

MODERN MOTORCYCLE TECHNOLOGY

Third Edition



Edward Abdo

MODERN MOTORCYCLE TECHNOLOGY



Third Edition

Edward Abdo



Australia • Brazil • Mexico • Singapore • United Kingdom • United States

Modern Motorcycle Technology, Third Edition
Edward AbdoSVP, GM Skills & Global Product Management:
Dawn Gerrain

Product Director: Matthew Seeley

Product Team Manager: Erin Brennan

Senior Director, Development:
Marah BellegardeSenior Product Development Manager:
Larry Main

Senior Content Developer: Meaghan Tomaso

Product Assistant: Maria Garguilo

Vice President, Marketing Services:
Jennifer Ann Baker

Marketing Director: Michele McTighe

Senior Production Director: Wendy Troeger

Production Director: Andrew Crouth

Senior Content Project Manager: Cheri Plasse

Senior Art Director: Benjamin Gleeksman

Cover image(s):

1. © Shannon Kirk
2. © ManoAfrica/istockphoto.com
3. © styleTTT/istockphoto.com
4. © saicie/istockphoto.com
5. © stockphotomania/Shutterstock

© 2017, 2013 Cengage Learning

WCN: 01-100-101

ALL RIGHTS RESERVED. No part of this work covered by the copyright herein may be reproduced, transmitted, stored, or used in any form or by any means graphic, electronic, or mechanical, including but not limited to photocopying, recording, scanning, digitizing, taping, Web distribution, information networks, or information storage and retrieval systems, except as permitted under Section 107 or 108 of the 1976 United States Copyright Act, without the prior written permission of the publisher.

For product information and technology assistance, contact us at
Cengage Learning Customer & Sales Support, 1-800-354-9706

For permission to use material from this text or product,
submit all requests online at **www.cengage.com/permissions**.

Further permissions questions can be e-mailed to
permissionrequest@cengage.com

Library of Congress Control Number: 201595851

ISBN: 978-1-3054-9745-0

Cengage Learning20 Channel Center Street
Boston, MA 02210
USA

Cengage Learning is a leading provider of customized learning solutions with employees residing in nearly 40 different countries and sales in more than 125 countries around the world. Find your local representative at
www.cengage.com.

Cengage Learning products are represented in Canada by
Nelson Education, Ltd.

To learn more about Cengage Learning, visit **www.cengage.com**

Purchase any of our products at your local college store or at our preferred online store **www.cengagebrain.com**

Notice to the Reader

Publisher does not warrant or guarantee any of the products described herein or perform any independent analysis in connection with any of the product information contained herein. Publisher does not assume, and expressly disclaims, any obligation to obtain and include information other than that provided to it by the manufacturer. The reader is expressly warned to consider and adopt all safety precautions that might be indicated by the activities described herein and to avoid all potential hazards. By following the instructions contained herein, the reader willingly assumes all risks in connection with such instructions. The publisher makes no representations or warranties of any kind, including but not limited to, the warranties of fitness for particular purpose or merchantability, nor are any such representations implied with respect to the material set forth herein, and the publisher takes no responsibility with respect to such material. The publisher shall not be liable for any special, consequential, or exemplary damages resulting, in whole or part, from the readers' use of, or reliance upon, this material.

Preface

Modern Motorcycle Technology (MMT) is designed to meet the basic needs of students and individuals interested in the subject of motorcycle and all-terrain vehicle (ATV) repair and also by helping instructors present information that will aid in students' learning experience. The subject matter is intended to help students become more qualified candidates for dealers looking for well-prepared, entry-level technicians.

MMT has been written to make learning enjoyable; the easy-to-read and easy-to-understand chapters and the great number of illustrations will assist visual learners with content comprehension. The book consists of 20 chapters, and starts with the history of the motorcycle and ends with information about troubleshooting various conditions found on any motorcycle. Because of the similarity of the technologies used, the servicing of ATVs is automatically included in the text.

MMT can be used not only for pre-entry-level technicians but also as a reference manual for practicing technicians. Motorcycle technicians

are currently sought after and will continue to be in demand in the future as technology advances in the manufacturing of modern motorcycle and ATV products. In today's world, technicians who have an education prior to working in the field are becoming more desirable to hiring dealerships.

I have been in the motorcycle industry on "all sides of the fence." I have been a rider and a racer most of my life, as well as a customer, technician, service manager, motorcycle trade school technical instructor, chief instructor, curriculum developer, manufacturer's service representative, and head of a technical training department tasked to ensure that over 4,000 technicians are up to date with technologies and technical instruction and am now the owner of a successful motorcycle and ATV shop. I have had a passion for motorcycles since my first mini-bike back in the 1960s, and I have a unique outlook on my job. I love doing what I do! This is something that everyone should strive for, as there is nothing more rewarding.

