WARREN COUNTY SCHOOL DISTRICT

Planned Instruction

Course Title: Power Equipment Technology

Course Number: 00909 (AM); 00959 (PM)

Suggested Educational Level(s) 10 – 12

Suggested Periods Per Week: 15 (3 per day) **Length of Period:** 40 min./period

Suggested Length Of Course: 3 years

Units Of Credit (If Appropriate): 3 per year

Date Written: February, 2005 **Date Approved:**

Date Reviewed: **Implementation Year:**

Teacher Certification Required: Voc. II – Small Engine Mechanic

Standards Addressed:
Career Education and Work: 13.1.11D, 13.2.11B, D, F, G, 13.3.11A
Science and Technology: 3.1.10A, D, E
Math: 2.3.11A, C, 2.5.11C, D
Reading, Writing, Speaking and Listening: 1.1.11A, 1.4.11D, E, 1.6.11A

Relationship to Other Planned Instruction:
Equipment and Engine Training Council

Prerequisites:
Tenth grade students. Student must achieve 85% on Safety Program.

Special Requirements
Mechanical aptitude, manipulative dexterity, and a good work ethic are important for success in this field.

Writing Team Members: James Mechling, Power Equipment Technology; Occupational Advisory Committee; and Mark Lindberg

Standards addressed:

13.1.11 Career Awareness and Planning

D. Justify the selection of a career.

13.2.11 Career Acquisition

B. Analyze and evaluate complex technical tasks using sophisticated processes.
D. Identify sources of health, safety and regulatory practices and their effects.
F. Analyze performance-based assessments components.
G. Analyze the need for manipulative/motor skills.

13.3.11 Career Retention

A. Analyze work habits needed to advance within a career.

3.1.10 Unifying Themes

A. Discriminate among the concepts of systems, subsystems, feedback, and control in solving technology problems.
E. Describe patterns of change in nature, physical, and man-made systems.

2.311 Measurement and Estimation

A. Select and use appropriate units and tools to measure to the degree of accuracy required in particular measurement situations.
C. Demonstrate the ability to produce measures with specified levels of precision.

2.5.11 Mathematical Problem-Solving and Communication

C. Present mathematical procedures and results clearly, systematically, succinctly, and correctly.
D. Conclude a solution process with a summary of results and evaluate the degree to which the results obtained represent an acceptable response to the initial problem and why the reasoning is valid.

1.11.11 Learning to Read Independently

A. Locate various texts, media, and traditional resources for assigned and independent projects before reading.

1.4.11 Types of Writing

D. Maintain a written record of activities, coursework, experience, honor and interest.
E. Write a personal resume.

1.6.11 Speaking and Listening

A. Listen to others.

COURSE DESCRIPTION:

The Power Equipment Technology provides students instruction through hands-on experiences, performance labs, classroom instruction, and manufacturer's training materials.

The program is a three-year program where the student will service, repair and troubleshoot a variety of power products including lawn and garden equipment, motorcycles, and ATVs, industrial equipment, and marine engine and systems. Students may specialize in any of these ares of instruction. Course content and standards are developed from manufacturers, dealerships, associations, and academic.

Enrolled students have opportunity to become a SkillsUSA member. This enables the student to enter leadership training, run for office, and/or compete in SkillsUSA competitions.

Students completing the course are required to take the N.O.C.T.I. (National Occupational Competency Testing Institute) exam. Also, students are encouraged to take the Equipment and Engine Training Council endorsed exam from the Outdoor Power Equipment & Engine Association Exam along with other O.E.M. Original Engine Manufacturer's Programs. Advanced placement is possible through some of these programs.

Outline of Sequence and Recommended Time:
The outline that follows describes the content of an ungraded course where grade 10, 11, and 12 grade students work in specialty areas of content determined by student choice rather than grade level. The instructor provides continual and developing instruction while students work independently in one of the areas listed below. The student must attain a 60% competency in the knowledge and skills of one specialty area before moving to another.

