Small Engine Service & Repair

Second Edition

Instructor Guide

10-7650-I

In cooperation with
Agricultural Education Department of Practical Arts and Vocational-Technical Education
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Instructor Guide

Small Engine Service and Repair

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Second Edition

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FOREWORD

Small Engine Service and Repair, Second Edition, is written in easy to follow "step-by-step" procedures. The instructor packet includes lesson plans with motivational techniques, transparency masters, unit tests, and eight student lab manuals. The student lab manuals are easy to read and include step-by-step procedures for Briggs and Stratton engines.

This material consists of eight modules containing twelve competency-based lessons. These lessons include:

- Installing Magnetron Ignition and Breaker Points
- Servicing a Composite Magnetron Ignition System
- Installing Retrofit Magnetron Ignition
- Servicing Breaker Point Ignition
- Identifying and Servicing Air Cleaners
- Identifying and Servicing the Fuel System
- Automatic Choke Operation
- Identifying and Servicing Starters
- Small Engine Compression
- Inspecting and Servicing a Valve Assembly
- Inspecting and Servicing Governor Systems
- Inspecting and Servicing the Lubrication System
- Troubleshooting Small Engines
- Maintaining Small Engines and Equipment

For many years those responsible for teaching small engine repair have needed basic, readable and usable materials. These materials can be used in all day classes and adult education programs. We hope these materials contribute to the quality of your program.

The author, Amon Herd, brings 25 years of teaching and repairing small engines.

ACKNOWLEDGMENTS

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SMALL ENGINE SERVICE AND REPAIR

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OBJECTIVES

MODULE 1--INSTALLING A MAGNETRON IGNITION AND BREAKER POINTS

1. After completion of this unit, the student should be able to identify ignition tools and their use and install a Composite Magnetron ignition system.

2. After completion of this unit, the student will be able to test and install a retrofit Magnetron.

3. After completion of this unit, the student should be able to identify special tools and ignition parts and properly install breaker points.

MODULE 2--CARBURETOR SERVICE AND REPAIR

1. After completion of this lesson, the student will be able to identify and service small engine air cleaners.

2. After completion of this unit, the student will be able to identify carburetor parts and service the fuel system.

3. After completion of this unit, the student will be able to explain the operation of the all-temperature and the standard automatic choke.

MODULE 3--REWIND STARTERS

1. After completing this unit, the student should be able to remove and replace a starter, replace a starter rewind spring, replace starter rope, service a starter clutch, and service a vertical pull starter.

MODULE 4--SMALL ENGINE COMPRESSION

1. After completion of this unit, the student should be able to identify tools and their appropriate use and inspect and service valves.

MODULE 5--GOVERNOR ADJUSTMENT AND REPAIR

1. After completion of this unit, the student should be able to inspect and service governor systems on small engines.

MODULE 6--LUBRICATING SMALL ENGINES

1. After completion of this unit, the student should be able to select the type and grade of oil to use in a four-cycle engine. The student should be able to properly inspect and service the lubrication system.

MODULE 7--TROUBLESHOOTING

1. After completion of this unit, the student should be able to troubleshoot the four basic engine systems: 1) Ignition System, 2) Spark Plug Condition, 3) Fuel System, and 4) Compression.

MODULE 8--OPERATION AND MAINTENANCE OF SMALL ENGINES

1. After completion of this unit, the student should be able to safely operate and maintain a small engine.

COMPETENCIES

MODULE 1--INSTALLING A MAGNETRON IGNITION AND BREAKER POINTS

1. Demonstrate the ability to install and test a Composite Magnetron Ignition System.
2. Demonstrate the ability to install and test a retrofit Magnetron ignition system.
3. Demonstrate the ability to install and test breaker point and condenser ignition system.

MODULE 2--CARBURETOR SERVICE AND REPAIR

1. Identify and service air cleaners.
2. Identify carburetor parts and service the fuel system.
3. Explain the operation and service of the all-temperature automatic choke.

MODULE 3--REWIND STARTERS

1. Demonstrate the ability to:
   a) Remove, disassemble, test, service, and reassemble a starter.
   b. Replace a starter rewind spring.
   c. Replace a starter rope.
   d. Service a starter clutch assembly.

MODULE 4--SMALL ENGINE COMPRESSION

1. The student should demonstrate the ability to identify and service worn valves.

MODULE 5--GOVERNOR ADJUSTMENT AND REPAIR

1. After completion of this unit, the student should be able to inspect and service governor systems on small engines.

MODULE 6--LUBRICATING SMALL ENGINES

1. After completion of this unit, the student should be able to select the type and grade of oil to use in a four-cycle engine. The student should be able to properly inspect and service the lubrication system.

MODULE 7--TROUBLESHOOTING

1. After completion of this unit, the student should be able to troubleshoot the four basic engine systems which are: 1) Ignition System, 2) Spark Plug Condition, 3) Fuel System, and 4) Compression.

MODULE 8--OPERATION AND MAINTENANCE OF SMALL ENGINES

1. After completion of this unit, the student should be able to safely operate and maintain a small engine.

REFERENCES AND MATERIALS

1. Student References

Step-by-Step Procedure Manuals (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994.

Module 1. Installing Magnetron Ignition and Breaker Points.
Module 2. Carburetor Service and Repair.
Module 3. Rewind Starters.
Module 4. Compression, Valve Service and Repair.
Module 5. Governors.
Module 6. Lubricating Small Engines.
Module 7. Troubleshooting Small Engines.
Module 8. Operation and Maintenance of Small Engines.

Briggs and Stratton. Service and Repair Instructions for Single Cylinder Four-Cycle Engines, Milwaukee, Wisconsin, 1990.

2. Teacher References

Roth, Alfred C. Small Gas Engines. South Holland, Illinois: Goodheart-Wilcox Company, Inc., 1992.

Small Engine Repair. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, 1985.

Small Engine Operation: Maintenance and Repair. Athens, Georgia: American Association for Vocational Instructional Materials, 1987.

Fuels and Lubricants. Athens, Georgia: American Association for Vocational Instructional Materials.

Briggs and Stratton. Service and Repair of Instructions for Single Cylinder Four-Cycle Engines. Milwaukee, Wisconsin, 1990.

Webster, Jay. Small Engines Operation and Service. Chicago, Illinois: American Technical Publishers.

MOTIVATIONAL TECHNIQUE OR INTEREST APPROACH

1. Invite your local small engine dealer to visit the class and display all of the new tools and test equipment to properly service small engines.
2. Arrange field trips to local small engine dealers.
3. Display samples of air cleaners.
4. Display a fuel tank contaminated with gum and varnish.
5. Display the three types of carburetors.
6. Ask students to assist you in collecting carburetors for class use.
7. Have students construct a carburetor cut-a-way for class presentation.
8. Illustrate the dangers of a starter spring.
9. Have students assist you in starter repair demonstrations.
10. Have students assist you in checking compression on small engines.
11. Demonstrate the proper procedures in removing valves.
12. Perform tests to determine if the valves are seating properly.
13. Demonstrate techniques in using Neway Valve Seat Cutter.
14. Demonstrate how to properly hand lap valves.
15. Demonstrate how the governor works by using a water faucet.
16. Invite a local oil company representative to speak to your class about oil additives and API Service Classification.
17. Ask a student to assist you in performing a spark test.
18. Demonstrate blade balancing.
19. Demonstrate the Brake Adjustment Gauge.
20. Demonstrate safety systems.

EVALUATION

1. Give short, objective tests following each lesson and a more in-depth objective test at the conclusion of the modules.

2. Observe the changes in behavior as evidence of an improved ability of students to deal with problems in these modules using background acquired from earlier modules.

Module 1: Installing a Magnetron Ignition and Breaker Points

Lesson 1: Servicing a Composite Magnetron Ignition System

Objective

After completion of this unit, you should be able to identify ignition installation tools and their use, and install a Composite Magnetron ignition system.

Study Questions

1. **What is the primary purpose of the ignition system?**

2. **What tools and supplies are needed to service a composite ignition system?**

3. **Are there any moving parts in a Magnetron ignition or capacitive discharge system?**

4. **What is the procedure for checking the Magnetron ignition system?**

5. **What is the proper procedure in installing a Composite Magnetron ignition system?**

6. **What are typical safety and housekeeping procedures when installing a Composite Magnetron ignition system?**

References

1. Briggs and Stratton. Service and Repair Instructions for Single Cylinder Four-Cycle Engines. Milwaukee, Wisconsin, 1990.

2. Herd, Amon. Installing Magnetron Ignition and Breaker Points. Columbia, Missouri: Instructional Materials Laboratory, University of Missouri-Columbia, 1994.

3. Roth, Alfred C. Small Gas Engines. South Holland, Illinois: Goodheart-Wilcox Company, Inc., 1992.

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Module 1: Installing Magnetron Ignition and Breaker Points

Lesson 1: Servicing a Composite Magnetron Ignition System

Teaching Procedures

A. Introduction

B. Motivation

Discuss the different types of electronic ignition systems. Observe the condition of defective armatures.

C. Assignment

D. Supervised Study

E. Discussion

1. Ask students to identify engines that they have at home with breaker points or solid state ignition. Display an engine with solid state ignition. Discuss its merits. Demonstrate how the ignition must provide a strong spark in the combustion chamber at the proper time for igniting the fuel-air mixture.

What is the primary purpose of the ignition system?

The purpose of the ignition system is to provide a strong spark in the combustion chamber at the proper time for igniting the fuel-air mixture. The spark must be "hot" enough to ignite the fuel-air mixture. If the spark is too weak, the fuel will not ignite. If the spark is too strong, the spark plug electrode will burn. The spark must take place at exactly the proper time.

2. Invite your local small engine dealer to visit the class and display the newest ignition system tools and test equipment. TM-1.1.

What tools and supplies are needed to service a composite ignition system?

Special tools and supplies needed include:
a) Flywheel holder.
b) Starter clutch wrench.
c) Flywheel puller.
d) Torque wrench.
e) Spark tester.
f) Composite Magnetron.

Note: These special tools are available from your local small engine dealer.

3. Discuss the two electronic ignition systems. Use charts and diagrams to illustrate systems. Invite your electronic or auto mechanics instructor to talk to your class. TM-1.1 and TM-1.2.

Are there any moving parts in a Magnetron ignition or capacitive discharge system?

No. The electronic components in a solid state system are extremely small. The only moving parts are the flywheel magnets. Electronic ignition is rapidly replacing the old breaker point system.

4. Have a student assist you in a spark test. Explain how a spark tester can be made.

What is the procedure for checking the Magnetron ignition system?

a) Spin the flywheel rapidly with one end of the ignition cable clipped to the tester and the other end of the tester grounded to the cylinder head. The spark should jump the tester gap if the system is functioning satisfactorily. You can also use a test plug to observe the spark (rotate the flywheel at a minimum of 350 R.P.M). The spark should be a bright blue color. This indicates the system is functioning satisfactorily.
b) Check for a defective ignition switch. The ignition switch is the most vulnerable part of a Magnetron ignition system. The switch must be kept dry and clean.
c) The Magnetron armature or capacitive discharge (CD) can be checked with task-specific test equipment. Most small engine shops have this electronic test equipment for checking armatures.

5. Ask two students to demonstrate to the class the installation of a Composite Magnetron ignition system. Invite questions. Have two assistants repeat the demonstration.

What is the proper procedure in installing a Composite Magnetron ignition system?

a) Wear proper safety equipment.
b) Read Briggs and Stratton Service and Repair Instructions.
c) Organize your work station.
d) Select proper tools and equipment.
e) Disconnect spark plug wire and remove spark plug.
f) Check Magnamatic ignition.

g) Remove tank assembly and blower housing.
h) Test Magnetron armature.
i) Remove flywheel and check key.
j) Remove Magnetron armature.
k) Route stop switch wire from the module to the kill switch.
l) Install flywheel and new key.
m) Torque flywheel to specification.
n) Attach flywheel screen.
o) Install new Magnetron ignition armature.
p) Set air gap.
q) Install blower housing.
r) Install tank assembly.
s) Test Magnetron ignition system.
t) Gap spark plug to .030 inch.
u) Clean work area and return tools and equipment to their proper places.

6. Issue shop safety rules and regulations. Discuss the importance of good housekeeping. The students should clean their work area and return tools and equipment to their proper places. Emphasize that equipment is expensive and student cooperation is important in caring for the tools and equipment.

What are typical safety and housekeeping procedures when installing a Composite Magnetron ignition system?

a) Assigned work areas.
b) Assigned tool check responsibility.
c) Assigned working partners.
d) Specific location for special tools.
e) Proper parts washer use.
f) Proper carburetor cleaner use.

The engines used in class should not be run. They are used to teach proper procedures in basic repair of small engines. After basic instruction an operational engine can be brought in and run.

F. Other Activities

1. Have students assist in collecting defective armatures.

2. Contact a local small engine dealer and explain your program.

3. Borrow new armatures from your small engine dealer for use in class.

4. Purchase the Magnetron Ignition Theory MS-7867 slide series from Briggs & Stratton Corporation, P.O. Box 702, Milwaukee, Wisconsin 53201, Attention: Education Department.

5. Invite retired small engine mechanics to assist in teaching the class.

6. Obtain a cutaway diagram of a spark plug.

7. Have students create a display of different spark plug types.

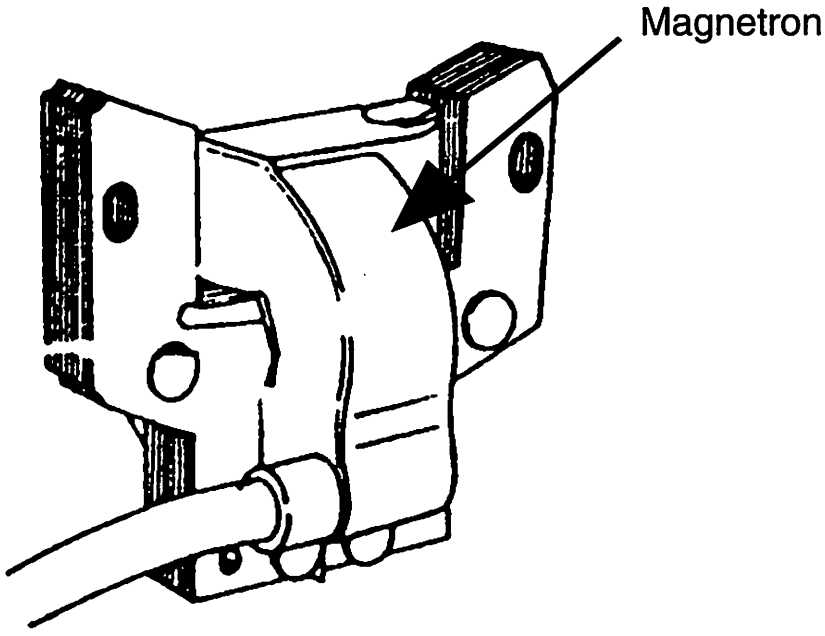
G. Conclusion

Until recently the breaker point and condenser system has been the only ignition system used in small engines. Electronic ignition is now common on all small engines. Electronic ignition is more efficient and trouble free.

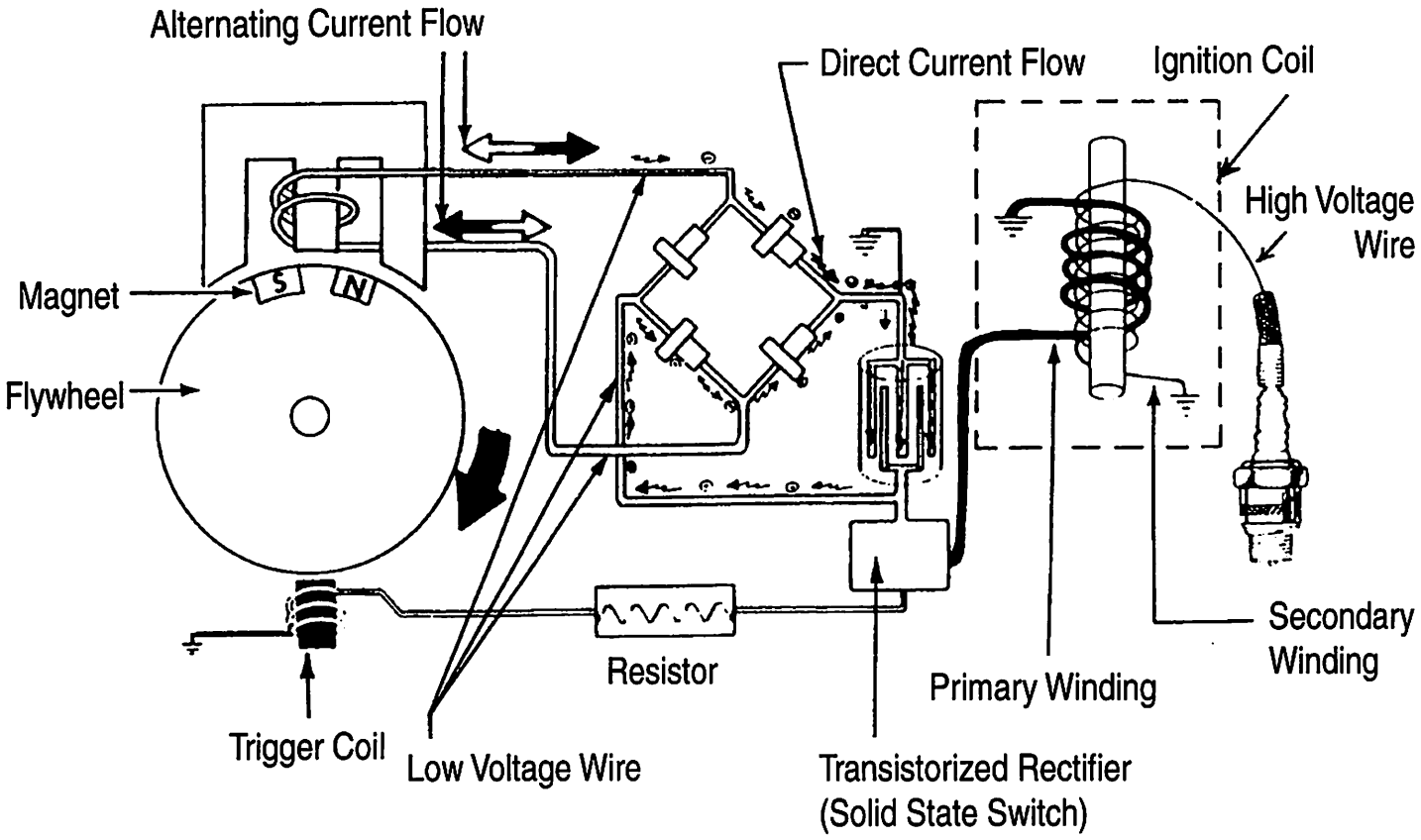
H. Competency

Demonstrate the ability to install and test a Composite Magnetron ignition system.

Composite Magnetron Armature



Solid State Ignition System



Module 1: Installing Magnetron Ignition and Breaker Points

Lesson 2: Installing a Retrofit Magnetron Ignition

Objective

After completion of this unit, you should be able to test and install a retrofit Magnetron.

Study Questions

1. **What are the three types of ignition systems?**

2. **What is the cost to convert from breaker points to retrofit Magnetron ignition?**

3. **When is it advisable to convert from breaker point ignition to electronic ignition?**

4. **What are the advantages of converting to electronic ignition?**

5. **What is the proper procedure to install a retrofit Magnetron?**

6. **What is the procedure for testing the Magnetron ignition?**

References

1. Herd, Amon. Installing Magnetron Ignition and Breaker Points. Columbia, Missouri: Instructional Materials Laboratory, University of Missouri-Columbia, 1994.

2. Briggs and Stratton. Service and Repair Instructions for Single Cylinder Four-Cycle Engines. Milwaukee, Wisconsin, 1990.

3. Roth, Alfred C. Small Gas Engines. South Holland, Illinois: Goodheart-Wilcox Company, Inc., 1992.

4. Small Engine Repair. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, 1985.

5. Small Engine Operation, Maintenance and Repair. Athens, Georgia: American Association for Vocational Instructional Materials, 1987.

6. Small Gasoline Engines, Operation, Repair and Maintenance. St. Paul, Minnesota: Hobar Publications, 1992.

Module 1: Installing a Magnetron Ignition and Breaker Points

Lesson 2: Installing a Retrofit Magnetron Ignition

Teaching Procedures

A. Introduction

B. Motivation

Display an engine that has oil in the ignition and no spark. Discuss the reasons why oil is in the ignition system. Display an armature that has been fitted with the retrofit Magnetron. Discuss the breakerless system.

C. Assignment

D. Supervised Study

E. Discussion

1. Pass out information explaining the different types of small engine ignition systems. Follow up with discussion.

   What are the three types of ignition systems?

   a) Magneto ignition system: Produces current by magnetic induction for the primary ignition circuit without any outside source of electricity.
   b) Battery ignition system: Uses a battery to supply the source of current for the primary circuit.
   c) Magneto ignition system without breaker points: A solid-state system is classified as:
      1) CDI (Capacitor Discharge Ignition).
      2) Traditional coil with solid-state trigger coil.
      3) Briggs and Stratton Magnetron.

2. Contact your small engine dealer for brochures on retrofit Magnetrons. Have students give a report to the class. TM-2.1.

   What is the cost to convert from breaker points to retrofit Magnetron ignition?

   The cost of the Magnetron Ignition Kit is $15.00 plus installation.

3. Display an engine with oil in the ignition. Discuss why and where the oil is coming from. Remove the points and breaker point plunger. Check breaker point plunger hole. The plug gauge should enter the plunger hole about 1/4 of an inch. TM-2.2.

When is it advisable to convert from breaker point ignition to electronic ignition?

When oil has entered the ignition chamber through the breaker plunger hole. Check the breaker point plunger hole. A worn plunger hole will cause oil to leak past the plunger and contaminate the breaker points causing them to burn.

Use Tool #19055 to check the plunger hole for wear. If the flat end of the plug gauge will enter the plunger hole 1/4 inch or more, the hole must be rebushed. When the breaker point plunger hole is worn beyond repair, install a Magnetron retrofit ignition instead of further rebushing the breaker point plunger hole.

4. Show the class burned or pitted points and explain how quickly the points can be damaged if not properly installed. Emphasize the advantage of converting to electronic ignition.

What are the advantages of converting to electronic ignition?

a) Inexpensive and easy to install.
b) No breaker points to burn, pit or replace.
c) Easy starting.
d) A flooded engine will start easily.
e) Spark plug life will be increased.
f) Electronic ignition is automatic and never needs adjusting.
g) The electronic unit is sealed and is not affected by dust, oil, dirt, or moisture.
h) The system will improve performance of the engine under adverse operations.

5. Have a student assist you in installing a retrofit Magnetron ignition. Always involve students in the demonstrations. Discuss the use of the Student Lab Manual. Have the students follow the Step-by-Step Procedures.

What is the proper procedure to install a retrofit Magnetron?

Use the following list of competencies to assist you in doing the demonstration.

a) Wear proper safety equipment.
b) Read Briggs and Stratton Repair Instructions.
c) Disconnect spark plug wire.
d) Remove blower housing, screen, starter clutch or nut, flywheel, and key.

e) Cut armature primary and stop switch wires as near as possible to the dust cover. (Note: Applies when leaving old ignition on the engine.)
f) Remove dust cover, breaker points, condenser, and plunger.
g) Plug the hole and place dust cover on the engine. (Applies when removing old ignition on the engine.)
h) Remove armature from engine.
i) Cut armature primary wire three inches from end. Then, strip insulation and clean wire.
j) Install the module on the armature.
k) Insert spring and wire clip into module.
l) Press spring and insert armature primary wire, stop switch wire and module primary wire.
m) Twist armature ground wire and module ground wires together (two turns) close to armature coil and solder.
n) Remove the shortest ground wire by cutting close to the soldered connection.
o) Cement wires to armature coil using Permatex No. 2 or a similar sealer.
p) Fasten armature to the cylinder attaching armature and module ground wire.
q) Route stop switch wire from the module to the kill switch.
r) Install flywheel and new key.
s) Torque flywheel to specification.
t) Set flywheel/armature air gap to specification.
u) Install screen, blower housing.
v) Install throttle and adjust.

6. Ask a student to perform the ignition test. Discuss the possibility of no spark or ignition. If spark occurs but the engine does not start, check for a sheared flywheel key. Demonstrate what happens when you shear a flywheel key.

What is the procedure for testing the Magnetron ignition?

a) Place equipment control switch in "Stop" position.
b) Pull the starter; there should be no spark.
c) Place the control switch in "Start" position.
d) Pull the starter; there should be a spark.
e) Remove spark tester and fasten wire to spark plug.
f) Start the engine.

F. Other Activities

1. Arrange for students to visit a small engine repair shop. Ask the owner to explain the operation.

2. Use Briggs & Stratton visual aids regarding retrofitting Magnetrons. Contact your small engine dealer for assistance.

3. Always involve your students in teaching assignments and demonstrations.

G. Conclusion

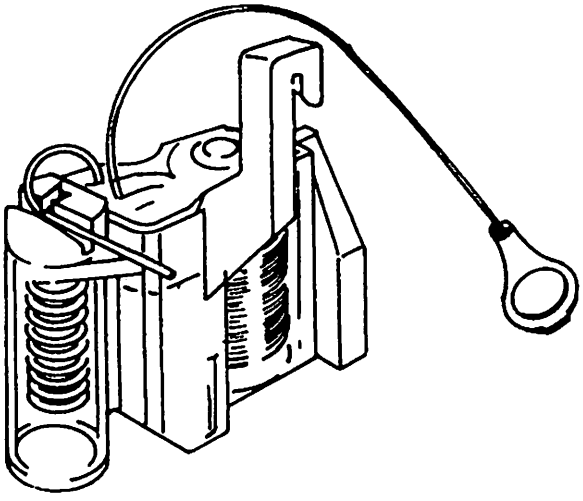
You can now restore your small engine ignition with a Magnetron conversion kit.

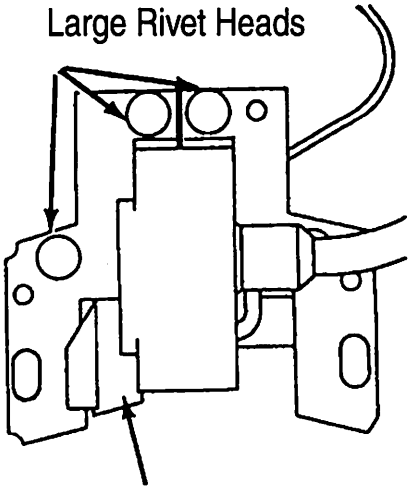
H. Competency

Demonstrate the ability to install and test a retrofit Magnetron ignition system.

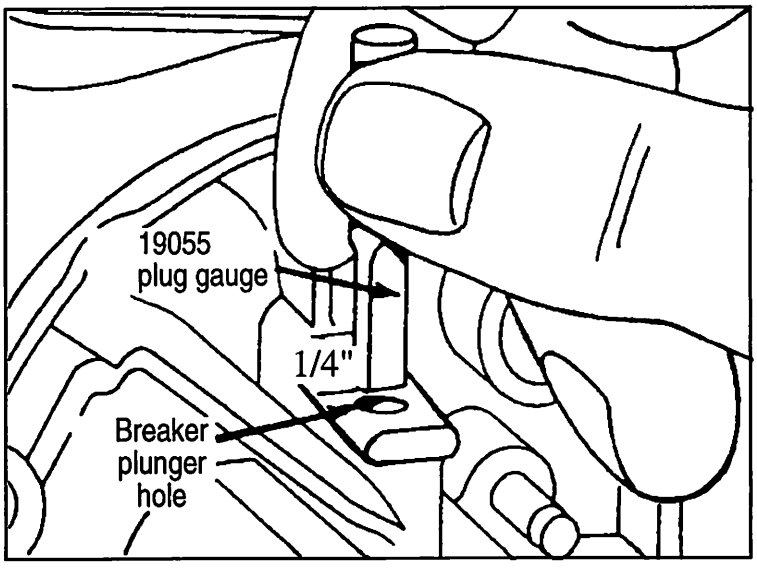
Magnetron Conversion Module

Module Assembly





Check Breaker Point Plunger Hole



Module 1: Installing Magnetron Ignition and Breaker Points

Lesson 3: Servicing Breaker Point Ignition

Objective

After completion of this unit, the student should be able to identify special tools and ignition parts and properly install breaker points.

Study Questions

1. **What are common terms used to describe the ignition parts of a small engine?**

2. **What special tools and materials are needed to properly service a breaker point ignition?**

3. **What is the proper procedure in servicing the spark plug?**

4. **What are the components of a magneto-ignition system?**

5. **What is the proper procedure in installing points and condenser?**

6. **What is the proper procedure for testing the coil, condenser, armature, and flywheel magnets?**

7. **What is the proper procedure for testing the ignition system?**

References

1. Briggs and Stratton. Service and Repair Instructions For Single Cylinder Four-Cycle Engines. Milwaukee, Wisconsin, 1990.

2. Herd, Amon. Installing Magnetron Ignition and Breaker Points. Columbia, Missouri: Instructional Materials Laboratory, University of Missouri-Columbia, 1994.

3. Roth, Alfred C. Small Gas Engines. South Holland, Illinois: Goodheart -Wilcox Company, Inc., 1992.

4. Small Engine Repair. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, 1985.

5. Small Engine Operation, Maintenance And Repair. Athens, Georgia: American Association for Vocational Instructional Materials, 1987.

6. Small Gasoline Engines, Operation, Repair and Maintenance. St. Paul, Minnesota: Hobar Publications, 1992.

Module 1: Installing a Magnetron Ignition and Breaker Points

Lesson 3: Servicing Breaker Point Ignition

Teaching Procedures

A. Introduction

B. Motivation

Perform a demonstration using an engine with no spark (the control switch has purposely been placed in the "kill" position). Move the switch to the "start" position and check the ignition. This is an example of what frequently happens to home owners.

C. Assignment

D. Supervised Study

E. Discussion

1. Have small engine ignition parts on display. Ask students to identify the parts and describe typical uses.

What are common terms used to describe the ignition parts of a small engine?

a) Breaker points: Two contact surfaces which are mechanically opened and closed to control the flow of electricity.
b) Coil: An electrical device (transformer) used to step up voltage for ignition. It has primary and secondary windings.
c) Condenser: A device for temporarily collecting and storing a surge of electrical current to be discharged at a specific time. The condenser acts the same as a capacitor to prevent the contact points from arcing.
d) Conductor: A material that allows electrical current to flow with little resistance.
e) Flywheel: A heavy wheel used to store energy and make the small engine run smoothly.
f) Ground: The contact point for the completion of the electric circuit. The frame of the engine serves as the negative point of the electric circuit.
g) High tension lead: A conductor wire going from the spark plug to the secondary windings of the coil. The wire carries high voltage and low amperage. The wire is well insulated to keep it from arcing.

h) Ignition system: An electrical system which provides a high-voltage spark to ignite the air-fuel mixture in the cylinder.
i) Armature: A device to "pick-up" a magnetic field from a moving magnet. Builds up a strong magnetic field within the coil.
j) Armature gap: A piece of hard steel that can be charged with magnetic power. Magnets are usually bent into "U" shape and have north and south poles.
k) Magneto-ignition system: A spark ignition system which receives its power from a magnet rotating near an armature. This system can be either solid-state or a breaker-point style.

2. Point out the advantage of having special tools. These inexpensive tools can make a job much easier. Ask a student to assist you in the use of the tools. Have a special tool price sheet and where they may be purchased.

What special tools and materials are needed to properly service a breaker point ignition?

a) Flywheel holder.
b) Flywheel puller.
c) Starter clutch wrench.
d) Ignition tester.
e) Torque wrench.
f) Condenser tool.

3. Discuss the importance of the spark plug. Prepare a display of defective spark plugs (combustion deposits, oil fouled, overheated and burned porcelain insulator tip, and cracked or broken insulator tip). Demonstrate a spark test.

What is the proper procedure in servicing the spark plug?

a) Remove spark plug and check its condition.
b) Remove oily deposits from the plug.
c) Clean threads with a wire brush.
d) Use a small knife to remove carbon deposits.
e) Blow loose particles from plug with compressed air. Note: Do not use abrasive cleaning machines to clean spark plugs.
f) Determine proper spark gap for your engine.
g) Use a round feeler gauge to regap the plug. Note: You should remove, inspect, clean and regap the spark plug after every 100 hours of operation. Always service the spark plug at the beginning of the season.

4. Discuss the type of ignition system you have on your small engine at home. Display damaged flywheels, enlarged key ways, broken

off fins, and damaged keys. Discuss the effects of burned or pitted points. TM-3.1.

