '94: The Future Shock Sport is similar to the Rock Shox Quadra 10. Most of the same procedures apply to both shocks. ***See Rock Shox Quadra 10*** for available crown/steerer/stanchion combinations and elastomers. It differs in that the negative spring is mounted slightly differently.

The '91 and '92 FS Standard forks arc like the Mag 30 fork except the Future Shock lacks a valve spring washer. '93 and '94 Non-adjustable FS forks are similar in construction to the '91 and '92 ES Standard fork except the valve mechanism is different.

The Mag crowns can be used on the Specialized air/oil forks and the Rock Shox fork brace fits any of the Specialized forks (up to 1995 models).

continued on next page

DESIGN ELEMENTS - SERVICE NOTES (coNro)

SPECIALIZED: Future Shock (cont'd)

Recommended Oil/Air Heights (for various rider weights:)

Model	Below 140 lbs Oil	Below 140 lbs Air	140-180 lbs Oil	140-180 lbs Air	Above 180 lbs Oil	Above 180 lbs Air
SPECIALIZED						
92 non-adjustable (lOwt)	43mm	35-40psi	**38mm**	**38-42psi**	33mm	42-48psi
92 adjustable (1 Owt)	49mm	35-40psi	**44mm**	**38-42psi**	33mm	42-48psi
93 SE (lOwt)	49mm	35-40psi	**44mm**	**38-42psi**	39mm	42-48psi
93 FS, FSX (lOwt)	43mm	35-40psi	**38mm**	**38-42psi**	33mm	42-48psi
94 FS (5wt)	43mm	35-40psi	**38mm**	**38-42psi**	33mm	42-48psi
94 FSX Carbon (5w1)	43mm	35-40psi	**38mm**	**38-42psi**	33mm	42-48psi

I**mportant Note:** 011 height is measured in millimeters from the top of the stanchion to the oil surface **when stanchion is fully compressed.** Stock oil viscosity is listed with each manufacturer/model. Information in this chart supplied by ***Bicycle Technology Ititertiational (B11).***

SR: DuoTrack, DuoTrack 7001, DuoCross SPK-8001, DuoTrack SPK-8001, DuoTrack 9001, DuoTrack SPK-200

SR DuoTrack and DuoCross suspension forks are standard telescoping leg forks with the stanchions, steerer, and crown bonded together. The sliders are bolted through slots in the stanchions. When removing the sliders, it is not necessary to remove the fork brace; just remove both legs at the same time. When unscrewing and removing the slider retaining bolts, compress the fork slightly to take any side loads off the bolts because the springs may be preloaded a little.

The slider retaining bolt also holds in the bushings. When re-installing the bushings, align the holes in the bushings with the holes in the slider. A tip for this alignment is to install one of the half bushings, put the stanchion retaining bolt through the hole in that bushing, and then install the other half of the bushing. install the bottom-out bumper before installing the bushings.

The 7001 has a main coil spring, a top-out coil spring, and a coil spring bottom-out bumper. Minimum tire clearance is about 40mm. The manufacturer lists the maximum tire diameter as 668min or roughly 26 x 2.1 tire size.

The 7001 is available for 20", 22", 24", 26", and 700C wheels with cantilever brakes.

The 8001 is available in 26" mountain hike or 700C hybrid versions.

The 9001 has a removable elastomer spring. Simply unscrew the yellow knob at the bottom of the sliders. Adjust elastomer preload by turning the alien screw at the bottom of the slider. Top-out is provided by a plastic bumper. There is no bottom-out.

DESIGN ELEMENTS - SERVICE NOTES (CONT'D)

SR: DuoTrack (cont'd)

Steerer/Crown Assemblies:

Steerer Tube Outside Diameter	Lengths
1"	150, 180, 210mm
1'/R"	**150, 180, 210mm**

Elastomers:

Density	Elastomer Color
soft	blue
medium	yellow
firm	red

Torque Specifications:

Bolt	Torque (in. lbs.)
fork brace bolts	70
slider retaining bolt	j 70

Make & Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
SR DuoTrack 7001	Telescopic	coil spring	none	N/A	1 3/4"	13/8"	N/A	
DuoCross SPK-8001	Telescopic	elastomer	none	1 71/2"	1 5/8"	1 3/8"	bumper/ none	
DuoTrack SPK-8001	Telescopic	elastomer	none	N/A	N/A	1 3/4"	bumper/ none	
DuoTrack 9001	Telescopic	elastomer	none	163/g"	1 1/2"	1 W	bumper/ none	
DuoTrack SPK-200	Telescopic	spring*	N/A	1 61/8"	1 W	1 W	coil spring/ bumper	

* Can upgrade to elastomer.

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

TANGE: Struts, Shockblades

ProStruts, Race Struts '94, Struts-S '94, Struts-GS '94, Struts '93, Shockblades

The Lange Struts style forks (ProStruts, Race Struts, Struts-S, Struts-GS, Struts, Shockblades) are similar in most respects. They have one-piece steerer, crown and stanchion combinations. Only the Shockblades have a separate, clamp-together style crown, steerer and stanchions. All the Struts and the Shockblades are telescoping leg, elastomer forks. The forks are not rider adjustable. The possible adjustments are the ones standard on an elastomer fork. The elastomers are interchangeable and a slightly greater elastomer stack height can be used to increase spring preload. Remove the lower leg fixing bolts in the stanchions to get to the elastomers. Then remove the sliders with the elastomers inside. Only the dust seal and the seal protector (and an 0-ring, depending on the model) keeps the upper bushing in place. Re-install these seals properly. The dust seal fits on the groove inside the slider, the seal protector fits over the dust seal and slider with the dust seal sticking partway through the seal protector. The 0-ring fits in the groove on the dust seal; you should be able to put the 0-ring on after the seal protector. If these are not installed properly, the seals could come loose. This might lead to a displaced upper bushing.

There are top-out bumpers but no bottom-out bumpers. There are also no bottom-out stops, so use the proper elastomers and stack height. The elastomer stack height should he 90mm for the Shockblades, Struts, Stnits-S, and Struts-GS; 120mm for the Race Struts and Pro Struts.

Pro Struts, Struts-GS Steerer/Crown Assemblies:

Steerer Tube Outside Diameter	Lengths (millimeters)
1"	140, 170, 200, 230, 260 unthreaded
1 W	140, 170, 200, 230, 260 unthreaded

Struts Struts-S Steerer/Crown Assemblies:

Steerer Tube Outside Diameter	Lengths (millimeters)
1	130, 160, 190, 220, 250 unthreaded
1 W	130, 160, 190, 220, 250 unthreaded

Shockblades Steerer/Crown Assemblies:

Steerer Tube Outside Diameter	Lengths
1"	130, 160, 190, 220, 250mm
1 W'	130, 1 60, 190, 220, 250mm

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

TANGE: Struts (cont'd)

Elastomers (color on end of elastomer):

Density	Elastomer Color
soft	black
medium	i)atural or green
hard	black

Torque Specifications:

Bolt	Torque (in. lbs.)
lower leg fixing bolts	60-70, 50-60 for ProStruts
crown fixing bolts	240-360
brace bolts	1 05-110
brake bosses	120

Make SI Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
TANGE Shockblades	Telescopic	elastomer	elastomer	16'/a"	13/8"	1 1/2"	bumper/ none	I
Struts '93	Telescopic	elastomer	elastomer	1 6 1/2"	1 3/s"	1 1/2"	bumper/ none	
Pro Struts	Telescopic	elastomer	elastomer	16Y"	1 W	1 1/2"	bumper/ none	
Struts-GS '94	Telescopic	elastomer	elastomer	1 6 1/2"	1 W	1 1/2"	bumper/ none	
Struts-S '94	Telescopic	elastomer	elastomer	16 1/2"	1 3/s"	1 1/2"	bumper/ none	
Race Struts '94	Telescopic	elastomer	elastomer	1 61/2"	13/8"	1 1/2"	bumper/ none	

TIOGA: Shock Fork *(See TANGE: Struts)*

SUSPENSION FORKS

DESIGN ELEMENTS - SERVICE NOTES (CONT'D)

TREK: DS, Mogul, Shockwave

DDS-3 '92, 135-2 '92, Mogul '93, Mogul Black Diamond '93, Mogul Extreme *(See Show(' EX-7),* **Shockwave** *(See lunge Struts)*

The DS-2, DDS-3, and Mogul series of forks are made for Trek by Showa. The Showa forks share many of the same design elements. The Mogul Black Diamond is similar to the Mogul Extreme except the Mogul Extreme has adjustments for variable air volume, but otherwise the disassembly and servicing is the same. The Mogul is not adjustable like the Mogul Black Diamond or the Mogul Extreme hut, the disassembly is very similar. The DDS-3 adjusts the same as the Mogul Black Diamond, but a separate tool (Trek part #T82314) is needed to adjust the damping. The DDS-3 does not have adjuster knobs on the top of the stanchions.

On the DDS-3, the Mogul Black Diamond, and the Mogul Extreme, it is possible to completely unscrew the adjuster rod from the valve body. Thread the adjuster rod completely back on when you re-install it.

The DS-2, DDS-3, and Moguls are air sprung, oil damped, telescoping leg forks. Many of the parts are interchangeable between the models. The stiffer Mogul brake arch fits on the DS-2 and DDS-3 when used with longer brake studs and arch bolts. The Moguls use an integrated crown and steerer tub, the older DS-2 and DDS-3 had a separate steerer tube and crown, but can use the Mogul steerer tube and crown combination. On all these forks, the stanchions should extend 3mm out of the crown.

The seals on all forks are pressed in very tightly. To remove them, fill the stanchion with oil and cap it off. Do not get any air bubbles in the oil. Use a lever (such as a 2 x 4) to press down on the stanchion to blow out the seal. Protect the stanchion and slider. For the Mogul Extreme, set the legs to the maximum air volume, with the stanchion capped and completely filled with oil and in the fully extended position. Tighten the knob on the bottom of the leg, decreasing the "air" volume until the seal pops off. You may need a hook spanner to tighten the adjuster knob and you may have to fill the leg with oil more than once. **These repairs can create tremendous pressures so make sure the end of the stanchion is not pointed at anyone and cover the seal area with a rag in case of oil spillage.**

For re-installation, a slide hammer may be needed to use on the bushings and seals. Place the installation cap provided with the rebuild kit over the end of the stanchion to prevent scratching the seal. Then place the seal in the slider so that the spring on it will be hidden. [he rebuild kit will work on any of the Trek air/oil forks.

For the DS-2 and DDS-3, newer bushings with better tolerances are available.

Steerer/Crown Assemblies (DS-2, DDS-3, and Mogul series):

Steerer Tube Outside Diameter	Lengths (millimeters)
1"	150, 171, 206, 255 unthreaded
1 1/8"	150, 171, 206, 210, 255 unthreaded, 255 unthreaded alloy

DESIGN ELEMENTS – SERVICE NOTES (CONT'D)

TREK: DS, Mogul, Shockwave (cont'd)

Recommended Oil/Air Heights (for various rider weights):

Model	Below 140 lbs		140-180 lbs		Above 180 lbs	
	Oil	Air	Oil	Air	Oil	Air
TREK						
DS2 (15wt)	63mm	30-38psi	**58mm**	**35-42psi**	53mm	42-45 psi
DDS3 (15wt)	59mm	30-38psi	**54mm**	**35-42psi**	49mm	42-45psi
93 Mogul (lOwt)	63mm	30- 38psi	**58mm**	**35-42psi**	53mm	42-45 psi
93 Black Diamond(1 Owt)	59mm	30- 38psi	**54mm**	**35-42psi**	49mm	42-45psi
94 Mogul (10wt)	52mm	30-38psi	**47mm**	**35-42psi**	42mm	42-45psi
94 Black Diamond (8wt)	48mm	30-38psi	**43mm**	**35-42psi**	38mm	42-45psi
94 Extreme (8wt)	54mm	30-38psi	**49mm**	**35-42psi**	44mm	42-45psi

Important Note: Oil height is measured in millimeters from the top of the stanchion to the oil surface **when stanchion is fully compressed.** Stock oil viscosity is listed with each manufacturer/model. Information in this chart supplied by ***Bicycle Technology International (BIT).***

Torque Specifications:

Bolt	Torque (in. lbs.)
pinch bolts (for separate crown and steerer)	330-380
pinch bolts (for integrated crown and steerer)	78-96
arch bolts	90-110
brake bosses	90-110
brake arch cable stop bolts	55-70

Make & Model	Kind of Fork	Spring	Damping	Length (Axle to Crown)	Rake	Travel	Top-out/ Bottom-out	Crown Assembly
TREK DS-2	Telescopic	air	oil	N/A	1 1/2"	N/A	elastomer/ elastomer	II
DDS-3	Telescopic	air	oil	N/A	1 1/2"	N/A	elastomer/ elastomer	II
Mogul	Telescopic	air	oil	16W	1 1/2"	1 3/d"	elastomer/ elastomer	II
Mogul Black Diamond	Telescopic	air	oil	1 6W	1 1/2"	1 3/4"	elastomer/ elastomer	II
Mogul Extreme	Telescopic	air	oil	163/8"	1 1/2"	1 3/4"	elastomer/ elastomer	II

SUSPENSION FORKS

TROUBLESHOOTING

Symptom	Cause	Remedy
GENERAL		
The adjuster knob is locked and will not turn.	Dirt or grit is stuck under the knob or on the adjuster shaft.	Remove and clean. Check for rust. Grease the adjuster rod.
Fork seems to "top out" or has a slight clunky feeling when front wheel comes off the ground.	Rebound bumper is insufficient.	Remove, inspect, and replace, if necessary.
	There is not enough rebound damping.	Put in heavier weight oil or remove grease from friction surfaces.
	Spring preload is too strong.	Decrease spring preload or install softer springs.
Fork doesn't turn.	Headset is too tight.	Adjust headset, check clearances on bushings.
	Steerer tube damaged.	Remove and inspect fork for signs of cracking, bending, or stress.
Fork feels sluggish and is not getting the travel it had when it was new.	The seal is dragging.	Remove, clean and lube seals.
	Parts are worn or bent.	Check stanchions for bending, make sure they are still parallel. Check all parts for signs of cracking, bending, stress, discoloration, etc.
Outer legs feel loose on inner legs and bushings; a knock or rock can be felt when pushed from side to side.	Bushings or stanchions are worn.	Measure and replace.
Fork rocks back and forth easily.	See "Outer legs feel loose..."	
	Steerer is damaged.	Remove and inspect.
Feels like a loose headset.	Headset is loose.	Tighten.
	Steerer is pulling loose.	Check steerer for damage. Inspect underneath crown at the steerer - check for slippage. If there is a clean area near the steerer with vertical scratches or

TROUBLESHOOTING (CONT'D)

Symptom	Cause	Remedy
GENERAL (cont'd)		
Feels like a loose headset (cont'd).	Steerer is pulling loose (cont'd).	other signs of slippage, replace steerer/crown combo, or tighten crown pinch bolts. Make sure there are mechanisms in place to prevent steerer slippage (lips on the steerer, circlips around the steerer under the crown, or a pin or bolt through the steerer).
Sliders are bent or dented.	Crash; left bike on roof rack and pulled into garage.	Replace.
Stanchions are scratched.	Main seal is worn, bushing is too large, dirt is intruding.	Replace stanchions, clean everything else. Inspect and replace bushings and seals if necessary.
Brake posts shear off.	Crashed or over tightened brake posts.	Replace posts, apply Loctite.
	Threads were stripped.	Replace slider, use helicoil kit to restore stripped threads.
Legs show corrosion.	Bare magnesium and aluminum are reactive to salt.	Get the legs painted or otherwise protected.
Stanchions are sliding on legs.	Insufficient grip at crown.	Tighten bolts to correct torque. Clean oil off stanchion and crown contact areas or roughen surfaces.
Tire hits down tube, handling is poor.	Crown is on backwards.	Remove legs and turn crown around.
Tire hits crown.	Tire is too large.	Check tire clearance.
	Bottom-out bumper is missing or too small.	Inspect bottom-out bumper, replace if necessary.
	Legs are clamped too low.	Legs should be clamped into the crown properly.

continued on next page

I TROUBLESHOOTING (CONTD)

Symptom	Cause	Remedy
GENERAL (cont'd)		
Legs are binding.	Stanchions are bent.	Remove sliders. Inspect them to be sure they are straight, and they are parallel when clamped into crown.
	Bearings are dirty or dry.	Clean and re-lubricate.
	Bearings are the wrong size.	Measure and replace.
Wheel is riot centered in fork,	Wheel is not dished.	Dish wheel.
	Legs are not aligned.	To align legs, unbolt fork brace, loosen stanchion bolts and align stanchions on crown properly.
Fork pulls to one side, or wheel tilts to one side while fork is compressed.	Spring tension or damping is uneven.	Adjust, check that oil in each leg is the same height and weight.
AIR/OIL		
Fork doesn't spring back.	No air pressure.	Check air pressure.
	Valving holes may be clogged.	Clean and overhaul fork.
Damping is inconsistent.	Too little oil.	Add oil.
	Oil is foaming.	Use different formulation oil.
	Oil dirty or damping holes blocked.	Overhaul and clean, replace oil.
Always loses air pressure,	Seal is bad.	Check air valve, (Schraeder cores can be replaced). Inspect upper seals and 0-rings.
Oil is leaking.	Seal is bad.	Inspect all seals and 0-rings; replace as necessary.
	Stanchions are worn.	Measure and replace.
	Bolt has punched through slider.	Check for oil leaking around bolt hole; replace slider and use a shorter bolt next ti me,

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TROUBLESHOOTING (CONT'D)

Symptom	Cause	1 Remedy
AIR/OIL (cont'd)		
Seals have blown out.	Seals are old.	Replace seals.
	Seal retaining ring or circlip is not seated properly, or is missing.	Make sure the retaining ring or circlip is located in the lowest groove on the slider.
ELASTOMER		
Elastomer is cracking.	Elastomer is too weathered, worn, or over-torqued.	Replace and grease.
Difficulty starting the skewer cap because of excessive elastomer preload.	There is excessive elastomer preload.	Decrease preload.
It is difficult to start the skewer.	Excessive elastomer preload.	Decrease preload.
	Bolt hole is not chamfered.	Be patient, keep trying.
	Bolt or bolt hole is stripped.	Replace bolt or stanchion (swap bolts and legs to see which is stripped).
SPRING		
Bottoms out too easily	Spring is too weak.	Replace spring with stiffer spring or increase preload.
Spring rebounds harshly.	This is inherent in some designs.	Replace with different rebound bumper.
	There is not enough damping.	Increase damping. For friction damping: wipe off grease from bushings or other friction areas.

TIRE CLEARANCE

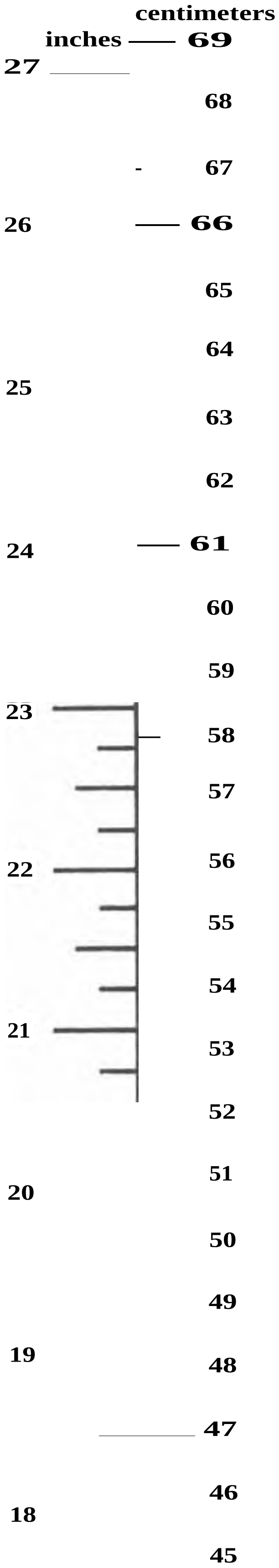
Check that the top of the tire is far enough away from the bottom of the crown. if the crown and stanchions are separate, it may be possible to get a crown with greater clearance.

DOWN TUBE CLEARANCE

Completely rotate the handlebars to check the clearance from the crown to the down tube. No matter what position the fork is in while turning, the crown should never hit the down tube. Some manufacturers make alternate crowns that are narrower and shorter. Others add a spacer underneath the headset crown race to bring up the head tube and angle the crown further from the down tube.

Do not raise the stanchion tubes above the fork crown. This reduces fire clearance.

Important note: Fork brace bolts tend to wear because of removal and overhaul; replace as needed.



TUBING OUTSIDE DIAMETERS

Standard Steel Tubing Frames

Frame Member	**English**	**French**	**Italian**	**USA**	**Early Mtn. Bikes**
Top Tube	25.4mm	26mm	25.4mm	*22.2mm*	28.6mm
Down Tube	28.6mm	28mm	28.6mm	25.4mm	31.75mm
Seat Tube	28.6mm	28mm	28.6mm	25.4mm	28.6mm
Head Tube	31.75mm	32mm	31.75mm*	Various	31.75mm
Steering Column	25.4mm	25mm	25.4mm	25.4mm	25.4mm
Mixte Tubes	13 or 14mm	13 or 14mm	13 or 14mm		

* Bianchi with Special Bianchi headset uses 30mm head tube.

Chain stay, seat stay, and fork blade dimensions vary between tubing manufacturers and it is difficult to make generalizations.

Other materials: Due to differences in physical properties, these may be engineered differently and have different dimensions depending on the design constraints determined by the manufacturer.

Comparative Scale Only

GEAR HANGERS

Thread Sizes

French 10111[11 1 nun **Italian** 10mm x 26 TPI

Drop-out gear hangers are most often French threaded. French, Spanish, and Japanese equipment is all French threaded.

Damage to the threads of both the gear hanger bolt and the drop-out occurs when threading a 10mm x lmm gear hanger bolt into a 10mm x 26 TPI hole and vice versa. The damage is slight, however, because 26 TPI is very dose to 1 thread per millimeter or 25.4 TPI. Running a tap of the correct size through the drop-out will minimize the damage.

Rear Drop-out Threads

Make	Gear Hanger Threads	Rear Tip Adjusters	Mud Guard Eyes
Campagnolo	10mm x 26TP1	3mm x 0.5mm	5mm x 0.8mm
Huret	10mm x lmm	3mm x 0.6mm	**4mm** hole with no threads tapped easily to 5mm x 0.8mm
Shimano	10mm x 1**mm**	3mm x 0.5mm	5mm x **0.8mm**
Simplex	9mm hole with no threads tapped easily to 10mm x 1 mm	3mm x 0.5mm	5.0mm hole with no threads
SunTour	1 0mm x 1 mm	3mm x 0.5mm	5mm x 0.8mm
Zeus	**10mm x 1 mm**	**3mm x 0.5mm**	**5mm x 0.8mm**

REPLACING FORKS

Viscount and Lamhert aluminum forks break without warning and should be replaced with steel forks.

The main problem in replacing a fork is that the original is often damaged, which makes it difficult to determine its characteristics such as rake and length..

Factors That Affect Handling

Rigidity: Unlike other frame members, the fork is not triangulated- it functions as a beam. The fork receives stress from the wheel and either transmits it to the frame or dissipates it by flexing (in the case of suspension forks, the fork dissipates much of the stress by compressing). A replacement fork should match the original in construction and materials unless a change in ride is desired.

Rake: The rake of a replacement fork should closely match that of the old one. Small changes in rake (on the order of 1/4") will quicken (less rake) or slow (more rake) the handling slightly. Larger changes will generally make the hike uncomfortable to ride.

REPLACING FORKS (CONT'D)

Factors That Affect Handling (cont'd)

Length: The length of the fork measured from the crown race seat to the center of the axle should also match that of the old fork. If the new fork is longer than the old, the head of the frame will be higher and the effective head angle will be decreased. The reverse is true if a shorter fork is used. As with changes in rake, changes in head tube angle affect the handling of the hike. Small changes are less likely to as unpleasant as large changes. Trail is a function of the headtube angle, the rake of the fork, and the outside radius of the wheel. Since head angle is dependent on the length of the fork, changes in the fork length and rake will also change the trail. if it is not possible to preserve the original forks length and rake, at least try to keep the trail the same. 11 you have to change either length or rake, change both. Using a replacement fork with less rake and less length will often give a faster handling but still balanced bicycle. Using a fork with more length and more rake results in slower bike handling.

In general, for a 26" to 27" wheel bike (with about a 40" wheelbase), a 1" increase in the length of the fork will result in approximately 1.3° decrease in head angle and 5116" increase in trail. This increase in trail can be diminished to almost nothing (1132") by increasing the rake of the fork by 1/4".

Factors That Affect Fit

Wheel: The dropouts should be the same distance apart as the lockriuts so the wheel can he installed acid removed easily.

The dropout slots should be approximately the same width as the diameter of the hub axle so that the axle can fit into the slot vet locate accurately. The dropouts should be thick enough for the quick release to clamp them firmly, If necessary, the ends of the axle can be filed or ground slight-ly shorter so that the quick release can be adjusted close enough to clamp tight on the dropouts.

Frame: The steerer must be sufficiently longer than the head tube to allow for the headset and stem in the case of pinch bolt style stems) to be installed. ***(Seepage 14-9 in Headset chapter.)***

Threads: If the steerer needs to be cut to length, enough threads must remain after cutting to allow the headset to be installed. Some steerers are made of an inappropriate material to thread or are butted such that extra threads would weaken the tube; otherwise, the steerer can he threaded to increase the length of the threaded portion. ***(See section on thread cutting, pages 0-6 to 0-8 and 0-11 to 0-12 in How To Use This Book chapter.)***

Stem: Steerer inside diameter must correspond with stem quill diameter or, in the case of pinch bolt stems, steerer outside diameter must correspond to stem inside diameter. The fit between stem and steerer should be a close sliding fit- there should be no wobble between stein and steerer. ***(See stem diameters page 14-20 in Headset chapter.)***

Brake Fit: This can be estimated by subtracting the rim centerline radius (about half the bead seat diameter) from the distance from the axle centerline to the brake hole. If this measurement is well within range ***(see the tire size chart page 12-9 in Tire chapter),*** the brake will fit. If this measurement indicates that the brake shoes will be at or near (within 2mm) the limit of travel, the wheel and brake should be tried on before attempting to install the fork on the bike.

Headset fit: ***(see Headset Chapter 14).***

SEAT POST SIZES

Tubing inside diameters vary so much from maker to maker that no size listed here can be considered correct until t he seat post has actually been tried in the bicycle.

Conventional Steel Tubing Frames

National Standard	Common Tubing	Quality Tubing Plain Gauge	Quality Tubing Butted
English	25.4 (1") 25.8 (1-1/64") 26.2 (1-1/32")	26.4 26.6	27.0 27.2* 27.4
French	25.0 25.0 25.8 26.0	26.2	26.4 26.6*
Italian	25.0 25.8 26.0	26.0 26.2	26.8 27.0 27.2
Japan	25.8 26.2	26.2 26.8	26.4 26.6 26.8 27.0 27.2
USA	22.2 (7/8") (.875") 20.6 (13/16') (.812")	See English	

* Most common

Other Tendencies

	Most Common	Next Most Common
BMX Steel	.875" (7/8") (22.2mm)	.812" (13/16") (20.6mm)
Mountain Steel	26.8	26.6
Aluminum Glued Welded	 25.4 27.2	 25.0 27.4

SEAT POSTS

SOME UNUSUAL SEAT POST SIZES

Fisher Mountain Bikes

Steel - 28.6mm
Aluminum - 31.6mm
Titanium (current production) - 27.4min
(earlier production) - 29.4mm

Mongoose IBOC Signature

Titanium with CroMo rear triangle - 29.4mm
Older, all-titanium model - 27.2mm

Alex Moulton AM Series

1-3/8" (35.0mm)

Charlie Cunningham and Indian

Oversized - 1-3/8" (34.9mm)
Some road hikes- I-1/4" (31.77min)

Klein

Current production - 27.2mm
Earlier production - 27.4mm

Cannondale

Current production - 27.2mm
1985 model 500 - 7/8" seat post and shim

Schwinn M.O.S.

29.8mm

Raleigh Twenty, Bridgestone Picnica

(and many other folding bikes with oversized posts)

28.6mm

Bikes with square seat posts

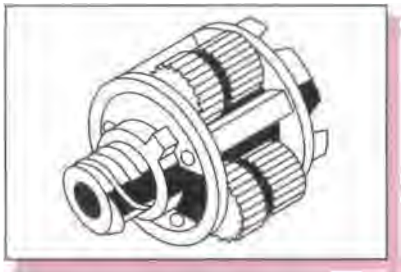
1" square

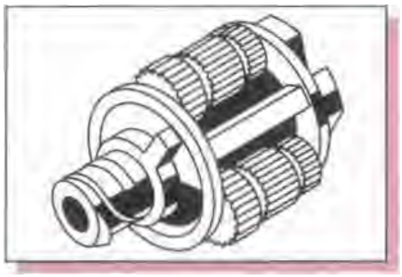
SEAT POST CLAMP BOLT

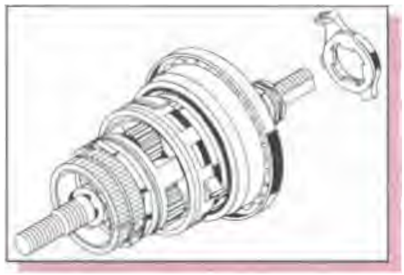
ISO - 8mm xlmm

INTERNAL MULTI-SPEED HUBS

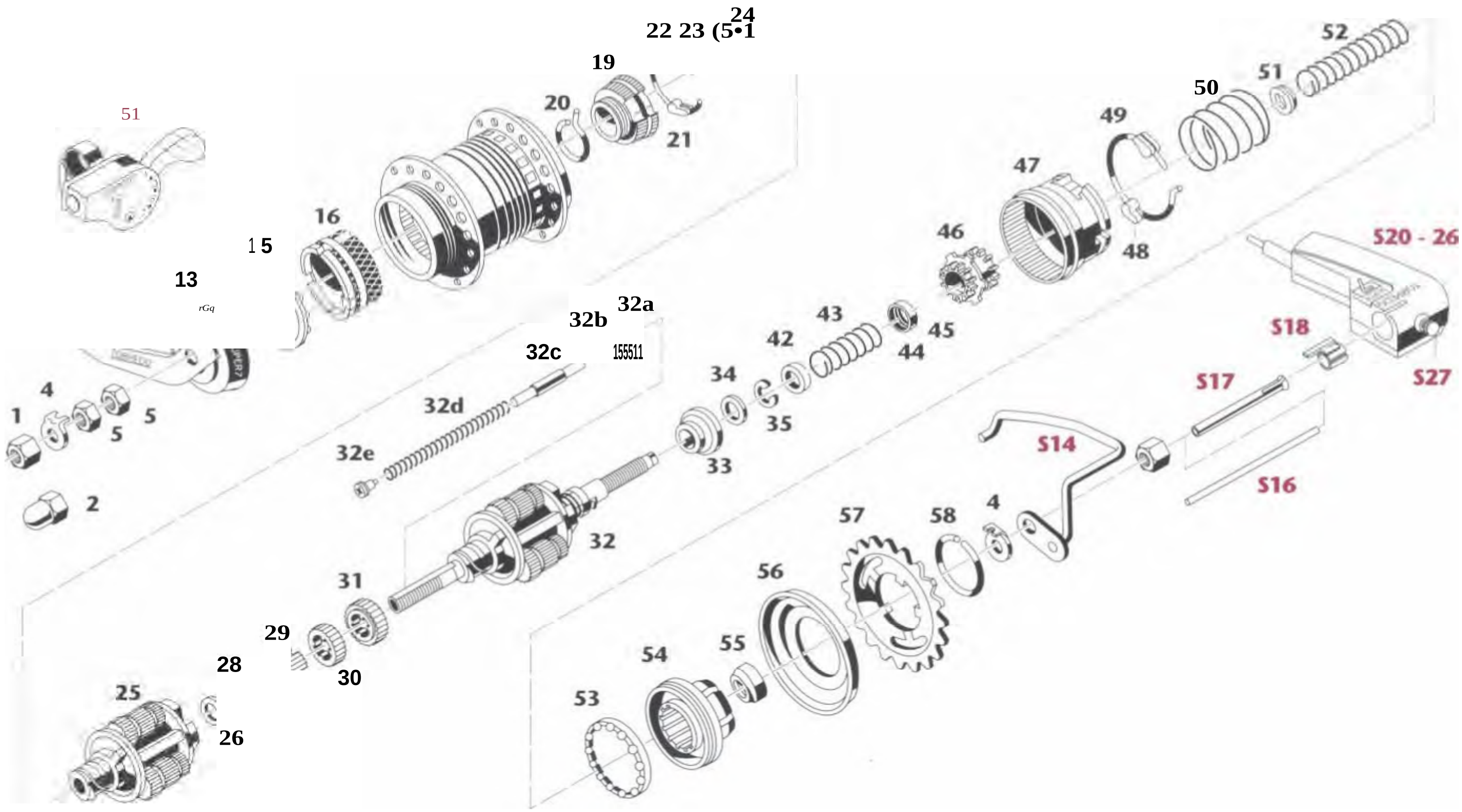
16







SUTHERLAND'S



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SACHS TORPEDO SUPER 7-SPEED
COASTER BRAKE/CLICK BOX HUB

How It Works

Operation of the right side of the huh is similar to that of Sachs three-speeds:

In the lower gears, the sliding clutch connects the driver with the gear ring, but pulls the gear ring to the right so its pawls are disengaged from their ratchet inside the huh shell. Drive is through the planetary gear system to the pawls on the brake cone assembly at the left side of the hub.

In 4th (middle gear), the sliding clutch still connects the driver to the gear ring, but the gear ring is released to the left so it drives its pawls directly, while the brake cone pawls freewheel backward slowly.

In the higher gears, the sliding clutch connects the driver to the planet carrier, and drive is through the planetary gear system to the gear ring; the brake cone pawls freewheel backward.

Drive to the coaster brake is through the gear train: there is no special set of rear-facing pawls as with the Sturmey-Archer S3C hub. Brake effectiveness therefore is the same in the three highest gears (1/1 drive to planet carrier), better in 4th arid 3rd (1.236/1) and better yet in 2nd (1.479/1) and 1st (1.685/1). Brake drive is, however, positive, as the gear ring is spring-loaded in both directions: the clutch engages the gear ring and planet cage at the same time during the only shift with a possible "neutral" position, between 4th and 5th. If the planetary gear train fails, brake drive will, however, be lost in 1st through 4th gears.

Alignment

This hub has an overlocknut spacing of 130 mm, a rear chainline of 48 mrn arid a minimum front chainline of 44mm (when the sprocket dishing faces toward the wheel). **Many retrofits of this hub will require realignment of the rear triangle and a longer bottom-bracket axle.** Spoking flange diameter is 75 mm. The hub is available only with 36 spoke holes, according to Sachs literature.

The wide gear range of this hub requires a lower chain drive ratio than other multi-speed hubs. A 24-tooth sprocket is provided. For example, this will provide a gear range of 31 to 87 inches (2.45 to 6.96 meters development) when used with a 46 tooth chainwheel and 27-inch rear wheel. Other, smaller Sachs, Sturmey, Shimano etc. sprockets will fit and are useful when installing this hub in a small wheel. Generally, the direct drive, middle gear should be about 5] inches (4.10 meters).

The provided 24-tooth sprocket is usable with 3/32" derailleur-type chain or with 1/8' chain, though it is stamped around the mounting hole to make it take up the same space on the driver as a thicker sprocket made only for 1/8" chain.

Shift Levers and Cables

Improper adjustment is the most common cause of problems with 3-, 4-, 5- and 7-speed hubs. Many people have quit riding bikes because their huh slipped out of gear when they were standing up on the pedals. Always check trigger and cable operation before deciding to overhaul a huh.

