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ABSTRACT

The last of six instructional blocks in automotive mechanics, the lessons and supportive information in the document provide a guide for teachers in planning an instructional program in the automotive cooling system at the secondary and post secondary level. The material, as organized, is a suggested sequence of instruction within each block. Each lesson is stated in terms of a specific teaching objective, teaching aids, references, and an outline of information. Upon successful completion of the 29 lessons in the block of work, students will be able to: (1) identify the major components of typical automotive engine cooling systems, (2) relate the functional significance of the components to the operation of the total system, (3) recognize common malfunctions of the cooling system. Included with the course outline are transparency masters and reference guide listing related books, texts, and other publications. (HW)

AUTOMOTIVE MECHANICS INSTRUCTIONAL PROGRAM

BLOCK VI

Cooling System

PREPARED FOR

Kentucky Industrial Education Teachers

IN COOPERATION WITH

Bureau of Vocational Education
State Department of Education
Frankfort, Kentucky

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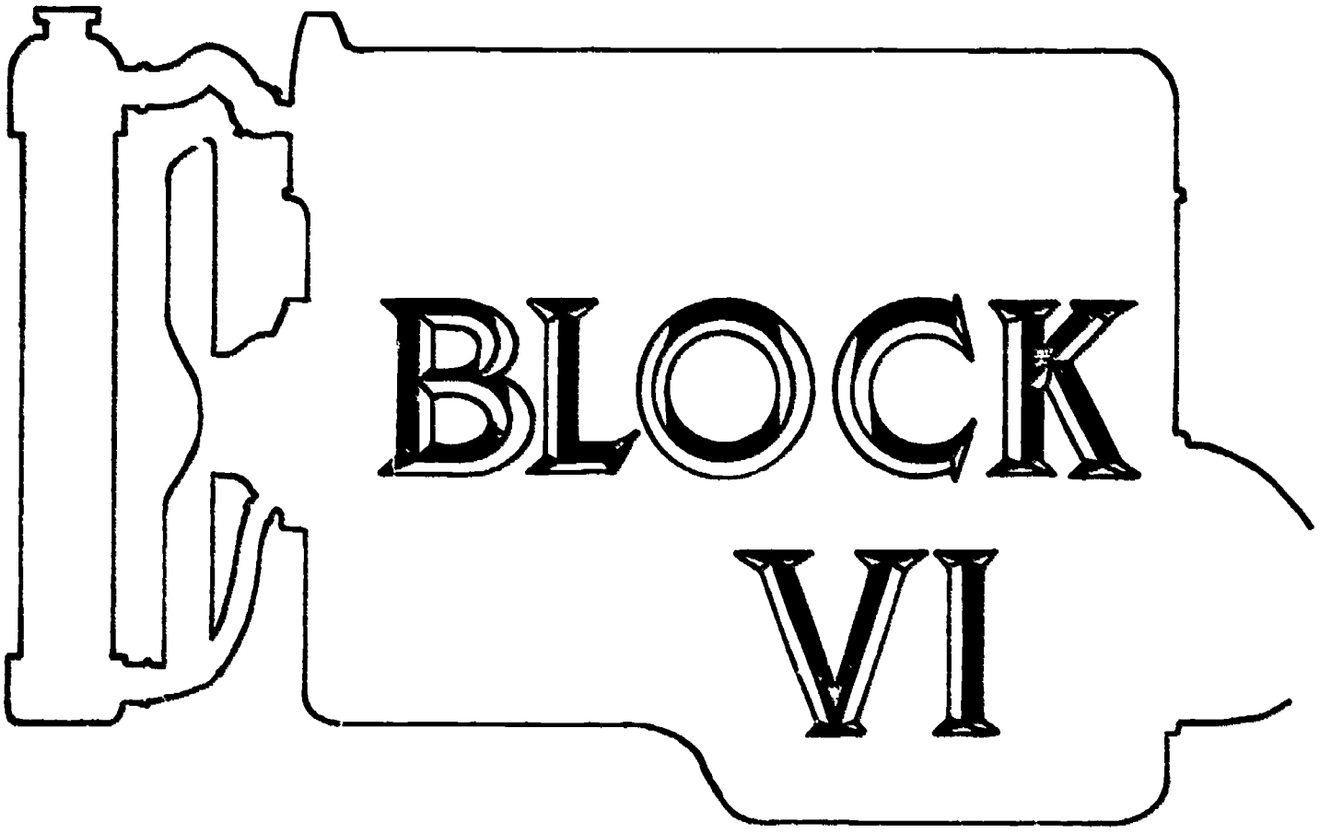


Cooling System

General Teaching Objectives

Upon successful completion of the twenty-nine lessons in this block of work, students will be able to:

1. Identify the major components of typical automotive engine cooling systems.
2. Relate the functional significance of the components to the operation of the total system.
3. Recognize common malfunctions of the cooling system.
4. Correct malfunctions to assure proper operation of the cooling system.

Teaching objectives for each information and operation lesson are specifically stated.

CONTENTS - BLOCK VI

COOLING SYSTEM

INFORMATION

Block: Cooling System

Lesson: Heat, Energy and Cooling

Block VI
Job
Lesson

Teaching Objective: Upon completion of this lesson, students will be able to describe the relationship of heat and energy to the internal combustion engine cooling system.

Teaching Aids: Transparency
- Total Energy In Gasoline, Block IV

References: A Power Primer, General Motors Corp.
Understanding the Automobile, Beck

Outline of Information:

1. The basis of the internal combustion engine is heat.

   a. Heat content of gasoline makes it a good fuel
      -- Heat expansion pushes piston initiating the energy conversion

   b. In reality the internal combustion engine is grossly inefficient because of the amount of heat energy discharged.

   c. The amount of energy lost is much greater than the energy utilized.

2. It is the task of the cooling system to dispose of heat and control desirable heat ranges.

   a. Retention of heat would result in immediate engine failure.

   b. Moving parts would lock up from metal expansion if the cooling system failed.

   c. Engine lubrication reduces effects of friction and assists cooling system in heat disposal.

INFORMATION

Block: Cooling System

Block VI
Job
Lesson

Lesson: Cooling System Purposes and Principles

Teaching Objective: Upon completion of this lesson, students will be able to identify the purposes and describe basic principles of the cooling system as they relate to engine operation.

Teaching Aids: Transparencies:
- Cooling System Principles, p. VI-3
- Cooling System, p. VI-4
- Absorption, p. VI-5
- Radiation, p. VI-6

References: Automotive Mechanics, Crouse, Chapters 12, 22
Automotive Encyclopedia, Goodheart-Wilcox, pp. 99, 100
Cooling System Manual, Dupont, pp. 3-10
Automechanics, Glenn, Chapter 2

Outline of Information:

1. Purposes

   a. To control metal temperature within safe limits by removing excess heat
   b. To maintain an engine temperature appropriate to proper performance

2. Principles of a cooling system

   a. Absorption - Removal of engine heat
   b. Circulation - Transferring engine heat to radiator
   c. Radiation - Transferring heat to ram air
   d. Control - Maintaining cooling temperature
   e. Temperature

      -- Combustion gas temperature may be as high as 4500° F.
      -- Modern engines transfer enough heat energy into the cooling system to melt an average 200 lb. engine block in 20 minutes.

   f. Consequences of inadequate cooling

      -- Preignition, detonation-knock
      -- Burned and scored pistons
      -- Warped and burned valves
      -- Lubrication failure

COOLING SYSTEM PRINC LES

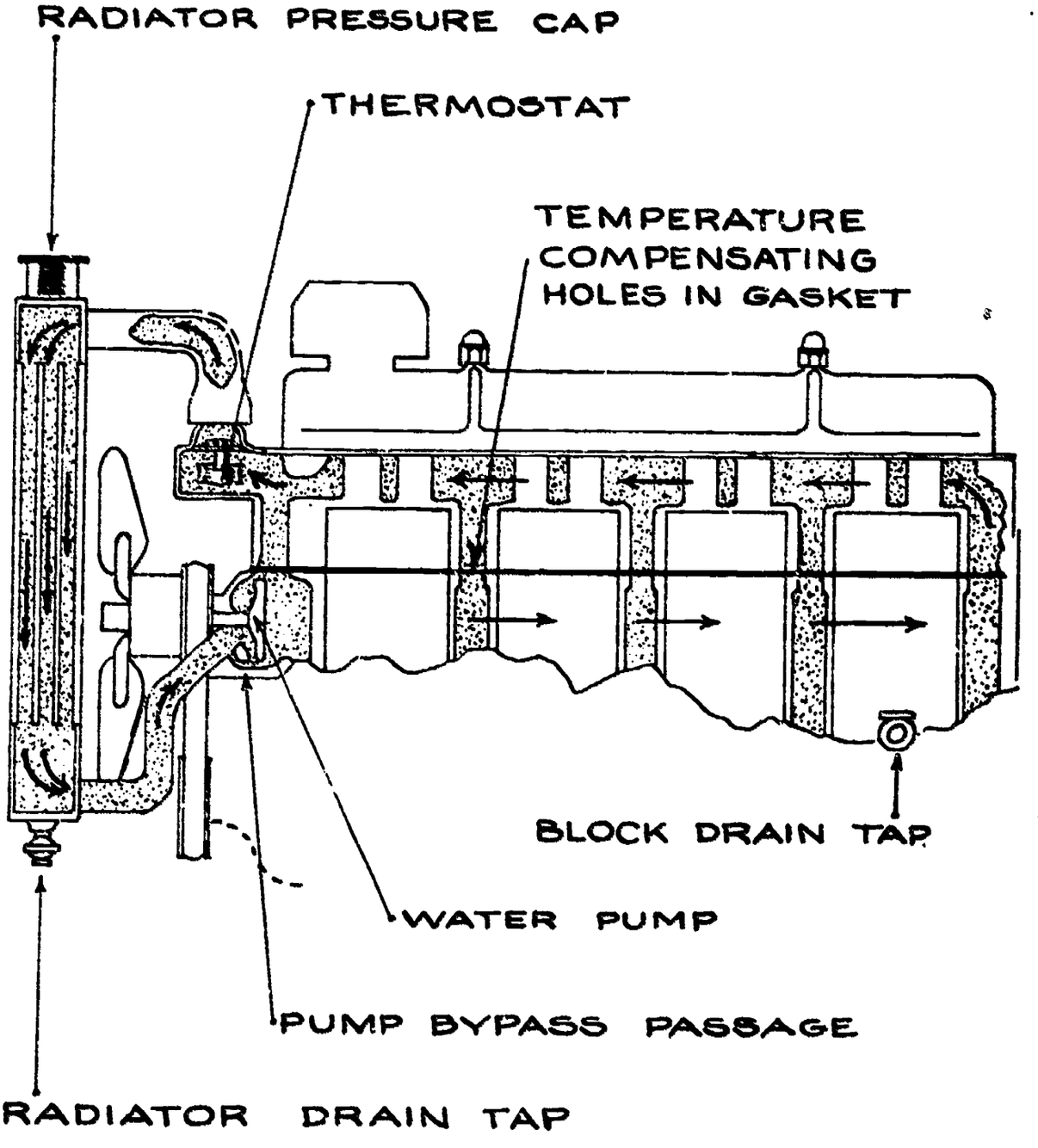
1. ABSORPTION (REMOVAL OF ENGINE HEAT)

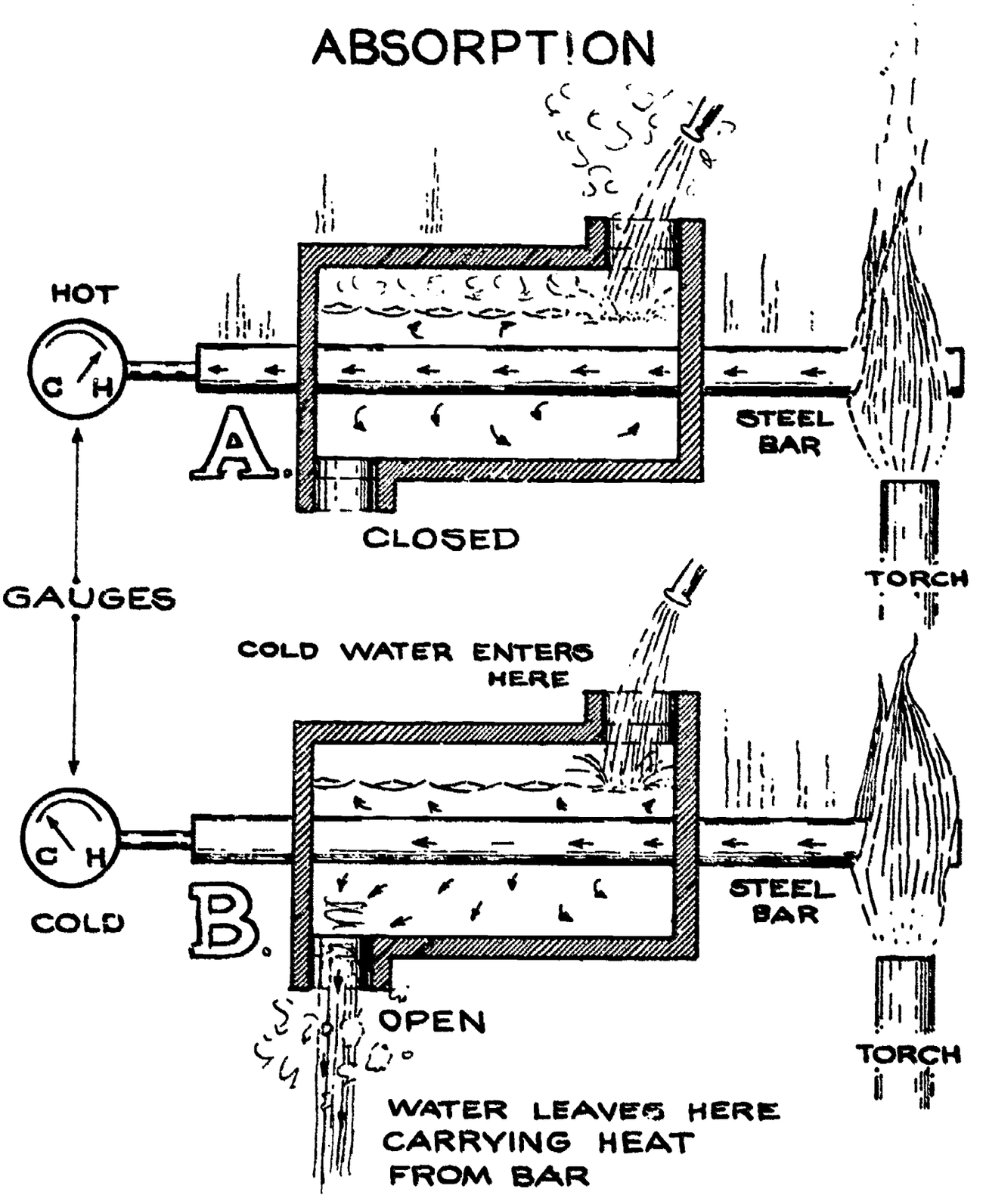
2. CIRCULATION (TRANSFERRING ENGINE HEAT TO RADIATOR)

