

FIFTH EDITION

MOTORCYCLES

Fundamentals, Service, Repair

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Publisher
The Goodheart-Willcox Company, Inc.
Tinley Park, IL
www.g-w.com

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Library of Congress Control Number: 2022942771

ISBN 978-1-68584-448-6

1 2 3 4 5 6 7 8 9 – 24 – 27 26 25 24 23 22

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Preface

Motorcycles: Fundamentals, Service, Repair is designed to help prepare you to service and repair motorcycles, all-terrain vehicles (ATVs), utility task vehicles (UTVs), and scooters. This textbook details the design, construction, operation, diagnosis, service, and repair of these vehicle systems and components. The information in this comprehensive textbook is easy to understand and applicable to all motorcycle, ATV, UTV, and scooter makes and models. *Motorcycles: Fundamentals, Service, Repair* can be used by the novice technician to learn the basics or by the experienced technician as a reference.

Motorcycles have changed significantly in recent years. Today's motorcycles use electronic ignition systems, emission control systems, cruise control, power drives, fuel injection, anti-lock brakes, and many other sophisticated innovations. *Motorcycles: Fundamentals, Service, Repair* covers conventional design features as well as the latest engineering advances.

Motorcycles: Fundamentals, Service, Repair provides a student-based approach to learning. Short sentences, concise definitions, and hundreds of high-quality

photos and color illustrations will help you learn quickly and easily. Information is presented using a building-block approach that starts with simple principles and progresses gradually to more complex topics.

Each chapter of *Motorcycles: Fundamentals, Service, Repair* opens with learning outcomes that tell you what will be covered. Each chapter also prepares you for the chapters that follow. Knowledge builds systematically as you progress through the text. All technical terms are defined as soon as they are mentioned. A glossary is also provided at the end of the text. This ensures that you can easily understand the many terms essential to motorcycle technicians.

A Lab Workbook for *Motorcycles: Fundamentals, Service, Repair* provides additional review questions for each textbook chapter, as well as guided shop procedures for hands-on practice of skills, allowing you to demonstrate what you have learned.

We congratulate you on your study of powersports technology and encourage you to take advantage of all the resources available as part of the *Motorcycles: Fundamentals, Service, Repair* learning solution.

About the Authors

Chris Grissom began working in the service department of a motorcycle dealership while racing flat track. He raced professionally during the 1970s and 80s, but came to realize his real talent was modifying motorcycles for maximum performance rather than racing them himself. Mr. Grissom eventually bought the dealership he had previously worked at and went on to operate it for 35 years.

Mr. Grissom has worked with top motorcycle and ATV riders in cross-country, motocross, and flat track racing. He has worked closely with Suzuki Amateur racing, Team Green, and Yoshimura Off-Road. His company, Chris Grissom Racing, has been a dominant player in race engine building around the world. His engines have won national championships in the United States and Australia.

In 2007, Chris Grissom was approached to develop a training program at Tennessee College of Applied Technology (TCAT) in Paris, Tennessee, and he became the Motorcycle/ATV Repair instructor in the very same shop where he studied small engine repair while in high school. The program also covers Outdoor Power Equipment and provides training to both dual-enrollment high school students and post-secondary adults. In 2022, Mr. Grissom had a student win the post-secondary National SkillsUSA[®] Motorcycle Service Technology competition and has had students place

in the top 5 in previous years of the competition as well. His students have also competed in the Outdoor Power Equipment competition and placed in the top 5.

Matt Spitzer has 28 years of experience as a technician and an instructor. He was formally trained at Shoreline Community College in the Toyota T-TEN program under legendary instructor Jack Shiel. While attending Shoreline, Mr. Spitzer won the Washington State SkillsUSA Automotive Technology competition and became a certified Toyota technician. He graduated with a 4.0 grade point average, earning his Associate in Applied Science.

After earning his Toyota Master Certification and ASE Master Technician Certification, Mr. Spitzer returned to Shoreline Community College, becoming the T-TEN Instructor of his former program. The program earned Toyota's prestigious Recognition Award as the top Toyota program in the country six out of the seven years Mr. Spitzer was employed at Shoreline.