For the 7-speed's push-pull cable to work properly, all fittings must he tight enough not to creep along the frame and the cable must be free of kinks and knots.

Three types of shift levers are listed in the literature: a single-lever thumhshifter, with mounting hardware for the front or rear of the handlebar, and a twist shifter. A push-pull shifter cable is used, like the old Shimano Positron cables (Refer to Sutherland's Handbook of Coaster Brakes and Internally Geared Flubs).

Cable lengths in the parts list are about 55 through 67 inches in increments of 50mm. The cable and its housing cannot be shortened or otherwise altered, hence the multiple assemblies with different stock numbers. **Measure the old cable before ordering a new one.**

The cable's motion is translated into motion of two concentric pushrods by a cam assembly in the clickbox which attaches to the right end of the hub axle.

The shift lever is sold as a separate item. Clickbox and cable are a single item, though they could be disassembled, allowing clickbox or cable to he replaced independently (see instructions below). The clickbox, with its plastic shell, is somewhat vulnerable even when equipped with the protective sted guard provided.

Testing Shifter Operation

Check shift lever/cable/clickbox assembly for straightness of cable, cracks to housings and other obvious problems.

The inner pushrod (16) selects which sun gear is in use, and the outer pushrod (17) selects the direction in which power passes through the gear train. Rushrod (and clickbox paddle) positions are (o W out, m = middle, i = in):

Gear	1	2	3	4	5	6	7
outer	❏	❏	o	m	i	i	i
inner	o	m	i	I	i	m	o

To inspect the clickbox for correct operation: with the clickbox disconnected from the hub, shift to 4th gear and then to 1st. Now push both paddles inside the axle hole of the clickbox as far away from you as possible. They should move smoothly and easily. Now shift from first through third gear; the central paddle should move toward you in two distinct steps. As you continue to fourth and fifth gear, the outer paddle should move toward you in two distinct steps.

Now shift to 7th gear and push the central paddle down. It should not he possible to push the outer paddle down. As you shift down from 7th to 6th and 5th, the central paddle should move toward you in two distinct steps. Note: you may test the clickbox and the shifter parts of the hub at the same time by installing the axle, guide sleeve and pushrods into the clickbox after installing both axle keys and the clutch but before installing the gear ring.

INTERNAL MULTI-SPEED HUBS

WHEEL REMOVAL AND DISASSEMBLY OF SHIFTER AND SPROCKET PARTS:

Loosen the knurled bolt on the clickbox (S27), and pull the clickhox off the end of the axle. Remove guide sleeve (S18) (snap fit). Remove inner and outer push rods (516, S17). Remove these parts before removing the wheel to avoid possible damage.

Remove wheel as usual after loosening axle nuts and removing brake arm clip bolt.

Remove axle nuts, tab washers and clickbox guard if hub will he rebuilt.

Note the direction of sprocket dish. Remove snap ring, sprocket and large dust cap from driver if necessary to replace.

REINSTALLATION OF SPROCKET, WHEEL AND CLICKBOX

To avoid possible damage, do not install pushrods, clickbox guide or clickbox before installing wheel into drop-outs.

Check for correct direction of sprocket dish, then replace large dustcap, sprocket and snap ring.

Place wheel in drop-outs: for a new installation, place one tab washer on outside of each drop-out, with tabs in closed end of drop-out slot, unless drop-out thickness is over 5.5 mm (7/32"); then place one tab washer inside and one outside left drop-out. Install but do not yet tighten the brake arm clip on the left chainstay. Install clickbox guard on the right end of the axle, and then install the axle nuts. Adjust drive chain slack, making sure that brake arm does not bind. Tighten the brake arm clip bolt.

Oil pushrods (516, 517) lightly and install them into axle, then install guide sleeve (518) with protruding nose at inner end and internal tab in slot of outer pushrod. Rotate guide sleeve until the nose is at the top.

Place shift lever in 1st gear position. Push clickbox onto the axle, with nose of guide sleeve engaging in groove of clickhox housing. Tighten knurled knob. No cable adjustment is necessary.

REPAIR OF SHIFT LEVER/CABLE/CLICKBOX

Shift levers may be replaced and interchanged by removing the Phillips-head screw which holds the lever body together. The cable has a barrel head and may be slipped in and out of its mounting slot.

The clickbox end of the cable has a plastic rack gear molded onto it; adjustment of cable length is therefore not possible. However, it is possible with care to replace a cable or clickbox without replacing the other. After removing the several small screws which hold the clickbox together, the cable and rack gear may be lifted out. When reassembling, take care that the cams and cam followers are correctly installed. **You must time the clickbox gears: with the shift lever in 4th gear position,** the upper cam follower is on middle land of its cam, and the lower one is pushing to max.

INTERNAL MULTI-SPEED HUBS

Troubleshooting Chart – Sachs 5 & 7 Speed Hubs

SYMPTOMS	Resulting from wear, improper lubrication or abuse	Resulting from improper assembly or installation
	Brake cone pawls (19) faulty	Brake cone pawls (19) improperly installed
Slips in 1st — 3rd gear- — — —	Clutch (46) teeth broken	
	Improper lubrication — gummed or dirty	
Slips in 4th gear — —	Gear ring spring (49) damaged	Gear ring spring (49) missing
Slip in Sth — 7th gear — —	[Gear ring pawls (48) faulty	Gear ring pawls (48) improperly installed
Jumps from 4th to 3rd		
Jumps from higher gear to 4th	Wear or damage to clickbox	Clickbox improperly installed
4th instead of higher gears	12-turn spring (52) damaged	12-turn spring (52) missing
Jumps from lower gear to 4th	Wear or damage to clickbox	Clickbox improperly installed
Jumps from 4th to higher gear	7 turn spring (43) weak or damaged	
Pedals driven forward-- while coasting	Chain too tight	
	Bearings too tight or loose	
	No/wrong lubrication	Planet gears (25) mistimed
Stiff running, noisy	Ball cage damaged/broken	Ball cage reversed
	Dustcap damaged	Dustcap reversed
	Brake lever (1 3) forcing cone out of line	Axle E-clip (24) missing
	Loose or broken parts inside hub	Friction spring (20) reversed
Jammed		
	Axle C-clip (35) broken	Axle C-clip (35) missing
	Axle bent	
Sluggish shifting - -	Clickbox damaged	Clickbox guide (518) absent
	Pushrods bent or dirty	
Shift lever will not move above 4th gear	Plastic washer (33) on wrong side of C-clip (35)	
Too much play in axle	Bearings loose or damaged	
No brake	Friction spring (20) weak or worn	Friction spring (20) missing
	Wrong lubricant	
Weak brake	Brake parts glazed or worn	

Parts numbers in parentheses refer to parts chart and exploded drawing.

INTERNAL MULTI-SPEED HUBS ti}

Troubleshooting Chart - Sachs 5 & 7 Speed Hubs

SYMPTOMS	Resulting from wear, improper lubrication or abuse	Resulting from improper assembly or installation
Brake too strong or jerky	Brake lever (13) loose at chainstay	
	Brake cylinder (16) unlubricated	
	Axle (32) loose in dropouts	
Brake does not release ___	Unlubricated thrust surface between axle (32) and planet carrier (25)	Thrust washer (26) missing
	Planet carrier (25) and brake cone (19) threads worn or chipped	
No brake in 1st — 4th gears No drive except 4th gear	Left axle key (32b) broken or stripped	Left axle key (32b) missing or misaligned
1st instead of 2nd and 3rd --___ 7th instead of 6th and 5th	Damaged or worn clickbox	Inner pushrod (51 7) absent
	Short (center) left axle key spring (32a) damaged	Short left axle key spring (32a) (toward middle of axle) missing
3rd instead of **1st** and 2nd 5th instead of 6th and 7th	Left axle key long return spring (32d) jammed	Left axle key long return spring (32d) missing
	Axle key guide rod (32c) bent	
Slips in 2nd and 6th gear I	Middle sun gear (30) stripped	Middle sun gear (30) reversed
No brake in 2nd gear	Spring (28) weak, damaged	Spring (28) missing
2nd instead of 3rd, 6th instead of 5th	Small sun gear (29) reversed	

Parts numbers in parentheses refer to parts chart and exploded drawing.

SACHS 5 & 7-SPEED HUBS - PARTS LIST

Hub		H 721 3 7-$pd. Coaster, click box		H 5213 S-Spd. Coaster, clickbox		H 5113 5-Spd. Coaster, pull chains		H 5 100 5-Spd. No Brake		H 5 120 5 Spd_ Drum brake	
Sachs parts list number		188.612		180.6		177.614		178.6		179.6/2	
Sachs parts list dated		Nov. 10, '93		Nov. 2, '93		Apr. 18, '91		Apr. 4, '91		May 10, '90	
Part		Part no.	compat.	Part no.	compat.	Part no.	compat.	Part no.	compat.	Part no.	compat.
1	Hex nut (10.5 mm) or	0516003 000	14567	0516 003 000							
2	Acorn nut (10.5 mm) : optional, left end of axle	051 6 107 000		0516 107 000							
3	Chain guide nut (10.5 mm)					0516 300 001	4567'	0516 300000		0516 300000	
4	Serrated washer with tab	0517 107 000	14567'	0517 107 000	14567'	0517 107 000	1.15r)7"	0517 107 000	14567*	0517 107 000	14567'
	Hex locknut	0516 111 000	14567'	0516 111 000	14567'	0516 111 000	145676	0516 111 000	14567"	0516 111 000	14567'
6	Lockwasher							0517 005 001	7		
7	Washer (10.6 x 20 x 3.3 mm)									0518 113 000	8
8	Adjusting washer									0517 103 000	8
9	Cable holder with adjusting barrel and hex locknut									0599190 084	
10	Drum brake assembly									0577 002 200	8
11	Washer (14.4 x 21 2.5 mm)									0518 112 000	8
12	Adjusting cone							05 74 302 001	l	0508 302 000	
13	Lever-cone assy. *with* dustcap	0574 301 101	C	0574 301 100		0574 301 100					
14	Dustcap		C	0534 309 000		0534 300 000				0121 112000	8
15	Ball retainer, lever-cone tide	0576 104 200	1234567"	0576 EN 200	1234567'	0576 104 200	1234567'	0576 104 200	1.7'	2376 003 000	8
16	Steel brake cylinder	0573 300 100		0573 300 100		05 73 300 100					
17	Lod:ring							2512007000	7	2512 007 000	7
18	Pawl carrier							0504 301 000		0504 301 000	
19	Brake cone assy.	9574 106 100	345	0574 106 100	345	05 74 106 100	345				
20	Friction spnng	0513 102 000	345	0513 102 000	345	0513 102 000	345				
21	Pawls	0536 104 100	1234567*	0536 104 100	1234567'	0536 104 100	1234567'	0536 104 100	1234567'	0536 104 100	1234567"
22	Pawl spring (32.5 x 0.8mm)	0512 102 100	23456 7	0512 102 100	234567	0512 102 100	234567	0512 102)00	234567	0512 102 100	234567
23	E-dip	0517 002 100	4567' z	0517 002 100	4567'	0517 002 100	4567'	0517 002 100	4567'	0517 002 100	4567'
24	0-hole washer (thrust)	0518 103 000	4567	0518 103 000	4567	0518 103 000	4567	0518 103 000	4567	0518 103 000	456/
25	Planet caner assy.	0372 105 000	i	0572 305 200		0572 305 100		0572 304 100		0572 304 100	
26	Washer (10.65 x 15 x 1 mm)	0518 106 000	1456	0518 106000	1456	0518 106 000	1456	0518 1 06 000	1456	0518 106 000	1456
27	Spring cap, flanged, (15mm CO) (same as 1151)			See Set Arltne59		0521 301 000	S	052T 301 000	5	0521 301 000	5
28	Compression spring	See Set A,line59		See Set A,Ine59		See set below		See set below.		See set below	
29	5un gear no. 1, 21T, 4 end dogs	0333 105 000									
30	Sun gear no. 2, 30T, 4 int. dogs	0333 102 100									
31	Sun gear no. 3, 337, 4 inc. dogs	0333 103 100									
32	Axle assy IN/left axle key parts,	0371 107 100		0571 300 000		I					
	32a Short compression spnng										
	32b Axle key(same as 45)	0327 101 000									
	32c Aide key guide rod										
	32d Long compression spring										
	32e Phillips head screw										
33	Plastic washer	0334 101 000									
34	Washer (18 x 12.5 x 0.6 mm)	0318 101 000		0318 101 000							
35	C-dip1-11210.(55 x 14.35 x 1 mm)	0512 301 OGO		0512 301 000		0512 301 000		0512 301 000		0512 301 000	

Part	Part no,	compat.	Part no.	compat.	Part no.	compat.	Part no.	compat.	Part no.	comport.
36 Sun gear set			0591 302 001		0591 302 001		0591 302 001		0591 302 001	
36a Small sun gear, 6 end dogs			0533 305 000		0533 305 000		0533 305 000		0533 305 000	
36b Large sun gear, 30T, 6 int. dogs			0533 307 000		0533 307 000		0533 307 000		0533 307 000	
39 Axle 159 mm					0509 300 001	1	0509 300 DOO			
40 Axle 168 mm					0509 301 000					
41 Axle 171 mm									0509 303 000	
42 Spring cap	See Set A,line6l				0521 308 000 S		0521 308 000 5		0521 308 000 S	
Compression spring	See Set A,line61		See Set A, line59		See set below		See set below		See set below	
44 Spring cap	See Set A,line61		See Set A, line59		0521 300 000 S		0521 300 000 5		0521 300 000 5	
45 Axle key (same as 32b)	0327 101 000		0527 301 100		0527 100 200 456'		0527 100 200 456'		0527 100 200 456"	
46 Splined clutch	05 72 301 000		0572 301 100		0572 301 000		0572 301 000		0572 301 000	
47 Gear ring assy. with	0381 100 000		0581 300 000		0581 300 000		0581 300 000		0581 300 000	
48 Pawts	0536 109 100 47		0536 109 100 47		0536 109 100 47		0536 109 000 47		0536 109 100 47	
49 Ring spring	0512 303 000		0512 303 000		0512 303 000		0512 303 000		0512 303 000	
50 Large compression spring	See Set A		See Set A. line59		See set below		See set below		See set below	
2 Spring cap, flanged (15mm OD),(same as #27)	0521 301 000	A	0521 301 000 A		0521 301 000 S		0521 301 000 S		0521 301 000 S	
52 Compression spring	See Set A		See Set A line59		See set below		See set below		See set below	
53 Ball cage- driver side	0376 102 000		0576 300 000		0576 300 000		0576 300 000		0576 300 000	
54 Driver	0372104 000		0572 302 000		0572 302 000		0572 302 000		0572 302 000	
55 Fixed cone (7-spd: serrated)	0308 024 000		0508 300 000		0508 300 000		0508 300 000		0508 300 000	
56 Sprocket dustcap	0321 101 000		0521 303 000		0521 303 000		0521 303 000		0521 303 000	
57 Sprockets X	1004... ...				1004... ...		1004... ...		1004... ...	
58 Circlip X	0512 011 000		0512 011 000		0512 011 000		0512 011 000		0512 011 000	
59 Spring set (no axle springs) including items 27, 28, 43, 44, 50, 51, 52			0591 304 000 (Set A)							
59 Set compression springs					0591 301 001		0591 301 00		0591 301 001	
60 Spring cap set -flanged (15 mm 00): flanged (21 nim OD); two-step (21 mm 001					0591 302 000		0591 302 000		0591 302 000	
61 Spring set (no axle springs) including items 28 , 42. 43, 44, 50, 51, 52	0391 004 000 (Set A)									
62 Planet gear timing aid	— 0324 103 000 blue	I —	0524 300 000 red		0524 300 000 red	—	0524 300 000 red		—0524 300 000 red	
63 Special grease type A, 35g	0369 135 100		0 369 135 100		0369 135 100					
64 SpeciA crease type A. 2 x 250q	0369 135 101		0369 135 101		0369 135 101					

INTERCHANGES WITH:

1. Duomatic 102 and 101 (if brake part, 102 only)
2. Automatic R 2110
3. Automatic A 2110
4. 3 spd. coaster H 31 1 1
5. 3 spd. coaster 515
6. 3 spd. 415
7. 3 spd. H 3102, and 3 sp. drum brake H 3120 except brake assembly and left side bearing parts
8. These brake assembly and left side bearing parts interchange with 3 spd. drum brake H 3120

Interchangeable in one direction.

A. Also see parts set A below

C. Cosmetic difference only.

X. See Sprocket interchangeability page 1-3 Sutherland's Handbook of Coaster Brakes and Internal Geared Hubs

S. Also see parts set below

Z. New style plastic adjuster/cable clamp works with new style pull rod.

Appears fully interchangeable despite part number difference. Has been checked against H3111.

I Vertical lines between numbers indicates parts are not interchangeable.

\+ Included in axle set #32 from Sachs.

HUBS

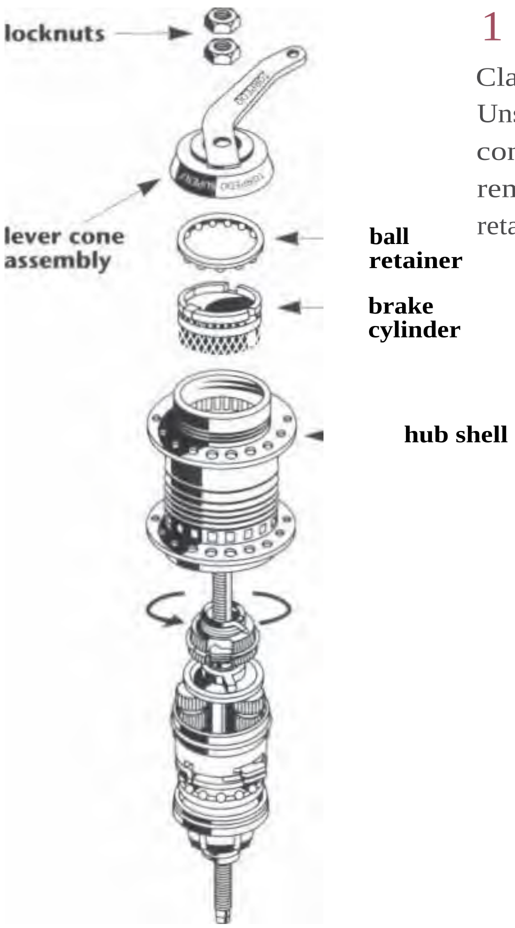
SHIFTER PARTS SACHS 5 & 7-SPEED HUBS

Hub	H 7213 7-5p4i. Coaster, clickbox		H 5213 5-Spd. Coaster, clickbox		H 5313 5-Spd. Coaster, pull chains		H 5100 5 Spd, No Brake		H 5120 5 Spd. Drum brake	
Sachs parts list number	188.612		180.6		177.6/4		178.6		179.6/2	
Sachs parts list dated	Nov. 10, '93		Nov, 2, '93		Apr. 18, '91		Apr. 4, '91		May 10, '90	
Part	Part no.	compat	Part no.	compat.	Part no.	Compat.	Part no.	compat.	Part no.	compat.
51 Trigger, Front of handlebar	0386 008 000		0586 318 000							
L 5501 black					00 0586 307 030		00 0586 307 030		00 0586 307 030	
L 5501 white/gray					00 0586 307 001		00 0586 307 001		00 0586 307 001	
L 5501 black/pink					00 0586 308 100		00 0586 308 100		00 0586 308 100	
52 Trigger, rear of handlebar	0386 004 000		0586 311 DOO							
53 Twist•grip shift control			0586 321 000							
54 Stem shifter, 1-lever										
with boll					0586 301 000		0586 301 000		0586 301 000	
L 5502 black					00 0586 301 300		00 0586 301 300		00 0586 301 300	
L 5502 white/gray					00 0586 304 100		00 0586 304 100		00 0586 304 100	
55 Stem shifter, 2-lever,					88 1186 740 089		88 11 86 740 089		88 1186 740 089	
l 5502 black										
S6 Left ATE trigger,					82 1186 837 021		82 1186 837 021		82 1186 837 021	
MA 82 2-position										
57 Right ATI3 trigger,					82 1186 836 021		82 11 86 836 021		82 1186 836 021	
MA $2 3-position										
58 Adjuster/cable clamp (2x)					0570 117 000	4567	0570 717 000	4567	0570 117 000	4567
59 Pull chainirod (long)					0187 102 000	2	0187 702 000	7	0187 102 000	7
510 Bolt, M6 x 16	1615 001 004	12345	1615 001 004	12345	1675 001 004	12345				
S31 Clamp	0326	12345	0376 . ..	12345	0326... .	12345				
512 Hex nut M6	0242 129 002	12345	0242 129 002	12345	0316 057 002	12345				
513 Pull chain/rod (short)					0587 102 000	4567 Z	0587 102 000	4567 Z	0587 102 000	4567 2
514 Clickbox guard	0520 302 000		0520 302 000							
515 Set B: shift parts	0391 004 001		0591 304 001							
516 Inner pushrod	See Set 8		See 5et							
517 Outer pushrwl	See Set B		See 5e1 B							
518 Cliclibrix guide	0334 103 000									
539 Clickbox with 1300 mm cable			0586 319 007							
520 Clickbox with 1400 mm cable	0386 009 000		0586 319 003							
S21 Clickbox with 1450 mm cable	0386 009 001		0586 319 004							
522 Clickbox with 1500 mm cable	0386 009 002		05136 319 000							
S23 Clickbox with 1550 mm cable	0386 009 003		0586 319 006							
524 Clickbox with 1600 mm cable	0386 009 004		0586 319 001							
52S Clickbox with 1650 mm cable	0386009 005		0586 319 005							
526 Clickbox with 1700 mm cable	0386 009 006		0586 319 002							
527 Knuded boll for clickbox	0515 307 000		0515 307 000							

(See page 16-9 for interchangeability notes.)

INTERNAL MULTI-SPEED HUBS

DISASSEMBLY AND ASSEMBLY INSTRUCTIONS FOR SACHS TORPEDO SUPER 7 HUB

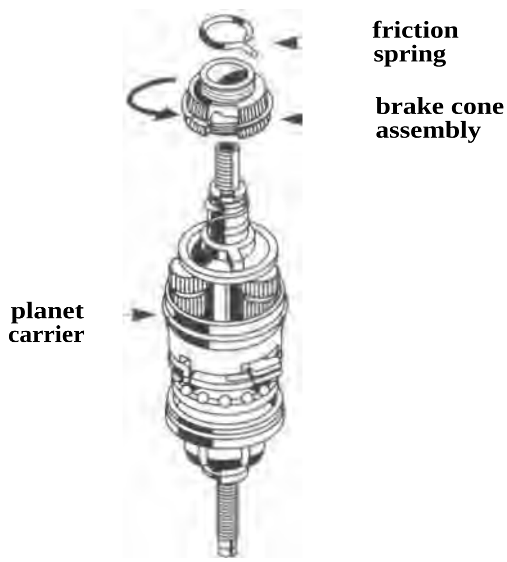


1 DISASSEMBLY

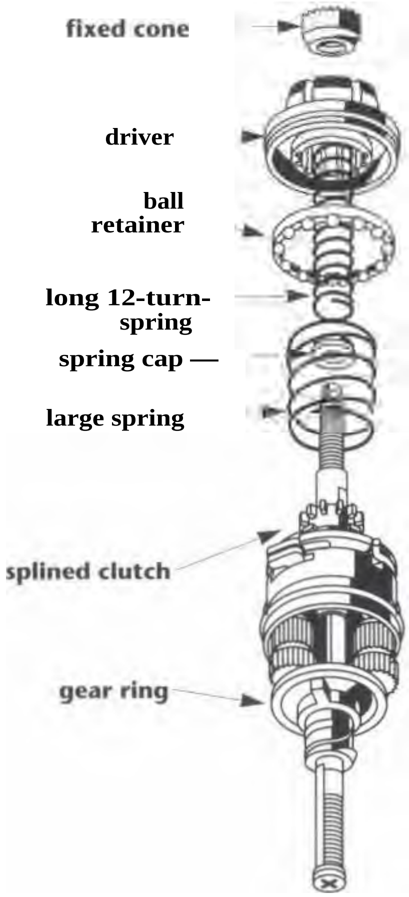
Clamp axle in axle vise, Phillips screw head end facing up. Unscrew the two locknuts (5) from each other using a 17 mm cone wrench and a 17 mm open end or box-end wrench; remove the locknuts. Remove lever cone assembly (13), ball retainer (15) and brake cylinder (16).

2 DISASSEMBLY

Litt off hub shell. Rotate brake cone assembly (19) counter-clockwise and remove.



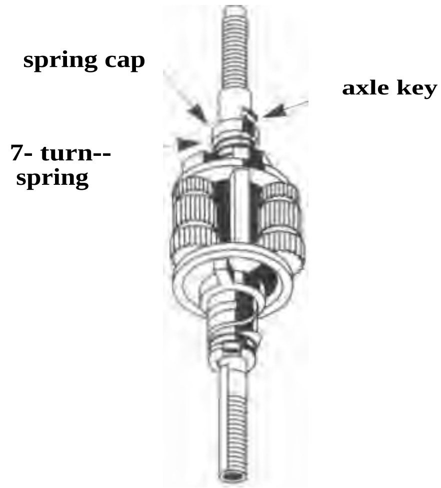
SACHS TORPEDO SUPER 7 (CONT'D)

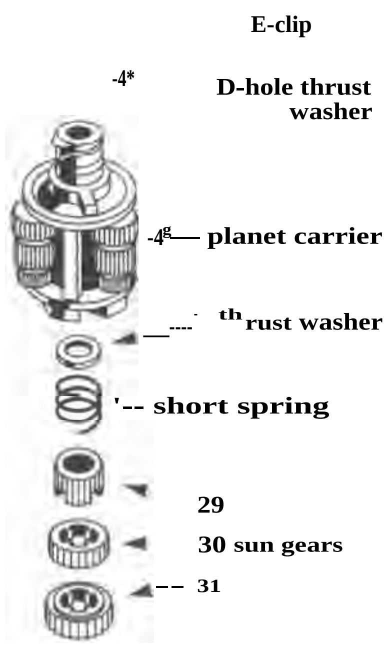


3 DISASSEMBLY

Invert assembly **in** axle vise — end of axle with Phillips head screw down, grooved end up. Using a 17mm open-end wrench, unscrew the fixed cone (55). Remove the driver (54), long 12-turn spring (52) with spring cap (careful – spring cap can stick in splined clutch) (51), large spring (50), ball retainer (53), gear ring (47) and splined clutch (46).

Compress 7-turn spring with spring cap (43) and remove axle key (45). Remove outer spring cap (44), 7-turn spring (43) and inner spring cap (42).





4 DISASSEMBLY

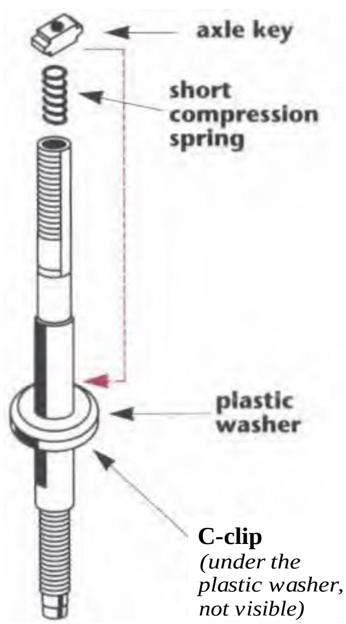
Invert assembly in axle vise — Remove axle E-clip (23) and D-hole thrust washer (24). Lift off planet carrier (25). Remove the round-hole thrust washer (26) from inside the planet carrier or from the axle. Sometimes grease causes washer to stick to planet carrier. The planet carrier is a unit. Do riot attempt to remove the planet pinions. Remove short compression spring (28) and the small diameter, medium diameter and large diameter sun gears (29, 30, 31).

SACHS TORPEDO SUPER 7 (coNro)

SUBDISASSEMBLIES

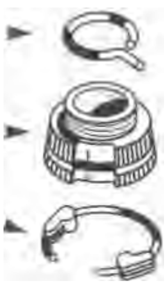
Axle

To prevent the spring behind Phillips head screw (32e) from flying out, grasp the screw with one hand as you turn it with the other, then release the spring carefully. Carefully remove the Phillips head screw (32e). Remove long compression spring (32d), axle key guide rod (32c), axle key (32h), and short compression spring (32a). Remove formed plastic washer (33) and steel washer (34). Only if necessary for replacement, remove C-clip (35).



Driver

Remove dustcap with a thin-bladed screwdriv-er. Work slowly around dustcap to avoid deforming it. Lift out ball retainer. **Note:** parts list shows driver as an **assembly** with the inter-nal ball cage and dustcap. "fhe same ball cage is found also in the 5-speed hubs, different from that used in Sachs 3-speed hubs. A mechanic could replace the bearing balls or the cage (Star 0103 2511.



Brake Cone

To remove pawls (21), pull outward until end of pawl spring (22) clears groove, then ease pawl spring off the end of brake cone. Remove friction spring (20) from brake cone only if it is to he replaced.

Gear Ring

To remove pawls (48), pry straight end of pawl spring (49) out of groove and ease over end of gear ring (47).

SACHS TORPEDO SUPER 7 (CONT'D)

Cleaning

Clean all parts, including outside of hub shell, in a suitable solvent. Be very careful not to introduce dirt or grit atter cleaning. Clean the planet cage with a brush or air, not by immersion.

Points to check

1. Pawls (21, 48) and ratchets for rounding and chipping.
2. Gear ring (47), planet gears of planet carrier (25) and sun gears (29, 30, 31) for worn and chipped gear teeth.
3. Planet carrier (25), gear ring (47), clutch (46), inside of driver (54) sun gears (29, 30, 31), brake cylinder (16) and lever cone (13) for worn or rounded splines or dogs.
4. Bearing surfaces of lever cone (13), hub shell, driver (54), fixed cone (55), ball retainers (15, 53), and inside driver (54) for wear or pitting.
5. Brake cylinder (16) and braking surface inside hub shell for wear and glazing.
6. Brake cone (19) for worn serrations.
7. Friction spring (20), compression springs (28, 43, 52), two internal axle springs (32a, d) and pawl springs (22, 49) for size and tension (manufacturer recommends replacing pawl springs at overhaul).
8. Axle (32), axle key guide rod (32C) and push rods (516, 51 71 for straightness.
9. Dust caps of lever cone and driver (13, 54), sprocket dustcap (56), spring caps (42, 44, 51), circlips (23, 35, sti) and ball retainers (15, 53), and inside driver (54) for straightness.
10. All threaded parts for worn or damaged threads.
11. Axle keys (32b, 45) and axle slots (32) for rounding or chipping.

Lubrication

To lubricate the planet gear bearings, stand the planet carrier on its wide end and apply 2 to 3 drops of oil at the hearing pins where visible under retaining ring, turning the gears to aid the oil in penetrating.

Lubricate bail cages by filling the spaces between balls will' grease. Be careful not to grease pawls or clutch. Lubricate hub shell, brake shoe and friction spring liberally with a high-temperature grease for steel brake shoes. Oil, never grease, brake cone and gear ring with a good cycle oil. (WD-40 is too light for lasting lubrication, 3-in-1 oil gums up with age.)

SACHS TORPEDO SUPER 7 (CONT'D)

SUBASSEMBLIES

Gear Ring

Install pawls (48) under hooked, circular pawl spring (49). Pawls must point clockwise when viewed from small end of gear ring. Hooked end of pawl spring should lie in the slot that intersects pawl spring groove.

pawl

pawl spring

gear ring

Brake Cone

friction spring—IP-

brake con e

pawl & pawl spring —I.

Install friction spring with hooked end clockwise from gap. Incorrect installation will cause excess drag, wear and possible brake failure.

Install pawls (21) under circular pawl spring without hooked end (22). Pawls must point counterclockwise when viewed from friction spring end of brake cone. Ends of pawl spring should lie adjacent to tabs that block pawl spring groove.

Driver

If starting with a replacement driver assembly, skip to the next section: the steps in this section have already been done for you.

Ball retainer is not available as a separate part from Sachs. If necessary, replace driver assembly. The ball cage is a Star 0103 251, or you might replace the bearing balls in the old cage. Install ball retainer flat side up. Start dustcap straight, flat side up*, and tap home with a soft hammer.

* opposite Sturmey alignment

dust cap

ball retainer

driver

SACHS TORPEDO SUPER 7 (coNro)

SUBASSEMBLIES (cont'd)

Axle

If starting with replacement axle kit, skip to the next section; the steps in this section have already been done for you.

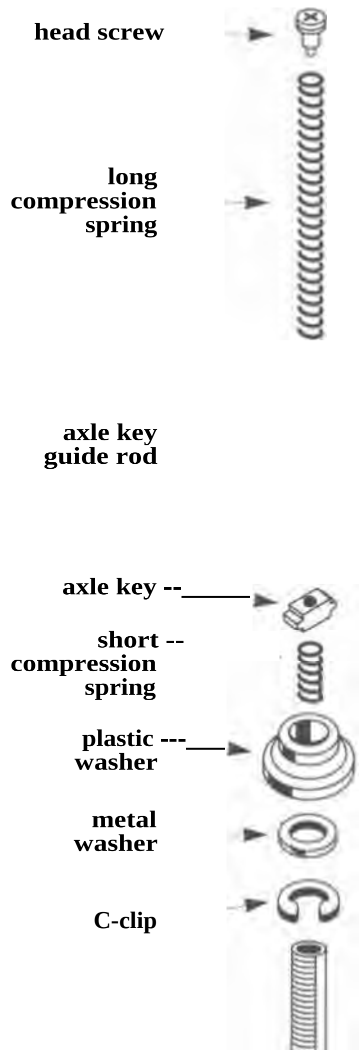
If rebuilding old axle put the axle in an axle vise, replace (-clip (35); then from the internally threaded end of axle, replace: larger round-hole metal washer (34) and then formed plastic washer (33), large side down.

Replace thin, short compression spring (32a) in long-slot (internally threaded) end of axle. With a small screwdriver blade or a spoke, compress spring inside slot toward center of axle. Install axle key (32b) (the two axle keys are identical) with its hole aligned with the axle, and then release the spring against the axle key.

Drop axle key guide rod (32c) into axle. Its end should pass through hole in the axle key and be visible inside spring.

Place long, thin compression spring (32d) over a spoke to guide it into axle hole. Make sure that the spring slips over the end of axle key guide rod. Hold end of the spring with fingernails and insert Phillips-head grub screw (32e). Tighten screw firmly into the end of the axle.

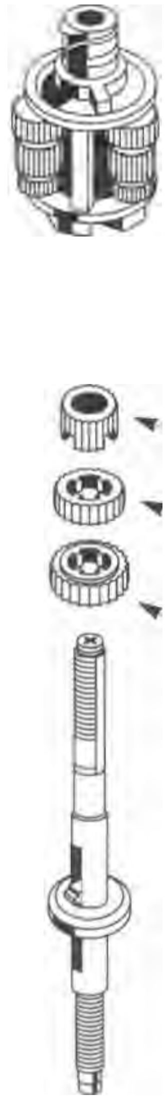
Test your work by pushing formed plastic washer toward end of axle. It should push axle key smoothly against spring force, almost all the way to outer end of slot.



SACHS TORPEDO SUPER 7 (CONT'D)

1 ASSEMBLY

Place axle in an axle vise by its flats, notched end down and Phillips head screw up. Install large diameter sun gear (31), bevels upward. Axle key should engage in slots of gear. Then install medium diameter sun gear (30), bevels upward; and small diameter sun gear (29), slots downward. Install shortest compression spring (28) Install remaining, round-hole thrust washer (26).



Blue Timing Aid

Align planet gears with timing marks facing precisely outwards and install planet carrier (25). Carrier must engage fully over sun gears and turn smoothly. Recheck timing marks after installation. **Caution: if planet gears are incorrectly timed, hub will sustain damage in use.** Sachs parts list mentions a blue timing aid (62) which aligns the gears during installation; correct assembly is, however, possible without using this. If the timing aid is not available, just be sure to have all dots on planet gears facing outward.