3. RADIATION (TRANSFERRING HEAT TO RAM AIR)

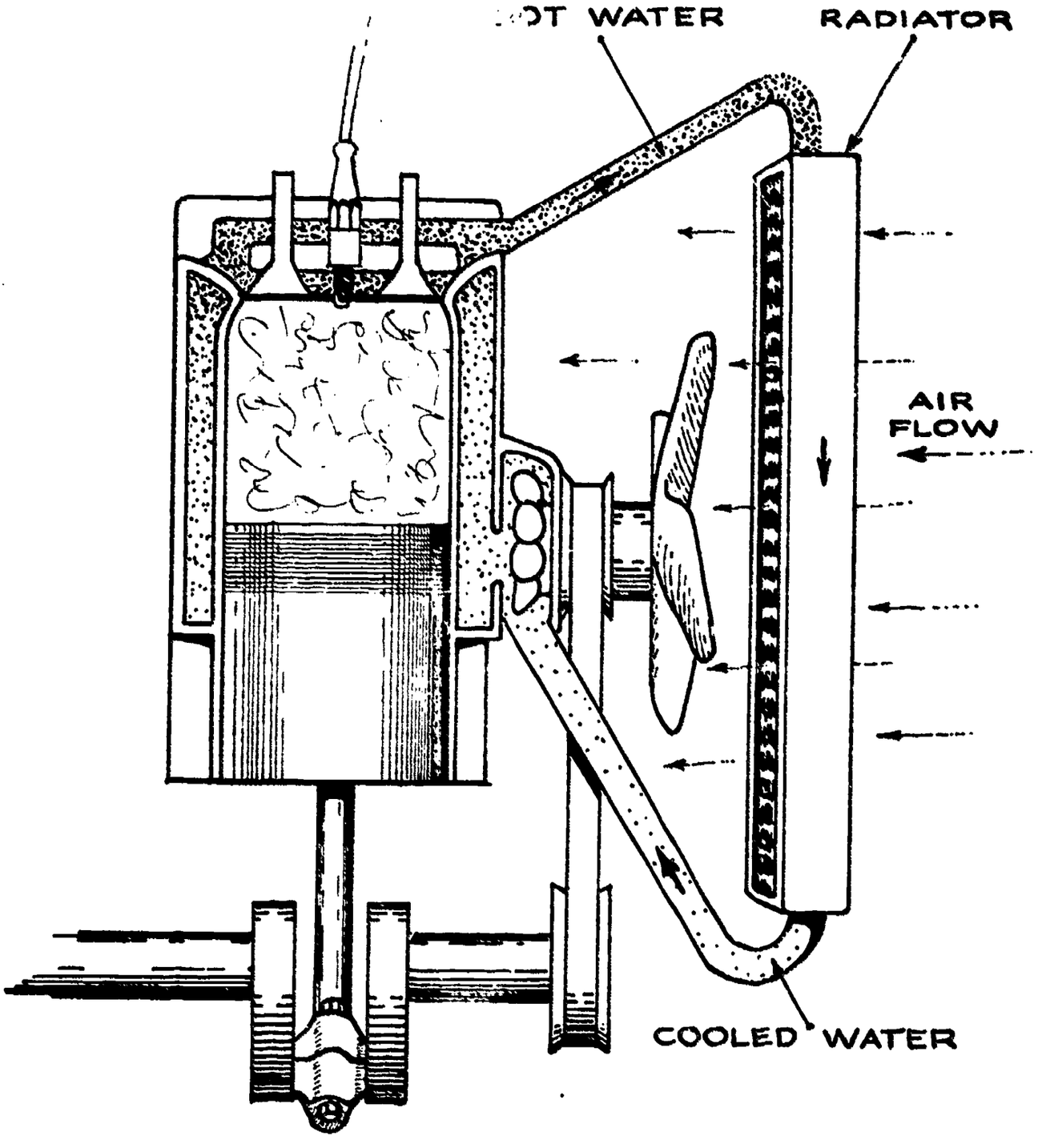
4. CONTROL (MAINTAINING COOLING TEMPERATURE AT PROPER LEVEL)

COOLING SYSTEM




ABSORPTION
HOT
C
H
A.
CLOSED
STEEL BAR
TORCH
GAUGES
COLD WATER ENTERS HERE
C
H
COLD
B.
STEEL BAR
OPEN
TORCH
WATER LEAVES HERE CARRYING HEAT FROM BAR

RADIATION



Block: Cooling System

Lesson: Types and Major Components

Block VI
Job ____
Lesson ____

Teaching Objective: Upon completion of this lesson, students will be able to classify the two basic types of cooling systems through recognition of pertinent components.

Teaching Aids: Transparencies:
- Parts of the Water Cooling System, p. VI-8
- Cooling Fins (air-cooled engines), p. VI-9
- Cooling System, p. VI-4

References: Automotive Mechanics, Crouse, Chapters 12, 22
Automechanics, Glenn, Chapter 2
Cooling System Manual, Dupont, pp. 3-10

Outline of Information:

1. Types

   a. Liquid-Cooled

      -- major components

         - radiator
         - radiator cap
         - water pump
         - thermostat
         - fan assembly
         - fan drive belt
         - water cooling passage

   b. Air-Cooled

      -- major components

         - fan
         - housing
         - baffle plates
         - cooling fins
         - thermostat
         - damper

PARTS OF THE
WATER COOLING SYSTEM

1. RADIATOR

2. RADIATOR CAP

3. WATER PUMP

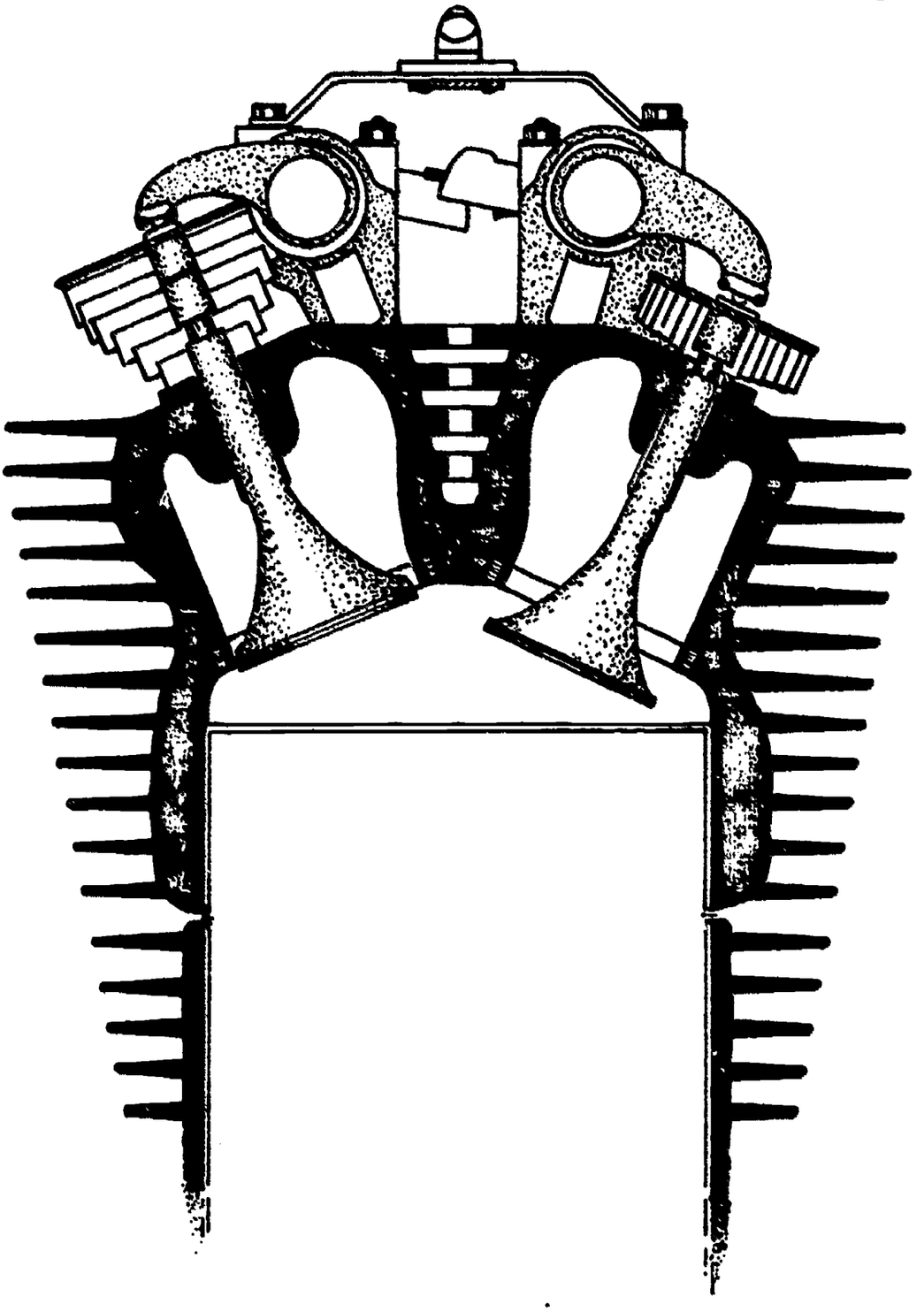
4. THERMOSTAT

5. FAN ASSEMBLY

6. FAN DRIVE BELT

7. WATER COOLING PASSAGE

COOLING FINS (air-cooled engines)



INFORMATION

Block: Cooling System — Block VI
Job
Lesson: Inspection and Services — Operation

Teaching Objective: Upon completion of this lesson, students can be expected to identify the areas of inspection and list the basic services to be performed on the cooling system.

Teaching Aids: Transparencies
- Reverse Flushing (Radiator) p. VI-43
- Reverse Flushing (Engine Block) p. VI-44

Reference: Cooling System Service Manual, Union Carbide, p. 16

Outline of Information:

1. Components to be inspected and typical corrective services

   a. Radiator
      -- Chemical cleaning
      -- Reverse flushing
      -- Protection (anti-freeze installation)
      -- Addition of sealer
      -- Cleaning of air-flow passages

   b. Hoses
      -- Tighten, seal, replace

   c. Belts
      -- Adjust, replace

   d. Water pump
      -- Lubricate, repack, rebuild, replace

   e. Gaskets
      -- Replace

   f. Expansion plugs
      -- Replace

   g. Pressure cap
      -- Test, replace

INFORMATION

Block: Cooling System

Block VI
Job
Lesson

Lesson: Coolants

Teaching Objective: Upon completion of this lesson, students will be able to identify the types of coolants and list the characteristics of each.

Teaching Aids: Transparency
- Hydrometer, p. VI-12
Samples of permanent and non-permanent anti-freeze

References: Automotive Mechanics, Crouse, Chapters 12, 22
Automotive Encyclopedia, pp. 106-110
Cooling System Service Manual, Union Carbide, pp. 37-41

Outline of Information:

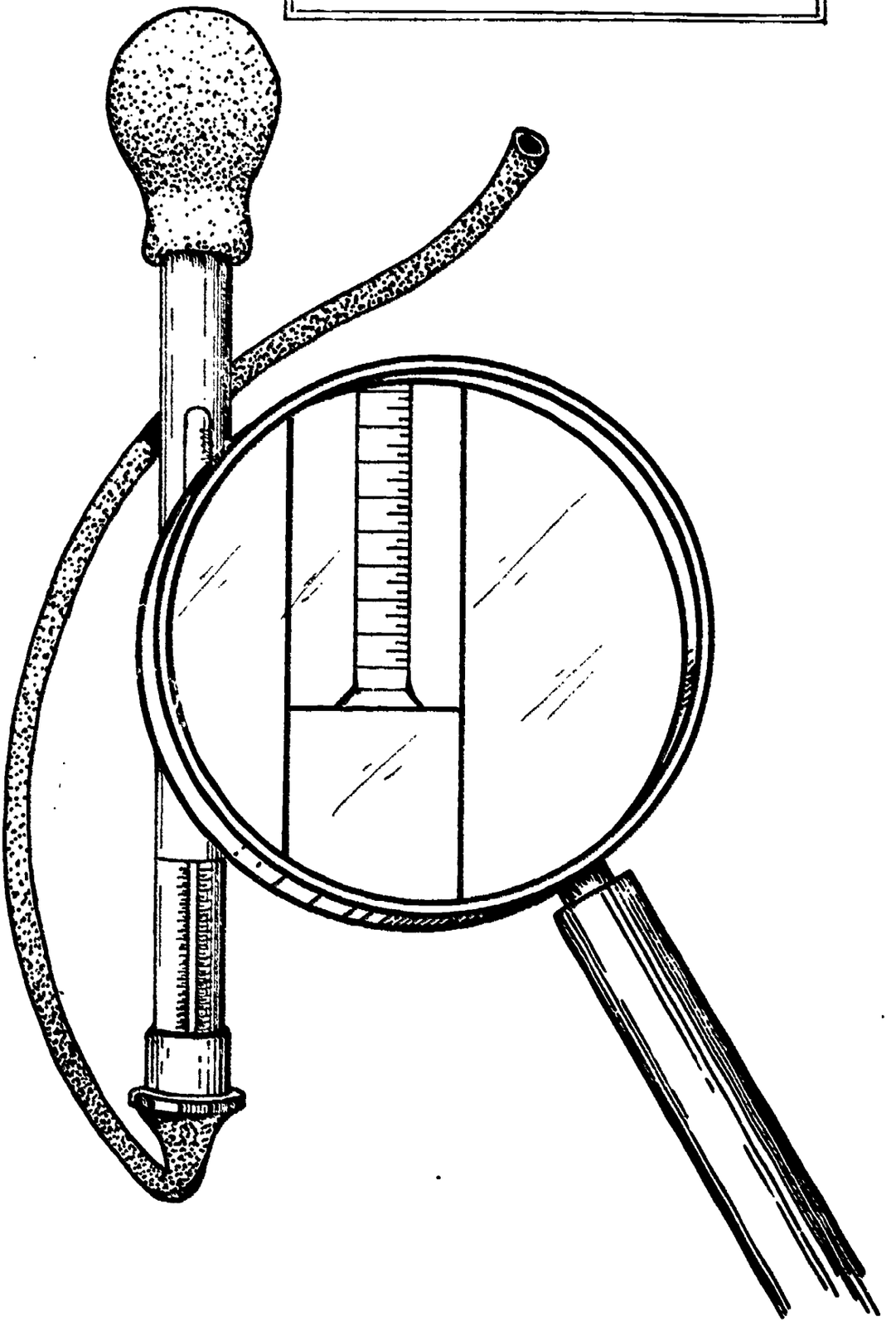
1. Types
   a. Permanent
      -- Ethylene glycol
   b. Non-permanent
      -- Methyl alcohol
      -- Ethyl alcohol

2. Characteristics
   a. Freezing
      -- Expansion
         (1) Water volume expands approximately 9% when it freezes.
         (2) Anti-freeze solutions expand slightly more than water when heated.
   b. Boiling
      -- Alcohol has a lower boiling point than plain water.
      -- Ethylene glycol has a higher boiling point than alcohol.