What are the components of a magneto-ignition system?

a) Primary system (low voltage).
   1) Flywheel with magnets.
   2) Armature (laminated).
   3) Control switch.
   4) Coil.
   5) Contact points.
   6) Condenser.

b) Secondary system (high voltage).
   1) Spark plug.
   2) High voltage wire.

5. Demonstrate the proper techniques of installing points and condenser. Have all tools and the engine ready for class. Discuss the use of the Student Lab Manual and issue a copy to each class member. Have the students follow along as you do your demonstration. TM-3.2 and TM-3.3.

What is the proper procedure in installing points and condenser?

a) Disassembly of ignition system:
   1) Wear proper safety equipment.
   2) Read operator's manual.
   3) Service spark plug.
   4) Check engine for spark.
   5) Remove throttle cable from carburetor.
   6) Remove flywheel shroud.
   7) Remove flywheel screen from flywheel.
   8) Place flywheel holder securely on flywheel.
   9) Place starter clutch wrench securely on starter clutch.
   10) Remove starter clutch.
   11) Place flywheel puller on flywheel.
   12) Remove flywheel and key and inspect.
   13) Wrap flywheel in shop towel for protection.
   14) Remove breaker point dust cover.
   15) Remove old condenser.
   16) Install new condenser.
   17) Remove points.

b) Reassembly of ignition system:
   1) Install new contact points and spring.
   2) Install new condenser.
   3) Set points at .020.
   4) Clean points using lint-free paper.
   5) Place sealer around wiring and replace dust cover.

6) Place flywheel on crankshaft and install key.
7) Place starter clutch/nut on crankshaft and torque to specifications.
8) Check air gap.
9) Install flywheel screen.
10) Install shroud.
11) Install throttle cable and adjust.
12) Install spark plug and check the spark.
13) Test engine. (See your instructor.)

6. Magneto coils seldom create trouble in the ignition system. When an ignition system develops a problem, check the coil before you decide to replace it. Use an approved coil tester to demonstrate the coil power test (you can use the same test equipment in checking the condenser). A condenser that checks correctly when cold may not when heated. Do a magnet test on the flywheel.

What is the proper procedure for testing the coil, condenser, armature, and flywheel magnets?

a) Checking the magneto coil:
   1) Inspect the coil assembly.
   2) Look for cracks or breaks in the insulation and evidence of overheating.
   3) Make sure the electrical leads are good and not shorted out.

b) Checking the coil spark:
   1) Use an approved coil tester and follow manufacturer's specifications for the coil being tested.
   2) Replace the coil if it fails the test.

c) Checking the condenser:
   1) Remove and check condenser for capacitance (.10 to .30) micro farads, depending on your type of magneto. Your dealer can check this for you if you are not equipped to check the condenser.

d) Checking the flywheel magnets:
   1) Hold a screwdriver 1 to 2 inches from the magnet in the flywheel. The magnets should pull the screwdriver immediately to the magnets which indicates the magnets are good. Dropping the flywheel will jar the magnetism from the magnets. Do not store the flywheel near iron or steel.

e) Checking the armature:
   1) The purpose of the armature and its legs are to pick up and build up a magnetic field from the moving magnet. The armature is constructed of many thin layers of laminations. A small amount of oxide between laminations can prevent the eddy currents from traveling from one lamination to another. This

causes the coil to heat up and cause failure.
Demonstrate a coil with broken laminations.

7. Do an ignition test and observe the color of the spark.
Bright blue color indicates that the ignition system is functioning properly. Yellow color indicates that the ignition system needs to be serviced. No spark indicates that the spark does not jump the gap from the shell to enter electrode.
Note: When the engine will not run, check the ignition, carburetor, compression, and spark plug.

What is the proper procedure for testing the ignition system?

Use a test plug and rotate the flywheel a minimum of 350 RPM. Observe the spark. The spark should be a bright blue color and jump .166 on the tester gap.

F. Other Activities

1. Obtain additional information from:
Briggs & Stratton Corporation
P.O. Box 702
Milwaukee, Wisconsin
Attention: Education Department
Request a copy of their teaching aids and visuals.

2. Use your local resource people to assist you in teaching.

3. Purchase the slide series:
Electricity & Basic Electrical Terms
Magnetron Ignition Theory, Retrofitting Magnetrons
from Briggs & Stratton Corporation.

4. Show examples of the different types of ignition systems.

5. Show primary and secondary windings of a coil.

6. Prepare a test board with coils and condensers for student use.

7. Cut a coil and condenser to illustrate the makeup.

8. Ask a student to install breaker points and condenser before the class.

G. Conclusion

You now have the ability to install breaker points and a condenser on small engines.

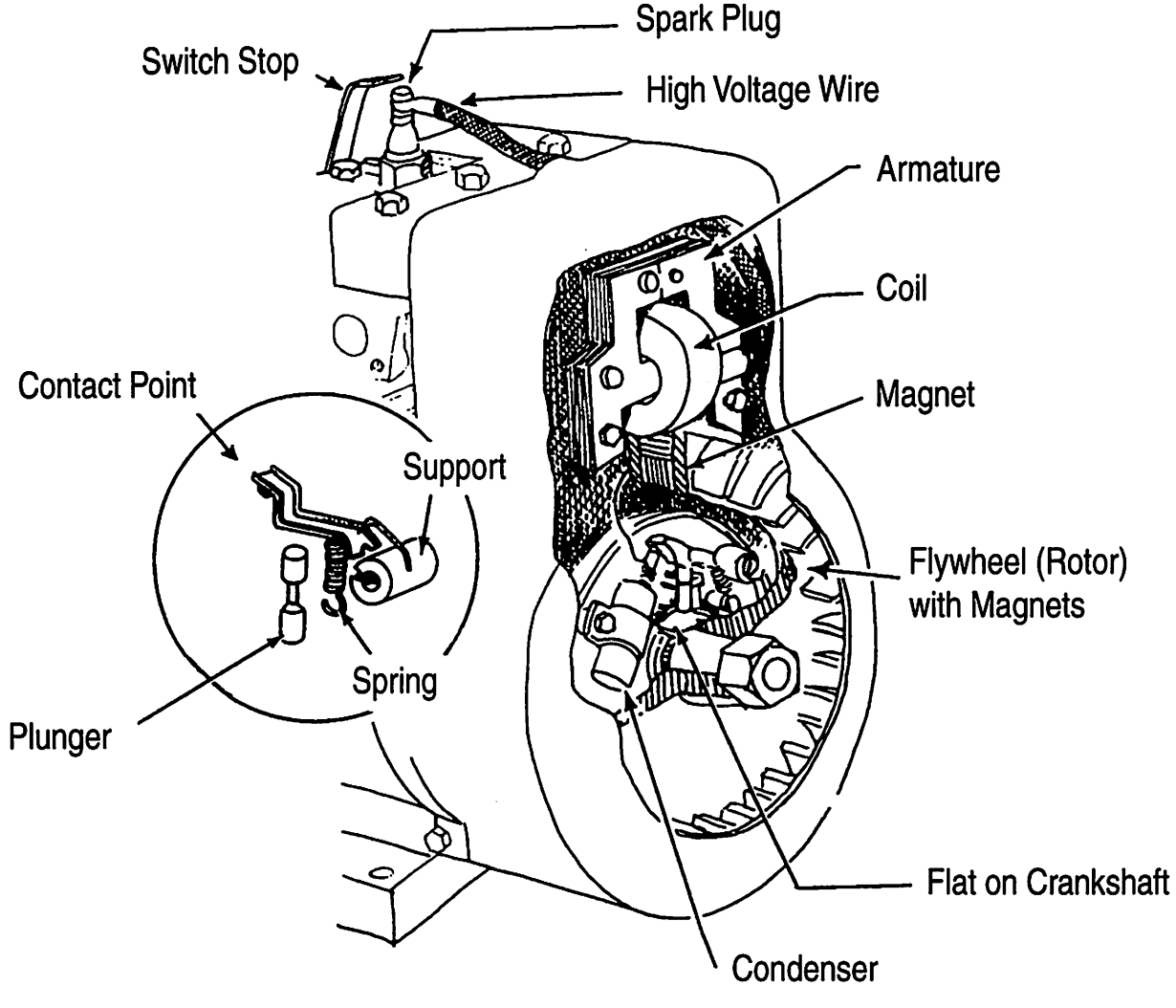
H. Competency

Demonstrate the ability to install and test a breaker point and condenser ignition system.

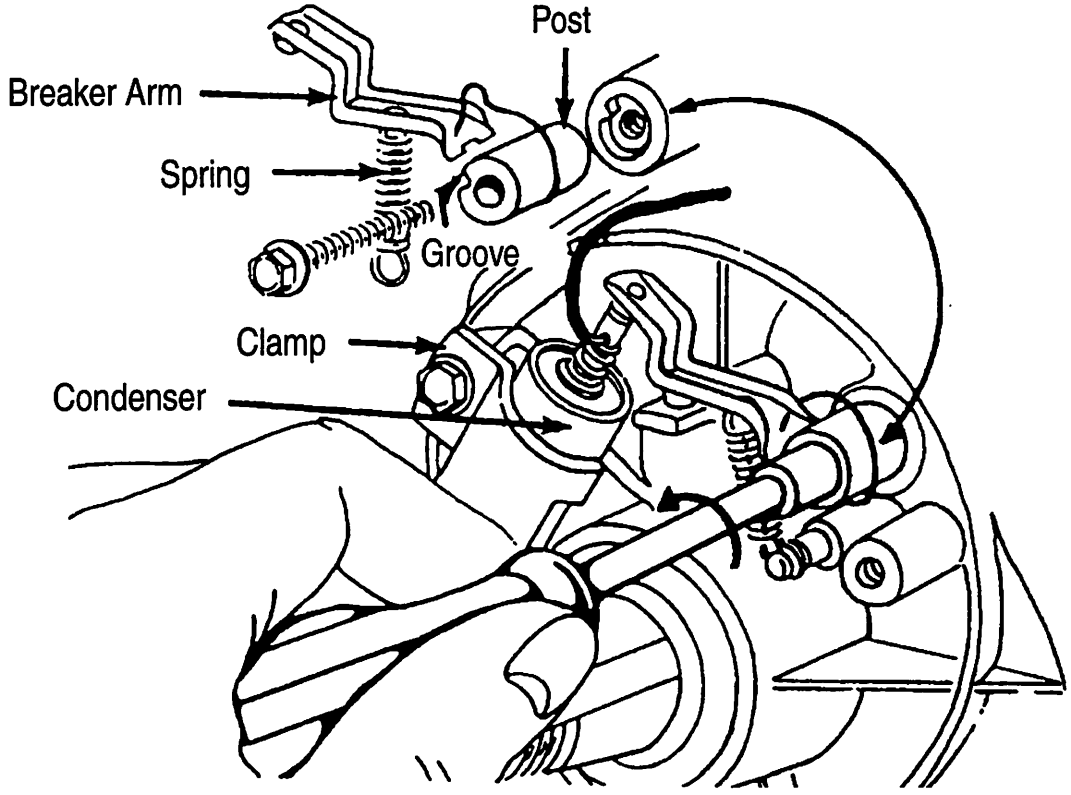
I. Answers to Evaluation

1. b
2. i
3. d
4. j
5. a
6. k
7. c
8. h
9. f
10. l
11. e
12. g
13. To provide strong spark in the combustion chamber at the proper time for igniting the fuel-air mixture.
14. b
15. d
16. a
17. c
18. When oil has entered into the ignition chamber through the breaker plunger hole.
19. Flywheel rotor
20. Armature
21. Stop switch
22. Coil
23. Contact point
24. Condenser
25. Spark plug
26. High voltage wire
27. Flywheel
28. Trigger coil
29. Resistor
30. Transistorized rectifier (solid state switch)
31. Diode rectifier
32. Ignition coil
33. Low voltage wire
34. Performance skills evaluated by the instructor.

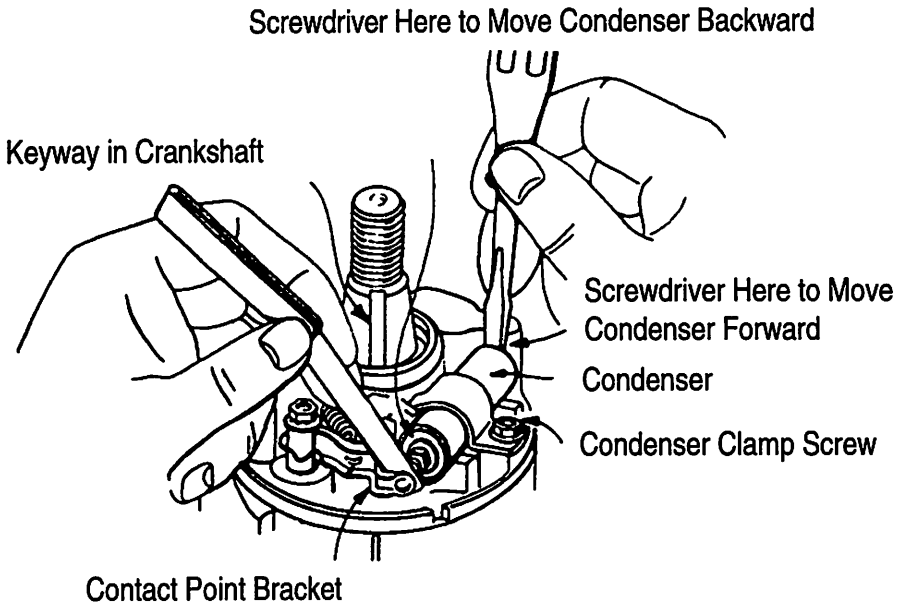
Magneto Ignition System



Removing Breaker Points and Condenser



How To Adjust Breaker Points



Module 1: Installing a Magnetron Ignition and Breaker Points

NAME_____

DATE _____

EVALUATION

Match the terms on the right with their correct definition.

____	1.	Breaker points	a. An electrical device used to step up voltage for ignition.
____	2.	Condenser	b. Two contact surfaces that are mechanically opened and closed to control the flow electricity.
____	3.	High tension lead	c. A heavy wheel used to store energy and make the small engine run smooth.
____	4.	Ground	d. A conductor wire going from the spark plug to the secondary windings of the coil.
____	5.	Coil	e. A piece of hard steel that can be charged with magnetic power.
____	6.	Conductor	e. An electrical system that provides a high-voltage spark to ignite the air-fuel mixture in the cylinder.
____	7.	Flywheel	g. Space between the armature and the flywheel magnets.
____	8.	Magneto-ignition	h. A spark ignition system which receives its power from a magnet rotating near an armature.
____	9.	Ignition system	i. A device for temporarily collecting and storing a surge of electrical current to be discharged at a certain time.
____	10.	Armature	j. The contact point for the completion of the electric circuit.
____	11.	Magnet	k. A material that allows current to flow with slight resistance.
____	l2.	Armature gap	l. A device to pick up a magnetic field from a moving magnet.

Answer the following question.

13. State the primary purpose of the ignition system.

Match the types of ignition systems at right with their correct descriptions.

____ 14. Produces current by magnetic induction for the primary circuit without any outside source of electricity.

____ 15. A system using semi-conductors in place of one or more standard ignition components.

____ 16. Uses a battery to supply a source of current for the primary ignition circuit.

____ 17. Uses electronic parts in place of mechanically-operated ignition points.

a. Battery ignition system

b. Magneto-ignition system

c. Breakerless ignition

d. Solid state ignition system

Answer the following question.

18. When is it advisable to convert from breaker point ignition to electronic ignition?

Identify the components of a magneto-ignition system.

_____ 19.

_____ 20.

_____ 21.

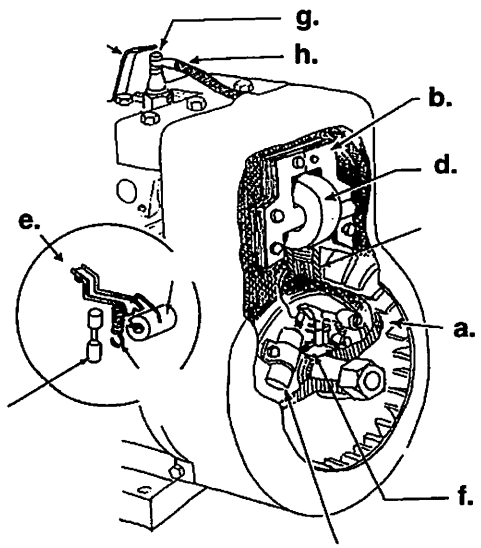
_____ 22.

_____ 23.

_____ 24.

_____ 25.

_____ 26.



Identify the components of a solid state ignition system.

_____ 27.

_____ 28.

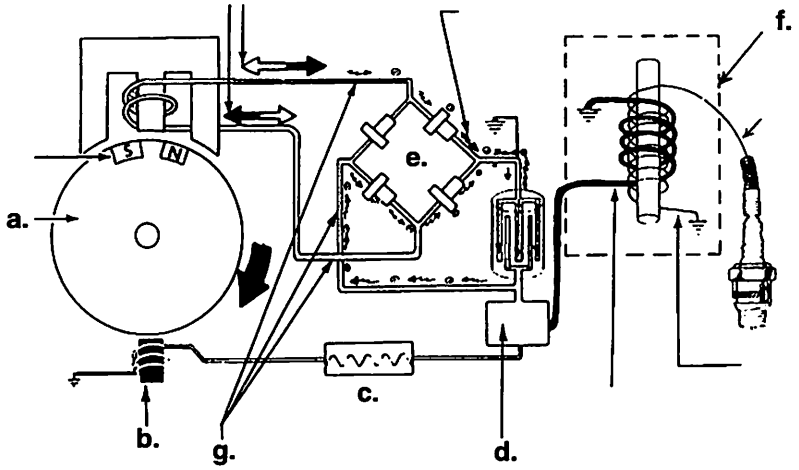
_____ 29.

_____ 30.

_____ 31.

_____ 32.

_____ 33.



Demonstrate the ability to:

34. Remove, service and replace spark plugs (Student Lab Manual).
35. Remove and replace contact points and condenser (Student Lab Manual).
36. Test the coil, condenser, armature, and flywheel magnets.
37. Test and adjust a solid state ignition system.
38. Perform a coil power test.
39. Test a condenser for leakage or short.

Note: Performance skills will be evaluated by the instructor.

Module 2: Carburetor Service and Repair

Lesson 1: Identifying and Servicing Air Cleaners

Objective

After completion of this lesson, you should be able to identify and service small engine air cleaners.

Study Questions

1. **What is the purpose of an air cleaner?**

2. **When should an air cleaner be serviced?**

3. **What are the three types of air cleaners used on small engines?**

4. **What tools and materials are needed to service air cleaners?**

5. **What is the proper procedure in servicing an oil-foam air cleaner?**

6. **What is the proper procedure in servicing the dry-filter type air cleaner?**

7. **What is the proper procedure in servicing a dual-element air cleaner?**

References

1. Briggs and Stratton. Service and Repair Instructions for Single Cylinder Four-Cycle Engines. Milwaukee, Wisconsin, 1990.

2. Herd, Amon. Carburetor Service and Repair. Columbia, Missouri: Instructional Materials Laboratory, University of Missouri-Columbia, 1994.

3. Roth, Alfred C. Small Gas Engines. South Holland, Illinois: Goodheart-Wilcox Company, Inc., 1992.

4. Small Engine Repair. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, 1985.

5. Small Engine Operation, Maintenance and Repair. Athens Georgia: American Association for Vocational Instructional Materials, 1987.

6. Small Gasoline Engine Operation, Repair and Maintenance. St. Paul, Minnesota: Hobar Publications, 1992.

Module 2: Carburetor Service and Repair

Lesson 1: Identifying and Servicing Air Cleaners

Teaching Procedures

A. Introduction

B. Motivation

Show an air cleaner in need of service. Discuss the importance of properly servicing air cleaners. Show an air cleaner that has been properly serviced.

C. Assignment

D. Supervised Study

E. Discussion

1. Ask the class how many different kinds of air cleaners are used on personal lawn mowers, tillers, chain saws, and weed trimmers.

What is the purpose of an air cleaner?

Air cleaners protect the internal parts of the engine from dust in the air.

2. Show an oil-foam air cleaner that does not properly fit. Explain how this effects the life of an engine.

When should an air cleaner be serviced?

Clean and re-oil the air cleaner element every 25 hours or at three month intervals under normal conditions. Clean and re-oil the foam pre-cleaner every 25 hours or at three month intervals, whichever occurs first. Air cleaners should be cleaned more frequently under extremely dusty conditions.

Dirt and oil form an abrasive mixture which wears moving parts instead of protecting them. To be safe, inspect the air cleaner at least once each day or before each use.

When continuously operating a chain saw, carry an extra filter for quick replacement. The operator should clean this air cleaner at least 2 to 3 times each day under continuous use.

3. Show TM-1.1. Explain the purpose of the foam pre-cleaner. Discuss the effectiveness of the paper filter element. Pass samples around the class.

What are the three types of air cleaners used on small engines?

a) Polyurethane air cleaner (oil-foam).
b) Dry-filter air cleaner cartridge (round and flat).
c) Dual-element air cleaner.

4. Demonstrate the use of a tool and supply caddy. These tool carriers save time by keeping tools and materials at your finger tips. Have students highlight appropriate tools and supplies listed in their lab manual.

What tools and materials are needed to service air cleaners?

a) Supplies:
   1) Filter.
   2) Petroleum solvent (mineral spirits).
   3) Detergent.
   4) Clean rags.
   5) Oil (crankcase) or special lubricant.

b) Tools:
   1) Slot-head screwdrivers (4" and 6").
   2) Phillips-head screwdrivers (4" and 6").
   3) Container for washing parts.
   4) Wooden scraper.
   5) Paint brush.
   6) Pliers (6").

5. Display samples of air cleaners. Have students review steps of procedure in their lab manuals as you demonstrate the proper procedure in servicing an oil-foam air cleaner. TM-1.2.

What is the proper procedure in servicing an oil-foam air cleaner?

a) Clean the filter element using a liquid detergent and hot water to remove grease and dirt.
b) Wrap the foam element in cloth and squeeze dry.
c) Dry the filter element by using compressed air.
d) Saturate the filter element with engine oil.
e) Squeeze to remove excess oil. Make sure the oil is evenly distributed.
f) Replace polyurethane filters which have become brittle with age.

6. Demonstrate the method of using a light source to quickly detect the amount of dirt in a filter. Have students review the steps of procedure in their lab manual as you demonstrate the following steps.

What is the proper procedure in servicing the dry-filter type air?

There are several types of dry-filter elements. Each uses a variation of a common cleaning method.

a) Dry-filter air cleaner cartridge:
   1) Clean the cartridge by tapping gently on a flat surface. If very dirty, wash filter in a non-sudsing detergent solution.
   2) Rinse thoroughly from inside the filter (sending dirt to the outside) until water is clear.
   3) Allow cartridge to dry thoroughly before using.

b) Cartridge air cleaner reverse air flow:
   1) Clean cartridge by tapping gently on flat surface. If very dirty, wash filter in a non-sudsing detergent solution.
   2) Rinse thoroughly from outside the filter toward the inside until water is clear.
   3) Allow cartridge to dry thoroughly before using.

c) Flat cartridge air cleaner:
   1) Clean cartridge by tapping gently on a flat surface. If very dirty, replace cartridge and pre-cleaner.
   2) Wash cartridge and pre-cleaner in a non-sudsing detergent and warm water solution. Rinse thoroughly with flowing water from mesh side until water is clear.
   3) Wrap foam pre-cleaner in a cloth and squeeze dry.
   4) Saturate foam pre-cleaner in engine oil.
   5) Squeeze to remove excess oil.
   6) Allow cartridge to dry thoroughly before using.

7. Display air cleaner elements with and without a pre-cleaner. Discuss the advantages of the pre-cleaner.

What is the proper procedure in servicing a dual-element air cleaner?

Service pre-cleaner, if so equipped, every 25 hours or every season, whichever occurs first. Service cartridge every 100 hours or every season, whichever occurs first, if equipped with pre-cleaner. Service cartridge every 25 hours or every season,

whichever occurs first, if not equipped with a pre-cleaner. Service more often under dusty conditions.

Have students review the steps of procedure in their lab manual as you demonstrate the following steps:

a) Loosen screws and tilt cover.
b) Carefully remove foam pre-cleaner when so equipped.

F. Other Activities

1. Visit a small engine shop in the community.

2. Invite local resource people to speak to your class.

3. Obtain additional materials on a loan basis from your local supplier.

G. Conclusion

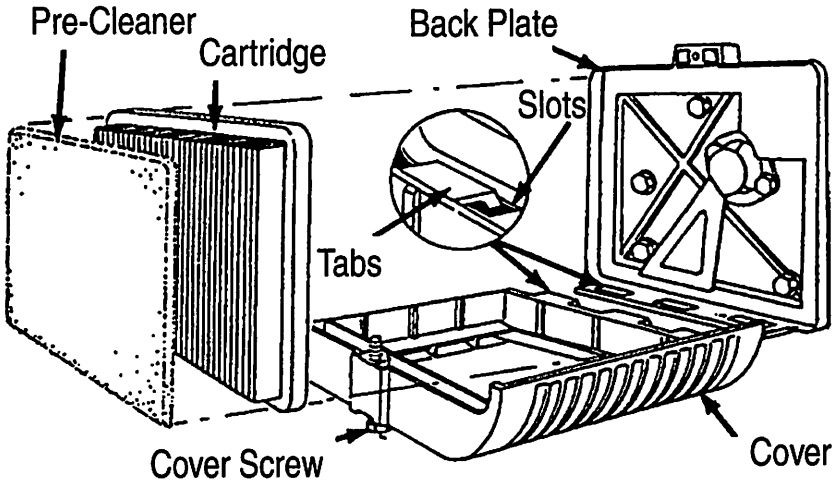
Have each student clean each type of air filter system.

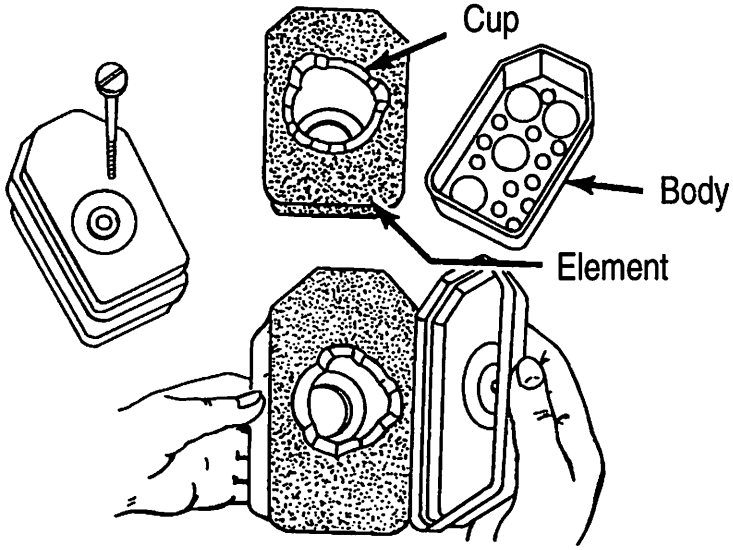
H. Competency

Identify and service air cleaners.

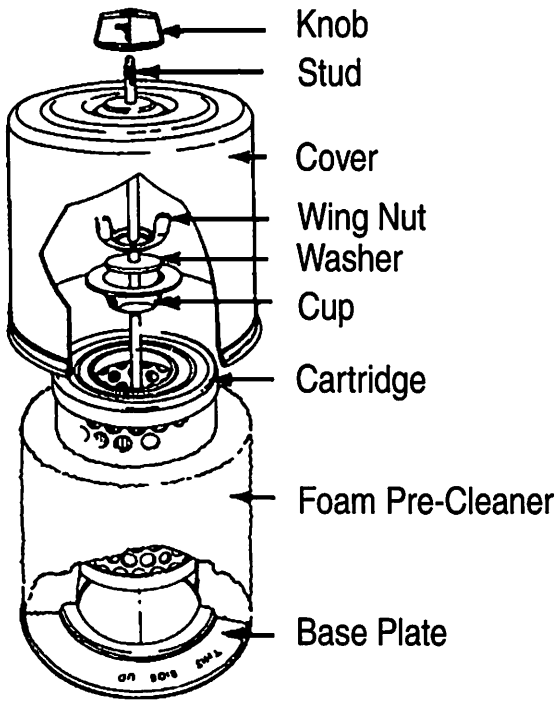
Types of Air Cleaners

Dry-Filter Air Cleaner (Cartridge)



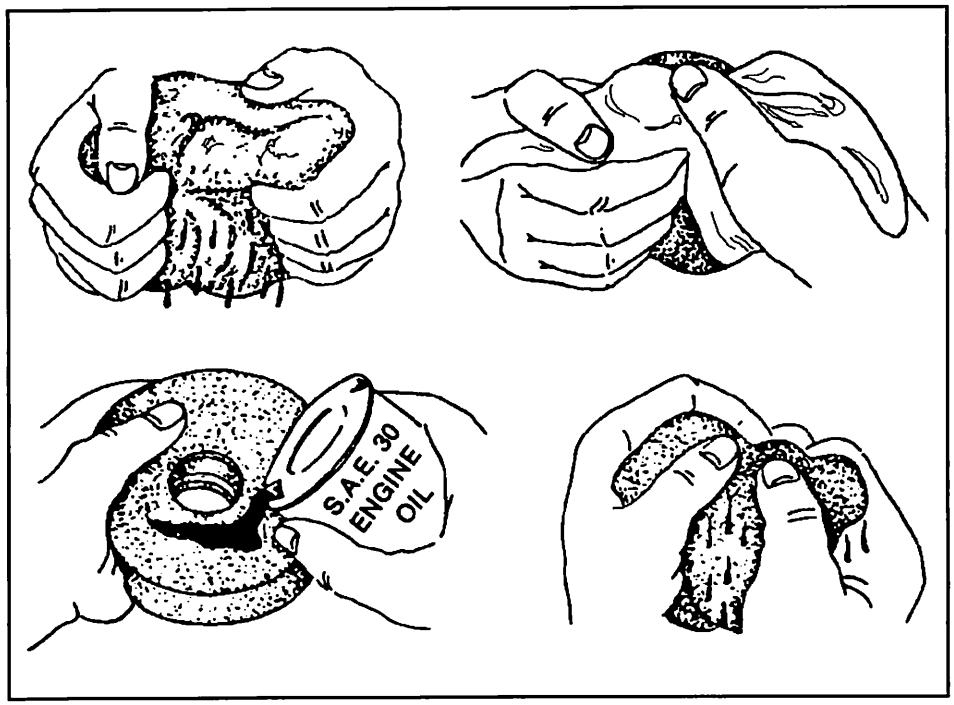


Polyurethane Air Cleaner (Oil-Foam)



Dual Element Air Cleaner

Cleaning and Servicing a Foam Air Cleaner



Module 2: Carburetor Service and Repair

Lesson 2: Identifying and Servicing Parts of a Fuel System

Objective

After completion of this lesson, you should be able to identify carburetor parts and service the fuel system.

Study Questions

1. **What are the common terms that describe carburetors and fuel systems.**
2. **What is the purpose of the fuel system?**
3. **What are the three types of fuel systems used on small engines?**
4. **What are the three types of carburetors?**
5. **What types of fuel filters are used on small engines?**
6. **What are the parts of a float-type carburetor?**
7. **What are the parts of the diaphragm-type carburetor?**
8. **What is the proper procedure in servicing a float-type carburetor?**
9. **What is the proper procedure in servicing a diaphragm carburetor?**

References

1. Briggs and Stratton. Service and Repair Instructions for Single Cylinder Four-Cycle Engines. Milwaukee, Wisconsin, 1990.
2. Herd, Amon. Carburetor Service and Repair. Columbia, Missouri: Instructional Materials Laboratory, University of Missouri-Columbia, 1994.
3. Roth, Alfred C. Small Gas Engines. South Holland, Illinois: Goodheart-Wilcox Company, Inc., 1992.
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5. Small Engines Operation, Maintenance and Repair. Athens, Georgia: American Association for Vocational Instructional Materials, 1987.

6. Small Gasoline Engines, Operation, Repair and Maintenance. St. Paul, Minnesota: Hobar Publications, 1992.

Module 2: Carburetor Service and Repair

Lesson 2: Identifying and Servicing Parts of a Fuel System

Teaching Procedures

A. Introduction

B. Motivation

Show a fuel tank clogged with gum and varnish. Discuss fuel additives which prevent this build up. Demonstrate effects of a clogged fuel filter. Discuss the importance of properly servicing fuel filters. Demonstrate the two types of carburetors.

C. Assignment

D. Supervised Study

E. Discussion

1. Use a cutaway carburetor to illustrate the parts of the carburetor. Demonstrate the types of fuel tanks and fuel filters.