Install D-hole thrust washer (24) and then install E-clip washer (23). Planet carrier should turn freely, with very slight lengthwise play on axle.

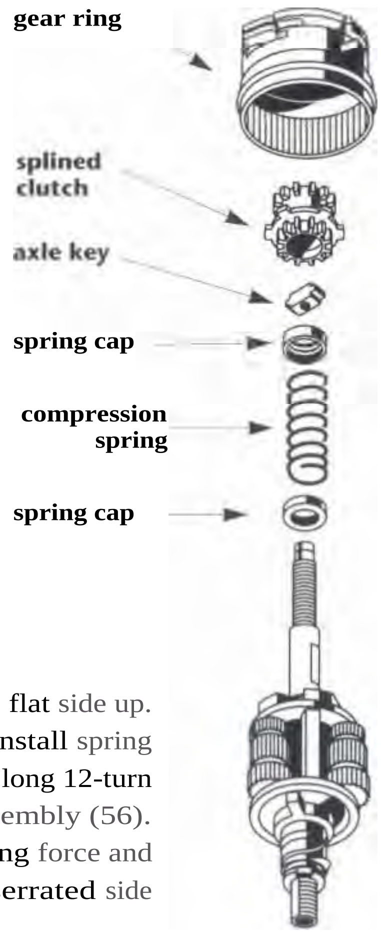
SACHS TORPEDO SUPER 7 (coN-rD)

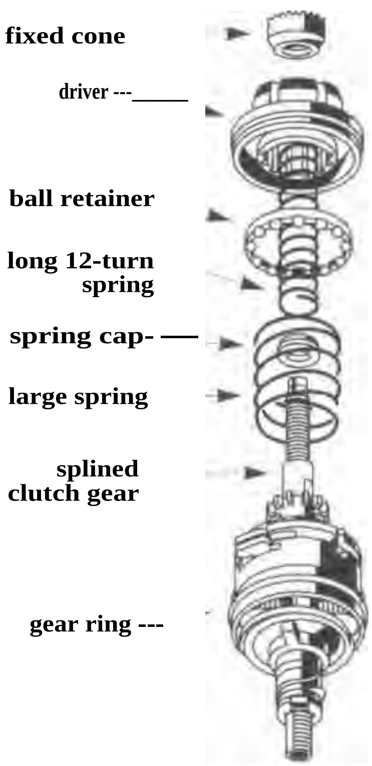
2 ASSEMBLY

Turn axle over in the vise, so the open end is now upwards. Install spring cap (42), flat side toward center of axle. (The spring caps are identical.) Install 7-turn compression spring (43) and another spring cap (44), flat side up. Compress spring and insert remaining axle key (45) from side of axle slot, with its hole aligned with axle and its shoulders engaging spring cap.

Install splined clutch (46), larger end down.

Install gear ring (47), with pawls and pawl spring, over splined clutch.





Install larger ball retainer (53), flat side up. Install the large spring (50). Install spring cap (51), flat side down. Install long 12-turn spring (52). Install driver assembly (56). Press driver down against spring force and screw down fixed cone (55), serrated side up; tighten to **14.5 It. lbs..**

SACHS TORPEDO SUPER 7 (coNrc)

3 ASSEMBLY

Turn t he axle over in axle vise, so Phillips screw head faces upwards.

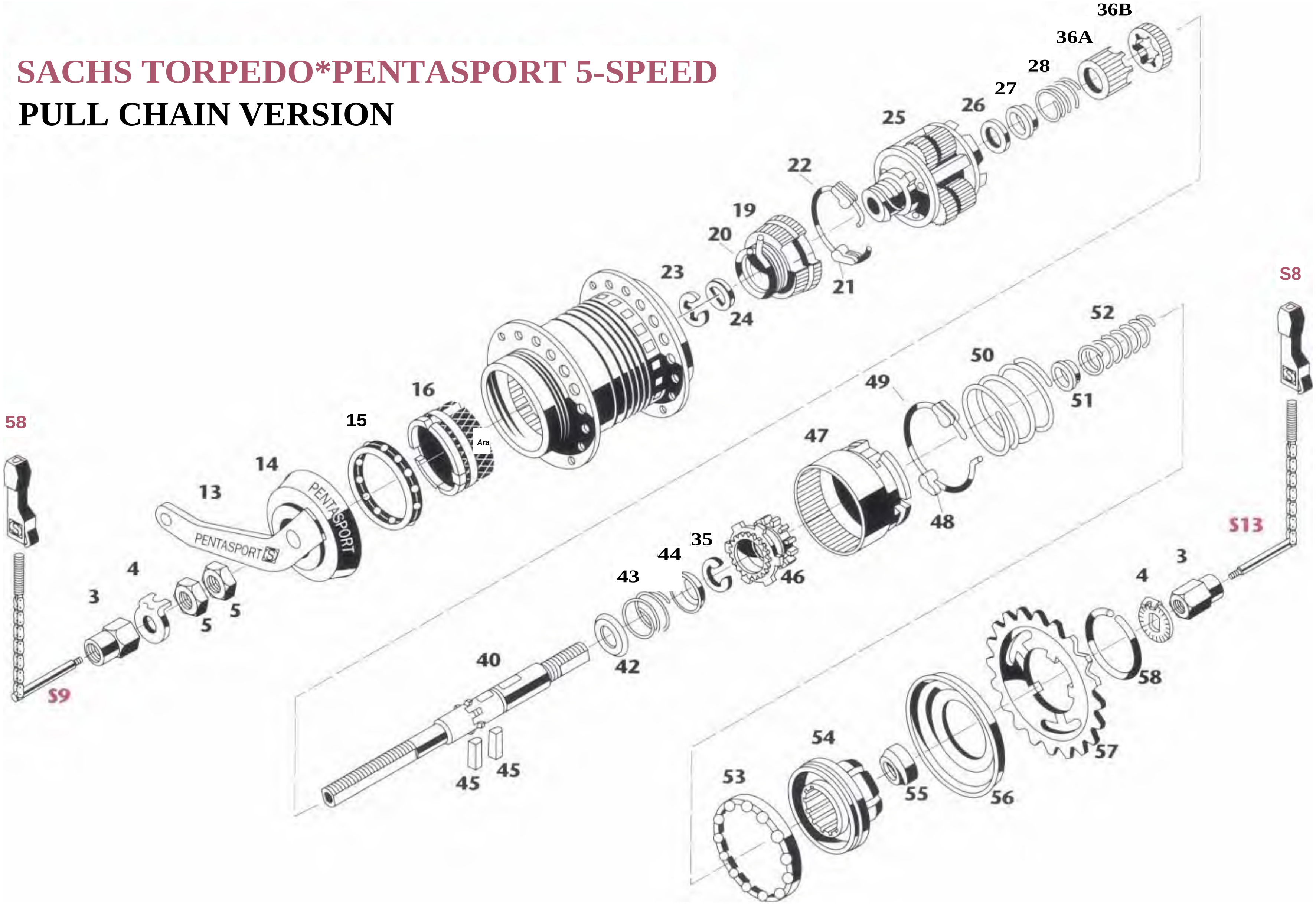
Screw brake cone assembly (19), conical side up, onto the threads of the planet cage. install huh shell, turning it slightly counterclockwise to clear pawls. Install brake cylinder (16), with internal tabs upwards. End of friction spring on brake cone must engage in one of the two slots in lower side of the brake shoe. Install remaining ball retainer (15), flat side up. Install lever cone assembly (13), turning it clockwise to engage brake shoe tabs. Screw on the two lockouts, adjust for minimal hearing play without binding, and lock the nuts against each other **(not against lever cone assembly!)** using a 17mm cone wrench and 17mm open-end or box-end wrench.

GEAR TABLE FOR INTERNALLY GEARED HUBS

Multiply by gear value obtained from chainwheel and rear sprocket gear charts

Gear		2		4	5	6	7
Sachs							
2-speed	1.00	1.36					
3-speed	0.73	1.00	1.36				
5-speed	0.67	0.78	1.00	1.29	**1.50**		
7-speed	**0.59**	**0.68**	**0.81**	**1.0**	4	**1.48**	1 **1.68**
Shimano					112		
3-speed	0.75	1.00	1.33				
7-speed	0.63	**0.74**	**0.84**	**0.99**	**1.14**	**1.33**	**1.55**
Sturmey-Archer							
3-speed	0.75	1.00	1.33				
4-speed	0.67	0.79	1.00	1.27			
5-speed	0.67	0.79	1.00	*1.27*	**1.50**		

SACHS TORPEDO*PENTASPORT 5-SPEED
PULL CHAIN VERSION



SUTHERLAND'S

DISASSEMBLY AND ASSEMBLY INSTRUCTIONS FOR SACHS PENTASPORT 5-SPEED HUB

How it works

Operation of the right side of the huh is similar to that of Sachs three-speeds.

In the lower gears, the sliding clutch connects the driver with the gear ring, but pulls the gear ring to the right so its pawls are disengaged from their ratchet inside the hub shell. Drive is through the planetary gear system to the pawls on the brake cone assembly at the left side of the hub.

In 3rd (middle) gear, the sliding clutch still connects the driver to the gear ring, but the gear ring is released to the left so it drives its pawls directly, while the brake cone pawls freewheel backward slowly.

In the higher gears, the sliding clutch connects the driver to the planet carrier, and drive is through the planetary gear system to the gear ring; the brake cone pawls freewheel backward.

Drive to the coaster brake is through the gear train: there is no special set of rear-facing pawls as with the Sturmey-Archer S3C hub. Brake effectiveness therefore is the same in the three highest gears (1/ I drive to planet carrier), better in 3rd and 2nd (1.29/1) and better yet in 1st (1.5/1). Brake drive is, however, positive, as the gear ring is spring-loaded in both directions: the clutch engages the gear ring and planet cage at the same time during the only shift with a possible "neutral" position, between 3rd and 4th. If the planetary gear train fails, brake drive will, however, he lost i 11 1st through 3rd gears.

Alignment

This huh has an overlocknut spacing of 122mm which can be padded to 126mm or 130mm with spacer washers. It will therefore fit most modern frames.

Two versions of the hub shell have been available. Spoking diameter is 75mm for the newer version with pressed-on spoking flanges. The earlier one-piece shell version has 68mm spoking diameter. The hub is available only with 36 spoke holes, according to Sachs literature.

As with most 5-speed hubs, using the middle gear as the "normal" gear places the low gears too high for good hill-climbing and the top gear too high to be useful at all. It is hest to use the 4th gear (1.29 step-up with this hub) as the normal level-ground gear of about 72 inches. A 22 tooth sprocket and 46-tooth chainwheel, for example, will provide this gearing with a 27-inch rear wheel. This will provide a gear range of 38 to 85 inches (3.00 to 6.76 meters' development) when used with a 46 tooth chainwheel and 27-inch rear wheel. Sachs sells a 24-tooth sprocket which is useful for hilly country or retrofitting a bicycle which has a large chainwheel. Other, smaller Sachs, Sturmey, Shimano etc. sprockets will fit and are useful when installing this huh in a small wheel. Generally, the direct drive, middle gear should be about 56 inches (4.10 meters).

The provided 20-tooth sprocket, like the 24-tooth sprocket supplied with the Sachs 7-speed hub, is usable with 3/32" derailleur-type chain or with 1/8" chain, though it is stamped around the mounting hole to make it take up the same space on the driver as a thicker sprocket made only for 1/8" chain.

SACHS PENTASPORT 5-SPEED (CONTD)

Shift Levers and Cables

Improper adjustment is the most common cause of problems with 3-, 4-, 5- and 7-speed hubs. Many people have quit riding bikes because their hub slipped out of gear when they were standing up on the pedals. Always check trigger and cable operation before deciding to overhaul a hub.

To have a cable that is in proper adjustment and will stay that way, all fittings must he tight enough not to creep along the frame, the cable must be free of kinks and knots, the pulley must operate smoothly arid the bell crank or indicator chain must not be twisted. (Always hack off a thread-on bell crank or an indicator chain at least 1/8 of a turn from finger tight).

Pul[chain Shifting

(See parts list, page 16 -10.)

Several types of shift levers are listed in the literature:

1. A single-lever handlebar shifter, available in three colors;
2. A single-lever stem shifter, available in two colors;
3. A "Pentacross" pair of stem shifters, right hand 3-position, left hand 2-position;
4. An ATB pair of handlebar shifters, right hand 3-position, left hand 2-position.

Clickbox Shifting

The Sachs parts list (180.6) for the clickhox 5-speed shows two types of shift levers, for the front and rear of the handlebar. The clickhox version uses a push-pull shifter cable, like the old Shimano Positron cables. ***(See Sutherland's Handbook of Coaster Brakes and Internally Geared Hubs.)***

The clickbox assembly is integral with its cable; cable lengths in the parts list are about 51 inches and about 55 through 67 inches in increments of 50mm. The cable and its housing can not be shortened or otherwise altered, hence the multiple assemblies with different stock numbers. Measure the old cable before ordering a new one.

The cable's motion is translated into motion of two concentric pushrods by a cam assembly in the clickhox, which attaches to the right end of the hub axle.

TESTING SHIFTER OPERATION

Pullchain Version

Operation and adjustment of the right-side pullchain are the same as for Sachs three-speed hubs. The pullchain is in its most slack position in 4th and 5th gears; in its middle position in 3rd gear; and in its tightest position in 1st and 2nd gears.

The left-side pullchain is tight in 1st and 5th gears and slack in the others. Adjust it so it is taut in 1st and 5th gears.

SACHS PENTASPORT 5-SPEED (CONT'D)

Clickbox Version

Check shift lever/cable/clickbox assembly for straightness of cable, cracks to housings and other obvious problems.

The inner pushrod works like the left pullchain, selecting which sun gear is in use, and the outer pushrod works like the right pullchain, selecting the direction in which power passes through the gear train. Push rod land clickbox paddle) positions are to = out, m = middle, i in):

Gear	1	2	3	4	S
outer	o	o	m	i	i
inner	i	o	o		

lb inspect the clickbox for correct operation: with the clickbox disconnected from the hub, shift to 3rd gear and then to 2nd. Now push both paddles inside the axle hole of the clickbox as far away from you as possible. They should move smoothly and easily. Now shift up to fourth gear; the outer paddle should move toward you in two distinct steps. As you continue to fifth gear, the inner paddle lever should move toward you in one distinct step.

Now shift to 2nd gear and push both paddles down. As you shift down to 1st, the inner paddle should move toward you in one distinct step. Note: you may test the clickbox and the shifter parts of the hub at the same time by installing the axle and pushrods into the clickbox after installing both axle keys and the clutch but before installing the gear ring.

WHEEL REMOVAL AND DISASSEMBLY OF SHIFTER AND SPROCKET PARTS

Pullchain Version

Disconnect shift cables and unscrew pullchains.

Clickbox Version

Loosen the knurled bolt on the clickbox, and pull the clickbox off the end of the axle. Remove inner and outer pushrods. **Remove these parts before removing the wheel to avoid possible damage.**

Remove wheel as usual after loosening axle nuts and removing brake arm clip bolt.

Remove axle nuts, tab washers and clickbox guard of clickbox version if hub will be rebuilt.

Note the direction of sprocket dish. Remove snap ring, sprocket and large dust cap from driver if necessary to replace.

SACHS PENTASPORT 5-SPEED (coNTD)

REINSTALLATION OF SPROCKET AND WHEEL

To avoid possible damage, do not install pushrods or clickbox of clickbox version before installing wheel into drop-outs.

Check for correct direction of sprocket dishing, then replace large clustcap, sprocket and snap ring.

Place wheel in drop-outs: for a new installation, place one tab washer on outside of each drop-out, with tabs in closed end of drop-out slot, unless drop-out thickness is over 5.5 mm (7/32"); then place one tab washer inside and one outside left drop-out. Install but do not yet tighten the brake arm clip on the left chainstay. Install clickbox guard (clickbox version only) on the right end of the axle, and then install the axle nuts. Adjust drive chain slack, making sure that brake arm does not bind. Tighten the brake arm clip bolt.

Puilchain Version

Screw pullchains into the axle. Connect them to the shift cables. Place the shift lever into 4th gear position. Adjust for no slack, but without pulling pullchains out. Then shift to 1st gear. It should not be possible to pull pull-chains further out of the huh.

Clickbox Version

Oil pushrods lightly and install them into axle.

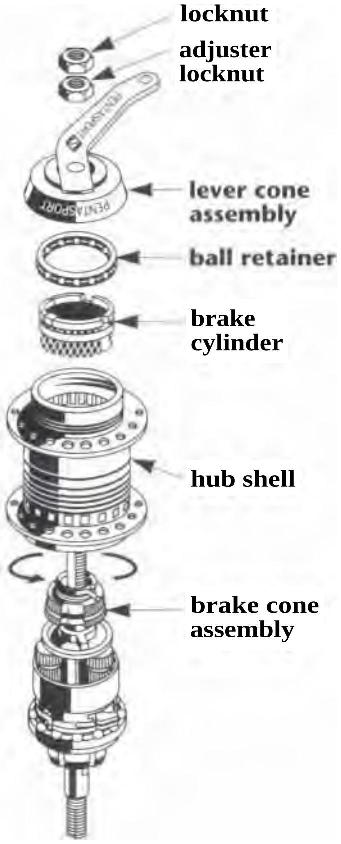
Place shift]ever in 2nd gear position. Push clickbox onto the axle. Tighten knurled knob. No cable adjustment is necessary.

REPAIR OF SHIFT LEVER-CABLE-CLICKBOX

Shift levers may be replaced and interchanged by removing the Phillips-head screw which holds the lever body together. The cable has a barrel head and may be slipped in and out of its mounting slot.

The clickbox end of the cable has a plastic rack gear molded onto it; adjustment of cable length is therefore not possible. I lowever, it is possible with care to replace a cable or clickbox without replacing the other. After removing the several small screws which hold the clickbox together, the cable and rack gear may be lifted out. When reassembling, take care that the cams and cam followers are correctly installed. You must time the clickbox gears: with the shift lever in .ird gear position, the upper cam follower is on the middle land of its cam, and the lower one is in the deepest indentation in the middle of its cant

DISASSEMBLY AND ASSEMBLY INSTRUCTIONS FOR SACHS PENTASPORT 5-SPEED PULLCHAIN HUB

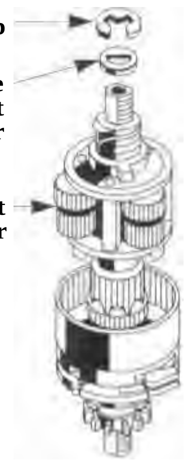


1 DISASSEMBLY

Clamp axle in axle vise, sprocket end down. Unscrew the two locknuts (5) from each other using a 17mm cone wrench and a 17mm open end or box-end wrench; remove the locknuts. Remove lever cone assembly (13), ball retainer (15) and brake cylinder (16). Lift off hub shell. Rotate brake cone assembly (19) counter clockwise and remove.

2 DISASSEMBLY

Remove axle E-clip (23) and D-hole thrust washer (24). Lift off planet carrier (25). Remove the round-hole thrust washer (26) from inside the planet carrier or from the axle. The planet carrier is a unit. Do riot attempt to remove the planet pinions.



Pullchain Version

Remove short spring (28) with its spring cap and the small sun gear (36a). If the hub is equipped with a large sun gear (36b) with notches all the way through and separate spring cap (42), lift off the sun gear. A one-piece sun gear cannot be removed at this time.

Clickbox Version

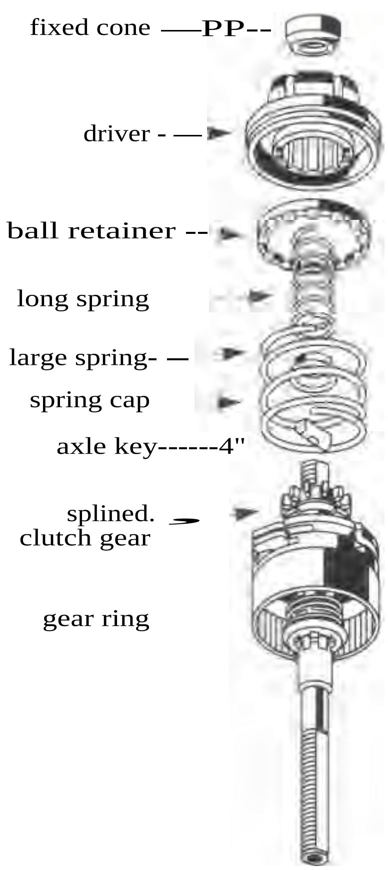
You will remove the sun gears later.

SACHS PENTASPORT 5-SPEED PULLCHAIN HUB (coNTD)

3 DISASSEMBLY

Invert assembly — sprocket end up. Using a 17mm open-end wrench, unscrew the fixed cone (55). Remove the driver assembly (54), long spring (52) with spring cap (51) **[Note: spring cap may be wedged into long spring],** large spring (SO), ball retainer (53), gear ring {47) and spli heti clutch (46).

Pullchain Version	Clkkbox Version
Remove axle key (45)	Compress short spring (43 Remove axle key (45). Remove short spring with its spring cap.



SACHS PENTASPORT 5-SPEED (CONT'D)

SUBDISASSEMBLIE5

Axle

With axle still clamped sprocket end up, remove C-clip (35), spring cap (44) and compression spring (43).

Pulichain Version

Remove axle key (32b). Remove spring cap (42), if present. Remove the large sun gear (36b), if you have not removed it already.

Pulichain

Clickbox Version

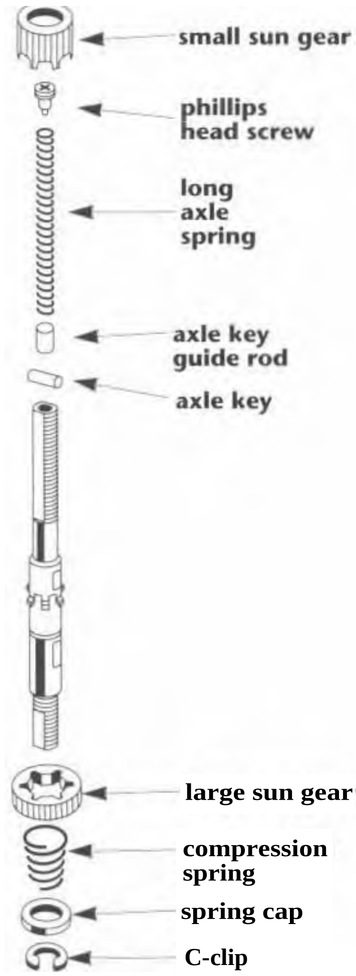
Remove the large sun gear (36b).

Invert assembly — Phillips screw (32e) end of axle up.

Remove the Phillips head screw (32e). To prevent the spring behind this screw from flying out, grasp the screw with one hand as you turn it with the other, then release the spring carefully.

Remove long axle spring (32d), axle key guide rod (32c), axle key (32b), and small sun gear (36a).

Clickbox



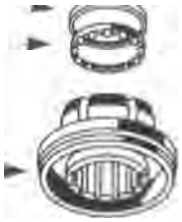
SACHS PENTASPORT 5-SPEED (cowl))

SUBDISASSEMBLIES (cont'd)

dust cover-

ball retainer

driver



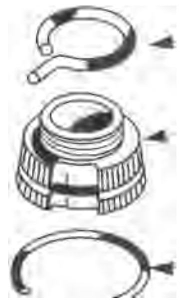
Driver

Remove dustcap with a thin-bladed screwdriver. Work slowly around dustcap to avoid deforming it. Lift out ball retainer.

Note: parts list shows driver as an assembly with the internal ball retainer and dustcap. The same ball retainer (Star 0103 251) is found also in the 7-speed hubs, different from that used in Sachs 3-speed hubs.

Brake Cone

To remove pawls (21), pull outward until end of pawl spring (22) clears groove, then ease pawl spring off the end **of** brake cone. Remove friction spring (20) from brake cone only if it is to be replaced.



- Friction spring

--- brake cone

— pawl spring

-- pawl

pawl - -11"

pawl spring

gear ring

Gear Ring

To remove pawls (48), pry straight end of pawl spring (49) out of groove and ease over end of gear ring (47).

SACHS PENTASPORT 5-SPEED (CONT'D)

Cleaning

Clean all parts, including outside of hub shell, in a suitable solvent. Be very careful not to introduce dirt or grit after cleaning.

Clean the planet cage with a brush, not by immersion.

Points to Check

Numbers in parentheses refer to parts chart and exploded drawing.

1. Pawls (21,48) and ratchets of hub shell for rounding and chipping.
2. Gear ring (47), planet gears of planet carrier (25) and sun gears (36a,b) for worn and chipped gear teeth.
3. Planet carrier (25), gear ring (47), clutch (46), inside of driver (54) sun gears (36a,b), brake shell (16) and lever cone (13) for worn or rounded splines or dogs.
4. Bearing surfaces of lever cone (13), huh shell, driver (54), fixed cone (55), ball retainers (15,53), and inside driver (54) for wear or pitting.
5. Brake shell (16) and braking surface inside hub shell for wear and glazing.
6. Brake cone (19) for worn serrations.
7. Friction spring (20), compression springs (52), internal axle spring of clickbox version and pawl springs (32d,22,49) for size and tension (manufacturer recommends replacing pawl springs at overhaul).
8. Axle (32), and pull chains (55,59), or pushrods of clickbox version for straightness.
9. Dust caps of lever cone and driver (13,54), sprocket dustcap (56), spring caps (27,42,44,51), circlips (23,35) and ball retainers (15,53) for straightness.
10. All threaded parts for worn or damaged threads.
11. Axle keys (32b,45) and axle slots (32) for rounding or chipping.

Lubrication

To lubricate the planet gear bearings, stand the planet carrier on its wide end and apply 2 to 3 drops of oil at the trunnion pins where visible under retaining ring, turning the gears to aid the oil in penetrating.

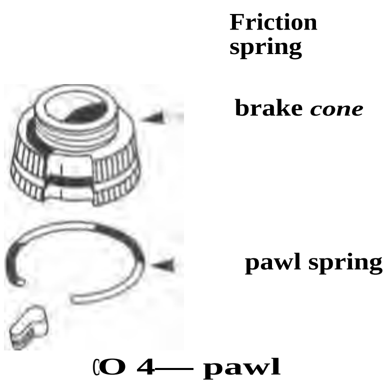
Lubricate ball cages by filling the spaces between balls with grease. Be careful not to grease pawls or clutch. lubricate hub shell, brake shoe and friction spring liberally with a high-temperature grease for steel brake shoes. Oil, never grease, brake cone and gear ring with a good cycle oil. (WD-40 is too light for lasting lubrication, 3-in-1 oil gums up with age.)

SACHS PENTASPORT 5-SPEED (CONTI))

SUBASSEMBLIES

Gear Ring

Install pawls (48i under hooked, circular pawl spring 09) Pawls must point clockwise when viewed from small end of gear ring. Hooked end of paw/ spring should lie in the slot that intersects pawl spring groove.



Brake Cone

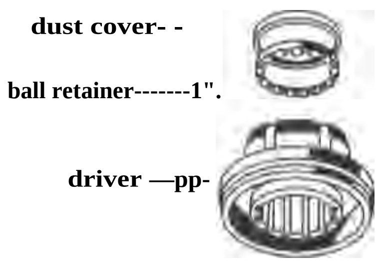
install friction spring (20) with hooked end clockwise from gap. Incorrect installation will cause excess drag, wear and possible brake failure.

Install pawls (21) under circular pawl spring without hooked end (22). Pawls must point counterclockwise when viewed from friction spring end of brake cone. Ends of pawl spring should lie adjacent to tabs that block pawl spring groove.

Driver

If starting with a replacement driver assembly, skip to the next section: the steps in this section have already been done for you.

Ball retainer is not available as a separate part from Sachs. If necessary, replace driver assembly. The ball retainer is a Star 0103 251, or you might replace the bearing balls in the old retainer. Install ball retainer flat side up. Start dustcap straight, flat side up, and tap home with a soft hammer.



SACHS PENTASPORT 5-SPEED (coNro)

SUBASSEMBLIES (cont'd)

Axle

Pullchain Version

Axle subassembly must be built up from separate parts.

Clickbox Version

If starting with a replacement axle assembly, skip this entire axle subassembly section; the steps in this section have already been done for you.

Both Versions

Clamp the axle in an axle vise with the long slot on top.

If using one-piece large sun gear with round opening (36), install it with the internal notches down and the round opening up. If using large sun gear with notches all the way through (36b). do not install it now.

Pullchain Version

If you did not install the sun gear, (36h) install the spring cap (42),concave side upward. Fit the axle key (45) into the lower axle slot, flat side down.

Install the compression spring of thinnest wire (43) and the cupped spring cap (44), concave sidedown.
Replace C-clip (35).

Clickbox Version

Install tapered compression spring, small end up, and the spring cap (44), concave side down. Replace C-clip (35).

Clamp the axle in a vise with the long slot down. Install large sun gear (36b); small sun gear, (36a) notches down; the cylindrical axle key; the axle key guide rod; and the long, thin compression spring. Compress the spring and install the Phillips-head screw into the end of the axle.

(See Clickbox illustration: page 16-27.)

SACHS PENTASPORT 5-SPEED (CONT'D)

1 ASSEMBLY

Pullchain Version

Install axle key (45) into the longer axle slot, flat side up.

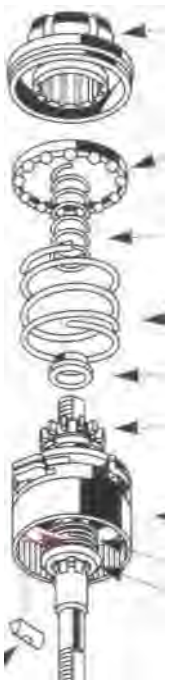
Clickbox Version

Install shorter compression spring between two spring caps, or sun gear and cap, (concave sides toward spring) then compress spring and install axle key with shoulders resting on face of upper spring cap.

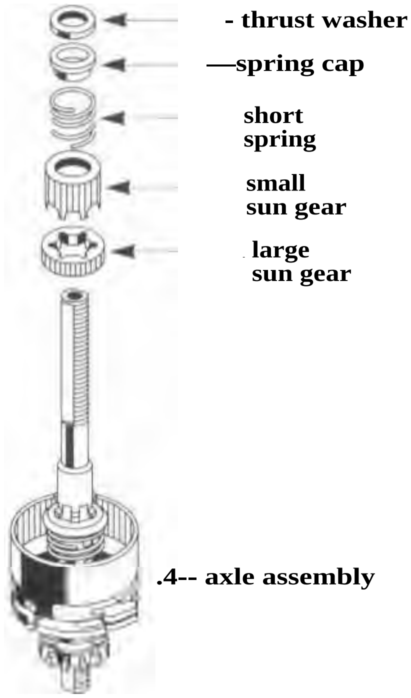
Install splined clutch (46), larger end down. Install gear ring (47), with pawls and pawl spring. Install largest ball retainer (53), flat side up.

Install spring cap (SI), flat side down. install the large spring (50). Install long spring (52).

Install driver assembly (54). Press driver down against spring force and screw down fixed cone (55), flat side up; tighten to 14.5 ft. lbs.



SACHS PENTASPORT 5-SPEED (CONT'D)



2 ASSEMBLY

Invert assembly — Place axle in a vise by its flats, long-slot end up.

Pullchain Version

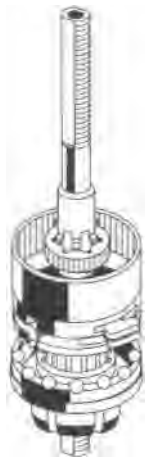
If using a large sun gear with notches all the way through (36b), you have not installed it yet. Install it now, push it past the axle dogs and twist it to lock it into place.

Install small sun gear (36a), tabs downward. Install shortest spring (28) and spring cap(42).

Install thrust washer (26).

Clickbox Version

Sun gears have already been installed. Skip these steps.



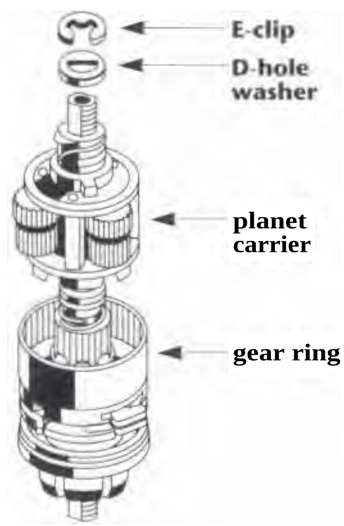
Red Timing Aid

Align planet gears with timing marks facing precisely outwards and install planet carrier (25). Sachs parts list mentions a red timing aid (62) which aligns the gears during installation; correct assembly is, however, possible without using this. Carrier must engage fully over sun gears and turn smoothly. Recheck timing marks after installation.

Caution: if planet gears are incorrectly timed, hub will sustain damage in use.

Work planet carrier down until E-clip notch on axle is exposed.

Install D-hole washer (24) and then install E-clip washer (23). Planet carrier should turn freely, with very slight lengthwise play on axle.



SACHS PENTASPORT 5-SPEED (coNrr)

3 ASSEMBLY

Screw brake cone assembly On conical side up, onto the threads of the planet cage.

install hub shell, turning it slightly counterclockwise to clear pawls.

Install brake shell 116), with internal tabs upwards. End of friction spring on brake cone must engage in one of the two slots in lower side of the brake shoe.

Install remaining bearing retainer (15), flat side up.

Install lever cone assembly (13), turning it clockwise to engage brake shoe tabs.

Screw on the two locknuts, (5) adjust for minimal bearing play without binding, and **lock the nuts against each other (not against lever cone assembly!)** using a 17 mm cone wrench and 17 mm open-end *or* box-end wrench.

GEAR TABLE FOR INTERNALLY GEARED HUBS

Multiply by gear value obtained from (..'hainwheei and rear sprocket gear charts.

Gear	1	2	3	4	5	6	7
Sachs							
2-speed	1.00	1.36					
3-speed	0.73	1.00	1.36				
MID-speed	ano	.8	11.00	1.29	1-50		
7-speed	0.59	0.67	0.81	1.0	1,24	1.48	**1.69**
Shimano							
3-speed	0.75	1.00	1.33				
7-speed	0.63	0.74	0.84	**0.99**	1.14	1.33	1.55
Sturmey Archer							
3-speed	0.75	1.00	1,33				
4-speed	0.67	0.79	1.00	1.27			
5-speed	0.67	0.79	1.00	1.27	1.50		

SACHS 3-SPEED PARTS LIST

Numbers listed under Item refer to the item numbers on the parts list referred to at the top of each column. Suth '92 CB book refers to Sutherland's Handbook for coaster brakes and internally geared hubs 1992.