3. Testing
   a. Measure of specific gravity using hydrometer
      -- Tested for quality of solution basically to prevent freezing

4. Leakage of ethylene glycol into crankcase
   a. Caused by cracked block and/or blown gaskets
   b. Effects are polluted crankcase oil and possibly seized pistons.
   c. Removal
      -- Drainage
      -- Chemical Flushing
   d. Correction
      -- Repair or replacement of damaged parts
      -- Replacement of crankcase oil

HYDROMETER



OPERATION

Block: Cooling System

Operation: Testing Cooling System Solution

Block VI
Job
Operation

Teaching Objective: To teach students to test the cooling system solution.

Tools: Anti-freeze hydrometer

Materials: Permanent anti-freeze (if needed, for adding), wipe cloths

Teaching Aids: Automobile or engine on stand

References: Automotive Mechanics, Crouse, Chapter 22
Vehicle Service Manual, Manufacturer

Steps:

1. Start engine and warm up (to operating temperature)

   CAUTION: Remove radiator cap slowly

2. Place end of hydrometer hose in anti-freeze solution

3. Squeeze blub to displace air

4. Release bulb slowly and draw in only enough coolant to lift float of hydrometer

5. Note reading on hydrometer float at coolant level

6. Compute protection rates from hydrometer scale

7. Remove hydrometer hose

8. Add anti-freeze if needed

9. Replace radiator cap

INFORMATION

Block: Cooling System

Block VI
Job
Lesson

Lesson: Radiator

Teaching Objective: Upon completion of this lesson students will be able to define the purpose of the automotive radiator, recognize three basic design types, and list their structural components.

Teaching Aids: Transparencies:
- Radiator, Upper Tank, p. VI-15
- Radiator Cores, p. VI-16
- Radiator Overflow Reservoir, p. VI-17

References: Automotive Mechanics, Crouse, Chapters 12, 22
Cooling System Manual, Dupont, pp. 5, 13
Automobile Guide, Biecker, pp. 516-518

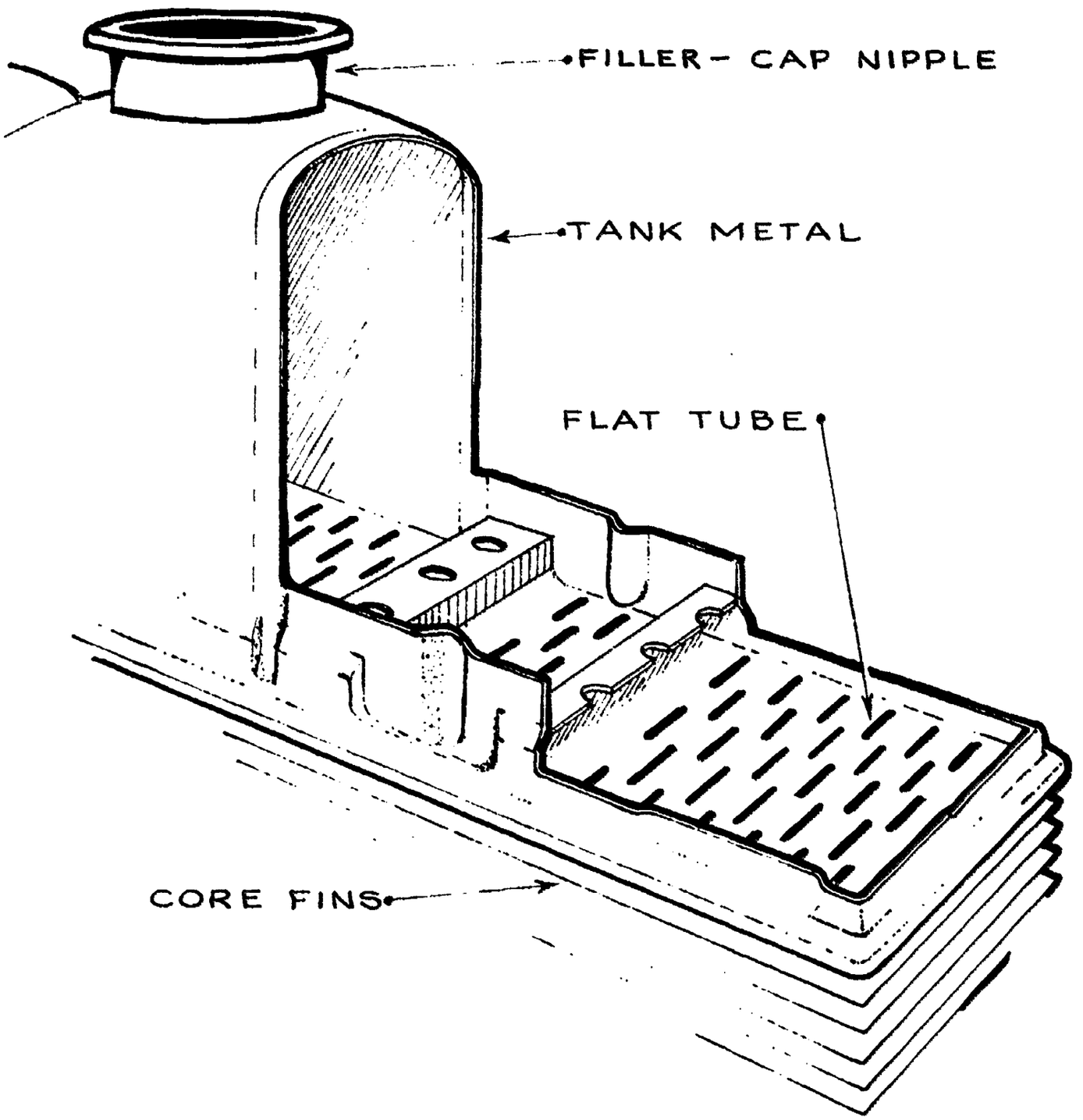
Outline of Information:

1. Purpose
   a. Device for holding large volume of coolant, designed to transfer engine heat to air
   b. Also absorbs and dissipates heat created by automotive transmission

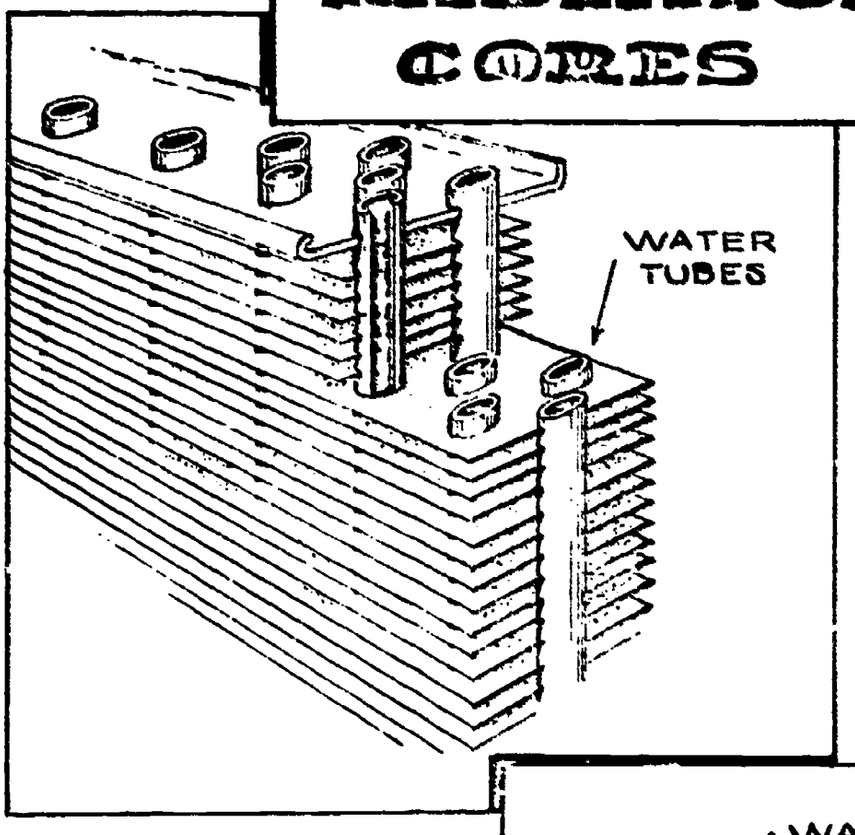
2. Types
   a. Vertical-flow
   b. Cross-flow
   c. Separate reservoir

3. Construction
   a. Inlet tank
      -- Filler neck
      -- Hose connection tube
      -- Overflow tube
   b. Outlet tank
      -- Hose connection tube
      -- Drain cock
      -- Oil cooler coils and connections
   c. Radiating Portion
      -- Tube and fin
      -- Ribbon cellular

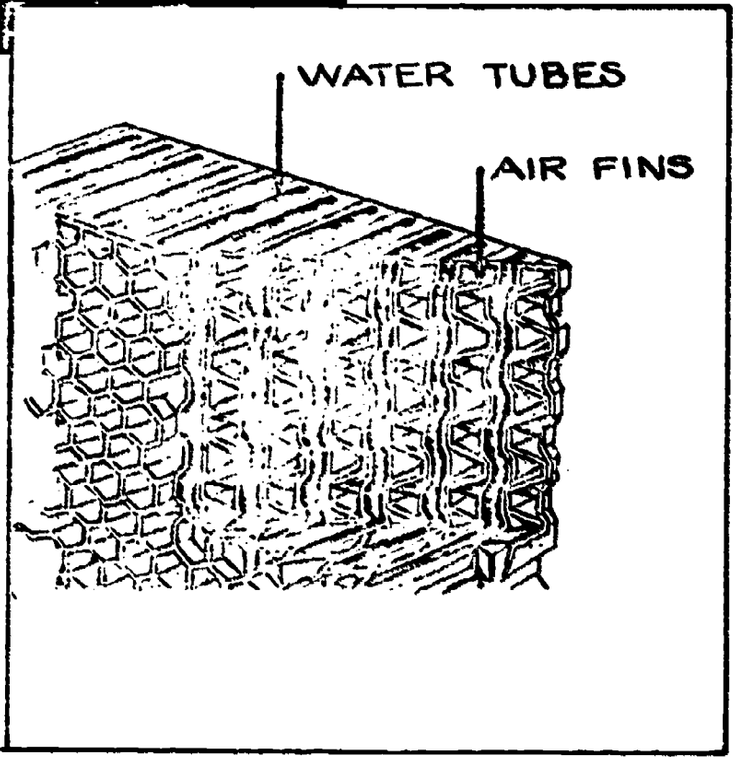
Radiator Upper Tank



RADIATOR CORES

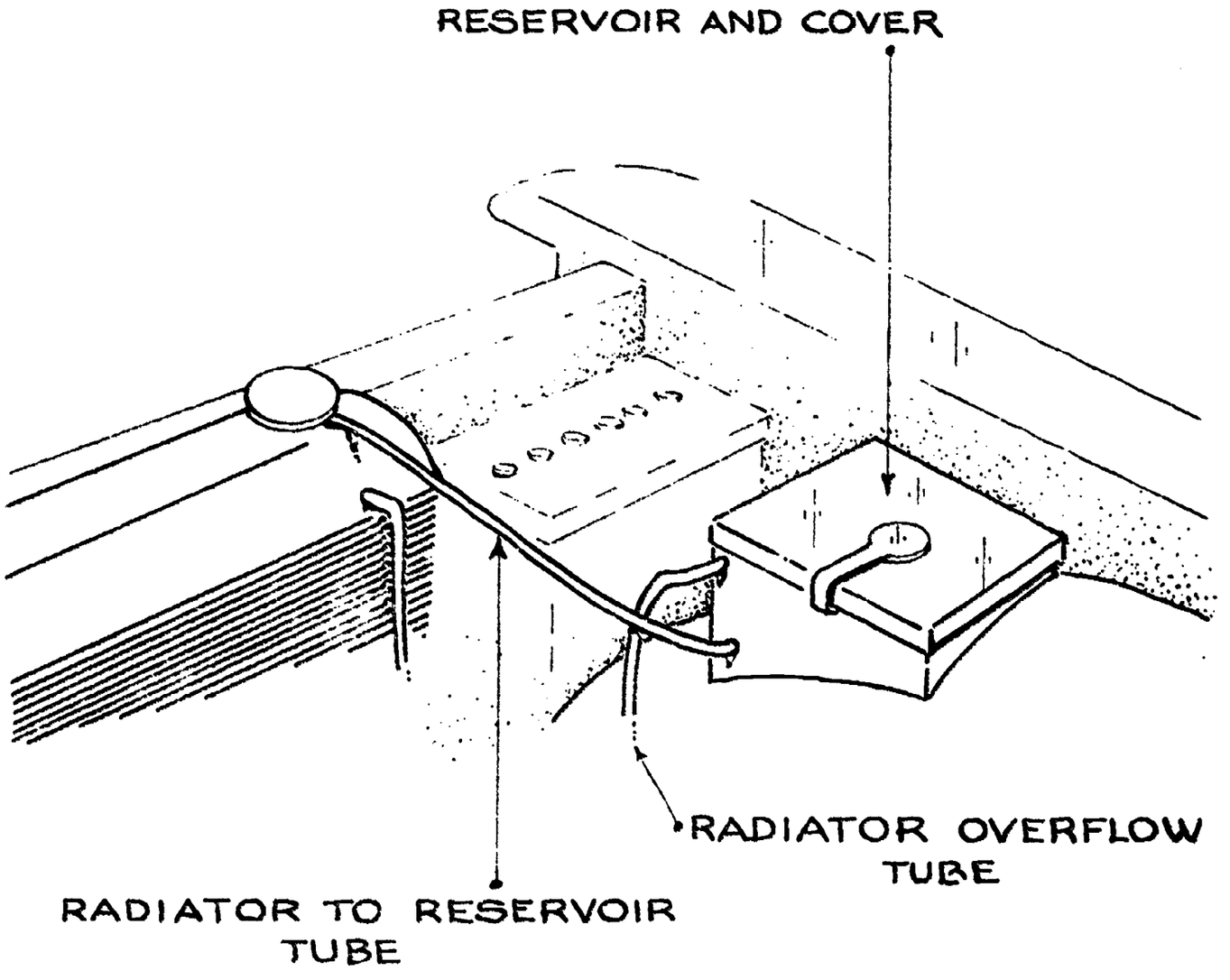


CONSTRUCTION OF TUBE-AND-FIN RADIATOR CORE.