- Small Gas Engine
- Motorcycle and ATV Repair
- Marine Mechanics
- Industrial Mechanics

Specific Educational Objectives to be Taught:
The student will be able to-

1. service, troubleshoot, and repair a variety of 2-cycle and 4-cycle engines and their related systems.
2. service, repair, and diagnose motorcycle and all-terrain vehicles.
3. service, maintain, repair, and diagnose marine engines, systems, and drives.
4. develop fundamental knowledge and skills in industrial mechanics, which includes industrial concepts, principles, and equipment involving hydraulics, pneumatics, and electronics.

General Outline of Instructional Areas:

Small Engines Specialty Area:

- Safety
- Tools and Measurement
- Technical Publication and Information
- Fasteners
- Engine Designs, Construction, and Operation
- 2 & 4 Cycle Engines
- Fuel and Emissions
- Carburetion and Fuel Injection
- Basic Electricity
- Ignition Systems
- Lubrication Systems
- Cooling Systems
- Preventive Maintenance
- Troubleshooting
- Career Opportunities and Certifications

Motorcycle and ATV Repair Specialty Area:

- Introduction to Motorcycles, ATV, and Scooters
- Shop Safety and Environmental Protection
- Tools, Measuring Instruments, and Shop Equipment
- Fasteners, Gaskets, and Diagnostic Procedures
- Basic Electricity and Electronics
- Engines and Designs and Overhaul
- Fuel Systems
- Battery and Charging Systems
- Ignition Systems
- Lubrication Systems
- Cooling Systems
- Power Transmission Systems
- Wheels and Tires
- Brakes
- Frame and Suspension
- Accessories Systems
- Tune-up and General Service
- The Business of Motorcycle ATV and Scooter Service

Marine Mechanics Specialty Area:

- Boating Safety
- Marine Service Literature
- Service Support Tools and Products
- Outboard Products

- Drive Systems
- Electrical Systems
- Fuel Systems, Carburetor and EFI
- Fuel and Combustion Control
- Water Pumps and Cooling Systems
- Hydraulic Systems
- Rigging and Accessories
- Propping Theory
- Preventive Maintenance and Winterization
- Diesel Engine Introduction
- Career Opportunitites and Certification

Industrial Mechanics Specialty Area:

- Introduction
- Safety in the Production Environment
- Calculations, Formulas, and Measurement
- Rigging
- Hydraulic Principles
- Practical Hydraulics
- Pneumatic Principles
- Practical Pneumatics
- Lubrication and Bearings
- Belt Drives
- Mechanical Drives
- Alignment and Vibration
- Industrial Electricity and Motor Controls

Additional Programs of Student Development as a SkillsUSA Member:

- SkillsUSA Professional Development Program (PDP)
- Total Quality Curriculum
- SkillsUSA Competition

Formative Assessments:

- Performance Lab Check Sheets
- Quizzes
- Written Tests
- Teacher monitoring and assessment of hands-on activities

Summative Assessments:

Student's competency (60%) in selected area and is addressed through the following:

1. Teacher monitoring of student work and performance evaluation checklist and/or competency checklist.
2. N.O.C.T.I. test is given in all selected areas of instruction.

Required/Approved Textbooks and Materials:

Book Title: Small Gas Engines
Publisher: The Goodheart-Wilcox Company
ISBN #: 1-59070-183-6
Copyright: 2003
Date of Adoption: 2003

Book Title: Motorcycles Fundamentals, Service, Repair
Publisher: The Goodheart-Wilcox Company
ISBN #: 1-56637-4-479-0
Copyright: 1999
Date of Adoption: 2003

Book Title: Small Engine
Publisher: American Technical Publishers Inc.
ISBN #: 0-8269-0008-9
Copyright: 1997
Date of Adoption: 2002

Book Title: Industrial Mechanics
Publisher: American Technical Publishers Inc.
ISBN #: 0-8269-3690-3
Copyright: 1999
Date of Adoption: 2002

Additional required publications and/or on-line requirements for E.E.T.C. and O.E.M.