Following his love of motorcycles and all things mechanical, Matt Spitzer accepted the position of Motorcycle and Marine Technology Instructor at Bates Technical College in Tacoma, WA in 2013. In 2017 and 2018, a Bates Technical College student won the National SkillsUSA Motorcycle Service Technology competition.



Reviewers

The authors and publisher wish to thank the following industry and teaching professionals for their valuable input into the development of *Motorcycles: Fundamentals, Service, Repair*.

Mark Burge

Thomas Nelson Community College
Hampton, VA

Jerome A. Fischer

Fox Valley Technical College
Appleton, WI

Samuel D. Gregory

Pulaski Technical College
Little Rock, AR

David Howard

Riverside High School
Chattaroy, WA

Roy King

Centennial College
Toronto, Ontario, Canada

Matt Lowry

Conestoga College
Guelph, Ontario, Canada

Christopher Mayville

SUNY Canton
Canton, NY

Jeremiah “J.J.” Martin

Ohio Hi-Point Career Center
Bellefontaine, OH

Mike Sachs

Georgia Piedmont Technical College
Clarkson, GA

William Young

Upper Bucks Technical School
Perkasie, PA

Acknowledgments

The authors and publisher would like to thank the following companies, organizations, and individuals for their contribution of resource material, images, or other support in the development of *Motorcycles: Fundamentals, Service, Repair*.

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New to This Edition

Some notable updates in this edition of *Motorcycles: Fundamentals, Service, Repair* include the following:

- Workplace Skills features have been added at the end of various chapters to provide students with an introduction to important soft skills and general workplace skills required in a professional workplace.
- Pedagogical updates have been made to each chapter's learning outcomes, summary, and review questions to improve student reading comprehension, retention, and assessment of chapter information.
- Current technology (including introduction of electric bikes) and industry changes are represented in updates throughout the chapters.
- Updated photos show new service practices and motorcycle, ATV, UTV, and scooter equipment and machines when possible.
- The chapter order has been restructured to better reflect training delivery. Students must have a foundational knowledge of engines and electricity before more complex systems are taught. The "Engines" and "Fuel Systems" chapters have been moved forward in the table of contents to accommodate the grouping of all the electrical chapters, beginning with the "Basic Electrical and Electronic Theory" chapter and followed by the "Ignition Systems," "Battery and Charging Systems," and "Electrical Accessory Systems" chapters.

SAMPLE

Features of the Textbook

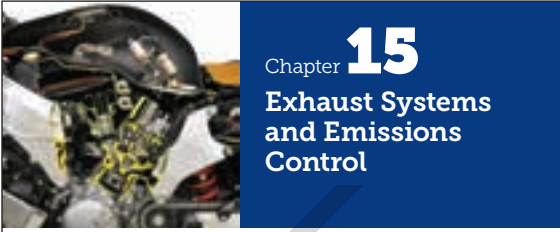
The instructional design of this textbook includes student-focused learning tools to help you succeed. This visual guide highlights these features.

Chapter Opening Materials

Each chapter opener contains a list of learning outcomes and a list of technical terms. **Learning Outcomes** clearly identify the knowledge and skills to be gained when the chapter is completed. **Technical Terms** list the key terms to be learned in the chapter. These words appear in **bold/italic** when introduced in the text and are defined in the Glossary.

Additional Features

Additional features are used throughout the body of each chapter to further learning and knowledge. **Warnings** alert you to potentially dangerous materials, practices, and improper service procedures that can cause personal injury if safety precautions are not followed. **Cautions** alert you to practices that could potentially damage a motorcycle, ATV, UTV, or scooter and their systems or damage service equipment and instruments. **Notes** provide supplemental information and guidance that is especially applicable for on-the-job situations and service procedures. **Procedures** are listed throughout the textbook to provide general instructions for hands-on service activities.