—Ed Abdo

New To This Edition

The third edition of *Modern Motorcycle Technology* (MMT) has been updated throughout and includes new content on the latest motorcycle models and technology from today's top manufacturers. This new edition features additional material on key topics such as fuel management systems, suspension systems, and electrical systems. It also provides an expanded suite of separately available

supplementary teaching and learning tools—including a hands-on Student Skill Guide and electronic instructor resources available on a companion website and CD-ROM. MMT is a valuable resource for anyone seeking the knowledge and skills to succeed in today's motorcycle technology field.

Acknowledgments

Many people were instrumental in making this book a reality. There were numerous reviews from those in the motorcycle industry; the suggestions were excellent and helped to make this a better textbook. There are also other people who helped make this book possible whom I would like to acknowledge: Bernie Thompson, Jeff Percival, Andy Parks, Kirk Nussbaum, Bill Kish, Adam Miller, Shawn Moen, and the staff from PowerSport Institute were all very helpful with the addition of material in several chapters of this edition as well as assisting with the updated pictures found within

the pages to follow. The staff from Motorcycle Mechanics Institute were also very instrumental in providing updated material for this book. A special thanks to Shannon Kirk for taking the action photos which includes my son used on the covers of this textbook. The late George Decker, who many years ago saw something in me that made him think that I could be a technician, hired me for my first job in this industry and became my mentor. There are three others who were all key in helping shape my instructional career: Art Ridgway, unknowingly to both of us at the time, showed me that teaching

what you have learned to others is not only self-satisfying but also rewarding in ways far exceeding my imagination. Art's passion to help others learn inspired me to want to teach others what I have learned over the years. Larry Barrington helped me prove to myself that I could get up in front of a large group of students and actually teach! Larry had a way of making me feel at ease in my early stages of teaching when I was questioning my abilities as an instructor. Doug McIntyre taught me more about myself than any other person I have ever had the pleasure to work with. His willingness to listen and help me through my problems when trying to sort

through instructional design issues will always be remembered. Next, my wife Bonnie and son Nick (shown as #268 in the action pictures used on the covers of this book!) for their endless love. The two of them find ways to inspire me every day. There were many more people who have helped me along the way in this great ride of a career, but the page is now getting long, so I will just say thank you all! It is an honor to give back to an industry that has done so much for me. Without all the support I have been fortunate to obtain throughout my life, you would not be reading this.

Reviewers

The author and publisher would like to thank the following reviewers for their valuable input during the development of the first and second editions of MMT:

Larry Barrington
Universal Technical Institute
Phoenix, AZ

Michael Baugus
Central Tech
Drumright, OK

Dan Clark
Fullerton, CA

Shane Conley
Western Iowa Technical Community College
Sioux City, IA

Tony DeBoeuf
Linn State Technical College
Linn, MO

Richard Deuschle
Motorcycle Mechanics Institute
Phoenix, AZ

Paul Fahey
ATI
Burleson, TX

Jason Finlay
Linn State Technical College
Linn, MO

Wayne Hightower
ATI
North Richland Hills, TX

Greg Hodges
Wyotech—Daytona Campus
Ormond Beach, FL

Roy King
Centennial College
Toronto, Canada

William W. Kish
PowerSport Institute
Cleveland, OH

Anthony V. Lambiase
Universal Technical Institute
Phoenix, AZ

Ray Luther
ATI
Joshua, TX

Adam Miller
PowerSport Institute
Cleveland, OH

Shawn Moen
PowerSport Institute
Cleveland, OH

Kara Moon
Universal Technical Institute
Phoenix, AZ

Robert Monroig
Lake Washington Technical College
Woodinville, WA

Terry A. Muncy, Jr.
Motorcycle Mechanics Institute
Orlando, FL

David Norman
Northern Georgia Technical College
Clarksville, GA

Kirk Nussbaum
PowerSport Institute
Cleveland, OH

Ryan J. Pagan
Wyotech—Daytona Campus
Ormond Beach, FL

Andy Parks
PowerSport Institute
Cleveland, OH

Jeffrey Percival
PowerSport Institute
Cleveland, OH

John Pfingstag
Universal Technical Institute
Phoenix, AZ

Michael Ross
Motorcycle Mechanics Institute
Phoenix, AZ

Michael Sachs
DeKalb Technical College
Clarkston, GA

Bernie Thompson
PowerSport Institute
Cleveland, OH

Supplements

Student Skill Guide: This workbook is designed to provide students with activities centered around diagnostic and repair procedures commonly performed on the modern motorcycle. Each chapter contains questions and activities to reinforce the content in the respective core text chapter. The Skill Guide also contains many job sheets that allow students to put the theory to work in the shop with illustrated, step-by-step guided lab activities.