   What are the common terms that describe carburetors and fuel systems.

   a) Venturi: The restriction in the carburetor air horn that produces the vacuum responsible for the movement of gasoline into the passing air.
   b) Airfoil: The tube in a stream of air inside the venturi which creates an air pattern with low pressure on one side.
   c) Atomize: The break up of a liquid into minute particles such as a fine spray.
   d) Metering: The correct proportion of fuel and air needed for good combustion.
   e) Vaporization: The process that changes a liquid into a gaseous state.
   f) Fuel tank: A reservoir to store fuel for engine use.
   g) Fuel filter: The device that prevents dirt or foreign matter from entering the carburetor.
   h) Fuel line: The tube that carries fuel from the fuel tank to the carburetor.

2. Show the importance of the carburetor in supplying fuel to the combustion chamber of the engine.

What is the purpose of the fuel system?

The fuel system supplies a combustible mixture of air and fuel vapor to the engine cylinder.

3. Show each type of fuel system. Contrast and compare the types using TM-2.1. Discuss the advantages and disadvantages of each type.

What are the three types of fuel systems used on small engines?

a) Suction feed.
b) Pump feed.
c) Gravity feed.

4. Display the three types of carburetors. Ask students what types of carburetors are used on lawn mowers, tillers and chain saws.

What are the three types of carburetors?

a) Float.
b) Diaphragm.
c) Suction.

5. Show each type of fuel filter. Compare and contrast the types using TM-2.2. Discuss the advantages and disadvantages of each type.

What types of fuel filters are used on small engines?

a) In-line filter.
b) Filter attached to the end of flexible fuel hose (in-tank) used on chain saws and weed trimmers.
c) Screen in fuel tank.
d) Glass or metal sediment bowl and screen.

6. Show the students a float-type carburetor. TM-2.3. Ask the student if a float level can be adjusted. Discuss what happens when the carburetor floods.

What are the parts of a float-type carburetor?

a) Float needle and seat.
b) Fuel inlet.
c) Nozzle.
d) Packing nut.
e) Needle valve.
f) Float.
g) Throttle valve.

h) Idle valve.
i) Venturi.
j) Choke valve.

7. Show a ruptured diaphragm to the class. Illustrate why no pumping action takes place with a ruptured diaphragm. TM-2.4.

What are the parts of the diaphragm-type carburetor?

a) Diaphragm.
b) Spring and cap.
c) Fuel pipes.
d) Pump cover.
e) Choke.
f) Idle adjusting screw.
g) Speed adjusting screw.
h) Needle valve.

8. Demonstrate procedures in servicing a float-type carburetor. Have students review the steps of procedure in their lab manual as you demonstrate the procedures. TM-2.5.

What is the proper procedure in servicing a float-type carburetor?

a) The float-type carburetor is made in two basic types: fixed high-speed main jet and the adjustable high-speed main jet.
b) Clean and inspect carburetor. After cleaning, inspect for any wear, damage, cracks, or plugged openings. Use only compressed air to clear plugged openings.
c) Always remove all nylon or rubber parts before the carburetor is soaked in a solvent.
d) Float height is not adjustable.
e) Initial adjustment: Turn idle speed screw until it just bottoms. Then, back off 1 1/4 turns. Turn idle mixture screw until it just bottoms, then, back off 1 1/4 turns. This setting will permit the engine to start.
f) On carburetors with a adjustable high-speed needle, turn high-speed adjustment clockwise until it just touches the needle seat, then back off 1 1/4 turn.
g) Run engine for five minutes. Make final adjustments for smooth operation.

9. Have students review the steps of procedure in their lab manual as you demonstrate the procedures in servicing a diaphragm carburetor.

What is the proper procedure in servicing a diaphragm carburetor?

a) To remove the carburetor and tank assembly, first disconnect the governor link at the throttle, leaving the governor link and governor spring hooked to the governor blade and control lever.
b) Remove the carburetor from tank.
c) Remove nylon and rubber parts if carburetor is to be soaked in solvent.
d) Remove and check O-ring.
e) Remove and inspect needle valve, packing and seat.
f) Metering holes in carburetor body should be cleaned with solvent and compressed air. Do not alter size of the holes.
g) Remove nylon choke and shaft. Pull nylon choke shaft sideways to separate choke shaft from choke valve. Check model series.
h) Check nylon fuel pipes. Do not remove if pipes and screen are clean. Use socket wrench to remove and replace fuel pipes. Nylon fuel pipes are threaded so no sealer is required.
i) Inspect the pulsa-jet diaphragm for punctures, wrinkles and wear since it serves as a gasket.
j) Assemble the carburetor to the tank by first positioning diaphragm on tank.
k) Place spring cap and spring on diaphragm.
l) Install carburetor and tighten mounting screws evenly to avoid distortion.
m) Install air cleaner and air cleaner stud on the engine before making carburetor adjustments. Tank should be half full of gasoline.
n) Initial adjustment: Turn needle valve clockwise to close it. Then open 1 1/2 turns.
o) Final adjustment: Start engine and warm up. With engine running at normal operating speed (no load), turn the needle valve clockwise until engine starts to lose speed (lean mixture).
p) Then, slowly turn needle valve counter-clockwise past the point of smoothest operation, until engine just begins to run unevenly. This mixture will give best performance under load.
q) Idle position: Turn idle-speed adjusting screw to 1750 R.P.M.
r) Test engine under full load. The mixture is too lean if engine stalls or dies.

F. Other Activities

1. Contact your local small engine dealer and explain your program. Invite her or him to visit your class.

2. Have students assist you in collecting carburetors for class use. Have students construct a carburetor cut-a-way for class instruction.

3. Invite retired small engine mechanics to be a part of your class.

4. Contact Briggs and Stratton for the latest teaching aids.

5. Assist students in evaluation of this lesson and identify possible areas for improvement.

G. Conclusion

Have the students service the fuel system on their small engine. Check yes on the performance checklist as the students successfully complete these steps.

___ Fuel Supply Systems.

___ Fuel Filters.

___ Parts of a Float Carburetor.

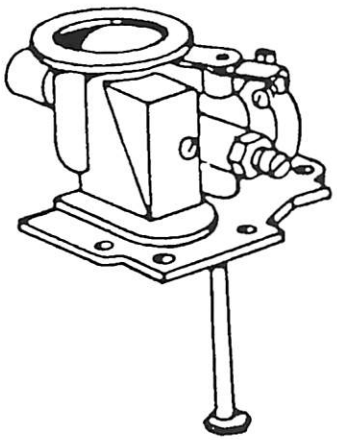
___ Parts of a Diaphragm Carburetor.

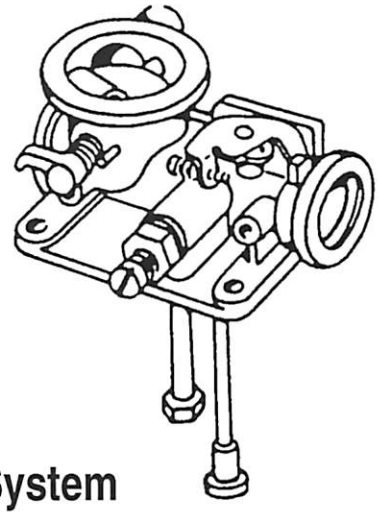
___ The Float System.

H. Competency

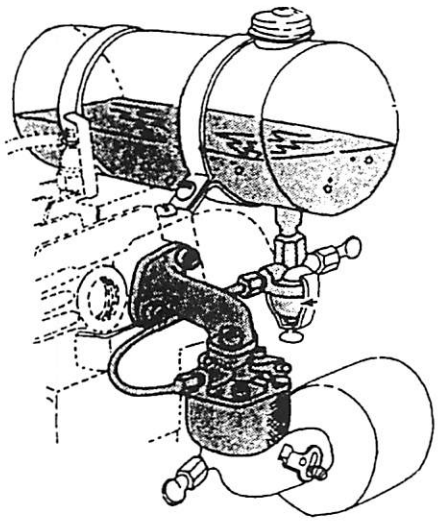
Identify carburetor parts and service the fuel system.

Fuel Supply Systems

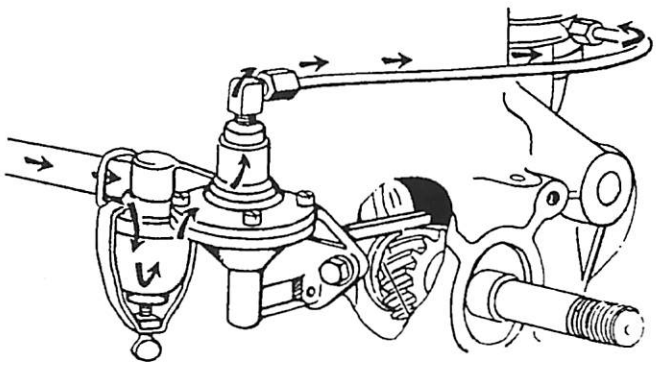




Suction Feed System

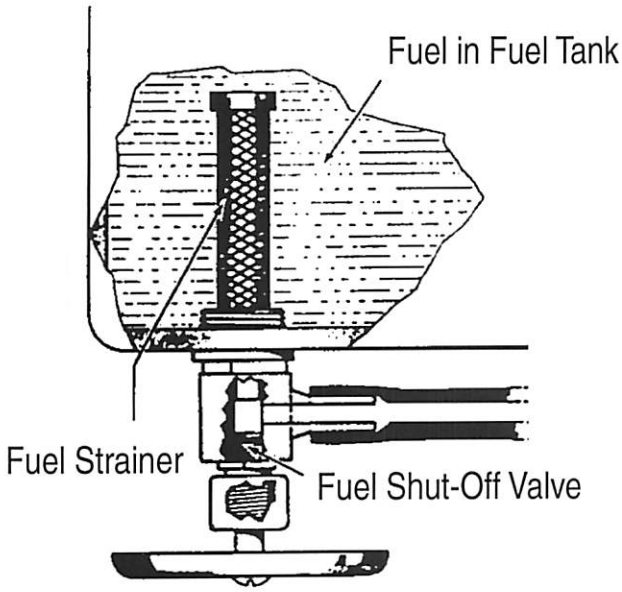


Gravity Feed System

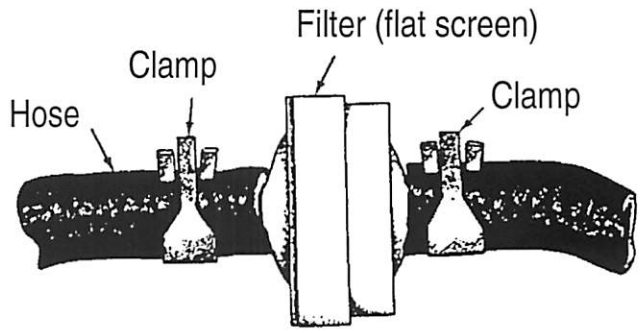


Pump Feed System

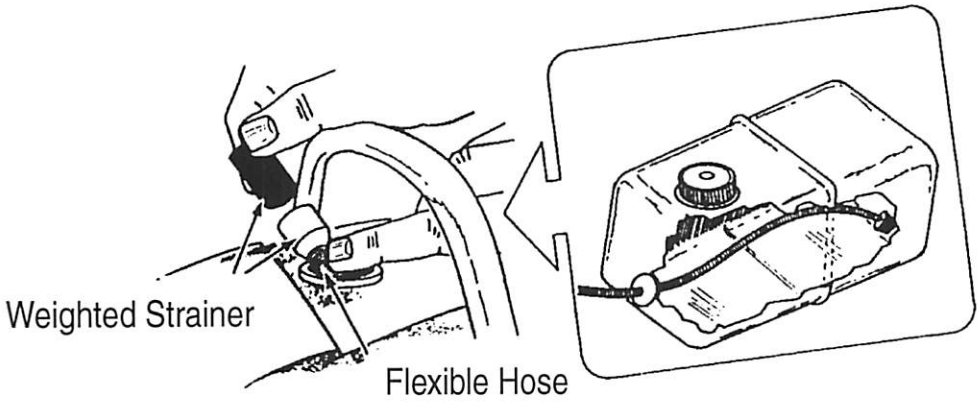
Fuel Filters



Fuel Filter - Screen in tank

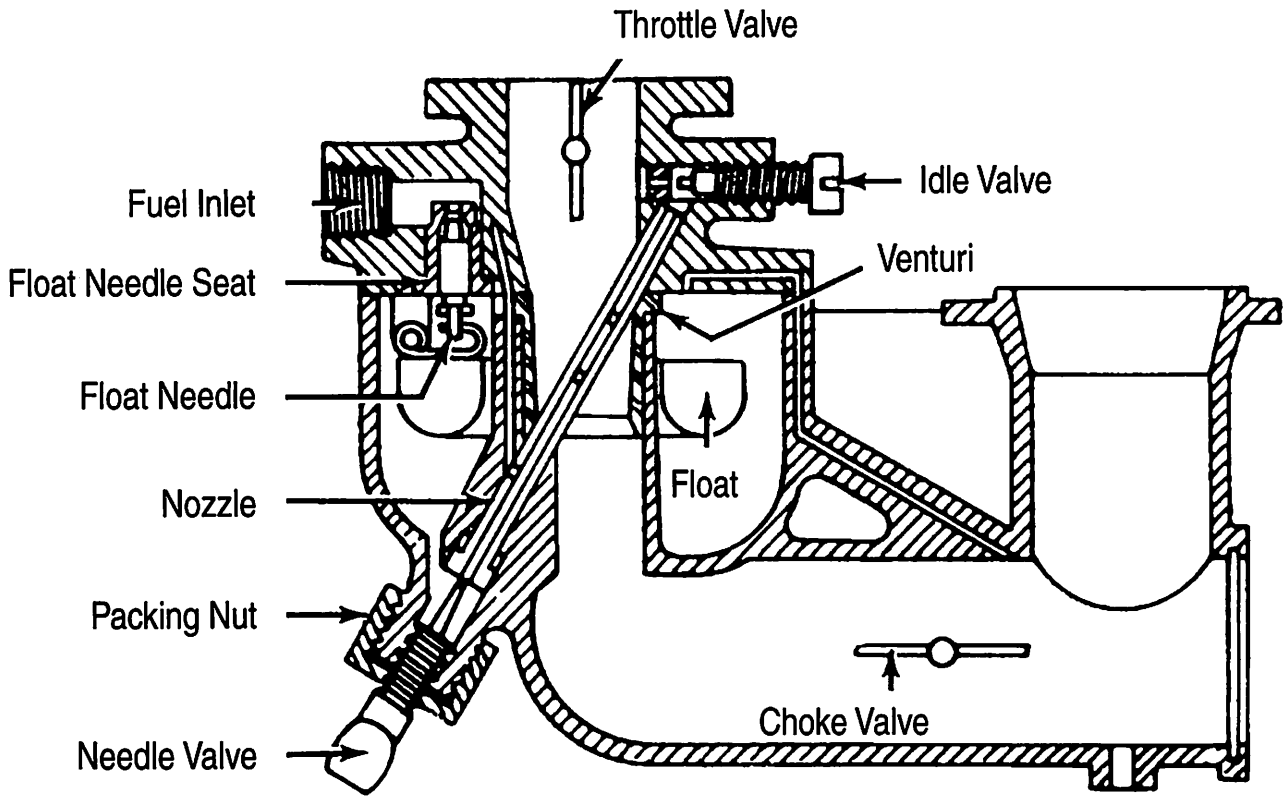


Fuel Filter - In-Line

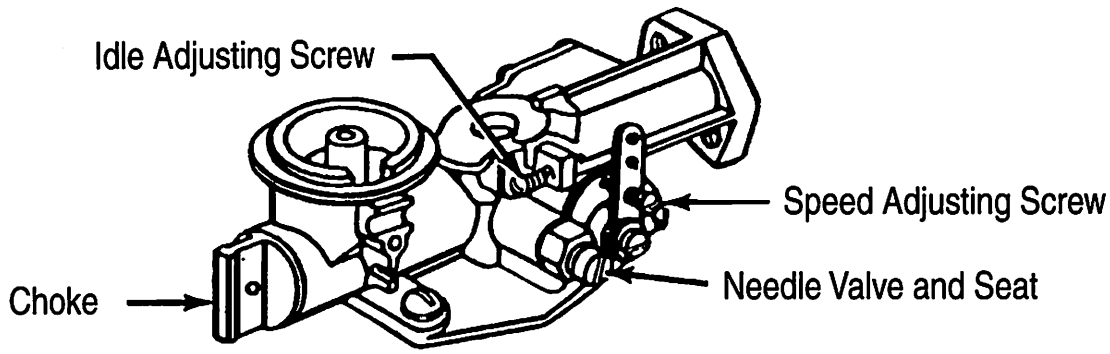


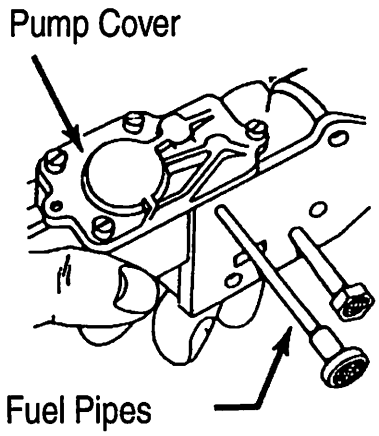
Fuel Filter - Attached to end of flexible hose

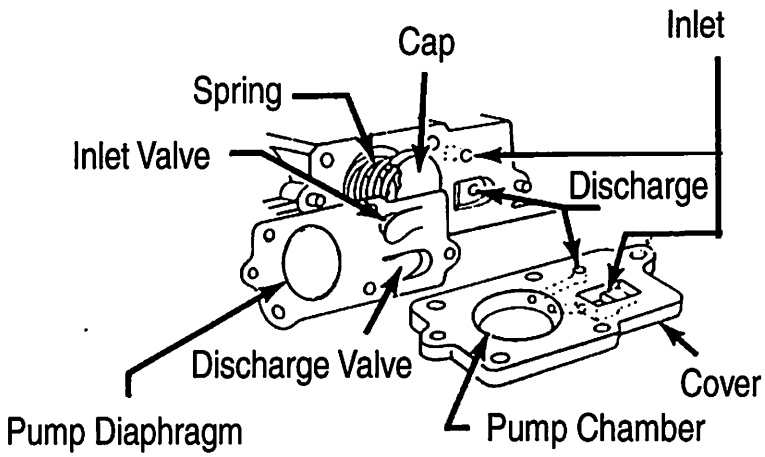
Parts of a Float Carburetor



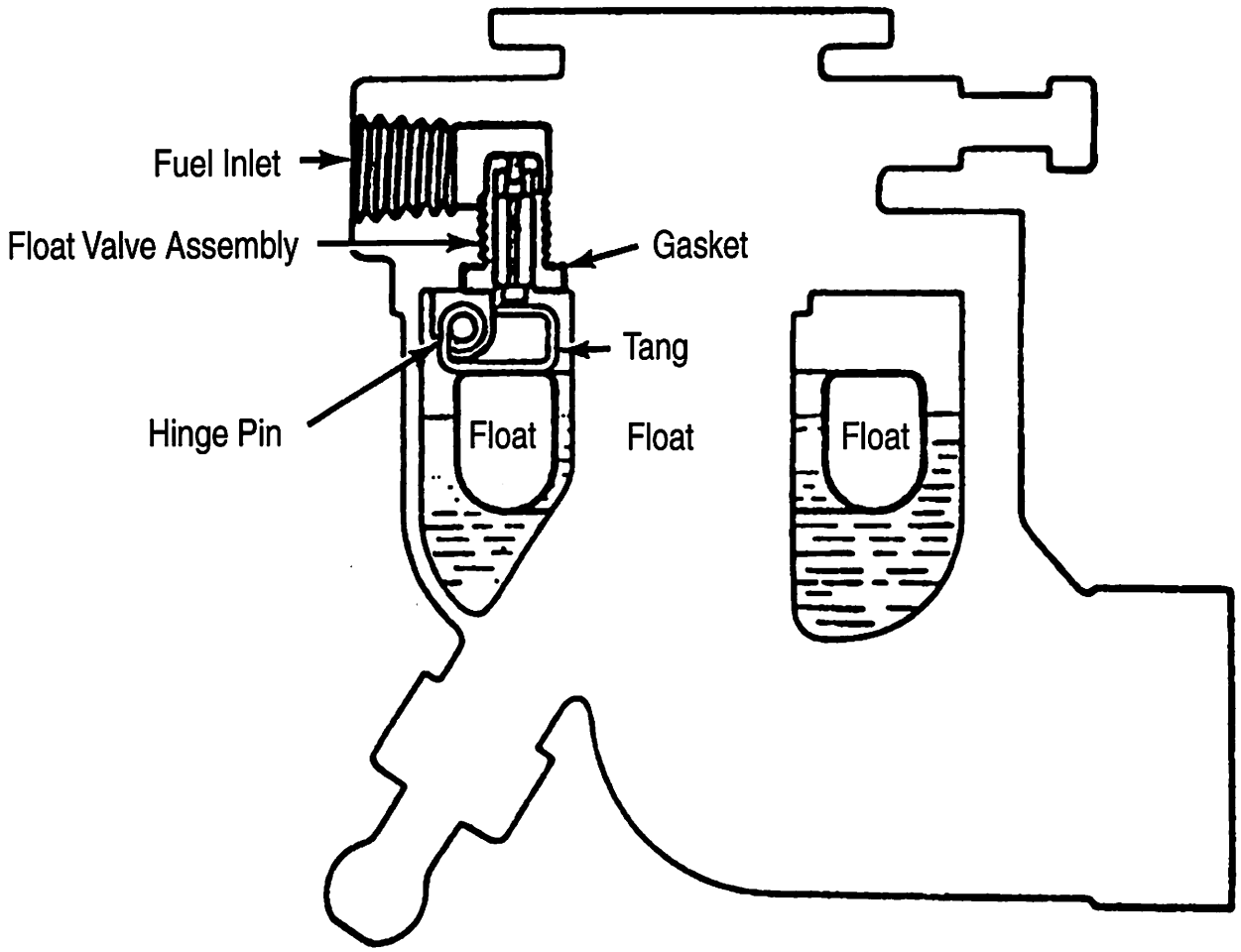
Parts of a Diaphragm Carburetor







The Float System



Module 2: Carburetor Service and Repair

Lesson 3: Operation of the Automatic Choke

Objective

After completion of this lesson, you should be able to explain the operation of the all-temperature and the standard automatic choke.

Study Questions

1. **What are the principles of operation of the bimetal automatic choke?**

2. **What is the proper procedure in servicing an all-temperature bimetal choke?**

3. **What is the proper procedure in servicing a standard automatic choke?**

References

1. Briggs and Stratton. Service and Repair Instructions for Single Cylinder Four-Cycle Engines. Milwaukee, Wisconsin, 1990.

2. Herd, Amon. Carburetor Service and Repair. Columbia, Missouri: Instructional Materials Laboratory, University of Missouri-Columbia, 1994.

3. Roth, Alfred C. Small Gas Engines. South Holland, Illinois: Goodheart-Wilcox Company, Inc., 1992.

4. Small Engine Repair. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, 1985.

5. Small Engine Operation, Maintenance and Repair. Athens, Georgia: American Association for Vocational Instructional Materials, 1987.

6. Small Gasoline Engines, Operation, Repair and Maintenance. St. Paul, Minnesota: Hobar Publications, 1992.

Module 2: Carburetor Service and Repair

Lesson 3: Operation of the Automatic Choke

Teaching Procedures

A. Introduction

B. Motivation

Apply heat to the bimetal spring to demonstrate change in position of the spring.

C. Assignment

D. Supervised Study

E. Discussion

1. Illustrate the principles of operation of the all-temperature bimetal automatic choke. Use transparencies TM-3.1 through TM-3.3.

What are the principles of operation of the bimetal automatic choke?

a) Starting temperature: The bimetal spring is in a relaxed state when the engine is cold and has no influence on the choke opening (see TM-3.1). The diaphragm spring acts alone to hold the choke plate closed.

b) Hot temperature starting: As the engine is started and begins to warm, the hot crankcase air passes through the breather tube and causes the bimetal spring to expand and curl outward (see TM-3.2). This action is caused by the inner end of the bimetal spring pulling the choke plate open. Since the diaphragm spring is opposing this force, the choke plate remains closed. However, this action makes it easier for starting vacuum to open the choke plate more quickly for improved starting and fewer hot restart problems.

c) Cold temperature starting: At lower engine starting temperatures, the cold air causes the bimetal spring to contract and curl inward (see TM-3.3). This action causes the inner end of the bimetal spring to push to choke plate closed which assists the diaphragm spring in holding the choke plate closed. The result is a slightly longer period of a richer fuel/air mixture assuring improved cold temperature starting.

2. Show an example of a poorly fitting rubber elbow connecting the breather tube to the carburetor. Illustrate why a proper fit is important to the operation of the choke.

What is the proper procedure in servicing the all-temperature bimetal automatic choke?

a) Remove the rubber elbow which connects the breather tube to the carburetor and inspect it for leaks and proper fit. The choke will not operate and must be replaced if a poor fit exists.
b) Inspect the bimetal spring assembly. The choke plate should be closed. If the bimetal spring is dirty, it can be removed and cleaned with a solvent. The bimetal spring reacts to the air temperature supplied by the crankcase via the breather tube.

3. Demonstrate the procedure in preloading a diaphragm. Have the students follow the steps in the lab manuals. Use the carburetor to illustrate the proper position of an automatic choke. Ask the students if the choke should be fully closed? Explain why the choke is in a closed position.

What is the proper procedure in servicing the standard automatic choke?

a) Remove the air cleaner and replace the stud bolt. Observe the position of the choke valve; it should be fully closed.
b) Move the speed control to the stop position; the governor spring should be holding the throttle in a closed position. Pull the starter rope rapidly. The choke valve should alternately open and close.
c) Use a small screwdriver to push open the choke plates. If the diaphragm is preloaded the choke plate should open and close.

F. Other Activities

1. Display examples of carburetors with different chokes.

2. Show examples of ruptured diaphragms.

3. Have students identify types of choking system.

G. Conclusion:

Have each student service the choke on an engine.

H. Competency

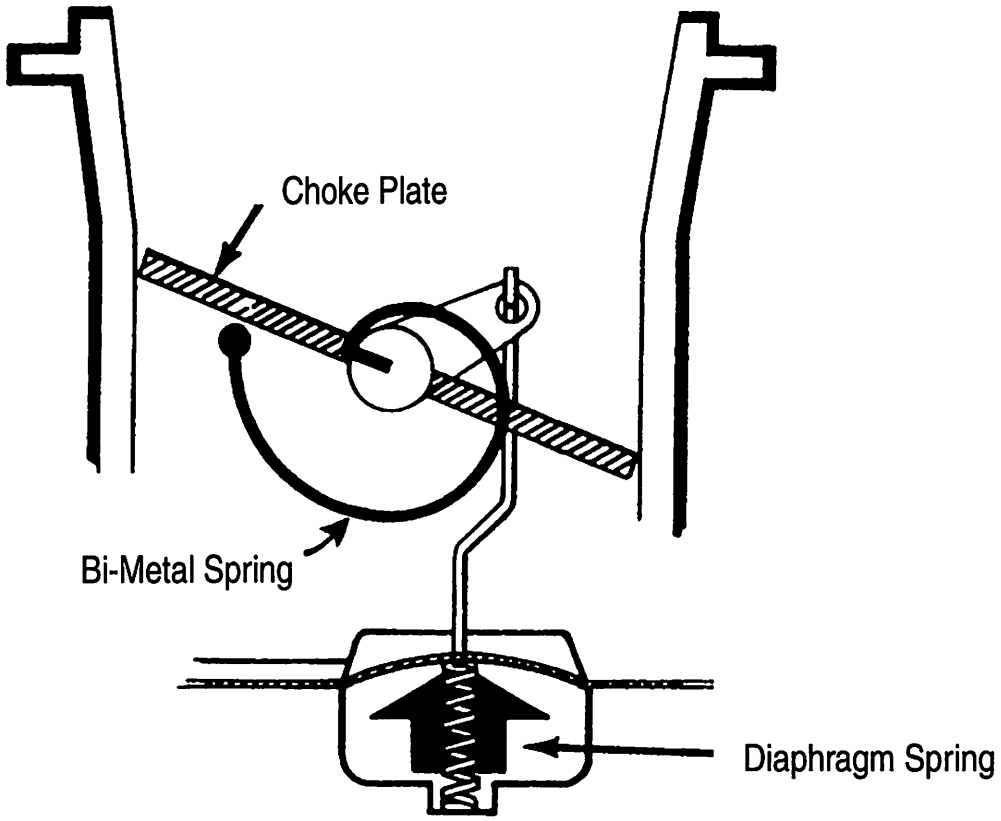
Explain the operation and service of the all-termperature automatc choke.

I. Answers to Evaluation

1. Dry-filter air cleaner
2. Oil-foam (polyurethane air cleaner)
3. Dual element air cleaner
   (Note: any order for questions 1-3.)
4. c
5. e
6. f
7. d
8. g
9. h
10. a
11. b
12. Float type
13. Diaphragm type
    (Note: any order for questions 12 and 13.)
14. Suction feed
15. Gravity feed
16. Pump feed
    (Note: any order for questions 14-16.)
17.
18. X
19. X
20. X
21.
22. b
23. a
24. c

All-Temperature Bi-Metal Automatic Choke Carburetor

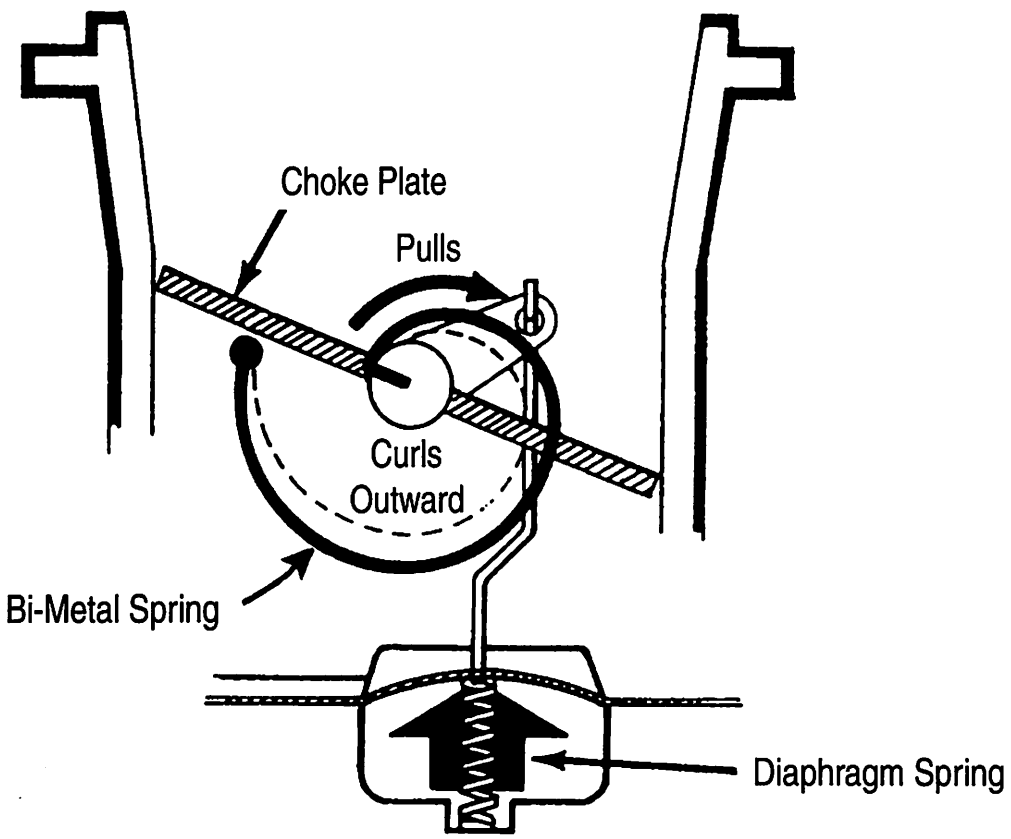
Principles of Operation



Starting Temperature - The Bi-metal spring is in a relaxed state. The diaphragm spring holds the choke plate closed.