CONSTRUCTION OF A RIBBON-CELLULAR RADIATOR CORE

RADIATOR OVERFLOW RESERVOIR



OPERATION

Block: Cooling System — Block VI

Operation: Removing and Replacing Radiator Assemblies — Job ____ Operation ____

Teaching Objective: To teach students to remove and replace radiator assemblies

Tools: Sockets (1/2" and 9/16"), ratchet, hose clamp pliers, screwdriver, drain pan and radiator filler can

Materials: Wipe cloths

Teaching Aids: Automobile or engine on stand

References: Vehicle Service Manual, Manufacturer

Steps:

1. Drain cooling system
2. Disconnect upper hose at radiator
3. Disconnect lower hose at radiator

   Caution: When using tools near the radiator, it is very important to avoid damaging any joints, connections, tubes, tanks, fins, etc. These are usually soft metal parts that may bend or puncture easily.

4. Remove engine fan blades, if necessary, to remove radiator
5. Remove fan shroud, if the automobile is equipped with one, by removing shroud attaching bolts
6. Remove transmission oil cooler lines from radiator if they are used
7. Remove radiator attaching bolts
8. Carefully lift radiator assembly from radiator support
9. Reverse steps for replacing
10. Check system thoroughly for leakage

INFORMATION

Block: Cooling System

Lesson: Hoses

Block VI
Job
Lesson

Teaching Objective: Upon completing this lesson, students will be able to identify the types of cooling system hoses and relate their service and failure limitations.

Teaching Aids: Samples of hoses

References: Automotive Mechanics, Crouse, Chapters 12, 22
Vehicle Service Manual, Manufacturer

Outline of Information:

1. Types and construction of Hoses

   a. Straight hose stock of various sizes

   b. Curved, molded hoses for standard fits
      -- Reinforced at ends (clamping area) with spring and/or increased wall thickness

2. Service of Hoses

   a. Subject to extreme conditions
      -- Vibration and twisting
      -- Heat and steam
      -- Pressure and suction
      -- Antifreeze and cleaning chemicals

3. Hose Failures

   a. Causes of hose failure
      -- Hardening and cracking
      -- Soft, rotted, and deteriorated hoses
      -- Harsh radiator cleaners and sealers
      -- Failure to install anti-collapse spring
      -- Corrosion of clamps and springs

   b. Effect of hose failure
      -- Pressure loss and coolant loss
      -- Hose collapse and restricted circulation
      -- Overheating and engine hot spots

OPERATION

Block: Cooling System

Operation: Removing and Replacing Coolant Hoses

Block VI
Job
Operation

Teaching Objective: To teach students to remove and replace hoses

Tools: Drain pan, hose clamp pliers, and screwdriver

Materials: Radiator hose, wipe cloths, hose clamps

Teaching Aids: Automobile or engine on stand

References: Vehicle Service Manual, Manufacturer

Steps:

1. Drain coolant from radiator
2. Loosen hose clamps
3. Remove hose

   Note: Inspect hose condition for signs of deterioration (Refer p. VI-19)
4. Clean radiator and engine hose connection tubes
5. Replace hose
6. Tighten hose clamps
7. Refill radiator
8. Check carefully for leakage

INFORMATION

Block: Cooling System

Lesson: Pressure Cap

Block VI
Job
Lesson

Teaching Objective: Upon completing this lesson, students will be able to define the purpose of the radiator pressure cap, describe its operating principles and list basic service operations.

Teaching Aids: Transparencies:
- The Use of a Pressure Cap, p. VI-23
- Radiator Pressure Cap, p. VI-24
- Radiator Pressure Cap, VI-25
- Pressure Cap Testing, p. VI-27

References: Automotive Mechanic, Crouse, Chapters 12, 22
Cooling System Manual, Dupont, pp. 19-20
Automechanics, Glenn, Chapter 2

Outline of Information:

1. Purpose

   a. Allows higher operating temperatures
      -- Improves cooling efficiency

   b. Permits higher altitude operation

   c. Prevents coolant loss at normal temperatures

2. Effects of pressure on a coolant

   a. Water at sea level boils at 212° F.

   b. Increasing pressure on fluid increases boiling point
      -- Improves circulation

3. Effects of atmospheric pressure on boiling points

   a. Pressure increase of one pound psi raises boiling point of pure water approximately 3° F.

4. Service operations

   a. Wash in clean water

   b. Keep sealing surface clean

   c. Check periodically for opening and closing temperatures

   d. Replace -- repairs not recommended

Pressure Cap (Continued)

5. Cap ratings

   a. Open system - 175° - 180° F.

   b. Pressurized

PSI	Maximum Operating Temperature
7	232°
9	235°
13	243°
15	247°

THE USE OF A PRESSURE CAP:

1. INCREASES COOLING EFFICIENCY

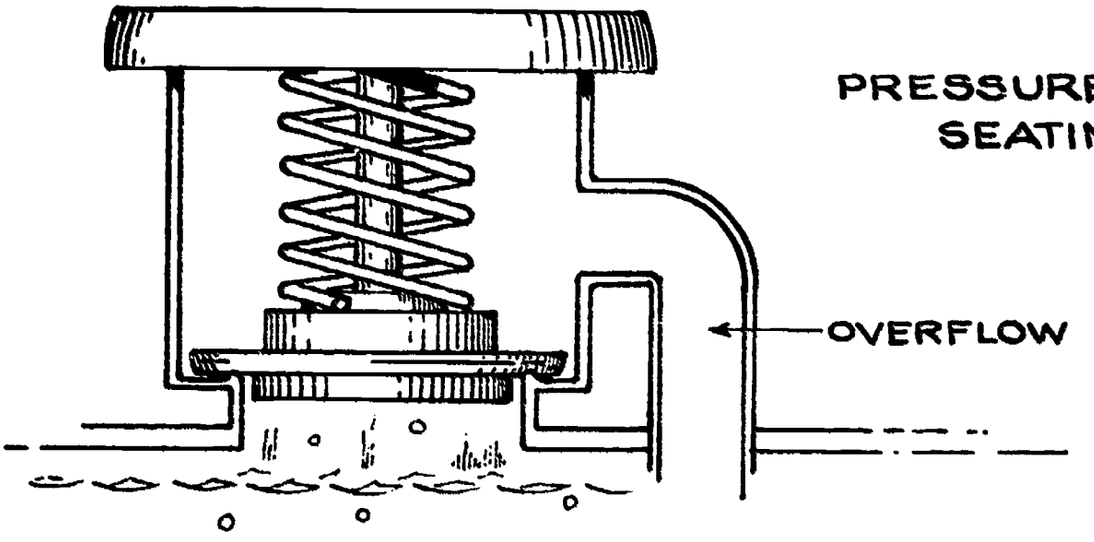
2. PREVENTS COOLING EVAPORATION (WATER AND ANTI-FREEZE)

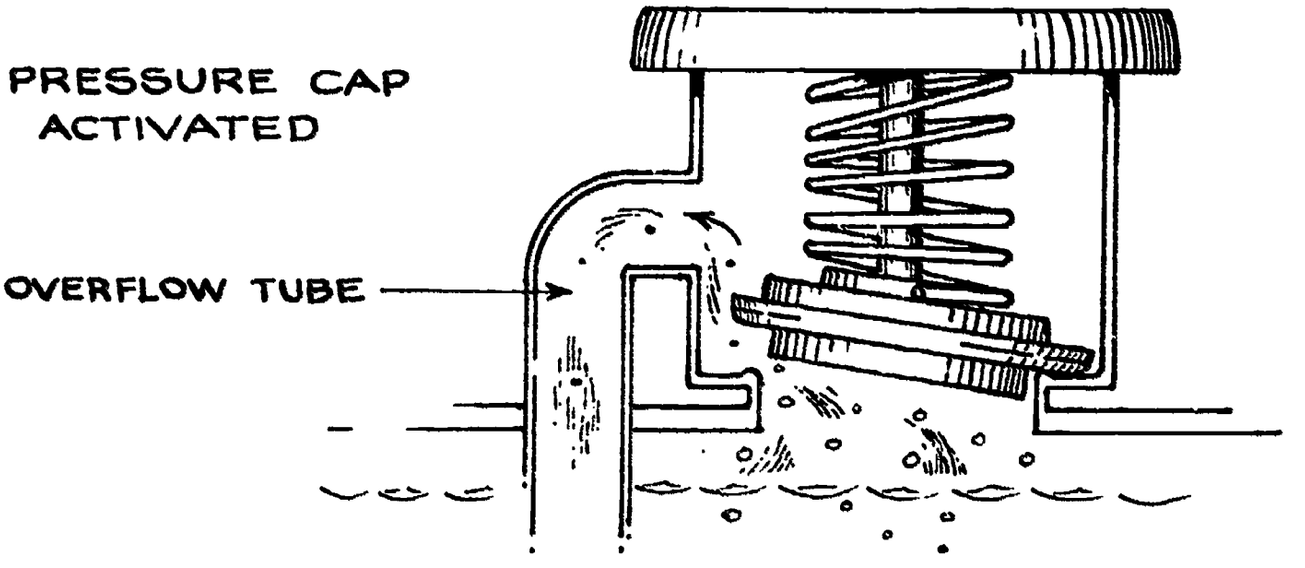
3. REDUCES SURGE LOSSES CAUSED BY COOLANT BEING FORCED OUT OF THE OVERFLOW TUBE OF THE RADIATOR BY HARD BRAKE APPLICATIONS

4. RETARDS BOILING LOSSES DUE TO "HOT SPOTS" IN THE MOTOR BLOCK

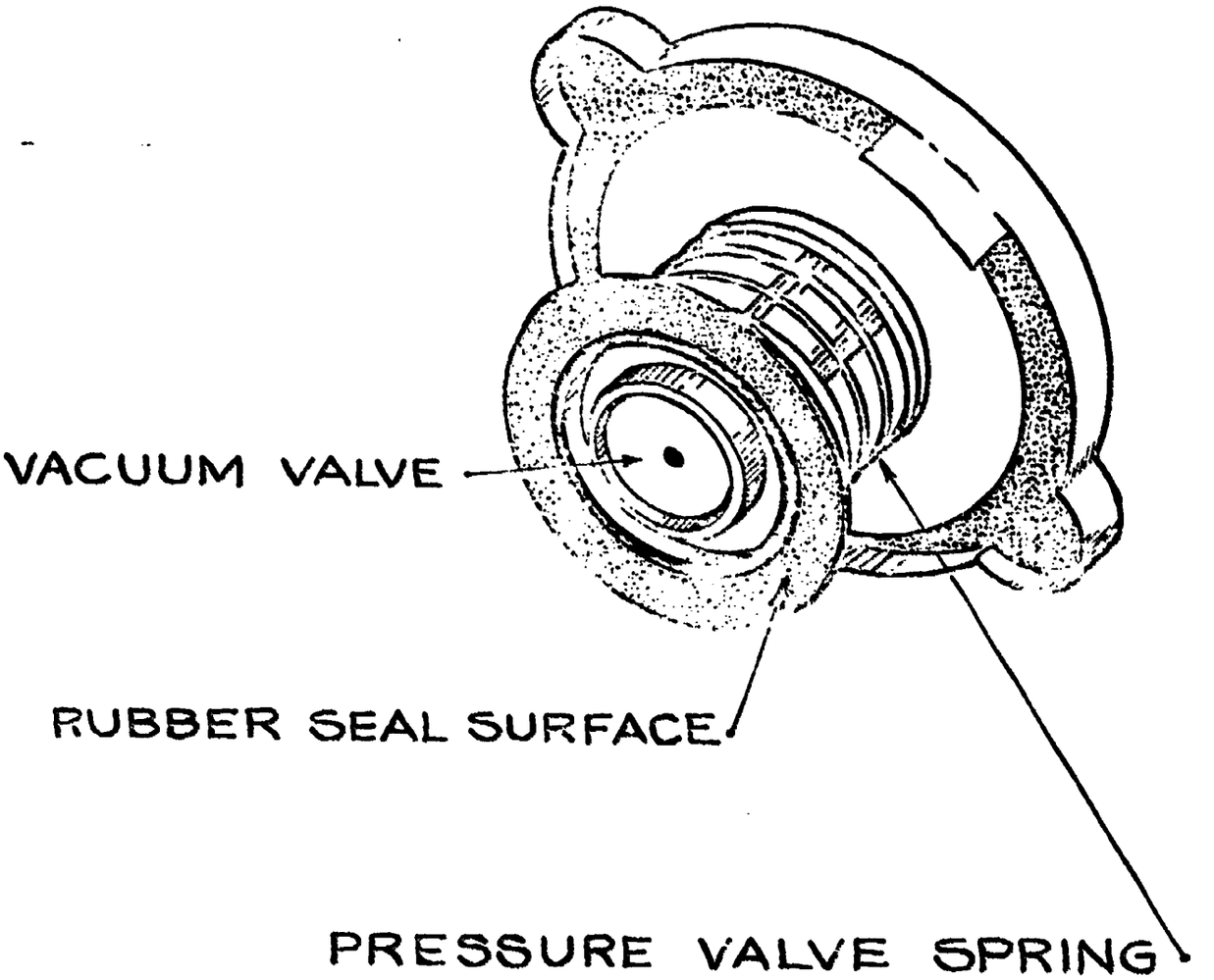
5. MAKES IT EASIER TO COOL THE ENGINE REGARDLESS OF ATMOSPHERIC PRESSURE, TEMPERATURES, ENGINE LOADS, OR DRIVING CONDITIONS