Chapter 15 Exhaust Systems and Emissions Control

Learning Outcomes

After studying this chapter, you will be able to:

- ✓ Explain the functions of an exhaust system and its components.
- ✓ Explain what is meant by exhaust scavenging.
- ✓ Describe procedures for inspecting and servicing exhaust systems.
- ✓ Explain the function of a turbocharger.
- ✓ Describe the different types of emission control systems.
- ✓ Describe the operation of a catalytic converter.
- ✓ Understand the uses of an exhaust gas analyzer.
- ✓ Recall restrictions on tampering with noise

Technical Terms

catalytic converter	exhaust gas analyzer	muffler
crankcase emission control system	exhaust gasket	oxides of nitrogen (NO _x)
evaporative emission control system	exhaust power valve	spark arrester
exhaust clamp	exhaust system	three-way catalytic converter system
exhaust collector	expansion chamber	turbocharger
exhaust emission control system	header pipe	
	heat diffuser	
	hydrocarbon emissions	

Engines generate exhaust gas and heat. If this gas were allowed to exit directly from the engine, the gas would be in the vicinity of the rider. It would also be a source of significant noise, since this gas would include the sound of moving hot air exiting the engine. Exhaust gas must be routed away from the rider and also silenced so surrounding noises are audible. In some areas, the engine must be equipped with *systems that clean the exhaust gas of harmful substances to reduce*

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Motorcycles, Fundamentals, Service, Repair

The following are examples of the different types of safety notices used in this textbook:

Warning
Use caution when using a press to disassemble or reassemble a crankshaft. The tremendous force created by the press could cause parts to fly out and cause injury.

Caution
Do not use a piece of wire, metal, or other conductor in place of a fuse. Doing so may allow excessive current to flow in the circuit, which may cause a fire.

Note
The nut is left-hand threaded.

Personal Safety
Work like a professional. While learning to become a motorcycle technician, it is easy to become excited about your work. Avoid working too fast—you could overlook a repair procedure or safety rule and cause an accident. If an accident does occur, report it immediately so proper first aid or medical assistance can be given. It is the technician's responsibility to adhere to all safety procedures, use safety equipment properly, and maintain a safe working environment. Motorcycles, ATVs, UTVs, and scooters may not appear to present as much danger to personal safety as larger motor vehicles. However, they are more than capable of causing injury or death if you do not exercise caution in handling, working on, and riding them. Many hazards are present in all shops. A hazard, or combination of hazards, can cause property damage, serious injury, or death. For example, a small oil spill may not seem like a hazard. However, this oil, combined with sparks from a nearby welding operation, could start a dangerous fire.

Chapter 16 | Wheels and Tires

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Green Tech
Tires that are taken to recycling facilities may be broken down and used to make new tires. This saves energy and materials used to produce new tires and keeps old tires out of landfills. Used tires should never be burned.

Changing a Tire
The steps for changing a tube tire mounted on a wire wheel are shown in Figure 16-38. Refer to the photos as each step is discussed.

1. To dismount a tire, unscrew and remove the valve core from the valve stem. **Figure 16-38A**. This will deflate the tire.
2. Loosen any bead locks (tire-to-rim locking device) that may be installed. Break the bead away from the rim and push the tire away from the rim with a tire bead breaker, **Figure 16-38B**. If a tire bead breaker is not available, step on the sidewall to collapse the bead. On wheels with tire pressure sensors (TPS), check that the sensor is positioned at least 90 degrees away from the bead breaker to prevent damage to the sensor.
3. Lubricate the rim with a rubber lubricant or water to aid removal and prevent tire damage. Never step on the rim when removing the tire.
4. Press one side of the tire into the drop center section of the wheel rim.




Figure 16-38 Steps for removing a tube motorcycle tire from its wire wheel. A—Unscrew valve core and stem locknut. B—Force tire off the outer lip of the rim. C—Lubricate the bead to aid removal and then pry the bead over the rim with the irons or levers. D—Remove the tube after freeing one bead. E—Pry other bead off the wheel. F—Check under strip for problems.