- Updated or recent OEM Reference Materials either on-line or published which include specification and procedures and parts acquisition for equipment and engine repair.
- Industry Periodicals
- OEM supplied video tapes or cd-roms
- Inventory Control System

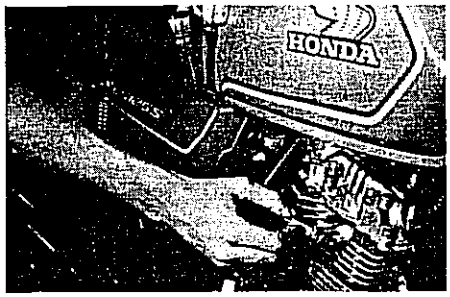
Required tools and equipment and education to comply with E.E.T.C. and O.E.M. Standards:

- O.E.M. engine manufactures special tools
- Working Parts Inventory
- O.E.M. technical and update training to gain, maintain, and update O.E.M. certifications

Power Equipment Technology Safety Program:

1. Safety Pledge and signed form
2. Daily safety requirements
3. Shop emergency procedure
4. Shop rules and consequences
5. Safety videos on equipment operation
6. CD-ROM safety in the workplace and testing
7. Act 116 Eye Protection
8. Safety Inspection Checklist
9. M.S.D.S. – Your Right to Know
10. Housekeeping in the workplace

Sample Unit attached



MOTORCYCLE ENGINES
UNIT VII

UNIT OBJECTIVE

After completion of this unit, the student should be able to list the parts and define the operations of four-stroke and two-stroke motorcycle engines. The student should also be able to discuss causes of poor engine performance, troubleshoot a no-start complaint on a one-cylinder motorcycle engine, and perform a leak-down test on a one-cylinder motorcycle engine. These competencies will be evidenced by correctly completing the procedures outlined in the job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to motorcycle engines with their correct definitions.
2. Complete statements concerning basic motorcycle engine theory.
3. Match terms related to piston movement with their meanings.
4. Complete statements concerning two-stroke and four-stroke operations.
5. Match terms concerning major components of a four-stroke engine with their functions.
6. Match terms concerning major components of a two-stroke engine with their functions.
7. Arrange in order the steps in the operation of a four-stroke engine.
8. Arrange in order the steps in the operation of a two-stroke engine.
9. Select true statements concerning four-stroke engine characteristics.
10. Select true statements concerning two-stroke engine characteristics.
11. Complete statements concerning problems that cause poor engine performance.
12. Complete a list of tools required for basic engine troubleshooting.

OBJECTIVE SHEET

13. Demonstrate the ability to:

    a. Troubleshoot a no-start complaint on a one-cylinder motorcycle engine. (Job Sheet #1)

    b. Perform a leak-down test on a one-cylinder motorcycle engine. (Job Sheet #2)

MOTORCYCLE ENGINES
UNIT VII

INFORMATION SHEET

I. Terms and definitions

A. Bore — Diameter of a cylinder

B. Cam ground — A manufacturing process that gives pistons an elliptical shape

C. cc (cubic centimeter) — The measurement of engine displacement on a metric scale

D. Combustion chamber — Area between the top of the piston and the cylinder head where the air/fuel mixture is ignited

E. Crankcase — Housing for the crankshaft, transmission, and related parts

F. Cycle — Completion of the series of events required to produce a power impulse from an engine

G. Horsepower — Measurement of work done in a given period of time

H. PSI (pounds per square inch) — A method of measuring pressure

I. Reciprocating motion — The back and forth or up and down motion made by a piston

J. Torque — The measurement of turning or twisting force

II. Basic motorcycle engine theory

A. There are two major types of motorcycle engines:

1. Two-stroke cycle engines

2. Four-stroke cycle engines

B. In the two-stroke cycle engine, the cycle of events that produces power takes two strokes to complete or 360 degrees of crankshaft rotation.

C. In the four-stroke cycle engine, the cycle of events that produces power takes four strokes to complete or 720 degrees of crankshaft rotation.