RADIATOR PRESSURE CAP





RADIATOR PRESSURE CAP



OPERATION

Block: Cooling System

Operation: Testing Pressure Caps

Block VI
Job
Operation

Teaching Objective: To teach students to test pressure radiator caps

Tools: Radiator pressure cap tester

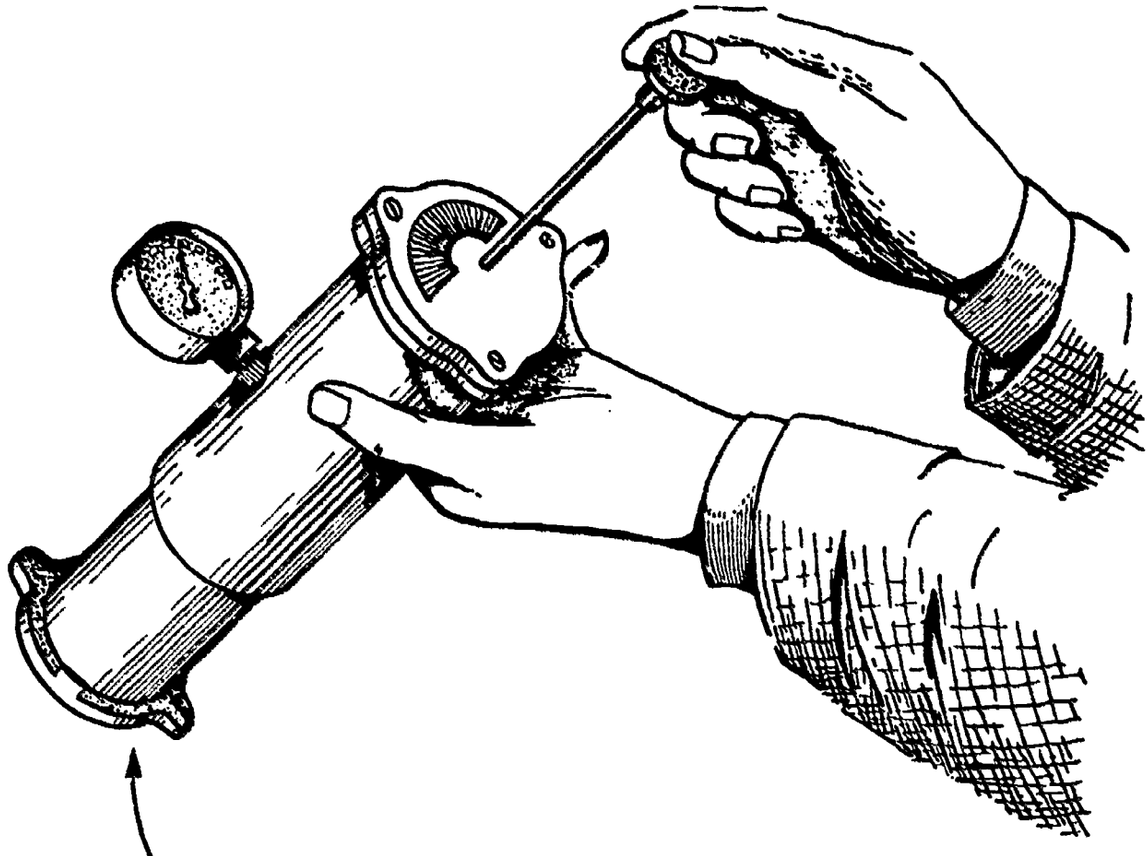
Teaching Aids: Samples of good and samples of defective pressure caps
Transparency:
- Pressure Cap Testing, p. VI-27

References: Automotive Mechanics, Crouse, Chapter 23

Steps:

1. Place a pressure cap on the end of the tester
2. Pump up a pressure equal to the rating stamped on top of the cap
3. Determine if the cap will hold its rated pressure by observing the gauge
4. Relieve pressure
5. Remove cap

PRESSURE CAP TESTING



INFORMATION

Block: Cooling System — Block VI
Job
Lesson: Thermostats — Lesson

Teaching Objective: Upon completion of this lesson, students will be able to define the prupose and principles of automotive thermostats.

Teaching Aids: Samples of the different types of thermostats
Transparencies:
- Thermostat - Open, p. VI-29
- Thermostat - Closed, p. VI-30
- Checking Thermostat "activating" Temperature, p. VI-32

References: Automotive Mechanics, Crouse, Chapters 12, 22

Outline of Information:

1. Purpose

   a. Regulation of coolant temperature for most efficient engine operation

   b. Restrict coolant circulation for rapid engine warm-up

2. Function

   a. Passage valve activated to temperature reaction (thermostatic) system

3. Types

   a. Bellows
      -- Coiled bellows, contains liquid which creates pressure upon evaporation causing bellows to activate valve

   b. Sleeve
      -- Wax pellet expands with temperature and activates valve

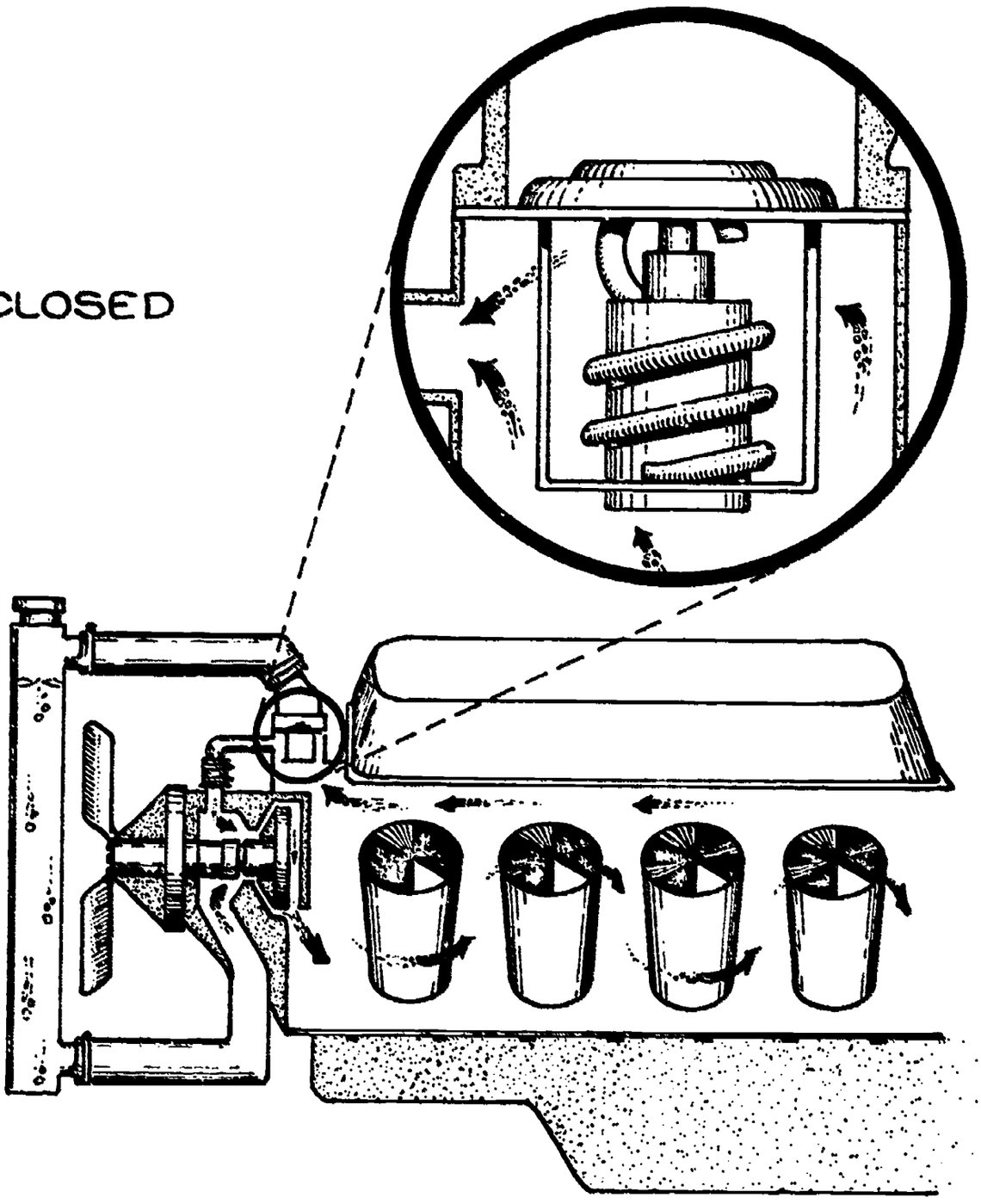
   c. Butterfly
      -- Wax pellet principle

4. Temperature and Ratings

   a. Rating designated according to average operating temperature
      Example: 180° Rating - opens between 177° and 182° F.
      - fully open at 202°

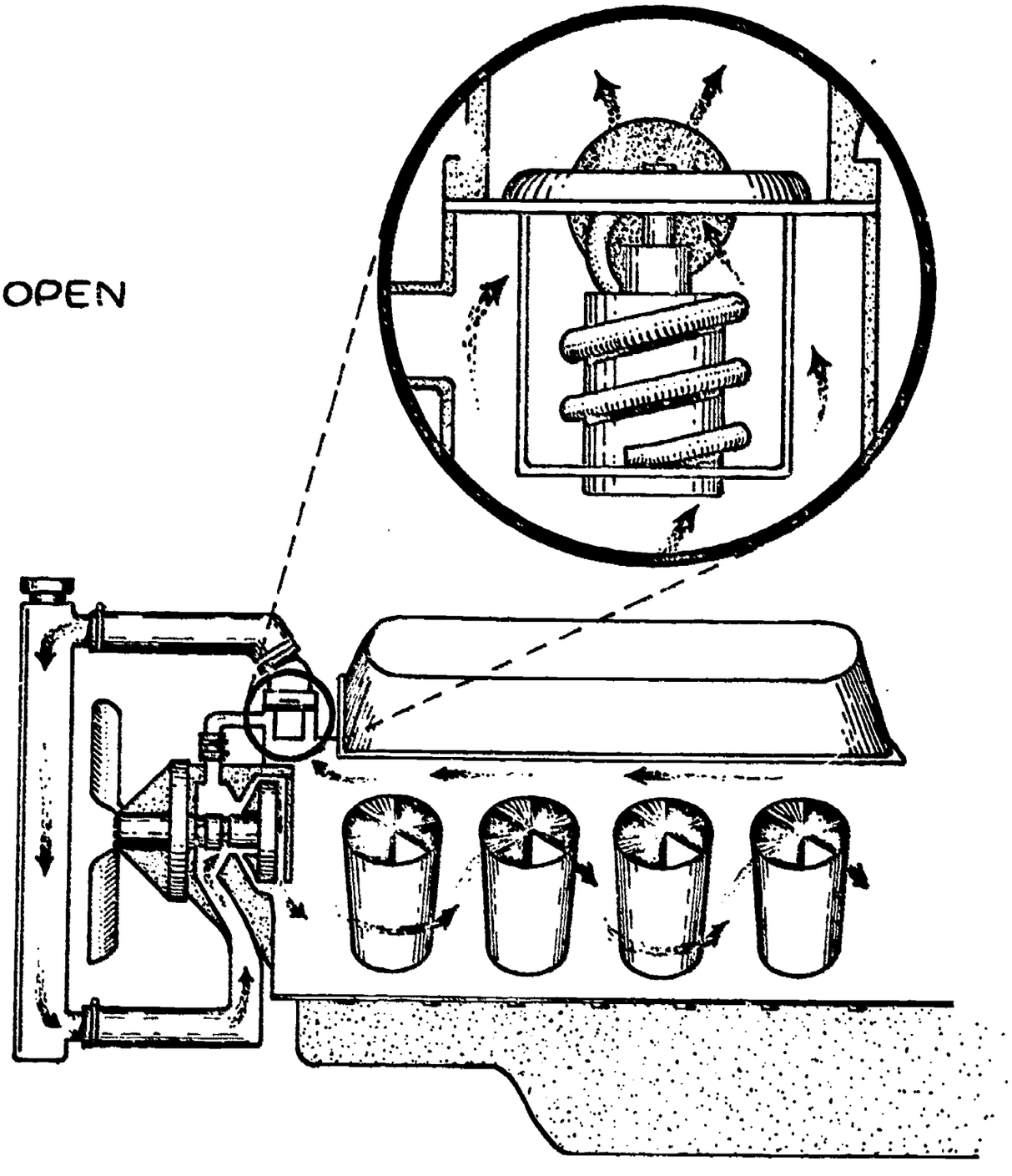
THERMOSTAT

CLOSED



THERMOSTAT

OPEN



OPERATION

Block: Cooling System

Operation: Testing Thermostats

Block VI
Job
Operation

Teaching Objective: To teach students to test thermostats

Tools: Electric hot plate or heating element, one quart open container, and centigrade thermometer