Hub	Type H3111 with coaster brake Parts Lists: Suth			H 3102 3-speed w/out brake Parts Lists: Suth			H 3120 3-speed with drum brake Parts Lists: Suth			11 21 101 3 x 7 hybrid system w/out brake Parts List: 189.6		
Part	Item	Part no.	compat.	Item	Part no.	corn pat.	Item	Part no.	compat.	Item	Part no.	compat.
1. Hex Nut	1	0516 003 000	189	1	0516 003 000	189	1	0516 OW 000	189	1	00 0516 003 000	189
1a. Cap nut	la	0516 107 000	89	1a	0516 107 000	89	la	0516 107 000	89	1a	00 0516 107 000	89
2. Locating washer (2 ea.)	2a	0517 102 000	1	2a	0517 102 000	1						
2a. Retaining wash. (1 ea.)	2b	051 7 104 000		2b	051 7 104 000		2b	0517 104 000		2	00 0517 107 000	1,5-9
3. tocknut (X)	3	0516 111 000	1,5-9	3	0516 111 000	1,5.9	3	0516 111 000 1,5.9		3	00 0516 111 000	1,5
4. lo(kwashei				4	0517 005 000	1?6?						
5. Lever cone Assy. short	8	0574 110 100										
So. long	8	0574 111 100										
6. Brake [ever short	H	0519 014 300										
7. Dust Cap	li	0521 103 100					15	0121 112 000 5		5	00 4621 404 071	
8. Adjusting Nut												
8o. Washer 10.6 x 20 x 3.3							5	0518 113 OOO 5				
8b. Adjusting washer PIP							6	0517 103 000 5				
8c. Brake carrier assembly							9	0577 002 000 S?				
8c1. Washer 14.4 x 21 x 2.5							13	0518 112 000 5				
9. Adjusting Cone				14	0574 112 100		14	0508 109 000		4	00 0574 114 000	
W. Ball Retainer	17	0576 104 200	1,6-9	17	0576 104 200	1,6-9	17	2376 403 000 5		6	00 2376 003 000 5	
11. Brake Shell	10	0573 103 100										
12 Hub Shell, 36 holes	H	0501 118 000			no info			no info			no info	
28 holes	H	0501 118 001			no into			no info			nn info	
13. Brake Cone Assembly	12	0574 106 000	1									
14. Friction Spring	11	0513 102 000	3789									
15. Pawls *	24	0536 104 100	123	24	0536 104 100	123	24	0536 104 000	123		00 0536 104 100	123 -4-
16. Ring spring	25	0512 102 100	1234									
17. Axle Circlip	18	0517 002 000	1,5-9	18	0517 002 000	1,5-9	18	0517 002 000	1,5-9	S	00 0517 002 100	1,5-9
18. D-hole washer (thrust)	19	0518 103 000	59	19	0518 103 000	59	19	0518 103 000	59	9	00 0518 103 000	59
18a. Washer							22h	0518 114 000			(W)	
19. Planet Carrier Assembly	29	0572 119 000		29	0572 120 100		29	0572 121 001		14	00 0572 120 200	
20. Circlip	21	0512 104 000		20	2512 007 000	56	20	2512 007 000	56	10	00 2512 007 000	56
21. locating Sleeve	26	05 14 103 000										
22. Planet Carrier	H	0502 112 000	1		not listed			not listed			not listed	
23. Thrust Washer (Z)	H	0518 106 000	1,5-9	H	0518 111 000	1,5-9						
24. Pivot Pins	H	0114 101 000	23		not listed			not listed			not listed	
2$. Planet Gear	H	0533 103 000	123		not listed			not listed			not listed	
26. Pawl Carrier Assembly				23	0524 102 000		23b	0504 103 000		13	00 0504 103 000	
27. Pawl Carrier					not listed			not listed			not listed	
M. Ring spring				25	0512 102 100	4,5-9 -141-4.-	25	0512 102 100	4,5-9	12	00 0512 115 001	--
29. Gear Ring Assembly	30	0581 104 101		30	0581 104 101		30	0581 104 101		16	00 0581 104 101	
30. Circlip	H	0312 003 000			not listed			not listed			not listed	
31. Dog Washer	H	0518 109 OW			not listed			not listed			not listed	
32. Gear Ring	H	0581 104 000			not listed			not listed			not listed	
33. Clutch Gear	H	0533 111 000			not listed			not listed			not listed	
34. Ring spring	31	0512 115 200		31	0512 115 200		31	0512 115 200		18	00 0512 115 200	
35. Pawl	32	0536 109 100	5-9	32	0536 109 100	5-9	32	0536 109 100	5-9	17	00 0536 109 100	5-9

SACHS 3-SPEED PARTS LIST

Hub	Type 113111 with coaster brake			H 3102 3-speed without brake			H 3120 3-speed with drum brake			H 21 101 3 x 7 hybrid system w/out brake		
Part	**Item**	**Part no.**	**compat.**	**Item**	**Part no.**	**compat.**	**Item**	**Part no.**	**compat.**	**Item**	**Part no.**	**corn pat.**
36. Dog Ring												
37. Bearing Bush												
38. Gear Change Plate												
39. Axle 146mm												
152mrn	51	0509 111 000		33	0509 111 000							
154mm												
159mm												
164mm	33	0509 112 000		33	0509 112 000		I 34	0509 114 000				
168mm										15	00 0509 122 *000*	
40. Ball Cup												
41. Ball Retainer (7)										23	00 0576 104 200	
42. Pressure Spring(large)	SS	0525 104 100		35	0525 104 100		35	0525 104 100		*22*	00 0525 104 100	
43. Pressure Spring(small)	36	0525 013 200		36	0525 013 200		36	0525 013 200		20	00 0525 013 200	
43a. Spoke protector										7	00 0503 003 000	
44. Driver Assembly	I 37	0572 118 200		37	0572 118 000		37	0572 **118** 000		I 24	00 0572 125 000	
4S. Ball Retainer	H	0576 102 000	123		not listed			not listed		25	00 0576 102 000	
46. Dust Cap	H	0121 108 000	123		riot listed			not listed		I 26	00 0521 114 000	
47. Fixed Cone	I 39	0508 105 000		39	0508 105 000		39	0508 105 000		28	00 0508 105 000	
47a. Spacer, 16.4 mm long										29	00 0534 119 100	
47b. Locknut (X)							44	0516 001 300				
48. Cap	38	0521 108 000		38	0521 108 000		38	0521 108 000		21	00 0521 108 000	
49. Dust Cap (sprocket)	I 40	0121 109 000	23	40	0121 109 000	23	40	0121 109 000	23	I 27	00 0521 115 000	
50. Spacer Washer	41	051 8 018 000		41	0518 018 000		41	0518 018 000				
51. Sprockets (9)	42			42			42					
S la. 7-sprkt. cluster 14-32										30	69 4600 403 404	
52. Cirdip	43	0512 011 000	1-9	43	0512 011 000	1-9	43	0512 011 000	1-9			
53. Chain Guide Nut	I 45	0516 100 102		45	0516 100 102		45	0516 100 107		I 31	00 0516 300 000	6
S4. **Axle Key**	46	0527 100 200		46	0527 100 200		46	0527 100 200		19	00 **05271C0 200**	
55. Small Pull Rod	47	0587 102 000	789	47	0587 102 000	789	47	0587 102 000	789			
SSa. Long Pull Rod										32	00 0587 103 000	
56. Knurled Nut				-at								
57. Adjuster Sleeve Assem.	48	0570 117 000	789	48	0570 117 000	89	48	0570 117 000	789	33	00 0570 117 000	789
Special grease A, 35g											0369 135 100	
Special grease A, 2x250g											0369 135 101	

COMPATIBILITY:

Duomatic 102 and l **01**

2. Automatic R 2110
3. **Duomatic A 21 10**
4. Ring springs of H3111 brake cone, H3102 and H3120 pawl carrier interchange
5. H 5120 Pentasport 5-speed with drum brake
6. H 5100 Pentasport 5-speed, no brake
7. Also see line 10

7. Probable but untested compatibility

H. Available as parts of newer assemblies by Sachs.

W. Part is shown in drawing but no part number is given.

X. Left locknut of 415 and 515 is compatible with right locknut of H3120 with drum brake.

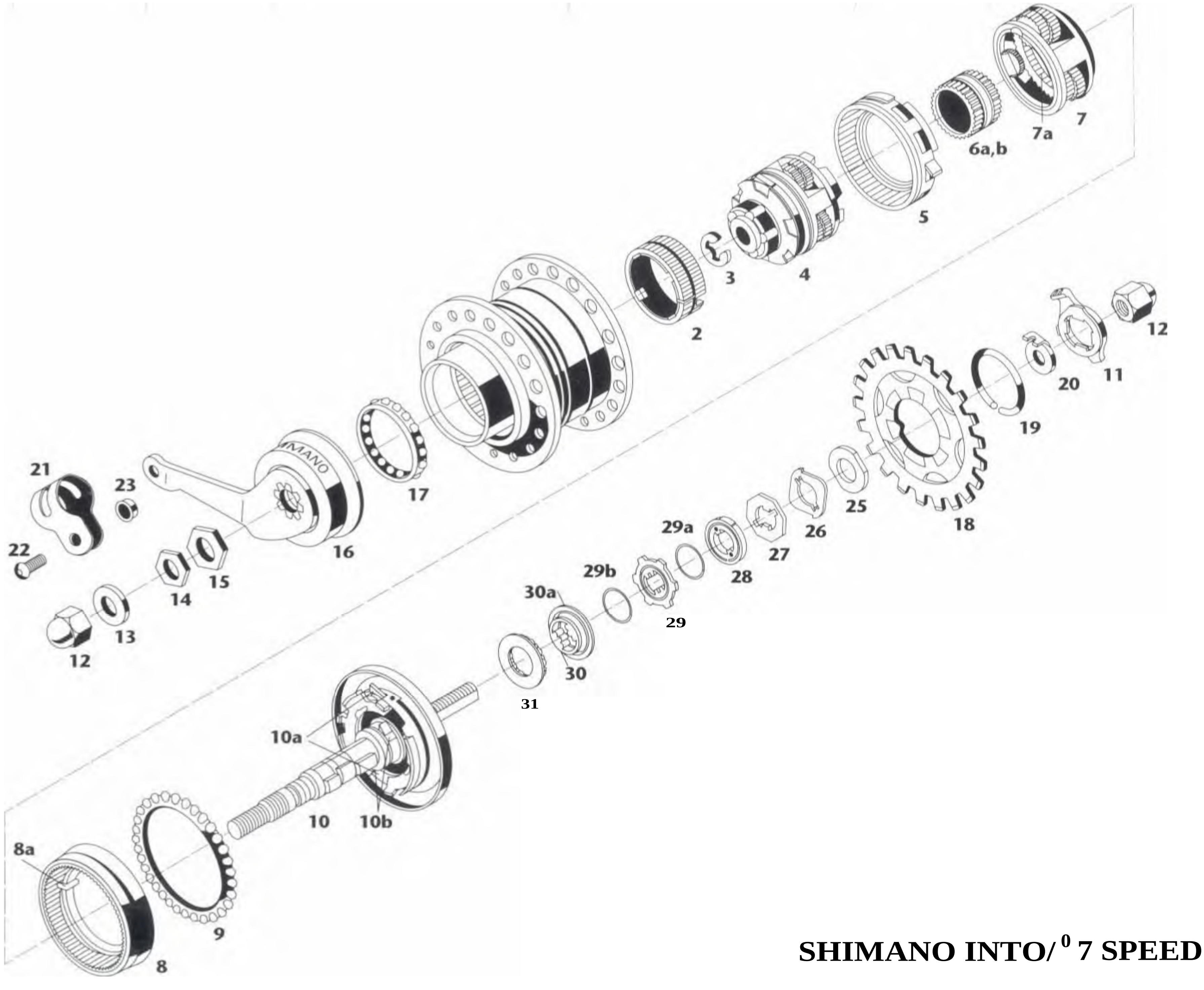
Z. May be used only in older version - check on this.

NOTE: 3 x 7 alloy shell Is rated by Sachs for tandem and offroad use. Steel shell with pressed-on flanges is not.

* #15 Pawls also used in #19 planet carrier assembly.

l Vertical lines between numbers indicates parts are not interchangeable.

lTEM - Sachs Instructions assigned parts number.
Number of part in Sachs instructions



SHIMANO INTO/ 0 7 SPEED

SHIMANO INTER*7 SPEED

How It Works

The Shimano 7-speed hub is of very different design and construction from other internal hub gears, as is clear just from looking at the gear ratios. There is no 1-1 ratio!

This results from the Shimano huh's unusual scheme for shifting gears: a rotating sleeve (cam) on the axle which, by its angle changes relative to the axle, opens up or blocks a number of different ratchets and pawls. This hub has four sun gears, in two compound planetary gear systems.

In all but the top two gears, drive from the sprocket is into the gear ring of the right-side planetary system. 11- the rightmost sun gear of this planetary system is stationary, the hub is in first gear. if the next sun gear to the left is held stationary, the huh is in second gear. The right-side planetary gear system can only gear down or transfer power at unity ratio, since drive can be input either at its planet cage or gear ring, and can not he output at its gear ring.

Gearing up is accomplished by a second planetary gear set at the left side of the huh. This is driven by the planet cage of the right side gear set. For 6th and 7th gear, a set of pawls is engaged to drive the right side planet cage directly at unity ratio, while the right side gear ring freewheels forward. The right side planet cage drives the left side planet cage, and depending on whether the right or left sun gear of the left planet cage is engaged, the hub is in 6th or 7th gear.

The most unusual feature of the hub is that its three middle gears use both planetary gear systetns, gearing down at the right side of the huh and back up at the left side. The multiplication of ratios is comparable to that of a derailleur gearing system which uses different ratios at chainwheels and sprockets to reach the desired final drive ratio. 3rd gear of the Shimano hub is 1st x 6th; 4th is 2nd x 6th; and 3rd is 2nd x 7th. You might ask why, if the right planetary system can transfer power at unity ratio, the middle gear is not unity ratio. The answer: this must have something to do with the hidden complexities of the shifting mechanism, since in theory, drive could be directly from the right to the left planet cage. Another possible explanation is that direct drive in 4th gear would reveal too clearly the hubs inefficiency in 3rd and 5th.

The 3rd and 5th gears must be achieved by using both planetary systems, since each planetary system has only two sets of pinions . The third and fifth gears, like the fourth, are achieved by multiplying one of the two ratios at the right side of the hub by another at the left side.

ALIGNMENT

This hub has an overlocknut spacing of 1.30mm, a rear chainline of 48mm. The spoking flange diameter is 87mm. The hub is available with 36 holes.

TESTING SHIFTER OPERATION

The cable may be replaced without removing the wheel from the bicycle.

Removing the Inner Cable

To remove the inner cable, set shift lever to first gear position. Loosen setscrew of cassette joint. Push the cable through the housing from the hub end, and withdraw it from the shift lever.

Replacing the Inner Cable

Use index-shifter certified cable and housing. The inner cable has a conventional cylindrical ferrule at the shift lever end, and you may replace it with a derailleur cable that has a similar ferrule.

Set the shift lever to first gear position. Pass the inner cable through the hole of the lever. Lubricate it and pass it through the housing, then the adjuster barrel of the cassette joint. Tighten the setscrew with a 2.5 mm Allen key while pulling lightly on the inner cable. Cut off excess cable and cap or solder the end. Rend the end of the cable slightly toward the outside, so it can not drag on the sprocket. Check cable adjustment, as follows:

Cable Adjustment

Set shift lever to 4th gear position. Check that red marks on cassette joint line up. If not, turn adjusting barrel at huh end of cable. Move shift lever to first gear and back to 4th, and recheck. If there is not sufficient adjustment range, loosen setscrew to reposition cable.

SHIMANO INTER-7 SPEED (CONTD)

Removal of Wheel from Frame

Remove cable end assembly from hub only after removing wheel from frame. You may, however, replace the cable itself without removing the wheel, ***(see "Repladng and Adjusting Cable," page 16-39).***

Loosen axle nuts. Slip wheel from dropout slots, taking care not to kink the shift cable. Turn tab of cassette joint fixing ring 45 degrees counterclockwise. Cassette joint and fixing ring may now be lifted over axle nut and tab washer, and you may remove the drive chain past the right end of the axle.

Assembly of Wheel to Frame

Install sprocket and clip ring to hub driver.

Install shift cable assembly to hub as follows, before installing wheel in frame.

If the drive chain has not been disconnected, place it over the sprocket now. Set shift lever to I. Make sure cable housing is seated in ferrules at both ends. Rotate pulley at hub end of cable clockwise with yellow marks facing upwards until they line up. Then align them over yellow marks at right end of hub. Position cassette joint fixing ring also with yellow marks aligned, press it down and rotate it 45 degrees clockwise to lock.

Check operation of shift lever. If there is a yellow pin in cassette joint which prevents shift pulley from turning, remove the pin.

Check that red marks on cassette joint line up with shift lever in 4th gear position. If not, ***(see "Replacing and Adjusting Cable," page 16-39).***

Position the shift cable on the frame and insert the hub into the rear fork.

Align the cassette joint nearly parallel to the chainstay and install the non-turn washer on the right end of the hub axle, with the tab projecting into the drop-out slot, facing toward the outer end of the slot. The flats of the axle and of the non-turn washer are not parallel to the drop-out slot. Black non-turn washer is for forward-facing slot and gold washer is for rear-facing (track-type) slot. Install a serrated washer without tab on the left end of the axle.

Install axle nuts, adjust chain slack and secure nuts. Secure the brake arm to the frame with the brake arm clip. Multi-hole strap must he cinched tightly around chainstay, not looped loosely over it.

Adjust position of cable on frame, and secure it with cable bands.

INTERNAL MULTI-SPEED HUBS,

Troubleshooting Chart Shimano Inter-^{0} 7 Speed

SYMPTOMS	Resulting from wear, improper lubrication or abuse	Resulting from improper assembly or installation
1. **Brake grabs or squeals.**	Incorrect or insufficient internal lubrication.	Brake arm loose at frame.
2. **Stiff running, noisy.**	Brake arm forcing brake cone out of line. One pawl of a pair faulty. Dropouts not parallel. Chain too light. Cones too tight. Bent dustcap. Broken or chipped gear teeth. Ball retainer damaged or broken.	Ball retainer (17) (left side) installed upside down. Friction spring of gear ring (5) reversed. One pawl of a pair improperly installed. E-clip missing.
3. **Carrier (4) covers or partly_ covers E-clip groove of axle.[redacted],_**		Ball retainer H (right side) installed flat side down. Friction spring of ring gear unit 1 improperly seated. Sun gear 2 and 3 assembly inverted.
4. **Hub jams in one or more gears.**	Axle bent. Pawls inside sun gear (4, 6a 6b) or in driver jammed. Broken or displaced parts inside hub.	Gears or pawls not properly seated.
5. **Hub will not shift to all gears (cable slack in lower gear; or lever will not move to higher gear).**	Axle sleeve bent, worn or chipped. Helical springs inside driver weak or damaged. Cable frayed, kinked or unlubricated.	Cable too tight or loose. Cassette joint assembly incorrectly installed.
6. **Jumps to next higher or lower gear.**		
7. **Slips in 1st and 2nd.**	External pawls of planet carrier (4) do not engage.	
8. **Slips in 1st and 3rd.**	Axle pawls (10b) engaging sun gear, (7a) (tiny pawls!) do not engage.	Forced assembly has displaced axle pawls engaging sun gear 1. They should point counterclockwise, looking from left end of axle.
9. **Slips, and brake release is erratic, in 1st through 5th.**	Driver pawls that should engage gear ring (8) retracted or damaged	
10. **1st instead of 2nd; 3rd instead of 4th.**	Pawls of sun gear (6a) retracted or damaged. Narrower teeth of pinions in planet carrier (7) stripped.	
11. **1st instead of 3rd; 2nd instead of 4th and 5th; "3rd" (unity ratio) instead of 6th and 7th.**	Sun gear (6a) stripped. Pawls of gear ring (6b) retracted or damaged.	

Troubleshooting Chart - Shimano inter s 7 Speed

SYMPTOMS	Resulting from wear, improper lubrication or abuse	Resulting from improper assembly or installation
12. **4th instead of 5th; 6th instead of 7th.**	Pawls of sun gear 3 retracted or damaged.	
13. **2nd instead of 6th; "4th" (1st x 7th) instead of 7th.**	Forward-driving pawls of driver which should engage ratchet at right end of planet carrier (7) are damaged, or remain retracted in 6th and 7th.	
14. **1st instead of 3rd; 2nd instead of 4th; "4th" (unity ratio) instead of 6th.**	Pawls of sun gear 4 (in planet carrier assembly 4) retracted or damaged. Sun gear (4a) (in planet carrier assembly 4) stripped. Narrower teeth of pinions in planet carrier (4) stripped.	
15. **Hub occasionally jumps forward when power is applied in 3rd through 7th.**	Pawl retractor sleeve of gear ring (5) damaged.	Pawl retractor sleeve of gear ring (5) missing.
16. **Excessive pedal travel before brake engages.**	Brake shoe or hub shell glazed or worn. Wrong lubricant. Friction spring of gear ring (8) weak.	Friction spring of gear ring (8) absent.
17. **No brake.**	Rollers of roller clutch of planet carrier (4) do not turn freely. Friction spring of planet carrier (4) weak.	Friction spring of planet carrier **(4)** absent.
18. **Brake does not release or releases erratically in 3rd through 7th.**		Reverse (clockwise, seen from left end of axle) pawls of driver damaged or retracted.

PARTS LIST FOR SHIMANO INTER•7-SPEED WITH COASTER BRAKE SG-7C21

1	33Z 9801	Internal Assembly (axle length 169.5 mm)
2	330 9801	Brake shoe
3	325 3200	E-Clip (9 mm diameter)
4	330 9804	Planet carrier assembly - unit 2
5	330 9802	Gear ring - unit 2
6a,b	330 9803	Sun gear assembly
7	330 9806	Planet carrier - unit 1
7a		Sun gear
8	330 9805	Gear ring - unit 1
8a		Friction spring
9	330 9807	Ball retainer H (3/16)
10	330 9808	Driver and axle (axle length 169.5 mm)
10a		C Pawls
10b		Axle Pawls
11	33Z 9802	Cassette joint fixing ring
12	314 1400	Cap nut (9.5mm thread)
13	220 0601	Washer (3.2 mm thick)
14	321 3801	Lock nut (3.5 mm thick)
15	335 4810	Stop nut
16	330 9810	Brake arm
17	330 9811	Ball retainer B (3/16 balls)
18		Sprockets1
19	321 2000	Snap ringl
20	337 2010	Non-turn washer 1 (black)
	33Z 2020	Non-turn washer 2 (gold)
21	330 9812	Brake arm clip, 16 mm (5/8)
	330 9813	Brake arm clip, 19 mm (3/4))
22	333 0702	Clip screw
23	282 2903	Clip nut
24	1 30 9890	TL-7520 Hub spanner (cone wrenches) (17mm x 22mm) 2 pcs.
25	321-3801	Locknut
26		Four-flat washe
27		Cam washer
28		Plated plastic washer
29		Eight-tab washer
29a,b		Wire ring
30		Axle cone
30a		Plastic seal
31		Bearing retainer
		26 – 31 not available from Shimano seQarat L

1 *(See Sutherlatuts Hatulhook of Coaster Brakes & Internally Geared Hubs pages 1-3.)*

PARTS LIST FOR SHIMANO INTER•7-SPEED WITH COASTER BRAKE SG-7C21 (coN-rD)

RAPIDFIRE LEVER ST-7S20 FOR 7-SPEED

1	61W 9804	R.H. shift lever unit
2	61W 9801	Bracket fixing screw (MS x 18) and nut
3	61W 9802	Lever fixing bolt (M5 x 1 3) and spring washer
4	61W 9803	Cable adjusting barrel unit
5	749 9804	Cassette joint unit for SG-7C21
	749 9803	Cassette joint unit for SG-7C20
6	749 9802	Cable adjusting barrel and spring for cassette joint
7	33Z 9802	Cassette joint fixing ring for SG-7C21 [also 411 1 in parts list for hub]
	749 1200	Cassette joint fixing ring for SG-7C20
8	600 9851	Inner cable box (Stainless/100 pcs.)
9	60B 1385-1	SIS-SP outer casing (1380mm/black)
	60B 1485-1	SIS-SP outer casing (1480mm/black)
	60B 1565-1	SIS-SP outer casing (1560mm/black)
	60B 1705-1	SIS-SP outer casing (1 700mm/black)
10	620 9803	Inner end cap (1.2 mm diameter/100 pcs.)

DISASSEMBLY INSTRUCTIONS FOR
SHIMANO INTER • 7 SPEED

1 DISASSEMBLY

Place the hub in axle vise, sprocket end down. You may leave the shifter mechanism and cable attached if you wish, for troubleshooting purposes: but in this case, put the shift lever into first gear position when installing or removing parts.

Using 22mm and 17mm cone wrenches (Shimano TL-7S20), loosen and remove lock nut (14) and stop nut (15).

Remove brake arm unit (16) and ball retainer (17). Lift off the huh shell. If you are replacing the entire internal assembly, skip to Drawing 1, Assembly.

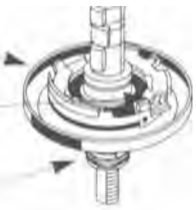
2 DISASSEMBLY

Remove the brake shoe (2). Remove the E-clip (3), using a screwdriver. Remove gear ring 2 (5) and planet carrier 2 (4) at the same time while rotating gear ring 2 (5) slightly to the left and right. Remove sun gear (6a and 6b) while turning them slightly to the left and right. Do not use excessive force, or you could damage the pawl springs inside them.

SHIMANO INTER • 7 SPEED (CONT'D)

3 DISASSEMBLY

Remove planet carrier 1 7). Remove guar ring 1 {8) while turning it slightly to the left and right. Remove axle from vise and invert. Shake loose and remove ball retainer (9) while depressing pawls C of the driver and axle unit. Be careful not to bend ball retainer (9).



AXLE DRIVER DISASSEMBLY

Shimano does not recommend the drive side of the hub be disassembled. The parts are not available.

While Shimano does not give instructions to disassemble the axle from the driver, it is necessary to do this, to check, clean and relubricate the hearing between the driver and axle. The disassembly and reassembly pose no unusual problems if care is taken not to lose any of the parts — they can not be replaced individually! Be careful not only of the cone and other axle-end parts, but also of the small pawls just inboard of the driver.

Insert the axle assembly in a vise with soft jaws just inboard of the left-end threads, driver end up.

Loosen the right-side locknut (25) with a 1.7min wrench while holding the axle flats with a thick 8min wrench or adjustable wrench. **Do not use a wrench on any part under the locknut. All of these parts are tabbed rather than threaded, and you could damage the tabs.**

Lift off tabbed four-flat washer (26). Remove cam washer (27) by lilting it off the axle. Carefully remove plated plastic washer (28) by lining it off the axle without losing the small wire ring (29a) under it. Remove the small wire ring from the top of the six-tab washer on the axle or from the underside of the plated plastic washer which you have just removed.

Lift six-tab washer (29) oft the axle. Re careful not to lose the small wire ring 129b) under it. Remove small wire ring from groove in top of fixed cone on the axle or rom underside of six-tab washer which you have just removed.

Remove fixed cone (30) by sliding or prying it upward off the notches of the axle. Remove flexible, plastic seal (30a1 from groove of fixed cone. Remove bearing retainer (31). Remove the driver assembly from the axle assembly.

SHIMANO INTER • 7 SPEED (CONT'D)

Cleaning

Clean all parts, including outside of huh shell, in a suitable solvent. Be very careful not to introduce dirt or grit after cleaning. If you have not disassembled the axle from the driver, do not clean the driver end of the axle-driver assembly, as you will be unable to relubricate it properly and may introduce dirt which you can not remove.

Points to Check

1. Pawls: 4 sets in driver/axle assembly (10); 2 sets in sun gear (6); 1 set in gear ring (5); 2 sets in carrier(4) — for chipped or rounded edges and for misalignment.
2. Pawl springs: 4 in driver/axle assembly (10); 2 sets in sun gear (6); 1 in gear ring (5); 2 sets in carrier (4) for shape and tension.
3. Ratchets: 2 in hub shell; 3 on axle (10); 1 inside gear ring (8); 2 inside and outside right end of carrier (7) for chipped or rounded edges.
4. Gear teeth of sun gear 6a and 6b; of sun and planet pinions of carrier (7) and carrier (4); of gear ring (8) and gear ring (5) — for wear and chipping.
5. 2 concentric helical shift sleeve return springs of axle (10); friction spring of gear ring (8); pawl retractor spring on outside of gear ring; ring spring of brake shoe assembly (2) for shape and tension.
6. Driver (10), brake cone (11) and hub shell bearing races for wear and pitting. Note: there is a concealed bearing between axle and driver. Unless you have disassembled it, test it by rotating it to feel for roughness.
7. Dustcaps, ball retainers (9), (17), E-clip (3) and axle (10) for straightness.
8. All threaded parts for damaged or stripped threads.
9. Brake shoes (2) and hub shell for wear or glazing.

Lubrication

Lubricate pinion pins by dripping a few drops of oil on their exposed ends. Lubricate pawl springs lightly with oil. Lubricate shifter springs, pawls and sleeve of axle-driver assembly lightly with oil. Use a good cycle oil. WD-40 is too light for lasting lubrication. 3-in-1 oil gums up with age.

Lubricate ball retainers by filling the spaces between the balls with grease. Lubricate hub shell, brake shoes (inside and out), axle assembly and pinion teeth liberally with grease: use Shimano 7-speed hub grease, part no. 041 3011.

INTERNAL MULTI-SPEED HUBS

ASSEMBLY INSTRUCTIONS FOR
SHIMANO INTER*7 SPEED

Note: all pawls point counterclockwise, looking from left end of axle, except:

1. Reverse pawls of driver for brake (at same diameter with counterclockwise pawls that retract in 1st through 5th gear);
2. Pawls of sun gear (6a).

Some pawls, particularly axle pawls (10b), engaging sun gear (7a), are tiny and easily displaced. Do not force assembly.

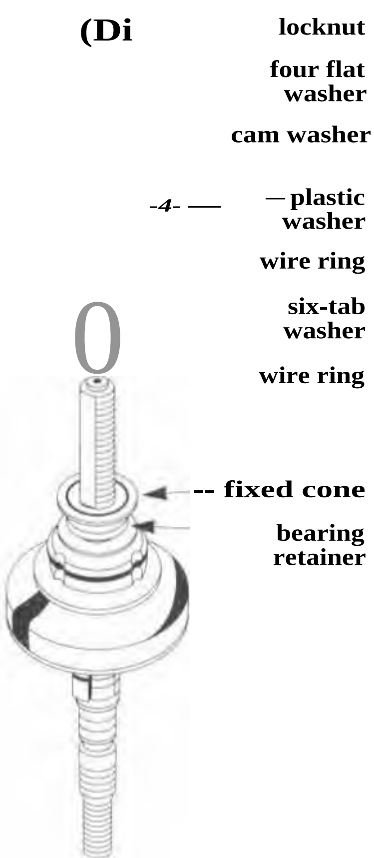
AXLE DRIVER ASSEMBLY

Place the axle assembly in soft jaws of a vise by the part just inboard of the threads, spring end up.

Install the driver (10) over the end of the axle so it rests on the shifting mechanism.

The bearing retainer is not available as an individual part, but you may replace bearing balls in retainer (3/16" balls). Install hearing retainer (31), flat side up.

Install seal (30a) into groove around outside of fixed cone, smooth side up. Install fixed cone (30) over the notches of the axle, flat side up.



Apply grease to top surface of fixed cone and lay small wire ring (29b) into groove in top of fixed cone.

Install six-tab washer (29), smoother side up, over ridges of axle.

Apply grease to top surface of six-tab washer (29) and lay the remaining small wire ring (29a) into the groove on top of six-tab washer.

Install plated plastic washer (28), yellow marker side up, with pins on underside mating with recesses of six-tab washer and tabs mating with grooves of axle.

Install cam washer (27), with notches counterclockwise of tabs, into grooves of axle.

Install four-flat tabbed washer (26) with tabs extending downward into notches of cam washer.

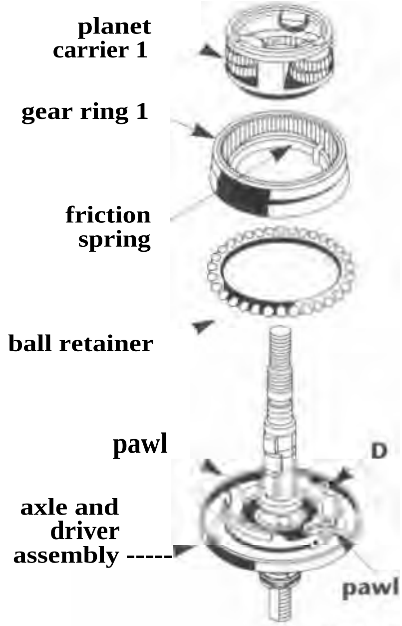
Thread locknut (25) over the end of the axle and tighten it with a 17mm wrench while holding the axle from turning using a wide 8mm wrench or adjustable wrench on its flats.

Test assembly. It should be possible to install the cassette joint as described in the section on shifters and cables, secure it with the lockring and shift through the gears. At this stage, with the cassette joint and cable attached to the axle assembly alone, you will have to rotate the driver forward 1/2 turn or more before the huh will downshift all the way to 1st gear.

INTERNAL MULTI-SPEED HUBS

SHIMANO INTER • 7 SPEED (CONT'D)

3 ASSEMBLY

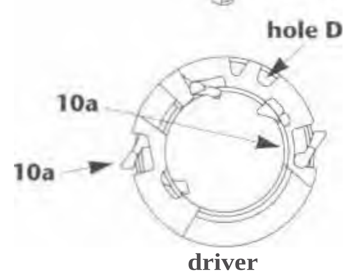


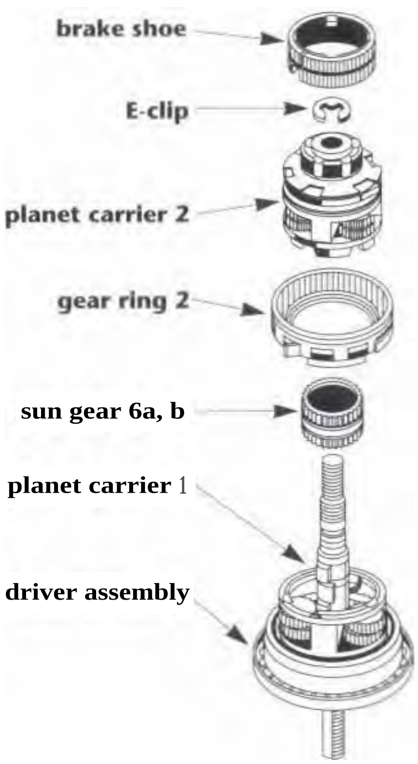
Insert the axle-driver assembly into a vise, sprocket end down. If assembling with the shift lever and cable attached for troubleshooting purposes, place the shift lever in first gear position. Otherwise, you will not be able to seat some of the assemblies, and you may force some pawls out of position.

install ball retainer (9) flat side up over one pawl (10a) of axle driver assembly (10). Then depress the other pawl (10a) with the tip of a screwdriver and pass ball retainer (9) into position beyond it. Be careful riot to bend ball retainer (9).

Insert the end of friction spring (8a) of gear ring I into the wide hole D of the driver ; depress pawls (10a) and install gear ring 1 (8). Face of gear ring should rest flat against ball retainer (9). Turn gear ring counterclockwise against resistance of friction spring (8a); pawls should click.

Install planet carrier 1 (7), small end down. Be especially careful that hub is in 1st gear (or cable is disconnected), and do not force assembly, as the tiny axle pawls (10b) which engage sun gear (7a) in this unit are easily dislodged. Turn planet carrier 1 (7) slightly back and forth to engage teeth of pinions with teeth of gear ring 1 (8). After installation, rotate planet carrier 1 (7) forward (counterclockwise) and check that both of the axle pawls (10b) inside sun gear (7a) are ratcheting correctly.





2 ASSEMBLY

Install sun gear (6a,b) to mesh with planet pinions of carrier (7). **Sun gear (6a), which is one piece with smooth middle ring of unit, must be at top.** Work the unit into place by carefully rotating left and right. Do not use force, as this could damage the pawls.

Place gear ring 2 (5) over planet carrier 1 (7), with the gear ring teeth facing upward.

Install planet carrier 2 (4), turning the carrier unit slightly to the right and left to engage the teeth of the planet pinions in gear ring 2 (5).

Push down planet carrier 2 (4), and check that the full width of the circlip groove of the axle is visible over the upper edge of planet carrier 2 (4). While pushing down on planet carrier 2, insert the E-clip (3) into the hub axle groove.