(NOTE: Two-stroke cycle and four-stroke cycle are technically the correct names for the two types of engines, but in normal reference they are usually called two-stroke or four-stroke engines, and they will be referenced that way throughout the remainder of this unit.)

INFORMATION SHEET

D. Engines are usually designed to meet specific demands, and this requires a variety of engine shapes or configurations.

1. One cylinder
2. In-line twin cylinders
3. V-twin cylinders
4. V-4 cylinders
5. Opposed-twin cylinders
6. Opposed-four cylinders
7. In-line three cylinders
8. In-line four cylinders
9. In-line six cylinders

III. Terms related to piston movement and their meanings

A. TDC (Top Dead Center) — The position of a piston at its highest point in a cylinder

B. ATDC (After Top Dead Center) — The position of a piston at a point between TDC and halfway down the stroke

C. BTDC (Before Top Dead Center) — The position of a piston at a point between halfway up and TDC

D. BDC (Bottom Dead Center) — The position of a piston at its lowest point in the cylinder

E. ABDC (After Bottom Dead Center) — The position of a piston at a point between BDC and halfway up the stroke

F. BBDC (Before Bottom Dead Center) — The position of a piston at a point between halfway down and BDC

IV. Two-stroke and four-stroke operations

A. The whole idea of an internal combustion engine is to create heat energy through combustion of the fuel/air mixture and convert that to mechanical energy through rotation of the crankshaft.

INFORMATION SHEET

B. A four-stroke engine requires four distinct piston strokes to produce one power impulse.

1. The intake stroke
2. The compression stroke
3. The power stroke
4. The exhaust stroke

C. Essentially, what happens in a four-stroke engine is what happens in a two-stroke engine except that the two-stroke operation is more complex because the two-stroke engine has intake and exhaust ports instead of valves.

D. The four-stroke engine can exhaust burned gases out of the exhaust valve, but the two-stroke engine has to force burned gases out an exhaust port in a unique way that is called "scavenging."

V. **Major components of a four-stroke engine** (Transparency 1)

A. Crankcase — Contains the crankshaft, bearings, transmission, and other components of the lower engine

B. Crankshaft — The shaft which changes reciprocating piston motion into rotary motion

C. Connecting rod — Attaches the piston to the crankshaft

D. Piston — A cam ground cylinder that slides up and down in an engine cylinder and is attached to a connecting rod

E. Rings — Metal inserts fitted into the top of a piston to retain pressure as the piston moves

F. Cylinder — The hollow cylinder extending from the engine case to the cylinder head to house the piston and permit piston movement

G. Cylinder head — The covering that closes the top end of the cylinder and may contain valves and cam shafts

H. Valves — Devices used to open and close intake and exhaust passages

I. Camshafts — Shafts with egg-shaped lobes that strike rocker arms to change rotary motion from the crankshaft into reciprocating motion to open valves

J. Gasket — Allows for the irregularities in the mating surfaces of two parts to assure a leak-proof seal

INFORMATION SHEET

VI. Major components of a two-stroke engine (Transparency 2)

A. Crankcase — Contains the crankshaft, bearings, transmission, and other components of the lower engine

B. Crankshaft — The shaft which changes reciprocating piston motion into rotary motion

C. Connecting rod — Attaches the piston to the crankshaft

D. Piston — A cam-ground cylinder that slides up and down in an engine cylinder and is attached to a connecting rod

E. Rings — Metal inserts fitted into the top of a piston to retain pressure as the piston moves

F. Cylinder — The hollow cylinder extending from the engine case that houses the piston and contains intake, transfer, and exhaust ports

G. Cylinder head — The covering that closes the top end of the cylinder

H. Gasket — Allows for irregularities in the mating surfaces of two parts to assure a leak-proof seal

VII. Steps in operation of a four-stroke engine (Transparency 1)

A. The 720 degree revolution of a four-stroke engine begins with the piston at TDC.

B. As the piston moves down to BDC, it creates a partial vacuum in the cylinder as the intake valve opens to allow the air/fuel mixture into the cylinder.

(NOTE: This is called the "intake" stroke.)