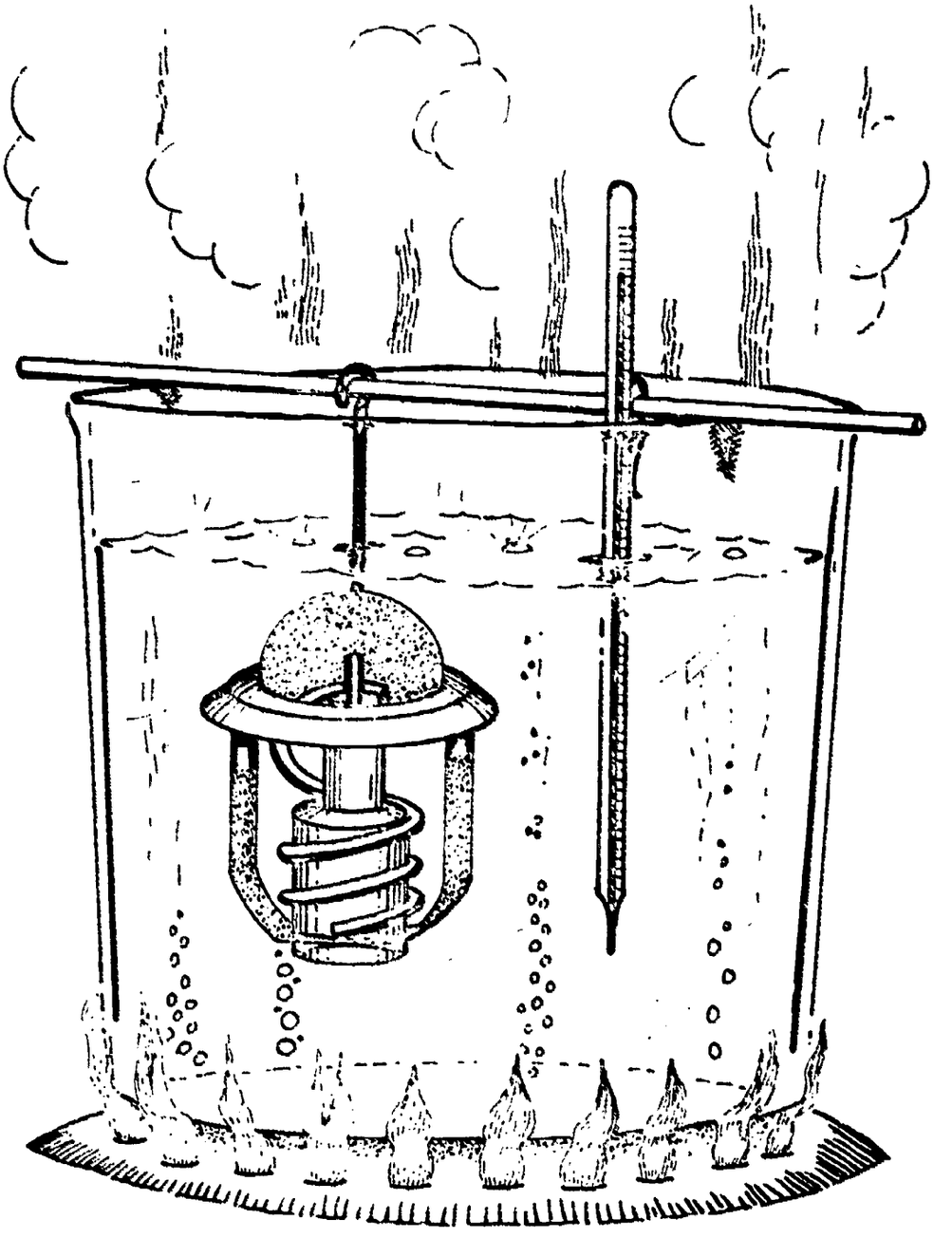
Materials: Container of water

Teaching Aids: Samples of good thermostats and defective thermostats
Transparency:
- Checking Thermostat "activating" Temperature, p. VI-32

References: Automotive Mechanics, Crouse, Chapter 22

Steps:

1. Place thermostat in an open container of about three inches of cool water
2. Place the thermometer in a vertical position in the water
3. Slowly heat the water and note the temperature at which the thermostat begins to open
4. Record this reading
5. Continue to heat the water until the thermostat is fully opened
6. Note and record this temperature
7. Remove the source of heat and observe the closing operation of the thermostat
8. Compare those results with standards
9. Replace the thermostat if not within limits



CHECKING THERMOSTAT "activating" TEMPERATURE

Both Thermometer and thermostat should be kept free of contact with container

OPERATION

Block: Cooling System

Operation: Removing and Replacing Thermostats

Block VI
Job
Operation

Teaching Objective: To teach students to remove and replace thermostats

Tools: Drain pan, combination wrenches (7/16 and 1/2 inch), screwdriver

Materials: Thermostat, water outlet gasket, gasket sealer, wipe cloths

Teaching Aids: Automobile or engine on stand

References: Vehicle Service Manual, Manufacturer

Steps:

1. Drain coolant from radiator
2. Remove thermostat housing bolts
3. Remove thermostat housing and old gasket
4. Remove thermostat
5. Clean gasket surfaces thoroughly
6. Install thermostat with spring or bellows down
7. Apply a small amount of sealer to a new gasket
8. Install housing and bolts
9. Tighten bolts securely
10. Refill radiator with coolant

Caution: Many housings are broken when installing thermostats. Care should be exercised to avoid the following errors:

-- Thermostat slips down (out of recess) during installation.
-- Bolts are not tightened evenly, together.
-- Bolts are overtightened.

INFORMATION

Block: Cooling System

Lesson: Water Pumps

Block VI
Job
Lesson

Teaching Objective: Upon completion of this lesson, students will be able to relate the design characteristics and functioning principles of typical automotive water pumps.

Teaching Aids: Transparency
- Water Pump, p. VI-35

References: Automotive Mechanics, Crouse, Chapters 12, 22
Automotive Encyclopedia, Goodheart-Wilcox, pp. 101-102

Outline of Information:

1. Design

   a. Modern engines utilize either impeller or rotating-vane type pump
      -- Both exert centrifigal force on water
      -- Creates suction on inlet line and pressure on outlet line

   b. Housing is made of cast iron or cast aluminum

   c. Impeller is mounted on shaft which extends through housing
      -- Often mounted on same shaft as fan pulley

   d. Spring-loaded, self-sealing device prevents leakage

   e. Bearings and lubrication
      -- Standard type with fittings requiring lubrication
      -- Pre-lubricated, sealed bearing unit

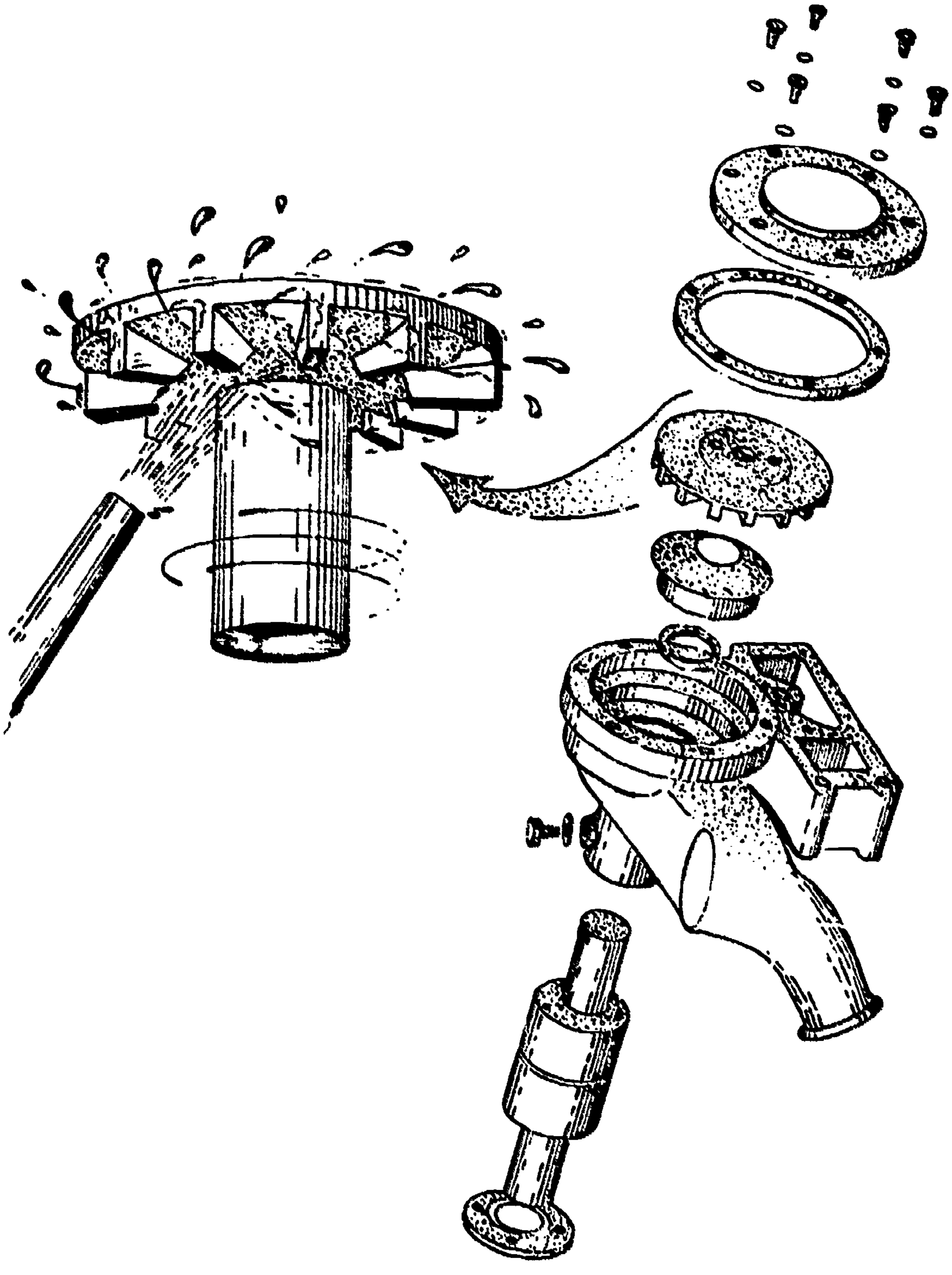
2. Function

   a. Coolant flow (full circulation)

   b. Impeller must rotate rapidly to be efficient

   c. Driven by V-belt

WATER PUMP WITH IMPELLER SPINNING



OPERATION

Block: Cooling System

Operation: Removing and Replacing Water Pumps

Block VI
Job
Operation

Teaching Objective: To teach students to remove and replace water pumps

Tools: Drain pan, screwdriver, combination wrenches (1/2" and 9/16"), slip-joint pliers, soft wire brush, 12" pry bar

Materials: Water pump assembly, water pump gasket, gasket sealer, wipe cloths

Reference: Vehicle Service Manual, Manufacturer

Steps:

1. Drain cooling system
2. Remove fan belt
3. Remove fan blade mounting bolts
4. Remove fan blades and hub from pump
5. Disconnect lower radiator hose at water pump
6. Remove water pump block mounting bolts
7. Remove water pump from block
8. Carefully clean all old gasket material from pump mounting surface on block
9. Transfer any heater fittings from old pump mounting surface on block
10. Apply a small amount of gasket sealer to both sides of the new pump gasket and position on pump
11. Install pump on block and start all mounting bolts
12. Tighten all bolts securely
13. Install and tighten lower radiator hose
14. Install fan blades and hub
15. Tighten bolts securely
16. Install fan belt
17. Fill cooling system
18. Check for leaks

INFORMATION

Block: Cooling System

Block VI
Job
Lesson

Lesson: Expansion Plugs

Teaching Objective: Upon completion of this lesson, students will be able to define the purpose and determine types and sizes of expansion plugs.

Teaching Aids: Variou types and sizes of expansion plugs (freeze plugs)

Reference: Vehicle Service Manual, Manufacturer

Outline of Information:

1. Purpose

   a. Protective measure against engine block cracking

   b. Designed to release upon excessive expansion and resulting pressure of coolant

2. Types

   a. Cup

   b. Saucer

3. Sizes

   a. Sizes differ on each engine.
      -- Specified by O.D. of plug

4. When to replace

   a. Evidence of water leakage

   b. Rust pits

OPERATION

Block: Cooling System

Operation: Removing and Replacing Expansion Plugs

Block VI
Job ____
Operation ____

Teaching Objective: To teach the students to remove and replace expansion plugs

Tools: Ball pein hammer, driver of proper size, and 1/4" pin punch

Materials: Expansion plug and #2 Permatex Sealer, wipe cloths

Teaching Aids: Automobile or engine on stand

Reference: Vehicle Service Manual, Manufacturer

Steps:

1. Drain cooling system
2. Remove any engine accessory that may be necessary to have free access to freeze plug
3. Using pin punch, drive a hole in the center of freeze plug
4. Pry out old freeze plug with punch
5. Thoroughly clean inside surface of freeze plug opening
6. Apply a light coating of #2 Permatex Sealer around the outer edge of the freeze plug
7. Position freeze plug in hole
8. Using a driver of proper size drive the freeze plug flush with the outer surface of the engine block
9. Replace any engine accessories that were removed
10. Refill cooling system
11. Check thoroughly for leaks

INFORMATION

Block: Cooling System — Block VI
Job
Lesson: Cooling System Cleaning — Lesson

Teaching Objective: Upon completion of this lesson, students will be able to outline the proper methods of cleaning automotive cooling systems.

Teaching Aids: Transparencies:
- Reverse Flushing (Radiator), p. VI-41
- Reverse Flushing (Engine Block), p. VI-42

References: Cooling System Service Manual, Union Carbide, pp. 30-35
Automotive Mechanics, Glenn, Chapter 2
Automotive Encyclopedia, Goodheart-Wilcox, pp. 179-180

Outline of Information:

1. Cleaning (chemical)

   a. Cleaning compounds (usually caustic solutions) are available commercially.

   b. Added to water for circulation throughout system
      -- Dissolves rust and scale
      -- May damage metal parts if manufacturer's directions are ignored
      -- Some types of compounds require use of a neutralizer.

2. Reverse flushing

   a. Dislodges foreign deposits to assure full circulation

   b. Radiator and Block flushed separately
      -- Reverse flush gun
      -- Air and water pressure
      -- Thermostat removed

      Note: When using cooling system additives, care should be exercised to prevent possible damage to machined and finished surfaces.