All-Temperature Bi-Metal Automatic Choke Carburetor

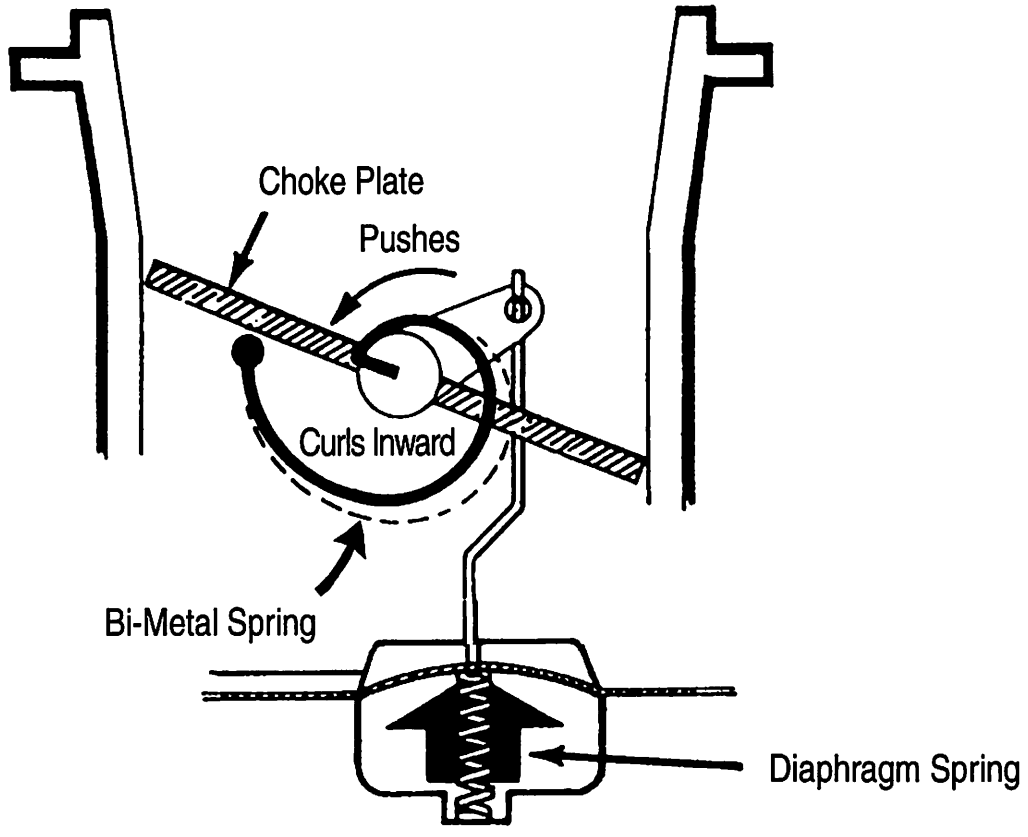
Principles of Operation



Hot Temperature Starting - Heat from the crankcase causes the bi-metal spring to expand and curl outward.

All-Temperature Bi-Metal Automatic Choke Carburetor

Principles of Operation



Cold Temperature Starting - Cold air causes the bi-metal spring to contract and curl inward.

Module 2: Carburetor Service and Repair NAME _____
DATE _____

EVALUATION

Name three types of air cleaners.

1. _____

2. _____

3. _____

Match the terms on the right with their correct definition.

____ 4. Restriction in the carburetor air horn that produces vacuum responsible for the movement of gasoline into the passing air.

____ 5. Correct proportion of fuel and air needed for good combustion.

____ 6. Tube in a stream of air inside the venturi which creates an air pattern with low pressure on one side.

____ 7. To change a liquid into a gaseous state.

____ 8. To break up a liquid into minute particles.

____ 9. A reservoir to store fuel.

____ 10. Carries fuel from the fuel tank to the carburetor.

____ 11. Prevents dirt or foreign matter from entering the carburetor.

a. Fuel line
b. Fuel filter
c. Venturi
d. Vaporization
e. Metering
f. Airfoil
g. Atomize
h. Fuel tank

Name two types of carburetors.

____ 12.

____ 13.

List the three basic types of fuel systems used on small engines.

____ 14.

____ 15.

____ 16.

Indicate types of fuel filters by placing an "X" in the appropriate blanks.

____ 17. Gravity feed.

____ 18. Glass sediment bowl and screen.

____ 19. Screen in fuel tank.

____ 20. Filter attached to the end of flexible fuel hose.

____ 21. Oil bath.

Match the terms on principles of operation of the automatic choke to their correct function.

____ 22. At lower engine starting temperatures, the cold air causes the bimetal spring to contract and curl inward.

____ 23. The bimetal spring is in a relaxed state and has no influence on the choke opening.

____ 24. As the engine is started and begins to warm up, the hot crankcase air passes through the breather tube and causes the bi-metal spring to expand and curl outward.

a. Starting temperature

b. Cold temperature

c. Hot temperature

Module 3: Rewind Starters

Lesson 1: Identifying and Servicing Starters

Objective

After completing this unit, the student should be able to remove and replace a starter, replace a starter rewind spring, replace a starter rope, service a starter clutch, and service a vertical pull starter.

Study Questions

1. **What are the common terms associated with starter systems on small engines?**

2. **What are the types of starters used on small engines?**

3. **What tools and supplies are needed to service starters?**

4. **What are the procedures for checking proper operation of starters?**

5. **What are the basic parts of a rope-rewind starter?**

6. **What are the proper shop safety, good housekeeping and equipment care procedures?**

7. **What is the procedure for servicing rewind starters and starter clutches?**

References

1. Briggs and Stratton. Service and Repair Instructions For Single Cylinder Four-Cycle Engines. Milwaukee, Wisconsin, 1990.

2. Herd, Amon. Carburetor Service and Repair. Columbia, Missouri: Instructional Materials Laboratory, University of Missouri-Columbia, 1994.

3. Roth, Alfred C. Small Gas Engines. South Holland, Illinois: Goodheart-Wilcox Company, Inc., 1992.

4. Small Engine Repair. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, 1985.

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Module 3: Rewind Starters

Lesson 1: Identifying and Servicing Starters

Teaching Procedures

A. Introduction

B. Motivation

When should a small engine starter be serviced? Display different types of starters. Illustrate the importance of safety when repairing starters. Ask the class how many engines at home have starter problems.

C. Assignment

D. Supervised Study

E. Discussion

1. Have starter parts on display and match terms to the actual part. Show defective parts to the class.

What are the common terms associated with starter system on small engines?

a) Starter: A system for rotating the engine to produce compression and ignition spark for combustion of the air-fuel mixture.
b) Starter housing: Cover for the starter mechanism.
c) Recoil spring: Used to automatically rewind the starter rope after each starting attempt.
d) Pulley: Housing for pawls that lock to crankshaft adapter to crank the engine.
e) Engaging pawl: Locks pulley to crankshaft adapter on starting pull of rope (sometimes referred to as a dog).
d) Pawl spring: Returns pawl to neutral position during rewind cycle.

2. Secure two types of starters for class demonstration. Discuss the advantages and disadvantages of each. TM-1.1.

What are the types of starters used on small engines?

There are two basic types of starters: manual and electric. Manual starters can be either a rope-rewind or vertical pull. There are two types of electric starters: AC (alternating current) and DC (direct current).

Electric starters are becoming more popular on small engines, especially 4 hp and above. Electric motors eliminate manual labor in starting.

3. Issue a handout about special tools that you can make in the shop or home. Your demonstration will require that you have a bench vise to hold the starter housing. Discuss the special tools you have on display for use in performing starter repair.

What tools and supplies are needed to service starters?

a) Tools:
   1) Tang tool.
   2) Flywheel holder.
   3) Rope inserter tool.
   4) Starter clutch wrench and torque adapter.
   5) Rewind starter tool.
   6) Cylinder support.

Note: A complete tool list is in the Student Lab Manual.

b) Supplies:
   1) Parts cleaning pan.
   2) Petroleum solvent.
   3) Shop towels.
   4) Penetrating oil.
   5) Matches.
   6) Nylon bumpers.
   7) Starter rope.
   8) Starter spring.
   9) Multi-purpose grease.
   10) Gloves.

4. Perform a series of demonstrations: (1) A starter with the rope too short, (2) starter rope will not rewind, (3) wrong size rope, and (4) a starter in good working condition.

What are the procedures for checking the proper operation of starters?

a) Disconnect the spark plug wire to prevent the engine from starting.
b) Grasp the handle and slowly pull the rope all the way out. The rope should unwind freely. Any binding indicates the recoil spring or rope is jammed.
   Note: If the engine crankshaft does not turn as the rope is pulled out, the starter drive mechanism is not engaging the

flywheel. You will need to repair or replace the starter drive mechanism.

c) Carefully inspect the rope for wear.

d) Allow the rope to rewind several times to verify that the starter is working properly.
Note: Never release the handle while the rope is extended and allow the rope to fly back freely.

5. Use transparency masters to illustrate starter parts. Discuss safety procedures when working when repairing starters. TM-1.2.

What are the basic parts of a rope-rewind starter?

The parts are:

a) Recoil spring.
b) Pulley.
c) Pawl spring.
d) Engaging pawl.
e) Blower or starter housing.
f) Rope.
g) Crankshaft adapter.
h) Rope guide.
i) Anchor wire.

6. Illustrate the dangers of a starter spring. Make sure your class is aware of safety procedures when installing or removing the starter spring. Discuss general safety rules and regulations used in shop. Explain the importance of good housekeeping and care of tools and equipment.

Discuss shop safety, good housekeeping and care of tools and equipment.

a) Use a handout to explain the importance of shop safety.

b) Explain the shop procedure for good housekeeping.

7. Ask a student to assist in a demonstrating common rewind starter repairs. Issue the Student Lab Manual and explain how the manual is to be used.

What is the proper procedure for servicing rewind starters and starter clutches? TM-1.3.

a) Rewind starters:
   1) Wear proper safety equipment.
   2) Disconnect the spark plug wire and place it in the safety notch on the engine.
   3) Remove tank assembly (if applicable).

4) Remove blower housing from engine.
5) Remove starter rope.
6) Remove starter spring (if applicable).
7) Disassemble starter.
8) Clean starter housing, pulley and spring.
9) Inspect pulley for cracks and rough edges.
10) Inspect starter housing for wear or burrs at rope eyelet.
11) Straighten and oil spring (if applicable).
12) Install starter spring.
13) Adjust tang gap (if applicable)
14) Install starter rope.
15) Install blower housing on engine.
16) Install tank assembly (if applicable).
17) Reconnect the spark plug wire.
18) Check proper operation of starter.

b) Vertical pull starters:
1) Wear proper safety equipment.
2) Disconnect spark plug wire.
3) Remove starter from engine.
4) Remove tension from rope.
5) Remove anchor bolt and spring anchor.
6) Remove starter spring and rope guide.
7) Remove rope from handle and install new rope in housing.
8) Install break spring and check for proper tension.
9) Install new rope in handle.
10) Wind pulley counterclockwise to fully retrieve rope.
11) Check proper position of rope guide.
12) Install starter spring.
13) Torque anchor bolt to 75-90 inch-pounds.
14) Wind starter spring and check spring tension.
15) Install starter assembly on engine.
16) Reconnect the spark plug wire.
17) Check proper operation of starter.

c) Starter clutch: TM-1.3.
1) Wear proper safety equipment.
2) Disconnect spark plug wire.
3) Remove flywheel shroud and screen.
4) Remove starter clutch.
5) Inspect starter clutch for proper operation.
6) Remove retainer cover, ratchet and ball bearings.
7) Clean and check condition of starter clutch parts.
8) Reassemble starter clutch.
9) Properly install starter clutch and torque to 55 foot-pounds.
10) Replace flywheel screen and blower housing.

11) Check operation of starter clutch.
12) Reconnect the spark plug wire.
13) Start engine several times to be sure starter and clutch are operating correctly.

F. Other Activities

1. Make transparencies. The transparencies will enhance the instruction.

2. Contact your local small engine dealer and explain your program. Invite her or him to speak to your class.

3. Always use your students to assist you in doing demonstrations or preparing class activities.

4. Use retired small engine mechanics to assist you with the program.

5. Contact Briggs & Stratton for the latest in films, videos and teaching aids.

6. Allow students to evaluate their completed units of instruction and indicate possible areas for improvement.

7. Provide examples of different types of starters and starter drives.

8. Prepare a work bench. Display starters, tools and equipment.

G. Conclusions

Most owners do not keep their small engines properly serviced. As a result, the engine is hard to start and the starter becomes overworked. Starters are subject to abnormal wear and will need to be serviced more frequently.

H. Competency

Demonstrate the ability to:
a) Remove, disassemble, test, service, and reassemble a starter.
b) Replace starter rewind spring.
c) Replace starter rope.
d) Service starter clutch assembly.

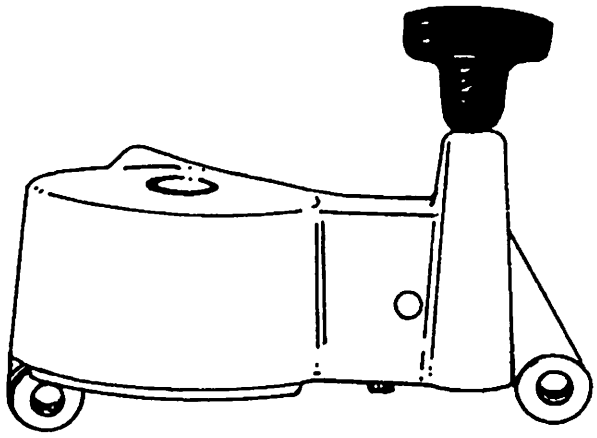
I. Answers to Evlauation

1 b
2. c
3. d
4. f

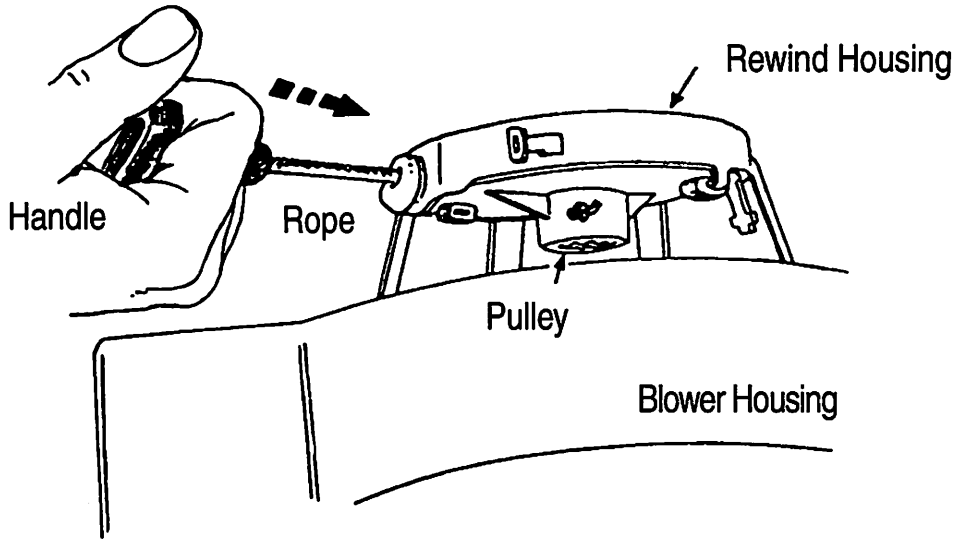
5. e
6. a
7. Rewind starter
8. Vertical pull starter
   (Note: Answers 7 and 8 can be in any order).
9. True
10. True
11. True
12. True
13. True
14. True
15. True
16. Evaluated by instructor.
17. Evaluated by instructor.
18. Evaluated by instructor.

Types of Starters

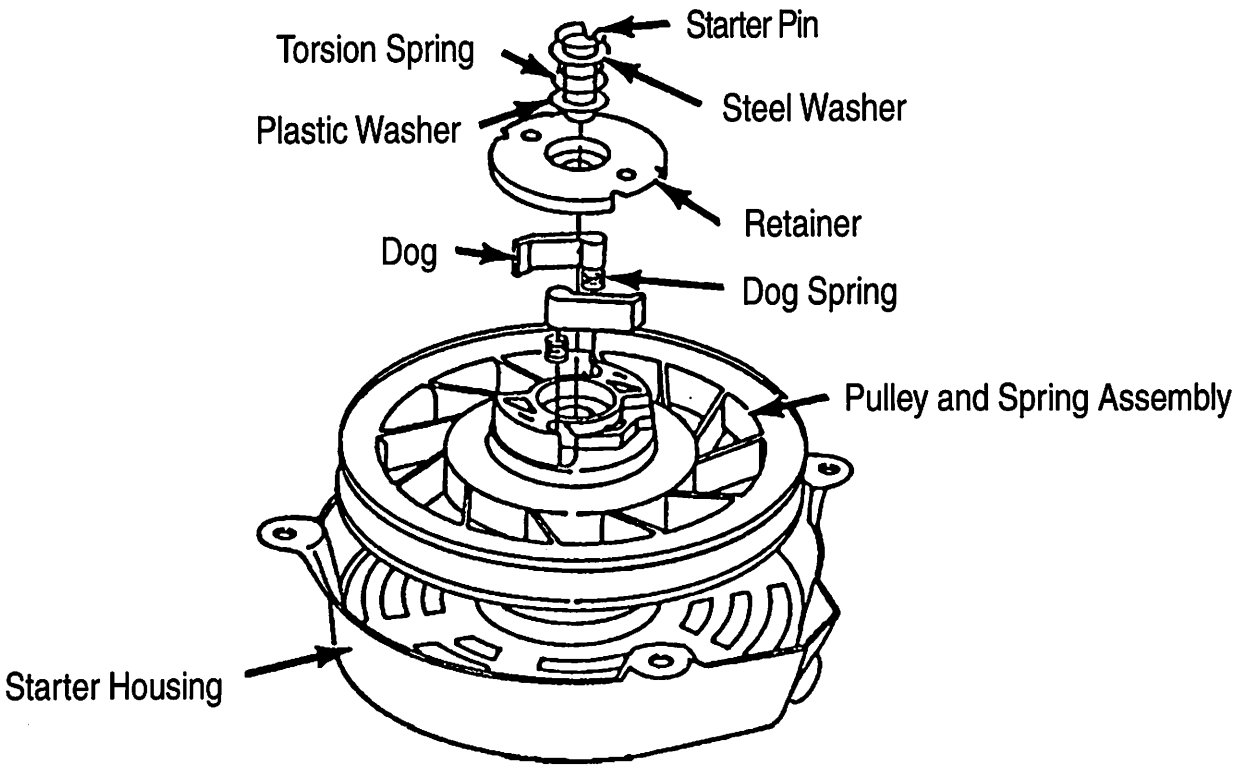
Vertical Pull



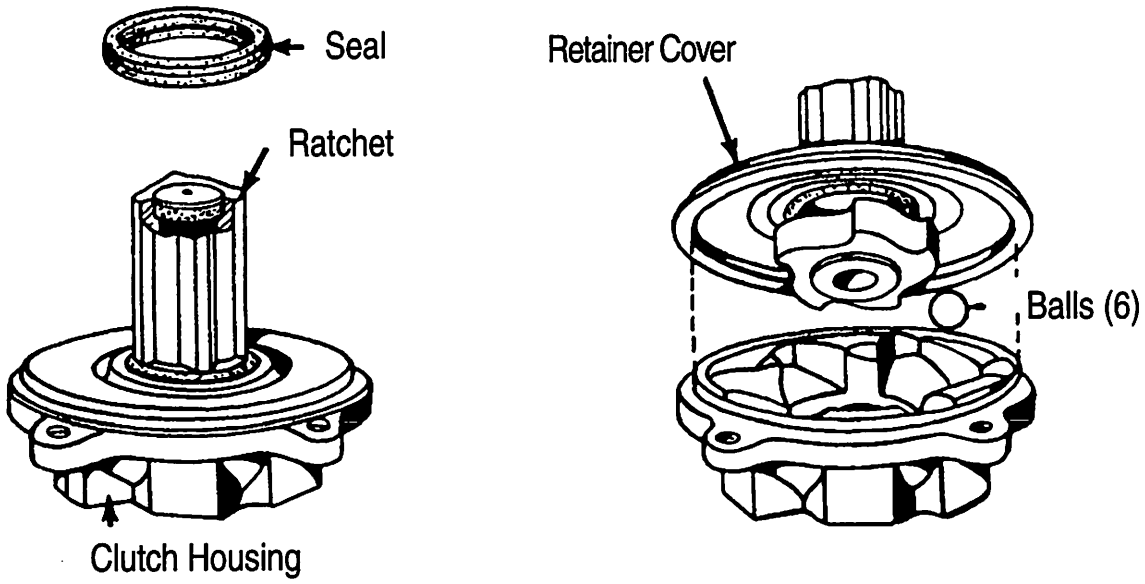
Rope Rewind



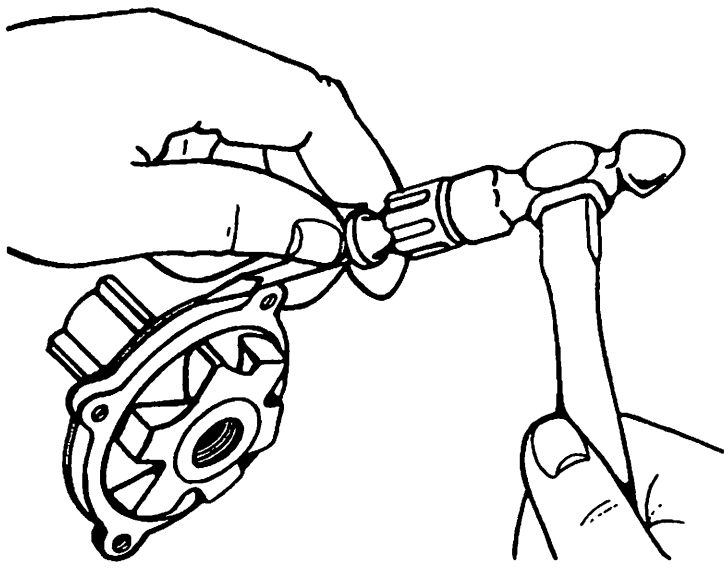
Starter Components



Starter Clutch (Sealed)



Sealed Clutch Assembly



Disassembling Sealed Clutch

Module 3: Rewind Starters NAME_____
DATE_____

EVALUATION

Match the terms on the right with their correct definition.

____	1.	A system for rotating the engine.	a.	Pulley
____	2.	Returns the pawl to neutral position during rewind cycle.	b.	Starter
____	3.	Cover for the starter housing.	c.	Pawl Spring
____	4.	Locks pulley to crankshaft adapter on starting pull of rope.	d.	Starter Housing
____	5.	Used to automatically rewind the starter rope.	e.	Recoil Spring
____	6.	Housing for pawls that lock to crankshaft adapter to crank the engine.	f.	Engaging Pawl

Identify two types of starters used on small engines.

____ 7.

____ 8.

True/False. (Place the correct response in the blank provided.)

____ 9. The spring causes the pawl to engage the crankshaft pulley.

____ 10. The sealed starter clutch can be disassembled for cleaning.

____ 11. The starter clutch should have one drop of oil on the end of the crankshaft before replacing clutch.

____ 12. Straighten the starter spring to restore tension.

____ 13. When installing a spring on the pulley you always wind the spring counterclockwise.

____ 14. When selecting new rope, your part number will tell you the correct length and diameter of the rope.

____ 15. When installing a Vertical Pull Starter, hold starter assembly, pull rope and observe movement of the gear. The gear should move in and out.

Demonstrate the ability to:

____ 16. Remove, disassemble, test, service, reassemble, and replace a starter.

____ 17. Replace starter rewind spring.

____ 18. Service a vertical pull starter.

Note: Use the Student Lab Manual Module 3 in completing the above activities.

Module 4: Small Engine Compression

Lesson 1: Inspecting and Servicing a Valve Assembly

Objective

After completion of this unit, you should be able to identify tools and their appropriate use and inspect and service small engine valves.

Study Questions

1. **What are the common terms used to describe the valve train assembly?**
2. **What are the special tools and materials needed to properly service valves?**
3. **What are the components of the valve train assembly?**
4. **What are the procedures used in checking the compression of a small engine?**
5. **What is the procedure for removing and inspecting valves?**
6. **What is the procedure for replacing valve guides?**
7. **What is the procedure for refacing valves?**
8. **What is the procedure for refacing valve seats?**
9. **What is the procedure for lapping valves?**
10. **What is the procedure for installing and adjusting valve-tappet clearance?**
11. **What is the procedure for installing a cylinder head?**

References

1. Briggs and Stratton. Service and Repair Instructions For Single Cylinder Four-Cycle Engines. Milwaukee, Wisconsin, 1990.
2. Herd, Amon. Carburetor Service and Repair. Columbia, Missouri: Instructional Materials Laboratory, University of Missouri-Columbia, 1994.

3. Roth, Alfred C. Small Gas Engines. South Holland, Illinois: Goodheart-Wilcox Company, Inc., 1992.

4. Small Engine Repair. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, 1985.

5. Small Engine Operation, Maintenance and Repair. Athens, Georgia: American Association for Vocational Instructional Materials, 1987.

6. Small Gasoline Engines, Operation, Repair and Maintenance. St. Paul, Minnesota: Hobar Publications 1992.

Module 4: Small Engine Compression

Lesson 1: Inspecting and Servicing a Valve Train Assembly

Teaching Procedures

A. Introduction

B. Motivation

Valves are exposed to extreme high temperatures and can open 2,000 times per minute when the engine is running 4,000 R.P.M. How do valves relate to compression of the engine? Use an engine cutaway to demonstrate how valves open and close.

C. Assignment

D. Supervised Study

E. Discussion

1. Use charts showing parts of the valve. Display and discuss the small engine parts that relate to the valve train.

What are the common terms used to describe the valve train assembly?

a) Valve stem: That portion of a valve which rests within a valve system guide.
b) Gasket: Substance placed between two metal surfaces to act as a seal.
c) Burr: A thin, rough edge of metal left on the tip of a part being ground or filed.
d) Compression: Applying pressure to a gas so that it is contained in a smaller volume.
e) Cylinder head: A detachable portion of an engine fastened securely to the top of the cylinder block.
f) Valve lapping: Process of mating the valve seat and valve face.
g) Valve margin: Space between valve face and head.
h) Valve head: The portion of the valve upon which the valve face is machined.
i) Valve seat: The matched surface which the valve face contacts.
j) Valve clearance: The allowable gap between the end of the valve stem and valve lifter to compensate for expansion of the valve due to heat.

k) Valve face: The part of a valve which contacts a seating surface.
l) Valve overlap: When both valves are open at the same time.
m) Valve stem guide: A part installed to support and maintain alignment of the valve.
n) Valve lifter: The part that rides on the cam and pushes open the valve.
o) Valve spring: A coil spring used to close a valve.
p) Valve grinding: Process of refacing the valve and seat to manufacturer's specifications.

2. Demonstrate the use of special tools in removing valves. Point out advantages of having special tools. Display all the special tools and have a handout with prices and where they may be purchased.

What are the special tools and materials needed to properly service valves?

a) Special tools:
   1) Valve spring compressor.
   2) Valve lapping tool.
   3) Valve seat puller kit.
   4) Valve seat cutter kit.
   5) Valve guide reject gauge.
   6) Valve guide bushing counterbore reamer.
   7) Valve guide bushing driver.
   8) Valve guide bushing.
b) Supplies:
   1) Prussian blue.
   2) Lapping compound.
   3) Cleaning solvent.
   4) Lead-Plate.
   5) Penetrating oil.

3. Illustrate the wearing parts of a valve. Use TMs or charts to show the valve train. TM-1.1.

What are the components of the valve train assembly?

Typical components are:
   a) Margin.
   b) Seat.
   c) Stem.
   d) Face.
   e) Retainer.
   f) Adjusting nut.
   g) Tappet guide.
   h) Cam.
   i) Head.

j) Valve guide.
k) Valve spring.
l) Clearance.
m) Locknut.
n) Tappet.
o) Shaft.

4. Ask a student to assist you in checking the compression of a small engine. Demonstrate the oil test to check compression on small engines.

What are the procedures used in checking the compression of a small engine?

a) To check the compression quickly: manually spin the flywheel counter-clockwise against the compression stroke. A sharp rebound indicates the compression is satisfactory. Slight or no rebound indicates poor compression.
b) To check the compression accurately, use a compression gauge. The proper method for using a compression gauge is to screw it hand-tight into the cylinder. Pull the engine over until the needle in the gauge stops advancing. Note the reading on the gauge should be a minimum of 90 P.S.I. This would indicate upper cylinder compression is sufficient for starting and running the engine.
If compression is low and you are not certain of the cause, use another compression check technique. Squirt a teaspoon of oil into the cylinder through the spark-plug-hole and crank the engine several times for the oil to be distributed around the piston rings. Recheck the compression. If compression improves, the trouble is worn or damaged piston rings (the oil helps provide a seal which causes compression pressure to increase).

5. Ask a student to assist you demonstrating the proper procedures in removing the cylinder head. Note the carbon deposits on the cylinder head and valves. Demonstrate how to check a cylinder head for warpage. Have two students assist you in a demonstration of proper procedures for removing valves. Discuss the use of the Student Lab Manual and issue a copy to each class member. The lab manual can serve as a job sheet. TM-1.2.

What is the procedure for removing and inspecting valves?

a) Removing the valves:
    1) Remove the valve spring, retainer and valves.
    2) Clean carbon deposits from valves and store in an organized manner for reassembly.
b) Inspecting the valves and accessories:

1) Become familiar with parts of the valve train.
2) Inspect the valve head for proper margin.
3) Inspect valves for a warped head, necked or worn stems, burned face, or cracked or dished head.
4) Clean valve guide and check for wear.
5) Inspect the valve spring for distortion, pits and cracks.
6) Inspect the valve seats for cracking and pitting.

6. Discuss special tools needed in repairing valve guides. Demonstrate how to use the plug gauge. If the plug gauge enters the valve guide 5/16" or more, the valve guide is worn and should be replaced. Show an engine that has a new valve guide bushing installed. Demonstrate the correct procedure in repairing valve guides. Illustrate how important it is to ream the valve guide squarely. TM-1.3.

What is the procedure for replacing valve guides?

a) Select the proper size reamer.
b) Ream the cylinder block to accommodate the valve-guide bushing.
c) Install valve guide and bushing.
d) Finish reaming the replacement bushing.
e) Remove metal clippings.
f) Use a plug gauge to check new valve guide bushing.
g) Clean and lubricate valve guide bushing.

7. Using your demonstration engine, have a student assist you in performing tests to determine if the valves are seating properly.

With the valve spring removed, lift the valve and place a piece of paper under the valve. Apply pressure to the valve and try removing the paper from the valve. If the paper tears around the valve there is good valve and seat contact.

Perform a lapping demonstration showing the effects of poor valve and seat contact. Good seat contact will leave a ring all around the valve.

Inspect and discuss the valves on display. Discuss when valves should be ground or replaced. TM-1.4.

Refer to the Student Lab Manual on proper techniques in refacing valves.

Allow your students time for questions and comments.

What is the procedure for refacing valves?

NOTE: When valve grinding equipment is not available, contact your local machine shop. Proper grinding and refacing the valves are very important.

a) Inspect valves:
   1) Visually check valve for any unusual or uneven wear, burned spots, pits, cracks, bent or burned stems, or other damage.
   2) Discard the valve when the cracks or pits are too deep to dress off during regrinding or if stem is bent. TM-1.5.
   3) Measure the valve stem with a micrometer.
   4) Discard the valve if it does not fall within manufacturer's specifications.
   5) Measure the valve margin.
   6) Discard the valve when the margin is 1/64" or less.

b) Grinding valves: TM-1.6.
   1) Determine the correct angle and face width from the appropriate service manual.
   2) Chuck valve in grinder. Refer to grinder directions for proper procedure. Dress grinding wheel if necessary.
   3) Set grinder angle. Check to see that the valve face is in proper position to contact the grinding wheel.
   4) Start grinder and make sure the cutting oil is flowing properly.
   5) Move the valve face up to the wheel and start grinding lightly.
   6) Stop the grinder and remove the valve. Check the face width.
   7) Clean the valves with a solvent and store for reassembly.
   8) Discard valve if suitable margin cannot be attained.

8. Demonstrate techniques in using a Neway Valve Seat Cutter. Each tungsten carbide blade is precisely designed and machined to cut a flat surface. Use the series of short blocks and have each student use the valve seat cutter. Make sure each student gets a chance to use the cutter.

What is the procedure for refacing valve seats?

a) Select a valve-seat cutter.
b) Check engine specifications for proper valve seat angle.
c) Install the pilot in the valve guide.
d) Install the T-handle on the cutter head and cut the valve seat.
e) Check valve seat for condition and width.
f) Lap the valve to the seat.

9. It is a good idea to "lap" the valves to the seats anytime you have the valves out of your engine. Lapping is recommended when installing new valves and seats.

Demonstrate how to properly hand lap valves. After lapping the valve, remove the valve and wipe off the excess compound. Inspect the impression left by the lapping compound. Make sure it is of equal width all the way around the valve. If this is readily evident, there is no need to check the valve with machinist's ink. Each student should hand lap at least one valve.