C. As the piston moves up from BDC to TDC, both the intake and exhaust valves close and the air/fuel mixture in the cylinder is compressed.

(NOTE: This is called the "compression" stroke.)

D. As the piston reaches TDC, the spark plug ignites the air/fuel mixture and the combustion produces high pressure which forces the piston to move down.

E. The downward movement of the piston is carried through the connecting rod to the crankshaft, and it causes the crankshaft to rotate.

(NOTE: The previous two events are called the "power" stroke.)

INFORMATION SHEET

F. As the piston completes the power stroke, and just before it reaches BDC, the exhaust valve opens and burned gases are forced out of the cylinder as the piston moves on up to TDC.

(NOTE: The final step is called the "exhaust" stroke.)

G. The piston has made four complete strokes, has completed a 720 degree rotation, and is at TDC once more as the cycle starts over.

VIII. Steps in operation of a two-stroke engine (Transparency 2)

A. The 360 degree revolution of a two-stroke engine begins with the piston at BDC.

B. As the piston moves upward, it clears the intake port and allows a fresh supply of the air/fuel mixture from the carburetor to enter the crankcase.

C. As the air/fuel mixture enters the crankcase, the piston moves past and closes the exhaust port as it compresses the air/fuel mixture above the piston.

D. As the piston reaches TDC, a spark ignites the compressed fuel/air mixture and drives the piston down with enough force that the power turns the crankshaft.

E. As the piston moves down, it closes the intake port and compresses the air/fuel mixture in the crankcase.

F. As the piston moves farther down it slides past the exhaust port which opens to allow burned gases to flow out of the cylinder.

G. As the piston moves even farther down, it opens the transfer port which allows the air/fuel mixture that has been compressed in the crankcase to enter the upper part of the cylinder.

(NOTE: This is how the air/fuel mixture gets to the upper cylinder combustion chamber so it can be compressed as indicated in Step C.)

H. The fresh air/fuel mixture sweeps into the upper cylinder and quickly pushes out remaining exhaust gases from the cylinder in a scavenging action.

I. Just as the combustion chamber above the piston is filled with a fresh supply of air/fuel, the piston reaches BDC and starts the cycle over again.

INFORMATION SHEET

IX. Four-stroke engine characteristics

A. Four-stroke engines are typically found on street bikes and touring bikes because they are durable, reliable, and run more smoothly than two-stroke engines.

(NOTE: There are exceptions to the rule, but in the 50cc to 1400cc range and beyond, street and touring bikes usually have four-stroke engines.)

B. A four-stroke engine properly operated and maintained is virtually trouble free and will not require nearly as much service as a two-stroke engine.

C. Four-stroke engines typically give excellent gas mileage and generally give better performance in a wider power band.

D. Four-stroke engines have lower pollution levels in the exhaust emissions and four-stroke engines do meet EPA standards for exhaust emission control.

E. Four-stroke engines usually run a bit cooler than two-stroke engines.

F. Four-stroke engines are identified by:

1. Number of cylinders and valves per cylinder
2. Cylinder arrangement
3. Number of camshafts
4. Placement of camshafts

Example: A Honda V-65 engine is a V-4 double overhead cam with four valves per cylinder

X. Two-stroke engine characteristics

A. Two-stroke engines are typically used on off-road bikes and ATV's because they are lightweight, compact, powerful, and cost less than four-stroke engines.

B. Two-stroke engines have few moving parts and are easy to service, but require service more often.

(NOTE: High rpm and heat build-up contribute to fast piston, ring, and cylinder wear in two-stroke engines.)

INFORMATION SHEET

C. Modern two-stroke engines have several improvements that enhance performance:

1. They are liquid cooled.

2. They have smaller bores and longer strokes.

3. They turn at a slower rpm, yet produce horsepower comparable to older type two-strokes because they produce more torque.