Instructor Resources: The Instructor Resources will help make classroom time more efficient and

engaging with tools like chapter presentations in PowerPoint for each text chapter; an Image Gallery of photos and illustrations from the book; chapter tests powered by Cognero for use as exams, quizzes, or homework assignments; and the end-of-chapter questions available as Word files. An Answer Key is also provided for the end-of-chapter questions.

To access these Instructor Resources online, go to login.cengagebrain.com, and create an account or log into your existing account.

Contents

CHAPTER 1

Introduction to Modern Motorcycle Technology

Learning Objectives	1
Key Terms	1
Introduction	2
A Brief History of the Motorcycle	2
Types of Motorcycles and ATVs	8
Motorcycle Industry Opportunities	15
Summary	20
Chapter 1 Review Questions	21

CHAPTER 2

Safety First

Learning Objectives	22
Key Terms	22
Introduction	23
The Safety Attitude	23
Fire Safety	23
Hazardous Chemicals	28
Electrical Safety	30
Exhaust Gas Safety	32
Safe Operation of Equipment	32
Good Housekeeping Practices	32
Handling Heavy Objects and Materials	34
Using Personal Protective Equipment (PPE)	35
Using Tools Safely	38
Safe Riding Practices	39
Summary	39
Chapter 2 Review Questions	40

CHAPTER 3

Tools

Learning Objectives	41
Key Terms	41
Introduction	42
Basic Hand Tools	43
Power Tools	56
Special Tools	59
Purchasing Tools	66
Storing Tools	67
Service Information Library	67
Dealer Management Systems	69
Summary	69
Chapter 3 Review Questions	69

CHAPTER 4

Measuring Systems, Fasteners, and Thread Repair

Learning Objectives	70
Key Terms	70
Introduction	71
Measurement Systems	71
Fasteners	72
Inspection, Cleaning, and Repair of Threaded Fasteners	79
Stresses on Threaded Fasteners	80
Tips for Working with Threaded Fasteners	81
Tightening and Torque	81
Repairing and Replacing Broken Fasteners	84
Summary	86
Chapter 4 Review Questions	87

CHAPTER 5

Introduction to Basic Engine Operation and Configurations

Learning Objectives	88
Key Terms	88
Introduction	89
Engine Ratings	91
Basic Four-Stroke Engine Design	96
Basic Two-Stroke Engine Design	100
Engine Cooling	102
Engine Configurations	104
Summary	108
Chapter 5 Review Questions	108

CHAPTER 6

Internal-Combustion Engines

Learning Objectives	110
Key Terms	110
Introduction	111
General and Scientific Terms	112
Basic Internal-Combustion Engine Operation	113
Internal-Combustion Engine Operation	116
Basic Four-Stroke Engine Components	116
Four-Stroke Engine Theory of Operation	128
Two-Stroke Engines	130
Two-Stroke Engine Components	130
Two-Stroke Engine Theory of Operation	134
Two-Stroke Engine Induction Systems	138

Comparing Two-Stroke and Four-Stroke Engines	140
Summary	143
Chapter 6 Review Questions	143

CHAPTER 7

Lubrication and Cooling Systems	144
Learning Objectives	144
Key Terms	144
Introduction	145
Lubricants and Lubrication	146
Friction-Reducing Devices	150
Two-Stroke Engine Lubrication	153
Four-Stroke Engine Lubrication	156
Cooling Systems	161
Lubrication System Maintenance	165
Summary	166
Chapter 7 Review Questions	166

CHAPTER 8

Fuel and Engine Management Systems	168
Learning Objectives	168
Key Terms	168
Introduction	169
Fuel	169
Oxygen	170
The Carburetor	172
Fuel Delivery Systems	174
Carburetor Systems and Phases of Operation	179
Types of Carburetors	184
Multiple Carburetors	189
Engine Management Systems	191
Fuel Injection	191
Traction Control Systems	204
Summary	205
Chapter 8 Review Questions	206

CHAPTER 9

Drives, Clutches, and Transmissions	207
Learning Objectives	207
Key Terms	207
Introduction	208
Gears	208
Gear Ratios	210
Primary Drives	212
Clutch Systems	213
Transmissions	221

Starting Systems	229
Final Drive Systems	230
Summary	232
Chapter 9 Review Questions	232

CHAPTER 10

Two-Stroke Engine Top-End Inspection	234
Learning Objectives	234
Key Terms	234
Introduction	235
Diagnostics	235
General Tips Before Beginning Engine Repairs	235
Repair Procedures	235
Two-Stroke Top-End Disassembly and Inspection	237
Two-Stroke Engine Top-End Inspection	237
Starting the Rebuilt Engine	250
Summary	250
Chapter 10 Review Questions	251