What is the procedure for lapping valves?

a) Apply a thin coat of lapping compound to the valve face.
b) Insert valve into the cylinder block.
c) Attach the lapping tool to the valve.
d) Rotate the valve-lapping tool until the grinding sound ceases.
e) Thoroughly clean all grinding compound from the valves and the engine.

10. Why is there valve clearance? What happens when there is too little valve clearance? Too much valve clearance? TM-1.7.

Valve clearance is the space between the end of the valve stem and the top of the valve lifter when the valve is closed. When the valve has been refaced, it rides lower in the guide, and therefore, valve-to-tappet clearance is reduced. To adjust the valve, the end of the valve stem must be ground to obtain correct clearance. To check the clearance, turn the camshaft until the lobe is away from the tappet. Hold the valve against its seat while testing clearance with a thickness gauge.

Have three students demonstrate setting up three types of valve clearance on three engines:
a) No valve clearance.
b) Too much clearance.
c) Correct valve clearance.

Have all students check the valve clearance on the three engines and report to class. Use the Student Lab Manual to assist you in checking valve-tappet clearance.

What is the proper procedure for installing and adjusting valve-tappet clearance?

a) Apply "Lead-Plate" or crankcase oil to the valve stems and guides before installing.

b) Place the valve in the cylinder block.
c) Turn the crankshaft to top-dead-center.
d) Check operator's manual for recommended valve-tappet clearance.
e) Check valve-tappet clearance.
f) Observe the valve spring. The more closely wound part of the spring should be installed toward the head of the valve.
g) Install the stronger spring on the exhaust valve.
h) Compress retainer and spring.
i) Insert compressed spring and retainer into valve chamber.
j) Push spring down over valve stem and release compressor.
k) Rotate crankshaft two complete turns and recheck valve clearance.
l) Install valve-cover plate.

11. When installing the cylinder head, keep in mind the following: Cylinder head bolts may be different lengths for different positions. The sequence in which the head bolts are to be tightened is critical. The amount of torque to apply to the head bolts is critical.

Follow a recommended sequence in tightening head bolts to prevent warping the cylinder head. TM-1.8. When threads are damaged, you can replace them with a Heli-coil thread. The Heli-coil replacement threads come in various sizes. Drill the damaged thread out, retap the hole and install the Heli-coil.

Perform a demonstration using an engine with the head bolts installed in the wrong position. Always note any difference in the lengths of bolts as the head is being removed.

What is the procedure for installing a cylinder head?

a) Check piston, cylinder, valves, and cylinder head for cleanliness.
b) Install new head gasket.
c) Install cylinder head.
d) Tighten head bolts to specifications.
e) Torque head bolts to specifications.
f) Install carburetor on engine.
g) Install blower housing.
h) Reconnect spark plug wire.
i) Clean your work area and return tools to their proper places.

F. Other Activities

1. Display examples of new, used and abused valves.

2. Demonstrate engine performance with worn valves with that of an engine with new valves.

G. Conclusion

Valve wear is a normal and common part of small engine operation.

H. Competency

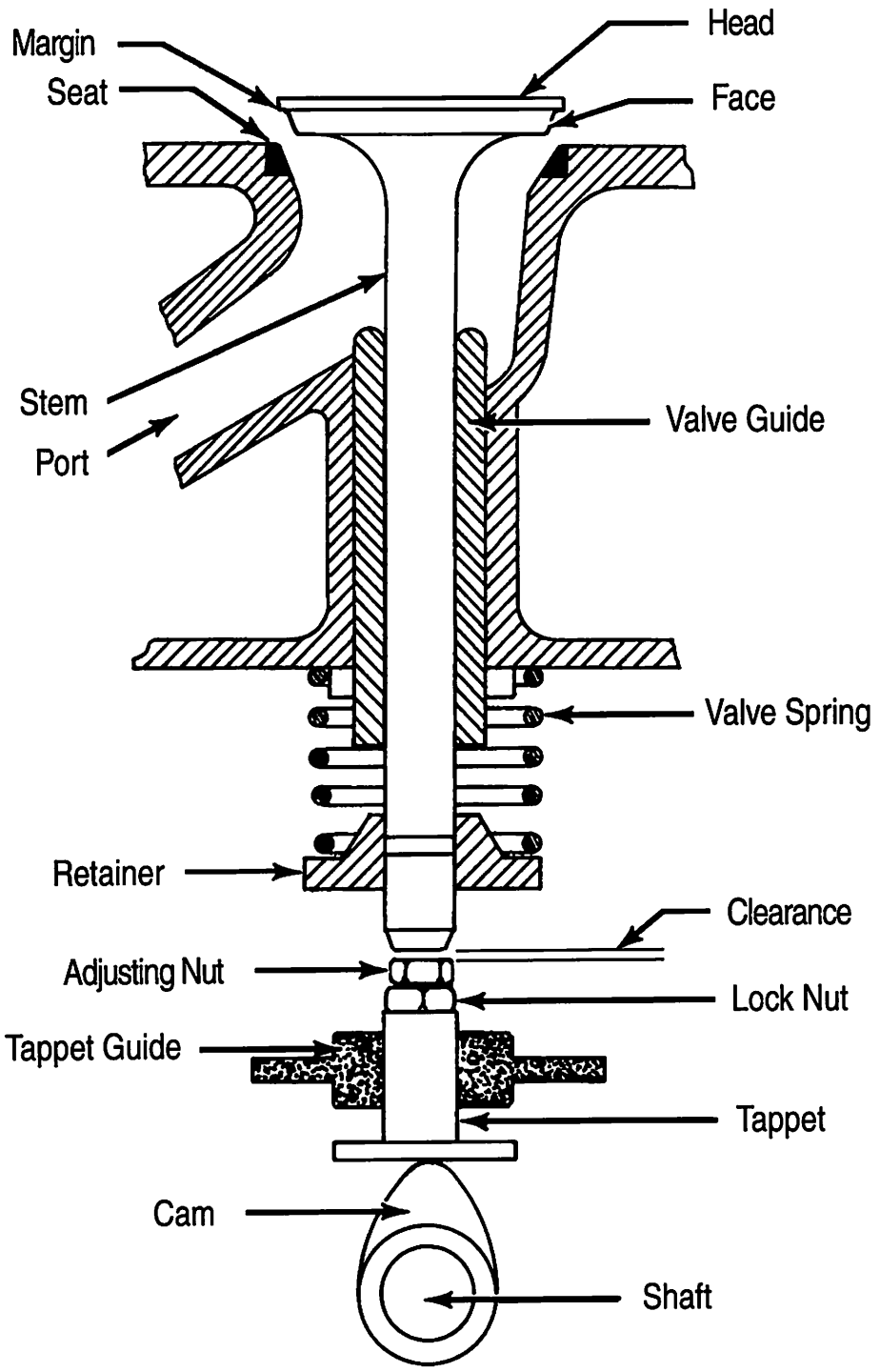
The student should demonstrate the ability to identify and service worn valves.

I. Answers to Evaluation

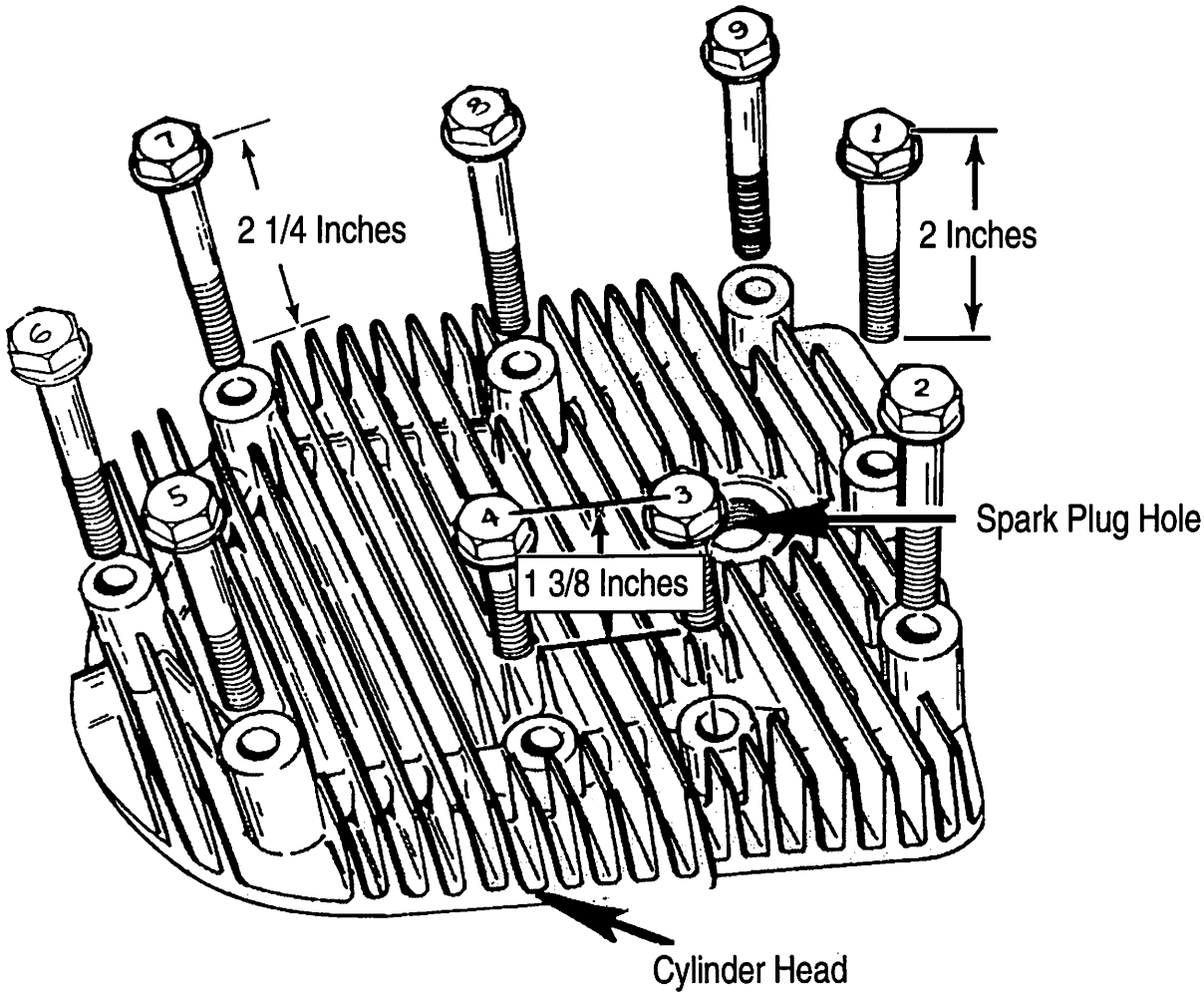
1. i
2. d
3. c
4. l
5. g
6. m
7. h
8. n
9. k
10. a
11. e
12. b
13. j
14. f
15. p
16. o
17. Head
18. Face
19. Valve guide
20. Valve spring
21. Clearance
22. Locknut
23. Tappet
24. Shaft
25. Cam
26. Tappet guide
27. Adjusting nut
28. Retainer
29. Stem
30. Seat
31. Margin
32. Grinding valves and replacement of any bad valves.
33. Grinding or refacing valve seats.
34. Repair or replacement of valve guides.
35. Lapping the valve faces to valve seat.
36. Checking valve springs.
37. Adjustment of valve tappet clearances.

38. Valve burning
39. Flat feeler gage
40. 1/32"
41. Exhaust
42. Evaluated by instructor.

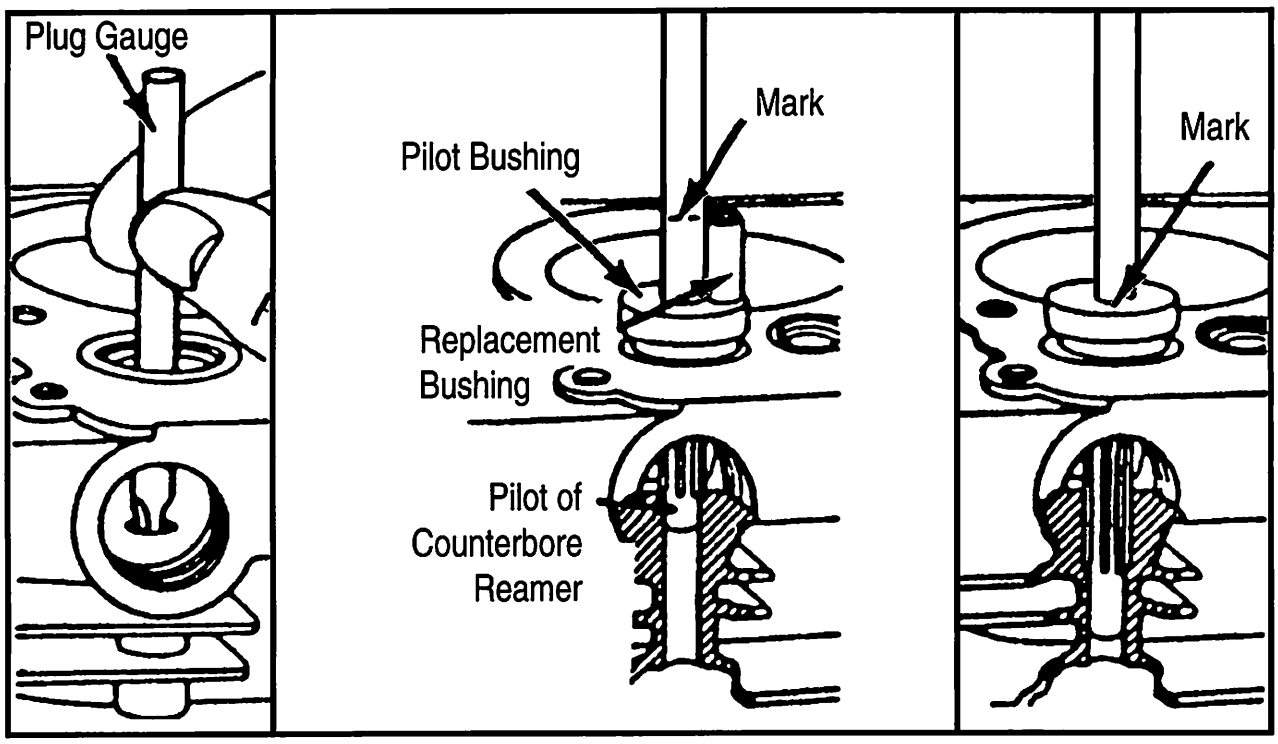
Valve Train


Margin
Seat
Head
Face
Stem
Port
Valve Guide
Valve Spring
Retainer
Clearance
Adjusting Nut
Lock Nut
Tappet Guide
Tappet
Cam
Shaft

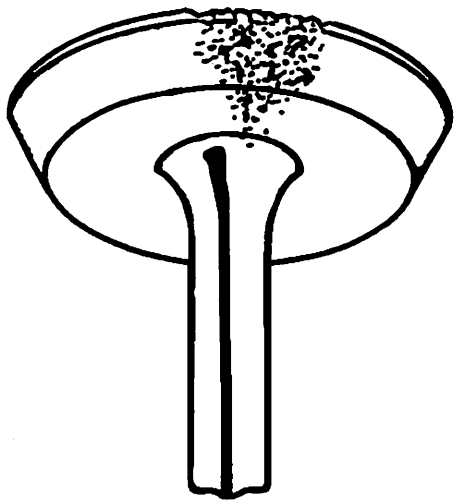
Typical Cylinder Head Bolts



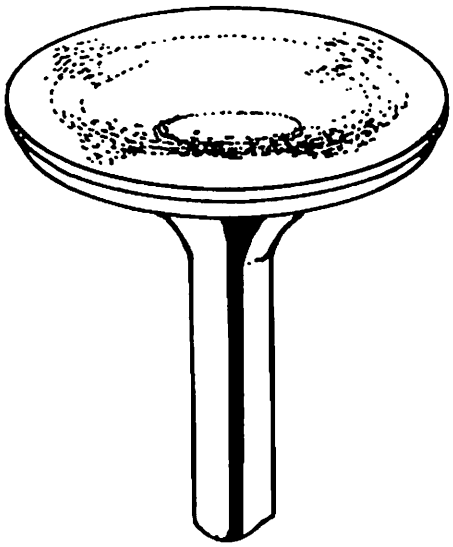
Servicing Valve Guides



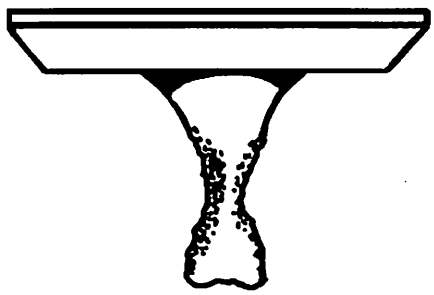
Improperly Maintained Valves



Burned

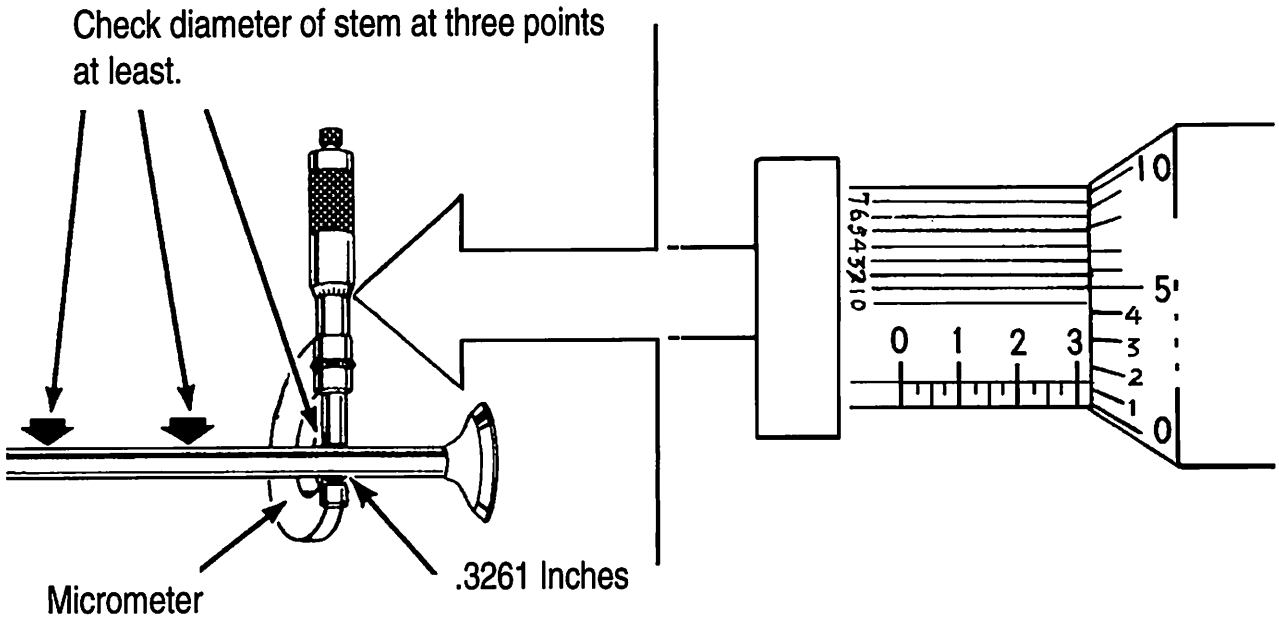


Dished

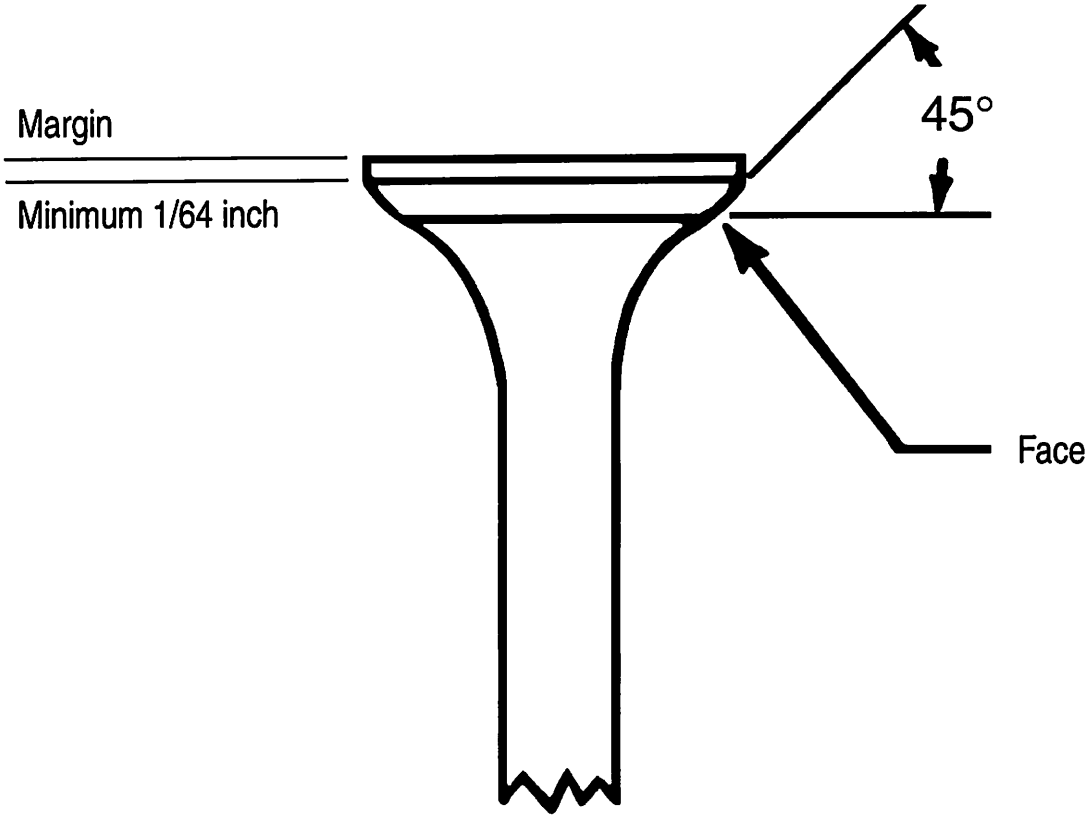


Necked

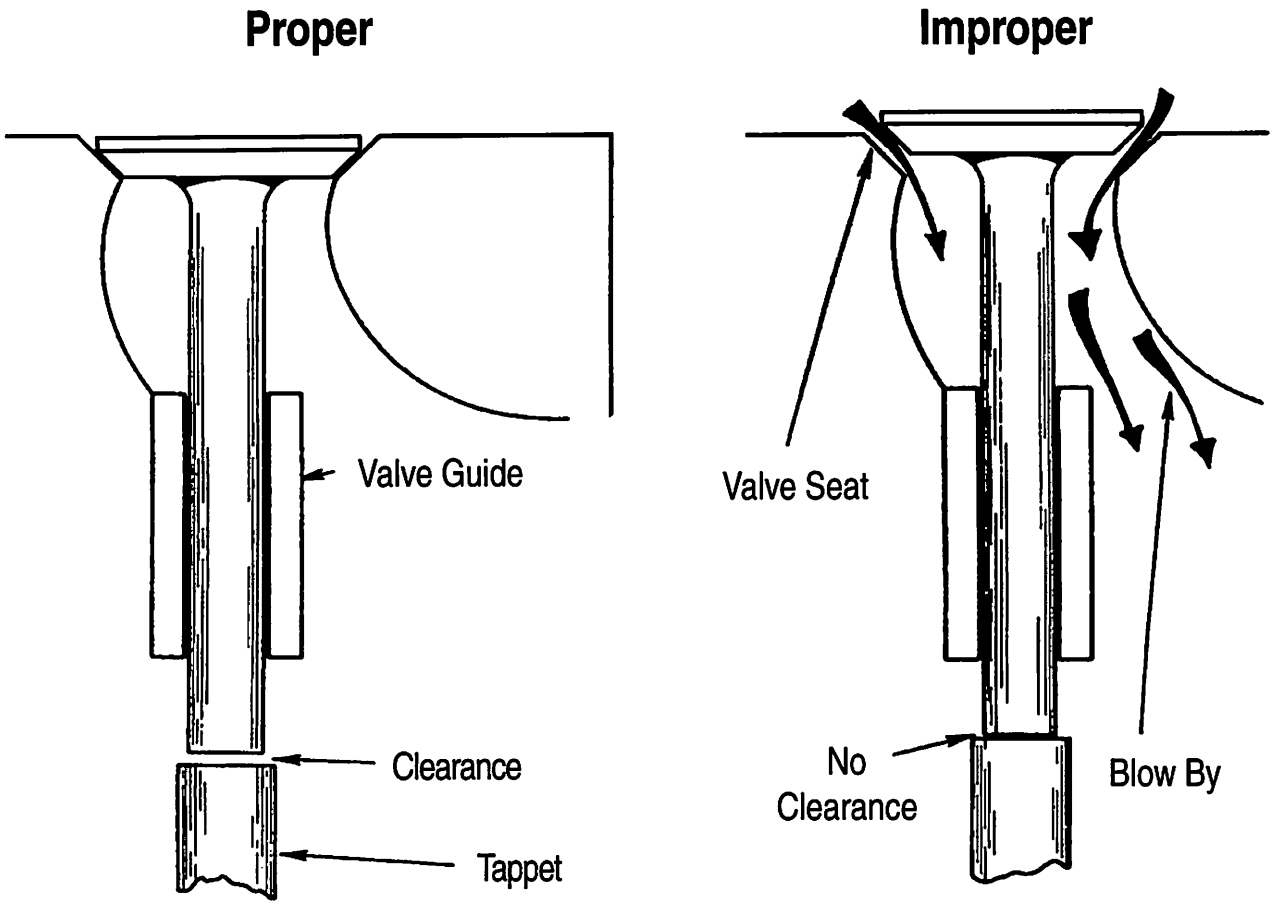
Measuring a Valve Stem



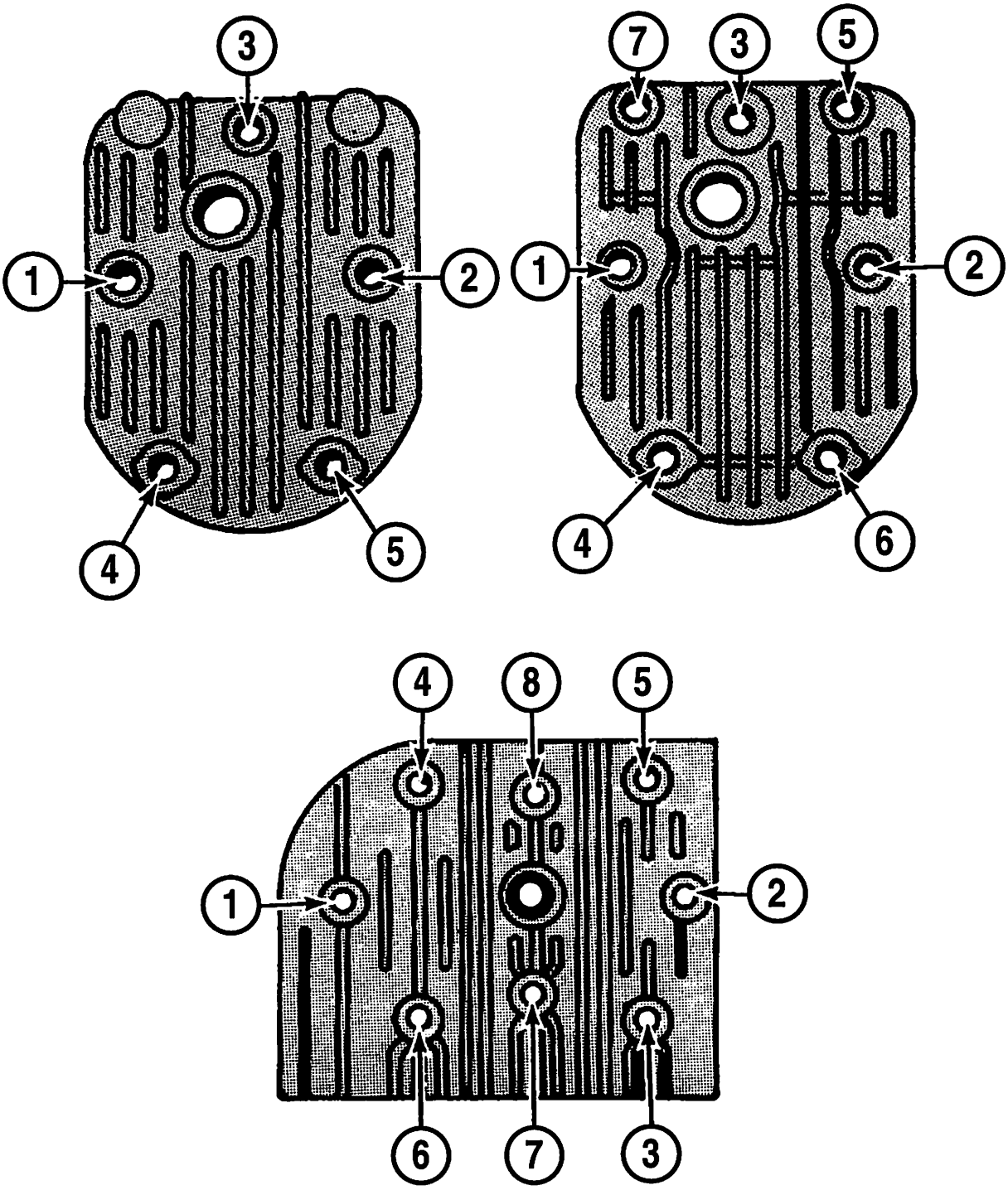
Typical Valve-Grinding Specifications



Valve Clearance Adjustment



Typical Cylinder Head, Bolt-Tightening Sequence



Module 4: Compression, Valve Service and Repair

NAME_____

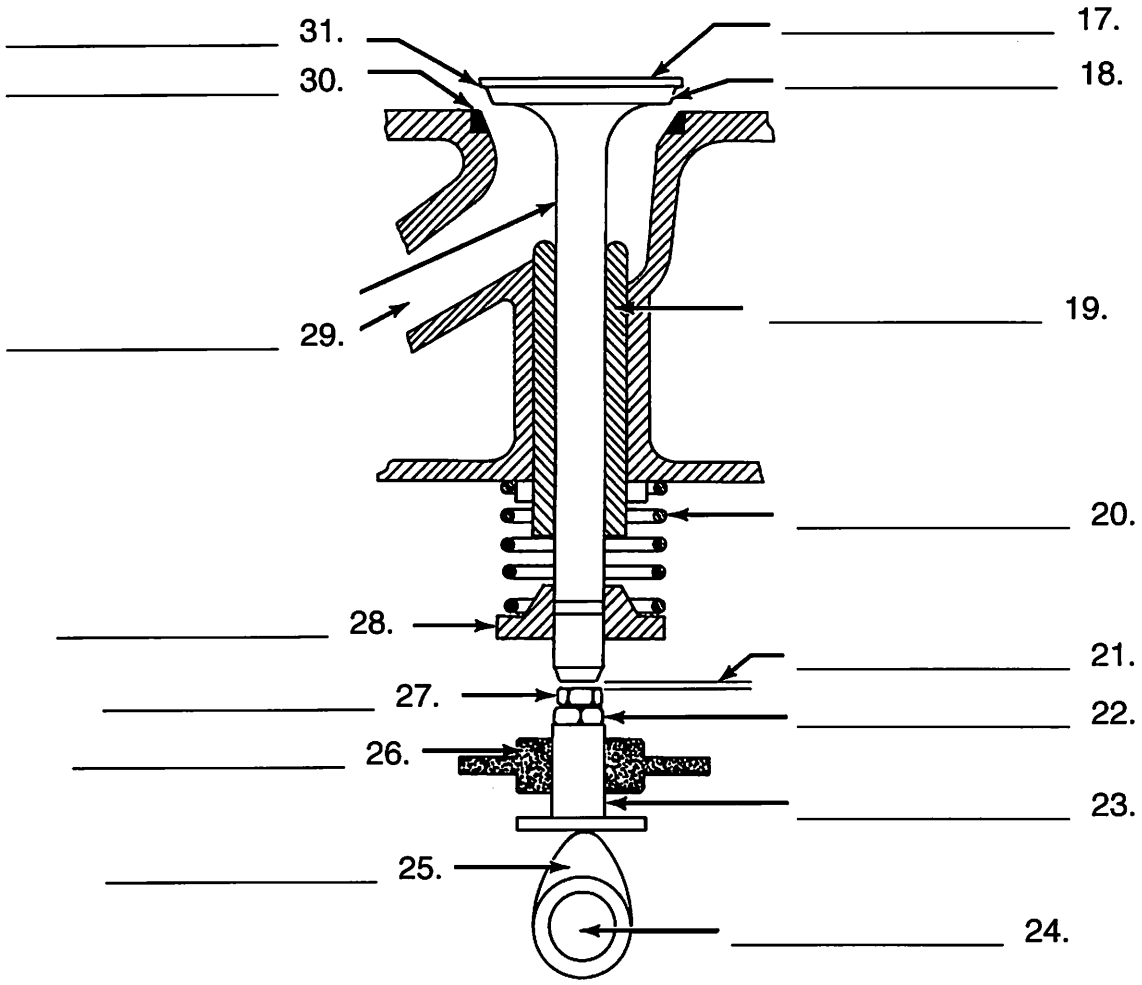
DATE_____

EVALUATION

Match the terms on the right with their correct definition.