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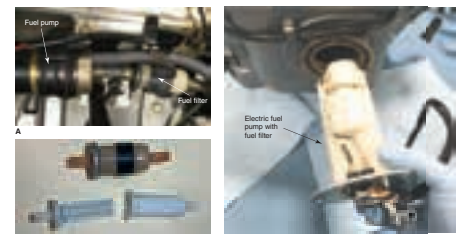


Figure 8-6. A—An in-line pump with an in-line filter installed in a carbureted vehicle's fuel system. B—An in-line fuel filter has a simple design to remove contaminants from the fuel. C—An electric pump installed inside the fuel tank on a vehicle equipped with a fuel injection system. The fuel filter is typically included in the pump assembly.



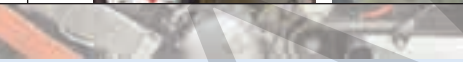
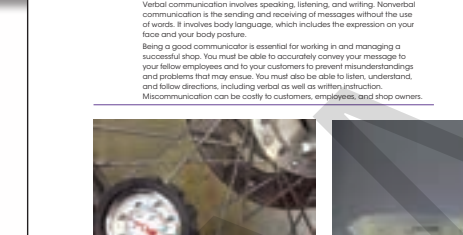
Figure 8-7. The three types of air filters are paper, foam, and gauze. A—Paper. B—Foam. C—Gauze.

Chapter 4 | Measurement and Measuring Tools 61

Air Pressure Gauge
An air pressure gauge measures the pressure in tires, Figure 4-21. ATVs and UTVs use very low pressure and require a low pressure gauge capable of accurately measuring pressures as low as 3 pounds per square inch (psi).

Graduated Cylinder
Measuring fluid volume is necessary to accurately measure oil for forks, shock absorbers, gearboxes, and more. A graduated cylinder or measuring cup can be used to accurately measure fluid volume. See Figure 4-22.

Workplace Skills
Communication is the process of exchanging ideas, thoughts, or information. The primary forms of communication are verbal and nonverbal. Verbal communication involves speaking, listening, and writing. Nonverbal communication is the sending and receiving of messages without the use of words. It involves body language, which includes the expression on your face and your body posture. Being a good communicator is essential for working in and managing a successful shop. You must be able to accurately convey your message to your fellow employees and to your customers to prevent misunderstandings and problems that may ensue. You must also be able to listen, understand, and follow directions, including verbal as well as written production. Miscommunication can be costly to customers, employees, and shop owners.



Review Questions

- Answer the following questions using the information provided in this chapter.
- True or False?** When the chain tensioner can no longer be adjusted, the primary drive chain is adjusted accurately.
 - Which of the following is *not* a cause of inadequate clutch spring pressure?
 - Worn clutch basket fingers.
 - Weak clutch springs.
 - Worn drive plates.
 - Improper clutch spring adjustments.
 - Inspection of clutch driven plates during an overhaul includes checking for _____.
 - worn splines
 - warpage
 - burned surfaces
 - All of the above.
 - True or False?** The inside diameter of a centrifugal clutch drum should be measured and compared to manufacturer wear limits during inspection.
 - All of the following components are part of a CVT's front unit, *except*:
 - fixed and movable drive face.
 - centrifugal clutch.
 - fixed drive plate.
 - variator.
 - True or False?** During primary drive and clutch assembly, the clutch basket must be installed before primary kick-start components to allow clearance during operation.
 - True or False?** A missing transmission gear ratio when one gear or ratio does not operate is a common transmission problem on powersports vehicles.
 - Which of the following parts does *not* need to be checked when inspecting a transmission shift mechanism?
 - Proper adjustment for the shift stopper pin.
 - Broken or damaged shift mechanism return spring.
 - Shift drum rotation speed.
 - Worn pivots in the shift arm.
 - True or False?** Measuring transmission shaft runout after disassembly determines whether the shaft is bent or damaged.
 - True or False?** Manufacturers recommend replacing a single gear in the gear pair used for a specific transmission ratio if only one gear is damaged.
 - Which of the following is *not* a consideration during transmission reassembly?
 - Use a service manual.
 - Lubricate parts.
 - Reinstall the rear drive unit.
 - Replace all seals and gaskets.
 - How is a cassette-type transmission mounted and supported on a motorcycle?
 - The transmission and cover assembly are inserted into the crankcase cavity.
 - It is supported by a horizontally split crankcase.
 - It uses a separate transmission case.
 - It is supported by a vertically split crankcase.
 - True or False?** Index marks ensure proper sprocket and rear-wheel alignment during free-play adjustment of a final drive chain.
 - Rear drive unit service requires checking _____ after making any tooth contact pattern adjustments between the ring and pinion gears.
 - driveshaft runout
 - ring and pinion backlash
 - universal joint operation
 - final drive chain stretch
 - All of the following are causes of excessive noise in a final drive unit, *except*:
 - low oil level.
 - excessive pinion and ring gear backlash.
 - overlubricated final drive chain.
 - worn or damaged ring gear.