CHAPTER 11

Two-Stroke Engine Lower-End Inspection	252
Learning Objectives	252
Introduction	252
Common Lower-End Engine Failures	252
Two-Stroke Engine Removal and Disassembly	253
Two-Stroke Engine Lower-End Inspection	254
Summary	263
Chapter 11 Review Questions	264

CHAPTER 12

Four-Stroke Engine Top-End Inspection	265
Learning Objectives	265
Key Terms	265
Introduction	266
Diagnostics	266
Repair Procedures	266
Four-Stroke Top-End Disassembly and Inspection	267
Four-Stroke Engine Top-End Inspection	269
Four-Stroke Top-End Reassembly	293
Summary	295
Chapter 12 Review Questions	295

CHAPTER 13

Four-Stroke Engine Lower-End Inspection	296
Learning Objectives	296
Key Terms	296

Introduction	297	Types of Ignition Systems	384
Repair Procedures	297	Electric Starter Systems	390
Common Lower-End Engine Failures	298	Summary	393
Four-Stroke Engine Lower-End Disassembly	300	Chapter 16 Review Questions	394
Four-Stroke Engine Lower-End Inspection	302		
Four-Stroke Lower-End Reassembly	312	CHAPTER 17	
Summary	313	Frames and Suspension	395
Chapter 13 Review Questions	314	Learning Objectives	395
		Key Terms	395
CHAPTER 14		Introduction	396
Electrical Fundamentals	315	Motorcycle Frames	396
Learning Objectives	315	Motorcycle Suspension Systems	403
Key Terms	315	Summary	424
Introduction	316	Chapter 17 Review Questions	424
Safety Precautions with Electricity	317		
Basic Principles of Electricity	318	CHAPTER 18	
Units of Electricity	324	Brakes, Wheels, and Tires	426
Electrical Meters and Measurements	328	Learning Objectives	426
Magnetism	334	Key Terms	426
Electronic Devices	338	Introduction	427
Electrical Schematics and Symbols	340	Braking Systems	427
Electrical Terms	342	Wheels	439
Summary	345	Motorcycle Tires	442
Chapter 14 Review Questions	345	Summary	446
		Chapter 18 Review Questions	447
CHAPTER 15			
Motorcycle Charging Systems and DC Circuits	347	CHAPTER 19	
Learning Objectives	347	Motorcycle Maintenance and Emission Controls	448
Key Terms	347	Learning Objectives	448
Introduction	348	Key Terms	448
Charging Systems	348	Introduction	449
Charging System Operation	355	Maintenance Intervals	449
Types of Charging Systems	357	Motorcycle Engine Maintenance	452
Charging System Inspection	361	Motorcycle Chassis Maintenance	470
DC Electric Circuits	367	Motorcycle Storage Procedures	476
Summary	371	Emission Controls, Operation, and Maintenance	477
Chapter 15 Review Questions	371	Summary	480
		Chapter 19 Review Questions	481
CHAPTER 16			
Ignition and Electric Starter Systems	373	CHAPTER 20	
Learning Objectives	373	Motorcycle Troubleshooting	483
Key Terms	373	Learning Objectives	483
Introduction	374	Key Terms	483
Motorcycle Ignition Systems	374	Introduction	484
Basic Ignition System Components	377		

Systematic Approaches to Solving Problems	485	Abnormal Noise Troubleshooting	504
Types of Problems	485	Summary	505
Troubleshooting Engine Problems	487	Chapter 20 Review Questions	505
Fuel System Troubleshooting	490		
Related Problems for Other Fuel Systems	493	Glossary	507
Electrical Problem Troubleshooting	496	Index	521
Chassis Problem Troubleshooting	501		

CHAPTER 1

Introduction to Modern Motorcycle Technology

Learning Objectives

When you have completed the study of this chapter and its laboratory activities, you should be able to:

- Understand a brief history of the motorcycle and the motorcycle industry
- Describe different types of motorcycles
- List some of the many motorcycle industry job opportunities

Key Terms

Advertising and marketing specialists	Motocross	Service manager
All-terrain vehicles (ATVs)	Motorcycle	Service technical training instructors
Custom cruiser	Motorcycle repair instructors	Service writer
Customer service representatives	Motorcycle technician	Setup technician
Direct drive system	Motor scooters	Sport motorcycles
District parts managers	Multipurpose utility vehicles (MUVs)	Sport-touring motorcycles
District sales managers	Off-road motorcycles	Standard street motorcycles
District service managers	Parts department	Street motorcycles
Dual-purpose motorcycles	Parts technician	Technical advisors
Electric vehicle (EV)	Quality control specialists	Technical illustrators
Entry-level motorcycle technicians	Race team support technicians	Technical writer
Franchised dealerships	Research and development engineers	Three-wheelers
General manager	Road racing	Touring motorcycles
Hot-rod cruisers	Sales department	Universal Japanese Motorcycles (UJM)
Lot attendant	Service department	