____ 1.	The matched surface which the valve face contacts.	
____ 2.	That portion of a valve which rests within a valve stem guide.	
____ 3.	Substance placed between two metal surfaces to act as a seal.	
____ 4.	The portion of the valve upon which the valve face is machined.	
____ 5.	A thin rough edge of metal left on the tip of a part being filed.	
____ 6.	Space between valve face and head.	
____ 7.	Applying pressure to a gas so that it is contained in a smaller volume.	
____ 8.	Process of mating the valve seat and valve face.	
____ 9.	A detachable portion of an engine fastened securely to the top of the cylinder block.	
____ 10.	Process of refacing the valve and seat to manufacturer's specifications.	
____ 11.	The gap allowed between the end of the valve stem and the valve lifter.	
____ 12.	A coil spring used to close a valve.	
____ 13.	The part of a valve which contacts a seating surface.	
____ 14.	The part that rides on the cam and pushes open the valve.	
____ 15.	When both valves are open at the same time.	
____ 16.	A part installed to support and maintain alignment of the valve.	
		a. Valve grinding
		b. Valve spring
		c. Gasket
		d. Valve stem
		e. Valve clearance
		f. Valve lifter
		g. Burr
		h. Compression
		i. Valve seat
		j. Valve face
		k. Valve face
		l. Cylinder head
		m. Valve margin
		n. Valve lapping
		o. Valve stem guide
		p. Valve overlap

Identify parts of the valve train.



List six important steps in completing a valve job.

32.

33.

34.

35.

36.

37.

Fill in the blank.

38. A weak valve spring will cause._____.

39. A _____ feeler gage should be used in checking valve tappet clearance.

40. When the valve margin is ground to less than _____ inch, the valve should be replaced.

41. _____ valves operate under extreme high temperatures under normal engine operation.

Performance evaluation.

42. Inspect and service a valve assembly.

Module 5: Governor Adjustment and Repair

Lesson 1: Inspecting and Servicing Governor Systems

Objective

After completion of this unit, you should be able to inspect and service governor systems on small engines.

Study Questions

1. **What are common terms used in inspecting and servicing the governor system?**

2. **What is the purpose of the governor?**

3. **What are the types of governor systems used on small engines?**

4. **What are the component parts of the air vane governor?**

5. **What are the component parts of the mechanical governor?**

6. **What is the purpose of each component part of the air vane governor?**

7. **What is the purpose of each component part of the mechanical governor?**

8. **What is the procedure to inspect, adjust and repair an air vane governor?**

9. **What is the procedure to inspect and adjust external components of a mechanical governor with internal flyweights?**

References

1. Briggs and Stratton. Service and Repair Instructions For Single Cylinder Four-Cycle Engines. Milwaukee, Wisconsin, 1990.

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4. Small Engine Repair. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, 1985.

5. Small Engine Operation, Maintenance and Repair. Athens, Georgia: American Association for Vocational Instructional Materials, 1987.

6. Small Gasoline Engines, Operation, Repair and Maintenance. St. Paul, Minnesota: Hobar Publications 1992.

Module 5: Governor Adjustment and Repair

Lesson 1: Inspecting and Servicing Governor Systems

Teaching Procedures

A. Introduction

B. Motivation

The governor automatically regulates the speed of a small engine at the setting selected on the speed control. The governor regulates engine speed by adjusting the amount of fuel-air mixture fed through the carburetor.

C. Assignment

D. Supervised Study

E. Discussion

1. Use charts and TMs to illustrate parts of the governor system. Display the two governor systems used on small engines.

What are common terms used in inspecting and servicing the governor system?

a) Air vane: A fin on the governor system activated by air from the flywheel.
b) Linkage: A series of rods, springs and levers used to transmit motion from one unit to another.
c) Throttle valve: The round disk valve in the throttle body of the carburetor that can be turned to admit more or less air, thereby controlling engine speed.
d) Throttle: Lever controlling the throttle valve by linkage and spring adjustment.
e) Centrifugal force: A force which tends to move a body away from its center of rotation.
f) Pneumatic: Moved or worked by air.
g) Governor: A device used to automatically regulate speed.
h) Tachometer: A device for measuring and indicating the rotational speed of an engine.

2. Demonstrate how the governor works by using a water faucet. Slowly turn on the water and compare this action to the operation of the governor. As the load (water) is applied, the governor (faucet) opens the throttle to supply enough fuel-air mixture to maintain engine speed. Then slowly reduce the water. The

governor reduces the amount of fuel-air mixture and prevents the engine from overspeeding.

What is the purpose of the governor?

The governor maintains constant engine speed.

If your engine had no governor, it would "choke down" on application of load. With the governor functioning properly, the engine speed remains constant at variable loads as long as the load is within the horsepower capacity of the engine.

3. Display examples of both types of governors. Demonstrate how the air vane governor works (the air vane reacts to the air flow from the flywheel fins which opens and closes the throttle). Demonstrate how the mechanical governor works (the mechanical system operates by the use of centrifugal weights working against a spring).

What are the types of governor systems used on small engines?

TM-1.1 and TM-1.2.

a) Air vane governor: When the engine is running, the flywheel fins blow air against the air vane which is connected directly to the throttle. The force and movement of the air on the air vane tends to close the throttle and slow the engine. At the same time, the governor spring opposes the movement and forces the throttle open. On some engines the spring is connected to an adjustable speed control so that the tension on the spring can be adjusted by the operator. An increase in spring tension will increase engine speed. Decreasing the spring tension will slow the engine speed.
Note: The point at which the pull of the spring equals the force of the air vane is called governed speed.

b) Mechanical Governor: This system works in a similar way to the air vane type except, instead of force of air blowing against the vane, centrifugal weights oppose the governor spring. As the engine load increases, slowing the engine, the centrifugal force of the weights decrease and allows the governor spring to pull the throttle open. This will increase the amount of air-fuel mixture intake and compensates for the increased load to maintain the desired speed of the engine.

4. Display the component parts of the two governor systems. Discuss the function of the parts. Display governor springs and emphasize

how important it is to always replace the appropriate spring when servicing the governor.

Have students locate components of governor systems on demonstration engines.

What are the component parts of the air vane governor?

TM-1.1 and TM-1.2

a) Throttle control.
b) Control spring.
c) Air vane.
d) Throttle linkage.
e) Flywheel.

5. Have a student assist you in disassembling a mechanical governor. With the sump removed, you can observe and discuss the working parts of the mechanical governor. Discuss maintenance. Emphasize the danger of a runaway engine. Repairers should always be acquainted with the ignition kill system in case of malfunctioning governor.

What are the component parts of the mechanical governor?

a) Throttle control.
b) Throttle rod.
c) Throttle linkage.
d) Control spring.
e) Control arm.
f) Flyweights.
g) Throttle shaft.

6. Demonstrate an engine with a broken air vane, air vane binding, wrong spring, and a spring installed correctly.

What is the purpose of each component part of the air vane governor?

a) Throttle control: Regulates engine speed.
b) Control spring: Connection between throttle control and throttle valve shaft.
c) Air vane: Senses air movement and opens or closes throttle.
d) Linkage: Connects air vane to the throttle valve shaft.
e) Flywheel: Provides pneumatic pressure in relationship to engine R.P.M.

7. Demonstrate the control arm of the governor and illustrate how to properly adjust the mechanical governor. Discuss the use of the

Student Lab Manual and issue a copy to each class member. The lab manual serves as a job sheet.

What is the purpose of each component part of the mechanical governor?

a) Throttle control: Regulates engine speed.
b) Throttle rod: Transfers control adjustment to control spring.
c) Throttle linkage: Connects control arm to throttle shaft.
d) Control spring: Provides tension to control arm.
e) Control arm: Transfers flyweight action to throttle link.
f) Flyweights: Senses engine R.P.M. and controls governor control arm.

8. Ask a student to assist you in inspecting and adjusting an air vane governor. Issue the Student Lab Manual and explain how the manual is to be used.

What is the procedure to inspect, adjust and repair an air vane governor?

Note: Use step-by-step procedures in Student Lab Manual.

a) Wear proper safety equipment.
b) Read operator's manual.
c) Disconnect the spark plug wire.
d) Remove the shroud.
e) Inspect the air vane governor for worn linkage or damaged governor spring.
f) Remove carburetor from engine.
g) Remove link and spring assembly for the air vane.
h) Remove spring from control lever.
i) Remove spring from eyelet in link.
j) Remove bolt to free air vane governor from engine.
k) Use a solvent to clean governor assembly.
l) Install air vane governor.
m) Select the proper governor spring.
n) Install link on air vane.
o) Install new spring.
p) Install governor link to carburetor.
q) Install carburetor.
r) Install the shroud on the engine.
s) Reconnect the spark plug wire.
t) Check the top governed speed with a tachometer.
u) Check the no-load idle speed with a tachometer.

9. Have students assist you in inspecting and adjusting external components of a mechanical governor with internal flyweights.

What is the procedure to inspect and adjust external components of a mechanical governor with internal flyweights?

Note: Use step-by-step procedures in Student Lab Manual.

a) Read operator's manual.
b) Wear proper safety equipment.
c) Disconnect the spark plug wire.
d) Inspect the mechanical governor for worn linkage or damaged governor spring.
e) Loosen carburetor from engine to free governor linkage.
f) Remove spring from governor lever and linkage control.
g) Install new linkage.
h) Install carburetor on engine.
i) Install new spring.
j) Adjust governor lever.
k) Check the governor linkage.
l) Reconnect the spark plug wire.
m) Check the no-load idle speed with a tachometer.
n) Check the no-load high engine speed with a tachometer.

F. Other Activities

1. Show examples of new and worn governors.

2. Show examples of common linkage problems.

G. Conclusion

Governors are a common part of the small engine operating system and should receive regular inspection and adjustment.

H. Competency

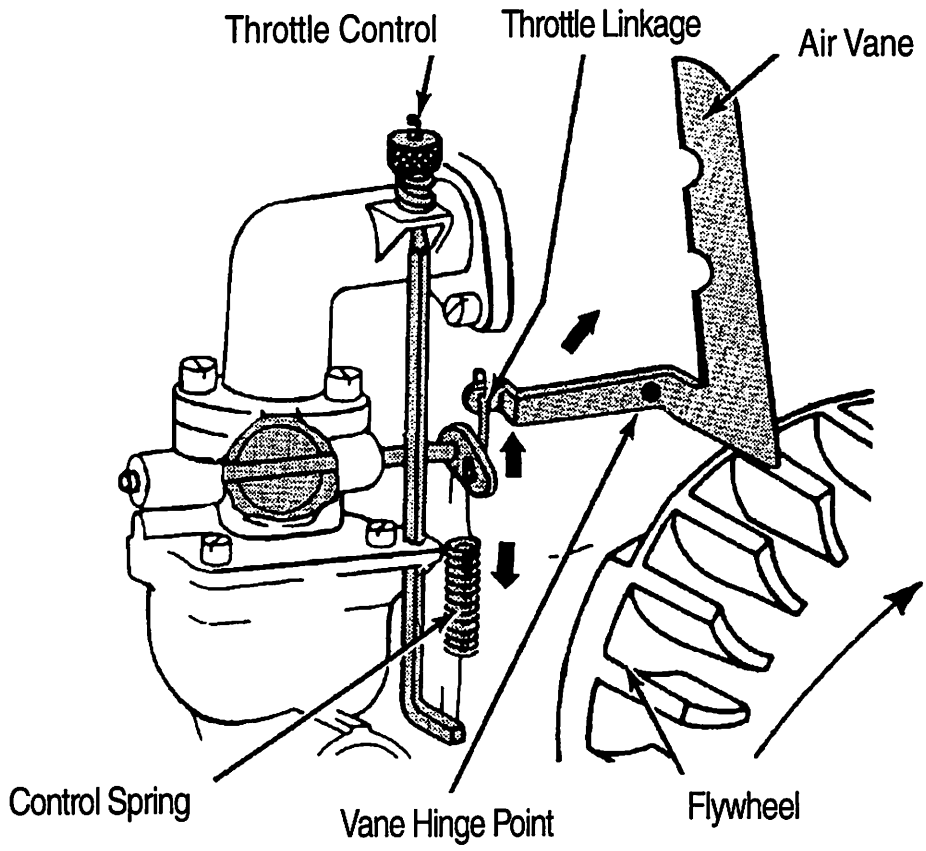
After completion of this unit, the student should be able to inspect and service governor systems on small engines.

I. Answers to Evaluation

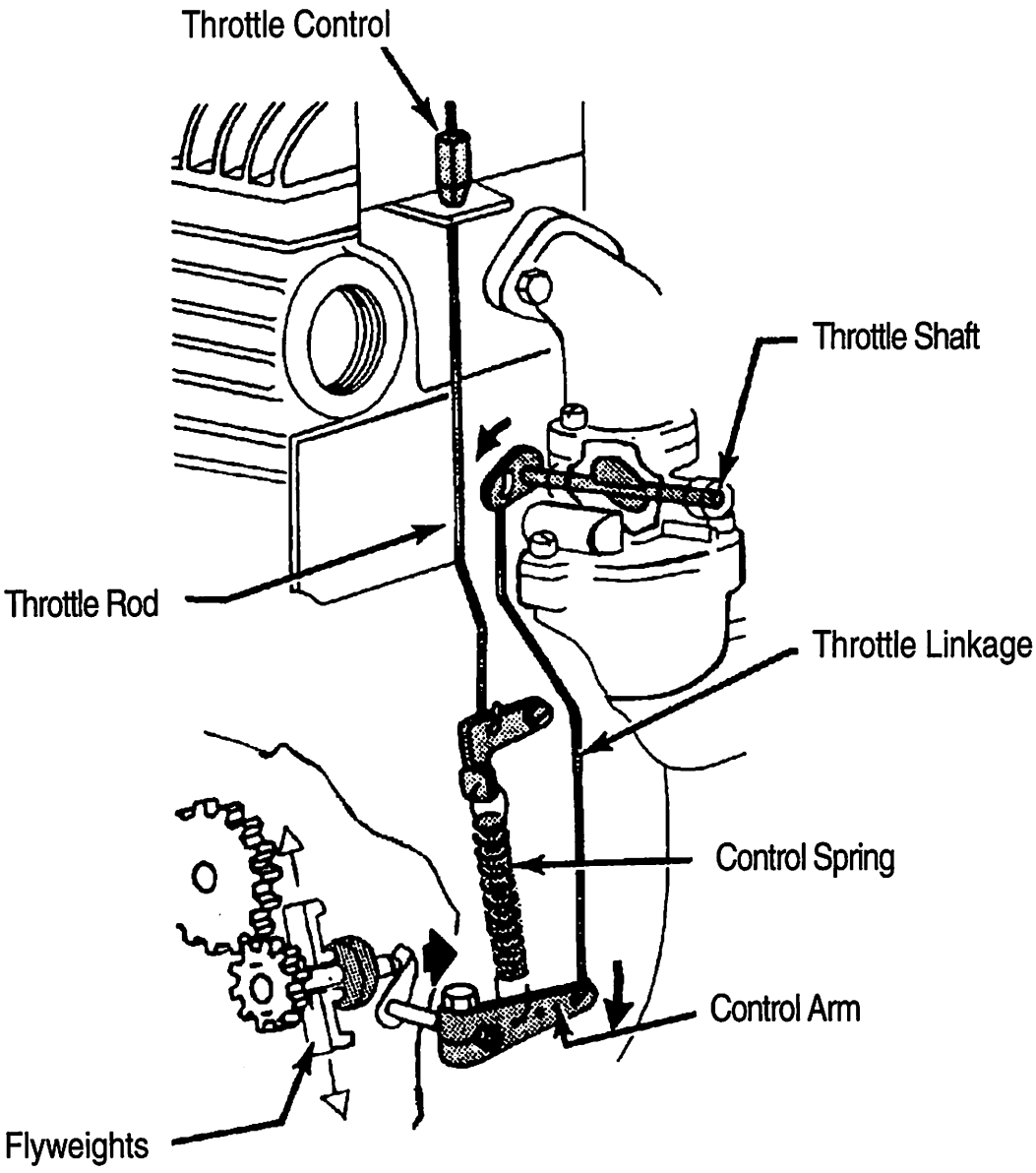
1. b
2. d
3. c
4. f
5. e
6. h
7. g
8. a
9. Air vane

10. Mechanical
    (Note: answers 9 and 10 can be in any order.)
11. X
12. X
13. X
14. Throttle control
15. Throttle linkage
16. Air vane
17. Flywheel
18. Control spring
19. Throttle control
20. Throttle shaft
21. Throttle linkage
22. Control spring
23. Control arm
24. Flyweights
25. Throttle rod
26. a
27. c
28. b
29. d
30. e
31. e
32. c
33. a
34. f
35. d
36. b
37. Evaluated by instructor.
38. Evaluated by instructor.

Components of an Air Vane Governor System



Components of a Mechanical Governor System



Module 5: Governor Adjustment and Repair

NAME_____

DATE_____

EVALUATION

Match the terms on the right with their correct definitions.

____	1.	A device on the governor system which is activated by air from the flywheel.	a. Tachometer
____	2.	A device used to automatically regulate speed.	b. Air Vane
____	3.	Series of rods, springs and levers used to transmit motion from one unit to another.	c. Linkage
____	4.	Moved or worked by air.	d. Governor
____	5.	The round disk valve in the throttle body of the carburetor that can be turned to admit more or less air, thereby controlling engine speed.	e. Throttle Valve
____	6.	A force which tends to move a body away from its center of rotation.	f. Pneumatic
____	7.	Lever controlling the throttle valve by linkage and spring adjustment.	g. Throttle
____	8.	A device for measuring and indicating the rotational speed of an engine.	h. Centrifugal Force

Name the two types of governors used on small engines.

9.

10.

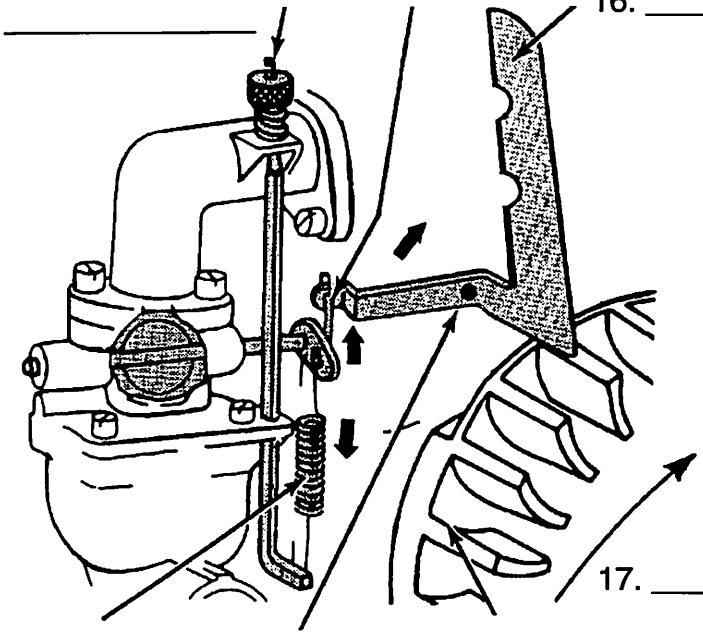
Select purposes of the governor system by placing an "X" in the appropriate blanks.

____ 11. Maintains constant speed of an engine.

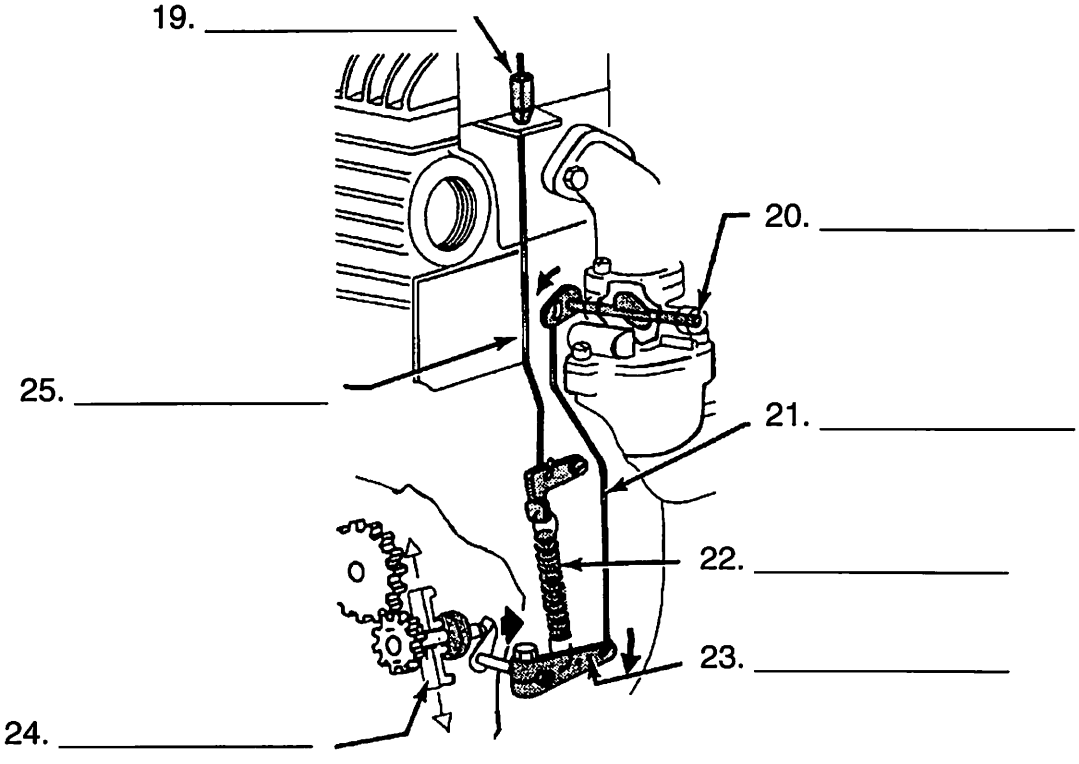
____ 12. Prevents overspeeding that may cause engine damage.

____ 13. Limits both high and low speeds.

Identify the components of the air vane governor.



Identify the components of the mechanical governor.



Match the components of the air vane governor system on the right with their correct purposes.

____	26. Connection between throttle control and throttle valve shaft.	a.	Control spring
____	27. Connects air vane to the throttle valve shaft.	b.	Flywheel
____	28. Provides pneumatic pressure in relationship to engine R.P.M.	c.	Linkage
____	29. Senses air movement and opens or closes throttle.	d.	Air vane
____	30. Regulates engine speed.	e.	Throttle control

Match the components of the mechanical governor system on the right with their correct purposes.

____	31. Transfers control adjustments to control spring.	a.	Flyweights
____	32. Provides tension to control arm.	b.	Control arm
____	33. Senses engine rpm and controls governor control arm.	c.	Control spring
____	34. Regulates engine speed.	d.	Throttle linkage
____	35. Connects control arm to throttle shaft.	e.	Throttle rod
____	36. Transfers flyweight action to throttle link.	f.	Throttle control

Demonstrate an ability to:

37. Inspect, adjust and repair an air vane governor.

38. Inspect and adjust external components of a mechanical governor with internal flyweights.

Module 6: Lubricating Small Engines

Lesson 1: Inspecting and Servicing the Lubrication Systems

Objective

After completion of this unit, you should be able to select the type and grade of oil to use in a Four-cycle engine. You should be able to properly inspect and service the lubrication system.

Study Questions

1. **What are common terms used when inspecting and servicing the lubrication system?**

2. **What are the two types of lubrication systems?**

3. **What is the purpose of the crankcase breather?**

4. **What is the correct maintenance procedure in checking the crankcase breather?**

5. **What is the function of oil?**

6. **What are the characteristics of good engine oil?**

7. **What does SAE Viscosity Number mean to you when purchasing oil?**

8. **What is the API Service Classification of oil?**

9. **What are five contaminants found in engine oil?**

10. **What common terms describe oil additives?**

11. **What facts should be considered in selecting engine oils for best performance?**

12. **What is the proper procedure to service the crankcase breather and change oil and filter?**

References

1. Briggs and Stratton. Service and Repair Instructions for Single Cylinder Four-Cycle Engines. Milwaukee, Wisconsin, 1990.

2. Head, Amon. Lubricating Small Engines. Columbia, Missouri: Instructional Materials Laboratory, University of Missouri-Columbia. 1994.

3. Roth, Alfred C. Small Gas Engines. South Holland, Illinois: Goodheart-Wilcox Company, Inc., 1992.

4. Small Engine Repair. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, 1985.

5. Small Engines Operation, Maintenance And Repair. Athens, Georgia: American Association for Vocational Instructional Materials. 1987.

6. Small Gasoline Engines, Operation, Repair and Maintenance. St. Paul, Minnesota: Hobar Publications 1992.

7. Fuels and Lubricants. Athens, Georgia; American Association for Vocational Instructional Materials.

Module 6: Lubricating Small Engines

Lesson 1: Inspecting and Servicing the Lubrication System

Teaching Procedures

A. Introduction

B. Motivation

Display a can of multi-grade oil and single-grade oil. Demonstrate how oil provides a cushion between the metal bearing surfaces. Emphasize that when selecting oil for an engine, oil viscosity and oil type (API Service Classification) should be considered.

C. Assignment

D. Supervised Study

E. Discussion

1. Use charts and TMs to illustrate the terminology used in the lubrication system of small engines.

What are common terms used when inspecting and servicing the lubrication system?

a) Additives: A material added to the oil to give it certain properties to improve performance.
b) Multi-grade or multi-viscosity grade oils: Oils which meet the viscosity requirements of two or more SAE grades. Example SAE 10w-30.
c) SAE: Society of Automotive Engineers. Usually refers to grade of viscosity.
d) API: American Petroleum Institute. Usually refers to Service Classification, the "type" of oil.
e) Friction: Resistance to movement between two objects placed in contact with one another.
f) "W" oils: Types of oils suitable for winter service. (Note: Type "W" viscosity is determined at 0 degree F or -18 degree C.)
g) Sludge: Heavy, thick residue found in the bottom of an oil pan caused by oil deterioration or oil contamination.
h) Blow-by: Leakage of unburned air-fuel mixture and some burned gases that have passed past the piston rings and into the crankcase during the compression and combustion strokes.

i) Dipper: Device fastened to connecting rod as a means of splashing oil.
j) Slinger: Device rotated by the camshafts for splashing oil.
k) Oil galley (passage): Passageways in the engine used to carry oil from one area to another.
l) Pressure relief valve: Valve in the lubrication system designed to limit maximum oil pressure.
m) Oil pickup: Device allowing the oil pump to "pick up" oil (which is free from sediment) in the oil pan.
n) Oil pan (sump): Cover on the bottom of the engine block providing a reservoir for the engine oil.
o) Oil filter: Device used to remove abrasive particles from the oil.
p) Viscosity: The resistance to flow or adhesive characteristics of an oil.

2. Ask a student to assist in demonstrating the two types of lubrication systems used in small engines. Discuss the importance of the characteristics of each lubrication system when purchasing a small engine. TM-1.1, TM-1.2 and TM-1.3.

What are the two types of lubrication systems?

(Note: Some engines use both systems)
a) Splash system (dipper type and slinger type).
b) Pump system (barrel and plunger type and gear and rotor type).

3. Demonstrate how to remove and check the breather for proper clearance. Show how the crankcase breather works. Have students check ten crankcase breathers and determine the ones that should be rejected. TM-1.4.

What is the purpose of the crankcase breather?

a) Allows blow-by to escape.
b) Limits corrosion of engine parts.
c) Prevents oil leaks at seals and gaskets by relieving crankcase pressure.
d) Allows entrance of fresh air.

4. Crankcase breathers should be checked and serviced once each year. Demonstrate how to inspect the venting elbows for loose fit and damaged tubes. Demonstrate operation of an engine with loose fit venting elbows. TM-1.5 and TM-1.6.

What is the correct maintenance procedure in checking the crankcase breather?

a) Remove breather from engine and check for proper clearance.
b) If a .045 wire gauge will enter the space between fiber disc valve and body, a new breather should be installed.
c) Do not apply force when checking with wire gauge.
d) When the breather is removed for inspection, a new gasket should be used. Tighten screws securely to prevent oil leakage.

5. Discuss how oil reduces rust and corrosive action, cleans, seals, lubricates and removes heat. Discuss how crankcase oil must also reduce friction and wear.

What is the function of oil?

a) Reduced friction and wear.
b) Cools moving parts.
c) Helps seal cylinders.
d) Keeps parts clean.
e) Cushions moving parts.

6. Discuss how a good engine oil is expected to retain enough fluid in the upper part of the cylinder to allow the engine to start easily. Discuss how a good oil should retain enough viscosity under enormous differences in temperature to reduce friction and wear between metal surfaces. Discuss how oil removes heat caused by friction and provides a seal against escaping gases that keeps the engine clean by holding carbon and sludge-forming materials in suspension until the oil is drained.

What are the characteristics of good engine oil?

a) Keeps a protective film on moving parts.
b) Resists breakdown at high temperatures.
c) Resists corrosion and rusting.
d) Prevents carbon build-up.
e) Prevents sludge formation.
f) Flows easily at low temperatures.
g) Resists foaming.
h) Resists breakdown after long use.

7. Describe how viscosity is the term used to describe how fluid an oil is (or its resistance to flow). Low-viscosity oil flows easily and is often called a thin oil. High viscosity oil has much more "body" and is called thick oil. Oils with a lower viscosity number followed by the letter "W" have been adapted for winter use. Demonstrate different viscosity characteristics of oil. TM-1.7.

What does SAE Viscosity Number mean to you when purchasing oil?

a) Oils vary in viscosity as temperatures change. Oil becomes more fluid as temperature increases and less fluid as temperature decreases.
b) Lighter oils for winter use are specified at 0 degree F and carry a 5w, 10w, or 20w symbol. Specifications are determined by time of flow through an instrument, such as a Saybolt viscometer, in seconds.
c) Heavier oils are specified at 210 degree F and carry 20, 30, 40, or 50 viscosity number.
d) Compounded oils, called multi-grade oils, behave as light oils in cold temperatures and heavier oils at high temperatures. The first two digits of its rating identify the low temperature capability. The second set of digits refer to the oil's high temperature capability. For example, a multi-grade 10w-30 oil has a low-temperature viscosity of a 10w oil and a high-temperature viscosity of a 30 oil. Thus, a 10w-30 oil meets the viscosity requirements for both 10w and SAE 30 oils.

8. Discuss information located on the bottle or can of oil. Explain the terms For API SERVICE, CC, CD, SF, and SG. Arrange for a demonstration of different brands of oil and check the API Service of each oil. TM-1.8.

What is the API Service Classification of oil?

Standardized specifications for oil qualities between the engine manufacturer, the petroleum industry, and the customer. Today's API Engine Service Classification includes the following oil service categories:

a) SF: 1980 gasoline engine warranty maintenance standard.
b) SG: 1989 gasoline engine warranty maintenance standard.
c) CC: Diesel engine service. Also used in certain heavy-duty gasoline engines.
d) CD: Diesel engine service. Service for turbocharged or supercharged diesel engines where highly effective control of wear and deposits is vital.

9. Demonstrate gum and varnish deposits in gasoline. Take two or three drops of gasoline and let it evaporate. Check for residue, gum or varnish stains remaining.

What are five contaminants found in engine oil?

a) Water.
b) Dirt or foreign particles.
c) Fuel.
d) Oxidation (causes oil to thicken).
e) Acids.

10. Ask assistance from your local oil company representative to speak to your class on oil additives.

What common terms describe oil additives?

a) Anti-corrosion: Helps prevent failure of alloy bearings from corrosive acids caused by combustion.
b) Oxidation inhibitor: Prevents acid, varnish, and sludge formations.
c) Anti-rust: Prevents rusting of metal parts during storage or downtime.
d) Viscosity index improver: Helps oil provide cylinder lubricating protection at both high and low temperatures.
e) Pour point depressant: Prevents wax crystals from congealing in cold weather and forming clumps.
f) Extreme pressure: Assures lubrication where extreme pressures between close tolerances are encountered.
g) Detergent-dispersant: Helps keep metal surfaces clean and prevents deposit formation.
h) Foam inhibitor: Helps prevent air bubbles which would restrict lubrication (fast circulation causes oil to foam).