   Example: An older two-stroke might have a 70mm bore, a 64mm stroke, and a 250cc displacement while a modern two-stroke with a 250cc displacement would have a 66 mm bore and a 72 mm stroke

4. They have hi-tech coatings on cylinder walls and pistons to improve durability.

5. They have improved exhaust design that increases horsepower and improves performance.

D. Almost all two-stroke engines use a reed valve induction system to control the intake flow of the fuel/air mixture.

E. Some two-stroke engines use some type of valve to control exhaust port timing and improve performance.

F. It's difficult to find a two-stroke engine that meets the exhaust emission control standards set by the EPA.

(NOTE: This is partly due to the fact that engine lubricating oil is either injected into the engine by an injector pump or premixed with the gas, and oil simply does not burn well.)

XI. Problems that cause poor engine performance

A. To perform well, an engine must have:

1. Good quality fuel

2. Good compression

3. A strong spark

   (NOTE: On a multi-cylinder engine, low compression, lack of fuel, or lack of spark may only cause a miss or a rough-running condition.)

B. Without the proper combination of fuel, compression, and spark, an engine will not run smoothly and may not run at all.

INFORMATION SHEET

C. The purpose of the carburetor is to mix a specified amount of fuel with air to serve engine needs at all speeds.

D. Problems with carburetors can almost always be corrected with a complete disassembly, cleaning, reassembly, and adjustment.

E. Compression is affected by several conditions:

1. Improper valve adjustment is the most common problem, especially on smaller engines (125cc or less).
2. Ring and piston wear or damage cause poor compression.
3. A leaking cylinder head gasket will cause poor compression.
4. Burned or bent valves cause poor or no compression.

F. The lack of a strong spark may be caused by the malfunction of any part of the ignition system:

1. Ignition points that are dirty, burned, worn, or improperly adjusted can cause a weak spark or no spark at all.
2. Defective triggering coils in electronic ignition systems can cause a weak spark or no spark at all.
3. A weak power source like a battery or primary coil can cause a weak spark or no spark at all.
4. A defective ignition control unit in an electronic ignition system can cause erratic spark, weak spark, or no spark at all.
5. Connecting wires that are disconnected, shorted, or damaged usually result in no spark at all.

G. For an engine to run smoothly, fuel, spark, and compression events must happen in a specific sequence and at a specific time.

XII. Tools required for basic engine troubleshooting

A. Basic hand tools

B. Clean shop towel

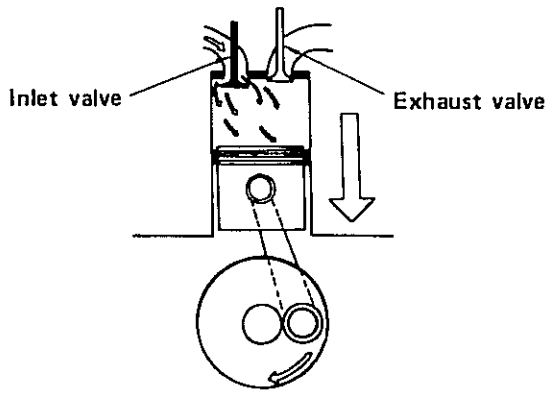
C. One liter container for catching gasoline