INTRODUCTION

Motorcycles have a long history that dates over 100 years, and the motorcycle industry has continued to grow at a tremendous rate with peak yearly unit sales of new motorcycles reaching over 1 million from 2003 through 2008 and all-terrain vehicle (ATV) unit sales surpassing 800,000. Over the past few years, the economic condition of the marketplace has seen a reduction of new sales through 2015, although the market has recovered every year since the bottoming of the market in 2010. Servicing these machines is different in many ways than in the past. Over the years, constant breakthroughs in engine, chassis, and electronic technology have greatly changed how motorcycles and ATVs are developed and marketed to the consumer. Because of this, trained motorcycle technicians are in high demand throughout the country.

A BRIEF HISTORY OF THE MOTORCYCLE

According to *Merriam-Webster's Collegiate Dictionary*, the word **motorcycle** is defined as “a 2-wheeled automotive vehicle having one or two saddles.” Of course, motorcycles are a bit more complex than that simple explanation.

In fact, motorcycles are a direct descendant of the bicycle. The early bicycle (actually called a velocipede, a bicycle with its pedals located on the front wheel) (Figure 1-1) appeared in the early 1860s and was also known as a “boneshaker,” both for its jarring ride and for its tendency to toss the riders when riding on cobblestone roadways.

Since its invention, the motorcycle has been considered to be more than just a bike with an engine attached. Riding a motorcycle gives people

a completely different perspective of the world around them as compared to driving in an automobile. Riding on the open road or along a trail is a feeling like no other. Furthermore, no matter which type or brand of motorcycle they have, all riders share a common bond between them. They are virtually all motorcycle enthusiasts and truly love to ride.

It could be argued that writing a book about the history of the motorcycle could easily take up more space than this entire textbook provides. Throughout the years, there have been literally thousands of different motorcycle manufacturers around the world. Therefore, we will briefly discuss only a few of the many highlights of the motorcycle's vast history.

The Birth of the Motorcycle

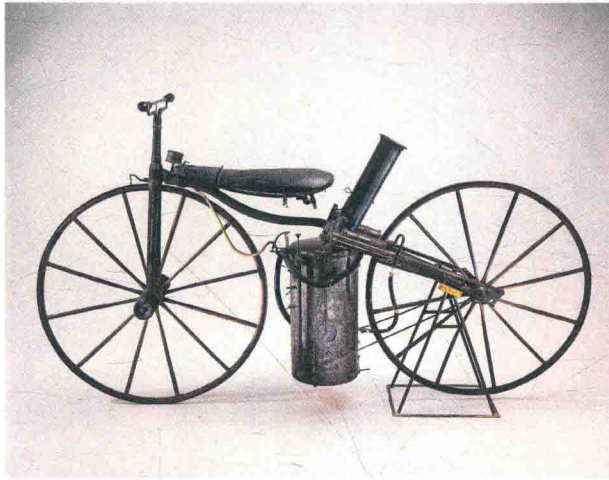
There are many different opinions pertaining to who exactly invented the first motorcycle, but using the definition by *Merriam-Webster*, it could be Sylvester H. Roper of Roxbury, Massachusetts. He built a steam-powered machine in 1869 (Figure 1-2) that could be considered to be the *first* motorcycle.

Roper's machine was considered to be quite remarkable, as it looked very similar to bicycles of that era but utilized a small vertical steam boiler under the seat. The boiler supplied two pistons that powered a crank-drive system to the rear wheel. The throttle was controlled by twisting the handlebar forward and back. The Roper machine had the first known—albeit a primitive version—use of the twist grip control. The twist grip throttle control was reinvented a couple of times over the years,



Courtesy Transportation Collections, Division of Work & Industry, National Museum of American History, Smithsonian Institution

Figure 1-1 The motorcycle is a direct descendant of the early bicycle, which was actually called a velocipede because of the placement of the pedals on the front wheel.



Courtesy Transportation Collections, Division of Work & Industry, National Museum of American History, Smithsonian Institution.

Figure 1-2 This could be considered the very first motorcycle, but since it was powered by the use of a steam engine, it can be debated that it was not a motorcycle. This machine was created by Sylvester H. Roper of Roxbury, Massachusetts, in 1869.

finally by the Indian Motorcycle Company—after this Roper design—and is still in use on today's motorcycles. Roper built more versions of his steam-powered motorcycle, and in 1896, at the age of 73, he showed up at a bicycle track near Harvard with a modified version of one of his designs. He was clocked at an unbelievable 40 miles per hour, and while slowing down, the bike went into a wobble, throwing Roper off the bike. Sadly, he died in this accident. Later, however, an autopsy is reported to have shown that Roper died of a heart attack and did not die from the fall.