11. Discuss different brands of oil. Have students check the API Service Classification. Discuss the different kinds of oil used by members of the class. Emphasize the importance of using an oil that meets the engine manufacturer's specifications.

What facts should be considered in selecting engine oils for best performance?

a) Use brands which meet engine manufacturer's specifications.
b) Drain and change at recommended intervals.
c) Select oils which have been performance tested.
d) Never mix oils of various specifications.
e) Bring engine up to normal operating temperature each time it is used.
f) Use clean oil containers and keep them covered, sealed, and protected to prevent oil contamination.
g) Replace or clean filters before they become plugged.

12. Ask a student to assist in a demonstration on servicing the crankcase breather and changing oil.

What is the proper procedure to service the crankcase breather and change oil and filter?

a) Check breather for signs of leakage.
b) Check breather fiber disc valve for proper clearance.
c) Properly install new breather if needed.
d) Inspect venting elbows for loose fit and damaged tubes.
e) Properly install new elbows or damaged tubes if needed.
f) Measure the level of the crankcase oil.
g) Start the engine and run for 10 minutes.
h) Stop the engine and disconnect the spark plug wire.
i) Locate the drain plug.
j) Clean and remove the drain plug.
k) Properly drain oil from crankcase.
l) Refill crankcase with new oil to manufacturer's specification.
m) Reconnect the spark plug wire and start the engine.
n) Stop the engine and recheck the oil level.
o) Clean your work area and return tools to their proper places.

F. Other Activities

1. Provide examples of worn and new oil for student comparison.

2. Provide examples of light and heavy weight oil for student comparison.

3. Provide examples of engine parts worn by insufficient lubrication.

G. Conclusions

Oil is the life blood of a small engine. Proper lubrication will help ensure long life and efficient operation.

H. Competency

After completion of this unit, the student should be able to select the type and grade of oil to use in a Four-cycle engine. You should be able to properly inspect and service the lubrication system.

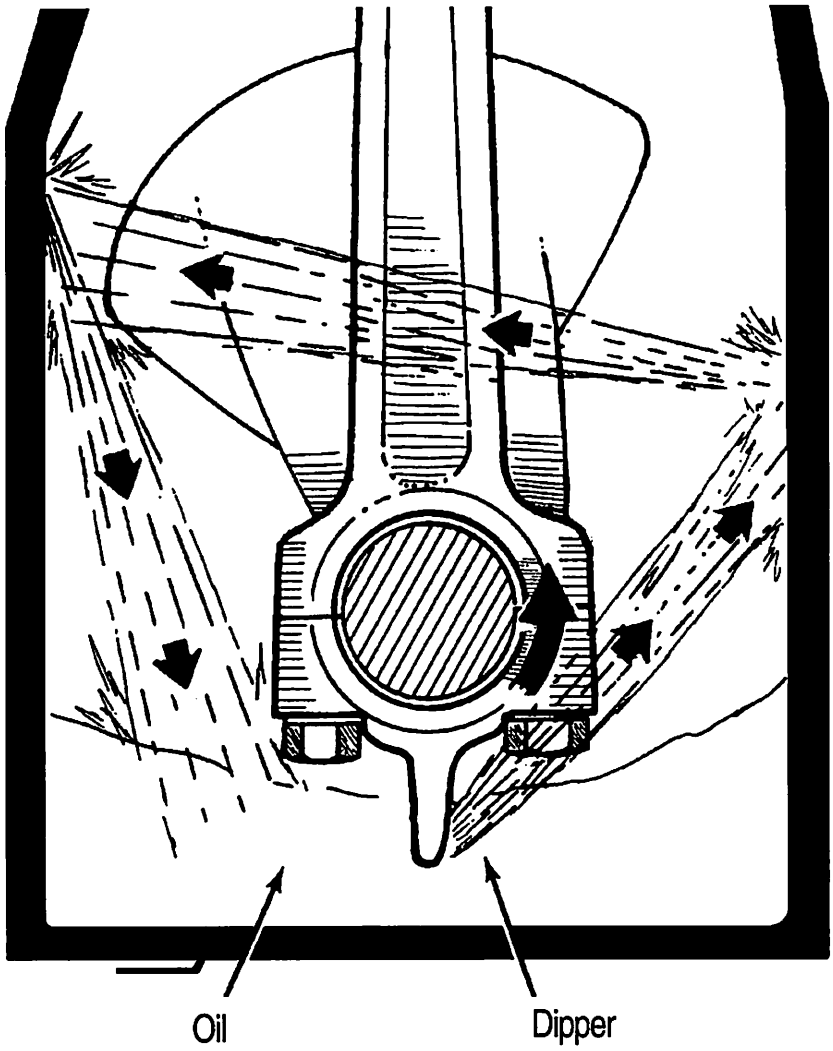
I. Answers to Evaluation

1. m
2. e
3. n
4. d
5. c

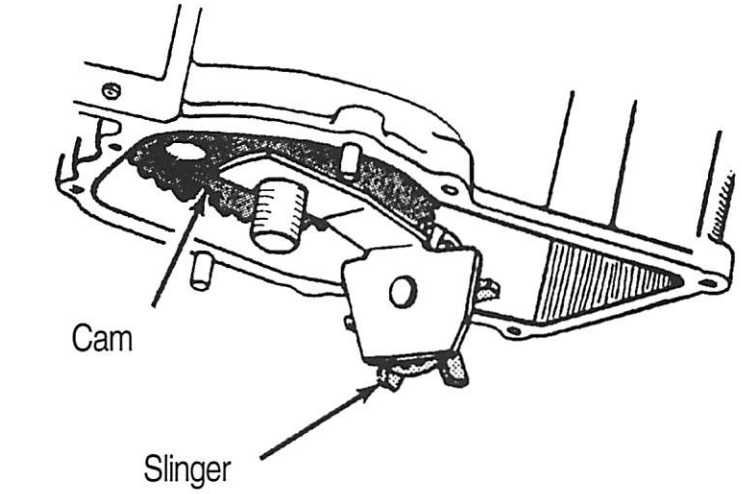
6. a
7. b
8. g
9. p
10. o
11. f
12. k
13. l
14. h
15. j
16. i
17. Splash system
18. Pump system
    (Note: answers 17 and 18 can be in any order.)
19.
20. X
21. X
22. X
23.
24. friction
25. Cools or cushions
26. cylinders
27. clean
28. X
29. X
30. X
31. X
32. X
33. X
34.
35. X
36. X
37. temperature
38. zero
39. 210
40. API Service SG
41. Oil's viscosity (such as SAE 10w-40)
42. Information on the oil's fuel saving properties (such as Energy Conserving II).
    (Note: answers 40-42 can be given in any order.)
43. c
44. b
45. a
46. d
47. e
48. f
49. h
50. g
51. X

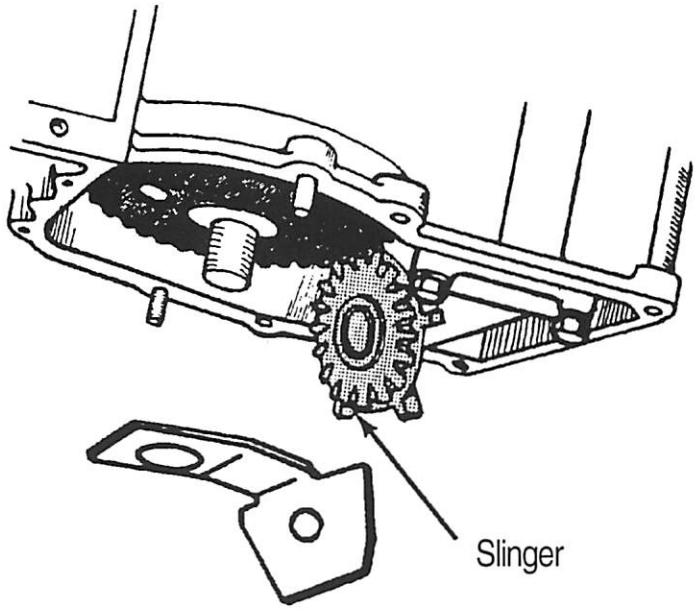
52. X
53. X
54. X
55. X
56. X
57. X
58. manufacturer's
59. Drain
60. performance tested
61. specifications
62. temperature
63. Evaluated by instructor.
64. Evaluated by instructor.

Dipper Lubrication System

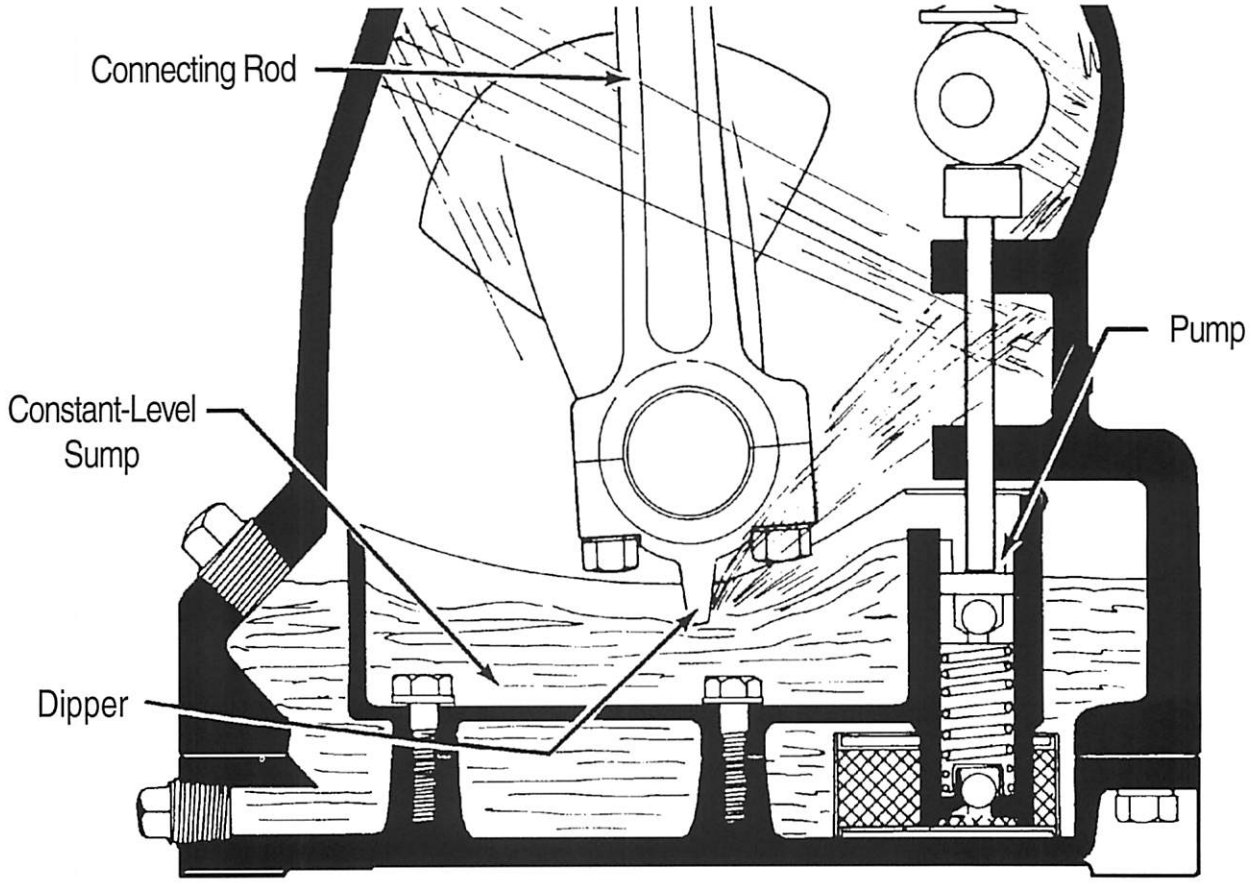


Slinger Lubrication System

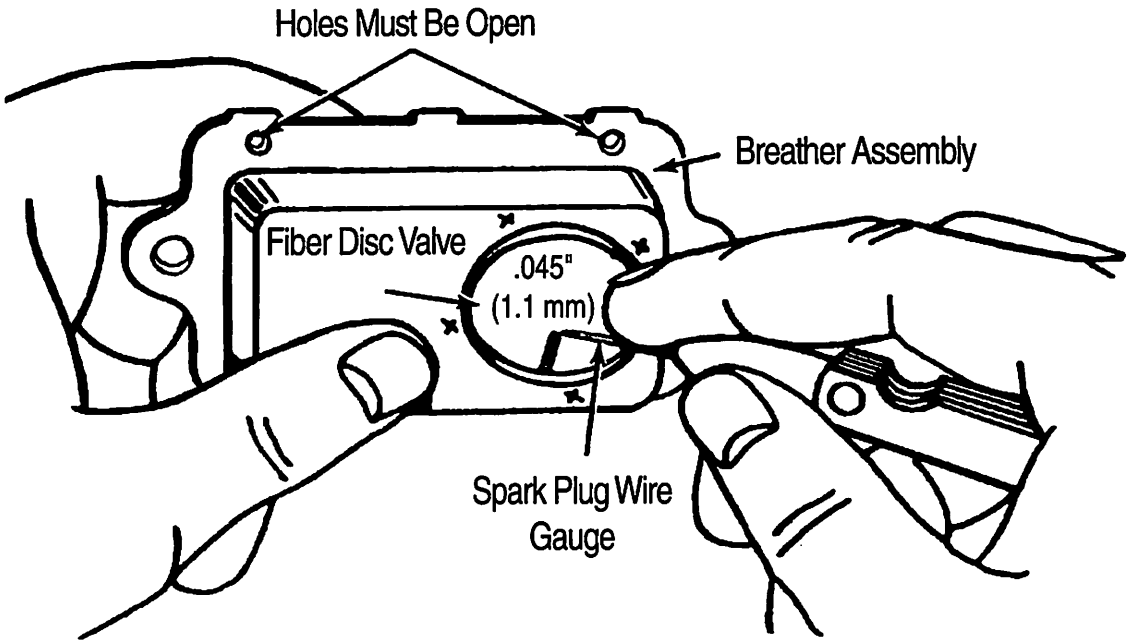




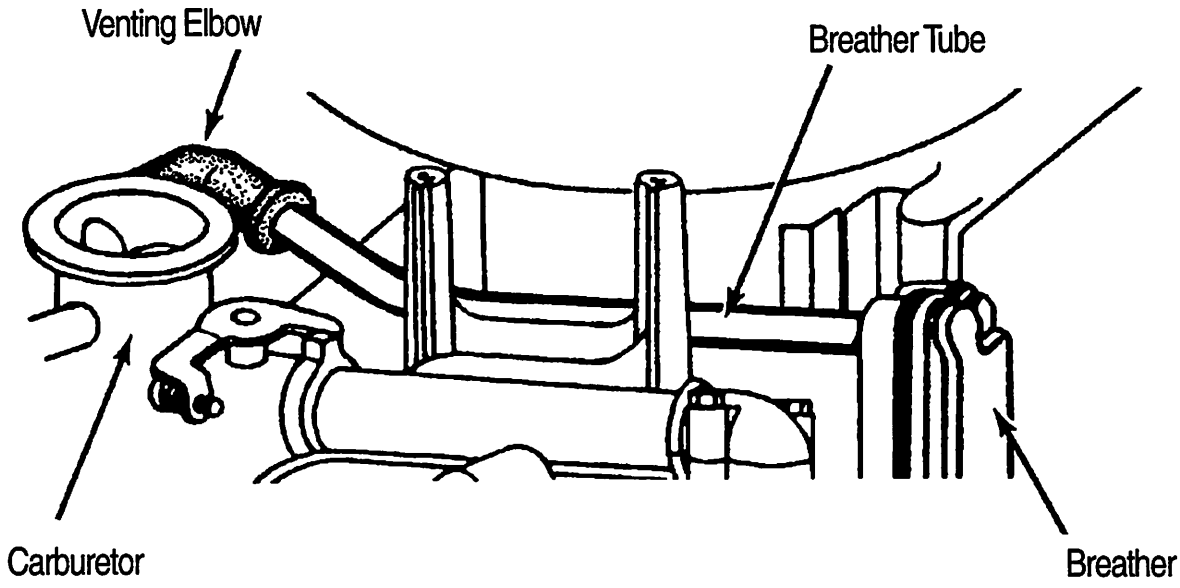
Dipper, Pump, and Constant-Level Sump



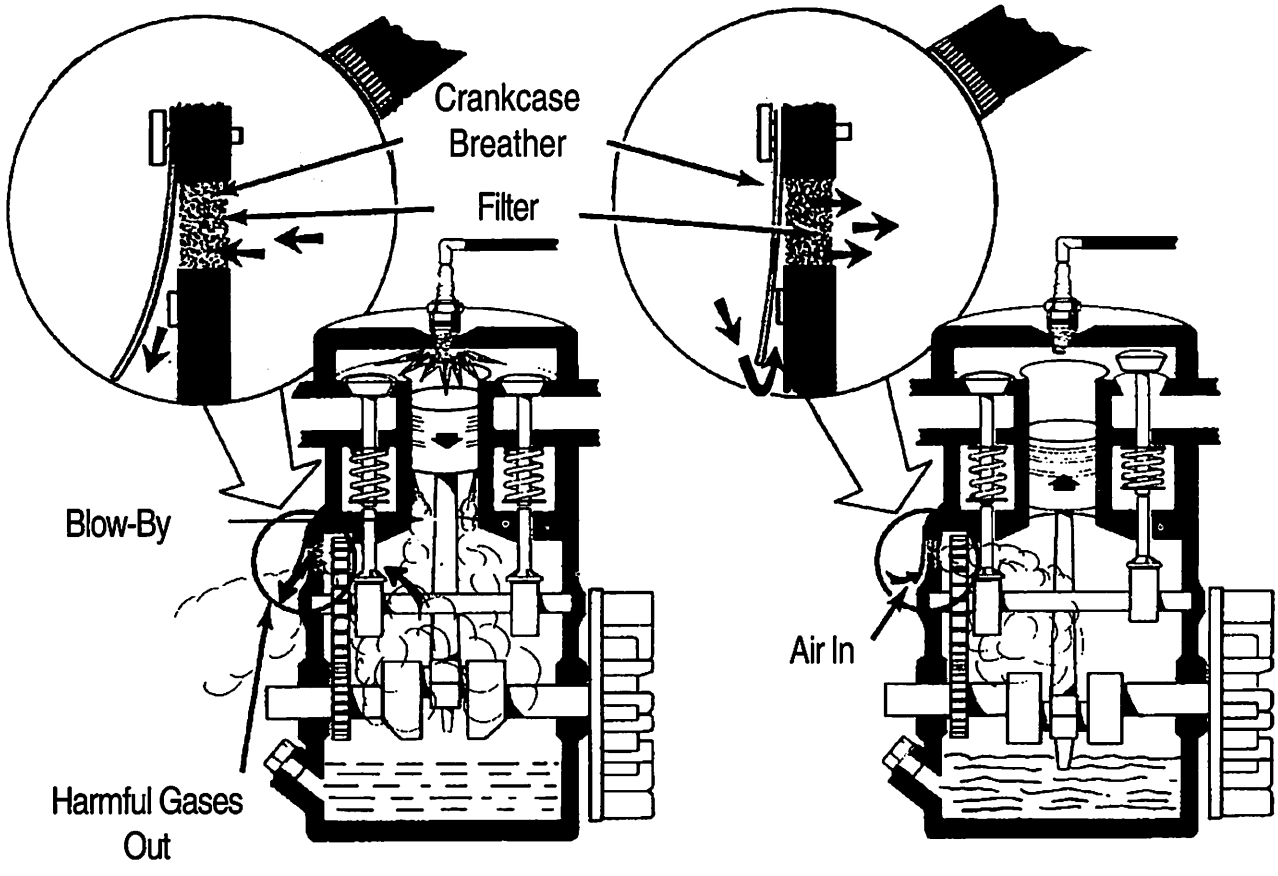
Crankcase Breather



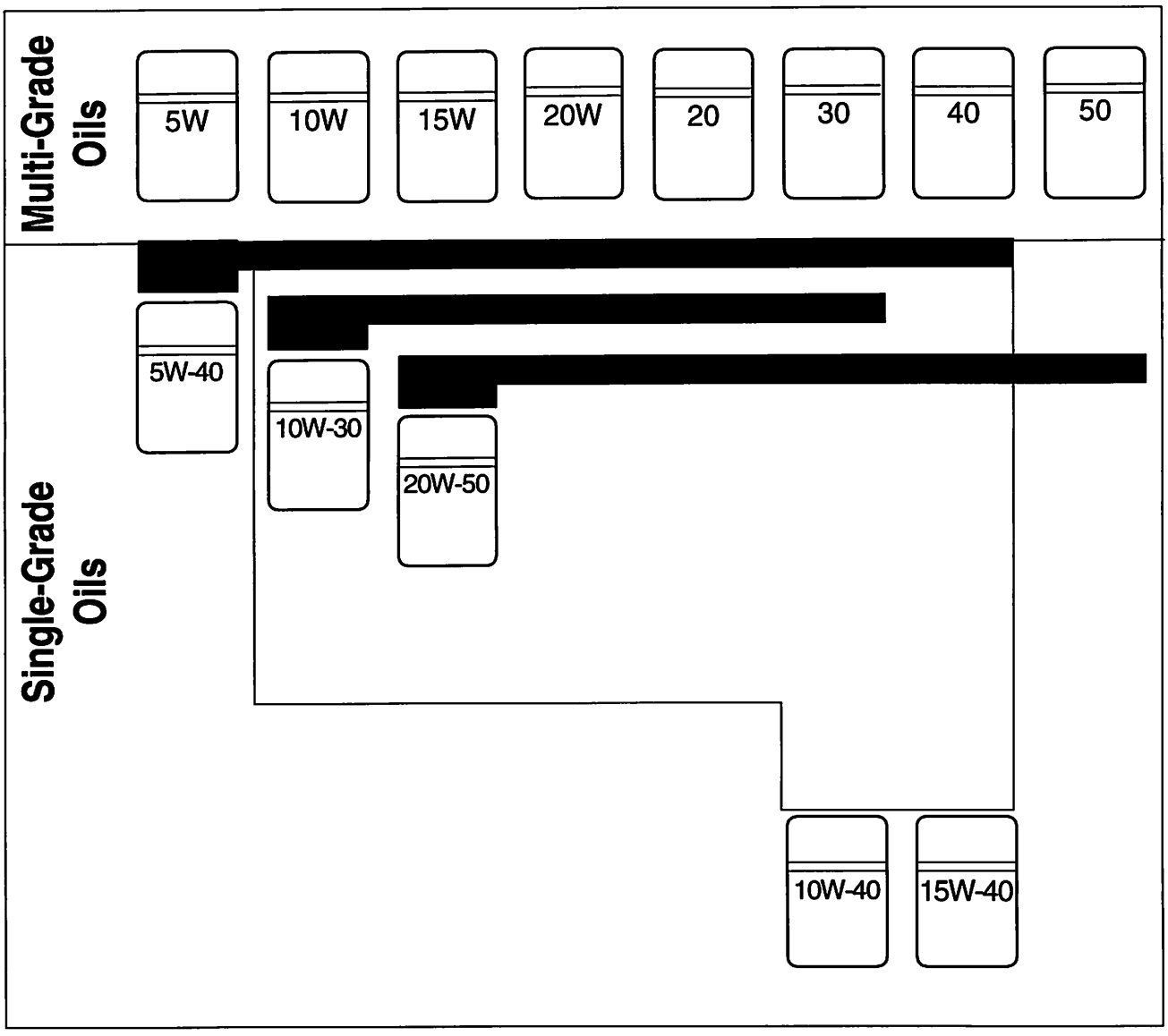
Crankcase Breather Vented To Carburetor



Crankcase Breather Principles (Four Cycle Engine)



Comparison of Crankcase Oils
(Viscosity Grades)



API Classification System

Check operator's manual for recommended oil classification. Use a high quality detergent oil classified "For Service SF, SG, CC, or CD."

Classification markings are on the oil can.

API Service SG, SF/CC, CD

CAUTION: Contains Petroleum Lubricant. Repeated skin contact can cause skin disorders.
ATTENTION: Used motor oil is a possible skin cancer hazard based on available data.
PRECAUTIONARY MEASURES: Avoid excessive and prolonged skin contact. Wash thoroughly after handling. Avoid penetration and inhalation of oil mists.

DON'T POLLUTE, CONSERVE RESOURCES, RETURN USED OIL TO COLLECTION CENTERS.

Module 6: Lubricating Small Engines NAME_____
DATE_____

EVALUATION

Match the terms on the right with their correct definition.

____	1.	Types of oils that are suitable for winter service. Type "W" viscosities are determined at 0 degree F or -18 degree C.)	a.	SAE
			b.	Viscosity
			c.	API
____	2.	A material that is added to the oil to give it certain properties to improve performance.	d.	Multi-grade oil
			e.	Additives
____	3.	Resistance to movement between two objects placed in contact with one another.	f.	Oil pan (sump)
			g.	Oil filter
____	4.	Oils which meet the viscosity requirement two or more SAE grades.	h.	Slinger
			i.	Pressure Relief Valve
____	5.	American Petroleum Institute.		
____	6.	Society of Automotive Engineers.	j.	Oil galley
____	7.	The resistance to flow or adhesive characteristics of an oil.	k.	Dipper
			l.	Oil pickup
____	8.	A device used to remove abrasive particles from the oil.	m.	"W" oils
____	9.	Heavy, thick residue found in the bottom of an oil pan caused by oil deterioration or oil contamination.	n.	Friction
			o.	Blow-by
____	10.	Leakage of unburned air-fuel mixture and some burned gases past the piston rings into the crankcase during the compression and combustion strokes.	9.	Sludge

____ 11. Cover on the bottom of the engine block providing a reservoir for the engine oil.

____ 12. Device fastened to connecting rod as a means of splashing oil.

____ 13. Device allowing the oil pump to pick up oil which is free from sediment in the oil pan.

____ 14. Device rotated by the camshafts for splashing oil.

____ 15. Passageways in the engine used to carry oil from one area to another.

____ 16. Valve in the lubrication system designed to limit maximum oil pressure.

Name the two types of lubricating system used on small engines?

17.

18.

Select purposes of the crankcase breather by placing an "X" in the appropriate blanks.

____ 19. Cools engine parts.

____ 20. Allows blow-by to escape.

____ 21. Limits corrosion of engine parts.

____ 22. Prevents oil leaks at seals and gaskets by relieving crankcase pressure.

____ 23. Prevents entrance of fresh air.

Complete the following list of functions of engine oil by correctly filling in the blanks.

24. Reduces_____ and wear.

25. _____moving parts.

26. Helps seal _____.

27. Keeps parts _____.

Select characteristics of a good engine oil by placing an "X" in the appropriate blanks.

____ 28. Keeps a protective film on moving parts.

____ 29. Resists breakdown at high temperatures.

____ 30. Resists corrosion and rusting.

____ 31. Prevents carbon build-up.

____ 32. Prevents sludge formation.

____ 33. Flows easily at low temperature.

____ 34. Flows easily at high temperatures.

____ 35. Resists foaming.

____ 36. Resists breakdown after long use.

Complete the following list of statements concerning the SAE viscosity number by correctly filling in the blanks.

37. Oils vary in viscosity as _____change.

38. Lighter oils for winter use are specified at _____ degree F and carry a 5w, 10w, or 20w symbol.

39. Heavier oils are specified at _____ degree F and carry a 20, 30, 40 or 50 viscosity number.

List three important points found on the label of an oil container as it relates to recommended applications.

40.

41.

42.

Match the oil additives on the right with their correct functions.

____	43. Helps prevent failure of alloy bearings from corrosive acids caused by combustion.	a.	Anti-rust
____	44. Prevents acid, varnish and sludge formations.	b.	Oxidation Inhibitor
____	45. Prevents rusting of metal parts during storage or downtime.	c.	Anti-corrosion
____	46. Helps oil give top lubricating protection at both high and low temperatures.	d.	Viscosity index improver
____	47. Prevents wax crystals from congealing in cold weather and forming clumps.	e.	Pour point depressant
____	48. Assures lubrication where extreme pressures between close tolerances are encountered.	f.	Extreme pressure
____	49. Helps keep metal surfaces clean and prevents deposit formation.	g.	Foaming inhibitor
____	50. Helps prevent air bubbles which would restrict lubrication.	h.	Detergent-dispersing

Select factual statements about oil by placing an "X" in the appropriate blanks.

___ 51. Oil becomes unfit for further use as it absorbs contaminations and as additives are depleted.

___ 52. Multi-viscosity oils are not always preferred.

___ 53. Black oil does not mean it is time for an oil change.

___ 54. Buy quality oil filters as recommended by machine operator's manual.

___ 55. Oil oxidation results in thicker oil.

___ 56. Using a light oil until consumption increases, and then switching to a heavier oil, is not a good practice.

___ 57. Following operator's manual recommendations is critical to insure good performance.

Complete the following list of statements concerning the selection and use of oils for best engine performance by correctly filling in the blanks.

58. Use brands which meet engine _____ specifications.

59. _____ and change at recommended intervals.

60. Select oils which have been _____.

61. Never mix oils of various _____.

62. Bring engine up to normal operating _____each time it is used.

Demonstrate the ability to:

63. Change engine oil and filter.

64. Service a crankcase breather.

Module 7: Troubleshooting

Lesson 1: Troubleshooting Small Engines

Objective

After completion of this unit, the student should be able to troubleshoot the four basic engine systems which are: 1) Ignition System, 2) Spark Plug Condition, 3) Fuel System, and 4) Compression. This knowledge will be evidenced through the student's ability to properly troubleshoot small engines.

Study Questions

1. **What is troubleshooting?**

2. **What are the requirements for an engine to operate?**

3. **What are the four basic engine tests to diagnose an engine problem?**

4. **When diagnosing a small engine, what basic troubleshooting procedures should you follow?**

5. **Why is it important to understand troubleshooting procedures?**

6. **What is the proper procedure to troubleshoot the fuel system?**

7. **What is the proper procedure to troubleshoot the ignition system?**

8. **What is the proper procedure to troubleshoot compression?**

References

1. Briggs and Stratton. Service and Repair Instructions for Single Cylinder Four-Cycle Engines. Milwaukee, Wisconsin, 1990.

2. Herd, Amon. Troubleshooting Small Engines. Columbia, Missouri: Instructional Materials Laboratory, University of Missouri-Columbia, Columbia, Missouri, 1994.

3. Roth, Alfred C. Small Gas Engines. South Holland, Illinois: Goodheart-Wilcox Company, Inc., 1992.

4. Small Engine Repair. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, 1985.

5. Small Engine Operation, Maintenance and Repair. Athens, Georgia: American Association for Vocational Instructional Materials. 1987.

6. Small Gasoline Engines, Operation, Repair and Maintenance. St. Paul, Minnesota: Hobar Publications, 1992.

7. Fuels and Lubricants. Athens, Georgia: American Association for Vocational Instructional Materials.

Module 7: Troubleshooting

Lesson 1: Troubleshooting Small Engines

Teaching Procedures

A. Introduction

B. Motivation

Introduce troubleshooting techniques and explain how proper procedures can save time and money. Ask a student to assist in demonstrating a spark test. Discuss what makes an engine operate.

C. Assignment

D. Supervised Study

E. Discussion

1. Troubleshoot the easiest procedures first when troubleshooting a small engine.

What is troubleshooting?

Troubleshooting is a systematic investigation into a technical problem. The simplest and easiest remedies are normally investigated first. Example: Before you make any extensive corrections or adjustments, carefully check the oil level, fuel, air filter, and check to see if the blade is loose.

2. Ask two students to perform a compression check. What are the causes of poor compression? Discuss maintenance and overhaul of small engines.

What are the requirements for an engine to operate?

a) Compression.
b) Ignition.
c) Carburetion.

3. Ask a student to troubleshoot a fuel system. Discuss fuel storage and the importance of fresh gasoline. Why should the fuel be removed from the tank and carburetor?

What are the four basic engine tests to diagnose an engine problem?

a) Checking the fuel system.
b) Checking the ignition system.
c) Checking the spark plug.
d) Checking compression.

4. Invite a small engine mechanic or service technician to speak to your class on troubleshooting procedures he or she uses.