OPERATION

Block: Cooling System

Block VI
Job
Operation

Operation: Reverse Flushing Cooling System

Teaching Objective: To teach students how to reverse flush cooling systems

Tools: Drain pan, screw driver, hose clamp pliers, combination wrenches (9/16" and 1/2"), water hose, radiator filler can

Materials: Gaskets, coolant additives, hose changes, wipe cloths

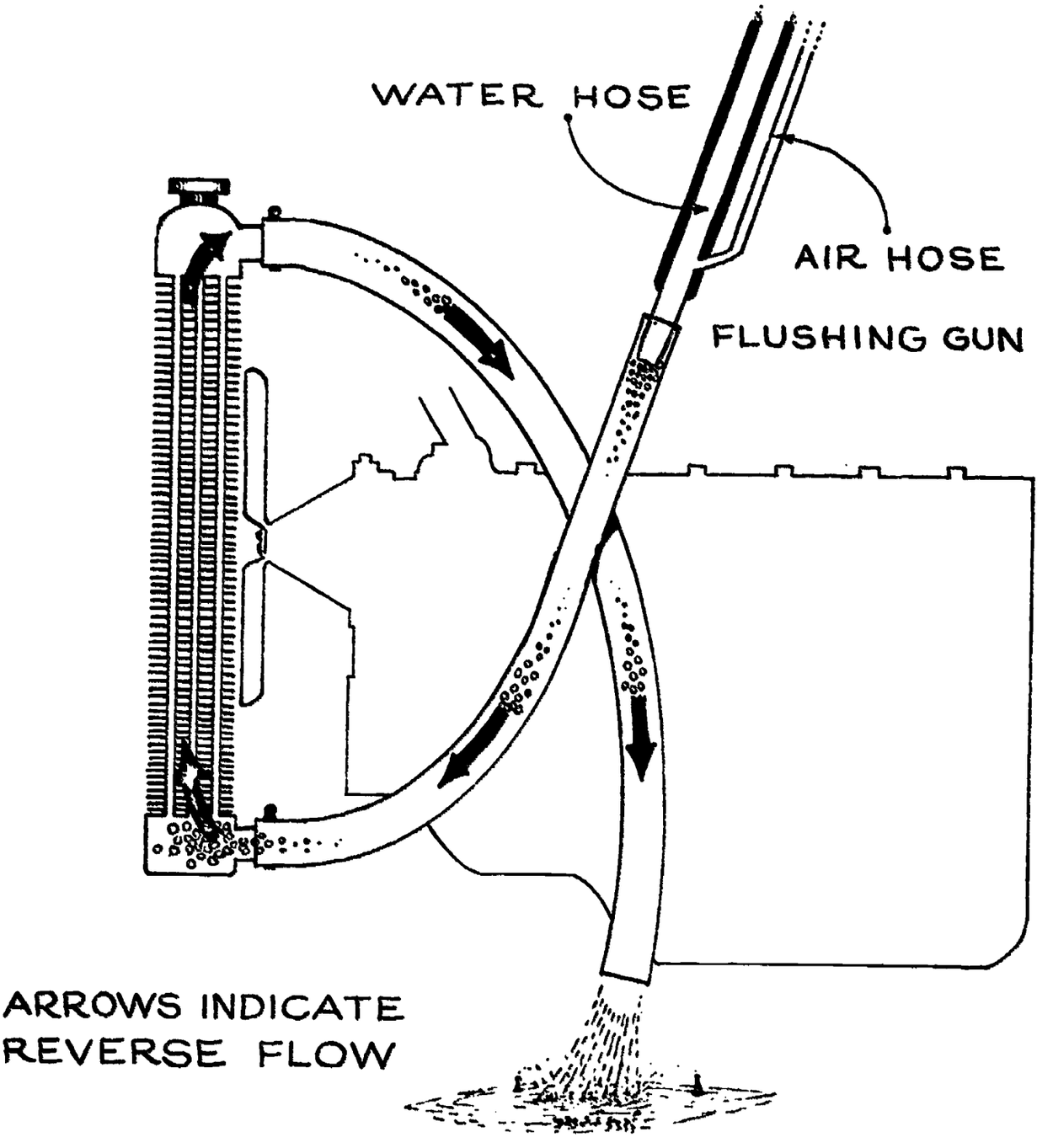
Teaching Aids: Automobile or engine on stand

References: Automotive Mechanics, 5th edition, Crouse, pp. 353-354

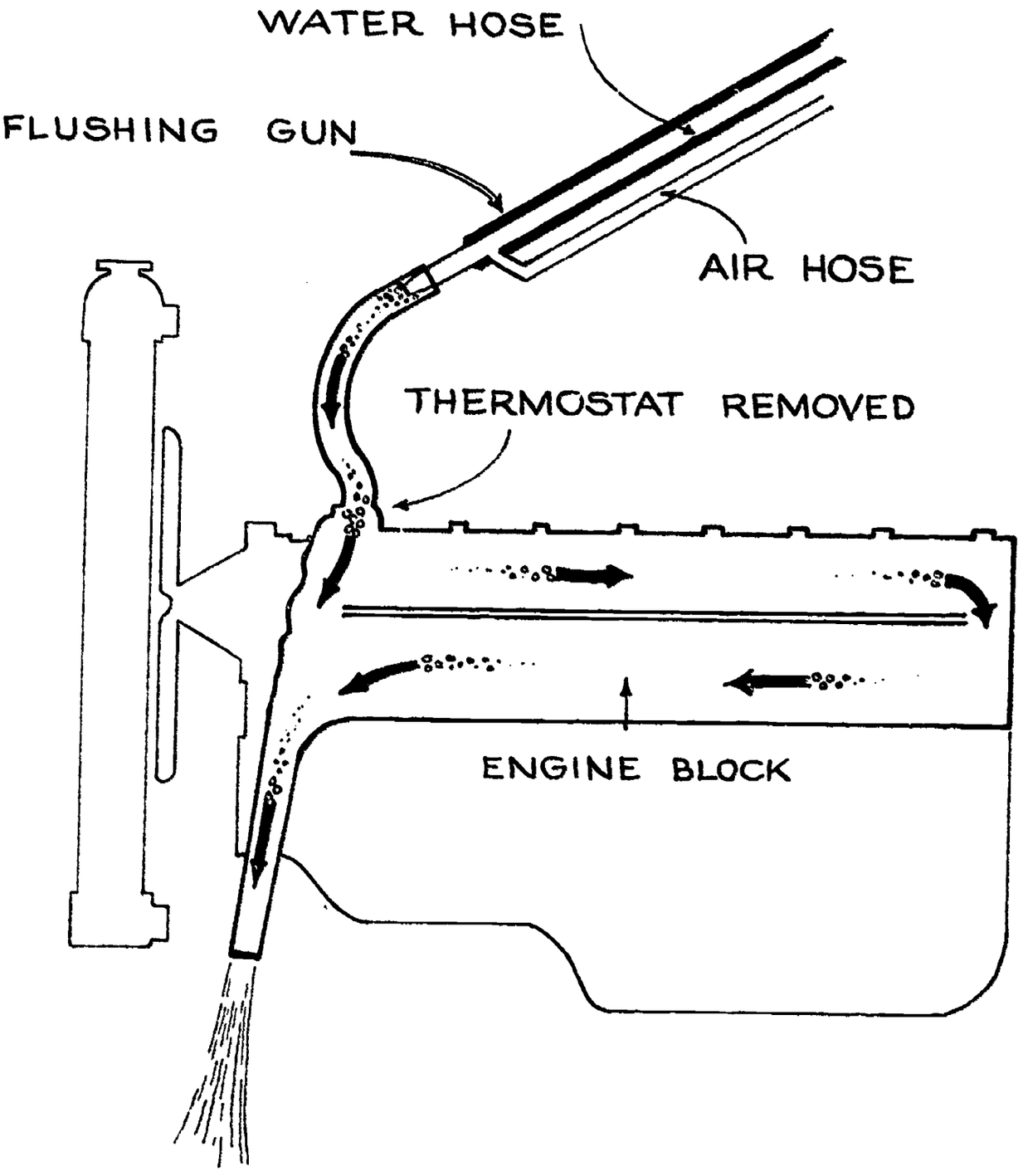
Steps:

1. Drain system
2. Remove thermostat
3. Replace thermostat housing
4. Remove upper end of upper and lower radiator hoses
5. Connect air and water lines tc flushing gun
6. Connect flushing gun adapter to lower hose
7. Press air lever to force air and water through the cooling system, with the water valve open
8. Remove flushing gun and connect to upper hose
9. Repeat step #7
10. Remove flushing gun
11. Disconnect air and water lines from gun
12. Replace thermostat
13. Connect upper and lower hoses
14. Refill cooling system
15. Check for leaks

REVERSE FLUSHING-(RADIATOR)



REVERSE FLUSHING-(ENGINE BLOCK)



INFORMATION

Block: Cooling System

Lesson: Temperature Indication System

Block VI
Job
Lesson

Teaching Objective: Upon completion of this lesson, students will be able to define the purpose of temperature indication systems and list the basic components and pertinent service operations.

Teaching Aids: Temperature indicator unit
Film: "Thermal Electric Gauges," Chrysler Motors Corp.
Transparencies:
- Resistor-type Temperature Indicator System, p. VI-44
- Hot and Cold Light Temperature Indicator System, p. VI-45

Reference: Automotive Mechanics, Crouse, Chapter 12

Outline of Information:

1. Purpose - to inform operator of engine operating temperature

2. Application

   a. Air-cooled engines

   b. Liquid-cooled engines

2. Components

   a. Heat indicator mounted in dash instrument panel receives heat signal and displays message.
      -- Bourdon tube construction

   b. Control bulb fastened into water jacket acts as a pick up unit.

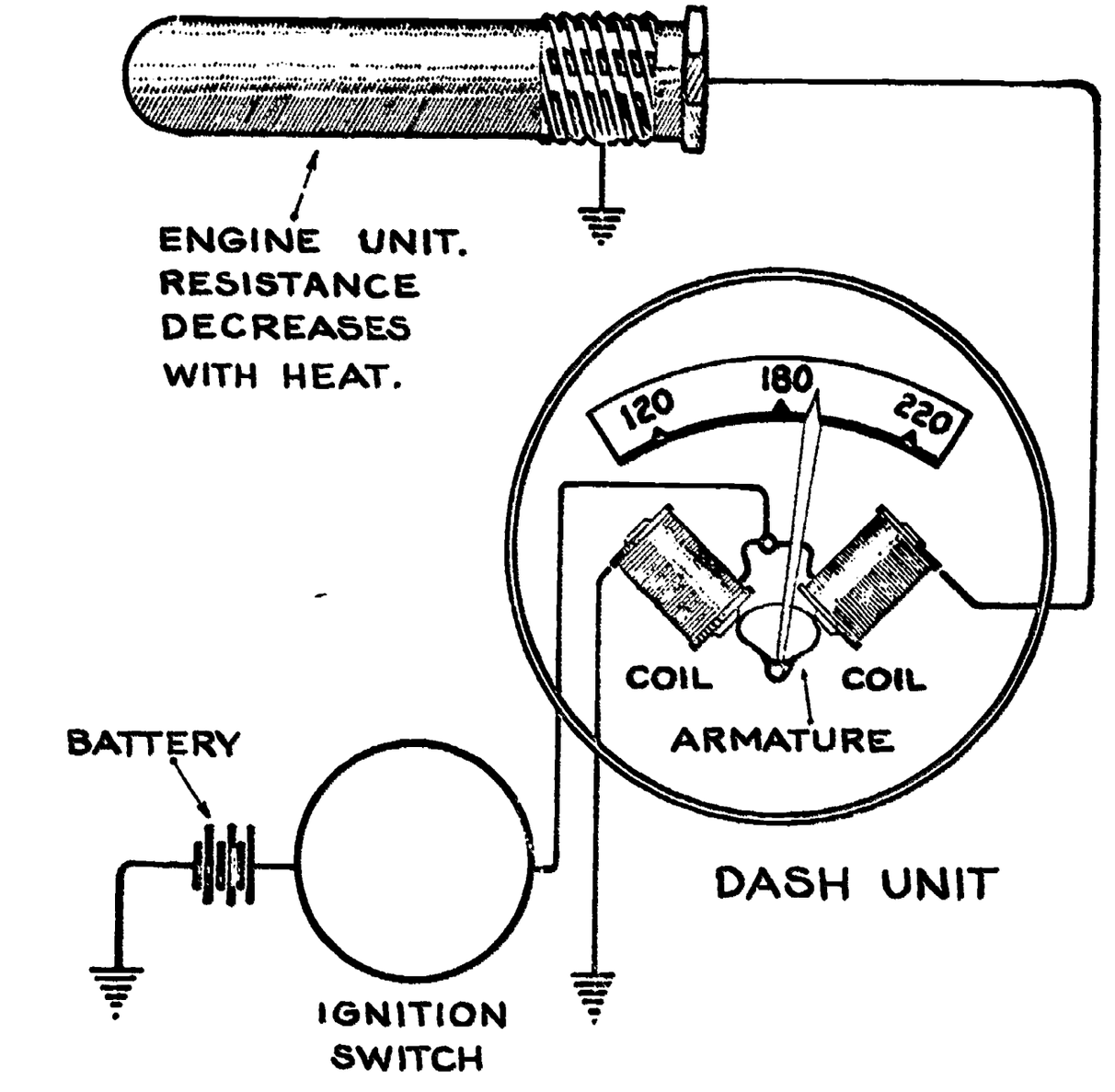
   c. Capillary tube carries signal (heat flow) to indicator.

3. Service Operation

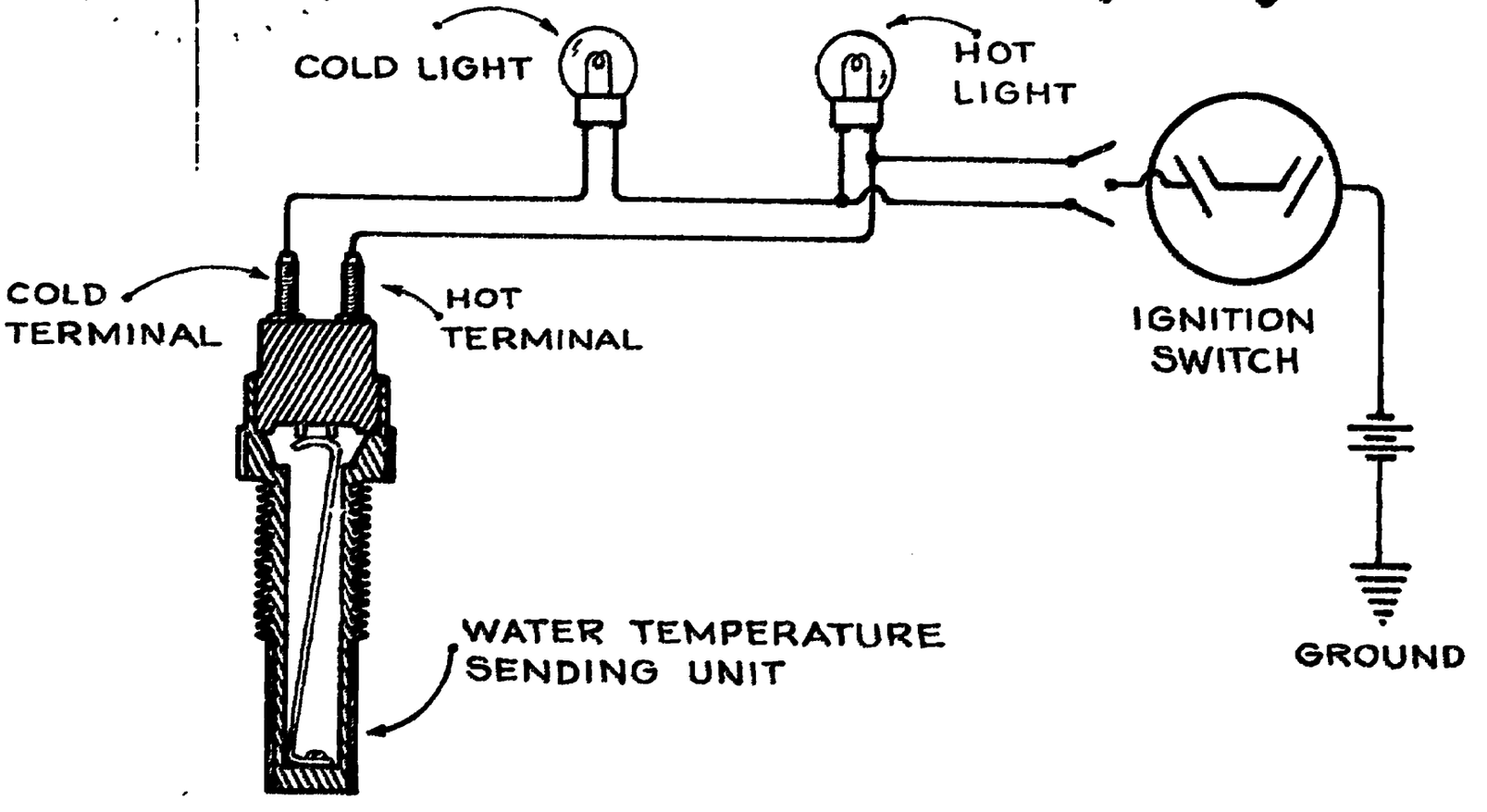
   a. Testing for accurate indication with a separate unit of known accuracy

   b. Replacement of essential components of most frequent failure
      -- Capillary tube
      -- Control bulb