Even though the Roper machine was designed years before, most historians credit Gottlieb Daimler with the invention of the motorcycle in 1885, as it was the first motorcycle in recorded history with an engine powered by petroleum (Figure 1-3). Daimler designed an engine and mounted it into a wooden-framed contraption in 1885.

As mentioned, the Roper machine is considered by most to be the first motorcycle even though it actually had four wheels. Historians overlook the two outrigger-type stabilizer wheels and consider this machine to be the grandfather to the motorcycle. Daimler's young son Paul was the first to give this machine a test ride. Daimler's machine had no pedals. Instead, the power was supplied only by the simple four-stroke engine design. Daimler later went on to build early automobiles. He left it to bicycle builders to further develop the motorcycle.



Courtesy Soiteis, published under the terms of the GNU Free Documentation License . <http://en.wikipedia.org/wiki/File:Daimler-1-motorcycle-1.jpg>

Figure 1-3 This is a replica of what many historians consider to be the first motorcycle to be powered by an internal combustion engine. A gentleman by the name of Gottlieb Daimler created it in 1885.

In 1892, Alex Millet invented a five-cylinder motorcycle and was the first to utilize pneumatic tires (Figure 1-4). The Millet-designed machine used a complex rotary engine built within the rear wheel. The cylinders rotated with the rear wheel, while the crankshaft was actually incorporated into the rear axle.

Although short-lived due to poor design, the first motorcycle built for sale (over 200 were sold) was the Hildebrand & Wolf Mueller (Figure 1-5) in Munich in 1894. This motorcycle utilized a water-cooled twin-cylinder engine that had a **direct drive system**, meaning that the wheels were directly attached to the engine and, therefore, would always

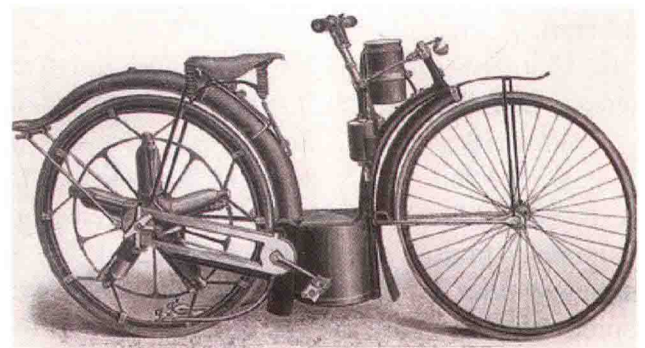


Figure 1-4 In 1892, Alex Millet of France built the first motorcycle with pneumatic tires. The engine was actually a part of the rear wheel and had five cylinders.



Courtesy Stahlkoeher, published under the terms of the GNU Free Documentation License.
http://en.wikipedia.org/wiki/File:Hildebrand-Wolfr%C3%BCll.jpg

Figure 1-5 The German company of Hildebrand & Wolf Mueller designed the first motorcycle that was produced for sale to the public. Design issues made this machine very hard to ride, and therefore it had a very short life.

be in motion if the engine were running. This made riding this motorcycle design difficult.

In 1895, the French firm of DeDion-Buton designed an engine that would allow motorcycle mass production to become a reality. The DeDion-Buton engine (Figure 1-6) design was a small high-revving four-stroke single using the first battery and coil-type ignition on such a small engine.

The engine was lubricated using a total loss system that dripped oil into the crankcase via a metering valve; the oil then sloshed around the internals to lubricate the moving components before burning or being pumped out onto the ground through a breather tube. While many of these engines were used, the engine design was copied by two very notable manufacturers in the United States: Indian and Harley-Davidson.

In 1900, two men, George Hendee and Carl Hedstrom, formed a partnership to manufacture a “motor-driven bicycle for the everyday use of the general public” in Springfield, Massachusetts, the Hendee Manufacturing Company. Hedstrom designed a motorcycle that debuted in 1901. A single-cylinder 1.75-horsepower engine that was copied from the DeDion-Buton engine gave the machine the ability to travel at speeds close to 25 miles per hour (Figure 1-7). The real secret to this design, however, was its chain drive, which was