INTERNAL MULTI-SPEED HUBS

SHIMANO INTER - 7 SPEED (CONT'D)

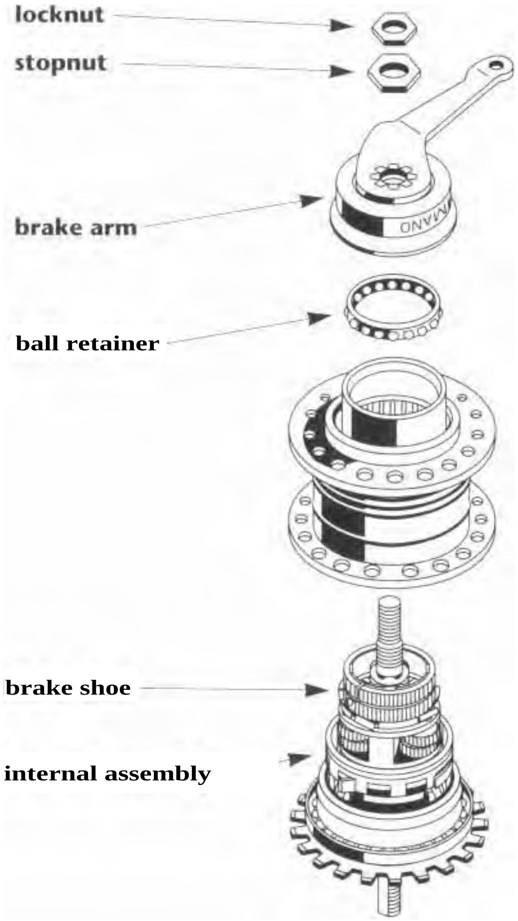
1 ASSEMBLY

Expand the brake shoe (2) over the roller clutch of planet carrier 2 (4) four-notch side up, aligning the notched Section between the two brake shoes with the end of the friction spring of planet carrier 2 (4).

Slip the hub shell over the assembly, turning it slightly to the left and right so that the sealing spring of the hub shell is positioned in the right hand dust cap of the internal assembly. Turn the hub shell counterclockwise to check that it turns smoothly.

Reinstall hall retainer (17), flat side up. Reinstall brake arm (16), turning it to the right and left until the notches of the brake shoe engage with the tabs of the brake arm unit.

Reinstall the larger nut (15), flange down, and the smaller nut (14). Adjust bearings so hub shell can he turned freely, but without bearing play, and tighten nuts against each other using 22 rum and 17 mm cone wrenches.



INTERNAL MULTI-SPEED HUBS

SHIMANO INTER • 7 SPEED (coNTD)

GEAR TABLE FOR INTERNALLY GEARED HUBS

Multiply by gear value obtained from chainwheel and rear sprocket gear charts.

Gear	1	2					
Sachs							
2-speed	1.00	1.36					
3-speed	0.73	1.00	1.36				
5-speed	0.50	0.78	1.00	1.29	1.5		
7-speed	0.59	0.67	.81	1.0	1.24	1.48	1.69
Shimano							
3-speed	0.75	1.00	1.33				
7-speed	0.63	**0.74**	10.84	0.99	1.14	11.33	0.55.41
Sturmey Archer							
3-speed	0.75	1.00	1.33				
4-speed	0.67	0.79	1.00	1.27			
5-speed	0.67	0.79	1.00	*1.27*	1.50		

CONTENTS

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APPENDIX

Appendix

SUTHERLAND'S

* APPENDIX

MARKINGS AND ABBREVIATIONS

		Where Used
A	British Standard Cycle	French parts
B	British	
BSC	British Standard Cycle	
D	Right-handed threads	French parts
F	Thread	Italian parts
FF	French threads	Italian parts
FI	English threads	Italian parts
	Left-handed threads	French parts
	Left-handed threads	Spanish parts
JIS	Japan Industrial Standard	
	Left-handed threads	English parts
LH	Left-hand	
M	Metric	
OEM	Original Equipment Manufacturer	
R	Right-handed threads	English parts
RH	Right-hand	
S	Left-handed threads	Italian parts
TPI	Threads per inch	

INTERNATIONAL STANDARDS ORGANIZATION STANDARDS

The following standards for bicycles have been approved:

ISO No.	Title and Description of Standard		Comments
DIS 4881	**Spoke Diameter and Threads**		
	1.8nun SO		Compatible with existing U.S.
	2.0mm 56 TP1J		and British spokes and nipples.
	2.3mm 56 TPI		
	2.6mm 56 TPI		
DIS 6692	**Marking of Components for Identification of Threading**		
	Metric*	British*	
	M 34.7 x I	B 1.375 x 24	Where there is ample space.
	M 34.7	B 1.375	Less space.
	M	B	Very little space.
DIS 6693	**Cottered Crank and Axle Attachment**		
	Axle diameter	I onim	
	Flat for cotter		
	Depth	3mtu	
	Width	8iiiiit	

(cont'd.)

*** (See pages 0-2 and 0-3 for an explanation of thread designation and measure.)***

ISO STANDARDS (CONTD)

ISO No.	Title and Description of Standard		Comments
DIS 6693	**Cottered Crank and Axle Attachment (cont'd)**		
	Cotter pin		
	Diameter	9.5mm (.374")	ISO cotter interchanges with British 3/8"1.375"). All other common sizes are smaller; cranks can be drilled out to standard size.
	Length	43mm	
	Taper		
	Thread	M 7 x 1	
DIS 6694	**Pedal to Crank Thread**		
	Primary standard (left pedal left-threaded1		
	Threading	B .500 x 20	Smaller diameter was chosen for compatibility with 1-piece cranks.
	thread length	12.5mm + 0.5 0	
	[bread angle	60' ISO	
	Alternate standard (left pedal left threaded)		
	Threading	B .562 x 20	Compatible with British.
	Thread length	12.5mm + 0.S — 0	For aluminum cranks.
		10mm + 0.5 – 0	For steel cranks.
	Thread angle	60" ISO	
DIS 6695	**Cotterless Crank (Square-End) Fitting**		
	Included-taper angle	4 ± 10 minutest	Taper angle is compatible with most cranks. Spindle flats are long enough at inside for all cranks, but spindle may protrude into extractor hole of a few cranks. Grind axle end if necessary.
	Length of flat		
	Right	18111111 +0.5 – 0	
	Left	16mm +0.5 – 0	
	Dimension across Hat 1.5mm from end	12.6mm +.02 – .05	
	Spindle end to bolt seat		
	Loose	3min	
	Tightened	1.5mm min.	
	Crank-fixing threads		
	Bolt-type	M 8x 1	Same as existing spindles.
	Nut-type	M 10 x 1.25	Fits all except Campagnolo Super Record.
	Crank holt or nut size 14nun		
	Dustcap threads	M 22x]	Fits all except TA, pre-1982 Stronglight.
DIS 6696	**Bottom Bracket Threads**		
	Left side	B 1.375 x 24	Compatible with British.
	Right side	B 1.375 x 24 I.	

t 2' on each side.

* See pages 0-2 and 0-3 for an explanation of thread designation and measure.

* APPENDIX

150 STANDARDS (coNro)

ISO No.	Title and Description of Standard			Comments
D15 6697	**Hub Axle Threading**			
	Solid			
	Front	M 8 x 1		Compatible with French.
	Rear	M 9 x 1		No current compatibility.
	Hollow			
	Front(and BMX solid)	M 9 x 1		Compatible with French.
	Rear	M 10 x 1		Compatible with many brands but not Campagnolo; Zeus: lOrnm x 26 TP1.
	Hub Width Between Drop Outs			
		Width	Space	
	Front	(±1)	(+1 - 0)	
	Primary Standard	1(X)		
	Secondary Standard	91		
	Rear			
	Single freewheel, coaster hub	110	21	
	3-, 4-speed freewheel, geared hub	117	28	
	4-, 5-speed	122	34	
	5-, 7-speed	126	36	
DIS 6698	**Freewheel Threads**			
	Threading	B 1.375 x 24		Compatible with British and Italian: thread diameter is intermediate. Thread form slightly different.
	Thread angle	60° ISO		
	length of thread			
	Freewheel	10min min.		
	Hub	lOrnm		
DIS 6699	**Seatpost Clamp Bolt**	M 8 x 1		
DIS 6700	**Brake Bolt Hole**	6.2mm		
	Handlebar Diameter	25.4mm +0 - .020mm		
	Threading of Fork and Headset			Compatible with British, Italian.
	Headset			
	TP1	24		
	Major diameter	25.522mm		
	Pitch diameter	24.836mm		
	Minor diameter	24.379 m m		

ISO STANDARDS (CONTD)

ISO No.	Title and Description of Standard	Comments
DIS 6700	**Threading of Fork and Headset (cont'd)**	

Fork	Min.	Max.
Major diameter	25.316mm	25.496mm
Pitch diameter	24.685mm	24.810mm
Minor diameter		24.209mm
Thread Form	ISO 965/1 (60' modified to H/6 truncation at root)	

DIS 6701 **Exterior Dimensions of Spoke Nipples**

Spoke diameter	Wrench flat	Nipple shank	Nipple head	Rim hole
1.8mm	3.3	4.0	6.0	5.0
2.0mm	3.3	4.0	6.0	5.0
2.3mm	3.8	4.8	6.5	5.5
2.6mm	4.5	5.5	7.5	6.5

To compare other standards, *(see **chart on** page 11-5)*.

Safety Standards

ISO 42101 The ISO has established tests for manufacturing quality assurance related to safety and integrity. Bicycles identified as meeting ISO 4210 conform to these standards.

Lighting and Reflectorization Standards ISO 6742

ISO 6742 ISO 6742 refers to lighting and rellectorization. Equipment bearing ISO 6742 markings conform to these standards. In particular, ISO standards for generator and battery lights are considerable higher than pre-existing national standards.

* APPENDIX

WIRE GAUGE COMPARISON CHART

English Gauge No.	British Standard Wire Gauge (SWG) mm	inches	French Wire Gauge No. (Jauge de Paris)	mm	inches
27	0.41	0.016	P	0.5	.020
26	0.46	0.018	1	0.6	.024
25	0.51	0.020	2	0.7	0.28
24	0.56	0.022	3	0.8	.031
23	0.61	0.024	4	0.9	.035
22	0.71	0.028	5	1.0	.039
21	0.81	0.032	6	1.1	.043
20	0.91	0.036	7	1.2	.047
19	1.02	0.040	8	1.3	.051
18	1.22	0.048	9	1.4	.055
17	1.42	0.056	10	1.5	.059
16	1.63	0.064	11	1.6	.063
15	1.83	0.072	12	1.8	.071
14	2.03	0.080	13	2.0	.079
13	2.34	0.092	14	2.2	.087
12	2.64	0.104	15	2.4	.095
11	2.95	0.116	16	2.7	.106
10	3.25	0.128	17	3.0	.118

Spoke Sizes

Note the underlined sizes in the chart above. they are a source of a lot of confusion. **English gauge numbers get smaller as wire gets larger. French gauge numbers get larger as wire gets larger.** 'The gauge numbers cross about where cycle spokes are.

TAP DRILL SIZES

Metrics Sizes

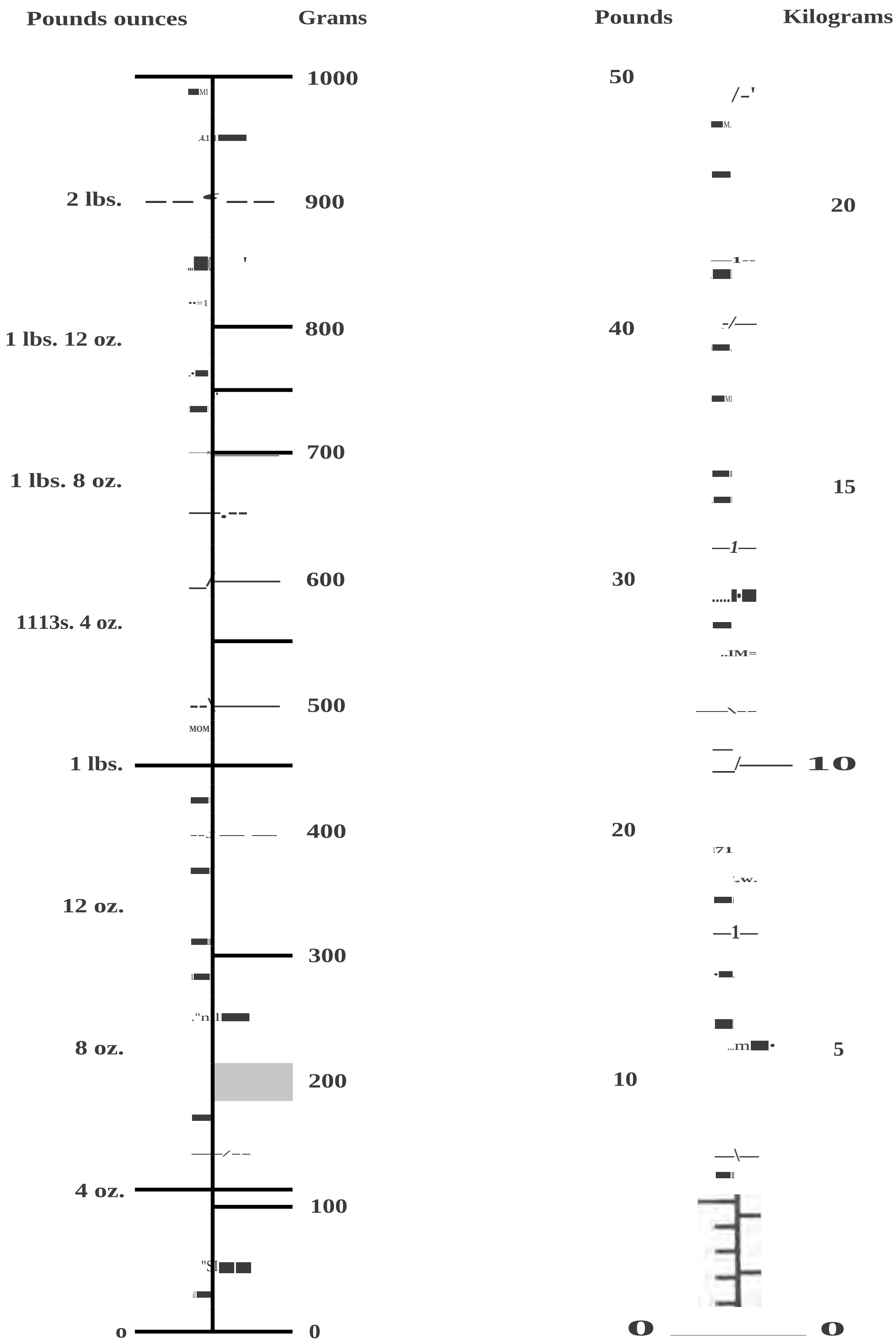
Thread Size	Nearest US Tap Drill Size	Metric Tap Drill Size
5.0mm x 0.8mm	#19	4.20mm
6.0mm x 1.0mm	#9	5mm
10mm x 1.0mm		9mm

American Sizes

Thread Size	US Tap Drill Size
6-32	#36
8-32	#29
10-32	#21
10-24	#25
1/4-20	#7

APPENDIX *

WEIGHT CONVERSIONS



SUTHERLAND'S

* APPENDIX

CONVERSION CHART

Millimeters to Inches

1mm = 0.0394 inches

1 inch = 25.4 millimeters

Milli meter	Dec. Equiv.	Frac- tional
.1	.0039	
.2	.0079	
.25	.0098	
.3	.0118	
.39	.0156	1/64
.4	.0157	
.5	.0197	
.6	.0236	
.7	.0275	
.75	.0295	
.79	.0312	1/32
.8	.0315	
.9	.0354	
1.0	.0394	
1.1	.0433	
1.19	.0469	3/64
1.2	.0472	
1.25	.0492	
1.3	.0512	
1.4	.0551	
1.5	.0591	
1.59	.0625	1/16
1.6	.0630	
1.7	.0669	
1.75	.0689	
1.8	,0709	
1.9	.0748	
1.98	.0781	5/64
2.0	.0787	
2.1	.0827	
2.2	.0866	
2.25	.0886	
2.3	.0905	
2.38	.0937	3/32
2.4	.0945	
2.5	.0984	
2.6	.1024	
2.7	.1063	
2.75	.1083	
2.78	.1094	7/64
2.8	.1102	
2.9	.1142	
3.0	.1181	
3.1	.1220	

meter	Dec. Equiv.	Frac, tional
3.18	.1250	1/8
3.2	.1260	
3.25	.1279	
3.3	.1299	
3.4	.1338	
3.5	.1378	
3,57	.1406	9/64
3.6	.1417	
3.7	.1457	
3.75	.1476	
3.8	.1496	
3.9	.1535	
3.97	.1562	5/32
4,0	.1575	
4,1	.1614	
4.2	.1654	
4.25	.1673	
4.3	.1693	
4.37	.1719	11/64
4.4	.1732	
4.5	.1772	
4.6	.1811	
4.7	.1850	
4.75	.1870	
4.76	.1875	3/16
4.8	.1890	
4.9	.1929	
5.0	.1968	
5.1	.2008	
5.16	.2031	13/64
5.2	.2047	
5.25	.2067	
5.3	.2087	
5,4	.2126	
5.5	.2165	
5.56	.2187	7/32
5.6	.2205	
5.7	.2244	
5.75	.2264	
5.8	.2283	
5.9	.2323	
5.95	.2344	15/64
6.0	.2362	
6.1	.2401	
6.2	.2441	
6.25	.2461	
6.3	.2480	

meter	Dec. Equiv.	Frac- tional
6.35	.2500	1/4
6,4	.2520	
6.5	.2559	
6.6	.2598	
6.7	.2638	
6.75	.2656	77/64
6.8	.2677	
6.9	.2716	
7.0	.2756	
7.1	.2795	
7.14	.2812	9/32
7.2	.2835	
7.25	.2854	
7.3	.2874	
7.4	.2913	
7.5	.2953	
7.54	.2969	19/64
7.6	.2992	
7.7	.3031	
7.75	.3051	
7.8	.3071	
7.9	.3110	
7.94	.3125	5/16
8.0	.3150	
8.1	.3189	
8.2	.3228	
8.25	.3248	
8.3	.3268	
8.33	.3281	21/64
8.4	.3307	
8.5	.3346	
8.6	.3386	
8.7	.3425	
8.73	.3437	11/32
8.75	.3445	
8.8	.3465	
8.9	.3504	
9.0	.3543	
9.1	.3583	

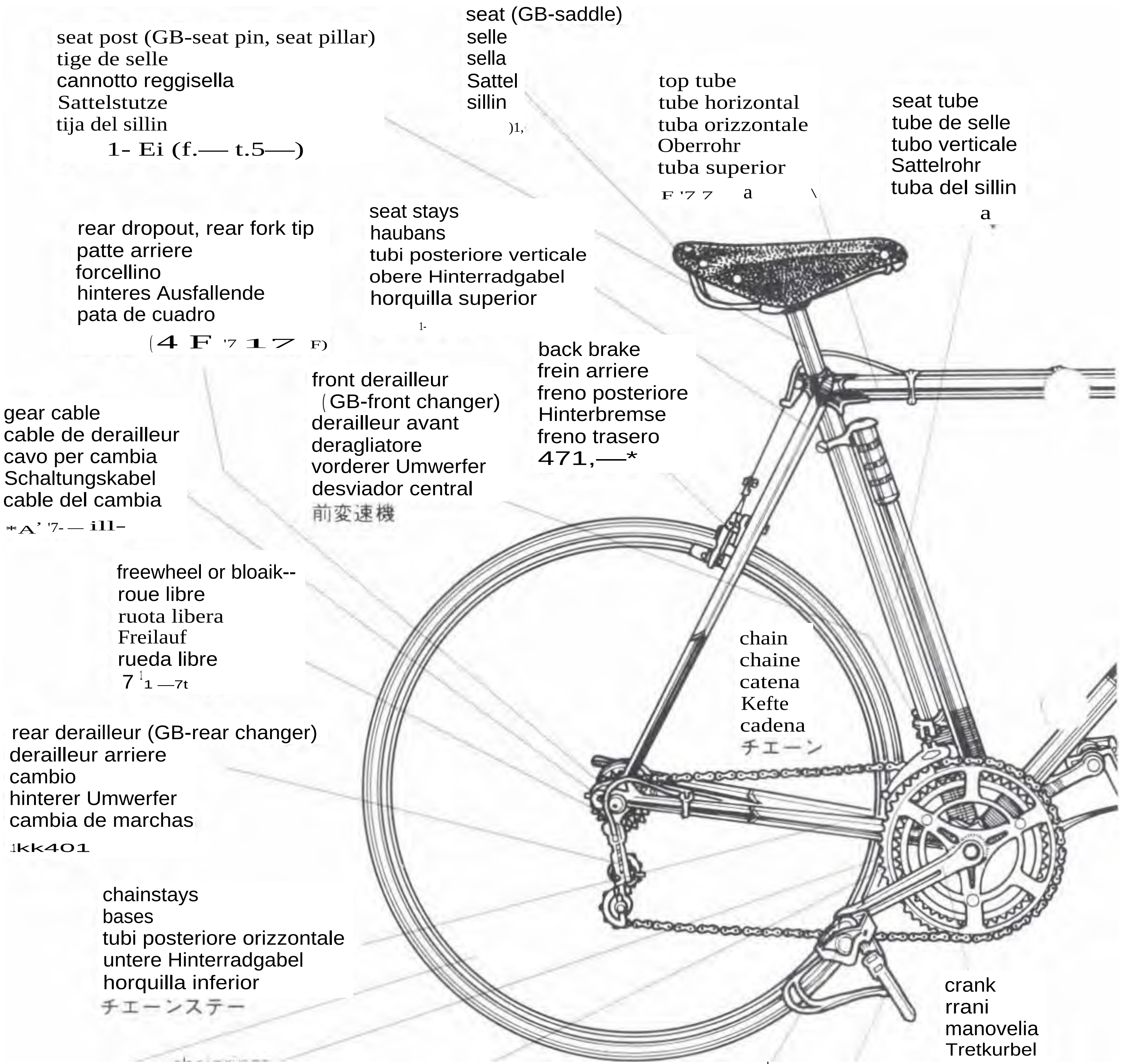
APPENDIX *

meter	Dec. Equiv.	F rac- tional
9.13	.3594	23/64
9,2	.3622	
9.25	.3641	
9.3	.3661	
9.4	.3701	
9.5	.3740	
9,53	.3750	3/8
9.6	.3780	
9.7	.3819	
9.75	.3838	
9.8	.3858	
9.9	.3898	
9.92	.3906	25/64
10.0	.3937	
10.32	,4062	13/32
10.5	.4134	
10,72	.4219	27/64
11.0	.4330	
11.11	.4375	7/16
11.5	.4528	
11.51	.4531	29/64
11.9	.4687	15/32
12.0	.4724	
12.30	.4843	31/64
12.5	.4921	
12.7	.5000	1/2
13.0	.5118	
13.10	.5156	33/64
13.49	.5312	17/32
13.5	.5315	
13.89	.5469	35/64
14,0	.5512	
14.29	.5625	9/16
14.5	.5709	
14.68	.5781	37/64
15.0	.5906	
15.08	.5937	19/32
15.48	.6094	39/64
15.5	.6102	

Milli meter	Dec. Equiv.	F rac- tional
15.88	.6250	5/8
16.0	.6299	
16,27	.6406	41/64
16.5	.6496	
16,67	.6562	21/32
17.0	.6693	
17.06	.6719	43/64
17.46	.6875	11/16
17,5	.6890	
17.86	.7031	45/64
18,0	.7087	
18.26	.7187	23/32
18.5	.7283	
18.65	.7344	47/64
19.0	.7480	
19,05	.7500	3/4
19.45	.7656	49/64
19.5	.7677	
19.84	.7812	25/32
20,0	.7874	
20.24	.7969	51/64
20.5	.8071	
20.64	.8125	13/16
21.0	.8268	
21.03	.8281	53/64
21,15	.8327	
21.43	.8437	27/32
21.5	.8465	
21.6	.8504	
21.7	.8543	
21.83	.8594	55/64
21.85	.8602	
21.9	.8622	
22.0	.8661	
22.23	.8750	7/8
22.5	.8858	
22.62	.8906	57/64
23.0	.9055	
23.02	.9062	29/32
23.42	.9219	59/64
23.5	.9252	

Milli- meter	Dec. Equiv.	F rac- tional
23,81	.9375	15/16
24.0	.9449	
24.21	.9531	61/64
24.5	.9646	
24.6	.9687	31/32
25.0	.9843	
25.0	.9844	63/64
25.4	1.0000	1
25.6	1.0079	
25.8	1.0157	1.1/64
26	1.0236	
26.19	1.0312	1-1/32
26.2	1.0315	
26.4	1.0394	
26,5	1,0433	
26.59	1.0469	1-3/64
26.6	1,0472	
26.8	1.0551	
26.99	1.0625	1-1/16
27	1.0629	
27.2	1.0708	
27.38	1.0781	1-5/64
27.4	1.0787	
27.78	1.0937	1-3/32
28.18	1.1094	1-7/64
28_58	1.1250	1-1/8
28.97	1.1406	1-9/64
29.37	1.1562	1-5/32
29.77	1.1719	1-11/64
30.16	1.1875	1-3/16
30.2	1 1889	
30.56	1.2031	1-13/64
30.95	1.2187	1-7/32
31.35	1.2344	1.15/64
31.75	1.250	1-1/4
32	1.2598	
34.7	1.3661	
34.92	1.3750	1-3/8
35	1.3779	
36	1.4173	

For larger numbers, move decimals to the right:
e.g., 220 mut = 8.661 inches



valve -
valve
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R11,1

plateaux
ingranaggi
Kettenrader
platos
÷2—

crankset
jeu de pedalier
guarnitura
Tretlager-Garnitur
movimento central
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toeclip
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Pedale
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bottom bracket
boite de pedalier
serie movimentc
Tretlager
caja de pedalier
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BICYCLE
PARTS GUIDE

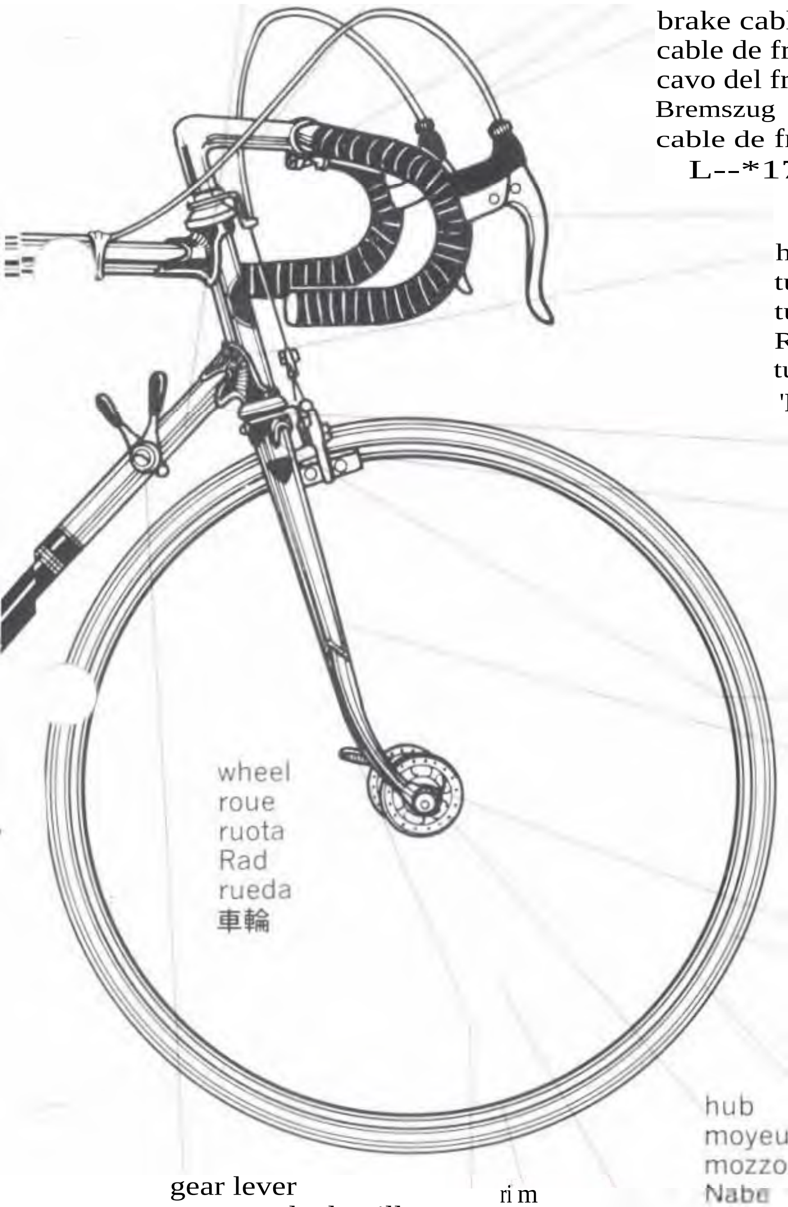
SUTHERLAND'S

bicycle — English
bicyclette, velo —French
bicicletta —Italian
Fahrrad —German
bicicleta - Spanish
Ei e$ Japanese

down tube
tube diagonal
tubo obliquo
Unterrohr
tubo inferior
9 r7 if–a–7

stem
potence
attacco
Lenkervorbau
potencia

handlebars
guidon
manubrio
Lenkstange
manillar
A > 14:)1- A



brake cable- inner
cable de frein
cavo del freno
Bremszug
cable de freno
L--*17--71L-4

brake cable outer
gaine
guaina
Bremszug-HLille
funda de freno
* 17- – — 7

brake lever
poignee de frein
leva freni
Bremshebel
maneta de freno
7 L. —

head tube
tube de direction
tubo sterzo
Rahmensteuerrohr
tubo de direcciOn
'N / F' *

headset
feu de direction
serie sterzo
Steuersatz
juego de direccián

front brake
frein avant
freno anteriore
Vorderbremse
freno delantero

fork crown
tete de fourche
testa forcella
Gabelkrone
amarre de tijera

fork
fourche
forcella
Vordergabel
horquilla
71K

fork tip
patte avant
punta forcella
vorderes Ausfallende
puntera de horquilla
fit717 —

inner tube
chambre 'a air
camera d'aria
Schlauch
camera
-1- a

hub
moyeu
mozzo
Nabe
buje
ハブ

gear lever
manette de derailleur
leva del cambio
Schalthebel
maneta del cambio

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jante
cerchio
Felge
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tire (GB-tyre)
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pneumatico
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9 4 A,

spoke
rayon
raggio
Speiche
radio

quick release
blocage rapide
bloccaggio rapido
Schnellspanner
cierre rapido

SUTHERLAND'S

* APPENDIX

SPOKE LENGTH FORMULA

$L = \sqrt{r_1^2 + r_2^2 + w^2 - 2 r_1 r_2 \cos x} - 1/2y$

Where:

L	=	spoke length
r_1	=	rim radius (to end of spoke position) = $\frac{A + 2(B-C)}{2}$ ***(from page 11-108)***
r_2	=	1/2 flange diameter measured to spoke hole centers
w	=	1/2 flange width = center of hub to flange
x	=	360' x number of crosses ± by 1/2 number of holes in hub
y	=	diameter of spoke hole in hub

TRAIL FORMULA

$T = \frac{\frac{D}{2}\cos a - R}{\sin a}$

$$\text{Trail} = \frac{\text{Wheel radius x cos (head tube angle) - rake}}{\text{sin (head tube angle)}}$$

GEAR RATIO FORMULAS

English

$$\frac{\text{Diameter of tire in inches x number of teeth of front chainwheel}}{\text{number of teeth on rear sprocket}}$$

Cycle gears are given in "inches". This dates to the time of the "Ordinary" or "Pennyfarthing" Bicycle and refers to the diameter of the big wheel. In the present chain driven bicycle the term "inches" is still used but it now refers to the size of an "Ordinary" wheel which would be required to move the same distance forward for one pedal revolution. To calculate the distance travelled for one revolution of the pedals, multiply the gear in inches by pi, i.e. 3.14.

- ***From Raleigh Catalog, England***

Metric

$$\frac{\text{Diameter of tire in meters x 3.14 (pi) x number of teeth on front chainwheel}}{\text{number of teeth on rear sprocket}}$$

The metric gear ratio formula gives you the number of meters travelled per pedal revolution.

THREAD STANDARDS

60%

International Standards Organization (I.S.O.)

60%

British Standard Cycle (BSC), American Standard

SS%

Italian Standard, Whitworth Standard

60%

Metric Standard

APPENDIX *

TORQUE RATINGS

There are no present standards for torque. There are, however, general ranges. It **is** always advisable to **follow the manufacturers specifications.**

Conversion Instructions

Multiply	By	To get
I-oot bounds	12	Inch pounds
Foot pounds	1.355	Nm
Foot pounds	13.826	Kgf-cm
Inch pounds	0.083	Foot pounds
Inch pounds	0.113	Nm
Inch pounds	1.152	Kgf-cm
Nm	0.738	Foot pounds
Nm	8.857	Inch pounds
Nm	0.098	Kgf-cm
Kgf-cm	0.072	Foot pounds
Kg f-c	0.868	Inch pounds
Kgf-cm	10.204	Nm

Tightening Specs

Pedals	350 in. lbs.
Seat post bolt **clamp**	75-100 in. lbs.
Seat **clamp**	
Single bolt	120-145 in. lbs.
Double bolt	72-96 in. lbs.
Headset **locknut**	300 in. lbs.
Handlebar binder bolt	175-260 in. lbs.
Hub axle locknut	88-220 in. lbs.
Cassette lockrings	300-440 in. lbs.
Front axle nuts	
(wheel mount)	180-240 in. lbs.
Rear axle nuts	
(wheel mount)	240-300 in. lbs.
Quick release	
To tighten:	not more than 45 lbs pressure at 55mm from pivot
To release:	12-25 lbs. pressure
Brake lever clamp	
Screwdriver	22-30 in. lbs.
Flex wrench	50-70 in. lbs.
Brake arch	
Attaching bolt	70-85 in. lbs.
Shoe bolt	43-60 in. lbs.
Cable bolt	50-70 in. lbs.
Cantilever brake	
Frame bolt	43-60 in. lbs.
Shoe bolt	50-75 in. lbs.
Cable carrier nut	50-70 in. lbs.
Bottom bracket fixed cup and lockring-steel bottom bracket	600-690 in. lbs.
(Alloy bottom bracket see *manufacture')*	
Chainwheel bolts	70-95 in. lbs.
Crank arm bolt	350 in. lbs.
Shift lever clamp bolt	
Screwdriver	22-26 in. lbs.
Hex wrench	44-52 in. lbs.
Rear derailleur	
Hanger bolt	70-85 in. lbs.
Cable bolt	45-60 **in. lbs.**
Front derailleur	
Clamp bolt	45-60 in. lbs.
Cable bolt	45-60 in. lbs.
Toe clip bolts	22 in. lbs.