When diagnosing a small engine, what basic troubleshooting procedures should you follow?

a) Know the engine. (This may involve the study of an engine's service manual if you are not already familiar with its design features.)
b) Ask questions of the operator.
Important questions you should ask the customer or operator include:
   1) When was the equipment last used?
   2) Does the engine start?
   3) Does it stall out?
   4) Is the engine hard to start?
   5) Is anything broken?
   6) Does the engine lack power under load?
   7) Does the engine overheat?
   8) Is the engine noisy?
   9) Does the engine vibrate?
c) Inspect the engine. Check level and condition of oil, level and condition of fuel, and coolant level if equipped. Look for clogged breathers and fuel system vent caps, loose hoses, manifolds, and wire connections while inspecting.
d) Consult any troubleshooting charts or service bulletins that the manufacturer may have issued. TM-1.1.
e) Operate the engine if possible. Listen to the sounds it makes while running as well as looking for erratic behavior such as oil leaks or unusual emissions.
f) List possible causes. Write down all symptoms and possible causes.
g) Formulate a conclusion. When looking at the list of possible causes, remember that one failure can cause another problem.
h) Test condition. Before you start repairing the engine, analyze the information you have and test your conclusion if possible. Be a troubleshooter, not a hit or miss person.

5. Always ask the owner questions about the performance of the engine. Take notes of the discussion.

Why is it important to understand troubleshooting procedures?

a) It saves the customer's money. The alternative to troubleshooting is parts exchanging which can get expensive.
b) Insures a better repair job because the procedure provides more opportunities to find weak or failing parts. This process also identifies problems which may hinder proper engine operations in the future.
c) Makes employees more valuable. Good service means continued business with present customers plus the drawing of new customers. Also, fewer jobs are returned for warranty work.

6. Discuss the construction of gas tanks. Tanks are made from untreated steel, galvanized steel, plastic and other materials. Rust is a common problem in the gas tank. Discuss plastic gas tanks.

What is the proper procedure to troubleshoot the fuel system?

a) Wear proper safety equipment.
b) Read the operator's manual.
c) Check flow of fuel to combustion chamber.
d) Check for plugged vents on fuel tank cap.
e) Check flow of fuel to carburetor bowl.
f) Check for obstructions in the tank and fuel line.
g) Check fuel for water or foreign materials.
h) Check fuel filter for dirt or clogged element.

7. Perform a demonstration using the ignition kill switch. Perform a demonstration in which there is no spark to the engine. Do a demonstration test on a defective solid state module. Ask a student to assist in troubleshooting the ignition system.

What is the proper procedure to troubleshoot the ignition system?

a) Disconnect the spark plug wire and remove the spark plug.
b) Correctly install test plug.
c) Perform spark test.
d) Determine quality of spark.

8. Demonstrate how an engine operates when its valves not seating properly . What effect do valves have on compression? Ask a student to demonstrate loss of compression.

What is the proper procedure to troubleshoot compression?

a) Spin the flywheel counterclockwise against the compression stroke, a sharp rebound indicates satisfactory compression.

b) Check the engine compression with a gauge. Crank the engine over at least six times and read the compression gauge. For satisfactory operation the minimum gage reading should read above 60 P.S.I on most engines. Briggs & Stratton does not publish compression pressures, as it is difficult to obtain an accurate reading. On four-cycle engines below 4.5 horsepower, the compression should be between 65 to 75 P.S.I. On engines greater than 4.5 horsepower, the compression should be more than 70 P.S.I.

F. Other Activities

1. Contact your local small engine dealer to class. Have him or her explain common workplace troubleshooting techniques.

2. Use retired engine mechanics to asssit you in demonstrations.

G. Conclusions

Proper troubleshooting techniques are one of the most important tools a small engine mechanic can have.

H. Competency

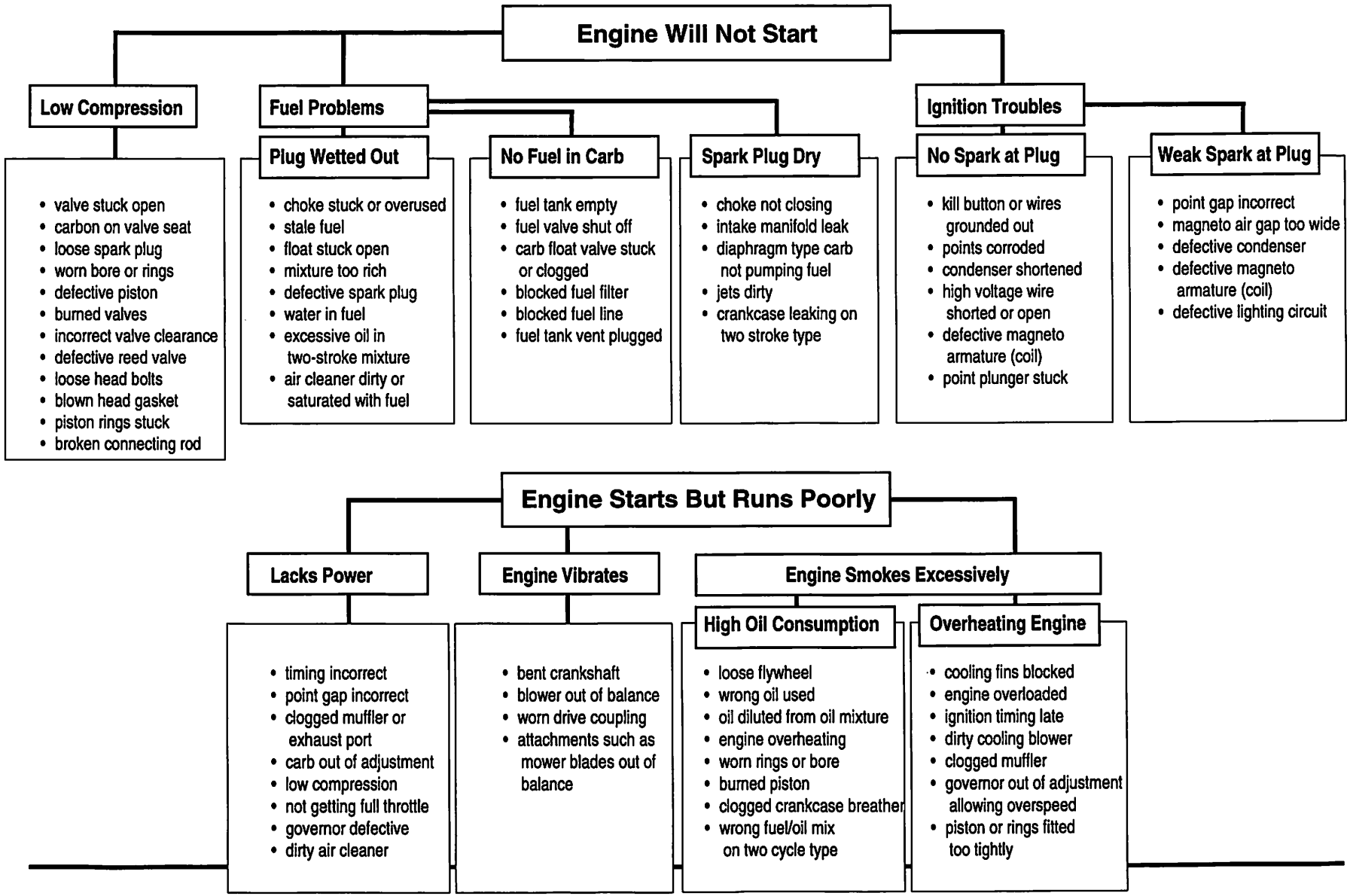
After completion of this unit, the student should be able to troubleshoot the four basic engine systems which are: 1) Ignition System, 2) Spark Plug Condition, 3) Fuel System, and 4) Compression. This knowledge will be evidenced through the student's ability to properly troubleshoot small engines.

I. Answers to Evaluation

1. troubleshooting
2. X
3.
4. X
5. X
6.
7.
8. X
9. X
10. X
11.
12. X
13. X
14. Performance evaluated by instructor.
    Example of answer: Fuel problem; fuel tank vent clogged.
15. Performance evaluated by instructor.
    Example of possible answer: Loose or bent blade; bent crankshaft.

16. Performance evaluated by instructor.
    Example of possible answer: Ignition switch in "kill" position.
17. Performance evaluated by instructor.
    Example of possible answer: Incorrect timing; improper armature air gap.
18. Performance evaluated by instructor.
    Example of possible answer: Fuel valve is shut off.
19. Performance evaluated by instructor.
    Example of possible answer: Low compression; carburetor is out of adjustment.
20. Performance evaluated by instructor.
    Example of possible answer: Cooling fins clogged; engine out of time.
21. Performance evaluated by instructor.
    Example of possible answer: Governor out of adjustment; carburetor out of adjustment.
22. Performance evaluated by instructor.
    Example of possible answer: Stop switch not connected to "kill" switch.
23. Performance evaluated by instructor.
    Example of possible answer: Flywheel brake is on.

Small Engine Troubleshooting Chart



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Module 7: Troubleshooting NAME_____
DATE_____

EVALUATION

1. Performing a systematic diagnosis of an engine malfunction is called _____.

Select requirements for an engine to run by placing an "X" in the appropriate blanks.

____ 2. Ignition

____ 3. Speed

____ 4. Compression

____ 5. Carburetion

____ 6. Centrifugal force

____ 7. Pulley

Select true statements concerning the importance of understanding troubleshooting procedures by placing an "X" in the appropriate blanks.

___ 8. Saves customer's money.

___ 9. Insures a better repair job as the total system or engine is observed.

___ 10. Insures better operating dependability.

___ 11. Fewer employees are needed to operate shop.

___ 12. Good service means continued business with present customers plus the drawing of new customers.

___ 13. Makes employees more valuable since less work is returned.

Demonstrate troubleshooting skills. Use the troubleshooting chart on TM 1.1 to assist you in solving questions (4-13).

14. The equipment has been in use for 30 minutes and the engine shuts down. Possible cause?

_____

_____

15. The engine begins to vibrate excessively. Possible cause?

_____

_____

16. Engine has just received an ignition tuneup and was in top starting and running order when turned over to the customer. Two days later the customer could not start the engine. Possible cause?

_____

_____

17. Engine is hard to start and has a kickback. Possible cause?

_____

_____

18. No fuel in carburetor. Possible cause?

_____

_____

19. Engine is beginning to lose power. Possible cause?

_____

_____

20. Engine overheating. Possible cause?

_____

_____

21. Engine runs unevenly and surges. Possible cause?

_____

_____

22. Engine won't stop. Possible cause?

_____

_____

23. Starter rope hard to pull. Possible cause?

_____

_____

Module 8: Operation and Maintenance of Small Engines

Lesson 1: Maintaining Small Engines and Equipment

Objective

After completion of this unit, the student should be able to safely operate and maintain a small engine.

Study Questions

1. **What are common terms that apply to maintenance procedures of small engines and equipment?**

2. **What should be checked before operating an engine?**

3. **What are the correct procedures in sharpening and balancing a mower blade?**

4. **What methods are used in servicing mufflers?**

5. **What methods are used in servicing pipe thread mufflers?**

6. **What is the proper procedure in servicing the brake adjustment to "System 2" and "System 4" Briggs and Stratton engines.**

7. **What is the proper procedure in servicing the ignition stop switch.**

8. **What is the proper procedure in servicing the brake band?**

9. **What are the standard requirements manufacturers must meet today in producing rotary lawn mowers?**

References

1. Briggs and Stratton. Service and Repair Instructions for Single Cylinder Four-Cycle Engines. Milwaukee, Wisconsin, 1990.

2. Herd, Amon. Small Engine Service and Repair. Columbia, Missouri: Instructional Materials Laboratory, University of Missouri-Columbia, Columbia, Missouri, 1994.

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Module 8: Operation and Maintenance of Small Engines

Lesson 1: Maintaining Small Engines and Equipment

Teaching Procedures

A. Introduction

B. Motivation

Demonstrate an engine with the blade out of balance. Discuss the effects of an engine with no exhaust. Discuss a maintenance plan on your equipment.

C. Assignment

D. Supervised Study

E. Discussion

1. Use charts and tools to illustrate the discussion.

What are common terms that apply to maintenance procedures of small engines and equipment?

a) Blade balancer: A special tool designed to balance lawn mower blades.
b) Safety: State or condition of being safe; freedom from danger, risk, or injury.
c) Accident: Any suddenly occurring, unintentional event which causes injury or property damage.
d) First aid: Immediate, temporary care given the victim of an accident or sudden illness until the services of a physician can be obtained.
e) Carbon monoxide: Colorless, odorless, very poisonous gas formed by incomplete combustion.
f) Service manual: Professional book giving exact details, tools, and procedures for servicing one or more types of engines.
g) OSHA: Occupational Safety and Health Act.
h) CPSC: Consumer Product Safety Commission.
i) Blade adapter: A device for connecting the blade to the crankshaft.
j) Brake adjustment gauge: A special tool (gauge) for placing the amount of brake band pressure against the flywheel.

2. Discuss changing oil--why and how often. Demonstrate servicing an air cleaner. Display various filters and oil.

What should be checked before operating an engine?

a) Check the oil.
b) Service the air cleaner.
c) Ask a student to demonstrate sharpening and balancing a blade. Discuss methods of blade balance.

3. Discuss the importance of a sharp and balanced mower blade.

What are the correct procedures in sharpening and balancing a mower blade?

a) Remove blade from mower.
b) Sharpen blade.
c) Clean blade and inspect for cracks and straightness.
d) Balance blade and install on mower.
e) Ask a student to assist you in doing a demonstration on installing a new muffler. Discuss the importance of mufflers on small engines.

4. Discuss the importance of a properly-operating muffler.

What methods are used in servicing bolt-on mufflers?

a) Inspect the condition of the muffler to be replaced. Check muffler periodically by squeezing it with your hand. If it is soft, replace it. (Cold muffler only.)
b) Prior to removing the muffler bolts, squirt a few drops of penetrating oil on bolt threads. Let it set overnight to loosen the rust.
c) Remove muffler bolts and clean for reassembly.
d) Remove gasket and clean residue from block.
e) Clean out exhaust port and bolt holes.
f) Install new gasket, muffler and bolts.

Note: The wrong size muffler will cause the engine to perform improperly. Follow manufacturer's specifications.

5. Discuss the special methods used when servicing pipe thread mufflers.

a) Return engine and tools to their proper place and clean work area.

What methods are used in servicing pipe thread mufflers?

a) Secure engine to be serviced and disconnect spark plug.

b) Inspect the condition of the muffler to be replaced. Check muffler periodically by squeezing it with your hand.
c) Prior to removing muffler, squirt penetrating oil on muffler pipe threads to loosen rust. The penetrating oil should be applied and let set overnight.
d) Use a punch and hammer to loosen locknut (on some models).
e) Use a pipe wrench to remove the muffler.
f) Inspect and clean exhaust port and threads.
g) Install new locknut and muffler. Lubricate threads with anti-seizing compound.
h) Tighten muffler pipe firmly in block. Hand tighten only.
i) Tighten locknut and return engine and tools to their proper places and clean work area.

6. Ask a student to demonstrate how to service the brake adjustment on System 2 and System 4 CPSC Compliance Engines. Ask your local dealer to demonstrate the Briggs and Stratton Custom VOA Meter for proper adjustment of the ignition stop switch. Use the slide series, "Servicing and Adjusting System 2 and System 4 CPSC Compliance Engines" by Briggs and Stratton (MS-8071). Use the slide series, "Briggs and Stratton Custom VOA Meter 61" (MS-7346).

What is the proper procedure in servicing the brake adjustment to "System 2" and "System 4" Briggs and Stratton engines. (TM-1.1 - TM-1.3)

a) Release spring from brake control bracket. Move brake actuating lever back and slip cable out of brake mechanism.
b) Place one end of the gauge into the control cable hole of the brake actuating lever. Move the actuating lever sideways until the 90 degree end of the gauge can be inserted into the tapped hole of the brake control bracket.
Note: The Brake Adjustment Gauge #19256 is available from Briggs & Stratton.
c) Move the brake control bracket sideways until the 90 degree bend of the brake adjustment gauge can slide "in and out" with a slight amount of friction against the inner surface of the tapered hole. The gauge will place the precise amount of brake band pressure against the flywheel.
d) Tighten the brake control bracket without loosing the friction. Remove the brake adjustment gauge.
e) Install the control cable to the brake control bracket.
f) Reconnect spring to brake mechanism. Check stretch.
g) Install the starter assembly and brake control cover.
h) Start engine and check out the safety system.
Note: The blade must stop within three seconds upon release of a blade control.

7. Demonstrate an ignition stop switch that is out of adjustment. Explain the dangers of defective stop switches.

   What is the proper procedure in servicing the ignition stop switch.

   a) To check stationary mechanical stop switch, move the control lever away from stop switch using the safety control on mower handle or by moving the control lever at engine.
   b) Release the control lever. The control lever at the engine must contact the tang stop switch.
   c) Adjust the stop switch as needed (it may be necessary to adjust the control bracket).

8. Ask your small engine repair shop to demonstrate an engine with a worn brake band, brake control bracket and spring. Demonstrate the proper techniques of inspecting, removing and installing the brake band.

   What is the proper procedure in servicing the brake band? TM-1.4.

   a) To remove the brake band, first disconnect the brake spring. Use the tang bending tool to bend the retainer tab on the brake control bracket. Now you can remove the brake band.
   b) Inspect the brake band. If damaged or distorted, replace the brake band. Also inspect the band pad for damage. DO NOT ATTEMPT TO REUSE OR RESHAPE A DISTORTED OR DAMAGED BRAKE BAND.
   c) Reinstall the brake band with the "cut out" section above the brake control bracket. Place the brake band over the retainer tab and bend the tab to lock band in place. Reconnect the brake spring.

9. Have a student report to class on CPSC Standards. Discuss the lawn mower accident rate in the community.

   What are the standard requirements manufacturers must meet today in producing rotary lawn mowers?

   a) Consumer Product Safety Commission (CPSC) Standards. (Note: June 30, 1982 marked the last day a walk-behind power lawnmower could be built or imported for U.S. consumers without complying with the CPSC "Safety Standard for Walk-Behind Power Lawn Mowers." The standard defines a "walk-behind lawn mower" as a grass cutting machine with a minimum cutting width of 12 inches.

Note: Commercial lawnmowers not customarily sold to consumers are not subject to the standard. The standard specifies performance requirements for most rotary lawnmowers manufactured or imported after June 30, 1982 and, in addition to the warning label, requires the following:

1) Every affected rotary lawnmower must carry a certification label.
2) The path of the blade on a rotary lawnmower be shielded in such a manner that the unit can successfully pass specified tests, including a "foot probe" test and an "obstruction" test.
3) A blade control system must prevent the blade from operating unless the operator actuates the control, requires continuous contact with the control to keep the blade in motion, and stops the blade completely within three seconds after release of the control.
   Note: Prior to June 30, 1982, the first phase of the standard only required a warning label stating "Danger, Keep Hands and Feet Away."
   Note: For electrically powered lawnmowers or electric start lawnmowers, the starting controls must be located within approximately 15" of the rear-most part of the lawnmower handle.
4) All units must be equipped with a second control, either a separate safety lever or a device incorporated into the blade control, so that two distinct actions are required to restart the blade. The standard expressly applies to the manufacturer and initial safe to consumers; it is silent with respect to service and repair of so-called "compliance" units.
   Note: Any modification made by a dealer at the time of the sale to a consumer that renders the mower non-complying would be a violation of the standard. However, if the owner brings the lawnmower in for servicing later and asks a dealer or repair person to disable a safety feature required by the standard, such an action would not be in violation of the standard since it does not involve a sale. Dealers are encouraged not to eliminate any safety feature since such action may create potential liability in the event someone is subsequently injured because a safety feature was missing.

F. Other Activities

1. Invite representatives from a small engine repair facility to address your class.

2. Invite a healthcare worker to describe the resultys of a small engine accident.

G. Conclusions

Proper daily maintenance procedures will increase safety and extend the operating life of a small engine.

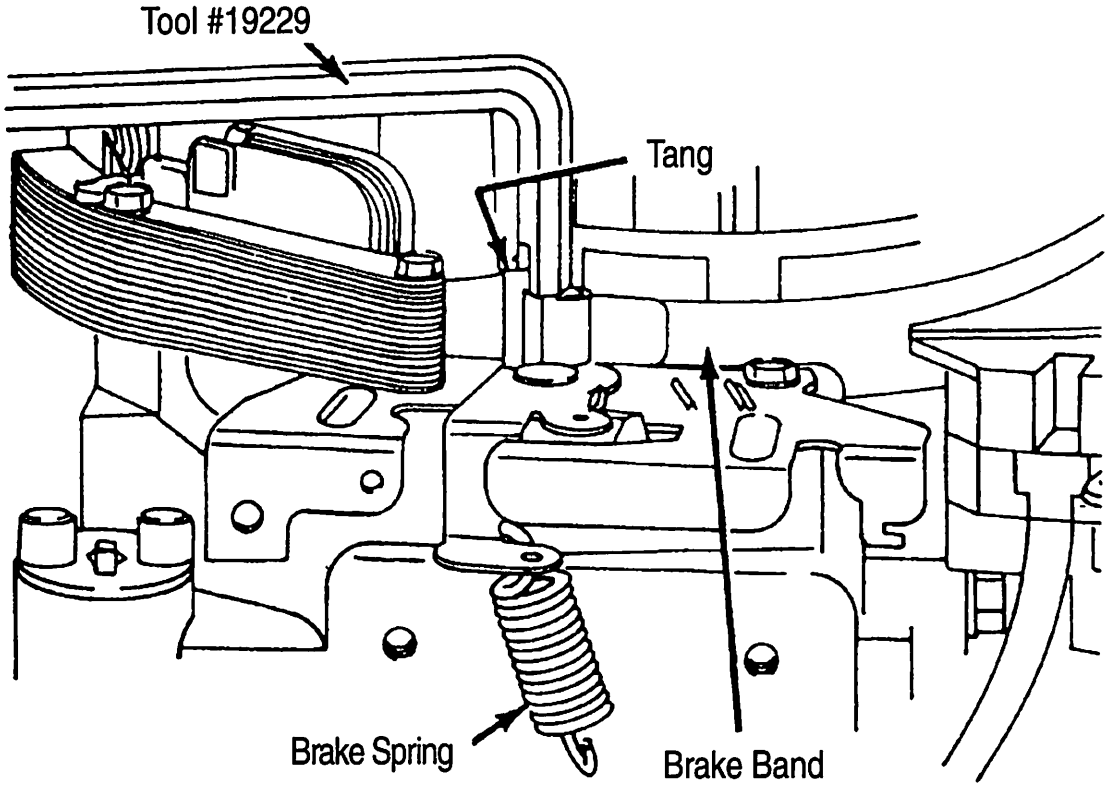
H. Competency

After completion of this unit, the student should be able to safely operate and maintain a small engine.

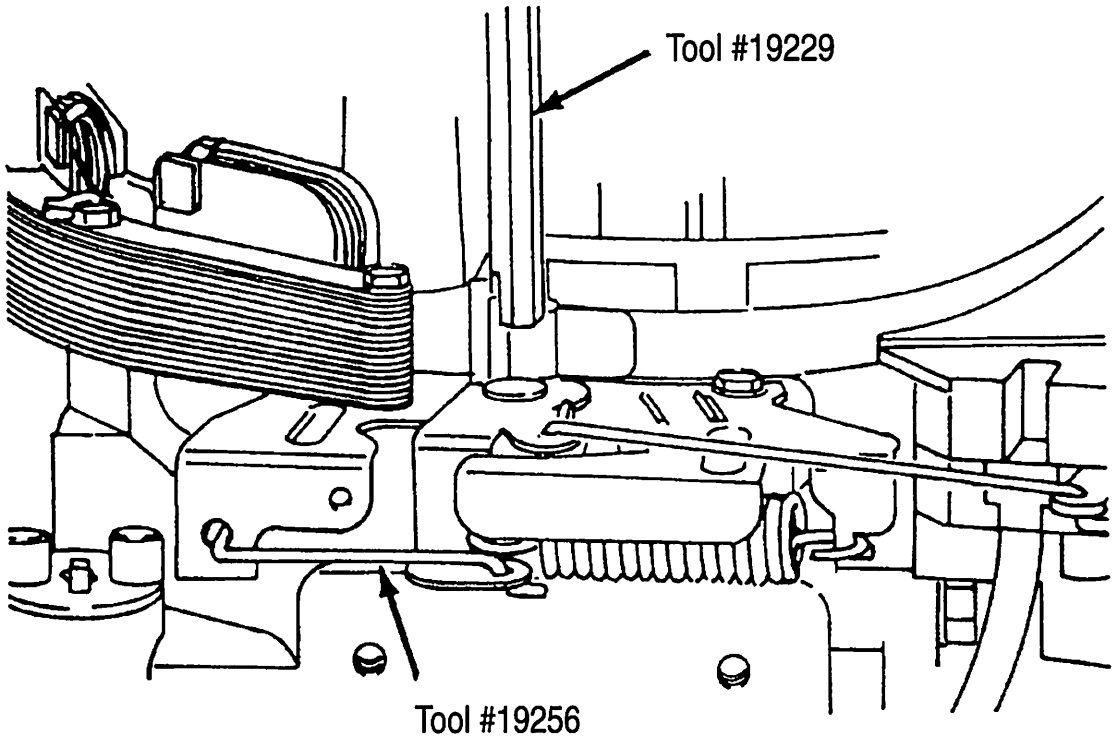
I. Answers to Evaluation

1. b
2. a
3. d
4. c
5. e
6. f
7. g
8. i
9. h
10. j
11. balance
12. Fill gas tank
13. Check the oil
14. Check the air cleaner
    (Note: answers to 12-14 can be in any order.)
15. Install a new O-ring.
16. 12
17. June 30, 1982
18. certification
19. three
20. manufacturer
21. Evaluated by instructor.
22. Evaluated by instructor.
23. Evaluated by instructor.

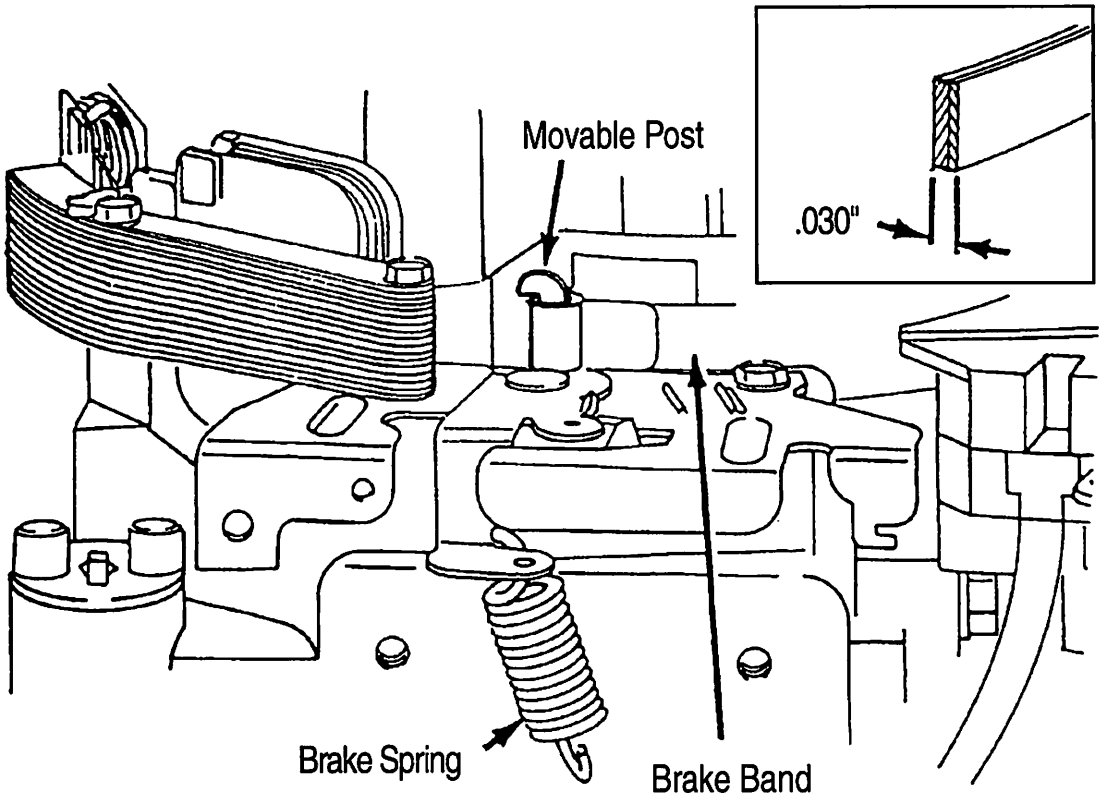
Removing Brake Band, Old Style



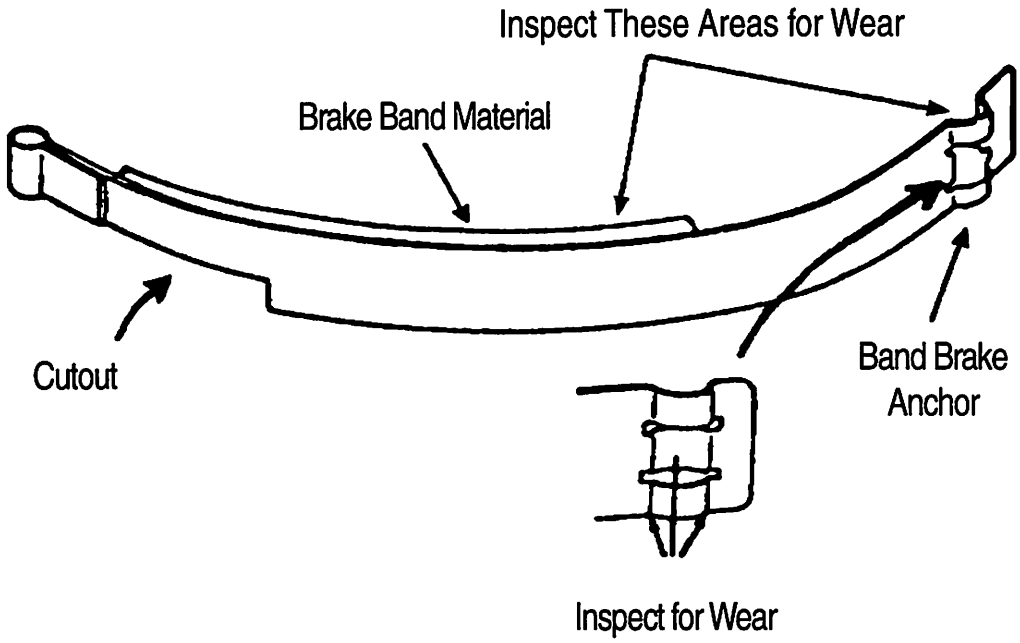
Adjusting Brake Band



Removing Brake Band, New Style



Typical Brake Band



Module 8: Maintaining Small Engines NAME_____
DATE_____

EVALUATION

Match the terms on the right with their correct definition.

____	1.	Immediate, temporary care given the victim of an accident or sudden illness until the services of a physician can be obtained.	a. Blade sharpener
____	2.	A special tool designed to balance lawn mower blades.	b. First aid
____	3.	Any suddenly occurring, unintentional event which causes injury or property damage.	c. Safety
____	4.	State or condition of being safe; freedom from danger, risk or injury.	d. Accident
____	5.	A special tool for placing the amount of brake band pressure against the flywheel.	e. Brake adjustment gauge
____	6.	Colorless, odorless, very poisonous gas formed by incomplete combustion.	f. Carbon monoxide
____	7.	A device for connecting the blade to the crankshaft.	g. Blade adapter
____	8.	Consumer Product Safety Commission.	h. Service manual
____	9.	Professional book giving exact details, tools, and procedures for servicing one or more types of engines.	i. SPSC
____	10.	Occupational Safety and Health Act.	j. OSHA

11. After you have sharpened the mower blade. The next step is to _____the blade.

List three maintenance requirements to complete before operating any engine.

12.

13.

14.

Complete the sentence.

15. An oil leak is discovered at the base of the oil tube. To correct this problem you should_____.

Complete the following list of statements concerning Consumer Product Safety Commission standards by correctly filling in the blanks.

16. The standard defines a "walk-behind lawnmower" as a grass cutting machine with a minimum cutting width of _____ inches.

17. The standard specifies performance requirements for most rotary lawnmowers manufactured or imported after _____.

18. Every affected rotary lawnmower must carry a _____ label.

19. A blade control system is required that stops the blade completely within _____ seconds after release of control.

20. The standard expressly applies to the _____ and initial sale to consumers; it is silent with respect to service and repair of so-called "compliance" units.

Demonstrate the ability to:

21. Properly service a brake adjustment for System 2 and System 4.

22. Service a brake band.

23. Service ignition stop switch.