Resistor-Type Temperature Indicating System



Hot and Cold Light Temperature Indicating System



OPERATION

Block: Cooling System — Block VI

Operation: Removing and Replacing Temperature Indicators — Job Operation

Teaching Objective: To teach the students to remove and replace temperature indicators

Tools: Phillips and standard screwdrivers, Open-end wrenches (3/8", 7/16", 1/2" and 9/16")

Materials: Temperature Indicator Unit, Wipe cloths

Teaching Aids: Automobile or engine on stand

Reference: Vehicle Service Manual, Manufacturer

Steps:

Gauge

1. Remove instrument group assembly
2. Remove cover holding screws
3. Remove thermal nuts and gauge unit
4. Reverse procedure for installation

Temperature sending unit

1. Relieve coolant system pressure by loosening radiator cap
2. Remove thermal-sender unit (if control-bulb type, first remove capillary tube)
3. Replace with new unit
4. Tighten radiator cap

INFORMATION

Block: Cooling System

Lesson: Passenger Compartment Heating System

Block VI
Job
Lesson

Teaching Objective: Upon completion of this lesson, students will be able to differentiate between the two most common types of automotive passenger heating systems.

Teaching Aids: Samples of heating system components (core, blower, air ducts, water hoses)

References: Automotive Mechanics, Crouse, Chapter 12
Automotive Essentials, Kuns, Chapter 1

Outline of Information:

1. System types and function

   a. Air-cooled system
      -- Sheet metal ducts and bellows providing for transfer of engine-created heat to passenger compartment
      -- System must be designed to seal out all engine fumes.
      -- Usually equipped with air blower to increase air flow
      -- Usually provides for fresh air introduction

   b. Liquid-cooled system
      -- Secondary radiator (core) receives hot water through circulation of engine cooling system
      -- Heat transfers from core to passenger compartment.
      -- Equipped with blower (usually multi-speed) to provide for desired air volume
      -- Separate vent and ducts for introduction of fresh air through heating system is typical.
      -- Duct system for window defrosting utilizes dust valve for control

OPERATION

Block: Cooling System

Operation: Removing and Replacing Heater Core

Block VI
Job
Operation

Teaching Objective: To teach the students to remove and replace heater cores

Tools: Drain pan, open-end wrench set, terminal puller, hose-clamp pliers, screwdriver

Materials: Wipe cloths

Teaching Aids: Automobile or engine on stand

Reference: Vehicle Service Manual, Manufacturer

Steps:

1. Drain radiator
2. Disconnect battery ground cable
3. Disconnect heater hoses from core tubes
4. Disconnect electrical leads to heater essembly
5. Remove heater assembly from vehicle

   Note: Give careful attention to specific steps of removal recommended by manufacturer

6. Remove core from heater assembly
7. Install replacement core in heater assembly
8. Replace heater assembly in vehicle
9. Carefully connect electrical leads
10. Connect battery ground cable
11. Try unit blower out to determine proper installation
12. Connect heater hoses to core tubes

    Note; Check hose connections for coolant leakage

INFORMATION

Block: Cooling System

Lesson: Drive Belts

Block VI
Job
Lesson

Teaching Objective: Upon completion of this lesson students will be able to identify the types and application of drive belt, describe how they are measured and recognize indicators of belt failure.

Teaching Aids: Samples of belts - new, worn, cross-sectioned
Samples of pulleys

References: Automotive Mechanic, Crouse, Chapter 12

Outline of Information:

1. Types
   a. Flat
   b. V-type
2. Sizes determined by three precise dimensions
   a. Length
   b. Width
   c. Degree of pitch
3. Application
   a. Transfer of power and motion
      -- Most typical automotive application is the fan belt - basically driving fan, water pump and alternator.
   b. Synchronization
   c. Variable speed applications
   d. To drive optional equipment units
   e. Dual and additional multiples of belts used to assure driving power
4. Indications of faulty belt
   a. Cracked or broken
   b. Frayed edges
   c. Glaze noise
   d. Running in bottom of pulley grooves

OPERATION

Block: Cooling System

Operation: Removing and Replacing Fan Belts

Block VI
Job
Operation

Teaching Objective: To teach students to remove and replace fan belts

Tools: Combination wrench (1/2", 9/16") pry bar, and torque wrench

Materials: Fan belt, wipe cloths, belt dressing

Teaching Aids: Automobile or engine on stand

Reference: Automechanics, Glenn, Chapter 2

Steps:

1. Loosen alternator adjusting strap bolt
2. Loosen alternator mounting bolting
3. Slide alternator toward engine to remove belt tension
4. Remove belt from pulley grooves
5. Inspect belt for excessive wear (replace if necessary)
6. Replace belt in pulley grooves
7. Slide alternator away from engine to specified distance when pressure is applied

   Note: Some tune-up specifications require use of strand tension guage to determine exact belt tension. One indication of correct adjustment is belt slippage in the pulley under 40-45 foot-pounds of torque.

8. Tighten alternator adjusting strap bolts
9. Tighten alternator mounting bolts

INFORMATION

Block: Cooling System

Block VI
Job
Lesson

Lesson: Fans

Teaching Objective: Upon completion of this lesson, students will be able to define the purpose of automotive fans and describe the design characteristics and application of the most common types.

Teaching Aids: Transparencies:
- Cooling System Fans, p. VI-52
- Fan Speed, p. VI-53

References: Automotive Mechanic, Crouse, Chapters 12, 22
Automechanics, Glenn, Chapter 2

Outline of Information:

1. Purpose
   -- Provides a powerful draft of air through the radiator to carry off heat that the water has brought from engine to radiator

2. Design and Applications

   a. Standard, light duty
      -- Passenger cars

   b. Heavy duty
      -- Trucks and tractors

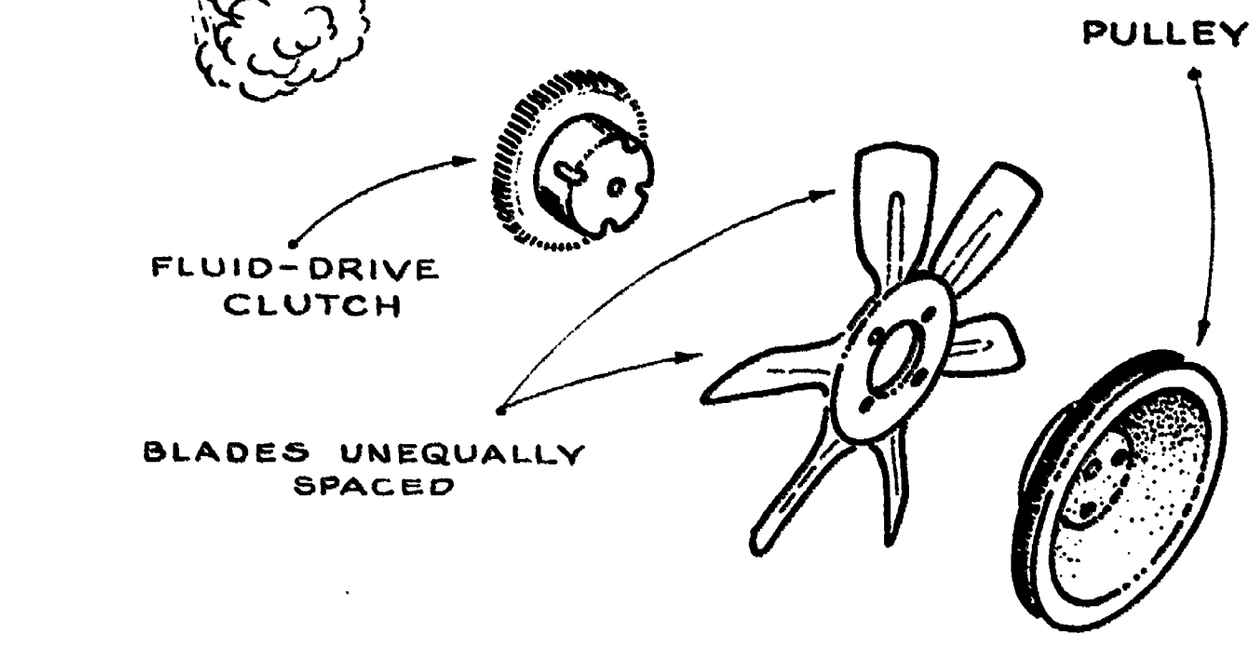
   c. Fluid drive clutch
      -- Variable speed - forward motion of vehicle increases air flow volume which requires less air flow production by fan

      -- Saves engine horsepower

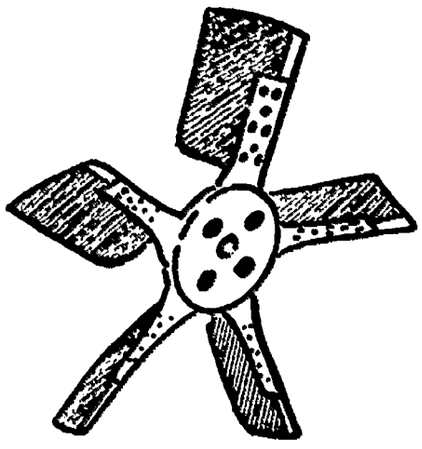
   d. Four-bladed
      -- Widely used in passenger cars

   e. Six-bladed
      -- Many V-8 engines
      -- Sometimes blades unequally spaced to minimize vibration

Cooling System Fans



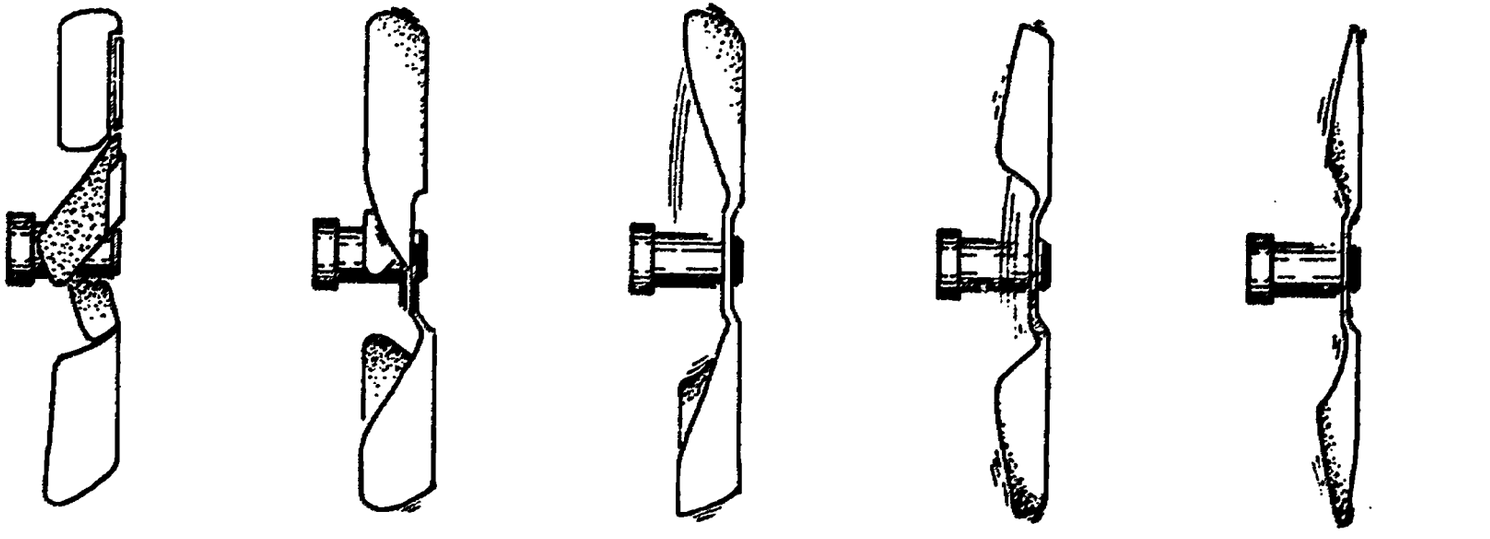
SIX BLADED FAN



BLADE PITCH DECREASES AS SPEED INCREASES

FLEX-BLADE FAN

FAN SPEED



0 RPM 500 RPM 1,500 RPM 2,500 RPM 3,000 RPM

OPERATION

Block: Cooling System

Operation: Removing and Replacing Fans

Block VI
Job
Operation

Teaching Objective: To teach the students to remove and replace fans

Tools: Combination wrench (7/16", 1/2")

Materials: Wipe cloths

Teaching Aids: Automobile or engine on stand

Reference: Vehicle Service Manual, Manufacturer

Steps:

1. Refer to operation sheet removing and replacing fan belt, page VI-50

   Note: Protect radiator fins and cores from being damaged by tool usage

2. Remove bolts from fan

3. Lift fan from hub

4. Reverse steps for replacing

   Note: When working with thermostatic fan clutches, care must be exercised to prevent leakage of silicone fluid.

References - Block VI

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