Suggested Activities

- Using the primary drive and clutch inspection summary in this chapter, perform all inspection procedures listed. Record your findings and make up a parts list to determine the cost of repairs.
- Measure transmission shaft end play. Compare your results to the specifications given in the service manual.
- Check the operation of a shift mechanism.
- Find examples of the different methods of transmission mounting.
- Verify chain adjuster index marks on a motorcycle.
- Determine chain wear on a used final drive chain.
- Adjust a primary drive chain following service manual directions.
- Remove and install a final drive chain using the master link.
- Check and adjust the tooth contact pattern and backlash in a ring and pinion gear rear drive unit.

Photos and Illustrations

High-Quality Photos and Illustrations have been used to clearly and simply communicate the specific topics within each chapter. Many photos have been updated to show the latest equipment and machines.

Expanding Your Learning

Workplace Skills features help you understand what you can anticipate and expect in the workplace. They highlight the professional behaviors and traits that employers want, including vital soft skills and the development of critical thinking, diagnostic, and troubleshooting skills needed in the workplace today. **Green Tech** notes highlight key items related to sustainability, energy efficiency, and environmental issues.

End-of-Chapter Content

End-of-chapter material provides an opportunity for review and application of concepts. A concise **Summary** provides an additional review tool and reinforces key learning outcomes. This helps you focus on important concepts presented in the text. **Review Questions** enable you to demonstrate knowledge, identification, and comprehension of chapter material. **Suggested Activities** extend your learning and help you apply knowledge to real-world scenarios involving the inspection, testing, diagnosis, and service of motorcycles, ATVs, UTVs, and scooters.

TOOLS FOR STUDENT AND INSTRUCTOR SUCCESS

Student Tools

Student Text

Motorcycles: Fundamentals, Service, Repair covers the design, construction, operation, diagnosis, service, and repair of motorcycle components and systems, including operation and service material relative to all-terrain vehicles (ATVs), utility task vehicles (UTVs), and scooters/mopeds.



Lab Workbook

- Review questions designed to reinforce the textbook content help students evaluate their understanding of the terms, concepts, theories, and procedures presented in each chapter.
- Hands-on jobs provide an opportunity to apply and extend knowledge gained from the textbook chapters by asking students to perform various hands-on tasks like those they will be required to perform in the industry. The tasks are completed in the shop with instructor guidance and supervision.

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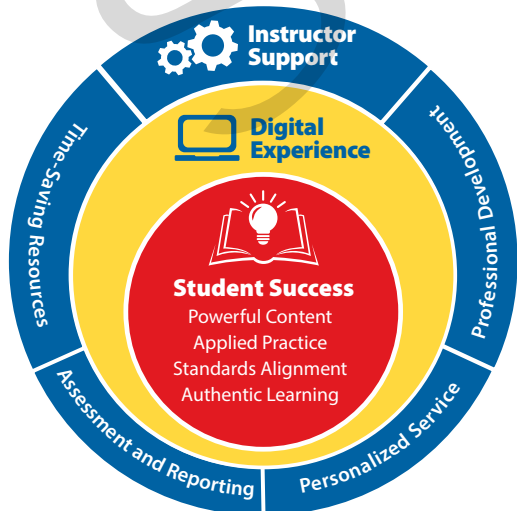
See www.g-w.com/motorcycles-fundamentals-service-repair-2024 for a list of all available resources.

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