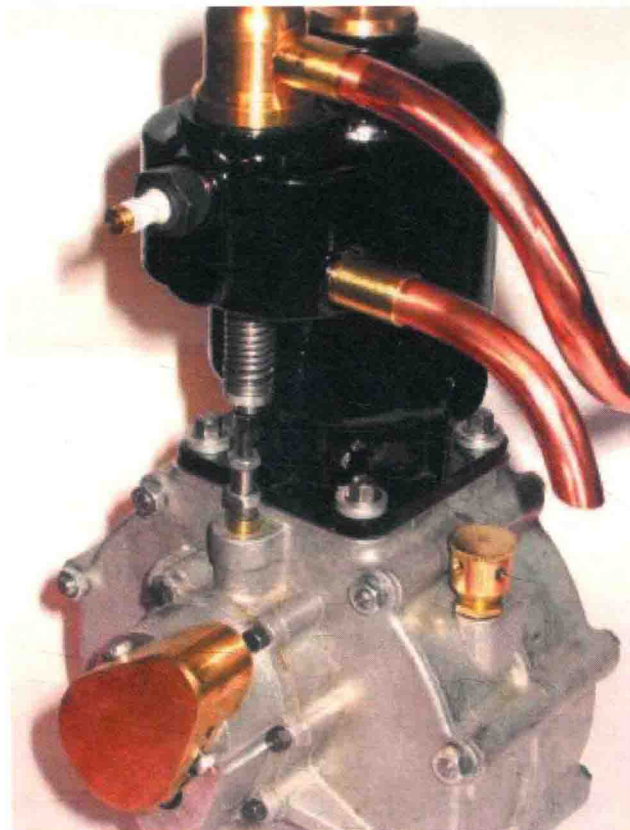
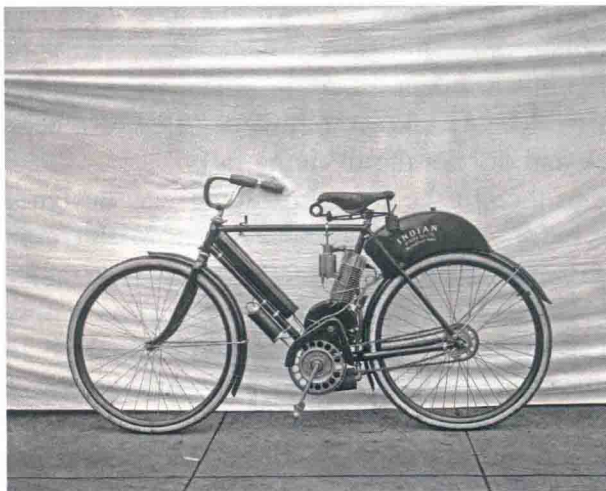


Figure 1-6 The French company of DeDion-Bouton built the first internal combustion engine that was mass-produced for usage specifically in a motorcycle.



Courtesy Transportation Collections, Division of Work & Industry,
National Museum of American History, Smithsonian Institution

Figure 1-7 The first Indian motorcycle was produced in 1902 and was very similar in design to a bicycle.

superior to the belt-driven machines around at that time.

The partners picked the name “Indian” for their motorcycles, thus starting what was to become the largest production motorcycle company in the United States. Indian was a leader in early



Figure 1-8 Similar in looks to the first Indian motorcycles, this 1905 Indian was called a “camelback” due to the shape and location of the fuel tank.

motorcycle design, registering patents on components that are still used today on modern motorcycles. The 1905 model was called a “camelback” due to the shape and location of the fuel tank (Figure 1-8). Indians were well constructed and often over-engineered. The company went on to build a V-Twin motorcycle with two- and three-speed gearboxes and further refined it with a swing arm rear suspension. In 1914, the world’s first motorcycle with an electric start and a full electrical system was introduced to the industry. The Hendee Special propelled Indian to be the largest motorcycle manufacturer in the world, producing over 20,000 bikes per year prior to World War I. One Indian motorcycle that was very popular with police departments was the Indian Four (Figure 1-9). While there have been a few attempts to revive the motorcycle brand Indian, the last true Indian motorcycle was the 1953 Indian Chief.

In 1903, 21-year-old William S. Harley and 20-year-old Arthur Davidson created for the public the first production Harley-Davidson motorcycle (Figure 1-10). The factory in which they worked was a 10- by 15-foot wooden shed with the words “Harley-Davidson Motor Company” crudely scrawled on the door (Figure 1-11).

Some of the earliest Harley-Davidson motorcycles were built with racing in mind. In 1908, Walter Davidson scored a perfect 1,000 points at the Federation of American Motorcyclists (FAM) 7th Annual Endurance and Reliability event. Then,



Figure 1-9 Over the years, many have attempted to bring back the Indian motorcycle, but the last true Indian was produced in 1953. This photo is of a 1940 Four, which could be considered the Cadillac of motorcycles in its day. They were smooth and flexible—at home trickling through traffic or cruising down the highway. These particular Indians were very popular with law enforcement agencies.



Figure 1-10 The first Harley-Davidson was produced in 1903.



Figure 1-11 An artist’s rendition of the very first Harley-Davidson factory. The building was in fact a 10- × 15-foot woodshed.



Photographs courtesy of the Harley-Davidson Motor Company Archives. Copyright H.D.

Figure 1-12 The first V-Twin built by Harley-Davidson had 7 horsepower and was built in 1909.

only three days later, he set the FAM economy record at over 188 miles per gallon.