D. A pump-type oil can with 30W oil in it

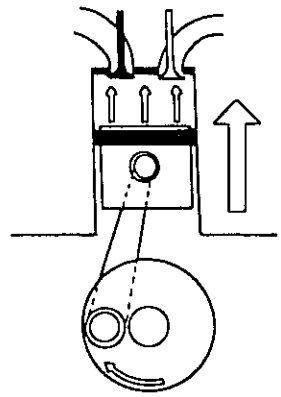
E. A compression gauge set

F. A spark tester

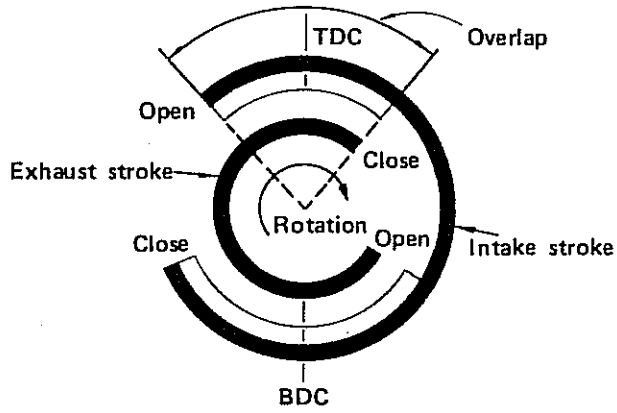
Four-Stroke Engine Operation

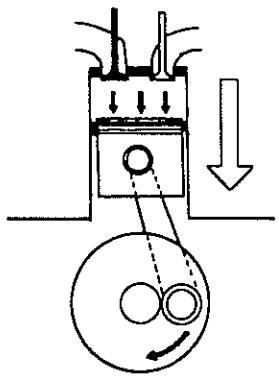


Intake

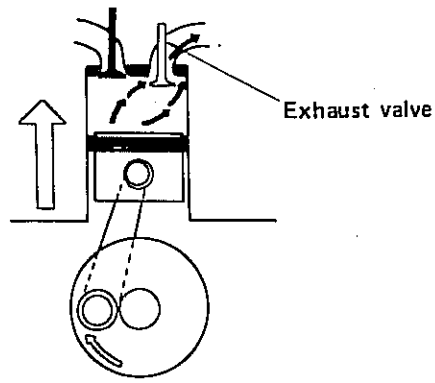


Compression





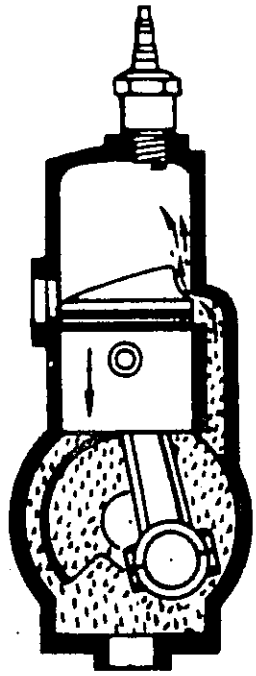
Power



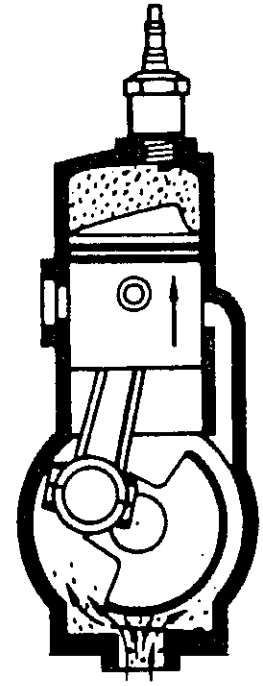
Exhaust

Courtesy Yamaha Motor Corporation, U.S.A.

Two-Stroke Engine Operation



Intake



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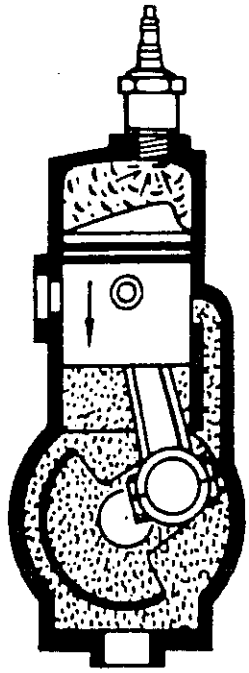

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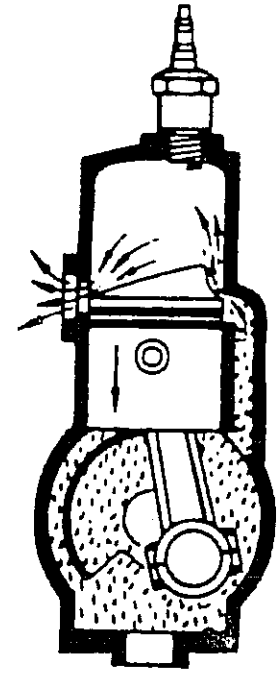

Exhaust