* APPENDIX

RECOMMENDED BOOKS

Barnett's Manual—Analysis and Procedures for Bicycle Mechanics, 1989, 1992
John Barnett
Vitesse Press
A division of FPL Corporation
P.O. Box 1886
Brattleboro, N'T 05302

Bicycling Magazine's Complete Guide to Bicycle Maintenance and Repair
Ruda l'ress
33 Minor Street
Emmaus. PA 18008-0099

Effective Cycling
John Forester
MIT Press
726 Madrone Ave.
Sunnyvale, CA 94086

The Bicycle Wheel
Jobst Brandt
Avocet
P.O. Box 120
Palo Alto, CA 04.302

Shimano Service Handbook, '88, '89, '91, '93
Shimano American Corporation
)ne Shimano Drive
Irvine, CA 92718

Shimano (Europa) GmbI I.
KleinhOlsen 1-3 4010 I lilden
West Germany

Bicycling Science—Ergonomics and Mechanics
Frank R. Whitt and David Wilson 1974
MIT Press
28 Carleton St.
Cambridge, MA 02142

Bicycles and Tricycles—An Elementary Treatise on Their Design and Construction, 1896
Archibald Sharp
MIT Press
28 Carleton St.
Cambridge, MA 02142

The Paterek Manual for Bicycle Framebuilders 1985
Tim Paterek
Framebuilders Guild
River Falls, WI 54022

The Ten Speed Commandments—An Irreverent Guide to the Complete Sport of Cycling, (humor), 1987
Mike Keefe
Doubleday & Company, Inc.
Garden City, New York

27", 700C WHEEL GEAR CHART*

SUTHERLAND'S

Rear Sprocket

Chainring (Front Sprocket)

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	34	38
20			41.5	38.6	36.0	33.8	31.8	30.0	28.4	27.0	25.7	24.5	23.5	22.5	21.6	20.8	20.0	19.3	18-6	12.0	17.4	16.9	15.9	14.2
22	54.0	49.5	45.7	42.4	39.6	37.1	34.9	13.0	31.3	29.7	28.3	27.0	25.8	24.8	23.8	22.8	22.0	21.2	20.5	19.8	19.2	18.6	17.5	15.6
24	58.9	54.0	49.8	46.3	43 2	40 5	38.1	36.0	34.1	32.4	30.9	29.5	28.2	27.0	25.9	24.9	24.0	23.3-	22.3	21.6	20.9	20.3	19 1	17.1
25	61.4	56.3	51.9	48.2	45.0	42.2	39.7	373–	35.5	33.8	32.1	30.7	29.3	28.1	27.0	26.0	25.0	24.1	23.3	22.5	21.8	2131119.9		17.8
26	63.8	58.5	54.0	50.1	46.8	43.9	41.3	39.0	36.9	35.1	33.4	31.9	30.5	29.3	28.1	27.0	26.0	25.1	24.2	23.4	22.6	21.9	20.6	18.5
27	66.3	60.8	56.1	52.1	48.6	45.6	42.9	40.5	38.4	36.5	34.7	33.1	31.7	30.4	29.2	28.0	77.0	26.0	25.1	24.3	23.5	22.8	21.4	19.2
28	4.7	63.0	58.2	54.0	50.4	47.3	44.5	42.0	39.8	37.8	36.0	34.4	t2.9	31.5	30.2	29.1	28.0	27.0	26.1	252	24.4	23.6	22.2	19.9
29	71.2	65.3	60.2	55.9	52.2	48.9	46.1	43.5	41.2	39.2	37.3	35.6	34.0	32.6	31.3	30.1	29.0	28.0	27.0	26.1	25.3	24.5	23.0	20.6
30	73.6	67.5	62 3	57 q	54.0	50.6	4 7 6	45.0	42.6	40.5	38.6	36.8	35.2	33.8	32.4	311	30.0	28.9	27.9	27.0	26.1	25.3	23.8	21.3
bl	76.1	6978	64.4	59.8	55.8	52.3	49.2	46.5	44.1	41.9	39.9	38.0	36.4	34.9	33.5	32.2	31.0	29.9	28.9	27.9	27.0	26.2	24.6	22.0
32	78.5	/2.0	66.5	61.7	57,6	54.0	50.8	48.0	15.5	43.2	41.1	39.3	37.6	36.0	34.6	33.2	32.0	30.9	29.8	28.8	27.9	27.0	25.4	22.7
33	81.0	74.3	68.5	63.6	59.4	55.7	52.4	49.5	46.9	44.6	42.4	40.5	38.7	37_1	35.6	34.3	33.0	31.8	30.7	29.7	28.7	27.8	26.2	23.4
34	83.5	76.5	70.6	65.6	61.2	57.4	54.0	51.0	48.3	45.9	43.7	41.7	39.9	38.3	36.7	35.3	34.0	32.8	31,7	30.6	29.6	28.7	27.0	24.2
35	85.9	78.8	72.7	67.5	63.0	59.1	55.6	52.5	49.7	47.3	45.0	43.0	41.1	39.4	37.8	36.3	35.0	33.8	32.6	31.5	30.5	29.5	27.8	24.9
36	88.4	81.0	74.8	69.4	64.8	60.8	57.2	54.0	51.2	48.6	46.3	44.2	42.3	40.5	38.9	37.4	36.0	34.7	31.5	32.4	31.4	30.4	28.6	25.6
37	90.8	83.3	76.8	71.4	66.6	62.4	58.8	55_5	52:6	50,0	47.6	45.4	43.4	41.6	40.0	38.4	37.0	35.7	34.4	33.3	32.2	31.2	29.4	26.3
38	93.3	85.5	/8.9	73.3	68.4	64.1	60.4	57.0	54.0	51.3	48.9	46.6	44.6	42.8	41.0	39.5	38.0	36.6	35.4	34.2	33.1	32.1	30.2	27.0
39	95.7	87.8	81.0	75.2	70.2	65.8	61.9	58.5	55.4	52.7	50.1	47.9	45.8	43.9	42.1	40.5	39.0	37.6	36.3	35.1	34.0	32.9	31.0	27.7
40	98.2	90.0	83.1	77.1	72.0	67.5	63.5	60.0	56.8	54.0	51.4	49.1	47.0	45.0	432	41.5	40.0	_38.6	37.2	36.0	34.8	33.8	31.8	28.4
41	100.6	92.3	85.2	79.1	73.8	69.2	65.1	61.5	58.3	55.4	52.7	50.3	48.1	46.1	44.3	42.6	41.0	39.5	38.2	36.9	35.7	34.6	32.6	29.1
42	1113.1	94.5	8/.2	81.0	75.6	70.9	66.7	63.0	59.7	56.7	54.0	51.5	49.3	47.3	45.4	43.6	42.0	40.5	39.1	37.8	36.6	35.4	33.4	29.8
43	105.5	96.8	89.3	82.9	77.4	72.6	68.3	643–	611	58.1	553	52.8	50.5	48.4	46.4	44.7	43.0	41.5	40.0	38.7	37.5	36.3	34.1	30.6
44	108,0	99.0	91.4	84.9	79.2	74.3	69.9	66.0	62.5	59.4	56.6	54.0	51.7	49.5	47.5	45.7	44.0	42.4	41.0	39.6	38.3	37.1	34.9	31.3
45	110.5	101 3	93.5	86.8	81.0	75.9	71.5	67.5	63.9	60.8	57.9	55.7	52.8	50.6	48.6	46.7	45.0	43.4	41.9	40.5	39.2	38.0	35.7	32.0
46	112.9	103.5	_955	88.7	8211E7.6		73.1	69.0_	65.4	62.1	59.1	.56.5	54.0	51.8	49.7	47.8	46.0	44.4	42.8	41.4	40.1	38.8	36.5	32.7
47	115.4	105.8	97.6	90.6	84.6	79.3	74.6	70.5	66.8	63.5	60.4	57.7	55.2	52.9	50.8	48.8	47.0	45 3	43.8	42.3	40.9	39.7	37.3	33.4
48	117.8	108.0	99.7	02.6	86.4	81.0	76.2	72.0	68.2	64.8	61.7	58.9	56.3	54.0	51.8	49.8	48.0	46.3	44.7	43.2	41.8	40.5	38.1	34.1
49	120.3	110.3	101.8	94.5	88.2	ifilEr	11	73.5	69.6	66.2	63.0	60.1	57.5	S5.1	S1.9	50.9	49.0	47.3	41'6-4	▮		▮	18.9	E.801"1141ifi
50	122.7	112.5	103.8	96.4	90.0	84.4	79.4	75.0	/1.1	67.5	64.3	61.4	58.7	5643	54.0	51.9	50.0	48.2	46.6	45.0	43.5	42.2	39.7	35.5
51	125.2	114.8	105.9	98.4	91.8	86.1	81.0	76.5	72.5	68.9	65.6	62.6	59.9	57 4	55.1	53.0	51.0	49.2	47.5	45.9	44.4	43.0	40.5	36.2
52	127.6	11,7.0	108.0	100.3	93.6	W..8	82.6	78.0	73.9	702	66.9	63.8	61.0	58,5	56.2	54.0_	52.0	50.1	48.4	46.	51=111.1a			_36.9
53	130,1	119.3	, 110	102.2	95.4	89.4	84.2	79.5	75.3	71.6	68.1	65.0	62.2	59.6	57.2	55.0	53.0	51.1	49.3	4 / 7	46.2	44.7	42.1	37./
54	132.5	121.5	112.2	104.1	97.2	91.1	85.8	81.0	76.7	72.9	69.4	66.3	63.4	60.8	58.3	56.1	54.0	52.1	50.3	48.6	47.0	45.6	42.9	38 4
SS	135.0	123.8	114.2	106.1	99.0	92.8	87.4	82.5	78.2		70.7	67.5	64.6	61.9	59.4	57.1	55.0	53.0	51.2	49.5	47.9	46.4	43.7	39.1
56	137.5	126.0	116.3	108.0	100.8	94.5	88.9	84.0	79.6	75.6	72.0	68.7	65.7	63.0	60.5	58.2	56.0	54.0	52.1	50.4	48.8	47.3	44.5	39.8

" For 27" 1686mm1 tire outside diameter; gives diameter in inches of equivalent direct-drive wheel. Multiply by pi 13.141 0) ()Wain distance traveled 10r one turn of the pedals in inched.

26" WHEEL GEAR CHART*

Rear Sprocket

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	34	38
20	41,,L.Aifritfig ,jkl					:		1&	27&_1§&,,211				331111			0	12,...4_116.			17.3	144	104._	ALM	
22	52.0	47.7	44.0	40.9	38.1	35.8	33.6	31.8	30.1	28.6	27.2	26.0	24.9	23.8	*22.9*	22.0	21.2	20.4	19.7	[illegible]	18.5	17.9	16.8	15.1
24	56.7	52.0	48.0	44.6	41.6	39.0	36.7	34.7	32.8	31.2	29.7	28.4	27.1	26.0	25.0	24.0	23.1	22.3	21.5	20.8	20.1	19.5	18.4	16.4
25	59.1	54.2	50.0	46.4	43.3		38.2	36.1	34.2Nr2.5		31.	29.5	28.3	27.1	26.0	25.0	11		_	21.7	21.0	20.3	19.1	
26	61.5	56.3	52.0	48.3	45.1	42.3	39.8	37.6	.35.6	33.8	32.2	30.7	29.4	*28.2*	*27.0*	26.0	25.0	24.1	23.3	*22.5*	21.8	21.1	19.9	17.8
27	63.8	58.5	54.0	50.1	46.8	43.9	41.3	39.0	36.9	35.1	33.4	319	30 5	29.3	28.1	27.0	26.0	25 1	24.2	23.4	22.6	21.9	20.6	18.5
										.4														
29	68.5	62.8	58.0	53.9	50.3	47.1	44.4	41.9	39.7	37.7	35.9	34.3	32.8	31.4	30.2	29.0	27.9	26.9	26.0	25.1	24.3	23.6	22.2	19.8
30	70.9	65.0	60.0	55.7	52.0	48.8	45.9	43.3	41.1	39.0	37.1	35.5	33.9	32.5	31.2	30.0	28.9	27.9	26.9	26.0	25.2	24.4	22.9	20.5
31	73.3	67.2	62.0	57.6	53.7	50.4	47,4	44.8	42.4	40.3	38.4	36.6	35.111.111		3	31.0	29.9	28.8	27.8	26.11M=F			23.7	21.2
32	/5.6	69.3	64.0	59.4	55.5	52.0	48.9	46.2	43.8	41.6	39.6	37.8	36.2	34.7	33.3	32.0	30.8	29.7	28.7	*27.7*	26.8	26.0	24.5	21.9
33	78.0	71.5	66.0	61.3	57.2	53.6	50.5	47.7	45.2	42.9	40.9	39.0	37.3	35.8	34.3	33.0	31.8	30.6	29.6	28.6	27.7	26.8	25.2	22.6
v **35**	82.7	75.8	70.0	65.0	60.7	56.9	53.5	50.6	47.9	45.5	43.3	41.4	39.6	37.9	36.4	35.0	33.7	32.5	31.4	30.3	29.4	28.4	26.8	23.9
h. **36**	85.1	78.0	72.0	66.9	62.4	58.5	55.1	52.0	49.3	46.8	44.6	42.5	40.7	39.0	37.4	36.0	34.7	33.4	32.3	31.2	30.2	29.3	27.5	24.6
11$7	4111.10.2		74.0	68.7	64.1	60.1	56.6	53.4	50.6	48.1	45.8	43.7	41.11V0.1		38.5	37.0	35.6	34.4					28.3	
2 38	89,8	82.3	76.0	70.6	65.9	61.8	58.1	54.9	52.0	49.4	41.0	44.9	43.0	41.2	39.5	38.0	36.6	35.3	34.1	32.9	31.9	30.9	29.1	26.0
39	t	84.5	78.0	72.4	67.6	63.4	59.6	56.3	53.4	50.7	48.3	46.1	44.1	42.3	40.6	39 0	37.6	36.2	35.0	33.8	32.7	31.7	29.8	26.7
'7 40	94.5									.511=1=16o			45.2	4=1_		40.(								
.c **41**	'-it, *9*	**88.8**	82.0	76.1	71.1	66.6	62.7	59.2	56.1	53.3	50.8	48.5	46.3	44.4	42.6	41.0	39.5	38.1	36.8	35.5	34.4	33.3	31.4	28.1
42	99.3	91 0	84.0	78.0	72.8	68.3	64.2	60.7	57.5	54.6	52.0	49.6	47.5	45.5	43.7	42.0	40.4	39.0	37.7	36.4	35.2	34.1	32.1	28.7
43	101.6	93.2	86.0	79.9	74.5	6a	65.8	62.		.9	.53.2	50.8	48.6	46.6	44.7	43.0	41.4	39.9M.		37 mi		t	32.911.11	
44	104.0	95.3	88.0	81.7	76.3	71.5	67.3	63.6	60.2	57.2	54.5	52.0	49.7	47.7	45.8	44.0	42.4	40.9	39.4	38.1	36.9	35.8	33.6	30.1
45	106.4	97.5	90.0	83.6	78.0	73.1	68.8	65.0	61.6	58.5	55.7	53.2	50.9	48.8	46.8	45.0	43.3	41.8	40.3	39.0	37.7	36.6	34.4	30.8
46	**108.7**	99.7																						
47	111.1	101.8	94.0	87.3	81.5	76.4	71.9	**67.9**	64.3	61.1	58.2	55.5	53.1	50.9	48.9	47.0	45.3	43.6	42.1	40.7	39.4	38.2	35.9	32.2
48	113.5	104.0	96.0	89.1	83.2	78.0	73.4	69.3	65.7	62.4	59.4	56.7	54.3	52.0	49.9	48.0	46.2	44.6	43.0	41.6	40.3	39.0	36.7	32.8
49	115.8	106.2	98.0	91.0	84.9|111=11,9			70.8	67.1	63.7	60.7	57.9	55.4	53.1	51.0	49.0	47.2	111	43.9	42.5	41.1	39.8	37.5	333
50	118.2	108.3	100.0	92.9	86.7	81.3	76.5	*72.2*	68.4	65.0	61.9	59.1	56.5	54.2	52.0	50.0	48.1	46.4	44.8	43.3	41.9	40.6	38.2	34.2
51	**120.5**	110.5	102.0	94.7	88.4	82.9	78.0	73.7	69.8	0'	6·-	60.3	57.7	55.3	53.0	51.0	49.1	47.4	45.7	44.2	42.8	41.4	39.0	34.9
52		112.7								.0				56.3										
53	125.3	114.8	106.0	98.4	91.9	86.1	81.1	76.6	72.5	68.9	65.6	62.6	59.9	57.4	55.1	53.0	51.0	49.2	47.5	45.9	44.5	43.1	40.5	36.3
54	127.6	117.0	108.0	100.3	93.6	87.8	82.6	78.0	73.9	70.2	66.9	63.8	61.0	58.5	56.2	54.0	52.0	50.1	48.4	46.8	45.3	43.9	41.3	36.9
55	1304.=1_		102.1	95.3	89.4	84.1	79.4	75.3	71.5	68.1	65.0	62.2	59.6	57.2	55.0	53.0	51.1	49.3	47.7	46.1	44.7	42.1	37.6	
56	132.4	121.3	112.0	104.0	97.1	91.0	85.6	80.9	76.6	72.8	69.3	66.2	63.3	60.7	58.2	56.0	53.9	52.0	50.2	48.5	47.0	45.5	42.8	38.3

- For 26" (660mm) tire outside diameter; gives diameter in inches of equivalent direct-drive wheel. Multiply by pi (3.14) to obtain distance traveled for one turn of the pedals (in inches).

SUTHERLAND'S

SUTHERLAND'S

24" WHEEL GEAR CHART*

Rear Sprocket

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	34	38
P20	43.6	40.0	36.9	34.3	32.0	30.0	28.2	26.7	25.3	24.0	22.9	21.8	20.9	20.0	19.2	18.5	17.8	17.1	16.6	16.0	15.5	15.0	14.1	12.6
22	48.0	44.0	40.6	37.7	35.2	33.0	31.1	29.3	27.8	26.4	25.1	24.0	23.0	22.0	21.1	20.3	19.6	18.9	18.2	17.6	17.0	16.5	15.5	13.9
24	52.4	48,0	44.3	41.1	38.4	36.0	33.9	32.0	30.3	78.8	27.4	26.2	25.0	24.0	23.0	22.2	21.3	20.6	19.9	19.2	18.6	18.0	16.9	15.2
25	stai			EMINIMMEh				3311111.6		30.0 gipmr		27.3k	26.1	25.									17.6	15.8
26	56.7	52.0	48.0	44.6	41.6	39.0	36.7	34.7	32.8	31.2	29./	28.4	27.1	26.0	25.0	24.0	23.1	22.3		20.8	20.1	19.5	18.4	16.4
27	58.9	54.0	49.8	46.3	43.2	40.5	38.1	36.0	34.1	32.4	30,9	29.5	28.2	27.0	25.9	24.9	24.0	23.1	22.3	21.6	20.9	20-3	19.1	17.1
28	61.1	56.0	51.7	48.0		42.0	39.5	37.3	35.4110.6		32.0	30.5	29.2	28.0	26.9	25.8	24.51111A4.0		23.2	22.4		21.0	19.8	411
29	63.3	58.0	53.5	49.7	46.4	43.5	40.9	38.7	36.6	34.8	33.1	31.6	30.3	29.0	27.8	26.8	25.8	24.9	24.0	23.2	22.5	21.8	20.5	18.3
30	65.5	60.0	55.4	51.4	48.0	45.0	42.4	40.0	37.9	36.0	34.3	32.7	31.3	30.0	28.8	27.7	26.7	25.7	24.8	24.0	23.2	22.5	21.2	18.9
o1	1.11111111"Allr49-6															28.6	271E6.6 7g:		WISMII					
32	69.8	64.0	59.1	54.9	51.2	48.0	45.2	42.7	40.4	38.4	36.6	34.9	33.4	32.0	30.7	29.5	28.4	27.4	26.5	25.6	24.8	24.0	22.6	20.2
33	72.0	66.0	60.9	56.6	52.8	49.5	46.6	44.0	41.7	39.6	37.7	36.0	34.4	33.0	31.7	30.5	29.3	28.3	27.3	26.4	25.5	24.8	23.3	20.8
34	74.2	68.0	62.8	58.3	54.4	51.0	48.0	45.3	42.00.8		38.9	37.1	35.5	34.0.							26.3	25.5	2	
35	76.4	70.0	64.6	60.0	56.0	52.5	49.4	46.7	44.2	42.0	40.0	38.2	36.5	35.0	33.6	32.3	31.1	30.0	29.0	28.0	27.1	26.3	24.7	22.1
Lth. 36	78.5	72.0	66.5	61.7	57.6	54,0	50 8	48.0	45.5	43.2	41.1	19.3	37,6	36.0	34.6	33.2	32.0	30.9	29 8	28.8	27.9	27.0	25.4	22.7
37	80.		683111.1.111.11!"								3	40.4	38.6							AM11.11.11115Tnrir				
38	82.9	76.0	70.2	65.1	60.8	57.0	53.6	50.7	48.0	45.6	43.4	41.5	39.7	38.0	36.5	35.1	33.8	32.6	31.4	30.4	29.4	28.5	26.8	24.0
39	85.1	78.0	72.0	66.9	62.4	58.5	55.1	52.0	49.3	46.8	44.6	42.5	40.7	39.0	37.4	36.0	34.7	33.4	32.3	31.2	30.2	29.3	27.5	24.6
40	87.3				64.0	60.0	56.5	53.3	50.5AME		45.7	43.6	411						33.1	32.0	31.0	30.0	28.2	2411
41	89.5	82.0	75.7	70.3	65.6	61.5	57.9	54.7	51.8	49.2	46.9	44.7	42.8	41.0	39.4	37.8	36.4	35.1	33.9	32.8	31.7	30.8	28.9	25.9
42	91.6	84.0	77.572.0		67.2	63.0	59.3	56.0	53.1	50.4	48.0	'15.8	41 6	42.0	40.3	38.8	37 3	36.0	34.8	33.6	32.5	31.5	29.6	26.5
	91111F		79.4			.5					.	46.9	44.9	43'.			38.			.4			30,4	27:7
44	96.0	88.0	81.2	75.4	70.4	66.0	62.1	58.7	55.6	52.8	50.3	48.0	45.9	44.0	42.2	40.6	39.1	37.7	36.4	35.2	34.1	33.0	31.	27.8
45	98.2	90.0	83.1	77.1	72.0	67.5	63.5	60.0	56.8	54.0	51.4	49.1	47.0	45.0	43.2	41.5	40.0	38.6	37.2	36.0	34.8	33.8	31 8	28.4
46	100.4	92.0	84.9	78.9	73.6	69.0	64.9	61.3	58.1	55.2	52.6	50.2	48.0	46.0	44.2	42.5	40.9	39.4	38.1	36.8	35.6		.5	29.1
47	102.5	94.0	86.8	80.6	75.2	70.5	66.4	62.7	59.4	56.4	53.7	51.3	49.0	47.0	45.1	43.4	41.8	40.3	38.9	37.6	36.4	35.3	33.2	29.7
48	104.7	96.0	88.6	82.3	76.8	72.0	67.8	64.0	60.6	57.6	54.9	s1 ·l		48.0	46.1	44.3	42.7	41	39.7	38.4	37.2	36.0	33.9	30.3
49	106.9	Mir 911111r134.0			78.4	a1Prar.innilliMrillit						53.5	i.1	Wailli		gark3.6		42.0	7513	937w	rniritir		-34.6	
50	109.1	100.0	92.3	85.7	80.0	75.0	70.6	66.7	63.2	60.0	57.1	54.5	52.2	50.0	48.0	46.2	44.4	42.9	41.4	40.0	38.7	37.5	35.3	31.6
51	111.3	102.0	94.2	87.4	81 6	76.5	72 0	68.0	64.4	61.2	58.3	55.6	53.2	51.0	49.0	47.1	45.3	43.7	42.2	40.8	39.5	38.3	36.0	32.2
52	113-5	104.0	96.0	89.1	83.2	78.0	73.4	69		62-4					49.9	4				41.6	40	911110.7		32,8
53	115.6	106.0	97.8	90.9	84.8	79.5	74.8	70.7	66.9	63.6	60.6	57.8	55.3	53.0	50.9	48.9	47.1	45.4	43.9	42.4	41.0	39.8	37.4	33.5
54	117.8	108.0	99.7	92.6	86.4	81.0	76.2	72.0	68.2	64.8	61.7	58.9	56.3	54.0		49.8	48.0	46.3	44.7	43.2	41.8	40.5	38.1	34.1
ss	ilertrOlo		wispnr			SZAIMMISlip								sn	52.8	5 irmisimpr-45					-2.6	-wimp		14:r
56	122.2	112.0	103.4	96.0	89.6	84.0	79.1	/4.7	70.7	67.2	64.0	61.1	58.4	56.0	53.8	51.7	49.8	48.0	46.3	44.8	43.4	42.0	39.5	35.4

* for 24" (61(1mm) tire outside diameter; gives diameter in inches of equivalent direct-drive wheel. Multiply by pi (3.14) to obtain distance traveled for one turn of the pedals (in inches),

20" WHEEL GEAR CHART*

Rear Sprocket

Chainring (Front Sprocket)	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	34	38
20	36.4	33.3	30.8	28.6	26.7	25.0	23.5	22.2	21.1	20.0	19.0	18.2	17.4	16.7	16.0	15.4	14.8	14.3	13.8	13.3	12.9	12.5	11.8	10.5
22	40.0	36.7	33.8	31.4	29.3	27.5	25.9	24.4	23.2	22.0	21.0	20.0	19.1	18_3	17.6	16.9	16.3	15.7	15.2	14.7	14.2	13.8	12.9	11.6
24	43.6	40.0	36.9	34.3	32.0	30.0	*28.2*	*26.7*	25.3	24,0	22.9	21.8	20.9	20.0	19.2	18.5	17.8	17.1	16.6	16.0	15.5	15.0	141	12.6
25	**45.5**	**41.7**	**38.5**	**35.7**	**33.3**	**31.3**	**29.4**	**27.8**	**26.3**	**25.0**	**23.8**	**22.7**	**21.7**	**20.8**	**20.0**	**19.2**	**183**	**17.9**	**17.2**	**16.7**	**16.1**	**15.6**	**14.7**	**13.2**
26	47.3	43.3	40.0	37.1	34.7	32.5	30.6	28.9	27.4	26.0	24.8	23.6	22.6	21.7	20.8	20.0	19.3	18.6	17.9	17.3	16.8	16.3	15.3	13.7
27	49.1	45.0	41.5	38.6	36.0	33.8	31.8	30.0	28.4	27.0	25.7	24.5	23.5	22.5	21.6	20.8	20.0	19.3	18.6	18.0	17.4	16.9	15.9	14.2
28	**50.9**	46.7	43.1	40.0	37.3	35.0	32.9	**31.1**	**293**	28.0	26.7	2.5.5	24.3	23.3	**22.4**	**21.5**	**20.7**	**20.0**	**19.3**	18.7	18.1	**173**	**16.5**	**14.7**
29	52.7	48.3	44.6	41.4	38.7	36.3	34.1	*32.2*	30.5	29.0	27.6	26.4	*25.2*	*24.2*	*23.2*	22.3	21.5	20.7	20.0	19.3	18.7	18.1	17.1	15.3
30	54.5	50.0	46.2	42.9	40.0	37.5	35.3	33.3	31.6	30.0	28.6	27.3	26.1	25.0	24.0	23.1	*22.2*	21.4	20.7	20.0	19.4	18.8	17.6	15.8
31	56.4	51.7	47.7	44.3	41.3	38.8	36.5	34.4	32.6	31.0	29.5	28.2	27.0	25.8	24.8	23.8	23.0	22.1	21.4	20.7	20.0	**19.4**	18.2	16.3
32	58.2	53.3	49.2	45.7	42.7	40.0	37.6	35.6	33.7	32.0	30.5	29.1	27.8	26.7	25.6	24.6	23.7	22.9	22.1	21.3	20.6	20,0	18.8	16.8
33	60.0	55.0	50.8	47.1	44.0	41.3	38.8	36.7	34.7	33.0	31.4	30.0	28.7	27.5	26.4	25.4	24.4	23.6	22.8	22.0	21.3	20.6	T9.4	17.4
34	61.8	56_7	52.3	48.6	4S.1	42.5	40.0	37.8	35.8	34.0	32.4	30.9	29.6	28.3	27.2	*26.2*	25.7	24.3	23.4	22.7	21.9	21.3	20.0	17.9
35	63.6	58.3	53.8	50.0	46.7	43.8	41.2	38.9	36.8	35.0	33.3	31.8	30.4	29.2	28.0	26.9	25.9	25.0	24.1	23.3	22.6	21.9	20.6	18.4
36	65.5	60.0	55.4	51.4	48.0	45.0	42.4	40.0	37.9	36.0	34.3	32.7	31.3	30.0	28.8	*27.7*	26.7	25.7	24.8	24.0	23.2	22.5	21.2	18.9
37	**67.3**	**61.7**	**56.9**	**52.9**	**49.3**	**46.3**	**43.5**	**41.1**	**38.9**	**37.0**	**35.2**	**33.6**	**32.2**	**30.8**	**29.6**	**283**	**27.4**	**26.4**	**25.5**	**24.7**	**23.9**	**23.1**	**21.8**	**19.5**
38	69.1	63.3	58.5	54.3	50.7	47.5	44.7	*42.2*	40.0	38.0	36.2	34.5	33.0	31.7	30.4	*29.2*	*28.1*	27.1	26.2	25.3	24.5	23.8	22.4	20.0
39	70.9	65.0	60.0	55.7	52.0	48.8	45.9	43.3	41.1	39.0	37.1	35.5	33.9	32.5	31.2	30.0	28.9	27.9	26.9	26.0	25.2	24.4	22.9	20.5
40	72.7	66.7	613	57.1	**533**	**50.0**	**47.1**	**444**	**42.1**	**40.0**	**38.1**	**364**	**34.8**	**33.3**	**32.0**	**30.8**	**29.6**	**28.6**	**27.6**	**26.7**	**25.8**	**25.0**	**233**	**21.1**
41	74.5	68.3	63.1	58.6	54.7	51.3	48.2	45.6	43.2	41.0	39.0	37.3	35.7	34.2	32.8	31.5	30.4	29.3	28.3	27.3	26.5	25.6	24.1	21.6
42	76.4	70.0	64.6	60.0	56.0	52.5	49.4	46.7	44.2	42.0	40.0	38.2	36.5	35.0	33.6	32.3	31.1	30.0	29.0	28.0	*27,1*	26.3	24.7	22.1
43	**78/**	**71.7**	**66.2**	**61A**	**57.3**	**53.8**	**50.6**	**47.8**	**45.3**	**43.0**	**41.0**	**39.1**	**37.4**	**35,8**	**34.4**	**33_1**	**31.9**	**30.7**	**29.7**	**28.7**	***27.7***	**26.9**	**25.3**	**22.6**
44	80.0	73.3	67.7	62.9	58.7	55.0	51.8	48.9	46.3	44.0	41.9	40.0	38.3	36.7	35.2	33.8	32.6	31.4	30.3	29,3	28.4	27.5	25.9	23.2
45	81.8	75.0	69.2	64.3	60.0	56.3	52.9	50.0	47.4	45.0	42.9	40.9	39.1	37.5	36.0	34.6	33.3	32.1	31.0	30.0	29.0	28.1	26.5	23.7
46	**83.6**	**76.7**	**70.8**	**65.7**	**61.3**	**57.5**	**54.1**	**51.1**	**48.4**	**46.0**	**43.8**	**41.8**	**40.0**	**38.3**	**36.8**	**35.4**	**34.1**	**32.9**	**31.7**	**30.7**	**29.7**	**28.8**	**27.1**	**24.2**
47	85.5	78.3	72.3	67.1	62.7	58.8	55.3	52.2	49.5	47.0	44.8	42.7	40.9	39.2	37.6	36.2	34.8	33.6	32.4	31.3	30.3	29.4	27.6	24.7
4.8	87.3	80.0	73.8	68.6	64.0	60.0	56.5	53.3	50.5	48.0	45.7	43.6	41.7	40.0	38.4	36.9	35.6	34.3	33.1	32.0	31.0	30.0	28.2	25.3
49	**89.1**	**81.7**	**75.4**	**70.0**	**65.3**	**61.3**	**57.6**	**54.4**	**51.6**	**49.0**	**46.7**	**44.5**	**42.6**	**40.8**	**39.2**	**37.7**	**36.3**	**35.0**	**33.8**	**32.7**	**31.6**	30.6	28.8	**25.8**
50	90.9	83.3	76.9	71.4	66.7	62.5	58.8	55.6	52.6	50.0	47_6	45.5	43.5	41.7	40.0	38.5	37.0	35.7	34.5	33.3	32.3	31.3	29.4	26.3
51	92.7	85.0	78.5	72.9	68.0	63.8	60,0	56.7	53.7	51.0	48.6	46.4	44.3	42.5	40.8	39.2	37.8	36.4	35.2	34.0	32.9	31.9	30.0	26.8
52	**94.5**	**86.7**	**80.0**	**74.3**	**69.3**	**65.0**	**61.2**	**57.8**	**54.7**	**52.0**	**49.5**	**47.3**	**45.2**	**43.3**	**41.6**	**40.0**	**38.5**	**37.1**	**35.9**	**34.7**	**315**	**32.5**	**30.6**	**27.4**
53	96.4	88.3	81.5	75.7	70.7	66.3	62.4	58.9	55.8	53.0	50.5	48.2	46.1	44.2	42.4	40.8	39.3	37.9	36.6	35.3	34.2	33.1	31.2	27,9
54	98.2	90.0	83.1	77.1	72.0	67.5	63.5	60.0	56.8	54.0	51.4	49.1	47.0	45.0	43.2	41.5	40.0	38.6	37.2	36.0	34.8	33.8	31.8	28.4
55	**100.0**	**91.7**	**84.6**	**78.6**	**73.3**	**68.8**	**64.7**	**61.1**	**57.9**	**55.0**	**52.4**	**50.0**	**47.8**	**45.8**	**44.0**	**42.3**	**40.7**	**39.3**	**37.9**	**36.7**	**35.5**	**34.4**	**32.4**	**28.9**
56	101.8	93.3	86.2	80.0	74.7	70.0	65.9	62.2	58.9	56.0	53.3	50.9	48.7	46,7	44.8	43.1	41.5	40.0	38.6	37,3	36.1	35.0	32.9	29.5

* I'or 2(1' (508min1 tire outside diameter; gives diameter in inches of equivalent direct-drive wheel. Multiply by pi t3.141 to obtain distance traveled for one turn of the pedals sin inchesi.