The first Harley-Davidson V-Twin was built in 1909; it had a displacement of 49.5 cubic inches and boasted 7 horsepower (Figure 1-12). It was not until 1914 that the company formally entered into the motorcycle racing scene, but team Harley-Davidson was nicknamed the “Wrecking Crew” because of their dominance in the sport. In the 1920s, board track racing was very popular, and Harley-Davidson dominated that sport (Figure 1-13). During World War I, nearly half of all Harley-Davidsons built were used by the U.S. military, and by the end of the war, it was estimated that the U.S. Army used approximately 20,000 motorcycles, with the majority being Harley-Davidsons. By the year 1920, Harley-Davidson became the largest motorcycle manufacturer in the entire world with over 2,000 dealers located in 67 countries.



Figure 1-13 This 1923 board track racer was found in a chicken coop and restored to this pristine condition. It is currently ridden in exhibition races within the United States and has been clocked at over 75 miles per hour. Bikes such as this one dominated motorcycle racing in the 1920s.



Figure 1-14 Harley-Davidson celebrated 100 years of manufacturing motorcycles in 2003.

This dominance lasted until the 1950s, when the British motorcycle industry came to full bloom. Today, the Harley-Davidson brand is an American icon, and their products appeal to many different types of riders. The only “true” American motorcycle manufacturer still in existence from the early days, the Harley-Davidson Motor Company celebrated its centennial in 2003 (Figure 1-14).

British Motorcycles

While British motorcycle production began in the early 1900s, it was not until the 1950s that motorcycle brands such as Triumph (Figure 1-15) and



Figure 1-15 Triumph was a strong contender in the United States from the 1950s up until the early 1970s. The company’s downfall was its failure to change its products to align itself with the changing trends of the marketplace. This 1970 Bonneville was one of the last strong attempts to bring up market share, but in the end it failed to keep the company going.

Birmingham Small Arms, better known as BSA (Figure 1-16), were brought to the forefront of the U.S. motorcycle industry. Britain's motorcycle industry dominance was at its peak in 1959. Happy with their success, these companies felt somewhat invincible and failed to take note of emerging trends or to replace their aging designs. Most of the engineers and company executives came from prewar days and paid attention only to the glory days of the 1930s but unfortunately failed to look into the future. BSA merged with the Norton Villiers Triumph, and the last BSA was produced in 1973. Triumph is the only British brand to make any successful attempts to reenter the motorcycle marketplace in the United States over the years.

European competition from Germany included the company BMW (Figure 1-17), which made a rapid recovery from postwar times, and the Italian companies Ducati (Figure 1-18) and MV Agusta (Figure 1-19). They began to intrude on

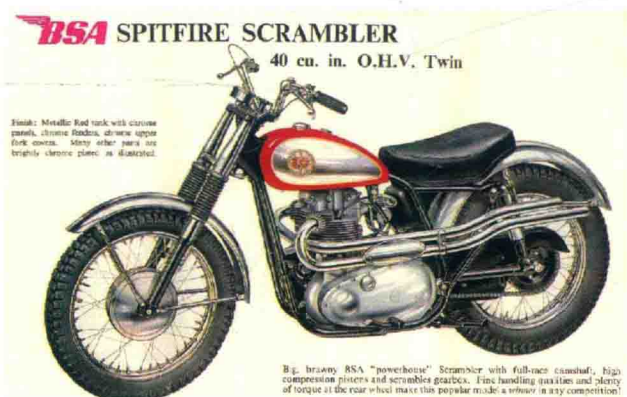


Figure 1-16 This vintage magazine advertisement of a BSA Spitfire Scrambler helped the British manufacturer create a strong consumer base with its power and looks.



Figure 1-17 German manufacturer BMW came back after World War II quickly to build very stylish (for the time) and reliable machines.



Figure 1-18 The Italian firm of Ducati has always been regarded to have motorcycles that could be considered just as much art as functional. Machines such as this helped to capsize the British motorcycle dominance of the 1960s.



Figure 1-19 MV Agusta was another strong manufacturer that built motorcycles that the public wanted and therefore helped to reduce the British motorcycle dominance.

market share with their desire to build more stylish machines. The final blow to the British motorcycle industry came from the Japanese as the U.S. and European markets began to import less expensive and more reliable machines. The Japanese motorcycles showed more innovation and engineering development, and the British companies were too slow to react to this competition.

Japanese Motorcycles

The motorcycle industry throughout the world saw its biggest change in the early 1960s, when a company from Japan, headed by Sochirio Honda, changed the way people looked at motorcycling. The Honda C100 Cub (Figure 1-20) was by far the most successful entry-level motorcycle, and in the United States the company utilized the ever-popular slogan "You meet the nicest people on a Honda." The cub alone has continued to sell over a half a million units per year every year since its