CP UTHERLAND'S

Cn

16" WHEEL GEAR CHART*

rrl

Rear Sprocket

Chainring (Front Sprocket)	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	34	38
20	29.1	26.7	24.6	22.9	21.3	20.0	18.8	17.8	16,8	16.0	15.2	14.5	13.9	13.3	12.8	12.3	11.9	11.4	11.0	10.7	10.3	10.0	9.4	8.4
22	32.0	29.3	27.1	25.1	23.5	22.0	20.7	19.6	18.5	17.6	16.8	16.0	15.3	14.7	14.1	13.5	13.0	12.6	12.1	11.7	11.4	11.0	10.4	9.3
24	34.9	32.0	29.5	27.4	25.6	24.0	22.6	21.3	20.2	19.2	18.3	17.5	16.7	16.0	15.4	14.8	14.2	13.7	13.2	12.8	12.4	12.0	11	10.1
25	36.4	33.3	30.8	28.6	26.7	25.0	23.5	22.2	21.1	20.0	19.0	18.2	17.4	16.7	16.0	15.4	14.8	14.3	13.8	13.3	12.9	12.5	11.8	10.5
26	37.8	34.7	32.0	29.7	27.7	26.0	24.5	23.1	21.9	20.8	19.8	18.9	18.1	17.3	16.6	16.0	15.4	14.9	14.3	13.9	13.4	13.0	12.2	10.9
27	39.3	36.0	33.2	30.9	28.8	27.0	25.4	24.0	22.7	21.6	20.6	19.6	18.8	18.0	17.3	16.6	16.0	15.4	14.9	14.4	13.9	13.5	12.7	11.4
28	40.7	37.3	-34.5	32.0	29.9	28.0	26.4	24.9	23.6	22.4	21.3	20.4	19.5	18.7	17.9	17.2	16.6	16.0	15.4	14.9	14.5	14.0	13.2	11.8
29	42.2	38.7	35.7	33.1	30.9	29.0	27.3	25.8	24.4	23.2	221	21.1	20.2	19.3	18.6	17.8	17.2	16.6	16.0	15.5	15.0	14.5	13.6	12.2
30	43.6	40.0	36.9	34.3	32.0	30.0	28.2	26.7	25.3	24.0	22.9	21.8	20.9	20.0	19.2	18.5	17.8	17.1	16.6	16.0	15.5	15.0	14.1	12.6
31	45.1	41.3	38.2	35.4	33.1	31.0	29.2	27.6	26.1	24.8	23.6	22.5	41 16	20.7	19.8	19.1	1 k4	17.7	17.1	16.5	16.0	15.5	14.6	13.1
32	46.5	42.7	39.4	36.6	34.1	32.0	30.1	28.4	26.9	25.6	24.4	23.3	22.3	21.3	20.5	19.7	19.0	18.3	17.7	17.1	16.5	16.0	15.1	13.5
33	48.0	44.0	40.6	37.7	35.2	33.0	31.1	29.3	27.8	26,4	25.1	24.0	23.0	22.0	21.1	20.3	19.6	18.9	18.2	17.6	17.0	16.5	15.5	13_9
34	49.5	45.3	4L8	38.9	36.3	34.0	32.0	30.2	28.6	27.2	25.9	24.7	23.7	22.7	21.8	20.9	20.1	19.4	18.8	18.1	17.5	11,C	60	14.3
35	50.9	46.7	43.1	40.0	37.3	35.0	32.9	31.1	29_5	28.0	26.7	25.5	24.3	23.3	22.4	21.5	20.7	20.0	19.3	18.7	18.1	17.5	16.5	14.7
36	32.4	48.0	44.3	41.1	38.4	36.0	33.9	32.0	30.3	28.8	27.4	26.2	25.0	24.0	23.0	22.2	21.3	20.6	19.9	19.2	18.6	18.0	16.9	15.2
37	53.8	49.3	45.5	42.3	39.5	37.0	34.8		31.2	29.6	28.2	26.9	25.7	-24.7	23.7	22.8	21.9	21.1	20.4	19.7	19.1	18:5	17.4	15.6
38	55.3	30.7	46.8	43.4	40.5	38.0	35.8	33.8	32.0	30.4	29.0	27.6	26.4	25.3	24.3	23.4	22.5	21.7	21.0	20.3	19.6	19.0	17.9	16.0
39	56.7	52.0	48.0	44.6	41.6	39.0	36.7	34.7	32.8	31.2	29.7	28.4	27.1	26.0	25.0	24.0	23.1	22.3	21.5	20.8	20.1	19.5	18.4	16.4
40	58.2	53.3	49.2	45.7	42.7	40.0	37.6	35.6	317	32.0	30.5	29.1	27.8	26.7	25.6	24.6	23.7	22.9	22.1	21.3	20.6	20.0	18.8	16.8
41	59.6	54.7	50.5	46.9	43.7	41.0	38.6	36.4	34.5	32.8	31.2	29.8	28.5	27.3	26.2	25.2	24.3	23.4	22.6	21.9	21.2	20.5	19.3	17.3
42	61.1	56.0	51.7	48.0	44.8	42.0	39.5	37.3	35.4	33.6	32.0	30.5	29.2	28.0	26.9	25.8	24 9	24.0	23.2	22.4	21.7	21.0	19 8	17.7
43	62.5	57.3	52.9	49.1	45.9	43.0	40.5	38.2	36.2	34.4	32.8	31.3	29.9	28.7	27.5	26,5	25.5	24.6	23.7	22.9	22.2	21.5	20.2	18.1
44	64.0	58.7	54.2	50.3	46.9	44.0	41.4	39.1	37.1	35.2	33.5	32.0	30.6	29.3	28.2	27.1	26.1	25.1	24.3	23.5	22.7	22.0	20.7	18.5
45	65.5	60.0	55.4	51.4	48.0	45.0	42.4	40.0	37.9	36.0	34.3	32.7	31.3	30.0	28.8	27.7	26.7	25.7	24.8	24.0	23.2	22.5	21.2	18.9
46	66.9	61.3	56.6	52.6	49.1	46.0	43.3	40.9	38.7	36.8	35.0	33.5	32.0	30.7	29.4	28.3	27.3	26.3	25.4	24.5	211	23.0	21.6	19.4
47	68.4	62.7	57.8	53.7	50,1	47,0	44.2	41.8	39.6	37.6	35.8	34.2	32.7	31.3	30.1	28.9	27.9	26.9	25.9	25.1	24.3	23.5	22.1	19.8
48	69.8	64.0	59.1	54.9	51.2	48.0	45.2	42.7	40.4	38,4	36.6	34.9	33.4	32.0	30.7	29.5	28.4	27.4	26.5	25.6	24.8	24.0	22.6	20.2
49	71.3	65.3	60.3	56.0	52.3	49.0	46.1	43.6	41.3	39.2	37.3	35.6	34.1	32.7	31.4	30.2	29.0	28.0	27.0	26.1	25.3	24.5	23.1	20.6
SO	72.7	66.7	61.5	57.1	53.3	50.0	47.1	44.4	42.1	40.0	38.1	36.4	34.8	33.3	32.0	30.8	29.6	28.6	27.6	26.7	25.8	25.0	23.5	21.1
51	74.2	68.0	62.8	58.3	54.4	51.0	48.0	45.3	42.9	40.8	38.9	37.1	35.5	34.0	32.6	31.4	30.2	29.1	28.1	27.2	26.3	25.5	24,0	21.5
52	75.6	69.3	64.(k'	49.4	55.5	52.0	48.9	46.2	43.8	41.6	39.6	37.8	36.2	34.7	33.3	32.0	30.8	29.7	28.7	27.7	26.8	26.0	24.5	21.9
53	77.1	70.7	65.2	60.6	56.5	53.0	49.9	47.1	44.6	42.4	40.4	38.5	36.9	35.3	33.9	32.6	31.4	30.3	29.2	28.3	27.4	26.5	24.9	22.3
54	78.5	72.0	66.5	61.7	57.6	54.0	.50.8	48.0	45.5	43.2	-11.1	39.3	37.6	36.0	34.6	33.2	12.0	30.9	29.8	28.8	27.9	27.0	25.4	22.7
55	80.0	73.3	67.7.	62.9	58.7	55.0	51.8	48.9	46.3	44.0	41.9	40.0	38.3	36.7	35.2	33.8	32.6	31.4	30.3	29.3	28.4	27.5	25.9	23.2
56	81.5	74.7	68.9	64.0	59.7	56.0	52.7	49.8	47.2	44.8	42.7	40.7	39.0	37.3	35.8	34.5	33.2	32.0	30.9	29_9	28.9	28.0	26.4	23.6

" tor 16' (406nnii) tire outside diameter; gives diameter in inches of equivalent direct-drive wheel. Multiply by pi (3.141 to obtain distance traveled for one turn of the pedals (in inches).

680MM WHEEL GEAR CHART*

Rear Sprocket

Chainring (Front Sprocket)

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	78	29	30	31	32	34	38
20	3.88	3.56	3.29	3.05	2.85	2.67	2.51	2.37	2.2.5	2.14	2.03	1.94	1.86	1.78	1.71	1.64	1.58	1.53	1.47	1.42	1.38	1.34	1.26	1.12
22	4.27	3.92	3.62	3.36	3.13	2.94	2.76	2.61	2.47	2.35	2.24	2.14	2.04	1,96	1.88	1.81	1.74	1.68	1.62	1.57	1.52	1.47	1.38	1.24
24	4.66	4 '	3.94	3.66	3.42	3.20	3.02	2.85	2.70	2.56	2.44	2.33	2.23	2.14	2.05	1.97	1.90	1.83	1.77	1.71	1.65	1.60	1.51	1.35
25	4.86			3.81	3.56	3.34	3.1.						2.3	3	2.14	2.05	138	1,21.11aL		1.78	1.72	1.67	1.57	AA
26	5.05	4.63	4.27	3.97	3.70	3.47	3.27	3.09	2.92	2.78	2.64	2.52	2.41	2.31	2.22	2.14	2.06	1.98	1.92	1.85	1.79	1.74	1.63	1.46
27	5.24	4.81	4.44	4.12	3.85	3.60	3.39	3.20	3.04	2.88	2.75	2.62	2.51	2.40	2.31	2.22	2.14	2.06	1.99	1.92	1.86	1.80	1.70	1.52
28	5.44	4.98	4.60	4.27	3.99	3.74	3.52	3.32	3.15	2.99	2.85	2.72	2.60	2.49	2.39	2.30	2.22	2.14	2.06	1.99	1.93	1.87	1.76	1.57
29	5.63	5.16	4.77	4.43	4.13	3.87	3,64	3.44	3.26	3.10	2.95	2.82	2.69	2.58	2.48	2.38	2.29	2.21	2.14	2.07	2.00	1.94	1.82	1.63
30	5.83	5.34	4.93	4.58	4.27	4.01	3.77	3.56	3.37	3.20	05	2.91	2.79	2.67	2.56	2.46	2.37	2.29	2.21	2.14	2.07	2.00	1.88	1.69
31	6.02	5.52	5.09	4.73	46	4.14	3.90	3.68	3.4		3.15	3.01	2.88	2.76	t4	2.54.1Mlbj28				2.21	2.14	2.07	1.95	1.74
32	6.21	5.70	5.26	4.88	4.56	4.27	4.02	3.80	3.60	3.42	3.26	3.11	2.97	2.85	2.73	2.63	2.53	2.44	2.36	2.28	2.21	2.14	2.01	1 80
33	6.11	5.87	5.42	5.04	4.70	4.41	4.15	3.92	3.71	3.52	3.36	3.20	3.07	2.94	2.82	2.71	2.61	2.52	2.43	2.35	2.27	2.20	2.07	1.86
34	6.60	6.05	5.59	5.19	4.84	4.54	4.27	4.04	3.82	3.63	3.46	3.30	3.16	3.03	2.91	2.79	2.69	2.59	2.50	2.42	2.34	2.27	2.14	1.91
35	6.80	6.23	5.75	5.34	4.98	4.67	4.40	4.15	3.94	3.74	3.56	3.40	3.25	3.12	2.99	2.88	2.77	2.67	2.58	2A9	2.41	2.34	2.20	1.97
36	6.99	6.4T	5.92	5.49	5.13	4.81	4.52	4.27	4.05	3.85	3.66	3.50	3.34	3.20	3.08	2.96	2.85	2.75	2.65	2.56	2.48	2.40	2.26	2.02
37	7.19	6.59	6.08	5.65	5.27	4.94	4.65	4.39	4.16	3.95	3.76	3.59	3de3.29		3.16	3.04	2.93	2.82	2.73	2.63	2.55	2.47	im	2.08
38	7.38	6.76	6.24	5.80	5.41	5.07	4.78	4.51	4.27	4.06	3.87	3.69	3.53	3.38	3.25	3.12	3.01	2.90	2.80	2.71	2.62	2.54	2.39	2.14
39	7.57	6.94	6.41	5.95	5.55	5.21	4.90	4.63	4.39	4.17	3.97	3.79	3.62	3.47	3.33	3.20	3.09	2.98	2.87	2.78	2_69	2.60	2.45	2.19
40	7.77	7.12	6.57	6.10	5.70	5.34	5.03	4.75	4.50	4.27	4.07	3.88	3.72	3.56	3.42	3.29	3.16	3.05	2.95	2.85	2.76	2.67	2.51	2.25
41	7.96	7.30	6.74	6.26	5.84	5.47	5.15	4.87	4.61	4.38	4.17	3.98	3.81	3.65	3.50	3.37	3.24	3.13	3.02	2.92	2.83	2.74	2.58	2.30
42	8.16	7.48	6.90	6.41	5.98	5.61	5.28	4.98	4.72	4.49	4.27	4.08	3.90	3.74	3.59	3.45	3.32	3.20	3.09	2.99	2.89	2.80	2.64	2.36
43	8.35	7.66	7.07	6.56	6.12	5.74	5.40	5.10	4.83	4.59	4.37	4.18	3.99	3.83	3.67	/53	3.40	3.28	3.17	3.06	2.96	2.87	2.70	2.42
44	8.55	7.83	7.23	6.71	6.27	5.87	5.53	5.22	4.95	4.70	4.48	4.27	4.09	3.92	3.76	3.62	3.48	3.36	3.24	3.13	3.03	2.94	2.76	2.47
45	8.74	8.01	7.39	6.87	6.41	6.01	5.65	5.34	5.06	4.81	4.58	4.37	4.18	4.01	3.85	3.70	3.56	3.43	3.31	3.20	3.10	3.00	2.83	2.53
46	8.93	8.19	7.56	7.02	6.55	6.14	5.78	5.46	5.17	4.91	4.68	4.47	4.27	4.09	3.93	3.78	3.64	3.51	3.39	3.28	3.17	3.07	2.89	2.59
47	9.13	8.37	7.72	7.17	6.69	6.28	5.91	5.58	5.28	5.02	4.78	4.56	4.37	4.18	4.02	3.86	3.72	3.59	3.46	3.35	3.24	3.14	2.95	2.64
4.8	9.32	8.55	7.89	7.32	6.84	6.41	6.03	5.70	5.40	5.13	4.88	4.66	4.46	4.27	4.10	3.94	3.80	3.66	3.54	3.42	3.31	3.20	3.02	2.70
49	9.52	8.72	8.05	7.48	6.98	6.51	6.16	5.82	5.51	5.23	4.98	4.76	4.55	4.36	4.19	4.03	3.88	3.74	3.61	3.49	3.38	3.27	3.08	2.75
50	9.71	8.90	8.22	7.63	7.12	6.68	6.28	5.93	5.62	5.34	5_09	4.86	4.64	4.45	4.27	4.11	3.96	3.81	3.68	3.56	3.45	3.34	3.14	2.81
51	9.90	9.08	8.38	7.78	7.26	6.81	6.41	6.05	5.73	5.45	5.19	4.95	4.74	4.54	4.36	4.19	4.04	3.89	3.76	3.63	3.51	3.40	3.20	2.87
52	10.10	9.26	8.55	7.93	7.41	6.94	6.53	6.17	50	5.55	5.29	5.05	4.83	4.63	4.44	4.27	4.11	3.97	3.83	3.70	3.58	3.47	3.27	2.92
53	1 0.29	9.44	8.71	8.09	7.55	7.08	6.66	6.29	5.96	5.66	5.39	5.15	4.92	4.72	4.53	4.35	4.19	4.04	3.90	3.77	3.65	3.54	3.33	2_98
54	10.49	9.61	8.87	8.24	7.69	7.21	6.79	6.41	6.07	5.77	5.49	5.24	5.02	4.81	4.61	4.44	4.27	4.12	3.98	3.85	3.72	3.60	3.39	3.04
55	10.68	9.79	9.04	8.39	7.83	7.34	6.9	1gffrirt	8	5.87	5.60	5.34	5.11	4.90	4.70	4.52	4.35	4.20	4.05	3.92	3.79	3.67	3.46	3.09
56	1 0.88	9.97	9.20	8.55	7.98	7.48	7.04	6.65	6.30	5.98	5.70	5.44	5.20	4.98	4.79	4.60	4.43	4.27	4.13	3.99	3.86	3.74	3.52	3.15

Cr

Z

tri

Z

Vi

* For 680mm (26.8") tire outside diameter; gives distance traveled in meters for one turn of the pedals.

670MM WHEEL GEAR CHART*

Rear Sprocket

Chainring (Front Sprocket)

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	34	38
20	183	3.51	3.24	3.01	2.81	2.63	2.48	2.34	**2.22**	**2.10**	2.00	1.91	1.83	1.75	1.68	1.62	1.56	1.50	1.45	1.40	1.36	1.32	1.24	1,11
22	4.21	3.86	3.56	3.31	3.09	2.89	2.72	2.57	2.44	*2.32*	*2.21*	2.10	2.01	1.93	1.85	1.78	1.72	1.65	1.60	1.54	1.49	1.45	1.36	*1.22*
24	4.59	4.21	3.89	3.61	3.37	3.16	2.97	2.81	2.66	2.53	2 41	2.30	*2.20*	2.10	2.02	1.94	1.87	1.80	1.74	1.68	1.63	1.58	1.49	1 33
25	**4.78**	**4.39**	l4.05	**3.76**	**3.51**	**3.29**	**3.10**	**2.92**	**2.77**	**2.63**	**2.51**	**2.39**	**2.29**	**2.19**	**2.10**	**2.02**	**1.95**	**1.88**	**1.81**	**1.75**	**1.70**	**1.64**	**1.55**	**1.38**
26	4.98	4.56	4.21	3.91	3.65	3.42	*3.22*	3.04	2.88	214	2.61	2.49	2.38	2.28	2.19	*2.10*	2.03	1.95	1.89	1.82	1.77	1.71	1.61	1.44
27	5.17	4,74	4.37	4.06	3.79	3.55	3.34	3.16	2.99	2.84	2.71	2.58	2.47	2.37	2.27	2.19	2.10	2.03	1.96	1.89	1,83	1.78	1.67	1.50
28	5.36	4.91	4.53	4.21	3.93	3.68	3.47	3.27	3.10	2.95	2.81	2.68	2.56	2.46	2.36	*2.27*	2.18	2.10	2.03	1.96	1.90	1.84	La	**1.55**
29	5.55	5.09	4.70	4.36	4.07	3.82	3.59	3.39	3.21	3.05	2.91	*2.77*	2.65	2.54	2.44	2.35	2.26	2.18	2.10	2.03	1.97	1.91	1.80	1.61
30	5.74	5.26	4.86	4 51	4.21	3.95	3.71	3.51	3.32	3.16	3.01	2.87	2.75	2.63	2.53	2.43	2.34	2.26	2.18	2.10	2.04	1.97	1.86	1.66
BSI	593	**5.44**	**5.02**	4.66	**4.35**	**4.08**	**3.84**	**3.63**	**3.43**	**3.26**	**3.11**	**2.97**	**2.84**	**2.72**	**2.61**	**2.51**	2.42	2.33	**2.25**	158	**2.10**	**2.04**	**1.92**	**1.72**
32	6.12	5.61	5.18	4.81	4.49	4.21	3.96	3.74	3.55	3.3/	3.21	3.06	2.93	2.81	2.69	2.59	2.49	2.41	*2.32*	2.25	*2.17*	*2.10*	1.98	1.77
33	6.31	5.79	5.34	4.96	4.63	4.34	4.09	3.86	3.66	3.47	3.31	3.16	3.02	2.89	2.78	2.67	2.57	2.48	2.40	2.32	2.24	2.17	2.04	1.83
34	6.51	5.96	5.51	5.11	4.77	4.47	4.21	3.98	3.77	3.58	3.41	3.25	3.11	2.98	2.86	2.75	2.65	2.56	2.47	2.39	2.31	2.24	2.10	1.88
35	6.70	6.14	5.67	5.26	4.91	4.60	4.33	4.09	3.88	3.68	3.51	3.35	3.20	3.07	2.95	2.83	2.73	2.63	2.54	2.46	2.38	2.30	2.17	1.94
36	6.89	6.31	5.83	5.41	5.05	4./4	4.46	4.21	3.99	3.79	3.61	3_44	3.29	3.16	3.03	2.91	2.81	2.71	2.61	2.53	2.44	2.37	2.23	1.99
37	7.08	**6.49**	**5.99**	**5.56**	**5.19**	**4.87**	**4.58**	**4.33**	**4.10**	**3:89**	**3.71**	**3.54**	**3.39**	**3.25**	**3.12**	**3.00**	**2.88**	**2.78**	**2.69**	**2.60**	**2.51**	**2.43**	**2.29**	**2.05**
38	*7.27*	6.67	6.15	5.71	5.33	5.00	4.70	4.44	4.21	4.00	3.81	3.64	3.48	3.33	3.20	3.08	2.96	2.86	2.76	2.67	2.58	2.50	2.35	*2.10*
39	7.46	6.84	6.31	5.86	5.47	5.13	4.83	4.56	4.32	4.10	3.91	3.73	3.57	3.42	3.28	3.16	3.04	2.93	2.83	2.74	2.65	2.57	*2* 41	2.16
40	7.65	7.02	6.48	6.01	5.61	5.26	**4.95**	**4.68**	4.43	4.21	4.01	3.83	3.66	3.51	3.37	3.24	3.12	**3.01**	2.90	2.81	*2.72*	**243**	2.48	*2.22*
41	7.85	7.19	6.64	6.16	5.75	5.39	5.08	4.79	4.54	4.31	4.11	3.92	3.75	3.60	3.45	3.32	3.20	3.08	2.98	2.88	2.78	2.70	2.54	*2.27*
42	8.04	7.37	6.80	6.31	5.89	5.53	5.20	4.91	4.65	4 42	4 21	4.02	3.84	3.68	3.54	3.40	3.27	3.16	3.05	2.95	2.85	2.76	2.60	2.33
43	8.23	**7.54**	**6.96**	**6.46**	**6.03**	**5.66**	**5.32**	**5.03**	**4.76**	**4.53**	**4.31**	**4.11**	**3.94**	**3.77**	**3.62**					**3.02**	**2.92**	**2.83**	**2.66**	**2.38**
44	8.42	7.72	7.12	6.62	6.17	5.79	5.45	5.15	4.87	4.63	4.41	4.21	4.03	3.86	3.70	3.56	3.43	3.31	3.19	3.09	2.99	2.89	*2./2*	2.44
45	8.61	7.89	7.29	6.77	6.31	5.92	5.57	5.26	4.99	4.74	4.51	4.31	4.12	3.95	3.79	3.64	3.51	3.38	3.27	3.16	3.06	2.96	2.79	2 49
46	8.80	8.07	7.45	6.92	6.45	6.05	5.70	**5.38**	5.10	4.84	4.61	4.40	4.21	4.03	3.87	3.72	3.59	**3.46**	3.34-	L23	**3.12**	**3.03**	2.0	**2.55**
47	8.99	8.24	7.61	7.07	6.60	6.18	5.82	5.50	5.21	4.95	4.71	4.50	4.30	4.12	3,96	3.80	3.66	3.53	3.41	3.30	3.19	3.09	2.91	2.60
48	9 18	8.42	7.77	*7.22*	6.74	6.31	5.94	5.61	5.32	5.05	481	4.59	4.39	4.21	4.04	3 89	3.74	3 61	3.48	3.37	3.26	**3.16**	2.97	2.66
1419	**9.38**	**8.59**	**7.93**			**-6.45**	**6.07**	**5.73**	**5.43**	**5.16**	**4.91**	**4.69**	*4.48*	**4.30**	**4.13**	**3.97**	**3.82**	**3.68**	**3.56**	**3.44**	3.33111.01NO3			**2.71**
50	9.57	8.77	8.10	7.52	7.02	6.58	6.19	5.85	5.54	5.26	5.01	4.78	4.58	4.39	4.21	4.05	3.90	3./6	3.63	3.51	3.39	3.29	3.10	2.77
51	9.76	8.95	8.26	7.67	7.16	6.71	6.31	5.96	5.65	5.37	5.11	4.88	4.67	4.47	4.29	4.13	3.98	3.83	3.70	3.58	3.46	3.35	3.16	2.82
52	9.95	9.12	Airgl	7.82	7.30	6.84	6.44	6.08	5.76	5.47	*5.21*	4.98	4.76	4.56	4.38	**4.21**	4.04111IMIL			**3.65**	**3.53**	**3.42**	**3.22**	**2.88**
53	10.14	9.30	8.58	7.97	7.44	6.97	6.56	6.20	5.87	5.58	5.31	5.07	4.85	4.65	4.46	4.29	4.13	3.98	3.85	3.72	3.60	3.49	3.28	2.94
54	10.33	9.47	8.74	8.12	7.58	7.10	6.69	6.31	5.98	5.68	5.41	5.17	4.94	4.74	4.55	4.37	4.21	4.06	3.92	3.79	3.67	3.55	3.34	2.99
"SS ITVAIM'						**7.2**	4111111r7.11111r6r5.7911111110156"						**5.03**	*4.8T*	74:63	474	7e-7.7r3.5*			**3.16'**				
56	10.72	9.82	9.07	8.42	7.86	7.37	6.93	6.55	6.20	5.89	5.61	5.36	5.12	4.91	4.71	4.53	4.37	*4.21*	4.06	3.93	3.80	3.68	3.47	3,10

For 670mm (26.4") tire outside diameter; gives distance traveled in meters for one turn of the pedals.

600MM WHEEL GEAR CHART*

Rear Sprocket

Chainring (Front Sprocket)

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	34	38
20	3.43	3.14	2.90	2.69	2.51	2.36	2.22	2.09	1.98	1.88	1.80	1.71	1.64	1.57	1.51	1.45	1.40	1.35	1.30	1.26	1.22	1.18	1.11	0.99
22	3.77	3.46	3.19	2.96	2.76	2.59	2.44	2.30	2.18	2.07	1.97	1.88	1.80	1.73	1.66	1.59	1.54	1.48	1.43	1.38	1.34	1.30	1.22	1.09
24	4.11	3.77	3.48	3.23	3.02	2.83	2.66	2.51	2.38	2.26	2.15	2.06	1.97	1.88	1.8T	1.74	1.68	1.62	1.56	1.51	1.46	1.41	1.33	1.19
25	4.28	3.93	3.62	3.37	3.14	2.95	2.77	2.62	2.48	2.36	224	2.14	2.05	1.96	1.88	1.81	1.75	1,68	1.62	1.57	1.52	1.47	1.39	1.24
26	4.46	4.08	3.77	3.50	3.27	3.06	2.88	2.72	2.58	2/15	2.33	2.23	2.13	2.04	1.96	1.88	1.82	1.75	1.69	1.63	1.58	1.53	1.44	1.29
27	4.63	4.24	3.91	3.64	3.39	3.18	2.99	2.83	2.68	2.54	2.42	2.31	2.21	2.12	2.04	1.96	1.88	1.82	1.75	1.70	1.64	1.59	1.50	1.34
28	4.80	4.40	4.06	3.77	3.52	3.30	3.10	2.93	2.78	2.64	2.51	2.40	2.29	2.20	2.11	2.03	1.95	1.88	1.82	1.76	1.70	1.65	1.55	1.39
29	4.97	4.56	4.20	3.90	3.64	3.42	3.22	3.04	2.88	2.73	2.60	2.48	2.38	2.28	2.19	2.10	2.02	1.95	1.88	1.82	1.76	1.71	1.61	1.44
30	5.14	4.71	4.35	4.04	3.77	3.53	3.33	3.14	2.98	2.83	2.69	2.57	2.46	2.36	2.26	2.17	2.09	2.02	1.95	1.88	1.82	1.77	1.66	1.49
31	5.31	4.87	4.49	4.17	3.90	3.65	3,44	3.25	3.08	2.92	2.78	266	2.54	2.43	2.34	2.25	2.16	2.09	2.01	1.95	1.88	1.83	1.72	134
32	5.48	5.03	4.64	4.31	4.02	3.77	3.55	3.35	3.17	3.02	2.87	2.74	2.62	2.51	2.41	2.32	2.23	2.15	2.08	2.01	1.95	1.88	1.77	1.59
33	5.65	5.18	4.78	4.44	4.15	3.89	3.66	3.46	3.27	3.11	2.96	2.83	2.70	2.59	2.49	2.39	2.30	2.22	2.14	2.07	2.01	1.94	1.83	1.64
34	5.83	5.34	4.93	4.58	4.27	4.01	3_77	3.56	3.37	3.20	3.05	2.91	2.79	2.67	2.56	2.46	2.37	2.29	2.21	2.14	2.07	2.00	1.88	1.69
35	6.00	5.50	5.07	4.71	4.40	4.12	3.88	3.67	3.47	3.30	3.14	3.00	2.87	2.75	2.64	2.54	2.44	2.36	2.27	2.20	2.13	2.06	1.94	1.74
36	6.17	5.65	5.22	4.85	4.52	4.24	3.99	3.77	3.57	3.39	3.23	3.08	2.95	2.83	2.71	2.61	2.51	2.42	2.34	2.26	2.19	2.12	2.00	1.79
37	6.34	5.81	5.36	4.98	4.65	4.36	4.10	3.87	3.67	3.49	3.32	4.17	3.03	2.91	2.79	2.68	2.58	2.49	2.40	2.32	2.25	2.18	2.05	1.84
38	6.51	5.97	5.51	5.12	4.78	4.48	4.21	3.98	3.77	3.58	3.41	3.26	3.11	2.98	2.87	2.75	2.65	2.56	2.47	2.39	2.31	2.24	2.11	1.88
39	6.68	6.13	5.65	5.25	4.90	4.59	4.32	4.08	3.87	3.68	3.50	3.34	3.20	3.06	2.94	2.83	2.72	2.63	2.53	2.45	2.37	2.30	2.16	1.93
40	6.85	6.28	5.80	5.39	5.03	4.71	4.44	4.19	3.97	3.77	3.59	3.43	3.28	3.14	3.02	2.90	2.79	2,o	2.60	2.51	2.43	2.36	2.22	1.98
41	7.03	6.44	5.94	5.52	5.15	4.83	4.55	4.29	4.07	3.86	3.68	3.51	3.36	3.22	3.09	2.97	2.86	2.76	2.66	2.58	2.49	2.42	2.27	2.03
42	7.20	6.60	6.09	5.65	5.28	4.9.5	4.66	4.40	4.17	3.96	3.77	3.60	3.44	3.30	3.17	3.04	2.93	7.83	7.73	2.64	7.55	2.47	2.33	2.08
43	7.37	44C.0.	6.23	5.79	SAO	5.07	4.77	4.50	4.27	4.05	3.86	3.68	3.52	3.38	3.24	3.12	3.00	2.89	2.79	2.70	2.61	2-53	2.38	2.13
44	7.54	6.91	6.38	5.92	5.53	5.18	4.88	4.61	4.37	4.15	3.95	3.77	3.6T	3.46	3.32	3.19	3.07	2.96	2.86	2.76	2.68	2.59	2.44	2.18
45	7.71	7.07	6.52	6.06	5.65	5.30	4.99	4.71	4.46	4.24	4.04	3.86	3 69	3.53	3.39	3.26	3.14	3.03	2.92	2.83	2.74	2.65	2.49	2.23
46	7.88	7.23	6.67	6.19	5.78	5.42	5.10	4.82	4.56	4.34	4.13	3.94	3.77	3.61	3.47	3.33	3.21	3.10	2.99	2.89	2.80	2.71	2.55	2.28
47	8.05	7.38	6.81	6.33	5.91	5.54	5.21	4.92	4.66	4.43	4.22	4.03	3.85	3.69	3.54	3.41	3.28	3.16	3.05	2.95	2.86	2.77	2.61	2.33
48	8.23	7.54	6.96	6.46	6.03	5.65	5.32	5.03	476	4.52	4.31	4.11	3.93	3.77	3.62	3.48	3.35	3.23	3.12	3.02	2.92	2.83	7.66	2.38
49	8.40	7.70	7.10	4.6Q,	6.16	5.77	ja	5.13	4..8kr4462		4.40	4.20	4.02	3.85	3.69	3.55	3.42	3.30	3.18	3.08	2.98	2.89	2.72	2.43
50	8.57	7.85	7.25	6.73	6.28	5.89	5.54	5.24	4.96	471	4.49	4.28	4.10	3.93	3.77	3.62	3.49	3.37	3.25	3.14	3.04	2.95	2.77	2.48
51	8.74	8.01	7.39	6.87	6.41	6.01	5.65	5.34	5.06	4.81	4.58	4.37	4.18	4.01	3.85	3.70	3.56	3.43	3.31	3.20	3.10	3.00	2.83	2.53
52	8.91	8.17	7.54	7.00	6.53	6.13	5.77	5.45	5.16	4.90	4.67	4.46	4.26	4.08	3.92	3.77	3.63	3.50	3.38	3.27	3.16	3.06	2.88	2.58
53	9.08	8.33	7.68	7.14	6.66	6.24	5.88	5.55	5.26	5.00	4.76	4.54	4.34	4.16	4.00	3.84	3.70	3.57	3.44	3.33	3.22	3.12	2.94	2.63
54	9.25	8.48	7.83	7.27	6.79	6.36	5.99	5.65	5.36	5.09	4.85	4.63	4.43	4.24	4.07	3.91	3.77	3.64	3.51	3.39	3.28	3.18	2.99	2.68
1$,S	9.42A	Nfignibigit,,giafid					g1 .fig72t1T~- je			lliMINIMErTW					M	3.99	3.84	3.70	3.57	3.4r	3.34	3.24	3.05	2.73
56	9.60	8.80	8.12	7.S4	7.04	6.60	6.21	5.86	5.56	5.28	5.03	4.80	4.59	4.40	4.22	4.06	3.91	3.77	3.64	3.52	3.41	3.30	3.10	2.78

For 600in m 123.4") tire outside diatneter; gives distance traveled in meters tor one turn of the pedals.

Cr

ERLAND'S

SUTHERLAND'S

500MM WHEEL GEAR CHART*

Rear Sprocket

Chainring (Front Sprocket)	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	34	38
20	2.86	2.62	2.42	2.24	2.09	1.96	1.85	1.75	1.65	1.57	1.50	1.43	1.37	1.31	1.26	1.21	1.16	1.12	1.08	1.05	1.01	0.98	0.92	0.83
22	3.14	2.88	2.66	2.47	2.30	2.16	2.03	1.92	1,82	1.73	1.65	1.57	1.50	1.44	1.38	1.33	1.28	1.23	1.19	1.15	1.11	1.08	1.02	0.91
24	3.43	3.14	2.90	2.69	2.51	2.36	2.22	2.09	¦ 98	1.88	1.80	1.71	1.64	¦57	¦ 51	1.45	1.40	1.35	1.30	1.26	1.22	1.18	1.11	0.99
25	3.57	3.27	3.02	2.80	2.62	2.45	2.31	2.18	2.07	1.96	1.87	1.78	1.71	1.64	1.57	1.51	1.45	1.40	1.35	1.31	1.27	1.23	1.15	1.03
26	3.71	3.40	114	2.92	2.72	2.55	2.40	2.27	2.15	2.04	1.94	1.86	1.78	1.70	1.63	1.57	1.51	1.46	1.41	1.36	1.32	1.28	1.20	1.07
27	3.86	153	3.26	3.03	2.83	2.65	2.49	2.36	2.23	2.12	2.02	1.93	1.84	1.77	1.70	1.63	1.57	ı 5 1	1.46	1.41	1.37	1.33	1.25	1.12
28	4.00	3.67	3.38	3.14	2.93	2.75	159	2.44	2.31	'2.20	2.09	2.00	1.91	1.83	1.76	1.69	1.63.	ı	V$.52	1.47	1.42	1.37	1.29	1.16
29	4.14	3.80	3.50	3.25	3.04	2.85	2.68	2.53	2.40	2.28	2.17	2.07	1.98	1.90	1.82	1.75	1.69	1.63	¦37	1.52	1.47	1.42	1.34	1.20
30	4.28	3.93	3.62	3.37	3.14	2.95	2.77	2.62	2.48	2.36	2.24	2.14	2.05	1.96	1.88	1.81	1.75	1.68	1.62	1.57	1.52	1.47	1.39	1.24
31	4.43	4.06	3.75	3.48	3.25	3.04	2.86	2.71	246	2.43	2.32	2.21	2.12	2.03	1.95	1.87	1.80	1.74	1.61	1.62	1.5V1.52		1.43	1.28
32	4.5?	4.19	3.87	3.59	3.35	3.14	2.96	2.79	2.65	2.51	2.39	2.28	2.19	2.09	2.01	1.93	1.86	1.80	1.73	1.68	1.62	1.57	1.48	1.32
33	4.71	4.32	3.99	3.70	3,46	3.24	3.05	2.88	2.73	2.59	2.47	2.36	2.25	2.16	2.07	1.99	1.92	1.85	1.79	1.73	1.67	1.62	1.52	1.36
34	4.86	4.45	4.11	3.81	3.S6	3.34	3.14	2.97	2.81	2.67	2.54	2.43	2.32	2.23	2.14	05	1.98	1.4	1.84	1.78	1.72	1.67	1.57	1.41
35	5.00	4.58	4.23	3.93	3.67	3.44	3.23	3.05	2.89	2.75	2.62	2.50	2.39	2.29	2.20	2.11	2.0f1	1.96	1.90	1.83	1.77	1.72	1.62	1.45
36	5.14	4.71	4.35	4.04	3.77	3.53	3.33	3.14	2.98	2.83	2.69	2.57	2.46	2.36	2.26	2 17	2.09	2.02	1.95	1 88	1_82	1.77	1.66	¦ 49
37	5.28	4.84	4.47	4.15	3.87	3.63	3.42	3.23	3.06	2.91	2.77	2.64	2.53	2.42	2.32	2.24	2.15	2.08	2.00	1.94	1.87	1.82	1.71	1.53
38	5.43	4.97	4.59	4.26	3.98	173	151	3.32	3.14	2.98	2.84	2.71	2.60	2.49	2.39	2.30	2.21	2.13	2.06	¦99	1.93	1.87	1.76	1.57
39	5.57	5.11	4.71	4.38	4.08	3.83	3.60	3.40	3.22	3.06	2.92	2.78	2.66	2.55	2.45	2.36	2.27	2.19	2.11	2.04	1.98	1.91	1.80	1.61
40	5.71	524	4.83	4.49	4.19	3.93	3.70	3.49	3.31	3.14	2.99	2.86	2.73	2.62	2.51	2.42	2.33	2.24	2.17	2.09	2.03	1.96	1.85	1.65
41	5.85	.5.37	4.95	4.60	4.29	4.03	3,79	3.58	3.39	3.22	3.07	2.93	2.80	2.68	2.58	2.48	2.39	2.30	2.22	2.15	2.08	2.01	1.89	1.69
42	6.00	5.50	5.07	4.71	4.40	4.12	3.88	3.67	3.47	3.30	3.14	3.00	2.87	2,75	2.64	7.54	2.44	2.36	2.27	2.20	2 13	2.06	1.94	1.74
43	6.14	5.63	5.20	4.82	4.50	4.22	3.97	3.75	3.55	3.38	3.22	3.07	2.94	2.81	2.70	2.60	2.50	2.41	2.33	2.25	2.18	2.11	1.99	1.78
44	6.28	5.76	5.32	4.94	4.61	4.32	4.07	3.84	3.64	3.46	3.29	3.14	3.01	2.88	2.76	2.66	2.56	2.47	2.38	2.30	2.23	2.16	2.03	1.82
45	6.43	5.89	5.44	5.05	4.71	4.42	4.16	3.93	3.72	3.53	3.37	3.21	107	2.95	2.83	2.72	2.62	2.52	2.44	2.36	2.28	2.21	2.08	1.86
46	6.57	6.02	5.56	5.16	4.82	4.52	4.25	4.01	3.80	3.61	3.44	3.28	3.14	3.01	2.89	2.78	2.68	2.58	2.49	2.41	233	2.26	2.13	1.90
47	6.71	6.15	5.68	5.27	4.92	4.61	4.34	4.10	3.89	3.69	3.52	3.36	3.21	3.08	2.95	2.84	2.73	2.64	2.55	2.46	2.38	2,31	2.17	1.94
48	e, 85	6.28	5.80	.5.39	5.03	4.71	4.44	4.19	3.97	3.77	3.59	3.43	3 78	3.14	3.02	2 90	2.79	2.69	2.60	2.51	2 43	2_56	2.22	1 98
49	7.00	6.41	5.92	5.50	5.13	4.81	4.53	4.28	4.05	3.85	3.67	3.50	3.35	3.21	3.08	2.96	2.85	2.	2.65	2.57	2.48	2.41	2.26	2.03
50	7.14	6.54	6.04	5.61	5.24	4.91	4.62	4.36	4.13	3.93	3.74	3.57	3.41	3.27	3.14	3.02	2.91	2.80	2.71	2.62	2.53	2.45	2.31	2.07
51	7.28	6.68	6.16	5.72	5.34	5.01	4.71	4.45	4.22	4.01	3.81	3.64	148	3 34	3.20	3.08	2.97	2.86	2.76	2.67	2.58	2.50	2.36	2.11
52	7.43	6.81	6.28	5.83	5.45	5.11	4.80	4.54	4.30	4.08	3.89	3.71	3.55	3.40	3.27	3.14	3.03	2.97	182	2.72	2.63	2.55	2.40	2.15
53	7.57	6.94	6.40	5.95	5,55	5.20	4.90	4.63	4.38	4.16	3.96	3.78	3.62	3.47	3.33	120	3.08	2.97	2.87	2.78	2.69	2.60	2.45	2.19
54	7.71	7.07	6.52	6.06	5.65	5.30	4.99	4 71	4.46	4.24	4.04	3.86	3.69	3.53	3.39	3.26	3.14	3.03	7.92	2.83	2.74	2.65	1.49	2.23
55	7.85	7.20	6.65	6:17	5.76	5.40	5.08	4.80	4.55	4.32	4.11	3.93	3.76	:3.60	3.46	3.32	3.20	3.09	2.98	2.88	2.79	2.70	2.54	2.27
56	8.00	7.33	6.77	6.28	5.86	5.50	5.17	4.89	4.63	4.40	4.19	4.00	3.82	3.67	3.52	3.38	3.26	3.14	3.03	2.93	2.84	2.75	2.59	2.31

ł-or 501litint i 10.7" ¦ tire ınitside diameter; gives distance traveled in meters tor onc turn of the pedals.

400MM WHEEL GEAR CHART*

Rear Sprocket

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	34	38
20	2.28	2.093	1.80	1.68	1.57	1.48	1.40	1.32	1.2eir0		1.14	1.09	1.05	1.01	0.97	0.93	0.90	0.87	0.84	0.81	0.79	0.74	0.66
22	2.51	2.30	2.13	1.97	1,84	1.73	1.63	1.54	1.46	1.38	1.32	1.26	1.20	1.15	1.11	1.06	1,02	0.99	0.95	0,92	0.89	0.86	0.81	0.73
24	2.74	2.51	2.32	2.15	2.01	1 88	1.77	1.68	1.59	1.51	1.44	1 37	1.31	1.26	1.21	1 16	1 12	1 08	1 04	1.01	0.97	0.94	0.89	0.79
25	2.86	2.62	2.42	2.24	2.09	1.96	1.85	1.75	1.6116A7		1.50	1.43	1.37	1.31	126	1.21	1.16	1.32,	1.08	1.05	1,01	048	0.92	0.83
26	2.97	2.72	2.51	2.33	2.18	2.04	1.92	1.82	1.72	1.63	1.56	1.49	1.42	1.36	1.31	1.26	1.21	1.17	1.13	1.09	1.05	1.02	0.96	0.86
27	3.08	2.83	2.61	2.42	2.26	2.12	2.00	1.88	1.79	1.70	1.62	1.54	1.48	1.41	1.36	1.30	1.26	1.21	1.17	1.13	1.09	1.06	1.00	0.89
28	3.20	2.93	2.71	2.51	2.35	2.20	2.07	1.95	1.85	1.76	1.68	1.60	1.53	1.47	1.41	1.	1 30	1.26	1.21	1.17	1.14	1.10	1.03	0.93
29	3.31	3.04	2.80	2.60	2.43	2.28	2.14	2.02	1.92	1.82	1,74	1.66	1.58	1.52	1_46	1.40	1.35	1.30	1.26	1.21	1.18	1.14	1.07	0.96
30	3 43	3.14	2.90	2.69	2.51	2.36	2.22	2.09	1.98	1.88	1.80	1.71	1 64	1.57	1.51	1.45	1.40	1 35	1.30	1.26	1.22	1.18	1.11	0.99
31	3.54	3.25	3,00	2.78	2.60	2.43	2.29	2.16	2.05	1.95	1.86	1.77	1.69	1.62	J.-3.6	1.50	1.44	1.39	1.34	1.30	1.26	1.22	1.15	1.03
32	3.66	3.35	3.09	2.87	2.68	2.51	2.37	2.23	2.12	2.01	1.91	1.83	1.75	1.68	1.61	1.55	1.49	1.44	1.39	1.34	1.30	1.26	1.18	1.06
33	3.77	3.46	3.19	2.96	2.76	2.59	2.44	2.30	2.18	2.07	1.97	1.88	1.80	1.73	1.66	1.59	1.54	1.48	1.43	1.38	1.34	1.30	1.22	1.09
34	3.88	3.511	.29	3.05	2.85	2.67	2.5t	2.37	2.25	2.14	2.03	t94	1.86	1.78	1.71	1.64	1.58	1.53	1.47	1.42	1.38	1.34	1.26	1.12
35	4.00	3.67	3.38	3.14	2.93	2.75	2.59	2.44	2.31	2.20	2.09	2.00	1.91	1.83	1.76	1.69	1.63	1.57	1.52	1.47	1.42	1.37	1.29	1.16
36	4_11	3.77	3.48	3.23	3.02	2.83	2.66	2.51	2.38	2.26	2 15	2.06	1.97	1 88	1.81	1.74	1.68	1.62	1.56	1.51	1.46	1 41	1.33	1.19
37	4.23	3.87	338	3.32	3.10	2.91	2.74	2.58	2.45	2.3	2.21	2.11	2.02	1.94	1.86	1.79	1.72	1.66	,a1.60	1.55	1.50	1.45	OW	1.22
38	4.34	3.98	3.67	3.41	3.18	2.98	2.81	2.65	2.51	2.39	2.27	2.17	2.08	1.99	1.91	1.84	1.77	1.71	1.65	1.59	1.54	1.49	1.40	1.26
39	4.46	4.08	3.77	3.50	3.27	3.06	2.88	2.72	2.58	2.45	2.33	2.23	2.13	2.04	1.96	1.88	1.82	1.75	1.69	1.63	1.58	1.53	1.44	1.29
40	4.57	4.19	3.87	3.59	3.35	3.14	2.96	2.79	2.65	2.51	2.39	2.28	2.19	2.09	2.01	1.93	1.86	1.80	1.73	1.68	1.62	1.57	1.48	1.32
41	4.68	4.29	3.96	3.68	3.43	3.22	3.03	2.86	2.71	2.58	2.45	2.34	2.24	2.15	2.06	1.98	1.91	1.84	1.78	1.72	1.66	1.61	1.52	1.36
42	4.80	4.40	4.06	3.77	3.52	3.30	3.10	2.93	2.78	2.64	2.51	2.40	2.29	2.20	2.11	2.03	1.95	1.88	1.82	1.76	1.70	1.65	1.55	1.39
43	4.91	4.50	4.16	3.86	3.60	3.38	3.18	3.00	2.84	2.70	2.57	2.46	2.35	2.25	2.16	2.08	2.00	1.93	1.86	1.80	iteL,_	1.69	1.59	1.42
44	5.03	4.61	4.25	3.95	3.69	3.46	3.25	3.07	2.91	2.76	2.63	2.51	2.40	2.30	2.21	2.13	2.05	1.97	1.91	1.84	1.78	1.73	1.63	1.46
45	5.14	4.71	4.35	4.04	3.77	3.53	3.33	3.14	2.98	2.83	2.69	2.57	2.46	2.36	2.26	2.17	2.09	2.02	1.95	1.88	1.82	1.77	1.66	1,49
46	5.26	110111113			3:45	3.61	3.40	3.21	3.04	2.89	2.75	2.63	2.51	2.41	2.31	2.22_	2.14	2.06	w99	1.93	1.86	1.81	1.70	1.52
47	5.37	4.92	4.54		3.94	3.69	3.47	3.28	3.11	2.95	2.81	2.68	2.57	2.46	2.36	2.27	2.19	2.11	2.04	1.97	1.91	1.85	1.74	1.55
48	5.48	5.03	4.64	4.31	4.02	3.77	3.55	3.3.5	3.17	3.02	2.87	2.74	2.62	2.51	2.41	2.32	2.23	2.15	2.08	2.01	1.95	1.88	1.77	1.59
49	5.60	5.13	4.74	4.40	4.11	3.85	3.62	3.42	3.24	_4.9L	243	2.80	2.68	2.57	2.46,	2.37	2.28	2.20	2.12	2.05	1.99	1.92	1.81	1.62
50	S.71	5.24	4.83	4.49	4,19	3,93	3.70	3.49	3.31	3.14	2.99	2.86	2.73	2.62	2.51	2.42	2.33	2.24	2.17	2.09	2.03	1.96	1.85	1.65
51	5.83	5.34	4.93	4.58	4.27	4.01	3.77	3.56	3.37	3.20	3.05	2.91	2.79	2.67	2.56	2.46	2.37	2.29	2.21	2.14	2.07	2.00	1.88	1.69
32	54	5.45	5.03	4.67	4.36	4.08	3.84	3.63	3.44	3.27	3.11	2.97	2.84	2.72	2.61	2.51	2.42	2.33	2.25	2.18	2.11	2.04	1.92	1.72
53	6.05	5.55	5.12	4.76	4.44	4.16	3.92	3.70	3.51	3.33	3.17	3.03	2.90	2.78	2.66	2.56	2.47	2.38	2.30	2.22	2.15	2.08	1.96	1.75
54	6.17	5.65	5.22	4.85	4.52	-1.24	3.99	3.77	3.57	3.39	3.23	3.08	2.95	2.83	2.71	2.61	2.51	2.42	2.34	2.26	2 19	2.17	2.00	1.79
55	648	576.	Alk2	441_	.4.61	_g,	;01			3.46					76	2.66	2.56	2.47	2.38	2.30	2.21.42.16		2.03	1.82
56	6.40	5.86	5.41	5.03	4_69	4.40	4.14	3.91	3.70	3.52	3.35	3.20	3.06	2.93	2.81	2.71	7.61	2.51	2.43	2.35	2.27	2.20	2.07	1.85

* For 400mm (15.7'1 tire outside diameter; gives distance traveled in meters for one turn of the pedals.

SUTHERLAND'S

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Sutherland's Bicycle Shop Aids, Inc.

INVENTORY/SALES FORMS

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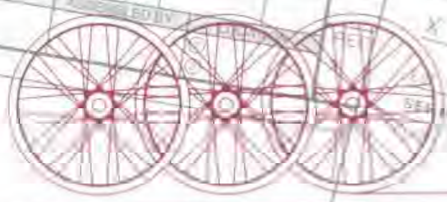
RENTAL FORMS

SPECIAL ORDER FORMS

LAYAWAY FORMS

GIFT CERTIFICATES

HANDBOOKS FOR BICYCLE MECHANICS



1-800-248-?10:0 0

INVENTORY/SALES TAGS

Keep Track of* Your *Bicycles Every Step of the Retail Process

These tags keep track of your bicycles every step of gip retail process! They serve the dual function of inventory tags that help keep track of stock. and they're sales receipts that give the customer a complete description of the bike and accessories purchased.

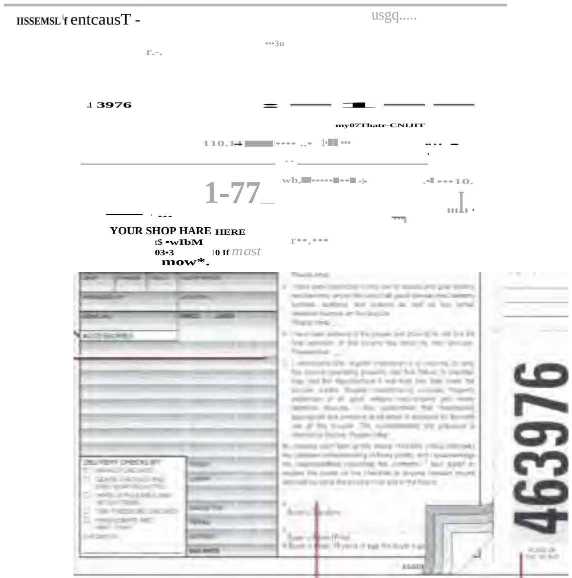
If these tags save you one minute per bike it's worth having. For instance. if you sell 600 bikes. you would enjoy a savings of 600 minutes or 10 hours. If your shop rate is $30 per hour, you realize a savings of $300!

TYPE DOUBLE C
9'/2" X SW'
5-part carbonless

Type Double C
5 Carbonless Parts — white for assembly. yellow for the customer (with Quick Release Presentation), pink file copy, green control and white hard copy.

* Includes Bicycle Buyer's Agreement and Inventory Control System that tracks every step from stocking to delivery.

♦ Assembly checklist on the back of the hard copy to help insure that all the details of assembly are completed. despite **ihe** interruptions of a bike shop.



Assenif4 *Checklist* on *back* of *the hard* copy

fist acres cones *sold ;Pith bike* here.

Culatan for *labor makes* It Mier tO *charge for* ti me-corl. stir/ling *bike assemble accessory installation*

• Delivery checklist. for a quick check before the bike goes out the door. catches any misadjustment from test rides like a loose seat post.

Buyer sign: *check* h SI of Bieyde Buyer 's .Agreement.

Easy *to read 1-nurrrher a* finches *to* box or *bicycle.* with *transfer tape attached. Space* foradditlonal notes sthOire *coattail number*

TYPE C
11⅛" X 4¼"
4-part tag

4 Parts — white copy for pre-assembly: yellow copy showing indicates that hike is assembled; pink copy showing means it's sold. Hard copy is your complete record filled out.

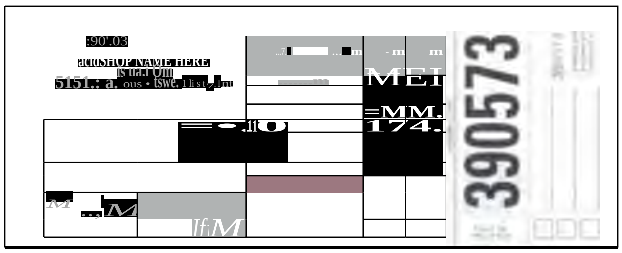
• Serves two functions: Inventory tag and sales slip.

• Lists make and model of bicycle and accessories sold.

• End stub is attached to box when bike enters inventory — upon purchase. stub is removed and attached to bicycle.

• Write layaway information on back of hard copy.

Description *of The* top is easy to read when *rag* al *rack or file cabaret*



Assembler Writes in ntitnner *here.*

check here when tested.

See `imprinting" *section for special messages to* go here

Capers agreement

Qu ick•Re *lease* Presentation en *hack of cur-*farr;er ropy *Assembly* checklist on *bock of hard* copy

Bar-coded tag number.

Delieery checklist.

TYPE DOUBLE E
10" X 8W'
4-part carbonless

Type Double E — Now Sutherland's has* inventory/Sales Forms for *Computer Printers

A tractor-feed version of the Double C with or without bar-coded tracking number.

• Includes: Buyers agreement, Assembly checklist. Delivery checklist. Quick-Release Presentation. Bar-coded tag number.

• Sutherland's ***NEW*** BikeTracker inventory software will *use* these forms. Call us toll-free for your complimentary informational brochure_

Urge your software supplier to incorporate these forms

4 carbonless copies

customer. (with Quick Release Presentation), pink control copy and white hard copy.

TYPE E
10" X 51/2"
4-part carbonless

A tractor-feed version of the Type C form with the addition of the delivery checklist and bar code.

CALL SUTHERLAND'S AT

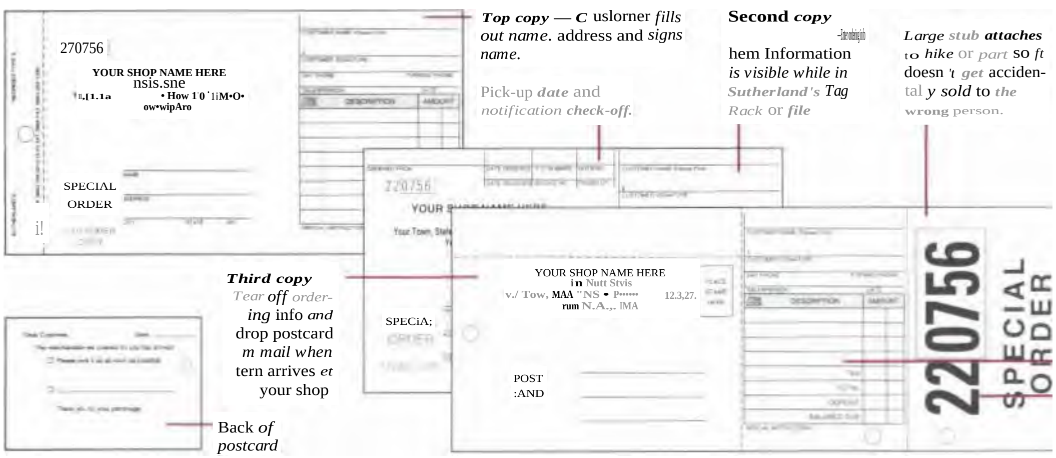
1800-248-2510 TO ORDER

TYPE L / LAYAWAY
10 54g" X Vie
2-part tag

Promote your Layaways

Turn "lookers" into buyers through the ease of your lay-away plan. Each order of these tags includes two tent signs for your sales counters.

- Designed to work with Sutherland's Bicycle Inventory Tags.
- Simplifies layaways — 2 copies plus ID tag for bike.
- Back has place to list alterations and installations.
- Customer gets top white copy. Attach canary copy to our inventory/Sales Tag to prevent the bicycle from being accidentally sold again.
- Sold tag with name goes on the bike or item.



TYPE S / SPECIAL ORDER
10 5h3" X 41/4"
5-part tag

End special-order confusion

Time-saving 3-part tag has a copy for you and customer. plus provides a postcard/ID stub to inform customer that merchandise has arrived.

Item listed here.

It her *makes* d

TYPE G/GIFT CERTIFICATE
7 74i" X 43/4"
2-part carbonless

Strengthen Sales with Sutherland's Gift Certificates

- Make that sale to the gift shopper in your store with these certificates.
- Two attractive colors on individual forms in convenient quantities.
- Each order includes envelopes and two advertising signs.
- Available only with your imprint.

REPAIR MANUALS

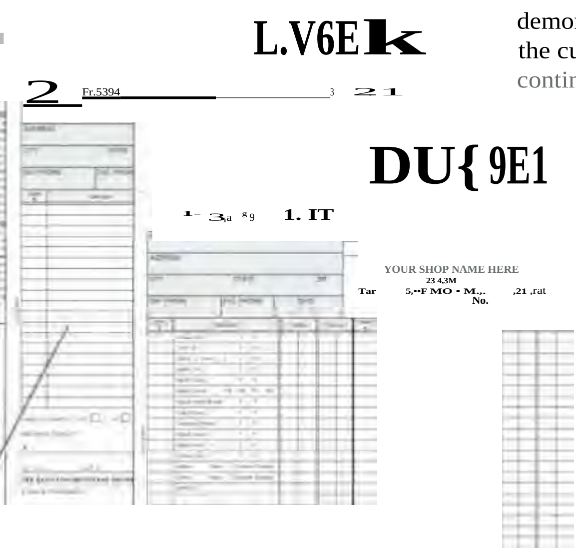
SUTHERLAND'S HANDBOOK FOR BICYCLE MECHANICS
Sixth Edition

We've packed these 450 pages with the information that is central to the current revolution of the bicycling industry.

- New specifications on mountain bike equipment.
- Revised spoke length tables for over 750 rims — 100 pages of spoke lengths including new numbers for your spoke length computer!
- Updated bottom bracket section, many new axle lengths and cartridge/spindle interchangeability charts.
- Chainring compatibility with adapter and spoke charts.
- All new chapter on front suspension maintenance and repair tips.
- All new clipless pedal compatibility chart.
- Updated headset compatibility chart.
- Sachs and Shimano internal 7-speed assembly and disassembly instructions.

REPAIR TAGS

*Te*roff stab gr'eA on the bike so you can find the bike by the cus-rorner's -141 71, or large, rºd numbers.*



Quick *Release informa-tion* is *priMed on !he back of the* white cus-tomer copy of *both* forms.

Type **88**
Same *for* us Type AA. *except service* work is II of pre-iisted

Type **AA**
Customer Sfyris *off for recommended* work *refused*

These spacious tags are ideal for your shop to create repair orders with specific listing of services to be performed. We've included our Quick Release Hub demonstration on the back of the customer's copy so that you continue to educate the consumer on this important safety issue long after the sale of the bicycle.

Both Double A and Double B fold to fit wail racks and file cabinets.

Type Double A

comprehensive Repair Tag allows you to circle pre-listed services or write in your own description of work

Folds to fit in Sutherland's *Tog* Rack *with the lidl* customer *name* showing.

TYPE DOUBLE A & B
8" X 91/4"
3-part carbonless

to be done. Also included is a space to note recommendations made to the customer and a sign off as to whether the suggested work was accepted or refused.

The 3-part carbonless tag allows you to give the customer a copy of the work to be performed when bicycle is dropped off. This tag also allows you to note what accessories were on the bicycle when it entered your shop, promised delivery date and mechanic's sign off.

Type Double B — Same as Double A. except ail services are written in by your shop rather than pre-listed.

TYPE A B
43/4" X 1-M"
2-part tag

Save time and money through increased efficiency. Featuring bright red one inch-high numbers. these tags help you to quickly write-up and find repair hikes. The tags can be imprinted with your shop's name, address, phone number and a short message. You'll be able to see your work load at a glance to avoid overbooking. Let work flow smoothly with Sutherland's Repair Tags.

Type A — Service work is pre-listed on a 2-pan carboned tag. This tag allows you to note bicycle accessories at check in, promised delivery date and mechanic's sign off. Fits in Sutherland's Tag Racks or hangs on a hook or a nail.

Type B is the same as Type A, except all services are written in by your shop rather than pre-listed.

Detachable customer claim check indicates promised *date of work's completion.*

Plaids up to fall our £USI N

Service is *pre-listed Simply circle* repair *to be done Additional* roam *on the back for* more work to *be lister}.*

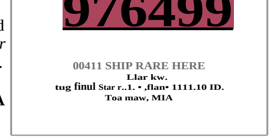
Desaripiion of bike and aCCf:tb5r1•Fteli *it come* in with. goes *here*

Mechanic signs off o.n Joh *here.*

I" number sows *time finding bike*

Customer *claim check has name. address.* phone and *message — See -Imprinting' for other ideas.*

Type A



Type *B*
&Me *for* us *Type A. except* service *work h not pre-listed*

COASTER BRAKE I INTERNALLY GEARED ROBS HANDBOOK

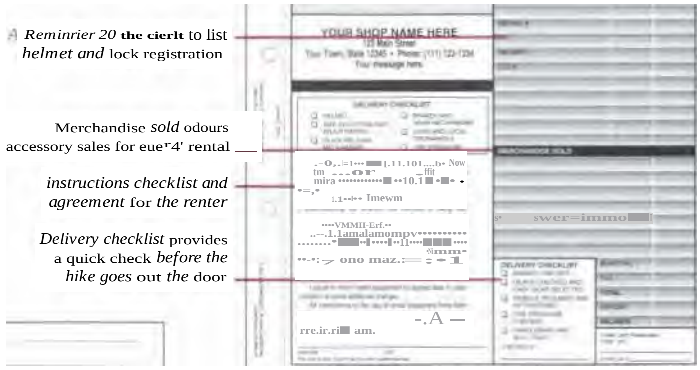
Instructions on assembly and disassembly of all major hubs on the market, plus many older hubs that are no longer sold.

- Step-by-step illustrations and a listing of the most common service needs of the hubs.
- Interchangeability charts that detail common parts within a family of hubs.
- Information on Sturmey Archer AWC 3-speed, Shimano E Type and NK Super Model 120 coaster brakes plus Sachs H3102 3-speed Hub not covered in previous editions.

SPECIALTY ITEMS

TYPE R / RENTAL
7 7/4;" X filib"
3-part carbonless

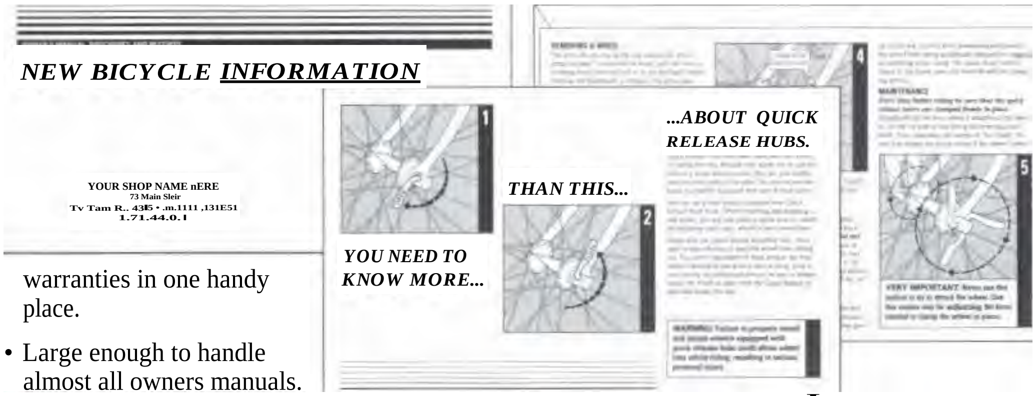
- Designed specifically for bicycle rentals, includes an agreement to be signed by renter before any equipment leaves your shop.
- Instructions Checklist in agreement section verifies that customer has been advised of proper use of rented bicycle and necessary auxiliary equipment.
- Quick Release Presentation on back of customer copy.



NEW BICYCLE OWNER'S ENVELOPE

Your professional option for delivering important papers to the new bicycle owner!

- Quick Release Hub Presentation on back and flap of envelope.
- Keeps owner's manual, receipts, brochures and warranties in one handy place.
- Large enough to handle almost all owners manuals.



IMPRINTING

Special imprint formats are available at no additional cost. Save time and money while giving your customers valuable information with special messages. Here are some helpful formats:

Logos and trademarks can also be printed ($40.00 one-time set-up charge). If you have special artwork you would like to include. please call for our logo guidelines sheet.

- Size of custom logo area is 3" x 3/4".

CALL SUTHERLAND'S
-1 800-248-2510-
FOR MORE INFORMATION ON CUSTOMIZING YOUR FORMS

DELIVER | MC'N | TUESI | WED | THU | FRI | SAT | MAE

81 4570

Responsible For Goods Left Over 30 Days.

CYCLE WORLD
9.627 Reseda Blvd • Northridge, CA 91324
Phone:15181 349-6900
5Aorage charges al $1,slay
ass* to days Sher cornoleeen

Extra lines for storage charges

Not Responsible For Goods Left Over 30 Days

CYCLE WORLD
710 0114EFSIty Avenue
Rochester, NY 14607 • Phone: 2714553
£0srr 10-8 Man Yes Fn. Sat 0-6 Sal 12-5
rAit tor wolev naps

Extra lines for store hours

Not Responsinee For Goods Left Over no Days

Sonny s
BICYCLE WORLD
6103-A Wesie',
Greenville, TX 75401
Phone: 12141454-3030

Extra line for name

Not Responsible For Goods Lett Over 30 Days

BYRD'S BICYCLES, INC.

1131 4th Si N	1506 54Th Ave. N.
St Pete, Root	St Pete, FL 33704
Ph, 8%-3791	Ph. 552-5605

2 stores

390573

YOUR SHOP NAME HERE
173 Main Shoot
D., Town. State 12345 • Phone: 11111123-1738
Your message here

BIKE AMERICA

Elk Grove	L Sacamento
9032 Elk Grove Blvd	6531 Brucevill Rd
6135-5021	423-X35

2 stores

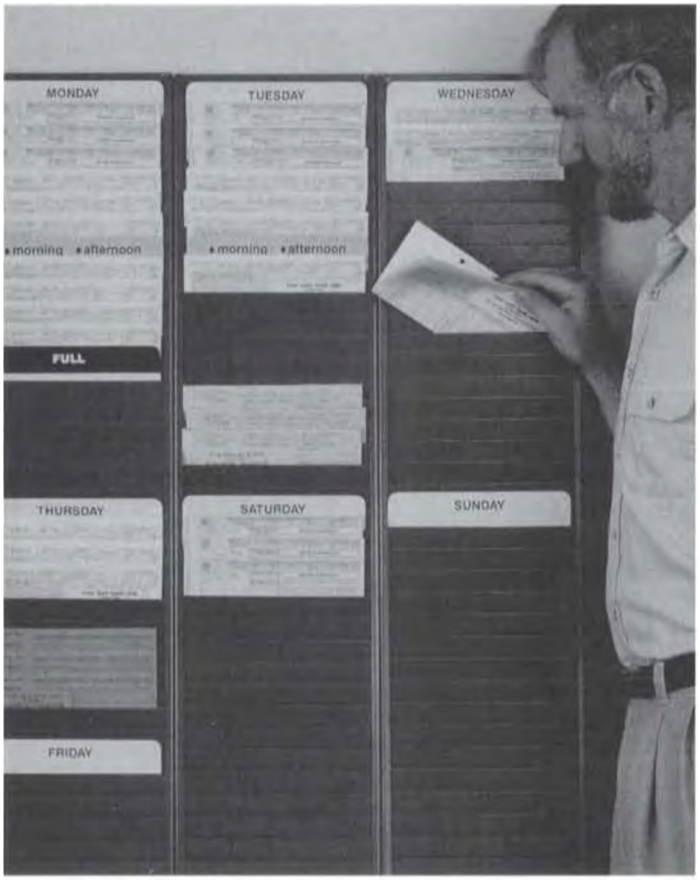
SCHWINN CYCLERY

ORMONO SCHWINN	VOLUSIA SCHWINN
205 S Yongeii15 #11	3132 5 Ridgewood iLIS tI)
Ormond Beach • 577-2425	So. Daytona • 156-0008

Lay-away deposits are non-retu nclable.

2 stores and extra message

FILING MATERIALS & RACKS



Three 40-Slot Racks shown with divider cards. (Divider cards sold separately.)

Use Sutherland's Tag Racks for efficient service management. All Sutherland's tags work with these sturdy grey-painted steel racks that will last a lifetime. See your workload at glance and locate the customer's tag quickly. For a new bike set up — pull the inventory tag for the hike to be assembled from your Sutherland's File cabinet and place the tag in the rack along with the repair tags. For a repair — when customer returns you can put your hand on the tag quickly. inform them how much the repair costs, then get the bike while they write their check. When you've promised all the work you can complete on any given day, put in the FULL sign. During the busy season it's easier to point to that FULL sign than try to explain why you can't take on more work for that day. Slot dimensions are 2 7/16" x 8 5Y16" x V deep. Shipping wt. is 12 3'4 lbs.

RACKS FOR SUTHERLAND'S TAGS

2 Sizes Available

- 40-Slot Rack has outside dimension of 44" x x 1 1 4c." deep.
- 20- Slot Rack has outside dimension of 22" x 9" x 1 1/16' deep.

Divider Cards

Heavy-duty varnished Divider Cards (sold separately) aid in grouping tags according to the day the work is to be completed. Printed in bold, easy-to-read letters. Each card is 41/4" x 73/4" long and fits into the same slots as the repair tags. Each set contains:

pr.a.

Arolinivs

WECNICW. •

ATCAL2Cti

AVOW.

7 Day Cards (Sunday, Monday, etc.) 7 FULL/ DONE cards and 7 MORNING/ AFTERNOON cards.

FILE CABINETS AND ACCESSORIES

File Cabinets

Simplify ordering bikes by keeping your inventory at your fingertips! These convenient, good looking files feature a nylon guide for smooth operation.

Type C — Overall dimensions of This" x 91/2'" x 16" deep. Will hold about 450 completed Type C forms.

Type E

Overall dimensions of S'%" x x 16" deep. Ideal for holding Type E forms.

File Guides for Type C

- Arrange your inventory tags by model and frame size.

- Guides are 1/5th cut for easy indexing.
- Made of heavy card stock for long use.
- Just the right size for your inventory forms.
- Available in sets of 100.

Cable *Ties*

A simple way to help organization. Handy re-usable beaded plastic ties allow you to attach our tags to the bicycles in your shop. Call for samples.

Sutherland's Bicycle Shop Aids, Inc.

P.O. Box 9061
Berkeley, CA 94709

Phone: (800) 248-2510 • (510) 547-3966
Fax: (800) 255-1039
Fax Outside USA: (510) 655-5445

CALL OR WRITE

FOR A FREE SAMPLE PACKET

TODAY!